New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Quackenderry Creek

Biological Assessment

2005 Survey

New York State
Department of Environmental Conservation
Region 1

George E. Pataki, Governor   Denise M. Sheehan, Commissioner

Quackenderry Creek

BIOLOGICAL ASSESSMENT

Lower Hudson River Basin
Rensselaer County, New York

Survey date: July 12, 2005
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Robert W. Bode
Margaret A. Novak
Lawrence E. Abele
Diana L. Heitzman
Alexander J. Smith
Christine Smith

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

CONTENTS

Stream: Quackenderry Creek, Rensselaer County, New York

Reach: North Greenbush to Rensselaer, New York

Drainage basin: Lower Hudson River

Background:

The Stream Biomonitoring Unit sampled Quackenderry Creek on July 21, 2005. The purpose of the sampling was to assess overall water quality, especially in relation to percent impervious surface cover of the watershed. In a riffle area at each of five 5 sites, a traveling kick sample for macroinvertebrates was taken using methods described in the Quality Assurance document (Bode, et al., 2002) 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 from each site. Macroinvertebrate community parameters used in the determination of water quality included species richness, biotic index, EPT richness, and percent model affinity (see Appendices II and III). Expected variability of results is stated in Smith and Bode (2004). Table 2 provides a listing of sampling sites and Table 3 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by macroinvertebrate data reports, including raw macroinvertebrate data from each site. Percent impervious surface cover was determined by Stream Biomonitoring Unit Volunteer and GIS analyst Christine Smith using methods described in Appendix XIII.

Results and Conclusions:

1. Water quality in the Quackenderry Creek ranged from non- to slightly impacted. Water quality worsened as percent impervious surface cover in the watershed increased from 15% to 21%.

2. Future increases in impervious surface cover greater than 25% are predicted to result in moderate impacts in Quackenderry Creek, and an inability to use the stream for fishing and fish propagation.

Discussion:

Quackenderry Creek originates approximately 0.7 mile east of Route 4 in North Greenbush, and flows west for 4 miles before joining the Hudson River at Rensselaer. The stream name does not appear on USGS topographic maps, but is listed in the stream gazetteer (USGS, 1981). At a former USGS gage site in Rensselaer, the drainage area is listed as 2.99 square miles. The stream is classified as C, meaning the best water use is for fishing and fish propagation. Quackenderry Creek was not previously sampled by the Stream Biomonitoring Unit.

The present sampling was conducted to document changes in macroinvertebrate communities and water quality in relation to changes in percent impervious surface cover (ISC) in a watershed. The Quackenderry Creek watershed was selected because of recent development in the basin, including the development of 34-acre parcel in 1999 into the Shoppes at Greenbush Commons shopping center. ISC was calculated for the Quackenderry Creek sites (Table 1) using techniques described in Appendix XIII.

Recent reports in the scientific literature have documented the effects of urbanization on the physical, chemical and biological characteristics of streams. A primary factor of urbanization is an increase in the percentage of ISC. Impervious surfaces are those which cover soils that previously allowed rainwater infiltration; primarily rooftops, roadways and parking areas. Effects of increasing ISC include: flooding, bank erosion, higher summer temperatures, lower winter temperatures, and increases in oxygen demand, conductivity, suspended solids, ammonium, hydrocarbons, metals, pesticides, nutrients and runoff. In examining the biological effects of elevated ISC, one proposed classification divides urban streams into three categories: sensitive (0-10% ISC), impacted (11-25% ISC), and non-supporting (26-100% ISC) (Schueler and Holland, 2000). A mitigating factor in estimating ISC is disconnected basins which provide some buffering. An example is a single-family residential area where rooftops drain to dry wells or other infiltration areas. In some calculations, these disconnected portions are subtracted from the total ISC to yield an effective ISC.

In the present study, water quality ranged from non-impacted to slightly impacted in Quackenderry Creek (Figure 1), generally declining from upstream to downstream. ISC ranged from 14% at the upstream site (Station-1) to 21% at the site immediately downstream of the shopping center (Station-3), and the ISC trend was closely correlated with specific conductance and the Nutrient Biotic Index for phosphorus (NBI-P) (Figure 2). An NBI-P value of 6.0 or greater, the provisional definition of eutrophic waters, was reported at all sites with ISC greater than 15% (Stations 2-5) in Quackenderry Creek. Impact Source Determination (Table 2) also show nutrients to be an influencing factor in the creek.

Subsequent to the building of the Shoppes at Greenbush Common, flooding occurs along Quackenderry Creek in Rensselaer downstream of Station-5 immediately after rain events, likely due to increased ISC in the basin. A dam project was developed and built one mile upstream of Station-5 to address the problem. The macroinvertebrate community at Station-5 reflects impoundment effects from the dam.

Due to the small watershed of Quackenderry Creek, two types of adjustments were made to metric values. Percent Model Affinity values at Stations 1-3 were adjusted upwards, due to high numbers of Plecoptera. Citing the Percent Model Affinity paper, "In a few cases, high contributions by an intolerant group, usually mayflies, may result in low percent similarity values, indicating a polluted condition where one does not exist; affinity values should therefore be reviewed to determine which groups cause deviation from the model," (Novak and Bode, 1992). The adjustment factor at each site reflects the number of Plecoptera exceeding the model.

Additionally, Stations 1-2 were adjusted for headwater effects (Appendix XII). These two sites met the criteria prescribed for headwater metric adjustment: a headwater location, a community dominated by an intolerant species, and species richness, EPT richness, or percent model affinity judged to be non-representative of actual water quality. A correction factor of 1.5 was applied to species richness and EPT richness from these two sites.

Although effects of ISC were documented in this study, Quackenderry Creek was not an ideal subject for a demonstration project. The headwater condition was a mitigating factor at upstream sites, and the most upstream site already had a high percentage of ISC, both contributing to limited fauna at the site. An ideal study situation would be a stream with a non-impacted upstream site that is not in headwater condition, and a downstream site with substantial increases in ISC.

Despite the urban/suburban setting and small size of Quackenderry Creek, many areas of the basin are still forested, and the stream maintains acceptable water quality. Future increases in ISC greater than 25% are predicted to result in moderate impacts, and an inability to use the stream for fishing and fish propagation. Many of the sites sampled in this study exhibited good habitat and high aesthetic value, yet had limited access and apparently received little use. The stream and its surrounding habitat has the potential to serve as a positive resource to the local community.

Literature Cited:

Bode, R.W., M.A. Novak, L.E. Abele, D.L. Heitzman and A.J. Smith, 2002, Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation, Technical Report, 115 pages.

Schueler, T.R, and H.K. Holland, 2000, The practice of watershed protection. Center for Watershed Protection, Ellicott City, MD. 742 pages.

Smith, A.J. and R.W. Bode, 2004, Analysis of variability in New York State benthic macroinvertebrate samples. New York State Department of Environmental Conservation, Technical Report, 43 pages.

U.S. Geological Survey, 1981, Drainage areas of New York streams, by river basins; A stream gazetteer; Part I - data compiled as of October 1980. U.S. Geological Survey Water-Resources Investigations, Open-file report 81-1055. 359 pages plus maps.

Overview of field data

On July 12, 2005, Quackenderry Creek at the sites sampled was 2-4 meters wide, 0.1 meters deep, and had current speeds of 40-70 cm/sec in riffles. Dissolved oxygen was 7.9-10.2 mg/l, specific conductance was 573-1642 µmhos, pH was 7.2-7.6 and temperature was 15.7-20.8 °C (60-69 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Quackenderry Creek, 2005. 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.

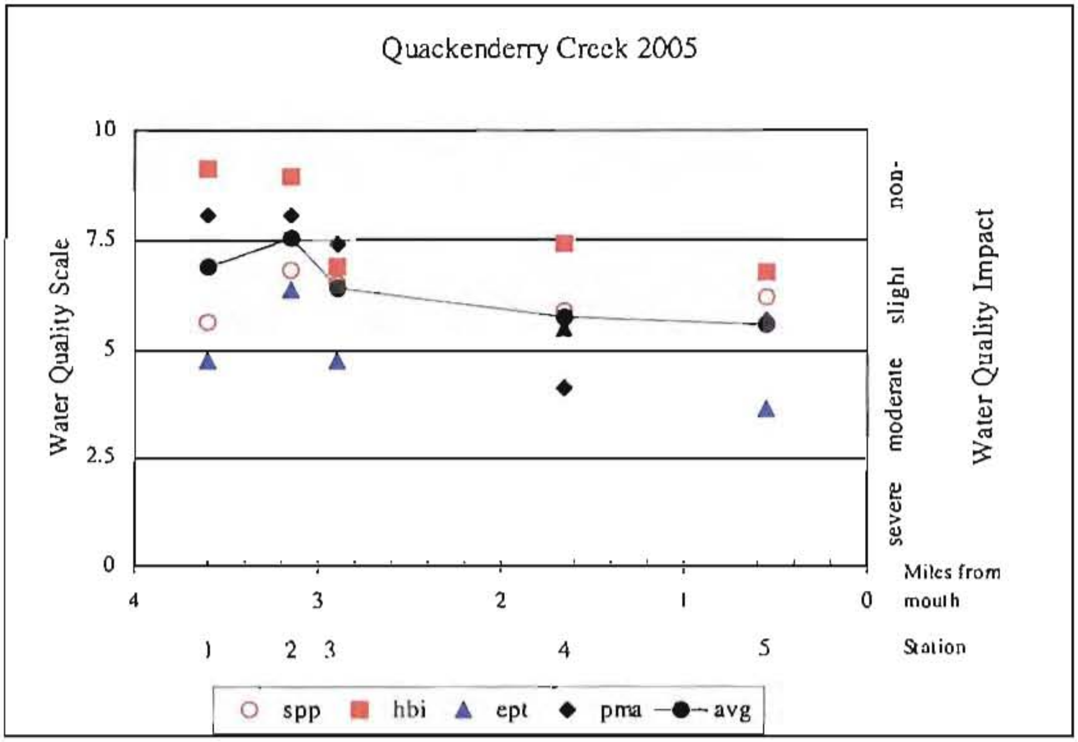


Table 1. Impervious surface calculations for Quackenderry Creek. Values reflect drainage sub-basins defined by the 5 stations.

	Station					
Parameter	1	2	3	4	5	mouth
Basin area (square meters)	891,270	1,062,257	3,128,655	4,167,136	7,127,012	7,722,131
Impervious surface area (square meters)	121,513	158,826	662,801	835,412	1,227,548	1,487,758
Percent impervious surface	13.63	14.95	21.18	20.04	17.22	19.26

Figure 2. Plot of Impervious Surface Cover, Conductivity and Nutrient Biotic Index values, Quackenderry Creek, 2005.

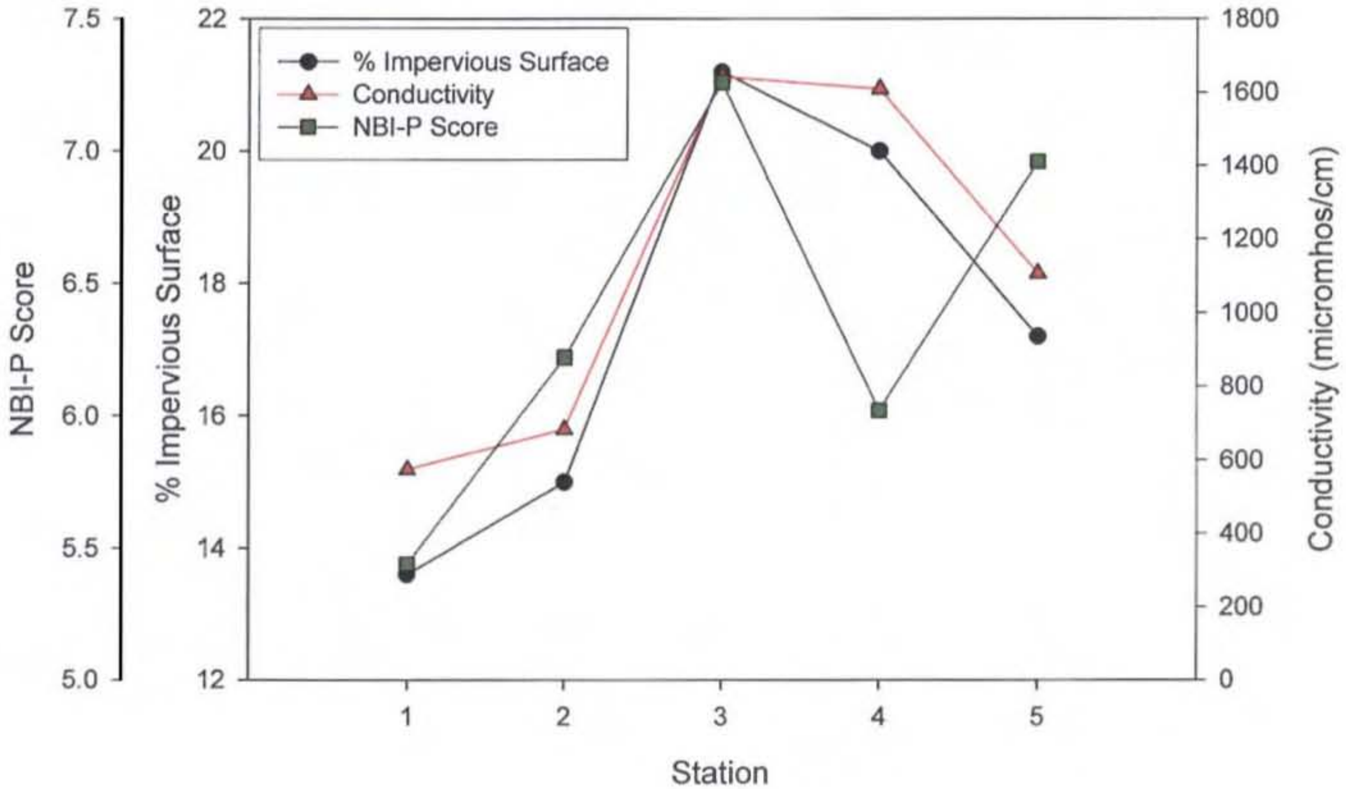


Table 2. Impact Source Determination, Quackenderry Creek, 2005. Numbers represent similarity to community type models for each impact category. The highest average similarities at each station are shaded. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	Station				
Community Type	01	02	03	04	05
Natural: minimal human impacts	39	46	39	35	28
Nutrient enrichment	21	47	47	57	41
Toxic: industrial, municipal discharges, or urban run-off	32	32	39	58	47
Organic: sewage or animal wastes	20	31	37	44	28
Complex: municipal and/or industrial	18	31	42	39	26
Siltation	19	39	42	54	38
Impoundment	19	37	45	35	51

STATION	COMMUNITY TYPE
QUCK-01	Natural
QUCK-02	Natural, Nutrients
QUCK-03	Nutrients, Complex, Siltation, Impoundment
QUCK-04	Nutrients, Toxic, Siltation
QUCK-05	Toxic, Impoundment

Table 3. Station Locations for Quackenderry Creek, Rensselaer County, NY, 2005

STATION	LOCATION
QUCK-01	North Greenbush, NY end of Thompson Court latitude 42°38'54" longitude 73°41'37" 3.6 river miles above mouth
QUCK-02	North Greenbush, NY off Route 43, above transmission lines latitude 42°39'04" longitude 73°42'04" 3.2 river miles above mouth
QUCK-03	North Greenbush, NY off Route 43, below runoff trib latitude 42°39'01" longitude 73°42'23" 2.9 river miles above mouth
QUCK-04	Rensselaer, NY off Ninth Street latitude 42°39'21" longitude 73°43'27" 1.7 river miles above mouth
QUCK-05	Rensselaer, NY Below Wilson Street bridge latitude 42°38'40" longitude 73°44'09" 0.6 river miles above mouth

Figure 3	Site Overview Map	Quackenderry Creek

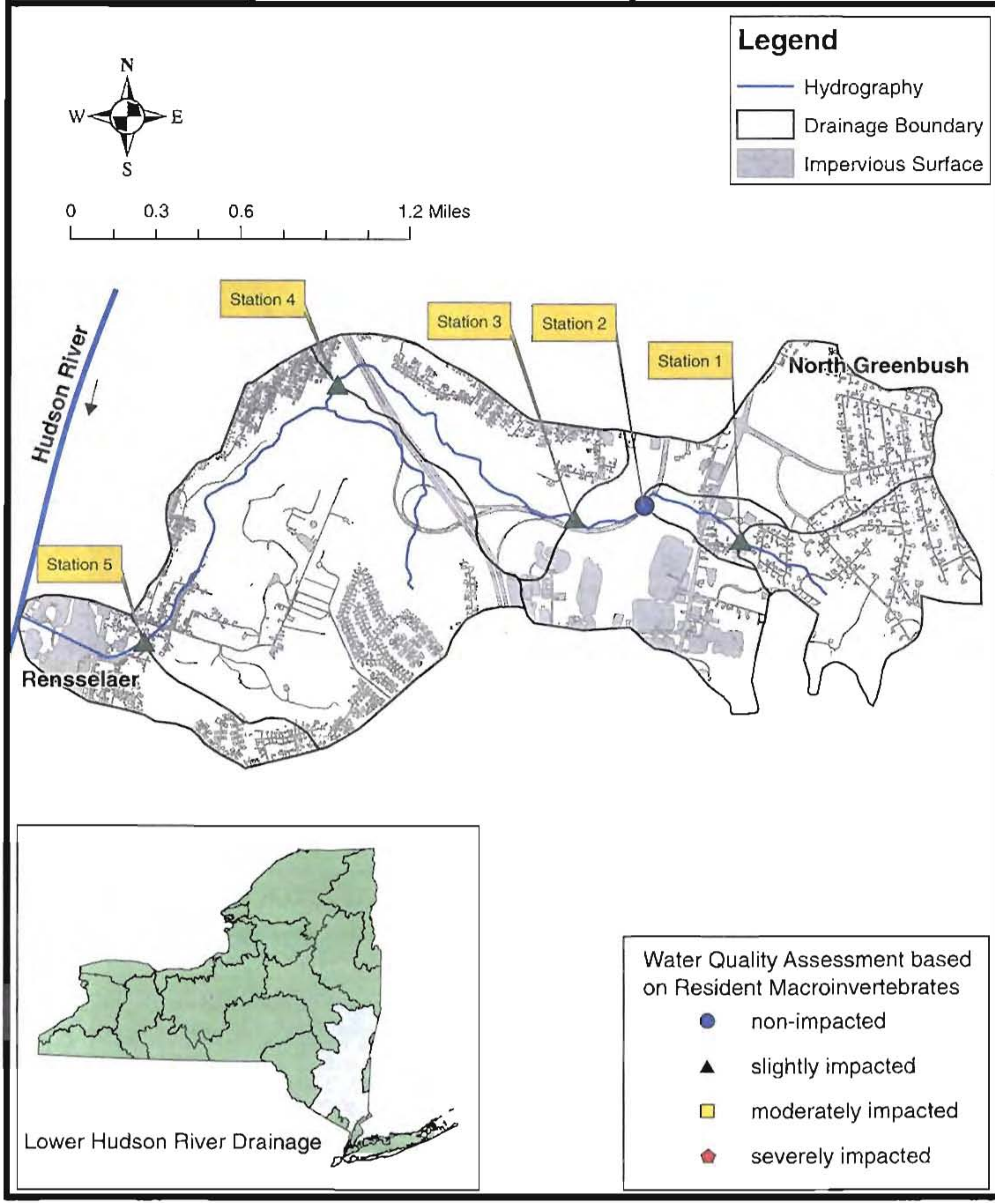


Table 4. Macroinvertebrates Species collected in Quackenderry Creek, July 12, 2005

PLATYHELMINTHES
TURBELLARIA
Planariidae
Undetermined Turbellaria
OLIGOCHAETA
LUMBRICIDA
Undetermined Lumbricina
LUMBRICULIDA
Lumbriculidae
Undetermined Lumbriculidae
TUBIFICIDA
Enchytraeidae
Undetermined Enchytraeidae
Tubificidae
Undet. Tubificidae w/ cap. setae
Undet. Tubificidae w/o cap. setae
MOLLUSCA
PELECYPODA
Sphaeriidae
Pisidium sp.
ARTHROPODA
CRUSTACEA
AMPHIPODA
Gammaridae
Gammarus sp.
ISOPODA
Asellidae
Caecidotea racovitzai
INSECTA
EPHEMEROPTERA
Baetidae
Baetis flavistriga
PLECOPTERA
Leuctridae
Leuctra sp.
ODONATA
Aeschnidae
Boyeria sp.
COLEOPTERA
Psephenidae
Ectopria nervosa
Psephenus herricki
Elmidae
Macronychus glabratus
Optioservus fastiditus
Stenelmis crenata
Stenelmis sp.
MEGALOPTERA
Sialidae
Sialis sp.
TRICHOPTERA
Philopotamidae
Chimarra aterrima?
Dolophilodes sp.
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche betteni
Hydropsyche slossonae
Hydropsyche sparna
Potamyia sp.
Rhyacophilidae
Rhyacophila sp.
DIPTERA
Tipulidae
Antocha sp.
Dicranota sp.
Hexatoma sp.
Tipula sp.
Simuliidae
Simulium tuberosum
Simulium vittatum
Simulium sp.
Athericidae
Atherix sp.
Empididae
Hemerodromia sp.
Chironomidae
Natarsia sp. A
Thienemannimyia gr. spp.
Diamesa sp.
Pagastia orthogonia
Brillia sp.
Cricotopus bicinctus
Cricotopus tremulus gr.
Eukiefferiella claripennis gr.
Parametriocnemus lundbecki
Tvetenia bavarica gr.
Polypedilum aviceps
Polypedilum illinoense
Polypedilum tuberculum
Paratanytarsus sp.
Rheotanytarsus exiguus gr.

Macroinvertebrate Data Reports: Raw Data

STREAM SITE:	Quackenderry Creek, Station QUCK-01
LOCATION:	North Greenbush, NY, off Thompson Court
DATE:	12 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	1
ARTHROPODA			
INSECTA			
PLECOPTERA	Leuctridae	*Leuctra sp.*	29
COLEOPTERA	Psephenidae	*Ectopria nervosa*	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	1
	Hydropsychidae	*Potamyia sp.*	8
DIPTERA	Tipulidae	*Dicranota sp.*	35
		Tipula sp.	2
	Empididae	*Hemerodromia sp.*	1
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Pagastia orthogonia	1
		Tvetenia bavarica gr.	2
		Polypedilum aviceps	9
		Polypedilum tuberculum	9

SPECIES RICHNESS:	13 (good*)
BIOTIC INDEX:	2.87 (very good)
EPT RICHNESS:	3 (poor*)
MODEL AFFINITY:	46 (very good**)
NUTRIENT INDEX (P)	5.44 (oligotrophic)
ASSESSMENT:	slightly impacted (6.88)

DESCRIPTION: This site was approximately 0.4 mile from the stream source. The habitat was well-shaded, but the stream was silty and slow-moving. The macroinvertebrate community was heavily dominated by cranefly larvae and stoneflies. The indication of slight impact was likely due to the slow-moving nature of the stream. Nearly all the species present were considered intolerant.

** Metrics were adjusted due to headwater conditions. See Appendix XII.*
*** Percent Model Affinity was adjusted up by the percent contribution of Plecoptera exceeding the model.*

Macroinvertebrate Data Reports: Raw Data (cont.)

STREAM SITE:	Quackenderry Creek, Station QUCK- 02
LOCATION:	North Greenbush, NY, off Route 43
DATE:	12 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis intercalaris*	1
PLECOPTERA	Leuctridae	*Leuctra sp.*	30
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus fastiditus*	16
		Stenelmis crenata	4
TRICHOPTERA	Philopotamidae	*Dolophilodes sp.*	1
	Hydropsychidae	*Hydropsyche sparna*	1
		Potamyia sp.	25
DIPTERA	Tipulidae	*Antocha sp.*	1
		Dicranota sp.	8
		Tipula sp.	3
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Pagastia orthogonia	2
		Tvetenia bavarica gr.	1
		Polypedilum aviceps	4

SPECIES RICHNESS:	16 (good*)
BIOTIC INDEX:	3.07 (very good)
EPT RICHNESS:	8 (good*)
MODEL AFFINITY:	45 (very good**)
NUTRIENT INDEX (P)	6.22 (eutrophic)
ASSESSMENT:	non-impacted (7.53)

DESCRIPTION: The sampling site was off Route 43 in North Greenbush, upstream of overhead transmission lines. Habitat was good, with faster current than Station-1. Based on adjusted values, water quality was assessed as non-impacted. The NBI-P indicated increased nutrients compared to Station-1.

* *Metrics were adjusted due to headwater conditions. See Appendix XII.*
** *Percent Model Affinity was adjusted up by the percent contribution of Plecoptera exceeding the model.*

Macroinvertebrate Data Reports: Raw Data (cont.)

STREAM SITE:	Quackenderry Creek, Station QUCK-03
LOCATION:	North Greenbush, NY, off Route 43
DATE:	12 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

PLATYHELMINTHES			
TURBELLARIA			
	Planariidae	Undetermined Turbellaria	1
ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	1
	Tubificidae	Undet. Tubificidae w/ cap. setae	1
		Undet. Tubificidae w/o cap. setae	11
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis intercalaris*	4
PLECOPTERA	Leuctridae	*Leuctra sp.*	9
COLEOPTERA	Elmidae	*Optioservus fastiditus*	2
		Stenelmis sp.	7
MEGALOPTERA	Sialidae	*Sialis sp.*	1
TRICHOPTERA	Hydropsychidae	*Hydropsyche betteni*	5
		Potamyia sp.	20
	Rhyacophilidae	*Rhyacophila sp.*	1
DIPTERA	Tipulidae	*Dicranota sp.*	3
		Hexatoma sp.	1
	Simuliidae	*Simulium tuberosum*	1
	Chironomidae	*Diamesa sp.*	20
		Pagastia orthogonia	4
		Prodiamesa olivacea	1
		Brillia sp.	1
		Cricotopus bicinctus	1
		Tvetenia bavarica gr.	2
		Polypedilum aviceps	2
		Paratanytarsus sp.	1

SPECIES RICHNESS:	23 (good)
BIOTIC INDEX:	5.00 (good)
EPT RICHNESS:	5 (poor)
MODEL AFFINITY:	60 (good*)
NUTRIENT INDEX (P):	7.26 (eutrophic)
ASSESSMENT:	slightly impacted (6.37)

DESCRIPTION: This site was only 0.25 mile downstream of Station-2, but received much more drainage, including run-off from the Shoppes at Greenbush Common. Habitat was comparable to that at Station-2. Conductivity had increased from 683 to 1642 µmhos, and the water appeared grey. The macroinvertebrate fauna had changed substantially from Station-2, being dominated by facultative midges and caddisflies; stoneflies were much less numerous. Using adjusted metric values, all values worsened compared to Station-2. Overall water quality was assessed as slightly impacted.

** Percent Model Affinity was adjusted up by the percent contribution of Plecoptera exceeding the model.*

STREAM SITE:	Quackenderry Creek, Station QUCK- 04
LOCATION:	Rensselaer, NY, off Ninth Street
DATE:	12 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

PLATYHELMINTHES			
TURBELLARIA			
	Planariidae	Undetermined Turbellaria	1
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	*Caecidotea racovitzai*	1
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	1
COLEOPTERA	Elmidae	*Optioservus fastiditus*	2
		Stenelmis crenata	24
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	5
	Hydropsychidae	*Cheumatopsyche sp.*	8
		Hydropsyche betteni	4
		Hydropsyche slossonae	12
		Hydropsyche sparna	3
DIPTERA	Tipulidae	*Dicranota sp.*	23
	Simuliidae	*Simulium tuberosum*	1
	Athericidae	*Atherix sp.*	2
	Chironomidae	*Natarsia sp. A*	1
		Thienemannimyia gr. spp.	3
		Pagastia orthogonia	1
		Cricotopus bicinctus	1
		Cricotopus tremulus gr.	4
		Parametriocnemus lundbecki	1
		Polypedilum tuberculum	1
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS:	21 (good)
BIOTIC INDEX:	4.60 (good)
EPT RICHNESS:	6 (good)
MODEL AFFINITY:	44 (poor)
NUTRIENT INDEX (P):	6.02 (eutrophic)
ASSESSMENT:	slightly impacted (5.71)

DESCRIPTION: The sampling site was accessed down a steep slope at Ninth Street and Birch Street in Rensselaer. Habitat was considered acceptable, and comparable to upstream sites. The macroinvertebrate community was dominated by caddisflies, riffle beetles, and cranefly larvae. Based on the metrics, water quality was assessed as slightly impacted.

Macroinvertebrate Data Reports: Raw Data (cont.)

STREAM SITE:	Quackenderry Creek, Station QUCK- 05
LOCATION:	Rensselaer, NY, below Wilson Street bridge
DATE:	12 July 2005
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	8
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	1
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	2
ODONATA	Aeschnidae	*Boyeria sp.*	2
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Macronychus glabratus*	3
		Stenelmis crenata	30
MEGALOPTERA	Sialidae	*Sialis sp.*	1
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	4
		Hydropsyche slossonae	2
DIPTERA	Tipulidae	*Antocha sp.*	1
		Dicranota sp.	11
	Simuliidae	*Simulium vittatum*	2
		Simulium sp.	1
	Athericidae	*Atherix sp.*	6
	Chironomidae	*Natarsia sp. A*	2
		Thienemannimyia gr. spp.	8
		Diamesa sp.	3
		Pagastia orthogonia	4
		Eukiefferiella claripennis gr.	2
		Parametriocnemus lundbecki	4
		Polypedilum illinoense	2

SPECIES RICHNESS: 22 (good)
BIOTIC INDEX: 5.11 (good)
EPT RICHNESS: 3 (poor)
MODEL AFFINITY: 53 (good)
NUTRIENT INDEX (P): 6.95 (eutrophic)
ASSESSMENT: slightly impacted (5.55)
DESCRIPTION: The kick sample was taken 20 meters downstream of the Wilson Street bridge in Rensselaer. It was 0.95 mile downstream of a dam on Quackenderry Creek. The site had much urban refuse in the stream, and abundant brown algae and silt were also present. The macroinvertebrate community was dominated by facultative riffle beetles and midges, and water quality was assessed as slightly impacted. Impact Source Determination reflected impoundment and urban runoff.

FIELD DATA SUMMARY				
STREAM NAME: Quackenderry Creek	**DATE SAMPLED: 7/12/2005**			
REACH: North Greenbush to Rensselaer				
FIELD PERSONNEL INVOLVED: Bode, Smith				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	8:00 AM	8:40 AM	9:10 AM	9:45 AM
LOCATION	North Greenbush off Thompson Ct	North Greenbush off Exit 8 ramp	Rensselaer off Exit 8 ramp	Rensselaer Ninth & Birch St
PHYSICAL CHARACTERISTICS				
Width (meters)	2.0	2.0	3.0	3.0
Depth (meters)	0.1	0.1	0.1	0.1
Current speed (cm per sec.)	40	70	70	70
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	10	20	10
Rubble (6.35 – 25.4 cm)	40	40	30	30
Gravel (0.2 – 6.35 cm)	20	20	20	30
Sand (0.06 – 2.0 mm)	10	10	10	10
Silt (0.004 – 0.06 mm)	20	20	20	20
Embeddedness (%)	30	30	20	30
CHEMICAL MEASUREMENTS				
Temperature (° C)	19.0	19.5	16.7	20.8
Specific Conductance (umhos)	573	683	1642	1609
Dissolved Oxygen (mg/l)	7.9	8.4	10.2	8.1
pH	7.2	7.2	7.5	7.6
BIOLOGICAL ATTRIBUTES				
Canopy (%)	100	50	70	90
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				
algae – diatoms				
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)			x	x
Plecoptera (stoneflies)	x	x	x	
Trichoptera (caddisflies)	x	x	x	x
Coleoptera (beetles)				x
Megaloptera (dobsonflies, alderflies)				x
Odonata (dragonflies, damselflies)		x		x
Chironomidae (midges)	x	x	x	x
Simuliidae (black flies)				
Decapoda (crayfish)	x	x	x	
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)	x	x		
Other		x		x
FAUNAL CONDITION	Very good	Very good	Very good	Good

FIELD DATA SUMMARY

STREAM NAME: Quackenderry Creek		**DATE SAMPLED: 7/12/2005**		
REACH: North Greenbush to Rensselaer				
FIELD PERSONNEL INVOLVED: Bode, Smith				
STATION	05			
ARRIVAL TIME AT STATION	10:20 AM			
LOCATION	Rensselaer Wilson St bridge			
PHYSICAL CHARACTERISTICS				
Width (meters)	4.0			
Depth (meters)	0.1			
Current speed (cm per sec.)	70			
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10			
Rubble (6.35 – 25.4 cm)	30			
Gravel (0.2 – 6.35 cm)	30			
Sand (0.06 – 2.0 mm)	10			
Silt (0.004 – 0.06 mm)	20			
Embeddedness (%)	30			
CHEMICAL MEASUREMENTS				
Temperature (° C)	15.7			
Specific Conductance (umhos)	1107			
Dissolved Oxygen (mg/l)	9.4			
pH	7.5			
BIOLOGICAL ATTRIBUTES				
Canopy (%)	80			
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				
algae – diatoms				
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	x			
Plecoptera (stoneflies)				
Trichoptera (caddisflies)	x			
Coleoptera (beetles)	x			
Megaloptera (dobsonflies, alderflies)				
Odonata (dragonflies, damselflies)	x			
Chironomidae (midges)	x			
Simuliidae (black flies)				
Decapoda (crayfish)				
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other	x			
FAUNAL CONDITION	Good			

LABORATORY DATA SUMMARY

STREAM NAME: Quackenderry Creek	DRAINAGE: 13
DATE SAMPLED: 7/12/2005	COUNTY: Rensselaer
SAMPLING METHOD: Travelling Kick	

STATION LOCATION	01 North Greenbush off Thompson Ct	02 North Greenbush off Exit 8 ramp	03 Rensselaer off Exit 8 ramp	04 Rensselaer Ninth & Birch St
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Dicronata sp. 35 % intolerant crane fly	Leuctra sp. 30 % intolerant stone fly	Potamyia sp. 20 % intolerant caddisfly	Stenelmis crenata 24 % facultative beetle
2. **Intolerant = not tolerant of poor water quality**	Leuctra sp. 29 % intolerant stone fly	Potamyia sp. 25 % intolerant caddisfly	Diamesa sp. 20 % facultative midge	Dicronata sp. 23 % intolerant crane fly
3. **Facultative = occurring over a wide range of water quality**	Polypedilum aviceps 9 % facultative midge	Optioservus fastiditus 16% intolerant beetle	Undet. Tubificidae w/o cap. setae 11 % facultative worm	Hydropsyche slossonae 12 % facultative caddisfly
4. **Tolerant = tolerant of poor water quality**	Polypedilum tuberculum 9 % facultative midge	Dicronata sp. 8 % intolerant crane fly	Leuctra sp. 9 % intolerant stone fly	Cheumatopsyche sp. 8 % facultative caddisfly
5.	Potamyia sp. 8 % intolerant caddisfly	Stenelmis crenata 4 % facultative beetle	Stenelmis sp. 7 % facultative beetle	Chimarra aterrima? 5 % intolerant caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	22.0 (5)	8.0 (4)	32.0 (8)	13.0 (8)
Trichoptera (caddisflies)	9.0 (2)	27.0 (3)	26.0 (3)	32.0 (5)
Ephemeroptera (mayflies)	0.0 (0)	1.0 (1)	4.0 (1)	1.0 (1)
Plecoptera (stoneflies)	29.0 (1)	30.0 (1)	9.0 (1)	0.0 (0)
Coleoptera (beetles)	1.0 (1)	21.0 (3)	9.0 (2)	26.0 (2)
Oligochaeta (worms)	1.0 (1)	1.0 (1)	13.0 (3)	0.0 (0)
Mollusca (clams and snails)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Crustacea (crayfish, scuds, sowbugs)	0.0 (0)	0.0 (0)	0.0 (0)	1.0 (1)
Other insects (odonates, diptera)	38.0 (3)	12.0 (3)	6.0 (4)	26.0 (3)
Other (Nemertea, Platyhelminthes)	0.0 (0)	0.0 (0)	1.0 (1)	1.0 (1)
SPECIES RICHNESS	20	24	23	21
BIOTIC INDEX	2.87	3.07	5.00	4.60
EPT RICHNESS	5	8	5	6
PERCENT MODEL AFFINITY	70	70	64	44
FIELD ASSESSMENT	Very good	Very good	Very good	Good
OVERALL ASSESSMENT	Slightly impacted	Non-impacted	Slightly impacted	Slightly impacted

LABORATORY DATA SUMMARY

STREAM NAME: Quackenderry Creek		**DRAINAGE: 13**		
DATE SAMPLED: 7/12/2005		**COUNTY: Rensselaer**		
SAMPLING METHOD: Travelling Kick				
STATION **LOCATION**	05 Rensselaer Wilson St bridge			
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Stenelmis crenata 30 % facultative beetle			
Intolerant = not tolerant of poor water quality 2.	Dicronata sp. 11 % intolerant crane fly			
Facultative = occurring over a wide range of water quality 3.	Undet. Tubificidae w/o cap. setae 8 % facultative worm			
Tolerant = tolerant of poor water quality 4.	Thienemannimyia gr. spp. 8 % facultative midge			
5.	Atherix sp. 6% intolerant crane fly			
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	25.0 (7)			
Trichoptera (caddisflies)	6.0 (2)			
Ephemeroptera (mayflies)	2.0 (1)			
Plecoptera (stoneflies)	0.0 (0)			
Coleoptera (beetles)	34.0 (3)			
Oligochaeta (worms)	8.0 (1)			
Mollusca (clams and snails)	0.0 (0)			
Crustacea (crayfish, scuds, sowbugs)	1.0 (1)			
Other insects (odonates, diptera)	24.0 (7)			
Other (Nemertea, Platyhelminthes)	0.0 (0)			
SPECIES RICHNESS **BIOTIC INDEX** **EPT RICHNESS** **PERCENT MODEL AFFINITY**	22 5.11 3 53			
FIELD ASSESSMENT **OVERALL ASSESSMENT**	Good Slightly impacted			

BIOLOGICAL METHODS FOR KICK SAMPLING

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

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

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

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

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

MACROINVERTEBRATE COMMUNITY PARAMETERS

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

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

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

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

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

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

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

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

LEVELS OF WATER QUALITY IMPACT IN STREAMS

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

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

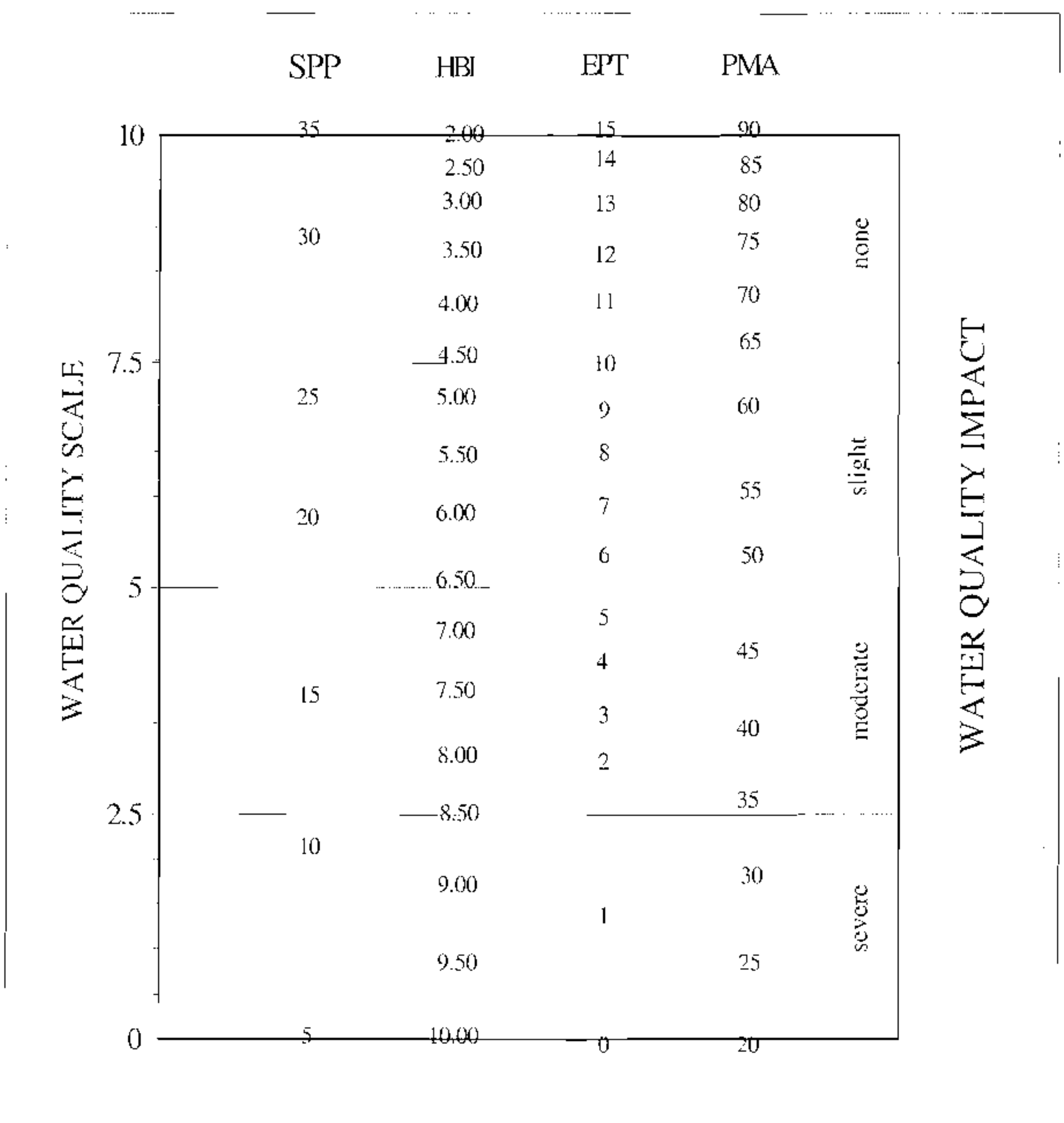
2. *Slightly impacted* Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50.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

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

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

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

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



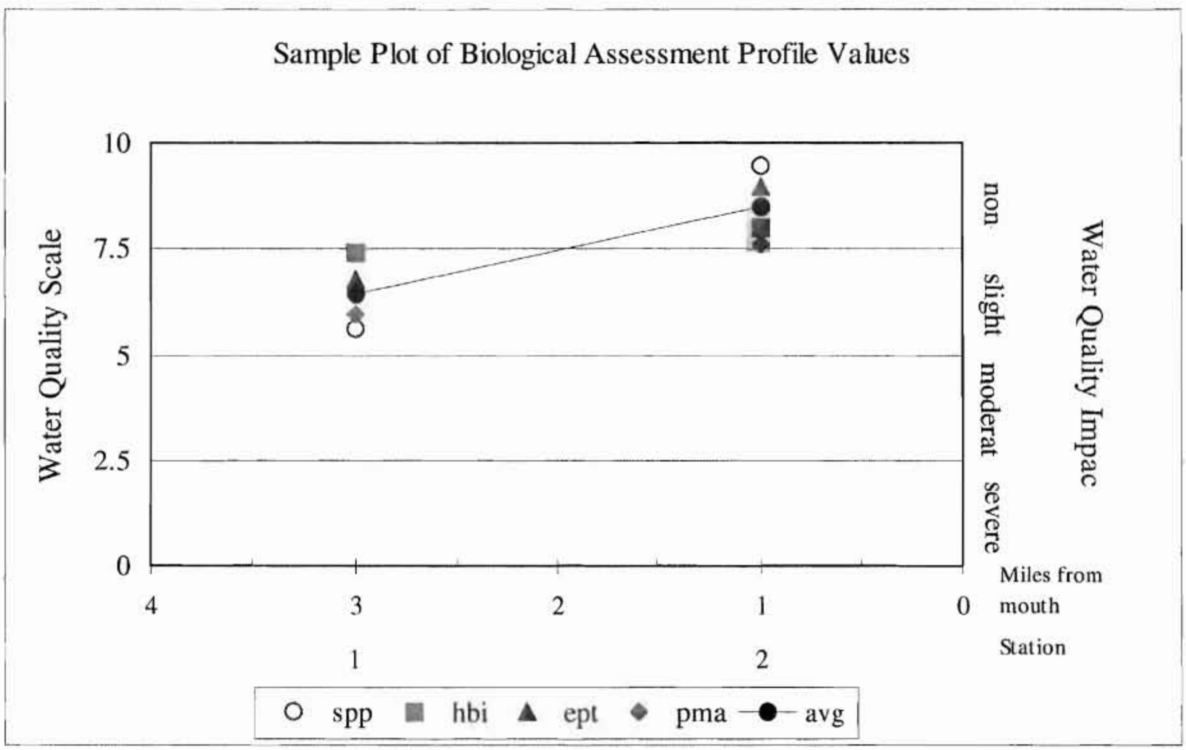
Biological Assessment Profile: Plotting Values

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

Example data:

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

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



Water Quality Assessment Criteria

Water Quality Assessment Criteria for Non-Navigable Flowing Waters

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

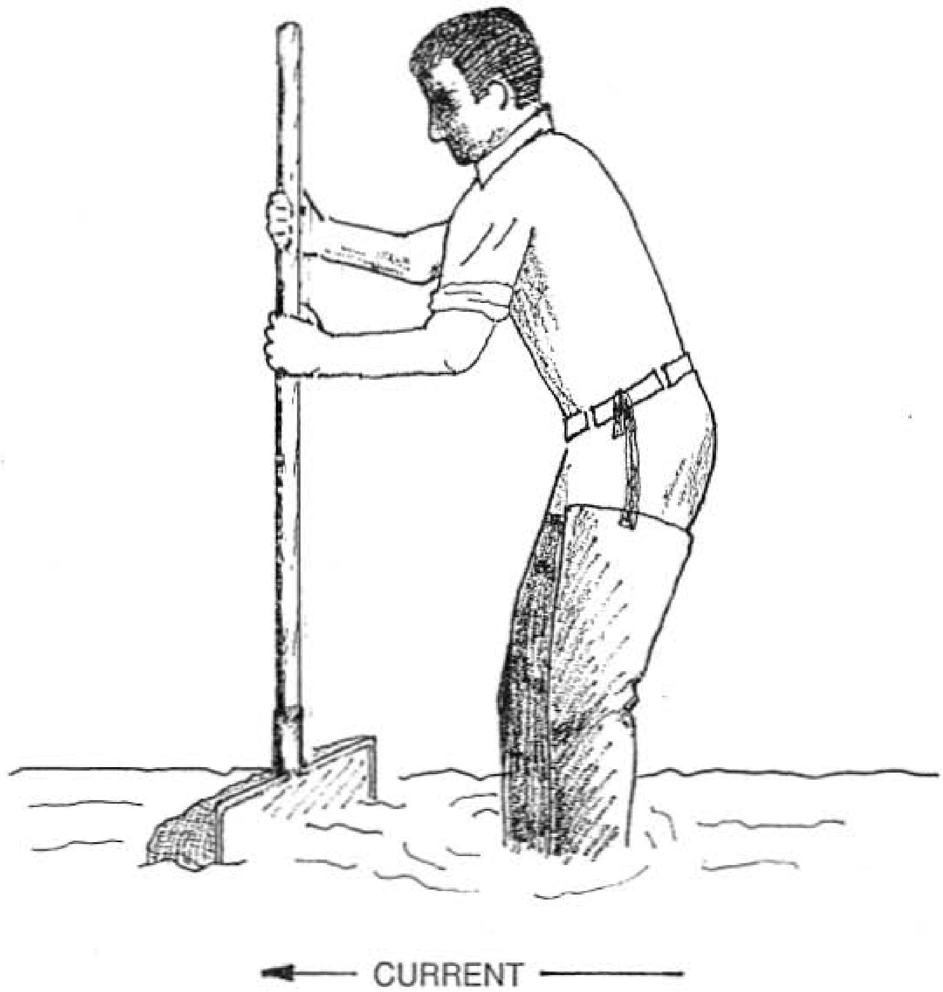
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

Water Quality Assessment Criteria for Navigable Flowing Waters

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

Appendix VI.

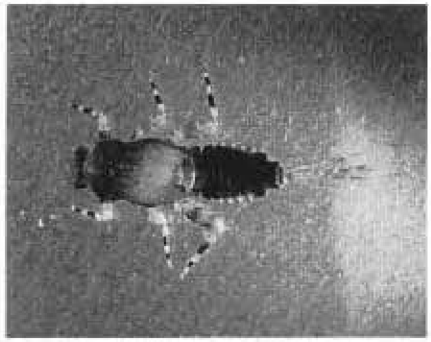
THE TRAVELING KICK SAMPLE



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

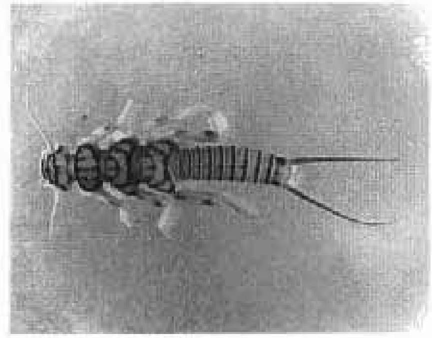
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

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



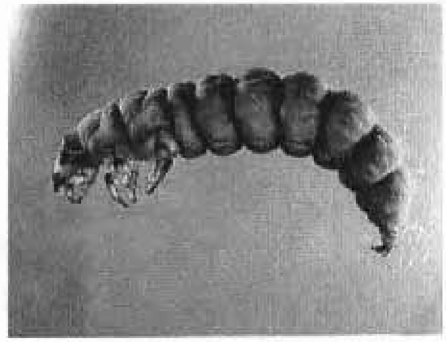
MAYFLIES

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



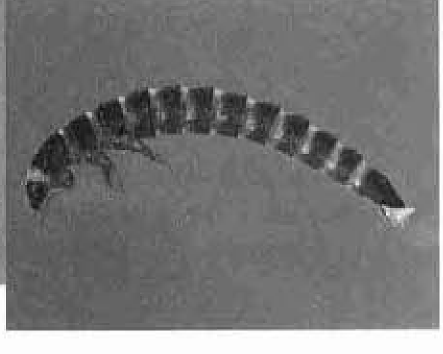
STONEFLIES

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



CADDISFLIES

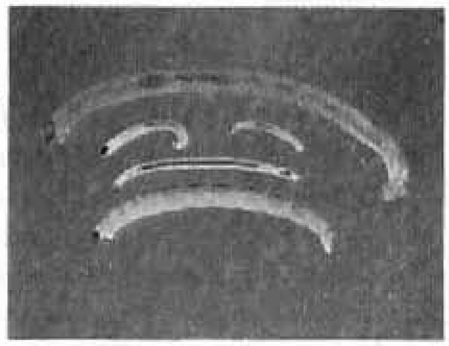
The most common beetles in streams are riffle beetles and water pennies. Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.



BEETLES

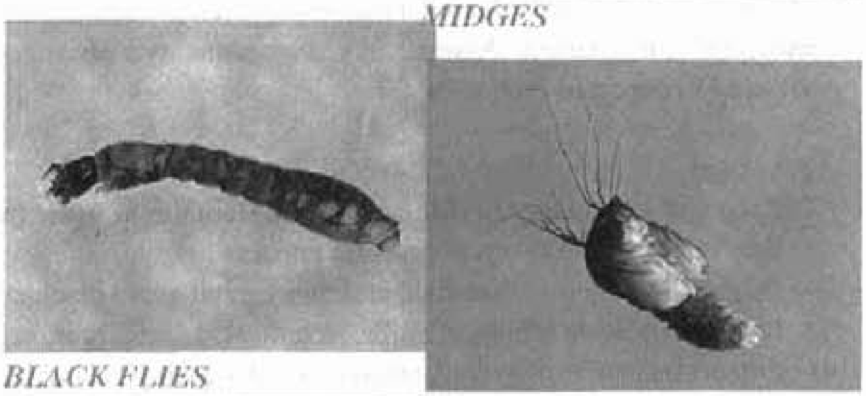
AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

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



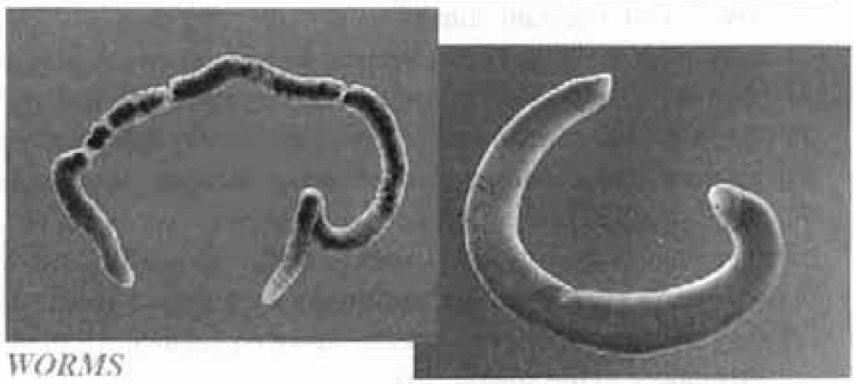
MIDGES

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



BLACK FLIES

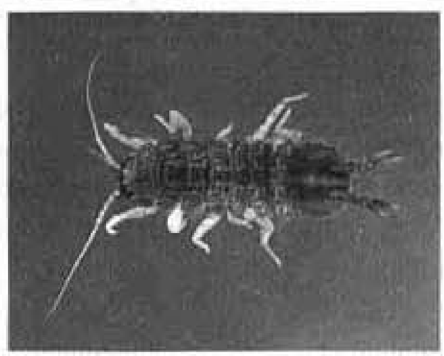
The segmented worms include the leeches and the small aquatic earthworms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution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



WORMS

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

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



SOWBUGS

THE RATIONALE OF BIOLOGICAL MONITORING

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

Concept

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

Advantages

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

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

Limitations

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

Anthropogenic: caused by human actions

Assessment: a diagnosis or evaluation of water quality

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

Bioaccumulate: accumulate contaminants in the tissues of an organism

Biomonitoring: the use of biological indicators to measure water quality

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

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

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

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

Fauna: the animal life of a particular habitat

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

Impairment: a detrimental effect caused by an impact

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

Intolerant: unable to survive poor water quality

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

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

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

Organism: a living individual

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

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

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

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

Station: a sampling site on a waterbody

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

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

Tolerant: able to survive poor water quality

Impact Source Determination Methods and Community Models

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

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

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

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

Impact Source Determination Models

NATURAL

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

Impact Source Determination Models

NONPOINT NUTRIENTS, PESTICIDES

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

Impact Source Determination Models

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

Impact Source Determination Models

SEWAGE EFFLUENT, ANIMAL WASTES

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

Impact Source Determination Models

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

METHODS FOR CALCULATION OF THE NUTRIENT BIOTIC INDEX

Definition: The Nutrient Biotic Index (Smith, 2005) is a diagnostic measure of stream nutrient enrichment identified by macroinvertebrate taxa. The frequency of occurrences of taxa at varying nutrient concentrations allowed the identification of taxon-specific nutrient optima using a method of weighted averaging. The establishment of nutrient optima is possible based on the observation that most species exhibit unimodal response curves in relation to environmental variables (Jongrnan et al. 1987). The assignment of tolerance values to taxa based on their nutrient optimum provided the ability to reduce macroinvertebrate community data to a linear scale of eutrophication from oligotrophic to eutrophic. Two tolerance values were assigned to each taxon, one for total phosphorus, and one for nitrate (listed in Smith, 2005). This provides the ability to calculate two different nutrient biotic indices, one for total phosphorus (NBI-P) and one for nitrate (NBI-N). Study of the indices indicate better performance by the NBI-P, with strong correlations to stream nutrient status assessment based on diatom information.

Calculation of the NBI-P and NBI-N: Calculation of the indices [2] follows the approach of Hilsenhoff (1987).

$$NBI\ Score_{(TP\ or\ NO3^-)} = \sum (a \times b)/c$$

Where ***a*** is equal to the number of individuals for each taxon, ***b*** is the taxon's tolerance value, and ***c*** is the total number of individuals in the sample (for which tolerance values have been assigned).

Classification of NBI Scores NBI scores have been placed on a scale of eutrophication with provisional boundaries between stream trophic status.

Index	Oligotrophic	Mesotrophic	Eutrophic
NBI-P	< 5.0	> 5.0 – 6.5	> 6.0
NBI-N	< 4.5	> 4.5 – 6.0	> 6.0

References:

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

Jongman, R. H. G., C. J. F. ter Braak, and O. F. R. van Tongeren. 1987. Data analysis in community and landscape ecology. Pudoc Wageningen, Netherlands 299pp.

Smith, A.J. 2005. Development of a Nutrient Biotic Index for use with benthic macroinvertebrates. Masters Thesis, SUNY Albany. 70 pages.

CHARACETERISTICS OF HEADWATER STREAMS SITES

Headwater stream sites are defined as first-order or second-order stream locations close to the stream source, usually less than three miles. The natural characteristics of headwaters may sometimes result in an erroneous assessment of impacted water quality.

1) Headwater sites have reduced upstream recruitment resource populations to provide colonization by drift, and may have reduced species richness.

2) Headwater sites usually are nutrient-poor, lower in food resources, and less productive.

3) The reduced, simplified fauna of headwater sites may result in a community in which a few intolerant species may be very abundant. For 100-organism subsamples, this can affect many community indices: species richness, EPT richness, and percent model affinity. The dominant species averages 37% of the total fauna, and is an intolerant mayfly (e.g., Epeorus, Paraleptophlebia, Stenonema), stonefly (e.g., Leuctridae or Capniidae), caddisfly (e.g., Brachycentrus, Dolophilodes, or Chimarra), or riffle beetle (e.g., Optioservus or Promoresia).

4) Although headwater stream invertebrate communities are dominated by intolerant species, many community indices are low. Average index values are: species richness - 19, EPT richness - 8, Hilsenhoff biotic index - 3.05, and percent model affinity - 57. These indices are based on headwaters of a number of streams across New York State.

5) Recommended corrective action for non-representative indices from headwater sites: a correction factor of 1.5 may be applied to species richness, EPT richness, and percent model affinity. Criteria for the use of the correction factor are: the headwater location is as described above, the community is dominated by intolerant species, and the above indices (species richness, EPT richness, and percent model affinity) are judged to be non-representative of actual water quality. Alternatively, index values may be maintained, and the overall assessment may be adjusted up to non-impacted if the above criteria are met.

Calculation of Impervious Surface Cover Using Orthoimagery

All data development and analysis are conducted using ArcGIS ArcView 9.1.

1. Delineation of watershed and site-location subbasin boundaries. Either of two methods may be used; the second of these was used for calculation in the Quackenderry Creek watershed.

    a. Digital boundary delineation using the l0m Digital Elevation Models (DEM) and NYSDEC Hydrography Network, and Waterbodies layer in ArcGIS. This method uses an automated procedure developed by the Martyn J. Smith of the USGS, 425 Jordan Road, Troy, NY 12180 (marsmith@usgs.gov).

    b. Delineation by hand using a hardcopy version of *USGS 7.5' Topographic Quadrangle* and with the resulting boundaries approved by a USGS staff hydrologist. Watershed boundaries are then "heads-up digitized" (traced by hand using mouse) as a GIS layer using a digital version of the same quadrangle obtained from the Cornell University Geospatial Information Repository (URL: http://cugir.n1annlib.comell.edu/).

2. Calculation of the area of each subbasin: use the Geo-processing Tools within ArcGIS.

3. Delineation of Impervious Surfaces: Impervious surfaces - including paved surfaces (roads, parking lots, driveways etc.), buildings, pools, paths, and walkways - are heads-up digitized into a GIS layer, using the latest 12-inch resolution, natural color orthoimagery from the NYS Office of Cyber Security & Critical Infrastructure Coordination. Twenty-four-inch resolution, color-infrared orthoimagery is used when available, to confirm the existence or absence of impervious surfaces in areas of dense vegetation or shadow present in the natural-color imagery. Both data sets can be obtained from the New York State GIS Clearinghouse (URL:http://www.nysgis.state.ny.us/).

4. Calculation of Percent Impervious Surface for Each Subbasin: The impervious surface layer is overlaid with the subbasin layer in ArcGIS. Geo-processing is then used to create a new layer, which subsequently allows for the derivation of the impervious surface areas within each subbasin. The sum of the impervious surface areas is then divided by the area of the entire subbasin and multiplied by 100 to calculate percent impervious surface area of the subbasin.