BIOLOGICAL STREAM ASSESSMENT

Cherry Valley Creek
Otsego County, New York
Susquehanna River Basin

Survey dates: July 25, 2007
Report date: July 31, 2008

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Stream: Cherry Valley Creek
Reach: Cherry Valley to Milford, NY
River Basin: Susquehanna

Background:

The Stream Biomonitoring Unit sampled Cherry Valley Creek, Otsego County, New York, on July 25, 2007. Sampling was conducted to document water quality in the stream. The survey was conducted at the request of concerned local citizens and as a follow up to the water quality survey of Butler and Payne (2006) which investigated water chemistry characteristics of the stream and concluded that a biological study might better characterize stream water quality. Additionally, this report may be useful to the Town of Cherry Valley in carrying out its comprehensive plan (CVCPC, 2007).

To characterize water quality based on benthic macroinvertebrate communities, a traveling kick sample was collected from riffle areas at each of five sites on Cherry Valley Creek. Methods used are described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of 100-specimen subsamples from each site. Macroinvertebrate community parameters used in the determination of water quality included: species richness, biotic index, EPT richness, and percent model affinity (see Appendices II and III). The amount of expected variability of results is stated in Smith and Bode (2004). Table 1 provides a listing of sampling sites, and Table 5 provides a listing of all species collected in the present survey. This is followed by macroinvertebrate data reports (Table 6), including raw data from each site.

Fish communities were also surveyed at each site on September 17, 2007 using a back-pack electro-shocker following the methods described in Bode et al. (2002). Fish community parameters used in determination of water quality included: species richness, percent non-tolerant individuals, percent non-tolerant species, and percent model affinity by trophic class (see Appendix VI). Fish species information collected on the day of sampling as well as results of the fish community metrics, are listed in Table 9.

Using multiple biological assemblages for the determination of water quality is thought to provide greater accuracy in impairment detection and significantly decrease the uncertainty in the overall assessment (USEPA 1996). Different assemblages may be more sensitive to different stressors. For example fish are more mobile and more likely to seek refuge from disturbance while macroinvertebrates are less so. Therefore macroinvertebrates are sensitive and indicative of localized disturbance. However, macroinvertebrates have shorter life cycles while fish persist for many years, making fish good indicators of long term effects that may occur (USEPA 1999).

To integrate the assessment information for both benthic macroinvertebrates and fish, the biological assessment profile were combined and the average of the two was used to assess overall water quality in the creek (Figure 7). Individual assessment profiles are plotted as well. This method capitalizes on the diversity of information provided by both assemblages.

Results and Conclusions:

1. Based on the combination of assessments using both macroinvertebrate and fish assemblages, water quality in the Cherry Valley Creek ranged from slightly impacted to non-impacted.

2. On the day of the survey, the site upstream of the Village of Cherry Valley (CHER-A) was dry. Without a comparison to a station located upstream of the village it is difficult to determine if the slight impact noted just downstream is wholly attributable to development in the village. Septic systems in the village may be a factor influencing water quality at these sites.

3. Improved water quality as sampling proceeded downstream can be attributed to an increase in forest cover and increased flow contributed by tributaries.

Discussion:

Cherry Valley Creek flows for approximately 30 river miles from its headwaters approximately 3 river miles above the village of Cherry Valley, NY to its confluence with the Susquehanna River just east of Milford, NY (Figure 1). The mainstem of Cherry Valley Creek is classified as C for its entire length, meaning its best designated use is for fishing. Class C rivers and streams must be "suitable for fish propagation and survival" and "the water quality shall be suitable for primary and secondary contact recreation, although other factors may limit its use for these purposes" (Water Quality Regulations Title 6, Chapter X Parts 700-706).

Two stream reaches are designated (T) for trout waters, dictating more stringent water quality standards. These are in the area of Westville and the Village of Cherry Valley. Until 1993, the stream was stocked by the NYSDEC with brown trout, but at one time had a substantial wild trout population (Butler and Payne 2006).

The Stream Biomonitoring Unit (SBU) sampled Cherry Valley Creek on July 25, 2007 to determine water quality based on resident benthic macroinvertebrates. The survey was meant as a follow up to the recommendations of the water chemistry study of Cherry Valley Creek by Butler and Payne (2006). Their study, in response to concern over possible fisheries degradation resulting from water quality declines, found no obvious impact to the stream. They recommended the evaluation of benthic invertebrate populations to further investigate water quality. In addition, the Village of Cherry Valley, which is located at the headwaters of the creek, is known to have problematic septic systems and storm sewers that contribute contaminated runoff to the stream (CVCPC, 2007). As part of the Town of Cherry Valley's Draft Comprehensive Plan (2007) the water quality degradation of Cherry Valley Creek and other area streams are listed as issues for the town to address. The plan recommends "initiating a stream water-quality monitoring program in order to determine any sources of pollutants." The SBU's effort presented here should help achieve the goals of the Cherry Valley Plan.

Five sites were sampled by the SBU, (Figures 1 – 6). On the day of the survey, a sixth site upstream of the village of Cherry Valley the creek was dry. As a result, the study presented here does not include data that would characterize conditions upstream of the village. Station 00 (Figure 3) is located just downstream of the village of Cherry Valley and provides adequate representation of water quality impacts that may be contributed by the village. The remaining four sites (Figures 3-6) are separated by approximately equal distances until the creek joins with the Susquehanna River. In addition to benthic macroinvertebrate collections on September 17, 2007 sampling of fish communities at the same five locations was also conducted using backpack electro-shocking techniques.

The use of both benthic macroinvertebrate and fish community assessments in combination provides a more complete picture of Cherry Valley Creek's ability to support aquatic life than the assessment of a single biological assemblage. Use of more than one assemblage is thought to provide greater accuracy in impairment detection and significantly decrease the uncertainty in the overall assessment (USEPA 1996). Therefore, the biological assessment profiles for both benthic macroinvertebrates and fish were combined and the average of the two was used to assess overall water quality in the creek (Figure 7). Appendices 2-6 include details on calculating the individual Biological Assessment Profiles (BAP) Scores for both macroinvertebrates and fish. Using the combination of both biological assemblages, water quality in the creek ranged from slightly impacted at stations 00 and 01, to non-impacted at stations 02, 03 and 04.

Previous sampling of Cherry Valley Creek was conducted at a single site (station 01) in 1997 and 2003 as part of the New York State ambient water quality monitoring program sampling cycle. Water quality was assessed as slightly impaired in both previous years. When using only benthic macroinvertebrate data from this 2007 survey however, water quality was assessed as non-impacted, signifying improved water quality at this site.

Without a comparison to a station located upstream of the Village of Cherry Valley, it is difficult to determine if the slight impact noted at station 00 and 01 is wholly attributable to development in the town. The rebound to non-impacted (Figure 7) downstream at stations 02, 03, and 04, and the lack of New York State permitted discharges to the stream suggests that there are no other major factors in the area that would limit water quality. The absence of a sewage treatment plant and use of septic systems could contribute to non-point source nutrient runoff and support the findings of the water quality assessment at station 00 and 01.

Using only benthic macroinvertebrate data all sites are considered either mesotrophic or eutrophic based on the nutrient biotic index for phosphorus (NBI-P), and either oligotrophic, mesotrophic, or eutrophic based on the nutrient biotic index for nitrogen (NBI-N) (Figure 8, see Appendix XI). Impact source determination (ISD) (Table 3), identifies most sites, except for station 04, as having invertebrate communities affected by nonpoint-source nutrient runoff. Station 04 is identified as natural. Although a predominantly forested watershed, agricultural activities may contribute to nonpoint-source runoff. Land-use analysis of the watersheds upstream of each sampling station suggest increasing forest cover and decreasing agricultural and developed land cover from upstream to downstream (Figure 9 and Table 4). Comparison of forest cover data to the combined macroinvertebrate and fish BAP scores shows the two track each other closely (Figures 7 and 9).

The improvement in water quality from station 00 to 04 can be attributed to distance from the village of Cherry Valley, the increase in forest cover, and the additional volume of water contributed by many adjoining tributaries. A short distance upstream of station 01 stream order changes from 3rd order (station 00) to 4th order (station 01), and then 5th order(stations 02-04). The increase in volume likely acts to dilute nonpoint-source runoff added further upstream in the watershed.

Overall, clean-water mayflies, stoneflies, and caddisflies were lacking in significant abundance at each station. The invertebrate community was dominated by either riffle beetles (*Optioservus, Stenelmis*) or net-spinning caddisflies (*Hydropsyche, Cheumatopsyche*). Dominance by these groups of insects is common in enriched stream environment. Excess nutrients increase autotrophic productivity and provide an abundance of attached and suspended algal material, which is used as food predominately by riffle beetles and net-spinning caddisflies respectively. Additionally, examination of dominant invertebrate feeding groups (Figure 10) suggests an increase in the percent of collector filterers and scrapers downstream, while collector gatherer and shredding invertebrates either decrease or show no change. These trends are expected as a stream increases in size and becomes more autotrophic in nature. Habitat changes significantly from station 00 to 01 and should be considered partly responsible for the change in water quality. Benthic macroinvertebrate communities are more sensitive to changes in stream habitat than fish and this may be why invertebrate data alone at station 01 appears much better than at station 00. Use of the fish data in this situation assists in reducing the variability associated with habitat affects on benthic invertebrate analyses.

Although water-quality assessment data indicates that use of the stream for fishing is unimpaired at all sites (per criteria defined in NYSDEC 2002), stations 00 and 01 are slightly impacted, which deviates from the natural condition of non-impacted. The ability of Cherry Valley Creek to recover to non-impacted conditions further downstream suggests that with proper watershed-management practices, water quality in the upper reaches could be improved to non-impacted. Therefore, it is recommended that further investigation be conducted to identify the exact sources of impact at stations 00 and 01, and a watershed plan be developed using best-management practices to mitigate those sources. If the concern is the influence of septic systems in the Village of Cherry Valley area, bacteria testing, including total and fecal coliform, should be conducted. Additionally, isotope studies to investigate the sources of nitrogen would be useful in pinpointing whether or not nutrient enrichment in the stream is the result of human/animal wastes, organic soil materials, or commercial fertilizers.

Literature Cited

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, and A. J. Smith. 2002. *Quality Assurance Work Plan for Biological Stream Monitoring in New York State*. New York State Department of Environmental Conservation, Technical Report, 115 pages.

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Table 1. Station locations for the Cherry Valley Creek, Otsego County, New York, 2007.

Station	Location
CHER-00	Below Cherry Valley, NY 100 meters below Route 166 Latitude: 42° 47’ 32” Longitude: 74° 45’ 26”


Station - 00

Station	Location
CHER-01	Above Roseboom, NY 100 meters below road off Route 166 Latitude: 42° 45’ 33” Longitude: 74° 46’ 17”


Station - 01

Station	Location
CHER-02	Middlefield, NY 50 meters above County Route 35 Latitude: 42° 41’ 23” Longitude: 74° 50’ 32”


Station - 02

Station	Location
CHER-03	Westville, NY 30 meters below County Route 43 Latitude: 42° 37’ 57” Longitude: 74° 52’ 58”


Station - 03

Station	Location
CHER-04	Above Milford, NY 20 meters below County Route 35 Latitude: 42° 35’ 36” Longitude: 74° 55’ 40”

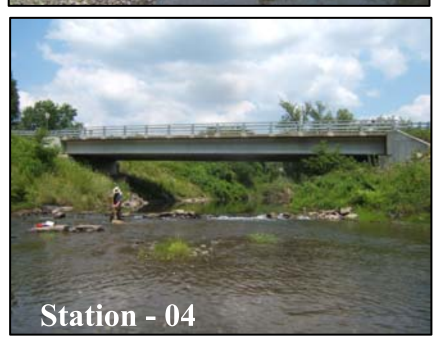

Station - 04

Figure 1. Watershed overview map, Cherry Valley Creek, Otsego County, NY.

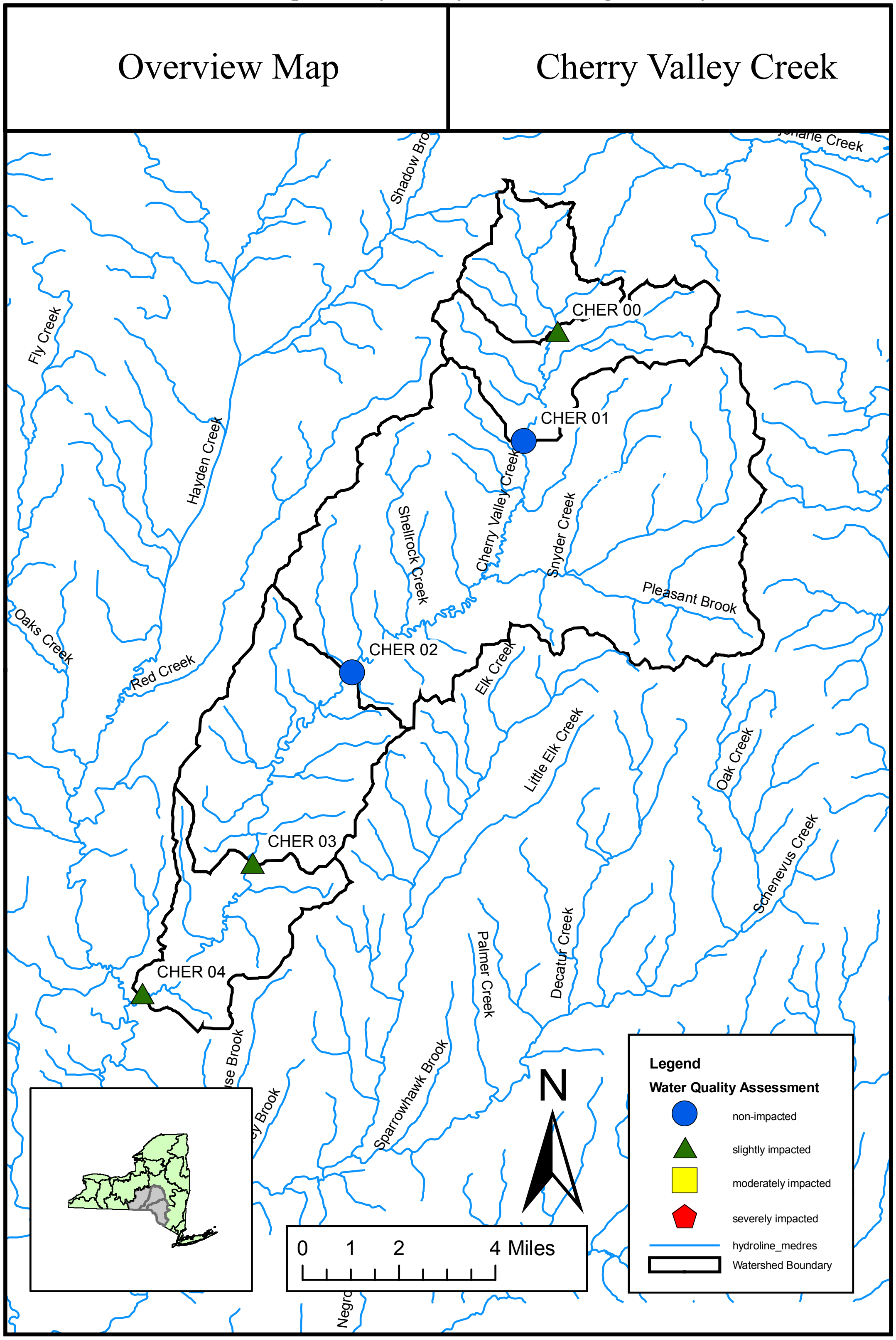


Figure 2. Map of Cherry Valley Creek Station 00

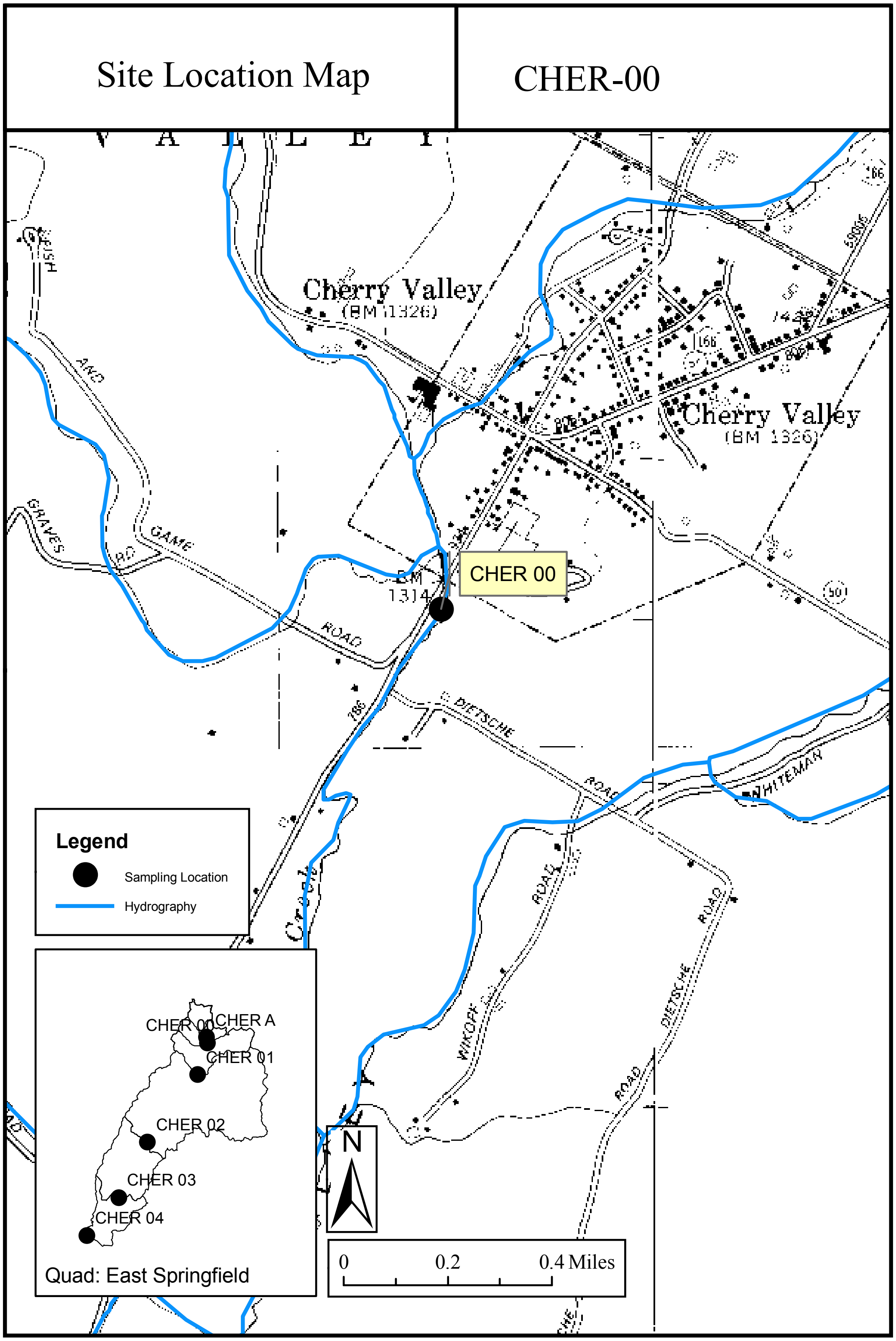


Figure 3. Map of Cherry Valley Creek Station 01

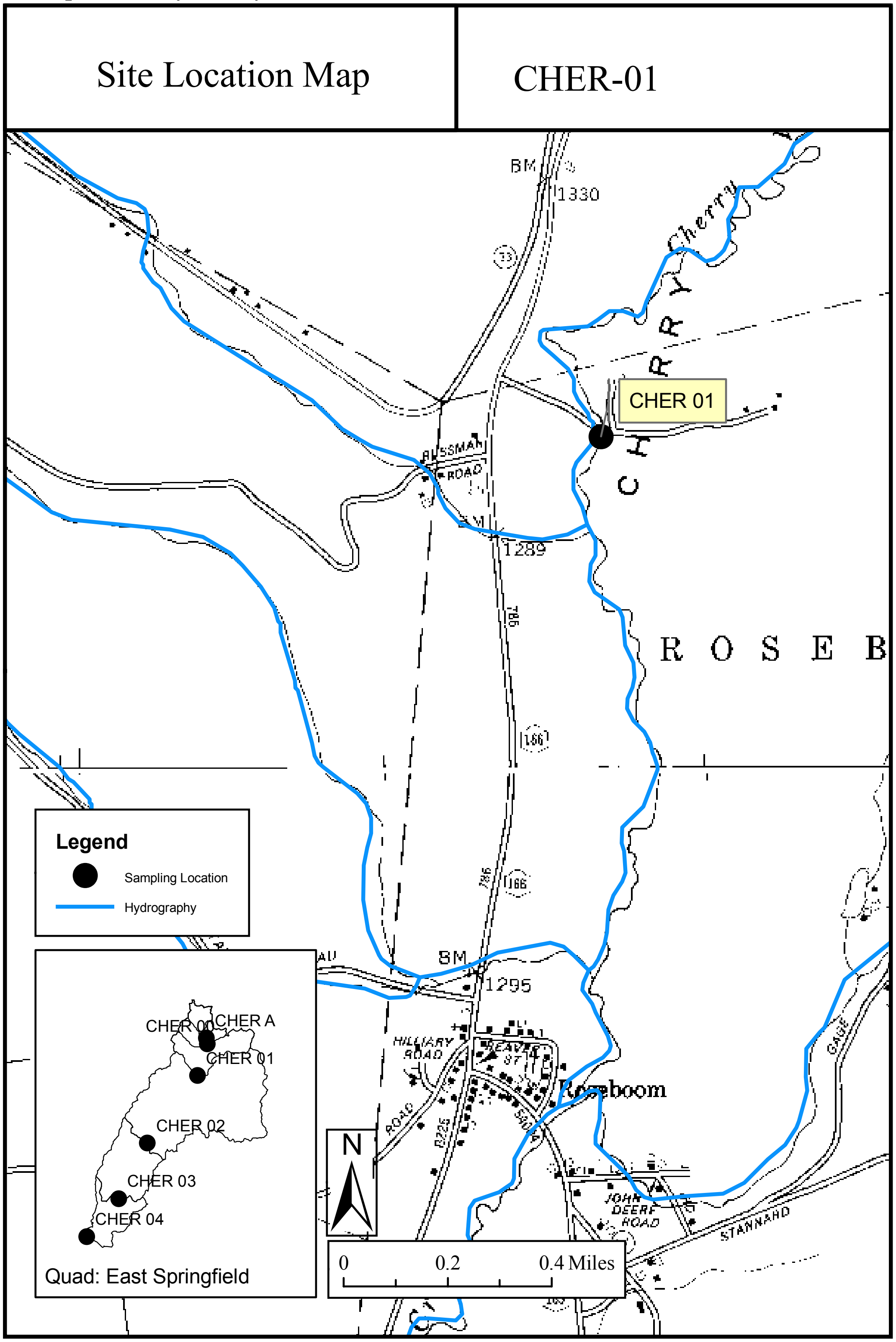


Figure 4. Map of Cherry Valley Creek Station 02

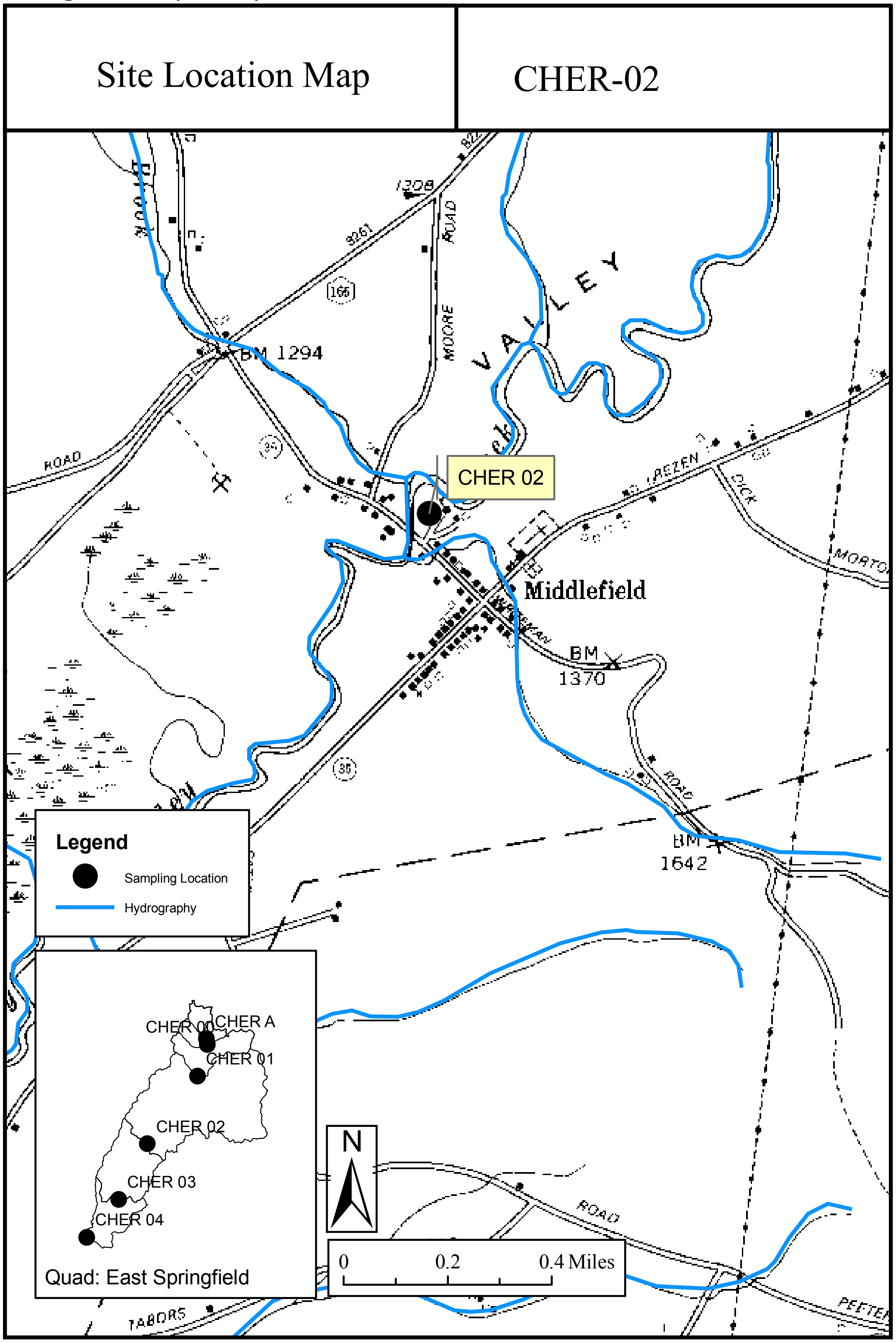


Figure 5. Map of Cherry Valley Creek Station 03

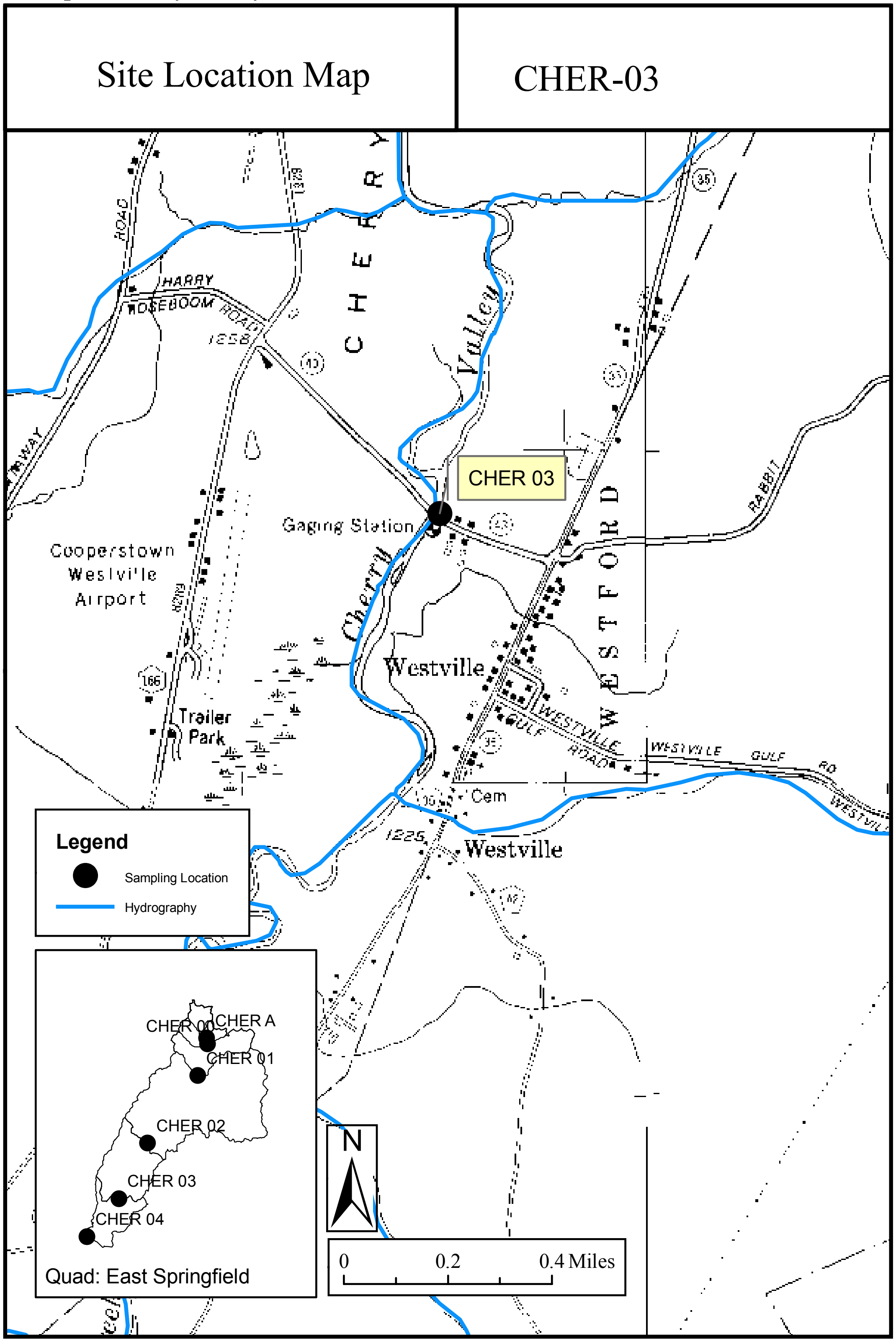


Figure 6. Map of Cherry Valley Creek Station 04

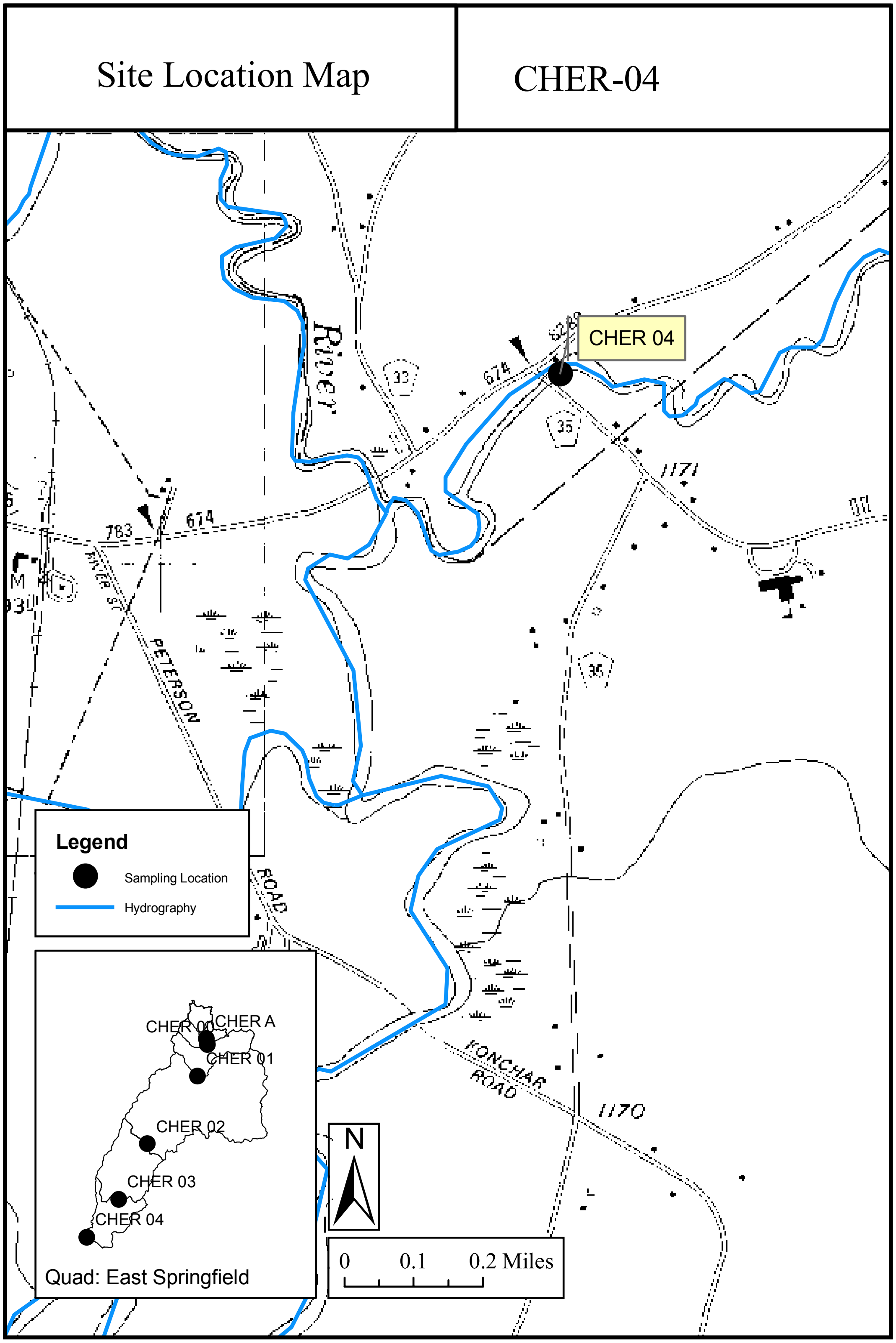


Figure 7. Individual Biological Assessment Profiles for both invertebrate (BAP) and fish (FAP) communities, as well as a combined mean invertebrate and fish assessment profile of index values, Cherry Valley Creek, 2007. Values are plotted on a normalized scale of water quality. For details on the calculation of these individual multimetrics, see Appendices 2-6.

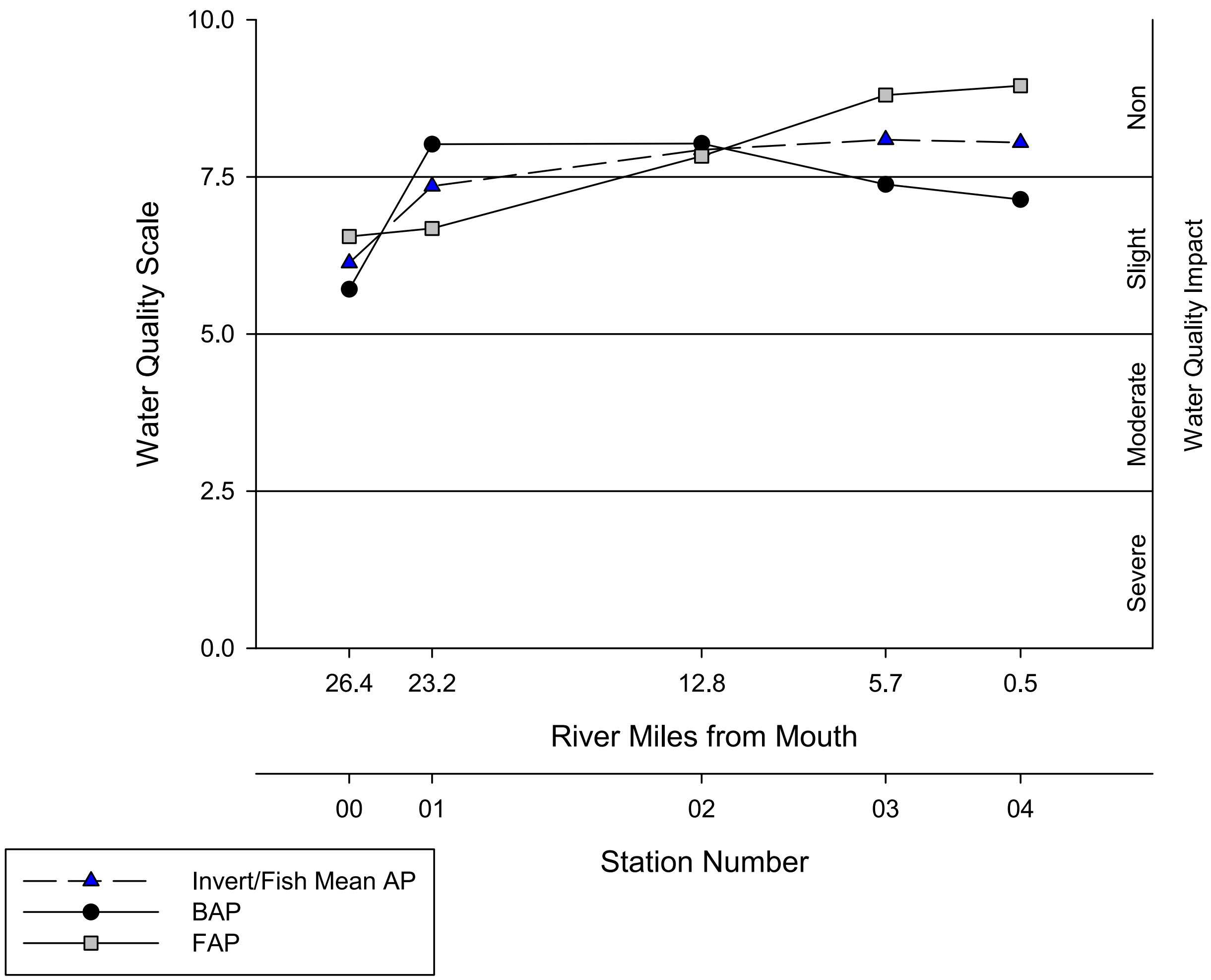
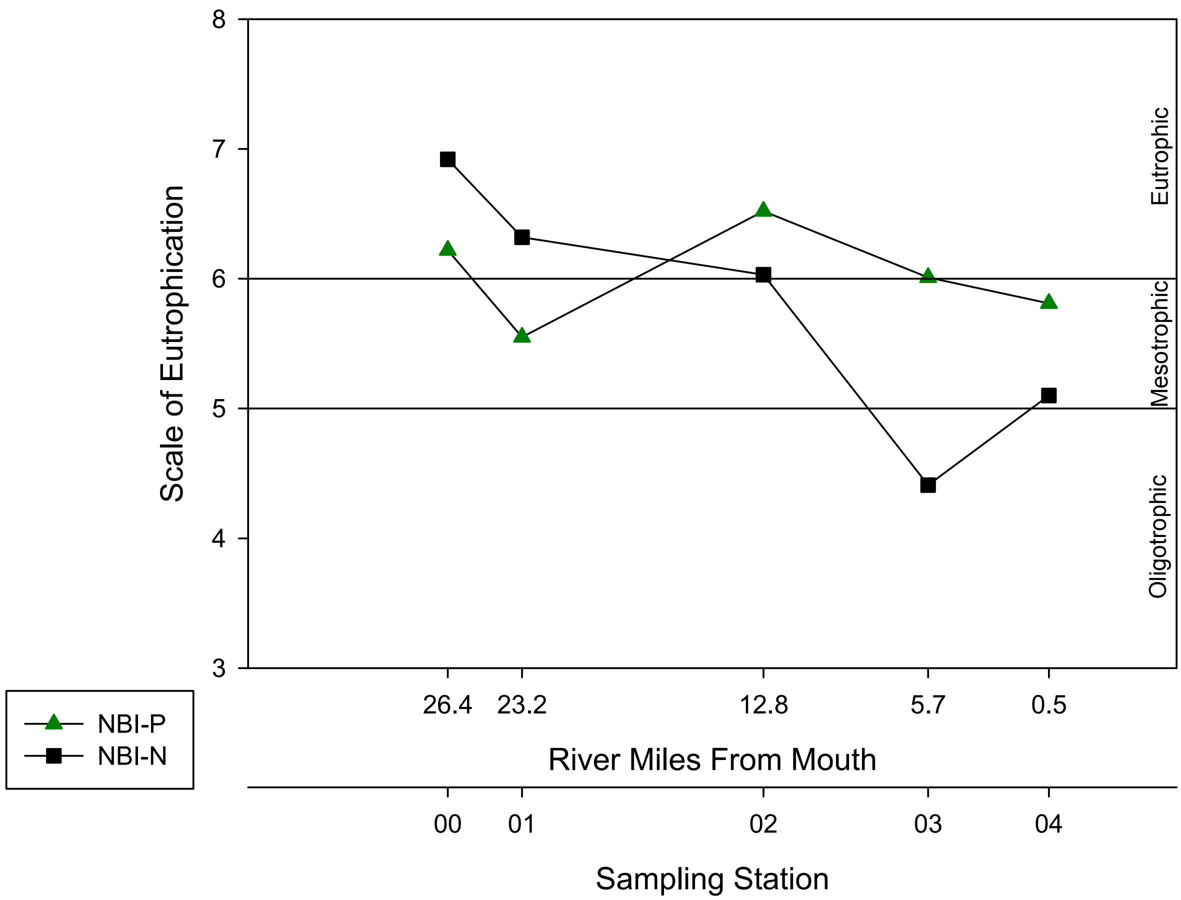


Table 2. Overview of field data

Location	Station	Depth (meters)	Width (meters)	Current (cm/sec)	Canopy (%)	Embed. (%)	Temp. ^{o}C	Cond. (µmol/cm)	pH (units)	DO (mg/l)	DO Sat. (%)
CHER	00	0.1	2	70	0	30	16	686	7.3	10.2	103
CHER	01	0.1	5	100	10	30	18	458	7.7	9.3	97
CHER	02	0.2	10	100	10	30	19	227	7.5	6.8	74
CHER	03	0.2	10	100	10	30	21	215	8.0	9.6	107
CHER	04	0.2	20	80	5	30	20	208	8.1	10.2	113

Figure 8. Nutrient Biotic Index values for Phosphorus (NBI-P) and Nitrogen (NBI-N). NBI values are plotted on a scale of eutrophication from oligotrophic to eutrophic. See Appendix XI for a detailed explanation of the index. Eutrophic conditions are likely to have adverse effects on natural in-stream biological communities.



Summary of Cherry Valley Trophic Conditions:

Station	Phosphorus	Nitrogen
CHER-00	Eutrophic	Eutrophic
CHER-01	Mesotrophic	Eutrophic
CHER-02	Eutrophic	Eutrophic
CHER-03	Eutrophic	Oligotrophic
CHER-04	Mesotrophic	Mesotrophic

Table 3. Impact Source Determintation (ISD), Cherry Valley 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 XII for further explanation.

Community Type	CHER-00	CHER-01	CHER-02	CHER-03	CHER-04
Natural: minimal human disturbance	44	56	41	51	51
Nutrient Enrichment: mostly nonpoint, agricultural	54	65	62	69	48
Toxic: industrial, municipal, or urban run-off	39	33	41	43	28
Organic: sewage effluent, animal wastes	34	41	54	57	30
Complex: municipal/industrial	35	26	49	55	22
Siltation	37	52	49	43	44
Impoundment	34	45	53	60	37

Summary of ISD results

Station	Community Type
CHER-00	Nutrient Enriched
CHER-01	Nutrient Enriched
CHER-02	Nutrient Enriched
CHER-03	Nutrient Enriched
CHER-04	Natural

Figure 9. Percent land cover for major land-use types within the Cherry Valley Creek sampling point watersheds. Landcover data was generated using the 2006 National Land Cover dataset.

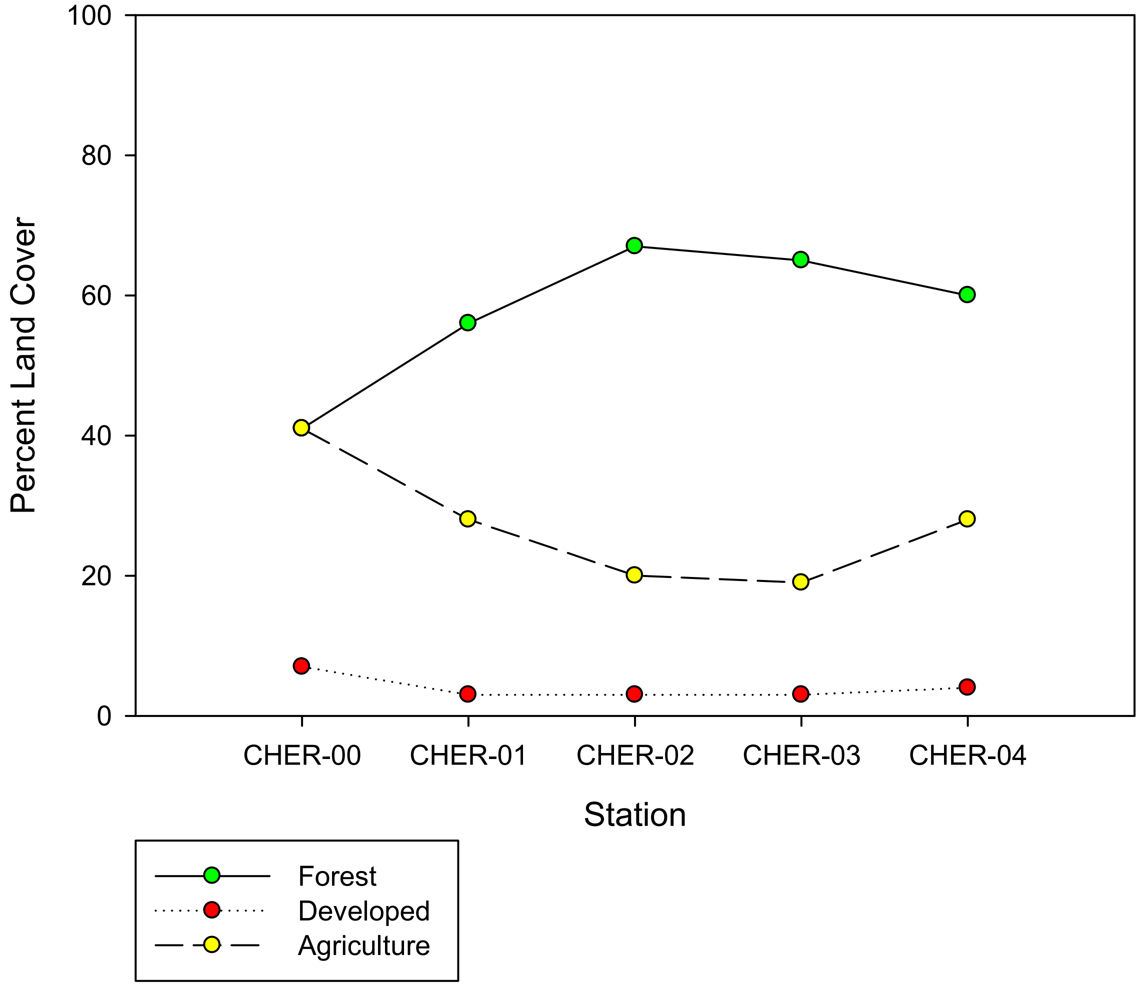


Table 4. Summary of percent land cover results.

Station	% Forest	% Developed	% Agriculture	% Impervious Surface
CHER-00	41	7	41	3
CHER-01	56	3	28	1
CHER-02	67	3	20	1
CHER-03	65	3	19	1
CHER-04	60	4	28	1

Figure 10. Percent contribution of benthic macroinvertebrate functional feeding groups from Cherry Valley Creek sampling locations. Functional feeding groups are abbreviated as follows: shredder (shr), scraper (scr), predator (prd), collector-gatherer (c-g), collector-filterer (c-f).

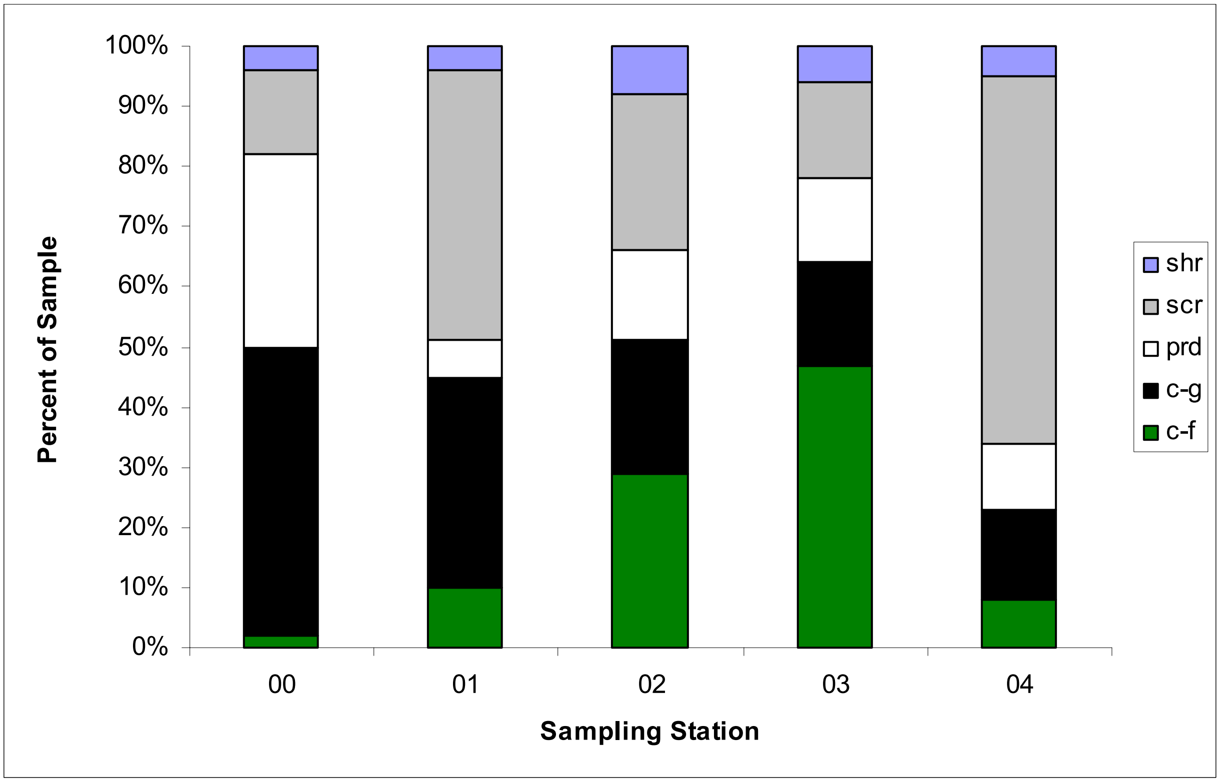


Table 5. Macroinvertebrate species collected in the Cherry Valley Creek - 2007.

ANNELIDA
OLIGOCHAETA
LUMBRICIDA
Undetermined Lumbricina

MOLLUSCA
GASTROPODA
BASOMMATOPHORA
Physidae
Physella sp.

ARTHROPODA
CRUSTACEA
AMPHIPODA
Gammaridae
Gammarus sp.

DECAPODA
Cambaridae
Cambarus sp.

INSECTA
EPHEMEROPTERA
Isonychiidae
Isonychia bicolor
Baetidae
Acentrella sp.
Acerpenna pygmaea
Baetis flavistriga
Baetis intercalaris
Heptageniidae
Epeorus (Iron) sp.
Leucrocuta sp.
Stenacron interpunctatum
Stenonema modestum
Leptophlebiidae
Paraleptophlebia sp.
Ephemerellidae
Serratella sp.
Leptohyphidae
Tricorythodes sp.
Caenidae
Caenis sp.
Potamanthidae
Anthopotamus sp.

PLECOPTERA
Leuctridae
Leuctra sp.
Perlidae
Acroneuria abnormis
Acroneuria carolinensis
Agnetina capitata
Paragnetina media

COLEOPTERA
Dytiscidae
Agabus sp.
Hydrophilidae
Hydrobius sp.
Psephenidae
Psephenus herricki
Elmidae
Dubiraphia vittata
Optioservus fastiditus
Optioservus trivittatus
Stenelmis crenata

MEGALOPTERA
Corydalidae
Nigronia serricornis
Sialidae
Sialis sp.

TRICHOPTERA
Philopotamidae
Chimarra aterrima?
Chimarra obscura
Chimarra socia

Hydropsychidae
Cheumatopsyche sp.
Hydropsyche betteni
Hydropsyche bronta
Hydropsyche morosa
Hydropsyche slossonae
Hydropsyche sparna
Rhyacophilidae
Rhyacophila formosa
Hydroptilidae
Hydroptila sp.

DIPTERA
Tipulidae
Antocha sp.
Dicranota sp.
Tipula sp.
Simuliidae
Simulium tuberosum
Athericidae
Atherix sp.
Stratiomyidae
Stratiomys sp.
Empididae
Hemerodromia sp.
Muscidae
Undetermined Muscidae
Chironomidae
Ablabesmyia mallochi
Conchapelopia sp.
Thienemannimyia gr. spp.
Cricotopus bicinctus
Orthocladius sp.
Paracricotopus sp.
Parametriocnemus lundbecki
Microtendipes pedellus gr.
Polypedilum fallax gr.
Polypedilum flavum
Polypedilum illinoense
Micropsectra sp.
Rheotanytarsus exiguus gr.
Stempellinella sp. 1
Sublettea coffman

Table 6. Macroinvertebrate Data Reports (MDR)

STREAM SITE: Cherry Valley Creek, Station 00
LOCATION: Below Cherry Valley, NY
DATE: 7/25/2007
SAMPLE TYPE: Kick
SUBSAMPLE: 100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Leptophlebiidae	*Paraleptophlebia* sp.	1
	Leptohyphidae	*Tricorythodes* sp.	1
PLECOPTERA	Leuctridae	*Leuctra* sp.	1
	Perlidae	*Agnetina capitata*	3
COLEOPTERA	Dytiscidae	*Agabus* sp.	2
	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus fastiditus*	40
		Stenelmis crenata	9
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche* sp.	19
		Hydropsyche slossonae	2
DIPTERA	Tipulidae	*Antocha* sp.	1
		Dicranota sp.	1
		Tipula sp.	2
	Chironomidae	*Conchapelopia* sp.	9
		Orthocladius sp.	1
		Microtendipes pedellus gr.	2
		Polypedilum fallax gr.	2
		Polypedilum flavum	2
		SPECIES RICHNESS:	19
		BIOTIC INDEX:	4.5
		EPT RICHNESS:	6
		MODEL AFFINITY:	47
		ASSESSMENT:	Slight

Description: This is the most upstream station sampled on the date of the biological assessment survey. The sample was collected 100 meters downstream of the Route 166 bridge just outside of Cherry Valley, NY. The macro-invertebrate community was well represented by many different groups of aquatic insects including mayflies, stoneflies, and caddisflies. The fauna was field assessed as good. Laboratory analysis found very few sensitive mayflies and stoneflies, and an abundance of riffle beetles and net-spinning caddisflies. The station was assessed as slightly impacted.

Table 6 continued. Macroinvertebrate Data Reports (MDR)

STREAM SITE:	Cherry Valley Creek, Station 01
LOCATION:	Above Roseboom, NY
DATE:	7/25/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA
INSECTA

Order	Family	Taxon	Count
EPHEMEROPTERA			
	Baetidae	*Acerpenna pygmaea*	4
		Baetis flavistriga	4
		Baetis intercalaris	1
	Heptageniidae	*Leucrocuta* sp.	8
		Stenacron interpunctatum	1
		Stenonema modestum	6
	Leptohyphidae	*Tricorythodes* sp.	1
PLECOPTERA	Perlidae	*Acroneuria carolinensis*	3
		Agnetina capitata	1
COLEOPTERA	Elmidae	*Optioservus fastiditus*	19
		Optioservus trivittatus	6
		Stenelmis crenata	23
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	2
	Hydropsychidae	*Cheumatopsyche* sp.	2
		Hydropsyche betteni	1
		Hydropsyche bronta	1
		Hydropsyche slossonae	4
DIPTERA	Tipulidae	*Dicranota* sp.	1
	Athericidae	*Atherix* sp.	5
	Empididae	*Hemerodromia* sp.	1
	Chironomidae	*Conchapelopia* sp.	1
		Parametriocnemus lundbecki	1
		Polypedilum flavum	1
		Polypedilum illinoense	1
		Stempellinella sp. 1	1
		Sublettea coffmani	1
		SPECIES RICHNESS:	26
		BIOTIC INDEX:	3.8
		EPT RICHNESS:	14
		MODEL AFFINITY:	62
		ASSESSMENT:	Non

Description: Station 01 was located above the town of Roseboom and the the sample was collected 100 meters downstream from an unnamed road off Route 166. In the field, the benthic macroinvertebrate community was assessed as good and was noted to be diverse but enriched. In the laboratory, processing the sample again found an abundance of riffle beetles, however, the entire community was more diverse than the upstream station with many more mayfly taxa. The site was assessed as non-impacted.

Table 6 continued. Macroinvertebrate Data Reports (MDR)

STREAM SITE:	Cherry Valley Creek, Station 02
LOCATION:	Middlefield, NY
DATE:	7/25/2007
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA			
		Undetermined Lumbricina	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	2
	Baetidae	*Baetis flavistriga*	1
		Baetis intercalaris	1
	Heptageniidae	*Stenonema modestum*	6
	Caenidae	*Caenis* sp.	1
PLECOPTERA	Leuctridae	*Leuctra* sp.	6
	Perlidae	*Acroneuria abnormis*	1
		Acroneuria carolinensis	1
COLEOPTERA	Elmidae	*Optioservus fastiditus*	4
		Optioservus trivittatus	8
		Stenelmis crenata	5
MEGALOPTERA	Sialidae	*Sialis* sp.	1
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	1
	Hydropsychidae	*Cheumatopsyche* sp.	6
		Hydropsyche betteni	4
		Hydropsyche bronta	17
		Hydropsyche morosa	3
		Hydropsyche slossonae	3
		Hydropsyche sparna	2
DIPTERA	Athericidae	*Atherix* sp.	10
	Chironomidae	*Conchapelopia* sp.	5
		Thienemannimyia gr. spp.	2
		Parametriocnemus lundbecki	1
		Microtendipes pedellus gr.	1
		Polypedilum flavum	7
		SPECIES RICHNESS:	26
		BIOTIC INDEX:	4.4
		EPT RICHNESS:	15
		MODEL AFFINITY:	63
		ASSESSMENT:	Non

Description: Station 02 is located in the town of Middlefield and the sample was collected from a riffle 50 meters upstream of the County Route 35 bridge. In the field, crew members noted collapsing clay banks with distinctly turbid, green/brown water (see photos page 6). Many net-spinning hydropsychid caddisflies were noted. The sample was dominated by several species of *Hydropsyche*. The site was assessed as non-impacted.

Table 6 continued. Macroinvertebrate Data Reports (MDR)

STREAM SITE: Cherry Valley Creek, Station 03
LOCATION: Westville, NY
DATE: 7/25/2007
SAMPLE TYPE: Kick
SUBSAMPLE: 100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA			
	Isonychiidae	*Isonychia bicolor*	3
	Baetidae	*Acentrella* sp.	6
		Baetis intercalaris	1
	Heptageniidae	*Leucrocuta* sp.	1
		Stenacron interpunctatum	1
	Ephemerellidae	*Serratella* sp.	2
	Caenidae	*Caenis* sp.	1
PLECOPTERA	Perlidae	*Acroneuria abnormis*	1
		Paragnetina media	4
COLEOPTERA	Psephenidae	*Psephenus herricki*	4
	Elmidae	*Optioservus trivittatus*	4
		Stenelmis crenata	7
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*?	1
		Chimarra obscura	1
		Chimarra socia	5
	Hydropsychidae	*Cheumatopsyche* sp.	4
		Hydropsyche bronta	13
		Hydropsyche morosa	20
		Hydropsyche sparna	8
DIPTERA	Athericidae	*Atherix* sp.	8
	Chironomidae	*Microtendipes pedellus* gr.	1
		Polypedilum flavum	2
		Rheotanytarsus exiguus gr.	1
		SPECIES RICHNESS:	24
		BIOTIC INDEX:	4.8
		EPT RICHNESS:	16
		MODEL AFFINITY:	53
		ASSESSMENT:	Slight

Description: The sample was collected from a riffle located in Westville, 30 meters downstream of the County Route 43 bridge. *Pteronarcys* stoneflies were noted in the field, however, they were not found in the processed sample. The stream was notably less turbid here. Facultative caddisflies again made up a significant portion of the community. The site was assessed as slightly impacted.

Table 6 continued. Macroinvertebrate Data Reports (MDR)

STREAM SITE: Cherry Valley Creek, Station 04
LOCATION: Above Milford, NY
DATE: 7/25/2007
SAMPLE TYPE: Kick
SUBSAMPLE: 100 organisms

ARTHROPODA			
CRUSTACEA			
AMPHIPODA			
	Gammaridae	*Gammarus* sp.	1
DECAPODA	Cambaridae	*Cambarus* sp.	1
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	4
	Baetidae	*Baetis flavistriga*	1
	Heptageniidae	*Epeorus* (Iron) sp.	1
		Leucrocuta sp.	8
		Stenonema modestum	2
	Potamanthidae	*Anthopotamus* sp.	1
PLECOPTERA	Perlidae	*Paragnetina media*	2
COLEOPTERA	Psephenidae	*Psephenus herricki*	2
	Elmidae	*Optioservus trivittatus*	40
		Stenelmis crenata	10
MEGALOPTERA	Corydalidae	*Nigronia serricornis*	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*?	1
		Chimarra socia	5
	Hydropsychidae	*Cheumatopsyche* sp.	5
		Hydropsyche bronta	1
		Hydropsyche sparna	3
	Rhyacophilidae	*Rhyacophila formosa*	1
DIPTERA	Simuliidae	*Simulium tuberosum*	4
	Athericidae	*Atherix* sp.	5
	Chironomidae	*Ablabesmyia mallochi*	1
		SPECIES RICHNESS:	22
		BIOTIC INDEX:	3.7
		EPT RICHNESS:	13
		MODEL AFFINITY:	50
		ASSESSMENT:	Slight

Description: Station 04 is located upstream of the town of Milford. The sample was collected from a riffle 20 meters downstream of the County Route 35 bridge. The stream was similar in condition to the previous two with greenish colored water and some turbidity although not as turbid as station 02. The fauna was field assessed as good and later assessed as slightly impacted after laboratory processing of the sample.

Table 7. Laboratory data summaries, Cherry Valley Creek, Otsego County, NY, 2007.

LABORATORY DATA SUMMARY				
STREAM NAME: Cherry Valley Creek				
DATE SAMPLED: 7/25/2007				
SAMPLING METHOD: Kick				
LOCATION	CHER	CHER	CHER	CHER
STATION	00	01	02	03
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME				
1.	Optioservus fastiditus 40 % intolerant beetle	Stenelmis crenata 23 % facultative beetle	Hydropsyche bronta 17 % facultative caddisfly	Hydropsyche morosa 20 % facultative caddisfly
2. Intolerant = not tolerant of poor water quality	Cheumatopsyche sp. 19 % facultative caddisfly	Optioservus fastiditus 19 % intolerant beetle	Atherix sp. 10 % intolerant snipe fly	Hydropsyche bronta 13 % facultative caddisfly
3. Facultative = occurring over a wide range of water quality	Stenelmis crenata 9 % facultative beetle	Leucrocuta sp. 8 % intolerant mayfly	Optioservus trivittatus 8 % intolerant beetle	Hydropsyche sparna 8 % facultative caddisfly
4. Tolerant = tolerant of poor water quality	Conchapelopia sp. 9 % facultative midge	Stenonema modestum 6 % intolerant mayfly	Polypedilum flavum 7 % facultative midge	Atherix sp 8 % intolerant snipe fly
5.	Agnetina capitata 3 % intolerant stonefly	Optioservus trivittatus 6 % intolerant beetle	Stenonema modestum 6 % intolerant mayfly	Stenelmis crenata 7 % facultative beetle
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	16 (5.0)	6 (6.0)	16 (5.0)	4 (3.0)
Trichoptera (caddisflies)	21 (2.0)	10 (5.0)	36 (7.0)	52 (7.0)
Ephemeroptera (mayflies)	2 (2.0)	25 (7.0)	11 (5.0)	15 (7.0)
Plecoptera (stoneflies)	4 (2.0)	4 (2.0)	8 (3.0)	5 (2.0)
Coleoptera (beetles)	52 (4.0)	48 (3.0)	17 (3.0)	15 (3.0)
Oligochaeta (worms)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)
Mollusca (clams and snails)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Crustacea (crayfish, scuds, sowbugs)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other insects (odonates, diptera)	5 (4.0)	7 (3.0)	11 (2.0)	9 (2.0)
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
SPECIES RICHNESS	19	26	26	24
BIOTIC INDEX	4.51	3.87	4.49	4.8
EPT RICHNESS	6	14	15	16
PERCENT MODEL AFFINITY	47	62	63	53
FIELD ASSESSMENT	Good	Good	Good	Good
OVERALL ASSESSMENT	slightly impacted	non-impacted	non-impacted	slightly impacted

Table 7 continued. Laboratory data summaries, Cherry Valley Creek, Otsego County, NY, 2007.

LABORATORY DATA SUMMARY				
STREAM NAME: Cherry Valley Creek				
DATE SAMPLED: 7/25/2007				
SAMPLING METHOD: Kick				
LOCATION	CHER			
STATION	04			
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME				
1.	Optioservus trivittatus 40 % intolerant beetle			
2. Intolerant = not tolerant of poor water quality	Stenelmis crenata 10 % facultative beetle			
3. Facultative = occurring over a wide range of water quality	Leucrocuta sp. 8 % intolerant mayfly			
4. Tolerant = tolerant of poor water quality	Chimarra socia 5 % intolerant caddisfly			
5.	Cheumatopsyche sp. 5 % facultative caddisfly			
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	1 (1.0)			
Trichoptera (caddisflies)	16 (6.0)			
Ephemeroptera (mayflies)	17 (6.0)			
Plecoptera (stoneflies)	2 (1.0)			
Coleoptera (beetles)	52 (3.0)			
Oligochaeta (worms)	0 (0.0)			
Mollusca (clams and snails)	0 (0.0)			
Crustacea (crayfish, scuds, sowbugs)	2 (2.0)			
Other insects (odonates, diptera)	10 (3.0)			
Other (Nemertea, Platyhelminthes)	0 (0.0)			
SPECIES RICHNESS	22			
BIOTIC INDEX	3.76			
EPT RICHNESS	13			
PERCENT MODEL AFFINITY	50			
FIELD ASSESSMENT	Good			
OVERALL ASSESSMENT	slightly impacted			

Table 8. Field data summaries, Cherry Valley Creek, Otsego County, NY, 2007.

FIELD DATA SUMMARY				
STREAM NAME: Cherry Valley Creek	**DATE SAMPLED:** 7/25/2007			
REACH:				
FIELD PERSONNEL INVOLVED: Bode/Heitzman				
STATION	00	01	02	03
ARRIVAL TIME AT STATION	10:30	9:30	12:00	1:00
LOCATION	CHER	CHER	CHER	CHER
PHYSICAL CHARACTERISTICS				
Width (meters)	2	5	10	10
Depth (meters)	0.1	0.1	0.2	0.2
Current speed (cm per sec.)	70	100	100	100
Substrate (%)				
Rock (>25.4 cm, or bedrock)				
Rubble (6.35 - 25.4 cm)	30	40	20	30
Gravel (0.2 - 6.35 cm)	20	30	40	30
Sand (0.06 - 2.0 mm)	20	10		20
Silt (0.004 - 0.06 mm)	30	20		20
Embeddedness (%)	30	30	30	30
CHEMICAL MEASUREMENTS				
Temperature (?C)	15.6	17.5	18.9	20.8
Specific Conductance (umhos)	686	458	227	215
Dissolved Oxygen (mg/l)	10.2	9.3	6.8	9.6
pH	7.3	7.7	7.5	8
BIOLOGICAL ATTRIBUTES				
Canopy (%)		10	10	10
Aquatic Vegetation				
Algae - suspended			X	X
Algae - attached, filamentous		X		
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)	X	X	X	X
Megaloptera (dobsonflies, damselflies)	X		X	
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X			
Simuliidae (black flies)				
Decapoda (crayfish)		X	X	X
Gammaridae (scuds)				
Mollusca (snails, clams)	X			
Oligochaeta (worms)				X
Other				X
FAUNAL CONDITION	Good	Good	Good	Good

Table 8 continued. Field data summaries, Cherry Valley Creek, Otsego County, NY, 2007.

FIELD DATA SUMMARY				
STREAM NAME: Cherry Valley Creek	**DATE SAMPLED:** 7/25/2007			
REACH:				
FIELD PERSONNEL INVOLVED: Bode/Heitzman				
STATION	04			
ARRIVAL TIME AT STATION	1:30			
LOCATION	CHER			
PHYSICAL CHARACTERISTICS				
Width (meters)	20			
Depth (meters)	0.2			
Current speed (cm per sec.)	80			
Substrate (%)				
Rock (>25.4 cm, or bedrock)				
Rubble (6.35 - 25.4 cm)				
Gravel (0.2 - 6.35 cm)				
Sand (0.06 - 2.0 mm)				
Silt (0.004 - 0.06 mm)				
Embeddedness (%)	30			
CHEMICAL MEASUREMENTS				
Temperature (?C)	20.4			
Specific Conductance (umhos)	208			
Dissolved Oxygen (mg/l)	10.2			
pH	8.1			
BIOLOGICAL ATTRIBUTES				
Canopy (%)	5			
Aquatic Vegetation				
Algae - suspended	X			
Algae - attached, filamentous	X			
Algae - diatoms	X			
Macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X			
Plecoptera (stoneflies)	X			
Trichoptera (caddisflies)	X			
Coleoptera (beetles)	X			
Megaloptera (dobsonflies, damselflies)				
Odonata (dragonflies, damselflies)				
Chironomidae (midges)				
Simuliidae (black flies)				
Decapoda (crayfish)	X			
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)	X			
Other	X			
FAUNAL CONDITION	Good			

Table 9. Fish species collected and metric summary, Cherry Valley Creek, Otsego County, NY, 2007.

Fish Species	CHER-00	CHER-01	CHER-02	CHER-03	CHER-04
Rhinichthys atratulus (blacknose dace)	12	4	0	1	0
Pimephales notatus (bluntnose minnow)	20	6	5	1	20
Culaea inconstans (brook stickleback)	10	0	0	0	0
Campostoma anomalum (central stoneroller)	12	0	0	0	0
Luxilus cornutus (common shiner)	30	0	20	0	3
Semotilus atromaculatus (creek chub)	70	30	30	12	0
Exoglossum maxillingua (cutlips minnow)	0	4	2	1	0
Semotilus corporalis (fallfish)	0	0	25	40	30
Etheostoma blennioides (greenside darter)	0	0	0	1	0
Nocomis biguttatus (hornyhead chub)	0	0	11	0	0
Micropterus salmoides (largemouth bass)	1	0	0	2	2
Rhinichthys cataractae (longnose dace)	1	2	0	0	1
Notropis volucellus (mimic shiner)	0	0	0	0	1
Cottus bairdi (mottled sculpin)	0	1	0	10	4
Hypentelium nigricans (northern hog sucker)	0	0	8	10	10
Lepomis gibbosus (pumpkinseed)	2	1	0	0	0
Nocomis micropogon (river chub)	0	25	0	8	1
Ambloplites rupestris (rock bass)	0	4	0	1	0
Notropis rubellus (rosyface shiner)	0	1	10	10	12
Percina peltata (shield darter)	0	0	25	40	40
Micropterus dolomieu (smallmouth bass)	0	0	25	10	20
Notropis hudsonius (spottail shiner)	0	0	7	0	0
Notropis procne (swallowtail shiner)	0	0	0	0	1
Etheostoma olmstedi (tessellated darter)	10	15	5	10	10
Catostomus commersoni (white sucker)	120	75	25	50	12
Perca flavescens (yellow perch)	0	0	0	0	1
Metrics					
Weighted Species Richness	13	12	11	14	12
Percent Non-Tolerant Individuals	27	34	70	70	80
Percent Non-Tolerant Species	73	75	78	81	88
Percent Model Affinity	32	38	55	61	70
Fish Assessment Profile Score	6.55	6.68	7.83	8.8	8.95
Overall Water Quality Assessment	Slight	Slight	Non	Non	Non

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; 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.

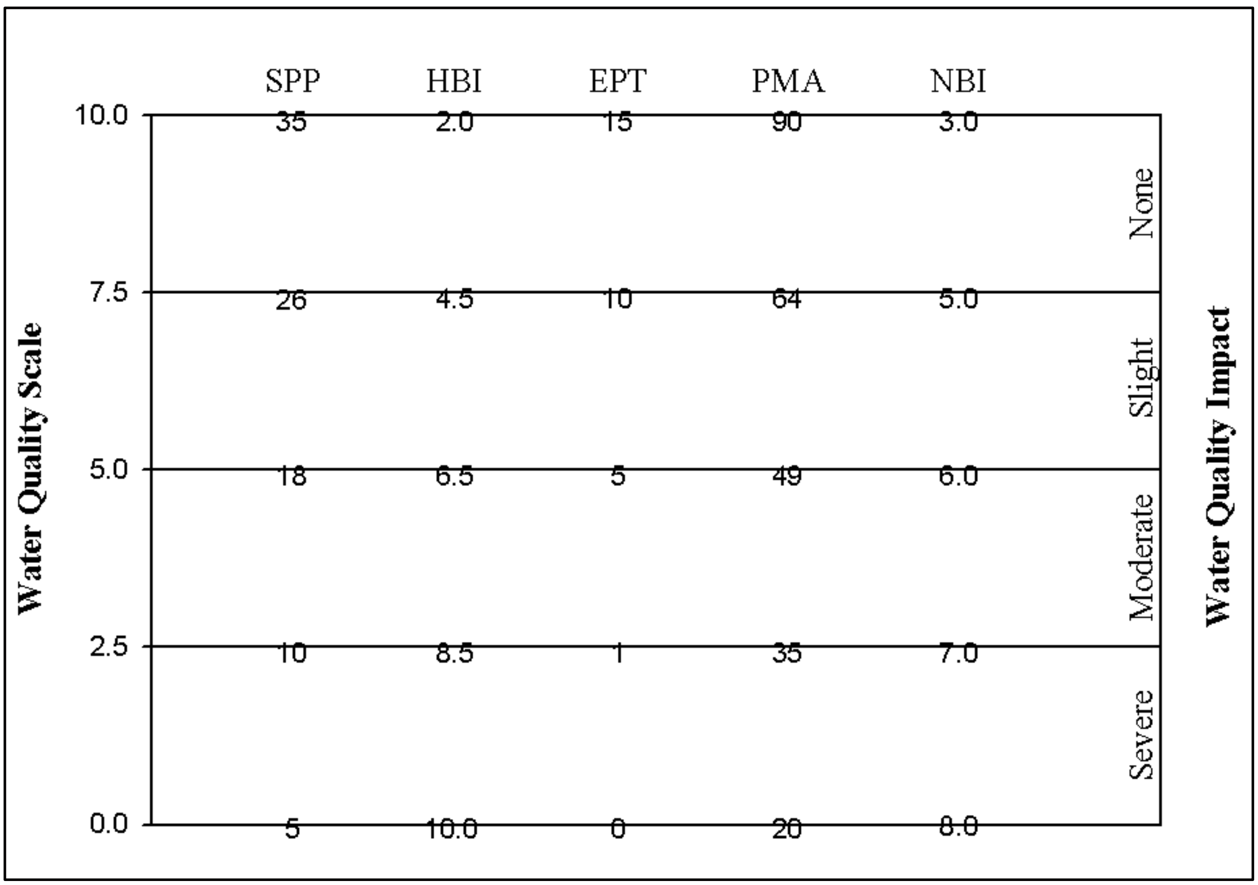
2. *Slightly impacted*: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50.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



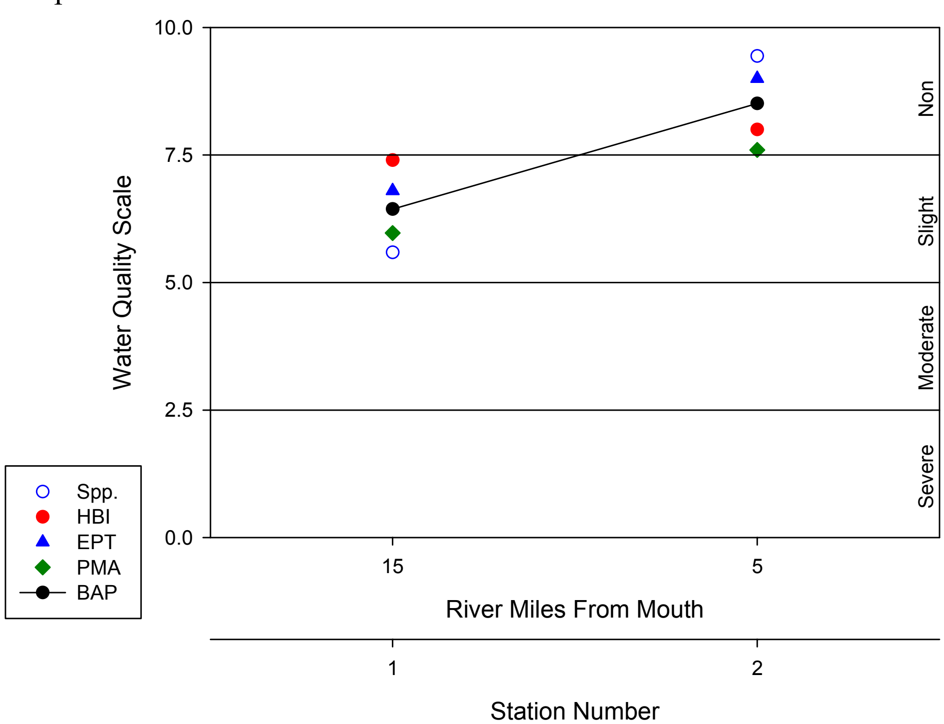
Appendix IV-B. Biological Assessment Profile: Plotting Values

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. Methods for Assessment of Water Quality Using Fish

A. Sampling: Sampling in wadeable streams consists of electrofishing for approximately 20 minutes, attempting to sample one pool and one riffle. A backpack electroshocker is used. All fish are identified, enumerated and released at the site.

B. Analysis of Data: Methods for interpretation of fish data with regard to water quality have not yet been standardized for northeastern streams. Four indices are presently used to assess water quality.

1. Weighted Species Richness:. Species richness is weighted by stream width using the following provisional formula where x= richness: for stream width 1-4 meters, value= x+2; for 5-9 meters, x; for 10-20 meters, x-2; for >20 meters, x-4. Maximum value= 10.

2. Percent Non-tolerant Individuals: The percentage of total individual organisms that are species considered intolerant or intermediate to environmental perturbations; this is the inverse of percent tolerant individuals. Tolerance ratings are derived from *Classification of freshwater fish species of the Northeastern United States* (Halliwell et al., 1998), with the exception of blacknose dace, which are here considered intermediate rather than tolerant.

3. Percent Non-tolerant Species: The percentage of total species that are considered intolerant or intermediate to environmental perturbations.

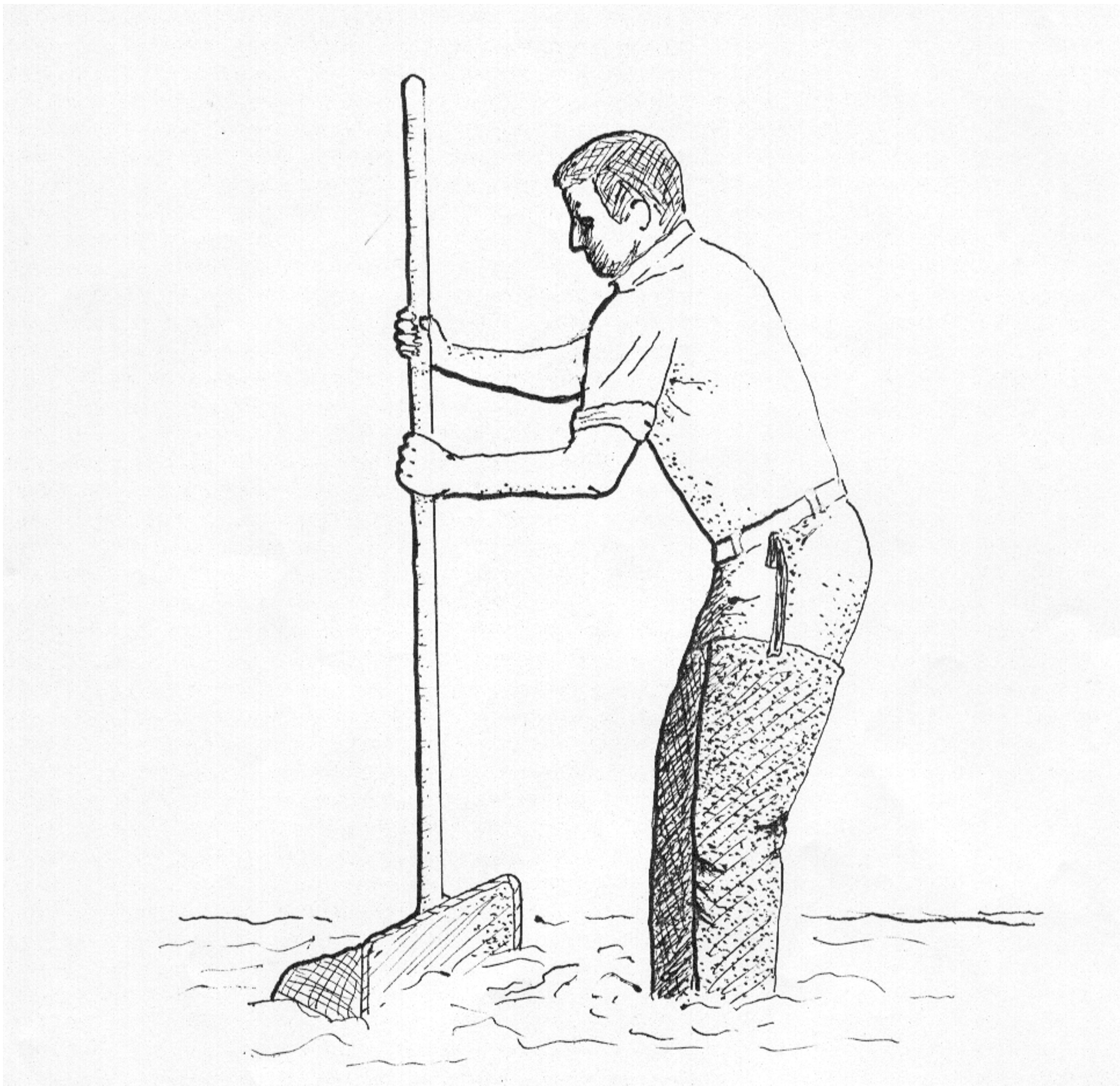
4. Percent Model Affinity, by Trophic Class. The highest percentage similarity of a sampled fish community with any of five models of non-impacted fish communities, by trophic class, as listed in Halliwell et al. (1998). The models are:

	A	B	C	D	E
Top carnivores	80	50	40	10	10
Insectivores	10	30	20	20	50
Blacknose dace	-	10	20	50	10
Generalist feeders	10	10	20	20	20
Herbivores	-	-	-	-	10

Overall assessment of water quality is assigned by *profile value*. Profile value = (Weighted Species Richness + 0.1[Percent Non-tolerant Individuals] + 0.1[Percent Non-tolerant Species] + 0.1[Percent Model Affinity]) ÷ 4. An adjustment factor may be applied when wild or juvenile trout are present and the overall assessment is other than non-impacted. In such cases, the profile value is adjusted up by the percentage contribution of the trout.

Halliwell, D.B., R.W. Langdon, R.A. Daniels, J.P. Kurtenbach, and R.A. Jacobson, 1998, Classification of freshwater fish species of the Northeastern United States for use in the development of indices of biological integrity, with regional applications. Chapter 12 In: Simon, T.P., ed. Assessing the sustainability and biological integrity of water resources using fish communities. CRC Press, Inc., 671 pages.

Appendix VII. The Traveling Kick Sample



←current

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

Appendix VIII - 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 VIII - 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 IX. 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 X: 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 XI. 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).

$$\text{NBI Score}_{(\text{TP or } NO_3^-)} = \sum (a \text{ x } b) / c$$

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
Hexatoma sp.	0	1
Hydropsyche betteni	7	9

TAXON	TP T-Value	NO3 T-Value
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 XII. Impact Source Determination Methods and Community Models

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

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

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

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

Impact Source Determination Models

NATURAL

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

Impact Source Determination Models

NONPOINT NUTRIENTS, PESTICIDES

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

Impact Source Determination Models

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

Impact Source Determination Models

SEWAGE EFFLUENT, ANIMAL WASTES

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

Impact Source Determination Models

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