New York State
Department of Environmental Conservation

Division of Water

West Branch Mongaup River

Biological Assessment

2000 Survey

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BIOLOGICAL STREAM ASSESSMENT

West Branch Mongaup River
Sullivan County, New York

Survey date: September 20, 2000
Report date: May 11, 2001

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Stream: West Branch Mongaup River, Sullivan County, New York

Reach: Swan Lake to Mongaup Valley, New York

Background:

The Stream Biomonitoring Unit conducted biological sampling on the West Branch Mongaup River on September 20, 2000. The purpose of the sampling was to assess general water quality, and determine the cause and extent of any water quality problems, particularly in relation to the Bethel Landfill . Traveling kick samples were taken in riffle areas at five sites, using methods described in the Quality Assurance document (Bode et al., 1996) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample. Water quality assessments were based on resident macroinvertebrates (aquatic insects, worms, mollusks, crustaceans). Community parameters used in the determination of water quality included species richness, biotic index, EPT value, and percent model affinity (see Appendices II and III). Table 2 provides a listing of sampling sites, and Table 3 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by macroinvertebrate data reports, including individual site descriptions and raw invertebrate data from each site.

Results and Conclusions:

1. Water quality in the West Branch Mongaup River ranged from non-impacted to moderately impacted, based on resident macroinvertebrate communities. Upstream impact apparently results from natural effects of the Swan Lake outlet, and possibly from the Liberty (T) Swan Lake wastewater treatment plant discharge and other septic inputs.

2. Water quality showed slight impact downstream of the Bethel Landfill, but recovered quickly downstream. The influence of the Bethel Landfill is considered to extend no more than 0.5 miles.

Discussion:

The purpose of this biological sampling was to determine if the West Branch Mongaup River received any impacts resulting from drainage from the Bethel Landfill. In order to place any impacts in the larger context of overall water quality in the river, two sites were sampled upstream of the landfill, and three sites were sampled downstream.

Results of the present sampling show background effects in the West Branch Mongaup River upstream of the landfill (Figure 1). The most upstream site (WMON-1) exhibited moderate impact, apparently influenced by the Swan Lake outflow, 0.6 miles upstream (see Appendix XI, Impoundment Effects), and possibly by organic and nutrient enrichment from the discharge of the Liberty (T) Swan Lake Sewage Treatment Plant, which enters the river 0.3 miles upstream. Unsewered summer camps and a small package sewage treatment plant in this area may also affect the stream. Impact Source Determination (Table 1) suggests that the impact at this site reflects influences of both the impoundment and the septic inputs.

Water quality was improved 2 miles downstream (WMON-2), just above the Bethel Landfill. The sampling site was just below a tributary that flows westerly along the northern bank of the landfill (Figure 3b). All indices improved, resulting in an assessment of non-impacted (Figure 1). Approximately 0.3 miles below this site, a site was sampled that was downstream from the landfill (WMON-3). Compared to the upstream site, all indices worsened slightly, resulting in a water quality assessment of slightly impacted.

Downstream of the impact site (WMON-3), water quality improved, and is assessed as non-impacted. All community indices improved from Station 3 to 4, and both Stations 4 and 5 have high similarities to natural communities, using Impact Source Determination (Table 1). Based on the macroinvertebrate communities, the influence of the Bethel Landfill extends no more than 0.5 miles downstream in the West Branch Mongaup River. At its confluence with the Middle Branch Mongaup River, 0.5 miles downstream of Station 5, the West Branch Mongaup River contributes water of excellent quality.

Literature Cited:

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

Overview of field data

On the date of sampling, September 20, 2000, the West Branch Mongaup River at the sites sampled was 8-15 meters wide, 0.2-0.3 meters deep, and had current speeds of 80-110 cm/sec in riffles. Dissolved oxygen was 9.0-10.1 mg/l, specific conductance was 90-94 μmhos, pH was 6.9-7.1, and the temperature was 18.4-19.8 °C (65-68 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, West Branch Mongaup River, 2000. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.

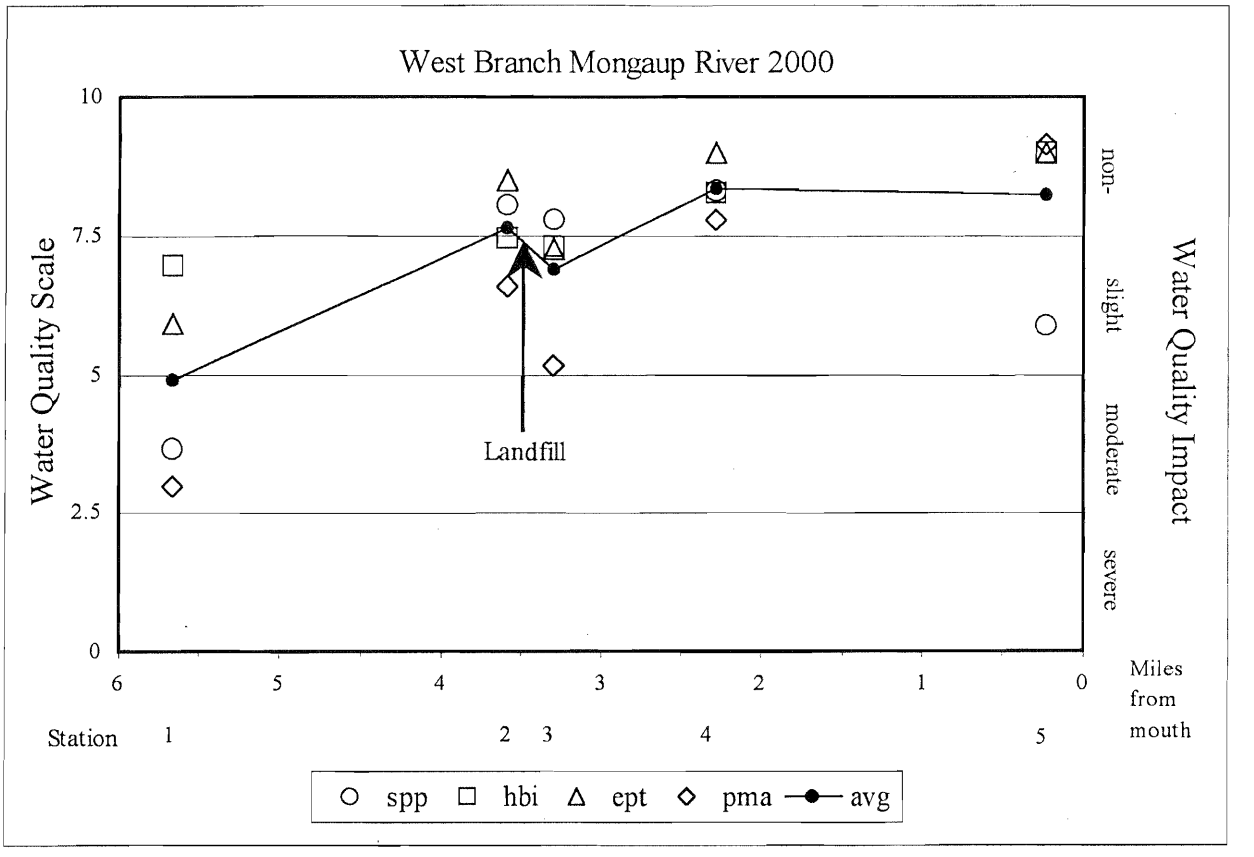


Table 1. Impact Source Determination, West Branch Mongaup River, 2000. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. See Appendix X for more complete explanation.

	STATION				
Community Type	WMON-1	WMON-2	WMON-3	WMON-4	WMON-5
Natural: minimal human impacts	33	47	45	62	59
Nutrient additions; mostly nonpoint, agricultural	59	64	40	53	47
Toxic: industrial, municipal, or urban run-off	35	36	37	32	26
Organic: sewage effluent, animal wastes	58	55	30	36	27
Complex: municipal/industrial	54	53	26	32	26
Siltation	41	48	38	46	37
Impoundment	61	61	43	49	38

TABLE 2. STATION LOCATIONS FOR THE WEST BRANCH MONGAUP RIVER, SULLIVAN COUNTY, NEW YORK (see map).

STATION	LOCATION
01	below Swan Lake off Rte 55; 2.3 mi north of intersection with Old White Lake Rd. 5.7 river miles upstream of mouth latitude/longitude: 41°44'42"; 74°47'07"
02	below Swan Lake 50 meters below unnamed trib that runs by landfill; above White Lake Road bridge 3.6 river miles upstream of mouth latitude/longitude: 41°43'09"; 74°47'25"
03	Bethel 30 meters above Blum Rd bridge at intersection with Creamery Rd 3.3 river miles upstream of mouth latitude/longitude: 41°42'56"; 74°47'34"
04	Bethel Creamery Rd at trib; 0.6 miles south of Old White Lake Rd./ Blum Rd. 2.3 river miles upstream of mouth latitude/longitude: 41°42'26"; 74°47'19"
05	Mongaup Valley 20 m above Gale Rd bridge 0.2 river miles upstream of mouth latitude/longitude: 41°40'52"; 74°46'30"

Figure 2	Site Overview Map	West Branch Mongaup River

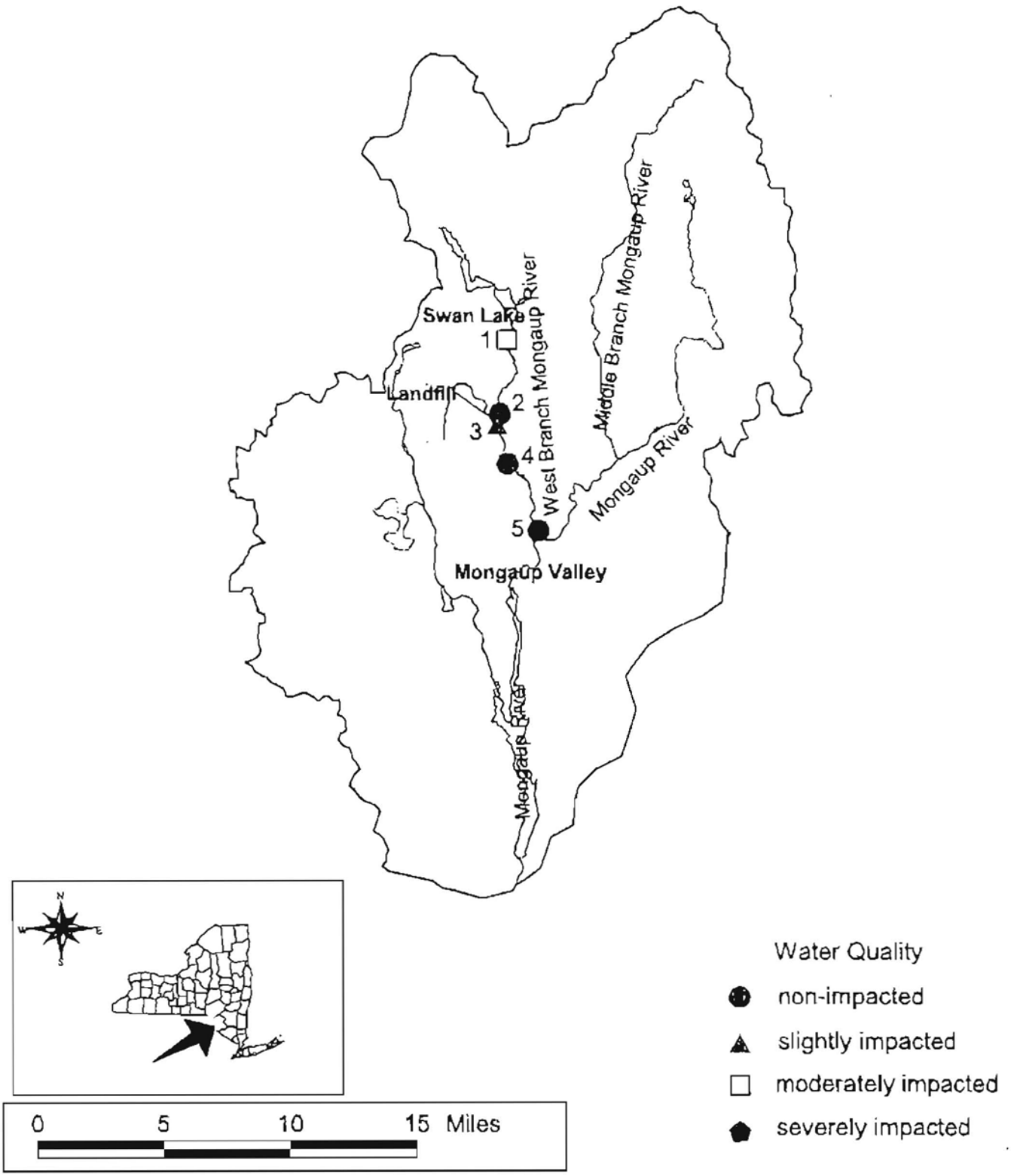
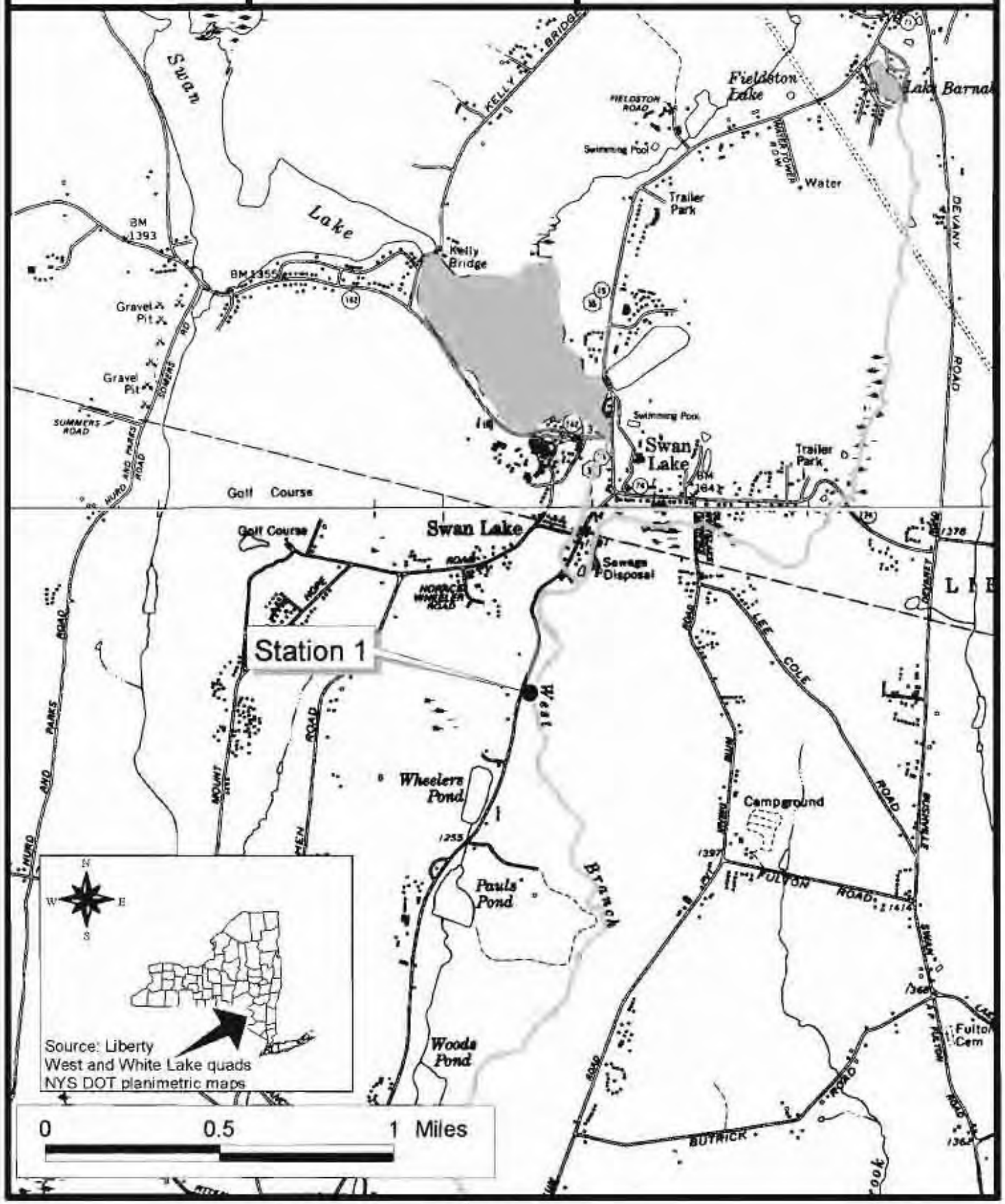
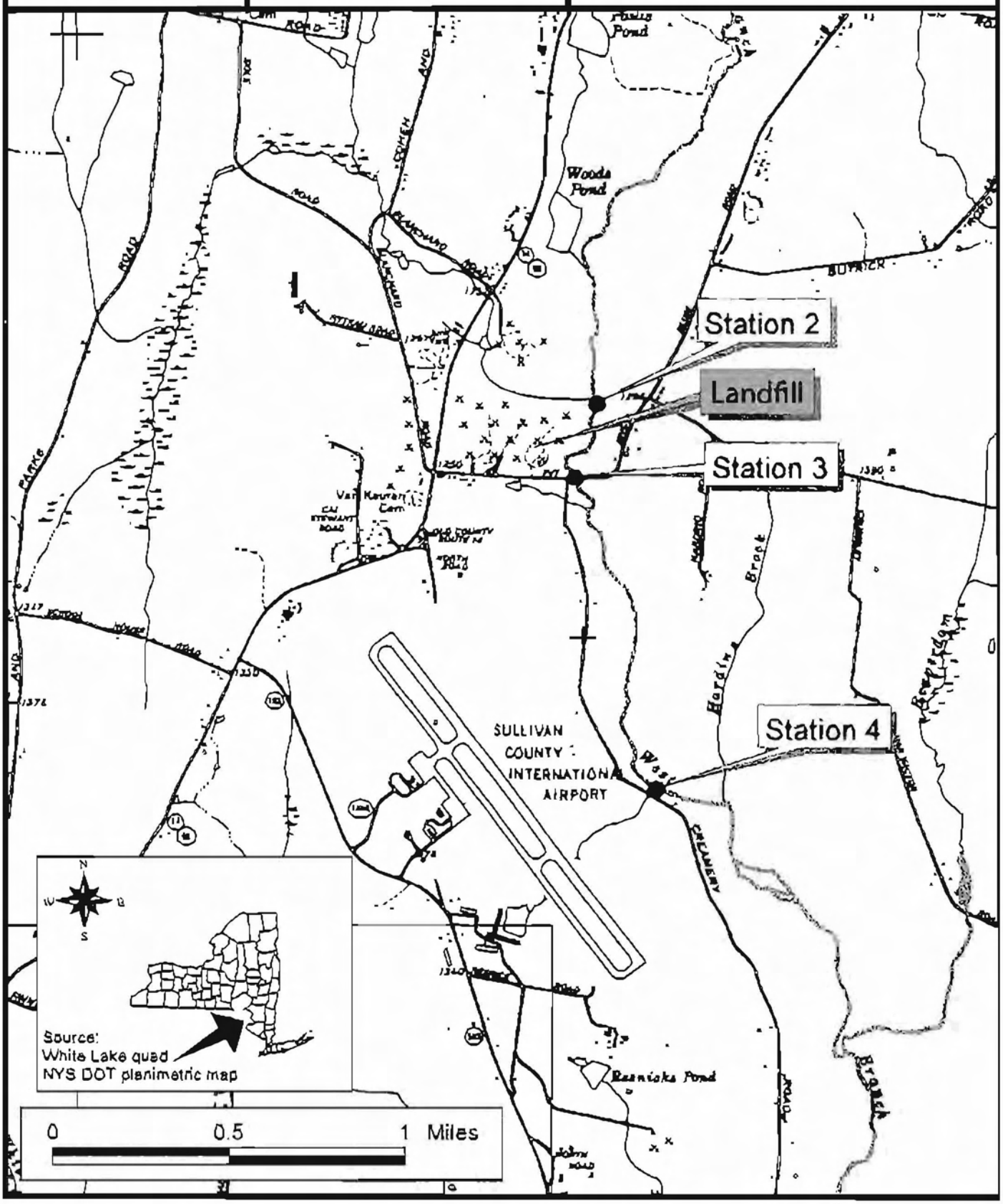


Figure 3a	Site Location Map	West Branch Mongaup River



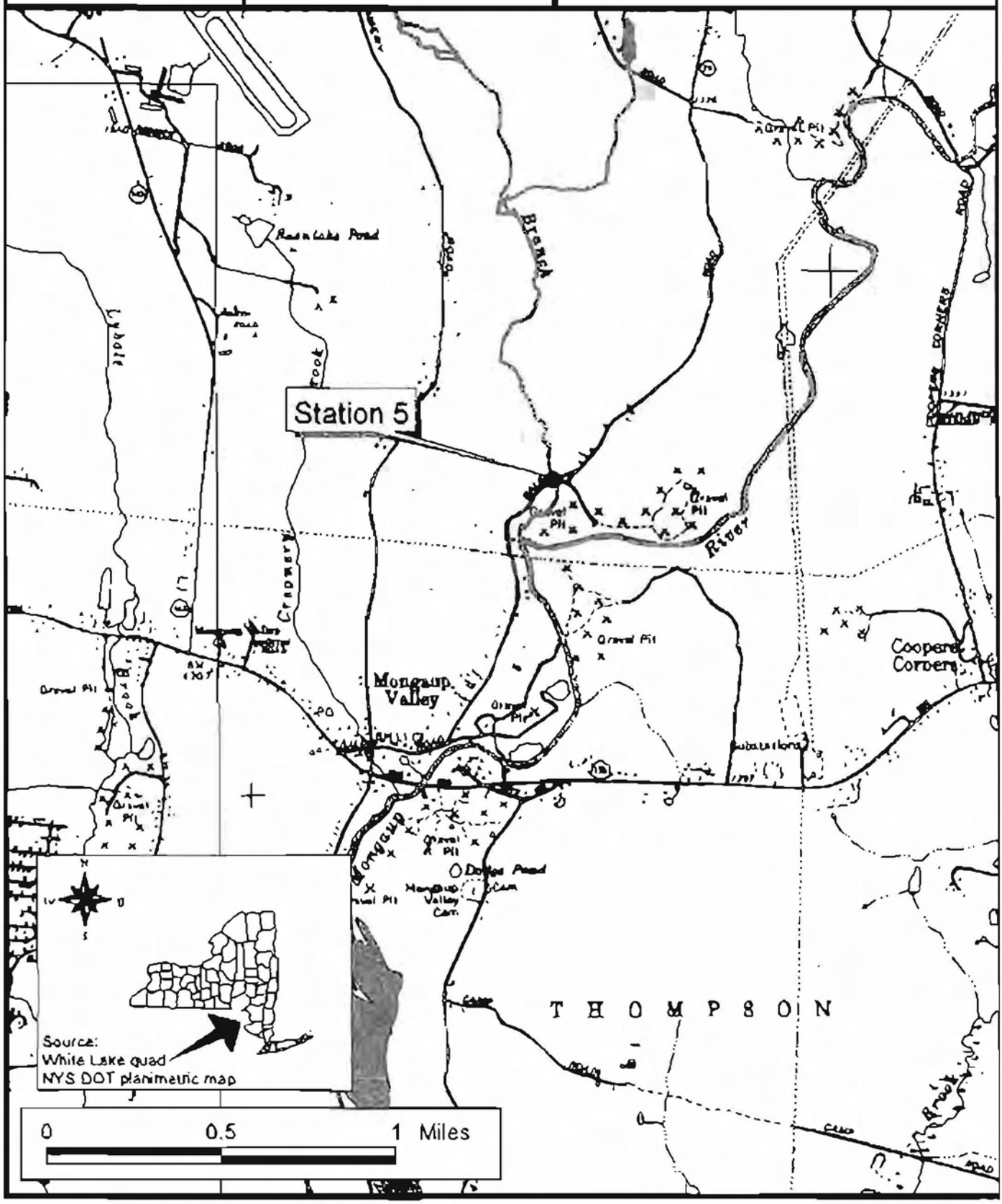
stream flow

Figure 3b	Site Location Map	West Branch Mongaup River



stream flow

Figure 3c	Site Location Map	West Branch Mongaup River



stream flow

TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN THE WEST BRANCH MONGAUP RIVER, SULLIVAN COUNTY, NEW YORK, SEPTEMBER 20, 2000.

- NEMERTEA
  - Prostoma graecense
- ANNELIDA
  - OLIGOCHAETA
    - Lumbriculidae
      - Undetermined Lumbriculidae
- MOLLUSCA
  - GASTROPODA
    - Ancylidae
      - Ferrissia sp.
  - PELECYPODA
    - Sphaeriidae
      - Sphaerium sp.
- ARTHROPODA
  - CRUSTACEA
    - ISOPODA
      - Asellidae
        - Caecidotea racovitzai
  - INSECTA
    - EPHEMEROPTERA
      - Isonychiidae
        - Isonychia bicolor
      - Baetidae
        - Acentrella sp.
        - Baetis brunneicolor
        - Baetis flavistriga
        - Baetis intercalaris
      - Heptageniidae
        - Stenonema modestum
        - Stenonema terminatum
      - Ephemerellidae
        - Ephemerella subvaria
        - Undetermined Ephemerellidae
    - ODONATA
      - Gomphidae
        - Ophiogomphus sp.
    - PLECOPTERA
      - Perlidae
        - Acroneuria abnormis
        - Paragnetina media
    - COLEOPTERA
      - Psephenidae
        - Ectopria nervosa
        - Psephenus herricki
      - Elmidae
        - Macronychus glabratus
        - Optioservus sp.
        - Stenelmis crenata
    - MEGALOPTERA
      - Corydalidae
        - Nigronia serricornis
    - TRICHOPTERA
      - Philopotamidae
        - Chimarra aterrima?
        - Dolophilodes sp.
      - Hydropsychidae
        - Cheumatopsyche sp.
        - Hydropsyche betteni
        - Hydropsyche bronta
        - Hydropsyche morosa
        - Hydropsyche sparna
      - Rhyacophilidae
        - Rhyacophila carolina?
        - Rhyacophila fuscula
        - Rhyacophila sp.
      - Glossosomatidae
        - Glossosoma sp.
      - Hydroptilidae
        - Leucotrichia sp.
      - Brachycentridae
        - Undetermined Brachycentridae
    - DIPTERA
      - Tipulidae
        - Antocha sp.
        - Dicranota sp.
      - Simuliidae
        - Simulium tuberosum
        - Simulium vittatum
        - Simulium sp.
      - Empididae
        - Hemerodromia sp.
      - Chironomidae
        - Diamesinae
          - Diamesa sp.
          - Potthastia longimana
        - Orthocladiinae
          - Eukiefferiella brehmi gr.
          - Eukiefferiella claripennis gr.
          - Nanocladius spiniplenus
          - Parachaetocladius sp.
          - Rheocricotopus robacki
          - Tvetenia bavarica gr.
          - Tvetenia vitracies
        - Chironominae
          - Microtendipes pedellus gr.
          - Microtendipes rydalensis gr.
          - Polypedilum aviceps
          - Polypedilum convictum
          - Stenochironomus sp.
          - Rheotanytarsus distinctissimus gr.
          - Rheotanytarsus exiguus gr.

STREAM SITE:	West Branch Mongaup River, Station 1
LOCATION:	below Swan Lake, New York, at Route 55
DATE:	September 20, 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

NEMERTEA		Prostoma graecense	2
MOLLUSCA			
PELECYPODA	Sphaeriidae	Sphaerium sp.	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	3
		Baetis flavistriga	2
	Heptageniidae	Stenonema modestum	9
MEGALOPTERA	Corydalidae	Nigronia serricornis	2
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	40
		Hydropsyche betteni	31
		Hydropsyche bronta	1
	Hydroptilidae	Leucotrichia sp.	1
DIPTERA	Simuliidae	Simulium vittatum	1
	Chironomidae	Potthastia longimana	1
		Eukiefferiella brehmi gr.	1
		Polypedilum convictum	4

SPECIES RICHNESS	14 (poor)
BIOTIC INDEX	4.92 (good)
EPT RICHNESS	7 (good)
MODEL AFFINITY	37 (poor)
ASSESSMENT	moderately impacted

DESCRIPTION This site was located less than 0.5 miles downstream of the outlet of Swan Lake, and also a short distance downstream of a wastewater treatment plant discharge. The macroinvertebrate fauna was enriched, and heavily dominated by caddisflies, although mayflies and stoneflies were also present. Due to the heavy dominance of caddisflies, the community indices were low, and water quality was assessed as moderately impacted. Some or all of this impact is attributed to natural effects of lake outlets (see Appendix XI.)

STREAM SITE:	West Branch Mongaup River, Station 2
LOCATION:	below Swan Lake, New York, above Old White Lake Road
DATE:	September 20, 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

NEMERTEA		Prostoma graecense	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	2
		Baetis brunneicolor	1
	Heptageniidae	Stenonema modestum	2
	Ephemerellidae	Undetermined Ephemerellidae	1
PLECOPTERA	Perlidae	Acroneuria abnormis	2
		Paragnetina media	3
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus sp.	6
		Stenelmis crenata	1
MEGALOPTERA	Corydalidae	Nigronia serricornis	5
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	6
		Hydropsyche betteni	28
		Hydropsyche bronta	4
		Hydropsyche sparna	5
	Rhyacophilidae	Rhyacophila fuscula	1
	Glossosomatidae	Glossosoma sp.	6
DIPTERA	Tipulidae	Dicranota sp.	1
	Simuliidae	Simulium tuberosum	1
		Simulium vittatum	2
	Chironomidae	Nanocladius spiniplenus	1
		Tvetenia vitracies	8
		Microtendipes pedellus gr.	1
		Microtendipes rydalensis gr.	1
		Polypedilum aviceps	1
		Polypedilum convictum	1
		Rheotanytarsus distinctissimus gr.	6
		Rheotanytarsus exiguus gr.	2

SPECIES RICHNESS	28 (very good)
BIOTIC INDEX	4.55 (good)
EPT RICHNESS	12 (very good)
MODEL AFFINITY	59 (good)
ASSESSMENT	non-impacted

DESCRIPTION The sample was taken 50 meters downstream of an unnamed tributary that runs by the landfill. The macroinvertebrate fauna was rich and diverse, with many mayflies, stoneflies, caddisflies, and hellgrammites. Based on the community indices, water quality was assessed as non-impacted.

STREAM SITE: West Branch Mongaup River, Station 3
LOCATION: Bethel, New York, Blum Road at Creamery Road
DATE: September 20, 2000
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

NEMERTEA		Prostoma graecense	2
ANNELIDA			
OLIGOCHAETA	Lumbriculidae	Undetermined Lumbriculidae	1
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea racovitzai	1
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	1
	Heptageniidae	Stenonema terminatum	4
	Ephemerellidae	Ephemerella subvaria	1
PLECOPTERA	Perlidae	Acroneuria abnormis	3
		Paragnetina media	2
COLEOPTERA	Elmidae	Macronychus glabratus	1
		Optioservus sp.	1
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	7
	Hydropsychidae	Cheumatopsyche sp.	1
		Hydropsyche betteni	21
	Rhyacophilidae	Rhyacophila sp.	1
	Brachycentridae	Undetermined Brachycentridae	1
DIPTERA	Simuliidae	Simulium tuberosum	1
		Simulium sp.	1
	Empididae	Hemerodromia sp.	1
	Chironomidae	Eukiefferiella brehmi gr.	15
		Parachaetocladius sp.	1
		Rheocricotopus robacki	2
		Tvetenia bavarica gr.	7
		Tvetenia vitracies	19
		Polypedilum aviceps	2
		Stenochironomus sp.	1
		Rheotanytarsus distinctissimus gr.	1
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS 27 (very good)
BIOTIC INDEX 4.65 (good)
EPT RICHNESS 10 (good)
MODEL AFFINITY 50 (good)
ASSESSMENT slightly impacted

DESCRIPTION This site was located approximately 100 meters downstream of the landfill. The macroinvertebrate fauna was mostly similar to that at the upstream site. However, slight decreases in all community indices resulted in an overall assessment of slightly impacted.

STREAM SITE: West Branch Mongaup River, Station 4
LOCATION: Bethel, New York, south of Old White Lake Road at Creamery Road
DATE: September 20, 2000
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

NEMERTEA		Prostoma graecense	1
ANNELIDA			
OLIGOCHAETA	Lumbriculidae	Undetermined Lumbriculidae	2
MOLLUSCA			
GASTROPODA	Ancylidae	Ferrissia sp.	1
PELECYPODA	Sphaeriidae	Sphaerium sp.	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Acentrella sp.	5
	Heptageniidae	Stenonema modestum	5
	Ephemerellidae	Ephemerella subvaria	1
ODONATA	Gomphidae	Ophiogomphus sp.	2
PLECOPTERA	Perlidae	Acroneuria abnormis	6
		Paragnetina media	1
COLEOPTERA	Psephenidae	Ectopria nervosa	1
	Elmidae	Optioservus fastiditus	9
MEGALOPTERA	Corydalidae	Nigronia serricornis	4
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	3
		Dolophilodes sp.	4
	Hydropsychidae	Hydropsyche betteni	17
		Hydropsyche bronta	2
		Hydropsyche sparna	3
	Rhyacophilidae	Rhyacophila carolina?	3
		Rhyacophila fuscula	1
	Glossosomatidae	Glossosoma sp.	1
DIPTERA	Tipulidae	Antocha sp.	7
	Simuliidae	Simulium sp.	1
	Chironomidae	Diamesa sp.	1
		Eukiefferiella claripennis gr.	1
		Tvetenia vitracies	6
		Polypedilum aviceps	4
		Rheotanytarsus distinctissimus gr.	6
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS 29 (very good)
BIOTIC INDEX 3.72 (very good)
EPT RICHNESS 13 (very good)
MODEL AFFINITY 67 (very good)
ASSESSMENT non-impacted

DESCRIPTION The sample was taken off Creamery Road, approximately 0.6 miles south of Old White Lake Road. The macroinvertebrate fauna was rich and diverse, with many mayflies, stoneflies, and caddisflies. All community indices were within the range of non-impacted water quality.

STREAM SITE:	West Branch Mongaup River, Station 5
LOCATION:	Mongaup Valley, New York, above Gale Road bridge
DATE:	September 20, 2000
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

NEMERTEA		Prostoma graecense	4
ANNELIDA			
OLIGOCHAETA	Lumbriculidae	Undetermined Lumbriculidae	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	1
	Baetidae	Acentrella sp.	3
		Baetis intercalaris	2
	Heptageniidae	Stenonema modestum	1
	Ephemerellidae	Ephemerella subvaria	22
PLECOPTERA	Perlidae	Paragnetina media	2
COLEOPTERA	Elmidae	Optioservus sp.	10
MEGALOPTERA	Corydalidae	Nigronia serricornis	8
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	1
		Dolophilodes sp.	4
	Hydropsychidae	Cheumatopsyche sp.	9
		Hydropsyche morosa	3
		Hydropsyche sparna	4
	Rhyacophilidae	Rhyacophila carolina?	5
		Rhyacophila fuscula	1
DIPTERA	Chironomidae	Parachaetocladius sp.	5
		Tvetenia bavarica gr.	2
		Polypedilum aviceps	6
		Rheotanytarsus distinctissimus gr.	5

SPECIES RICHNESS	21 (good)
BIOTIC INDEX	3.02 (very good)
EPT RICHNESS	13 (very good)
MODEL AFFINITY	81 (very good)
ASSESSMENT	non- impacted

DESCRIPTION The kick sample was taken upstream of the Gale Road bridge in Mongaup Valley. The macroinvertebrate community at this site was dominated by mayflies, compared to upstream communities that were dominated by caddisflies. Based on the community indices, water quality was assessed as non-impacted.

LABORATORY DATA SUMMARY				
STREAM NAME: Mongaup River-West Branch		**DRAINAGE: 14**		
DATE SAMPLED: 09/20/00		**COUNTY: Sullivan**		
SAMPLING METHOD: Traveling Kick				
STATION	01	02	03	04
LOCATION	below Swan Lake	below Swan Lake	Bethel	Bethel
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Cheumatopsyche sp. 40 % facultative caddisfly	Hydropsyche betteni 28 % facultative caddisfly	Hydropsyche betteni 21 % facultative caddisfly	Hydropsyche betteni 17 % facultative caddisfly
2.	Hydropsyche betteni 31 % facultative caddisfly	Tvetenia vitracies 8 % facultative midge	Tvetenia vitracies 19 % facultative midge	Optioservus fastiditus 9 % intolerant beetle
3.	Stenonema modestum 9 % intolerant mayfly	Optioservus sp. 6 % intolerant beetle	Eukiefferiella brehmi gr. 15 % intolerant midge	Antocha sp. 7 % intolerant crane fly
4.	Polypedilum convictum 4 % facultative midge	Cheumatopsyche sp 6. % facultative caddisfly	Chimarra aterrima? 7 % facultative caddisfly	Acroneuria abnormis 6 % intolerant stonefly
5.	Acentrella sp. 3 % intolerant mayfly	Glossosoma sp. 6 % intolerant caddisfly	Tvetenia bavarica gr. 7 % facultative midge	Tvetenia vitracies 6 % facultative midge
Intolerant = not tolerant of poor water quality				
Facultative = occurring over a wide range of water quality				
Tolerant = tolerant of poor water quality				
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	6 (3)	21 (8)	49 (9)	19 (6)
Trichoptera (caddisflies)	73 (4)	50 (6)	31 (5)	34 (8)
Ephemeroptera (mayflies)	14 (3)	6 (4)	6 (3)	11 (3)
Plecoptera (stoneflies)	0 (0)	5 (2)	5 (2)	7 (2)
Coleoptera (beetles)	0 (0)	8 (3)	2 (2)	10 (2)
Oligochaeta (worms)	0 (0)	0 (0)	1 (1)	2 (1)
Other	7 (4)	10 (5)	6 (5)	17 (7)
SPECIES RICHNESS	14	28	27	29
BIOTIC INDEX	4.92	4.55	4.65	3.72
EPT RICHNESS	7	12	10	13
PERCENT MODEL AFFINITY	37	59	50	67
FIELD ASSESSMENT	good	very good	very good	very good
OVERALL ASSESSMENT	moderately imptd	non-impacted	slightly impacted	non-impacted

LABORATORY DATA SUMMARY				
STREAM NAME: Mongaup River-West Branch DATE SAMPLED: 09/20/00		DRAINAGE: 14 COUNTY: Sullivan		
SAMPLING METHOD: Traveling Kick				
STATION LOCATION	05 Mongaup Valley			
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Ephemerella subvaria 22 % intolerant mayfly			
2. Intolerant = not tolerant of poor water quality	Optioservus sp. 10 % intolerant beetle			
3. Facultative = occurring over a wide range of water quality	Cheumatopsyche sp. 9 % facultative caddisfly			
4. Tolerant = tolerant of poor water quality	Nigronia serricornis 8 % intolerant dobsonfly			
5.	Polypedilum aviceps 6 % facultative midge			
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	18 (4)			
Trichoptera (caddisflies)	27 (7)			
Ephemeroptera (mayflies)	29 (5)			
Plecoptera (stoneflies)	2 (1)			
Coleoptera (beetles)	10 (1)			
Oligochaeta (worms)	2 (1)			
Other	12 (2)			
SPECIES RICHNESS	21			
BIOTIC INDEX	3.02			
EPT RICHNESS	13			
PERCENT MODEL AFFINITY	81			
FIELD ASSESSMENT OVERALL ASSESSMENT	very good non-impacted			

FIELD DATA SUMMARY

STREAM NAME: Mongaup River-West Br. **DATE SAMPLED: 09/20/00**
REACH: Swan Lake to Mongaup Valley
FIELD PERSONNEL INVOLVED: Abele, Gabriel

STATION	01	02	03	04
ARRIVAL TIME AT STATION	1:05	12:20	1:40	2:05
LOCATION	below Swan Lake	below landfill trib	Blum Rd. bridge	Creamery Rd.
PHYSICAL CHARACTERISTICS				
Width (meters)	8	8	10	10
Depth (meters)	0.3	0.2	0.3	0.2
Current speed (cm per sec.)	80	100	110	100
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10		10	10
Rubble (6.35 - 25.4 cm)	30	30	30	30
Gravel (0.2 – 6.35 cm)	30	30	20	30
Sand (0.06 – 2.0 mm)	20	30	30	20
Silt (0.004 – 0.06 mm)	10	10	10	10
Embeddedness (%)	30	50	40	50
CHEMICAL MEASUREMENTS				
Temperature (°C)	19.8	18.4	19.0	19.1
Specific Conductance (umhos)	90	90	94	94
Dissolved Oxygen (mg/l)	9.0	10.0	9.9	9.8
pH	7.0	7.1	6.9	7.0
BIOLOGICAL ATTRIBUTES				
Canopy (%)	60	70	60	80
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous		present	present	present
algae - diatoms	present	present	present	present
macrophytes or moss			present	
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)		X	X	X
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)				
Megaloptera(dobsonflies,alderflies)	X	X	X	
Odonata (dragonflies, damselflies)	X			
Chironomidae (midges)	X	X	X	X
Simuliidae (black flies)	X	X	X	
Decapoda (crayfish)	X			X
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)	X	X		X
Other				
FIELD ASSESSMENT	good	very good	very good	very good

FIELD DATA SUMMARY				
STREAM NAME: Mongaup River-West Br. DATE SAMPLED: 09/20/00 REACH: Swan Lake to Mongaup Valley FIELD PERSONNEL INVOLVED:Abele, Gabriel				
STATION ARRIVAL TIME AT STATION	05 2:40			
LOCATION	Mongaup Valley			
PHYSICAL CHARACTERISTICS				
Width (meters)	15			
Depth (meters)	0.3			
Current speed (cm per sec.)	90			
Substrate (%)				
Rock (>25.4 cm, or bedrock)				
Rubble (6.35 - 25.4 cm)	20			
Gravel (0.2 – 6.35 cm)	30			
Sand (0.06 – 2.0 mm)	30			
Silt (0.004 - 0.06 mm)	20			
Embeddedness (%)	50			
CHEMICAL MEASUREMENTS				
Temperature (°C)	19.1			
Specific Conductance (umhos)	91			
Dissolved Oxygen (mg/l)	10.1			
pH	7.1			
BIOLOGICAL ATTRIBUTES				
Canopy (%)	20			
Aquatic Vegetation				
algae – suspended				
algae - attached, filamentous				
algae - diatoms	present			
macrophytes or moss	present			
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X			
Plecoptera (stoneflies)	X			
Trichoptera (caddisflies)	X			
Coleoptera (beetles)	X			
Megaloptera(dobsonflies,alderflies)	X			
Odonata (dragonflies, damselflies)	X			
Chironomidae (midges)	X			
Simuliidae (black flies)				
Decapoda (crayfish)				
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)	X			
Other				
FIELD ASSESSMENT	very good			

APPENDICIES

I. Biological methods for kick sampling

II. Macroinvertebrate community parameters

III. Levels of water quality impact in streams

IV. Biological Assessment Profile derivations

V. Water quality assessment criteria

VI. Traveling kick sample illustration

VII. Macroinvertebrate illustrations

VIII. Rationale for biological monitoring

IX. Glossary

X. Methods for Impact Source Determination

XI. Effect of impoundment on aquatic invertebrate communities

BIOLOGICAL METHODS FOR KICK SAMPLING

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

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

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

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

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

MACROINVERTEBRATE COMMUNITY PARAMETERS

1. Species richness is the total number of species or taxa found in the sample. For subsamples of 100-organisms each that are taken from kick samples, expected ranges in most New York State streams are: greater than 26, non-impacted; 19-26, slightly impacted; 11 - 18, moderately impacted; less than 11, severely impacted.

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

3. Hilsnhoff Biotic index is a measure of the tolerance of the organisms in the sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For purposes of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Values are listed in Hilsenhoff (1987); additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in the Quality Assurance document (Bode et al., 1996). Ranges for the levels of impact are: 0-4.50, non-impacted; 4.5 1-6.50, slightly impacted; 6.5 1-8.50, moderately impacted; and 8.51 - 10.00, severely impacted.

4. Percent Model Affinity is a measure of similarity to a model non-impacted community based on percent abundance in seven major macroinvertebrate groups (Novak and Bode, 1992). Percent abundances in the model community are 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other. Impact ranges are: greater than 64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and less than 35, severely impacted.

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

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

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

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

LEVELS OF WATER QUALITY IMPACT IN STREAMS

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

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

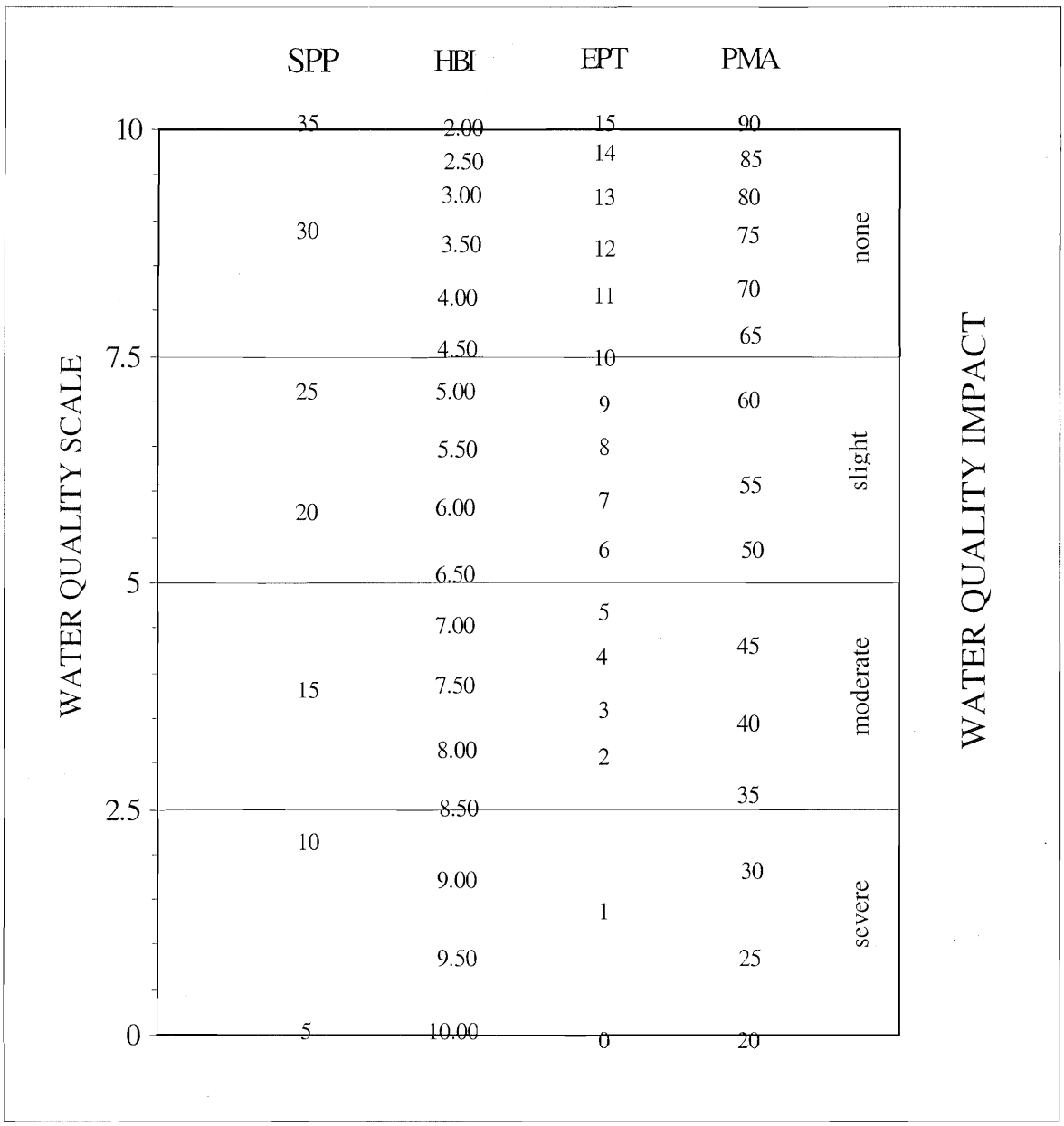
2. *Slightly impacted* Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50.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

3. *Moderately impacted* Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT richness is 2-5. The biotic index value is 6.51- 8.50. The percent model affinity value is 35-49. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. *Severely impacted* Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. Species richness is 10 or less. Mayflies, stoneflies, and caddisflies are rare or absent; EPT richness is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

Biological Assessment Profile: Conversion of Index values to Common 10-Scale

The Biological Assessment Profile of index values, developed by Phil O'Brien, Division of Water, NYSDEC, is a method of plotting biological index values on a common scale of water-quality impact. Values from the four indices, defined in the Macroinvertebrate Community Parameter Appendix, are converted to a common 0-10 scale using the formulae in the Quality Assurance document (Bode, et al., 2002) and as shown in the figure below.



Biological Assessment Profile: Plotting Values

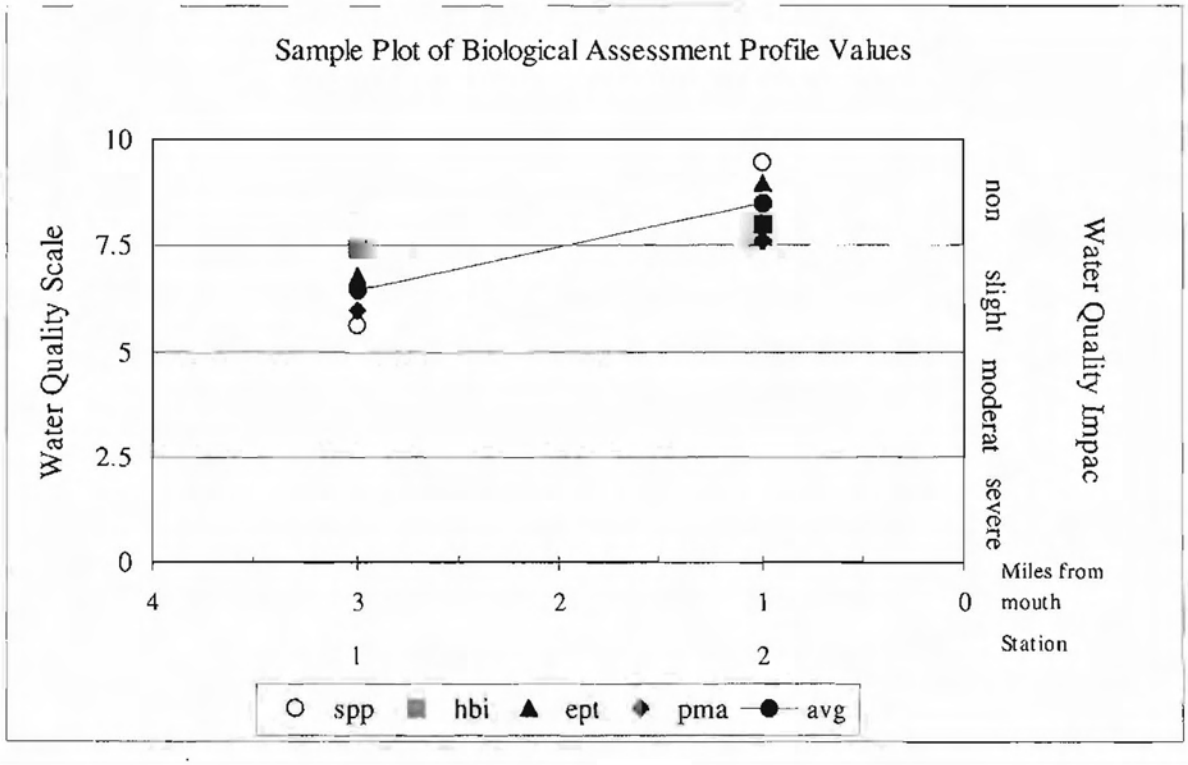
To plot survey data:

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

Example data:

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

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



Water Quality Assessment Criteria

Water Quality Assessment Criteria for Non-Navigable Flowing Waters

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

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

Water Quality Assessment Criteria for Navigable Flowing Waters

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

Appendix VI.

THE TRAVELING KICK SAMPLE

← CURRENT ——

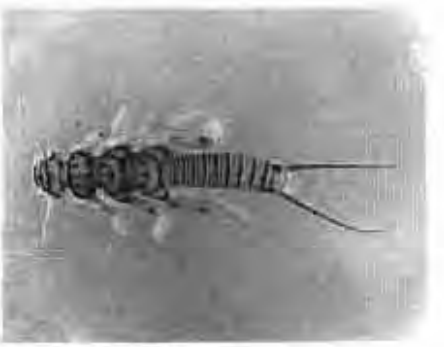
Rocks and sediment in the stream riffle are dislodged by foot upstream of a net; dislodged organisms are carried by the current in the net. Sampling is continued for a specified time, gradually moving downstream to cover a specified distance.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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

MAYFLIES

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



STONEFLIES

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

CADDISFLIES

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

BEETLES

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

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

MIDGES

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

BLACK FLIES

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

WORMS

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

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

SOWBUGS

THE RATIONALE OF BIOLOGICAL MONITORING

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

Concept

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

Advantages

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

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

Limitations

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

Anthropogenic: caused by human actions

Assessment: a diagnosis or evaluation of water quality

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

Bioaccumulate: accumulate contaminants in the tissues of an organism

Biomonitoring: the use of biological indicators to measure water quality

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

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

EPT richness: the number of species of mayflies (**E**phemeroptera), stoneflies (**P**lecoptera), and caddisflies (**Tr**ichoptera) in a sample or subsample

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

Fauna: the animal life of a particular habitat

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

Impairment: a detrimental effect caused by an impact

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

Intolerant: unable to survive poor water quality

Longitudinal trends: upstream-downstream changes in water quality in a river or stream

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

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

Organism: a living individual

PAHs: Polycyclic Aromatic Hydrocarbons, a class of organic compounds that are often toxic or carcinogenic

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

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

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

Station: a sampling site on a waterbody

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

Synergistic effect: an effect produced by the combination of two factors that is greater than the sum of the two factors

Tolerant: able to survive poor water quality

Impact Source Determination Methods and Community Models

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

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

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

Limitations: These methods were developed for data derived from subsamples of 100-organisms each that are taken from traveling kick samples of New York State streams. Application of these methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

Impact Source Determination Models

NATURAL

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

Impact Source Determination Models

NONPOINT NUTRIENTS, PESTICIDES

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

Impact Source Determination Models

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

Impact Source Determination Models

SEWAGE EFFLUENT, ANIMAL WASTES

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

Impact Source Determination Models

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

EFFECTS OF LAKE OUTLETS AND IMPOUNDMENTS ON AQUATIC INVERTEBRATE COMMUNITIES

Lakes, ponds, and impoundments have pronounced effects on the invertebrate faunas of their outflows. Although each outflow is dependent on the characteristics of the lake, most outflows share the following traits:

1. Species richness is nearly always lower below lake outlets. Due primarily to the lack of upstream communities to provide a resource for colonization and drift, lake outlet communities often have only about 60% of the number of species found in comparable non-impacted segments. EPT richness is often only 30% of that found at non-impacted sites. Biotic index values and percent model affinity values are also depressed (see below).

2. Several types of invertebrate communities are found downstream of impoundments. Invertebrates which are commonly numerous below lake outlets include Simulium (black fly larvae), Cheumatopsvche or Hydropsyche (filter-feeding caddisflies), Nais (worms), Gammarus (crustacean), Rheotanytarsus (midges), Stenelmis (riffle beetles) Sphaerium (fingernail clams), or Platyhelminthes (flatworms). To date, 8 community types have been identified from streams in New York State.

3. A marked succession of species often occurs over a short distance. Productivity may be initially high below the lake, but usually decreases a short distance downstream. Plankton carried downstream from the lake increases the biomass immediately downstream, primarily of organisms which feed by filtering plankton, such as certain caddisflies, black flies, and midges. This enriching effect does not persist very far downstream, as the plankton is diminished, and communities below this may have very low productivity.

4. Lakes with cold-water hypolimnion releases limit the fauna additionally by interference with life cycles of aquatic insects such as mayflies, stoneflies, and caddisflies. Because the temperature of hypolimnetic releases is usually very cold, the downstream communities are often limited to midges, worms, black flies, snails, and sowbugs.

5. Water quality assessments of impoundment-affected sites usually indicate slight or moderate impact. Of 25 lake-affected stream sites across New York State, the following index means and ranges were obtained: species richness: 17 (7-24); EPT richness: 4 (0-12); Hilsenhoff biotic index: 5.83 (4.48-8.22); Percent Model Affinity: 45 (24-67). Correct interpretation of these assessments should reflect that although the resident fauna is affected, the impact is usually not a pollutional impairment. However, faunal effects caused by hypolimnion releases should be considered temperature-related and anthropogenic.

6. Corrective action for data judged to be affected by lake outlets is the adjustment of the water quality assessment up one category (e.g., slightly impacted to non-impacted) to reflect genuine water quality.