New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Owasco Lake Inlet

Biological Assessment

2006 Survey

New York State
Department of Environmental Conservation

Owasco Lake Inlet

BIOLOGICAL ASSESSMENT

Seneca-Oneida-Oswego Rivers Basin
Cayuga and Tompkins Counties, New York

Survey date: July 6, 2006
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CONTENTS

Stream: Owasco Lake Inlet, Cayuga and Tompkins Counties, New York

Reach: Above Groton to below Moravia, New York

NYS Drainage Basin: Seneca-Oneida-Oswego Rivers Basin

Background:

The Stream Biomonitoring Unit sampled Owasco Lake Inlet in Cayuga and Tompkins counties, New York, on July 6, 2006. The purpose of the sampling was to assess overall water quality and determine the extent and causes of nutrient enrichment in the stream.

In riffle areas at seven sites, a traveling kick sample for macroinvertebrates was taken using methods described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample from each site. Macroinvertebrate community parameters used in the determination of water quality included species richness, biotic index, EPT richness, and percent model affinity (see Appendices II and III). Expected variability of results is stated in Smith and Bode (2004). Table 3 provides a listing of sampling sites and Table 4 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Thanks to Scott Cook, DEC Region 7, for his assistance in this survey.

Results and Conclusions:

1. Water quality in Owasco Lake Inlet ranged from non-impacted to moderately impacted based on resident macroinvertebrate communities. A substantial decline in water quality occurred downstream of the Groton (V) Wastewater Treatment Plant (WWTP) discharge.

2. The Nutrient Biological Index indicated the greatest effects of nutrient inputs downstream of the Groton (V) Wastewater Treatment Plant discharge. Effects diminished linearly from Groton to Moravia. This trend is similar to previous measurements of total phosphorus in the stream.

3. Based on the Biological Assessment Profile, the Nutrient Biotic Index, and Cayuga County phosphorus data, the Groton (V) WWTP is indicated to be the major source of phosphorus in Owasco Inlet. Upgrading of the Groton treatment plant to include phosphorus removal would be a major step toward reducing nutrient loading to Owasco Lake.

Discussion:

Owasco Lake Inlet begins north of Freeville, New York, and flows approximately 21 miles in a northwesterly direction before flowing into Owasco Lake north of Moravia. The stream was previously sampled by the Stream Biomonitoring Unit at Moravia in 2001, and was assessed as slightly impacted (Bode et al., 2004). The purpose of the present survey was to assess overall water quality in relation to nutrient enrichment in the stream. Excess nutrients, resulting in increased plant and algal growth, are of concern in Owasco Lake as the primary cause of eutrophication. Owasco Lake Inlet is cited in the NYSDEC Priority Waterbody Listing as being a significant source of nutrients to Owasco Lake (NYSDEC, 1996). To document this problem, water column sampling of phosphorus levels in the watershed was conducted by Cornell Cooperative Extension of Cayuga County (Fallone, 2005).

In the present study, water quality assessments in Owasco Lake Inlet ranged from non-impacted to moderately impacted based on macroinvertebrate communities. A substantial decline in water quality occurred downstream of the Groton (V) Wastewater Treatment Plant discharge, as indicated by the Biological Assessment Profile (Figure 1). The macroinvertebrate community at this site was dominated by tolerant aquatic worms and black fly larvae, and had a high similarity to the model for the type of community expected downstream of sewage treatment plant discharges (Table 1).

The Nutrient Biological Index (NBI) also indicated the greatest effects downstream of the Groton (V) WWTP discharge, with effects diminishing linearly from Groton to Moravia (Figure 2). NBI scores used in this figure were combined scores for phosphorus and nitrogen (Table 2). Since an NBI value of 6 or greater corresponds to eutrophic conditions (Appendix XI), all sites in Owasco Inlet are considered biologically eutrophic.

Phosphorus data compiled by a sampling program in the Cayuga and Owasco lakes watersheds were reported by Fallone (2005). These data, based on means of monthly sampling from May to October at five Owasco Inlet sites, show the highest levels of total phosphorus (TP) at the site downstream of the Groton (V) WWTP. This trend correlates well with the Nutrient Biological Index in highlighting the inputs of this facility (Figure 2, Table 2). Although high phosphorus levels decrease linearly downstream of Groton as phosphorus is consumed by bacteria, algae, and macrophytes, the levels at Moravia would very likely be much lower without the addition at Groton. Levels upstream of Groton, averaging 0.26 mg/l, are already considered high, and are likely contributed primarily by agricultural sources. Studies have shown that TP levels above 0.06 mg/l can cause detrimental changes to fish communities (Miltner and Rankin, 1998).

Based on the Biological Assessment Profile, the Nutrient Biotic Index, and Cayuga County phosphorus data, the Groton (V) WWTP is indicated to be the major source of phosphorus in Owasco Inlet. Upgrading of the Groton treatment plant to include phosphorus removal would be a major step toward reducing nutrient loading to Owasco Lake.

Overview of field data:

On July 6, 2006, Owasco Lake Inlet at the sites sampled was 3-20 meters wide, 0.2-0.3 meter deep, and had current speeds of 90-150 cm/sec in riffles. Dissolved oxygen was 9.1-11.8 mg/l, specific conductance was 369-479 µmhos, pH was 7.3-8.7 and temperature was 16.8-17.9 °C (62-64 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile (BAP) of index values, Owasco Inlet, 2006. 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 (SPP), EPT richness (EPT), Hilsenhoff Biotic Index (HBI), and Percent Model Affinity (PMA). See Appendix IV for more complete explanation.

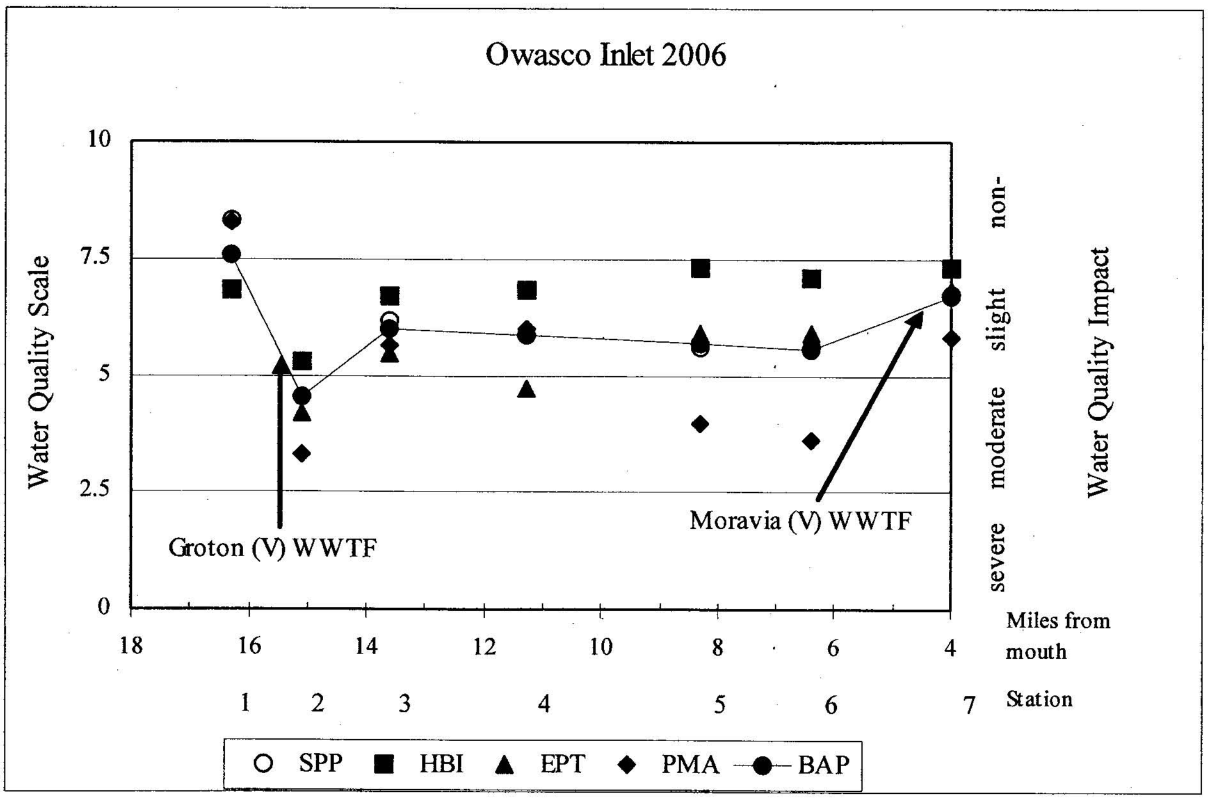


Figure 2. Nutrient Biotic Index (NBI) and total phosphorus (TP) values from Owasco Inlet. TP values are means of seven monthly values, May-October, 2004 (Fallone, 2005). NBI values are means for nitrogen and phosphorus (See Table 2).

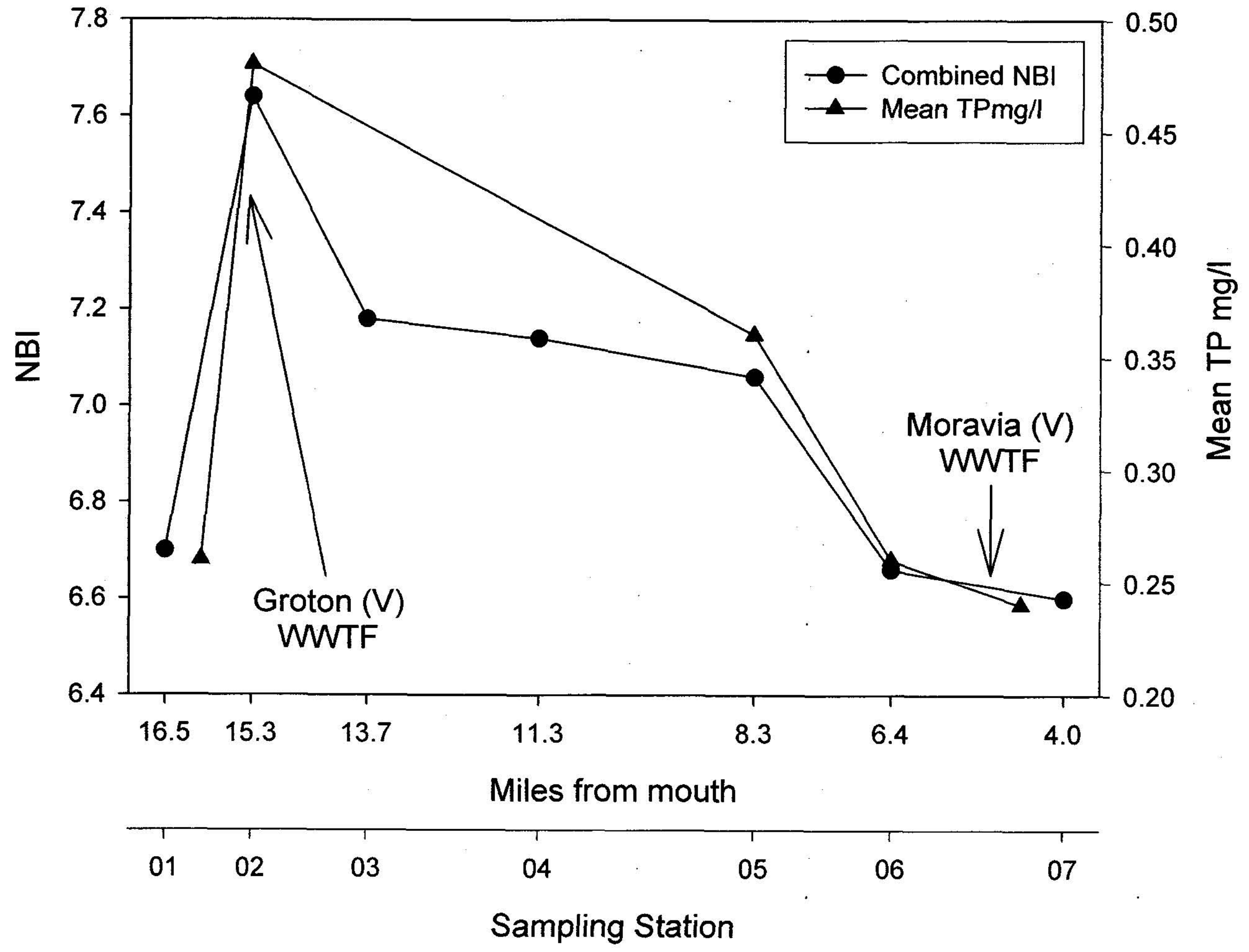


Table 1. Impact Source Determination, Owasco Lake Inlet, 2006. Numbers represent percent similarity to community type models for each impact category. Highest similarities at each station are shaded. Similarities less than 50 percent are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	STATION						
Community Type	1	2	3	4	5	6	7
Natural: minimal human impacts	48	27	32	49	50	54	60
Nutrient additions: mostly nonpoint, agricultural	56	40	48	51	52	57	66
Toxic: industrial, municipal, or urban run-off	44	52	42	35	40	39	45
Organic: sewage effluent, animal wastes	33	64	36	39	30	32	36
Complex: municipal/industrial	43	48	53	43	29	34	35
Siltation	44	35	38	41	36	37	48
Impoundment	42	62	42	39	41	40	50

STATION	COMMUNITY TYPE
OWLI-01	Nutrient enrichment
OWLI-02	Organic (impoundment considered spurious)
OWLI-03	Complex, nutrient enrichment
OWLI-04	Nutrient enrichment, natural
OWLI-05	Nutrient enrichment, natural
OWLI-06	Nutrient enrichment, natural
OWLI-07	Nutrient enrichment

Table 2. NBI and TP values from Owasco Inlet. TP values are means of seven monthly values, May-October, 2004 (Fallone, 2005).

Miles from mouth	DEC Station Number	Cayuga Co. Station number	NBI-P	NBI-N	Combined NBI	Average Total Phosphorus
16.5	OWLI-01	-	6.38	7.01	6.70	-
16.0	-	OWL-604	-	-	-	0.26
15.3	OWLI-02	OWL-158	7.02	8.26	7.64	0.48
13.7	OWLI-03	-	7.16	7.20	7.18	
11.3	OWLI-04	-	7.16	7.11	7.14	-
8.3	OWLI-05	OWL-154	6.96	7.16	7.06	0.36
6.4	OWLI-06	OWL-112	7.24	6.07	6.66	0.26
4.6	-	OWL-111	-	-	-	0.24
4.0	OWLI-07	-	6.33	6.89	6.60	-

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.

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman and A. J. Smith, 2004, Thirty-year trends in water quality of rivers and streams in New York State, based on macroinvertebrate data. New York State Department of Environmental Conservation, Technical Report, 384 pages.

Fallone, K., 2005, Total phosphorus sampling program for the Cayuga and Owasco Lake watersheds, 2004, Cornell Cooperative Extension of Cayuga County, 26 pages.

Miltner, R. J., and E. T. Rankin, 1998, Primary nutrients and the biotic integrity of rivers and streams, Freshwater Biology 40:145-158.

NYS DEC, 1996 (reprinted 2001), The 1996 Priority Waterbodies List for the Oswego-Seneca-Oneida River Basin. New York State Department of Environmental Conservation, Technical Report, 196 pages.

Smith, A. J. and R. W. Bode, 2004, Analysis of variability in New York State benthic macroinvertebrate samples. New York State Department of Environmental Conservation, Technical Report, 43 pages.

Table 3. Station Locations for Owasco Inlet, Cayuga and Tompkins Counties, New York

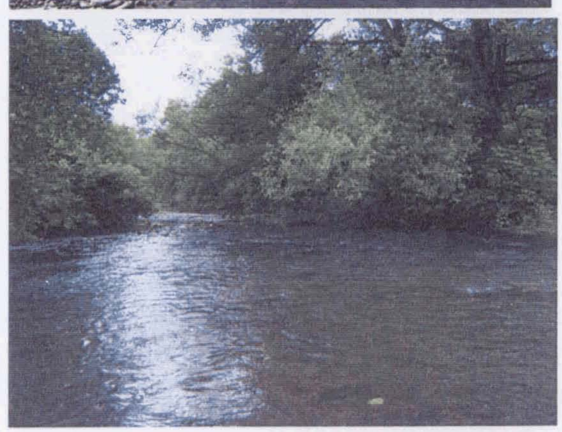
Station	Location	
OWLI-01	Above Groton, NY at Peru Road bridge latitude 42°35'06" longitude 76°22'05" 16.3 stream miles above mouth	
OWLI-02	Below Groton, NY at Walpole Road bridge latitude 42°35'56" longitude 76°22'23" 15.1 stream miles above mouth	
OWLI-03	Below Groton, NY at Route 38 bridge latitude 42°37'05" longitude 76°23'03" 13.6 stream miles above mouth	
OWLI-04	Above Locke, NY at Route 38 bridge latitude 42°38'32" longitude 76°24'28" 11.3 stream miles above mouth	

Table 3, continued

Station	Location
OWLI-05	Below Locke, NY at Route 38 bridge latitude 42°40'09" longitude 76°25'52" 8.3 stream miles above mouth
OWLI-06	Above Moravia, NY at Rounds Lane latitude 42°41'28" longitude 76°25'31" 6.4 stream miles above mouth
OWLI-07	Below Moravia, NY at Route 38 bridge latitude 42°43'00" longitude 76°26'14" 4.0 stream miles above mouth

Figure 3	Watershed Overview	Owasco Inlet

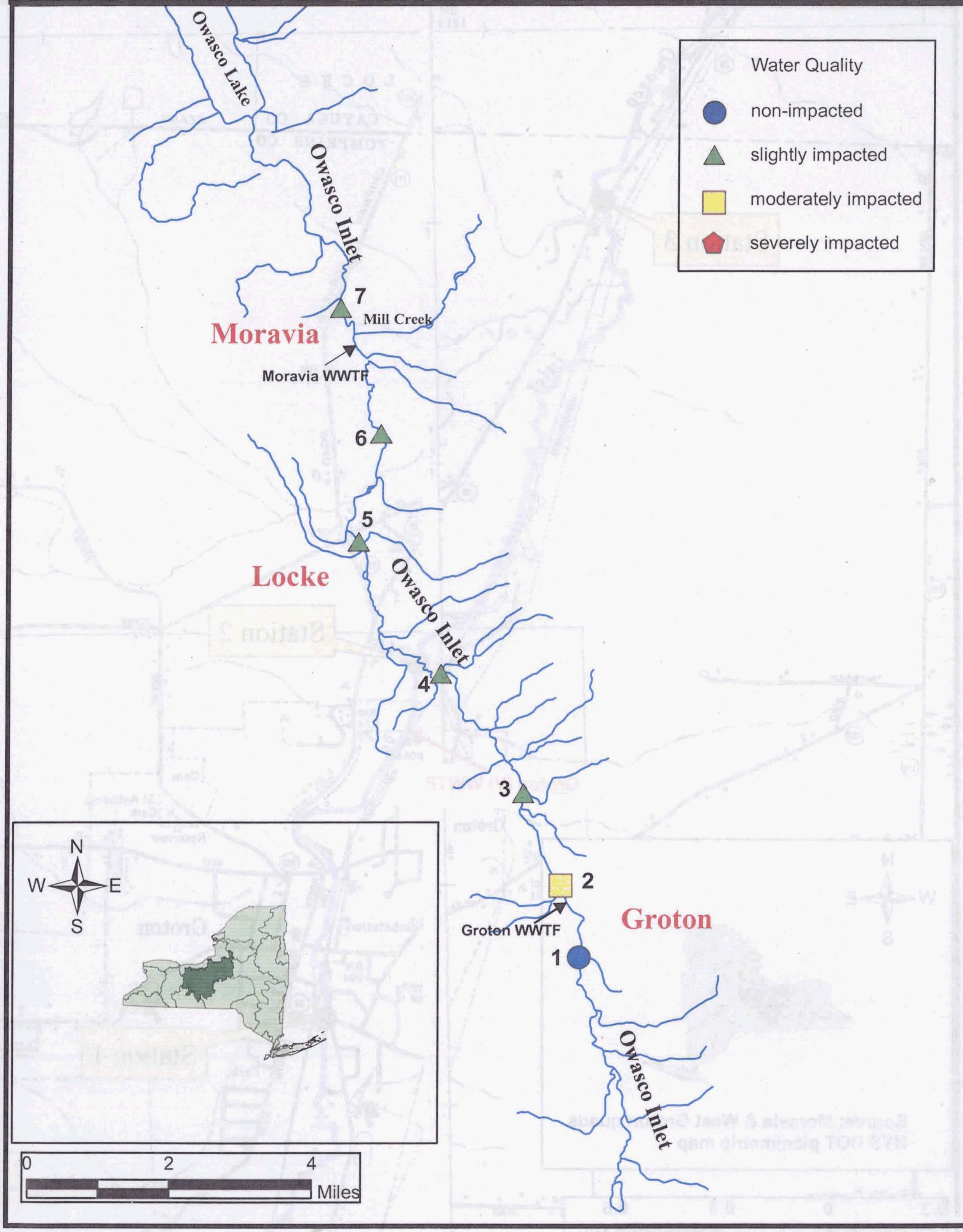


Figure 4a	Site Location Map	Owasco Inlet

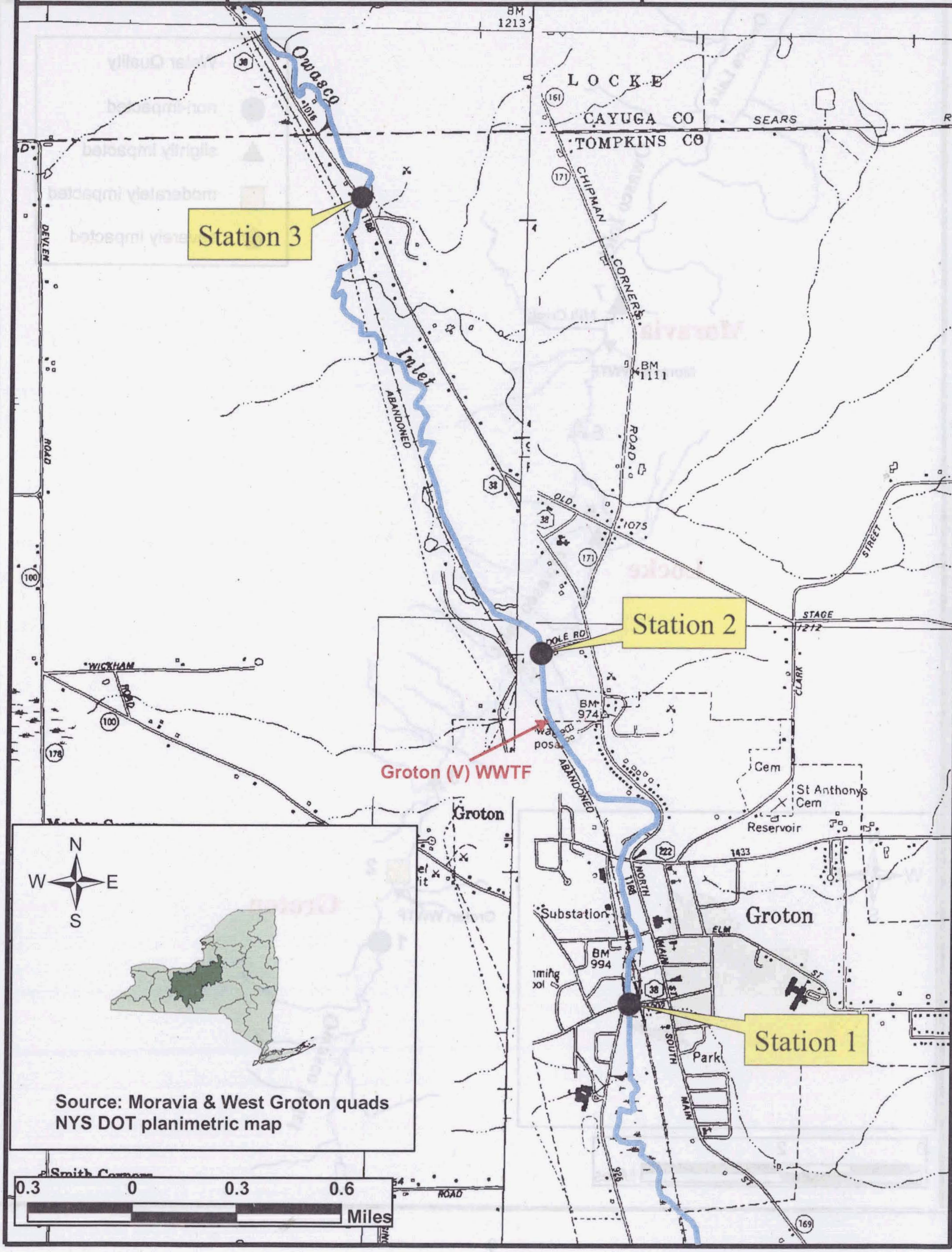


Figure 4b	Site Location Map	Owasco Inlet

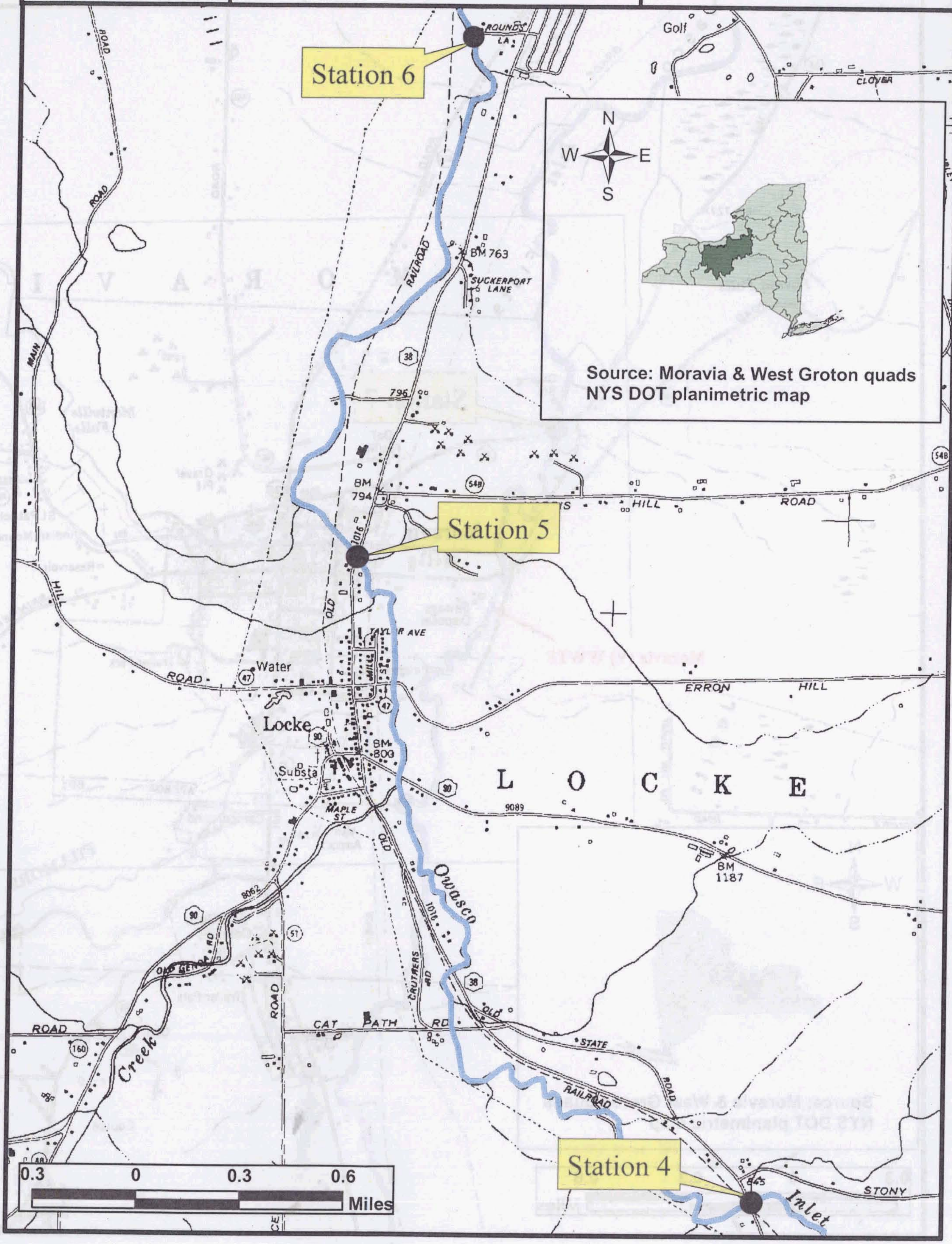
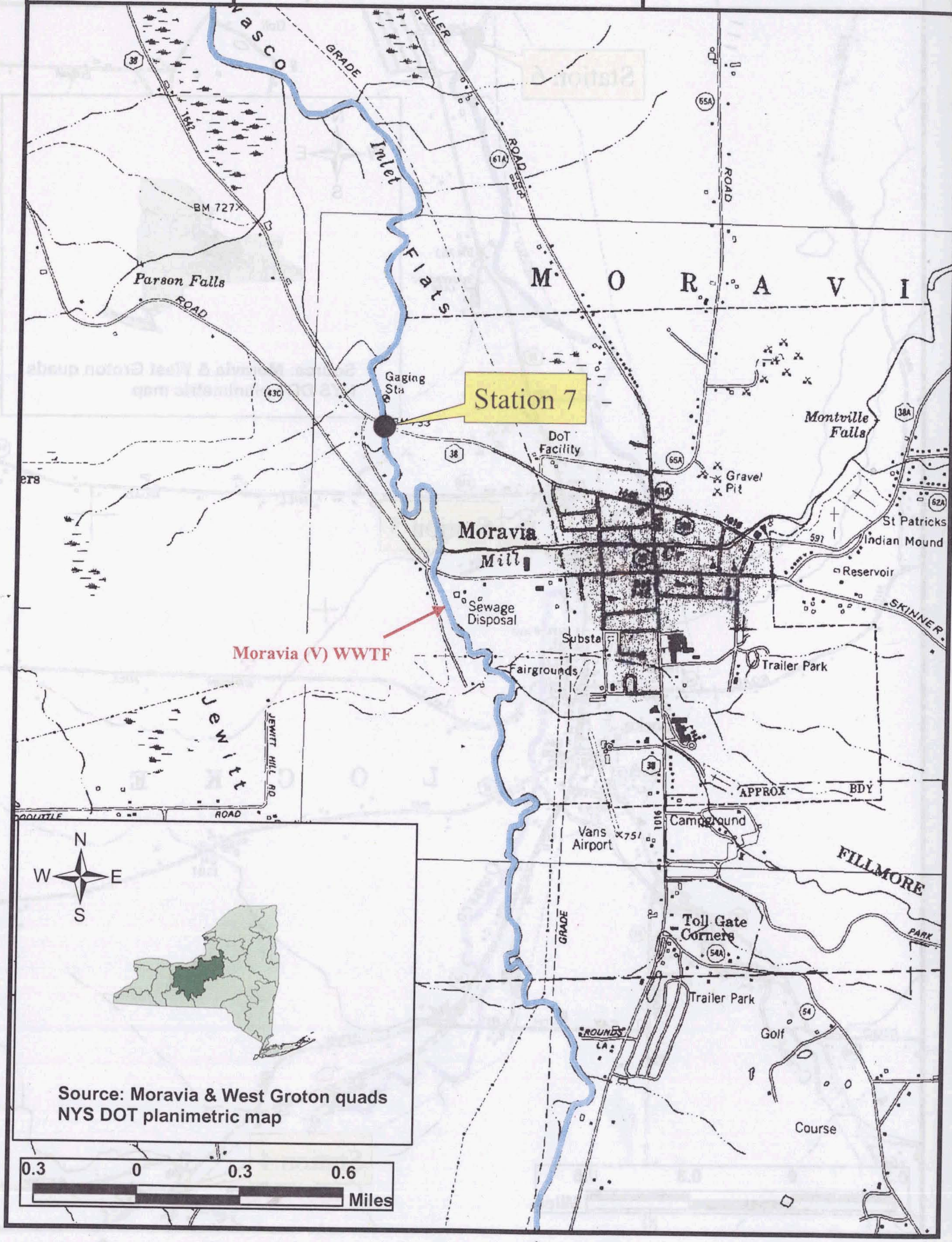


Figure 4c	Site Location Map	Owasco Inlet



↑ stream flow

Table 4. Macroinvertebrate Species Collected in Owasco Lake Inlet, Cayuga and Tompkins Counties, New York, 2006.

NEMERTEA
  Tetrastemmatidae
    Prostoma graecense
PLATYHELMINTHES
 TURBELLARIA
    Undetermined Turbellaria

ANNELIDA
 TUBIFICIDA
  Enchytraeidae
    Undetermined Enchytraeidae
  Tubificidae
    Limnodrilus hoffmeisteri
    Undet. Tubificidae w/ cap. setae
  Naididae
    Nais behningi
    Ophidonais serpentina

MOLLUSCA
 GASTROPODA
  Physidae
    Physella sp.
  Ancylidae
    Ferrissia sp.
 PELECYPODA
  Sphaeriidae
    Sphaerium sp.

ARTHROPODA
 CRUSTACEA
  ISOPODA
   Asellidae
    Caecidotea sp.
  AMPHIPODA
   Gammaridae
    Gammarus sp.

INSECTA
 EPHEMEROPTERA
  Baetidae
    Acentrella sp.
    Baetis flavistriga
    Baetis intercalaris
  Heptageniidae
    Heptagenia marginalis
    Leucrocuta sp.
    Stenonema sp.
  Ephemerellidae
    Undetermined Ephemerellidae
  Tricorythidae
    Tricorythodes sp.

PLECOPTERA
  Leuctridae
    Undetermined Leuctridae

  Perlidae
    Agnetina capitata
    Paragnetina immarginata
  Chloroperlidae
    Undetermined Chloroperlidae

COLEOPTERA
  Psephenidae
    Ectopria nervosa
    Psephenus herricki
  Elmidae
    Optioservus fastiditus
    Optioservus ovalis
    Optioservus trivittatus
    Optioservus sp.
    Oulimnius sp.
    Promoresia elegans
    Promoresia sp.
    Stenelmis crenata

TRICHOPTERA
  Philopotamidae
    Chimarra aterrima
    Chimarra obscura
    Chimarra socia
  Psychomyiidae
    Psychomyia flavida
  Hydropsychidae
    Cheumatopsyche sp.
    Hydropsyche bronta
    Hydropsyche slossonae
    Hydropsyche sparna

DIPTERA
  Tipulidae
    Antocha sp.
    Dicranota sp.
    Hexatoma sp.
  Psychodidae
    Undetermined Psychodidae
  Simuliidae
    Simulium vittatum
  Athericidae
    Atherix sp.
  Empididae
    Hemerodromia sp.

Table 4, Continued.

Chironomidae

Thienemannimyia gr. spp.
Diamesa sp.
Pagastia orthogonia
Cardiocladius obscurus
Cricotopus bicinctus
Cricotopus tremulus
Cricotopus trifascia
Cricotopus sp.
Eukiefferiella devonica gr.
Parametriocnemus lundbecki
Rheocricotopus robacki
Synorthocladius nr. semivirens
Tvetenia vitracies
Cryptochironomus fulvus gr.
Microtendipes pedellus gr.
Polypedilum aviceps
Polypedilum fallax gr.
Polypedilum flavum
Polypedilum illinoense
Micropsectra sp.
Rheotanytarsus exiguus gr.

Macroinvertebrate Data Report: Raw Data.

STREAM SITE:	Owasco Lake Inlet, Station OWLI-01
LOCATION:	Groton, NY, below Peru Road bridge
DATE:	06 July 2006
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

PLATYHELMINTHES			
TURBELLARIA			
	Planariidae	Undetermined Turbellaria	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	12
		Baetis intercalaris	5
	Heptageniidae	*Stenonema sp.*	2
		Heptagenia marginalis	1
PLECOPTERA	Perlidae	*Agnetina capitata*	2
COLEOPTERA	Psephenidae	*Psephenus herricki*	2
	Elmidae	*Optioservus sp.*	11
		Oulimnius sp.	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima?*	6
	Hydropsychidae	*Cheumatopsyche sp.*	4
		Hydropsyche bronta	3
		Hydropsyche sparna	1
DIPTERA	Tipulidae	*Antocha sp.*	1
		Dicranota sp.	2
		Hexatoma sp.	3
	Simuliidae	*Simulium vittatum*	17
	Chironomidae	*Thienemannimyia gr. spp.*	2
		Diamesa sp.	3
		Pagastia orthogonia	1
		Cardiocladius obscurus	2
		Cricotopus bicinctus	1
		Cricotopus tremulus gr.	3
		Cricotopus trifascia gr.	3
		Parametriocnemus lundbecki	1
		Rheocricotopus robacki	1
		Microtendipes pedellus gr.	1
		Polypedilum flavum	3
		Micropsectra sp.	4

SPECIES RICHNESS:	29 (very good)
BIOTIC INDEX:	5.03 (good)
EPT RICHNESS:	9 (good)
MODEL AFFINITY:	72 (very good)
ASSESSMENT:	non-impacted (7.57)

DESCRIPTION: The kick sample was taken downstream of the Peru Road bridge (Route 38) in Groton. The habitat was considered good, and the macroinvertebrate fauna was diverse and well balanced, with mayflies, stoneflies, and caddisflies well represented. Based on the metrics, water quality was assessed as non-impacted.

Macroinvertebrate Data Report: Raw Data, cont'd.

STREAM SITE:	Owasco Lake Inlet, Station OWLI-02
LOCATION:	Below Groton, NY, above Walpole Road bridge
DATE:	06 July 2006
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Naididae	*Nais behningi*	40
		Ophidonais serpentina	2
	Tubificidae	Undet. Tubificid w/ cap. setae	2
MOLLUSCA			
GASTROPODA			
	Physidae	*Physella sp.*	1
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	*Caecidotea sp.*	2
AMPHIPODA	Gammaridae	*Gammarus sp.*	2
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	6
		Baetis intercalaris	1
TRICHOPTERA	Hydropsychidae	*Hydropsyche bronta*	4
		Hydropsyche sparna	9
DIPTERA	Psychodidae	*Undetermined Psychodidae*	1
	Simuliidae	*Simulium vittatum*	23
	Chironomidae	*Cricotopus tremulus gr.*	1
		Cricotopus trifascia gr.	1
		Rheocricotopus robacki	1
		Polypedilum aviceps	1
		Polypedilum flavum	1
		Polypedilum illinoense	1
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS:	19 (good)
BIOTIC INDEX:	6.27 (good)
EPT RICHNESS:	4 (poor)
MODEL AFFINITY:	39 (poor)
ASSESSMENT:	moderately impacted (4.52)

DESCRIPTION: The sampling site was estimated to be 200 meters downstream of the Groton (V) Sewage Treatment Plant discharge. A poor macroinvertebrate community was found, and was assessed as moderately impacted. Although mayflies, stoneflies and caddisflies were present, tolerant worms and blackflies dominated the sample. All metrics declined compared to those at upstream Station-1.

Macroinvertebrate Data Report: Raw Data, cont'd.

STREAM SITE:	Owasco Lake Inlet, Station OWLI-03
LOCATION:	Below Groton, NY, at Route 38 bridge
DATE:	06 July 2006
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	7
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	5
		Baetis intercalaris	3
COLEOPTERA	Elmidae	*Optioservus sp.*	5
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	4
		Hydropsyche bronta	25
		Hydropsyche slossonae	1
		Hydropsyche sparna	4
DIPTERA	Tipulidae	*Antocha sp.*	2
		Dicranota sp.	3
	Simuliidae	*Simulium vittatum*	1
	Chironomidae	*Diamesa sp.*	12
		Pagastia orthogonia	5
		Cardiocladius obscurus	5
		Cricotopus bicinctus	2
		Cricotopus trifascia gr.	1
		Eukiefferiella devonica gr.	1
		Synorthocladius nr. semivirens	1
		Tvetenia vitracies	1
		Microtendipes pedellus gr.	2
		Polypedilum flavum	2
		Rheotanytarsus exiguus gr.	8

SPECIES RICHNESS:	22 (good)
BIOTIC INDEX:	5.14 (good)
EPT RICHNESS:	6 (good)
MODEL AFFINITY:	53 (good)
ASSESSMENT:	slightly impacted (6.00)

DESCRIPTION: This site was 1.6 miles downstream of the Groton (V) WWTF discharge. The macroinvertebrate community had partially recovered from the effects of the effluent discharge indicated at Station 2, with all metrics improving. Facultative midges and caddisflies dominated the community. All metrics were within the range of slightly impacted water quality.

Macroinvertebrate Data Report: Raw Data, cont'd.

STREAM SITE:	Owasco Lake Inlet, Station OWLI-04
LOCATION:	Above Locke, NY, at Route 38 bridge
DATE:	06 July 2006
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

NEMERTEA			
		Prostoma graecense	1
ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	*Limnodrilus hoffmeisteri*	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	2
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	2
		Baetis intercalaris	1
PLECOPTERA	Chloroperlidae	Undetermined Chloroperlidae	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	4
	Elmidae	*Optioservus fastiditus*	11
		Optioservus trivittatus	11
		Stenelmis crenata	4
TRICHOPTERA	Hydropsychidae	*Hydropsyche bronta*	21
		Hydropsyche sparna	7
DIPTERA	Tipulidae	*Antocha sp.*	4
		Dicranota sp.	4
	Chironomidae	*Diamesa sp.*	12
		Cardiocladius obscurus	1
		Eukiefferiella devonica gr.	1
		Cryptochironomus fulvus gr.	1
		Microtendipes pedellus gr.	3
		Polypedilum fallax gr.	6
		Micropsectra sp.	2

SPECIES RICHNESS:	21 (good)
BIOTIC INDEX:	5.04 (good)
EPT RICHNESS:	5 (poor)
MODEL AFFINITY:	55 (good)
ASSESSMENT:	slightly impacted (5.85)

DESCRIPTION: The kick sample was taken downstream of the Route 38 bridge above Locke. The macroinvertebrate community was similar to that at Station-3, except more algal-scraping beetles were present at this site, and the riffle seemed to be more embedded with silt. The metrics were very similar to those at Station-3, and water quality was similarly assessed as slightly impacted.

Macroinvertebrate Data Report: Raw Data, cont'd.

STREAM SITE:	Owasco Lake Inlet, Station OWLI-05
LOCATION:	Below Locke, NY, at Route 38 bridge
DATE:	06 July 2006
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

PLATYHELMINTHES			
TURBELLARIA			
	Planariidae	Undetermined Turbellaria	2
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	2
INSECTA			
EPHEMEROPTERA	Baetidae	*Acentrella sp.*	1
		Baetis intercalaris	4
PLECOPTERA	Leuctridae	Undetermined Leuctridae	1
	Perlidae	*Agnetina capitata*	1
COLEOPTERA	Psephenidae	*Ectopria nervosa*	1
		Psephenus herricki	9
	Elmidae	*Optioservus fastiditus*	32
		Promoresia elegans	1
		Stenelmis crenata	19
TRICHOPTERA	Hydropsychidae	*Hydropsyche bronta*	11
		Hydropsyche slossonae	1
		Hydropsyche sparna	3
DIPTERA	Tipulidae	*Dicranota sp.*	2
	Athericidae	*Atherix sp.*	2
	Empididae	*Hemerodromia sp.*	1
	Chironomidae	*Diamesa sp.*	3
		Cricotopus sp.	2
		Microtendipes pedellus gr.	2

SPECIES RICHNESS:	20 (good)
BIOTIC INDEX:	4.65 (good)
EPT RICHNESS:	7 (good)
MODEL AFFINITY:	43 (poor)
ASSESSMENT:	slightly impacted (5.69)

DESCRIPTION: The macroinvertebrate community at this site was heavily dominated by algal-scraping riffle beetles. Mayflies, stoneflies, and caddisflies were also present, but water quality was assessed as slightly impacted.

Macroinvertebrate Data Report: Raw Data, cont'd.

STREAM SITE:	Owasco Lake Inlet, Station OWLI-06
LOCATION:	Above Moravia, NY, at Rounds Lane
DATE:	06 July 2006
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

PLATYHELMINTHES			
TURBELLARIA			
	Planariidae	Undetermined Turbellaria	2
ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	1
	Tubificidae	*Limnodrilus hoffmeisteri*	1
MOLLUSCA			
PELECYPODA			
	Sphaeriidae	*Sphaerium sp.*	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	*Gammarus sp.*	11
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	2
		Baetis intercalaris	2
	Heptageniidae	*Stenonema sp.*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	7
	Elmidae	*Optioservus ovalis*	33
		Stenelmis crenata	16
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	1
		Chimarra socia	1
	Hydropsychidae	*Hydropsyche bronta*	9
		Hydropsyche sparna	5
DIPTERA	Tipulidae	*Antocha sp.*	3
	Chironomidae	*Diamesa sp.*	1
		Pagastia orthogonia	1
		Tvetenia vitracies	1
		Cryptochironomus fulvus gr.	1

SPECIES RICHNESS:	20 (good)
BIOTIC INDEX:	4.83 (good)
EPT RICHNESS:	7 (good)
MODEL AFFINITY:	41 (poor)
ASSESSMENT:	slightly impacted (5.56)

DESCRIPTION: The sampling site was located at the end of Round Lane, upstream of Moravia. The habitat was adequate, although embeddedness was higher than at upstream sites. Metrics were very similar to those at Station-5, and water quality was similarly assessed as slightly impacted. Riffle beetles dominated the fauna, as at Station-5.

Macroinvertebrate Data Report: Raw Data, cont'd.

STREAM SITE:	Owasco Lake Inlet, Station OWLI-07
LOCATION:	Below Moravia, NY, below Route 38 bridge
DATE:	06 July 2006
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 organisms

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Tubificidae	*Limnodrilus hoffmeisteri*	1
MOLLUSCA			
GASTROPODA			
	Ancylidae	*Ferrissia sp.*	1
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	*Caecidotea sp.*	2
AMPHIPODA	Gammaridae	*Gammarus sp.*	3
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	8
	Heptageniidae	*Leucrocuta sp.*	1
	Ephemerellidae	Undet. Ephemerellidae	1
	Leptohyphidae	*Tricorythodes sp.*	6
PLECOPTERA	Perlidae	*Paragnetina immarginata*	1
COLEOPTERA	Elmidae	*Optioservus fastiditus*	20
		Promoresia sp.	2
		Stenelmis crenata	23
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	1
	Psychomyiidae	*Psychomyia flavida*	1
	Hydropsychidae	*Hydropsyche bronta*	4
		Hydropsyche sparna	12
DIPTERA	Tipulidae	*Antocha sp.*	5
	Simuliidae	*Simulium vittatum*	1
	Athericidae	*Atherix sp.*	1
	Chironomidae	*Thienemannimyia gr. spp.*	1
		Pagastia orthogonia	1
		Rheocricotopus robacki	1
		Tvetenia vitracies	2
		Polypedilum flavum	1

SPECIES RICHNESS:	24 (good)
BIOTIC INDEX:	4.65 (good)
EPT RICHNESS:	9 (good)
MODEL AFFINITY:	54 (good)
ASSESSMENT:	slightly impacted (6.68)

DESCRIPTION: Sampling was conducted a short distance downstream of Route 38, downstream of Moravia. The stream bottom was covered with abundant diatoms, filamentous algae, and macrophytes. The macroinvertebrate community contained mayflies, stoneflies, and caddisflies, but was dominated by riffle beetles, similar to the two upstream sites. Water quality was similarly assessed as slightly impacted.

LABORATORY DATA SUMMARY				
STREAM NAME: Owasco Lake Inlet		DRAINAGE: 07		
DATE SAMPLED: 7/6/2006		COUNTY: Cayuga & Tompkins		
SAMPLING METHOD: Travelling Kick				
STATION	01	02	03	04
LOCATION	Above Groton Peru Rd.	Below Groton Walpole Rd.	Below Groton Rte 38	Above Locke Rte 38
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Simulium vittatum	Nais behningi	Hydropsyche bronta	Hydropsyche bronta
	17 %	40 %	25 %	21%
	facultative	facultative	facultative	facultative
	blackfly	worm	caddisfly	caddisfly
2.	Baetis flavistriga	Simulium vittatum	Diamesa sp.	Diamesa sp.
Intolerant = not tolerant of poor	12 %	23 %	12 %	12 %
water quality	intolerant	facultative	facultative	facultative
	mayfly	blackfly	midge	midge
3.	Optioservus sp.	Hydropsyche sparna	Rheotanytarsus exiguus gr.	Optioservus fastiditus
Facultative = occurring over a	11 %	9%	8 %	11 %
wide range of water quality	intolerant	facultative	facultative	intolerant
	beetle	caddisfly	midge	beetle
4.	Chimarra aterrima?	Baetis flavistriga	Gammarus sp.	Optioservus trivittatus
Tolerant = tolerant of poor	6 %	6 %	7 %	11 %
water quality	intolerant	intolerant	facultative	intolerant
	caddisfly	mayfly	scud	beetle
5.	Baetis intercalaris	Hydropsyche bronta	Baetis flavistriga	Hydropsyche sparna
	5 %	4 %	5 %	7 %
	facultative	facultative	intolerant	facultative
	mayfly	caddisfly	mayfly	caddisfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	25.0 (12.0)	7.0 (7.0)	40.0 (11.0)	26.0 (7.0)
Trichoptera (caddisflies)	14.0 (4.0)	13.0 (2.0)	34.0 (4.0)	28.0 (2.0)
Ephemeroptera (mayflies)	20.0 (4.0)	7.0 (2.0)	8.0 (2.0)	3.0 (2.0)
Plecoptera (stoneflies)	2.0 (1.0)	0.0 (0.0)	0.0 (0.0)	1.0 (1.0)
Coleoptera (beetles)	14.0 (3.0)	0.0 (0.0)	5.0 (1.0)	30.0 (4.0)
Oligochaeta (worms)	0.0 (0.0)	44.0 (3.0)	0.0 (0.0)	1.0 (1.0)
Mollusca (clams and snails)	0.0 (0.0)	1.0 (1.0)	0.0 (0.0)	0.0 (0.0)
Crustacea (crayfish, scuds, sowbugs)	0.0 (0.0)	4.0 (2.0)	7.0 (1.0)	2.0 (1.0)
Other insects (odonates, diptera)	23.0 (4.0)	24.0 (2.0)	6.0 (3.0)	8.0 (2.0)
Other (Nemertea, Platyhelminthes)	2.0 (1.0)	0.0 (0.0)	0.0 (0.0)	1.0 (1.0)
SPECIES RICHNESS	29	19	22	21
BIOTIC INDEX	5.03	6.27	5.14	5.04
EPT RICHNESS	9	4	6	5
PERCENT MODEL AFFINITY	72	39	53	55
FIELD ASSESSMENT	Very Good	Poor	Good	Very good
OVERALL ASSESSMENT	Non	Moderate	Slight	Slight

LABORATORY DATA SUMMARY

STREAM NAME: Owasco Lake Inlet	DRAINAGE: 07
DATE SAMPLED: 07/06/2006	COUNTY: Cayuga & Tompkins

SAMPLING METHOD: Travelling Kick

STATION	05	06	07	
LOCATION	Below Locke Rte 38	Above Moravia End of Rounds Ln	Below Moravia Rte 38	
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Optioservus fastiditus	Optioservus trivittatus	Stenelmis crenata	
	32 %	33 %	23 %	
	intolerant	intolerant	facultative	
	beetle	beetle	beetle	
2.	Stenelmis crenata	Stenelmis crenata	Optioservus fastiditus	
Intolerant = not tolerant of poor	19 %	16 %	20 %	
water quality	facultative	facultative	intolerant	
	beetle	beetle	beetle	
3.	Hydropsyche bronta	Gammarus sp.	Hydropsyche bronta	
Facultative = occurring over a	11 %	11 %	12 %	
wide range of water quality	facultative	facultative	facultative	
	caddisfly	scud	caddisfly	
4.	Psephenus herricki	Hydropsyche bronta	Baetis flavistriga	
Tolerant = tolerant of poor	9 %	9 %	8 %	
water quality	intolerant	facultative	intolerant	
	beetle	caddisfly	mayfly	
5.	Baetis intercalaris	Psephenus herricki	Tricorythodes sp.	
	4 %	7 %	6 %	
	facultative	intolerant	intolerant	
	mayfly	beetle	mayfly	
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	7.0 (3.0)	4.0 (4.0)	6.0 (5.0)	
Trichoptera (caddisflies)	15.0 (3.0)	16.0 (4.0)	18.0 (4.0)	
Ephemeroptera (mayflies)	5.0 (2.0)	5.0 (3.0)	16.0 (4.0)	
Plecoptera (stoneflies)	2.0 (2.0)	0.0 (0.0)	1.0 (1.0)	
Coleoptera (beetles)	62.0 (5.0)	56.0 (3.0)	45.0 (3.0)	
Oligochaeta (worms)	0.0 (0.0)	2.0 (1.0)	1.0 (1.0)	
Mollusca (clams and snails)	0.0 (0.0)	1.0 (1.0)	1.0 (1.0)	
Crustacea (crayfish, scuds, sowbugs)	2.0 (1.0)	11.0 (1.0)	5.0 (2.0)	
Other insects (odonates, diptera)	5.0 (3.0)	3.0 (1.0)	7.0 (3.0)	
Other (Nemertea, Platyhelminthes)	2.0 (1.0)	2.0 (1.0)	0.0 (0.0)	
SPECIES RICHNESS	20	20	24	
BIOTIC INDEX	4.65	4.83	4.65	
EPT RICHNESS	7	7	9	
PERCENT MODEL AFFINITY	43	41	54	
FIELD ASSESSMENT	Very good	Very good	Very good	
OVERALL ASSESSMENT	Slight	Slight	Slight	

FIELD DATA SUMMARY				
STREAM NAME: Owasco Lake Inlet	DATE SAMPLED: 7/6/2006			
REACH: Above Groton to Moravia				
FIELD PERSONNEL INVOLVED: Bode/Novak/Cook (DEC Region 7)				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	9:20	9:50	10:20	11:00
LOCATION	Above Groton Peru Rd.	Below Groton Walpole Rd.	Below Groton Rte 38	Above Locke Rte 38
PHYSICAL CHARACTERISTICS				
Width (meters)	3.0	3.0	10	12
Depth (meters)	0.2	0.2	0.2	0.2
Current speed (cm per sec.)	110	125	100	90
Substrate (%)				
Rock (>25.4 cm, or bedrock)	0	0	0	0
Rubble (6.35 – 25.4 cm)	20	30	30	40
Gravel (0.2 – 6.35 cm)	40	30	30	30
Sand (0.06 – 2.0 mm)	20	20	20	10
Silt (0.004 – 0.06 mm)	20	20	20	20
Embeddedness (%)	20	20	30	30
CHEMICAL MEASUREMENTS				
Temperature (° C)	17.4	17.3	17.1	16.8
Specific Conductance (umhos)	369	479	442	427
Dissolved Oxygen (mg/l)	9.1	10.0	11.5	11.6
pH	7.3	7.8	8.4	8.6
BIOLOGICAL ATTRIBUTES				
Canopy (%)	20	30	0	90
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	X	X	X	X
algae – diatoms	X	X	X	X
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)	X	X	X	X
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X		X	X
Megaloptera (dobsonflies, alderflies)	X		X	X
Odonata (dragonflies, damselflies)			X	X
Chironomidae (midges)	X		X	X
Simuliidae (black flies)		X		
Decapoda (crayfish)	X		X	
Gammaridae (scuds)		X	X	X
Mollusca (snails, clams)				
Oligochaeta (worms)				X
Other	X	X		
FAUNAL CONDITION	Very good	Poor	Good	Very good

FIELD DATA SUMMARY				
STREAM NAME: Owasco Lake Inlet	DATE SAMPLED: 7/6/2006			
REACH: Above Groton to Moravia				
FIELD PERSONNEL INVOLVED: Bode/Novak/Cook (DEC Region 7)				
STATION	05	06	07	
ARRIVAL TIME AT STATION	11:40	12:05	12:30	
LOCATION	Below Locke Rte 38	Above Moravia End of Rounds Ln	Below Moravia Rte 38	
PHYSICAL CHARACTERISTICS				
Width (meters)	8.0	10	20	
Depth (meters)	0.3	0.2	0.2	
Current speed (cm per sec.)	150	100	120	
Substrate (%)				
Rock (>25.4 cm, or bedrock)	0		0	
Rubble (6.35 – 25.4 cm)	40	40	40	
Gravel (0.2 – 6.35 cm)	30	30	30	
Sand (0.06 – 2.0 mm)	10	10	10	
Silt (0.004 – 0.06 mm)	20	20	20	
Embeddedness (%)	20	30	30	
CHEMICAL MEASUREMENTS				
Temperature (° C)	16.8	17.7	17.9	
Specific Conductance (umhos)	404	406	389	
Dissolved Oxygen (mg/l)	11.7	11.8	11.6	
pH	8.7	8.7	8.7	
BIOLOGICAL ATTRIBUTES				
Canopy (%)	10	70	0	
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous			X	
algae – diatoms	X	X	X	
macrophytes or moss			X	
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, alderflies)	X	X	X	
Odonata (dragonflies, damselflies)				
Chironomidae (midges)				
Simuliidae (black flies)				
Decapoda (crayfish)	X	X	X	
Gammaridae (scuds)	X	X	X	
Mollusca (snails, clams)			X	
Oligochaeta (worms)		X		
Other		X		
FAUNAL CONDITION	Very good	Very good	Very good	

Appendix I. Biological Methods for Kick Sampling

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

B. Site Selection: Sampling sites are selected based on these criteria: (1) The sampling location should be a riffle with a substrate of rubble, gravel and sand; depth should be one meter or less, and current speed should be at least 0.4 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.

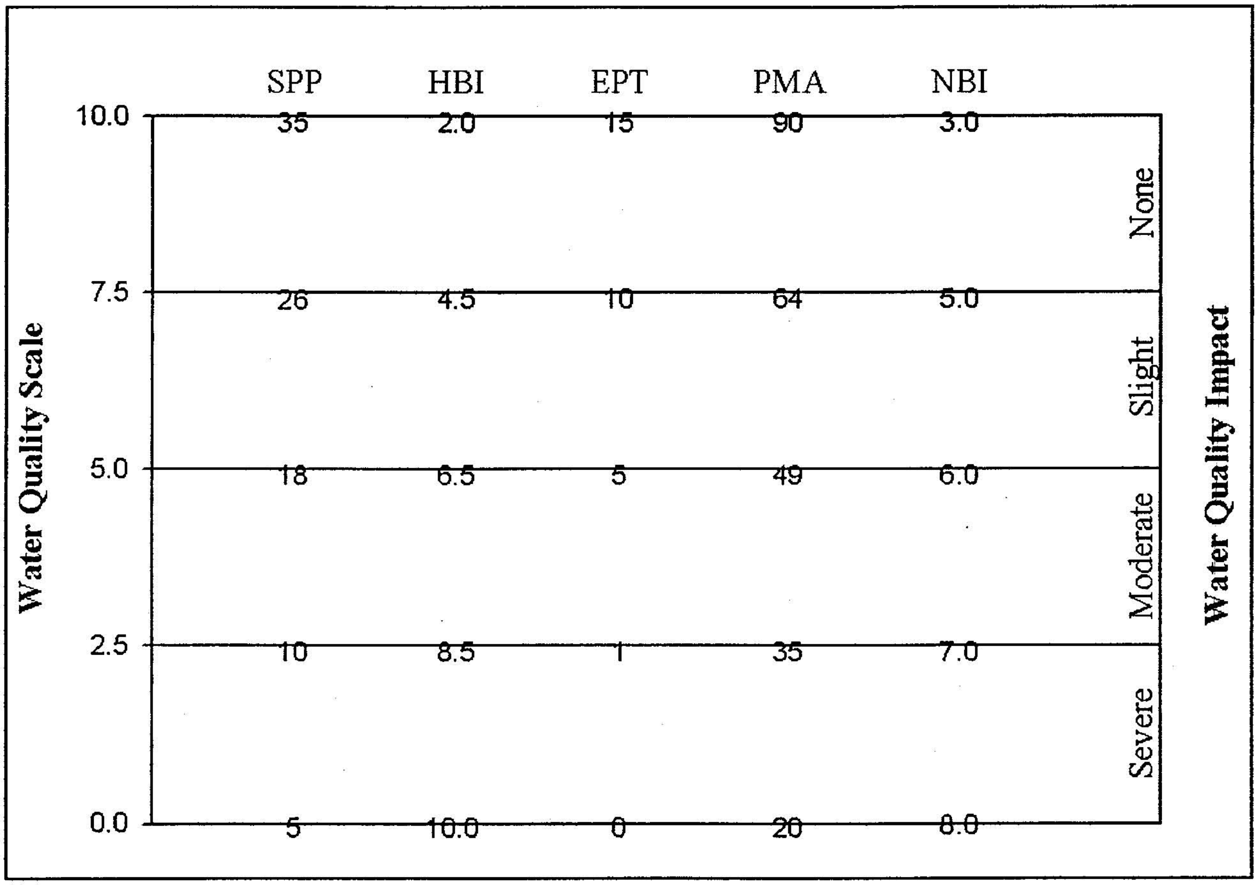
2. *Slightly impacted*: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness is usually 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50.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



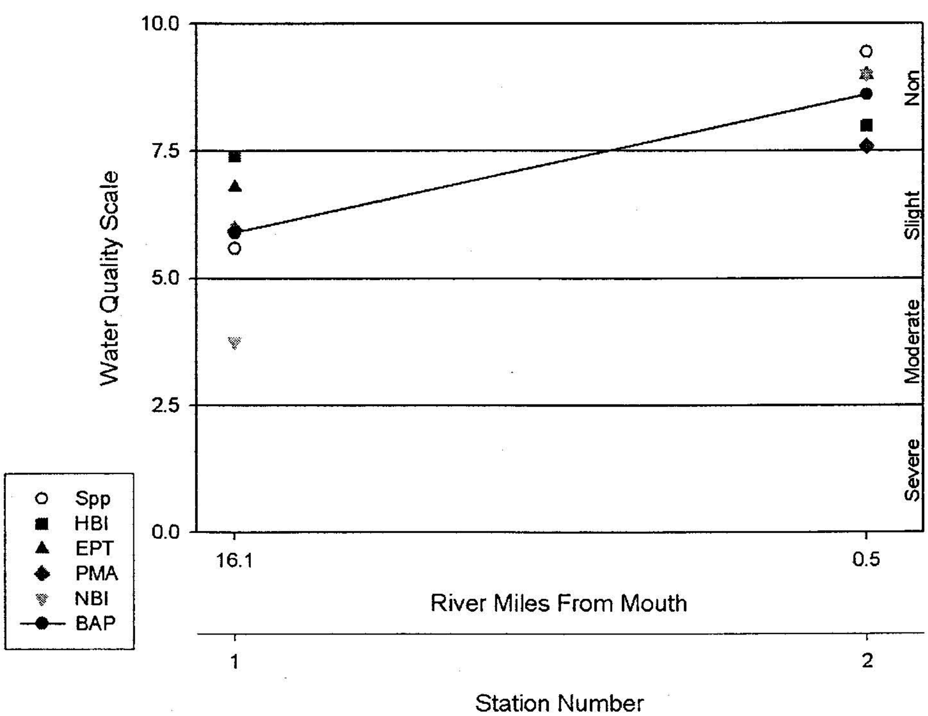
Appendix IV-B. Biological Assessment Profile: Plotting Values

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	.00
Percent Model Affinity	55	5.97	65	7.60
Nutrient Biotic Index	6.50	3.75	3.50	9.00
Average		5.90 (slight)		8.61 (non-)

Sample Plot of Biological Assessment Profile values



Appendix V. Water Quality Assessment Criteria

Non-Navigable Flowing Waters

	Species Richness	Hilsenhoff Biotic Index	Nutrient Biotic Index*	EPT Value	Percent Model Affinity#	Diversity **
Non-Impacted	>26	0.00-4.50	0.00-5.00	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	5.01-6.00	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	6.51-7.00	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	7.01-10.00	0-1	<35	0.00-2.00

* Nutrient Biotic Index (for total phosphorus, NBI-P) used for traveling kick samples but not for multiplate samples.

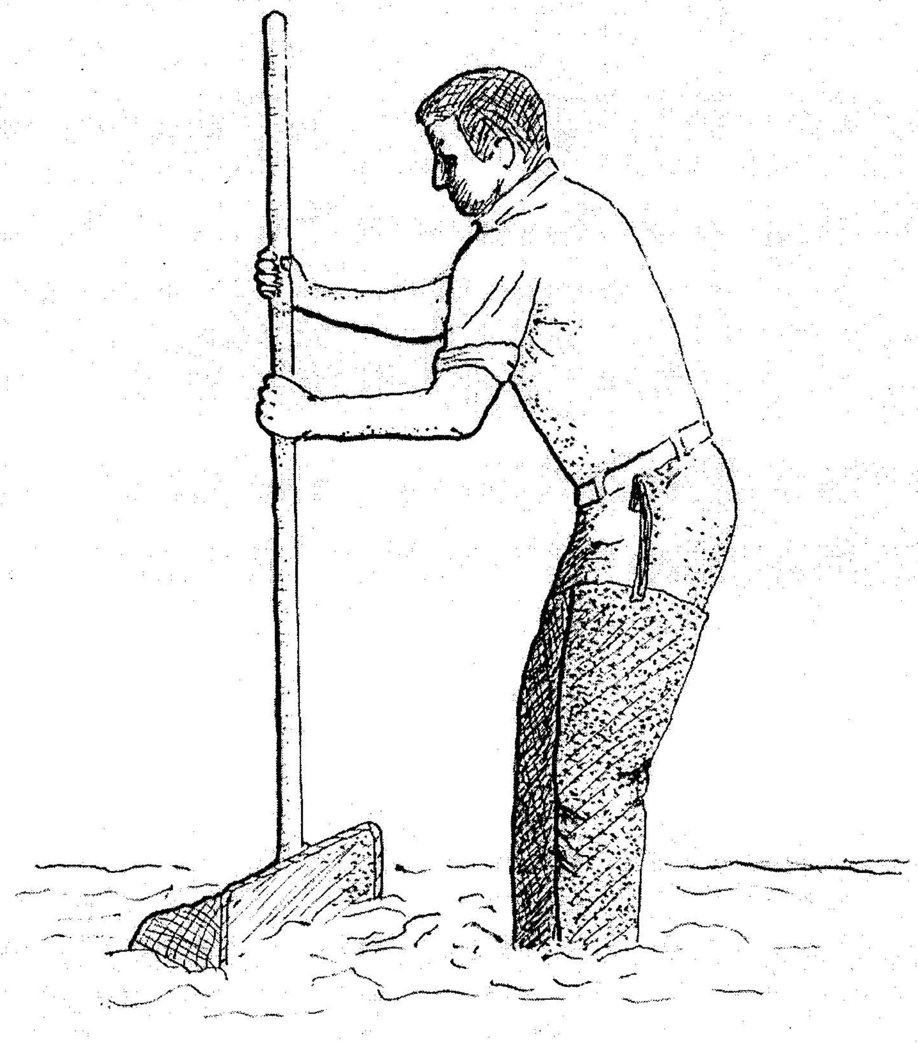
Percent model affinity criteria used for traveling kick samples but not for multiplate samples.

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

Navigable Flowing Waters

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

Appendix VI: The Traveling Kick Sample



← current

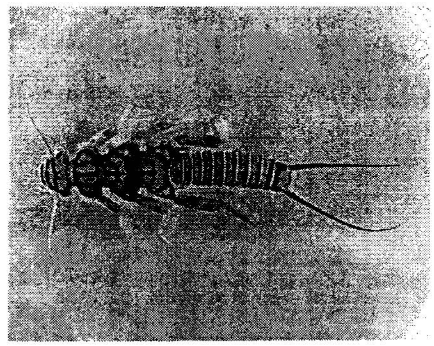
Rocks and sediment in a riffle are dislodged by foot upstream of a net. Dislodged organisms are carried by the current into the net. Sampling continues for five minutes, as the sampler gradually moves downstream to cover a distance of five meters.

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

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

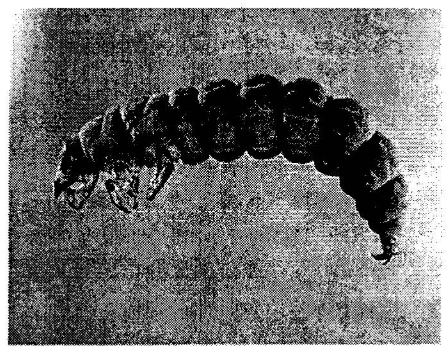
MAYFLIES

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



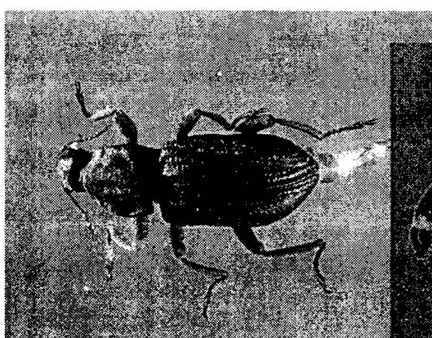
STONEFLIES

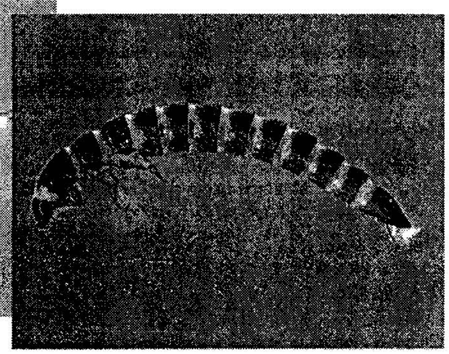
Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.



CADDISFLIES

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

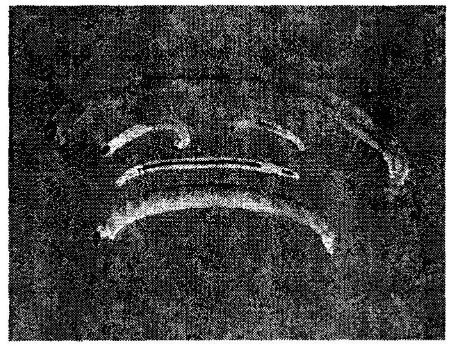




BEETLES

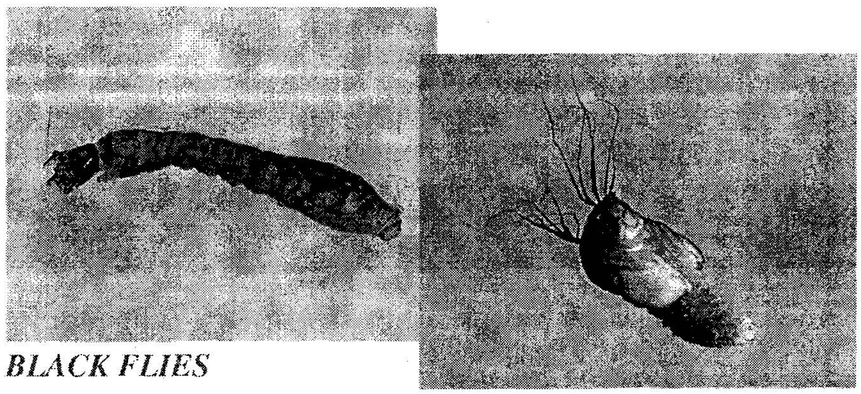
Appendix VII. B. Aquatic Macroinvertebrates that Usually Indicate Poor Water Quality

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



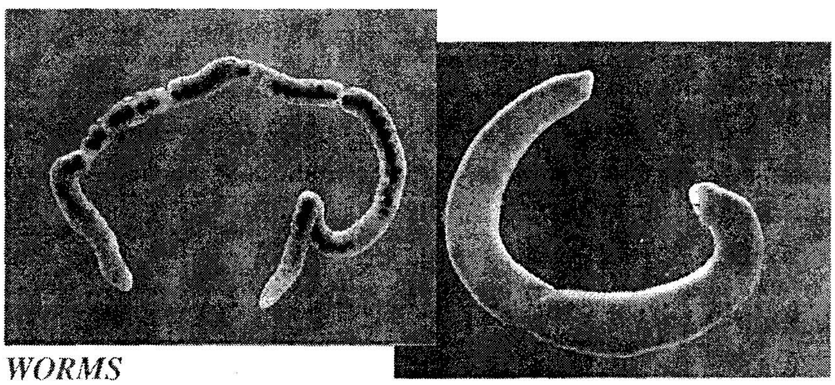
MIDGES

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



BLACK FLIES

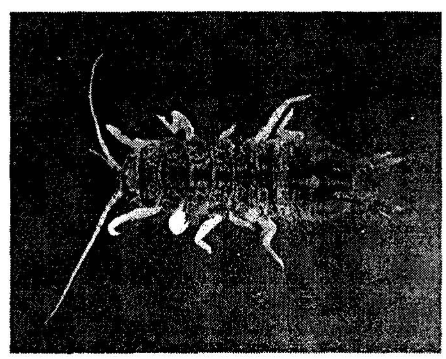
The segmented worms include the leeches and the small aquatic worms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution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



WORMS

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

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 direct comparison of specimens, and
- bioaccumulate many contaminants, so that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain.

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

Appendix IX: Glossary

anthropogenic: caused by human actions

assessment: a diagnosis or evaluation of water quality

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

bioaccumulate: accumulate contaminants in the tissues of an organism

biomonitoring: the use of biological indicators to measure water quality

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

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

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

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

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

fauna: the animal life of a particular habitat

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

impairment: a detrimental effect caused by an impact

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

intolerant: unable to survive poor water quality

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

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

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

organism: a living individual

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

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

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

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

station: a sampling site on a waterbody

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

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

tolerant: able to survive poor water quality

Appendix X. 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 TABLE
NATURAL MACROINVERTEBRATE COMMUNITY TYPE

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

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

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

ISD MODELS TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPES

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

ISD MODELS TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPE
SEWAGE EFFLUENT, ANIMAL WASTES IMPACTED

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

ISD MODELS TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPES

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

APPENDIX XI: Methods for Calculation of the Nutrient Biotic Index

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

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

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

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

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

Index	Oligotrophic	Mesotrophic	Eutrophic
NBI-P	< 5.0	> 5.0 - 6.0	> 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.

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