Department of Environmental Conservation

Division of Water

Biological Assessment

Schoharie Creek

1995 Survey

New York State Recycles — Printed on Recycled Paper

New York State Department of Environmental Conservation
GEORGE E. PATAKI, *Governor* MICHAEL D. ZAGATA, *Commissioner*

BIOLOGICAL STREAM ASSESSMENT

Schoharie Creek
Greene County, New York

Survey date: June 28, 1995
Report date: July 28, 1995

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Division of Water
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CONTENTS

Stream: Schoharie Creek, Greene County, New York

Reach: Below Tannersville to below Hunter, New York

Background:

Biological sampling was performed by the Stream Biomonitoring Unit on Schoharie Creek on June 28, 1995. The purpose of the sampling was to assess general water quality, particularly in relation to winter water withdrawals for snowmaking at the Hunter Mountain Ski Area. At each of five sites, three traveling kick samples were taken in riffle areas, as described in Appendix I, with samples being taken midstream and near the north and south banks of the stream. 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, etc.). 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 1 provides a listing of the index values for each sample, and additional listings provide the macroinvertebrate data collected at each site.

Results and Conclusions:

1. Results of the invertebrate sampling do not indicate a community change attributable to the flow diversion. Community indices among all five sites, among the three lateral collections, and compared to 1989 data were very similar, showing no differences longitudinally, laterally, or temporally.

2. These results do not necessarily indicate that no impacts occur during the winter months, but if they do occur, they are short-lived, lasting less than 4-5 months.

Discussion:

The purpose of this biological sampling of Schoharie Creek was to determine if any biological impacts were apparent that were attributable to winter water withdrawals in the Hunter area. Sizeable diversions from the stream are made for snow-making purposes at the Hunter Mountain Ski Area, causing low winter flows downstream of the diversion.

At five sites, located an average of one mile apart (Figure 1), three traveling kick samples were taken across the stream. The flow diversion is located between Stations 5 and 6A. Using community indices, comparisons were made longitudinally downstream and laterally across the stream to determine if any changes in macroinvertebrate communities occur in the study area.

The results presented in Table 1 are the individual and mean values for the five indices prescribed in the New York State biological impairment criteria document (Bode et al., 1990). These results show very similar communities at all five sites sampled in the present survey. Invertebrate communities at all sites were clearly within the non-impacted range, and no criteria were exceeded between sites.

The results of the present sampling were analyzed to determine if any longitudinal, lateral, or temporal differences could be discerned from the data. Figure 2 provides the biological profile of the study area, using the average index values from the three samples at each site. The longitudinal similarity between sites is shown in this figure, showing only very small differences between the sites. Figure 3 gives individual biological profiles for individual kick samples. This shows only slight lateral differences between the north and south sides of the creek. Figure 4 compares biological profile values from 1989 with those from 1995 at the four sites sampled in both studies. The values are very similar from both years, the small differences within the range of expected variability, and showing no temporal differences.

A previous biological sampling was conducted by the Stream Biomonitoring Unit in Schoharie Creek and tributaries in 1989 (Novak et al., 1990). In 1990 an additional sampling was conducted on Shanty Hollow Brook, a tributary in the present study area (Bode et al., 1990a). Four of the five sites sampled in the present survey correspond to locations sampled in the 1989 survey, and the same station numbers are used. Comparing the results obtained at these four sites, indices were very similar in 1989 and 1995. No temporal differences were found in invertebrate communities at these sites.

A primary biological concern in Schoharie Creek is flow reduction caused by heavy water flow diversions for snow-making purposes. The resulting reduction in flow during the winter months could impact stream communities through freezing, and possible formation of anchor ice. A description of anchor ice and its effects on stream organisms is provided in The ecology of running waters (Hynes, 1970). Anchor ice is a type of underwater ice that forms on the surfaces of the stream substrate in shallow water. Reports of minimum air temperatures required for anchor ice formation vary from -15.6 to -23 °C (-4 to -9.4 °F). Anchor ice forms first on the upstream faces of larger stones, and may extend into pools.

Normally anchor ice detaches during the day due to sunlight radiation, and is washed downstream. As it detaches it often scours the stream bottom, and through abrasion may destroy much of the algae and many of the invertebrates associated with the rocks. Scouring also increases the rate of invertebrate catastrophic drift, in which organisms are dislodged and carried downstream, often with a high mortality rate. The daily rhythm of freezing, detaching, and scouring is considered to be the primary mode of action impacting stream populations.

The results of the present sampling do not indicate invertebrate community changes attributable to the flow diversion or anchor ice formation. However, neither can these results be used to show that no impacts occur during the winter months. It is possible that communities downstream of the diversion are affected during the winter months, and the effects are short-lived. If it were assumed that impact occurred through February, this would necessitate a recovery time of approximately four months.

The recovery time required by a stream following the elimination or diminution of a source of impact is controlled by several factors. These include type, severity, and duration of impact, geomorphometry of stream (including flow, current speed, and aeration), and recolonization mechanisms available (downstream drift from upstream or from tributaries, migration from the deeper hyporheic zone, upstream movement, or aerial recruitment by insect adults). The scientific literature on recovery includes recovery times ranging from a few weeks to several decades. The vast majority of these studies were performed on toxic (non-organic) pollutants, and most deal with one-time spills. Data provided by Stream Biomonitoring Unit studies with artificial substrate samplers show that colonization of barren substrates takes place in five weeks, assuming recruitment is available from immediately upstream. If a long reach is impacted, the five week estimate would be extended for colonization of downstream portions of the reach.

A consideration of some factors in Schoharie Creek can be used to help estimate probable recovery times for invertebrate communities recovering from anchor ice impact. First, anchor ice would exert an impact with no lingering effects, such as contaminated sediments, so that recovery would begin immediately following cessation of impact. Second, the current speed is relatively high, which would tend to accelerate recovery downstream. Third, the upstream source of organisms is diverse, and would be ample for providing downstream recruitment. These three factors would contribute to a fairly short recovery time from any impacts of anchor ice, and this would be consistent with the lack of impacts found in the present survey.

Literature Cited:

Bode, R.W., M.A. Novak, and L.E. Abele. 1990a. Biological stream assessment, Shanty Hollow Brook, 1990 Survey. New York State Department of Environmental Conservation Technical Report. 17 pages.

Bode, R.W., M.A. Novak, and L.E. Abele. 1990b. Biological impairment criteria for flowing waters in New York State. New York State Department of Environmental Conservation Technical Report. 110 pages.

Bode, R.W., M.A. Novak, and L.E. Abele. 1991. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation Technical Report. 79 pages.

Hynes, H.B.N. 1970. The ecology of running waters. University of Toronto Press. 555 pages.

Novak, M.A., R.W. Bode, and L.E. Abele. 1990. Biological stream assessment, Schoharie Creek, 1989 Survey. New York State Department of Environmental Conservation, Technical Report, 24 pages.

Overview of field data:

On the date of sampling, June 28, 1995, Schoharie Creek at the sites sampled was 12-25 meters wide, 0.1-0.3 meters deep in riffles, and had current speeds of 50-71 cm/sec in riffles. Dissolved oxygen was 8.5-9.3 mg/l, specific conductance was 66-92 μmhos, pH was 7.3-8.6, and the temperature was 17.5-23.8 °C (64-75 °F). Measurements for each site are found on the field data summary sheets.

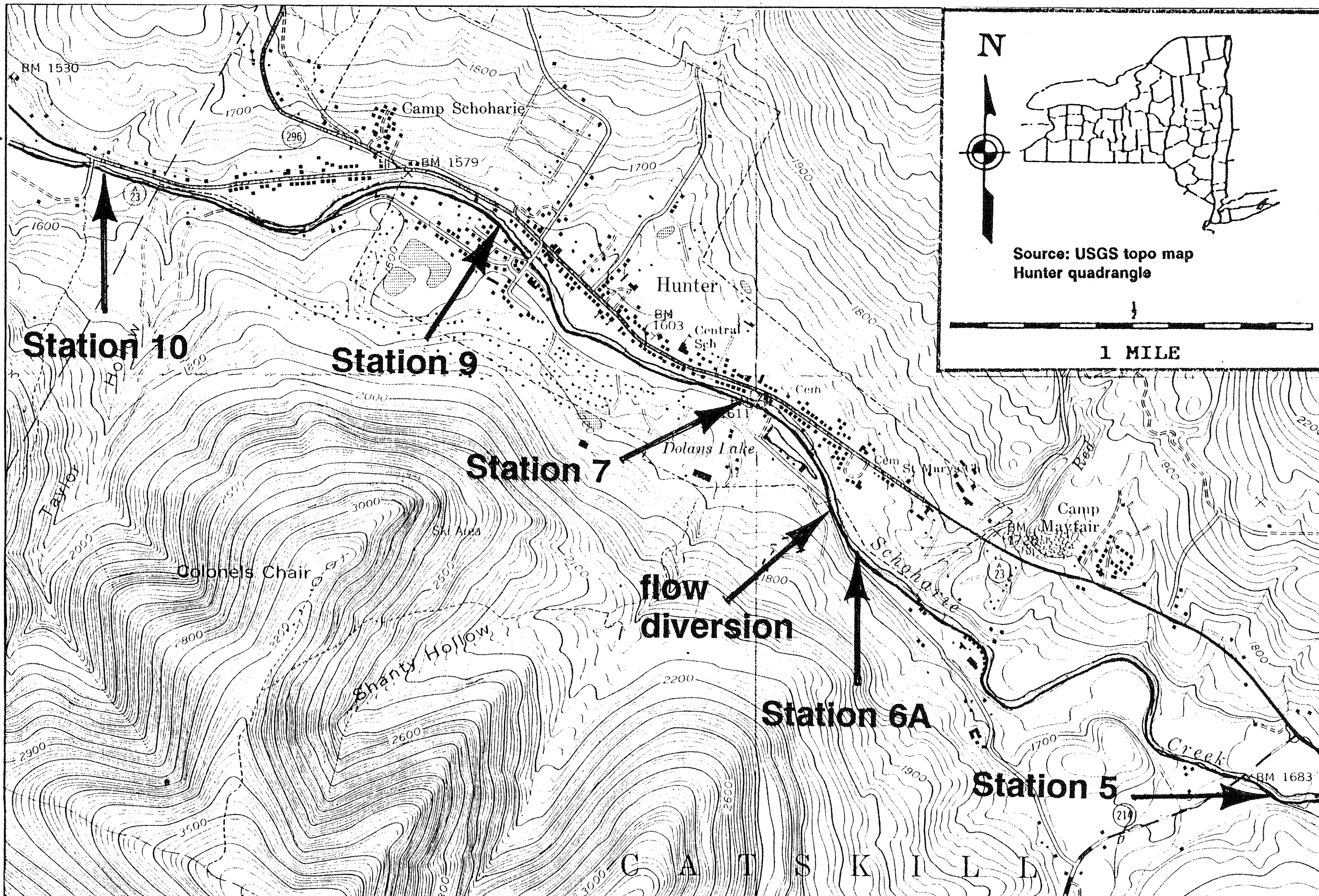


Figure 1	Site location map	Schoharie Creek

Figure 2. Biological Assessment Profile of index values, Schoharie Creek, showing longitudinal water quality trends. Values are plotted on a normalized scale of water quality. SPP= species richness, EPT= EPT value, HBI= Hilsenhoff Biotic Index, PMA= Percent Model Affinity. See Appendix IV for more complete explanation of profile calculation.

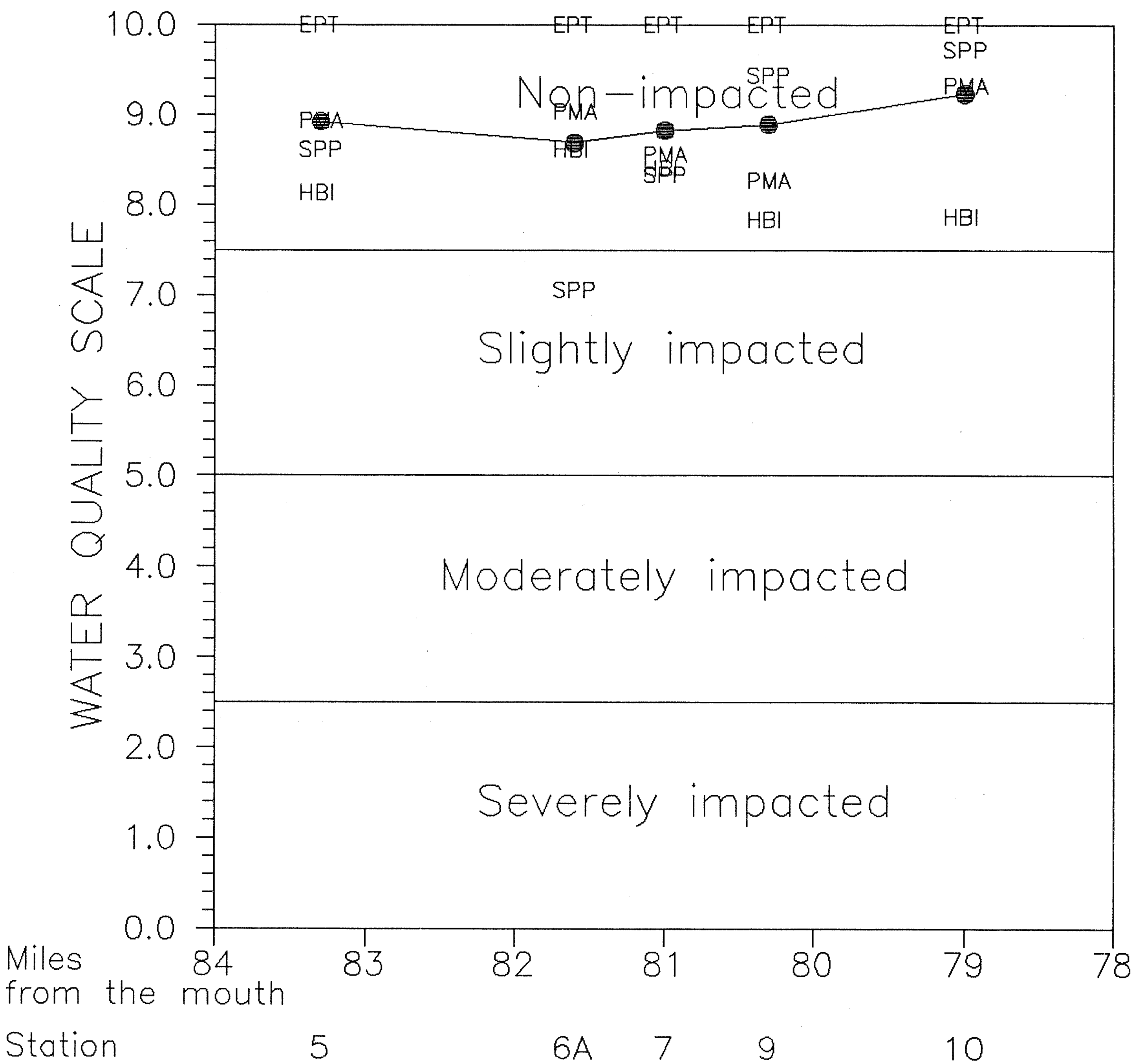


Figure 3. Biological Assessment Profile of index values, Schoharie Creek, showing lateral water quality trends. Values represent the normalized mean of four water quality indices for each sample, plotted on a scale of water quality. See Appendix IV for more complete explanation of profile calculation.

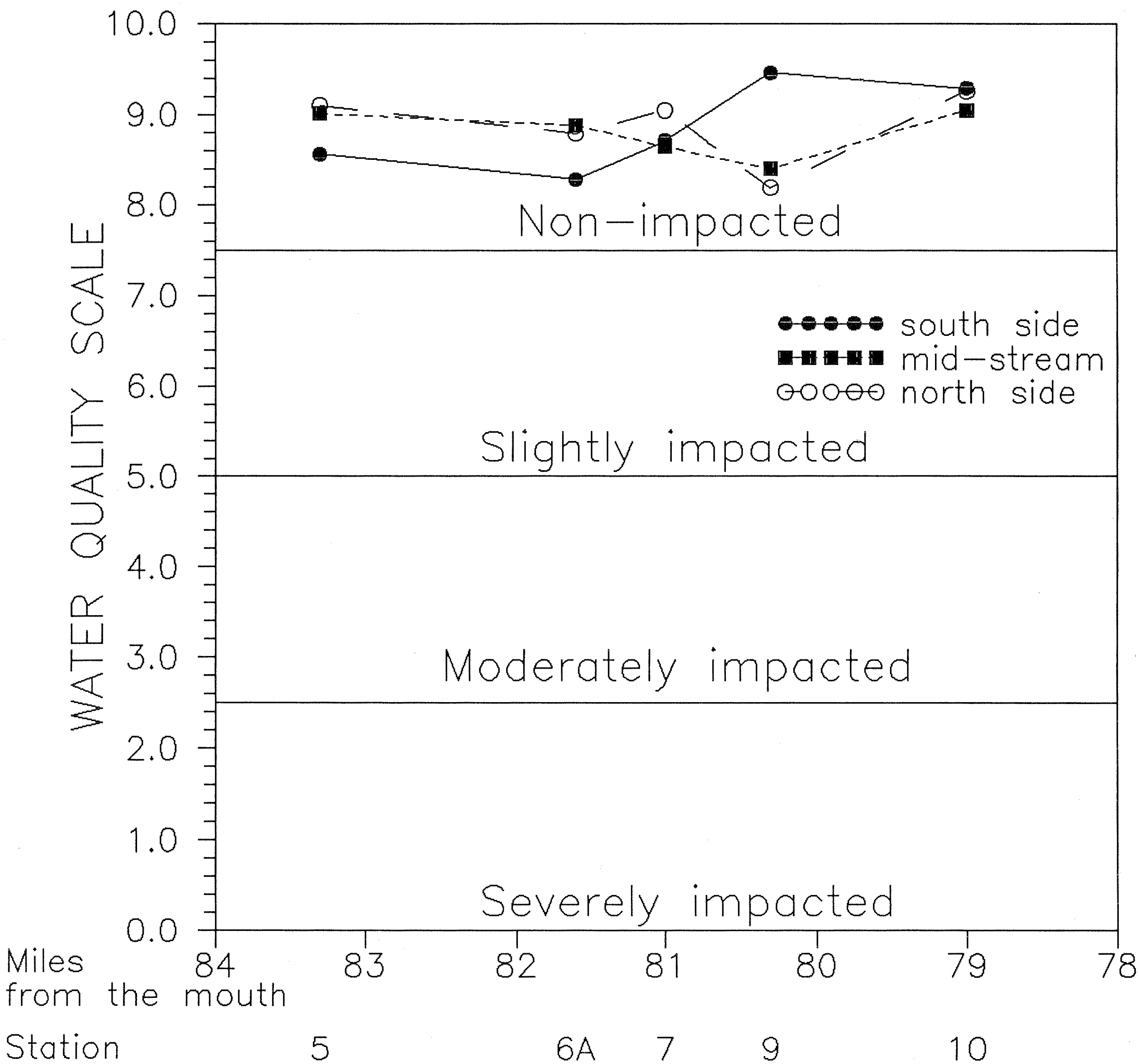


Figure 4. Biological Assessment Profile of index values, Schoharie Creek, showing temporal water quality trends between 1989 and 1995. Values represent the normalized mean of four water quality indices for each site, plotted on a scale of water quality. See Appendix IV for more complete explanation of profile calculation.

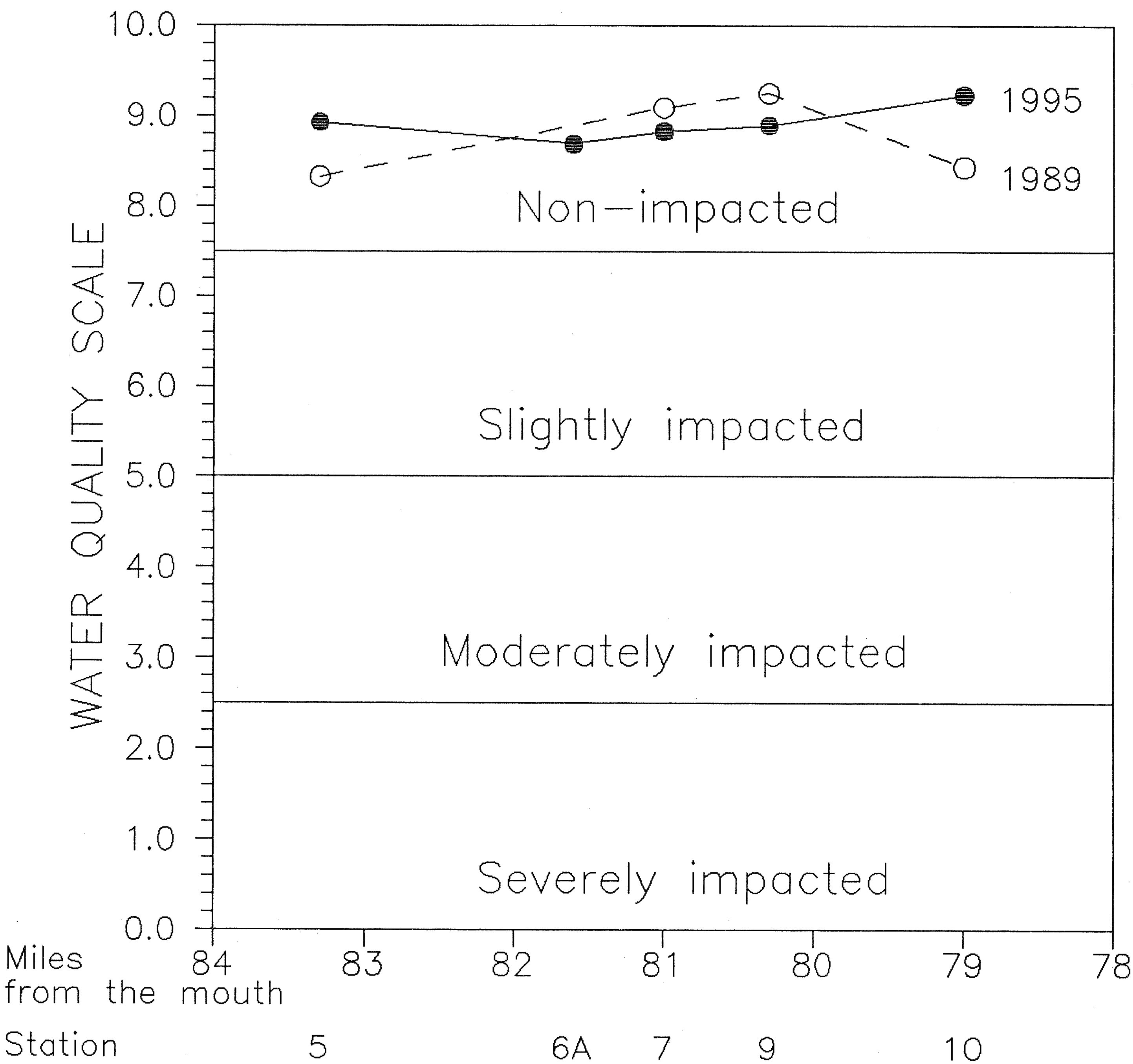


TABLE 1. SUMMARY OF INDEX VALUES, SCHOHARIE CREEK KICK SAMPLES.

		STATION				
		5	6a	7	9	10
Species richness	A	27	21	26	36	34
	B	30	27	29	28	33
	C	32	27	33	34	34
	MEAN	30	25	29	33	34
Biotic index	A	3.82	2.82	3.36	3.57	4.09
	B	3.69	3.69	3.92	3.82	4.10
	C	4.11	3.65	3.52	5.09	4.19
	MEAN	3.87	3.39	3.60	4.16	4.13
EPT richness	A	15	14	14	18	18
	B	15	18	15	13	16
	C	17	16	19	14	17
	MEAN	16	16	16	15	17
Percent model affinity	A	72	75	83	84	85
	B	81	84	71	73	78
	C	83	80	72	60	85
	MEAN	79	80	75	72	83
Species dominance	A	13	26	15	13	13
	B	12	17	14	14	13
	C	9	13	13	19	13
	MEAN	11	19	13	15	13

TABLE 2. Station locations for Schoharie Creek, Greene County. (See map)

STATION	LOCATION
05	above Hunter 100 m above Rte. 214 bridge 83.3 miles from the mouth Latitude/Longitude: 42 11 31; 74 10 55
06A	above Hunter 200 m above Hunter Mt. water diversion 81.6 miles from the mouth Latitude/Longitude: 42 12 04; 74 12 09
07	Hunter 80 m below Rte. 83 bridge 81.0 miles from the mouth Latitude/Longitude: 42 12 27; 74 12 31
09	Hunter 100 m below Bridge St. bridge 80.3 miles from the mouth Latitude/Longitude: 42 12 48; 74 13 14
10	below Hunter 100 m above Deming Rd. bridge 79.0 miles from the mouth Latitude/Longitude: 42 12 59; 74 14 34

TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN SCHOHARIE CREEK, GREEN COUNTY, NEW YORK, JUNE 28, 1995.

PLATYHELMINTHES
- TURBELLARIA
    - Undetermined Turbellaria

NEMERTEA
- Prostoma graecense (=rubrum)

ANNELIDA
- OLIGOCHAETA
    - Lumbriculidae
        - Undetermined Lumbriculidae
    - Naididae
        - Nais behningi
        - Nais communis
- BRANCHIOBDELLIDA
    - Branchiobdellidae
        - Undetermined Branchiobdellidae

ARTHROPODA
- INSECTA
    - EPHEMEROPTERA
        - Isonychiidae
            - Isonychia bicolor
            - Isonychia obscura
        - Baetidae
            - Acentrella sp.
            - Baetis flavistriga
            - Baetis tricaudatus
            - Baetis sp.
        - Heptageniidae
            - Epeorus (Iron) sp.
            - Heptagenia sp.
            - Nixe (Nixe) sp.
            - Stenonema modestum
            - Stenonema sp.
            - Undetermined Heptageniidae
        - Leptophlebiidae
            - Paraleptophlebia mollis
            - Paraleptophlebia sp.
        - Ephemerellidae
            - Drunella cornutella
            - Serratella deficiens
            - Serratella sp.
            - Undetermined Ephemerellidae
        - Caenidae
            - Caenis sp.
    - ODONATA
        - Gomphidae
            - Gomphus sp.
            - Undetermined Gomphidae
    - PLECOPTERA
        - Leuctridae
            - Leuctra sp.
        - Perlidae
            - Agnetina capitata
            - Neoperla sp.
            - Paragnetina immarginata
            - Paragnetina media
            - Undetermined Perlidae
    - COLEOPTERA
        - Psephenidae
            - Psephenus sp.
        - Elmidae
            - Optioservus trivittatus
            - Stenelmis cheryl
    - TRICHOPTERA
        - Philopotamidae
            - Dolophilodes sp.
        - Psychomyiidae
            - Psychomyia flavida
        - Polycentropodidae
            - Polycentropus sp.
        - Hydropsychidae
            - Cheumatopsyche sp.
            - Hydropsyche bronta
            - Hydropsyche morosa
            - Hydropsyche slossonae
        - Rhyacophilidae
            - Rhyacophila fuscula
        - Glossosomatidae
            - Glossosoma sp.
        - Hydroptilidae
            - Ithytrichia sp.
        - Helicopsychidae
            - Helicopsyche borealis
        - Leptoceridae
            - Ceraclea sp.
    - DIPTERA
        - Tipulidae
            - Antocha sp.
            - Dicranota sp.
            - Hexatoma sp.
        - Ceratopogonidae
            - Undetermined Ceratopogonidae
        - Rhagionidae
            - Atherix sp.
        - Empididae
            - Hemerodromia sp.
        - Chironomidae
            - Tanypodinae
                - Nilotanypus fimbriatus
                - Telopelopia okoboji
                - Thienemannimyia gr. spp.
            - Diamesinae
                - Pagastia sp. A
            - Orthocladiinae
                - Cardiocladius obscurus
                - Cricotopus bicinctus
                - Cricotopus reversus gr.
                - Cricotopus tremulus gr.
                - Eukiefferiella pseudomontana gr.
                - Orthocladius (Symposiocladius) lignicola
                - Paracricotopus sp.
                - Synorthocladius nr. semivirens
                - Tvetenia vitracies

TABLE 3 (continued). MACROINVERTEBRATE SPECIES COLLECTED IN SCHOHARIE CREEK, GREEN COUNTY, NEW YORK, JUNE 28, 1995.

Chironominae
- Chironomini
  - Microtendipes rydalensis gr.
  - Microtendipes pedellus gr.
  - Phaenopsectra dyari?
  - Polypedilum aviceps
  - Polypedilum convictum
- Tanytarsini
  - Cladotanytarsus nr. dispersopilosus
  - Micropsectra nr. deflecta
  - Micropsectra sp.
  - Rheotanytarsus distinctissimus gr.
  - Rheotanytarsus exiguus gr.
  - Sublettea coffmani
  - Tanytarsus glabrescens gr.
  - Tanytarsus guerlus gr.

STREAM SIRE:

STREAM SITE:	Schoharie Creek, Station 5				
LOCATION:	Below Tannersville, Route 214				
DATE:	28 June 1995				
SAMPLE TYPE:	Kick sample				
SUBSAMPLE:	100 individuals				
			A	B	C
PLATYHELMINTHES	Turbellaria	Undetermined Turbellaria	.	.	2
ANNELIDA					
BRANCHIOBDELLIDA					
	Branchiobdellidae	Undet. Branchiobdellidae	.	.	3
ARTHROPODA					
INSECTA					
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	2	.	2
		Isonychia obscura	.	.	1
	Baetidae	Acentrella sp.	8	2	1
		Baetis flavistriga	.	3	.
		Baetis tricaudatus	2	3	.
		Baetis sp.	.	.	4
	Heptageniidae	Epeorus sp.	6	1	.
		Nixe (Nixe) sp.	6	7	7
		Stenonema sp.	.	1	.
	Leptophlebiidae	Paraleptophlebia mollis	3	6	9
	Ephemerellidae	Drunella cornutella	12	12	8
		Serratella deficiens	2	.	1
		Serratella sp.	3	7	1
ODONATA	Gomphidae	Gomphus sp.	.	1	1
PLECOPTERA	Leuctridae	Leuctra sp.	.	1	1
	Perlidae	Neoperla sp.	.	1	.
		Undetermined Perlidae	.	.	1
COLEOPTERA	Psephenidae	Psephenus sp.	.	1	1
	Elmidae	Stenelmis cheryl	1	6	8
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	3	4	4
	Polycentropodidae	Polycentropus sp.	3	3	4
	Hydropsychidae	Cheumatopsyche sp.	2	3	2
		Hydropsyche morosa	5	.	4
		Hydropsyche slossonae	5	1	2
	Rhyacophilidae	Rhyacophila fuscula	.	.	1
	Helicopsychidae	Helicopsyche borealis	1	.	.
DIPTERA	Tipulidae	Antocha sp.	1	.	.
		Dicranota sp.	.	.	2
		Hexatoma sp.	.	1	.
	Chironomidae	Telopelopia sp.	.	1	.
		Thienemannimyia gr. spp.	.	1	2
		Pagastia sp. A	1	1	.
		Cricotopus bicinctus	.	.	1
		Cricotopus reversus gr.	3	1	3
		Cricotopus tremulus gr.	1	1	1
		Eukiefferiella pseudomontana	2	.	3
		Tvetenia vitracies	1	3	.
		Microtendipes pedellus gr.	4	9	6
		Microtendipes rydalensis gr.	1	11	5

Schoharie Creek Station 5, continued

	Polypedilum aviceps	13	5	4
	Micropsectra spp.	8	2	5
	Rheotanytarsus exiguus gr.	.	1	.
	Tanytarsus glabrescens gr.	1	.	.
SPECIES RICHNESS		27	30	32
BIOTIC INDEX		3.82	3.69	3.65
EPT RICHNESS		15	15	17
MODEL AFFINITY		72	81	83
SPECIES DOMINANCE		13	12	9

DESCRIPTION Sampling was conducted 100 meters upstream of the Route 214 bridge. A high diversity of invertebrates was found, including many mayflies, stoneflies, and caddisflies. Water quality was assessed as non-impacted, and the fauna compared well to previous collections at this site.

STREAM SITE:	Schoharie Creek, Station 6A
LOCATION:	Above Hunter, above diversion, off Riverside Drive
DATE:	28 June 1995
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

			A	B	C
ANNELIDA					
BRANCHIOBDELLIDA					
	Branchiobdellidae	Undet. Branchiobdellidae	.	4	.
ARTHROPODA					
INSECTA					
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	1	1	.
		Isonychia obscura	.	1	1
	Baetidae	Acentrella sp.	4	3	6
		Baetis tricaudatus	.	4	.
		Baetis sp.	2	.	4
	Heptageniidae	Epeorus sp.	3	1	1
		Heptagenia sp.	.	1	.
		Nixe (Nixe) sp.	26	16	13
		Stenonema modestum	.	.	1
	Leptophlebiidae	Paraleptophlebia mollis	7	5	7
	Ephemerellidae	Drunella cornutella	7	9	8
		Serratella deficiens	1	1	1
		Serratella sp.	.	.	3
		Undetermined Ephemerellidae	.	1	.
ODONATA	Gomphidae	Undetermined Gomphidae	.	.	1
PLECOPTERA	Leuctridae	Leuctra sp.	.	1	.
	Perlidae	Neoperla sp.	1	2	2
COLEOPTERA	Psephenidae	Psephenus sp.	.	2	2
	Elmidae	Optioservus trivittatus	.	.	1
		Stenelmis cheryl	6	2	2
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	13	4	3
	Polycentropodidae	Polycentropus sp.	.	3	8
	Hydropsychidae	Cheumatopsyche sp.	5	1	5
		Hydropsyche morosa	3	3	4
		Hydropsyche slossonae	2	.	4
	Glossosomatidae	Glossosoma sp.	.	1	.
	Lepidostomatidae	Ceraclea sp.	1	.	.
DIPTERA	Tipulidae	Hexatoma sp.	1	3	2
	Chironomidae	Thienemannimyia gr. spp.	1	.	.
		Pagastia sp. A	.	.	1
		Cricotopus reversus gr.	.	1	2
		Tvetenia vitracies	1	.	.
		Microtendipes pedellus gr.	2	7	3
		Microtendipes rydalensis gr.	.	4	2
		Polypedilum aviceps	12	17	12
		Micropsectra spp.	1	2	1

Schoharie Creek Station 6A, continued

SPECIES RICHNESS	21	27	27
BIOTIC INDEX	2.82	3.69	3.65
EPT RICHNESS	14	18	16
MODEL AFFINITY	75	84	80
SPECIES DOMINANCE	26	17	13

DESCRIPTION Sampling was conducted about 200 meters upstream of the diversion of stream water to Dolans Lake. The invertebrate fauna was similar to that at Station 5, and included many mayflies, stoneflies, and caddisflies. Water quality was assessed as non-impacted.

STREAM SITE: Schoharie Creek, Station 7
LOCATION: In Hunter, below Route 83 bridge
DATE: 28 June 1995
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

			A	B	C
PLATYHELMINTHES	Turbellaria	Undetermined Turbellaria	.	1	.
ANNELIDA					
OLIGOCHAETA	Naididae	Nais behningi	1	2	1
BRANCHIODELLIDA					
	Branchiobdellidae	Undet. Branchiobdellidae	.	2	.
ARTHROPODA					
INSECTA					
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	.	1	1
	Baetidae	Acentrella sp.	1	3	3
		Baetis flavistriga	1	.	.
		Baetis sp.	.	1	2
	Heptageniidae	Epeorus sp.	1	1	2
		Nixe (Nixe) sp.	15	3	2
	Leptophlebiidae	Paraleptophlebia mollis	10	10	3
		Paraleptophlebia sp.	.	3	8
	Ephemerellidae	Drunella cornutella	12	2	8
		Serratella sp.	5	2	2
ODONATA	Gomphidae	Undetermined Gomphidae	3	.	3
PLECOPTERA	Leuctridae	Leuctra sp.	.	1	2
	Perlidae	Agnetina capitata	2	.	.
		Paragnetina immarginata	.	.	1
		Paragnetina media	.	.	4
COLEOPTERA	Psephenidae	Psephenus sp.	1	.	1
	Elmidae	Stenelmis cheryl	6	6	.
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	3	14	4
	Psychomyiidae	Psychomyia flavida	.	.	1
	Polycentropodidae	Polycentropus sp.	7	2	2
	Hydropsychidae	Cheumatopsyche sp.	3	2	3
		Hydropsyche morosa	4	5	2
		Hydropsyche slossonae	3	2	13
	Rhyacophilidae	Rhyacophila fuscula	1	.	.
	Lepidostomatidae	Helicopsyche borealis	.	.	1
DIPTERA	Tipulidae	Dicranota sp.	.	.	1
		Hexatoma sp.	.	1	.
	Ceratopogonidae	Undetermined Ceratopogonidae	.	1	.
	Rhagionidae	Atherix sp.	.	1	.
	Chironomidae	Thienemannimyia gr. spp.	1	.	1
		Pagastia sp. A	.	.	1
		Cardiocladius obscurus	1	.	.
		Cricotopus bicinctus	.	.	3
		Cricotopus reversus gr.	3	3	3
		Cricotopus tremulus gr.	.	1	.
		Synorthocladius nr. semivirens	.	.	1
		Microtendipes pedellus gr.	6	9	8
		Microtendipes rydalensis gr.	4	4	.
		Polypedilum aviceps	4	7	4

Schoharie Creek Station 7, continued

Cladotanytarsus nr. disperso.	.	.	1
Micropsectra spp.	1	9	5
Rheotanytarsus exiguus gr.	1	.	.
Sublettea coffmani	.	.	3
Tanytarsus glabrescens gr.	.	1	.

SPECIES RICHNESS	26	29	33
BIOTIC INDEX	3.36	3.92	3.52
EPT RICHNESS	14	15	19
MODEL AFFINITY	83	71	72
SPECIES DOMINANCE	15	14	13

DESCRIPTION The samples were taken downstream of the Route 83 bridge (bridge to Hunter Mt. ski area) but upstream of the entrance of the tributary Shanty Hollow. The habitat was similar to that of upstream sites, and the invertebrate fauna also appeared similar. Many trout were seen at this site.

STREAM SITE: Schoharie Creek, Station 9
LOCATION: In Hunter, below Bridge Street bridge
DATE: 28 June 1995
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

			A	B	C
PLATYHELMINTHES	Turbellaria	Undetermined Turbellaria	.	2	.
NEMERTEA	Prostomatidae	Prostoma gracense	.	2	.
ANNELIDA					
OLIGOCHAETA	Lumbriculidae	Undetermined Lumbriculidae	.	1	1
	Naididae	Nais behningi	4	14	2
		Nais communis	.	.	2
BRANCHIOBDELLIDA					
	Branchiobdellidae	Undet. Branchiobdellidae	.	1	.
ARTHROPODA					
INSECTA					
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	1	.	2
	Baetidae	Acentrella sp.	4	1	.
		Baetis sp.	1	1	.
	Heptageniidae	Nixe (Nixe) sp.	12	3	1
		Undetermined Heptageniidae	.	3	3
	Leptophlebiidae	Paraleptophlebia mollis	1	6	1
		Paraleptophlebia sp.	2	.	5
	Ephemerellidae	Drunella cornutella	13	10	4
		Serratella deficiens	1	4	.
		Serratella sp.	3	2	.
	Caenidae	Caenis sp.	2	1	3
ODONATA	Gomphidae	Undetermined Gomphidae	2	1	2
PLECOPTERA	Leuctridae	Leuctra sp.	1	.	.
	Perlidae	Paragnetina immarginata	1	.	.
COLEOPTERA	Psephenidae	Psephenus sp.	1	.	2
	Elmidae	Stenelmis cheryl	7	3	.
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	4	9	1
	Polycentropodidae	Polycentropus sp.	6	.	3
	Hydropsychidae	Cheumatopsyche sp.	2	6	3
		Hydropsyche bronta	1	3	.
		Hydropsyche morosa	3	.	1
		Hydropsyche slossonae	7	6	10
	Hydroptilidae	Ithytrichia sp.	3	.	1
DIPTERA	Tipulidae	Hexatoma sp.	1	2	1
	Rhagionidae	Atherix sp.	5	4	.
	Empididae	Hemerodromia sp.	.	1	.
	Chironomidae	Nilotanypus fimbriatus	1	.	.
		Thienemannimyia gr. spp.	1	.	2
		Pagastia sp. A	1	.	.
		Cardiocladius obscurus	1	2	1
		Cricotopus bicinctus	1	.	2
		Cricotopus reversus gr.	1	.	3
		Cricotopus tremulus gr.	.	.	1
		Eukiefferiella pseudomonatana	1	2	1
		Microtendipes pedellus gr.	1	.	19

Schoharie Creek Station 9, continued

Microtendipes rydalensis gr.	2	5	1
Phaenopsectra dyari	1	.	3
Polypedilum aviceps	.	2	2
Micropsectra spp.	1	3	13
Micropsectra nr. deflecta	.	.	1
Rheotanytarsus distinctissimus	1	.	.
Tanytarsus glabrescens gr.	.	.	1
Tanytarsus guerlus gr.	.	.	1

SPECIES RICHNESS	36	28	34
BIOTIC INDEX	3.57	3.82	5.09
EPT RICHNESS	18	13	14
MODEL AFFINITY	84	73	60
SPECIES DOMINANCE	13	14	19

DESCRIPTION Sampling was conducted approximately 100 meters downstream of the Bridge Street bridge. The stream above here included large pooled areas and mostly bedrock stream bottom. The samples taken at this site were field-assessed as having fewer invertebrates, especially fewer mayflies and stoneflies. Many trout were seen at this site.

STREAM SITE: Schoharie Creek, Station 10
LOCATION: Below Hunter, above Deming Road bridge
DATE: 28 June 1995
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

			A	B	C
PLATYHELMINTHES	Turbellaria	Undetermined Turbellaria	.	.	1
NEMERTEA	Prostomatidae	Prostoma gracense	1	.	.
ANNELIDA					
OLIGOCHAETA	Lumbriculidae	Undetermined Lumbriculidae	1	1	1
	Naididae	Nais behningi	3	1	3
BRANCHIOBDELLIDA					
	Branchiobdellidae	Undet. Branchiobdellidae	.	1	.
ARTHROPODA					
INSECTA					
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	4	9	1
		Isonychia obscura	.	1	.
	Baetidae	Acentrella sp.	3	2	1
		Baetis sp.	1	3	.
	Heptageniidae	Epeorus sp.	.	1	.
		Nixe (Nixe) sp.	8	.	5
		Undetermined Heptageniidae	5	2	4
	Leptophlebiidae	Paraleptophlebia mollis	2	5	4
		Paraleptophlebia sp.	3	4	9
	Ephemerellidae	Drunella cornutella	8	3	3
		Serratella deficiens	.	.	1
		Serratella sp.	.	.	2
		Undetermined Ephemerellidae	1	.	.
	Caenidae	Caenis sp.	1	.	6
ODONATA	Gomphidae	Undetermined Gomphidae	1	2	3
PLECOPTERA	Perlidae	Agnetina capitata	1	.	.
		Paragnetina media	.	.	1
COLEOPTERA	Psephenidae	Psephenus sp.	2	2	2
	Elmidae	Optioservus trivittatus	.	1	.
		Stenelmis cheryl	13	13	5
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	2	5	3
	Polycentropodidae	Polycentropus sp.	1	1	1
	Hydropsychidae	Cheumatopsyche sp.	3	3	.
		Hydropsyche bronta	3	6	13
		Hydropsyche morosa	6	5	1
		Hydropsyche slossonae	1	1	1
	Hydroptilidae	Ithytrichia sp.	4	5	4
DIPTERA	Tipulidae	Antocha sp.	1	.	.
		Hexatoma sp.	.	1	2
	Rhagionidae	Atherix sp.	.	2	1
	Empididae	Hemerodromia sp.	2	.	.
	Chironomidae	Thienemannimyia gr. spp.	1	1	1
		Pagastia sp. A	1	.	1
		Cardiocladius obscurus	.	1	.
		Cricotopus bicinctus	1	.	.
		Cricotopus reversus gr.	3	1	.

Schoharie Creek Station 10, continued

Cricotopus tremulus gr.	.	.	1
Orthocladius lignicola	.	1	.
Paracricotopus sp.	.	.	1
Microtendipes pedellus gr.	1	3	1
Microtendipes rydalensis gr.	.	.	4
Polypedilum aviceps	7	7	4
Polypedilum convictum	3	.	.
Micropsectra spp.	2	4	8
Rheotanytarsus exiguus gr.	.	2	.
Tanytarsus glabrescens gr.	.	.	1
SPECIES RICHNESS	34	33	34
BIOTIC INDEX	4.09	4.10	4.19
EPT RICHNESS	18	16	17
MODEL AFFINITY	85	78	85
SPECIES DOMINANCE	13	13	13

DESCRIPTION Samples were taken about 100 meters upstream of the bridge. The stream bottom consisted of more rubble and gravel than Station 9, constituting a more favorable habitat for invertebrates. A high diversity of invertebrates was found, including many mayflies, stoneflies, and caddisflies. Water quality was assessed as non-impacted.

FIELD DATA SUMMARY SHEET

STREAM NAME: Schoharie Creek
REACH: above and below Hunter DATE SAMPLED: 06-28-95
FIELD PERSONNEL INVOLVED: Abele, Bode, Novak

STATION ARRIVAL TIME AT STATION LOCATION	05 10:30 Rt. 214 bridge	06A 11:50 above diversion	07 1:15 Rt. 83 bridge	09 1:45 Bridge St bridge
PHYSICAL CHARACTERISTICS				
Width (meters)	12	12	12	15
Depth (meters)	0.2	0.3	0.2	0.2
Current speed (cm per sec)	61	71	53	59
Substrate (%)				
rock (> 10 in. or bedrock)	20	20	20	20
rubble (2.5-10 in.)	30	30	30	30
gravel (0.08-2.5 in.)	30	30	30	30
sand (0.06-2.0 mm)	20	20	10	10
silt (0.004-0.06 mm)			10	10
clay (less than 0.004 mm)				
Embeddedness (%)	20	20	20	20
CHEMICAL MEASUREMENTS				
Temperature (oC)	17.5	19.3	21.2	22.5
Specific conductance (umhos)	66	72	79	87
Dissolved Oxygen (mg per l)	9.3	8.7	8.7	8.5
pH	7.3	7.3	7.4	8.1
BIOLOGICAL ATTRIBUTES				
Canopy (%)	5	5	5	10
Aquatic Vegetation				
algae - water column				
algae - filamentous				
algae - diatoms		present	present	
macrophytes; moss				
Occurrence of Macroinvertebrates				
Chironomidae (midges)		X	X	X
Trichoptera (caddisflies)		X	X	X
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X	X	X	X
Coleoptera (beetles)	X	X	X	X
Oligochaeta (worms)				
Other (**)	X	X	X	X
ESTIMATED BIOMASS	high	high	high	medium
FIELD ESTIMATE OF WATER QUALITY	non	non	non	non
FIELD COMMENTS				

** crayfish, hellgrammites, tipulids, dragonflies

FIELD DATA SUMMARY SHEET				
STREAM NAME: Schoharie Creek REACH: above and below Hunter DATE SAMPLED: 06-28-95 FIELD PERSONNEL INVOLVED: Abele, Bode, Novak				
STATION	10			
ARRIVAL TIME AT STATION	2:20			
LOCATION				
PHYSICAL CHARACTERISTICS				
Width (meters)	25			
Depth (meters)	0.1			
Current speed (cm per sec)	50			
Substrate (%)				
rock (> 10 in. or bedrock)	10			
rubble (2.5-10 in.)	40			
gravel (0.08-2.5 in.)	30			
sand (0.06-2.0 mm)	10			
silt (0.004-0.06 mm)	10			
clay (less than 0.004 mm)				
Embeddedness (%)	20			
CHEMICAL MEASUREMENTS				
Temperature (oC)	23.8			
Specific conductance (umhos)	92			
Dissolved Oxygen (mg per l)	8.5			
pH	8.6			
BIOLOGICAL ATTRIBUTES				
Canopy (%)	10			
Aquatic Vegetation				
algae - water column				
algae - filamentous				
algae - diatoms				
macrophytes; moss				
Occurrence of Macroinvertebrates				
Chironomidae (midges)	X			
Trichoptera (caddisflies)	X			
Ephemeroptera (mayflies)	X			
Plecoptera (stoneflies)	X			
Coleoptera (beetles)	X			
Oligochaeta (worms)				
Other (**)	X			
ESTIMATED BIOMASS	high			
FIELD ESTIMATE OF WATER QUALITY	non			
FIELD COMMENTS				

** crayfish, tipulids, dragonflies

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 to which rose bengal stain has been added.

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 and placed in a petri dish with alcohol. This portion is examined under a dissecting stereomicroscope and 100 organisms are removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. 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.

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 sample is recorded on a data sheet. All organisms from the subsample are archived, either slide-mounted or preserved in alcohol.

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 value. EPT 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. Biotic index. The Hilsenhoff Biotic Index is a measure of the pollution tolerance of the organisms in the sample. 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). Values are listed in Hilsenhoff (1987); additional values are assigned by the NYS Stream Biomonitoring Unit. 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.

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 Technical 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.

1. Non-impacted

Indices reflect excellent water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well-represented; the EPT value is greater than 10. The biotic index value is 4.50 or greater. 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

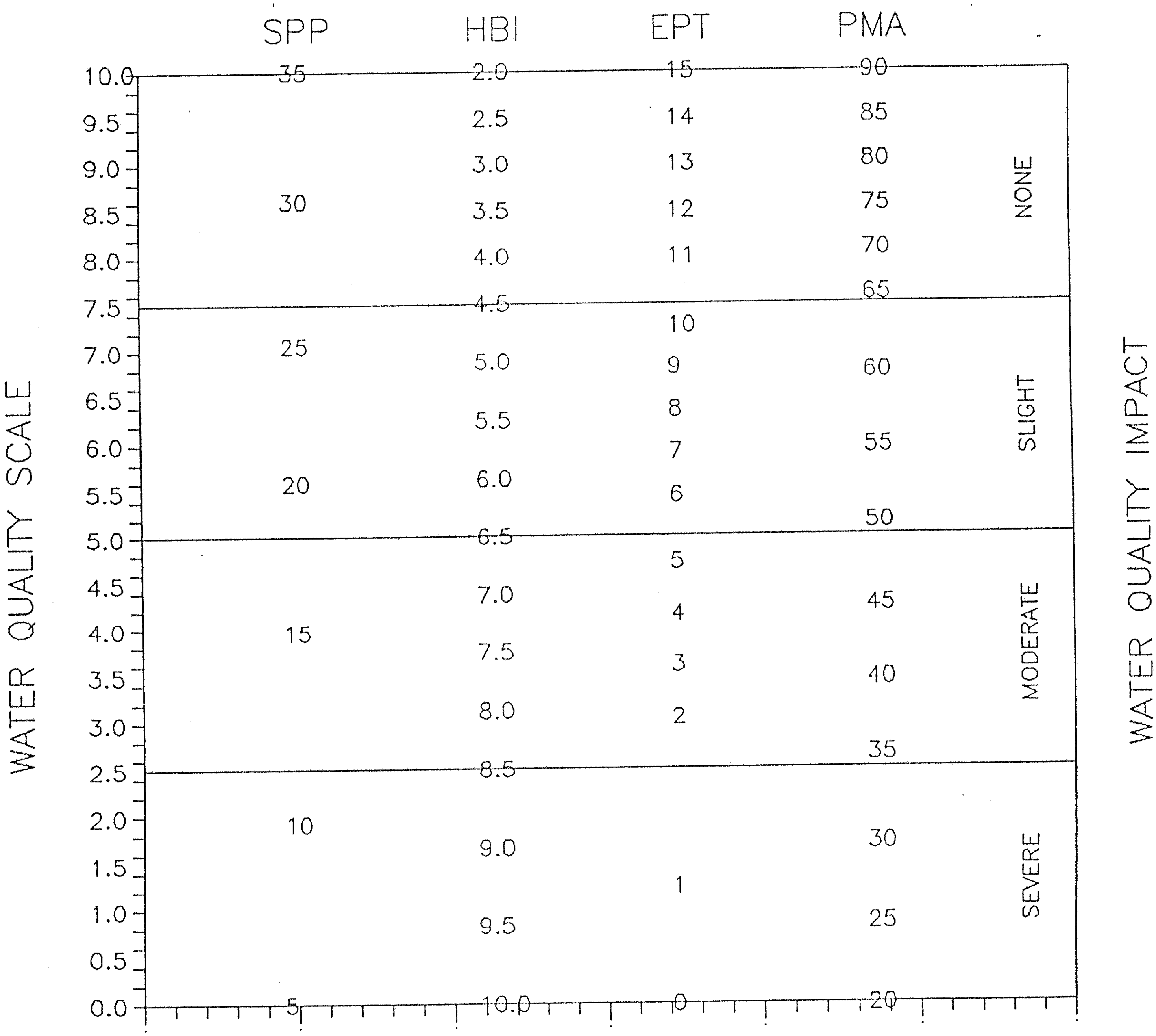
Indices reflect fair water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The percent model affinity value is 35-49. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. Severely impacted

Indices reflect 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 value is 0-1. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

Appendix IV. BIOLOGICAL ASSESSMENT PROFILE OF INDEX VALUES

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



To plot survey data, each site is positioned on the x-axis according to river miles from the mouth, and the scaled values for the four indices are plotted on the common scale. The mean scale value of the four indices is represented by a circle; this value is used for graphing trends between sites, and 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.

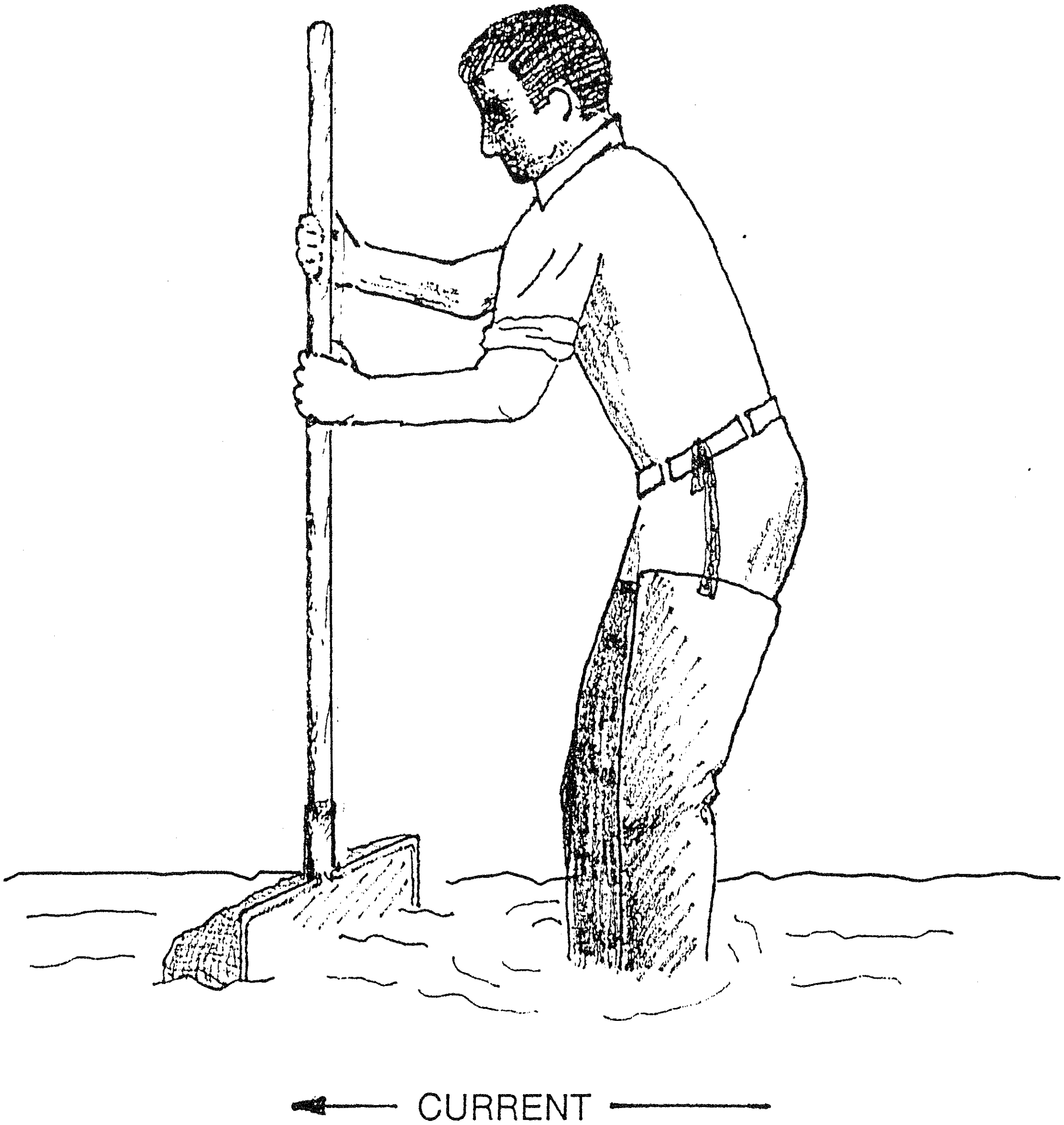
WATER QUALITY ASSESSMENT CRITERIA

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

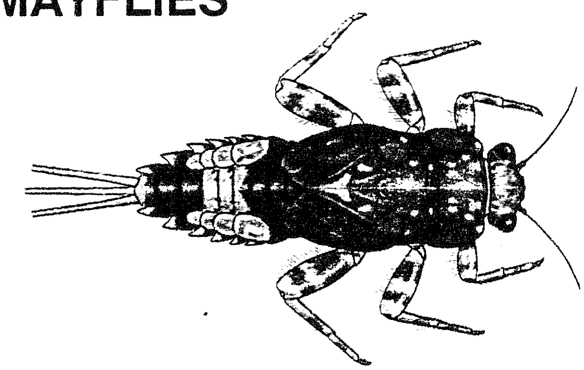


Rocks and sediment in the stream riffle are dislodged by foot upstream of a net; dislodged organisms are carried by the current in the net. Sampling is continued for a specified time, gradually moving downstream to cover a specified distance.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

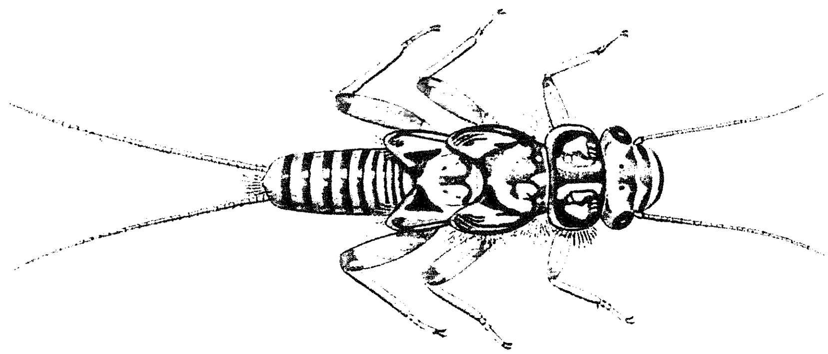
MAYFLIES

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.



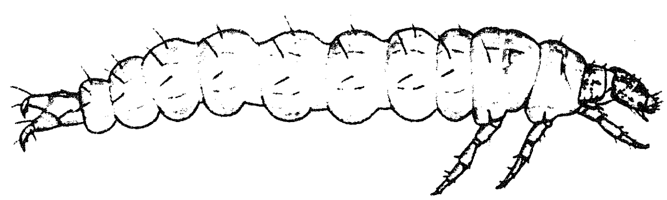
STONEFLIES

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.



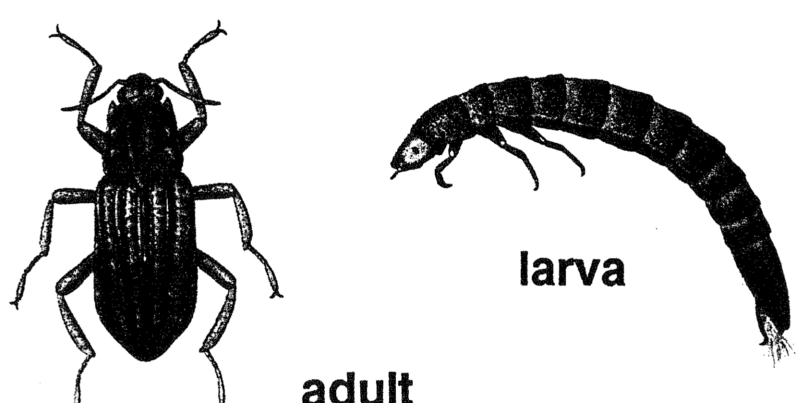
CADDISFLIES

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 recovery zones below sewage discharges.



BEETLES

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.



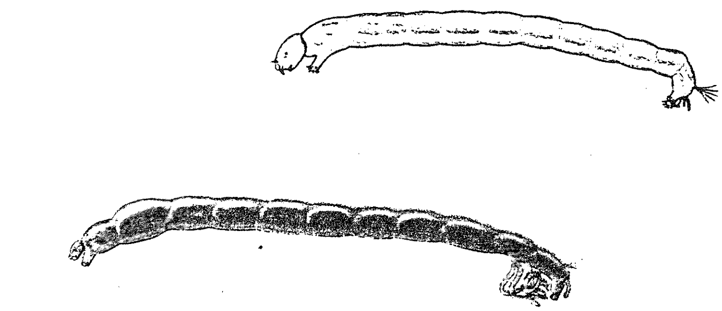
Illustrations by Arwin Provonsha
In McCafferty: Aquatic Entomology

Appendix VII. B.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

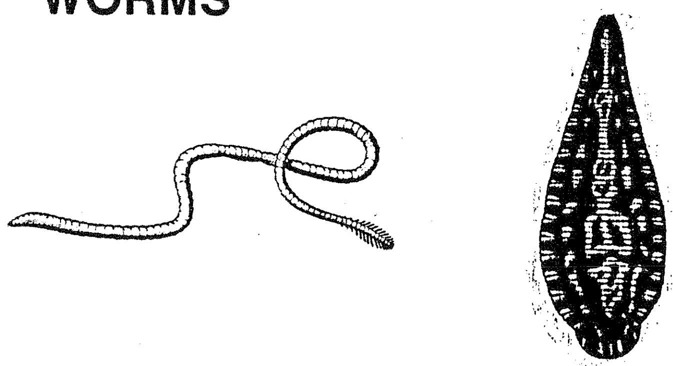
MIDGES

Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution; most of these are red and are called "bloodworms". Other species filter suspended food particles, and are numerous in sewage recovery zones.



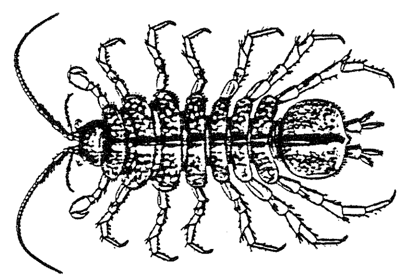
WORMS

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.



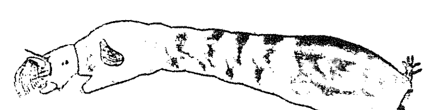
SOWBUGS

Aquatic sowbugs are crustaceans that are often numerous in situations of high organic content and low oxygen levels. When numerous they can indicate a stream segment in the recovery stage of sewage pollution.

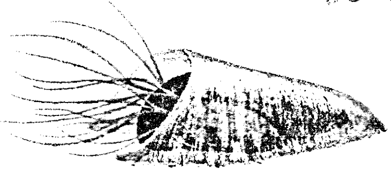


BLACK FLIES

Black fly larvae have specialized antennae for filtering plankton and bacteria from the water, and require a strong current. Some species are numerous in the decomposition and recovery zones of sewage pollution, while others are intolerant of pollutants.



larva



pupa

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.

<u>Concept</u>

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.

<u>Advantages</u>

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, such as 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

<u>Limitations</u>

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