New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Owasco Lake Inlet

Biological Assessment

2011 Survey

New York State
Department of Environmental Conservation

BIOLOGICAL STREAM ASSESSMENT

Owasco Lake Inlet
Tompkins and Cayuga Counties, New York
Seneca-Oneida-Oswego River Basin

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Stream: Owasco Lake Inlet

River Basin: Seneca-Oneida-Oswego

Reach: Below Moravia to Above Groton, NY

Background

The Stream Biomonitoring Unit sampled Owasco Lake Inlet, Tompkins and Cayuga Counties, New York, on June 28, 2011. Sampling was conducted at seven locations to compare water quality data to previous sampling events (Table 1, Figures 1, 1a-g). A benthic macroinvertebrate survey conducted in 2006 reflects conditions in Owasco Lake Inlet prior to nutrient limitations put in place at the Groton (V) WWTP. Sampling was also conducted below the Groton and Moravia WWTPs in 2007 to continue monitoring of biological communities. Nutrient controls at the WWTP were implemented between 2006 and 2009.

To characterize water quality based on benthic macroinvertebrate communities, a traveling kick sample was collected from riffle areas at each site. Methods used are described in the Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State (Smith et al. 2012). 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 indices or metrics used in the determination of water quality were: species richness, biotic index, EPT richness, percent model affinity, and nutrient biotic index. Amount of expected variability of results is stated in Smith and Bode (2004). Table 1, Figures 1, and 1a-g provide an overview of sampling locations. This is followed by water quality assessment outcomes (Figures 2 and 3), impact source determination (Table 2), and summaries of benthic macroinvertebrate species collected (Tables 3, 4a-g, and 5a-b). A summary of field water quality and habitat parameters is provided in Table 6.

Results and Conclusions

1. Water quality in Owasco Lake Inlet remains altered as a result of excessive nutrients in the watershed. However, measurable improvements to macroinvertebrate communities were observed downstream of the Groton (V) WWTP compared with previous sampling years. These improvements can be attributed to reductions in phosphorus loads in the treatment plant's effluent.

2. Water quality at the previously impaired Station 02 improved to slightly impacted and can now be considered supporting of aquatic life use. The greatest changes in community composition at this site were in the reduction of oligochaete taxa indicating lower nutrients and higher dissolved oxygen.

3. Control of nutrient loads to the stream should continue and needs to include reduction of diffuse, nonpoint sources in the watershed. Additional watershed nutrient management strategies along with nutrient limitations at sewage treatment plants will further reduce nutrient loads reaching Owasco Lake.

Discussion

Owasco Lake Inlet originates north of Freeville, New York. It flows approximately 21 miles northwest, draining 117 mi^2 of mixed agricultural (45%), forest (42%), and urban (6%) land use. It reaches Owasco Lake near Moravia, New York (Bode et al. 2007; USGS 2012). Concerns over water quality impacts, specifically eutrophication in Owasco Lake Inlet have existed for many years. Previous sampling includes studies by the NYSDEC Avon Pollution Investigations Unit in 1974 (Neuderfer 1975) and the NYSDEC Stream Biomonitoring Unit in 2001, 2006, and 2007 (Bode et al. 2004, 2007). On each occasion results suggested water quality was degraded and biological communities were negatively affected by nutrients (Neuderfer 1975; Bode et al. 2004, 2007). The Groton (V) Wastewater Treatment Plant (WWTP) has been identified as a major contributor to in-stream nutrient concentrations, which are the primary source of impacts to biological condition in the stream (NYSDEC 2008; Bode et al. 2007). Elevated phosphorus concentrations in the southern end of Owasco Lake coming from the inlet have also contributed to abundant aquatic vegetation growth, impairing recreation uses in the lake (NYSDEC 2008).

Elevated nutrient concentrations in surface waters are known to cause alterations in the natural composition of biological communities. These changes may be the result of factors (Deegan et al. 1997; Perrin and Richardson 1997; Miltner and Rankin 1998) influencing food quality and quantity, such as increased algal biomass and aquatic vegetation growth (Hart and Robinson 1990), which are observed in Owasco Lake and its inlet. Increases in algal and plant biomass can also result in increased diel shifts in dissolved oxygen concentrations, which can limit the suitability of waters for invertebrates and fish (Correll 1998; Munn et al. 2010).

Aquatic macroinvertebrates have long been among the principal biological communities used for freshwater resource monitoring. However, macroinvertebrate methods have only recently begun to incorporate nutrient measures into assessment strategies (Smith et al. 2007). To better assess nutrient enrichment in streams using benthic macroinvertebrates the NYSDEC developed a nutrient biotic index (NBI) (Smith et al. 2007). This new measure improves the accuracy of macroinvertebrate assessments of stream eutrophication (Smith et al. 2007; Smith and Tran 2010). This index has now been integrated into the overall biological assessment method of surface waters used by the NYSDEC and has application in the development of numeric nutrient criteria (Smith et al. 2012).

The purpose of the current survey was to reassess Owasco Lake Inlet water quality and the effects of nutrient enrichment on biological condition. This assessment uses the NBI (Smith et al. 2012). Improvement in water quality as measured by biological community assessment was expected due to nutrient limitations placed on the treated effluent of the Groton (V) WWTP. Several treatment plant upgrades were implemented between 2006 and 2009. Upgrades were effective in reducing effluent phosphorus loads to Owasco Lake Inlet from approximately 9.0 lbs/day in 2004 to less than 1.0 lbs/day at the time of this survey, as well as in reducing conventional pollutant loadings (Ron Entringer, NYSDEC, Personal Communication).

In order to assess the effects of these changes in phosphorus loads on biological community condition and water quality assessment, the 2006 survey was replicated in 2011. Benthic macroinvertebrate communities were sampled, basic water chemistry parameters collected, and habitat and substrate composition was characterized at each of seven sites (Table 1 and Figures 1,1a-g). Water quality was assessed using the Biological Assessment Profile (BAP) for macroinvertebrates which now includes the NBI as a component metric (Figure 2). We herein refer to the BAP that includes the NBI as the 5-metric BAP and without the NBI as the 4-metric BAP. Results from the 2006 survey were reanalyzed using the 5-metric BAP and compared to the results of the 2011 survey (Figure 3). Data from both years were also analyzed using the 4-

metric BAP to illustrate the difference in assessments resulting from the addition of the NBI to assessment methods (Figure 3).

Results of the current survey indicated water quality to be slightly impacted at all seven sites. 5-metric BAP scores fluctuate in response to the various inputs of organic enrichment to the stream (Figure 2). The slightly impacted category suggests biological community metrics reflect good water quality, fully supporting aquatic life. However, the benthic macroinvertebrate community is altered from the natural state (Smith et al. 2012). Improvement in water quality occurs at Station 02 immediately downstream of the Groton (V) WWTP. This is a significant departure from conditions observed in 2006 at this site when water quality was assessed as moderately impacted (Figure 3). Previous work suggests that normal variation in BAP scores is ± 1 unit for streams with slightly impacted water quality (Smith and Bode 2004). BAP scores for Station 02 and Station 03 have a difference of 2 BAP units between 2006 and 2011. This suggests the improvement in water quality at these two sites is not likely due to chance alone. The individual component metrics do indicate nutrient enrichment at Station 02 reflected in worsening of both the NBI and Hilsenhoff's Biotic Index scores (Figure 2). Although this enrichment appears to no longer impair the community.

Impact source determination (ISD) indicated nutrient enrichment as the dominant source of water quality impacts at all sites except Station 02 (Table 2). This station is immediately downstream of the Groton (V) WWTP, and reflected complex municipal discharges as the primary impact source and nutrients as a secondary source (Table 2). The ISD category of complex municipal reflects biological communities responding to a myriad of pollutant types from various municipal and industrial sources. For example pollutants such as pathogens, metals, and toxicants from sources such as landfills, sanitary discharges, industrial process discharges or urban/storm runoff. Based on functional feeding group and ecological traits the invertebrate community at most sites (except Station 02) indicated nutrient enrichment and an abundance of fine particulate organic matter. Invertebrate communities were dominated by a combination of filter feeding caddisflies (Trichoptera: Hydropsychidae), riffle beetles (Coleoptera: Elmidae), facultative mayflies (Ephemeroptera: Baetidae), and non-biting midge larvae (Diptera:Chironomidae) (Tables 4a-g and 5a-b). Mode of feeding for most of these organisms capitalizes on increased benthic algal biomass through either scraping periphyton and associated materials or collecting and gathering of decomposing fine particulate organic material (Merritt and Cummins 1996).

Comparison of current survey results to those of 2006 and 2007 suggests a significant improvement in water quality conditions immediately downstream of the Groton (V) WWTP (Figure 3). Assessment results from 2006 were recalculated using the 5-metric BAP for comparison with 2011 results. Both data sets were also assessed using the 4-metric BAP (Figure 3). The improvement at Station 02 and 03 is less distinct when the 5-metric BAP is used which incorporates the addition of the NBI (Figure 3). Water quality at the remaining downstream sites is similar between years and is considered within the limits of expected natural variance (Smith and Bode 2004). In 2007, two sites (Station 02 and Station 07) were revisited. Water quality assessments remained unchanged from 2006, moderately and slightly impacted respectively.

For most sites (Stations 01, 04, 05, 06, and 07) invertebrate communities were similar to previous years and changes that occurred were within expected limits of variability (Tables 4a-g) (Smith and Bode 2004). This is in accordance with what was observed in assessment results for these sites as well (Figure 3). The most striking changes in invertebrate community composition occurred at Station 02, just downstream of the Groton (V) WWTP (Table 4b). The improvements in water quality assessment are reflected in the absence of aquatic worms (Oligochaeta), presence of stoneflies (Plecoptera), and a diversification of the netspinning caddisfly larvae (Trichoptera: Hydropsychidae) in 2011 compared with 2006. Most striking is the decline in

percent contribution of the aquatic worms at this site from 44% in 2006 to 1% in 2011. Aquatic worms tend to be strong indicators of pollution (Goodnight 1973) and are tolerant to the eutrophication of surface waters (Wielgolaski 1975), increasing in abundance downstream of sewage discharges with high nutrient loads (Gaufin and Tarzwell 1956). Their persistence in such conditions is often due to their respiratory physiology, which is adapted to operating at low levels of dissolved oxygen or in some cases anaerobic conditions (Aston 1973). This shift in the aquatic worm community suggests improvement in water quality conditions consisting of improved dissolved oxygen levels and a reduction in nutrient levels.

Although the results of the 2011 survey suggest improvements in water quality and biological condition, further improvement is still possible. This is evident in the abundance of freshwater scuds (Gammaridae: *Gammarus* sp.) (Table 4b). These organisms are usually present in areas of moderate pollution, and may be abundant when sensitive mayflies, stoneflies, and caddisflies are absent or in low abundance (Metcalfe 1989). Further improvements will be identified by the reduction of *Gammarus* sp. at Station 02. The community shift at Station 03 in 2011was predominantly a transition to more diverse mayfly and riffle beetle fauna (Table 4c).

Water quality in Owasco Lake Inlet remains altered due to excessive nutrients in the watershed. However, measurable improvements to macroinvertebrate communities were observed downstream of the Groton (V) WWTP compared with previous sampling years. These improvements can be attributed to reductions in phosphorus loads in the treatment plant's effluent. Water quality at the previously impaired Station 02 improved to slightly impacted and can now be considered supporting of aquatic life. The greatest changes in community composition at this site were in the reduction of aquatic worm taxa indicating lower nutrients and higher dissolved oxygen. Control of nutrient loads to the stream should continue, and need to include reduction of diffuse, nonpoint sources in the watershed. Additional watershed nutrient management strategies along with nutrient limitations at sewage treatment plants will reduce nutrient loads reaching Owasco Lake. If nutrient concentrations in Owasco Lake are adequately reduced, impairments should be eliminated. Monitoring the southern end of Owasco Lake is recommended to determine the effectiveness of nutrient controls in Owasco Lake Inlet.

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Table 1. Station locations for Owasco Lake Inlet, stations 01-07.

STATION	DIRECT	LATITUDE	LONGITUDE	DESCRIPT
01	Above Groton	42.5849991	-76.3680573	At Peru Rd. Bridge
02	Below Groton	42.5988884	-76.3730469	At Walpole Rd. Bridge, 50 m upstream
03	Below Groton	42.6175003	-76.3841629	At Rte. 38 Bridge, 100 m upstream
04	Above Locke	42.6422234	-76.4077759	At Rte. 38 Bridge, 50 m downstream
05	Below Locke	42.6691666	-76.4311142	At Rte. 38 Bridge, 30 m downstream
06	Above Moravia	42.6911125	-76.4252777	At the end of Rounds Lane
07	Below Moravia	42.7166709	-76.4372329	At Rte. 38 Bridge, 20 m downstream

Figure 1. Overview map, Owasco Lake Inlet, Tompkins and Cayuga Counties, New York.

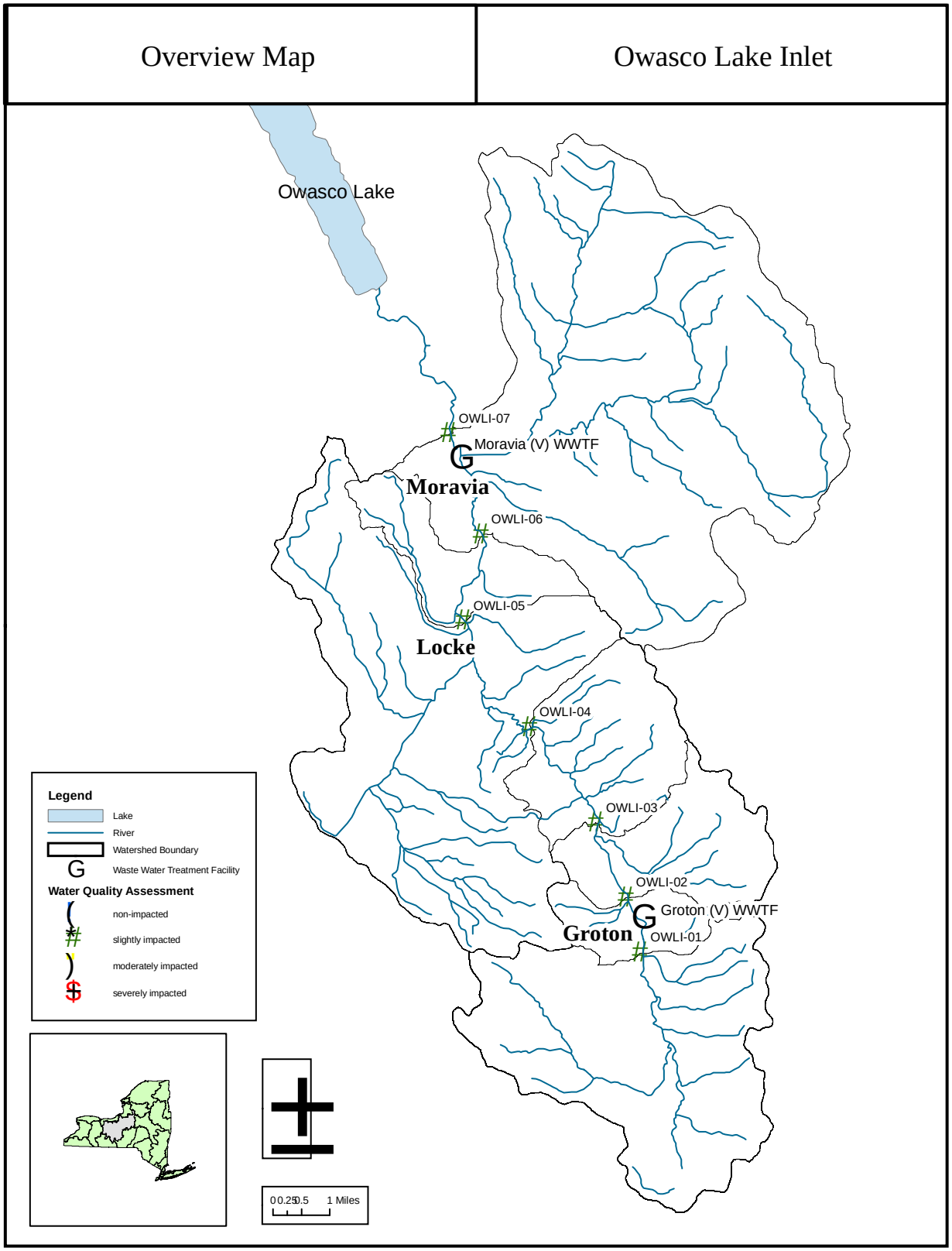

Figure 1a. Site location map, station 01.

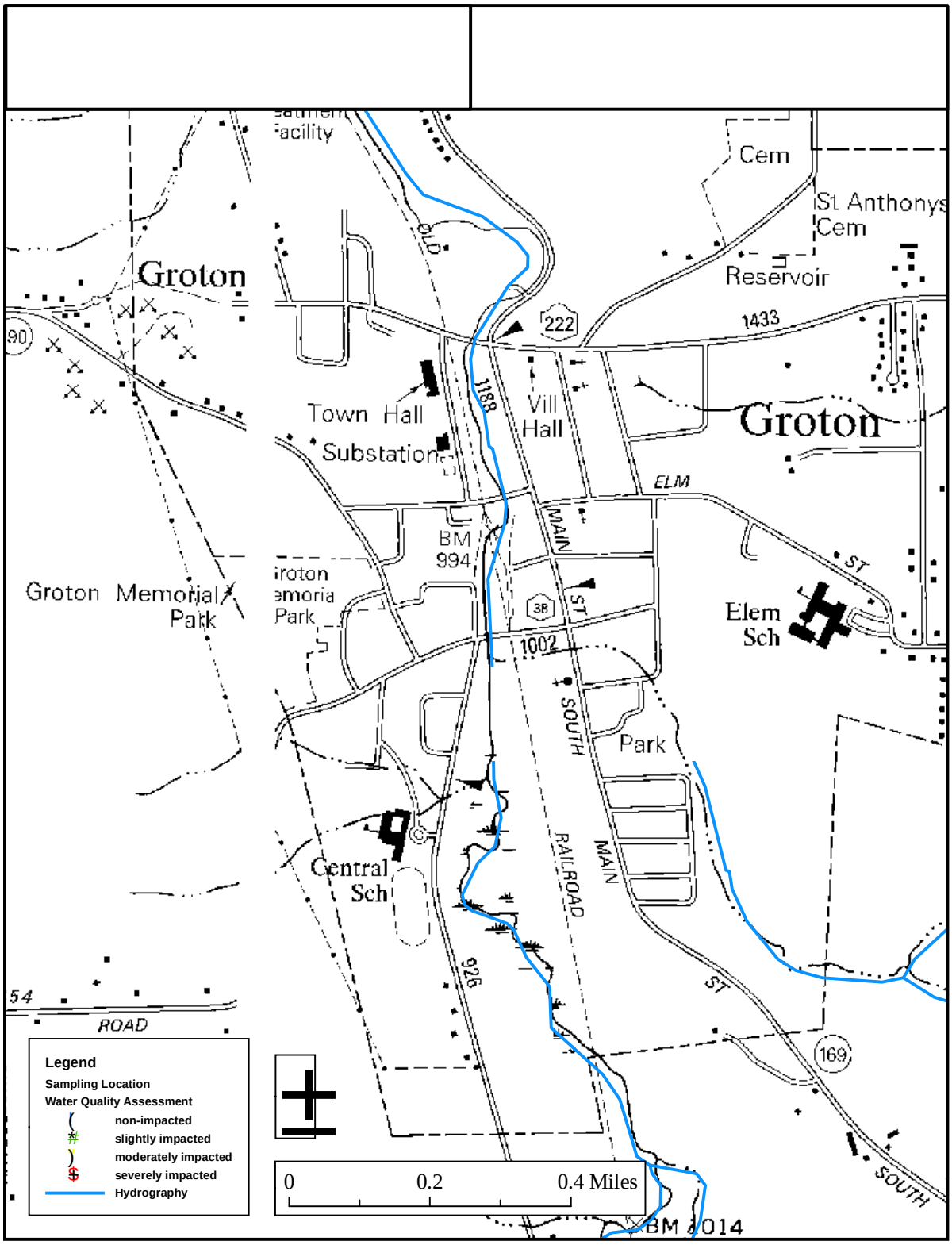

Figure 1b. Site location map, station 02.

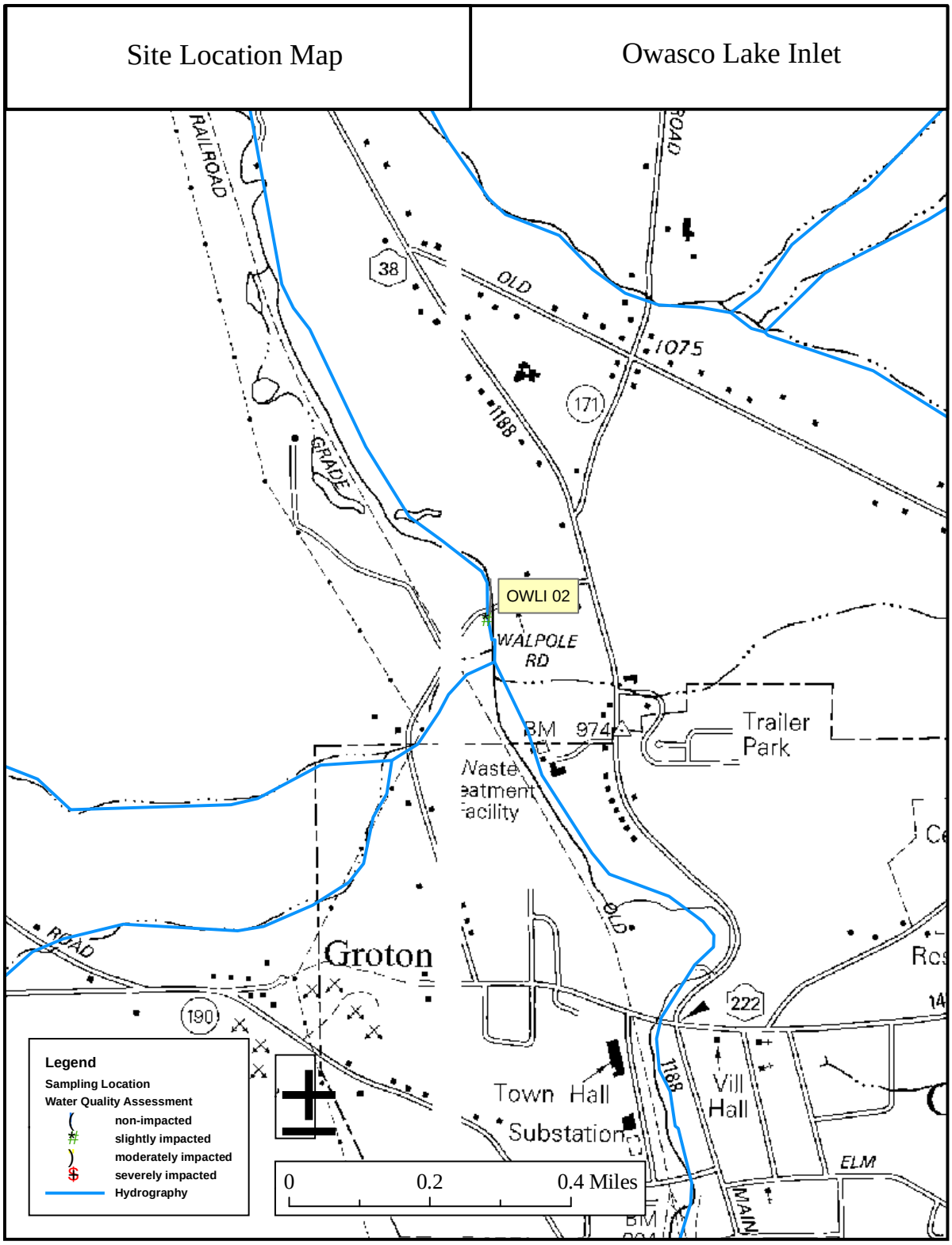

Figure 1c. Site location map, station 03.

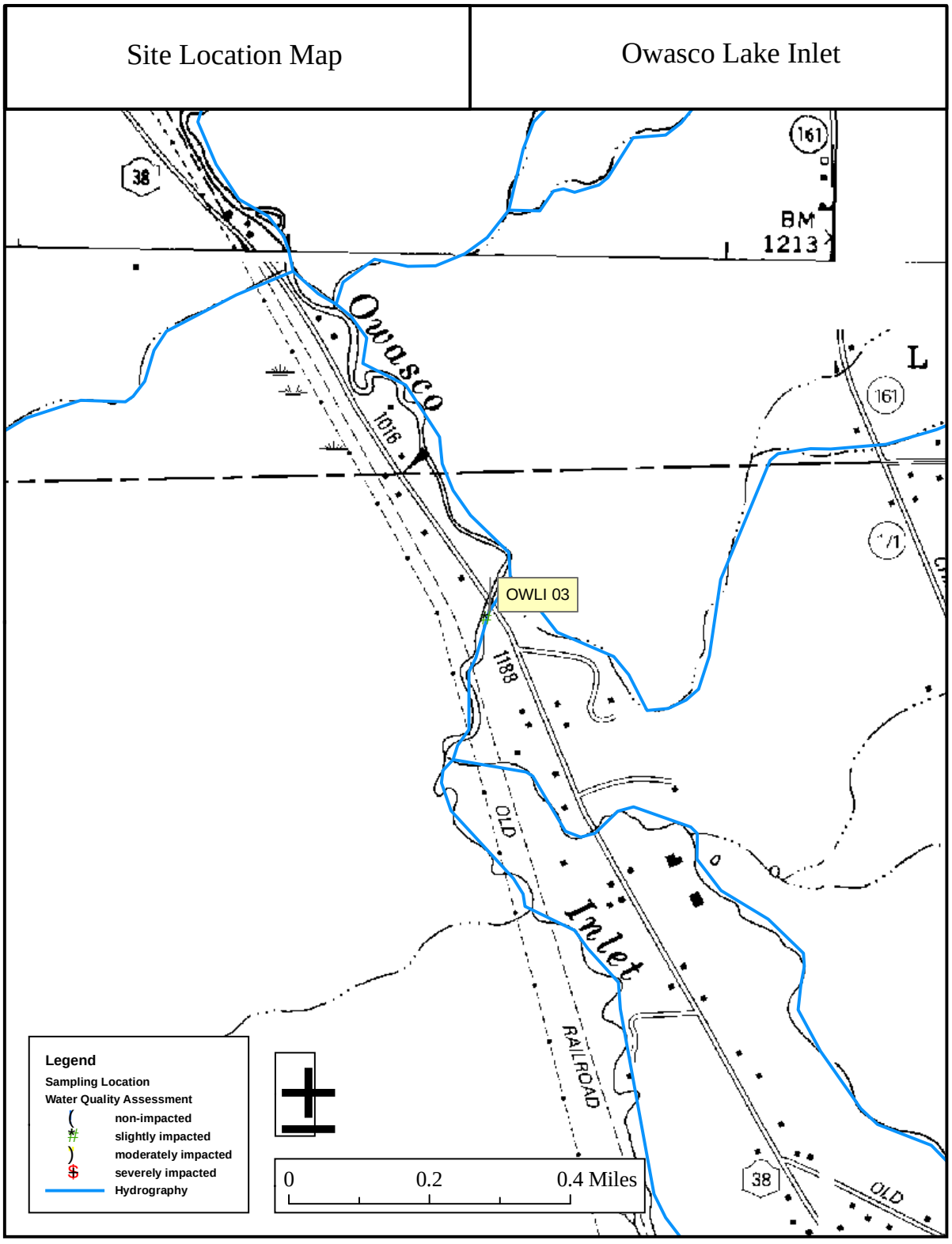

Figure 1d. Site location map, station 04.

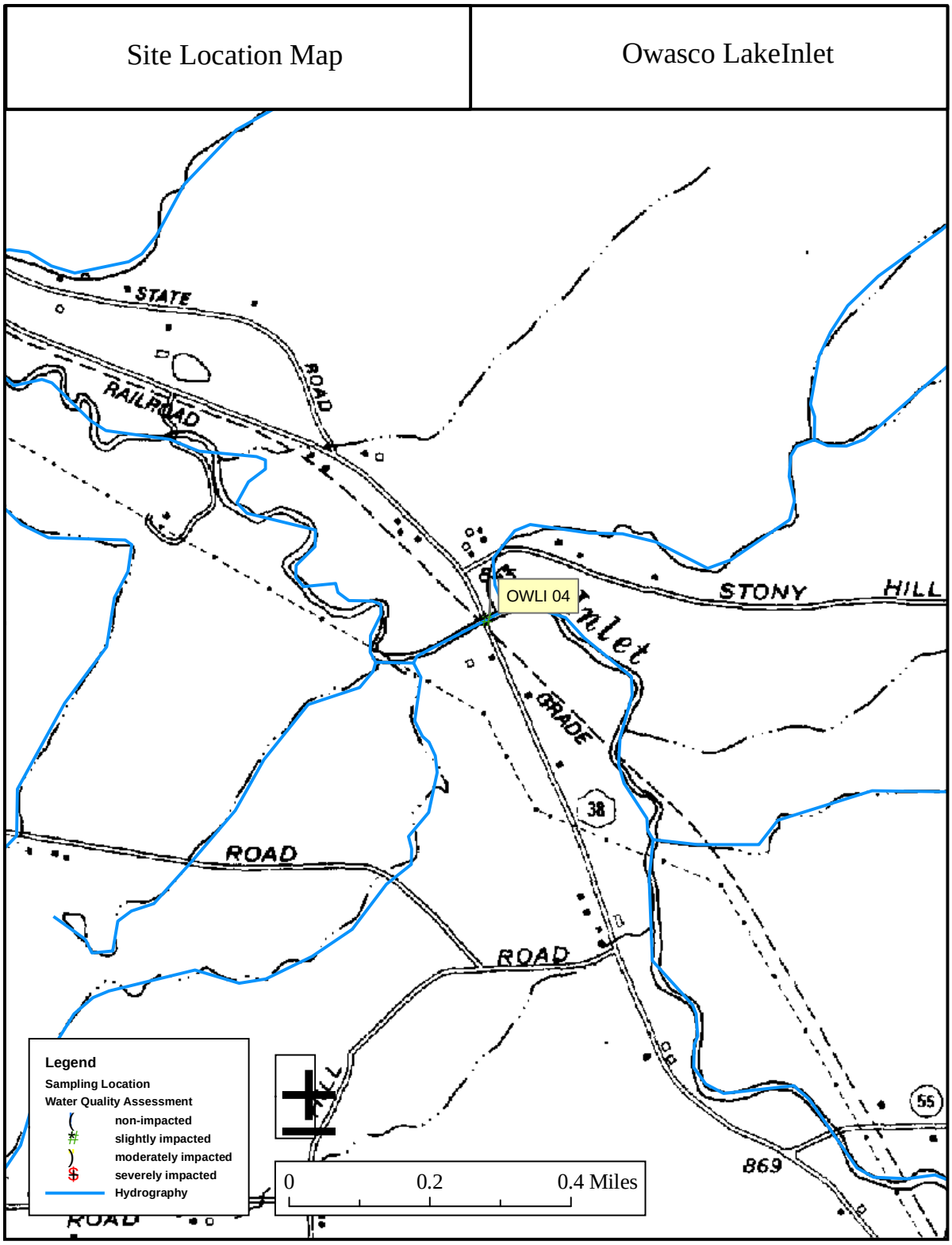

Figure 1e. Site location map, station 05.

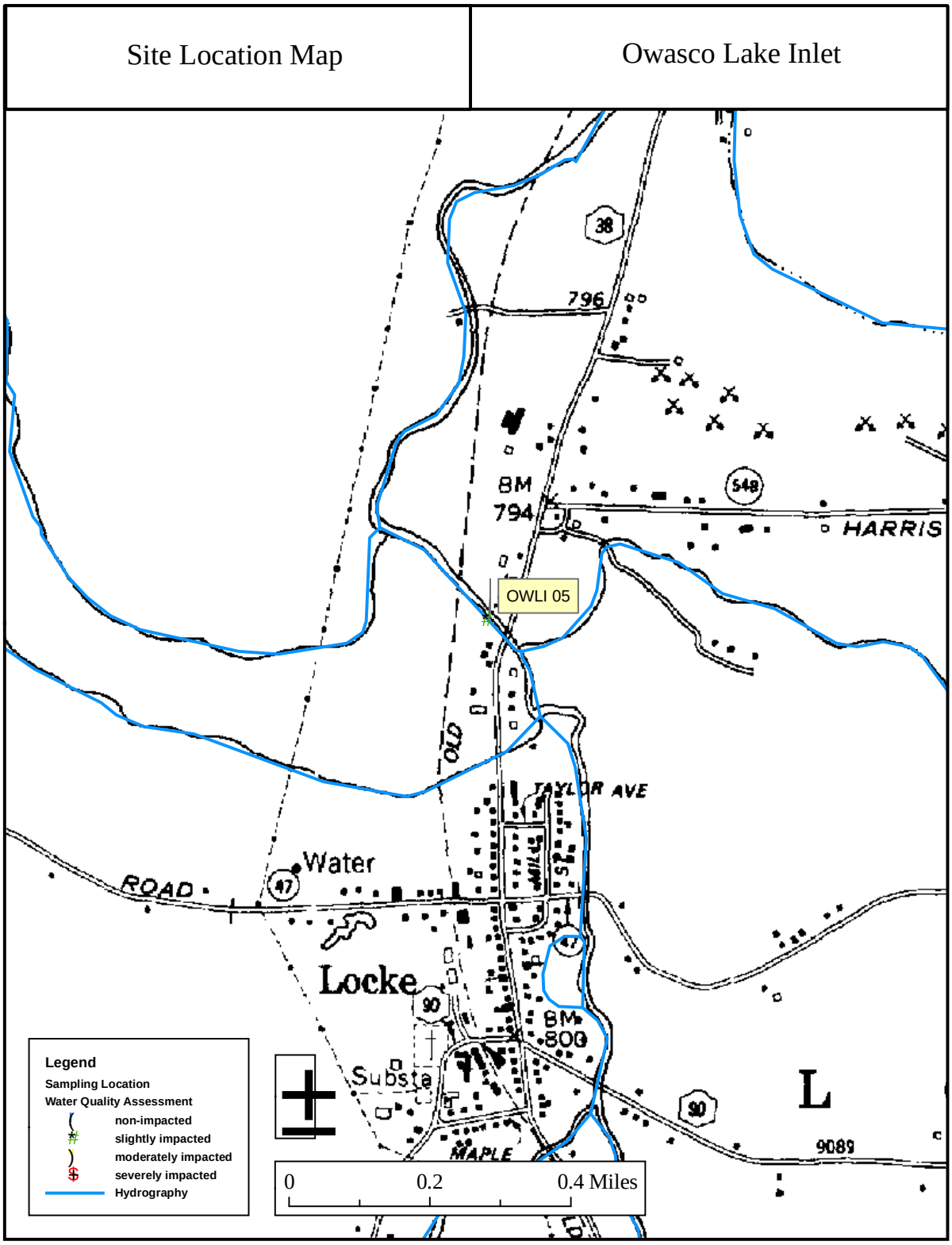

Figure 1f. Site location map, station 06.

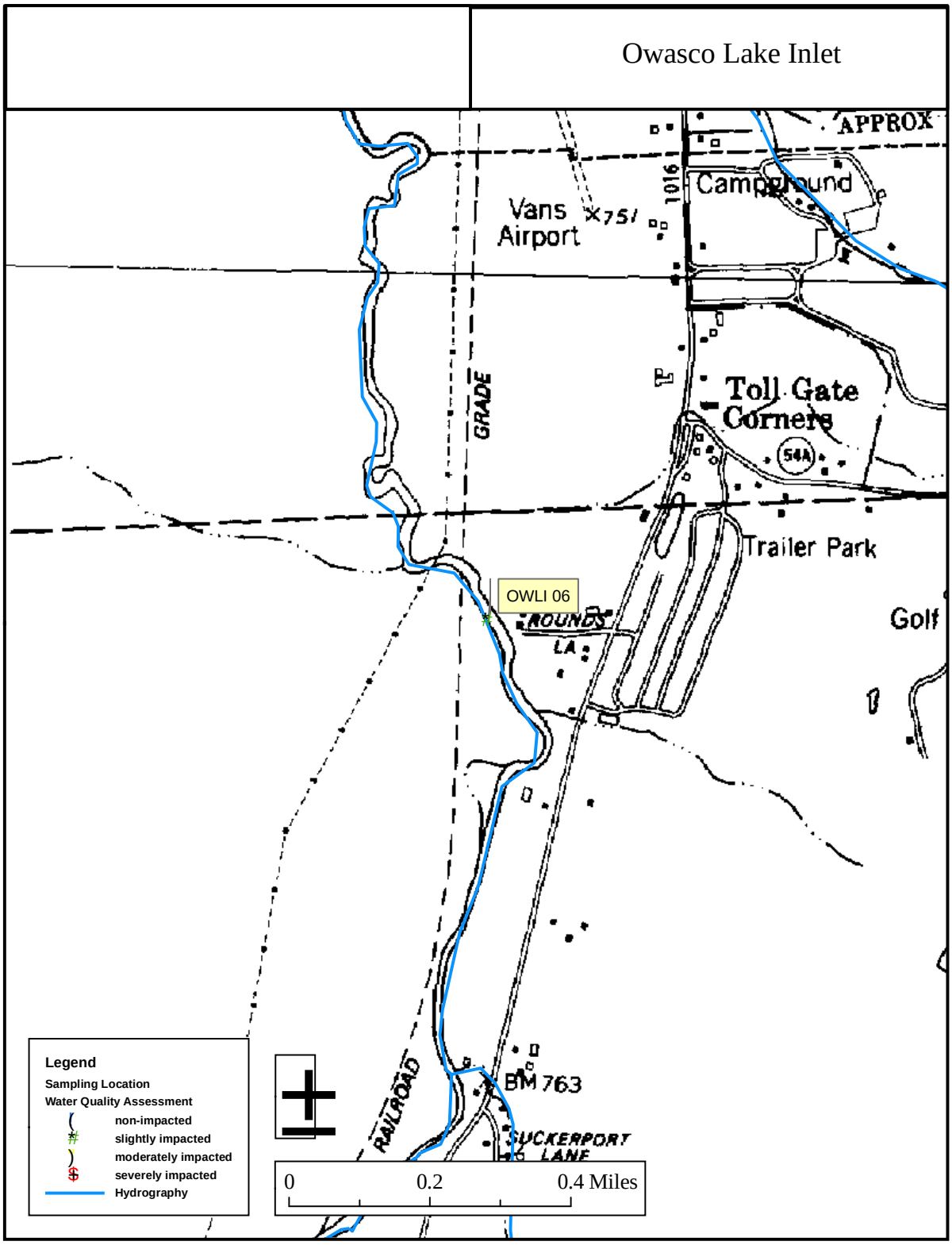

Figure 1g. Site location map, station 07.

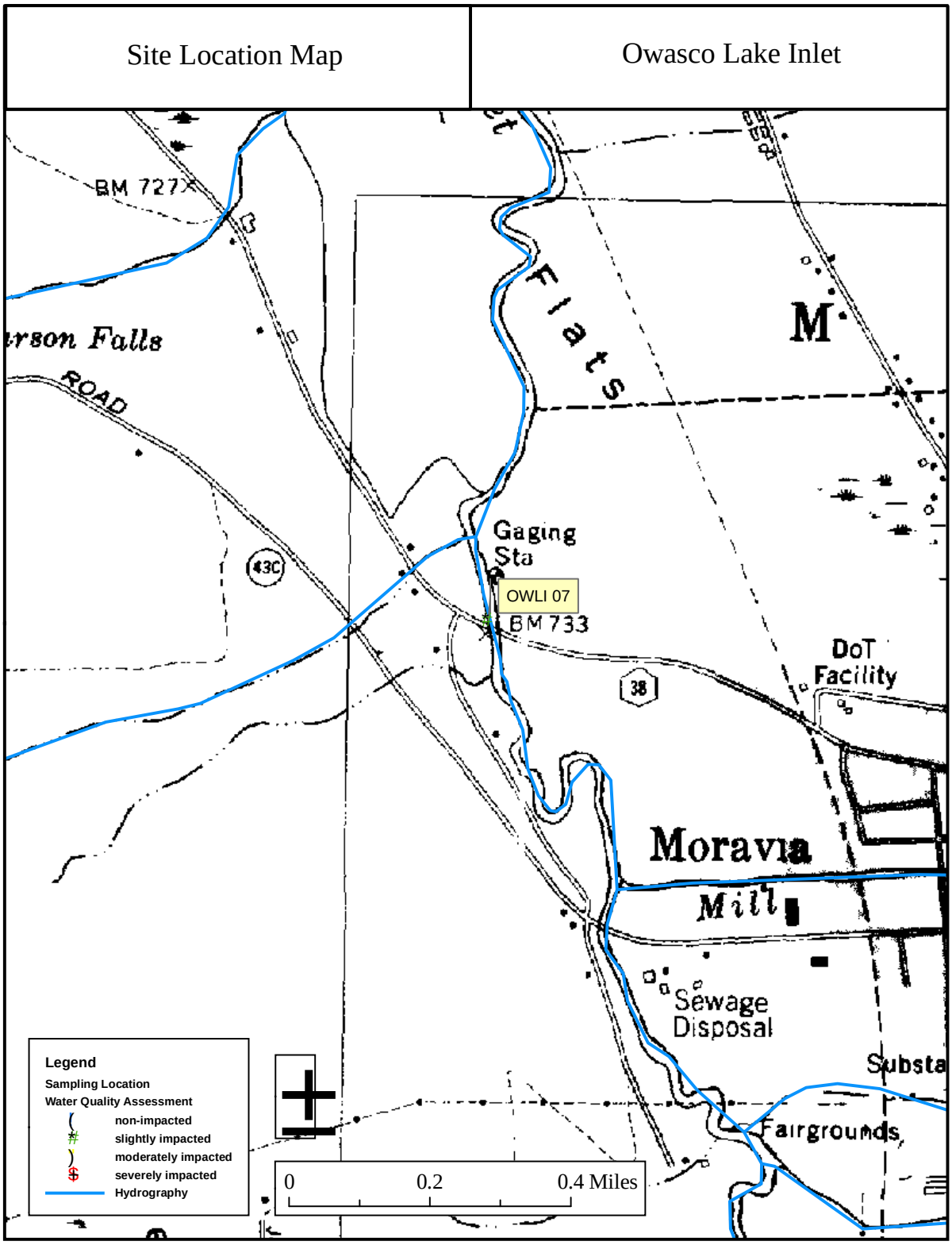

Figure 2. Biological Assessment Profile (BAP) of index values, Owasco Lake Inlet, 2011. Values are plotted on a normalized scale of water quality. The BAP represents the mean of the five values for each site, representing species richness (Spp), EPT richness, Hilsenhoff Biotic Index (HBI), Percent Model Affinity (PMA), and Nutrient Biotic Index (NBI). See Smith et al. (2012) for a more complete explanation.

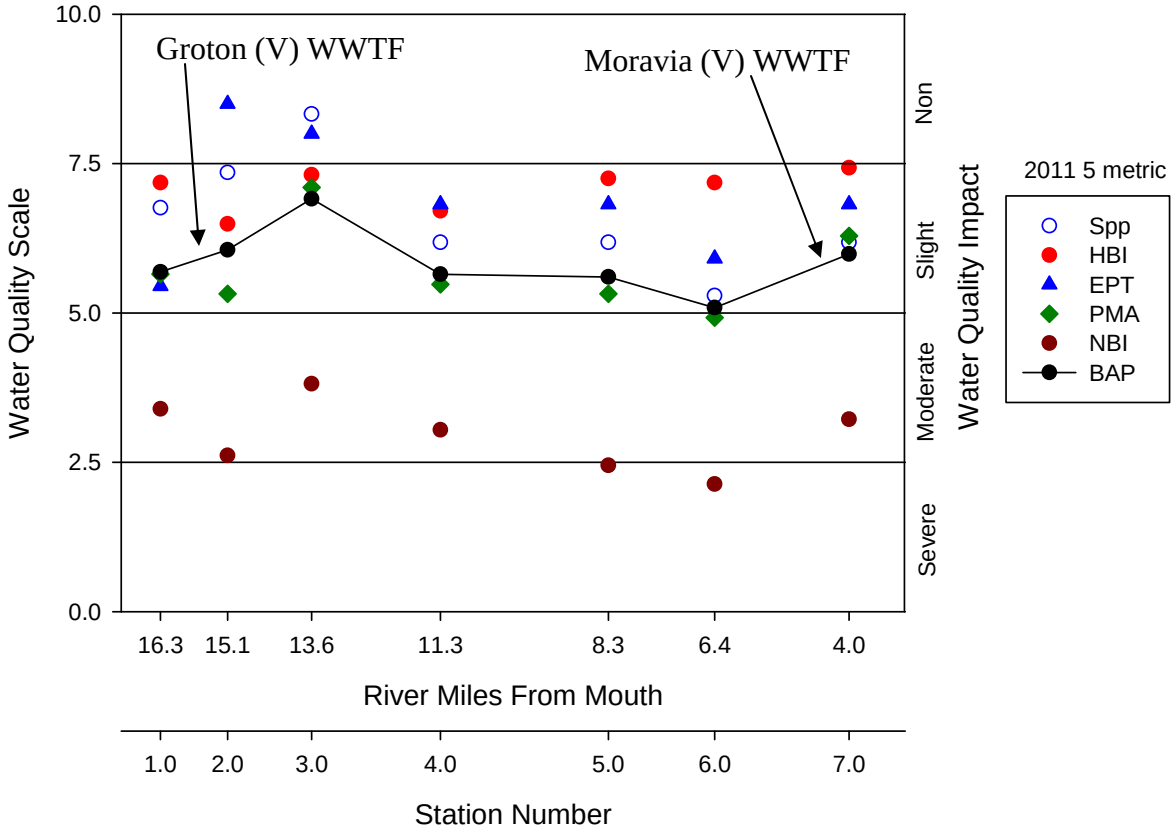

Figure 3. Biological Assessment Profile (BAP) of index values, Owasco Lake Inlet, 2006 and 2011. Figure A shows results of the new 5 metric BAP scores for 2006 and 2011. Figure B shows results of the previously used 4 metric BAP for 2006 and 2011.

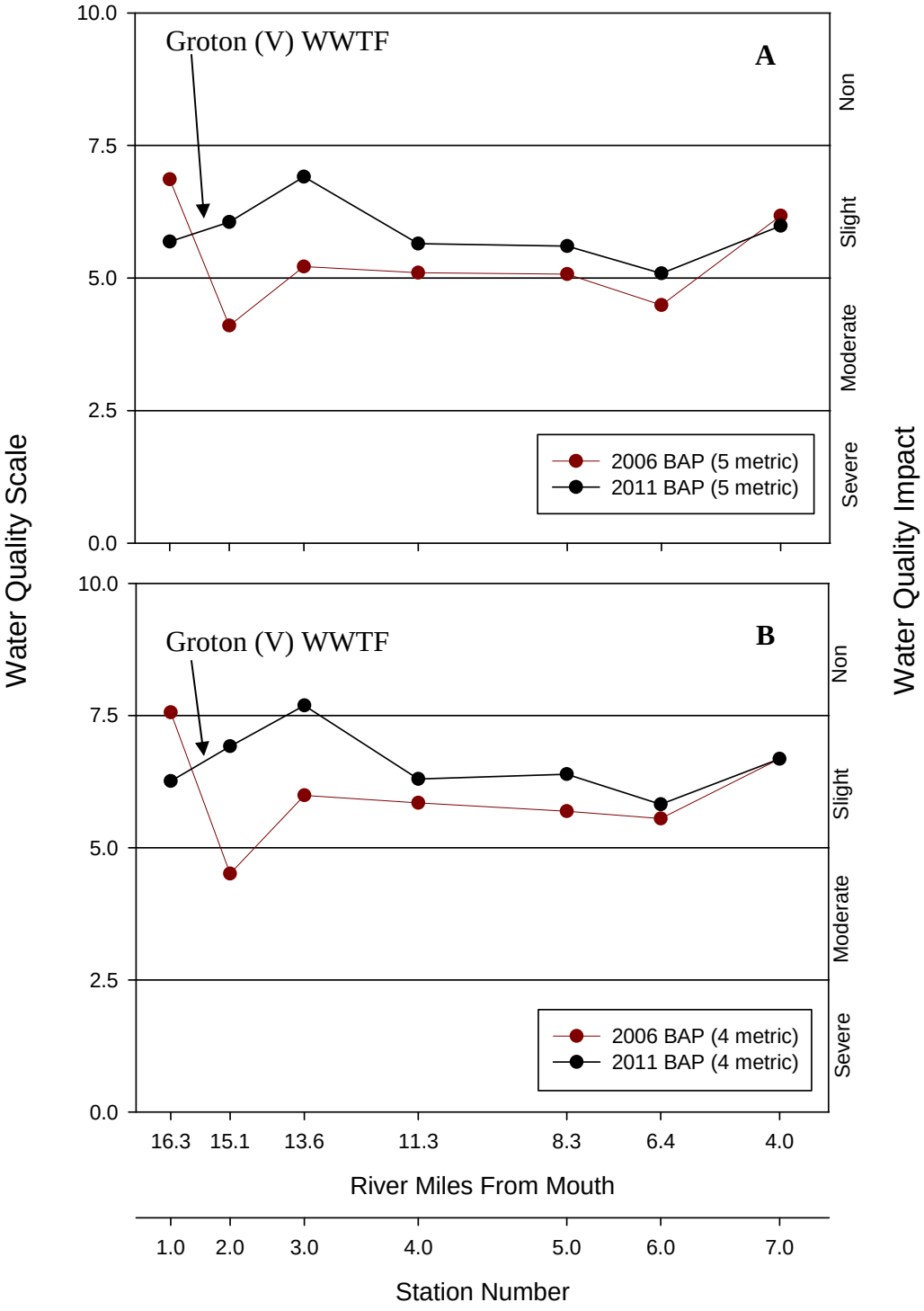

Table 2. Impact Source Determination (ISD), Owasco Lake Inlet, 2011. Numbers represent percent similarity to community type models for each impact category. Highest similarities at each station are shaded. Similarities less than 50% are less conclusive. Highest numbers represent probable stressor(s) to the community. See Smith et al. (2012) for further explanation.

Community Type	Station						
	01	02	03	04	05	06	07
Natural: minimal human disturbance	48	40	55	54	49	54	52
Nutrient Enrichment: mostly nonpoint, agricultural	59	50	56	64	61	67	57
Toxic: industrial, municipal, or urban run-off	41	40	48	52	36	40	35
Organic: sewage effluent, animal wastes	28	46	40	49	27	33	31
Complex: municipal/industrial	39	53	52	59	25	27	26
Siltation	36	44	45	43	36	43	39
Impoundment	42	46	48	54	39	46	37

Note: Impact Source Determinations (ISD) are intended as supplemental data to the macroinvertebrate community assessments.

Table 3. 2011 Macroinvertebrate species collected in Owasco Lake Inlet, stations 01-07.

PLATYHELMINTHES
TURBELLARIA
TRICLADIDA
Undetermined Turbellaria
ANNELIDA
OLIGOCHAETA
LUMBRICIDA
Lumbricina
Undetermined Lumbricina
TUBIFICIDA
Tubificidae
Undet. Tubificidae w/o cap. setae
ARTHROPODA
CRUSTACEA
ISOPODA
Asellidae
Caecidotea sp.
AMPHIPODA
Gammaridae
Gammarus sp.
EPHEMEROPTERA
Baetidae
Acentrella turbida
Acentrella sp.
Baetis brunneicolor
Baetis flavistriga
Baetis intercalaris
Baetis tricaudatus
Undetermined Baetidae
Heptageniidae
Epeorus vitreus
Heptagenia sp.
Ephemerellidae
Drunella sp.
Serratella deficiens
PLECOPTERA
Perlidae
Acroneuria sp.
Perlodidae
Malirekus sp.
Capniidae
Undetermined Capniidae
Leuctridae
Leuctra sp.
COLEOPTERA
Psephenidae
Psephenus herricki
Elmidae
Macronychus glabratus
Microcylloepus sp.
Optioservus ovalis
Optioservus trivittatus
Optioservus sp.
Promoresia elegans
Promoresia sp.
Stenelmis crenata
Stenelmis sp.
TRICHOPTERA
Philopotamidae
Chimarra aterrima?
Dolophilodes sp.
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche betteni
Hydropsyche bronta
Hydropsyche morosa
Hydropsyche scalaris
Hydropsyche slossonae
Hydropsyche sparna
Glossosomatidae
Glossosoma sp.
LEPIDOPTERA
Undetermined Lepidoptera
DIPTERA
Tipulidae
Antocha sp.
Dicranota sp.
Limonia sp.
Simuliidae
Simulium sp.
Athericidae
Atherix sp.
Chironomidae
Thienemannimyia gr. spp.

Diamesa sp.
Pagastia orthogonia
Cricotopus bicinctus
Cricotopus trifascia gr.
Orthocladius dubitatus
Orthocladius obumbratus
Orthocladius sp.
Parametriocnemus sp.
Tvetenia bavarica gr.
Tvetenia vitracies
Cryptochironomus sp.
Microtendipes pedellus gr.
Polypedilum aviceps
Polypedilum flavum
Micropsectra sp.
Rheotanytarsus exiguus gr.
Sublettea coffmani
Tanytarsus guerlus gr.
Tanytarsus sp.

Table 4a. Macroinvertebrate Data Report (MDR), Station 01.

DATE SAMPLED:	Owasco Lake Inlet	Station 01		
LOCATION:	Above Groton			
DATE:	2006-2011			
SAMPLE TYPE:	Kick			
SUBSAMPLE:	100			
			7/6/2006	6/28/2011
PLATYHELMINTHES				
TURBELLARIA				
TRICLADIDA		Undetermined Turbellaria	2	2
ARTHROPODA				
INSECTA				
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	12	~
		Baetis intercalaris	5	2
		Baetis tricaudatus	~	1
	Heptageniidae	*Heptagenia marginalis*	1	~
		Stenonema sp.	2	~
PLECOPTERA	Perlidae	*Agnetina capitata*	2	~
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*?	6	8
	Hydropsychidae	*Cheumatopsyche* sp.	4	6
		Hydropsyche bronta	3	4
		Hydropsyche sparna	1	12
COLEOPTERA	Psephenidae	*Psephenus herricki*	2	9
	Elmidae	*Macronychus glabratus*	~	1
		Optioservus sp.	11	17
		Oulimnius sp.	1	~
		Promoresia sp.	~	1
		Stenelmis sp.	~	2
DIPTERA	Tipulidae	*Antocha* sp.	1	6
		Dicranota sp.	2	2
		Hexatoma sp.	3	~
	Simuliidae	*Simulium vittatum*	17	~
	Chironomidae	*Thienemannimyia* gr. spp.	2	2
		Diamesa sp.	3	~
		Pagastia orthogonia	1	2
		Cardiocladius obscurus	2	~
		Cricotopus tremulus gr.	3	~
		Cricotopus trifascia gr.	3	1
		Cricotopus bicinctus	1	~
		Orthocladius sp.	~	2
		Parametriocnemus lundbecki	1	~
		Rheocricotopus robacki	1	~
		Tvetenia vitracies	~	1
		Cryptochironomus sp.	~	1
		Microtendipes pedellus gr.	1	10

Polypedilum aviceps	~	4
Polypedilum flavum	3	3
Micropsectra sp.	4	~
Tanytarsus guerlus gr.	~	1
SPECIES RICHNESS:	29	24
BIOTIC INDEX:	5.03	4.76
EPT RICHNESS:	9	6
MODEL AFFINITY:	72	53
NUTRIENT BIOTIC INDEX:	6.4	6.6
BIOLOGICAL ASSESS. PROFILE:	6.9	5.7
ASSESSMENT:	Slight	Slight

Table 4b. Macroinvertebrate Data Report (MDR), Station 02.

DATE SAMPLED:	Owasco Lake Inlet	Station 02
LOCATION:	Below Groton	
DATE:	2006-2011	
SAMPLE TYPE:	Kick	
SUBSAMPLE:	100	

			7/6/2006	6/28/2011
PLATYHELMINTHES				
TURBELLARIA				
TRICLADIDA		Undetermined Turbellaria	~	1
ANNELIDA				
OLIGOCHAETA				
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/ cap. setae	2	~
	Naididae	*Nais behningi*	40	~
		Ophidonais serpentina	2	~
LUMBRICIDA	Lumbricina	Undetermined Lumbricina	~	1
MOLLUSCA				
GASTROPODA				
BASOMMATOPHORA	Physidae	*Physella* sp.	1	~
ARTHROPODA				
CRUSTACEA				
ISOPODA	Asellidae	*Caecidotea* sp.	2	1
AMPHIPODA	Gammaridae	*Gammarus* sp.	2	22
INSECTA				
DIPTERA	Chironomidae	*Rheocricotopus robacki*	1	~
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	6	~
		Baetis intercalaris	1	~
		Baetis tricaudatus	~	1
		Undetermined Baetidae	~	1
PLECOPTERA	Capniidae	Undetermined Capniidae	~	2
	Leuctridae	*Leuctra* sp.	~	3
TRICHOPTERA	Philopotamidae	*Dolophilodes* sp.	~	1
	Hydropsychidae	*Cheumatopsyche* sp.	~	12
		Hydropsyche betteni	~	1
		Hydropsyche bronta	4	5
		Hydropsyche morosa	~	1
		Hydropsyche slossonae	~	1
		Hydropsyche sparna	9	12
	Glossosomatidae	*Glossosoma* sp.	~	1
COLEOPTERA	Elmidae	*Optioservus trivittatus*	~	3
DIPTERA	Tipulidae	*Limonia* sp.	~	1
	Psychodidae	Undetermined Psychodidae	1	~

Simuliidae	*Simulium vittatum*	23	~
	Simulium sp.	~	2
Athericidae	*Atherix* sp.	~	1
Chironomidae	*Thienemannimyia* gr. spp.	~	3
	Cricotopus tremulus gr.	1	~
	Cricotopus trifascia gr.	1	~
	Microtendipes pedellus gr.	~	6
	Polypedilum aviceps	1	6
	Polypedilum flavum	1	6
	Polypedilum illinoense	1	~
	Rheotanytarsus exiguus gr.	1	2
	Tanytarsus sp.	~	4
	SPECIES RICHNESS:	19	26
	BIOTIC INDEX:	6.27	5.31
	EPT RICHNESS:	4	12
	MODEL AFFINITY:	39	51
	NUTRIENT BIOTIC INDEX:	7.0	6.9
	BIOLOGICAL ASSESS. PROFILE:	4.1	6.1
	ASSESSMENT:	Moderate	Slight

Table 4c. Macroinvertebrate Data Report (MDR), Station 03.

DATE SAMPLED:	Owasco Lake Inlet	Station 03
LOCATION:	Below Groton	
DATE:	2006-2011	
SAMPLE TYPE:	Kick	
SUBSAMPLE:	100	

			7/6/2006	6/28/2011
PLATYHELMINTHES				
TURBELLARIA				
TRICLADIDA		Undetermined Turbellaria	~	1
ANNELIDA				
OLIGOCHAETA				
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	~	1
ARTHROPODA				
CRUSTACEA				
AMPHIPODA	Gammaridae	*Gammarus* sp.	7	2
INSECTA				
EPHEMEROPTERA	Baetidae	*Baetis brunneicolor*	~	3
		Baetis flavistriga	5	4
		Baetis intercalaris	3	1
		Baetis tricaudatus	~	7
	Heptageniidae	*Heptagenia* sp.	~	3
	Ephemerellidae	*Drunella* sp.	~	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*?	~	1
		Dolophilodes sp.	~	2
	Hydropsychidae	*Cheumatopsyche* sp.	4	~
		Hydropsyche bronta	25	9
		Hydropsyche slossonae	1	4
		Hydropsyche sparna	4	17
COLEOPTERA	Psephenidae	*Psephenus herricki*	~	1
	Elmidae	*Optioservus ovalis*	~	1
		Optioservus trivittatus	~	1
		Optioservus sp.	5	13
		Promoresia sp.	~	1
		Stenelmis sp.	~	4
DIPTERA	Tipulidae	*Antocha* sp.	2	14
		Dicranota sp.	3	~
	Simuliidae	*Simulium vittatum*	1	~
	Chironomidae	*Diamesa* sp.	12	~
		Pagastia orthogonia	5	2
		Cardiocladius obscurus	5	~
		Cricotopus bicinctus	2	1
		Cricotopus trifascia gr.	1	1

Orthocladius dubitatus	~	2
Eukiefferiella devonica gr.	1	~
Synorthocladius nr. *semivirens*	1	~
Tvetenia vitracies	1	1
Microtendipes pedellus gr.	2	3
Polypedilum flavum	2	~
Rheotanytarsus exiguus gr.	8	1
Sublettea coffmani	~	1
SPECIES RICHNESS:	22	29
BIOTIC INDEX:	5.14	4.65
EPT RICHNESS:	6	11
MODEL AFFINITY:	53	62
NUTRIENT BIOTIC INDEX:	7.2	6.5
BIOLOGICAL ASSESS. PROFILE:	5.2	6.9
ASSESSMENT:	Slight	Slight

Table 4d. Macroinvertebrate Data Report (MDR), Station 04.

DATE SAMPLED:	Owasco Lake Inlet	Station 04
LOCATION:	Above Locke	
DATE:	2006-2011	
SAMPLE TYPE:	Kick	
SUBSAMPLE:	100	

			7/6/2006	6/28/2011
NEMERTEA				
ENOPLA				
HOPLONEMERTEA	Tetrastemmatidae	*Prostoma graecense*	1	~
PLATYHELMINTHES				
TURBELLARIA				
TRICLADIDA		Undetermined Turbellaria	~	1
ANNELIDA				
OLIGOCHAETA				
TUBIFICIDA	Tubificidae	*Limnodrilus hoffmeisteri*	1	~
ARTHROPODA				
CRUSTACEA				
AMPHIPODA	Gammaridae	*Gammarus* sp.	2	4
INSECTA				
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	2	~
		Baetis intercalaris	1	4
		Baetis tricaudatus	~	11
	Heptageniidae	*Heptagenia* sp.	~	1
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*?	~	2
		Dolophilodes sp.	~	3
	Hydropsychidae	*Hydropsyche bronta*	21	8
		Hydropsyche slossonae	~	2
		Hydropsyche sparna	7	29
PLECOPTERA	Chloroperlidae	Undetermined Chloroperlidae	1	~
	Perlodidae	*Malirekus* sp.	~	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	4	9
	Elmidae	*Microcylloepus* sp.	~	1
		Optioservus fastiditus	11	~
		Optioservus trivittatus	11	5
		Stenelmis crenata	4	1
		Stenelmis sp.	~	7
DIPTERA	Tipulidae	*Antocha* sp.	4	~
		Dicranota sp.	4	~
	Simuliidae	*Simulium* sp.	~	1
	Chironomidae	*Diamesa* sp.	12	1

Cardiocladius obscurus	1	~
Eukiefferiella devonica gr.	1	~
Tvetenia bavarica gr.	~	2
Cryptochironomus fulvus gr.	1	~
Microtendipes pedellus gr.	3	2
Polypedilum aviceps	~	3
Polypedilum fallax gr.	6	~
Micropsectra sp.	2	1
SPECIES RICHNESS:	21	22
BIOTIC INDEX:	5.04	5.13
EPT RICHNESS:	5	9
MODEL AFFINITY:	55	52
NUTRIENT BIOTIC INDEX:	7.2	6.8
BIOLOGICAL ASSESS. PROFILE:	5.1	5.6
ASSESSMENT:	Slight	Slight

Table 4e. Macroinvertebrate Data Report (MDR), Station 05.

DATE SAMPLED:	Owasco Lake Inlet	Station 05
LOCATION:	Below Locke	
DATE:	2006-2011	
SAMPLE TYPE:	Kick	
SUBSAMPLE:	100	

			7/6/2006	6/28/2011
PLATYHELMINTHES				
TURBELLARIA				
TRICLADIDA		Undetermined Turbellaria	2	~
ANNELIDA				
OLIGOCHAETA				
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	~	1
ARTHROPODA				
CRUSTACEA				
AMPHIPODA	Gammaridae	*Gammarus* sp.	2	6
ARTHROPODA				
INSECTA				
EPHEMEROPTERA	Baetidae	*Acentrella* sp.	1	~
		Baetis flavistriga	~	3
		Baetis intercalaris	4	2
		Baetis tricaudatus	~	2
	Heptageniidae	*Heptagenia* sp.	~	2
PLECOPTERA	Leuctridae	Undetermined Leuctridae	1	~
	Perlidae	*Acroneuria* sp.	~	1
		Agnetina capitata	1	~
TRICHOPTERA	Hydropsychidae	*Hydropsyche bronta*	11	1
		Hydropsyche scalaris	~	1
		Hydropsyche slossonae	1	1
		Hydropsyche sparna	3	3
COLEOPTERA	Psephenidae	*Ectopria nervosa*	1	~
		Psephenus herricki	9	9
	Elmidae	*Optioservus fastiditus*	32	~
		Optioservus trivittatus	~	6
		Optioservus sp.	~	16
		Promoresia elegans	1	1
		Stenelmis crenata	19	1
		Stenelmis sp.	~	23
DIPTERA	Tipulidae	*Antocha* sp.	~	3
		Dicranota sp.	2	~
	Athericidae	*Atherix* sp.	2	~
	Empididae	*Hemerodromia* sp.	1	~
	Chironomidae	*Diamesa* sp.	3	~

Cricotopus sp.	2	~
Parametriocnemus sp.	~	1
Microtendipes pedellus gr.	2	11
Polypedilum aviceps	~	2
Sublettea coffmani	~	1
SPECIES RICHNESS:	20	22
BIOTIC INDEX:	4.65	4.7
EPT RICHNESS:	7	9
MODEL AFFINITY:	43	51
NUTRIENT BIOTIC INDEX:	6.9	7.0
BIOLOGICAL ASSESS. PROFILE:	5.1	5.6
ASSESSMENT:	Slight	Slight

Table 4f. Macroinvertebrate Data Report (MDR), Station 06.

DATE SAMPLED: Owasco Lake Inlet Station 06
LOCATION: Above Moravia
DATE: 2006-2011
SAMPLE TYPE: Kick
SUBSAMPLE: 100

			7/6/2006	6/28/2011
PLATYHELMINTHES				
TURBELLARIA				
TRICLADIDA		Undetermined Turbellaria	2	1
ANNELIDA				
OLIGOCHAETA				
TUBIFICIDA	Tubificidae	*Limnodrilus hoffmeisteri*	1	~
	Enchytraeidae	Undetermined Enchytraeidae	1	~
MOLLUSCA				
PELECYPODA				
VENEROIDEA	Sphaeriidae	*Sphaerium* sp.	1	~
ARTHROPODA				
CRUSTACEA				
AMPHIPODA	Gammaridae	*Gammarus* sp.	11	2
INSECTA				
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	2	~
		Baetis intercalaris	2	8
		Baetis tricaudatus	~	10
	Heptageniidae	*Epeorus vitreus*	~	1
		Heptagenia sp.	~	2
		Stenonema sp.	1	~
	Ephemerellidae	*Serratella deficiens*	~	1
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	1	~
		Chimarra socia	1	~
	Hydropsychidae	*Hydropsyche bronta*	9	4
		Hydropsyche sparna	5	5
LEPIDOPTERA		Undetermined Lepidoptera	~	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	7	10
	Elmidae	*Optioservus ovalis*	33	~
		Optioservus trivittatus	~	1
		Optioservus sp.	~	20
		Promoresia sp.	~	2
		Stenelmis crenata	16	4
		Stenelmis sp.	~	24
DIPTERA	Tipulidae	*Antocha* sp.	3	1
	Chironomidae	*Diamesa* sp.	1	~
		Pagastia orthogonia	1	~
		Tvetenia vitracies	1	~

Cryptochironomus fulvus gr.	1	~
Microtendipes pedellus gr.	~	2
Rheotanytarsus exiguus gr.	~	1
SPECIES RICHNESS:	20	19
BIOTIC INDEX:	4.83	4.76
EPT RICHNESS:	7	7
MODEL AFFINITY:	41	49
NUTRIENT BIOTIC INDEX:	7.9	7.1
BIOLOGICAL ASSESS. PROFILE:	4.5	5.1
ASSESSMENT:	Moderate	Slight

Table 4g. Macroinvertebrate Data Report (MDR), Station 07.

DATE SAMPLED:	Owasco Lake Inlet	Station 07
LOCATION:	Below Moravia	
DATE:	2006-2011	
SAMPLE TYPE:	Kick	
SUBSAMPLE:	100	

			7/6/2006	6/28/2011
PLATYHELMINTHES				
TURBELLARIA				
TRICLADIDA		Undetermined Turbellaria	~	4
ANNELIDA				
OLIGOCHAETA				
TUBIFICIDA	Tubificidae	*Limnodrilus hoffmeisteri*	1	~
MOLLUSCA				
GASTROPODA				
BASOMMATOPHORA	Ancylidae	*Ferrissia* sp.	1	~
ARTHROPODA				
CRUSTACEA				
ISOPODA	Asellidae	*Caecidotea* sp.	2	~
AMPHIPODA	Gammaridae	*Gammarus* sp.	3	~
INSECTA				
EPHEMEROPTERA	Baetidae	*Acentrella turbida*	~	1
		Acentrella sp.	~	1
		Baetis brunneicolor	~	5
		Baetis flavistriga	8	~
		Baetis intercalaris	~	4
		Baetis tricaudatus	~	14
	Heptageniidae	*Leucrocuta* sp.	1	~
	Ephemerellidae	Undetermined Ephemerellidae	1	~
	Leptohyphidae	*Tricorythodes* sp.	6	~
PLECOPTERA	Perlidae	*Paragnetina immarginata*	1	~
TRICHOPTERA	Philopotamidae	*Chimarra aterrima*?	~	1
		Chimarra obscura	1	~
		Dolophilodes sp.	~	2
	Psychomyiidae	*Psychomyia flavida*	1	~
	Hydropsychidae	*Cheumatopsyche* sp.	~	3
		Hydropsyche bronta	4	~
		Hydropsyche sparna	12	2
COLEOPTERA	Psephenidae	*Psephenus herricki*	~	3
	Elmidae	*Optioservus fastiditus*	20	~
		Optioservus ovalis	~	1
		Optioservus sp.	~	24
		Promoresia elegans	~	4
		Promoresia sp.	2	~

		Stenelmis crenata	23	2
		Stenelmis sp.	~	19
DIPTERA	Tipulidae	*Antocha* sp.	5	2
	Simuliidae	*Simulium vittatum*	1	~
	Athericidae	*Atherix* sp.	1	~
	Chironomidae	*Thienemannimyia* gr. spp.	1	~
		Pagastia orthogonia	1	1
		Orthocladius obumbratus	~	2
		Rheocricotopus robacki	1	~
		Tvetenia vitracies	2	~
		Microtendipes pedellus gr.	~	1
		Polypedilum flavum	1	~
		Micropsectra sp.	~	1
		Sublettea coffmani	~	3
		SPECIES RICHNESS:	24	22
		BIOTIC INDEX:	4.65	4.56
		EPT RICHNESS:	9	9
		MODEL AFFINITY:	54	57
		NUTRIENT BIOTIC INDEX:	6.3	6.7
		BIOLOGICAL ASSESS. PROFILE:	6.2	5.9
		ASSESSMENT:	Slight	Slight

Table 5a. Laboratory data summary, Owasco Lake Inlet, Stations 01-04.

DATE SAMPLED: 6/28/2011				
SAMPLING METHOD: Kick				
STATION	01	02	03	04
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Optioservus sp. 17% intolerant beetle	Gammarus sp. 22% facultative scud	Hydropsyche sparna 17% facultative caddisfly	Hydropsyche sparna 29% facultative caddisfly
2.	Hydropsyche sparna 12% facultative caddisfly	Hydropsyche sparna 12% facultative caddisfly	Antocha sp. 14% intolerant crane fly	Baetis tricaudatus 11% facultative mayfly
3.	M. pedellus gr. 10% facultative midge	Cheumatopsyche sp. 12% facultative caddisfly	Optioservus sp. 13% intolerant beetle	Psephenus herricki 9% intolerant beetle
4.	Psephenus herricki 9% intolerant beetle	Polypedilum flavum 6% facultative midge	Hydropsyche bronta 9% facultative caddisfly	Hydropsyche bronta 8% facultative caddisfly
5.	Chimarra aterrima? 8% intolerant caddisfly	Polypedilum aviceps 6% facultative midge	Baetis tricaudatus 7% facultative mayfly	Stenelmis sp. 7% facultative beetle
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)				
Chironomidae (midges)	27 (10)	27 (6)	12 (8)	9 (5)
Trichoptera (caddisflies)	30 (4)	34 (8)	33 (5)	44 (5)
Ephemeroptera (mayflies)	3 (2)	2 (2)	19 (6)	16 (3)
Plecoptera (stoneflies)	0 (0)	5 (2)	0 (0)	1 (1)
Coleoptera (beetles)	30 (5)	3 (1)	21 (6)	23 (5)
Oligochaeta (worms)	0 (0)	1 (1)	1 (1)	0 (0)
Mollusca (clams and snails)	0 (0)	0 (0)	0 (0)	0 (0)
Crustacea (Crayfish, scuds etc…)	0 (0)	23 (2)	2 (1)	4 (1)
Other insects (odonates, diptera)	8 (2)	4 (3)	14 (1)	1 (1)
Other	1 (0)	1 (0)	1 (0)	1 (0)
BIOLOGICAL COMMUNITY METRICS AND ASSESSMENTS				
SPECIES RICHNESS	24	26	29	22
BIOTIC INDEX	4.76	5.31	4.65	5.13
EPT RICHNESS	6	12	11	9

Intolerant = not tolerant of poor water quality

Facultative = occuring over a wide range of water quality

Tolerant = tolerant of poor water quality

PERCENT MODEL AFFINITY	53	51	62	52
NUTRIENT BIOTIC INDEX	6.6	6.9	6.5	6.8
BIOLOGICAL ASSESSMENT PROFILE	5.7	6.1	6.9	5.6
FIELD ASSESSMENT	Good	Poor	Poor	Good
OVERALL ASSESSMENT	slightly impacted	slightly impacted	non-impacted	slightly impacted

Table 5b. Laboratory data summary, Owasco Lake Inlet, Stations 05-07.

DATE SAMPLED: 6/28/2011			
SAMPLING METHOD: Kick			
STATION	05	06	07
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME			
1.	Stenelmis sp. 24% facultative beetle	Stenelmis sp. 24% facultative beetle	Optioservus sp. 24% intolerant beetle
2.	Optioservus sp. 16% intolerant beetle	Optioservus sp. 20% intolerant beetle	Stenelmis sp. 19% facultative beetle
3.	Microtendipes pedellus gr. 11% facultative midge	Baetis tricaudatus 10% facultative mayfly	Baetis tricaudatus 14% facultative mayfly
4.	Psephenus herricki 9% intolerant beetle	Psephenus herricki 10% intolerant beetle	Baetis brunneicolor 5% intolerant mayfly
5.	Optioservus trivittatus 6% intolerant beetle	Baetis intercalaris 8% facultative mayfly	Baetis intercalaris 4% facultative mayfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESIS)			
Chironomidae (midges)	15 (4)	3 (2)	8 (5)
Trichoptera (caddisflies)	6 (4)	9 (2)	8 (4)
Ephemeroptera (mayflies)	9 (4)	22 (5)	25 (5)
Plecoptera (stoneflies)	1 (1)	0 (0)	0 (0)
Coleoptera (beetles)	56 (6)	61 (6)	53 (6)
Oligochaeta (worms)	1 (1)	0 (0)	0 (0)
Mollusca (clams and snails)	0 (0)	0 (0)	0 (0)
Crustacea (Crayfish, scuds etc…)	6 (1)	2 (1)	0 (0)
Other insects (odonates, diptera)	3 (1)	2 (2)	2 (1)
Other	0 (0)	1 (0)	1 (0)
BIOLOGICAL COMMUNITY METRICS AND ASSESSMENTS			
SPECIES RICHNESS	22	19	22
BIOTIC INDEX	4.7	4.76	4.56
EPT RICHNESS	9	7	9
PERCENT MODEL AFFINITY	51	49	57
NUTRIENT BIOTIC INDEX	7.0	7.1	6.7
BIOLOGICAL ASSESSMENT PROFILE	5.6	5.1	5.9
FIELD ASSESSMENT	Good	Good	Good
OVERALL ASSESSMENT	slightly impacted	slightly impacted	slightly impacted

Intolerant = not tolerant of poor water quality

Facultative = occuring over a wide range of water quality

Tolerant = tolerant of poor water quality

Table 6a. Field data summary, Owasco Lake Inlet, Stations 01-04.

DATE SAMPLED: 6/28/2011				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	10:30 AM	11:40 AM	12:55 PM	1:47 PM
PHYSICAL CHARACTERISTICS				
Width (meters)	4	5	5	4
Depth (meters)	0.22	0.12	0.18	0.2
Current speed (cm per sec.)	50	80	100	125
Substrate (%)				
Rock (>25.4 cm, or bedrock)	0	10	55	0
Rubble (6.35 - 25.4 cm)	40	50	30	70
Gravel (0.2 - 6.35 cm)	50	35	10	25
Sand (0.06 - 2.0 mm)	5	4	4	5
Silt (0.004 - 0.06 mm)	5	1	1	0
Embeddedness (%)	40	25	75	40
CHEMICAL MEASUREMENTS				
Temperature (° C)	18.4	18.6	19.2	18.94
Specific Conductance (umhos)	432	580	507	479
Dissolved Oxygen (mg/l)	8.02	9.63	10.62	10.76
pH	7.9	8.04	8.91	8.69
BIOLOGICAL ATTRIBUTES				
Canopy (%)	1	90	0	75
Aquatic Vegetation				
algae - suspended				
algae - attached, filamentous	Y	Y	Y	Y
algae - diatoms	100	100	75	100
macrophytes or moss	0	5	10	0
OCCURRENCE OF MACROINVERTEBRATES				
Ephemeroptera (mayflies)	Y	Y	Y	Y
Plecoptera (stoneflies)	Y	Y		
Trichoptera (caddisflies)	Y	Y	Y	Y
Coleoptera (beetles)	Y	Y	Y	Y
Megaloptera (dobsonflies, alderflies)				
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	Y	Y	Y	Y
Simuliidae (black flies)				Y
Decapoda (crayfish)				
Gammaridae (scuds)		Y	Y	
Mollusca (snails, clams)				
Oligochaeta (worms)		Y	Y	
Other	Sowbug	Sowbug		
FIELD ASSESSMENT	Good	Poor	Poor	Good

Table 6b. Field data summary, Owasco Lake Inlet, Stations 05-07.

DATE SAMPLED: 6/28/2011			
STATION	05	06	07
ARRIVAL TIME AT STATION	2:34 PM	3:33 PM	4:22 PM
PHYSICAL CHARACTERISTICS			
Width (meters)	5	8	12
Depth (meters)	0.3	0.25	0.24
Current speed (cm per sec.)	70	100	110
Substrate (%)			
Rock (>25.4 cm, or bedrock)	10	5	2
Rubble (6.35 - 25.4 cm)	40	40	60
Gravel (0.2 - 6.35 cm)	30	40	35
Sand (0.06 - 2.0 mm)	10	5	3
Silt (0.004 - 0.06 mm)	5	5	0
Embeddedness (%)	35	50	20
CHEMICAL MEASUREMENTS			
Temperature (° C)	20.28	21.63	21.2
Specific Conductance (umhos)	443	443	438
Dissolved Oxygen (mg/l)	11.16	11.15	10.4
pH	8.62	8.75	8.61
BIOLOGICAL ATTRIBUTES			
Canopy (%)	4	40	15
Aquatic Vegetation			
algae - suspended			
algae - attached, filamentous	Y	Y	Y
algae - diatoms	100	100	100
macrophytes or moss	0	0	0
OCCURRENCE OF MACROINVERTEBRATES			
Ephemeroptera (mayflies)	Y	Y	Y
Plecoptera (stoneflies)	Y		Y
Trichoptera (caddisflies)	Y	Y	Y
Coleoptera (beetles)	Y	Y	Y
Megaloptera (dobsonflies, alderflies)			
Odonata (dragonflies, damselflies)			
Chironomidae (midges)	Y	Y	Y
Simuliidae (black flies)			
Decapoda (crayfish)		Y	Y
Gammaridae (scuds)	Y	Y	
Mollusca (snails, clams)			Y
Oligochaeta (worms)			
Other			
FIELD ASSESSMENT	Good	Good	Good