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MS303-1980

Centimeter

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 mm

1 2 3 4 5

Inches

1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0 4.5 5.0

New York State
Department of Environmental Conservation

Division of Water

Batten Kill

Biological Assessment

2001 Survey

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

BIOLOGICAL STREAM ASSESSMENT

Batten Kill
Washington County, New York
and
Bennington County, Vermont

Survey date: September 6, 2001
Report date: July 6, 2002

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CONTENTS

Stream: Batten Kill, Washington County, New York, and Bennington County, Vermont

Reach: Manchester, Vermont to Center Falls, New York

Background:

The Stream Biomonitoring Unit conducted a biological survey of the Batten Kill on September 6, 2001. The purpose of the sampling was to assess general water quality and compare results to previous surveys, in particular the survey conducted by the Unit in 1999. In the report of the 1999 survey, it was recommended that the river be resurveyed in two years to see if the changes seen were still present.

Traveling kick samples were taken in riffle areas at 9 sites on the river, 5 in New York State and 4 in Vermont, 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 ethyl 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 were 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 for each sampling location, which include the raw invertebrate data and descriptions of each site. At the Vermont sites, samples were also taken by Vermont DEC personnel, using Vermont methodology.

Accompanying on the survey were Steve Fiske and Doug Burnham, Vermont Department of Environmental Conservation, Gene Webster, Trout Unlimited, and Kevin Malone, NYSDEC, Division of Water.

Results and Conclusions:

1. Four locations sampled in Vermont, including one directly below the discharge of the Manchester sewage treatment plant, had very good water quality, and were assessed as non-impacted. Side-by-side sampling by Vermont personnel using their sampling and analytical methods produced similar water quality assessments.

2. The five sampling locations in New York were assessed as slightly or non-impacted. However, the resampling reported here, as recommended in the 1999 report, did not clarify the declines in water quality seen from previous years.

3. Gradual changes in the watershed, such as residential and commercial development, may be causing increases in inputs to the river and its tributaries, resulting in small but detectable changes in water quality.

4. It is expected that several locations on the main stem Batten Kill and its tributaries will continue to be sampled as part of DEC's Rotating Intensive Basin Studies (RIBS) ambient water quality monitoring program. These will allow for additional follow-up on trends in the watershed.

Discussion:

In 1999, the Batten Kill and several tributaries were sampled, partly in response to information about a decline in trout populations. The results of the 1999 survey did indicate that water quality, as reflected in the macroinvertebrate communities, was not as high as in previous years (Bode, et. al., 1999). However, stream flow was very low in 1999, and the possibility existed that water quality changes noted were the result of extremely low flows in the months preceding the survey. In the 1999 report, it was recommended that the river be resampled in two years, to determine if the apparent decline was still present or a short-term response to a drought situation. Unfortunately, flows in 2001 were also low, and the results from this present survey have not clarified the results obtained previously.

Since water quality at the Vermont/New York border was assessed as slightly impacted in 1999, in the present survey four locations were sampled in Vermont, including one directly below the discharge of the Manchester sewage treatment plant. These four had very good water quality, and were assessed as non-impacted using New York State methods (Figure 1). Side-by-side sampling with Vermont personnel using their sampling and analytical methods produced similar water quality assessments (Doug Burnham, VT DEC, unpublished data). While there was a sharp dip in the Biological Assessment Profile at the site (VT2A) directly below the treatment plant (Figure 1), the metrics still indicated non-impacted water quality, and returned to above-treatment plant levels downstream approximately 1200 meters at Station VT2. Samples taken previously by Vermont indicated that water chemistry also changed below the discharge, but these changes attenuated quickly downstream (Doug Burnham, VT DEC, unpublished data).

The five sampling locations in New York were assessed as non- or slightly impacted (Figure 1). There were some sites that showed small shifts from the 1999 results (Figure 2), although there does not appear to be a linear pattern to these shifts. The location at the Vermont/New York border (Station AA) was assessed as slightly impacted based on the community collected in 1999, and as non-impacted in 2001. The next three downstream sites (Stations A, B, and 0) were all fairly consistent in both 1999 and 2001 although water quality appears to have declined since 1986. The most downstream location (Station 3: Center Falls) appeared to have water quality that had declined since 1999. Impact source determination (Table 1) indicates that non-point nutrient additions are most likely the cause at the locations where water quality had changed substantially.

Gradual changes in the watershed, such as residential and commercial development, may be causing increases in inputs to the river and its tributaries, resulting in small but detectable declines in water quality. Slight increases in conductance seem to have occurred over the 18 year period for which the Stream Biomonitoring Unit has collected data at various locations from Manchester, Vermont to Clarks Mills, New York (Figure 5). While certain conditions, such as rain preceding sampling, can shift conductance, there are small but detectable increases that seem to be more than equipment variability. These are difficult to attribute to one specific cause, but taken as a pattern over a nearly 20 year period, the conductance increases should be considered to be real and significant. However, these small gradual shifts in water chemistry, and accompanying changes in macroinvertebrate communities and water quality assessments, do not seem to be the same types of acute changes seen in the fish community structures found in both

Vermont and New York fisheries studies (NYS DEC, unpublished data). Macroinvertebrate communities in the Batten Kill remain rich, balanced, and diverse; monitoring of these communities should continue to ensure they remain so.

It is expected that several locations on the main stem Batten Kill and its tributaries will continue to be sampled as part of DEC's RIBS ambient water quality monitoring program. These will allow for additional follow-up on current trends in water quality in the Batten Kill.

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, Albany, NY. NYS DEC Technical Report, 89 pages.

Bode, R.W., M.A. Novak, L.E. Abele, and D. L. Heitzman. 1999. Biological Assessment of the Batten Kill and selected tributaries. New York State Department of Environmental Conservation, Albany, NY. NYS DEC Technical Report, 51 pages.

NYS DEC. 1996. Upper Hudson River Drainage Basin, Biennial Report, 1993 - 1994, Rotating Intensive Basin Studies. New York State Department of Environmental Conservation, Albany, NY. NYS DEC Technical Report, 110 pages plus appendices.

Overview of field data:

On the date of sampling, September 6, 2001, the sites sampled on the Batten Kill were 5 - 70 meters wide, 0.2 - 0.4 meters deep in riffles, and had current speeds of 77 - 125 cm/sec in riffles. Dissolved oxygen was 9.1 - 10.1 mg/l, specific conductance was 295 - 501 µmhos, pH was 7.9 - 8.4, and the temperature was 14.8 - 19.3 °C (59 - 67 °F). Measurements for each site for both the New York and Vermont sites are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Batten Kill, 2001. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.

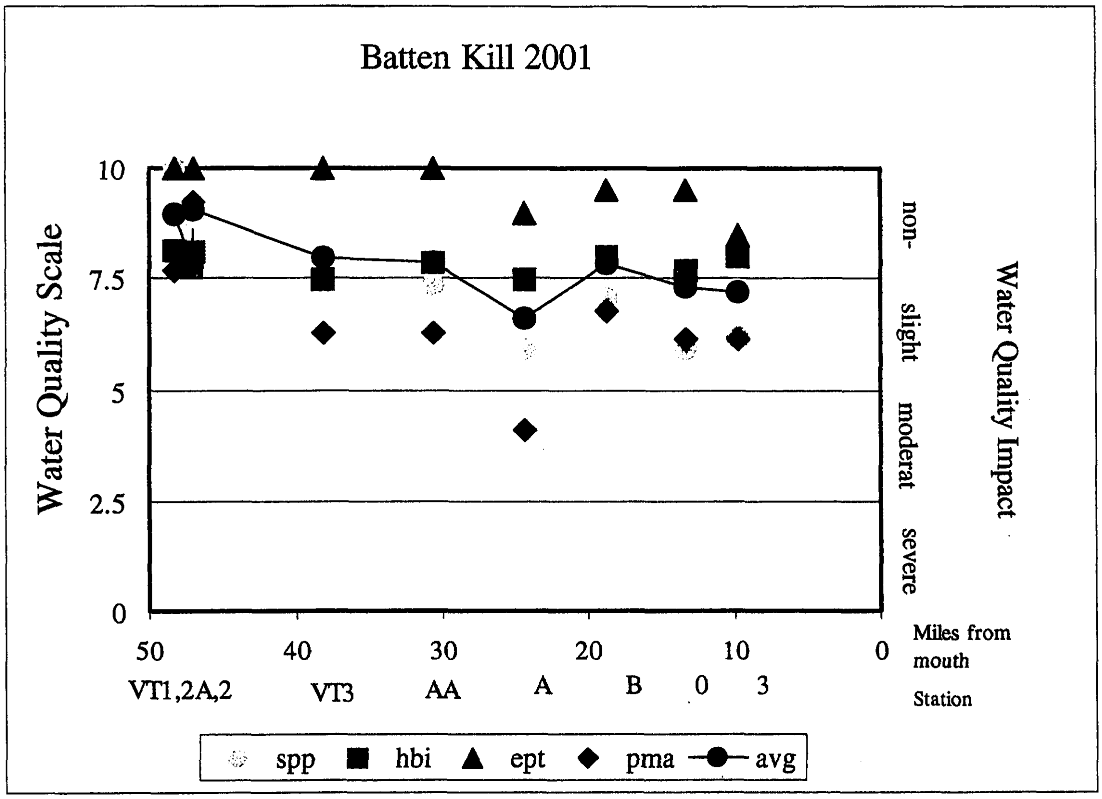


Figure 2. Biological Assessment Profile of index values, Batten Kill, for 2001 and previous years. Values are plotted on a normalized scale of water quality. The lines connect the mean of the four values for each site and year, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. Individual values for 2001 are shown on Figure 1. See Appendix IV for more complete explanation.

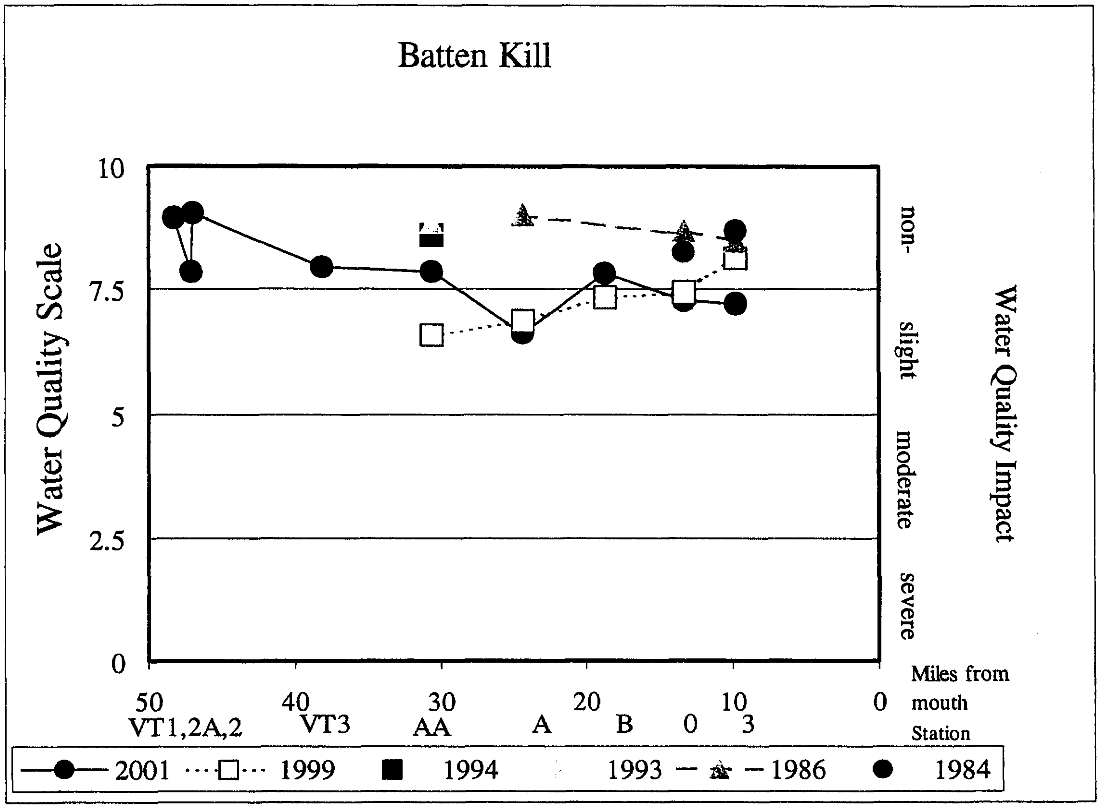


Table 1. Impact Source Determination, Batten Kill, 1999. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. See Appendix X for a more complete explanation of Impact Source Determination.

	STATION								
Community Type	VT 1	VT 2A	VT 2	VT 3	AA	A	B	0	3
Natural: minimal humanmpacts	58	60	67	48	52	45	55	47	54
Nutrient additions; mostly nonpoint, agricultural	57	58	45	55	71	59	60	61	57
Toxic: industrial, municipal, or urban run-off	39	44	34	38	46	37	35	46	41
Organic: sewage effluent, animal wastes	29	32	34	42	36	47	37	47	50
Complex: municipal/industrial	34	30	26	50	47	44	34	52	40
Siltation	40	40	40	38	44	40	45	36	49
Impoundment	41	32	35	49	51	57	54	53	48

TABLE SUMMARY:

Station #	Community Most Characteristic of:
VT1	Natural community with minimal human inputs; inputs are primarily from non-point sources
VT2A	Natural community with minimal human inputs; inputs are primarily from non-point sources
VT2	Natural community
VT3	Non-point and agricultural nutrient additions; possibly complex municipal/industrial effects
AA	Non-point and agricultural nutrient additions; possibly impoundment effects
A	Non-point and agricultural nutrient additions
B	Natural community with minimal human inputs; inputs are primarily from non-point sources
00	Non-point and agricultural nutrient additions
03	Natural community with minimal human inputs; inputs are primarily from non-point sources

TABLE 2. STATION LOCATIONS FOR THE BATTEN KILL, BENNINGTON COUNTY, VERMONT AND WASHINGTON COUNTY, NEW YORK (see map).

STATION	LOCATION
Batten Kill -Vermont	
VT1	Manchester Center 10m below Union St bridge 48.3 river miles above the mouth 43°09'43"; 73°03'22"
VT2A	below Manchester 500 meters below Manchester STP effluent 47.1 river miles above the mouth 43°09'11"; 73°03'20"
VT2	below Manchester off Riverbend Rd; 50 meters above Lye Brook confluence 47.0 river miles above the mouth 43°08'45"; 73°03'35"
VT3	Arlington 200 meters above Benedict Crossing bridge 38.1 river miles above the mouth 43°05'17"; 73°11'52"

TABLE 2 (continued). STATION LOCATIONS FOR THE BATTEN KILL, BENNINGTON COUNTY, VERMONT AND WASHINGTON COUNTY, NEW YORK (see map).

Batten Kill -New York

AA	Vermont border 100 meters above Rt. 313 parking area 30.6 river miles above the mouth latitude/longitude: 43°05'56"; 73°16'56"
A	above Shushan 100 meters downstream of Rte 64 bridge 24.4 river miles above the mouth latitude/longitude: 43°04'39"; 73°20'38"
B	below Rexleigh downstream of Rte 22 bridge 18.7 river miles above the mouth latitude/longitude: 43°08'43"; 73°21'53"
00	above Battenville off Rt. 29 0.6 miles above bridge 13.4 river miles above the mouth latitude/longitude: 43°07'05"; 73°25'17"
03	below Center Falls off Rt. 29 9.8 river miles above the mouth latitude/longitude: 43°05'37"; 73°27'45"

Figure 3	Site Overview Map	Batten Kill

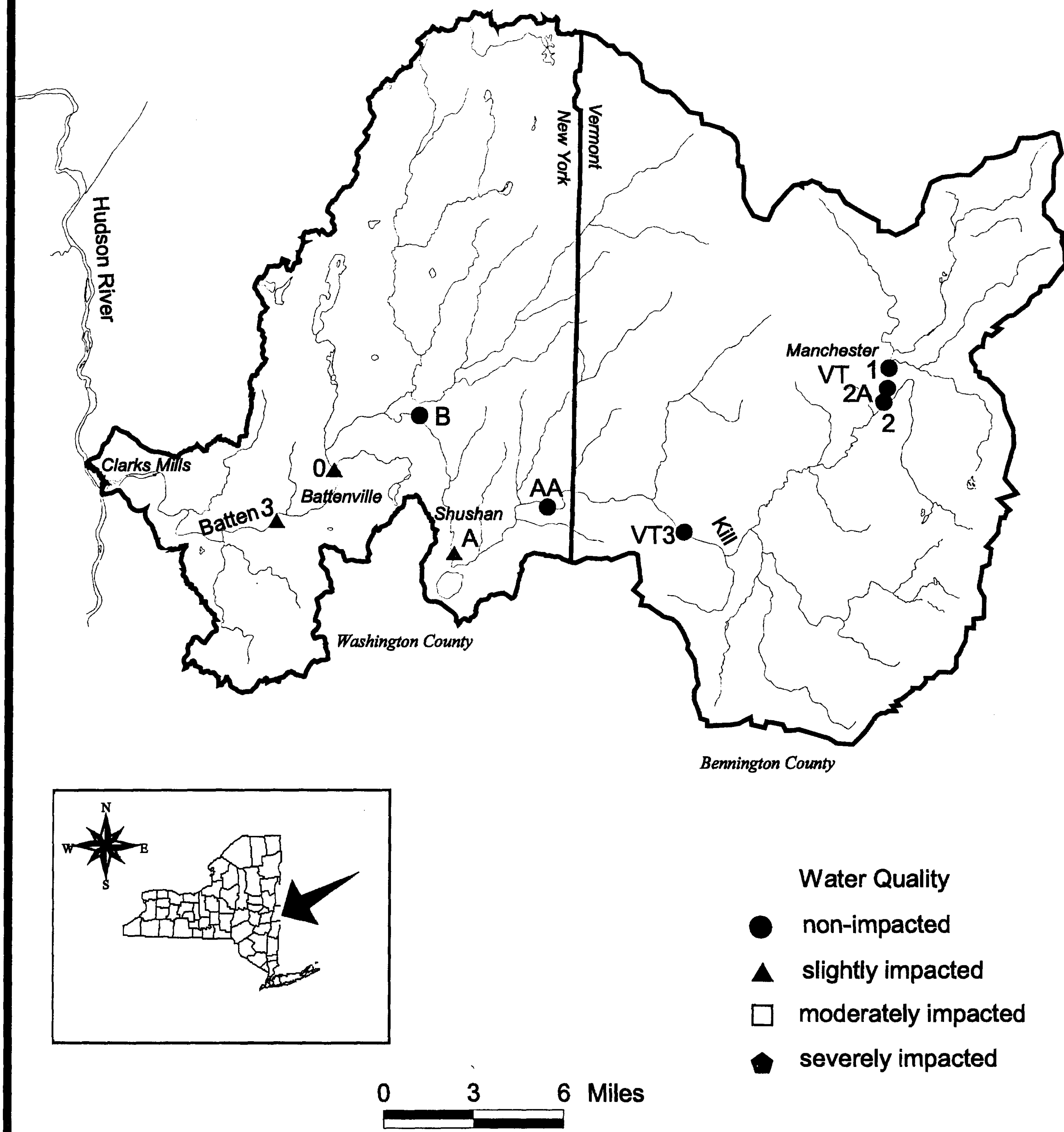


Figure 4a	Site Location Map	Batten Kill

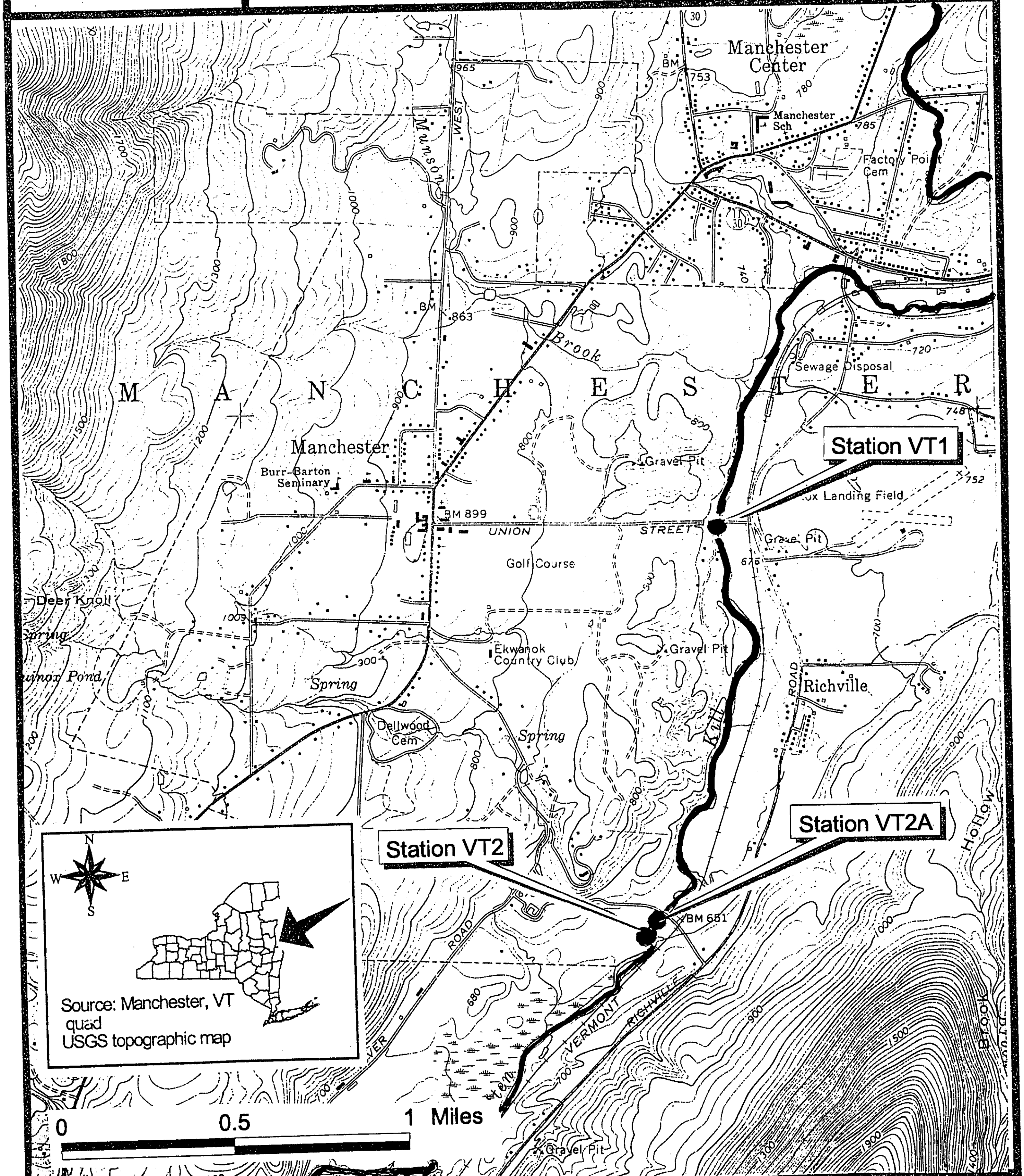


Figure 4b	Site Location Map	Batten Kill

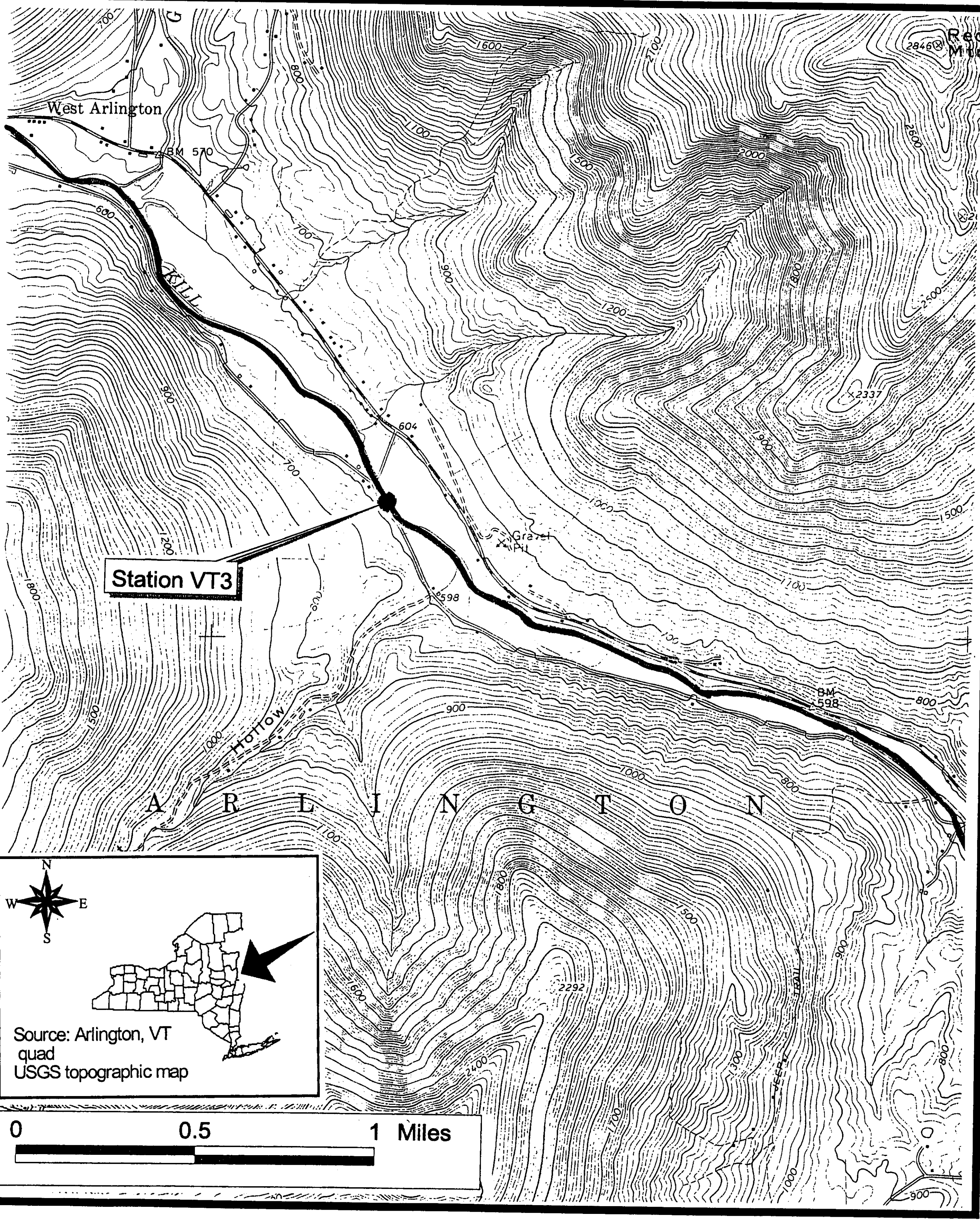


Figure 4c	Site Location Map	Batten Kill

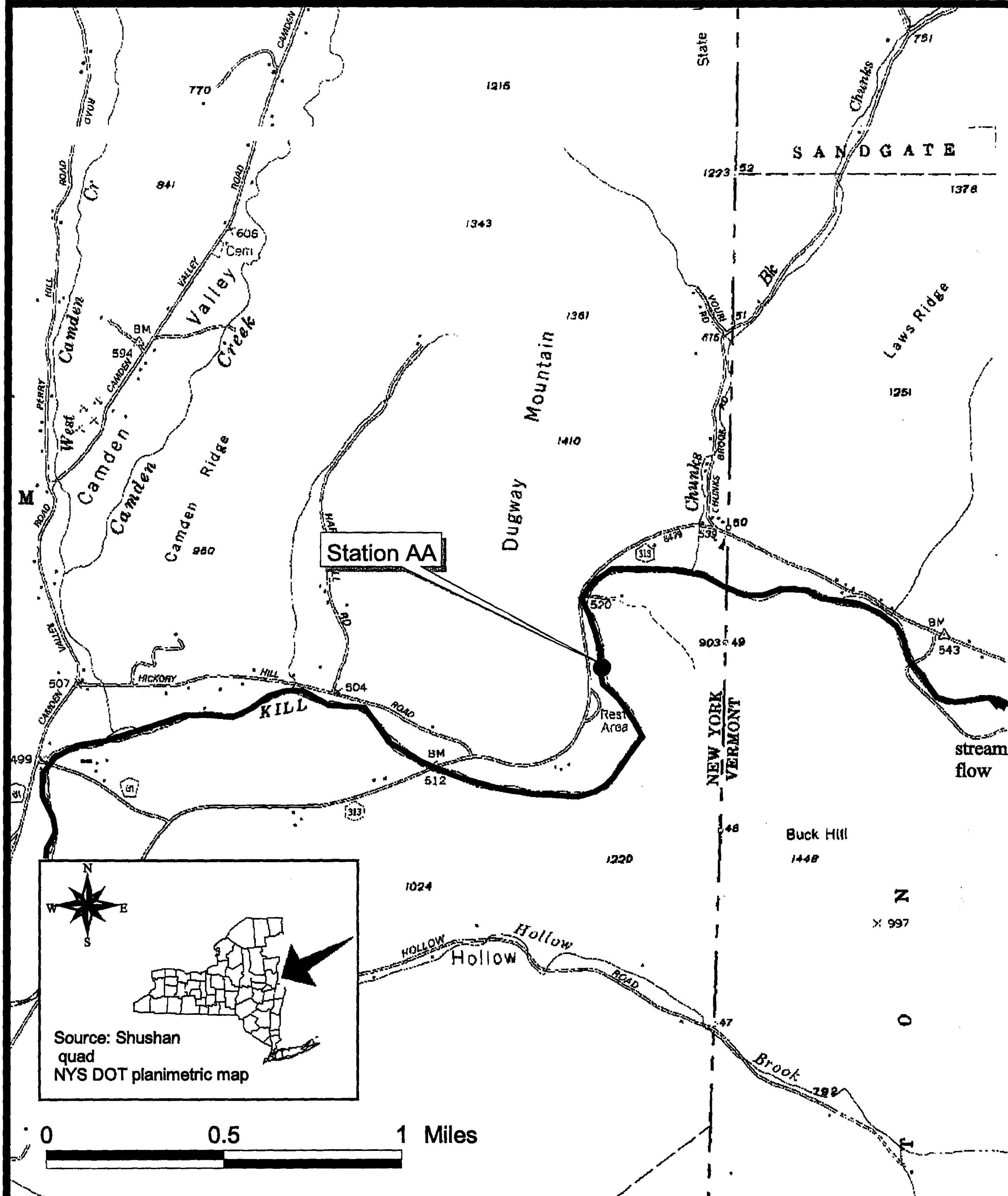


Figure 4d	Site Location Map	Batten Kill

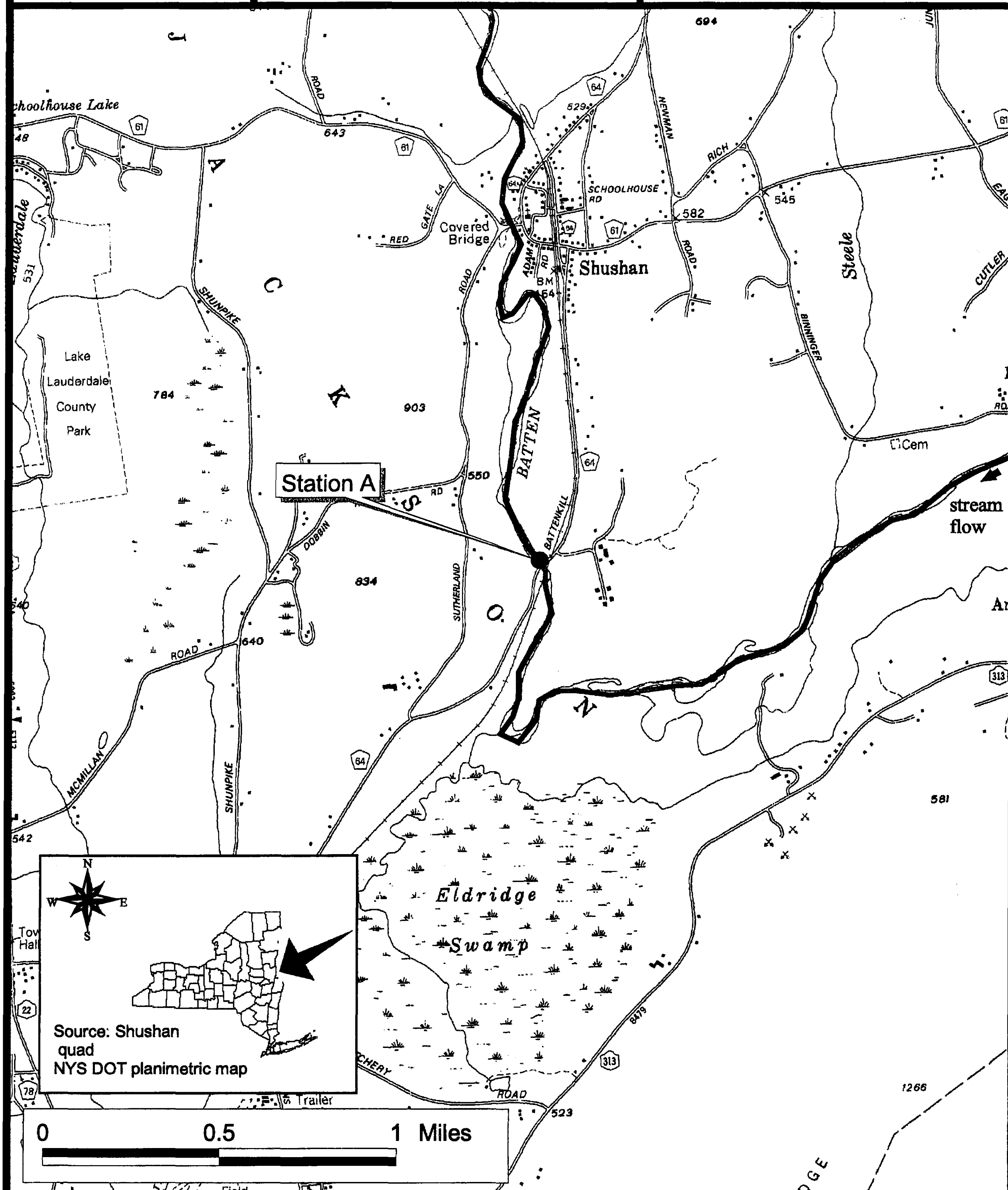


Figure 4e	Site Location Map	Batten Kill

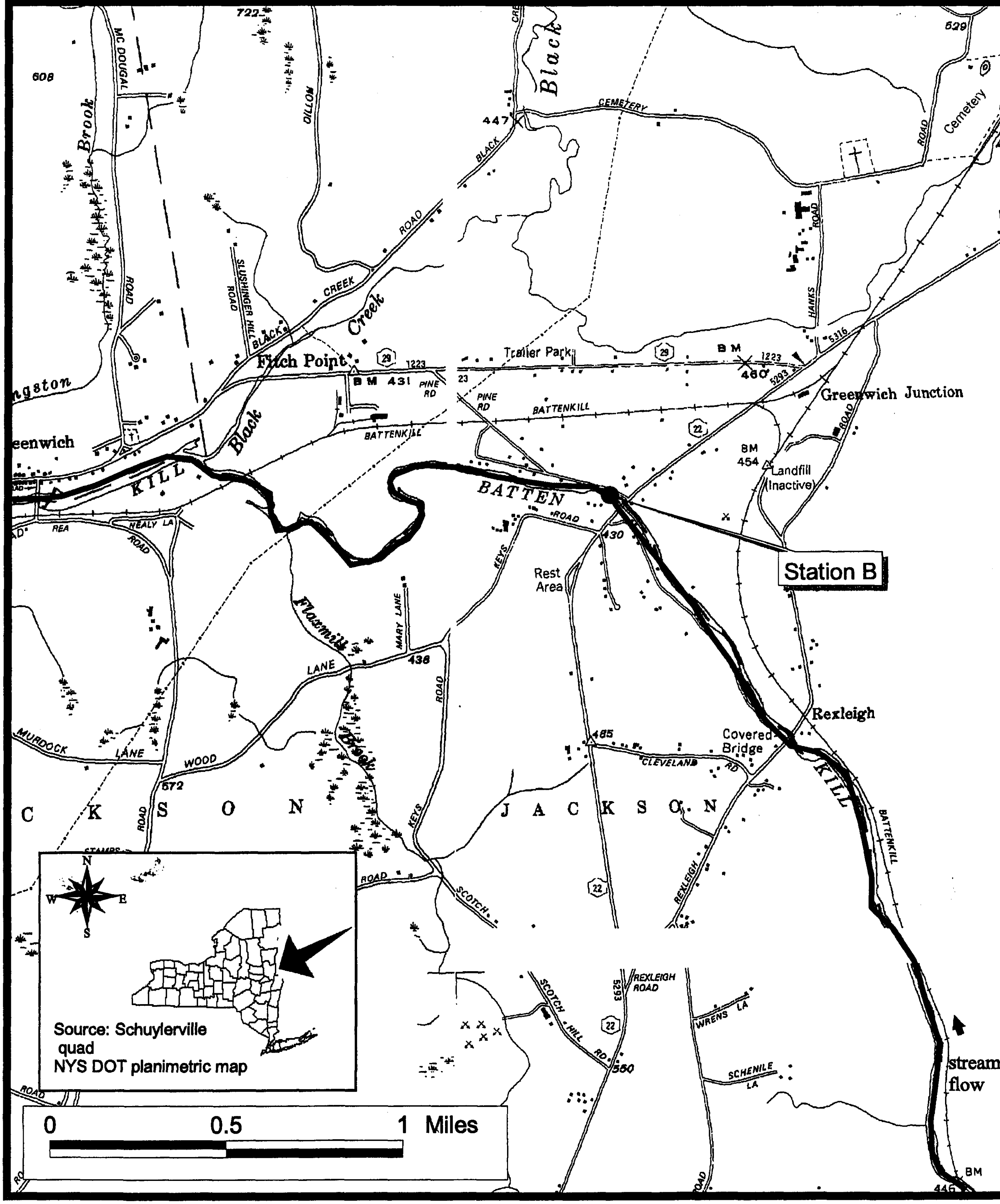


Figure 4f	Site Location Map	Batten Kill

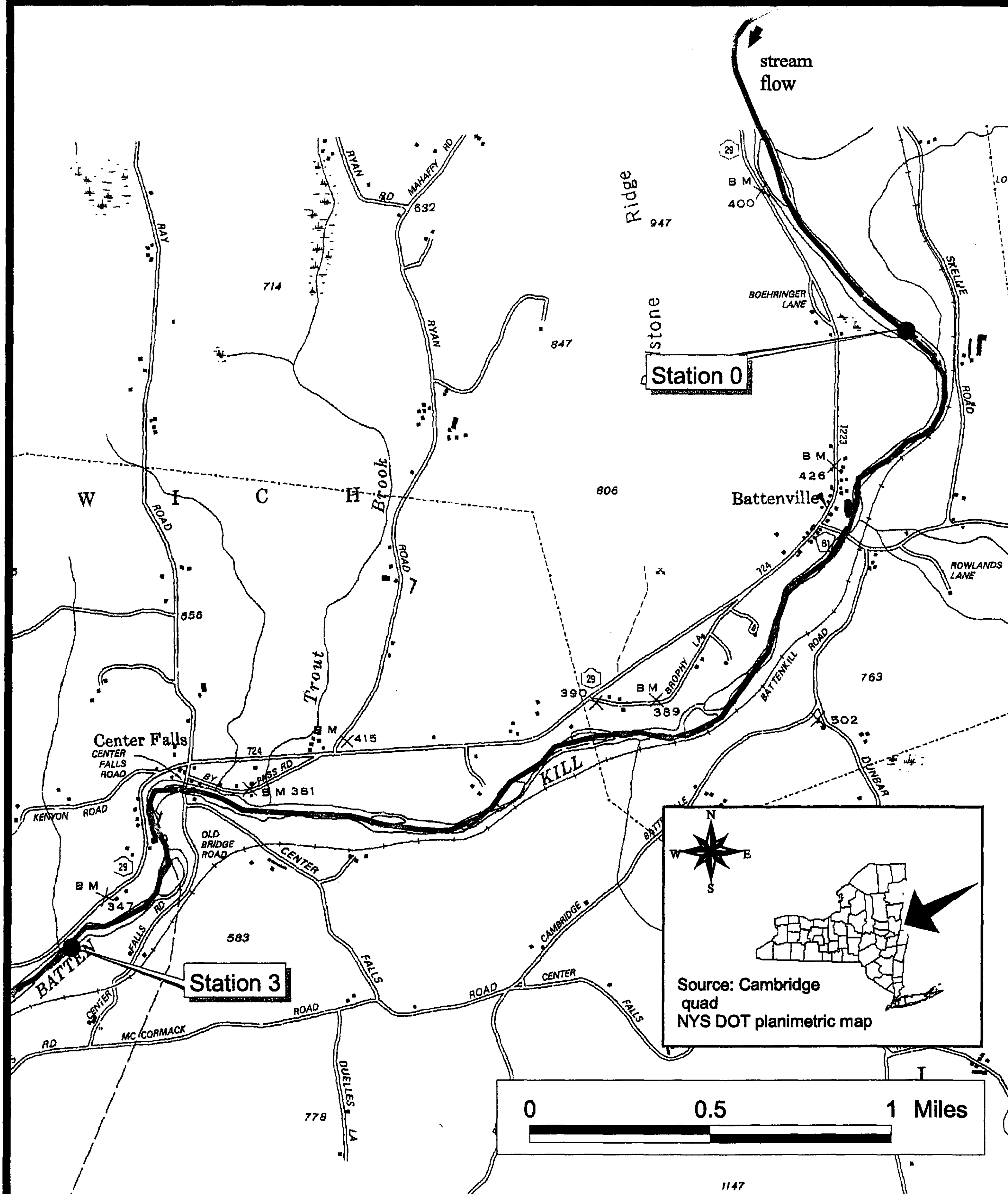


Figure 5. Mean Conductance Values in μmhos in the Batten Kill from 1984 - 2001. Means are of up to 5 sampling locations from the NY/VT border to Center Falls. Trendline (r=0.67) shown in black.

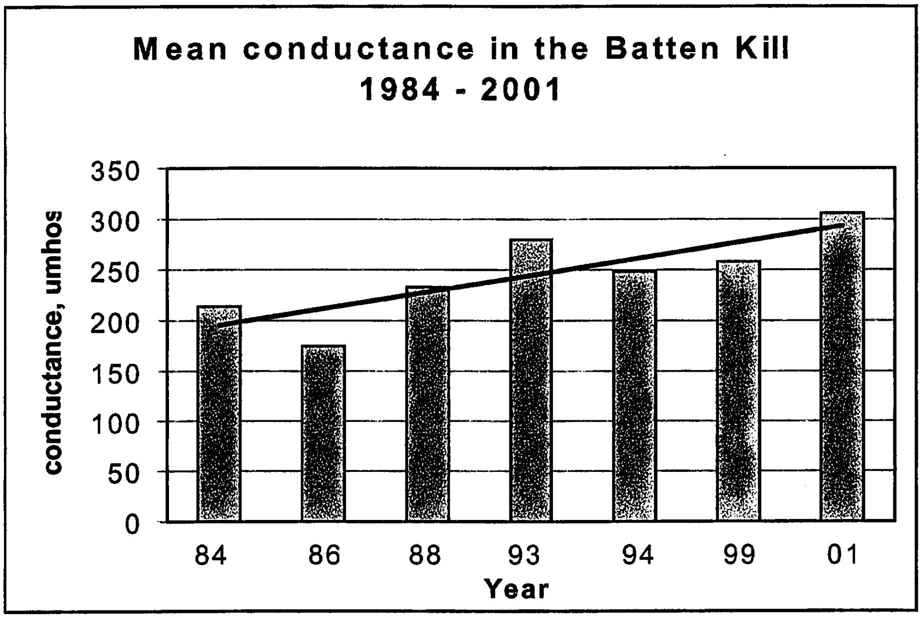


TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN THE BATTEN KILL, WASHINGTON COUNTY, NEW YORK AND BENNINGTON COUNTY, VERMONT, SEPTEMBER 6, 2001.

PLATYHELMINTHES
Undetermined Turbellaria
ANNELIDA
OLIGOCHAETA
LUMBRICIDA
Undetermined Lumbricina
LUMBRICULIDA
Lumbriculidae
Undetermined Lumbriculidae
TUBIFICIDA
Enchytraeidae
Undetermined Enchytraeidae
MOLLUSCA
GASTROPODA
Ancylidae
Ferrissia sp.
ARTHROPODA
INSECTA
EPHEMEROPTERA
Isonychiidae
Isonychia bicolor
Baetidae
Acentrella sp.
Baetis brunneicolor
Baetis flavistriga
Baetis intercalaris
Plauditus sp.
Heptageniidae
Epeorus (Iron) sp.
Leucrocuta sp.
Stenonema modestum
Stenonema terminatum
Stenonema sp.
Undetermined Heptageniidae
Ephemerellidae
Serratella deficiens
Serratella serrata
Serratella sp.
Undetermined Ephemerellidae
Baetiscidae
Baetisca sp.
Potamanthidae
Anthopotamus sp.
PLECOPTERA
Perlidae
Agnetina capitata
Undetermined Perlidae
Perlodidae
Undetermined Perlodidae
COLEOPTERA
Psephenidae
Psephenus herricki
Elmidae
Optioservus fastiditus
Optioservus trivittatus
Optioservus sp.
Promoresia elegans
Promoresia tardella
Stenelmis crenata
Stenelmis sp.
MEGALOPTERA
Corydalidae
Corydalus cornutus
Nigronia serricornis
TRICHOPTERA
Philopotamidae
Chimarra aterrima?
Dolophilodes sp.
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche bronta
Hydropsyche leonardi
Hydropsyche morosa
Hydropsyche scalaris
Hydropsyche sparna
Hydropsyche venularis
Hydropsyche sp.
Rhyacophilidae
Rhyacophila carpenteri?
Rhyacophila fuscula
Rhyacophila mainensis
Rhyacophila manistee
Rhyacophila sp.
Glossosomatidae
Glossosoma sp.
Hydroptilidae
Hydroptila consimilis
Brachycentridae
Brachycentrus solomoni
Apataniidae
Apatania sp.
Helicopsychidae
Helicopsyche borealis

TABLE 3 (continued). MACROINVERTEBRATE SPECIES COLLECTED IN THE BATTEN KILL, WASHINGTON COUNTY, NEW YORK AND BENNINGTON COUNTY, VERMONT, SEPTEMBER 6, 2001.

DIPTERA
- Tipulidae
  - Antocha sp.
  - Hexatoma sp.
- Ceratopogonidae
  - Undetermined Ceratopogonidae
- Simuliidae
  - Simulium venustum
  - Simulium vittatum
  - Simulium sp.
- Athericidae
  - Atherix sp.
- Empididae
  - Hemerodromia sp.
- Chironomidae
  - Tanypodinae
    - Thienemannimyia gr. spp.
  - Diamesinae
    - Diamesa sp.
    - Pagastia sp. A
    - Potthastia gaedii gr.
  - Orthocladiinae
    - Cardiocladius albiplumus
    - Cardiocladius obscurus
    - Cricotopus bicinctus
    - Cricotopus absurdus
    - Cricotopus tremulus gr.
    - Cricotopus trifascia gr.
    - Cricotopus vierriensis
    - Eukiefferiella pseudomontana gr.
    - Nanocladius (Plecopteracoluthus) downesi
    - Orthocladius nr. dentifer
    - Orthocladius (Symposiocladius) lignicola
    - Parametriocnemus lundbecki
    - Tvetenia vitracies
  - Chironominae
    - Chironomini
      - Microtendipes pedellus gr.
      - Polypedilum aviceps
      - Polypedilum flavum
    - Tanytarsini
      - Micropsectra dives gr.
      - Paratanytarsus confusus
      - Rheotanytarsus exiguus gr.
      - Rheotanytarsus pellucidus
      - Sublettea coffmani
      - Tanytarsus guerlus gr.

STREAM SITE:	Batten Kill Station VT1
LOCATION:	Manchester Center, Vermont, Union St. bridge
DATE:	September 6, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	6
	Baetidae	Baetis brunneicolor	7
		Baetis flavistriga	2
		Baetis intercalaris	1
		Plauditus sp.	2
	Heptageniidae	Stenonema sp.	4
	Ephemerellidae	Undetermined Ephemerellidae	1
	Baetiscidae	Baetisca sp.	1
COLEOPTERA	Elmidae	Optioservus fastiditus	10
		Optioservus trivittatus	2
		Promoresia elegans	2
		Promoresia tardella	4
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	6
	Hydropsychidae	Cheumatopsyche sp.	7
		Hydropsyche bronta	10
		Hydropsyche sparna	4
	Rhyacophilidae	Rhyacophila carpenteri?	1
		Rhyacophila fuscula	1
		Rhyacophila mainensis	2
		Rhyacophila manistee	1
	Glossosomatidae	Glossosoma sp.	1
	Hydroptilidae	Hydroptila consimilis	1
	Apataniidae	Apatania sp.	2
DIPTERA	Tipulidae	Hexatoma sp.	1
	Ceratopogonidae	Undetermined Ceratopogonidae	1
	Empididae	Hemerodromia sp.	1
	Chironomidae	Cricotopus vierriensis	1
		Parametriocnemus lundbecki	1
		Tvetenia vitracies	1
		Microtendipes pedellus gr.	3
		Polypedilum aviceps	4
		Micropsectra dives gr.	2
		Paratanytarsus confusus	1
		Rheotanytarsus exiguus gr.	2
		Sublettea coffmani	1

SPECIES RICHNESS	37 (very good)
BIOTIC INDEX	3.85 (very good)
EPT RICHNESS	19 (very good)
MODEL AFFINITY	66 (very good)
ASSESSMENT	non-impacted
DESCRIPTION	This sample was collected in Manchester Center, off Union St. at the site of the village well. The fauna was diverse and included baetiscid mayflies, a group found mainly in areas of excellent water quality. Water quality was assessed as non-impacted.

STREAM SITE:	Batten Kill Station VT2A
LOCATION:	below Manchester, 500 meters below STP discharge
DATE:	September 6, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	3
	Baetidae	Acentrella sp.	11
		Baetis brunneicolor	2
		Baetis intercalaris	4
	Ephemerellidae	Serratella serrata	9
COLEOPTERA	Elmidae	Optioservus fastiditus	4
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	3
	Hydropsychidae	Cheumatopsyche sp.	3
		Hydropsyche bronta	5
		Hydropsyche sparna	5
		Hydropsyche sp.	2
	Apataniidae	Apatania sp.	1
DIPTERA	Tipulidae	Hexatoma sp.	1
	Simuliidae	Simulium venustum	1
	Athericidae	Atherix sp.	1
	Empididae	Hemerodromia sp.	2
	Chironomidae	Cardiocladius albiplumus	1
		Cardiocladius obscurus	3
		Cricotopus bicinctus	1
		Cricotopus reversus gr.	1
		Cricotopus trifascia gr.	2
		Cricotopus vierriensis	2
		Eukiefferiella pseudomontana gr.	1
		Orthocladius nr. dentifer	4
		Parametriocnemus lundbecki	1
		Tvetenia vitracies	1
		Polypedilum aviceps	26

SPECIES RICHNESS	27 (very good)
BIOTIC INDEX	4.25 (very good)
EPT RICHNESS	11 (very good)
MODEL AFFINITY	68 (very good)
ASSESSMENT	non-impacted

DESCRIPTION

This sample was collected approximately 500 meters below the discharge pipe of the Manchester wastewater treatment plant. Just downstream, at Station VT2, the water had a slight grayish cast, and the source of that color was of interest. The effluent was determined to be the source of the gray color. Although most metrics were poorer than at the upstream site, the fauna collected was balanced and diverse, and water quality based on the macroinvertebrate metrics was assessed as non-impacted.

STREAM SITE:	Batten Kill Station VT2
LOCATION:	below Manchester, above confluence with Lye Brook
DATE:	September 6, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	2
		Baetis brunneicolor	1
		Baetis flavistriga	2
		Baetis intercalaris	2
	Heptageniidae	Stenonema terminatum	3
	Ephemerellidae	Serratella serrata	27
PLECOPTERA	Perlidae	Agnetina capitata	1
	Perlodidae	Undetermined Perlodidae	1
COLEOPTERA	Elmidae	Optioservus fastiditus	6
		Optioservus trivittatus	11
		Promoresia tardella	1
		Stenelmis sp.	1
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	4
		Hydropsyche bronta	7
		Hydropsyche leonardi	1
		Hydropsyche sparna	2
	Rhyacophilidae	Rhyacophila mainensis	1
	Brachycentridae	Brachycentrus solomoni	1
	Helicopsychidae	Helicopsyche borealis	2
DIPTERA	Athericidae	Atherix sp.	1
	Chironomidae	Pagastia sp. A	1
		Cricotopus tremulus gr.	1
		Cricotopus trifascia gr.	2
		Cricotopus vierriensis	1
		Eukiefferiella pseudomontana gr.	1
		Orthocladius nr. dentifer	5
		Tvetenia vitracies	1
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	6
		Rheotanytarsus distinctissimus gr.	2

SPECIES RICHNESS	31 (very good)
BIOTIC INDEX	3.91 (very good)
EPT RICHNESS	15 (very good)
MODEL AFFINITY	82 (very good)
ASSESSMENT	non-impacted
DESCRIPTION	This site, approximately 50 meters above where Lye Brook enters the Batten Kill, appeared to have more algae on the rocks and cobbles, and more baetid mayflies than at Station 1. The water had a slight grayish cast, and because of this, the walk upstream was conducted to determine that effluent from the Manchester wastewater treatment plant was the source. However, the fauna collected was balanced and diverse, and included baetiscid mayflies and the stonefly, *Pteronarcys*, both indicators of excellent water quality. The percent model affinity value was actually higher than at the location above the treatment plant, and water quality was judged to be non-impacted, based on the macroinvertebrate community.

STREAM SITE:	Batten Kill Station VT3
LOCATION:	Arlington, Vermont, above Benedict Crossing bridge
DATE:	September 6, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	1
MOLLUSCA			
GASTROPODA	Ancylidae	Ferrissia sp.	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	7
		Baetis brunneicolor	1
		Baetis intercalaris	5
		Plauditus sp.	1
	Heptageniidae	Stenonema sp.	1
	Ephemerellidae	Serratella deficiens	1
		Serratella serrata	5
PLECOPTERA	Perlidae	Agnetina capitata	1
	Perlodidae	Undetermined Perlodidae	1
COLEOPTERA	Elmidae	Optioservus fastiditus	1
		Optioservus trivittatus	8
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	2
	Hydropsychidae	Cheumatopsyche sp.	11
		Hydropsyche bronta	8
		Hydropsyche morosa	20
	Rhyacophilidae	Rhyacophila mainensis	2
	Apataniidae	Apatania sp.	10
DIPTERA	Tipulidae	Hexatoma sp.	1
	Chironomidae	Thienemannimyia gr. spp.	1
		Diamesa sp.	1
		Potthastia gaedii gr.	1
		Orthocladius nr. dentifer	1
		Polypedilum aviceps	4
		Rheotanytarsus distinctissimus gr.	2
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS	28 (very good)
BIOTIC INDEX	4.53 (good)
EPT RICHNESS	15 (very good)
MODEL AFFINITY	57 (good)
ASSESSMENT	non-impacted

DESCRIPTION

Just below the village of Arlington, Vermont, a sample was taken, 200 meters above the Benedict Crossing Rd. bridge. Although taxa richness had declined slightly and biotic index had increased from upstream, and some metrics were within the range of slight impact, the overall water quality assessment remained non-impacted.

STREAM SITE:	Batten Kill Station AA
LOCATION:	Vermont border, Rt. 313 parking area
DATE:	September 6, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	4
	Baetidae	Acentrella sp.	7
		Baetis intercalaris	5
	Heptageniidae	Epeorus (Iron) sp.	1
		Stenonema integrum	1
	Ephemerellidae	Serratella serrata	1
PLECOPTERA	Perlidae	Agnetina capitata	2
		Paragnetina immarginata	2
	Perlodidae	Undetermined Perlodidae	6
COLEOPTERA	Elmidae	Optioservus sp.	3
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	12
		Dolophilodes sp.	5
	Hydropsychidae	Cheumatopsyche sp.	15
		Hydropsyche bronta	4
		Hydropsyche morosa	9
		Hydropsyche sparna	3
DIPTERA	Tipulidae	Hexatoma sp.	1
	Athericidae	Atherix sp.	1
	Chironomidae	Cricotopus trifascia gr.	1
		Cricotopus vierriensis	1
		Orthocladius (Sympos.) lignicola	1
		Tvetenia vitracies	1
		Polypedilum aviceps	8
		Polypedilum convictum	1
		Micropsectra dives gr.	2
		Rheotanytarsus exiguus gr.	3

SPECIES RICHNESS	26 (good)
BIOTIC INDEX	4.15 (very good)
EPT RICHNESS	15 (very good)
MODEL AFFINITY	57 (good)
ASSESSMENT	non-impacted

DESCRIPTION

At the border of New York and Vermont, the fauna was similar to that upstream in Arlington. Hydropsychid caddisflies were a substantial contributor to the sample. While richness had declined from upstream by 2 taxa, EPT richness and percent model affinity were unchanged, and biotic index was better than at Station VT3. Water quality was assessed as non-impacted.

STREAM SITE:	Batten Kill Station A
LOCATION:	above Shushan, Rt. 64
DATE:	September 6, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	7
	Baetidae	Acentrella sp.	1
	Heptageniidae	Stenonema sp.	2
		Undetermined Heptageniidae	1
PLECOPTERA	Perlidae	Undetermined Perlidae	1
	Perlodidae	Undetermined Perlodidae	1
COLEOPTERA	Elmidae	Optioservus fastiditus	2
		Optioservus trivittatus	12
		Stenelmis crenata	1
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	16
	Hydropsychidae	Cheumatopsyche sp.	9
		Hydropsyche bronta	13
		Hydropsyche morosa	20
	Rhyacophilidae	Rhyacophila sp.	1
	Glossosomatidae	Glossosoma sp.	1
	Apataniidae	Apatania sp.	1
DIPTERA	Athericidae	Atherix sp.	4
	Empididae	Hemerodromia sp.	1
	Chironomidae	Tvetenia vitracies	2
		Polypedilum aviceps	3

SPECIES RICHNESS	21 (good)
BIOTIC INDEX	4.53 (good)
EPT RICHNESS	13 (very good)
MODEL AFFINITY	44 (poor)
ASSESSMENT	slightly impacted

DESCRIPTION

At this location, above the village of Shushan, the sample was collected 100 meters below the Rte. 64 bridge. The substrate here contained more gravel than upstream sites, and while a well-balanced fauna was present, species richness was lower than expected and percent model affinity was poor. The water quality, based on macroinvertebrates, was assessed as slightly impacted.

STREAM SITE: Batten Kill Station B
LOCATION: below Rexleigh, New York, Rt. 22
DATE: September 6, 2001
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	4
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	15
	Baetidae	Acentrella sp.	1
		Baetis intercalaris	2
	Heptageniidae	Leucrocuta sp.	1
		Stenonema sp.	2
	Ephemerellidae	Serratella sp.	1
PLECOPTERA	Perlidae	Agnetina capitata	1
	Perlodidae	Undetermined Perlodidae	1
COLEOPTERA	Elmidae	Optioservus trivittatus	8
		Stenelmis crenata	1
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	22
	Hydropsychidae	Cheumatopsyche sp.	9
		Hydropsyche bronta	1
		Hydropsyche morosa	13
		Hydropsyche scalaris	3
	Glossosomatidae	Glossosoma sp.	2
DIPTERA	Chironomidae	Cricotopus vierriensis	1
		Parametriocnemus lundbecki	2
		Tvetenia vitracies	2
		Polypedilum aviceps	3
		Micropsectra dives gr.	2
		Rheotanytarsus distinctissimus gr.	1

SPECIES RICHNESS 25 (good)
BIOTIC INDEX 4.01 (very good)
EPT RICHNESS 14 (very good)
MODEL AFFINITY 60 (good)
ASSESSMENT non-impacted

DESCRIPTION This sampling location, downstream of the Route 22 bridge below the hamlet of Rexleigh was considered to be non-impacted based on field observation; good diversity and biomass were noted. These observations were confirmed with laboratory identification of the 100 organism subsample, and water quality was assessed as non-impacted.

STREAM SITE:	Batten Kill Station 00
LOCATION:	above Battenville, Rt. 29
DATE:	September 6, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

PLATYHELMINTHES		Undetermined Turbellaria	2
ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	9
	Baetidae	Acentrella sp.	4
		Baetis flavistriga	4
		Baetis intercalaris	8
		Plauditus sp.	1
	Heptageniidae	Stenonema sp.	2
	Ephemerellidae	Serratella deficiens	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus trivittatus	9
		Stenelmis sp.	1
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	11
	Hydropsychidae	Cheumatopsyche sp.	22
		Hydropsyche bronta	1
		Hydropsyche leonardi	3
		Hydropsyche morosa	9
		Hydropsyche sparna	2
		Hydropsyche venularis	5
DIPTERA	Simuliidae	Simulium vittatum	1
	Chironomidae	Nanocladius (Plecop.) downesi	2

SPECIES RICHNESS	21 (good)
BIOTIC INDEX	4.30 (very good)
EPT RICHNESS	14 (very good)
MODEL AFFINITY	56 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

At this location above the village of Battenville, species richness and percent model affinity both decreased from the site upstream at Rexleigh, and while the fauna still had good representation by mayflies, hydropsychid caddisflies were the dominant group, indicating probable nutrient inputs, which resulted in an assessment of slightly impacted water quality.

STREAM SITE:	Batten Kill Station 03
LOCATION:	below Center Falls, off Rt. 29
DATE:	September 6, 2001
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	5
	Baetidae	Baetis flavistriga	3
		Plauditus sp.	1
	Heptageniidae	Leucrocuta sp.	3
		Stenonema modestum	7
	Potamanthidae	Anthopotamus sp.	6
COLEOPTERA	Elmidae	Optioservus trivittatus	14
		Stenelmis crenata	10
MEGALOPTERA	Corydalidae	Corydalus cornutus	1
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	4
	Hydropsychidae	Cheumatopsyche sp.	23
		Hydropsyche bronta	3
		Hydropsyche leonardi	1
		Hydropsyche morosa	3
	Apataniidae	Apatania sp.	6
DIPTERA	Tipulidae	Antocha sp.	2
	Simuliidae	Simulium sp.	1
	Athericidae	Atherix sp.	2
	Empididae	Hemerodromia sp.	1
	Chironomidae	Potthastia gaedii gr.	1
		Cricotopus tremulus gr.	1
		Tvetenia vitracies	2

SPECIES RICHNESS	22 (good)
BIOTIC INDEX	3.99 (very good)
EPT RICHNESS	12 (very good)
MODEL AFFINITY	56 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

This site was sampled in Center Falls, below the Hollingsworth & Vose Co. discharge. The invertebrate community was similar to that collected upstream at Battenville, with substantial contribution to the subsample by net-spinning caddisflies, and water quality was similarly assessed as slightly impacted.

LABORATORY DATA SUMMARY				
STREAM NAME: Batten Kill		**DRAINAGE: Upper Hudson**		
DATE SAMPLED: 09/06/01		**COUNTY: Washington**		
SAMPLING METHOD: Traveling Kick				
STATION **LOCATION**	VT1 Manchester Center	VT2A below Manchester	VT2 below Manchester	VT3 Arlington
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Optioservus fastiditus 10 % intolerant beetle	Polypedilum aviceps 26 % facultative midge	Serratella serrata 27 % intolerant mayfly	Hydropsyche morosa 20 % facultative caddisfly
2. **Intolerant = not tolerant of poor water quality**	Hydropsyche bronta 10 % facultative caddisfly	Acentrella sp. 11 % intolerant mayfly	Optioservus trivittatus 11 % intolerant beetle	Cheumatopsyche sp. 11 % facultative caddisfly
3. **Facultative = occurring over a wide range of water quality**	Baetis brunneicolor 7 % intolerant mayfly	Serratella serrata 9 % intolerant mayfly	Hydropsyche bronta 7 % facultative caddisfly	Apatania sp. 10 % intolerant caddisfly
4. **Tolerant = tolerant of poor water quality**	Cheumatopsyche sp. 7 % facultative caddisfly	Hydropsyche bronta 5 % facultative caddisfly	Optioservus fastiditus 6 % intolerant beetle	Optioservus trivittatus 8 % intolerant beetle
5.	Isonychia bicolor 6 % intolerant mayfly	Hydropsyche sparna 5 % facultative caddisfly	Polypedilum aviceps 6 % facultative midge	Hydropsyche bronta 8 % facultative caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	16.0 (9.0)	43.0 (11.0)	21.0 (10.0)	11.0 (7.0)
Trichoptera (caddisflies)	36.0 (11.0)	19.0 (6.0)	18.0 (7.0)	53.0 (6.0)
Ephemeroptera (mayflies)	24.0 (8.0)	29.0 (5.0)	37.0 (6.0)	21.0 (7.0)
Plecoptera (stoneflies)	0.0 (0.0)	0.0 (0.0)	2.0 (2.0)	2.0 (2.0)
Coleoptera (beetles)	18.0 (4.0)	4.0 (1.0)	19.0 (4.0)	9.0 (2.0)
Oligochaeta (worms)	2.0 (1.0)	0.0 (0.0)	2.0 (1.0)	2.0 (2.0)
Other	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
SPECIES RICHNESS	37	27	31	28
BIOTIC INDEX	3.85	4.25	3.91	4.53
EPT RICHNESS	19	11	15	15
PERCENT MODEL AFFINITY	66	68	82	57
FIELD ASSESSMENT	non	-	non	non
OVERALL ASSESSMENT	non	non	non	non

LABORATORY DATA SUMMARY				
STREAM NAME: Batten Kill		**DRAINAGE: Upper Hudson**		
DATE SAMPLED: 09/06/01		**COUNTY: Washington**		
SAMPLING METHOD: Traveling Kick				
STATION	AA	A	B	00
LOCATION	Vermont border	above Shushan	Below Rexleigh	above Battenville
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Cheumatopsyche sp. 15 % facultative caddisfly	Hydropsyche morosa 20 % facultative caddisfly	Chimarra aterrima? 22 % intolerant caddisfly	Cheumatopsyche sp. 22 % facultative caddisfly
2. **Intolerant = not tolerant of poor water quality**	Chimarra aterrima? 12 % intolerant caddisfly	Chimarra aterrima? 16 % intolerant caddisfly	Isonychia bicolor 15 % intolerant mayfly	Chimarra aterrima? 11 % intolerant caddisfly
3. **Facultative = occurring over a wide range of water quality**	Hydropsyche morosa 9 % facultative caddisfly	Hydropsyche bronta 13 % facultative caddisfly	Hydropsyche morosa 13 % facultative caddisfly	Isonychia bicolor 9 % intolerant mayfly
4. **Tolerant = tolerant of poor water quality**	Polypedilum aviceps 8 % facultative midge	Optioservus trivittatus 12 % intolerant beetle	Cheumatopsyche sp. 9 % facultative caddisfly	Optioservus trivittatus 9 % intolerant beetle
5.	Acentrella sp. 7 % intolerant mayfly	Cheumatopsyche sp. 9 % facultative caddisfly	Optioservus trivittatus 8 % intolerant beetle	Hydropsyche morosa 9 % facultative caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	18.0 (8.0)	5.0 (2.0)	11.0 (6.0)	2.0 (1.0)
Trichoptera (caddisflies)	48.0 (6.0)	61.0 (7.0)	50.0 (6.0)	53.0 (7.0)
Ephemeroptera (mayflies)	19.0 (6.0)	11.0 (4.0)	22.0 (6.0)	29.0 (7.0)
Plecoptera (stoneflies)	10.0 (3.0)	2.0 (2.0)	2.0 (2.0)	0.0 (0.0)
Coleoptera (beetles)	3.0 (1.0)	15.0 (3.0)	9.0 (2.0)	11.0 (3.0)
Oligochaeta (worms)	0.0 (0.0)	1.0 (1.0)	5.0 (2.0)	2.0 (1.0)
Other	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	2.0 (1.0)
SPECIES RICHNESS	26	21	25	21
BIOTIC INDEX	4.15	4.53	4.01	4.3
EPT RICHNESS	15	13	14	14
PERCENT MODEL AFFINITY	57	44	60	56
FIELD ASSESSMENT	non	non	non	non
OVERALL ASSESSMENT	non	slt	non	slt

LABORATORY DATA SUMMARY				
STREAM NAME: Batten Kill	**DRAINAGE: Upper Hudson**			
DATE SAMPLED: 09/06/01	**COUNTY: Washington**			
SAMPLING METHOD: Traveling Kick				
STATION	03			
LOCATION	below Center Falls			
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Cheumatopsyche sp. 23 % facultative caddisfly			
2. **Intolerant = not tolerant of poor water quality**	Optioservus trivittatus 14 % intolerant beetle			
3. **Facultative = occurring over a wide range of water quality**	Stenelmis crenata 10 % facultative beetle			
4. **Tolerant = tolerant of poor water quality**	Stenonema modestum 7 % intolerant mayfly			
5.	Anthopotamus sp. 6 % intolerant mayfly			
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	4.0 (3.0)			
Trichoptera (caddisflies)	40.0 (6.0)			
Ephemeroptera (mayflies)	25.0 (6.0)			
Plecoptera (stoneflies)	0.0 (0.0)			
Coleoptera (beetles)	24.0 (2.0)			
Oligochaeta (worms)	0.0 (0.0)			
Other	0.0 (0.0)			
SPECIES RICHNESS	22			
BIOTIC INDEX	3.99			
EPT RICHNESS	12			
PERCENT MODEL AFFINITY	56			
FIELD ASSESSMENT	slt			
OVERALL ASSESSMENT	slt			

FIELD DATA SUMMARY				
STREAM NAME: Batten Kill	DATE SAMPLED: 09/06/01			
REACH: Manchester to Arlington				
FIELD PERSONNEL INVOLVED:Abele, Novak, Malone				
STATION	VT1	VT2A	VT2	VT3
ARRIVAL TIME AT STATION	10:50	12:00	11:35	1:30
LOCATION	Union Ave.	below Manchester STP	below Manch. STP discharge	Arlington
PHYSICAL CHARACTERISTICS				
Width (meters)	12	5.0	15	30
Depth (meters)	0.3	0.2	0.2	0.3
Current speed (cm per sec.)	77	100	83	111
Substrate (%)				
Rock (>25.4 cm, or bedrock)	20			
Rubble (6.35 - 25.4 cm)	40	30	20	30
Gravel (0.2 - 6.35 cm)	20	30	40	30
Sand (0.06 - 2.0 mm)	10	20	30	30
Silt (0.004 - 0.06 mm)	10	20	10	10
Embeddedness (%)	40	40	40	30
CHEMICAL MEASUREMENTS				
Temperature (° C)	14.8	16.6	15.4	16.5
Specific Conductance (umhos)	468	501	488	335
Dissolved Oxygen (mg/l)	9.1	9.6	9.9	10.1
pH	8.1	8.1	8.2	8.4
BIOLOGICAL ATTRIBUTES				
Canopy (%)	40	20	10	20
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	X	X	X	
algae - diatoms	X	X	X	X
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X		X	X
Plecoptera (stoneflies)	X		X	X
Trichoptera (caddisflies)	X		X	X
Coleoptera (beetles)			X	X
Megaloptera(dobsonflies,alderflies)	X		X	
Odonata (dragonflies, damselflies)				
Chironomidae (midges)				
Simuliidae (black flies)				
Decapoda (crayfish)				
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)			X	
Other			X	
FIELD ASSESSMENT	non	-	non	non

FIELD DATA SUMMARY				
STREAM NAME: Batten Kill	DATE SAMPLED: 09/06/01			
REACH: State Line to Battenville				
FIELD PERSONNEL INVOLVED: Abele, Novak, Malone				
STATION	AA	A	B	00
ARRIVAL TIME AT STATION	2:25	3:25	3:50	4:15
LOCATION	Vermont border	above Shushan	Rexleigh	Battenville
PHYSICAL CHARACTERISTICS				
Width (meters)	20	25	20	70
Depth (meters)	0.4	0.3	0.3	0.2
Current speed (cm per sec.)	100	-	125	111
Substrate (%)				
Rock (>25.4 cm, or bedrock)	-	-	10	-
Rubble (6.35 - 25.4 cm)	30	20	40	30
Gravel (0.2 – 6.35 cm)	30	30	20	40
Sand (0.06 – 2.0 mm)	30	30	20	20
Silt (0.004 – 0.06 mm)	10	20	10	10
Embeddedness (%)	30	40	40	40
CHEMICAL MEASUREMENTS				
Temperature (° C)	17.4	17.4	18.6	19.3
Specific Conductance (umhos)	309	304	295	310
Dissolved Oxygen (mg/l)	9.1	9.3	9.2	9.5
pH	8.1	7.9	8.0	8.1
BIOLOGICAL ATTRIBUTES				
Canopy (%)	10	20	5	5
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				
algae - diatoms	X	X		X
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)				X
Megaloptera(dobsonflies,alderflies)				X
Odonata (dragonflies, damselflies)		X		
Chironomidae (midges)	X	X		X
Simuliidae (black flies)				
Decapoda (crayfish)			X	
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)		X		X
Other	X	X		
FIELD ASSESSMENT	non	non	non	non

FIELD DATA SUMMARY

STREAM NAME: Batten Kill **DATE SAMPLED: 09/06/01**
REACH: Center Falls
FIELD PERSONNEL INVOLVED:Abele, Novak, Malone

STATION	03			
ARRIVAL TIME AT STATION	4:55			
LOCATION	Center Falls			
PHYSICAL CHARACTERISTICS				
Width (meters)	50			
Depth (meters)	0.3			
Current speed (cm per sec.)	91			
Substrate (%)				
Rock (>25.4 cm, or bedrock)				
Rubble (6.35 - 25.4 cm)	30			
Gravel (0.2 – 6.35 cm)	40			
Sand (0.06 – 2.0 mm)	20			
Silt (0.004 – 0.06 mm)	10			
Embeddedness (%)	40			
CHEMICAL MEASUREMENTS				
Temperature (°C)	18.3			
Specific Conductance (umhos)	315			
Dissolved Oxygen (mg/l)	9.4			
pH	8.0			
BIOLOGICAL ATTRIBUTES				
Canopy (%)	5			
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	X			
algae - diatoms	X			
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X			
Plecoptera (stoneflies)				
Trichoptera (caddisflies)				
Coleoptera (beetles)	X			
Megaloptera(dobsonflies,alderflies)	X			
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X			
Simuliidae (black flies)				
Decapoda (crayfish)	X			
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other				
FIELD ASSESSMENT	slight			

Appendix I. BIOLOGICAL METHODS FOR KICK SAMPLING

A. Rationale. The use of the standardized kick sampling method provides a biological assessment technique that lends itself to rapid assessments of stream water quality.

B. Site Selection. Sampling sites are selected based on these criteria: (1) The sampling location should be a riffle with a substrate of rubble, gravel, and sand. Depth should be one meter or less, and current speed should be at least 0.4 meters per second. (2) The site should have comparable current speed, substrate type, embeddedness, and canopy cover to both upstream and downstream sites to the degree possible. (3) Sites are chosen to have a safe and convenient access.

C. Sampling. Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that the dislodged organisms are carried into the net. Sampling is continued for a specified time and for a specified distance in the stream. Rapid assessment sampling specifies sampling 5 minutes for a distance of 5 meters. The net contents are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol.

D. Sample Sorting and Subsampling. In the laboratory the sample is rinsed with tap water in a U.S. No. 40 standard sieve to remove any fine particles left in the residues from field sieving. The sample is transferred to an enamel pan and distributed homogeneously over the bottom of the pan. A small amount of the sample is randomly removed with a spatula, rinsed with water, and placed in a petri dish. This portion is examined under a dissecting stereomicroscope and 100 organisms are randomly removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. The total number of organisms in the sample is estimated by weighing the residue from the picked subsample and determining its proportion of the total sample weight.

E. Organism Identification. All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species, and the total number of individuals in the subsample is recorded on a data sheet. All organisms from the subsample are archived, either slide-mounted or preserved in alcohol. Following identification of a subsample, if the results are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

Appendix II. MACROINVERTEBRATE COMMUNITY PARAMETERS

1. Species richness. This is the total number of species or taxa found in the sample. Expected ranges for 100-specimen subsamples of kick samples in most streams in New York State are: greater than 26, non-impacted; 19-26, slightly impacted; 11-18, moderately impacted; less than 11, severely impacted.

2. EPT 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 tolerance of the organisms in the sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For purposes of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Values are listed in Hilsenhoff (1987); additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in the Quality Assurance document (Bode et al., 1996). Ranges for the levels of impact are: 0-4.50, non-impacted; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted; and 8.51-10.00, severely impacted.

4. Percent Model Affinity is a measure of similarity to a model non-impacted community based on percent abundance in 7 major groups (Novak and Bode, 1992). Percentage similarity is used to measure similarity to a community of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other. Ranges for the levels of impact are: >64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and <35, severely impacted.

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NYS DEC technical report, 89 pp.

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

Lenat, D. R. 1987. Water quality assessment using a new qualitative collection method for freshwater benthic macroinvertebrates. North Carolina DEM Tech. Report. 12 pp.

Novak, M.A., and R.W. Bode. 1992. Percent model affinity: a new measure of macroinvertebrate community composition. J. N. Am. Benthol. Soc. 11(1):80-85.

Appendix III. LEVELS OF WATER QUALITY IMPACT IN STREAMS.

The description of overall stream water quality based on biological parameters uses a four-tiered system of classification. Level of impact is assessed for each individual parameter, and then combined for all parameters to form a consensus determination. Four parameters are used: species richness, EPT value, biotic index, and percent model affinity. The consensus is based on the determination of the majority of the parameters; since parameters measure different aspects of the community, they cannot be expected to always form unanimous assessments. The ranges given for each parameter are based on 100-organism subsamples of macroinvertebrate riffle kick samples, and also apply to most multiplate samples, with the exception of percent model affinity.

1. Non-impacted

Indices reflect very good water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well-represented; the EPT value is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

2. Slightly impacted

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

3. Moderately impacted

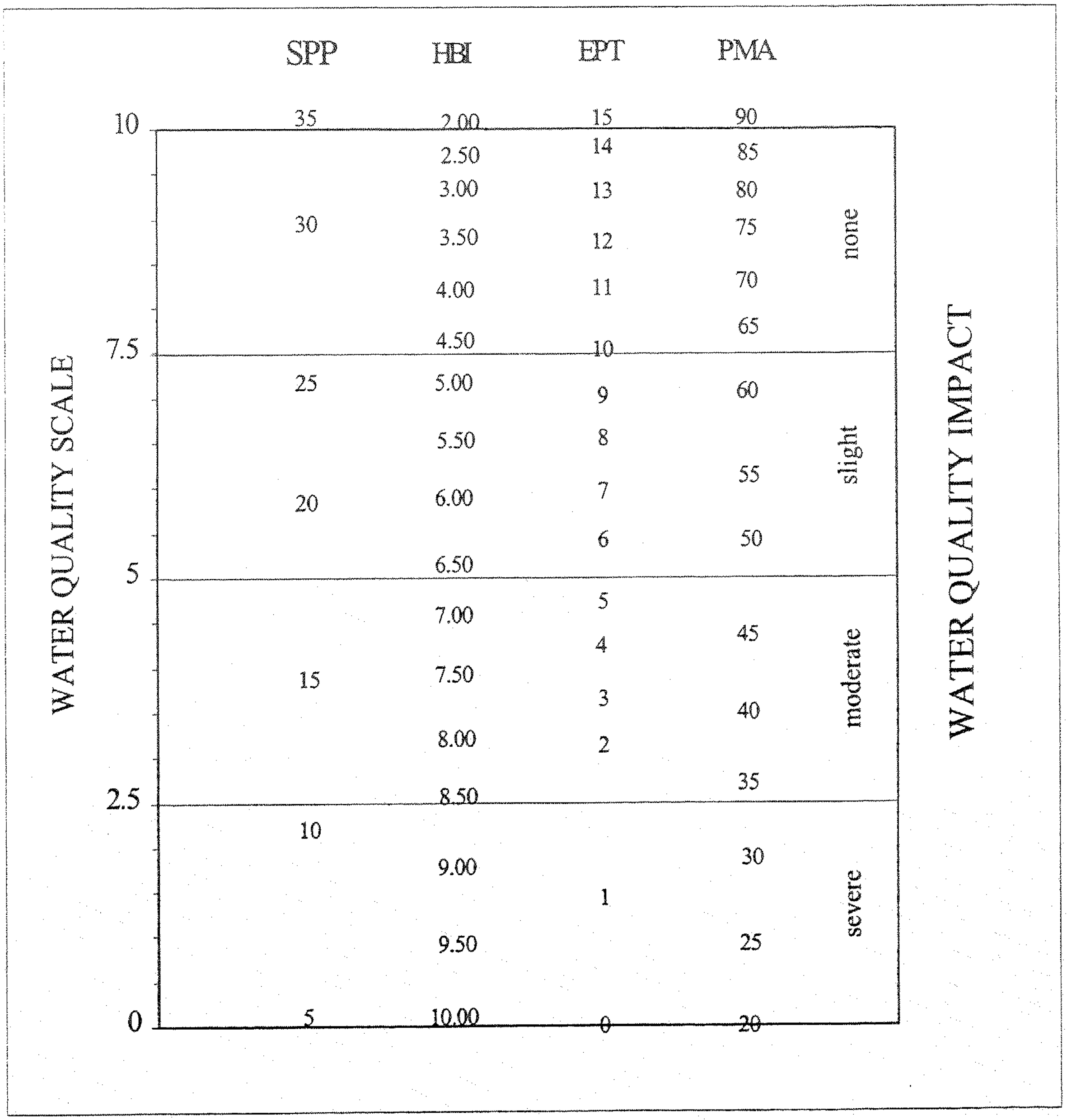
Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50. 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 value is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

Appendix IV. BIOLOGICAL ASSESSMENT PROFILE OF INDEX VALUES

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



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

Appendix V.
WATER QUALITY ASSESSMENT CRITERIA

for non-navigable flowing waters

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

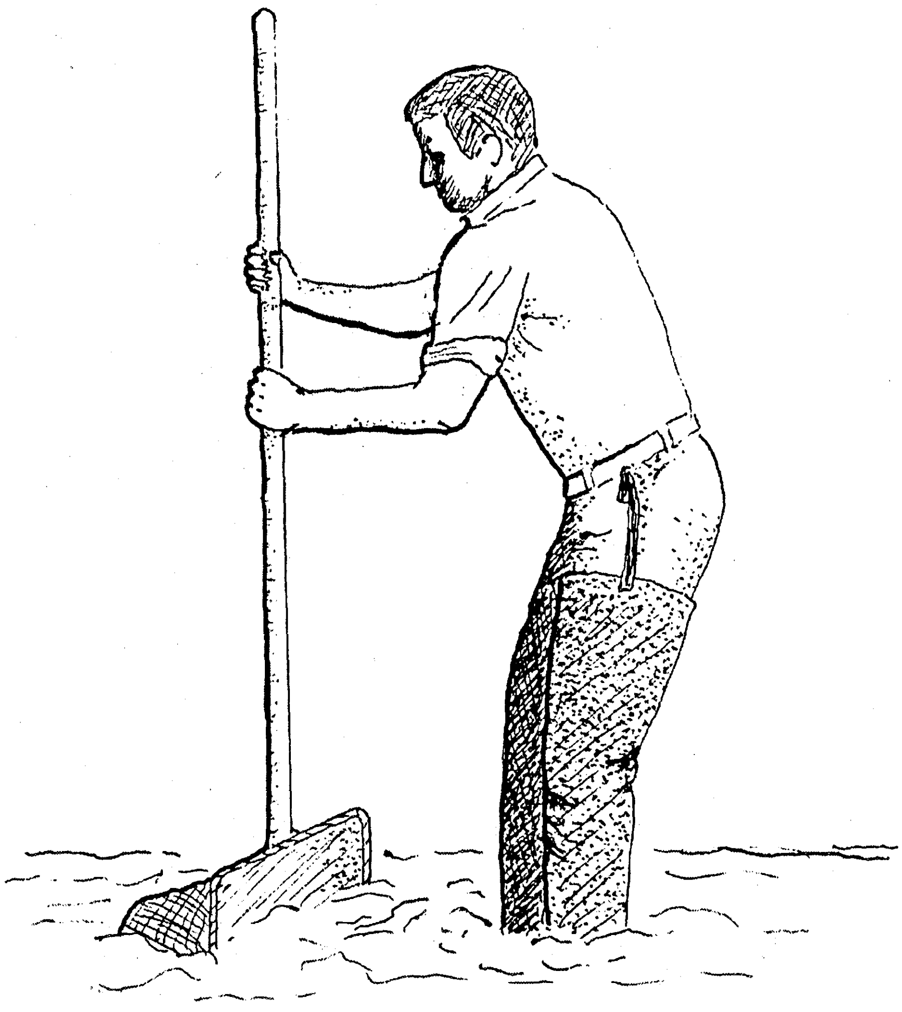
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

WATER QUALITY ASSESSMENT CRITERIA
for navigable flowing waters

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

Appendix VI.

THE TRAVELING KICK SAMPLE



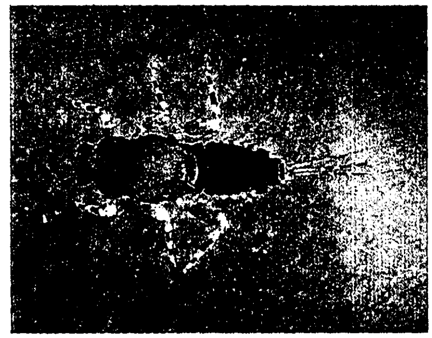
← current

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

Appendix VII. A.

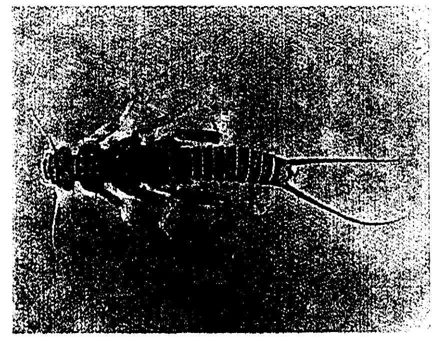
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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



MAYFLIES

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

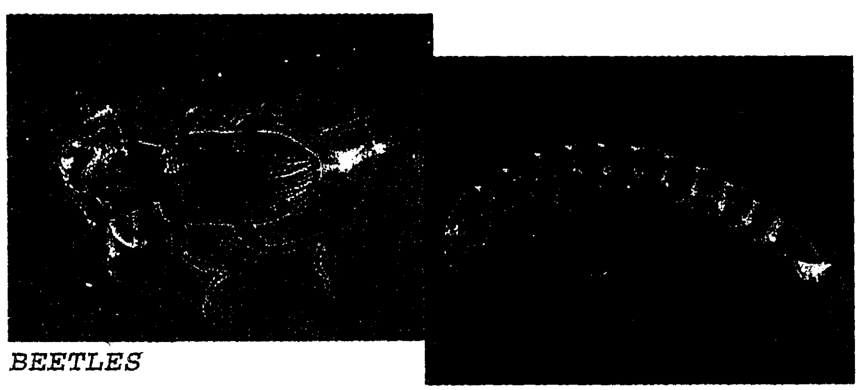


STONEFLIES

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

CADDISFLIES

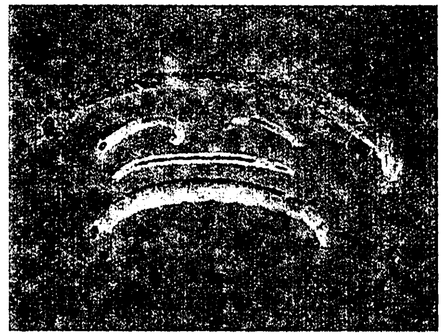
The most common beetles in streams are riffle beetles and water pennies. Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.



BEETLES

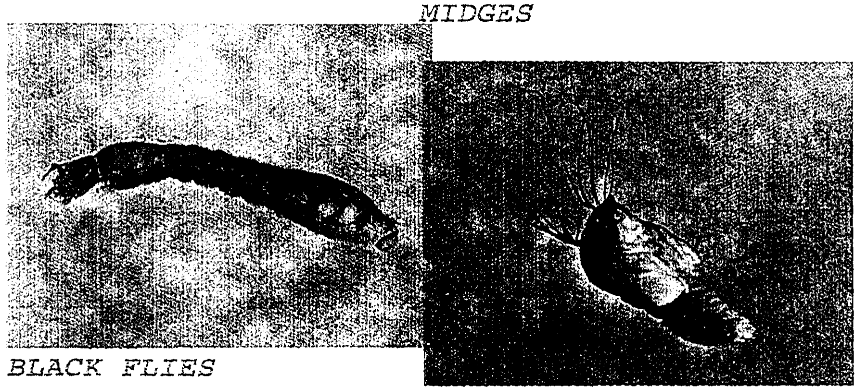
Appendix VII. B.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY



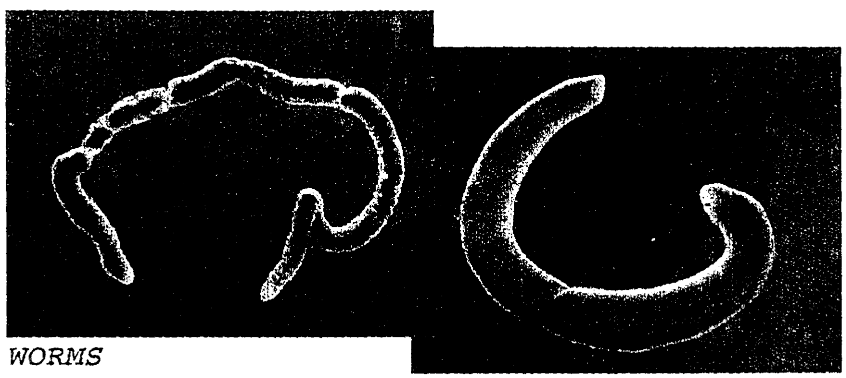
MIDGES

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.



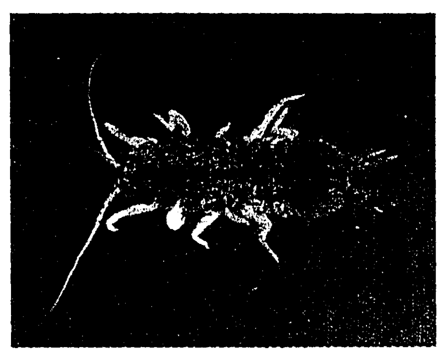
BLACK FLIES

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.



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. They are classic indicators of sewage pollution, and can also thrive in toxic situations.

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

APPENDIX VIII. THE RATIONALE OF BIOLOGICAL MONITORING

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

Concept

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

Advantages

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

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

Limitations

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

APPENDIX IX. GLOSSARY

assessment: a diagnosis or evaluation of water quality

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

biomonitoring: the use of biological indicators to measure water quality

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

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

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

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

fauna: the animal life of a particular habitat

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

impairment: a detrimental effect caused by an impact

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

intolerant: unable to survive poor water quality

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

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

organism: a living individual

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

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

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

station: a sampling site on a waterbody

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

tolerant: able to survive poor water quality

APPENDIX X. METHODS FOR IMPACT SOURCE DETERMINATION

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

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

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

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

NATURAL

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

NONPOINT NUTRIENTS, PESTICIDES

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	-	5	-	-	-	-	-	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	5	-	-	-	-	-	-
<u>Isonychia</u>	-	-	-	-	-	-	-	5	-	-
BAETIDAE	5	15	20	5	20	10	10	5	10	5
HEPTAGENIIDAE	-	-	-	-	5	5	5	5	-	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	5	-	-
<u>Caenis/Tricorythodes</u>	-	-	-	-	5	-	-	5	-	5
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	5	-	-	5	-	5	5	-	-	-
<u>Optioservus</u>	10	-	-	5	-	-	15	5	-	5
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	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	-
<u>Simulium vittatum</u>	-	-	-	-	-	-	-	-	5	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	-	5
CHIRONOMIDAE										
Tanypodinae	-	-	-	-	-	-	5	-	-	5
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/ Orthocladius</u>	10	15	10	5	-	-	-	-	5	5
<u>Eukiefferiella/ Tvetenia</u>	-	15	10	5	-	-	-	-	5	-
<u>Parametriocnemus</u>	-	-	-	-	-	-	-	-	-	-
<u>Microtendipes</u>	-	-	-	-	-	-	-	-	-	20
<u>Polypedilum aviceps</u>	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (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

	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
iocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-
otopus/ rthocladius	5	10	20	-	5	10	5	5	15	10	25	10	5	10
ıkiefferiella/ vetenia	-	-	-	-	-	-	-	-	-	-	20	10	-	-
arametriocnemus	-	-	-	-	-	-	-	-	-	-	-	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

SEWAGE EFFLUENT, ANIMAL WASTES

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

	SILTATION					IMPOUNDMENT									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
<u>Isonychia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Caenis/Tricorythodes</u>	5	20	10	5	15	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
<u>Optioservus</u>	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	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	-	-	-	-	-	-	-	-
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/ Orthocladius</u>	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
<u>Eukiefferiella/ Tvetenia</u>	-	-	10	-	5	5	15	-	-	-	-	-	-	-	-
<u>Parametriocnemus</u>	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
<u>Chironomus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum aviceps</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (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