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New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Snook Kill

Biological Assessment

2007 Survey

New York State
Department of Environmental Conservation

BIOLOGICAL STREAM ASSESSMENT

Snook Kill
Upper Hudson River Basin
Saratoga County, New York

Survey date: July 10, 2007
Report date: January 8, 2009

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Stream: Snook Kill

Reach: Wilton to Gansevoort (Saratoga County, NY)

River Basin: Upper Hudson

Background

The Stream Biomonitoring Unit sampled the Snook Kill and Little Snook Kill, north of Saratoga, on July 10, 2007. Sampling was conducted to collect baseline water quality data in this area of the Upper Hudson River watershed. One site, at Dimmick Corners in Wilton (Station 05) had been sampled previously.

To characterize water quality based on benthic macroinvertebrate communities, a traveling kick sample was collected from riffle areas at each five sites on the Snook Kill and one site on the Little Snook Kill. High gradient and riffle habitat dictated kick sampling at most sites with the exception of the site closest to the mouth (Station 07). This location was low gradient with sandy substrate and was sampled and processed using methods for sandy streams. Methods used are 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 100-specimen subsamples 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). Amount of expected variability of results is stated in Smith and Bode (2004). Table 1 provides a listing of sampling sites, and Table 3 provides a listing of all species collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Results and Conclusions

1. Snook Kill water quality ranged from non-impacted to slightly-impacted, with stressors consisting of urban/non point source enrichment.

2. As in past years, Station 05 was assessed as non-impacted, although enrichment effects are still reflected in the community.

Discussion

The Snook Kill is a tributary of the Hudson River located north of Saratoga, NY. The Stream Biomonitoring Unit sampled six sites between Wilton at King's Corners and Gansevoort, near Mott Rd., on July 10, 2007. The survey was conducted to establish baseline data at sites ranging from near the mouth up to the headwaters (Figure 1). Prior to this sampling, one site on the Snook Kill at Dimmicks Corners had been assessed.

The highest quality, high gradient macroinvertebrate community was found at the most upstream site, Station 02, with several intolerant taxa such as *Leuctra sp.*, *Dolophilodes sp.*, and *Epeorus sp.* making up a large percentage of the community. Biological integrity decreases moving downstream towards more development and agriculture (Figure 4). Agricultural practices commonly change hydrology, and increase sedimentation and stream temperatures through erosion, nutrient loading, riparian reduction and altered land cover (Allan 2004).

Downstream of Station 02, Station 03 shows a clear nutrient/development "footprint" with a shift towards a more facultative macroinvertebrate community. This is reflected in the Nutrient Biotic Index (NBI) (Figure 5) and the Hilsenhoff Biotic Index (HBI) (Figure 3). Additionally, Station 03 had a specific conductance three times higher than Station 02 (583 vs. 187, respectively), coinciding with 10 percent impervious surface in its watershed compared to near zero percent upstream (Figure 4). Higher specific conductance reflects the larger amounts of dissolved solids in the water, often the result of runoff from roads, parking lots, lawns and farms (Appendix XIII). Species and EPT diversity also decrease as expected (Figure 3) as stressors on the community increase, favoring more tolerant organisms.

Station 04, on the Little Snook Kill, while heavily forested and with less agriculture than other sites along the Snook Kill, was found to be slightly impacted due largely to low species richness. Macroinvertebrate data does not indicate enrichment, but Impact Source Determination (ISD) (Table 4) indicates impoundment as the most likely influence on the community. There is a large percentage of filter-feeding *Simulium tuberosum* and *Hydropsyche sparna* in the community. Ortho-imagery shows several small farm ponds upstream from the sampling site. It is possible that the outlets from these ponds flow into the Little Snook Kill and contribute enough organic material to simulate impoundment effects.

Station 05 on the Snook Kill shows recovering species and EPT diversity and the HBI and NBI values indicate less nutrient enrichment than Station 03. The macroinvertebrate community was assessed as non-impacted with slight enrichment, consistent with assessments in 2001 and 2006. Station 06 was also assessed as non-impacted. NBI values, well above the eutrophic threshold (Figure 5), were likely due to agricultural runoff, as evidenced by land use analysis (Figure 4).

Station 07 was identified as a low-gradient, sandy site (Appendix XII). Sandy stream criteria were used to assess water quality and the location was found to be non-impacted. Typically, low-gradient sandy streams have a more tolerant community because of naturally fluctuating dissolved oxygen (DO) levels and less-than-optimal substrate for invertebrates. Often, these streams are associated with wetlands. This downstream Snook Kill site had a high HBI value, due partially to increasing nutrient influence but also the natural condition of the stream.

The biological condition of the Snook Kill reflects the land cover and land uses of the watershed. Undeveloped headwaters are reflected in a high quality macroinvertebrate community, which gives way to typical enrichment impacts from development and agriculture.

Literature Cited

Allan, J. D. 2004. Landscapes and Riverscapes: The Influence of Land Use on Stream Ecosystems. Annual Review of Ecology, Evolution and Systematics 35: 257-84.

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.

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

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.

Smith, A.J., R. W. Bode, and G. S. Kleppel. 2007. A nutrient biotic index for use with benthic macroinvertebrate communities. Ecological Indicators 7(200):371-386.

Table 1. Station locations for the Snook Kill, Saratoga County, NY, 2007.

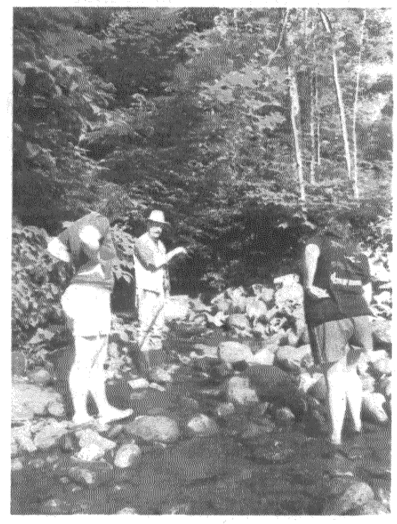
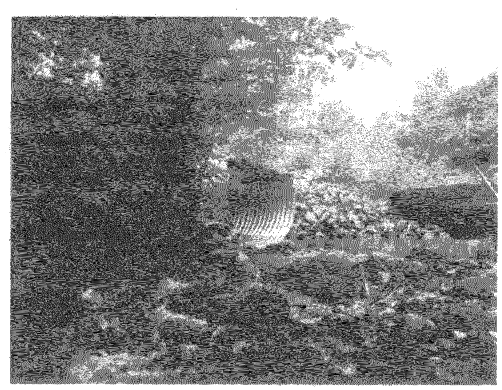
Station	Location	
SNOK-02	Wilton, NY at King's Corners 10 m above route 9 bridge River Mile 15.2 Latitude: 43.1497 Longitude: -73.763	
SNOK-03	Wilton, NY north of Gurn Spring North Rd. at fishing access site River Mile 11.5 Latitude: 43.1825 Longitude: -73.7226	
SNOK-04 Little Snook	Wilton, NY at Gansevoort 10 m below Gansevoort Rd River Mile 0.3 Latitude: 43.18777 Longitude: -73.7225	

Table 1 cont'd. Station locations for the Snook Kill, Saratoga County, NY, 2007.

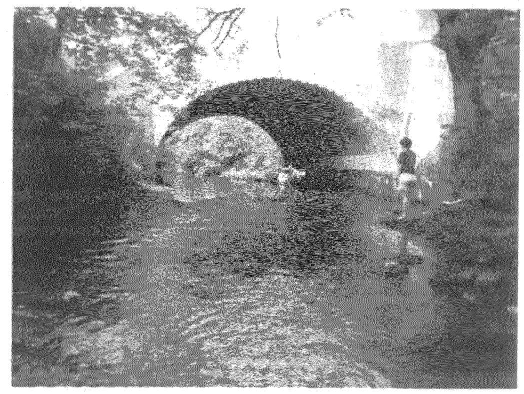
SNOK-05	Wilton, NY at Dimmick Corners 50 m above Dimmick Rd. bridge River Mile 9.9 Latitude: 43.1872 Longitude: -73.6989	
SNOK-06	Northumberland, NY at Gansevoort 10 m above Gansevoort Rd. River Mile 6.7 Latitude: 43.1985 Longitude: -73.656	
SNOK-07	Northumberland, NY northeast of Gansevoort 10 m above Mott Rd. River Mile 2.8 Latitude: 43.21277 Longitude: -73.614	no photo available

Figure 1. Overview map, Snook Kill, Saratoga County.

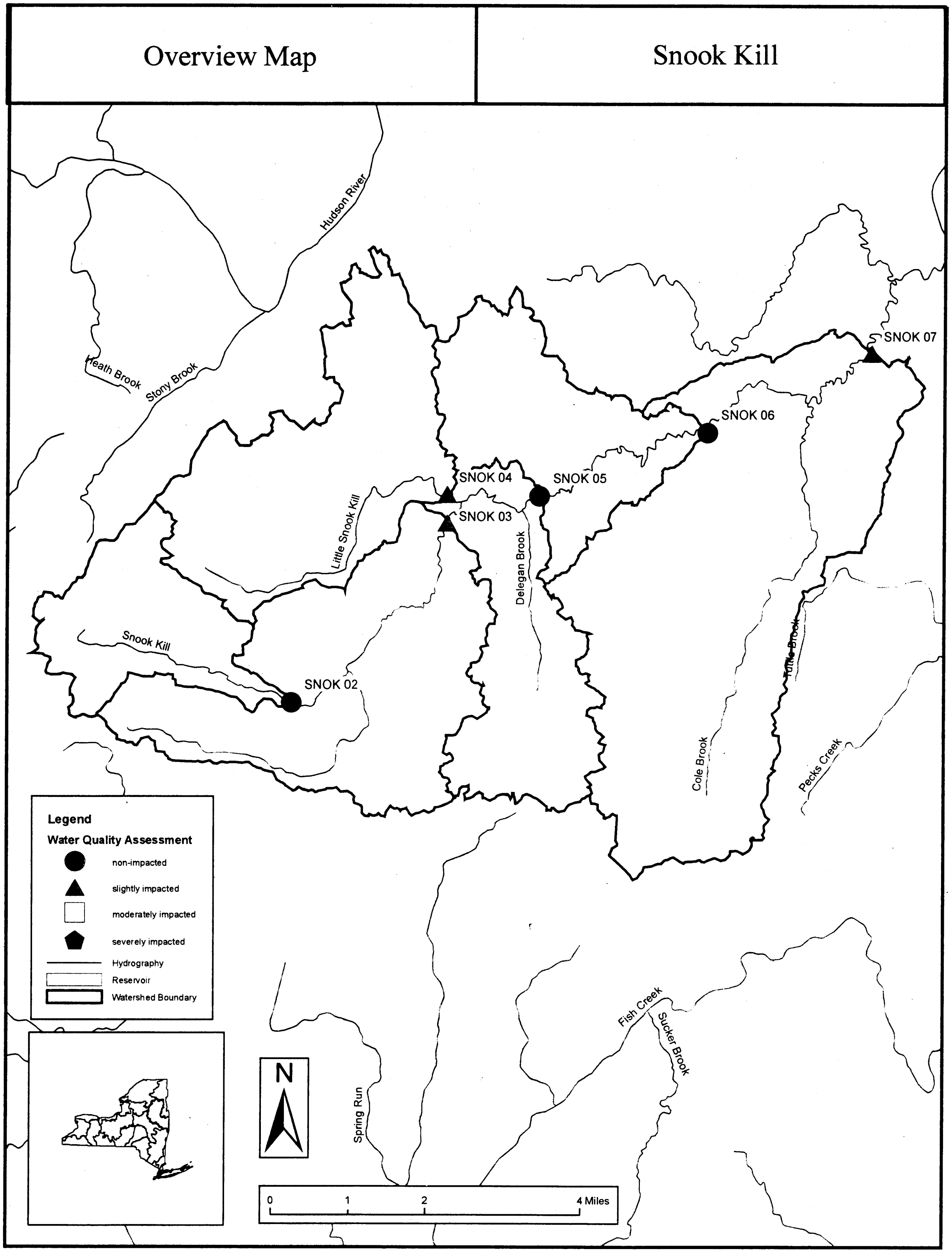


Figure 2a. Site location map

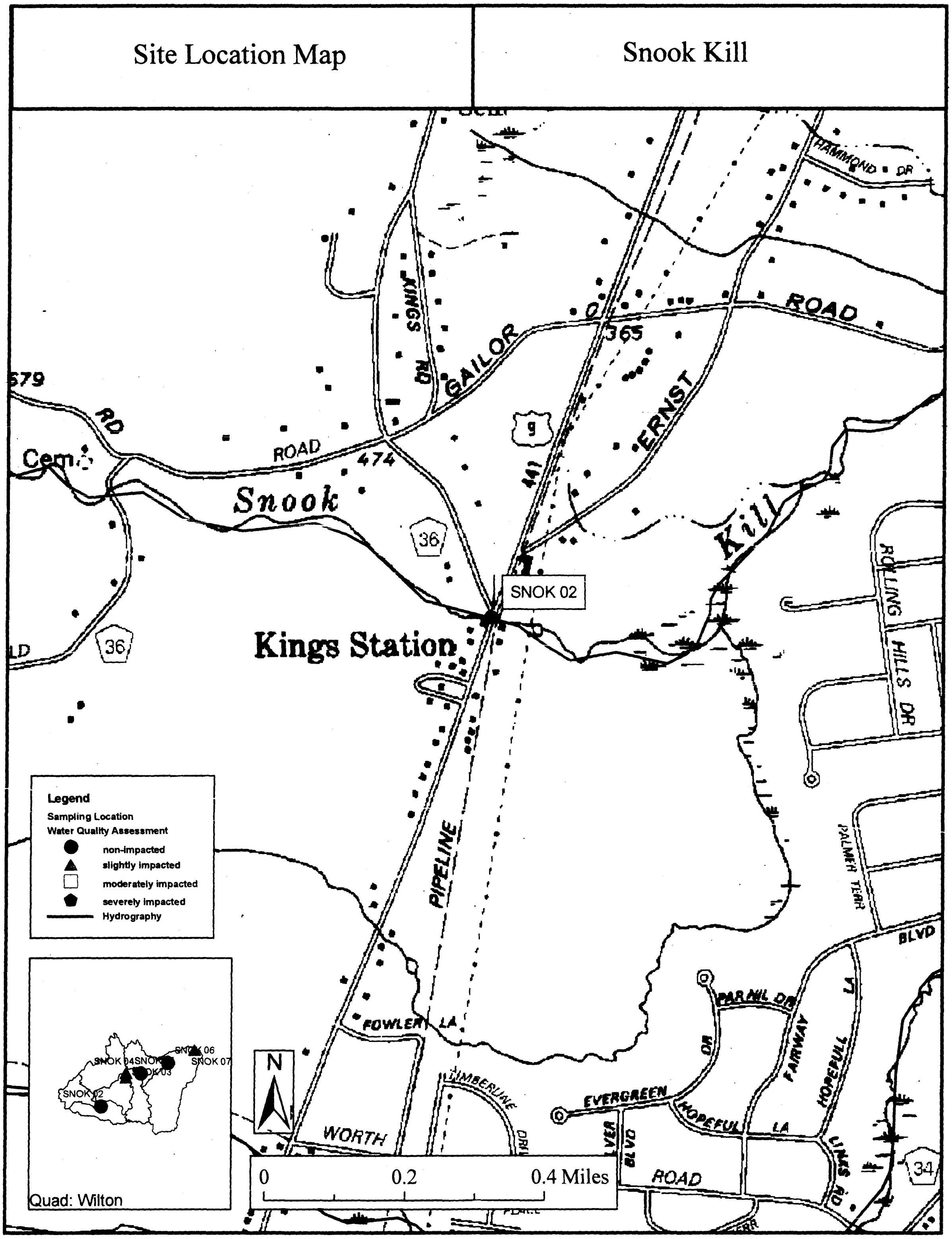
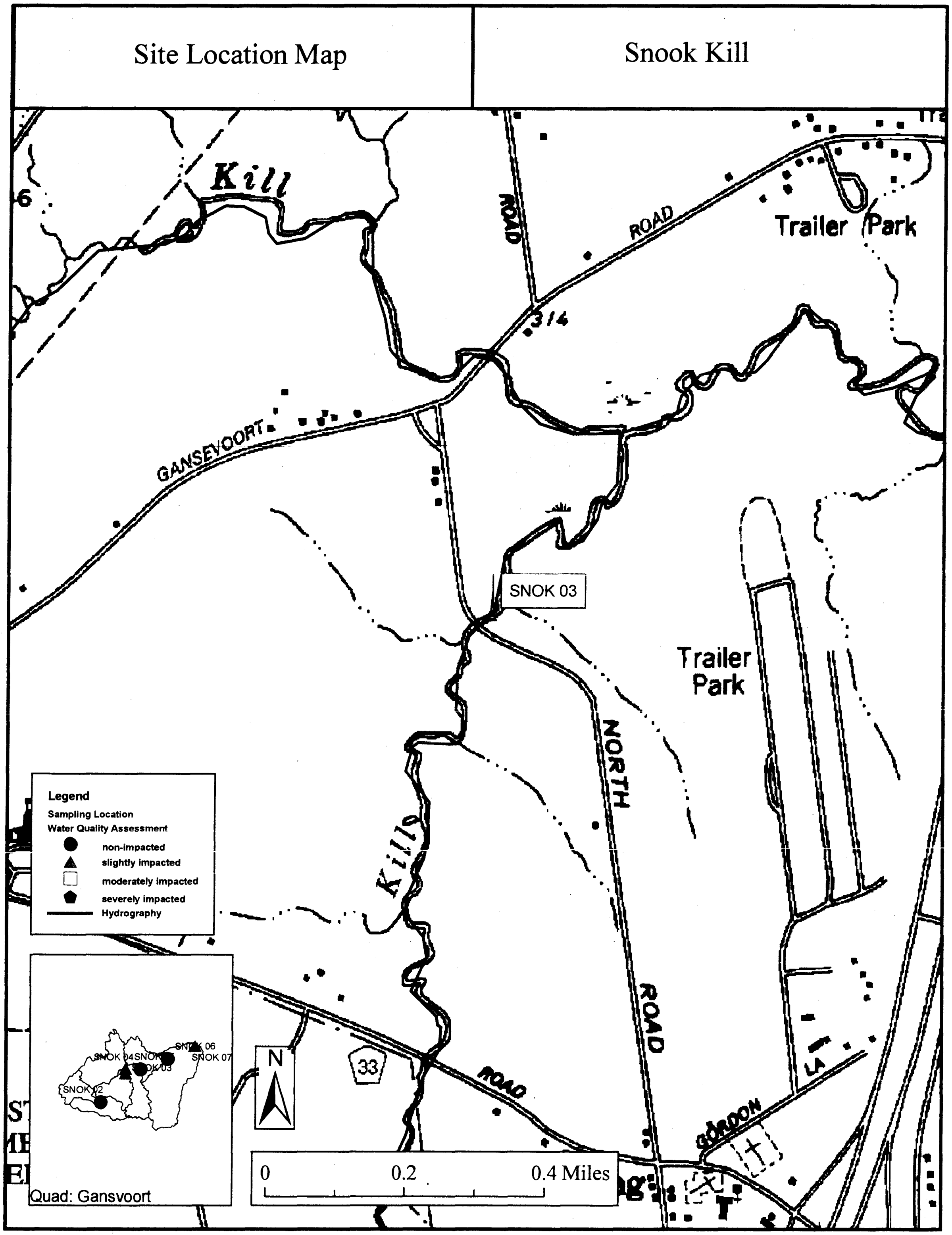


Figure 2b.



Site Location Map
Snook Kill
Kill
ROAD
ROAD
Trailer Park
GANSEVOORT
SNOK 03
Trailer
Park
NORTH
ROAD
Kill
Legend
Sampling Location
Water Quality Assessment
non-impacted
slightly impacted
moderately impacted
severely impacted
Hydrography
Quad: Gansvoort
N
33
ROAD
GORDON
LA
0
0.2
0.4 Miles

Figure 2c.

Site Location Map	Little Snook Kill

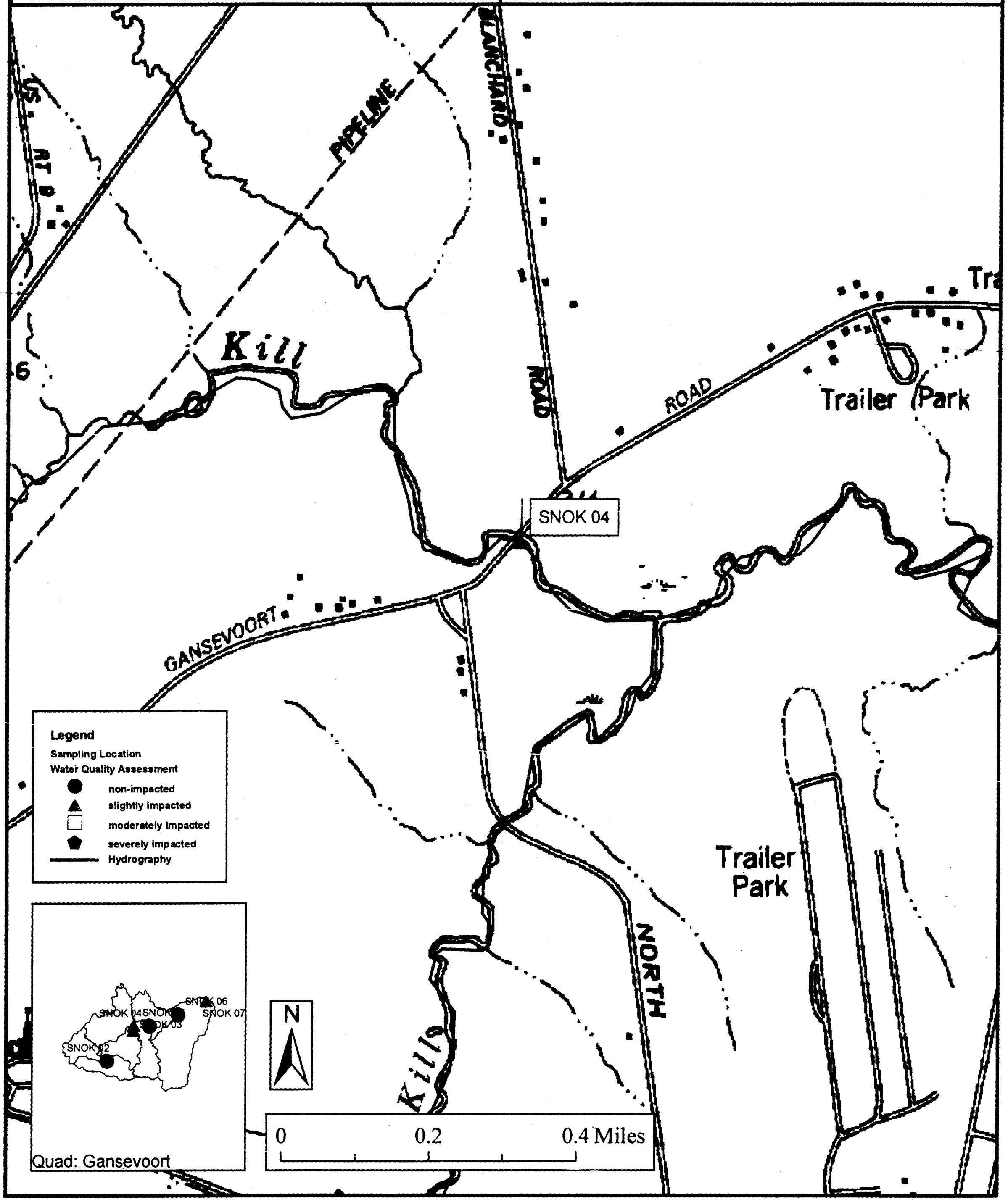


Figure 2d.

Site Location Map	Snook Kill

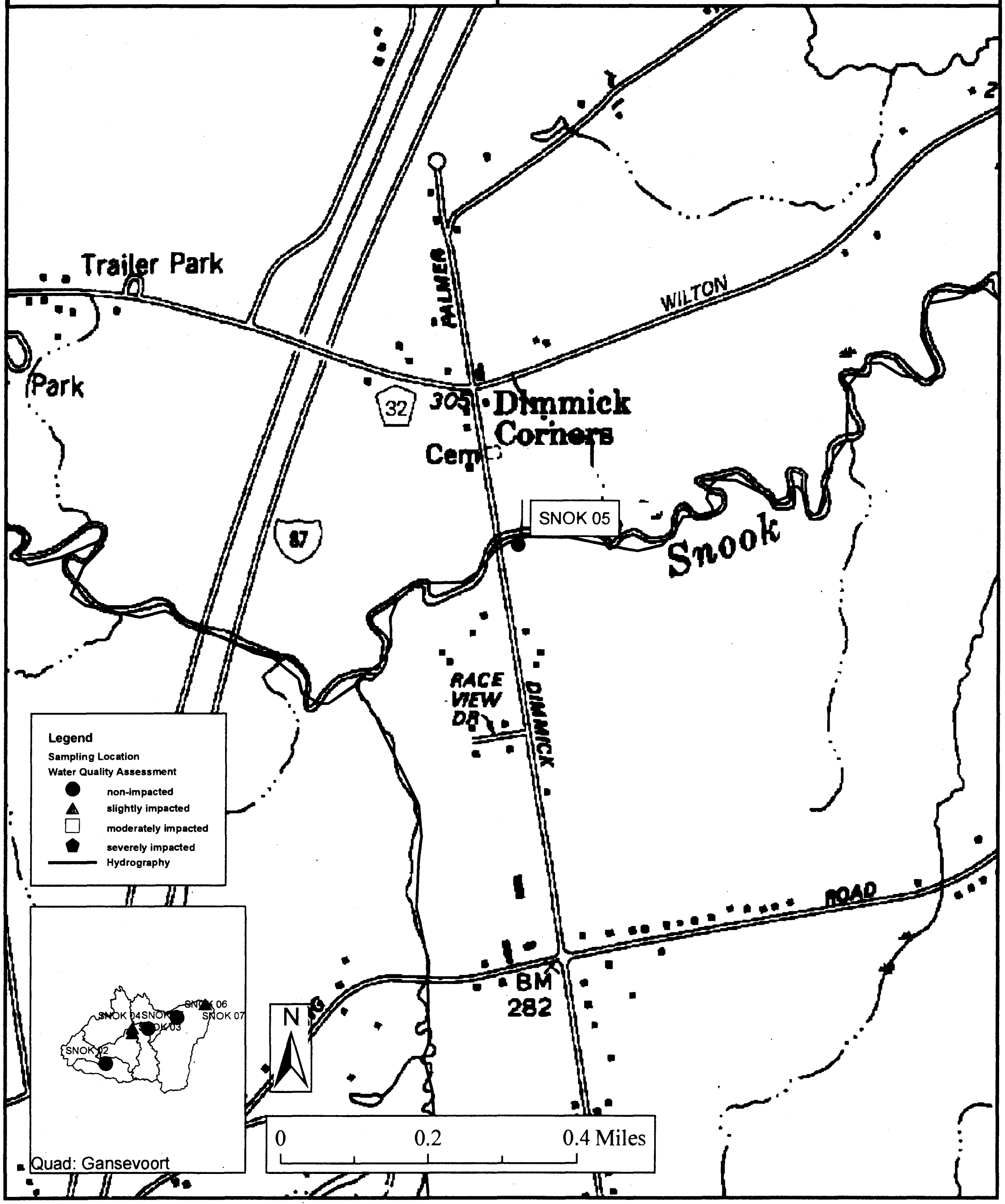


Figure 2e.

Site Location Map	Snook Kill

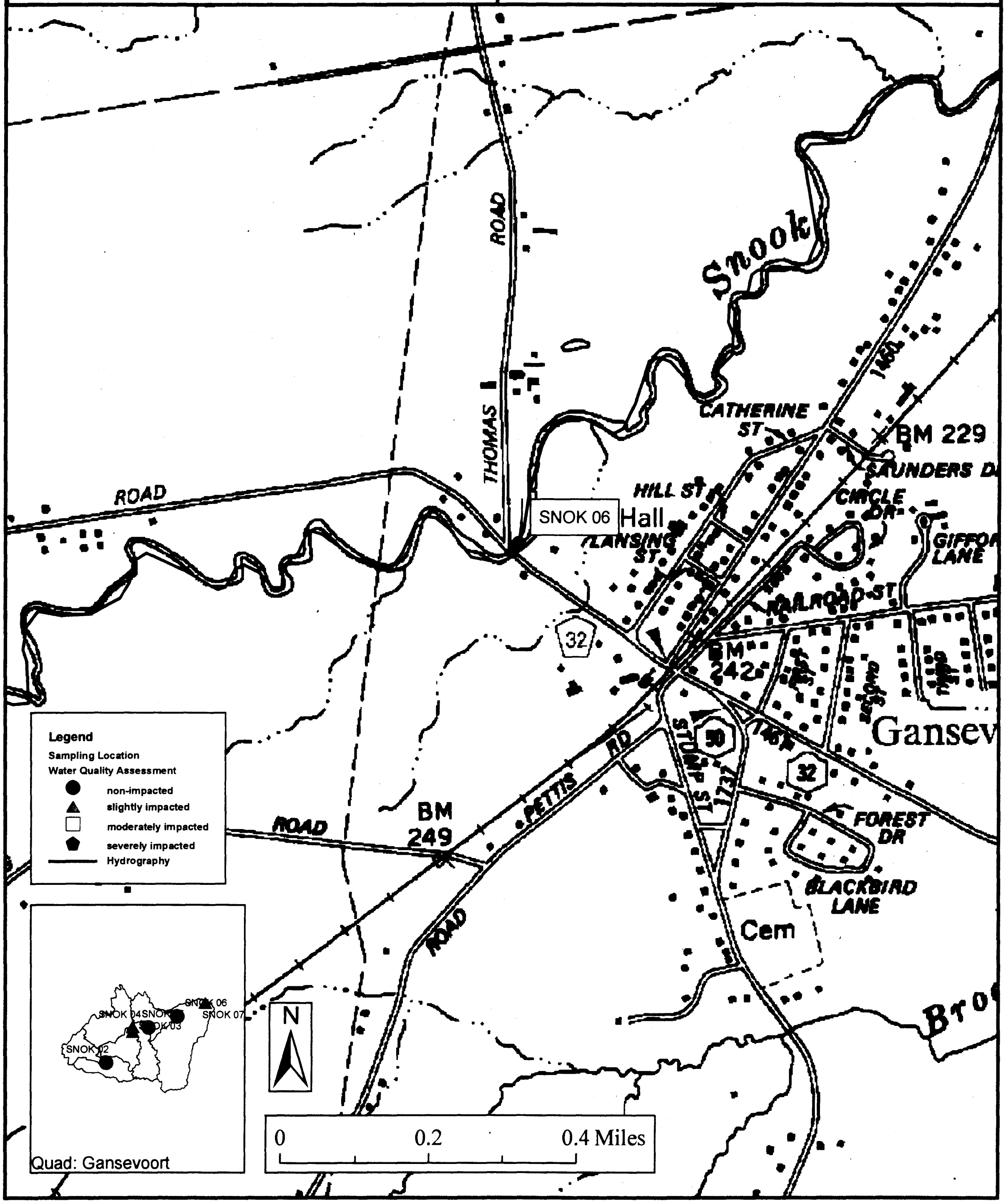


Figure 2f.

Site Location Map	Snook Kill

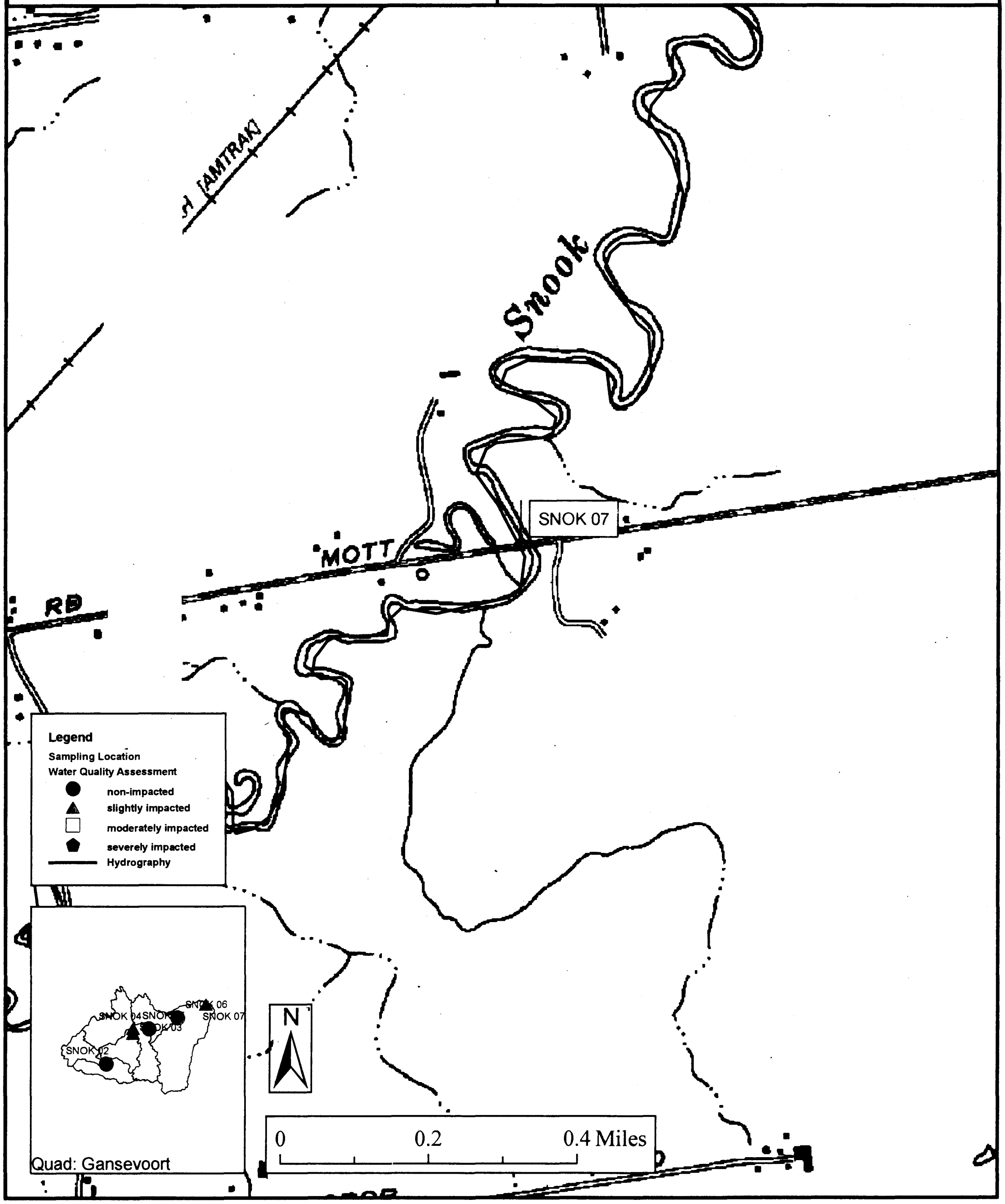
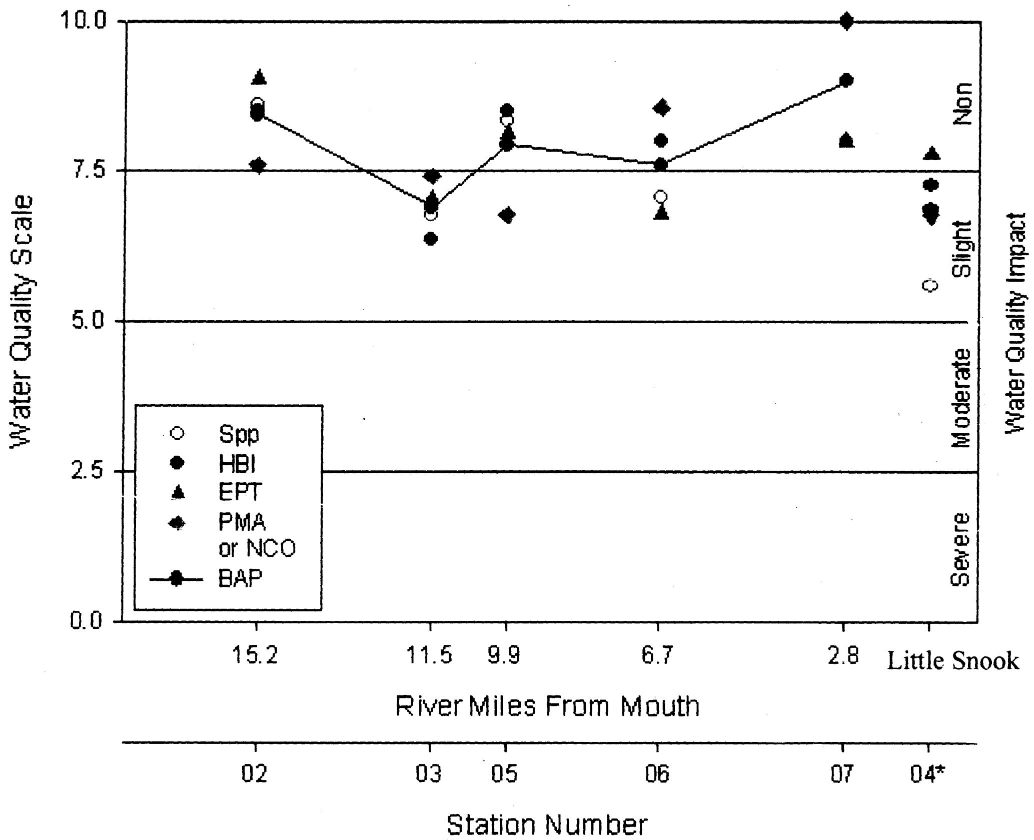


Figure 3. Biological Assessment Profile (BAP) of index values, the Snook Kill, 2007. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index (HBI), and either Percent Model Affinity (PMA) or Non-Chironomidae/Oligochaeta (NCO) richness. Station 07 uses NCO in place of PMA. See Appendix IV for a more complete explanation.



*denotes a tributary to the Snook Kill

Table 2. Biological Assessment Profile scores.

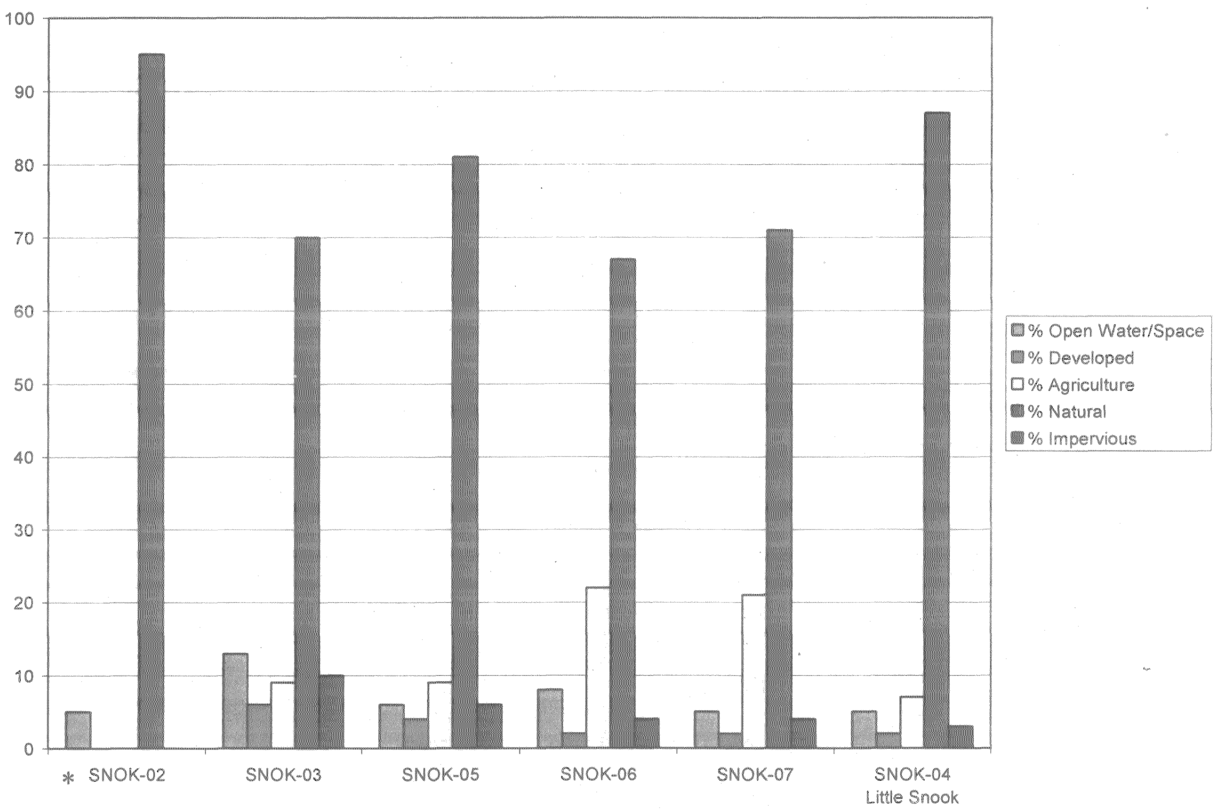
Location/Station	BAP
SNOK-02	8.44
SNOK-03	6.90
SNOK-05	7.93
SNOK-06	7.61
SNOK-07	9.00
SNOK-04	6.85

Table 3. Overview of field data.

Location/Station	Width (meters)	Depth (meters)	Current (cm/s)	Canopy (%)	Embed. (%)	Temp (°C)	Cond. (umhom/cm)	DO (mg/L)	pH
SNOK-02	2	0.1	70	40	30	19.3	187	11.1	6.5
SNOK-03	6	0.1	100	60	30	19.2	583	10.3	6.9
SNOK-05	8	0.2	70	80	30	19.3	432	11.0	7.3
SNOK-06	10	0.2	80	80	20	20.8	429	10.6	7.7
*SNOK-07	8	0.3	40	40	20	20.9	366	10.6	7.6
SNOK-04	3	0.2	80	20	30	19.3	290	11.1	7.4

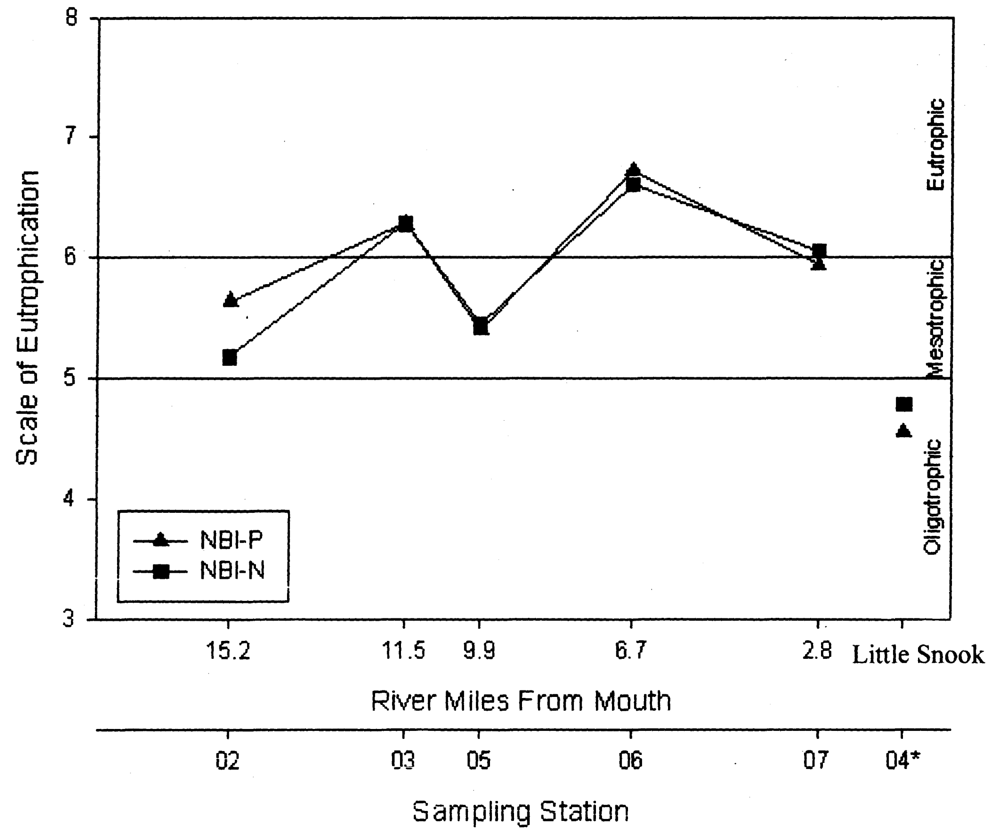
* denotes low-gradient, sandy stream assessment

Figure 4. Percent land-cover and land-use for each sampling station. Percent impervious surface is included independent of land cover/use.



* Station 02 contains less than 0.5% cover for developed, agriculture, and impervious surface and thus shows 0% for these categories

Figure 5. Nutrient Biotic Index values for Phosphorus (NBI-P) and Nitrogen (NBI-N). NBI values are plotted on a scale of eutrophication from oligotrophic to eutrophic. See Appendix X for a detailed explanation of the index.



* denotes a tributary to the Snook Kill

Table 4. Impact Source Determination (ISD), Snook Kill, 2007. Numbers represent percent similarity to community type models for each impact category. Highest similarities at each station are shaded. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix XI for further explanation.

Community Type	SNOK-02	SNOK-03	SNOK-04	SNOK-05	SNOK-06	SNOK-07
Natural: minimal human disturbance	60	50	57	49	64	46
Nutrient Enrichment: mostly nonpoint, agricultural	43	50	57	43	51	43
Toxic: industrial, municipal, or urban run-off	32	53	42	39	51	44
Organic: sewage effluent, animal wastes	36	46	31	32	49	42
Complex: municipal/industrial	35	55	44	42	44	40
Siltation	35	54	39	39	49	47
Impoundment	45	48	61	41	45	45

Note: Many of the Snook Kill macroinvertebrate communities are similar to more than one impact model. Impact Source Determinations (ISD) are intended as supplemental data to the macroinvertebrate community assessments.

Table 5. Macroinvertebrate species collected in the Snook Kill, Saratoga County, NY.

GASTROPODA
BASOMMATOPHORA
Ancylidae
Ferrissia sp.

PELECYPODA
VENEROIDEA
Sphaeriidae
Pisidium sp.

ARTHROPODA
CRUSTACEA
AMPHIPODA
Gammaridae
Gammarus sp.

DECAPODA
Cambaridae
Undetermined Cambaridae

INSECTA
EPHEMEROPTERA
Isonychiidae
Isonychia bicolor
Baetidae
Acentrella sp.
Baetis flavistriga
Baetis intercalaris
Baetis tricaudatus
Plauditus sp.
Heptageniidae
Epeorus (Iron) sp.

Stenonema modestum
Stenonema sp.
Leptophlebiidae
Paraleptophlebia sp.
Ephemerellidae
Serratella deficiens
Caenidae
Caenis sp.

PLECOPTERA
Leuctridae
Leuctra sp.
Perlidae
Acroneuria abnormis
Agnetina capitata
Perlesta sp.
Pteronarcidae
Pteronarcys proteus

COLEOPTERA
Gyrinidae
Dineutus sp.
Psephenidae
Psephenus herricki
Elmidae
Microcylloepus pusillus
Optioservus fastiditus
Optioservus trivittatus
Optioservus sp.
Oulimnius latiusculus
Promoresia tardella
Stenelmis crenata
Stenelmis sp.

MEGALOPTERA
Corydalidae
Nigronia serricornis
Sialidae
Sialis sp.

TRICHOPTERA

Philopotamidae
Chimarra aterrima?
Dolophilodes sp.
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche betteni
Hydropsyche bronta
Hydropsyche sparna

Rhyacophilidae
Rhyacophila fuscula
Glossosomatidae
Glossosoma sp.
Hydroptilidae
Hydroptila sp.
Brachycentridae
Brachycentrus appalachia

LEPIDOPTERA

Undetermined Lepidoptera

DIPTERA
Tipulidae
Antocha sp.
Dicranota sp.
Hexatoma sp.
Ceratopogonidae
Undetermined Ceratopogonidae
Simuliidae
Simulium tuberosum
Athericidae
Atherix sp.
Chironomidae
Thienemannimyia gr. spp.
Pagastia orthogonia
Cardiocladius obscurus
Cricotopus bicinctus
Cricotopus trifascia gr.
Cricotopus vierriensis
Cricotopus sp.
Nanocladius (Plecopt.) branchicolus
Orthocladius nr. dentifer
Parametriocnemus lundbecki

Table 6a. Macroinvertebrate Data Report (MDR)

STREAM SITE:	Snook Kill, Station 02
LOCATION:	Saratoga, NY
DATE:	7/10/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Acentrella sp.*	4
		Baetis intercalaris	4
	Heptageniidae	*Epeorus (Iron) sp.*	4
	Ephemerellidae	*Serratella deficiens*	3
	Caenidae	*Caenis sp.*	1
PLECOPTERA	Leuctridae	*Leuctra sp.*	9
	Perlidae	*Acroneuria abnormis*	1
	Pteronarcidae	*Pteronarcys proteus*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	15
	Elmidae	*Optioservus sp.*	2
		Stenelmis crenata	3
TRICHOPTERA	Philopotamidae	*Dolophilodes sp.*	14
	Hydropsychidae	*Hydropsyche sparna*	8
	Rhyacophilidae	*Rhyacophila fuscula*	4
	Glossosomatidae	*Glossosoma sp.*	3
DIPTERA	Tipulidae	*Antocha sp.*	2
		Dicranota sp.	2
		Hexatoma sp.	1
	Simuliidae	*Simulium tuberosum*	1
	Athericidae	*Atherix sp.*	1
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Cardiocladius obscurus	1
		Cricotopus bicinctus	1
		Orthocladius nr. dentifer	1
		Parametriocnemus lundbecki	1
		Tvetenia bavarica gr.	3
		Polypedilum aviceps	1
		Cladotanytarsus sp.	1
		Micropsectra sp.	6
		Stempellinella sp.	1
		SPECIES RICHNESS:	30
		BIOTIC INDEX:	2.97
		EPT RICHNESS:	12
		MODEL AFFINITY:	65
		ASSESSMENT:	non

DESCRIPTION: This site is 10 m above Rte 9 bridge at Parkhurst Rd. Many sensitive EPT species were found here, with a relatively low proportion of midges.

Table 6b.

STREAM SITE:	Snook Kill, Station 03
LOCATION:	Saratoga, NY
DATE:	7/10/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

MOLLUSCA			
GASTROPODA			
BASOMMATOPHORA	Ancylidae	*Ferrissia sp.*	2
ARTHROPODA			
INSECTA	Baetidae	*Baetis intercalaris*	10
EPHEMEROPTERA	Heptageniidae	*Stenonema modestum*	2
	Perlidae	*Perlesta sp.*	2
PLECOPTERA			
	Psephenidae	*Psephenus herricki*	1
COLEOPTERA	Elmidae	*Optioservus fastiditus*	3
		Optioservus trivittatus	3
		Oulimnius latiusculus	1
		Stenelmis crenata	7
	Hydropsychidae	*Cheumatopsyche sp.*	8
TRICHOPTERA		*Hydropsyche betteni*	3
		Hydropsyche sparna	19
	Glossosomatidae	*Glossosoma sp.*	3
	Brachycentridae	*Brachycentrus appalachia*	1
	Tipulidae	*Antocha sp.*	1
DIPTERA		*Dicranota sp.*	3
	Athericidae	*Atherix sp.*	4
	Chironomidae	*Thienemannimyia gr. spp.*	4
		Pagastia orthogonia	5
		Cricotopus bicinctus	10
		Cricotopus trifascia gr.	1
		Cricotopus vierriensis	1
		Rheotanytarsus exiguus gr.	4
		Rheotanytarsus pellucidus	1
		SPECIES RICHNESS:	24
		BIOTIC INDEX:	4.87
		EPT RICHNESS:	8
		MODEL AFFINITY:	64
		ASSESSMENT:	slight

DESCRIPTION: This site is at the North Rd fishing access site. The macroinvertebrate community shifts towards more facultative taxa, with a significantly higher HBI score than upstream.

Table 6c.

STREAM SITE:	Little Snook Kill, Station 04
LOCATION:	Saratoga, NY
DATE:	7/10/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Baetidae	*Baetis flavistriga*	1
		Baetis intercalaris	6
	Ephemerellidae	*Serratella deficiens*	3
PLECOPTERA	Perlidae	*Acroneuria abnormis*	1
		Agnetina capitata	1
COLEOPTERA	Elmidae	*Optioservus sp.*	3
		Stenelmis crenata	5
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	5
		Dolophilodes sp.	7
	Hydropsychidae	*Cheumatopsyche sp.*	2
		Hydropsyche bronta	1
		Hydropsyche sparna	19
DIPTERA	Tipulidae	*Dicranota sp.*	4
		Hexatoma sp.	1
	Simuliidae	*Simulium tuberosum*	18
	Athericidae	*Atherix sp.*	3
	Chironomidae	*Parametriocnemus lundbecki*	3
		Tvetenia bavarica gr.	1
		Polypedilum aviceps	12
		Micropsectra sp.	4
		SPECIES RICHNESS:	20
		BIOTIC INDEX:	4.22
		EPT RICHNESS:	10
		MODEL AFFINITY:	60
		ASSESSMENT:	slight

DESCRIPTION: This site is 10 m below Gansevoort Rd. The site is dominated by facultative species with low species diversity. This is a tributary to the Snook Kill.

Table 6d.

STREAM SITE: Snook Kill, Station 05
LOCATION: Saratoga, NY
DATE: 7/10/2007
SAMPLE TYPE: Kick
SUBSAMPLE: 100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Isonychiidae	*Isonychia bicolor*	5
	Baetidae	*Baetis flavistriga*	3
		Baetis intercalaris	10
	Leptophlebiidae	*Paraleptophlebia sp.*	1
PLECOPTERA	Perlidae	*Agnetina capitata*	1
COLEOPTERA	Elmidae	*Microcylloepus pusillus*	2
		Optioservus sp.	4
		Promoresia tardella	1
		Stenelmis crenata	4
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	5
	Sialidae	*Sialis sp.*	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	2
	Hydropsychidae	*Hydropsyche betteni*	4
		Hydropsyche bronta	2
		Hydropsyche sparna	19
	Rhyacophilidae	*Rhyacophila fuscula*	3
	Glossosomatidae	*Glossosoma sp.*	2
	Brachycentridae	*Brachycentrus appalachia*	6
DIPTERA	Tipulidae	*Antocha sp.*	3
		Dicranota sp.	1
		Hexatoma sp.	7
	Simuliidae	*Simulium tuberosum*	3
	Athericidae	*Atherix sp.*	1
	Chironomidae	*Pagastia orthogonia*	1
		Nanocladius (Plecopt.) branchicolus	1
		Tvetenia bavarica gr.	4
		Microtendipes rydalensis gr.	1
		Cladotanytarsus sp.	2
		Rheotanytarsus exiguus gr.	1
		SPECIES RICHNESS:	29
		BIOTIC INDEX:	3.87
		EPT RICHNESS:	12
		MODEL AFFINITY:	60
		ASSESSMENT:	non

DESCRIPTION: This site is 50 m above Dimmick Rd. bridge. Species richness increased HBI dropped compared to upstream Station 03.

Table 6e.

STREAM SITE:	Snook Kill, Station 06
LOCATION:	Saratoga, NY
DATE:	7/10/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA
INSECTA

EPHEMEROPTERA			
	Isonychiidae	*Isonychia bicolor*	2
	Baetidae	*Acentrella sp.*	11
		Baetis flavistriga	8
		Baetis intercalaris	2
		Baetis tricaudatus	11
	Heptageniidae	*Stenonema sp.*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Stenelmis crenata*	6
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	5
	Hydropsychidae	*Hydropsyche bronta*	1
		Hydropsyche sparna	8
	Glossosomatidae	*Glossosoma sp.*	1
	Hydroptilidae	*Hydroptila sp.*	7
LEPIDOPTERA		Undetermined Lepidoptera	1
DIPTERA	Tipulidae	*Hexatoma sp.*	1
	Chironomidae	*Pagastia orthogonia*	1
		Cricotopus trifascia gr.	6
		Parametriocnemus lundbecki	4
		Tvetenia vitracies	2
		Microtendipes pedellus gr.	1
		Polypedilum flavum	14
		Cladotanytarsus sp.	1
		Rheotanytarsus exiguus gr.	1
		Tanytarsus glabrescens gr.	3
		SPECIES RICHNESS:	25
		BIOTIC INDEX:	5.06
		EPT RICHNESS:	11
		MODEL AFFINITY:	75
		ASSESSMENT:	non

DESCRIPTION: This site is 10 m above Gansevoort Rd. Species richness is down slightly and the HBI increased compared to upstream.

Table 6f.

STREAM SITE:	Snook Kill, Station 07
LOCATION:	Saratoga, NY
DATE:	7/10/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

PLATYHELMINTHES			
TURBELLARIA			
TRICLADIDA			
		Undetermined Turbellaria	1
ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	2
MOLLUSCA			
GASTROPODA			
	Ancylidae	*Ferrissia sp.*	6
BASOMMATOPHORA			
PELECYPODA	Sphaeriidae	*Pisidium sp.*	1
VENEROIDEA			
ARTHROPODA			
CRUSTACEA	Gammaridae	*Gammarus sp.*	8
AMPHIPODA			
	Cambaridae	Undetermined Cambaridae	1
DECAPODA			
INSECTA	Baetidae	*Baetis flavistriga*	8
EPHEMEROPTERA		*Baetis intercalaris*	1
		Plauditus sp.	5
	Heptageniidae	*Stenonema modestum*	3
	Gyrinidae	*Dineutus sp.*	1
COLEOPTERA	Elmidae	*Optioservus trivittatus*	2
		Stenelmis sp.	18
	Sialidae	*Sialis sp.*	2
MEGALOPTERA			
	Hydropsychidae	*Cheumatopsyche sp.*	5
TRICHOPTERA	Hydroptilidae	*Hydroptila sp.*	1
	Tipulidae	*Dicranota sp.*	1
DIPTERA	Ceratopogonidae	Undetermined Ceratopogonidae	1
	Simuliidae	*Simulium tuberosum*	7
	Chironomidae	*Thienemannimyia gr. spp.*	5
		Cricotopus sp.	2
		Chironomus sp.	1
		Cryptochironomus sp.	1
		Microtendipes pedellus gr.	1
		Microtendipes rydalensis gr.	2
		Rheotanytarsus exiguus gr.	2
		Tanytarsus glabrescens gr.	8
		Tanytarsus guerlus gr.	4
		SPECIES RICHNESS:	28
		BIOTIC INDEX:	5.2
		EPT RICHNESS:	6

Non Chironomidae/Oligochaeta:	17
ASSESSMENT:	non

DESCRIPTION: This site is 10 m above Mott Rd. This site has a very high species richness value due to the hybrid habitat found here. Taxa here are a mix of both high and low gradient stream communities. Taxa such as Gammarus sp., Ferrissia sp., and Pisisium sp. are found more commonly and in greater numbers in either low-gradient habitat or degraded stream reaches. Also, EPT numbers are typically lower in low-gradient streams.

Table 7. Laboratory data summary, the Snook Kill, Saratoga County, NY, 2007.

LABORATORY DATA SUMMARY				
STREAM NAME: Snook Kill				
DATE SAMPLED: 7/10/2007				
SAMPLING METHOD: Kick				
LOCATION	SNOK	SNOK	SNOK	SNOK
STATION	02	03	04	05
DOMINANT SPECIES / % CONTRIBUTION / TOLERACE / COMMON NAME				
Tolerance Definitions:	1. Psephenus herricki 15 % intolerant beetle	Hydropsyche sparna 19 % facultative caddisfly	Hydropsyche sparna 19 % facultative caddisfly	Hydropsyche sparna 19 % facultative caddisfly
Intolerant = not tolerant of poor water quality	2. Dolophilodes sp. 14 % intolerant caddisfly	Baetis intercalaris 10 % facultative mayfly	Simulium tuberosum 18 % intolerant black fly	Baetis intercalaris 10 % facultative mayfly
Facultative = occurring over a wide range of water quality	3. Leuctra sp. 9 % intolerant stonefly	Cricotopus bicinctus 10 % tolerant midge	Polypedilum aviceps 12 % facultative midge	Hexatoma sp. 7 % intolerant crane fly
Tolerant = tolerant of poor water quality	4. Hydropsyche sparna 8 % facultative caddisfly	Cheumatopsyche sp. 8 % facultative caddisfly	Dolophilodes sp. 7 % intolerant caddisfly	Brachycentrus appalachia 6 % intolerant caddisfly
	5. Micropsectra sp. 6 % facultative midge	Stenelmis crenata 7 % facultative beetle	Baetis intercalaris 6 % facultative mayfly	Isonychia bicolor 5 % intolerant mayfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	17 (10.0)	26 (7.0)	20 (4.0)	10 (6.0)
Trichoptera (caddisflies)	29 (4.0)	34 (5.0)	34 (5.0)	38 (7.0)
Ephemeroptera (mayflies)	16 (5.0)	12 (2.0)	10 (3.0)	19 (4.0)
Plecoptera (stoneflies)	11 (3.0)	2 (1.0)	2 (2.0)	1 (1.0)
Coleoptera (beetles)	20 (3.0)	15 (5.0)	8 (2.0)	11 (4.0)
Oligochaeta (worms)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mollusca (clams and snails)	0 (0.0)	2 (1.0)	0 (0.0)	0 (0.0)
Crustacea (crayfish, scuds, sowbugs)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other insects (odonates, diptera)	7 (5.0)	8 (3.0)	26 (4.0)	21 (7.0)
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
SPECIES RICHNESS	30	24	20	29
BIOTIC INDEX	2.97	4.87	4.22	3.87
EPT RICHNESS	12	8	10	12
PERCENT MODEL AFFINITY	65	64	60	60
FIELD ASSESSMENT	VG	VG	G	G
OVERALL ASSESSMENT	non-impacted	slightly impacted	slightly impacted	non-impacted

Table 7. (cont'd) Laboratory data summary, the Snook Kill, Saratoga County, NY, 2007.

LABORATORY DATA SUMMARY				
STREAM NAME: Snook Kill				
DATE SAMPLED: 7/10/2007				
SAMPLING METHOD: Kick				
LOCATION	SNOK	SNOK		
STATION	06	07		
DOMINANT SPECIES / % CONTRIBUTION / TOLERACE / COMMON NAME				
Tolerance Definitions:	1. Polypedilum flavum 14 % facultative midge	Stenelmis sp. 18 % facultative beetle		
Intolerant = not tolerant of poor water quality	2. Acentrella sp. 11 % intolerant mayfly	Baetis flavistriga 8 % intolerant mayfly		
Facultative = occurring over a wide range of water quality	3. Baetis tricaudatus 11 % facultative mayfly	Tanytarsus glabrescens gr. 8 % facultative midge		
Tolerant = tolerant of poor water quality	4. Baetis flavistriga 8 % intolerant mayfly	Gammarus sp. 8 % facultative scud		
	5. Hydropsyche sparna 8 % facultative caddisfly	Simulium tuberosum 7 % intolerant black fly		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	33 (9.0)	26 (9.0)		
Trichoptera (caddisflies)	22 (5.0)	6 (2.0)		
Ephemeroptera (mayflies)	35 (6.0)	17 (4.0)		
Plecoptera (stoneflies)	0 (0.0)	0 (0.0)		
Coleoptera (beetles)	7 (2.0)	21 (3.0)		
Oligochaeta (worms)	0 (0.0)	2 (1.0)		
Mollusca (clams and snails)	0 (0.0)	7 (2.0)		
Crustacea (crayfish, scuds, sowbugs)	0 (0.0)	9 (2.0)		
Other insects (odonates, diptera)	3 (3.0)	11 (4.0)		
Other (Nemertea, Platyhelminthes)	0 (0.0)	1 (0.0)		
SPECIES RICHNESS	25	28		
BIOTIC INDEX	5.06	5.2		
EPT RICHNESS	11	6		
PERCENT MODEL AFFINITY	75	65		
FIELD ASSESSMENT	G	G		
OVERALL ASSESSMENT	non-impacted	non- impacted		

Table 8. Field data summary, the Snook Kill, Saratoga County, NY, 2007.

FIELD DATA SUMMARY				
STREAM NAME: Snook Kill	DATE SAMPLED: 7/10/2007			
REACH: Wilton to Gansevoort				
FIELD PERSONNEL INVOLVED: Bode/Heitzman				
STATION	02	03	04	05
ARRIVAL TIME AT STATION	8:30	9:15	9:50	10:20
LOCATION	SNOK	SNOK	SNOK	SNOK
PHYSICAL CHARACTERISTICS				
Width (meters)	2	6	3	8
Depth (meters)	0.1	0.1	0.2	0.2
Current speed (cm per sec.)	70	100	80	70
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10		10	20
Rubble (6.35 - 25.4 cm)	30	20	30	30
Gravel (0.2 - 6.35 cm)	30	50		20
Sand (0.06 - 2.0 mm)	20	20		10
Silt (0.004 - 0.06 mm)	10	10		20
Embeddedness (%)	30	30	30	30
CHEMICAL MEASUREMENTS				
Temperature (?C)	19.3	19.2	19.3	19.3
Specific Conductance (umhos)	187	583	290	432
Dissolved Oxygen (mg/l)	11.1	10.3	11.1	11
pH	6.5	6.9	7.4	7.3
BIOLOGICAL ATTRIBUTES				
Canopy (%)	40	60	20	80
Aquatic Vegetation				
Algae - suspended				
Algae - attached,filamentous	X	X		X
Algae - diatoms	X	X	X	X
Macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X	X		
Megaloptera (dobsonflies, damselflies)	X	X		X
Odonata (dragonflies, damselflies)	X	X	X	
Chironomidae (midges)	X	X		
Simuliidae (black flies)	X		X	
Decapoda (crayfish)				
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other			X	X
FAUNAL CONDITION	VG	VG	G	G

Table 8. (cont'd) Field data summary, the Snook Kill, Saratoga County, NY, 2007.

FIELD DATA SUMMARY				
STREAM NAME: Snook Kill	**DATE SAMPLED:** 7/10/2007			
REACH: Wilton to Gansevoort				
FIELD PERSONNEL INVOLVED: Bode/Heitzman				
STATION	06	07		
ARRIVAL TIME AT STATION	10:55	11:20		
LOCATION	SNOK	SNOK		
PHYSICAL CHARACTERISTICS				
Width (meters)	10	8		
Depth (meters)	0.2	0.3		
Current speed (cm per sec.)	80	40		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	30			
Rubble (6.35 - 25.4 cm)	20	10		
Gravel (0.2 - 6.35 cm)	10	50		
Sand (0.06 - 2.0 mm)	20	20		
Silt (0.004 - 0.06 mm)	20	20		
Embeddedness (%)	20	20		
CHEMICAL MEASUREMENTS				
Temperature (?C)	20.8	20.9		
Specific Conductance (umhos)	429	366		
Dissolved Oxygen (mg/l)	10.6	10.6		
pH	7.7	7.6		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	80	40		
Aquatic Vegetation				
Algae - suspended				
Algae - attached,filamentous	X			
Algae - diatoms	X	X		
Macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X		
Plecoptera (stoneflies)	X	X		
Trichoptera (caddisflies)	X			
Coleoptera (beetles)		X		
Megaloptera (dobsonflies, damselflies)	X	X		
Odonata (dragonflies, damselflies)		X		
Chironomidae (midges)				
Simuliidae (black flies)				
Decapoda (crayfish)	X	X		
Gammaridae (scuds)		X		
Mollusca (snails, clams)	X			
Oligochaeta (worms)				
Other	X			
FAUNAL CONDITION	G	G		

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 meter 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 organisms are dislodged and carried into the net. Sampling is continued for a specified time and distance in the stream. Rapid assessment sampling specifies sampling for five minutes over a distance of five meters. The contents of the net are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol.

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

E. Organism Identification: All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species and the total number of individuals in the subsample are 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.

Appendix II. Macroinvertebrate Community Parameters

1. Species Richness: the total number of species or taxa found in a 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, and less than 11, severely impacted.

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

3. Hilsenhoff Biotic Index: a measure of the tolerance of organisms in a 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 the purpose of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Tolerance 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 Quality Assurance document, Bode et al. (2002). Impact ranges 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: a measure of similarity to a model, non-impacted community based on percent abundance in seven major macroinvertebrate groups (Novak and Bode, 1992). Percentage 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.

5. Nutrient Biotic Index: a measure of stream nutrient enrichment identified by macroinvertebrate taxa. 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 with assigned tolerance values. Tolerance values ranging from intolerant (0) to tolerant (10) are based on nutrient optima for Total Phosphorus (listed in Smith, 2005). Impact ranges are: 0-5.00, non-impacted; 5.01-6.00, slightly impacted; 6.01-7.00, moderately impacted, and 7.01-10.00, severely impacted.

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 richness, biotic index, and percent model affinity (see Appendix II). 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-organisms 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. Nutrient Biotic Index is 5.00 or less. 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.

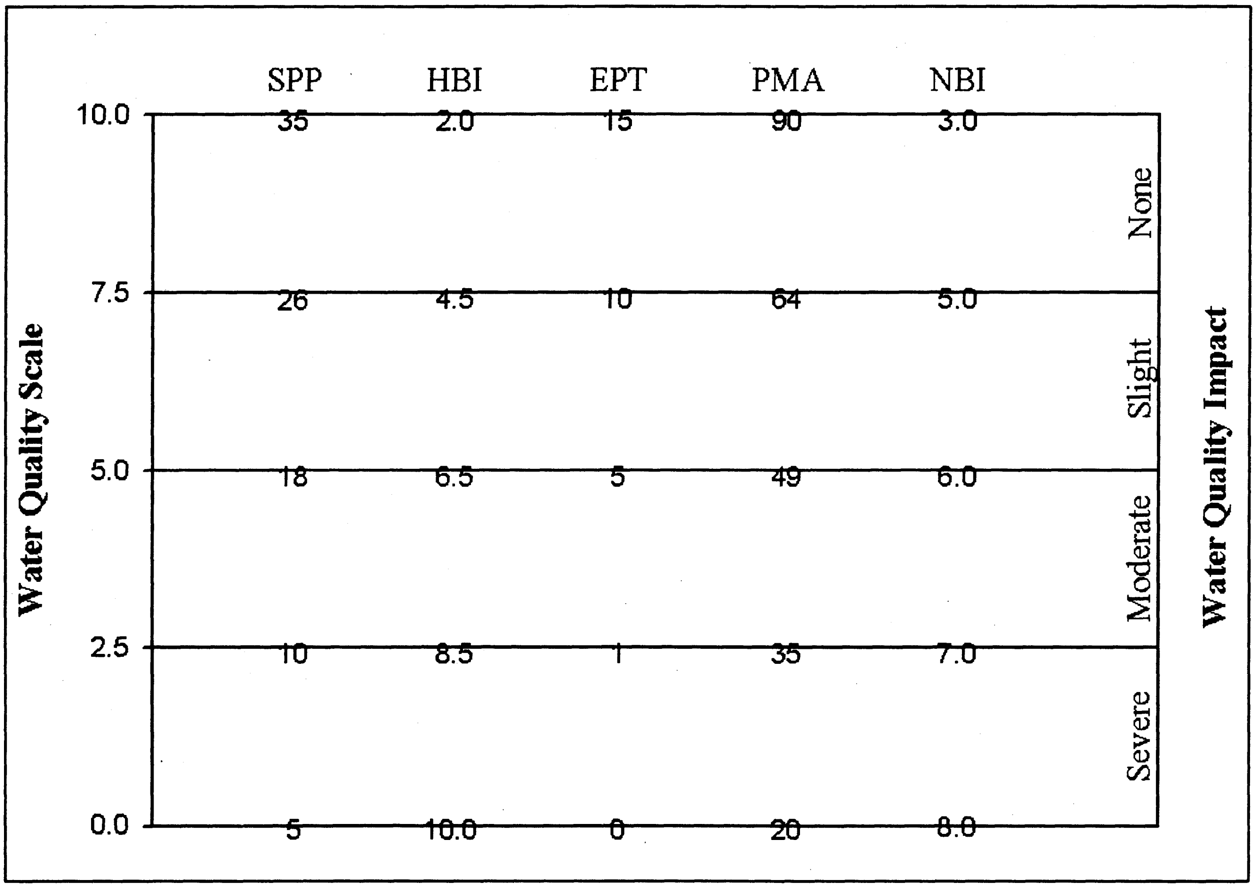
2. *Slightly impacted*: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Nutrient Biotic Index is 5.01-6.00. 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 is usually 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. Percent model affinity is 35-49. Nutrient Biotic Index is 6.01-7.00. 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 fewer. 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. Nutrient Biotic Index is greater than 7.00. 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-A. Biological Assessment Profile: Conversion of Index Values to a 10-Scale

The Biological Assessment Profile (BAP) 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 five indices -- species richness (SPP), EPT richness (EPT), Hilsenhoff Biotic Index (HBI), Percent Model Affinity (PMA), and Nutrient Biotic Index (NBI)- - defined in Appendix II 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.



Appendix IV-B. Biological Assessment Profile: Plotting Values

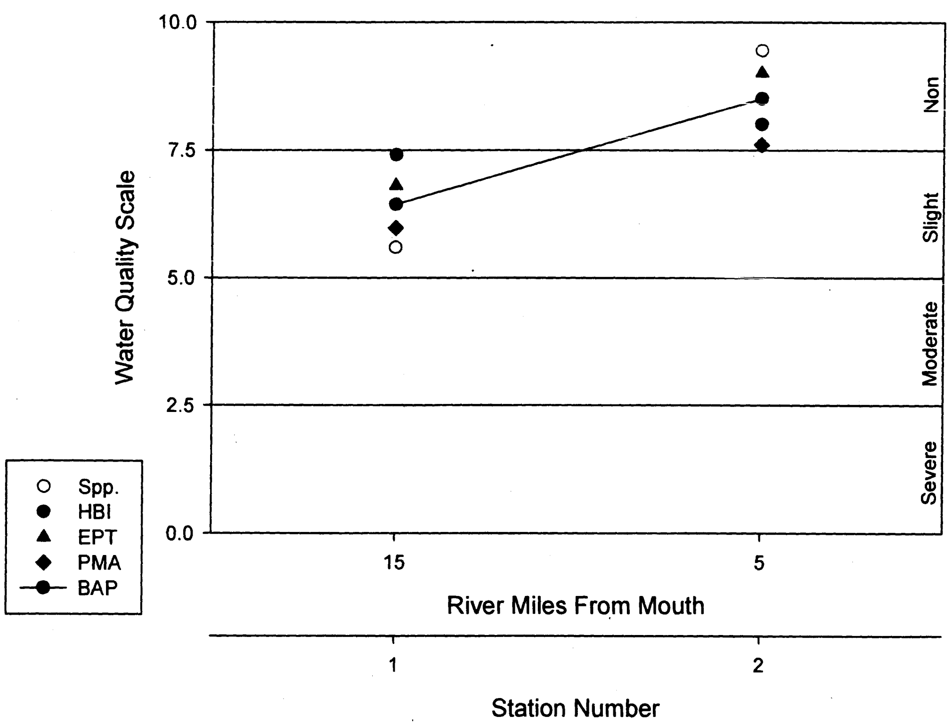
To plot survey data:

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-)

Sample BAP plot:



Appendix V. Water Quality Assessment Criteria

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

Navigable Flowing Waters

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

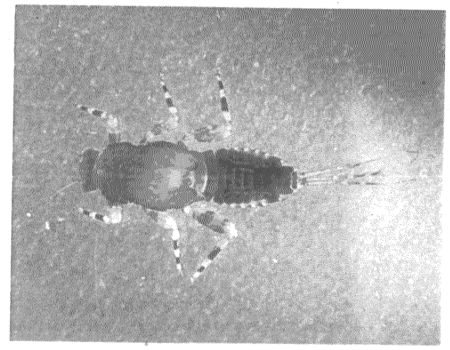
Appendix VI. The Traveling Kick Sample

← current

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

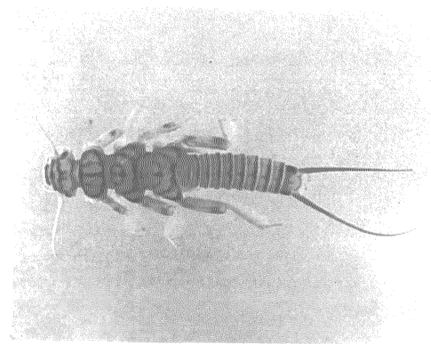
Appendix VII-A. Aquatic Macroinvertebrates Usually Indicative of Good Water Quality

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.



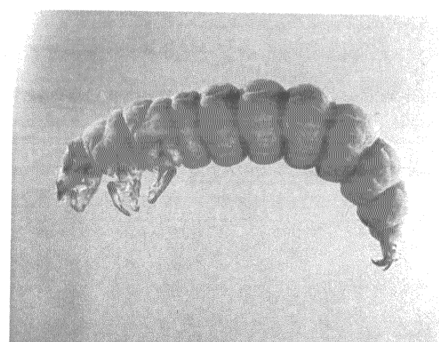
MAYFLIES

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.



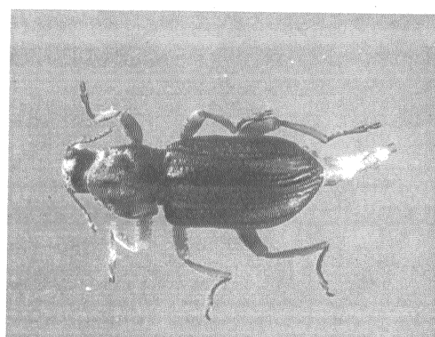
STONEFLIES

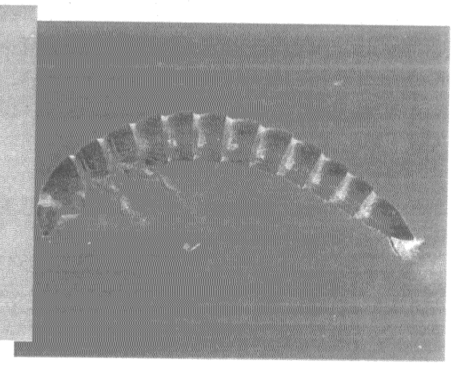
Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.



CADDISFLIES

The most common beetles in streams are riffle beetles (adult and larva pictured) and water pennies (not shown). Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.





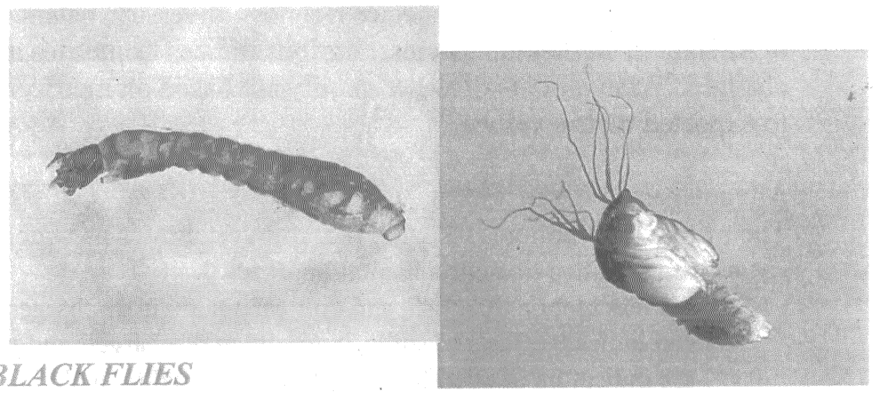
BEETLES

Appendix VII-B. Aquatic Macroinvertebrates Usually Indicative of 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.

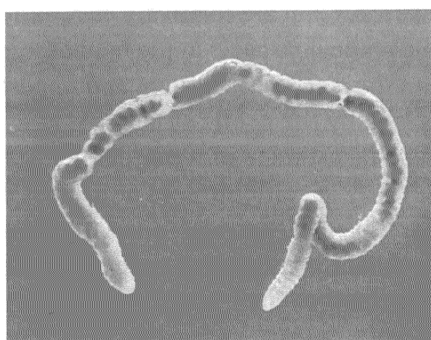
MIDGES

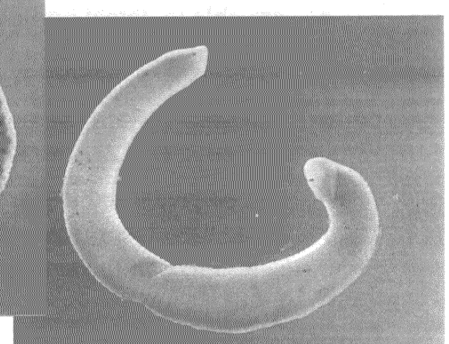
Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.



BLACK FLIES

The segmented worms include the leeches and the small aquatic worms. 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.

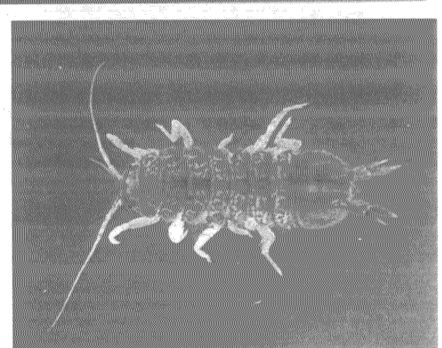




WORMS

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

Appendix VIII. 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 that they:

- are sensitive to environmental impacts
- are less mobile than fish, and thus cannot avoid discharges
- can indicate effects of spills, intermittent discharges, and lapses in treatment
- are indicators of overall, integrated water quality, including synergistic effects
- are abundant in most streams and are relatively easy and inexpensive to sample
- are able to detect non-chemical impacts to the habitat, e.g. siltation or thermal changes
- are vital components of the aquatic ecosystem and important as a food source for fish
- are more readily perceived by the public as tangible indicators of water quality
- can often provide an on-site estimate of water quality
- can often be used to identify specific stresses or sources of impairment
- can be preserved and archived for decades, allowing for direct comparison of specimens
- 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

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

Electrofishing: sampling fish by using electric currents to temporarily immobilize them, allowing capture

EPT richness: the number of taxa of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) in a sample or subsample

Eutrophic: high nutrient levels normally leading to excessive biological productivity

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

Mesotrophic: intermediate nutrient levels (between oligotrophic and eutrophic) normally leading to moderate biological productivity

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

Non Chironomidae/Oligochaeta (NCO) richness: the number of taxa neither belonging to the family Chironomidae nor the subclass Oligochaeta in a sample or subsample

Oligotrophic: low nutrient levels normally leading to unproductive biological conditions

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 turn-around time; usually involves kick sampling and laboratory subsampling of the sample

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

Species richness: the number of macroinvertebrate taxa 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

Trophic: referring to productivity

Appendix X. Methods for Calculation of the Nutrient Biotic Index

Definition: The Nutrient Biotic Index (Smith et al., 2007) 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 (Jongman 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 indicates 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).

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

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 - 6.0	> 6.0
NBI-N	< 4.5	> 4.5 - 6.0	> 6.0

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, 299 pages.

Smith, A.J., R. W. Bode, and G. S. Kleppel. 2007. A nutrient biotic index for use with benthic macroinvertebrate communities. Ecological Indicators 7(200):371-386.

Tolerance values assigned to taxa for calculation of the Nutrient Biotic Indices

TAXON	TP T-Value	NO3 T-Value
Acentrella sp.	5	5
Acerpenna pygmaea	0	4
Acroneuria abnormis	0	0
Acroneuria sp.	0	0
Agnetina capitata	3	6
Anthopotamus sp.	4	5
Antocha sp.	8	6
Apatania sp.	3	4
Atherix sp.	8	5
Baetis brunneicolor	1	5
Baetis flavistriga	7	7
Baetis intercalaris	6	5
Baetis sp.	6	3
Baetis tricaudatus	8	9
Brachycentrus appalachia	3	4
~~*Caecidotea racovitzai*~~	6	2
Caecidotea sp.	7	9
Caenis sp.	3	3
Cardiocladius obscurus	8	6
Cheumatopsyche sp.	6	6
Chimarra aterrima?	2	3
Chimarra obscura	6	4
Chimarra socia	4	1
Chimarra sp.	2	0
Chironomus sp.	9	6
Cladotanytarsus sp.	6	4
Corydalus cornutus	2	2
Cricotopus bicinctus	7	6
Cricotopus tremulus gr.	8	9
Cricotopus trifascia gr.	9	9
Cricotopus vierriensis	6	5
Cryptochironomus fulvus gr.	5	6
Diamesa sp.	10	10
Dicranota sp.	5	10
Dicrotendipes neomodestus	10	4
Dolophilodes sp.	4	3
Drunella cornutella	4	4
Ectopria nervosa	10	9
Epeorus (Iron) sp.	0	0
Ephemerella sp.	4	4
Ephemerella subvaria	4	1
Ephoron leukon?	1	1
Eukiefferiella devonica gr.	9	9
Ferrissia sp.	9	5
Gammarus sp.	8	9
Glossosoma sp.	6	0
Goniobasis livescens	10	10
Helicopsyche borealis	1	2
Hemerodromia sp.	5	6
Heptagenia sp.	0	0
Hexatoma sp.	0	1
Hydropsyche betteni	7	9
Hydropsyche bronta	7	6
Hydropsyche morosa	5	1
Hydropsyche scalaris	3	3

TAXON	TP T-Value	NO3 T-Value
Hydropsyche slossonae	6	10
Hydropsyche sp.	5	4
Hydropsyche sparna	6	7
Hydroptila consimilis	9	10
Hydroptila sp.	6	6
Hydroptila spatulata	9	8
Isonychia bicolor	5	2
Lepidostoma sp.	2	0
Leucotrichia sp.	6	2
Leucrocuta sp.	1	3
Macrostemum carolina	7	2
Macrostemum sp.	4	2
Micrasema sp. 1	1	0
Micropsectra dives gr.	6	9
Micropsectra polita	0	7
Micropsectra sp.	3	1
Microtendipes pedellus gr.	7	7
Microtendipes rydalensis gr.	2	1
Nais variabilis	5	0
Neoperla sp.	5	5
Neureclipsis sp.	3	1
Nigronia serricornis	10	8
Nixe (Nixe) sp.	1	5
Ophiogomphus sp.	1	3
Optioservus fastiditus	6	7
Optioservus ovalis	9	4
Optioservus sp.	7	8
Optioservus trivittatus	7	6
Orthocladius nr. dentifer	3	7
Pagastia orthogonia	4	8
Paragnetina immarginata	1	2
Paragnetina media	6	3
Paragnetina sp.	1	6
Paraleptophlebia mollis	2	1
Paraleptophlebia sp.	2	3
Parametriocnemus lundbecki	8	10
Paratanytarsus confusus	5	8
Pentaneura sp.	0	1
Petrophila sp.	5	3
Phaenopsectra dyari?	4	5
Physella sp.	8	7
Pisidium sp.	8	10
Plauditus sp.	2	6
Polycentropus sp.	4	2
Polypedilum aviceps	5	7
Polypedilum flavum	9	7
Polypedilum illinoense	10	7
Polypedilum laetum	7	6
Polypedilum scalaenum gr.	10	6
Potthastia gaedii gr.	9	10
Promoresia elegans	10	10
Prostoma graecense	2	7
Psephenus herricki	10	9
Psephenus sp.	3	4

NBI tolerance values (cont'd)

TAXON	TP T-Value	NO3 T-Value
Psychomyia flavida	1	0
Rheocricotopus robacki	4	4
Rheotanytarsus exiguus gr.	6	5
Rheotanytarsus pellucidus	3	2
Rhithrogena sp.	0	1
Rhyacophila fuscula	2	5
Rhyacophila sp.	0	1
Serratella deficiens	5	2
Serratella serrata	1	0
Serratella serratoides	0	1
Serratella sp.	1	1
Sialis sp.	5	6
Simulium jenningsi	6	2
Simulium sp.	7	6
Simulium tuberosum	1	0
Simulium vittatum	7	10
Sphaerium sp.	9	4
Stenacron interpunctatum	7	7
~~*Stenelmis concinna*~~	5	0
Stenelmis crenata	7	7
Stenelmis sp.	7	7
Stenochironomus sp.	4	3
Stenonema mediopunctatum	3	3
Stenonema modestum	2	5
Stenonema sp.	5	5
Stenonema terminatum	2	3
Stenonema vicarium	6	7
Stylaria lacustris	5	2
Sublettea coffmani	3	5

TAXON	TP T-Value	NO3 T-Value
Synorthocladius nr. semivirens	6	9
Tanytarsus glabrescens gr.	5	6
Tanytarsus guerlus gr.	5	5
Thienemannimyia gr. spp.	8	8
Tipula sp.	10	10
Tricorythodes sp.	4	9
Tvetenia bavarica gr.	9	10
Tvetenia vitracies	7	6
Undet. Tubificidae w/ cap. setae	10	8
Undet. Tubificidae w/o cap. setae	7	7
Undetermined Cambaridae	6	5
Undet. Ceratopogonidae	8	9
Undet. Enchytraeidae	7	8
Undet. Ephemerellidae	3	6
Undetermined Gomphidae	2	0
~~Undet. Heptageniidae~~	5	2
Undetermined Hirudinea	9	10
Undetermined Hydrobiidae	6	7
Undetermined Hydroptilidae	5	2
Undet. Limnephilidae	3	4
Undet. Lumbricina	8	8
Undet. Lumbriculidae	5	6
Undetermined Perlidae	5	7
Undetermined Sphaeriidae	10	8
Undetermined Turbellaria	8	6
Zavrelia sp.	9	9

Appendix XI. 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.

ISD 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

ISD Models (cont'd)

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

ISD Models (cont'd)

	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

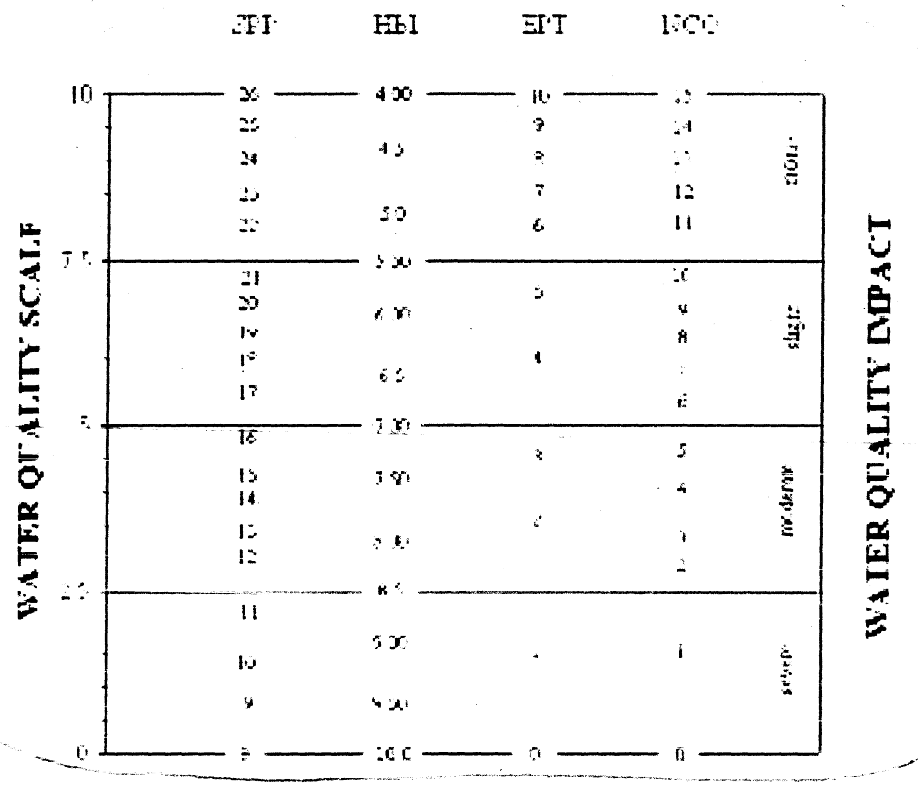
ISD Models (cont'd)

	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

ISD Models (cont'd)

	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

Appendix XII. Biological Assessment Profile of Slow, Sandy Streams.



The Biological Assessment Profile of index values is a method of plotting biological index values on a common scale of water quality impact. For kick-net samples from slow, sandy streams, these indices are used: SPP (species richness), HBI (Hilsenhoff Biotic Index), EPT (EPT richness), and NCO (NCO richness). Values from the four indices are converted to a common 0-10 scale as shown in this figure. The mean scale value of the four indices represents the assessed impact for each site.

Appendix XIII. Biological Impacts of Waters with High Conductivity

Definition: Conductivity is a measure of the ability of an aqueous solution to carry an electric current. It may be used to estimate salinity, total dissolved solids (TDS), and chlorides. Salinity is the amount of dissolved salts in a given amount of solution. TDS, although not precisely equivalent to salinity, is closely related, and for most purposes can be considered synonymous. EPA has not established ambient water-quality criteria for salinity; for drinking water, maximum contaminant levels are 250 mg/L for chlorides, and 500 mg/L for dissolved solids (EPA, 1995).

Measurement: Conductivity is measured as resistance and is reported in micromhos per centimeter (µmhos/cm), which is equivalent to microsiemens per centimeter (µS/cm). To estimate TDS and salinity, multiply conductivity by 0.64 and express the result in parts per million. For marine waters, salinity is usually expressed in parts per thousand. To estimate chlorides, multiply conductivity by 0.21 and express the result in parts per million. Departures from these estimates can occur when elevated conductivity is a result of natural conditions, such as in situations of high alkalinity (bicarbonates), or sulfates.

Effects on macroinvertebrates: Bioassays on test animals found the toxicity threshold for *Daphnia magna* to be 6-10 parts per thousand salinity (6000-10,000 mg/L) (Ingersoll et al., 1992). Levels of concern for this species were set at 0.3-6 parts per thousand salinity (300-6000 mg/L) (U.S. Dept. of Interior, 1998).

Stream Biomonitoring findings: Of 22 New York State streams sampled with specific conductance levels exceeding 800 µmhos/cm, 9% were assessed as severely impacted, 50% were assessed as moderately impacted, 32% were assessed as slightly impacted, and 9% were assessed as non-impacted. Many of the benthic communities in the impacted streams were dominated by oligochaetes, midges, and crustaceans (scuds and sowbugs). Thirty-five percent of the streams were considered to derive their high conductance primarily from natural sources, while the remainder were the result of contributions from point and nonpoint anthropogenic (human caused) sources. For nearly all streams with high conductivity, other contaminants are contained in the water column, making it difficult to isolate effects of high conductance.

Recommendations: Conductivity may be best used as an indicator of elevated amounts of anthropogenic-source contaminants. Based on findings that the median impact at sites with specific conductance levels exceeding 800 µmhos/cm is moderate impact, 800 µmhos/cm is designated as a level of concern with expected biological impairments. Eight-hundred umhos/cm corresponds to ~170 mg/L chlorides, ~510 parts per million Total Dissolved Solids, and ~0.51 parts per thousand salinity.

References:

US Dept. of Interior. 1998. Guidelines for interpretation of the biological effects of selected constituents in biota, water, and sediment. National Irrigation Water Quality Program Information Report No. 3.

Ingersoll, C.G., F.J. Dwyer, S.A. Burch, M.K. Nelson, D.R. Buckler, and J.B. Hunn. 1992. The use of freshwater and saltwater animals to distinguish between the toxic effects of salinity and contaminants in irrigation drain water. Environmental Toxicology and Chemistry, 11:503-511.

U.S. EPA. 995. Drinking water regulations and health advisories. U.S. Environmental Protection Agency, Office of Water, Washington, D.C., 11 pages.