New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Great Chazy River

Biological Assessment

2008 Survey

New York State
Department of Environmental Conservation

BIOLOGICAL STREAM ASSESSMENT

Great Chazy River
Lake Champlain Basin
Clinton County, NY

Survey date: July 2, 2008
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Stream: Great Chazy River

Reach: Coopersville to Ledger's Corner (Clinton County, NY)

River Basin: Lake Champlain

Background

The Stream Biomonitoring Unit sampled the Great Chazy River and its North Branch in Clinton County on July 2, 2008. Sampling was conducted to collect baseline water-quality data in this area of the Lake Champlain watershed. The survey was performed at the request of NYSDEC Region 5 to assess the impact of two Concentrated Animal Feeding Operations in the town of Champlain. The survey also added new data to historical sites and added new sites to assess the overall water quality of the river.

To characterize water quality based on benthic macroinvertebrate communities, a traveling kick sample was collected from riffle areas at each of five sites on the main stem and two on the north branch. Methods used are described in the Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State (Smith et al., 2009) 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). Expected variability of results is described in Smith and Bode (2004). Table 1 provides a listing of sampling sites, and Table 3 provides a listing of all species collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Results and Conclusions

1. Water quality of the Great Chazy River and its north branch was assessed as non-impacted for all sites. Agriculture, however, does appear to be causing some enrichment in the lower watershed that is not reflected in the final assessments.

2. Concentrated Animal Feeding Operations in the town of Champlain do not have a significant impact on the macroinvertebrate community. More subtle effects are not separable from other potential influences.

Discussion

The Great Chazy River originates in the western part of Clinton County, NY and flows eastward, emptying into northern Lake Champlain in the Town of Champlain. The Stream Biomonitoring Unit (SBU) conducted a Rapid Assessment Survey (RAS) of the river on July 2, 2008, at the request of the NYSDEC region 5 office, because of concerns related to Concentrated Animal Feeding Operations (CAFOs) in the Town of Champlain. The SBU also sampled new and established sites on both the main stem and North Branch to characterize the overall condition of the watershed and relate it to historical data. Sites were located from the village of Champlain upstream to Ellenburg Center (North Branch) and Ledgers Corner (main stem).

The biological condition of the Great Chazy River and its North Branch was found to be non-impacted at all sites (Figures 3 and 4). The most upstream location sampled (GCHZ-01) supported a natural community reflective of its largely undeveloped watershed that contains little agriculture compared to sites in the lower drainage (Figure 5). Land use is one of the most influential factors on water quality and biological integrity (Allan 2004, Miltner, et al. 2004, Paul and Meyer 2001). The next site downstream (GCHZ-02) showed a slight drop in the Biological Assessment Profile (BAP) but still maintained a high quality macroinvertebrate community. The Nutrient Biotic Index for nitrogen (NBI-N) showed an increase but the phosphorus index remained almost identical. Except for 1994, GCHZ-02 has supported a non-impacted biological community (Table 2).

The North Branch enters the main stem in Mooers Forks, approximately five miles below GCHZ-02. Both sites on the North Branch (NCHZ-01 and NCHZ-02) show a higher amount of macro-algal growth than main stem sites to this point, but still support non-impacted macroinvertebrate communities. Impact Source Determinations (ISD) (Table 4) suggest natural communities, but also indicate non-point source enrichment effects at NCHZ-02. This is likely a function of the agricultural land use (Figure 5). The 2008 sample shows a slightly higher BAP score than its only previous visit in 2003.

GCHZ-03, located 2.5 miles below the confluence with the North Branch, is a new site for this survey and showed a slight decrease in BAP score compared with both upstream main-stem sites. The river here is wider and shallower with less relative canopy cover. These changes may be contributing to the small decline by allowing increased light penetration and higher temperatures. The micro-algal index score (Table 5, Appendix XIV) increases compared to upstream and the Percent Model Affinity (PMA) (Appendix II) community metric was the only one that dropped significantly, likely due to a shift caused by the habitat change between this and upstream sites.

GCHZ- 04, on the main stem, maintained a BAP score consistent with GCHZ-03, but ISD indicates that the community is affected by a variety of stressors with siltation the most likely (Table 4). The pebble count found 14 percent substrate as sand (Table 7) and an elevated macro-algae cover (Figure 5). Fourteen percent sand in the substrate is above the 90th percentile for pebble counts in New York State. Sedimentation fills in interstitial space and can impact macroinvertebrate and other aquatic communities by eliminating habitat used for survival and reproduction (Chutter 1969, Berkman and Rabeni 1987, Asmus et al. 2009). The two CAFOs in question for this survey were upstream of GCHZ- 04, and may be contributing to the substrate condition and are a possible nutrient source causing the increase in raw HBI score (Table 6) at GCHZ 04 and 05. This section of the Chazy River also shows extensive reaches of wetland and row-crop agriculture. Further investigation would be necessary to determine the sediment and nutrient sources and the extent to which they are natural or anthropogenic.

GCHZ- 05 was first sampled in 1993 and again in 1994, 2003, and 2004, with all assessments except 2003, when it was found to be slightly impacted, indicating non-impacted conditions. This site and GCHZ-04 show signs of increasing nutrients that are likely linked to agriculture in the lower watershed as shown in Figure 8 and the macro-algae index score (Table 5). Enrichment has not yet, however, reduced biological integrity.

Biological assessment of the Great Chazy River does not reflect significant impact on its water quality. Ancillary data such as pebble counts, macro-algae index, and Impact Source Determinations, though, indicate increasing nutrient enrichment moving downstream reflective of the agriculture in the watershed. Evidence of CAFO impacts is inconclusive and a more targeted, in-depth study would be necessary to determine more direct, local impacts.

Literature Cited

Allan, J. D. 2004. Landscapes and riverscapes: The influence of land use on stream ecosystems. *Annual Review of Ecology, Evolution and Systematics* 35: 257-84.

Asmus, B., J. Magner, B. Vondracek and J. Perry. 2009. Physical integrity: The missing link in biological monitoring and TMDLs. *Environmental Monitoring and Assessment* 159:443-463

Berkman, H. and C. Rabeni. 1987. Effect of siltation on stream fish communities. *Environmental Biology of Fishes* 18:285-294

Chutter, F. M. 1969. The effects of silt and sand on the invertebrate fauna of streams and rivers. *Hydrobiologia* 34(1): 57-76.

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

Miltner, R. J., D. White, and C. Yoder. 2004. The biotic integrity of streams in urban and suburbanizing landscapes. *Landscape and Urban Planning* 69(1): 87-100.

Paul, M. J. and J. L. Meyer. 2001. Streams in the Urban Landscape. *Annual Reviews in Ecology and Systematics* 32(1): 333-365.

Smith, A. J., and R. W. Bode. 2004. Analysis of Variability in New York State Benthic Macroinvertebrate Samples. New York State Department of Environmental Conservation, Technical Report, 43 pages.

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

Smith, A. J., D. L. Heitzman, and B. T. Duffy. 2009. Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State. New York State Department of Environmental Conservation, Division of Water. Technical Report, 153 pages.

Table 1. Station Locations for the Great Chazy River, Clinton County, NY, 2008.

Station	Location
GCHZ-01	Ellenburg, NY at Ledger Corners Above Plank Rd. bridge River miles from mouth, 41.2 Latitude: 44.7825 Longitude: -73.76611

Station	Location
GCHZ-02	Altona, NY at Altona Below Route 191 bridge River miles from mouth, 29.4 Latitude: 44.88889 Longitude: -73.64528

Station	Location
GCHZ-03	Mooers, NY at Mooers Off Mill Street River miles from mouth, 21.3 Latitude: 44.95722 Longitude: -73.58861

Table 1 cont'd. Station Locations for Great Chazy River, Clinton County, NY, 2008.

GCHZ-04 Champlain, NY, at Twin Bridges
Above Route 11 bridge
River miles from mouth, 12.0
Latitude: 44.97667
Longitude: -73.51666

GCHZ-05 Champlain, NY at Champlain
50 m below Route 9 bridge
River miles from mouth, 6.7
Latitude: 44.98694
Longitude: -73.44945

Table 1 cont'd. Station Locations for North Branch Great Chazy River, Clinton County, NY, 2008.

NCHZ-01 Ellenburg, NY at Ellenburg Center
10 m above Route 54 bridge
River miles from mouth, 15.4
Latitude: 44.89139
Longitude: -73.84139

NCHZ-02 Mooers, NY at Mooers Forks
100 m above Route 11 bridge
River miles from mouth, 0.5
Latitude: 44.95722
Longitude: -73.64278

Figure 1. Overview Map, Great Chazy River, Clinton County.

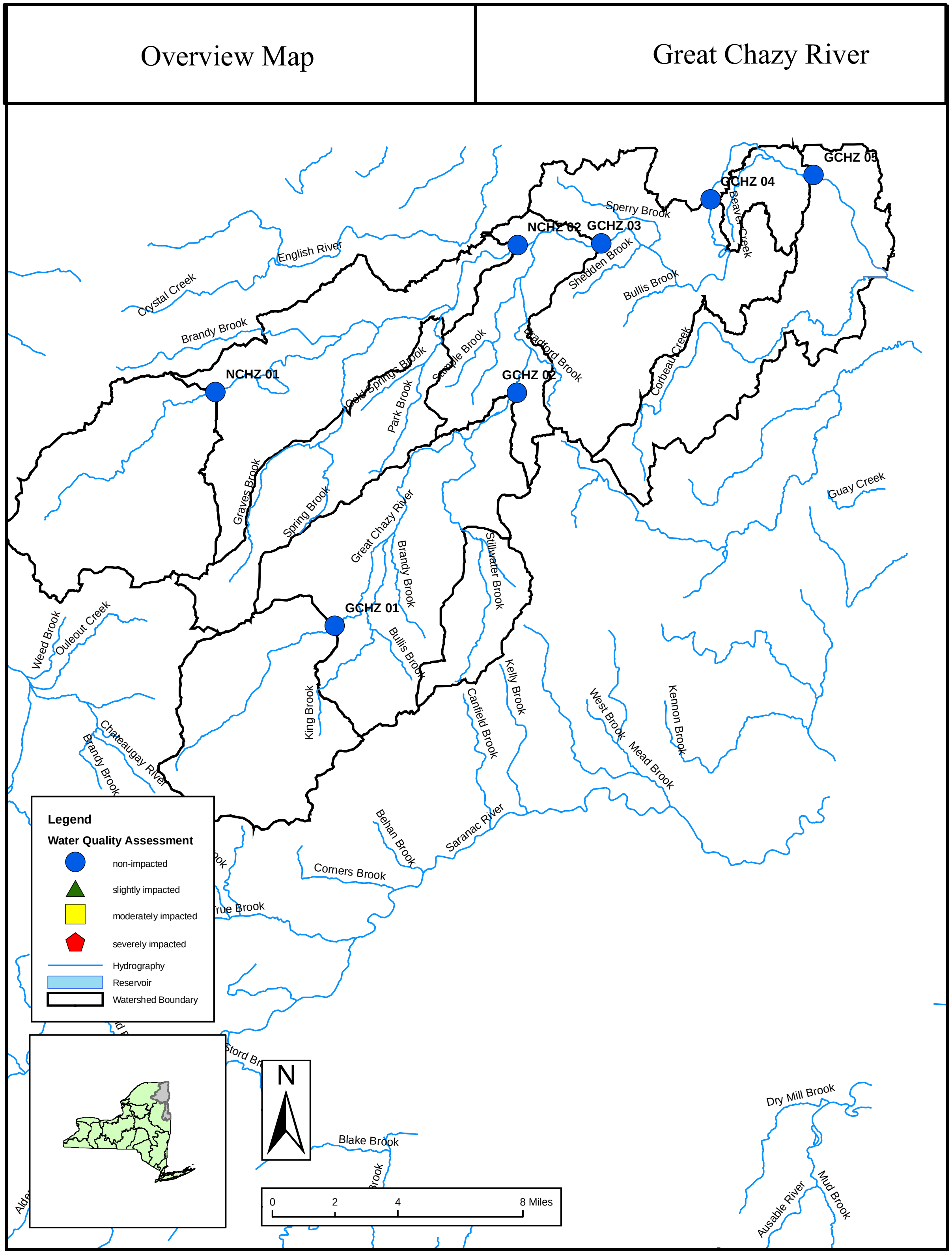


Figure 2a. Site Location Maps

Site Location Map	Great Chazy River

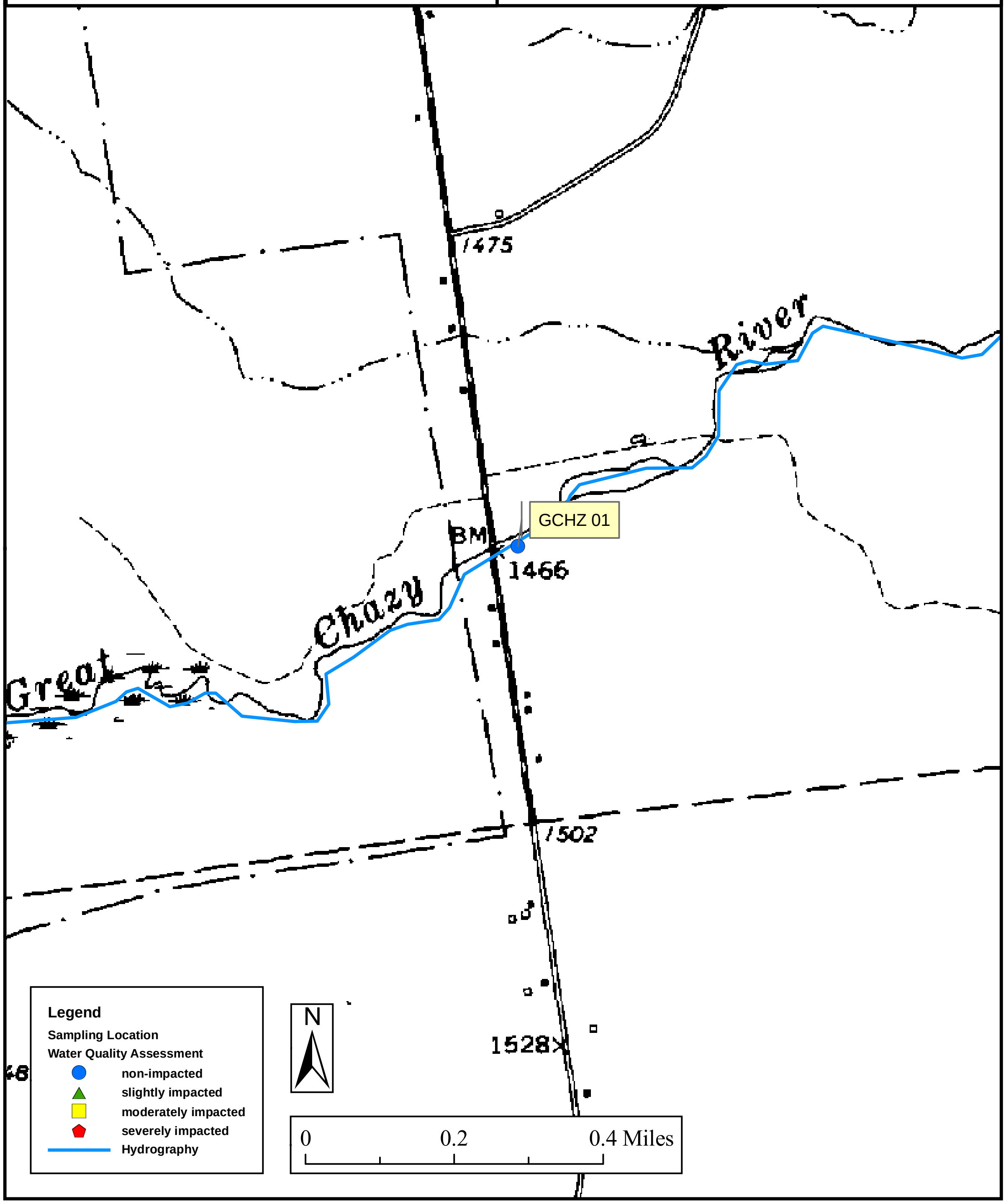


Figure 2b.

Site Location Map	Great Chazy River

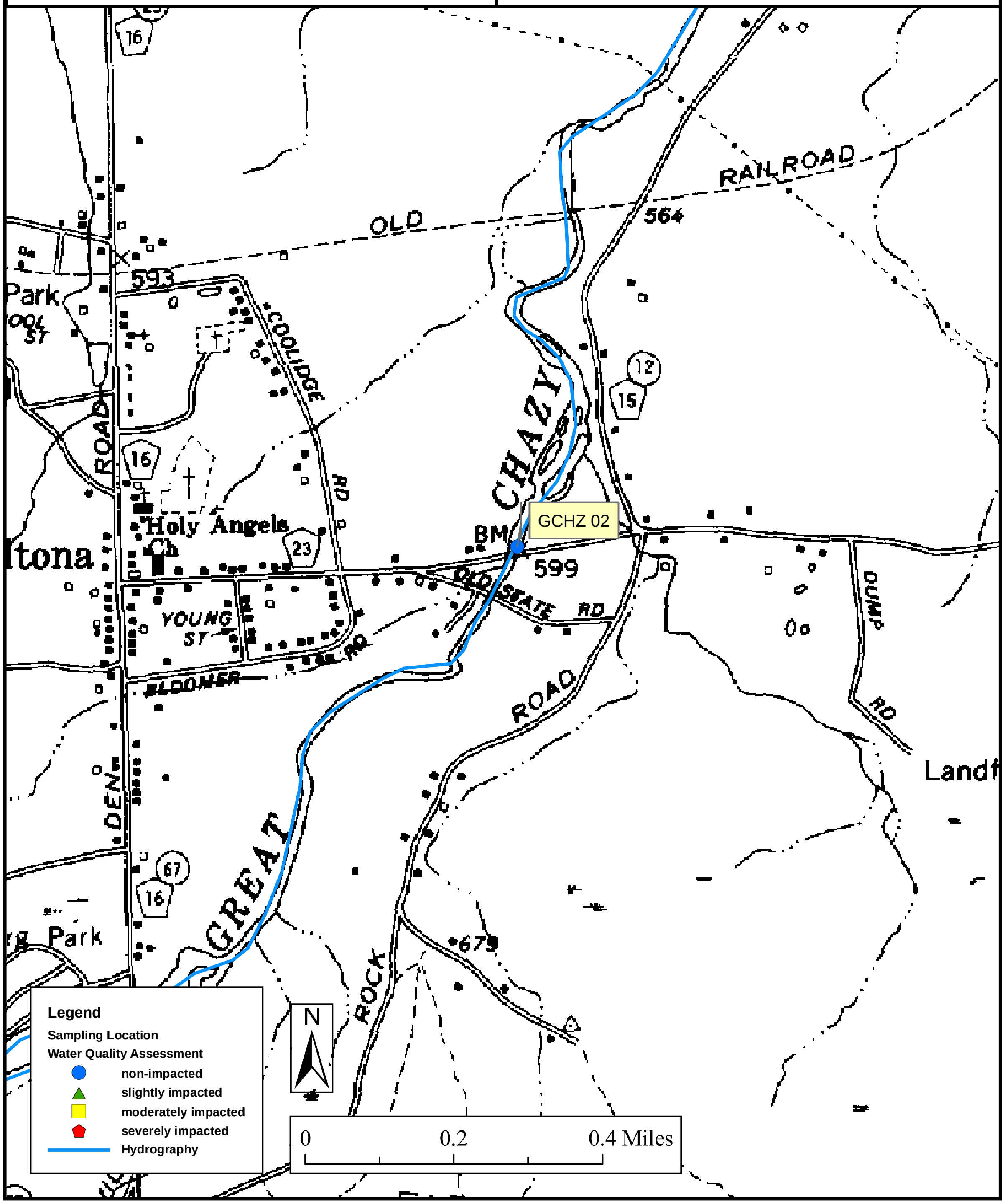


Figure 2c.

Site Location Map	Great Chazy River

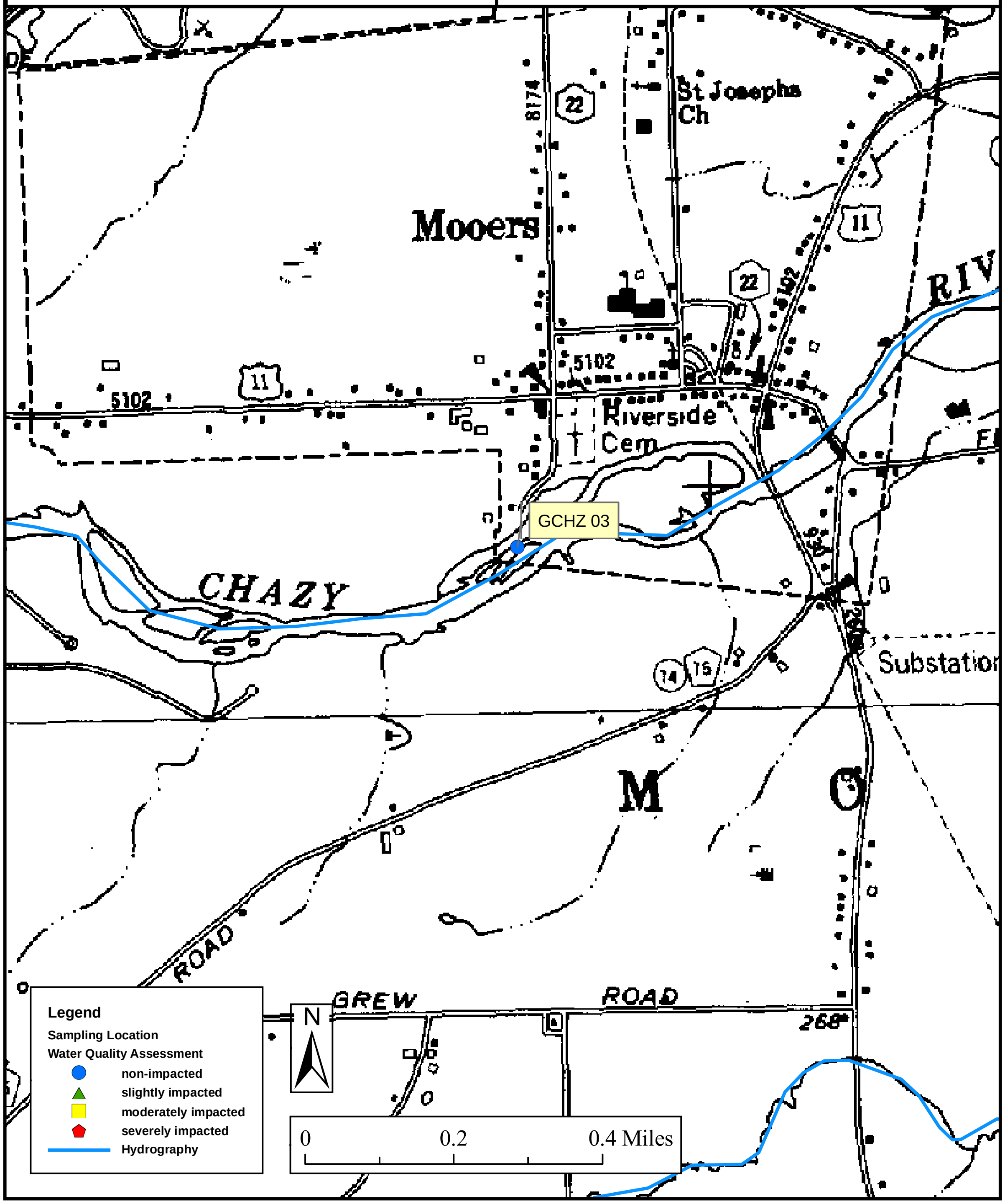
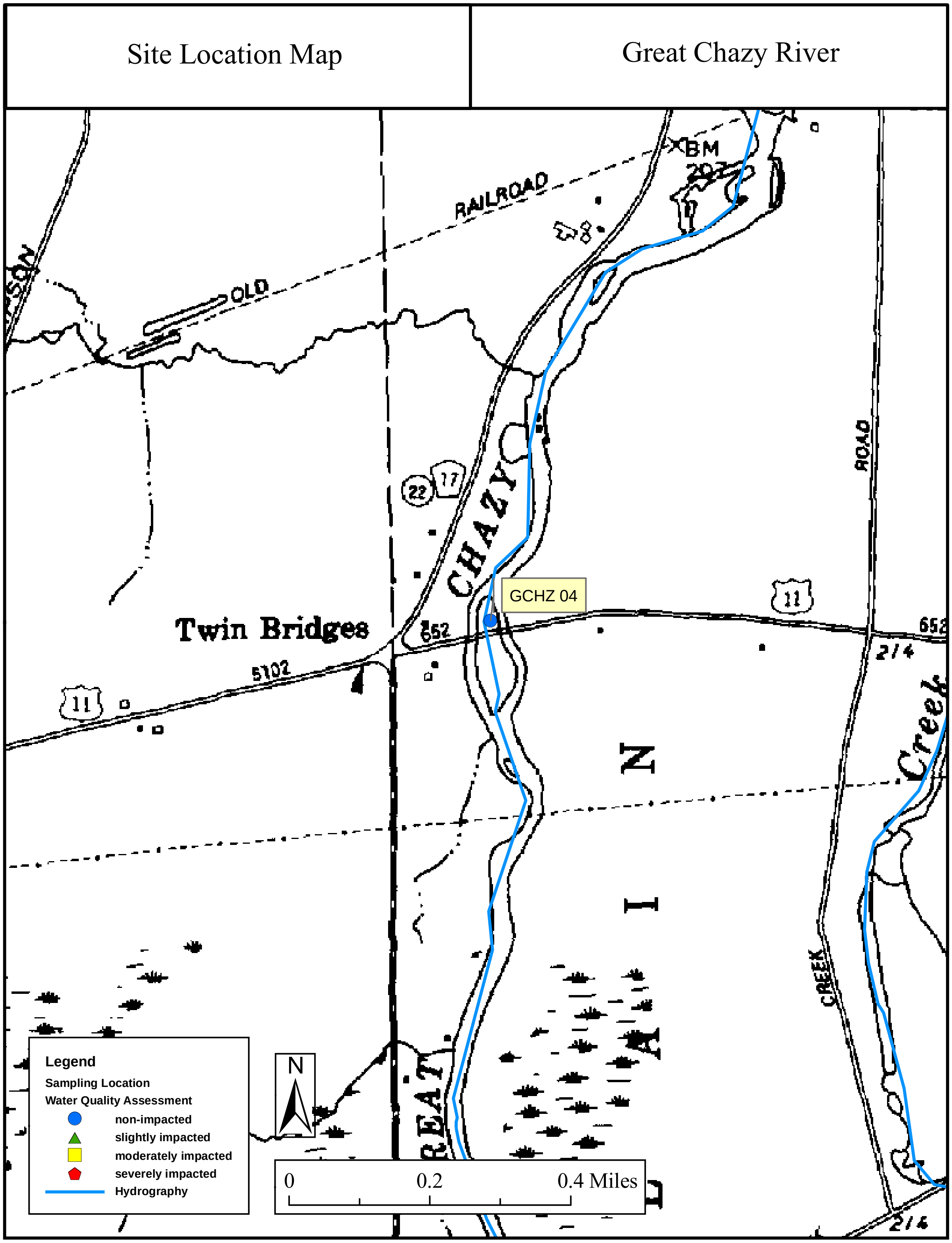


Figure 2d.



Site Location Map
Great Chazy River
RAILROAD
OLD
CHAZY
GCHZ 04
Twin Bridges
5102
652
11
22
17
ROAD
214
Creek
CREEK
Legend
Sampling Location
Water Quality Assessment
non-impacted
slightly impacted
moderately impacted
severely impacted
Hydrography
N
0
0.2
0.4 Miles

Figure 2e.

Site Location Map	Great Chazy River

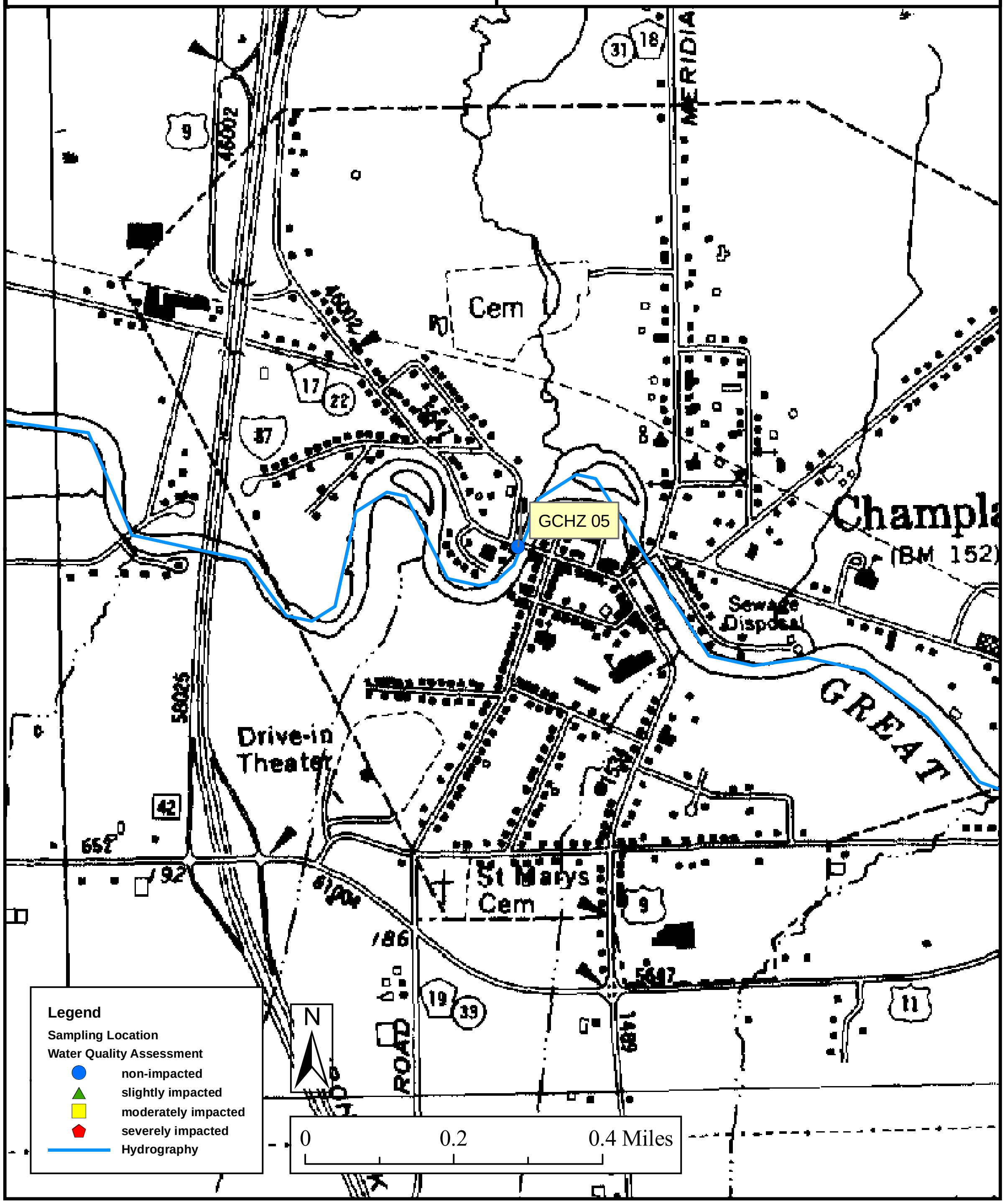


Figure 2g.

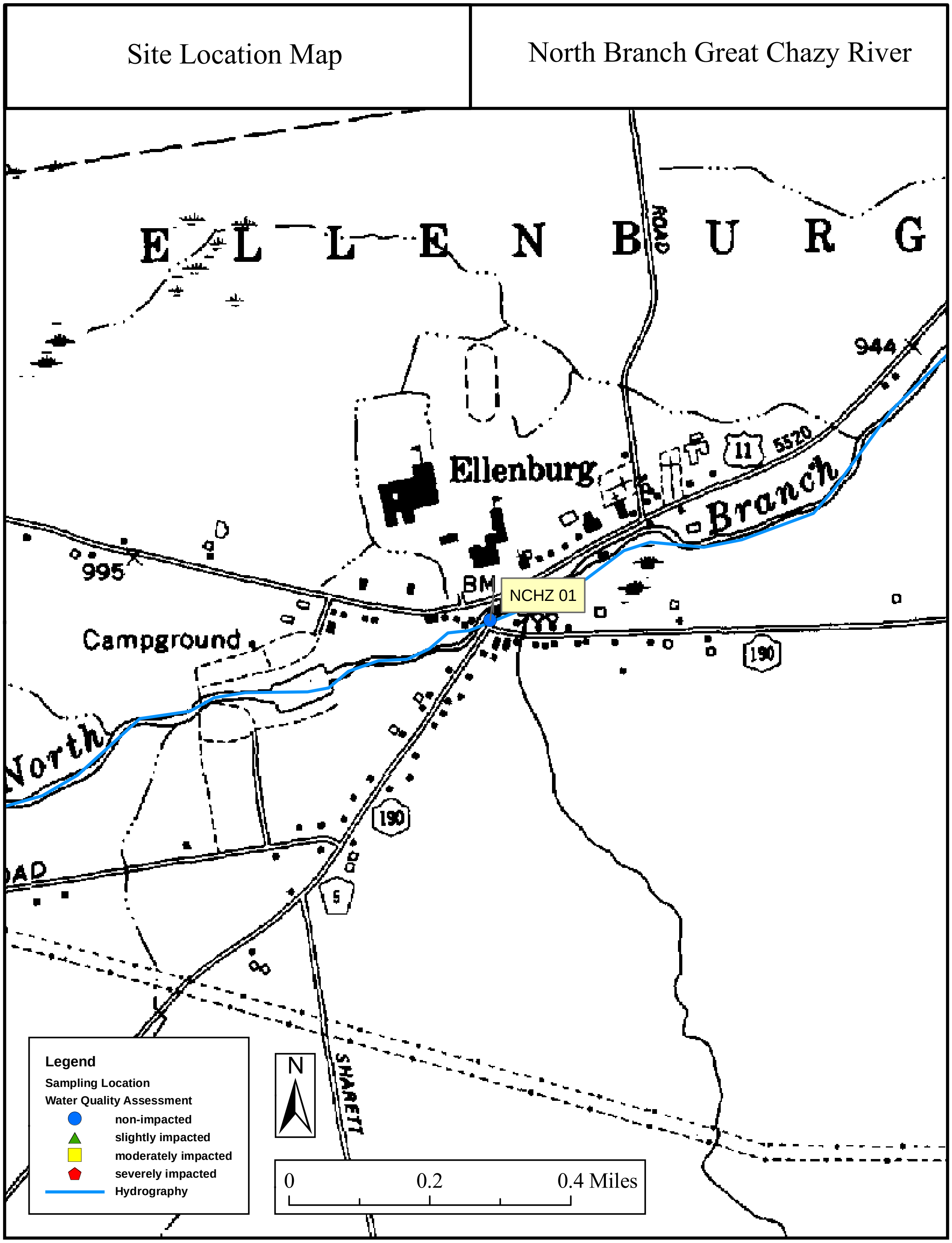

Site Location Map
North Branch Great Chazy River
E L L E N B U R G
ROAD
944
11
5520
Ellenburg
Branch
995
BM
NCHZ 01
Campground
190
North
190
AD
5
SHARETT
Legend
Sampling Location
Water Quality Assessment
non-impacted
slightly impacted
moderately impacted
severely impacted
Hydrography
N
0
0.2
0.4 Miles

Figure 2h.

Site Location Map	North Branch Great Chazy River

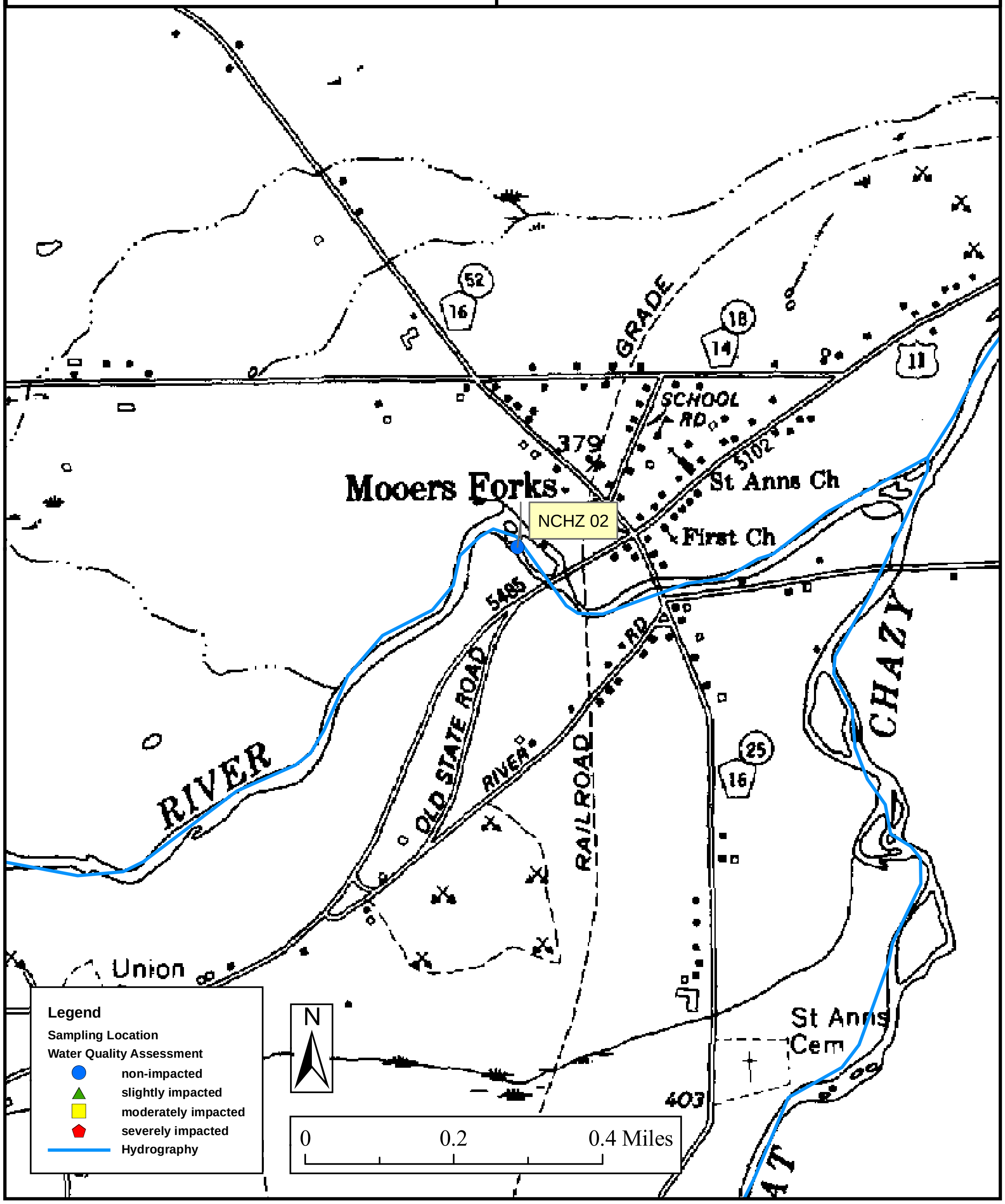


Figure 3. Biological Assessment Profile (BAP) of Index Values, Great Chazy River, 2008. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index (HBI), and Percent Model Affinity (PMA). See Appendix IV for a more complete explanation. The North Branch (Figure 4) enters the main stem at approximately river-mile 25.

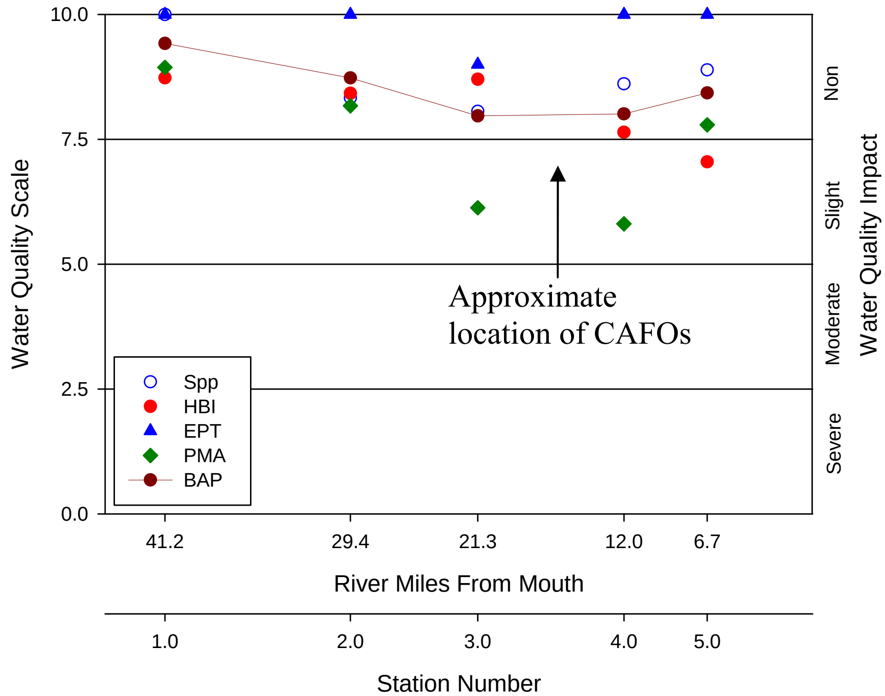


Figure 4. Biological Assessment Profile (BAP) of Index Values, North Branch Great Chazy River, 2008. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index (HBI), and Percent Model Affinity (PMA).

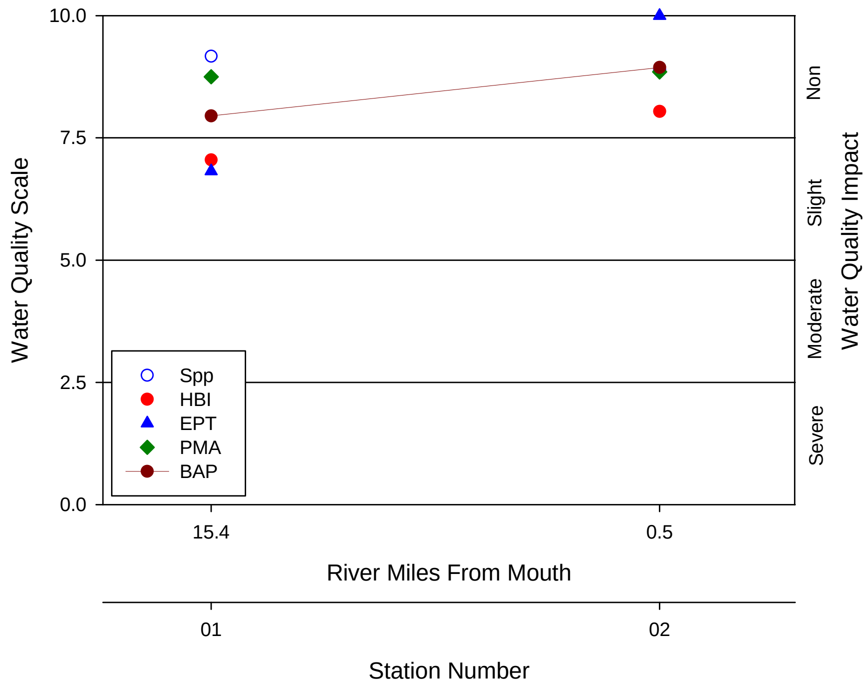


Table 2. Biological Assessment Profile Scores from the Great Chazy River. The 2008 assessments are in bold.

Location/Station	River Mile	Date	Assessment	BAP
GCHZ-01	**41.2**	**7/2/2008**	**non**	**9.42**
GCHZ-02	29.4	7/22/1993	non	8.45
GCHZ-02	29.4	7/19/1994	slt	7.24
GCHZ-02	29.4	8/19/2003	non	7.78
GCHZ-02	**29.4**	**7/2/2008**	**non**	**8.73**
GCHZ-03	**21.3**	**7/2/2008**	**non**	**7.97**
GCHZ-04	**12.0**	**7/2/2008**	**non**	**8.01**
GCHZ-05	6.7	7/22/1993	non	9.1
GCHZ-05	6.7	7/19/1994	non	9.2
GCHZ-05	6.7	8/19/2003	slt	7.23
GCHZ-05	6.7	9/7/2004	non	7.62
GCHZ-05	**6.7**	**7/2/2008**	**non**	**8.43**
NCHZ-01	15.4	8/19/2003	slt	6.5
NCHZ-01	15.4	7/2/2008	non	7.95
NCHZ-02	**0.5**	**7/2/2008**	**non**	**8.94**

Table 3. Overview of 2008 Field Data for Great Chazy River. Cells marked by (-) signify that the parameter was not recorded in the field.

Location/Station	Width (meters)	Depth (meters)	Current (cm/s)	Canopy (%)	Embed. (%)	Temp (˚C)	Cond. (umhom/cm)	DO (mg/L)	pH
GCHZ-01	12	0.3	83	50	40	22.78	90	9.06	7.5
GCHZ-02	25	0.4	91	25	40	20.05	124	11.72	7.71
GCHZ-03	40	0.2	77	25	25	20.52	161	8.54	8.04
GCHZ-04	15	0.3	91	50	40	24.06	168	7.13	7.83
GCHZ-05	40	0.3	71	10	15	23.3	187	6.46	7.84
NCHZ-01	12	0.2	-	25	40	18.19	179	11.32	7.57
NCHZ-02	25	0.3	56	25	35	21	168	10.19	8.42

Figure 5. Nutrient Biotic Index Values for Phosphorus (NBI-P) and Nitrogen (NBI-N) on the Great Chazy River. NBI values are plotted on a scale of eutrophication from oligotrophic to eutrophic. The North Branch enters at approximately river mile 25 (Figure 6). See Appendix X for a detailed explanation of the index. Station 06 is not included due to non-comparable habitat and sampling methods.

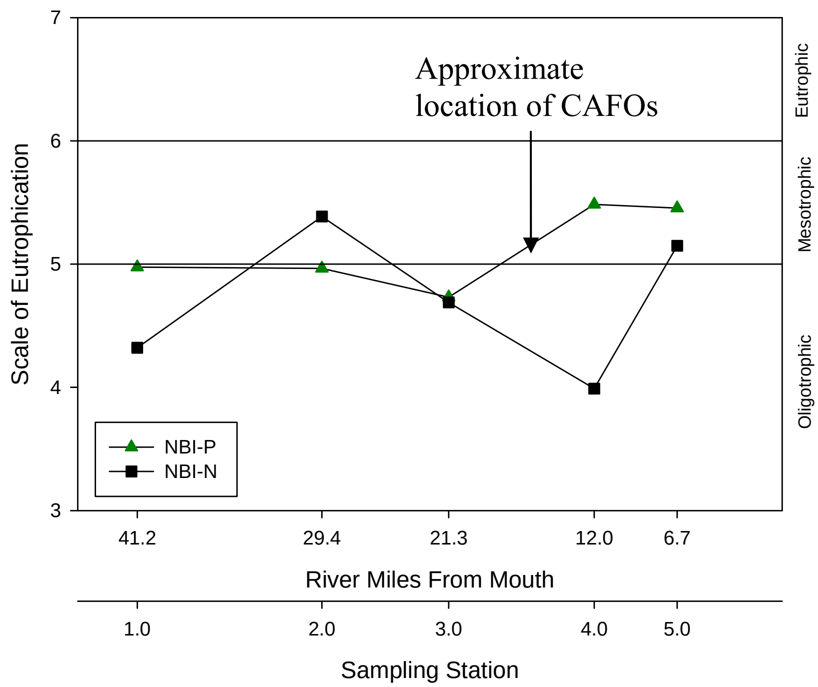


Figure 6. Nutrient Biotic Index Values for Phosphorus (NBI-P) and Nitrogen (NBI-N) on the North Branch Great Chazy River. NBI values are plotted on a scale of eutrophication from oligotrophic to eutrophic. See Appendix X for a detailed explanation of the index.

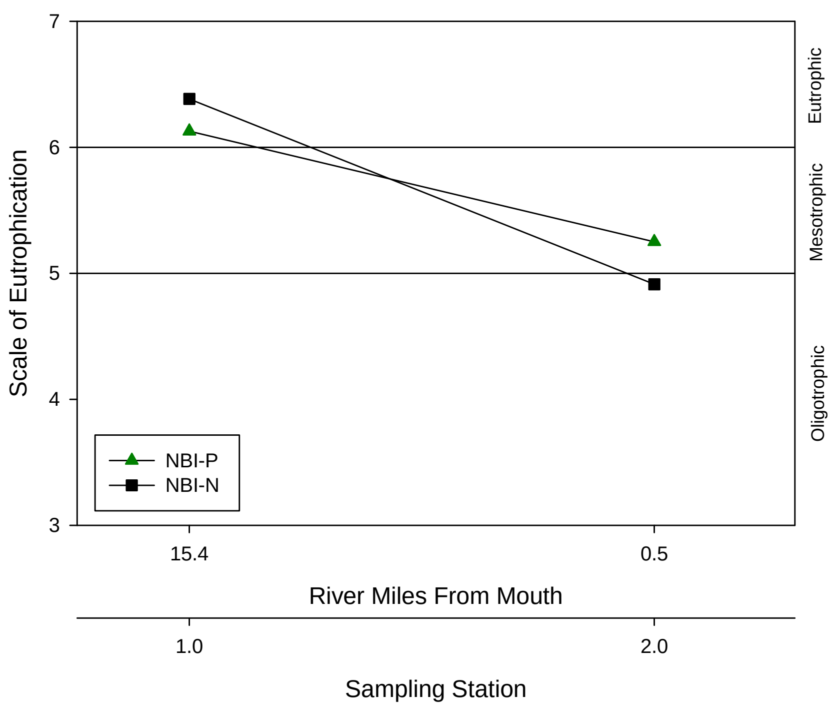


Table 4. Impact Source Determination (ISD), Great Chazy River, 2008. Numbers represent percent similarity to community type models for each impact category. Highest similarities at each station are shaded. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix XI for further explanation.

Community Type	GCHZ -01	GCHZ -02	GCHZ -03	GCHZ -04	GCHZ -05	NCHZ -01	NCHZ -02
Natural: minimal human disturbance	53	59	51	47	48	56	53
Nutrient Enrichment: mostly nonpoint, agricultural	41	54	44	58	51	40	52
Toxic: industrial, municipal, or urban run-off	29	37	39	59	53	37	45
Organic: sewage effluent, animal wastes	34	35	37	53	47	40	38
Complex: municipal/industrial	31	27	29	49	49	25	35
Siltation	42	40	38	65	53	47	43
Impoundment	31	39	42	62	52	38	46

Note: Many of the Great Chazy River macroinvertebrate communities are similar to more than one impact model. ISD is intended as supplemental data to the macroinvertebrate community assessments.

Figure 7. Pebble Count Results for the Great Chazy River, 2008. Pebble counts are used to describe the channel bed materials within riffle stream reaches. See Appendix XIV for a more detailed description of the pebble count procedure.

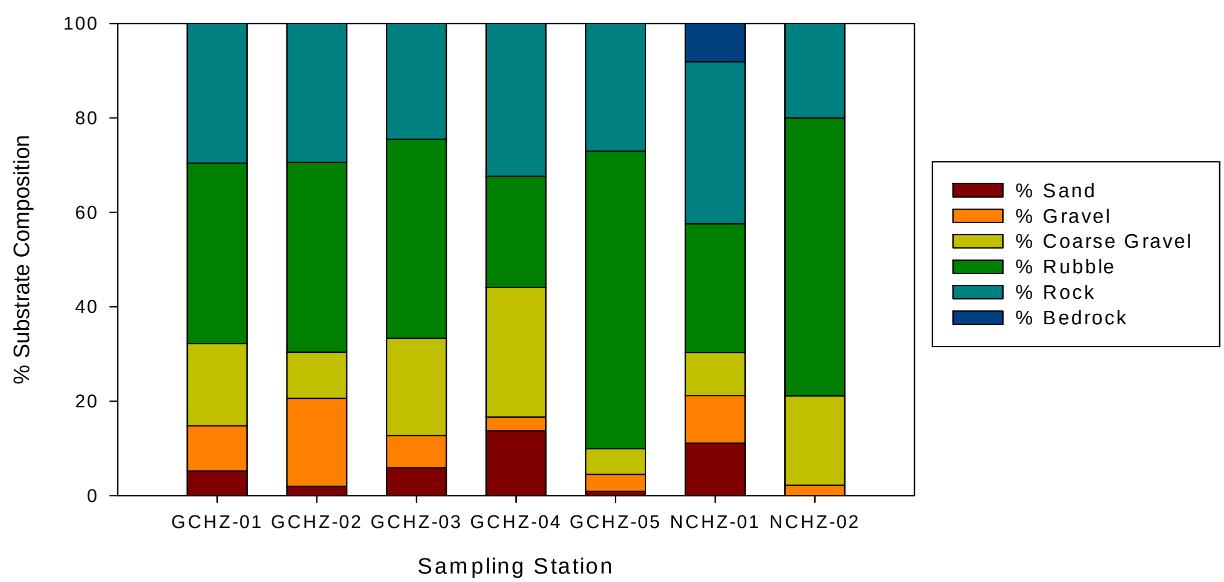


Table 5. Periphyton and Silt Index Scores for Riffle Sites Sampled with the Traveling Kick-net Method.

Location	Moss Index Score (0-10)	Macroalgae Index Score (0-10)	Microalgae Index Score (0-10)	Silt Index Score (0-10)
GCHZ-01	1.0	0.7	0.6	0.1
GCHZ-02	0.0	0.0	1.0	1.9
GCHZ-03	0.0	0.6	3.1	0.1
GCHZ-04	0.0	2.6	1.4	1.0
GCHZ-05	0.0	3.8	2.0	0.0
NCHZ-01	0.4	2.3	0.7	0.7
NCHZ-02	0.0	2.4	0.8	0.0

Figure 8. Percent Land-cover and Land-use for Each Sampling Station. Percent impervious surface is included independent of land cover/use.

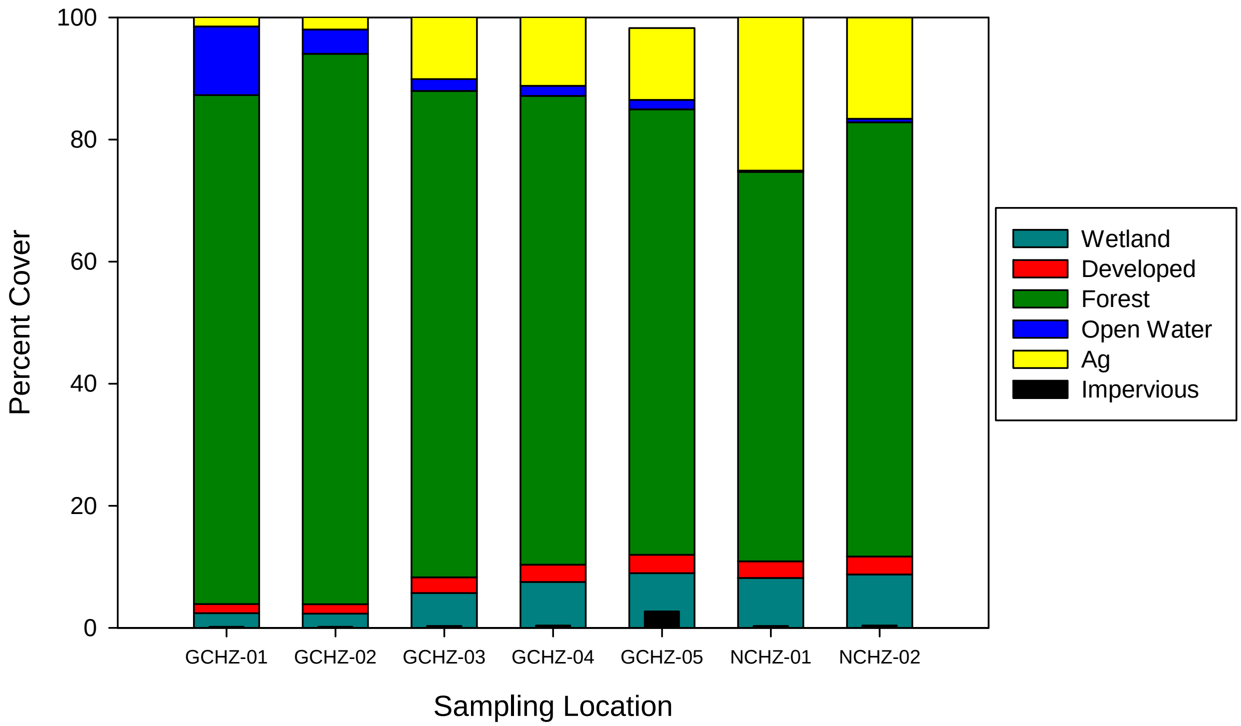


Table 6. Macroinvertebrate Species Collected in Great Chazy River and North Branch, Clinton County, NY.

ANNELIDA
OLIGOCHAETA
LUMBRICULIDA
Lumbriculidae
Undetermined Lumbriculidae
APHANONEURA
MOLLUSCA
GASTROPODA
BASOMMATOPHORA
Physidae
Physella sp.
PELECYPODA
VENEROIDEA
Sphaeriidae
Sphaerium sp.
ARTHROPODA
CRUSTACEA
ISOPODA
Asellidae
Caecidotea sp.
INSECTA
EPHEMEROPTERA
Isonychiidae
Isonychia bicolor
Isonychia obscura
Baetidae
Acentrella sp.
Acerpenna pygmaea
Baetis flavistriga
Baetis intercalaris
Baetis tricaudatus
Baetis sp.
Plauditus sp.
Baetidae
Procloeon sp.
Heptageniidae
Epeorus vitreus
Epeorus sp.
Heptagenia sp.
Leucrocuta sp.
Stenonema terminatum
Stenonema sp.
Undetermined Heptageniidae
Ephemerellidae
Drunella cornutella
Drunella lata
Serratella deficiens
Serratella serrata
Serratella serratoides
Serratella sp.
Undetermined Ephemerellidae
Leptohyphidae
Tricorythodes sp.
Caenidae
Caenis sp.
Polymitarcyidae
Ephoron sp.
ODONATA
Gomphidae
Ophiogomphus sp.
Undetermined Gomphidae
PLECOPTERA
Leuctridae
Leuctra sp.
Perlidae
Acroneuria abnormis
Agnetina capitata
Paragnetina immarginata
Perlesta sp.
Undetermined Perlidae
COLEOPTERA
Psephenidae
Psephenus herricki
Elmidae
Optioservus trivittatus
Optioservus sp.
Promoresia elegans
Promoresia tardella
Stenelmis concinna
Stenelmis crenata
Stenelmis sp.
TRICHOPTERA
Philopotamidae
Chimarra obscura
Chimarra socia
Chimarra sp.
Dolophilodes sp.
Psychomyiidae
Psychomyia flavida
Polycentropodidae
Neureclipsis sp.
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche bronta
Hydropsyche morosa
Hydropsyche scalaris
Hydropsyche sparna
Hydropsyche sp.

Table 6. cont'd

TRICHOPTERA
Macrostemum carolina
Rhyacophilidae
Rhyacophila fuscula
Glossosomatidae
Glossosoma sp.
Hydroptilidae
Hydroptila sp.
Brachycentridae
Brachycentrus appalachia
Micrasema sp.
Apataniidae
Apatania sp.
Helicopsychidae
Helicopsyche borealis
Leptoceridae
Oecetis avara
Setodes sp.
DIPTERA
Tipulidae
Antocha sp.
Hexatoma sp.
Simuliidae
Simulium jenningsi
Simulium pictipes
Simulium tuberosum
Simulium sp.
Empididae
Hemerodromia sp.
Chironomidae
Thienemannimyia gr. spp.
Pagastia orthogonia
Potthastia gaedii gr.
Cardiocladius obscurus
Cricotopus bicinctus
Cricotopus nr. cylindraceus
Cricotopus trifascia gr.
Cricotopus sp.
Eukiefferiella brehmi gr.
Eukiefferiella claripennis gr.
Eukiefferiella devonica gr.
Orthocladius dubitatus
Orthocladius sp.
Tvetenia bavarica gr.
Tvetenia vitracies
Microtendipes pedellus gr.
Microtendipes rydalensis gr.
Phaenopsectra sp.
Polypedilum aviceps
Polypedilum flavum
Polypedilum halterale gr.
Cladotanytarsus sp.
Micropsectra sp.
Rheotanytarsus exiguus gr.
Rheotanytarsus pellucidus
Rheotanytarsus sp.
Stempellinella sp.
Tanytarsus curticornis gr.
Tanytarsus sp.

Table 7a. Macroinvertebrate Data Report (MDR)

STREAM SITE: Great Chazy River, Station 01
LOCATION: Ledger Corners, NY
DATE: 7/2/2008
SAMPLE TYPE: Kick
SUBSAMPLE: 100 organisms

MOLLUSCA			
PELECYPODA			
VENEROIDEA	Sphaeriidae	*Sphaerium sp.*	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	2
		Isonychia obscura	1
	Baetidae	*Acentrella sp.*	8
		Baetis intercalaris	1
		Baetis tricaudatus	1
	Baetidae	*Procloeon sp.*	1
	Heptageniidae	*Epeorus sp.*	1
		Heptagenia sp.	1
	Ephemerellidae	*Drunella cornutella*	9
		Serratella sp.	3
ODONATA	Gomphidae	Undetermined Gomphidae	2
PLECOPTERA	Leuctridae	*Leuctra sp.*	7
	Perlidae	*Acroneuria abnormis*	4
		Undetermined Perlidae	1
COLEOPTERA	Elmidae	*Optioservus trivittatus*	11
TRICHOPTERA	Philopotamidae	*Chimarra sp.*	1
		Dolophilodes sp.	2
	Hydropsychidae	*Hydropsyche bronta*	7
		Hydropsyche sparna	3
		Hydropsyche sp.	2
	Rhyacophilidae	*Rhyacophila fuscula*	1
	Glossosomatidae	*Glossosoma sp.*	4
DIPTERA	Empididae	*Hemerodromia sp.*	3
	Chironomidae	*Pagastia orthogonia*	3
		Cricotopus bicinctus	1
		Tvetenia bavarica gr.	1
		Microtendipes rydalensis gr.	2
		Polypedilum flavum	2
		Polypedilum halterale gr.	1
		Cladotanytarsus sp.	1
		Micropsectra sp.	1
		Rheotanytarsus exiguus gr.	3
		Stempellinella sp.	1
		Tanytarsus curticornis gr.	4
		Tanytarsus sp.	1

Table 7a. cont'd

SPECIES RICHNESS:	36
BIOTIC INDEX:	3.27
EPT RICHNESS:	20
MODEL AFFINITY:	79
ASSESSMENT:	Non-Impacted

DESCRIPTION: This site is located at the Plank Road bridge about 2.5 miles below the Chazy Lake outlet. Typical lake effects have dissipated with the distance from the outlet and the community reflects the high forest cover in the watershed.

Table 7b.

STREAM SITE:	Great Chazy River, Station 02
LOCATION:	Altona, NY
DATE:	7/2/2008
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	4
		Baetis intercalaris	4
		Baetis tricaudatus	2
		Plauditus sp.	6
	Heptageniidae	*Epeorus sp.*	5
		Stenonema sp.	1
	Ephemerellidae	*Drunella cornutella*	1
		Undetermined Ephemerellidae	7
ODONATA	Gomphidae	*Ophiogomphus sp.*	5
PLECOPTERA	Perlidae	*Acroneuria abnormis*	1
		Paragnetina immarginata	5
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus trivittatus*	11
		Stenelmis crenata	20
TRICHOPTERA	Philopotamidae	*Chimarra socia*	2
		Dolophilodes sp.	2
	Hydropsychidae	*Cheumatopsyche sp.*	1
		Hydropsyche morosa	1
		Hydropsyche sp.	1
	Rhyacophilidae	*Rhyacophila fuscula*	1
	Hydroptilidae	*Hydroptila sp.*	1
	Brachycentridae	*Brachycentrus appalachia*	1
		Micrasema sp.	6
DIPTERA	Empididae	*Hemerodromia sp.*	2
	Chironomidae	*Cardiocladius obscurus*	1
		Cricotopus sp.	3
		Orthocladius sp.	2
		Microtendipes rydalensis gr.	2
		Rheotanytarsus sp.	1
		SPECIES RICHNESS:	29
		BIOTIC INDEX:	3.58
		EPT RICHNESS:	19
		MODEL AFFINITY:	71
		ASSESSMENT:	Non-Impacted

DESCRIPTION: Located at the Route 191 bridge, this site continues to benefit from a largely undeveloped watershed.

Table 7c.

STREAM SITE:	Great Chazy River, Station 03
LOCATION:	Mooers, NY
DATE:	7/2/2008
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Acentrella sp.*	3
		Baetis flavistriga	1
		Baetis sp.	2
		Plauditus sp.	5
	Ephemerellidae	*Serratella serrata*	4
	Polymitarcyidae	*Ephoron sp.*	2
PLECOPTERA	Perlidae	*Perlesta sp.*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus sp.*	1
		Promoresia elegans	1
		Stenelmis concinna	7
		Stenelmis crenata	15
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	5
		Hydropsyche morosa	2
		Hydropsyche scalaris	2
	Rhyacophilidae	*Rhyacophila fuscula*	2
	Brachycentridae	*Brachycentrus appalachia*	24
	Apataniidae	*Apatania sp.*	4
DIPTERA	Simuliidae	*Simulium sp.*	1
	Chironomidae	*Potthastia gaedii gr.*	2
		Cardiocladius obscurus	1
		Cricotopus bicinctus	1
		Cricotopus sp.	3
		Orthocladius sp.	1
		Tvetenia vitracies	3
		Microtendipes pedellus gr.	3
		Microtendipes rydalensis gr.	2
		Polypedilum aviceps	1
		SPECIES RICHNESS:	28
		BIOTIC INDEX:	3.3
		EPT RICHNESS:	13
		MODEL AFFINITY:	56
		ASSESSMENT:	Non-Impacted

DESCRIPTION: This site has a slightly different community structure than upstream sites, likely due to the wide, shallow, low canopied nature of the river at this point. The filter feeding *Brachycentrus appalachia* makes up a significant portion of the community.

Table 7d.

STREAM SITE:	Great Chazy River, Station 04		
LOCATION:	Twin Bridges, NY		
DATE:	7/2/2008		
SAMPLE TYPE:	Kick		
SUBSAMPLE:	100 organisms		
ANNELIDA			
OLIGOCHAETA			
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
MOLLUSCA			
PELECYPODA			
VENEROIDEA	Sphaeriidae	*Sphaerium sp.*	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	2
	Baetidae	*Acerpenna pygmaea*	1
		Baetis flavistriga	1
		Baetis intercalaris	1
		Plauditus sp.	1
	Heptageniidae	*Stenonema sp.*	1
	Ephemerellidae	*Serratella serratoides*	3
	Polymitarcyidae	*Ephoron sp.*	3
COLEOPTERA	Elmidae	*Optioservus sp.*	2
		Promoresia elegans	1
		Stenelmis concinna	24
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	1
	Hydropsychidae	*Cheumatopsyche sp.*	21
		Hydropsyche scalaris	4
		Hydropsyche sparna	2
		Macrostemum carolina	1
	Brachycentridae	*Brachycentrus appalachia*	6
		Micrasema sp.	1
	Helicopsychidae	*Helicopsyche borealis*	1
	Leptoceridae	*Oecetis avara*	2
DIPTERA	Simuliidae	*Simulium jenningsi*	1
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Cricotopus bicinctus	3
		Cricotopus nr. cylindraceus	1
		Cricotopus trifascia gr.	1
		Tvetenia vitracies	3
		Microtendipes pedellus gr.	1
		Polypedilum flavum	7
		SPECIES RICHNESS:	30
		BIOTIC INDEX:	4.36
		EPT RICHNESS:	17
		MODEL AFFINITY:	54
		ASSESSMENT:	Non-Impacted

DESCRIPTION: This site is located where the river splits around an island at Route 11. The site shows evidence of slightly higher nutrient concentrations compared with upstream. Some of the increase is likely natural but also may be due to increasing agricultural land use.

Table 7e.

STREAM SITE:	Great Chazy River, Station 05
LOCATION:	Champlain, NY
DATE:	7/2/2008
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

MOLLUSCA			
GASTROPODA	Physidae	*Physella sp.*	5
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	1
	Baetidae	*Baetis flavistriga*	1
		Plauditus sp.	9
	Ephemerellidae	*Serratella deficiens*	2
		Serratella serratoides	1
	Leptohyphidae	*Tricorythodes sp.*	3
PLECOPTERA	Perlidae	*Perlesta sp.*	1
COLEOPTERA	Elmidae	*Optioservus sp.*	1
		Promoresia elegans	1
		Stenelmis crenata	13
TRICHOPTERA	Polycentropodidae	*Neureclipsis sp.*	2
	Hydropsychidae	*Cheumatopsyche sp.*	4
		Hydropsyche morosa	11
		Hydropsyche scalaris	2
		Hydropsyche sparna	1
		Hydropsyche sp.	3
	Brachycentridae	*Brachycentrus appalachia*	3
		Micrasema sp.	5
DIPTERA	Simuliidae	*Simulium tuberosum*	2
	Empididae	*Hemerodromia sp.*	2
DIPTERA	Chironomidae	*Cricotopus bicinctus*	2
	Chironomidae	*Cricotopus trifascia gr.*	1
		Cricotopus sp.	4
		Tvetenia vitracies	2
		Microtendipes pedellus gr.	7
		Microtendipes rydalensis gr.	2
		Phaenopsectra sp.	1
		Polypedilum flavum	6
		Rheotanytarsus pellucidus	1
		Stempellinella sp.	1
		SPECIES RICHNESS:	31
		BIOTIC INDEX:	4.86
		EPT RICHNESS:	15
		MODEL AFFINITY:	67
		ASSESSMENT:	Non-Impacted

DESCRIPTION: This site is similar to the previous station with a shift towards a larger river community, with filter feeding Hydropsychidae making up a large portion of the biota.

Table 7g.

STREAM SITE:	North Branch Great Chazy River, Station 01
LOCATION:	Ellenburg, NY
DATE:	7/2/2008
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis intercalaris*	1
		Baetis tricaudatus	26
	Heptageniidae	*Epeorus vitreus*	1
		Undetermined Heptageniidae	1
	Ephemerellidae	*Serratella sp.*	2
PLECOPTERA	Perlidae	*Agnetina capitata*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus sp.*	6
		Promoresia tardella	3
		Stenelmis concinna	2
		Stenelmis crenata	1
TRICHOPTERA	Hydropsychidae	*Hydropsyche sparna*	1
	Rhyacophilidae	*Rhyacophila fuscula*	2
	Brachycentridae	*Brachycentrus appalachia*	2
DIPTERA	Tipulidae	*Hexatoma sp.*	1
	Simuliidae	*Simulium pictipes*	5
	Empididae	*Hemerodromia sp.*	4
	Chironomidae	*Thienemannimyia gr. spp.*	3
		Cardiocladius obscurus	2
		Cricotopus bicinctus	4
		Cricotopus sp.	1
		Eukiefferiella brehmi gr.	1
		Eukiefferiella claripennis gr.	2
		Eukiefferiella devonica gr.	3
		Orthocladius dubitatus	1
		Tvetenia bavarica gr.	1
		Tvetenia vitracies	3
		Microtendipes rydalensis gr.	3
		Polypedilum aviceps	8
		Cladotanytarsus sp.	1
		Micropsectra sp.	6
		Rheotanytarsus pellucidus	1
		SPECIES RICHNESS:	32
		BIOTIC INDEX:	4.86
		EPT RICHNESS:	9
		MODEL AFFINITY:	77
		ASSESSMENT:	Non-Impacted

DESCRIPTION: This site is in a relatively urban location compared to the rest of the survey. There was very little canopy, allowing light penetration and likely elevated nutrient levels as indicated by the Nutrient Biotic Index scores, which help explain the slightly decreased BAP score.

Table 7h.

STREAM SITE:	North Branch Great Chazy River, Station 02
LOCATION:	Mooers Forks, NY
DATE:	7/2/2008
SAMPLE TYPE:	Kick
SUBSAMPLE:	100 organisms

ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	*Caecidotea sp.*	1
INSECTA			
EPHEMEROPTERA	Isonychiidae	*Isonychia bicolor*	1
	Baetidae	*Baetis flavistriga*	7
		Baetis intercalaris	6
		Baetis sp.	1
	Heptageniidae	*Leucrocuta sp.*	2
		Stenonema terminatum	1
	Ephemerellidae	*Drunella lata*	2
		Serratella deficiens	1
		Serratella serrata	13
	Caenidae	*Caenis sp.*	3
	Polymitarcyidae	*Ephoron sp.*	1
PLECOPTERA	Perlidae	*Perlesta sp.*	1
COLEOPTERA	Elmidae	*Optioservus sp.*	3
		Stenelmis sp.	17
TRICHOPTERA	Psychomyiidae	*Psychomyia flavida*	2
	Hydropsychidae	*Cheumatopsyche sp.*	15
		Hydropsyche sp.	1
	Rhyacophilidae	*Rhyacophila fuscula*	1
	Brachycentridae	*Brachycentrus appalachia*	1
		Micrasema sp.	1
	Leptoceridae	*Setodes sp.*	1
DIPTERA	Tipulidae	*Antocha sp.*	4
	Chironomidae	*Pagastia orthogonia*	1
		Potthastia gaedii gr.	1
		Cardiocladius obscurus	1
		Orthocladius sp.	1
		Microtendipes pedellus gr.	3
		Microtendipes rydalensis gr.	3
		Polypedilum flavum	3
		Tanytarsus curticornis gr.	1
		SPECIES RICHNESS:	31
		BIOTIC INDEX:	3.96
		EPT RICHNESS:	19
		MODEL AFFINITY:	78
		ASSESSMENT:	Non-Impacted

DESCRIPTION: This site is located 100 meters above the Route 11 bridge. The macroinvertebrate community reflects a small improvement in water quality likely due to improved riparian conditions and more natural immediate land cover compared to upstream.

Table 8. Laboratory Data Summary, Great Chazy River, Clinton County, NY, 2008.

LABORATORY DATA SUMMARY				
STREAM NAME: Great Chazy				
DATE SAMPLED: 7/2/2008				
SAMPLING METHOD: Kick				
LOCATION	GCHZ	GCHZ	GCHZ	GCHZ
STATION	02	04	03	01
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME				
Tolerance Definitions:	1. Stenelmis crenata 20 % facultative beetle	Stenelmis concinna 24 % facultative beetle	Brachycentrus appalachia 24 % intolerant caddisfly	Optioservus trivittatus 11 % intolerant beetle
Intolerant = not tolerant of poor water quality	2. Optioservus trivittatus 11 % intolerant beetle	Cheumatopsyche sp. 21 % facultative caddisfly	Stenelmis crenata 15 % facultative beetle	Drunella cornutella 9 % intolerant mayfly
Facultative = occurring over a wide range of water quality	3. Undetermined Ephemerellidae 7 % intolerant mayfly	Polypedilum flavum 7 % facultative midge	Stenelmis concinna 7 % facultative beetle	Acentrella sp. 8 % intolerant mayfly
Tolerant = tolerant of poor water quality	4. Plauditus sp. 6 % intolerant mayfly	Brachycentrus appalachia 6 % intolerant caddisfly	Plauditus sp. 5 % intolerant mayfly	Leuctra sp. 7 % intolerant stonefly
	5. Micrasema sp. 6 % intolerant caddisfly	Hydropsyche scalaris 4 % intolerant caddisfly	Cheumatopsyche sp. 5 % facultative caddisfly	Hydropsyche bronta 7 % facultative caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	9 (5.0)	17 (7.0)	17 (9.0)	21 (12.0)
Trichoptera (caddisflies)	16 (9.0)	39 (9.0)	39 (6.0)	20 (7.0)
Ephemeroptera (mayflies)	30 (8.0)	13 (8.0)	17 (6.0)	28 (10.0)
Plecoptera (stoneflies)	6 (2.0)	0 (0.0)	1 (1.0)	12 (3.0)
Coleoptera (beetles)	32 (3.0)	27 (3.0)	25 (5.0)	11 (1.0)
Oligochaeta (worms)	0 (0.0)	2 (1.0)	0 (0.0)	0 (0.0)
Mollusca (clams and snails)	0 (0.0)	1 (1.0)	0 (0.0)	1 (1.0)
Crustacea (crayfish, scuds, sowbugs)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other insects (odonates, diptera)	7 (2.0)	1 (1.0)	1 (1.0)	5 (2.0)
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
SPECIES RICHNESS	29	30	28	36
BIOTIC INDEX	3.58	4.36	3.3	3.27
EPT RICHNESS	19	17	13	20
PERCENT MODEL AFFINITY	71	54	56	79
FIELD ASSESSMENT	VG	VG	VG	
OVERALL ASSESSMENT	non-impacted	non-impacted	non-impacted	non-impacted

Table 8. (cont'd) Laboratory Data Summary, Great Chazy River and North Branch, Clinton County, NY, 2008.

LABORATORY DATA SUMMARY				
STREAM NAME: Great Chazy				
DATE SAMPLED: 7/2/2008				
SAMPLING METHOD: Kick				
LOCATION	GCHZ	NCHZ	NCHZ	
STATION	05	02	01	
DOMINANT SPECIES / %CONTRIBUTION / TOLERACE / COMMON NAME				
Tolerance Definitions:	1. Stenelmis crenata 13 % facultative beetle	Stenelmis sp. 17 % facultative beetle	Baetis tricaudatus 26 % facultative mayfly	
Intolerant = not tolerant of poor water quality	2. Hydropsyche morosa 11 % facultative caddisfly	Cheumatopsyche sp. 15 % facultative caddisfly	Polypedilum aviceps 8 % facultative midge	
Facultative = occurring over a wide range of water quality	3. Plauditus sp. 9 % intolerant mayfly	Serratella serrata 13 % intolerant mayfly	Optioservus sp. 6 % intolerant beetle	
Tolerant = tolerant of poor water quality	4. Microtendipes pedellus gr. 7 % facultative midge	Baetis flavistriga 7 % intolerant mayfly	Micropsectra sp. 6 % facultative midge	
	5. Polypedilum flavum 6 % facultative midge	Baetis intercalaris 6 % facultative mayfly	Simulium pictipes 5 % intolerant black fly	
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	27 (10.0)	14 (8.0)	40 (15.0)	
Trichoptera (caddisflies)	31 (8.0)	22 (7.0)	5 (3.0)	
Ephemeroptera (mayflies)	17 (6.0)	38 (11.0)	31 (5.0)	
Plecoptera (stoneflies)	1 (1.0)	1 (1.0)	1 (1.0)	
Coleoptera (beetles)	15 (3.0)	20 (2.0)	13 (5.0)	
Oligochaeta (worms)	0 (0.0)	0 (0.0)	0 (0.0)	
Mollusca (clams and snails)	5 (1.0)	0 (0.0)	0 (0.0)	
Crustacea (crayfish, scuds, sowbugs)	0 (0.0)	1 (1.0)	0 (0.0)	
Other insects (odonates, diptera)	4 (2.0)	4 (1.0)	10 (3.0)	
Other (Nemertea, Platyhelminthes)	0 (0.0)	0 (0.0)	0 (0.0)	
SPECIES RICHNESS	31	31	32	
BIOTIC INDEX	4.86	3.96	4.86	
EPT RICHNESS	15	19	9	
PERCENT MODEL AFFINITY	67	78	77	
FIELD ASSESSMENT	VG	VG	VG	
OVERALL ASSESSMENT	non-impacted	non-impacted	non-impacted	

Table 9. Field Data Summary, Great Chazy River and North Branch, Clinton County, NY, 2008.

FIELD DATA SUMMARY				
STREAM NAME: Great Chazy	**DATE SAMPLED:** 7/2/2008			
REACH: Champlain to Mooers				
FIELD PERSONNEL INVOLVED: Newman/Duffy				
STATION	02	04	03	01
ARRIVAL TIME AT STATION	11:40	8:20	9:30	1:50
LOCATION	GCHZ	GCHZ	GCHZ	GCHZ
PHYSICAL CHARACTERISTICS				
Width (meters)	25	15	40	12
Depth (meters)	0.4	0.3	0.2	0.3
Current speed (cm per sec.)	91	91	77	83
Substrate (%)				
Rock (>25.4 cm, or bedrock)	40	20	40	40
Rubble (6.35 - 25.4 cm)	30	25	40	40
Gravel (0.2 - 6.35 cm)	20	20	20	15
Sand (0.06 - 2.0 mm)	10	35		5
Silt (0.004 - 0.06 mm)				
Embeddedness (%)	40	40	25	40
CHEMICAL MEASUREMENTS				
Temperature (Celsius)	20.05	24.06	20.52	22.78
Specific Conductance (umhos)	124	168	161	90
Dissolved Oxygen (mg/l)	11.72	7.13	8.54	9.06
pH	7.71	7.83	8.04	7.5
BIOLOGICAL ATTRIBUTES				
Canopy (%)	25	50	25	50
Aquatic Vegetation				
Algae - suspended				
Algae - attached,filamentous		X	X	X
Algae - diatoms	100	100	100	100
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	
Megaloptera (dobsonflies, damselflies)	X	X	X	X
Odonata (dragonflies, damselflies)	X			
Chironomidae (midges)	X	X		X
Simuliidae (black flies)		X		
Decapoda (crayfish)	X		X	X
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)	X			
Other				
FAUNAL CONDITION	VG	VG	VG	

Table 9. (cont'd) Field Data Summary, Great Chazy River and North Branch, Clinton County, NY, 2008.

FIELD DATA SUMMARY				
STREAM NAME: Great Chazy	**DATE SAMPLED:** 7/2/2008			
REACH: Mooers to Ledgers Corners				
FIELD PERSONNEL INVOLVED: Newman/Duffy				
STATION	05	02	01	
ARRIVAL TIME AT STATION	7:10	10:25	12:45	
LOCATION	GCHZ	NCHZ	NCHZ	
PHYSICAL CHARACTERISTICS				
Width (meters)	40	25	12	
Depth (meters)	0.3	0.3	0.2	
Current speed (cm per sec.)	71	56		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	40	30	50	
Rubble (6.35 - 25.4 cm)	40	45	40	
Gravel (0.2 - 6.35 cm)	15	20	10	
Sand (0.06 - 2.0 mm)	5	5		
Silt (0.004 - 0.06 mm)				
Embeddedness (%)	15	35	40	
CHEMICAL MEASUREMENTS				
Temperature (Celsius)	23.3	21	18.19	
Specific Conductance (umhos)	187	168	179	
Dissolved Oxygen (mg/l)	6.46	10.19	11.32	
pH	7.84	8.42	7.57	
BIOLOGICAL ATTRIBUTES				
Canopy (%)	10	25	25	
Aquatic Vegetation				
Algae - suspended				
Algae - attached, filamentous		X	X	
Algae - diatoms	100	100	100	
Macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	
Plecoptera (stoneflies)	X	X	X	
Trichoptera (caddisflies)	X	X	X	
Coleoptera (beetles)	X	X	X	
Megaloptera (dobsonflies, damselflies)				
Odonata (dragonflies, damselflies)	X		X	
Chironomidae (midges)	X	X	X	
Simuliidae (black flies)			X	
Decapoda (crayfish)	X			
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)		X		
Other		X	X	
FAUNAL CONDITION	VG	VG	VG	

Appendix I. Biological Methods for Kick Sampling

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

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

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

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

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

Appendix II. Macroinvertebrate Community Parameters

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

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

3. Hilsenhoff Biotic Index: a measure of the tolerance of organisms in a sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For the purpose of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Tolerance values are listed in Hilsenhoff (1987). Additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in Quality Assurance document, Bode et al. (2002). Impact ranges are: 0-4.50, non-impacted; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted, and 8.51-10.00, severely impacted.

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

5. Nutrient Biotic Index: a measure of stream nutrient enrichment identified by macroinvertebrate taxa. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals with assigned tolerance values. Tolerance values ranging from intolerant (0) to tolerant (10) are based on nutrient optima for Total Phosphorus (listed in Smith, 2005). Impact ranges are: 0-5.00, non-impacted; 5.01-6.00, slightly impacted; 6.01-7.00, moderately impacted, and 7.01-10.00, severely impacted.

Appendix III. Levels of Water Quality Impact in Streams

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

1. *Non-impacted*: Indices reflect very good water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well represented; EPT richness is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Nutrient Biotic Index is 5.00 or less. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

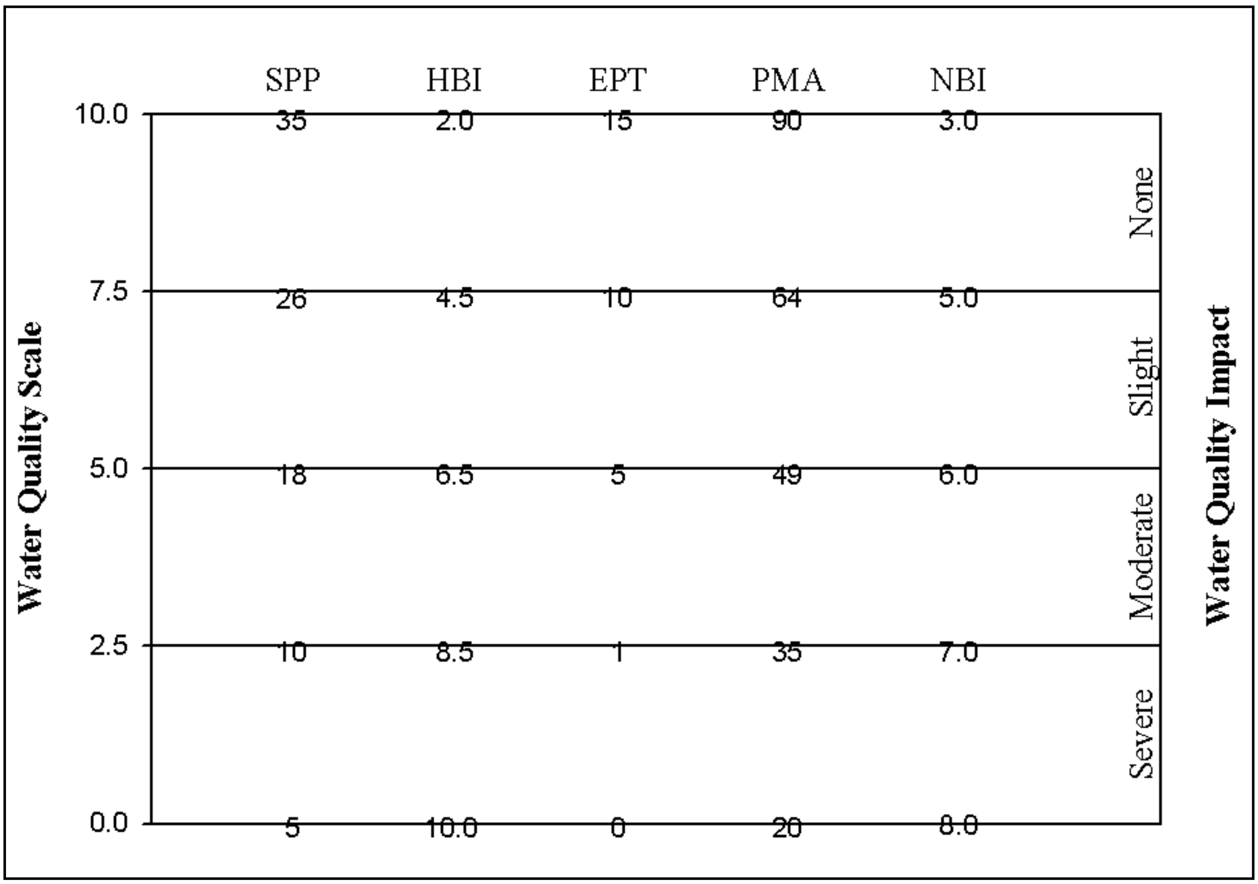
2. *Slightly impacted*: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Nutrient Biotic Index is 5.01-6.00. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

3. *Moderately impacted*: Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness is usually 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT richness is 2-5. The biotic index value is 6.51-8.50. Percent model affinity is 35-49. Nutrient Biotic Index is 6.01-7.00. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. *Severely impacted*: Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. Species richness is 10 or fewer. Mayflies, stoneflies and caddisflies are rare or absent; EPT richness is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. Nutrient Biotic Index is greater than 7.00. The dominant species are almost all tolerant, and are usually midges and worms. Often, 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

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

The Biological Assessment Profile (BAP) of index values, developed by Phil O'Brien, Division of Water, NYSDEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the five indices -- species richness (SPP), EPT richness (EPT), Hilsenhoff Biotic Index (HBI), Percent Model Affinity (PMA), and Nutrient Biotic Index (NBI)-- defined in Appendix II are converted to a common 0-10 scale using the formulae in the Quality Assurance document (Bode, et al., 2002), and as shown in the figure below.



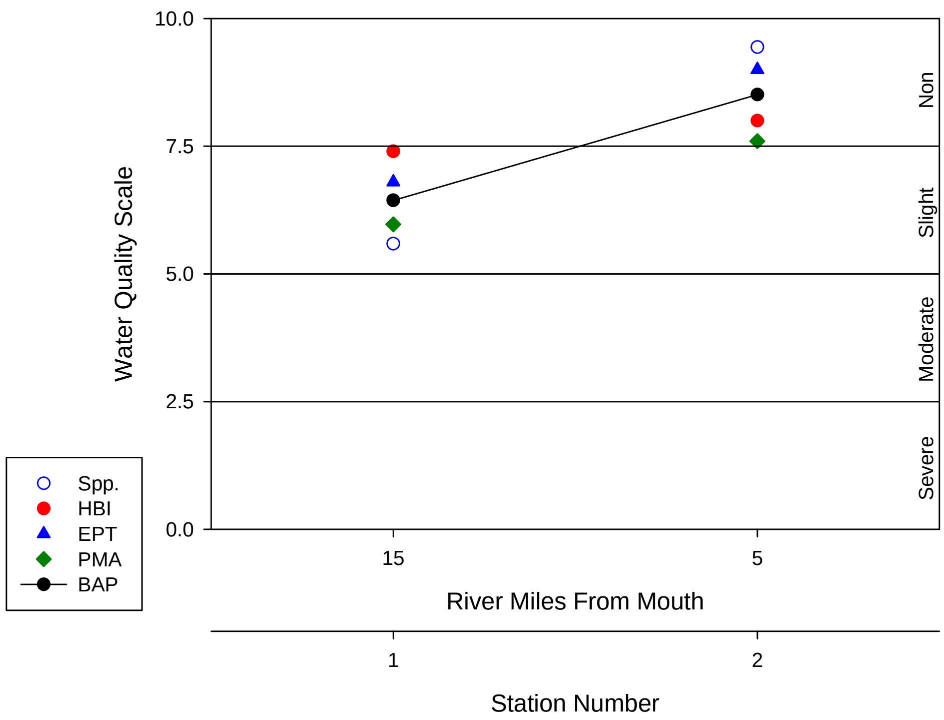
Appendix IV-B. Biological Assessment Profile: Plotting Values

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

Example data:

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

Sample BAP plot:



Appendix V. Water Quality Assessment Criteria

Non-Navigable Flowing Waters

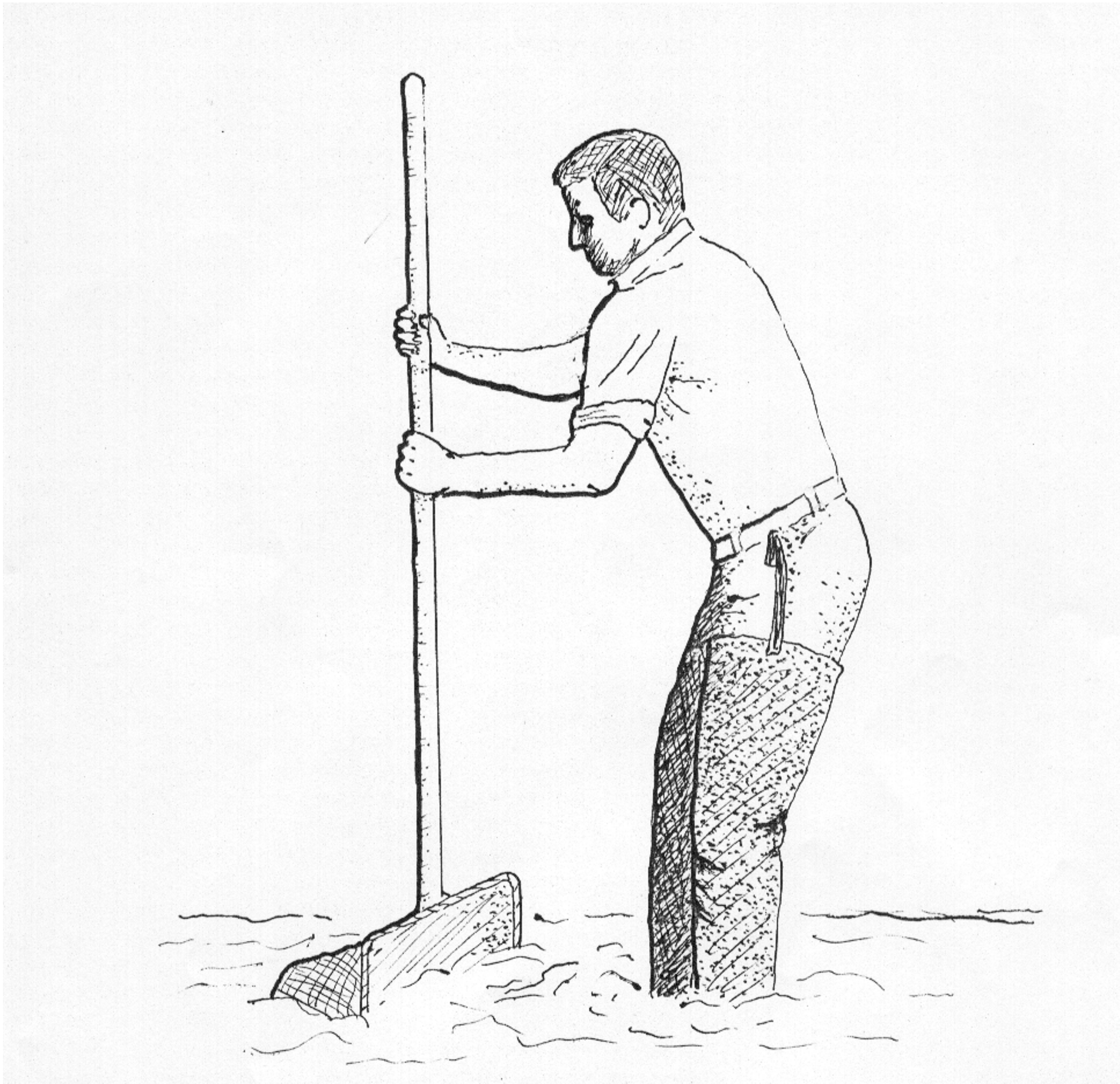
	Species Richness	Hilsenhoff Biotic Index	EPT Value	Percent Model Affinity*	Diversity **
Non-Impacted	>26	0.00-4.50	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	0-1	<35	0.00-2.00

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

Navigable Flowing Waters

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

Appendix VI. The Traveling Kick Sample



← current

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

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

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

MAYFLIES

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

STONEFLIES

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

CADDISFLIES

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

BEETLES

Appendix VII-B. Aquatic Macroinvertebrates Usually Indicative of Poor Water Quality

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

MIDGES

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

BLACK FLIES

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

WORMS

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

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

SOWBUGS

Appendix VIII. The Rationale of Biological Monitoring

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

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

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

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

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

Appendix IX. Glossary

Anthropogenic: caused by human actions

Assessment: a diagnosis or evaluation of water quality

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

Bioaccumulate: accumulate contaminants in the tissues of an organism

Biomonitoring: the use of biological indicators to measure water quality

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

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

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

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

Eutrophic: high nutrient levels normally leading to excessive biological productivity

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

Fauna: the animal life of a particular habitat

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

Impairment: a detrimental effect caused by an impact

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

Intolerant: unable to survive poor water quality

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

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

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

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

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

Oligotrophic: low nutrient levels normally leading to unproductive biological conditions

Organism: a living individual

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

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

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

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

Station: a sampling site on a waterbody

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

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

Tolerant: able to survive poor water quality

Trophic: referring to productivity

Appendix X. Methods for Calculation of the Nutrient Biotic Index

Definition: The Nutrient Biotic Index (Smith et al., 2007) is a diagnostic measure of stream nutrient enrichment identified by macroinvertebrate taxa. The frequency of occurrences of taxa at varying nutrient concentrations allowed the identification of taxon-specific nutrient optima using a method of weighted averaging. The establishment of nutrient optima is possible based on the observation that most species exhibit unimodal response curves in relation to environmental variables (Jongman et al., 1987). The assignment of tolerance values to taxa based on their nutrient optimum provided the ability to reduce macroinvertebrate community data to a linear scale of eutrophication from oligotrophic to eutrophic. Two tolerance values were assigned to each taxon, one for total phosphorus, and one for nitrate (listed in Smith, 2005). This provides the ability to calculate two different nutrient biotic indices, one for total phosphorus (NBI-P), and one for nitrate (NBI-N). Study of the indices indicates better performance by the NBI-P, with strong correlations to stream nutrient status assessment based on diatom information.

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

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

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

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

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

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

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

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

TAXON	TP T-Value	NO3 T-Value
Acentrella sp.	5	5
Acerpenna pygmaea	0	4
Acroneuria abnormis	0	0
Acroneuria sp.	0	0
Agnetina capitata	3	6
Anthopotamus sp.	4	5
Antocha sp.	8	6
Apatania sp.	3	4
Atherix sp.	8	5
Baetis brunneicolor	1	5
Baetis flavistriga	7	7
Baetis intercalaris	6	5
Baetis sp.	6	3
Baetis tricaudatus	8	9
Brachycentrus appalachia	3	4
Caecidotea racovitzai	6	2
Caecidotea sp.	7	9
Caenis sp.	3	3
Cardiocladius obscurus	8	6
Cheumatopsyche sp.	6	6
Chimarra aterrima?	2	3
Chimarra obscura	6	4
Chimarra socia	4	1
Chimarra sp.	2	0
Chironomus sp.	9	6
Cladotanytarsus sp.	6	4
Corydalus cornutus	2	2
Cricotopus bicinctus	7	6
Cricotopus tremulus gr.	8	9
Cricotopus trifascia gr.	9	9
Cricotopus vierriensis	6	5
Cryptochironomus fulvus gr.	5	6
Diamesa sp.	10	10
Dicranota sp.	5	10
Dicrotendipes neomodestus	10	4
Dolophilodes sp.	4	3
Drunella cornutella	4	4
Ectopria nervosa	10	9
Epeorus (Iron) sp.	0	0
Ephemerella sp.	4	4
Ephemerella subvaria	4	1
Ephoron leukon?	1	1
Eukiefferiella devonica gr.	9	9
Ferrissia sp.	9	5
Gammarus sp.	8	9
Glossosoma sp.	6	0
Goniobasis livescens	10	10
Helicopsyche borealis	1	2
Hemerodromia sp.	5	6
Heptagenia sp.	0	0
Hexatoma sp.	0	1
Hydropsyche betteni	7	9
Hydropsyche bronta	7	6
Hydropsyche morosa	5	1
Hydropsyche scalaris	3	3
Hydropsyche slossonae	6	10
Hydropsyche sp.	5	4
Hydropsyche sparna	6	7
Hydroptila consimilis	9	10
Hydroptila sp.	6	6
Hydroptila spatulata	9	8
Isonychia bicolor	5	2
Lepidostoma sp.	2	0
Leucotrichia sp.	6	2
Leucrocuta sp.	1	3
Macrostemum carolina	7	2
Macrostemum sp.	4	2
Micrasema sp. 1	1	0
Micropsectra dives gr.	6	9
Micropsectra polita	0	7
Micropsectra sp.	3	1
Microtendipes pedellus gr.	7	7
Microtendipes rydalensis gr.	2	1
Nais variabilis	5	0
Neoperla sp.	5	5
Neureclipsis sp.	3	1
Nigronia serricornis	10	8
Nixe (Nixe) sp.	1	5
Ophiogomphus sp.	1	3
Optioservus fastiditus	6	7
Optioservus ovalis	9	4
Optioservus sp.	7	8
Optioservus trivittatus	7	6
Orthocladius nr. dentifer	3	7
Pagastia orthogonia	4	8
Paragnetina immarginata	1	2
Paragnetina media	6	3
Paragnetina sp.	1	6
Paraleptophlebia mollis	2	1
Paraleptophlebia sp.	2	3
Parametriocnemus lundbecki	8	10
Paratanytarsus confusus	5	8
Pentaneura sp.	0	1
Petrophila sp.	5	3
Phaenopsectra dyari?	4	5
Physella sp.	8	7
Pisidium sp.	8	10
Plauditus sp.	2	6
Polycentropus sp.	4	2
Polypedilum aviceps	5	7
Polypedilum flavum	9	7
Polypedilum illinoense	10	7
Polypedilum laetum	7	6
Polypedilum scalaenum gr.	10	6
Potthastia gaedii gr.	9	10
Promoresia elegans	10	10
Prostoma graecense	2	7
Psephenus herricki	10	9
Psephenus sp.	3	4

NBI tolerance values (cont'd)

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

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

Appendix XI. Impact Source Determination Methods and Community Models

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

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

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

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

ISD Models

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

NONPOINT NUTRIENTS, PESTICIDES

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

ISD Models (cont'd)

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

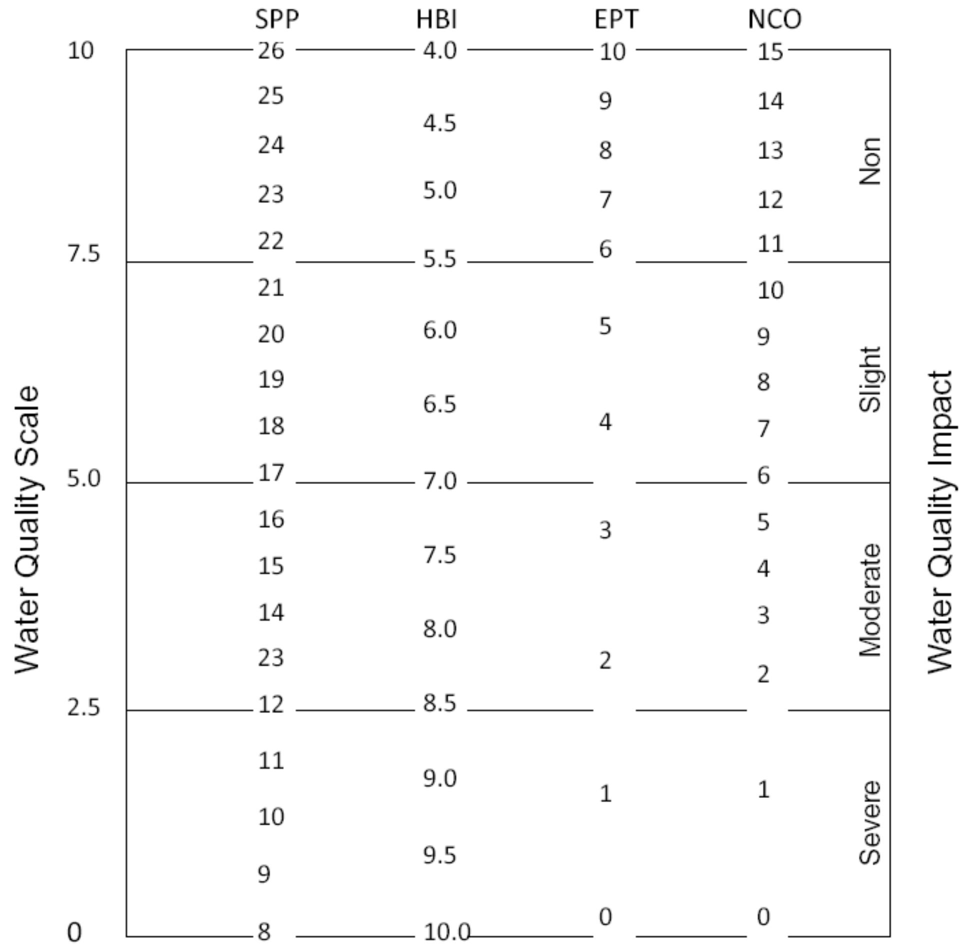
ISD Models (cont'd)

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

ISD Models (cont'd)

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

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



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

Appendix XIII. Biological Impacts of Waters with High Conductivity

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

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

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

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

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

References:

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

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

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

Appendix XIV. Pebble Count and Periphyton/Silt Cover Index

Pebble Count

This method is used to describe the substrate particle size classes within the "riffle" habitat of high gradient stream types that are targeted by the NYSDEC for macroinvertebrate community assessments. The method is based on the more rigorous technique developed by Wolmen (1954) to describe coarse river bed materials, and modifications of this technique developed by the Forest Service to describe channel bed materials within stream reaches Bevenger and King (1995).

1. A minimum of 100 particles are to be recorded on a tally sheet.

2. Diagonal transects across the stream are paced off until a minimum 100 count is reached. Transects begin at the lower end of the wetted portion of the stream bed within the macroinvertebrate sampling section or riffle. A pebble is selected as described in step 3; every two paces in streams > 20m across, or every pace in streams < 20m across.

3. With eyes closed, a pebble is randomly selected from the bottom. The pebble is then categorized by its particle size. Size categories were initially based on Wentworth's size classes, which were then lumped into larger biologically based size classes used by the NYSDEC to describe substrate composition. The NYSDEC size categories are: Sand < 2mm (.08"), Gravel 2-16mm (.08-2.5"), Course Gravel 16-64mm (.63-2.5"), Cobble 64-256mm (2.5-10.1"), Boulder > 256mm (>10.1").

4. Size categories are determined by using a gravelometer, essentially a metal plate with squares of the above size classes cut out. The particle must be placed thru the smallest cut out so that the intermediate axis is perpendicular to the sides (not diagonally across) of the cut out. The smallest size class which the pebble falls through is called out to a recorder, who keeps track of the tally until the 100-particle minimum is reached, at which time the transect is completed.

Characterize the amount of moss, macro-algae, micro-algae, and silt cover separately. If substrates are less than 2 cm in diameter, do not tally an entry, but measure the substrate size with the gravelometer as described previously. Record moss and macro-algae cover using a scale from 0-3 with separate estimates for each, where:

0 = no moss or macro-algae present;
1 = some moss or macro-algae present, but < 5% coverage;
2 = 5-25% cover of substratum by moss or macro-algae, and
3 = > 25% cover of substratum by moss or macro-algae.

Appendix XIV. cont'd.

Estimate average thickness of micro-algae (periphyton) on the rock with a 0-6 thickness scale, where:

0 = substrate is rough with no apparent growth;
1 = substrate is slimy, but biofilm is not visible (tracks cannot be drawn in the film with the back of your fingernail; endolithic algae can appear green but will not scratch easily from the substratum);
2 = a thin layer of microalgae is visible (tracks can be drawn in the film with the back of your fingernail);
3 = accumulation of microalgae to a thickness of 0.5-1 mm;
4 = accumulation of microalgae from 1-5 mm thick;
5 = accumulation of microalgae from 5-20 mm;
6 = layer of microalgae is > 20 mm.

(Note that if substrate is too large to pickup, algal growth should still be characterized.)

Weighted Periphyton and Silt Index Calculation (PI) (0-10)

Moss and Macro Algae percent cover
= ((%Cat. 0*0) + (%Cat. 1*2) + (%Cat. 2*6) + (%Cat. 3*10))/100

Micro Algae Thickness
= ((%Cat. 0*0)+(%Cat. 1*5)+(%Cat. 2*2)+(%Cat. 3*4)+(%Cat. 4*7)+(%Cat. 5*10))/100

Silt Cover Index
= (%Cat0*0)+(%Cat1*3)+(%Cat2*6)+(%Cat3*8)+(%Cat4*10)

Percentile analyses for periphyton and silt index scores in NYS.

	Percentiles			
Index	25th	50th	75th	90th
Moss	0	0	0	0.34
Macro-aglae	0.85	2.63	5.96	7.98
Micro-algae	0.44	0.50	0.83	1.55
Silt Cover	0.60	1.89	3.63	4.45

Bevenger, G. S. and R. M. King (1995). A pebble count procedure for assessing watershed cumulative effects. Research paper RM (USA).

Wolman, M. G. (1954). A method of sampling coarse river-bed material. *Transactions of the American Geophysical Union*, 35(6): 951-956.