New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Upper Esopus Creek

Biological Assessment

2007 Survey

New York State
Department of Environmental Conservation

BIOLOGICAL STREAM ASSESSMENT

Upper Esopus Creek
Ulster County, New York
Lower Hudson River Basin

Survey dates: July 23, 2007
Report date: September 30, 2008

Alexander J. Smith
Robert W. Bode
Margaret A. Novak
Lawrence E. Abele
Diana L. Heitzman
Brian T. Duffy

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

Table of Contents

Stream: Upper Esopus Creek

Reach: Oliverea to Boiceville, NY

River Basin: Lower Hudson

Background:

The Stream Biomonitoring Unit (SBU) sampled the Upper Esopus Creek from Oliverea to Boiceville, Ulster County, New York, on July 23, 2007. Sampling was conducted as routine monitoring of long-term sites to document changes in water quality that may have occurred since previous sampling events.

To characterize water quality based on benthic macroinvertebrate communities, a traveling kick sample was collected from riffle areas at each of six sites along the stream. 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 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). The amount of expected variability of results is stated in Smith and Bode (2004). Table 1 provides a listing of sampling sites, and Table 4 provides a listing of all species collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Stream Biomonitoring Unit staff were accompanied by Trout Unlimited (TU) members, who have been sampling the stream using leaf pack samplers. The SBU identified the organisms from these samples and has provided the results to TU.

Results and Conclusions:

1. Water quality in the Upper Esopus Creek was assessed as non- to slightly impacted.

2. Results of the 2007 survey suggest a slight decline in biological assessment profile scores at most sites except for station 01, which appears to have improved. However, due to the amount of variability in the water-quality score (Smith and Bode 2004) it cannot be said for certain whether or not this indicates an actual decline in water quality at any site other than station 03, which was non-impacted and is now slightly impacted. Further investigation is needed.

3. Water quality downstream of the Shandaken Portal is similar to that of previous years. The effects of Birch Creek on overall water quality (organic and nutrient inputs) may be stronger determinants in shaping the community than the portal.

4. Water quality is assessed as slightly impacted below the village of Phoenicia. Impacts may be the result of runoff from the un-sewered village.

Discussion:

The Esopus Creek is a tributary to the Hudson River located in the Catskill Mountains. Upper Esopus Creek is defined as the reach between the source in Winisook Lake and the Ashoken Reservoir near Boiceville, NY.

The Stream Biomonitoring Unit (SBU) sampled the Upper Esopus Creek from Oliverea to Boiceville at six sites on July 23, 2007 (Table 1, Figures 1-7). Sampling was conducted as routine monitoring of these previously-sampled sites to document changes in water quality that may have occurred.

There are several possible sources of impact to the natural condition of the stream including: 1) Birch Creek which joins the Upper Esopus in Big Indian, NY and carries effluent from the NYCDEP Pine Hill (V) Sewage Treatment Plant and partial drainage from the Belleayre Ski Resort (Bode et al. 2000, 2005); Birch Creek is also used as a water source for operations at the Belleayre Ski Resort; 2) the Shandaken Portal, which discharges turbid, cold water from the Schoharie Reservoir into the Upper Esopus Creek in the area of Shandaken NY, (Bode et al. 1995, 2000) and 3) concentrated areas of septic system use in close proximity to the stream.

Previous sampling determined that water quality was non-impacted at each of the six sampling locations in 1995 (Bode et al 1995) and non- to slightly impacted in 2000 (Bode et al 2000). In 2000, some faunal changes were noted at Stations 04 and 05, with several temperature-sensitive mayfly taxa (*Isonychia*, *Heptagenia*, and *Drunella*) replaced with one, less sensitive taxon (*Baetis*). This shift was attributed to the low-temperature discharge from the Shandaken Portal (Bode et al 1995). Results from the 2000 survey did not clarify the cause of the slight impact noted at Station 05. Diatom communities were sampled and indicated slight impacts at stations 02 and 04. Downstream of Birch Creek (station 02), the diatom community was indicative of organic and nutrient inputs, while downstream of the Shandaken Portal (station 04) the changes appeared to reflect an increase in siltation (Bode et al. 2000).

Results of the 2007 survey suggest a slight decline in biological assessment profile scores at most sites except for station 01, which appears to have improved (Figure 8). Due to variability in the water-quality score (Smith and Bode 2004) it cannot be said for certain whether this indicates actual decline in water quality at any site other than station 03. In previous surveys, station 01 had been identified as a classic headwater-effect location with low species richness and diversity, which were the result of poor recruitment, reduced food resources/lower productivity, and limited abundance (Bode et al. 1995). If this assessment is, true then the current assessment of non-impacted may be the result of increased nutrient runoff at this site, which in turn increases in-stream productivity and available food resources. Station 03 was assessed as non-impacted in 1995 and 2000, and is assessed as slightly impacted in the current survey.

The nutrient biotic index for phosphorus (NBI-P) 2007 shows upstream sites to be mesotrophic (stations 01-03), station 04 to be oligotrophic, and stations 05 and 06 as mesotrophic (Figure 9). Data from previous years indicates substantial increases in nutrient concentrations resulting in shifts in stream trophic state at all sites except station 04. In 1995 and 2000, all sites were categorized as oligotrophic based on the NBI-P (Figure 9). This information supports the idea of station 01 previously having low productivity.

Downstream of the confluence of Birch Creek with the Esopus, water quality scores decline (Figure 8). This may be due to the input of the Pine Hill (V) Sewage Treatment Facility and runoff the stream receives from development in the watershed. At the two stations immediately below Birch Creek, the invertebrate community shifts from one dominated by mayflies, to codominance by non-biting midges, caddisflies and mayflies. The increase in the number of non-biting midges and caddisflies is indicative of nutrient and organic enrichment. Impact Source Determination (Appendix XI) suggests that station 01 is most similar to a natural community, while stations 02 and 03 mark the first signs of similarity to enriched communities (Table 3).

The water-quality score at station 04, downstream of the Shandaken Portal, is similar to previous years and is now slightly better than stations 02 and 03. The shifts in the mayfly taxa noted by Bode et al. (1995) that were attributed to the Shandaken Portal discharge are no longer apparent. The mayfly community in the present survey is very similar to that found at upstream stations. The effects of Birch Creek on overall water quality (organic and nutrient inputs) may be stronger determinants in shaping the community than the portal. Therefore, the community at this station is now more reflective of that immediately following the confluence with Birch Creek.

Further downstream at station 05, water quality is assessed as slightly impacted. The Village of Phoenicia, located between stations 04 and 05, contains approximately 270 homes and some commercial buildings. The impact noted here in the water quality assessment may be a sign of enrichment from the unsewered village and its reliance on aging septic systems. Water quality at station 06 appears to recover from any impacts.

Water quality in the Upper Esopus Creek appears to mainly be affected by Birch Creek and enrichment from aging septic systems. The effects of the Shandaken Portal appear to be secondary to these other sources. It is likely that the portal plays some role in shifts in macroinvertebrate communities at downstream stations, but to what extent has not been quantified. There should be continued monitoring and incorporation of additional water quality variables that will assist in quantifying the inputs presented here. Pebble counts and diatom analyses will provide additional information on siltation, and water chemistry sampling will provide information on sources and extent of impacts from septic systems.

Literature Cited

Bode, R. W., M. A. Novak, L. E. Abele. 1995. *Upper Esopus Creek Biological Assessment.* New York State Department of Environmental Conservation, Technical Report, 40 pages.

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, S. I. Passy, and A. J. Smith. 2000. *Upper Esopus Creek Biological Assessment.* New York State Department of Environmental Conservation, Technical Report, 43 pages.

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.

Bode, R. W., E. Kuzia, L. E. Abele, D. L. Heitzman, A. J. Smith, N. D. Wright, and M. A. Novak. 2005. *Birch Creek Biological Assessment.* New York State Department of Environmental Conservation, Technical Report, 36 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.

Table 1. Station locations for the Upper Esopus Creek. Ulster County, New York, 2007.

Station	Location	
USOP-01	Oliverea, NY	
	30 meters below McKinley Hollow Rd. bridge	
	20.6 river miles above the mouth	
	Latitude:	42^{o} 03’ 56”
	Longitude:	74^{o} 27’ 38”
USOP-02	Big Indian, NY	
	10 meters below Co. Rte. 47 bridge	
	16.9 river miles above the mouth	
	Latitude:	42^{o} 06’ 15”
	Longitude:	74^{o} 26’ 12”
USOP-03	Shandaken, NY	
	30 meters above Rte. 28 bridge	
	14.2 river miles above the mouth	
	Latitude:	42^{o} 07’ 10”
	Longitude:	74^{o} 23’ 51”

Table 1 cont. Station locations for the Upper Esopus Creek. Ulster County, New York, 2007.

Station	Location
USOP-04	Above Phoenicia, NY DOT access off Rte. 28 10.2 river miles above the mouth Latitude: 42^{o} 05’ 32” Longitude: 74^{o} 20’ 11”
USOP-05	Mount Pleasant, NY 200 meters above the confluence with the Beaver Kill 4.6 river miles above the mouth Latitude: 42^{o} 02’ 48” Longitude: 74^{o} 16’ 49”
USOP-06	Boiceville, NY 10 meters above Rte. 28A bridge 1.3 river miles above the mouth Latitude: 42^{o} 00’ 14” Longitude: 74^{o} 16’ 06”

Figure 1. Watershed overview map, Upper Esopus Creek, Ulster County, NY.

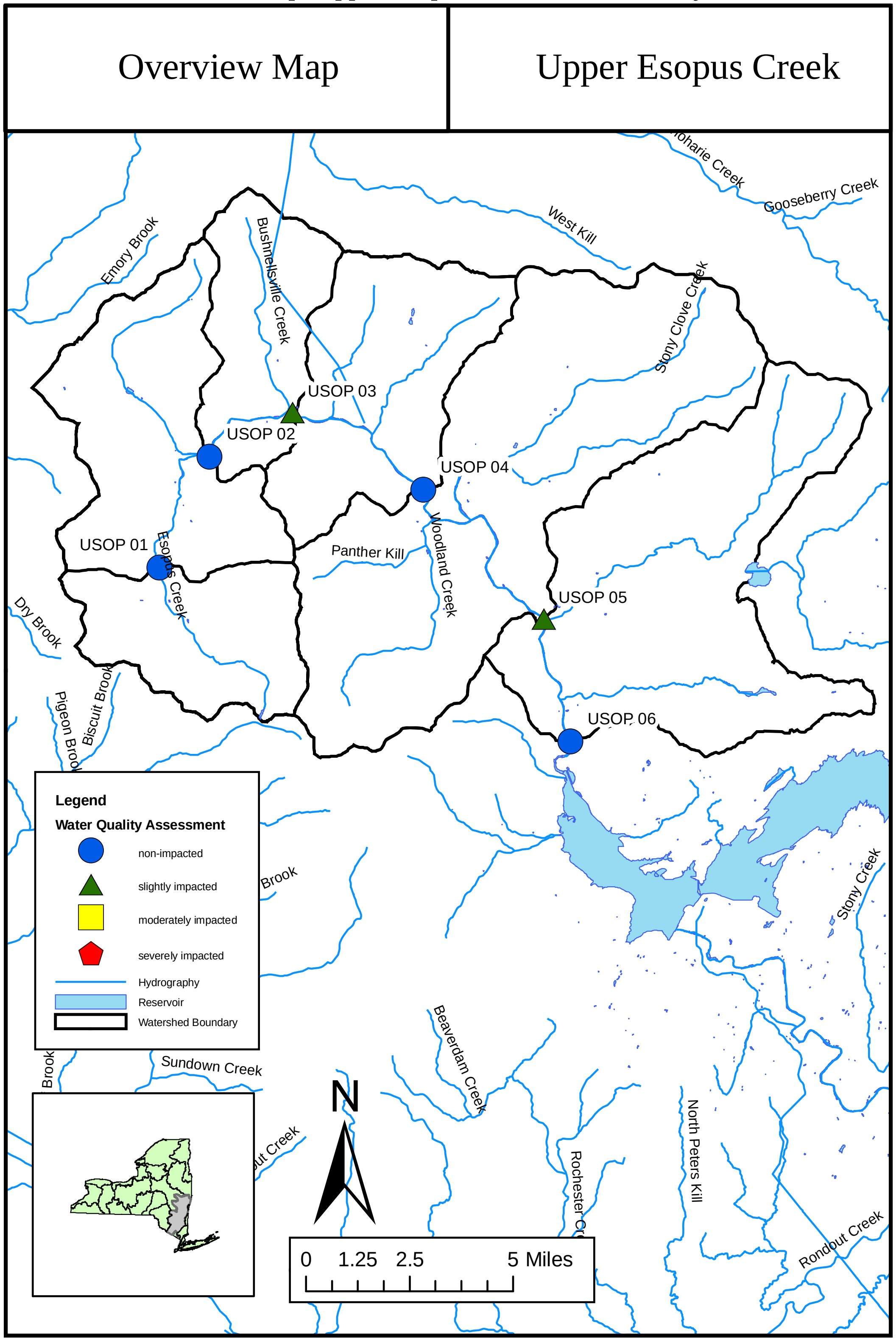


Figure 2. Overview map of Upper Esopus Creek Station 01.

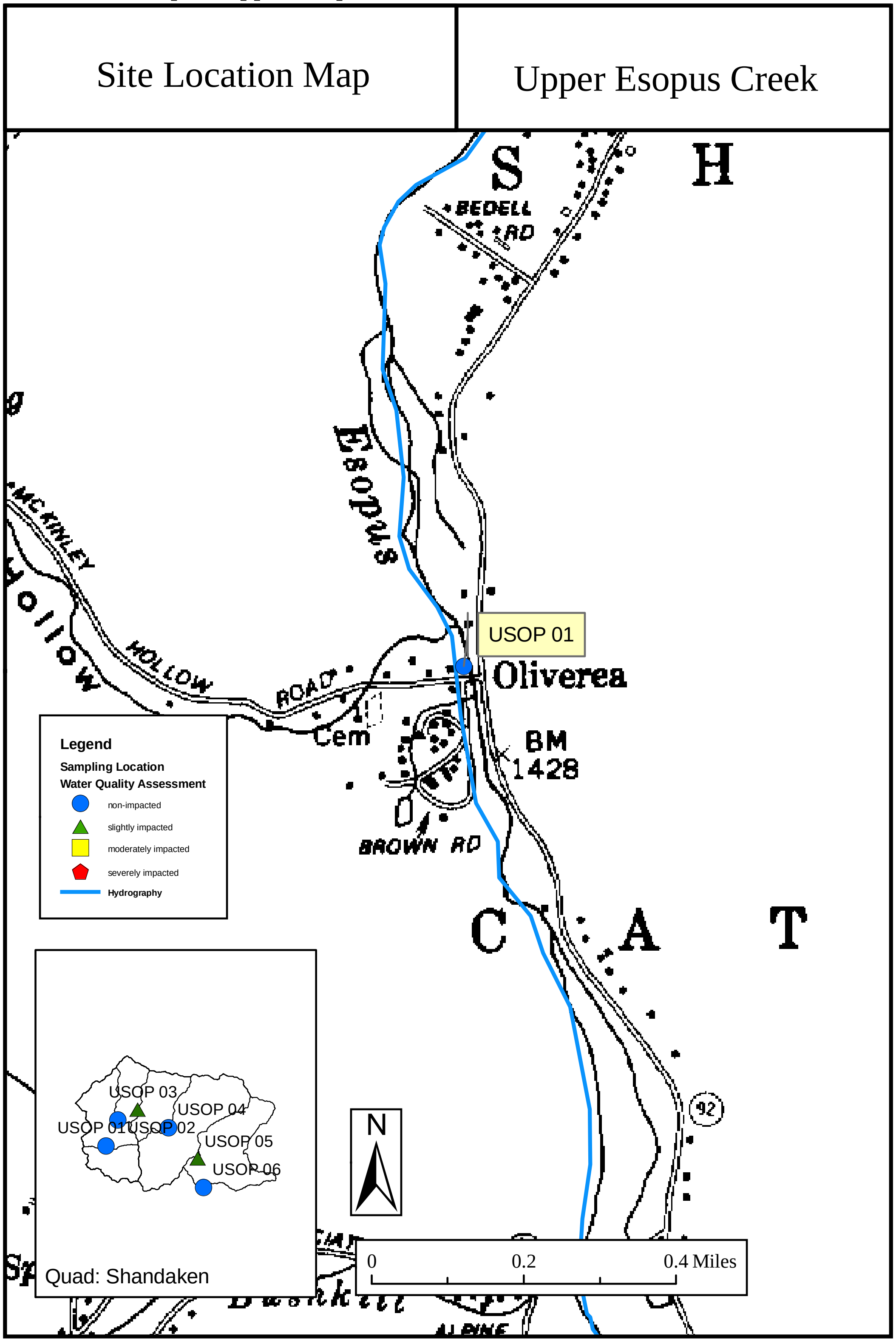


Figure 3. Overview map of Upper Esopus Creek Station 02.

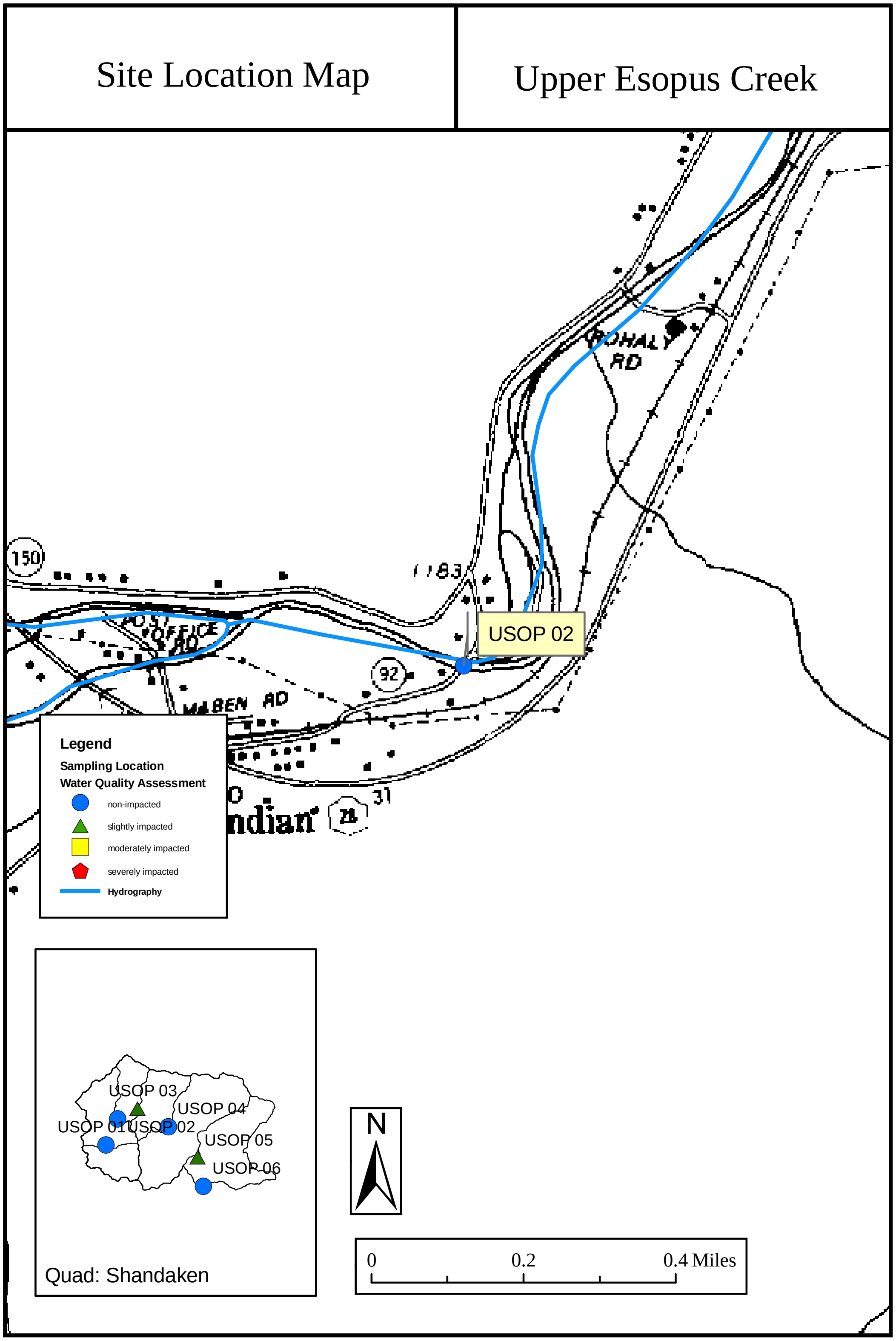


Figure 4. Overview map of Upper Esopus Creek Station 03.

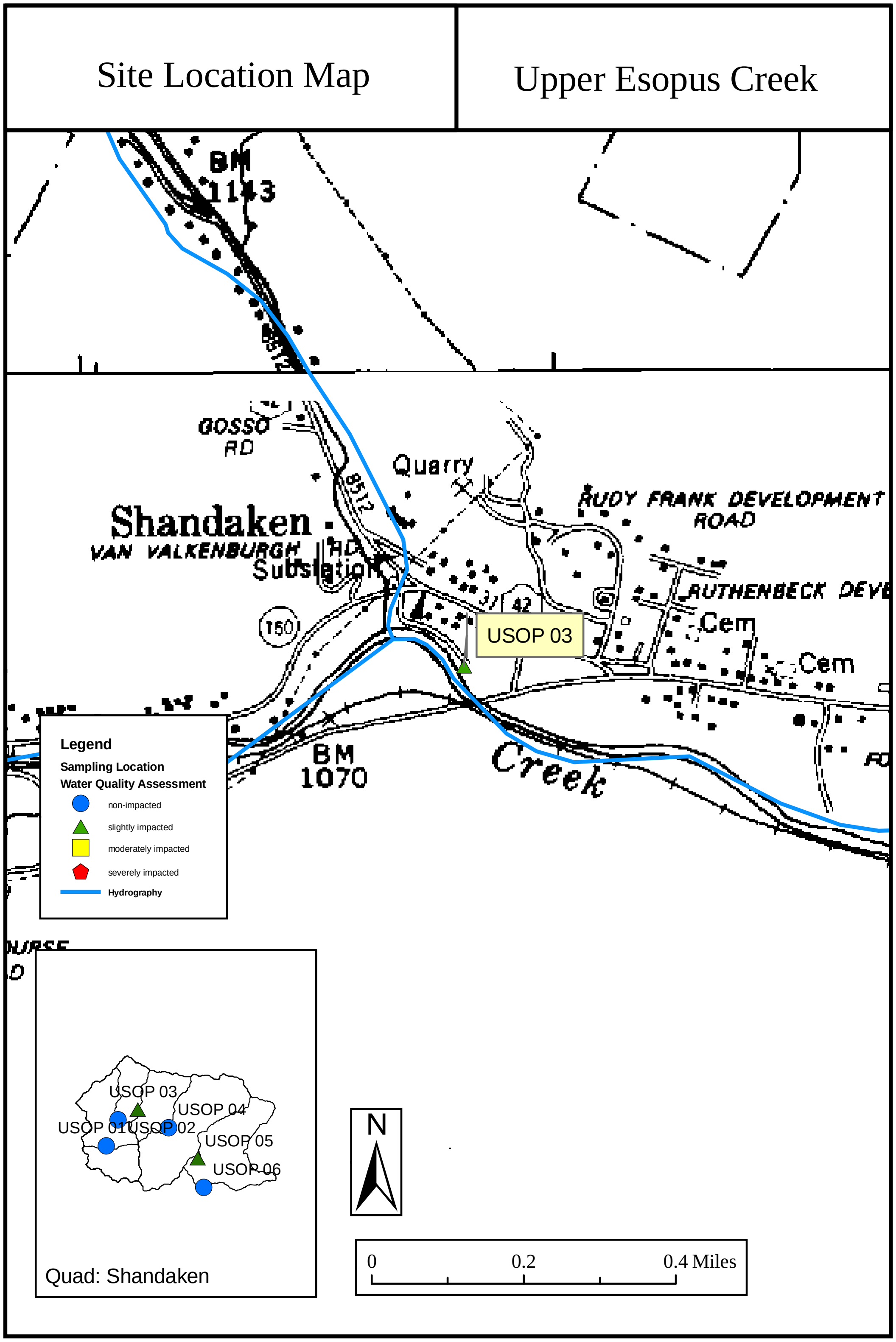


Figure 5. Overview map of Upper Esopus Creek Station 04.

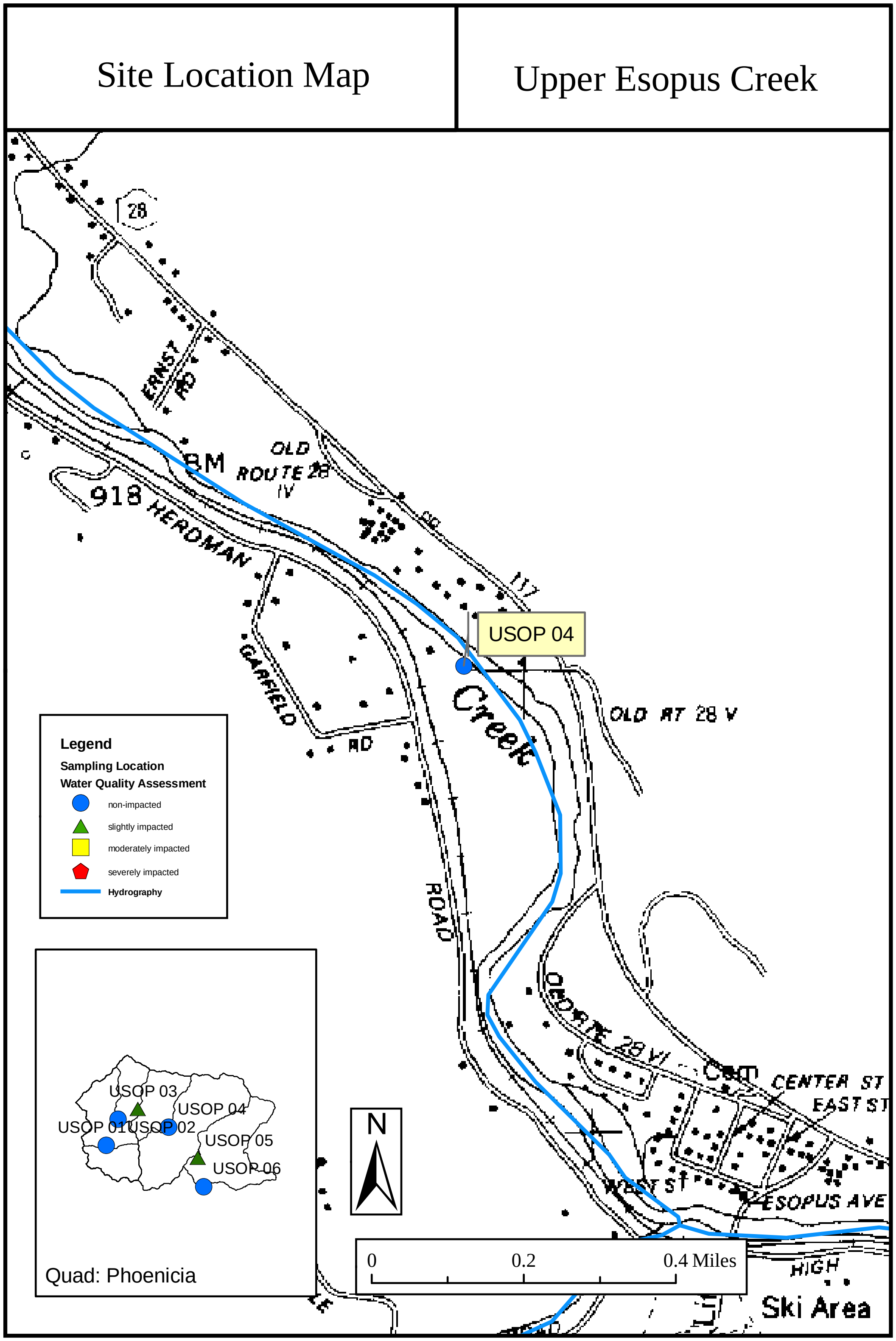


Figure 6. Overview map of Upper Esopus Creek Station 05.

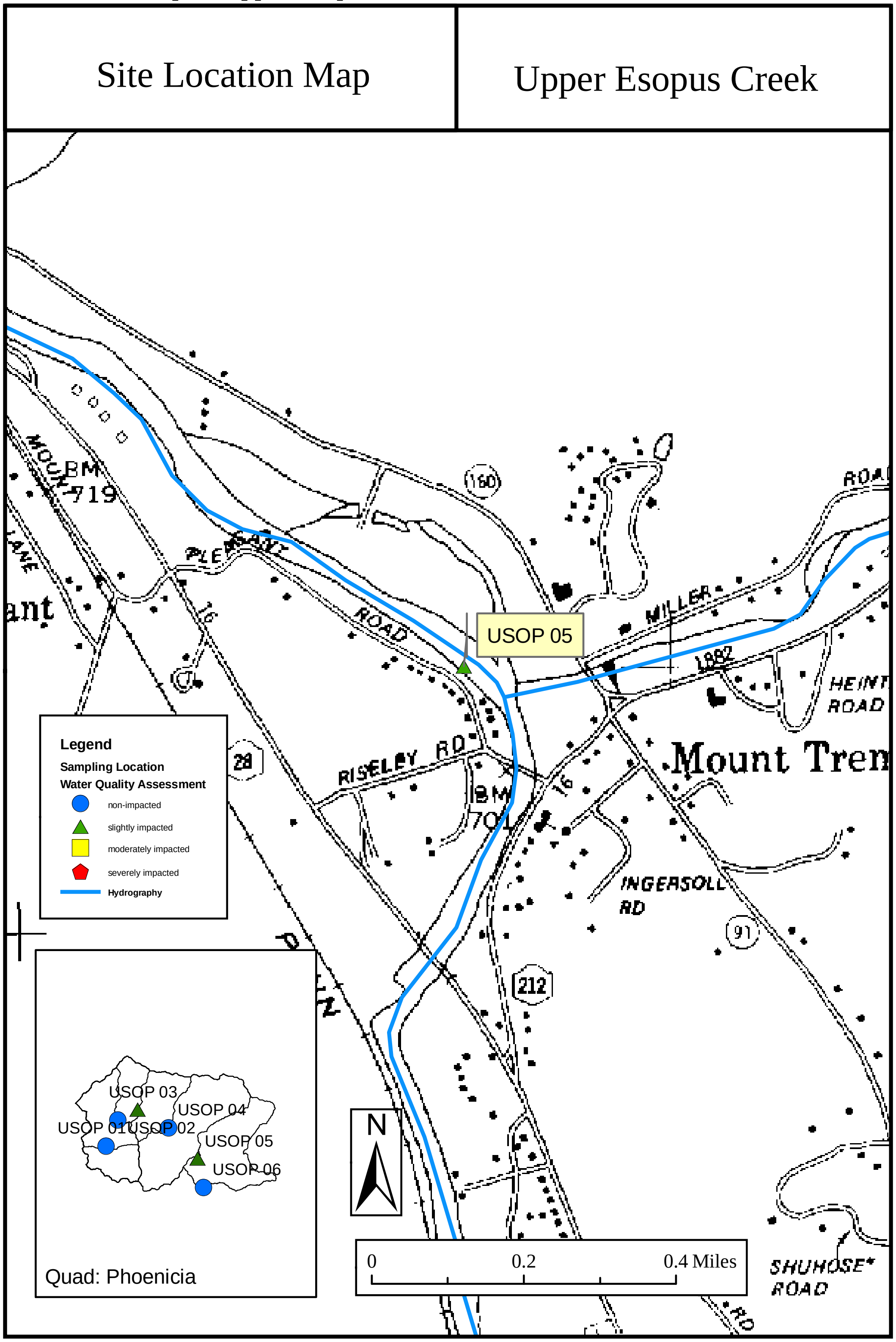


Figure 7. Overview map of Upper Esopus Creek Station 06.

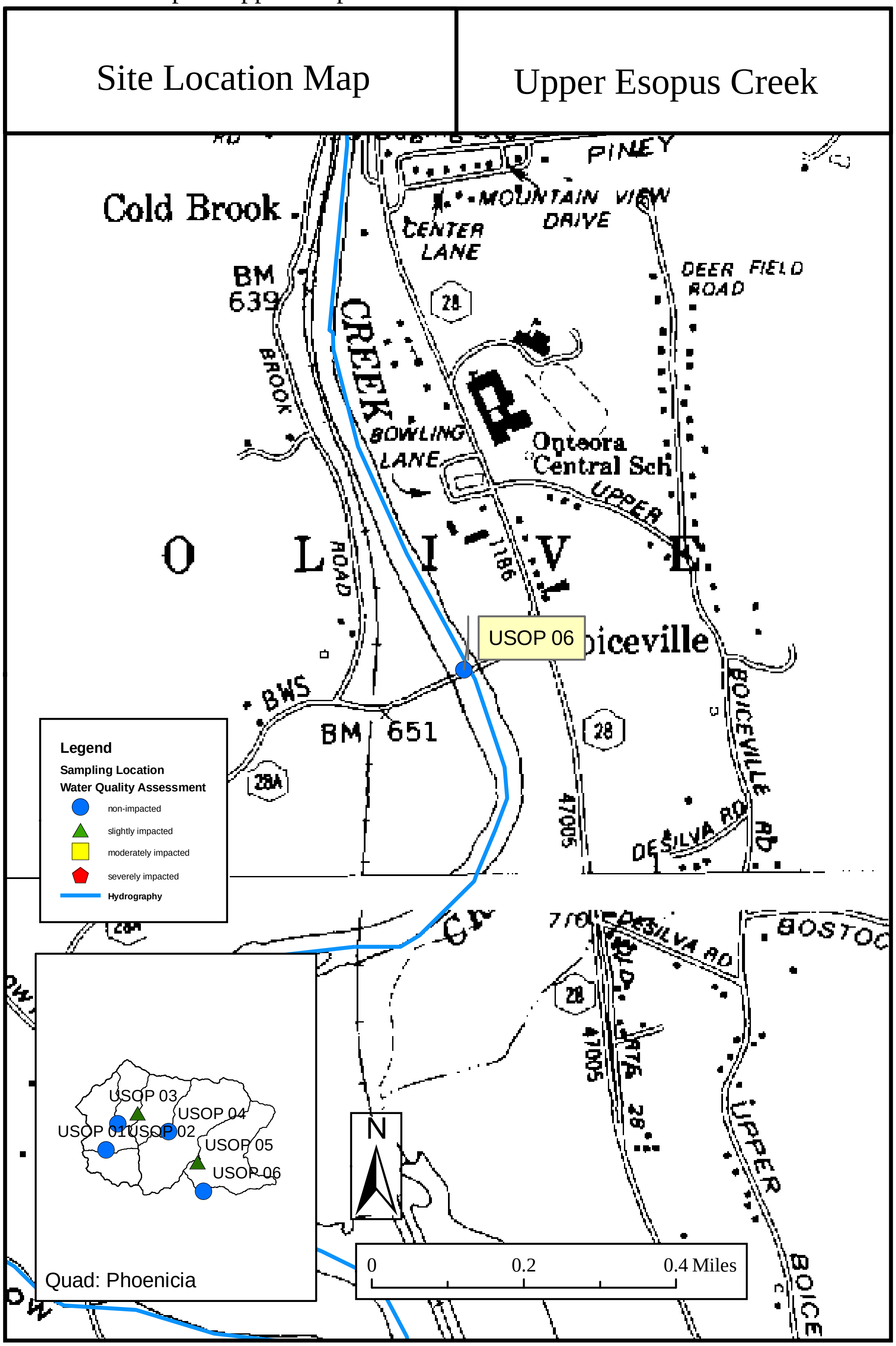


Figure 8. Biological Assessment Profile of index values, the Upper Esopus Creek, 1995, 2000 and 2007. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for a more complete explanation. Approximate locations of possible impact sources are labeled.

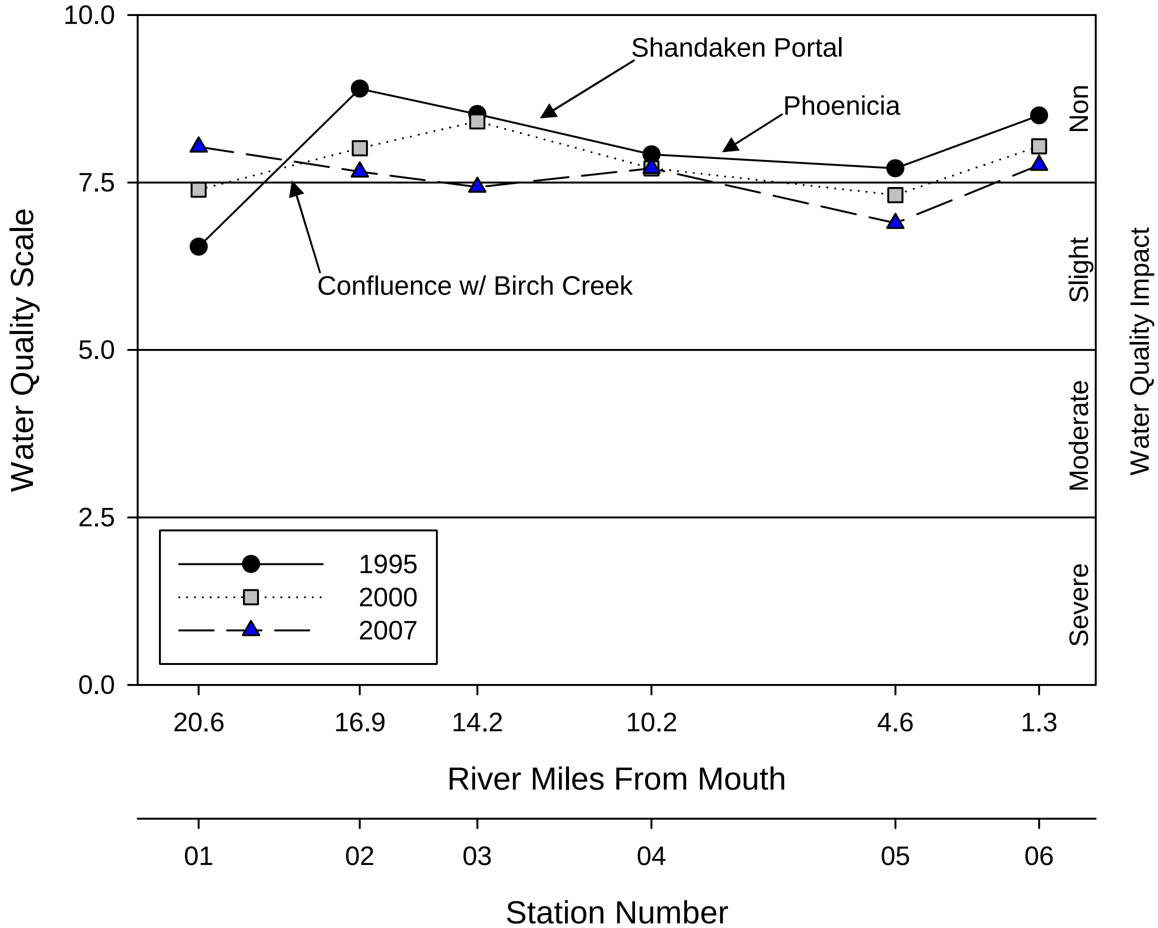
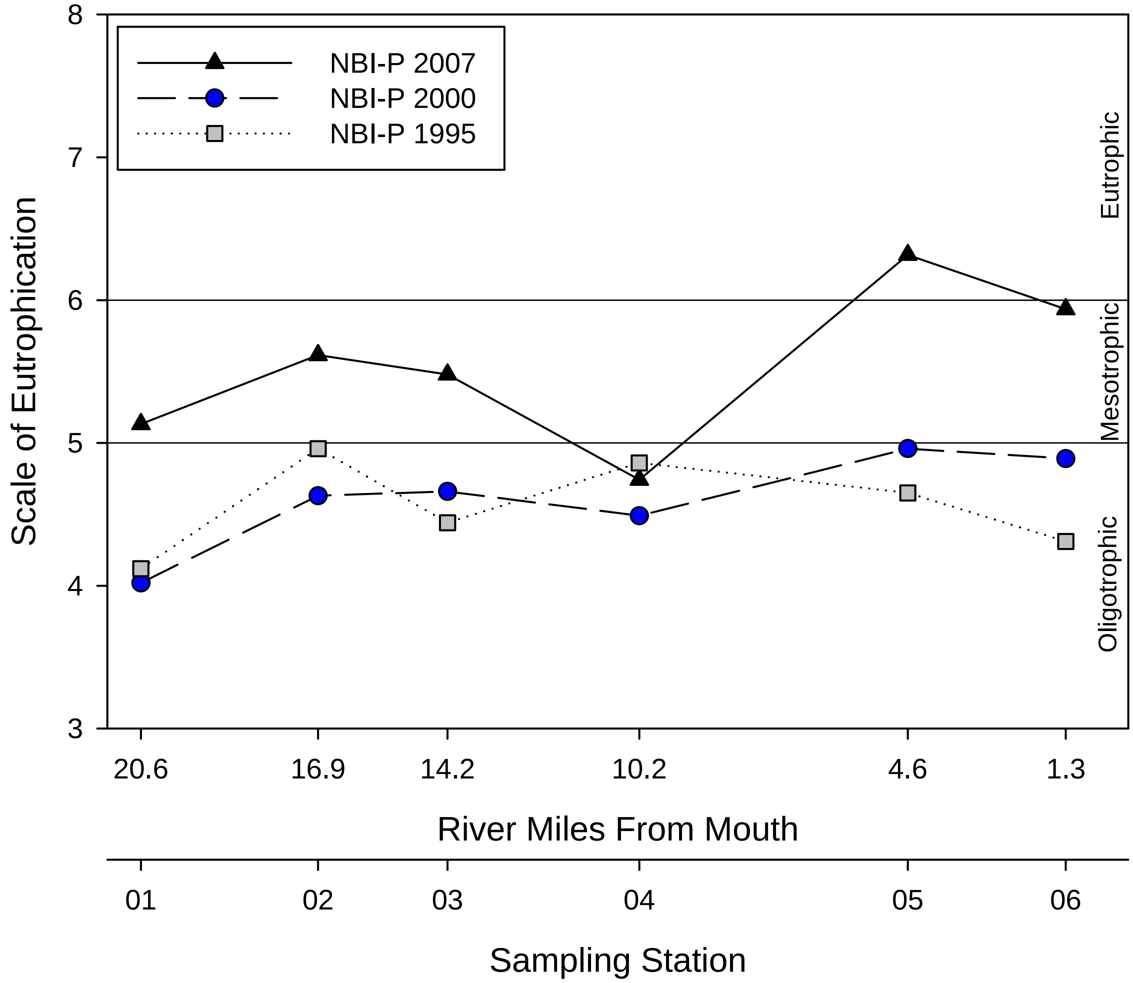


Table 2. Overview of field data

Location	Station	Depth (meters)	Width (meters)	Current (cm/sec)	Canopy (%)	Embed. (%)	Temp. ^{O}C	Cond. (µmol/cm)	pH (units)	DO (mg/l)	DO Sat. (%)
USOP	01	0.1	3.5	83	10	25	14.8	44	6	8	76
USOP	02	0.1	7	59	10	25	14.7	76	6	8	76
USOP	03	0.2	8	56	10	25	14.9	80	7	8	77
USOP	04	0.3	40	67	10	25	13.8	70	7	9	79
USOP	05	0.3	30	77	10	25	14.4	67	7	8	78
USOP	05	0.2	45	63	10	25	15.5	72	7	8	77

Figure 9. Nutrient Biotic Index values for Phosphorus (NBI-P) from the Upper Esopus Creek 1995, 2000 and 2007. NBI values are plotted on a scale of eutrophication from oligotrophic to eutrophic. See Appendix X for a detailed explanation of the index.



Summary of Upper Esopus Creek Trophic Conditions:

Station	Phosphorus
USOP-01	Mesotrophic
USOP-02	Mesotrophic
USOP-03	Mesotrophic
USOP-04	Oligotrophic
USOP-05	Eutrophic
USOP-06	Mesotrophic

Table 3. Impact Source Determintation (ISD), Upper Esopus Creek, 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	USOP-01	USOP-02	USOP-03	USOP-04	USOP-05	USOP-06
Natural: minimal human disturbance	46	54	59	54	55	52
Nutrient Enrichment: mostly nonpoint, agricultural	29	54	55	50	57	53
Toxic: industrial, municipal, or urban run-off	18	50	50	26	35	38
Organic: sewage effluent, animal wastes	25	34	41	37	47	46
Complex: municipal/industrial	18	41	42	28	47	44
Siltation	25	35	38	37	46	47
Impoundment	25	34	43	37	48	45

Summary of dominant ISD results

Station	Community Type
USOP-01	Natural
USOP-02	Natural/Nutrient Enrichment
USOP-03	Natural/Nutrient Enrichment
USOP-04	Natural/Nutrient Enrichment
USOP-05	Nutrient Enrichment/Natural
USOP-06	Nutrient Enrichment/Natural

Table 4. Macroinvertebrate species collected in the Upper Esopus Creek, Ulster County, NY, 2007.

ANNELIDA
 OLIGOCHAETA
  LUMBRICULIDA
   Lumbriculidae
    Undetermined Lumbriculidae

  TUBIFICIDA
   Enchytraeidae
    Undetermined Enchytraeidae
   Naididae
    Ophidonais serpentina

ARTHROPODA
 INSECTA
  EPHEMEROPTERA
   Isonychiidae
    Isonychia bicolor
   Baetidae
    Acentrella sp.
    Baetis flavistriga
    Baetis intercalaris
    Baetis tricaudatus
   Heptageniidae
    Epeorus (Iron) sp.
    Heptagenia sp.
    Leucrocuta sp.
    Stenonema modestum
    Stenonema terminatum
   Leptophlebiidae
    Paraleptophlebia sp.
   Ephemerellidae
    Drunella cornutella
    Serratella sp.

  PLECOPTERA
   Leuctridae
    Leuctra sp.
   Perlidae
    Acroneuria abnormis
    Paragnetina immarginata
   Chloroperlidae
    Undetermined Chloroperlidae
   Pteronarcidae
    Pteronarcys sp.

  COLEOPTERA
   Elmidae
    Promoresia elegans

  TRICHOPTERA
   Philopotamidae
    Dolophilodes sp.
   Hydropsychidae
    Cheumatopsyche sp.
    Hydropsyche bronta
    Hydropsyche slossonae
    Hydropsyche sparna
   Rhyacophilidae
    Rhyacophila mainensis
   Brachycentridae
    Brachycentrus appalachia

  DIPTERA
   Tipulidae
    Dicranota sp.
    Tipula sp.
   Simuliidae
    Simulium tuberosum
   Tabanidae
    Undetermined Tabanidae
   Chironomidae
    Rheopelopia acra gr.
    Thienemannimyia gr. spp.
    Diamesa sp.
    Pagastia orthogonia
    Tvetenia vitracies
    Microtendipes pedellus gr.
    Polypedilum aviceps
    Polypedilum flavum
    *Micropsectra div*es gr.
    Micropsectra sp.
    Rheotanytarsus exiguus gr.
    Stempellinella sp. 1
    Tanytarsus guerlus gr.
    Undetermined Chironomidae

Table 5. Macroinvertebrate Data Reports (MDR), Upper Esopus Creek, Station 01.

STREAM SITE:	Upper Esopus Creek, Station 01
LOCATION:	Oliverea, NY
DATE:	7/23/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Heptageniidae	*Epeorus* (Iron) sp.	6
		Leucrocuta sp.	1
	Leptophlebiidae	*Paraleptophlebia* sp.	3
	Ephemerellidae	*Drunella cornutella*	40
		Serratella sp.	1
PLECOPTERA	Leuctridae	*Leuctra* sp.	1
	Perlidae	*Acroneuria abnormis*	1
	Pteronarcidae	*Pteronarcys* sp.	1
COLEOPTERA	Elmidae	*Promoresia elegans*	3
TRICHOPTERA	Philopotamidae	*Dolophilodes* sp.	1
	Hydropsychidae	*Hydropsyche bronta*	1
		Hydropsyche sparna	16
DIPTERA	Tipulidae	*Dicranota* sp.	4
		Tipula sp.	5
	Simuliidae	*Simulium tuberosum*	1
	Chironomidae	*Diamesa* sp.	11
		Pagastia orthogonia	1
		Polypedilum aviceps	2
		Micropsectra sp.	1
		SPECIES RICHNESS:	19
		BIOTIC INDEX:	2.31
		EPT RICHNESS:	11
		MODEL AFFINITY:	81
		ASSESSMENT:	non

Description: The kick sample was collected 30 meters downstream of the McKinley Hollow Road bridge in Oliverea, NY. The water level was low at the time of sampling, and a distinct, bright green alga was noted on the streambed. A diverse invertebrate community with high biomass was observed in the field. Many clean water mayflies, stoneflies and caddisflies were present.

Table 6. Macroinvertebrate Data Report (MDR), Upper Esopus Creek, Station 02.

STREAM SITE:	Upper Esopus Creek, Station 02
LOCATION:	Big Indian, NY
DATE:	7/23/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Isonychiidae	*Isonychia bicolor*	1
	Baetidae	*Acentrella* sp.	11
		Baetis flavistriga	1
		Baetis tricaudatus	4
	Heptageniidae	*Heptagenia* sp.	1
		Leucrocuta sp.	1
	Ephemerellidae	*Drunella cornutella*	18
PLECOPTERA	Chloroperlidae	Undetermined Chloroperlidae	1
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche* sp.	5
		Hydropsyche bronta	8
		Hydropsyche slossonae	1
		Hydropsyche sparna	7
	Brachycentridae	*Brachycentrus appalachia*	3
DIPTERA	Simuliidae	*Simulium tuberosum*	2
	Chironomidae	*Rheopelopia acra* gr.	8
		Diamesa sp.	2
		Tvetenia vitracies	2
		Polypedilum aviceps	14
		Polypedilum flavum	10
		SPECIES RICHNESS:	19
		BIOTIC INDEX:	3.74
		EPT RICHNESS:	13
		MODEL AFFINITY:	70
		ASSESSMENT:	non

Description: The sample at Big Indian was collected 10 meters below the County Route 47 bridge and downstream of the confluence with Birch Creek. This sample was also dominated by pollution intolerant macroinvertebrates with high diversity.

Table 7. Macroinvertebrate Data Report (MDR), Upper Esopus Creek, Station 03.

STREAM SITE:	Upper Esopus Creek, Station 03
LOCATION:	Shandaken, NY
DATE:	7/23/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Isonychiidae	*Isonychia bicolor*	6
	Baetidae	*Acentrella* sp.	10
		Baetis tricaudatus	3
	Heptageniidae	*Heptagenia* sp.	5
		Leucrocuta sp.	1
	Ephemerellidae	*Drunella cornutella*	23
PLECOPTERA	Leuctridae	*Leuctra* sp.	1
TRICHOPTERA	Philopotamidae	*Dolophilodes* sp.	6
	Hydropsychidae	*Hydropsyche bronta*	9
		Hydropsyche slossonae	7
		Hydropsyche sparna	4
DIPTERA	Chironomidae	*Thienemannimyia* gr. spp.	1
		Diamesa sp.	1
		Tvetenia vitracies	3
		Polypedilum aviceps	5
		Polypedilum flavum	13
		Rheotanytarsus exiguus gr.	1
		Stempellinella sp. 1	1
		SPECIES RICHNESS:	18
		BIOTIC INDEX:	3.31
		EPT RICHNESS:	11
		MODEL AFFINITY:	71
		ASSESSMENT:	slight

Description: Station 03 was sampled in Shandaken, 30 meters upstream of the Route 28 bridge. The stream became substantially larger at this station, however, the invertebrate community continued to be dominated by clean water macroinvertebrates. This site was assessed as slightly impacted due to slight reductions in species richness, number of EPT taxa, and a decline in the biotic index score.

Table 8. Macroinvertebrate Data Report (MDR), Upper Esopus Creek, Station 04.

STREAM SITE:	Upper Esopus Creek, Station 04
LOCATION:	above Phoenicia, NY
DATE:	7/23/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA			
	Naididae	*Ophidonais serpentina*	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	2
	Baetidae	*Baetis tricaudatus*	1
	Heptageniidae	*Heptagenia* sp.	8
		Leucrocuta sp.	1
	Ephemerellidae	*Drunella cornutella*	40
PLECOPTERA	Leuctridae	*Leuctra* sp.	1
	Pteronarcidae	*Pteronarcys* sp.	1
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche* sp.	3
		Hydropsyche bronta	15
		Hydropsyche slossonae	2
		Hydropsyche sparna	5
	Brachycentridae	*Brachycentrus appalachia*	1
DIPTERA	Tipulidae	*Dicranota* sp.	1
	Chironomidae	*Tvetenia vitracies*	4
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	11
		Polypedilum flavum	2
		SPECIES RICHNESS:	18
		BIOTIC INDEX:	2.77
		EPT RICHNESS:	12
		MODEL AFFINITY:	72
		ASSESSMENT:	non

Description: Station 04 was sampled just upstream of Phoenicia, NY at a DOT and fishing access off Route 28. This is the first station after the confluence with the Shandaken Portal. The water level was much higher here and very fast. Diversity and biomass appeared to be slightly reduced compared to upstream stations. Fewer Heptageniidae and Ephemerellidae were observed in the field.

Table 9. Macroinvertebrate Data Report (MDR), Upper Esopus Creek, Station 05.

STREAM SITE:	Upper Esopus Creek, Station 05
LOCATION:	Mount Pleasant, NY
DATE:	7/23/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA			
	Enchytraeidae	Undetermined Enchytraeidae	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	4
	Baetidae	*Acentrella* sp.	7
		Baetis tricaudatus	3
	Heptageniidae	*Epeorus* (Iron) sp.	1
		Heptagenia sp.	4
		Leucrocuta sp.	3
	Ephemerellidae	*Drunella cornutella*	4
		Serratella sp.	1
TRICHOPTERA	Hydropsychidae	*Hydropsyche bronta*	1
		Hydropsyche sparna	11
DIPTERA	Simuliidae	*Simulium tuberosum*	1
	Tabanidae	Undetermined Tabanidae	1
	Chironomidae	*Rheopelopia acra* gr.	1
		Thienemannimyia gr. spp.	2
		Diamesa sp.	1
		Tvetenia vitracies	1
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	11
		Polypedilum flavum	34
		Micropsectra dives gr.	1
		Rheotanytarsus exiguus gr.	2
		Tanytarsus guerlus gr.	4
		SPECIES RICHNESS:	23
		BIOTIC INDEX:	4.86
		EPT RICHNESS:	10
		MODEL AFFINITY:	60
		ASSESSMENT:	slt

Description: The sample was collected in Mount Pleasant, NY, 200 meters above the confluence with the Beaver Kill. The stream is a very wide channel here with the majority of the flow restricted to one side. Although, in the field, diversity was noted to be lower, in the lab, species richness suggested high diversity. No stoneflies were identified at this station.

Table 10. Macroinvertebrate Data Report (MDR), Upper Esopus Creek, Station 06.

STREAM SITE:	Upper Esopus Creek, Station 06
LOCATION:	Boiceville, NY
DATE:	7/23/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA			
	Lumbriculidae	Undetermined Lumbriculidae	6
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	4
	Baetidae	*Acentrella* sp.	6
		Baetis flavistriga	1
		Baetis intercalaris	1
		Baetis tricaudatus	1
	Heptageniidae	*Epeorus* (Iron) sp.	1
		Leucrocuta sp.	1
		Stenonema modestum	2
		Stenonema terminatum	8
	Ephemerellidae	*Serratella* sp.	2
PLECOPTERA	Perlidae	*Acroneuria abnormis*	1
		Paragnetina immarginata	3
	Pteronarcidae	*Pteronarcys* sp.	1
TRICHOPTERA	Hydropsychidae	*Hydropsyche bronta*	7
		Hydropsyche sparna	12
	Rhyacophilidae	*Rhyacophila mainensis*	1
DIPTERA	Tabanidae	Undetermined Tabanidae	1
	Chironomidae	*Polypedilum aviceps*	8
		Polypedilum flavum	30
		Undetermined Chironomidae	3
		SPECIES RICHNESS:	21
		BIOTIC INDEX:	4.69
		EPT RICHNESS:	16
		MODEL AFFINITY:	68
		ASSESSMENT:	non

Description: The sample at Boiceville was collected 10 meters upstream of the Route 28A bridge. More enrichment tolerant caddisflies and fewer mayflies were observed at this station.

Table 11. Laboratory data summaries, the Upper Esopus Creek, Ulster County, NY, 2007.

LABORATORY DATA SUMMARY				
STREAM NAME: Upper Esopus Creek				
DATE SAMPLED: 7/23/2007				
SAMPLING METHOD: Kick				
LOCATION	USOP	USOP	USOP	USOP
STATION	01	02	03	04
DOMINANT SPECIES / % CONTRIBUTION / TOLERACE / COMMON NAME				
1.	Drunella cornutella 40 % intolerant mayfly	Drunella cornutella 18 % intolerant mayfly	Drunella cornutella 23 % intolerant mayfly	Drunella cornutella 40 % intolerant mayfly
2. Intolerant = not tolerant of poor water quality	Hydropsyche sparna 16 % facultative caddisfly	Polypedilum aviceps 14 % facultative midge	Polypedilum flavum 13 % facultative midge	Hydropsyche bronta 15 % facultative caddisfly
3. Facultative = occurring over a wide range of water quality	Diamesa sp. 11 % facultative midge	Acentrella sp. 11 % intolerant mayfly	Acentrella sp. 10 % intolerant mayfly	Polypedilum aviceps 11 % facultative midge
4. Tolerant = tolerant of poor water quality	Epeorus (Iron) sp. 6 % intolerant mayfly	Polypedilum flavum 10 % facultative midge	Hydropsyche bronta 9 % facultative caddisfly	Heptagenia sp. 8 % intolerant mayfly
5.	Tipula sp. 5 % intolerant crane fly	Hydropsyche bronta 8 % facultative caddisfly	Hydropsyche slossonae 7 % intolerant caddisfly	Hydropsyche sparna 5 % facultative caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	15 (4.0)	36 (5.0)	25 (7.0)	18 (4.0)
Trichoptera (caddisflies)	18 (3.0)	24 (5.0)	26 (4.0)	26 (5.0)
Ephemeroptera (mayflies)	51 (5.0)	37 (7.0)	48 (6.0)	52 (5.0)
Plecoptera (stoneflies)	3 (3.0)	1 (1.0)	1 (1.0)	2 (2.0)
Coleoptera (beetles)	3 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)
Oligochaeta (worms)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)
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)	0 (0.0)
Other insects (odonates, diptera)	10 (3.0)	2 (1.0)	0 (0.0)	1 (1.0)
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
SPECIES RICHNESS	19	19	18	18
BIOTIC INDEX	2.31	3.74	3.31	2.77
EPT RICHNESS	11	13	11	12
PERCENT MODEL AFFINITY	81	70	71	72
FIELD ASSESSMENT	Very Good	Very Good	Very Good	Very Good
OVERALL ASSESSMENT	non-impacted	non-impacted	slightly impacted	non-impacted

Table 11 cont. Laboratory data summaries.

LABORATORY DATA SUMMARY				
STREAM NAME: Upper Esopus Creek				
DATE SAMPLED: 7/23/2007				
SAMPLING METHOD: Kick				
LOCATION	USOP	USOP		
STATION	05	06		
DOMINANT SPECIES / % CONTRIBUTION / TOLERACE / COMMON NAME				
1.	Polypedilum flavum 34 % facultative midge	Polypedilum flavum 30 % facultative midge		
2. Intolerant = not tolerant of poor water quality	Hydropsyche sparna 11 % facultative caddisfly	Hydropsyche sparna 12 % facultative caddisfly		
3. Facultative = occurring over a wide range of water quality	Polypedilum aviceps 11 % facultative midge	Stenonema terminatum 8 % intolerant mayfly		
4. Tolerant = tolerant of poor water quality	Acentrella sp. 7 % intolerant mayfly	Polypedilum aviceps 8 % facultative midge		
5.	Isonychia bicolor 4 % intolerant mayfly	Hydropsyche bronta 7 % facultative caddisfly		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	58 (10.0)	41 (3.0)		
Trichoptera (caddisflies)	12 (2.0)	20 (3.0)		
Ephemeroptera (mayflies)	27 (8.0)	27 (10.0)		
Plecoptera (stoneflies)	0 (0.0)	5 (3.0)		
Coleoptera (beetles)	0 (0.0)	0 (0.0)		
Oligochaeta (worms)	1 (1.0)	6 (1.0)		
Mollusca (clams and snails)	0 (0.0)	0 (0.0)		
Crustacea (crayfish, scuds, sowbugs)	0 (0.0)	0 (0.0)		
Other insects (odonates, diptera)	2 (2.0)	1 (1.0)		
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)		
SPECIES RICHNESS	23	21		
BIOTIC INDEX	4.86	4.69		
EPT RICHNESS	10	16		
PERCENT MODEL AFFINITY	60	68		
FIELD ASSESSMENT		Very Good		
OVERALL ASSESSMENT	slightly impacted	non-impacted		

Table 12. Field data summaries, the Upper Esopus Creek, Ulster County, NY, 2007.

FIELD DATA SUMMARY				
STREAM NAME: Upper Esopus Creek	**DATE SAMPLED:** 7/23/2007			
REACH: Oliverea				
FIELD PERSONNEL INVOLVED: Smith/Heitzman/Tran				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	8:05	9:06	9:25	10:07
LOCATION	USOP	USOP	USOP	USOP
PHYSICAL CHARACTERISTICS				
Width (meters)	3.5	7	8	40
Depth (meters)	0.1	0.1	0.2	0.3
Current speed (cm per sec.)	83	59	56	67
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	20	30	30
Rubble (6.35 - 25.4 cm)	60	50	50	50
Gravel (0.2 - 6.35 cm)	20	20	15	10
Sand (0.06 - 2.0 mm)				
Silt (0.004 - 0.06 mm)	10	10	5	10
Embeddedness (%)	25	25	25	25
CHEMICAL MEASUREMENTS				
Temperature (?C)	14.8	14.7	14.9	13.8
Specific Conductance (umhos)	44	76	80	70
Dissolved Oxygen (mg/l)	8	8	8	9
pH	6	6	7	7
BIOLOGICAL ATTRIBUTES				
Canopy (%)	10	10	10	10
Aquatic Vegetation				
Algae - suspended	X			
Algae - attached,filamentous				
Algae - diatoms	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)				
Megaloptera (dobsonflies, damselflies)				
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X			
Simuliidae (black flies)	X			
Decapoda (crayfish)	X			
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other	X	X	X	

Table 12 cont. Field data summaries

FIELD DATA SUMMARY				
STREAM NAME: Upper Esopus Creek	**DATE SAMPLED:** 7/23/2007			
REACH: Mount Pleasant				
FIELD PERSONNEL INVOLVED: Smith/Heitzman/Tran				
STATION	05	06		
ARRIVAL TIME AT STATION	10:55	11:20		
LOCATION	USOP	USOP		
PHYSICAL CHARACTERISTICS				
Width (meters)	30	45		
Depth (meters)	0.3	0.2		
Current speed (cm per sec.)	77	63		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	10		
Rubble (6.35 - 25.4 cm)	40	40		
Gravel (0.2 - 6.35 cm)	30	30		
Sand (0.06 - 2.0 mm)	20	20		
Silt (0.004 - 0.06 mm)				
Embeddedness (%)	25	25		
CHEMICAL MEASUREMENTS				
Temperature (?C)	14.4	15.5		
Specific Conductance (umhos)	67	72		
Dissolved Oxygen (mg/l)	8	8		
pH	7	7		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	10	10		
Aquatic Vegetation				
Algae - suspended				
Algae - attached,filamentous				
Algae - diatoms	X	X		
Macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X		
Plecoptera (stoneflies)	X	X		
Trichoptera (caddisflies)	X	X		
Coleoptera (beetles)				
Megaloptera (dobsonflies, damselflies)				
Odonata (dragonflies, damselflies)				
Chironomidae (midges)				
Simuliidae (black flies)				
Decapoda (crayfish)				
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other				

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.

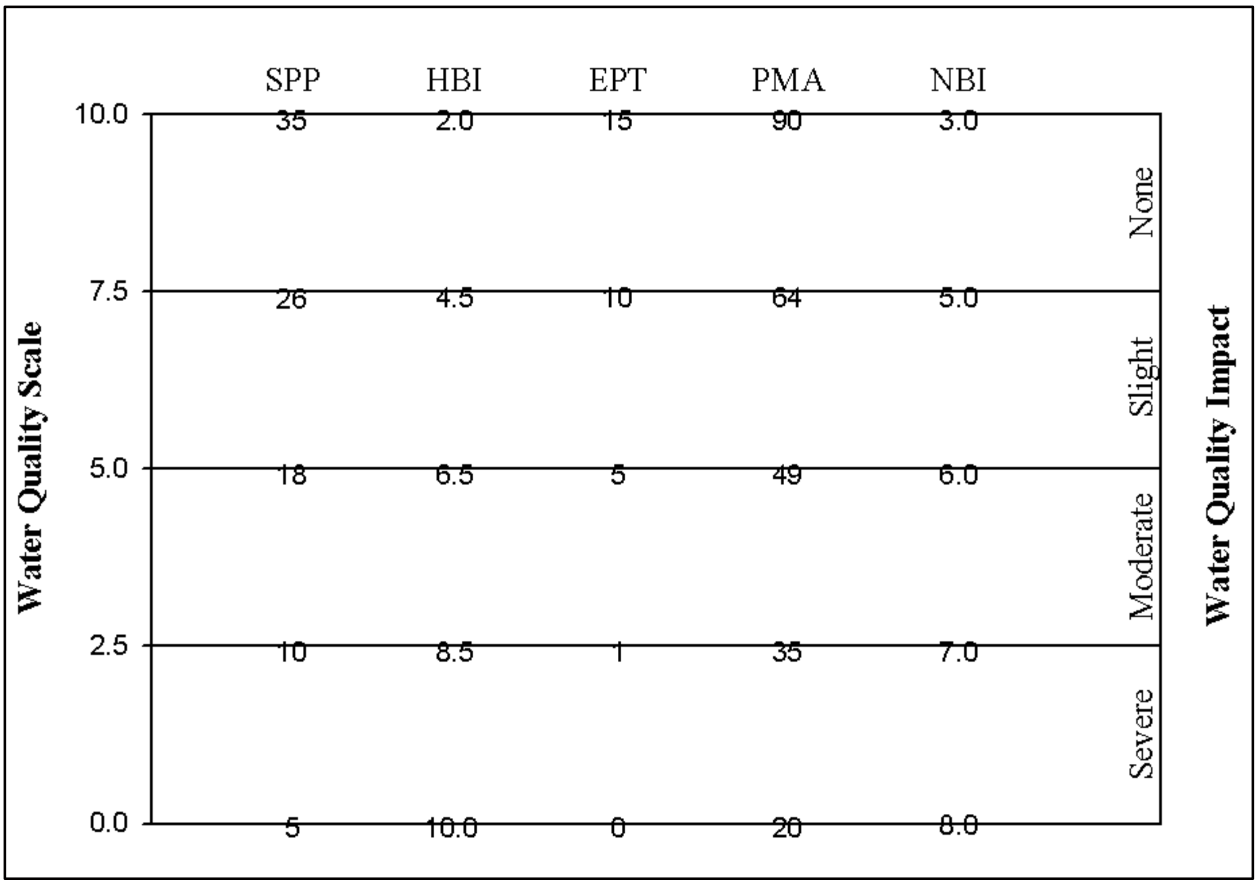
2. *Slightly impacted*: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. 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 (BAP): Conversion of Index Values to a 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 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.



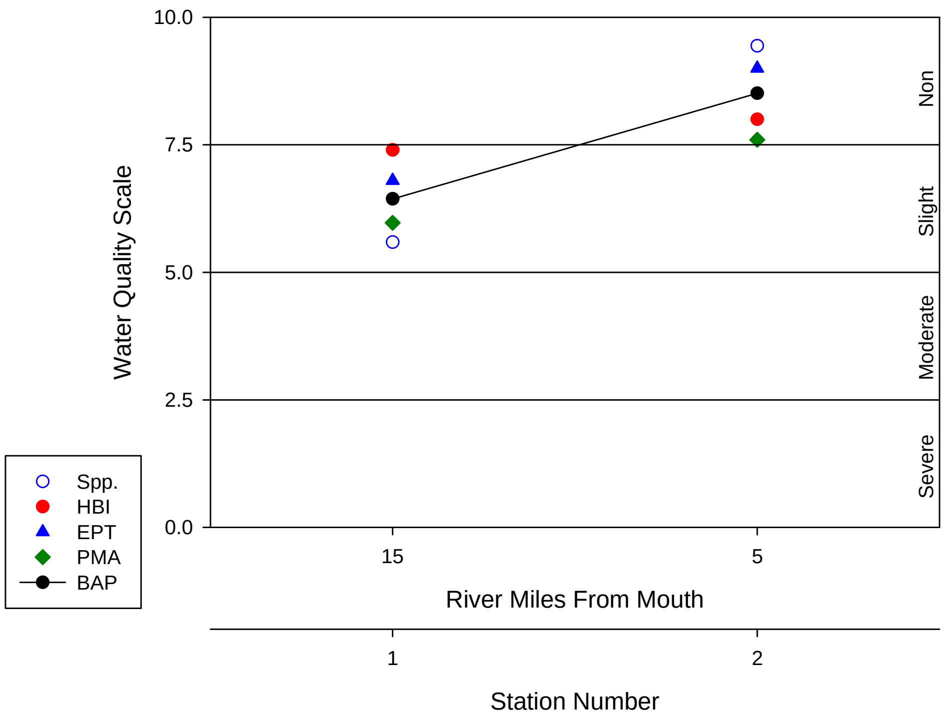
Appendix IV-B. Biological Assessment Profile (BAP): Plotting Values

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

$\leftarrow$ 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 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 (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 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 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.

SOWBUGS

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

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 species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) 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 turn-around time; usually involves kick sampling and laboratory subsampling of the sample

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

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

Station: a sampling site on a waterbody

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

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

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 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).

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

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

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, 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

TAXON	TP T-Value	NO3 T-Value
Hexatoma sp.	0	1
Hydropsyche betteni	7	9
Hydropsyche bronta	7	6
Hydropsyche morosa	5	1
Hydropsyche scalaris	3	3
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

TAXON	TP T-Value	NO3 T-Value
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
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
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

TAXON	TP T-Value	NO3 T-Value
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.

Impact Source Determination (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

Impact Source Determination (ISD) 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 (ISD) 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 (ISD) 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 (ISD) 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

Appendix XII. Characteristics of Headwater Stream Sites

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

The following are typical characteristics of headwater sites:

1. Upstream community recruitment reduces populations are reduced, reducing drift colonization and possible species richness.

2. The stream is usually nutrient-poor, lower in food resources, and less productive.

3. A few intolerant species may be very abundant, due to reduced, simplified fauna. For a 100-organism subsample, this can affect species richness, EPT richness, and percent model affinity. The dominant species averages 37% of the total fauna, and is an intolerant species of either 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. Many community indices are low, even though invertebrate communities are dominated by intolerant species. Average index values are: species richness - 19, EPT richness - 8, Hilsenhoff biotic index - 3.05, and percent model affinity - 57 (based on headwaters sampling of a number of New York State streams).

Due to the above characteristics, it is recommended that corrective action be taken to adjust 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: a headwater location as described above; a community dominated by an intolerant species, and species richness, EPT richness, and percent model affinity 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.*