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West Brook

Biological Assessment

1999 Survey

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BIOLOGICAL STREAM ASSESSMENT

West Brook
Warren County, New York

Survey date: September 22, 1999
Report date: March 10, 2000

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Stream Biomonitoring Unit
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Division of Water
NYS Department of Environmental Conservation
Albany, New York

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CONTENTS

Stream: West Brook, Warren County, New York

Reach: Lake George

Background:

The Stream Biomonitoring Unit conducted biological sampling on West Brook on September 22, 1999. The purpose of the sampling was to assess general water quality and compare to results of previous sampling on the stream. Traveling kick samples were taken in riffle areas at three 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, Table 3 provides a listing of all macroinvertebrate species collected in the present survey, and Table 4 lists diatoms collected. 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 West Brook is generally good, ranging from non-impacted upstream to slightly impacted downstream. Road runoff, groundwater contributions, and differences in habitat and land use appear to account for the faunal differences seen. A groundwater seep downstream of the Lake George (V) Wastewater Treatment Facility contributes small amounts of nutrients to the stream.

2. Results of diatom sampling were combined with results of macroinvertebrate sampling and chemical analysis to produce the final assessment of water quality in this survey.

Discussion:

West Brook is a small stream that flows off Prospect Mountain in the southeastern Adirondack Mountains and travels approximately 2 miles as a permanent stream before emptying into the southern end of Lake George. It was the subject of a previous invertebrate sampling by the Stream Biomonitoring Unit in 1998, when Station 3 in Lake George Village was sampled using methods identical to those used in the present survey (Bode et al., 1999). Results of the 1998 sampling indicated moderately impacted (poor) water quality. The stream bottom was characterized by profuse algal growth, suggesting probable nutrient enrichment. West Brook has been listed in the Priority Waterbodies List (NYS DEC, 1996), citing impacts caused by road sanding, urban runoff, and storm sewers, including chlorinated pool water dumped by several motels. The present follow-up sampling was conducted to document the extent of impacts in West Brook.

Results of the present study show better water quality than that documented in the 1998 sampling. Water quality ranged from non-impacted (very good) at the upstream site to slightly impacted (good) at the downstream site (Figure 1), declining linearly downstream. Impact Source Determination showed that macroinvertebrate communities at all 3 sites were most similar to natural communities (Table 1), suggesting that habitat differences may be partially responsible for the downstream faunal changes observed. Differences in water quality between 1998 and 1999 are not known, but may be flow-related; 1999 was considered a drought year, while 1998 flows were normal to high.

Aquatic habitat in West Brook differed substantially among the 3 sites. The most upstream site, Station 1, was characterized by large rocks and rubble embedded in sand, in a forest setting. Station 2 was mostly rubble and gravel, with low embeddedness, in a lightly populated area. Station 3 had more sand and gravel, and was bordered by roads on both sides, in a commercial setting. Specific conductance increased from 69 μmhos at Station 1 to 94 μmhos at Station 2 to 211 μmhos at Station 3. Other chemical parameters were quite similar among the sites.

As described in Fuhs (1972) and Sutherland et al.(1983), West Brook receives groundwater input indirectly from the Lake George (V) Wastewater Treatment Facility, which uses subsurface discharge. This input is in the form of a seep, located approximately 100 meters downstream (east) of where the stream passes under the Northway, Route 87. The location of the seep has apparently not changed since the 1983 publication of Sutherland et al., although Fuhs (1972) suggested a more downstream location. Elevated phosphorous and chloride levels occur in West Brook as a result of this seep (Sutherland et al., 1983), and coincide with a slight drop in water quality documented at the Gage Road site (Station 2) located 0.3 miles downstream.

In addition to macroinvertebrate sampling, diatoms were sampled at Station 3 on September 3, 1999. Methods are described in Appendix X, and results are presented in Table 4. Five indices were calculated for the data, measuring for effects of organic inputs, eutrophication, elevated salts, acidity, and siltation. Of these, slight impact was indicated in four areas: organic inputs, eutrophication, elevated salts, and siltation. Integrating these results with macroinvertebrate results tends to show that the impact seen at Station 3 is slight, and is consistent with effects of nutrient enrichment.

Overall, water quality in West Brook is considered good to very good, with no major impacts of concern. Nutrient enrichment from the seep, road runoff, groundwater contributions, and differences in habitat and land use appear to account for the major faunal differences. All sites retain healthy populations of mayflies, stoneflies, and caddisflies, which are the major groups of less tolerant aquatic macroinvertebrates expected to be found in streams of good water 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.

Fuhs, G. W. 1972. The chemistry of streams tributary to Lake George, New York. Environmental Health Report No. 1. New York State Department of Health, Albany, NY.

New York State Department of Environmental Conservation. 1996. The 1996 priority waterbodies list for the Lake Champlain basin. NYS DEC Technical bulletin, 128 pages.

Sutherland, J. W., J. A. Bloomfield, and J. M. Swart. 1983. Lake George urban runoff study, Nationwide Urban Runoff Program. New York State Department of Environmental Conservation, Technical Report, 84 pages + appends.

Overview of field data:

On the date of sampling, September 22, 1999, West Brook at the sites sampled was 5-7 meters wide, 0.2-0.3 meters deep, and had current speeds of 100-110 cm/sec in riffles. Dissolved oxygen was 9.8-10.5 mg/l, specific conductance was 69-211 µmhos, pH was 6.9-7.2, and the temperature was 10.2-10.4 °C (50-51 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, West Brook, 1999. 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.

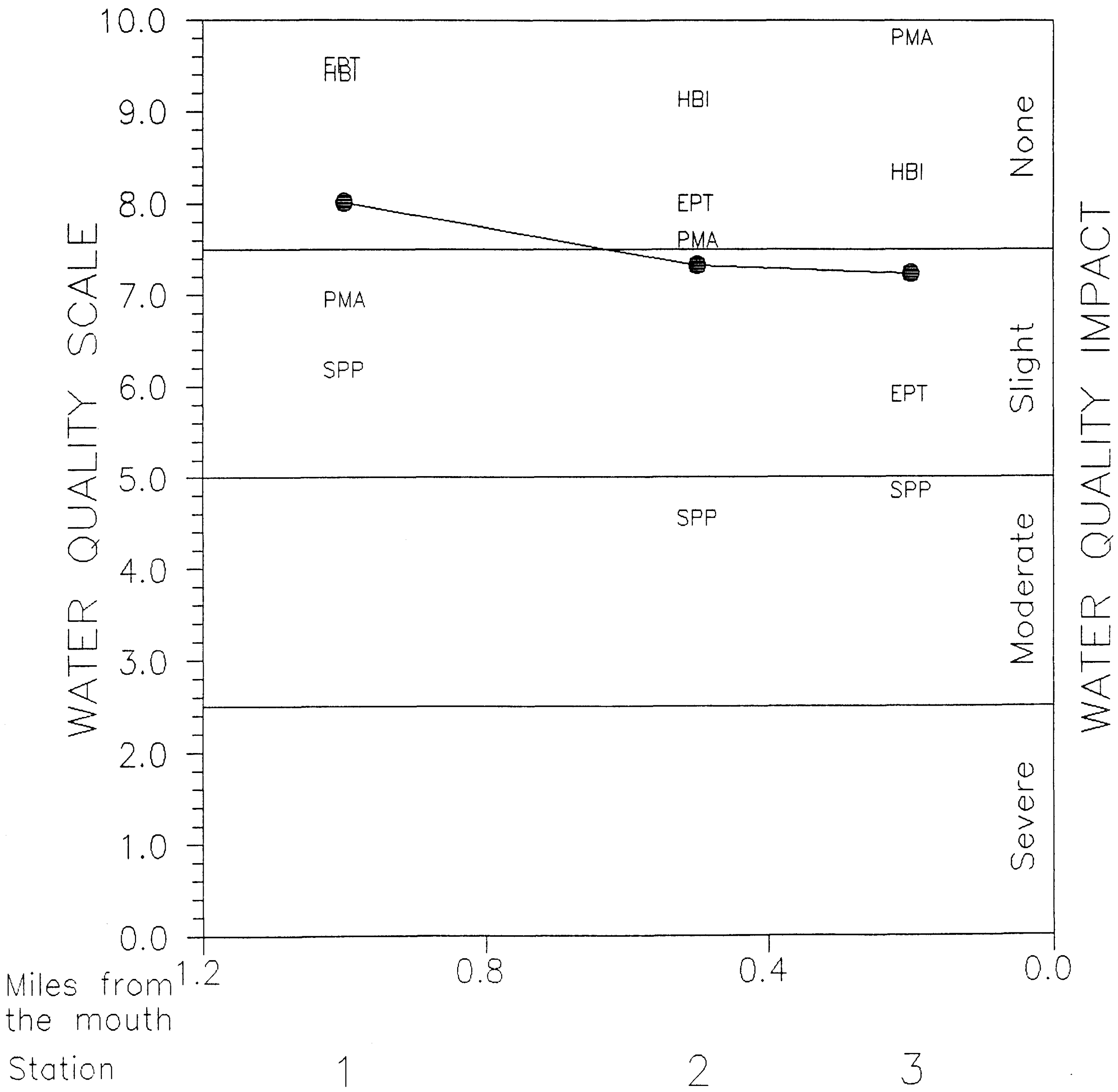


TABLE 1. IMPACT SOURCE DETERMINATION FOR WEST BROOK. Numbers represent similarity to community type models for each impact category. The highest similarity at each station is highlighted. Similarities less than 50% are less conclusive. See Appendix XII for more complete explanation.

	STATION		
Community Type	WSBR-1	WSBR-2	WSBR-3
Natural: minimal human impacts	55	49	51
Nutrient additions; mostly nonpoint, agricultural	36	38	38
Toxic: industrial, municipal, or urban run-off	33	28	26
Organic: sewage effluent, animal wastes	40	29	34
Complex: municipal/industrial	26	19	15
Siltation	37	34	36
Impoundment	30	24	27

Figure 2	Site Location Map	West Brook

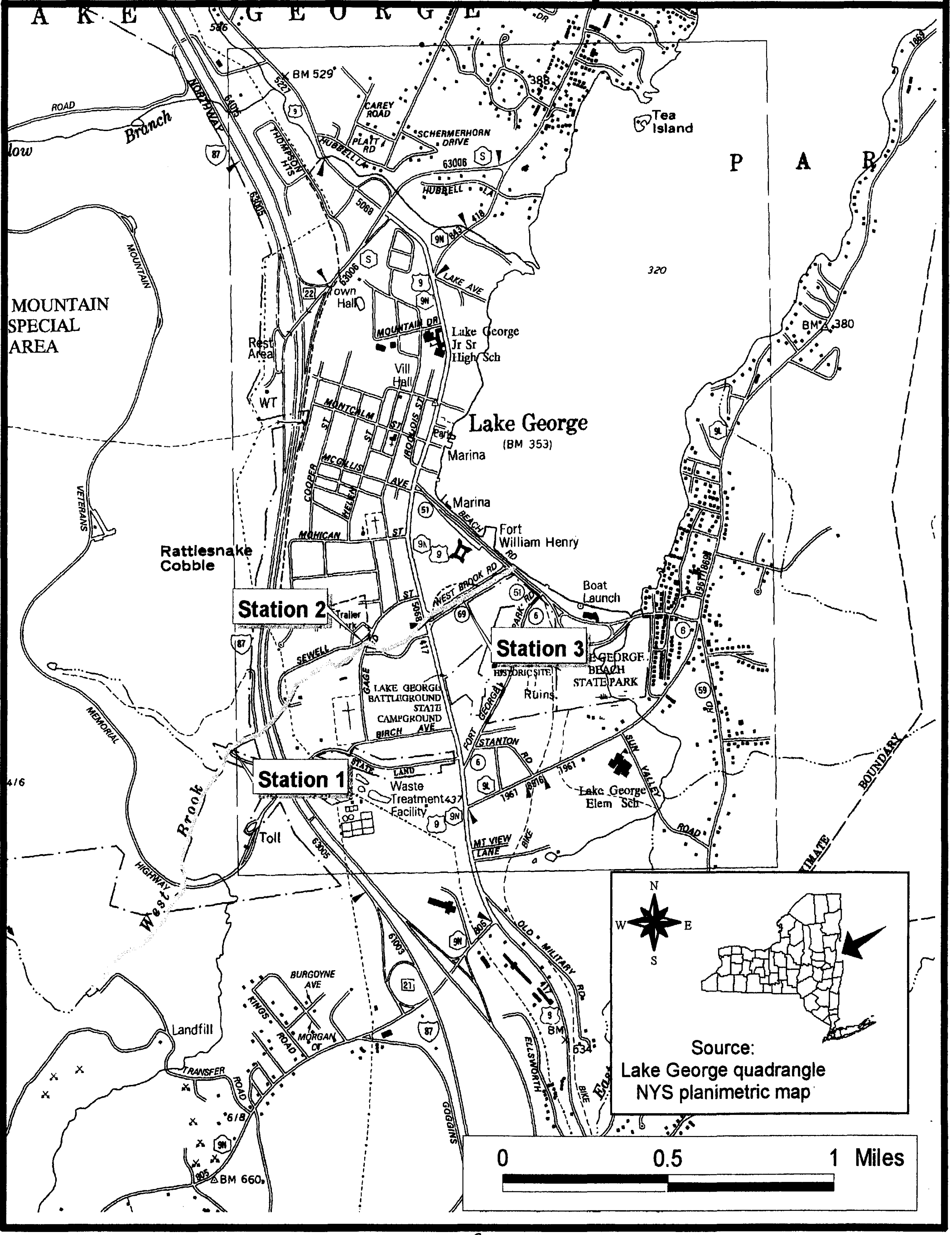


TABLE 2. STATION LOCATIONS FOR WEST BROOK, WARREN COUNTY, NEW YORK (see map).

STATION	LOCATION
01	Lake George off Prospect Hwy; 50m below culvert 1.0 miles above mouth latitude/longitude: 43°24'43"; 73°43'30"
02	Lake George Gage St; 5m above culvert 0.5 miles above mouth latitude/longitude: 43°25'02"; 73°43'02"
03	Lake George 30 m below foot bridge; opposite Action Park 0.2 miles above mouth latitude/longitude: 43°25'06"; 73°42'39"

TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN WEST BROOK, WARREN COUNTY, NEW YORK, SEPTEMBER 22, 1999.

ANNELIDA
- OLIGOCHAETA
  - Lumbriculidae
    - Undetermined Lumbriculidae

ARTHROPODA
- INSECTA
  - EPHEMEROPTERA
    - Baetidae
      - Baetis brunneicolor
    - Ephemerellidae
      - Ephemerella aurivillii
  - PLECOPTERA
    - Chloroperlidae
      - Undetermined Chloroperlidae
    - Perlodidae
      - Malirekus iroquois
    - Pteronarcidae
      - Pteronarcys proteus
  - COLEOPTERA
    - Elmidae
      - Optioservus sp.
  - TRICHOPTERA
    - Philopotamidae
      - Dolophilodes sp.
    - Hydropsychidae
      - Hydropsyche slossonae
      - Hydropsyche sp.
      - Parapsyche sp.
    - Rhyacophilidae
      - Rhyacophila acropedes
      - Rhyacophila carolina
      - Rhyacophila fuscula
      - Rhyacophila nigrita
      - Rhyacophila torva
      - Rhyacophila sp.
    - Glossosomatidae
      - Glossosoma sp.
    - Uenoidae
      - Neophylax sp.
    - Lepidostomatidae
      - Lepidostoma sp.

DIPTERA
- Tipulidae
  - Antocha sp.
  - Dicranota sp.
  - Hexatoma sp.
- Chironomidae
  - Diamesinae
    - Diamesa sp.
    - Pagastia sp. A
  - Orthocladiinae
    - Cricotopus tremulus gr.
    - Eukiefferiella claripennis gr.
    - Parametriocnemus lundbecki
    - Rheocricotopus robacki
    - Tvetenia bavarica gr.
  - Tanytarsini
    - Micropsectra dives gr.
    - Micropsectra polita
    - Tanytarsus guerlus gr.

TABLE 4. DIATOM DATA REPORT, WEST BROOK AT LAKE GEORGE (WSBR-3)

No	Diatom taxa	% RA
1	Achnanthes affinis + A. linearis + A. minutissima	16.8
2	A. lanceolata et var. rostrata	35.0
3	Amphipleura pellucida	0.3
4	Amphora pediculus	1.0
5	Cocconeis placentula et vars	2.6
6	Cyclotella meneghiniana	0.3
7	Cymbella minuta	3.6
8	Diatoma hiemale var. mesodon	0.3
9	Fragilaria capucina et var. mesolepta	2.6
10	F. capucina var. vaucheriae	1.3
11	Melosira varians	4.9
12	Meridion circulare et var. constricta	7.1
13	Navicula cryptocephala	1.0
14	N. gregaria	9.1
15	N. lanceolata	2.9
16	N. tripunctata	2.6
17	Nitzschia dissipata	0.6
18	N. linearis	2.9
19	Reimeria sinuata	1.6
20	Rhoicosphenia curvata	1.0
21	Surirella amphioxys	1.0
22	Synedra ulna et vars	1.6

%RA= Percent relative abundance.

Results are from a periphytic multihabitat sample collected from WSBR-3 on September 3, 1999. The Pollution Index had a value of 2.16, indicating a slight anthropogenic organic impact on the stream. The Siltation Index had a value of 20 and shows slight siltation. The Trophic index value was 67%, indicating slight nutrient enrichment. The Salinity Index was 13%, indicating slightly elevated salts. The Acidity index was 0, indicating no acid effects. See Appendix X for explanation of indices.

STREAM SITE:	West Brook Station 1
LOCATION:	Lake George, New York, unnamed road off Prospect Highway
DATE:	September 22, 1999
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA	Lumbriculidae	Undetermined Lumbriculidae	11
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis brunneicolor	13
	Ephemerellidae	Ephemerella aurivillii	12
PLECOPTERA	Perlodidae	Malirekus iroquois	16
	Pteronarcidae	Pteronarcys proteus	3
TRICHOPTERA	Philopotamidae	Dolophilodes sp.	4
	Hydropsychidae	Hydropsyche slossonae	2
		Hydropsyche sp.	2
		Parapsyche sp.	2
	Rhyacophilidae	Rhyacophila fuscula	5
		Rhyacophila nigrita	2
		Rhyacophila torva	2
	Glossosomatidae	Glossosoma sp.	8
	Uenoidae	Neophylax sp.	1
	Lepidostomatidae	Lepidostoma sp.	1
DIPTERA	Tipulidae	Dicranota sp.	2
		Hexatoma sp.	1
	Chironomidae	Cricotopus tremulus gr.	1
		Eukiefferiella claripennis gr.	1
		Tvetenia bavarica gr.	1
		Micropsectra polita	9
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS	22 (good)
BIOTIC INDEX	2.59 (very good)
EPT RICHNESS	14 (very good)
MODEL AFFINITY	61 (good)
ASSESSMENT	non- impacted

DESCRIPTION

The site was an unpopulated forested setting, entirely canopied with fir trees. The stream bottom was largely sand and gravel, with embedded rock and rubble. The invertebrate fauna was somewhat limited in diversity, but was almost entirely intolerant species, with many mayflies, stoneflies, and caddisflies. Water quality was assessed as non-impacted.

STREAM SITE:	West Brook Station 2
LOCATION:	Lake George, New York, Sewell Street at Gage Road
DATE:	September 22, 1999
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis brunneicolor	19
	Ephemerellidae	Ephemerella aurivillii	6
PLECOPTERA	Chloroperlidae	Undetermined Chloroperlidae	7
	Perlodidae	Malirekus iroquois	9
	Pteronarcidae	Pteronarcys proteus	4
TRICHOPTERA	Hydropsychidae	Parapsyche sp.	4
	Rhyacophilidae	Rhyacophila acropedes	10
		Rhyacophila carolina	3
		Rhyacophila sp.	1
	Glossosomatidae	Glossosoma sp.	4
	Lepidostomatidae	Lepidostoma sp.	1
DIPTERA	Tipulidae	Antocha sp.	4
		Hexatoma sp.	1
	Chironomidae	Diamesa sp.	11
		Eukiefferiella claripennis gr.	3
		Tvetenia bavarica gr.	2
		Micropsectra polita	11

SPECIES RICHNESS	17 (poor)
BIOTIC INDEX	2.87 (very good)
EPT RICHNESS	11 (very good)
MODEL AFFINITY	65 (very good)
ASSESSMENT	slightly impacted

DESCRIPTION

The site was in a lightly populated area. The section sampled was a riffle composed of rubble, gravel, and sand, that was judged to be an ideal riffle. Species richness was found to be poor, although the three other index values were very good. Overall water quality was assessed as slightly impacted.

STREAM SITE:	West Brook Station 3
LOCATION:	Lake George, New York, off West Brook Road
DATE:	September 22, 1999
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA	Lumbriculidae	Undetermined Lumbriculidae	4
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis brunneicolor	30
	Ephemerellidae	Ephemerella aurivillii	7
PLECOPTERA	Chloroperlidae	Undetermined Chloroperlidae	4
	Perlodidae	Malirekus iroquois	3
COLEOPTERA	Elmidae	Optioservus sp.	2
TRICHOPTERA	Rhyacophilidae	Rhyacophila acropedes	6
		Rhyacophila fuscula	2
		Rhyacophila sp.	2
DIPTERA	Tipulidae	Antocha sp.	4
		Dicranota sp.	7
	Chironomidae	Diamesa sp.	2
		Pagastia sp. A	4
		Eukiefferiella claripennis gr.	2
		Parametriocnemus lundbecki	1
		Rheocricotopus robacki	2
		Micropsectra dives gr.	1
		Micropsectra polita	17

SPECIES RICHNESS	18 (poor)
BIOTIC INDEX	3.66 (very good)
EPT RICHNESS	7 (good)
MODEL AFFINITY	88 (very good)
ASSESSMENT	slightly impacted

DESCRIPTION

This site was bounded on both sides by roads, and was in a commercial area. The stream bottom was more sand and gravel than rubble, but an adequate riffle was found and sampled. Mayflies, stoneflies, and caddisflies were present. Index values ranged from very good to poor, and overall water quality was assessed as slightly impacted.

LABORATORY DATA SUMMARY

STREAM NAME West Brook | DRAINAGE 10
DATE SAMPLED 09/22/99 | COUNTY Warren
SAMPLING METHOD Traveling kick

STATION	01	02	03	
LOCATION	off Prospect Hy	Gage Rd.	opposite Action Park	
DOMINANT SPECIES\% CONTRIBUTION\TOLERANCE\COMMON NAME				
Genus and species names are abbreviated here to accommodate format. Complete names are reported elsewhere in this report. 1.	Malirekus iroquois 16 intolerant stonefly	Baetis brunnei 19 intolerant mayfly	Baetis brunnei 30 intolerant mayfly	
2.	Baetis brunnei 13 intolerant mayfly	Diamesa spp. 11 facultative midge	Micropsect polita 17 facultative midge	
Intolerant = not tolerant of poor water quality; Facultative = occurring over a wide range of water quality; Tolerant = tolerant of poor water quality. 3.	Ephemeralla aurivill 12 intolerant mayfly	Micropsect polita 11 facultative midge	Ephemeralla aurivill 7 intolerant mayfly	
4.	Undeterm. Lumbricu 11 tolerant worm	Rhyacophila acroped 10 intolerant caddisfly	Dicranota sp. 7 intolerant crane fly	
5.	Micropsect polita 9 facultative midge	Malirekus iroquois 9 intolerant stonefly	Rhyacophila acroped 6 intolerant caddisfly	
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	13 (5)	27 (4)	29 (7)	
Trichoptera (caddisflies)	29 (10)	23 (6)	10 (3)	
Ephemeroptera (mayflies)	25 (2)	25 (2)	37 (2)	
Plecoptera (stoneflies)	19 (2)	20 (3)	7 (2)	
Coleoptera (beetles)	0 (0)	0 (0)	2 (1)	
Oligochaeta (worms)	11 (1)	0 (0)	4 (1)	
Others (**)	3 (2)	5 (2)	11 (2)	
TOTAL	100 (22)	100 (17)	100 (18)	
SPECIES RICHNESS	22	17	18	
HBI INDEX	2.59	2.87	3.66	
EPT VALUE	14	11	7	
PMA VALUE	61	65	88	
FIELD ASSESSMENT	no impact	no impact	no impact	
OVERALL ASSESSMENT	non-impacted	slightly impacted	slightly impacted	

** crane flies

FIELD DATA SUMMARY SHEET

STREAM NAME: West Brook
REACH: vicinity of Lake George DATE SAMPLED: 09-22-99
FIELD PERSONNEL INVOLVED: Bode, Andrews

STATION ARRIVAL TIME AT STATION LOCATION	01 9:15 Prospect Highway	02 9:50 Gage Rd.	03 10:10 at Action Park	
PHYSICAL CHARACTERISTICS				
Width (meters)	7	6	5	
Depth (meters)	0.3	0.2	0.2	
Current speed (cm per sec)	100	110	110	
Substrate (%)				
rock (> 10 in. or bedrock)	20			
rubble (2.5-10 in.)	30	50	40	
gravel (0.08-2.5 in.)	20	30	30	
sand (0.06-2.0 mm)	20	20	30	
silt (0.004-0.06 mm)				
clay (less than 0.004 mm)				
Embeddedness (%)	40	20	20	
CHEMICAL MEASUREMENTS				
Temperature (oC)	10.4	10.2	10.4	
Specific conductance (umhos)	69	94	211	
Dissolved Oxygen (mg per l)	10.5	10.5	9.8	
pH	6.9	7.2	7.1	
BIOLOGICAL ATTRIBUTES				
Canopy (%)	100	30	30	
Aquatic Vegetation				
algae - water column				
algae - filamentous			present	
algae - diatoms				
macrophytes; moss				
Occurrence of Macroinvertebrates				
Chironomidae (midges)				
Trichoptera (caddisflies)				
Ephemeroptera (mayflies)	X	X	X	
Plecoptera (stoneflies)	X	X	X	
Coleoptera (beetles)				
Oligochaeta (worms)				
Other (**)		X		
ESTIMATED BIOMASS				
FIELD ESTIMATE OF WATER QUALITY	non	non	non	
FIELD COMMENTS				

** crane flies (Station 2)

Appendix I. BIOLOGICAL METHODS FOR KICK SAMPLING

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

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

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

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

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

Appendix II. MACROINVERTEBRATE COMMUNITY PARAMETERS

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

2. EPT 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

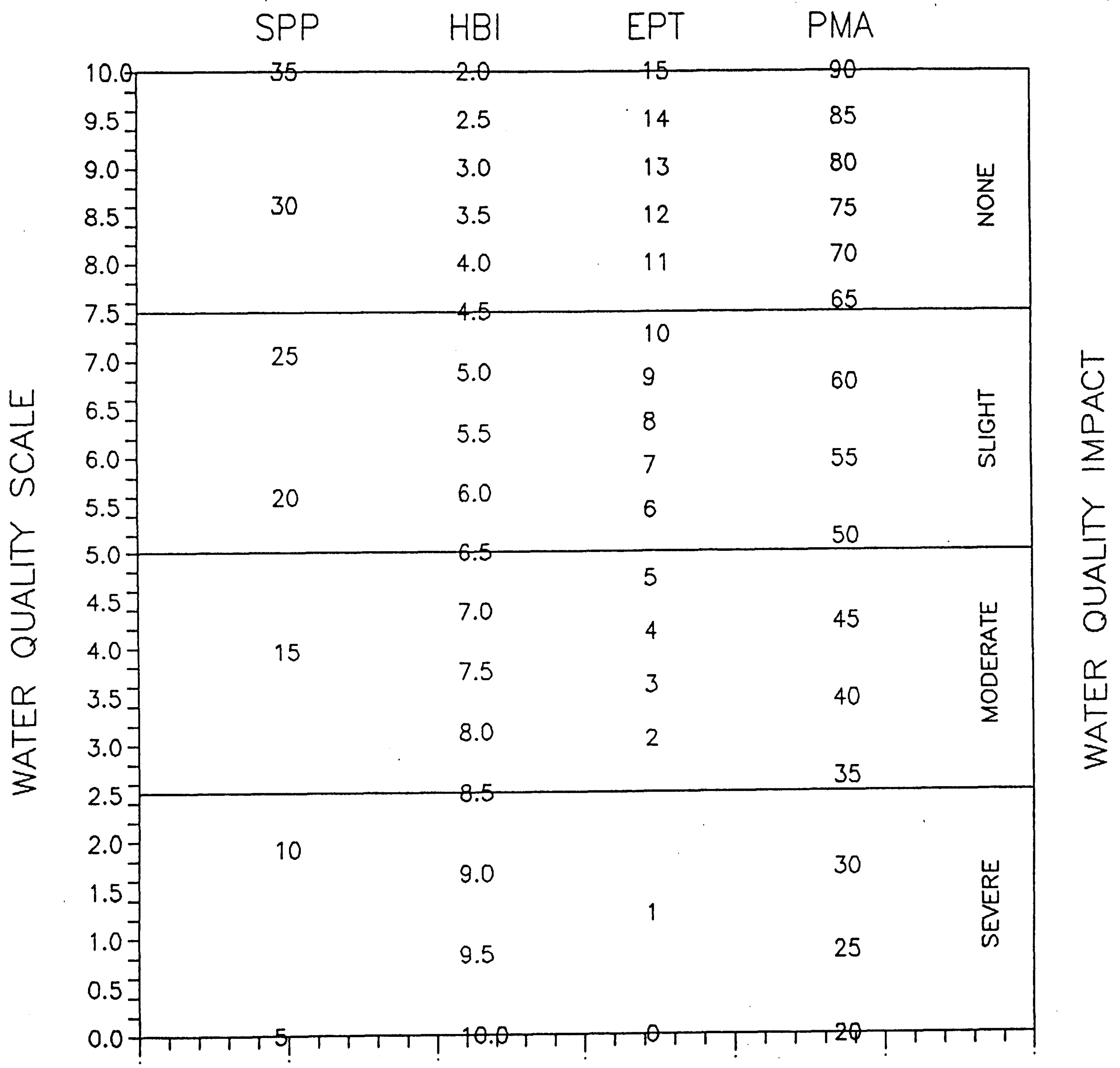
Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50. 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 is represented by a circle; this value is used for graphing trends between sites, and represents the assessed impact for each site.

Appendix V

WATER QUALITY ASSESSMENT CRITERIA

for non-navigable flowing waters

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

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

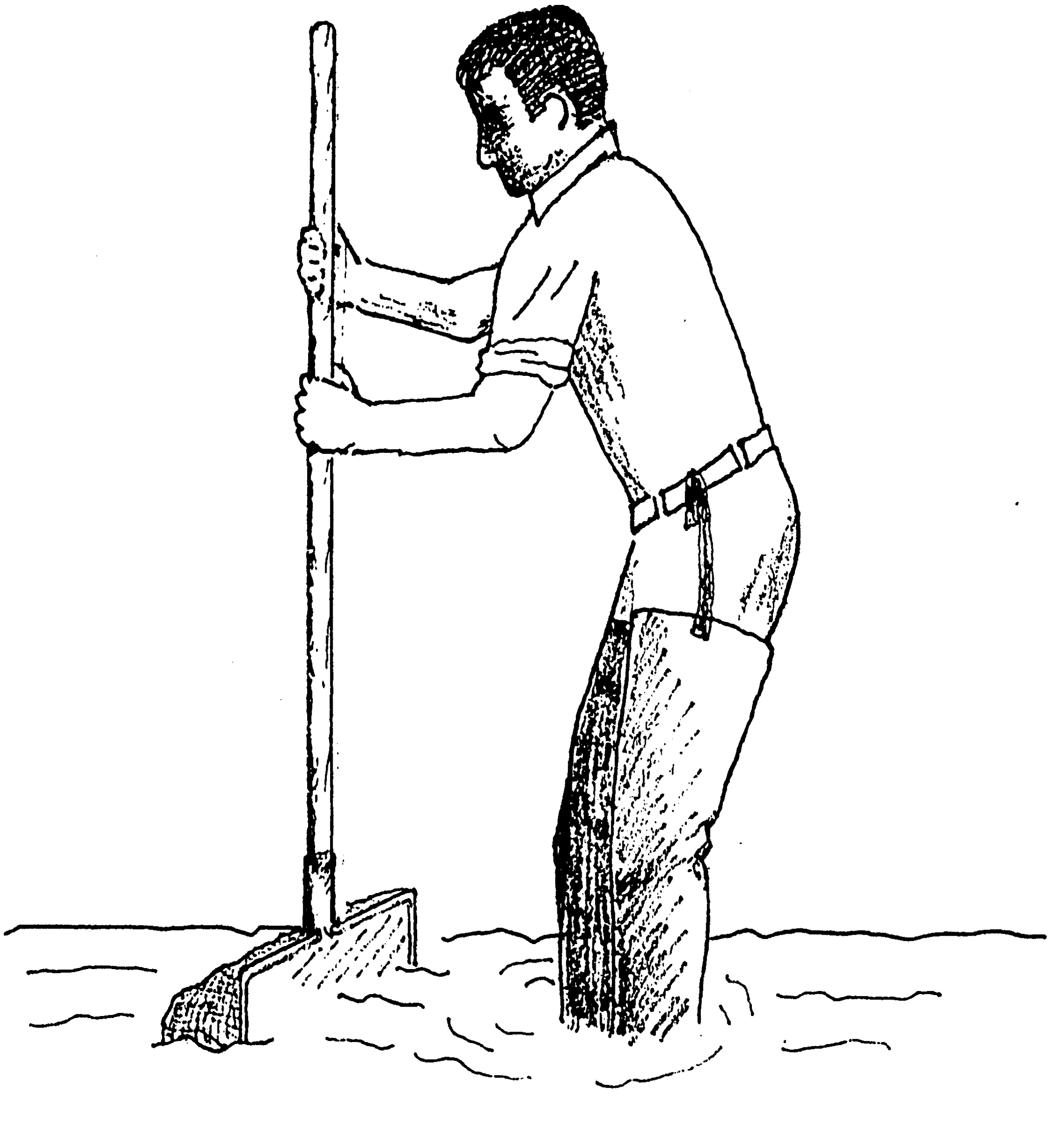
WATER QUALITY ASSESSMENT CRITERIA

for navigable flowing waters

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

Appendix VI.

THE TRAVELING KICK SAMPLE

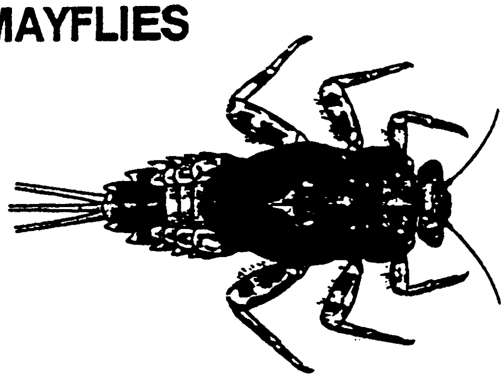


← CURRENT ———

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.

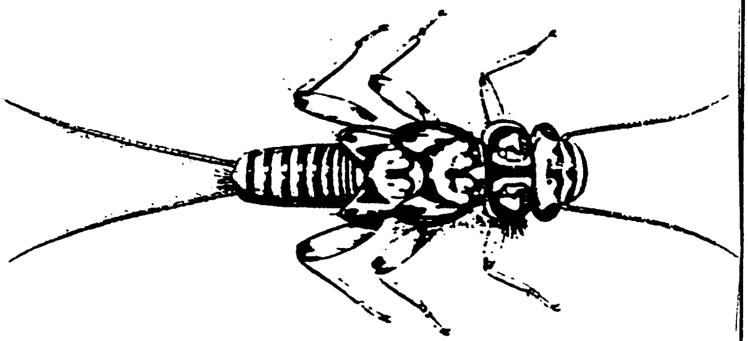
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

MAYFLIES



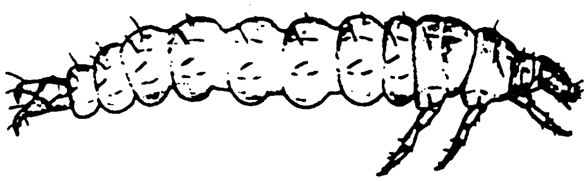
Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides, and acidity. Most mayflies are found clinging to the undersides of rocks.

STONEFLIES



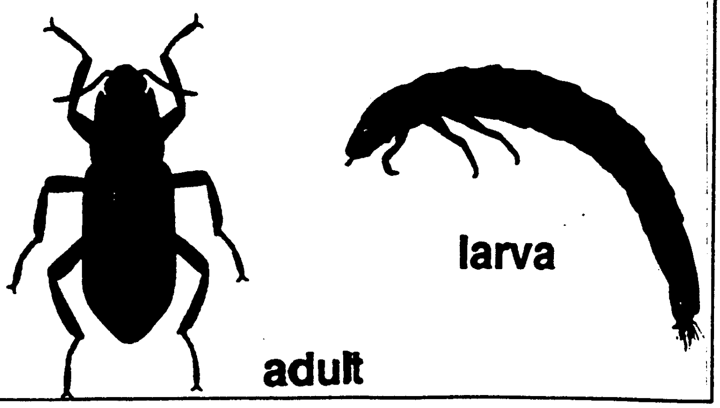
Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained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

CADDISFLIES



Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in recovery zones below sewage discharges.

BEETLES



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

Illustrations by Arwin Provonsha
In McCafferty: Aquatic Entomology
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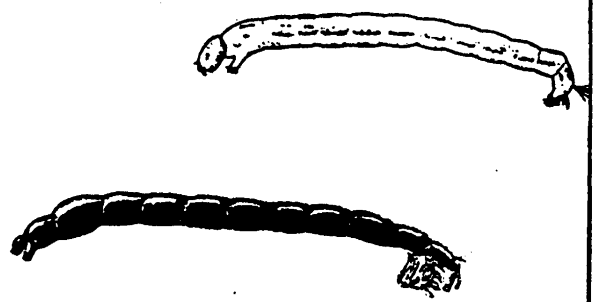
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

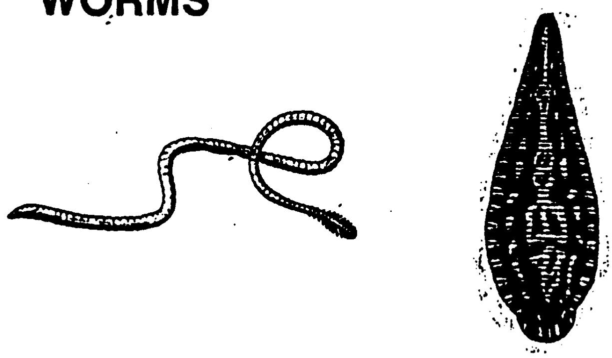
MIDGES

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



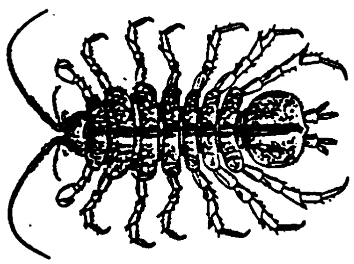
WORMS

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



SOWBUGS

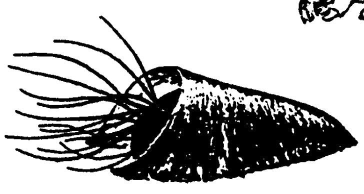
Aquatic sowbugs are crustaceans that are often numerous in situations of high organic content and low oxygen levels. When numerous they can indicate a stream segment in the recovery stage of sewage pollution.



BLACK FLIES

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

larva



pupa

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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 ASSESSMENT OF WATER QUALITY USING DIATOMS.

A. Sampling: All major benthic habitats available - stones, macrophytes and mud - are sampled for diatom analysis at every site and mixed in a single, multi-habitat sample (MHS), representative of the periphytic flora of that site. Epilithon (diatom community growing on rocks) is scraped from pebbles, cobbles and boulders with a knife. Epiphyton (diatom community developing on plants) is collected from nonvascular and vascular plants by adding the whole plant or parts of it to the MHS. Brown flocculent material forming over mud is sampled for epipelic diatoms (those occurring on the surface of mud) using a pipette. All samples are preserved with 4% formaldehyde in the field.

B. Sample processing and organism identification: Samples are processed in the laboratory with sulfuric acid following the method of Hasle and Fryxell (1970). Cleaned material is washed with distilled water eight times and then preserved in 100% ethanol. For light microscopy, the cleaned material is dried onto a cover glass with the flame of an alcohol lamp. A drop of ethanol is employed to speed the evaporation and spread the diatoms into an even layer. Permanent mounts are prepared using Naphrax® and at least 300 cells per mount are identified employing an oil immersion objective at 1,250x magnification.

C. Analysis of data: The data are analyzed using five indices: Pollution Tolerance Index, the Trophic Index, the Salinity Index, the Acidity Index , and the Siltation Index.

1. The Pollution Tolerance Index (PTI) is calculated as the sum of the relative abundance of each species multiplied by the pollution tolerance class of that species (Bahls, 1993). Provisional ranges for the levels of impact are: >2.50, non-impacted; 2.01-2.50, slightly impacted; 1.51-2.00, moderately impacted; and <1.50, severely impacted.

2. The Trophic Index is a measure of % mesotrophic to hypereutrophic individuals. Provisional ranges for the levels of impact are: 0-50, non-impacted; 51-70, slightly impacted; 71-85, moderately impacted; and 86-100, severely impacted.

3. The Salinity Index is a measure of % halophilous individuals, indicating dissolved salts. Provisional ranges for the levels of impact are: 0-10, non-impacted; 11-30, slightly impacted; 31-50, moderately impacted; and 51-100, severely impacted.

4. The Acidity Index is a measure of % acidophilous individuals, reflecting acid effects. Provisional ranges for the levels of impact are: 0-20, non-impacted; 21-50, slightly impacted; 51-75, moderately impacted; and 76-100, severely impacted.

5. The Siltation Index (SI) is a measurement of the percent relative abundance of individuals belonging to motile genera, mostly *Navicula, Nitzschia* and *Surirella*, which are adapted to living on unstable substrates. SI ranges from 0 to 100, using the following provisional ranges for the levels of siltation: in mountainous streams: <20, no siltation; 20-39, minor siltation; 40-60, moderate siltation; and >60, heavy siltation. For lowland streams (low elevation and slope) the ranges are: <60, no siltation; 60-69, minor siltation; 70-80, moderate siltation; and >80, heavy siltation.

Bahls, L.L. 1993. Periphyton bioassessment methods for Montana streams. Montana Department of Health and Environmental Sciences Report.

Hasle, G. & Fryxell, G. 1970. Mounting for light and electron microscopy. Trans. Am. Microsc. Soc. 89: 469-74.

APPENDIX XI. METHODS FOR IMPACT SOURCE DETERMINATION

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

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

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

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

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

NONPOINT NUTRIENTS, PESTICIDES

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

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

MUNICIPAL/INDUSTRIAL

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