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New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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#973

Division of Water

Woodbury Creek

Biological Assessment

2005 Survey

New York State
Department of Environmental Conservation

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

WOODBURY CREEK
BIOLOGICAL ASSESSMENT

Lower Hudson River Basin
Orange County, New York

Survey date: May 5, 2005
Report date: November 3, 2005

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Stream: Woodbury Creek, Orange County, New York

Reach: Highland Mills to mouth at Moodna Creek, Mountainville, New York

NYS Drainage Basin: Lower Hudson River

Background

The Stream Biomonitoring Unit sampled Woodbury Creek in Orange County, New York, on May 5, 2005. The purpose of the sampling was to assess overall water quality and compare it to the results of surveys in 2004 and 1987. A specific goal was to determine if nymphs of the stonefly *Amphinemura delosa* were present in the stream, as they were in the 1987 sampling. Dick Manley of the Moodna Watershed Coalition, and local resident Mary Gross-Ferraro, assisted in the survey and provided additional information.

One traveling kick sample for macroinvertebrates was taken in a riffle area at each of four sites using methods described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each sample were field-inspected, to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample from each site. Macroinvertebrate community parameters used in the determination of water quality included species richness, biotic index, EPT richness, and percent model affinity (see Appendices II and III). Expected variability of results is stated in Smith and Bode (2004). Table 2 provides a listing of sampling sites and Table 3 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Results and Conclusions:

1. Water quality in Woodbury Creek ranged from non-impacted to slightly impacted in the present sampling. Compared to previous surveys, water quality at Station-2 in Quaker Meetinghouse appeared worse, likely due to nutrient enrichment.

2. The indicator stonefly *Amphinemura delosa* was not found to be present in Woodbury Creek. This sensitive species was named in the 1987 report as a suitable species for monitoring future water quality in the creek. While it has not been shown conclusively that this species has been extirpated from the creek, increased levels of chlorides and nutrients have likely contributed to its decline. Continued targeted sampling is recommended to confirm the status of this species in Woodbury Creek.

Discussion

Woodbury Creek was previously sampled by the Stream Biomonitoring Unit in July, 2004 at the same four sites used in the present survey (Bode et al., 2004) and in 1987 (Novak et al., 1987). In the 2004 survey, water quality was assessed as moderately impacted at the upstream site and slightly impacted at the three downstream sites, based on resident macroinvertebrate communities. Water quality at all sites in the 2004 sampling appeared slightly worse compared to results of 1987 sampling. Elevated specific conductance in Woodbury Creek was cited as the greatest change in the stream since 1987, with a rise in conductance from 160 µmhos/cm in 1987 to 1226 µmhos/cm in 2004, a 766% increase. The increase was traced to the outlet of Peckmans Pond - the source of Woodbury Creek - located adjacent to Woodbury Commons mall. The outlet had a conductance of 1705 µmhos/cm. On-site examination showed that the mall's salt storage facility apparently drained to the pond, along with drainage from the auxiliary parking lot of the mall.

Novak et al. (1987) noted, "The continued presence of *Amphinemura delosa*, an intolerant stonefly found in abundance at Station 2, will be a good indicator of high water quality ...". This stonefly was not found in the 2004 survey, but this species normally emerges as an adult in the spring, and would not be expected to be found as a nymph in a July sampling. In order to determine whether *Amphinemura delosa* is still found at Station-2, follow-up sampling was conducted on May 5, 2005, to allow direct comparison to the 1987 data.

No *Amphinemura delosa* were found in the present survey at any site in Woodbury Creek, neither in the 100-organism subsamples nor in supplementary scanning of the entire samples. Additionally, none were found in the stream on April 26, 2005, when a special sampling was conducted at Station 2 in search of this species. The present survey was conducted on May 5, the same date as the 1987 survey. Examination of heating degree days for the December-April period of each year shows that 2005 was a slightly cooler year than 1987, so *Amphinemura* stoneflies would not be expected to emerge prior to the May 5 sampling date in 2005. A supplementary site was sampled on Mineral Springs Brook, a stream regarded as having high quality, to search for *Amphinemura delosa*. This search was also unsuccessful, leaving the question of the species' status unresolved. It was thought that if the species were found in Mineral Springs Brook but not Woodbury Creek, it would mean that water quality was responsible for its disappearance. The status of *Amphinemura delosa* is unresolved, and more sampling may help determine if it has indeed been extirpated.

Water quality at the four sites ranged from slightly impacted to non-impacted in the present sampling (Figure 1). Station-1 was largely affected by slow current speed and pond-like conditions upstream, as in previous years. Station-2 at Quaker Meetinghouse appeared more impacted than in previous years, while Stations-3 and -4 appeared better than in previous years (Figure 2).

Two types of impact are of concern in Woodbury Creek, which may be related to the disappearance of *Amphinemura delosa*: increased chlorides and nutrient enrichment. Increased chlorides were documented in the 2004 survey, and much of this is likely attributable to salt runoff from the Woodbury Commons mall. Fluctuations in specific conductance over several months were documented by Dick Manley of the Moodna Creek Coalition (Figure 5). Examination of this data shows that although the ponds that receive direct drainage from Woodbury Commons - denoted here as Fire Pond and Parking Lot Pond - have peak conductance in March, delayed flow through the wetlands results in peak conductance in July at Station-1 of Woodbury Creek.

The second indicator of impact, especially noted at Station-2, was an abundance of algae, likely caused by nutrient enrichment. The dissolved oxygen level of the stream at this site was supersaturated (134%), indicating high photosynthetic activity and probable nighttime oxygen deficits. High amounts of algae documented near shore were the likely cause of this. The pH at this site was very high (8.8), and this also is probably caused by the photosynthetic activity of the abundant algae.

A new macroinvertebrate measure of nutrient enrichment, the Nutrient Biotic Index (NBI), was recently developed by Smith (see Appendix XII). Similar to the Hilsenhoff Biotic Index, it is based on assigned tolerance values for each species on a 0-10 scale, where 0 is low tolerance and 10 is high. Indices were developed for total phosphorus (NBI-P) and nitrate (NBI-N). Examining the values for NBI-P and NBI-N, biological response to nutrient enrichment in Woodbury Creek shows highest response at Station-2, downstream of Highland Mills (Figure 3). This assessment correlates well with the large amounts of algae, and high pH and high dissolved oxygen levels measured at this site, and the correspondingly poorer macroinvertebrate community. Effluents from the sewage treatment facilities of two developments in Highland Mills enter through tributaries between Stations-1 and -2, and are likely related to the changes documented in the creek.

On August 9, 2005, follow-up sampling was conducted to define the contribution of tributaries to Woodbury Creek water quality at Quaker Meetinghouse. Two tributaries were sampled: Tributary 7, which enters Woodbury Creek just downstream of Station 1, and Tributary 6, which enters Woodbury Creek just upstream of Station-2. Results showed that both tributaries are affected by nutrient enrichment, with macroinvertebrate communities dominated by facultative midges and caddisflies. Additionally, Tributary 7 showed biological effects of sewage inputs from municipal or industrial sources (ISD, Table 1), and Tributary 6 exhibited a layer of silt on the stream bottom (Figure 4).

Since the original 1987 survey, Woodbury Creek has been affected by three types of inputs which threaten its water quality: elevated conductivity, nutrient enrichment, and siltation. These are substantial burdens for a stream that is classified as trout spawning and carries sensitive species of mayflies and stoneflies. Any additional appreciable inputs into Woodbury Creek can be predicted to have detrimental effects that would result in further decline of the stream ecosystem.

Literature Cited:

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, and A. J. Smith. 2004. Woodbury Creek Biological Assessment, 2004 survey. New York State Department of Environmental Conservation, Technical Report, 36 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.

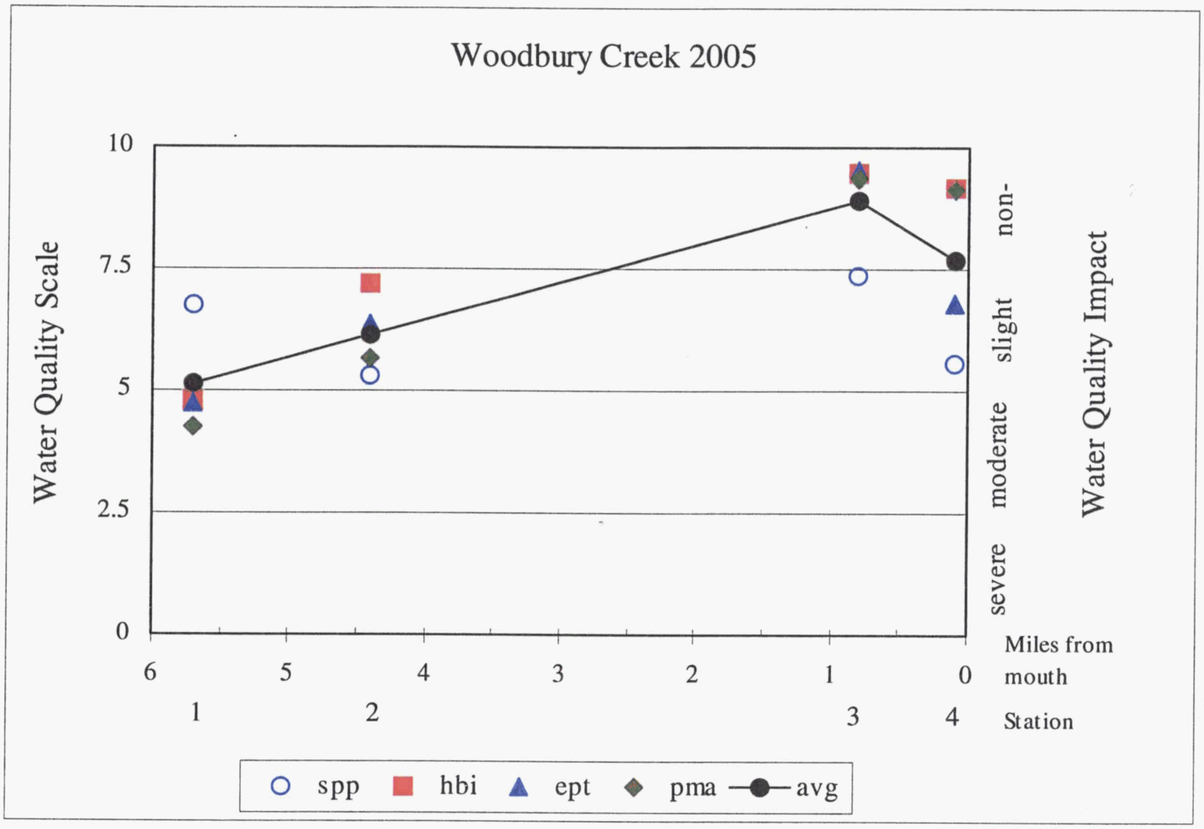
Novak, M. A., R. W. Bode, and L. E. Abele. 1987. Rapid biological assessment: Woodbury Creek, 1987. New York State Department of Environmental Conservation, Technical Report, 12 pages.

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.

Overview of field data:

On May 5, 2005, Woodbury Creek at the sites sampled was 8-15 meters wide, 0.2 meters deep, and had current speeds of 14-150 cm/sec in riffles. Dissolved oxygen was 10.1-14.9 mg/l, specific conductance was 436-831 μmhos, pH was 7.7-8.8 and the temperature was 9.7-10.8 °C (49-51 °F). Measurements for each site and for the tributaries sampled in August are found on the field data summary sheets.

Figure 1 and 2. Biological Assessment Profile of index values, Woodbury Creek 2005 and 1987 vs. 2004, 2005. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.



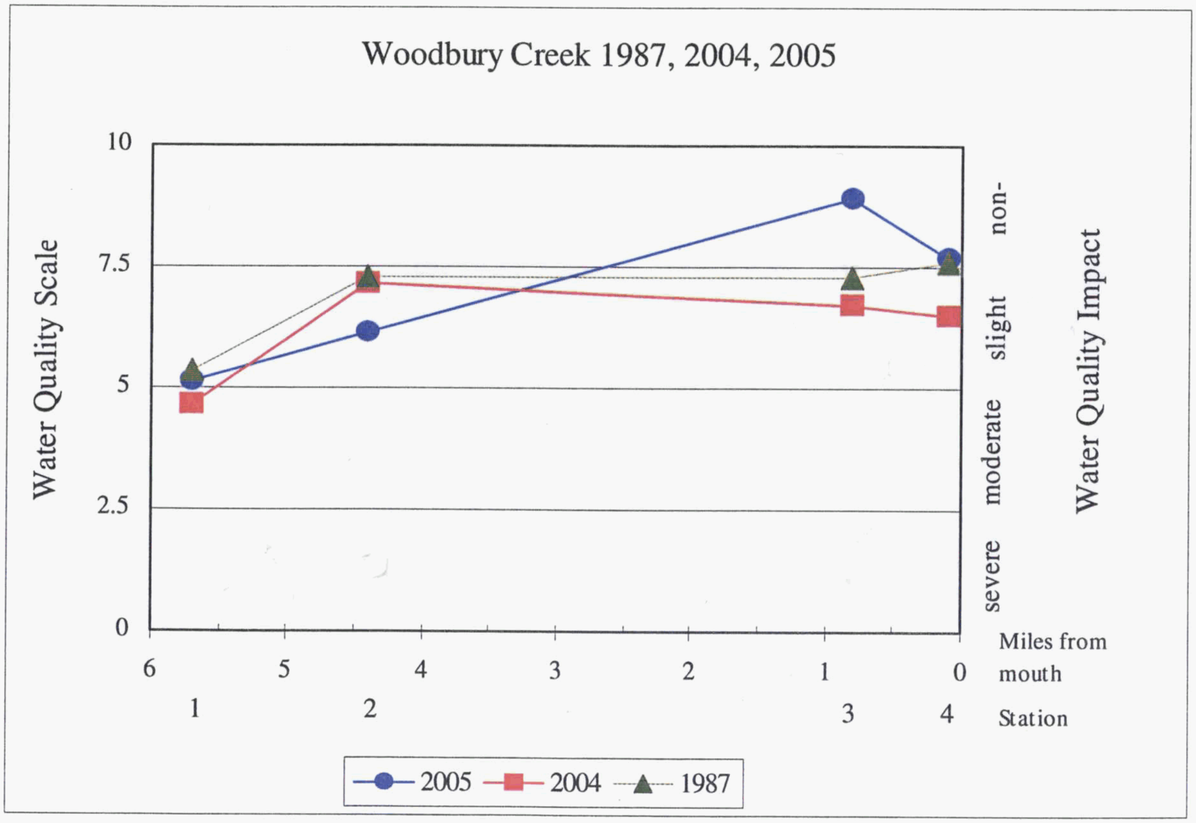


Figure 3. Nutrient Biotic Indices for Woodbury Creek, May 2005. Higher values indicate greater nutrient enrichment.

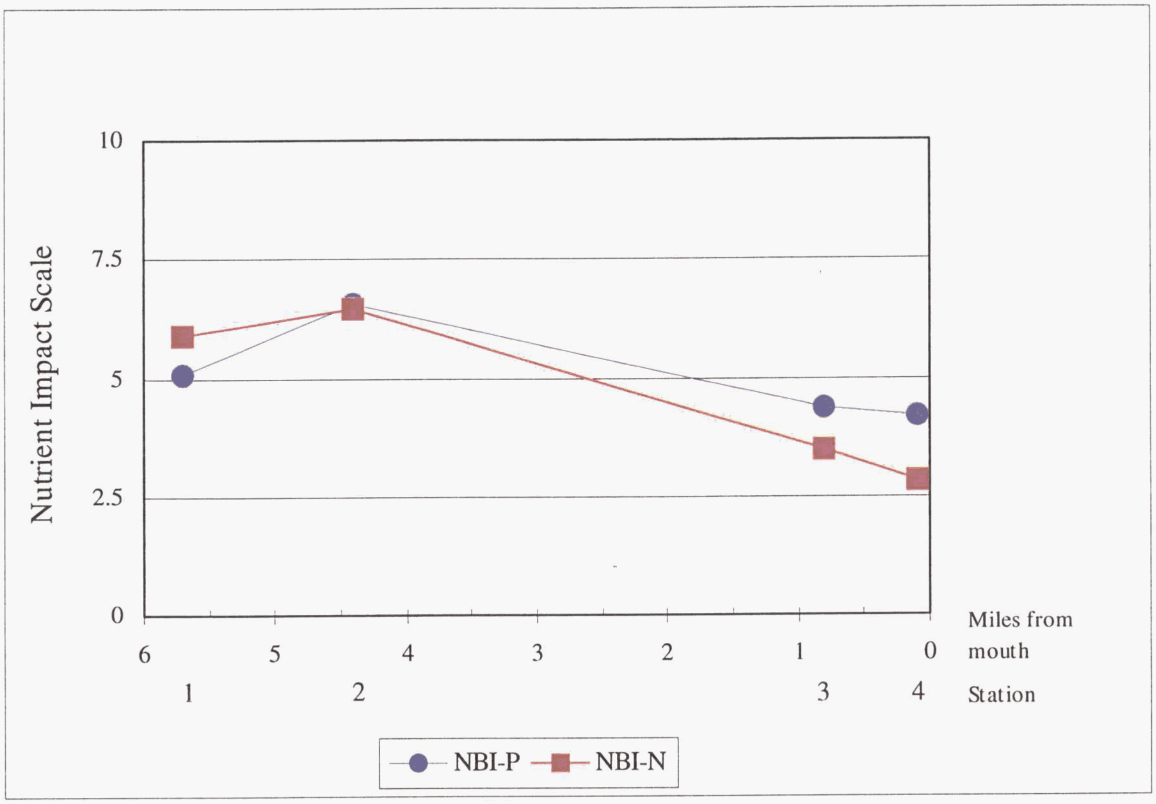


Figure 4. Siltation in Tributary 6. Photograph by Mary Gross-Ferraro

Figure 5. Specific conductance levels in headwaters of Woodbury Creek. Data collected by Dick Manley, Moodna Creek Coalition.

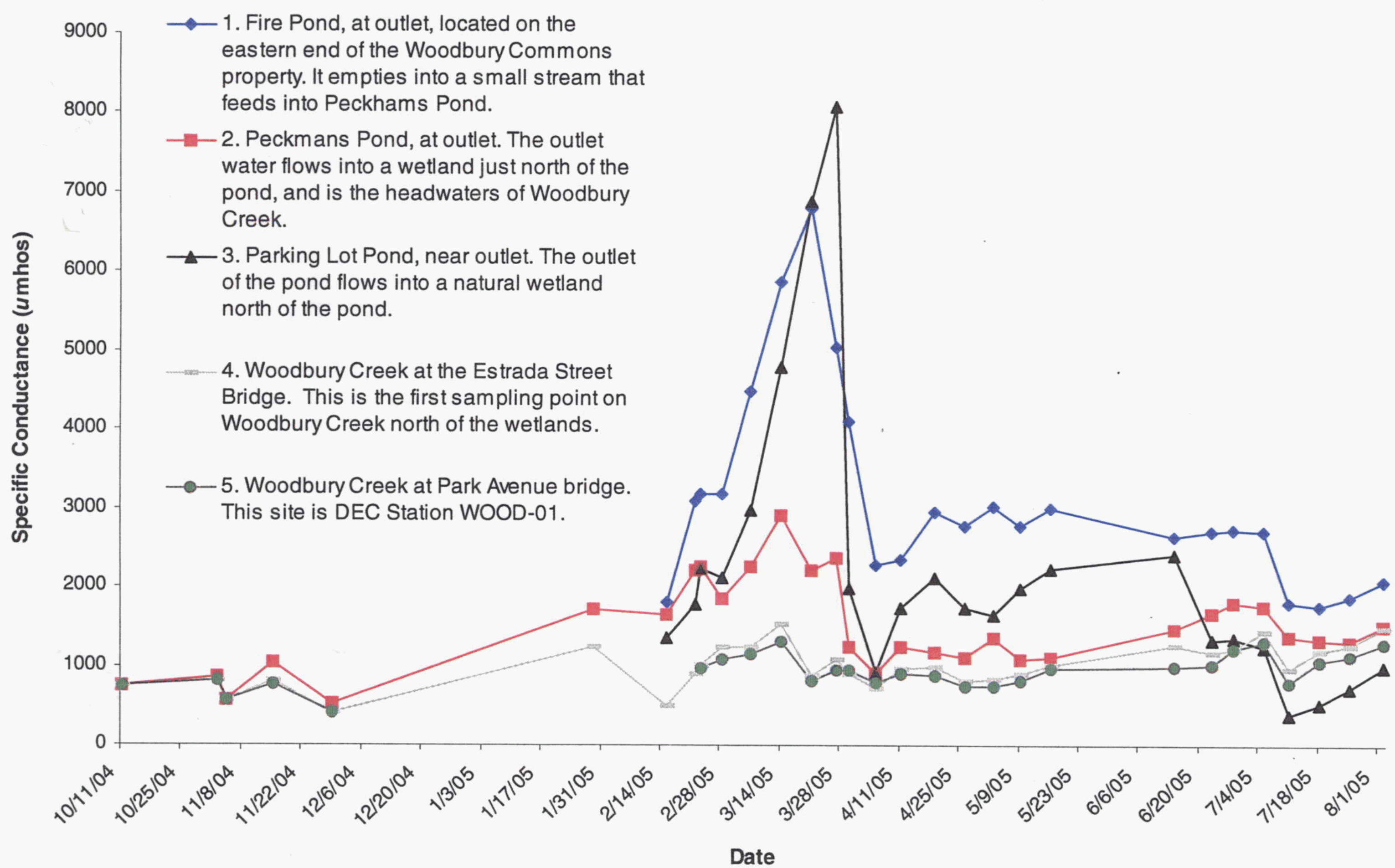


Table 1. Impact Source Determination, Woodbury Creek, 2005. Numbers represent percent similarity to community type models for each impact category. Highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	STATION					
Community Type	WOOD-1	WOOD-2	WOOD-3	WOOD-4	WOOD-1A Trib. 7	WOOD-2A Trib. 6
Natural: minimal human impacts	21	29	60	62	27	33
Nutrient additions: mostly nonpoint, agricultural	30	32	36	29	59	49
Toxic: industrial, municipal, or urban run-off	39	32	24	18	41	39
Organic: sewage effluent, animal wastes	29	15	27	21	59	38
Complex: municipal/industrial	34	20	22	17	64	38
Siltation	20	40	44	28	41	39
Impoundment	28	37*	44	33	62*	49*

STATION	COMMUNITY TYPE
WOOD-1	Toxics
WOOD-2	Siltation
WOOD-3	Natural
WOOD-4	Natural
WOOD-1A	Nutrients, organic, complex
WOOD-2A	Nutrients

*Designations of impoundment effects are considered spurious.

TABLE 2. Station Locations for Woodbury Creek, Orange County, NY

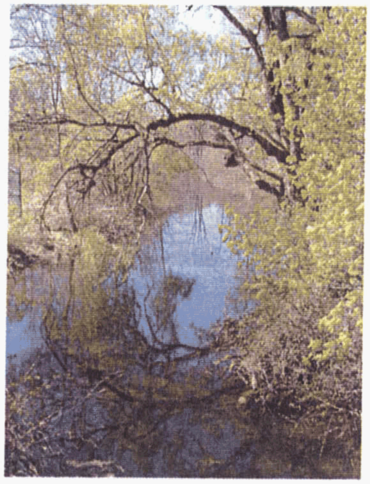
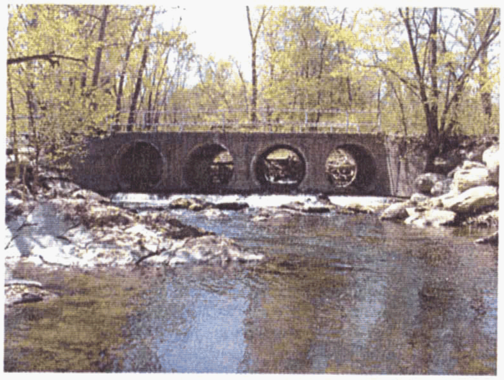
STATION	LOCATION	
01	Highland Mills, New York Below Park Avenue bridge Latitude/Longitude 41° 20' 41"; 74° 07' 16" 5.7 stream miles above mouth Photograph facing upstream	
02	Quaker Meetinghouse, New York Off Route 32 pull-off Latitude/Longitude 41° 21' 31"; 74° 06' 33" 4.4 stream miles above mouth Photograph facing upstream	
03	Mountainville, New York Below Industry Drive bridge Latitude/Longitude 41° 24' 01"; 74° 04' 54" 0.8 stream miles above mouth Photograph facing upstream	
04	Mountainville, New York Off Pleasant Hill Road Latitude/Longitude 41° 24' 28"; 74° 04' 31" 0.1 stream miles above mouth Photograph facing upstream	

Figure 6	Site Overview Map	Woodbury Creek

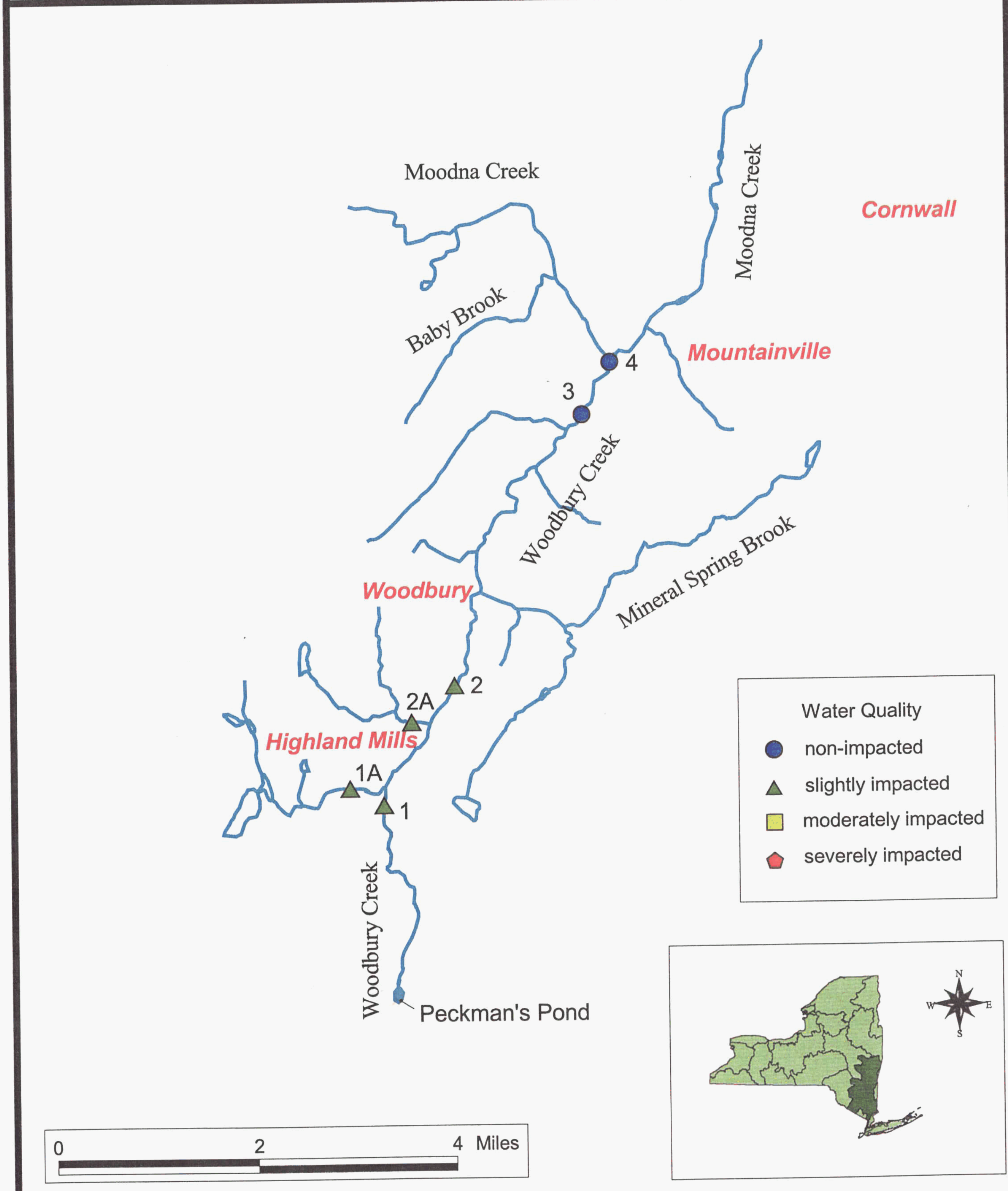
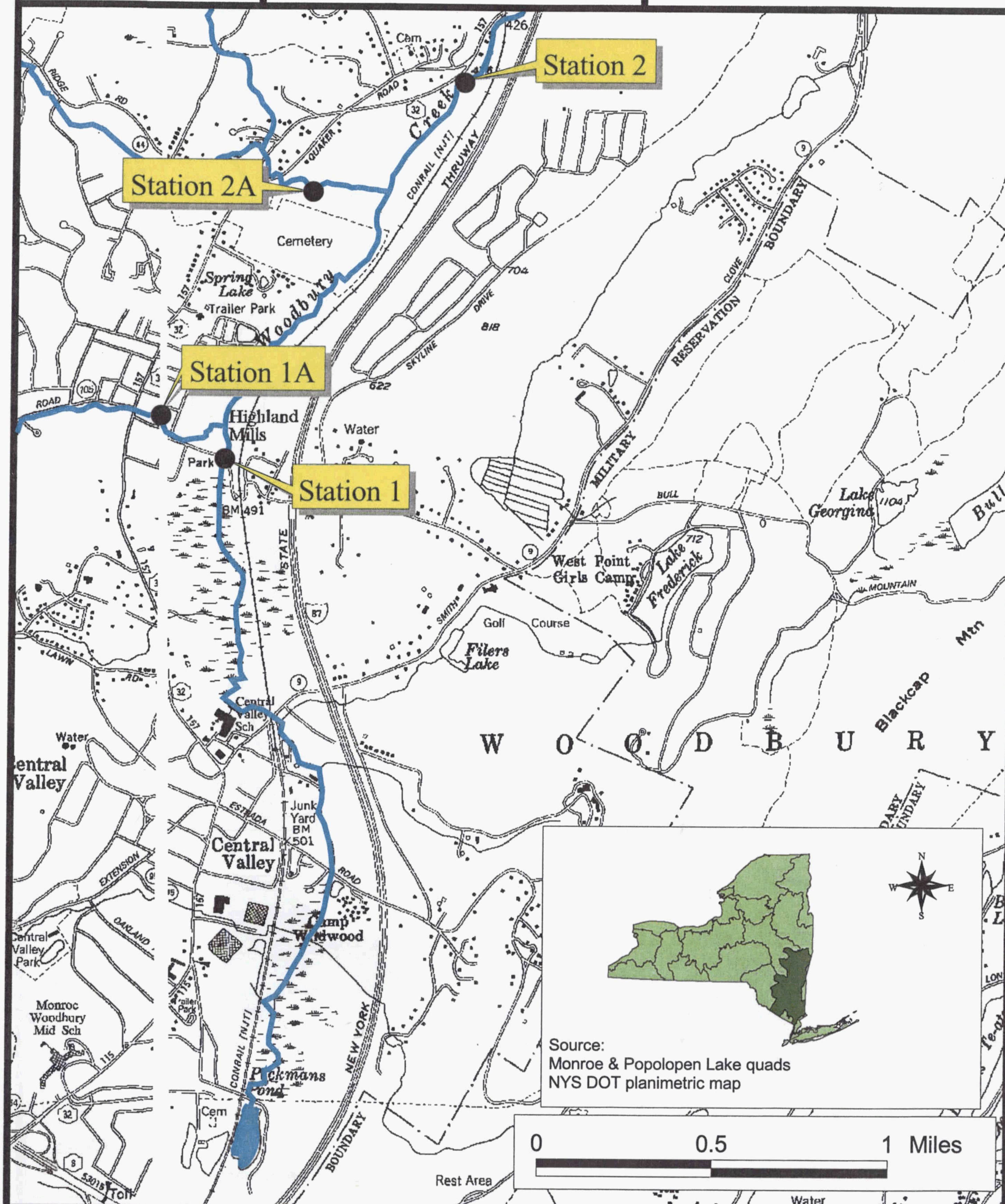
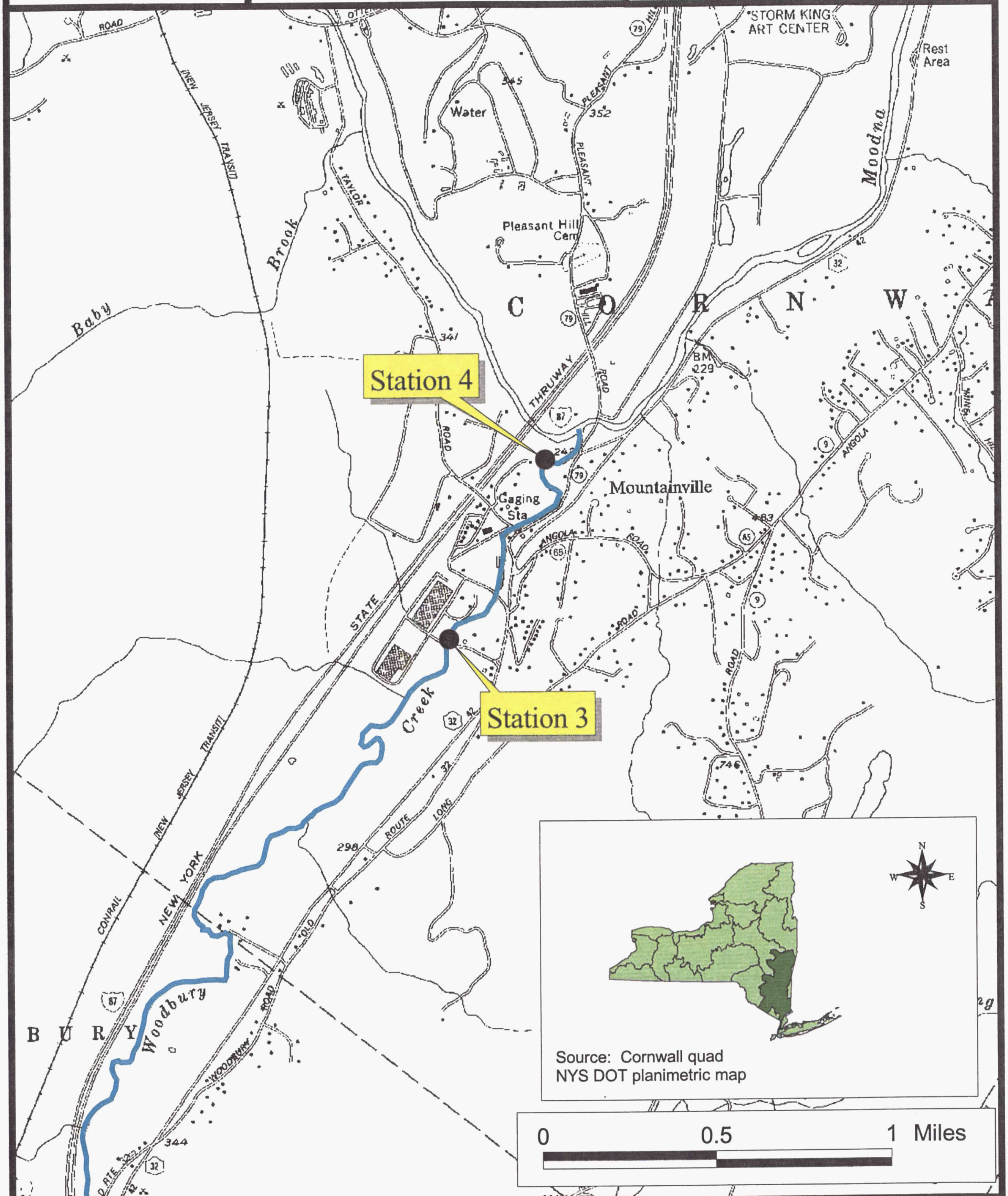


Figure 7a	Site Location Map	Woodbury Creek



stream flow

Figure 7b	Site Location Map	Woodbury Creek



stream flow

TABLE 3. Macroinvertebrate Species Collected in Woodbury Creek, Orange County, New York, 2005.

ANNELIDA
- OLIGOCHAETA
  - TUBIFICIDA
    - Enchytraeidae
      - Undetermined Enchytraeidae
    - Tubificidae
      - Undet. Tubificidae with cap. setae

HIRUDINEA
- Glossiphoniidae
  - Undetermined Hirudinea

ARTHROPODA
- CRUSTACEA
  - ISOPODA
    - Asellidae
      - *Caecidotea sp.*
  - AMPHIPODA
    - Talitridae
      - Hyalella azteca
- DIPLOPODA
  - POLYDESMIDA
    - Undetermined Polydesmida
- INSECTA
  - EPHEMEROPTERA
    - Isonychiidae
      - *Isonychia* sp.
    - Baetidae
      - *Acentrella* sp.
      - *Baetis* sp.
    - Heptageniidae
      - *Epeorus (Iron) sp.*
    - Ephemerellidae
      - *Ephemerella subvaria*
  - PLECOPTERA
    - Perlidae
      - *Acroneuria abnormis*
      - *Acroneuria carolinensis*
      - *Paragnetina media*
      - Undetermined Perlidae
    - Chloroperlidae
      - *Sweltsa* sp.
    - Perlodidae
      - *Isoperla* sp.
  - COLEOPTERA
    - Psephenidae
      - *Psephenus herricki*
    - Elmidae
      - *Dubiraphia bivittata*
      - *Oulimnius* sp.
      - *Stenelmis crenata*
      - *Stenelmis sp.*

MEGALOPTERA
- Corydalidae
  - *Corydalus cornutus*
  - *Nigronia serricornis*
- Sialidae
  - *Sialis* sp.

TRICHOPTERA
- Philopotamidae
  - *Chimarra aterrima?*
- Polycentropodidae
  - *Polycentropus* sp.
- Hydropsychidae
  - *Cheumatopsyche sp.*
  - *Hydropsyche betteni*
  - *Hydropsyche bronta*
  - *Hydropsyche slossonae*
  - *Hydropsyche sparna*
- Rhyacophilidae
  - *Rhyacophila carolina*?
  - *Rhyacophila fuscula*
- Lepidostomatidae
  - Undetermined Lepidostomatidae

DIPTERA
- Tipulidae
  - *Hexatoma* sp.
- Empididae
  - *Wiedemannia* sp.
- Simuliidae
  - *Prosimulium magnum*
  - *Simulium jenningsi*
  - *Simulium venustum*
- Chironomidae
  - *Ablabesmyia mallochi*
  - *Thienemannimyia* gr. spp.
  - *Diamesa* sp.
  - *Sympotthastia* sp.
  - *Eukiefferiella claripennis gr.*
  - *Eukiefferiella devonica gr.*
  - *Orthocladius obumbratus*
  - *Orthocladius (Eu.) rivulorum*
  - *Orthocladius (Eu.) sp.*
  - *Parakiefferiella sp.*
  - *Rheocricotopus robacki*
  - *Tvetenia bavarica gr.*
  - *Tvetenia vitracies*
  - *Cryptochironomus fulvus gr.*
  - *Cryptotendipes sp.*
  - *Polypedilum aviceps*
  - *Polypedilum illinoense*
  - *Micropsectra polita*
  - *Micropsectra sp.*
  - *Rheotanytarsus pellucidus*
  - *Tanytarsus guerlus* gr.

STREAM SITE	Woodbury Creek	WOOD-01
LOCATION:	Highland Mills, NY	Below Park Avenue bridge
DATE:	05 May 2005	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	1
	Tubificidae	Undet. Tubificidae w/ cap. setae	2
HIRUDINEA			
	Glossiphoniidae	Undetermined Hirudinea	1
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	*Caecidotea sp.*	15
AMPHIPODA	Talitridae	*Hyalella azteca*	7
INSECTA			
EPHEMEROPTERA	Ephemerellidae	*Ephemerella subvaria*	1
PLECOPTERA	Perlidae	*Undetermined Perlidae*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Dubiraphia bivittata*	1
		Stenelmis sp.	2
MEGALOPTERA	Sialidae	*Sialis sp.*	1
TRICHOPTERA	Polycentropodidae	*Polycentropus sp.*	2
	Hydropsychidae	*Cheumatopsyche sp.*	3
		Hydropsyche betteni	1
DIPTERA	Chironomidae	*Ablabesmyia mallochi*	2
		Thienemannimyia gr. spp.	20
		Orthocladius obumbratus	10
		Parakiefferiella sp.	2
		Cryptochironomus fulvus gr.	1
		Cryptotendipes sp.	1
		Polypedilum illinoense	1
		Micropsectra polita	10
		Micropsectra sp.	12
		Tanytarsus guerlus gr.	2

SPECIES RICHNESS:	24 (good)
BIOTIC INDEX:	6.67 (poor)
EPT RICHNESS:	5 (poor)
MODEL AFFINITY:	45 (poor)
ASSESSMENT:	slightly impacted (5.14)

DESCRIPTION: The sampling site was a slow-moving run immediately downstream of a wetland. Rocks in the stream were heavily laden with algae and silt, and the macroinvertebrate fauna was heavily dominated by midges and sowbugs. A small number of mayflies, stoneflies, and caddisflies were also present. The water column showed a specific conductance of 831 µmhos, compared to 160 µmhos in 1987 and 1227 µmhos in 2004. Although three of the four macroinvertebrate metrics were poor, overall water quality was within the range of slightly impacted.

STREAM SITE:	Woodbury Creek	WOOD-02
LOCATION:	Quaker Meetinghouse	Route 32 pull-off
DATE:	05 May 2005	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Ephemerellidae	*Ephemerella subvaria*	4
PLECOPTERA	Perlidae	*Acroneuria abnormis*	1
COLEOPTERA	Elmidae	*Stenelmis crenata*	8
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	1
	Polycentropodidae	*Polycentropus sp.*	1
	Hydropsychidae	*Hydropsyche betteni*	3
		Hydropsyche bronta	1
		Hydropsyche sparna	3
	Rhyacophilidae	*Rhyacophila fuscula*	3
DIPTERA	Simuliidae	*Simulium jenningsi*	1
		Simulium venustum	3
	Empididae	*Wiedemannia sp.*	5
	Chironomidae	*Diamesa sp.*	29
		Sympotthastia sp.	10
		Eukiefferiella claripennis gr.	1
		Orthocladius obumbratus	23
		Orthocladius (Euorthoclad.) rivulorum	1
		Rheotanytarsus pellucidus	1

SPECIES RICHNESS:	19 (good)
BIOTIC INDEX:	4.73 (good)
EPT RICHNESS:	8 (good)
MODEL AFFINITY:	53 (good)
ASSESSMENT:	slightly impacted (6.13)

DESCRIPTION: The site was accessed by walking from a pull-off of Route 32 near Quaker Meetinghouse. The dissolved oxygen level of the stream at this site was supersaturated (134%), indicating high photosynthetic activity, and probable nighttime oxygen deficits. High amounts of algae near shore were the likely cause of this. The pH at this site was very high (8.8) and this can also be caused by algal photosynthetic activity. The macroinvertebrate community was dominated by midges, with a few mayflies and stoneflies. All metrics were within the range of slightly impacted water quality, and ISD was most similar to silt-impacted communities.

STREAM SITE:	Woodbury Creek	WOOD-03
LOCATION:	Mountainville, NY	Below Industry Drive bridge
DATE:	05 May 2005	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia sp.*	1
	Baetidae	*Acentrella sp.*	2
		Baetis sp.	2
	Heptageniidae	*Epeorus (Iron) sp.*	7
	Ephemerellidae	*Ephemerella subvaria*	34
PLECOPTERA	Perlidae	*Acroneuria abnormis*	2
		Acroneuria carolinensis	1
	Chloroperlidae	*Sweltsa sp.*	1
	Perlodidae	*Isoperla sp.*	2
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Oulimnius sp.*	1
		Stenelmis crenata	12
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
	Sialidae	*Sialis sp.*	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	1
	Hydropsychidae	*Cheumatopsyche sp.*	4
		Hydropsyche slossonae	4
	Rhyacophilidae	*Rhyacophila carolina?*	1
		Rhyacophila fuscula	3
DIPTERA	Tipulidae	*Hexatoma sp.*	1
	Simuliidae	*Prosimulium magnum*	3
		Simulium venustum	7
	Chironomidae	*Rheocricotopus robacki*	1
		Tvetenia bavarica gr.	1
		Tvetenia vitracies	1
		Polypedilum aviceps	5

SPECIES RICHNESS:	26 (good)
BIOTIC INDEX:	2.51 (very good)
EPT RICHNESS:	14 (very good)
MODEL AFFINITY:	83 (very good)
ASSESSMENT:	non-impacted (8.92)

DESCRIPTION: The kick sample was taken approximately 50 meters downstream of Industry Drive bridge in Mountainville. The macroinvertebrate community was greatly improved from that found at Station-2, and was dominated by clean-water mayflies. The metrics placed water quality high in the non-impacted category, and Impact Source Determination showed highest similarity to natural communities.

STREAM SITE:	Woodbury Creek	WOOD-04	
LOCATION:	Mountainville, NY	Off Pleasant Hill Road	
DATE:	05 May 2005		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Acentrella sp.*	4
	Heptageniidae	*Epeorus (Iron) sp.*	5
	Ephemerellidae	*Ephemerella subvaria*	40
PLECOPTERA	Perlidae	*Acroneuria carolinensis*	1
DIPLOPODA			
POLYDESMIDA		Undetermined Polydesmida	1
ARTHROPODA			
INSECTA			
COLEOPTERA	Elmidae	*Stenelmis sp.*	4
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	1
		Hydropsyche betteni	1
		Hydropsyche sparna	1
	Rhyacophilidae	*Rhyacophila fuscula*	2
	Lepidostomatidae	*Lepidostoma sp.*	1
DIPTERA	Simuliidae	*Prosimulium magnum*	3
		Simulium venustum	13
	Empididae	*Wiedemannia sp.*	2
	Chironomidae	*Diamesa sp.*	11
		Sympotthastia sp.	3
		Eukiefferiella claripennis gr.	3
		Eukiefferiella devonica gr.	1
		Orthocladius (Euorthoclad.) sp.	1
		Polypedilum aviceps	2

SPECIES RICHNESS:	20 (good)
BIOTIC INDEX:	2.84 (very good)
EPT RICHNESS:	9 (good)
MODEL AFFINITY:	81 (very good)
ASSESSMENT:	non-impacted (7.68)

DESCRIPTION: This site, approximately 150 meters upstream of the confluence with Moodna Creek, was accessed off Pleasant Hill Road. Conditions were similar to those at Station-3, and the macroinvertebrate community was dominated by the mayfly *Ephemerella subvaria*. Water quality was assessed as non-impacted.

STREAM SITE:	Woodbury Cr., Trib. 7	WOOD 01A	
LOCATION:	Highland Mills, NY	above Hollis Street	
DATE:	09 August 2005		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis sp.*	2
ODONATA	Calopterygidae	*Calopteryx sp.*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	7
	Elmidae	*Stenelmis crenata*	2
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	1
	Hydropsychidae	*Cheumatopsyche sp.*	39
		Hydropsyche betteni	9
		Hydropsyche sparna	4
	Leptoceridae	Undetermined Leptoceridae	1
DIPTERA	Chironomidae	*Thienemannimyia gr. spp.*	3
		Cricotopus bicinctus	2
		Polypedilum aviceps	3
		Polypedilum flavum	5
		Polypedilum illinoense	12
		Stempellinella sp.	3
		Tanytarsus glabrescens gr.	4

SPECIES RICHNESS:	17 (poor)
BIOTIC INDEX:	5.60 (good)
EPT RICHNESS:	6 (good)
MODEL AFFINITY:	44 (poor)
ASSESSMENT:	Slightly impacted (5.06)

DESCRIPTION: The sample was taken approximately 5 meters upstream of Hollis Street in Highland Mills. Stream flow was very low, and the streambed downstream of Hollis Street was mostly dry, with isolated pools. The stream rocks were covered with filamentous algae. The macroinvertebrate community was strongly dominated by facultative caddisflies and midges. Water quality was assessed as slightly impacted, and the NBI indicated mesotrophic to eutrophic conditions.

STREAM SITE:	Woodbury Cr. Trib. 6	WOOD 02A	
LOCATION:	Quaker Meetinghouse, NY	below Hazzard Road	
DATE:	09 August 2005		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Naididae	*Nais variabilis*	2
MOLLUSCA			
GASTROPODA			
	Physidae	Undetermined Physidae	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	1
INSECTA			
PLECOPTERA	Capniidae	Undetermined Capniidae	1
	Leuctridae	*Leuctra truncata*	1
ODONATA	Calopterygidae	*Hetaerina sp.*	1
DIPLOPODA			
POLYDESMIDA		Undetermined Polydesmida	1
ARTHROPODA			
INSECTA			
COLEOPTERA	Psephenidae	*Psephenus herricki*	2
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	8
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	7
	Polycentropodidae	*Polycentropus sp.*	1
	Hydropsychidae	*Cheumatopsyche sp.*	20
		Hydropsyche sp.	7
DIPTERA	Chironomidae	*Thienemannimyia gr. spp.*	2
		Diamesa sp.	19
		Limnophyes sp.	1
		Parametriocnemus lundbecki	5
		Tvetenia bavarica gr.	6
		Polypedilum aviceps	4
		Polypedilum flavum	5
		Polypedilum illinoense	4
		Stempellinella sp.	1

SPECIES RICHNESS:	22 (good)
BIOTIC INDEX:	4.93 (good)
EPT RICHNESS:	6 (good)
MODEL AFFINITY:	46 (poor)
ASSESSMENT:	Slightly impacted (5.76)

DESCRIPTION: The sampling site was approximately 200 meters downstream of Hazzard Road at Quaker Meetinghouse. The stream bottom was covered with silt. The macroinvertebrate community was dominated by midges and caddisflies; no mayflies were found. Overall water quality was assessed as slightly impacted, and the NBI indicated eutrophic conditions.

LABORATORY DATA SUMMARY

STREAM NAME: Woodbury Creek	**DRAINAGE: 13**			
DATE SAMPLED: 5/5/2005	**COUNTY: Orange**			
SAMPLING METHOD: Travelling Kick				
STATION	01	02	03	04
LOCATION	Highland Mills	Quaker Meetinghouse	Mountainville	Mountainville
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Thienemannimyia gr. spp.	Diamesa sp.	Ephemerella subvaria	Ephemerella subvaria
	20 %	29 %	34 %	40 %
	facultative	facultative	intolerant	intolerant
	midge	midge	mayfly	mayfly
2.	Caecidotea sp.	Orthocladius obumbratus	Stenelmis crenata	Simulium venustum
Intolerant = not tolerant of poor	15 %	23 %	12 %	13 %
water quality	tolerant	facultative	facultative	facultative
	sowbug	midge	beetle	black fly
3.	Micropsectra sp.	Sympotthastia sp.	Epeorus (Iron) sp.	Diamesa sp.
Facultative = occurring over a	12 %	10 %	7 %	11 %
wide range of water quality	facultative	intolerant	intolerant	facultative
	midge	midge	mayfly	midge
4.	Orthocladius obumbratus	Stenelmis crenata	Simulium venustum	Epeorus (Iron) sp.
Tolerant = tolerant of poor	10 %	8 %	7 %	5 %
water quality	facultative	facultative	facultative	intolerant
	midge	beetle	black fly	mayfly
5.	Micropsectra polita	Wiedemannia sp.	Polypedilum aviceps	Acentrella sp.
	10 %	5 %	5 %	4 %
	facultative	facultative	facultative	intolerant
	midge	dance fly	midge	mayfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	61.0 (10.0)	65.0 (6.0)	8.0 (4.0)	21.0 (6.0)
Trichoptera (caddisflies)	6.0 (3.0)	12.0 (6.0)	13.0 (5.0)	6.0 (5.0)
Ephemeroptera (mayflies)	1.0 (1.0)	4.0 (1.0)	46.0 (5.0)	49.0 (3.0)
Plecoptera (stoneflies)	1.0 (1.0)	1.0 (1.0)	6.0 (4.0)	1.0 (1.0)
Coleoptera (beetles)	4.0 (3.0)	8.0 (1.0)	14.0 (3.0)	4.0 (1.0)
Oligochaeta (worms)	3.0 (2.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Mollusca (clams and snails)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Crustacea (crayfish, scuds, sowbugs)	22.0 (2.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Other insects (odonates, diptera)	1.0 (1.0)	10.0 (4.0)	13.0 (5.0)	18.0 (3.0)
Other (Nemertea, Platyhelminthes)	1.0 (1.0)	0.0 (0.0)	0.0 (0.0)	1.0 (1.0)
SPECIES RICHNESS	24	19	26	20
BIOTIC INDEX	6.67	4.73	2.51	2.84
EPT RICHNESS	5	8	14	9
PERCENT MODEL AFFINITY	45	53	83	81
FIELD ASSESSMENT	Good	Good	Very good	Very good
OVERALL ASSESSMENT	Slight	Slight	Non-impacted	Non-impacted

LABORATORY DATA SUMMARY

STREAM NAME: Woodbury Creek		**DRAINAGE: 13**		
DATE SAMPLED: 8/9/2005		**COUNTY: Orange**		
SAMPLING METHOD: Travelling Kick				
STATION	01A	02A		
LOCATION	Highland Mills	Quaker Meetinghouse		
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Cheumatopsyche sp.	Cheumatopsyche sp.		
	39 %	20 %		
	facultative	facultative		
	caddisfly	caddisfly		
2.	Polypedilum illinoense	Diamesa sp.		
Intolerant = not tolerant of poor	12 %	19 %		
water quality	facultative	facultative		
	midge	midge		
3.	Hydropsyche betteni	Nigronia serricornis		
Facultative = occurring over a	9 %	8 %		
wide range of water quality	facultative	intolerant		
	caddisfly	hellgramite		
4.	Psephenus herricki	Chimarra aterrima?		
Tolerant = tolerant of poor	7 %	7 %		
water quality	intolerant	intolerant		
	beetle	caddisfly		
5.	Polypedilum flavum	Hydropsyche sp.		
	5 %	7 %		
	facultative	facultative		
	midge	caddisfly		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	32.0 (7.0)	47.0 (9.0)		
Trichoptera (caddisflies)	54.0 (5.0)	35.0 (4.0)		
Ephemeroptera (mayflies)	2.0 (1.0)	0.0 (0.0)		
Plecoptera (stoneflies)	0.0 (0.0)	2.0 (2.0)		
Coleoptera (beetles)	9.0 (2.0)	2.0 (1.0)		
Oligochaeta (worms)	2.0 (1.0)	2.0 (1.0)		
Mollusca (clams and snails)	0.0 (0.0)	1.0 (1.0)		
Crustacea (crayfish, scuds, sowbugs)	0.0 (0.0)	1.0 (1.0)		
Other insects (odonates, diptera)	1.0 (1.0)	9.0 (2.0)		
Other (Nemertea, Platyhelminthes)	0.0 (0.0)	1.0 (1.0)		
SPECIES RICHNESS	17	22		
BIOTIC INDEX	5.60	4.93		
EPT RICHNESS	6	6		
PERCENT MODEL AFFINITY	44	46		
FIELD ASSESSMENT	Good	Good		
OVERALL ASSESSMENT	Slight	Slight		

FIELD DATA SUMMARY

STREAM NAME: Woodbury Creek	**DATE SAMPLED: 5/5/2005**			
REACH: Highland Mills to Mountainvile				
FIELD PERSONNEL INVOLVED: Smith, Bode, Novak				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	10:10	10:50	11:25	12:20
LOCATION	Highland Mills	Quaker Meetinghouse	Mountainville	Mountainville
PHYSICAL CHARACTERISTICS				
Width (meters)	8	8	15	10
Depth (meters)	0.2	0.2	0.2	0.2
Current speed (cm per sec.)	14	83	100	150
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	10	10	
Rubble (6.35 – 25.4 cm)	40	40	40	40
Gravel (0.2 – 6.35 cm)	20	20	20	30
Sand (0.06 – 2.0 mm)	10	20	20	20
Silt (0.004 – 0.06 mm)	20	10	10	10
Embeddedness (%)	20	40	30	20
CHEMICAL MEASUREMENTS				
Temperature (°C)	9.7	10.8	10.4	10.8
Specific Conductance (umhos)	831	678	436	436
Dissolved Oxygen (mg/l)	10.1	14.9	13.0	12.9
pH	7.7	8.8	8.3	8.6
BIOLOGICAL ATTRIBUTES				
Canopy (%)	20	80	60	90
Aquatic Vegetation				
algae – attached, filamentous	XXX	XXXX		
algae – diatoms				
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)		X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X		X	X
Megaloptera(dobsonflies, alderflies)			X	
Odonata (dragonflies, damselflies)	X			
Chironomidae (midges)	X	X		
Simuliidae (black flies)				X
Decapoda (crayfish)				
Gammaridae (scuds)	X			
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other	X			
FAUNAL CONDITION	Poor	Good	Very good	Very good

LABORATORY DATA SUMMARY

STREAM NAME: Woodbury Creek		DRAINAGE: 13		
DATE SAMPLED: 8/9/2005		COUNTY: Orange		
SAMPLING METHOD: Travelling Kick				
STATION	01A	02A		
LOCATION	Highland Mills	Quaker Meetinghouse		
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Cheumatopsyche sp.	Cheumatopsyche sp.		
	39 %	20 %		
	facultative	facultative		
	caddisfly	caddisfly		
2.	Polypedilum illinoense	Diamesa sp.		
Intolerant = not tolerant of poor	12 %	19 %		
water quality	facultative	facultative		
	midge	midge		
3.	Hydropsyche betteni	Nigronia serricornis		
Facultative = occurring over a	9 %	8 %		
wide range of water quality	facultative	intolerant		
	caddisfly	hellgramite		
4.	Psephenus herricki	Chimarra aterrima?		
Tolerant = tolerant of poor	7 %	7 %		
water quality	intolerant	intolerant		
	beetle	caddisfly		
5.	Polypedilum flavum	Hydropsyche sp.		
	5 %	7 %		
	facultative	facultative		
	midge	caddisfly		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	32.0 (7.0)	47.0 (9.0)		
Trichoptera (caddisflies)	54.0 (5.0)	35.0 (4.0)		
Ephemeroptera (mayflies)	2.0 (1.0)	0.0 (0.0)		
Plecoptera (stoneflies)	0.0 (0.0)	2.0 (2.0)		
Coleoptera (beetles)	9.0 (2.0)	2.0 (1.0)		
Oligochaeta (worms)	2.0 (1.0)	2.0 (1.0)		
Mollusca (clams and snails)	0.0 (0.0)	1.0 (1.0)		
Crustacea (crayfish, scuds, sowbugs)	0.0 (0.0)	1.0 (1.0)		
Other insects (odonates, diptera)	1.0 (1.0)	9.0 (2.0)		
Other (Nemertea, Platyhelminthes)	0.0 (0.0)	1.0 (1.0)		
SPECIES RICHNESS	17	22		
BIOTIC INDEX	5.60	4.93		
EPT RICHNESS	6	6		
PERCENT MODEL AFFINITY	44	46		
FIELD ASSESSMENT	Good	Good		
OVERALL ASSESSMENT	Slight	Slight		

FIELD DATA SUMMARY				
STREAM NAME: Woodbury Creek		DATE SAMPLED: 8/9/2005		
REACH: Highland Mills to Mountainvile				
FIELD PERSONNEL INVOLVED: Abele, Bode				
STATION	01A	02A		
ARRIVAL TIME AT STATION	10:30	11:05		
LOCATION	Highland Mills	Quaker Meetinghouse		
PHYSICAL CHARACTERISTICS				
Width (meters)	2.0	1.5		
Depth (meters)	0.1	0.05		
Current speed (cm per sec.)	35	50		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	10	20		
Rubble (6.35 – 25.4 cm)	30	30		
Gravel (0.2 – 6.35 cm)	30	20		
Sand (0.06 – 2.0 mm)	10	10		
Silt (0.004 – 0.06 mm)	20	20		
Embeddedness (%)	40	30		
CHEMICAL MEASUREMENTS				
Temperature (°C)	23.0	20.8		
Specific Conductance (umhos)	940	1024		
Dissolved Oxygen (mg/l)	8.9	8.4		
pH	7.2	7.4		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	80	50		
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	XXX			
algae – diatoms				
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)				
Plecoptera (stoneflies)		X		
Trichoptera (caddisflies)	X	X		
Coleoptera (beetles)	X			
Megaloptera(dobsonflies, alderflies)	X	X		
Odonata (dragonflies, damselflies)				
Chironomidae (midges)				
Simuliidae (black flies)	X			
Decapoda (crayfish)	X			
Gammaridae (scuds)				
Mollusca (snails, clams)	X			
Oligochaeta (worms)				
Other				
FAUNAL CONDITION	Poor	Good		

Appendix I. Biological Methods for Kick Sampling

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

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

C. Sampling. Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that 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 is recorded on a data sheet. All organisms from the subsample are archived (either slide-mounted or preserved in alcohol). If the results of the identification process are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

Appendix II. Macroinvertebrate Community Parameters

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

2. EPT Richness denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-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 is 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., (1996). 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 is a measure of similarity to a model, non-impacted community based on percent abundance in seven major macroinvertebrate groups (Novak and Bode, 1992). Percent abundances in the model community are: 40% Ephemeroptera; 5% Plecoptera; 10% Trichoptera; 10% Coleoptera; 20% Chironomidae; 5% Oligochaeta; and 10% Other. Impact ranges are: greater than 64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and less than 35, severely impacted.

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NYSDEC Technical Report, 89 pages.

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

Lenat, D. R. 1987. Water quality assessment using a new qualitative collection method for freshwater benthic macroinvertebrates. North Carolina Division of Environmental Management Technical Report. 12 pages.

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

Appendix III. Levels of Water Quality Impact in Streams

The description of overall stream water quality based on biological parameters uses a four-tiered system of classification. Level of impact is assessed for each individual parameter and then combined for all parameters to form a consensus determination. Four parameters are used: species richness, EPT 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; the EPT richness is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

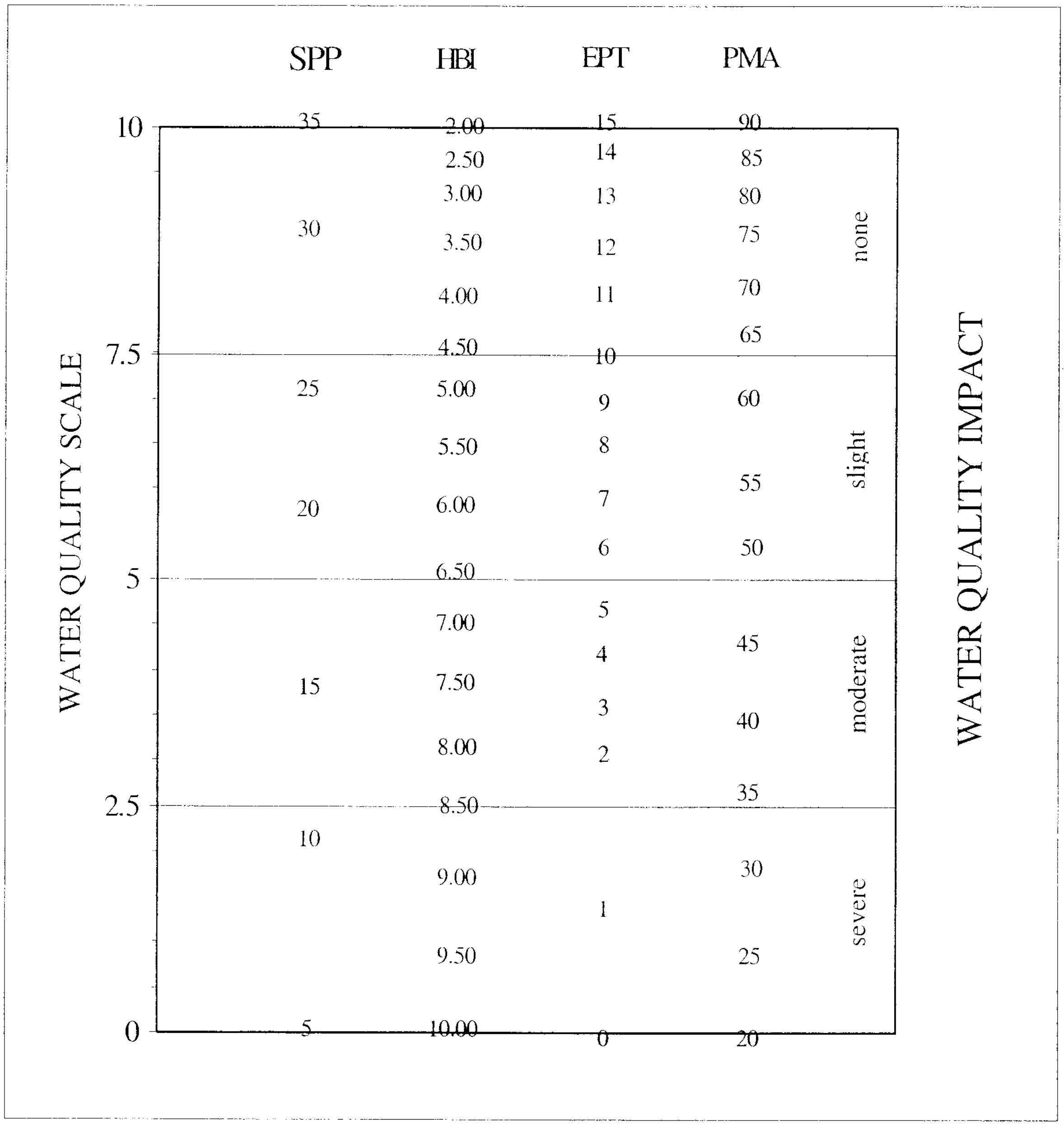
2. _Slightly impacted_ Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50.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

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

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

Appendix IV-A. Biological Assessment Profile: Conversion of Index Values to Common 10-Scale

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



Appendix IV-B. Biological Assessment Profile: Plotting Values

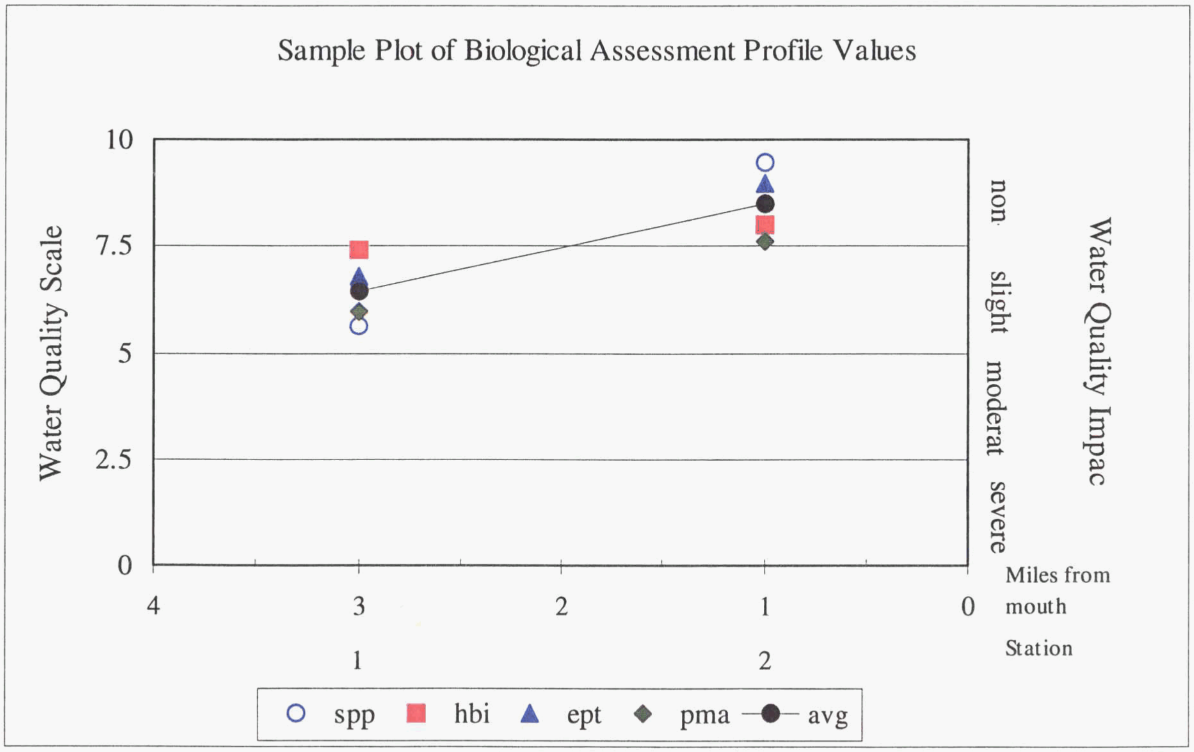
To plot survey data:

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-)

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



Appendix V. Water Quality Assessment Criteria

Water Quality Assessment Criteria for Non-Navigable Flowing Waters

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

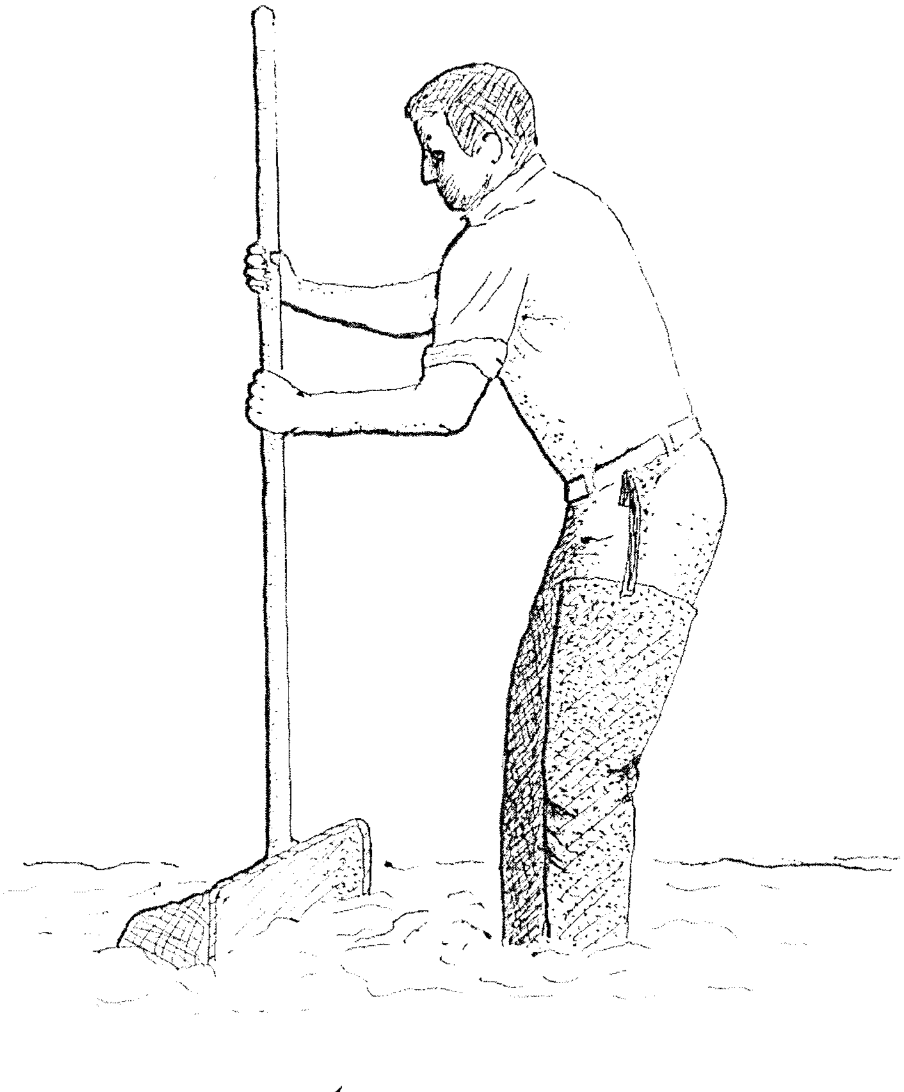
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

Water Quality Assessment Criteria for Navigable Flowing Waters

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

Appendix VI.

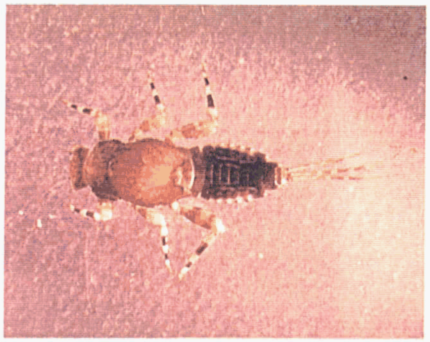
The Traveling Kick Sample



Rocks and sediment in 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.

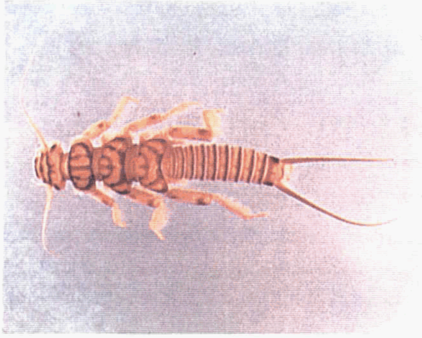
Appendix VII. A.
Aquatic Macroinvertebrates that Usually Indicate Good Water Quality

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.

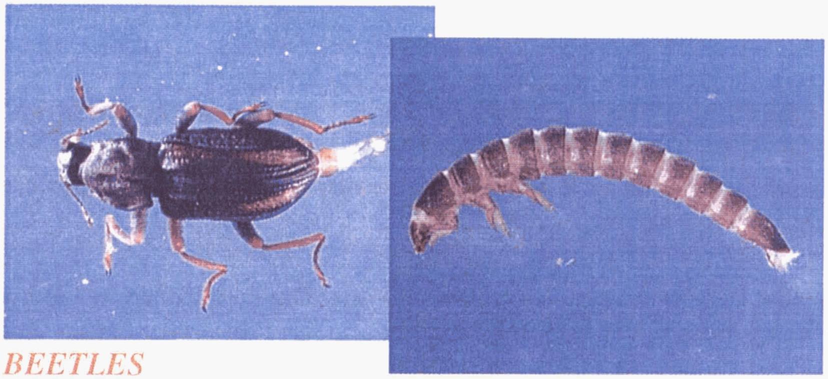


STONEFLIES

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.



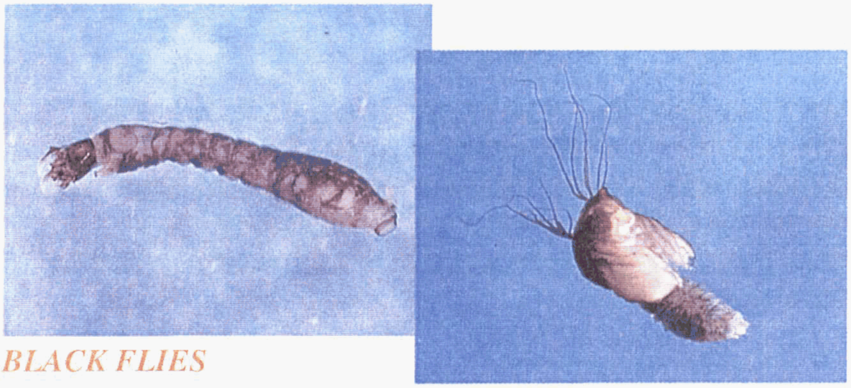
BEETLES

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.

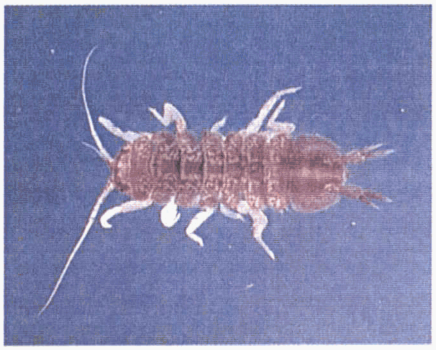


BLACK FLIES

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:

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

Limitations

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

Appendix IX. Glossary

anthropogenic: caused by human actions

assessment: a diagnosis or evaluation of water quality

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

bioaccumulate: accumulate contaminants in the tissues of an organism

biomonitoring: the use of biological indicators to measure water quality

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

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

EPT richness: the number of species of mayflies (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 Impact Source Determination

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

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

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

Limitations: These methods were developed for data derived from 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 TABLE
NATURAL MACROINVERTEBRATE COMMUNITY TYPE

	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 TABLE (cont.)
NONPOINT NUTRIENT ENRICHMENT IMPACTED MACROINVERTEBRATE COMMUNITY TYPE

	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 TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPES

	MUNICIPAL/INDUSTRIAL WASTES IMPACTED								TOXICS IMPACTED					
	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 TABLE (cont.)
NONPOINT NUTRIENT ENRICHMENT IMPACTED MACROINVERTEBRATE COMMUNITY TYPE

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	-	5	-	-	-	-	-	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	5	-	-	-	-	-	-
<u>Isonychia</u>	-	-	-	-	-	-	-	5	-	-
BAETIDAE	5	15	20	5	20	10	10	5	10	5
HEPTAGENIIDAE	-	-	-	-	5	5	5	5	-	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	5	-	-
<u>Caenis</u>/<u>Tricorythodes</u>	-	-	-	-	5	-	-	5	-	5
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
<u>Psephenus</u>	5	-	-	5	-	5	5	-	-	-
<u>Optioservus</u>	10	-	-	5	-	-	15	5	-	5
<u>Promoresia</u>	-	-	-	-	-	-	-	-	-	-
<u>Stenelmis</u>	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	-
<u>Simulium vittatum</u>	-	-	-	-	-	-	-	-	5	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	-	5
CHIRONOMIDAE										
Tanypodinae	-	-	-	-	-	-	5	-	-	5
<u>Cardiocladius</u>	-	-	-	-	-	-	-	-	-	-
<u>Cricotopus</u>/ <u>Orthocladius</u>	10	15	10	5	-	-	-	-	5	5
<u>Eukiefferiella</u>/ <u>Tvetenia</u>	-	15	10	5	-	-	-	-	5	-
<u>Parametriocnemus</u>	-	-	-	-	-	-	-	-	-	-
<u>Microtendipes</u>	-	-	-	-	-	-	-	-	-	20
<u>Polypedilum aviceps</u> -	-	-	-	-	-	-	-	-	-	
<u>Polypedilum</u> (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 TABLE (cont.)
SEWAGE EFFLUENT, ANIMAL WASTES IMPACTED MACROINVERTEBRATE COMMUNITY TYPE

	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 TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPES

	SILTATION IMPACTED					IMPOUNDMENT IMPACTED									
	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 XI. 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). 35% 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, this amount is designated as a level of concern, with expected biological impairments. This level 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. Nat. Irrigat. Water Qual. Prog. Inform. Rep. 3.

Ingersoll, C.G., F.J. Dwyer, S.A. Burch, M.K. Nelson, D.R. Buckler, and J.B. Hunn. 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. 1995. Drinking water regulations and health advisories. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. 11 pages.

APPENDIX XII. METHODS FOR CALCULATION OF THE NUTRIENT BIOTIC INDEX

Definition The Nutrient Biotic Index (Smith, 2005) is a diagnostic measure of stream nutrient enrichment identified by macroinvertebrate taxa. The frequency of occurrences of taxa at varying nutrient concentrations allowed the identification of taxon-specific nutrient optima using a method of weighted averaging. The establishment of nutrient optima is possible based on the observation that most species exhibit unimodal response curves in relation to environmental variables (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).

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

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

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

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

References:

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

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

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