



New York State
Department of Environmental Conservation

N/A (insert)

Division of Water

Fall Kill

Biological Assessment

1997 Survey



GEORGE E. PATAKI, Governor

JOHN P. CAHILL, Commissioner

✓
✓
✓

✓

✓

✓

✓

BIOLOGICAL STREAM ASSESSMENT

**Fall Kill
Dutchess County, New York**

**Survey date: September 4, 1997
Report date: August 26, 1998**

**Robert W. Bode
Margaret A. Novak
Lawrence E. Abele**

**Stream Biomonitoring Unit
Bureau of Watershed Assessment and Research
Division of Water
NYS Department of Environmental Conservation
Albany, New York**

CONTENTS

Background.....	1
Results and Conclusions.....	1
Discussion.....	2
Figure 1. Biological Assessment Profile, ...	3
Table 1. Impact Source Determination.....	4
Literature cited.....	5
Overview of field data.....	5
Table 2. Station locations.....	6
Figure 2. Site overview map.....	7
Figure 3. Site location maps.....	8
Table 3. Macroinvertebrate species collected.....	11
Invertebrate collection data	12
Laboratory data summary.....	16
Field data summary.....	17
Appendix I. Biological methods for kick sampling.....	18
Appendix II. Macroinvertebrate community parameters.....	19
Appendix III. Levels of water quality impact in streams.....	20
Appendix IV. Biological Assessment Profile derivation.....	21
Appendix V. Water quality assessment criteria.....	22
Appendix VI. Traveling kick sample illustration.....	23
Appendix VII. Macroinvertebrate illustrations.....	24
Appendix VIII. Rationale for biological monitoring.....	26
Appendix IX. Glossary.....	27
Appendix X. Impact Source Determination.....	28

Stream: Fall Kill, Dutchess County, New York

Reach: Hyde Park to Poughkeepsie

Background:

The Stream Biomonitoring Unit conducted biological sampling on the Fall Kill on August 20, 1997. The purpose of the sampling was to assess general water quality and establish a baseline set of invertebrate data. Traveling kick samples were taken in riffle areas at four 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 3 provides a listing of sampling sites, and Table 4 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by site collection data, which include the raw invertebrate data from each site.

Results and Conclusions:

1. Water quality in the Fall Kill ranged from slightly impacted to moderately impacted. Water quality declined steadily downstream.
2. The biota indicated that the Hyde Park sites received nutrient additions, and the Poughkeepsie sites were impacted by municipal/industrial sources and urban runoff.

Discussion:

Biological sampling was performed on the Fall Kill to assess general water quality and establish a baseline set of invertebrate data. The entire length of the stream is listed on the Priority Waterbodies List (NYS DEC, 1996) as stressed with nutrients and silt from urban runoff; high fecal coliform counts have been documented by the Dutchess County Health Department.

In the 7-mile reach of the Fall Kill sampled in the present survey, water quality was shown to decline nearly linearly downstream. At the most upstream site in Hyde Park (Station 2), water quality was only slightly impacted. Mayflies, stoneflies, and caddisflies were present, and the faunal structure resembled both natural communities and those somewhat affected by nonpoint nutrient additions. Proceeding downstream, stoneflies were lost by Station 3, and mayflies were lost by Station 4. By Station 5, the fauna was dominated by tolerant scuds, worms, sowbugs, and midges, and the indices pointed to moderately impacted water quality.

Sources of impact to the Fall Kill are considered to be primarily nonpoint. The fauna at Station 4 was consistent with effects observed downstream of golf course runoff. The fauna at Station 5 in Poughkeepsie is strongly aligned with municipal/industrial wastes, and these are believed to be the result of urban runoff and dumping of trash in the stream.

Previous sampling on the Fall Kill at Station 5 was conducted by the U.S. Geological Survey. The data collected includes fish, invertebrates, and physical/chemical measurements. Additionally, on one visit a list was compiled enumerating the various items found in the stream at this site (see below). This list illustrates the problem of urban streams, and emphasizes the fact that streams filled with this type of debris invariably suffer substantial associated impacts.

List of items found in the Fall Kill in Poughkeepsie (Station 5) by U.S.G.S. personnel Gary Wall and Chris Ryan on August 24, 1993.

Chair, chain link fence, automobile muffler, refrigerator rack, tray, sheet metal, plastic bag, chest of drawers, fan, refrigerator coil, automobile exhaust pipe, clothing articles, scrap metal, clothes hangers, trash can lid, oil filter, basket, toys, cinder blocks, traffic cone, teddy bear, plate, undergarments, speakers, rats, bicycle parts, pots and pans, bottles, glass, bricks, chicken wire fence posts, tire, tire rim, automobile bumper, nerf football, six-pack plastic holder, metal ladder, garden hose, plywood, plastic oil quart containers, umbrella, shopping cart parts, pick, battery cables, table, bowling ball, hair dryer.

Figure 1. Biological Assessment Profile of index values, Fall Kill, 1997. 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.

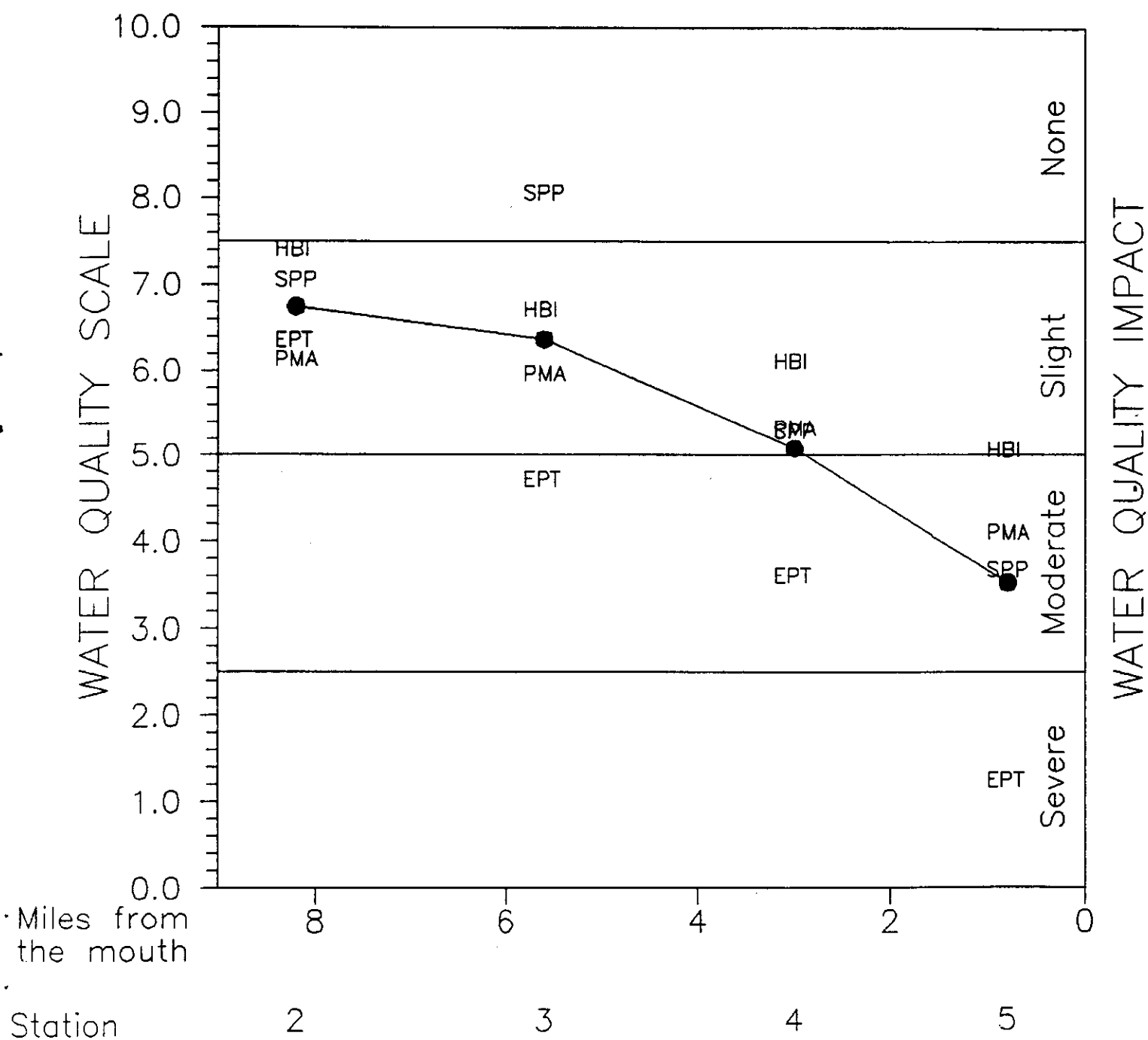


Table 1. Impact Source Determination results for the Fall Kill. Numbers represent similarity to community type models for each impact category. The highest similarity at each station is highlighted. Similarities less than 50% are less conclusive. See Appendix X for more complete explanation of ISD.

	STATION			
Community Type	FALL-2	FALL-3	FALL-4	FALL-5
Natural: minimal human impacts	48	46	40	27
Nutrient additions; mostly nonpoint, agricultural	49	53	61	22
Toxic: industrial, municipal, or urban run-off	31	35	56	47
Organic: sewage effluent, animal wastes	27	40	51	48
Complex: municipal/industrial	22	27	59	73
Siltation	32	40	55	31
Impoundment	52	45	65	54

Literature cited

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

New York State Department of Environmental Conservation. 1996. The 1996 Priority Waterbodies List for the Lower Hudson River Basin. NYS DEC Technical Report, 215 pp.

Overview of field data:

On the date of sampling, September 4, 1997, the Fall Kill at the sites sampled was 5-8 meters wide, 0.1-0.2 meters deep in riffles, and had current speeds of 63-77 cm/sec in riffles. Dissolved oxygen was 5.8-9.2 mg/l, specific conductance was 378-716 μ mhos, pH was 7.4-8.0, and the temperature was 15.2-17.4 °C (59-63 °F). Measurements for each site are found on the field data summary sheets.

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

<u>STATION</u>	<u>LOCATION</u>
02	Hyde Park at Haviland Rd. bridge 8.2 miles above the mouth latitude/longitude: 41°46'43"; 73°53'38"
03	Hyde Park 50 meters above East Dorsey Rd. (Co. Rt. 40) bridge 5.6 miles above the mouth latitude/longitude: 41°44'56"; 73°53'49"
04	Poughkeepsie immediately below Smith St. bridge 3.0 miles above the mouth latitude/longitude: 41°42'52"; 73°54'16"
05	Poughkeepsie 200 meters below Garden St. bridge 0.8 miles above the mouth latitude/longitude: 41°42'37"; 73°55'31"

Figure 2

Site Overview Map

Fall Kill

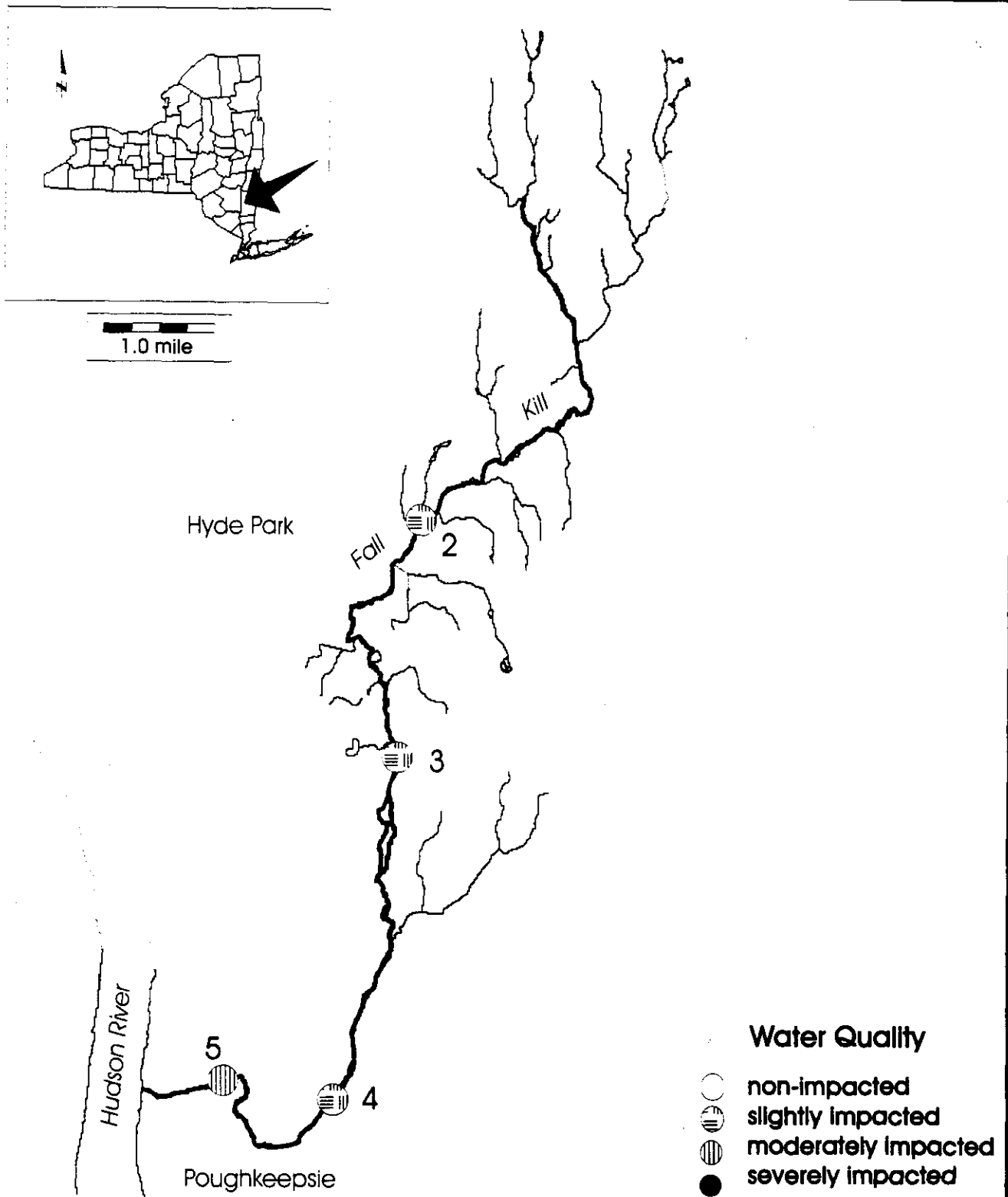


Figure 3a

Site Location Map

Fall Kill

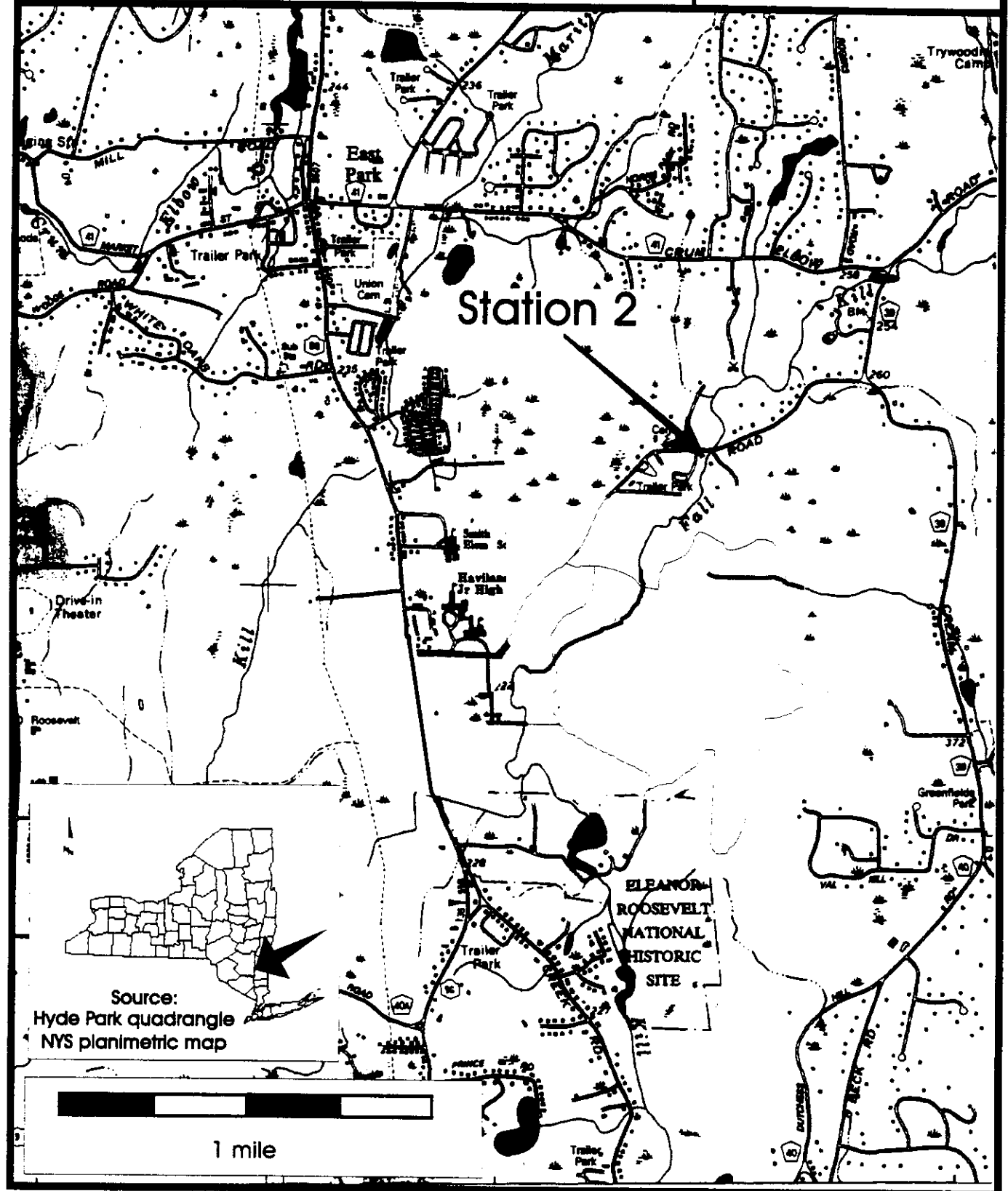


Figure 3b

Site Location Map

Fall Kill

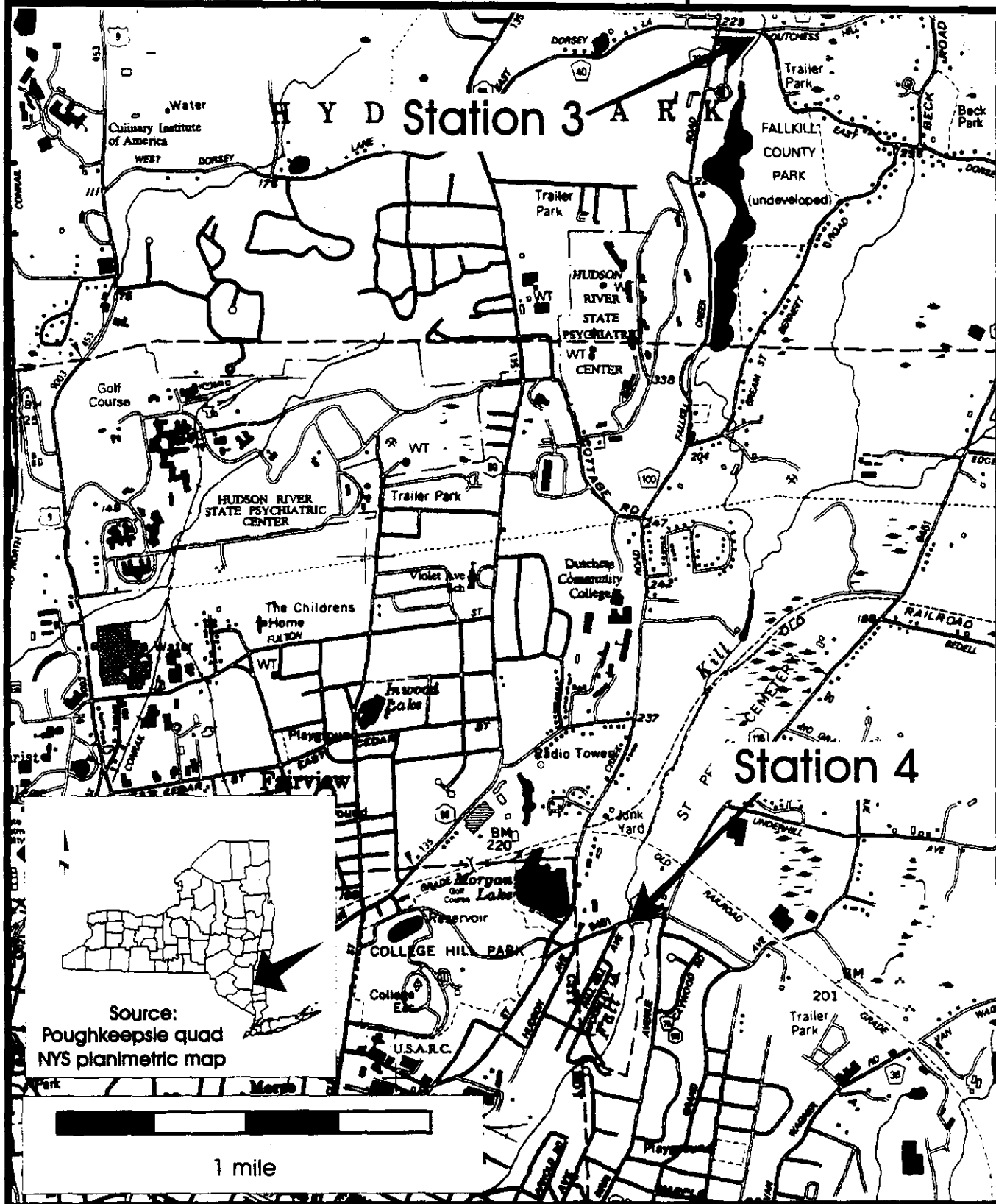


Figure 3c

Site Location Map

Fall Kill



TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN THE FALL KILL, DUTCHESS COUNTY, NEW YORK, SEPTEMBER 4, 1997.

ANNELIDA

OLIGOCHAETA

Undetermined Lumbricina

Tubificidae

Undet. Tubificidae w/o cap. setae

Naididae

Nais communis

Nais pardalis

MOLLUSCA

GASTROPODA

Ancylidae

Ferrissia walkeri

PELECYPODA

Sphaeriidae

Sphaerium sp.

Undetermined Sphaeriidae

ARTHROPODA

CRUSTACEA

ISOPODA

Asellidae

Caecidotea sp.

AMPHIPODA

Gammaridae

Gammarus sp.

DECAPODA

Cambaridae

Undetermined Cambaridae

EPHEMEROPTERA

Isonychiidae

Isonychia bicolor

Baetidae

Acerpenna pygmaea

Baetis sp.

Heptageniidae

Stenonema sp.

Tricorythidae

Tricorythodes sp.

ODONATA

Gomphidae

Stylogomphus sp.

Calopterygidae

Calopteryx sp.

PLECOPTERA

Perlidae

Paragnetina media

COLEOPTERA

Psephenidae

Psephenus herricki

Elmidae

Macronychus glabratus

Optioservus sp.

Stenelmis crenata

Stenelmis sp.

MEGALOPTERA

Corydalidae

Nigronia serricornis

TRICHOPTERA

Philopotamidae

Chimarra aterrima?

Undetermined Psychomyiidae

Hydropsychidae

Cheumatopsyche sp.

Hydropsyche betteni

DIPTERA

Tipulidae

Tipula sp.

Simuliidae

Simulium sp.

Empididae

Hemerodromia sp.

Chironomidae

Tanypodinae

Thienemannimyia gr. spp.

Orthocladinae

Brillia flavifrons

Brillia sp.

Cricotopus bicinctus

Cricotopus trifascia gr.

Cricotopus vierriensis

Parakiefferiella sp.

Parametriocnemus lundbecki

Psectrocladius psilopterus gr.

Rheocricotopus robacki

Tvetenia bavarica gr.

Chironominae

Chironomini

Microtendipes pedellus gr.

Microtendipes rydalsensis gr.

Phaenopsectra sp.

Polypedilum aviceps

Polypedilum convictum

Polypedilum fallax gr.

Polypedilum illinoense

Polypedilum scalaenum gr.

Tanytarsini

Micropsectra nr. *deflecta*

Micropsectra sp.

Rheotanytarsus distinctissimus gr.

Rheotanytarsus exiguus gr.

Stempellinella sp.

Tanytarsus glabrescens gr.

Tanytarsus guerlus gr.

STREAM SITE: Fall Kill 2
 LOCATION: Hyde Park, at Haviland Road bridge
 DATE: September 4, 1997
 SAMPLE TYPE: Kick sample
 SUBSAMPLE: 100 individuals

ANNELIDA			
OLIGOCHAETA	Tubificidae	Undet. Tubificidae w/o cap. setae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	Isonychia bicolor	6
	Baetidae	Baetis sp.	2
	Heptageniidae	Stenonema sp.	2
ODONATA	Gomphidae	Stylogomphus sp.	1
	Calopterygidae	Calopteryx sp.	2
PLECOPTERA	Perlidae	Paragnetina media	3
COLEOPTERA	Elmidae	Optioservus sp.	2
		Stenelmis crenata	6
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	34
	Psychomyiidae	Undetermined Psychomyiidae	1
	Hydropsychidae	Cheumatopsyche sp.	4
		Hydropsyche betteni	1
DIPTERA	Chironomidae	Brillia sp.	1
		Parakiefferiella sp.	1
		Parametriocnemus lundbecki	13
		Psectrocladius psilopterus gr.	2
		Tvetenia bavarica gr.	2
		Microtendipes rydalensis gr.	4
		Phaenopsectra sp.	1
		Polypedilum convictum	4
		Polypedilum illinoense	4
		Rheotanytarsus exiguus gr.	1
		Stempellinella sp.	1
SPECIES RICHNESS	25 (good)		
BIOTIC INDEX	4.57 (good)		
EPT RICHNESS	8 (good)		
MODEL AFFINITY	56 (good)		
ASSESSMENT	slightly impacted		

DESCRIPTION The stream in this upstream reach was slow-moving and mostly shaded, and was ponded in some upstream areas. The fauna was dominated by intolerant filter-feeding caddisflies, reflecting both the headwater character and upstream impoundments. Faunal diversity was quite high, and no major water quality problems were indicated. All water quality indices were within the range of slight impact.

STREAM SITE: Fall Kill 3
 LOCATION: Hyde Park, East Dorsey Road, 50 meters above bridge
 DATE: September 4, 1997
 SAMPLE TYPE: Kick sample
 SUBSAMPLE: 100 individuals

MOLLUSCA			
PELECYPODA	Sphaeriidae	Sphaerium sp.	10
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea sp.	1
AMPHIPODA	Gammaridae	Gammarus sp.	1
INSECTA			
EPHEMEROPTERA	Baetidae	Acerpenna pygmaea	1
	Heptageniidae	Stenonema sp.	3
	Tricorythidae	Tricorythodes sp.	1
COLEOPTERA	Psephenidae	Psephenus herricki	2
	Elmidae	Macronychus glabratus	1
		Stenelmis sp.	22
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	15
	Hydropsychidae	Cheumatopsyche sp.	6
DIPTERA	Chironomidae	Thienemannimyia gr. spp.	2
		Cricotopus vierriensis	1
		Parakiefferiella sp.	1
		Parametrioctenus lundbecki	2
		Tvetenia bavarica gr.	1
		Microtendipes pedellus gr.	1
		Microtendipes rydalensis gr.	6
		Phaenopsectra sp.	1
		Polypedilum aviceps	1
		Polypedilum convictum	2
		Polypedilum scalaenum gr.	1
		Micropsectra nr. deflecta	1
		Micropsectra sp.	4
		Rheotanytarsus distinctissimus gr.	1
		Rheotanytarsus exiguus gr.	1
		Stempellinella sp.	4
		Tanytarsus guerlus gr.	7
SPECIES RICHNESS	28 (excellent)		
BIOTIC INDEX	5.13 (good)		
EPT RICHNESS	5 (fair)		
MODEL AFFINITY	55 (good)		
ASSESSMENT	slightly impacted		

DESCRIPTION The stream bottom at this site had much dark organic material. The dissolved oxygen level had dropped substantially from the upstream site, possibly due to impoundments upstream. Most faunal indices also dropped, and stoneflies were not found at this site. Water quality was assessed as slightly impacted, likely from nutrient additions.

STREAM SITE: Fall Kill 4
 LOCATION: Poughkeepsie, Smith Street bridge, 5 meters below bridge
 DATE: September 4, 1997
 SAMPLE TYPE: Kick sample
 SUBSAMPLE: 100 individuals

ANNELIDA			
OLIGOCHAETA	Naididae	Nais pardalis	1
MOLLUSCA			
PELECYPODA	Sphaeriidae	Undetermined Sphaeriidae	4
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	6
INSECTA			
COLEOPTERA	Elmidae	Macronychus glabratus	4
		Stenelmis sp.	6
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	10
	Hydropsychidae	Cheumatopsyche sp.	11
		Hydropsyche betteni	23
DIPTERA	Tipulidae	Tipula sp.	1
	Simuliidae	Simulium sp.	2
	Chironomidae	Cricotopus bicinctus	5
		Cricotopus vierriensis	7
		Parametriocnemus lundbecki	8
		Rheocricotopus robacki	2
		Polypedilum convictum	2
		Polypedilum illinoense	1
		Rheotanytarsus exiguus gr.	4
		Tanytarsus glabrescens gr.	2
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS 19 (good)
 BIOTIC INDEX 5.61 (good)
 EPT RICHNESS 3 (fair)
 MODEL AFFINITY 51 (good)
 ASSESSMENT slightly impacted

DESCRIPTION The dissolved oxygen level increased at this site, compared to upstream Station 3. No mayflies were found, although a few stoneflies were collected. The fauna was heavily dominated by caddisflies. All water quality indices declined compared to Station 3, and the overall assessment was slightly impacted, but borderline moderately impacted.

STREAM SITE: Fall Kill 5
 LOCATION: Poughkeepsie, Garden Street, 200 meters downstream of bridge
 DATE: September 4, 1997
 SAMPLE TYPE: Kick sample
 SUBSAMPLE: 100 individuals

ANNELIDA			
OLIGOCHAETA		Undetermined Lumbricina	14
	Naididae	Nais communis	4
MOLLUSCA			
GASTROPODA	Ancylidae	Ferrissia walkeri	5
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea sp.	12
AMPHIPODA	Gammaridae	Gammarus sp.	31
DECAPODA	Cambaridae	Undetermined Cambaridae	1
INSECTA			
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	9
DIPTERA	Empididae	Hemerodromia sp.	2
	Chironomidae	Brillia flavifrons	3
		Cricotopus bicinctus	11
		Cricotopus trifascia gr.	1
		Cricotopus vierriensis	4
		Polypedilum fallax gr.	1
		Polypedilum illinoense	2
SPECIES RICHNESS	14 (fair)		
BIOTIC INDEX	6.44 (good)		
EPT RICHNESS	1 (poor)		
MODEL AFFINITY	44 (fair)		
ASSESSMENT	moderately impacted		

DESCRIPTION Access to the sampling site was difficult, due to an 8-foot wall. The stream was heavily shaded, and contained a large amount of refuse (see text). The water was greyish, and the substrate was oily; considerable oil was released in the process of taking the kick sample. The invertebrate fauna was dominated by tolerant scuds, worms, sowbugs, and midges; no mayflies or stoneflies were found. Water quality indices clearly indicated an overall assessment as moderately impacted.

LABORATORY DATA SUMMARY

STREAM NAME Fall Kill
DATE SAMPLED 09/04/97
SAMPLING METHOD Traveling kick

DRAINAGE 13
COUNTY Dutchess

STATION	02	03	04	05
LOCATION	Hyde Park Haviland Rd	Hyde Park E.Dorsey L.	Poughk'psie Smith St.	Poughk'psie Garden St.
DOMINANT SPECIES\% CONTRIBUTION\TOLERANCE\COMMON NAME				
Genus and species names are abbreviated here to accommodate format. Complete names are reported elsewhere in this report. Intolerant = not tolerant of poor water quality; Facultative = occurring over a wide range of water quality; Tolerant = tolerant of poor water quality.	1. Chimarra aterrima 34 intolerant caddisfly	Stenelmis sp. 22 facultative beetle	Hydropsyche betteni 23 facultative caddisfly	Gammarus sp. 31 facultative scud
	2. Parametrioc lundbeck 13 facultative midge	Chimarra aterrima 15 intolerant caddisfly	Cheumatopsy sp. 11 facultative caddisfly	Undeterm. Lumbrici 14 tolerant worm
	3. Isonychia bicolor 6 intolerant mayfly	Sphaerium sp. 10 facultative clam	Chimarra aterrima 10 intolerant caddisfly	Caecidotea sp. 12 tolerant sowbug
	4. Stenelmis crenata 6 facultative beetle	Tanytarsus guerlus 7 facultative midge	Parametrioc lundbeck 8 facultative midge	Cricotopus bicinct 11 tolerant midge
	5. Polypedilum illinoe 4 facultative midge	Microtend rydalen 6 facultative midge	Cricotopus vierrien 7 facultative midge	Hydropsyche betteni 9 facultative caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	34 (11)	37 (17)	32 (9)	22 (6)
Trichoptera (caddisflies)	40 (4)	21 (2)	44 (3)	9 (1)
Ephemeroptera (mayflies)	10 (3)	5 (3)	0 (0)	0 (0)
Plecoptera (stoneflies)	3 (1)	0 (0)	0 (0)	0 (0)
Coleoptera (beetles)	8 (2)	25 (3)	10 (2)	0 (0)
Oligochaeta (worms)	1 (1)	0 (0)	1 (1)	18 (2)
Others (**)	4 (3)	12 (3)	13 (4)	51 (5)
TOTAL	100 (25)	100 (28)	100 (19)	100 (14)
SPECIES RICHNESS	25	28	19	14
HBI INDEX	4.57	5.13	5.61	6.44
EPT VALUE	8	5	3	1
PMA VALUE	56	55	51	44
FIELD ASSESSMENT	no impact	slt impact	slt impact	mod impact
OVERALL ASSESSMENT	slightly impacted	slightly impacted	slightly impacted	moderately impacted

** fingernail clams (Sta.3,4); scuds (Sta.3,4,5); sowbugs (Sta.3,5);
Odonata (Sta.2); Megaloptera (Sta.2); black flies (Sta.4);
crayfish (Sta. 5); non-chironomid flies (Sta.4,5); snails (Sta.5)

FIELD DATA SUMMARY SHEET

STREAM NAME: Fall Kill

REACH: Hyde Park to Poughkeepsie

DATE SAMPLED: 09-04-97

FIELD PERSONNEL INVOLVED: Bode, Novak

STATION	02	03	04	05
ARRIVAL TIME AT STATION	10:15	11:10	12:15	12:45
LOCATION	Haviland Rd.	E. Dorsey Lane	Smith St.	Garden St.
PHYSICAL CHARACTERISTICS				
Width (meters)	5	5	6	8
Depth (meters)	0.1	0.2	0.1	0.1
Current speed (cm per sec)	70	63	77	67
Substrate (%)				
rock (> 10 in. or bedrock)	10	10	10	10
rubble (2.5-10 in.)	40	30	40	40
gravel (0.08-2.5 in.)	10	20	20	20
sand (0.06-2.0 mm)	20	10	10	10
silt (0.004-0.06 mm)	20	30	20	20
clay (less than 0.004 mm)				
Embeddedness (%)	20	20	-	20
CHEMICAL MEASUREMENTS				
Temperature (oC)	15.2	17.4	16.9	16.9
Specific conductance (umhos)	378	543	510	716
Dissolved Oxygen (mg per l)	8.4	5.8	7.0	9.2
pH	7.7	7.4	7.5	8.0
BIOLOGICAL ATTRIBUTES				
Canopy (%)	90	90	50	95
Aquatic Vegetation				
algae - water column				
algae - filamentous			abundant	
algae - diatoms				
macrophytes; moss	moss			present
Occurrence of Macroinvertebrates				
Chironomidae (midges)			X	
Trichoptera (caddisflies)	X	X	X	X
Ephemeroptera (mayflies)	X	X		
Plecoptera (stoneflies)	X		X	
Coleoptera (beetles)	X	X	X	
Oligochaeta (worms)				X
Other (**)	X	X	X	X
ESTIMATED BIOMASS	medium	high	high	low
FIELD ESTIMATE OF WATER QUALITY	non	slt	slt	mod
FIELD COMMENTS				

** Megaloptera (Sta. 2,3,4); Odonata (Sta.2,3); crayfish (Sta. 3,4,5); scuds (Sta. 4,5); black flies (Sta. 4)

Appendix I. BIOLOGICAL METHODS FOR KICK SAMPLING

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

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

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

D. Sample Sorting and Subsampling. In the laboratory the sample is rinsed with tap water in a U.S. No. 40 standard sieve to remove any fine particles left in the residues from field sieving. The sample is transferred to an enamel pan and distributed homogeneously over the bottom of the pan. A small amount of the sample is randomly removed with a spatula and placed in a petri dish with alcohol. This portion is examined under a dissecting stereomicroscope and 100 organisms are removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. Following identification of a subsample, if the results are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

E. Organism Identification. All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species, and the total number of individuals in the sample is recorded on a data sheet. All organisms from the subsample are archived, either slide-mounted or preserved in alcohol.

Appendix II. MACROINVERTEBRATE COMMUNITY PARAMETERS

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

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

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

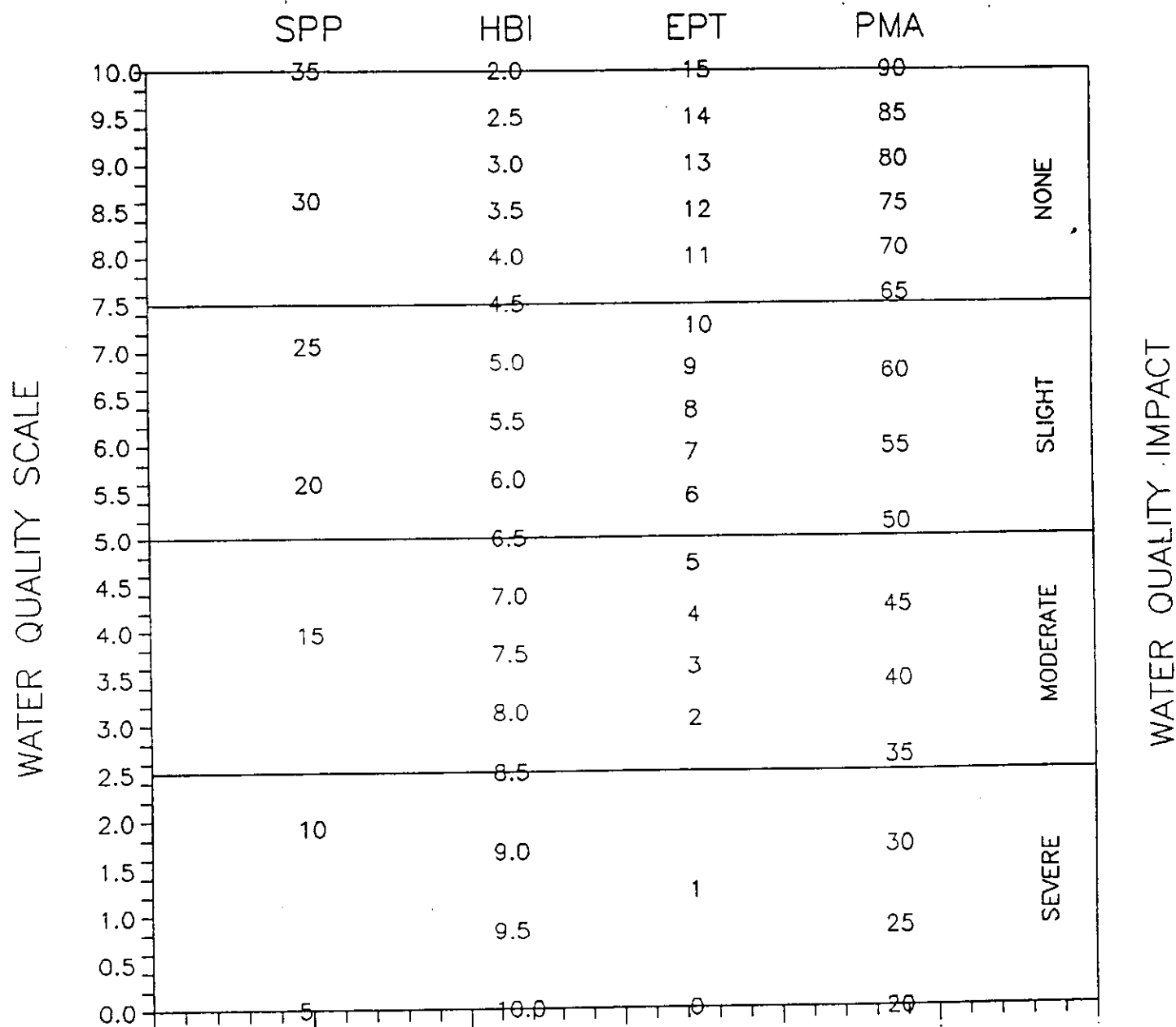
Indices reflect fair water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50. 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 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.

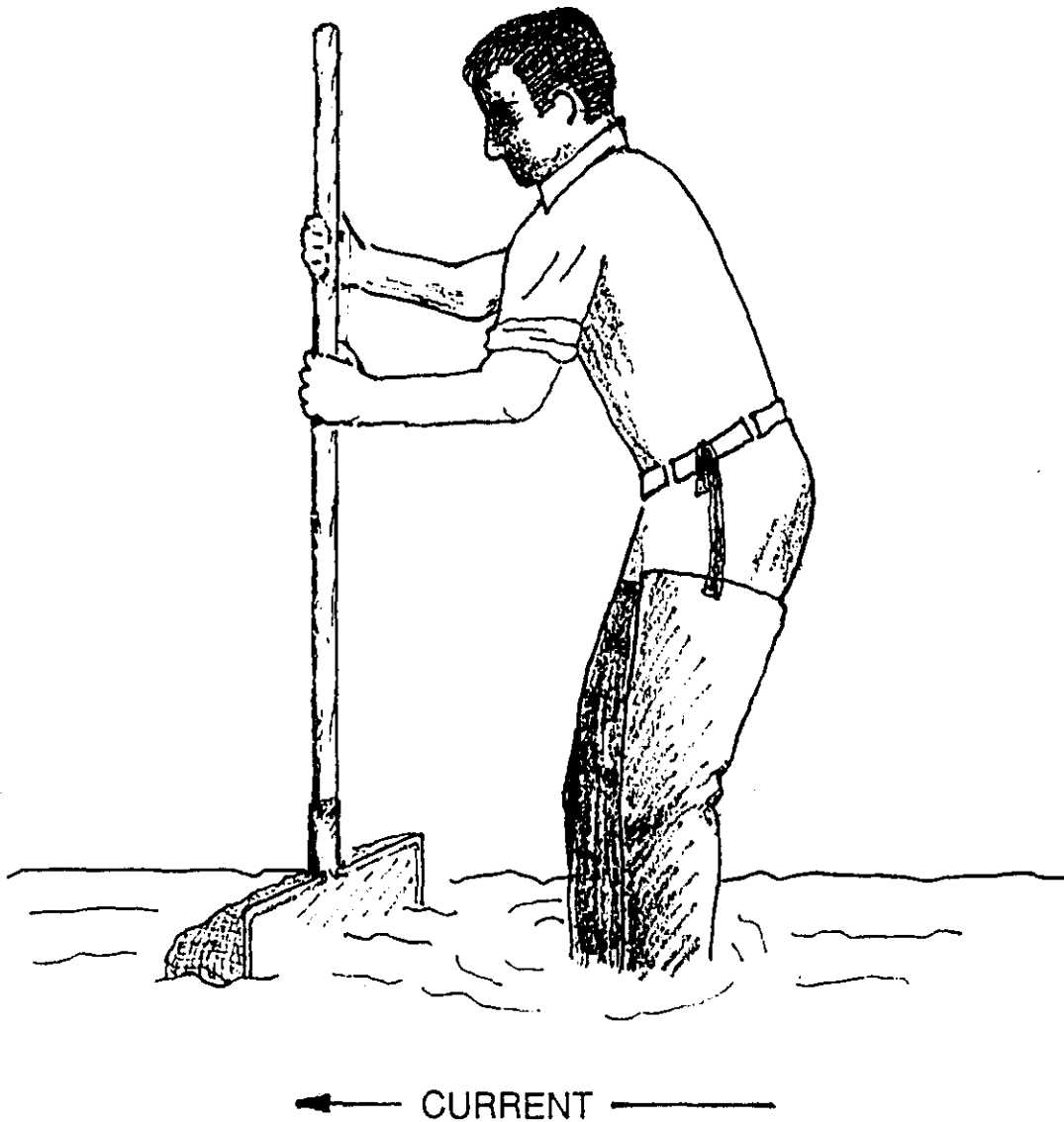
WATER QUALITY ASSESSMENT CRITERIA

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

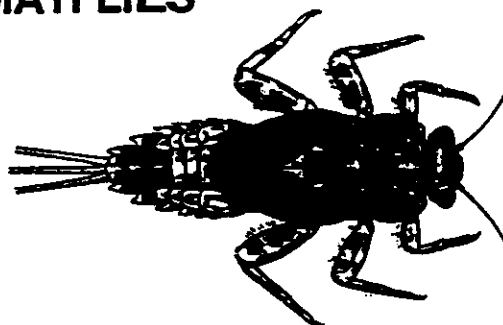


Rocks and sediment in the stream riffle are dislodged by foot upstream of a net; dislodged organisms are carried by the current in the net. Sampling is continued for a specified time, gradually moving downstream to cover a specified distance.

AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

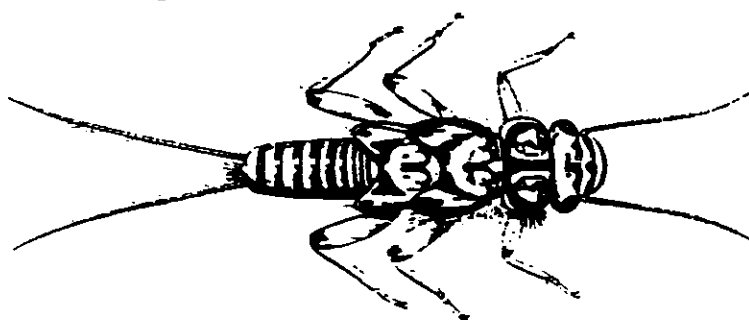
Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides, and acidity. Most mayflies are found clinging to the undersides of rocks.

MAYFLIES



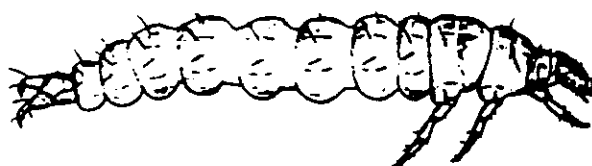
Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained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

STONEFLIES



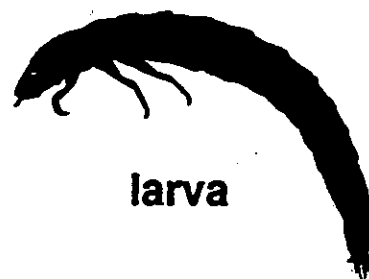
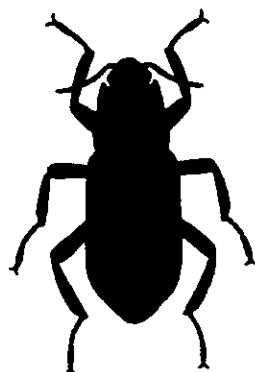
Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in recovery zones below sewage discharges.

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



larva

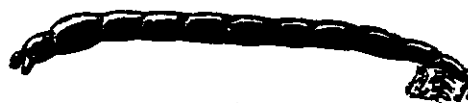
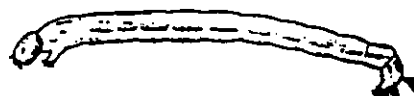
adult

Illustrations by Arwin Provonsha
In McCafferty: Aquatic Entomology
• 1983 Boston: Jones & Bartlett
Publishers. Reprinted by permission.

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; most of these are red and are called "bloodworms". Other species filter suspended food particles, and are numerous in sewage recovery zones.

MIDGES



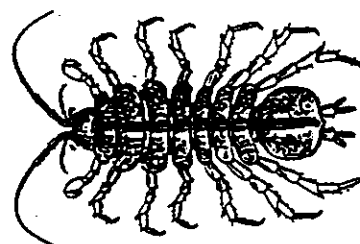
WORMS



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.

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.

SOWBUGS



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.

BLACK FLIES



larva



pupa

Illustrations by Arwin Provonsha
In McCafferty: Aquatic Entomology
• 1983 Boston: Jones & Bartlett
Publishers. Reprinted by permission.

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, such as siltation or thermal changes
- 7) they are vital components of the aquatic ecosystem and important as a food source for fish
- 8) they are more readily perceived by the public as tangible indicators of water quality
- 9) they can often provide an on-site estimate of water quality
- 10) they can often be used to identify specific stresses or sources of impairment
- 11) they can be preserved and archived for decades, allowing for direct comparison of specimens
- 12) they bioaccumulate many contaminants, so that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain

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

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

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

station: a sampling site on a waterbody

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

tolerant: able to survive poor water quality

APPENDIX X. METHODS FOR IMPACT SOURCE DETERMINATION

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

Development of methods The method found to be most useful in differentiating impacts in New York State streams was the use of community types, based on composition mostly 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: nonpoint nutrient additions, toxics, sewage effluent or animal wastes, municipal/industrial, siltation, impoundment, and natural. Cluster analysis was then performed within each group, using percent similarity, mostly at the family or genus level. Within each group different 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. Similarities less than 50% are less conclusive. 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	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Isonychia</u>	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
<u>Caenis/Tricorythodes</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	5	5	-	5	5	15	5	5	5	5
<u>Psephenus</u>	5	-	-	-	-	-	-	-	-	-	-	-	-
<u>Optioservus</u>	5	-	20	5	5	-	5	5	5	5	-	-	-
<u>Promoresia</u>	5	-	-	-	-	-	25	-	-	-	-	-	-
<u>Stenelmis</u>	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	-	-	-
<u>Simulium vittatum</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	5	-	-	-	-
CHIRONOMIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanypodinae	-	5	-	-	-	-	-	-	5	-	-	-	-
Diamesinae	-	-	-	-	-	-	5	-	-	-	-	-	-
Cardiocladius	-	5	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/</u> <u>Orthocladius</u>	5	5	-	-	10	-	-	5	-	-	5	5	5
<u>Eukiefferiella/</u> <u>Tvetenia</u>	5	5	10	-	-	5	5	5	-	5	-	5	5
<u>Parametriocnemus</u>	-	-	-	-	-	-	-	5	-	-	-	-	-
<u>Chironomus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum aviceps</u>	-	-	-	-	-	20	-	-	10	20	20	5	-
<u>Polypedilum</u> (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									TOXIC				
	A	B	C	D	E	F	G	H	I	A	B	C	D	E
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	-	-	-	5
OLIGOCHAETA	-	-	-	5	-	-	-	-	-	-	10	20	5	5
HIRUDINEA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-	5	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	10	10	-	20	10
GAMMARIDAE	-	-	-	5	-	-	-	-	-	5	-	-	-	5
<u>Isonychia</u>	-	-	-	-	-	-	-	5	-	-	-	-	-	-
BAETIDAE	5	15	20	5	20	10	10	5	10	15	10	20	-	-
HEPTAGENIIDAE	-	-	-	-	5	5	5	5	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	5	-	-	-	-	-	-
<u>Caenis/Tricorythodes</u>	-	-	-	-	5	-	-	5	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	5	-	-	5	-	5	5	-	-	-	-	-	-	-
<u>Optioservus</u>	10	-	10	5	-	-	15	5	-	-	-	-	-	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	15	15	-	10	15	5	25	5	10	10	15	-	40	35
PHILOPOTAMIDAE	15	5	-	5	-	25	5	-	-	10	-	-	-	-
HYDROPSYCHIDAE	15	15	15	25	10	35	20	45	20	20	10	15	10	35
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	5	-	15	5	5	-	-	-	40	-	-	-	-	-
<u>Simulium vittatum</u>	-	-	-	-	-	-	-	-	5	-	20	-	-	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE														
Tanypodinae	-	-	-	-	-	-	5	-	-	5	10	-	-	-
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/</u>														
<u>Orthocladius</u>	10	15	10	5	-	-	-	-	5	15	10	25	10	5
<u>Eukiefferiella/</u>														
<u>Tvetenia</u>	-	15	10	5	-	-	-	-	5	-	-	20	10	-
<u>Parametrioctenemus</u>	-	-	-	-	-	-	-	-	-	-	-	-	5	-
<u>Chironomus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum aviceps</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (all others)	10	10	10	10	20	10	5	10	5	10	-	-	-	-
Tanytarsini	10	10	10	5	20	5	5	10	-	-	-	-	-	-
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100

	SEWAGE EFFLUENT, ANIMAL WASTES									MUNICIPAL/INDUSTRIAL					
	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	40	-	-	-	5
OLIGOCHAETA	5	35	15	10	10	35	40	10	20	20	20	70	10	-	20
HIRUDINEA	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
SPHAERIIDAE	-	-	-	10	-	-	-	-	-	-	5	-	-	-	-
ASELLIDAE	5	10	-	10	10	10	10	50	-	10	5	10	10	15	5
GAMMARIDAE	-	-	-	-	-	10	-	10	-	40	-	-	-	15	-
<u>Isonychia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	10	5	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	5	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-
<u>Caenis/Tricorythodes</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Optioservus</u>	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	15	-	10	10	-	-	-	-	-	5	-	-	10	5	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	10	10	-	-	50	20	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Simulium vittatum</u>	-	-	-	25	10	35	-	-	5	-	-	-	-	-	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	5	-	-	-	-	-	-	-	-	10	-	-	5	15
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/</u> <u>Orthocladius</u>	-	10	15	-	-	10	10	-	5	5	10	20	-	5	10
<u>Eukiefferiella/</u> <u>Tvetenia</u>	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-
<u>Parametrioctenus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Chironomus</u>	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-
<u>Polypedilum aviceps</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Polypedilum</u> (all others)	10	10	10	10	60	-	30	10	10	-	-	-	10	20	40
Tanytarsini	10	10	10	10	-	-	-	10	20	-	-	-	10	10	-
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

	SILTATION					IMPOUNDMENT									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
<u>Isonychia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Caenis/Tricorythodes</u>	5	20	10	5	15	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
<u>Optioservus</u>	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	5	10	10	5	20	5	5	10	10	-	5	35	-	5	10
PHILOPOTAMIDAE	-	-	-	-	-	5	-	-	5	-	-	-	-	-	30
HYDROPSYCHIDAE	25	10	-	20	30	50	15	10	10	10	10	20	5	15	20
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
SIMULIIDAE	5	10	-	-	5	5	-	5	-	35	10	5	-	-	15
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus/</u> <u>Orthocladius</u>	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
<u>Eukiefferiella/</u> <u>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