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#644

New York State
Department of Environmental Conservation

Division of Water

Owasco Outlet

Biological Assessment

2002 Survey

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BIOLOGICAL STREAM ASSESSMENT

Owasco Outlet
Cayuga County, New York

Survey date: July 17, 2002
Report date: May 9, 2003

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Discussion:

In the current survey, water quality along the length of Owasco Outlet was assessed as slightly impacted at all 6 sites sampled from Auburn to North Port Byron. No substantial change was seen to the macroinvertebrate community below the discharge of the Auburn (C) Sewage Treatment Plant. Similarly, no decline in water quality was seen downstream of Port Byron, where wastewater from the Port Byron facility is also discharged to the stream, although here some shifts in the fauna do occur compared to samples collected above the village. According to results of an impact source determination analysis (Table 1), the main stressors to the macroinvertebrate communities along the length of the stream are most likely nutrients and urban municipal or industrial runoff.

Temporally, water quality is substantially improved from conditions documented in a 1990 survey (Bode *et al.*, 1990) in which the same 6 locations were sampled, as well as one additional site. The improvement from moderately to slightly impacted water quality at 3 of the 5 sites below the Auburn (C) Sewage Treatment Plant can be attributed to the 1995 upgrade of the plant, which now includes activated sludge treatment, phosphorus removal, post-aeration, and UV disinfection.

As in 1990, the most upstream location sampled (Station 2), approximately 5 miles below the lake outlet, was found to have slightly impacted water quality. The community collected in the current survey, while still slightly impacted (Figure 1) was of higher quality than that of 1990. In 1990, midges and worms, organisms often abundant in poor quality waters, constituted 62% of the 100 organism subsample, while in 2002 those groups only contributed 24%. In addition, the number of mayfly individuals increased in 2002, and the Hilsenhoff biotic index was improved. In 1990, the slight water quality impact above the treatment plant was attributed to other inputs to the stream in the city of Auburn, such as combined sewer overflows, since the effects of the lake outlet (Appendix XI) should have diminished at this distance downstream. Since 2002 was a very dry summer, water quality may be better at this location now because of reduced non-point runoff due to the dry weather conditions. Changes to the combined sewer system in the city of Auburn since 1990 are unknown.

The composition of the invertebrate community at Station 3, the first location below the Auburn Sewage Treatment Plant, was similar to that collected upstream of the discharge, indicating that the upgrade in treatment completed at the plant in 1995 has been effective in improving the quality of the discharge. In the 1990 survey, there were significant changes in community composition from Station 2 above the plant to Station 3, approximately 1 mile below the discharge, and water quality was assessed as moderately impacted. In 1990, the contribution of worms in the subsample increased between these 2 locations from 23% to 62% (Figure 3a), species richness declined from 23 to 14 taxa, and mayflies, an intolerant group, were not seen in the field and were absent from the subsample. Caddisflies declined from 18% to 2% (Figure 3b), indicative of a response to a toxic input. In 2002, the contribution of aquatic worms was constant, at 0 to 1 % (Figure 3a). From Station 2 to Station 3, species richness was unchanged. Mayflies were present at Station 3, noted in the field and identified in the 100-organism subsample.

In 1990, in Throopsville at Station 5, worms still dominated the subsample, mayflies were still absent, numbers of caddisflies were low (Figure 3b), water quality was assessed as moderately impacted, but sowbugs, indicators of a zone of sewage recovery were collected (Bode, *et. al.*, 1990). In the current survey, community composition continues to reflect slightly impacted water quality at Throopsville; since the plant discharge has much less impact on the macroinvertebrate fauna, no recognizable sewage recovery community is seen either at Station 3 or Station 5.

A site below Throopsville (Station 6), which was sampled and assessed as moderately impacted in 1990, was not sampled in the current survey. The sampling locations upstream of Port Byron (Station 8) and in Port Byron (Station 9) were very similar to one another in 2002, but in 1990 water quality improved from moderately to slightly impacted between these 2 sites.

In 1990, the site sampled in North Port Byron, 1.2 miles downstream of the Port Byron Wastewater Treatment Facility declined again to moderately impacted. Species richness and EPT richness were reduced, and the facility discharge was believed to be the cause. In the current survey, while water quality remained slightly impacted, community composition showed several substantial shifts that may still indicate effects from the Port Byron facility. The most dramatic were the decrease in caddisflies from 40% to 4% (Figure 3b) and the increase in beetles from 13 to 59% of the subsample. Even with these shifts in the fauna, water quality is improved at this station from that seen in the1990 survey. The reason for this apparent improvement is not known.

While the reason for changes to the invertebrate community below the Port Byron Wastewater Treatment Facility and the improvement to water quality were not clear in the current survey, the dramatic improvements seen below the Auburn (C) Sewage Treatment Plant are evidence that the upgrade in treatment completed at the plant in 1995 has been effective in improving the quality of the discharge and consequently the health of Owasco Outlet.

Literature cited

Bode, R.W., M.A. Novak, and L.E. Abele. 1990. Biological Assessment of Owasco Outlet. New York State Department of Environmental Conservation, Albany, NY. NYS DEC Technical Report, 30 pages.

Bode, R.W., M.A. Novak, L.E. Abele, D. L. Heitzman, and A. J. Smith. 2002. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation, Albany, NY. NYS DEC Technical Report, 115 pages.

Neuderfer, G. N. 1975. A macroinvertebrate study of Owasco Inlet and Owasco Outlet. New York State Department of Environmental Conservation Report, Avon Pollution Investigations. 71 pages.

Overview of field data:

On the date of sampling, July 17, 2002, the sites sampled on Owasco Outlet were 20 - 30 meters wide, 0.2 - 0.3 meters deep in riffles, and had current speeds of 77 - 125 cm/sec in riffles. Dissolved oxygen was 6.8 - 10.4 mg/l, specific conductance was 143 - 194 µmhos, pH was 7.9 - 8.8, and the temperature was 22.0 - 26.0 °C (71 - 79 °F). Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Owasco Outlet, 2002. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.

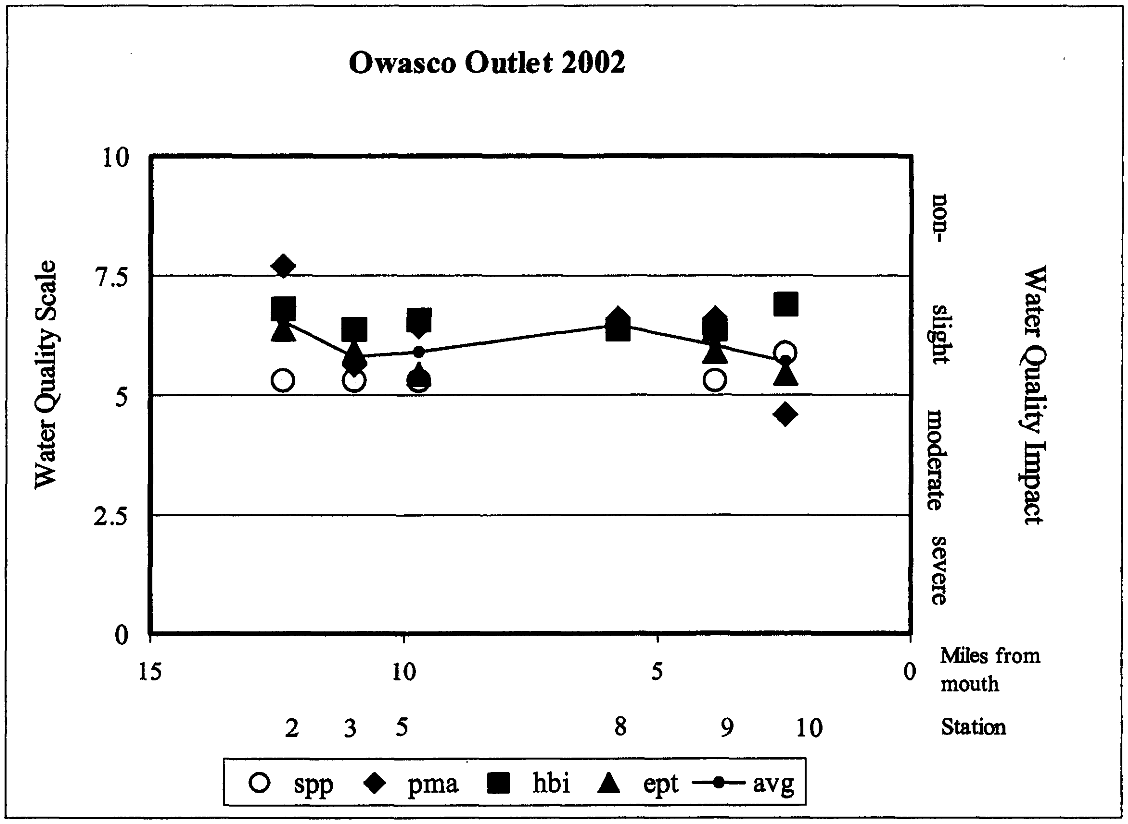


Figure 2. Biological Assessment Profile of index values, Owasco Outlet, for July 1990 and July 2002. Values are plotted on a normalized scale of water quality. The lines connect the mean of the four values for each site and year, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. Individual values for 2002 are shown on Figure 1. See Appendix IV for more complete explanation.

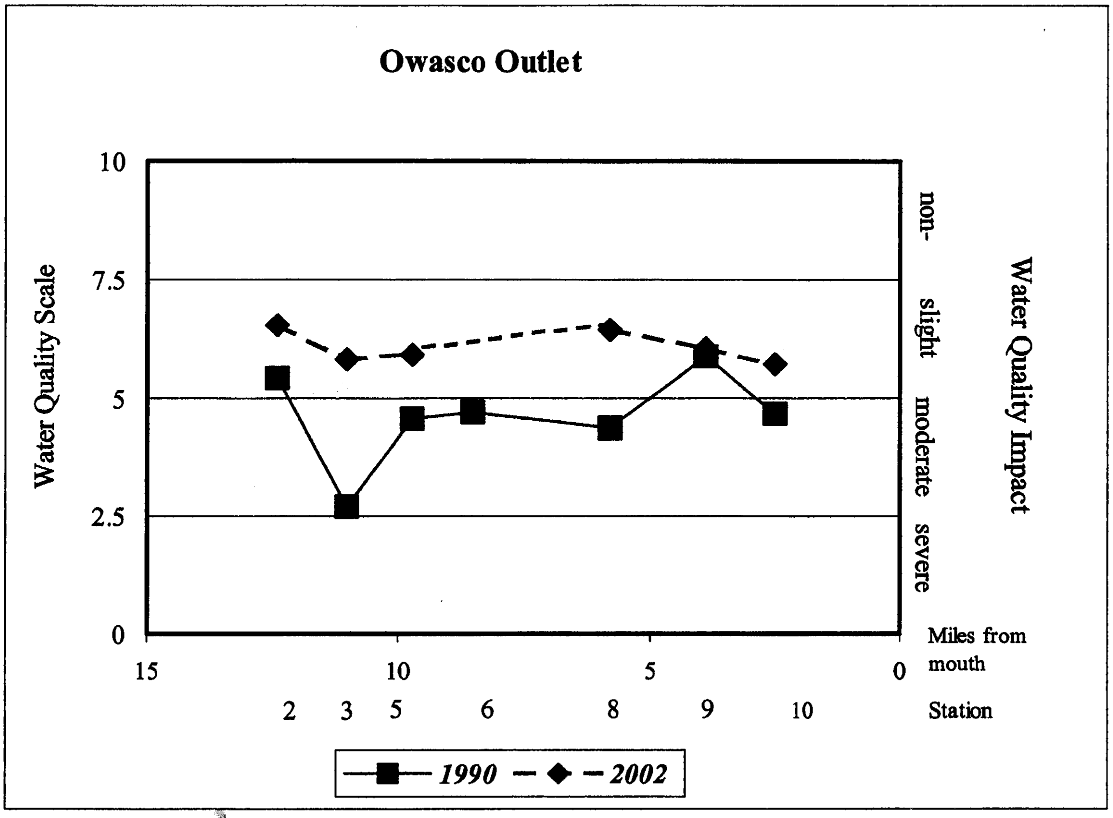


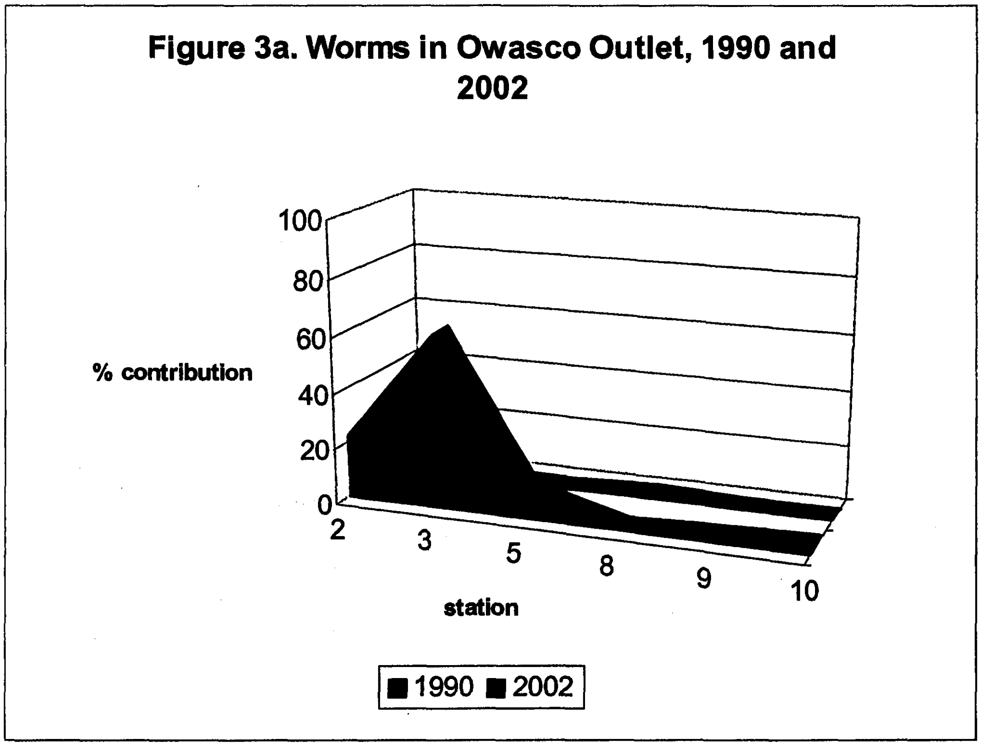
Table 1. Impact Source Determination, Owasco Outlet, 2002. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. See Appendix X for a more complete explanation of Impact Source Determination.

	STATION					
Community Type	02	03	05	08	09	10
Natural: minimal humanmpacts	45	39	44	52	49	35
Nutrient additions; mostly nonpoint, agricultural	57	65	56	66	65	60
Toxic: industrial, municipal, or urban run-off	55	52	61	65	63	44
Organic: sewage effluent, animal wastes	41	66	47	56	57	28
Complex: municipal/industrial	54	67	61	64	65	32
Siltation	45	52	48	55	49	41
Impoundment	43	60	47	57	53	52

TABLE SUMMARY:

Station #	Community Most Characteristic of:
02	Inputs are primarily from non-point sources, with possible municipal/urban/industrial inputs
03	Inputs are organic in nature, with inputs from sewage sources, as well as complex municipal/industrial, which may include CSOs
05	Inputs are municipal/industrial, possibly including CSOs
08	Complex municipal/industrial effects, with some possible non-point source inputs
09	Complex municipal/industrial effects, with some possible non-point source inputs
10	Non-point source effects

Figure 3. Changes in Abundance of Worms and Filter-feeding Caddisflies in the Owasco Outlet, from 1990 to 2002.



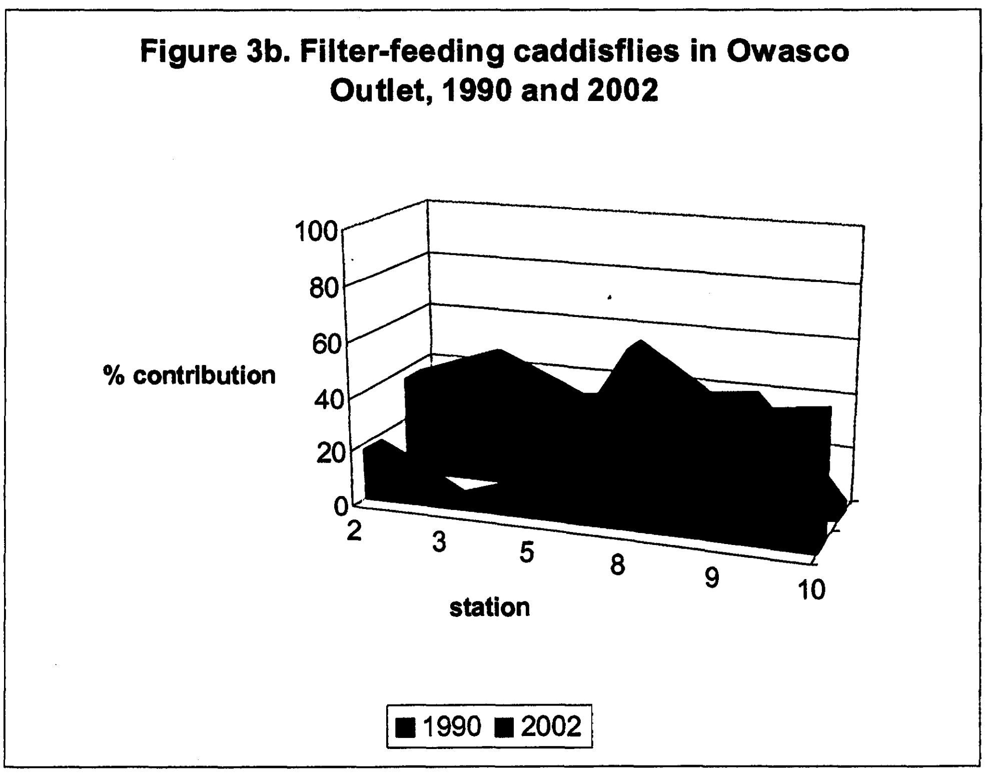


TABLE 2. STATION LOCATIONS FOR OWASCO OUTLET, CAYUGA COUNTY, NEW YORK (see map).

STATION	LOCATION
02	Auburn above STP, 30 meters below Canoga St. bridge 42°56'04"; 76°35'18" 12.4 river miles above the mouth
03	Auburn below STP, 100 meters above power lines 42°56'46"; 76°35'53" 11.0 river miles above the mouth
05	Throopsville 20 meters above Sherman Rd. bridge at Throop Highway Dept 42°57'53"; 76°36'12" 9.7 river miles above the mouth
08	above Port Byron 50 meters above Hayden Rd. bridge 43°00'47"; 76°36'58" 5.8 river miles above the mouth
09	Port Byron 200 meters above Rochester St. bridge 43°02'06"; 76°37'39" 3.9 river miles above the mouth
10	North Port Byron 2 meters below New York Central Rd. bridge 43°03'10"; 76°37'50" 2.5 river miles above the mouth

Figure 3	Site Overview Map	Owasco Outlet

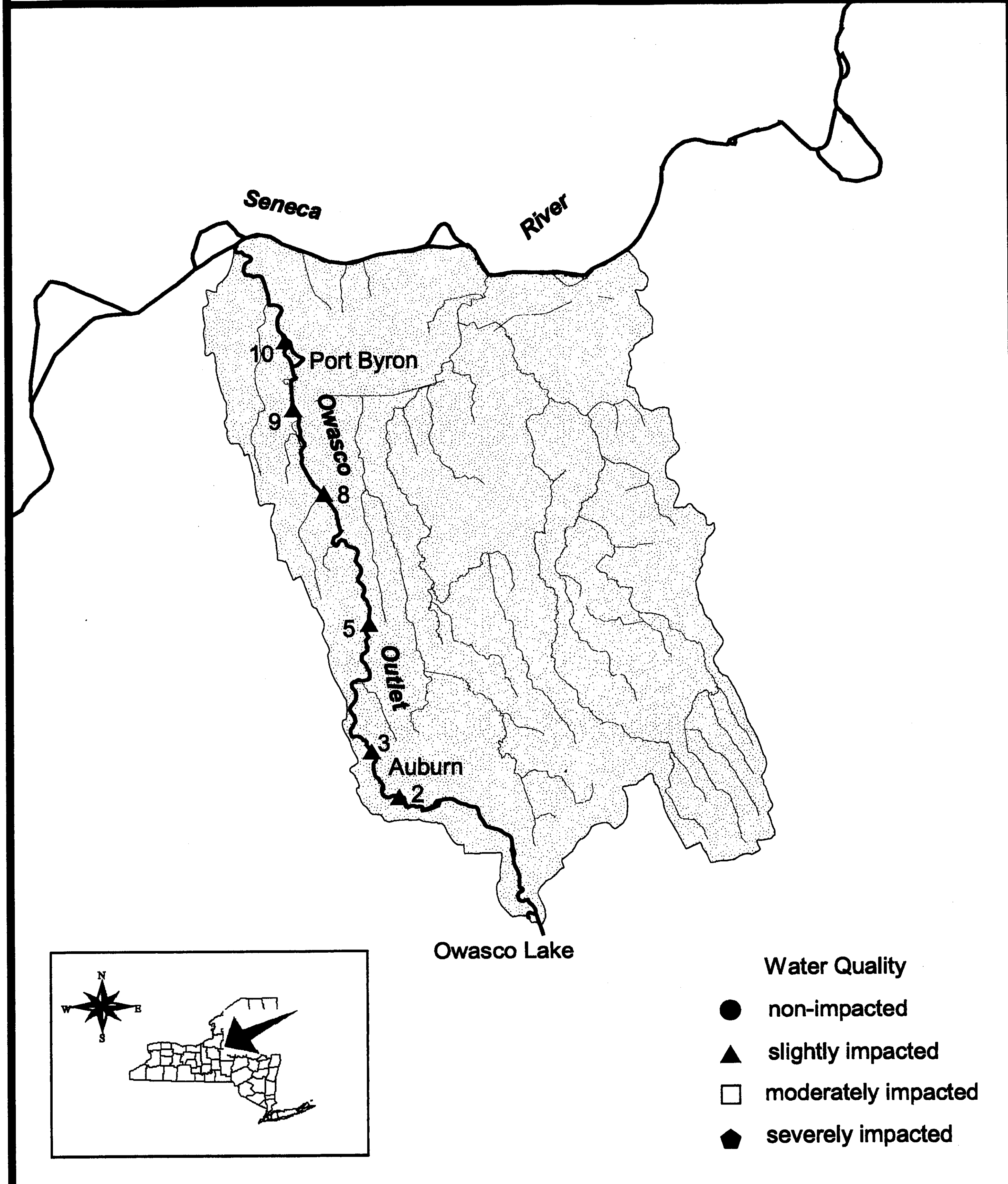


Figure 5a.	Site Location Map	Owasco Outlet

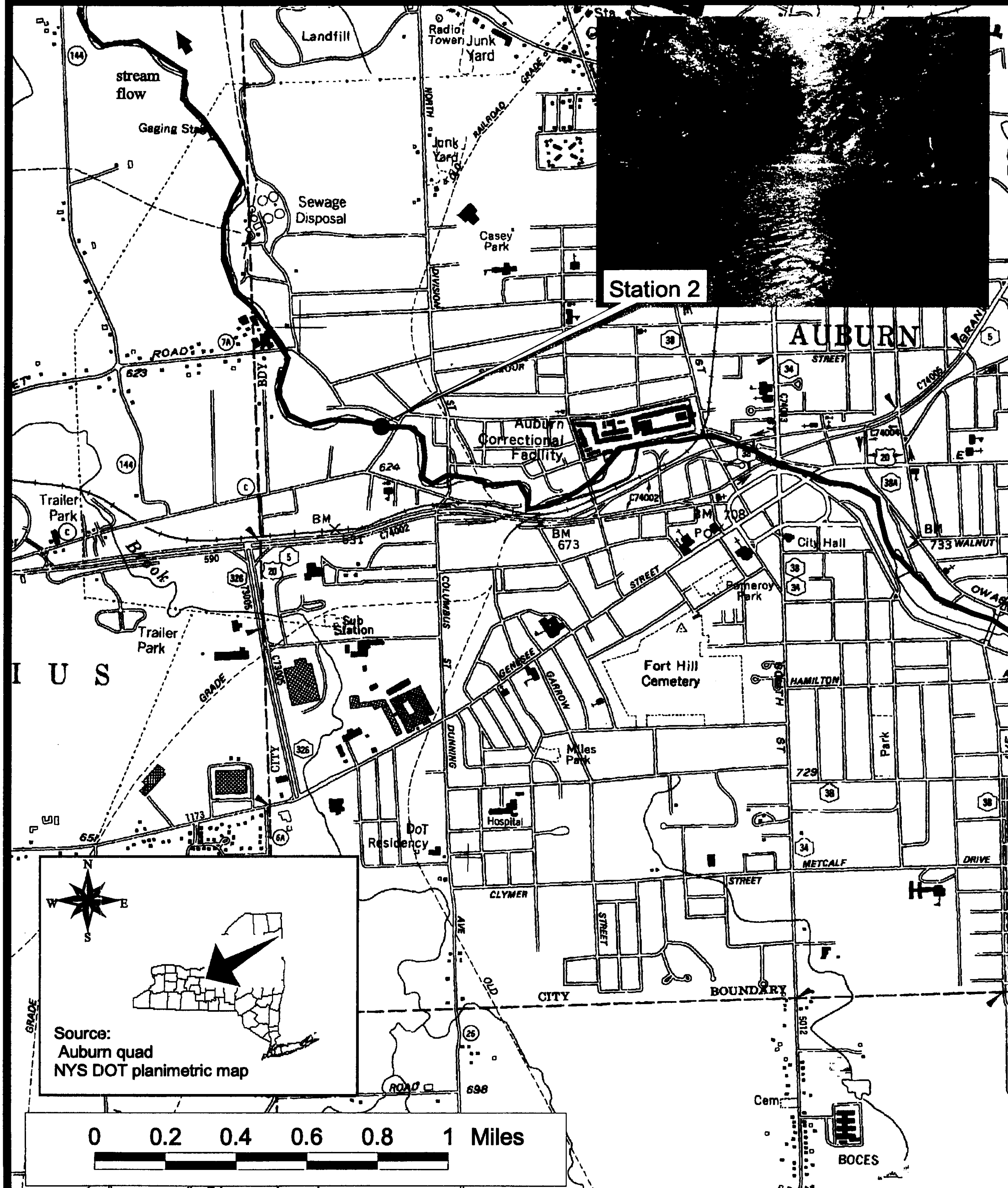


Figure 5b.	Site Location Map	Owasco Outlet

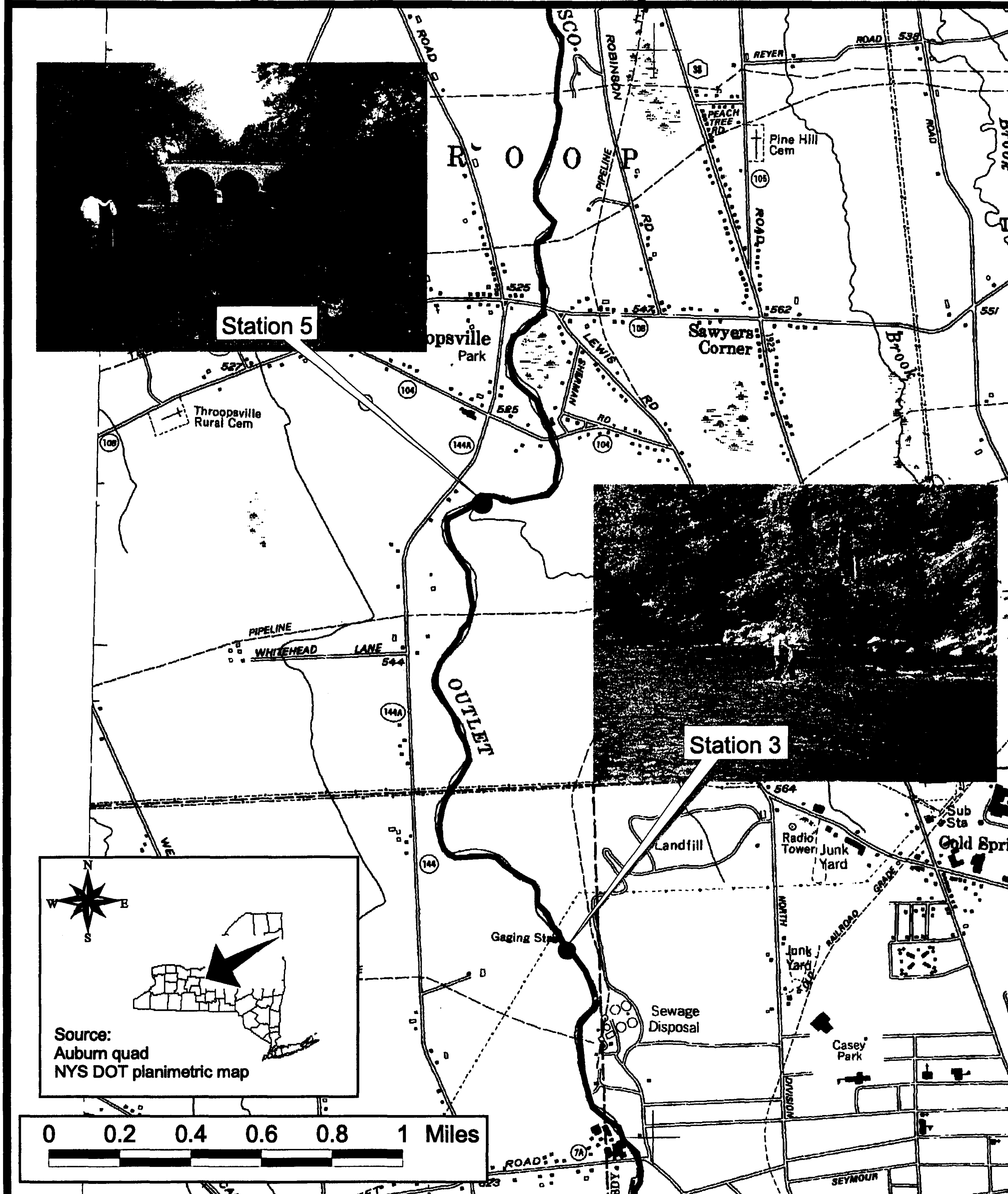


Figure 5c.	Site Location Map	Owasco Outlet

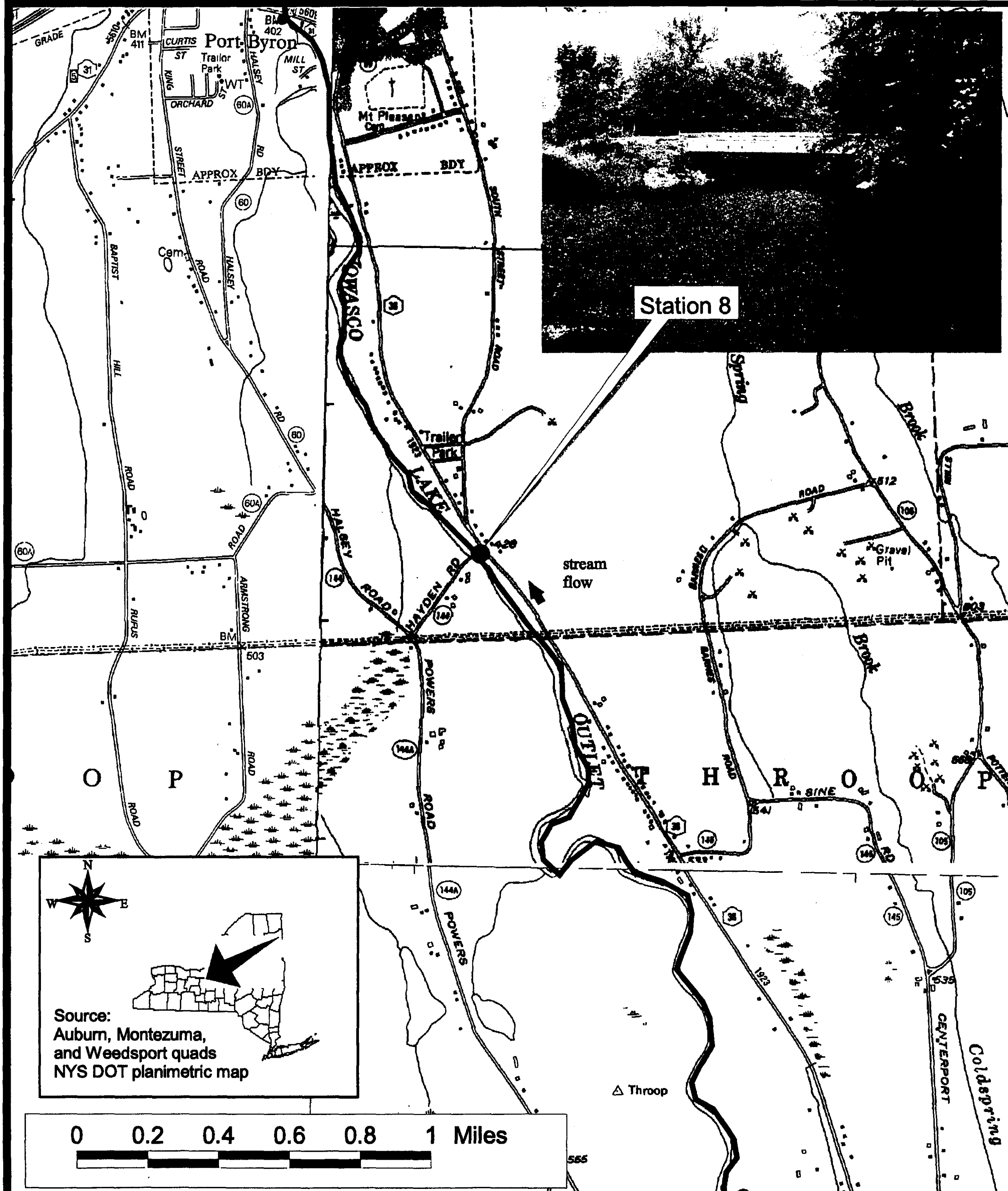


Figure 5d.	Site Location Map	Owasco Outlet

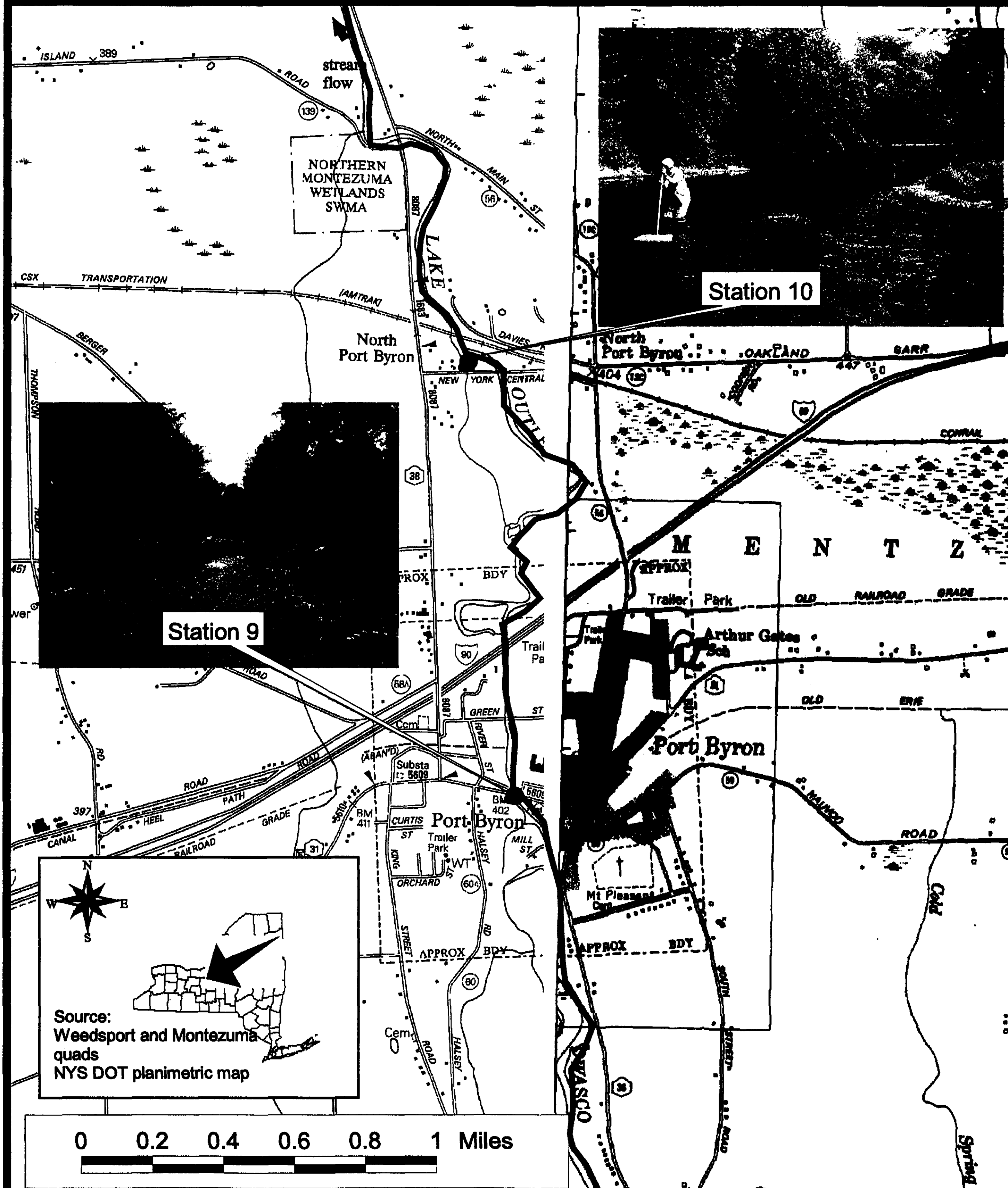


TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN OWASCO OUTLET, CAYUGA COUNTY, NEW YORK, JULY 17, 2002.

ANNELIDA
OLIGOCHAETA
LUMBRICIDA
Undetermined Lumbricina
TUBIFICIDA
Enchytraeidae
Undetermined Enchytraeidae
MOLLUSCA
GASTROPODA
Physidae
Physella sp.
Pleuroceridae
Undetermined Pleuroceridae
PELECYPODA
Sphaeriidae
Undetermined Sphaeriidae
ARTHROPODA
CRUSTACEA
ISOPODA
Asellidae
Caecidotea racovitzai
AMPHIPODA
Gammaridae
Gammarus sp.
INSECTA
EPHEMEROPTERA
Baetidae
Baetis flavistriga
Baetis intercalaris
Plauditus sp.
Heptageniidae
Stenacron interpunctatum
Stenonema femoratum
Stenonema terminatum
Stenonema vicarium
Stenonema sp.
COLEOPTERA
Gyrinidae
Dineutus sp.
Psephenidae
Psephenus herricki
Elmidae
Optioservus trivittatus
Optioservus sp.
Stenelmis crenata
Stenelmis sp.

MEGALOPTERA
Corydalidae
Nigronia serricornis
TRICHOPTERA
Philopotamidae
Chimarra aterrima?
Chimarra obscura
Psychomyiidae
Psychomyia flavida
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche bronta
Hydropsyche sparna
Hydroptilidae
Leucotrichia sp.
Undetermined Hydroptilidae
DIPTERA
Tipulidae
Antocha sp.
Simuliidae
Simulium vittatum
Simulium sp.
Chironomidae
Tanypodinae
Thienemannimyia gr. spp.
Diamesinae
Diamesa sp.
Orthocladiinae
Cardiocladius obscurus
Cricotopus bicinctus
Cricotopus tremulus gr.
Cricotopus trifascia gr.
Orthocladius nr. dentifer
Tvetenia vitracies
Chironominae
Chironomini
Microtendipes pedellus gr.
Polypedilum flavum
Tanytarsini
Rheotanytarsus exiguus gr.
Tanytarsus glabrescens gr.
Tanytarsus guerlus gr.

STREAM SITE:	Owasco Outlet, Station 2
LOCATION:	Auburn, Canoga St. bridge
DATE:	July 17, 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
MOLLUSCA			
GASTROPODA	Physidae	Physella sp.	1
ARTHROPODA			
CRUSTACEA			
ISOPODA	Asellidae	Caecidotea racovitzai	1
AMPHIPODA	Gammaridae	Gammarus sp.	9
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	10
		Baetis intercalaris	6
COLEOPTERA	Psephenidae	Psephenus herricki	4
	Elmidae	Stenelmis crenata	5
TRICHOPTERA	Philopotamidae	Chimarra aterrima?	2
	Psychomyiidae	Psychomyia flavida	4
	Hydropsychidae	Cheumatopsyche sp.	11
		Hydropsyche bronta	5
		Hydropsyche sparna	11
	Hydroptilidae	Leucotrichia sp.	3
DIPTERA	Tipulidae	Antocha sp.	4
	Chironomidae	Diamesa sp.	12
		Tvetenia vitracies	3
		Polypedilum flavum	7
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS	19 (good)
BIOTIC INDEX	5.07 (good)
EPT RICHNESS	8 (good)
MODEL AFFINITY	66 (very good)
ASSESSMENT	slightly impacted

DESCRIPTION

This site, sampled at the Canoga St. bridge, is above the Auburn (C) Sewage Treatment Plant. The bridge was under construction, with some periodic water level alterations occurring, but the sample was taken above the bridge and the substrate appeared to be undisturbed. Biomass was relatively high, and many hydropsyhids were present. These may be due to lake effects of Owasco Lake, approximately 5 miles upstream, or to any combined sewer overflows in the city of Auburn. The field assessment was of slight impact and the overall water quality assessment, based on laboratory-based metrics, was the same.

STREAM SITE:	Owasco Outlet, Station 3
LOCATION:	Auburn, below STP
DATE:	July 17, 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

MOLLUSCA			
GASTROPODA	Physidae	Physella sp.	1
PELECYPODA	Sphaeriidae	Undetermined Sphaeriidae	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	1
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	4
		Baetis intercalaris	3
	Heptageniidae	Stenacron interpunctatum	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Stenelmis sp.	11
TRICHOPTERA	Psychomyiidae	Psychomyia flavida	2
	Hydropsychidae	Cheumatopsyche sp.	12
		Hydropsyche sparna	32
	Hydroptilidae	Leucotrichia sp.	1
DIPTERA	Tipulidae	Antocha sp.	2
	Chironomidae	Diamesa sp.	7
		Cardiocladius obscurus	4
		Orthocladius nr. dentifer	4
		Tvetenia vitracies	1
		Polypedilum flavum	11
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS	19 (good)
BIOTIC INDEX	5.41(good)
EPT RICHNESS	7 (good)
MODEL AFFINITY	53(good)
ASSESSMENT	slightly impacted

DESCRIPTION

This location is approximately 1 mile below the sewage treatment plant discharge. The habitat was adequate, and in the field the fauna appeared similar to that found upstream of the plant, except no scuds were seen in the pan. While numbers of mayflies decreased, the EPT richness only declined by 1, and while some metrics declined from those measured above the discharge, all were still considered to indicate slight impact to the water quality.

STREAM SITE:	Owasco Outlet, Station 5
LOCATION:	Throopsville, 20 meters above Sherman Rd. bridge at Throop Highway Dept
DATE:	July 17, 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	1
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	6
		Baetis intercalaris	10
	Heptageniidae	Stenonema femoratum	1
COLEOPTERA	Elmidae	Stenelmis sp.	6
TRICHOPTERA	Psychomyiidae	Psychomyia flavida	3
	Hydropsychidae	Cheumatopsyche sp.	9
		Hydropsyche sparna	21
DIPTERA	Tipulidae	Antocha sp.	4
	Chironomidae	Thienemannimyia gr. spp.	3
		Diamesa sp.	9
		Cardiocladius obscurus	1
		Cricotopus bicinctus	3
		Cricotopus tremulus gr.	1
		Cricotopus trifascia gr.	1
		Orthocladius nr. dentifer	1
		Tvetenia vitracies	1
		Polypedilum flavum	17
		Rheotanytarsus exiguus gr.	2

SPECIES RICHNESS	19 (good)
BIOTIC INDEX	5.33(good)
EPT RICHNESS	6 (good)
MODEL AFFINITY	58 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

The substrate at this site contains a substantial contribution of bedrock, a change from upstream. The sample was collected in pockets of rubble. More algae were collected in the net and the fauna in the 100 organism subsample had a larger percentage of midges than upstream, but all metrics were in the range of slight impact

STREAM SITE:	Owasco Outlet, Station 8
LOCATION:	above Port Byron, 50 meters above Hayden Rd. bridge
DATE:	July 17, 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

ANNELIDA			
OLIGOCHAETA			
TUBIFICIDA	Enchytraeidae	Undetermined Enchytraeidae	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	2
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	5
		Baetis intercalaris	7
	Heptageniidae	Stenonema terminatum	1
		Stenonema vicarium	1
		Stenonema sp.	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus sp.	1
		Stenelmis sp.	10
TRICHOPTERA	Philopotamidae	Chimarra obscura	5
	Hydropsychidae	Cheumatopsyche sp.	4
		Hydropsyche sparna	28
DIPTERA	Simuliidae	Simulium sp.	1
	Chironomidae	Thienemannimyia gr. spp.	1
		Diamesa sp.	4
		Cardiocladius obscurus	6
		Cricotopus bicinctus	1
		Cricotopus trifascia gr.	1
		Orthocladius nr. dentifer	3
		Microtendipes pedellus gr.	2
		Polypedilum flavum	13
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS	23 (good)
BIOTIC INDEX	5.40 (good)
EPT RICHNESS	8 (good)
MODEL AFFINITY	59 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

Above the village of Port Byron, the sample was collected in an area of adequate rubble habitat. While fewer mayflies were noted during the field assessment, and scuds were seen for the first time since the most upstream site (above Auburn STP), all calculated metrics were within the range of slight impact, and this was reflected in the overall assessment of water quality.

STREAM SITE:	Owasco Outlet, Station 9
LOCATION:	Port Byron, 200 meters above Rochester St. bridge
DATE:	July 17, 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

MOLLUSCA			
GASTROPODA	Pleuroceridae	Undetermined Pleuroceridae	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	1
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	6
		Baetis intercalaris	8
		Plauditus sp.	1
COLEOPTERA	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus sp.	1
		Stenelmis sp.	11
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Philopotamidae	Chimarra obscura	4
	Hydropsychidae	Cheumatopsyche sp.	4
		Hydropsyche bronta	2
		Hydropsyche sparna	30
DIPTERA	Tipulidae	Antocha sp.	1
	Chironomidae	Diamesa sp.	3
		Cardiocladius obscurus	3
		Orthocladius nr. dentifer	3
		Polypedilum flavum	18
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS	19 (good)
BIOTIC INDEX	5.40 (good)
EPT RICHNESS	7 (good)
MODEL AFFINITY	59 (good)
ASSESSMENT	slightly impacted

DESCRIPTION

This sample was collected in the village of Port Byron. More mayflies were noted here than at the previous upstream site (Station 8), but overall biomass was also higher and the fauna appeared to be enriched. The abundance of filamentous algae, diatoms, and macrophytes supported this. The calculated metrics of species richness, biotic index, ept richness, and percent model affinity were all within the range of slightly impacted water quality.

STREAM SITE:	Owasco Outlet, Station 10
LOCATION:	North Port Byron, 2 meters below New York Central Rd. bridge
DATE:	July 17, 2002
SAMPLE TYPE:	Kick sample
SUBSAMPLE:	100 individuals

MOLLUSCA			
PELECYPODA	Sphaeriidae	Undetermined Sphaeriidae	1
ARTHROPODA			
CRUSTACEA			
AMPHIPODA	Gammaridae	Gammarus sp.	7
INSECTA			
EPHEMEROPTERA	Baetidae	Baetis flavistriga	4
		Baetis intercalaris	3
		Plauditus sp.	4
COLEOPTERA	Gyrinidae	Dineutus sp.	2
	Psephenidae	Psephenus herricki	1
	Elmidae	Optioservus trivittatus	16
		Stenelmis crenata	40
MEGALOPTERA	Corydalidae	Nigronia serricornis	1
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	2
		Hydropsyche sparna	1
	Hydroptilidae	Undetermined Hydroptilidae	1
DIPTERA	Simuliidae	Simulium vittatum	3
	Chironomidae	Thienemannimyia gr. spp.	2
		Diamesa sp.	3
		Orthocladius nr. dentifer	1
		Polypedilum flavum	4
		Tanytarsus glabrescens gr.	1
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS	21 (good)
BIOTIC INDEX	4.98 (good)
EPT RICHNESS	6 (good)
MODEL AFFINITY	47 (poor)
ASSESSMENT	slightly impacted

DESCRIPTION

This site is below the Port Byron (V) Wastewater Treatment Facility, and while the substrate contained more gravel than many of the upstream locations, it was considered adequate for a traveling kick sample. The biomass was lower here than upstream at Station 9, and there were far fewer hydropsychid caddisflies than upstream. This was noted in the field and confirmed in the laboratory sorting. Hydropsychids contributed 4% to the 100-organism subsample, in contrast to an average of 39% at the 5 upstream locations. While this dramatic decrease in filter-feeders indicates the possibility of a toxic input, Impact Source Determination (see Appendix X) did not indicate this to be the case. While percent model affinity was in the range of moderate impact, the overall water quality assessment for this location was slightly impacted.

LABORATORY DATA SUMMARY				
STREAM NAME: Owasco Outlet		**DRAINAGE: 07**		
DATE SAMPLED: 07/17/02		**COUNTY: Cayuga**		
SAMPLING METHOD: traveling kick				
STATION	02	03	05	08
LOCATION	Auburn-above STP	Auburn-below STP	Throopsville	above Port Byron
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Diamesa sp. 12 % facultative midge	Hydropsyche sparna 32 % facultative caddisfly	Hydropsyche sparna 21 % facultative caddisfly	Hydropsyche sparna 28 % facultative caddisfly
2. **Intolerant = not tolerant of poor water quality**	Cheumatopsyche sp. 11 % facultative caddisfly	Cheumatopsyche sp. 12 % facultative caddisfly	Polypedilum flavum 17 % facultative midge	Polypedilum flavum 13 % facultative midge
3. **Facultative = occurring over a wide range of water quality**	Hydropsyche sparna 11 % facultative caddisfly	Stenelmis sp. 11 % facultative beetle	Baetis intercalaris 10 % facultative mayfly	Stenelmis sp. 10 % facultative beetle
4. **Tolerant = tolerant of poor water quality**	Baetis flavistriga 10 % intolerant mayfly	Polypedilum flavum 11 % facultative midge	Cheumatopsyche sp. 9 % facultative caddisfly	Baetis intercalaris 7 % facultative mayfly
5.	Gammarus sp. 9 % facultative scud	Diamesa sp. 7 % facultative midge	Diamesa sp. 9 % facultative midge	Cardiocladius obscurus 6 % facultative midge
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	23 (4)	28 (6)	39 (10)	32 (9)
Trichoptera (caddisflies)	36 (6)	47 (4)	33 (3)	37 (3)
Ephemeroptera (mayflies)	16 (2)	8 (3)	17 (3)	15 (5)
Plecoptera (stoneflies)	0 (0)	0 (0)	0 (0)	0 (0)
Coleoptera (beetles)	9 (2)	12 (2)	6 (1)	12 (3)
Oligochaeta (worms)	1 (1)	0 (0)	0 (0)	1 (1)
Mollusca (clams and snails)	1 (1)	2 (2)	0 (0)	0 (0)
Crustacea (crayfish, scuds, sowbugs)	10 (2)	1 (1)	1 (1)	2 (1)
Other insects (odonates, diptera)	4 (1)	2 (1)	4 (1)	1 (1)
Other (Nemertea, Platyhelminthes)	0 (0)	0 (0)	0 (0)	0 (0)
SPECIES RICHNESS	19	19	19	23
BIOTIC INDEX	5.07	5.41	5.33	5.4
EPT RICHNESS	8	7	6	8
PERCENT MODEL AFFINITY	66	53	58	59
FIELD CONDITION	good	good	good	good
OVERALL ASSESSMENT	slightly impacted	slightly impacted	slightly impacted	slightly impacted

LABORATORY DATA SUMMARY				
STREAM NAME: Owasco Outlet		**DRAINAGE: 07**		
DATE SAMPLED: 07/17/02		**COUNTY: Cayuga**		
SAMPLING METHOD: traveling kick				
STATION **LOCATION**	09 Port Byron	10 North Port Byron		
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Hydropsyche sparna 30 % facultative caddisfly	Stenelmis crenata 40 % facultative beetle		
2. **Intolerant = not tolerant of poor water quality**	Polypedilum flavum 18 % facultative midge	Optioservus trivittatus 16 % intolerant beetle		
3. **Facultative = occurring over a wide range of water quality**	Stenelmis sp. 11 % facultative beetle	Gammarus sp. 7 % facultative scud		
4. **Tolerant = tolerant of poor water quality**	Baetis intercalaris 8 % facultative mayfly	Baetis flavistriga 4 % intolerant mayfly		
5.	Baetis flavistriga 6 % intolerant mayfly	Plauditus sp. 4 % intolerant mayfly		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	28 (5)	12 (6)		
Trichoptera (caddisflies)	40 (4)	4 (3)		
Ephemeroptera (mayflies)	15 (3)	11 (3)		
Plecoptera (stoneflies)	0 (0)	0 (0)		
Coleoptera (beetles)	13 (3)	59 (4)		
Oligochaeta (worms)	0 (0)	0 (0)		
Mollusca (clams and snails)	1 (1)	1 (1)		
Crustacea (crayfish, scuds, sowbugs)	1 (1)	7 (1)		
Other insects (odonates, diptera)	2 (2)	6 (3)		
Other (Nemertea, Platyhelminthes)	0 (0)	0 (0)		
SPECIES RICHNESS **BIOTIC INDEX** **EPT RICHNESS** **PERCENT MODEL AFFINITY**	19 5.4 7 59	21 4.98 6 47		
FIELD CONDITION **OVERALL ASSESSMENT**	good slightly impacted	good slightly impacted		

FIELD DATA SUMMARY				
STREAM NAME: Owasco Outlet	**DATE SAMPLED: 07/17/02**			
REACH: Auburn to below Port Byron				
FIELD PERSONNEL INVOLVED: Novak, Smith				
STATION	02	03	05	08
ARRIVAL TIME AT STATION	8:50	10:05	10:45	11:35
LOCATION	Auburn	town of Throop	Throopsville	above Port Byron
PHYSICAL CHARACTERISTICS				
Width (meters)	20	20	30	30
Depth (meters)	0.3	0.3	0.2	0.2
Current speed (cm per sec.)	100	125	77	125
Substrate (%)				
Rock (>25.4 cm, or bedrock)	-	10	-	-
Rubble (6.35 - 25.4 cm)	50	50	40	40
Gravel (0.2 – 6.35 cm)	30	20	30	40
Sand (0.06 – 2.0 mm)	10	10	20	10
Silt (0.004 – 0.06 mm)	10	10	10	10
Embeddedness (%)	20	40	20	40
CHEMICAL MEASUREMENTS				
Temperature (° C)	23.0	23.0	23.0	22.0
Specific Conductance (umhos)	144	171	171	181
Dissolved Oxygen (mg/l)	6.8	6.9	7.7	8.5
pH	7.9	7.9	8.3	8.4
BIOLOGICAL ATTRIBUTES				
Canopy (%)	50	40	40	40
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous				present
algae - diatoms	present	present		present
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X	X	X
Plecoptera (stoneflies)				
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X	X	X	X
Megaloptera(dobsonflies,alderflies)				
Odonata (dragonflies, damselflies)	X	X	X	
Chironomidae (midges)	X	X	X	X
Simuliidae (black flies)				X
Decapoda (crayfish)		X	X	
Gammaridae (scuds)	X			X
Mollusca (snails, clams)				
Oligochaeta (worms)			X	X
Other				
FIELD CONDITION	good	good	good	good

FIELD DATA SUMMARY				
STREAM NAME: Owasco Outlet DATE SAMPLED: 07/17/02 REACH: Auburn to below Port Byron FIELD PERSONNEL INVOLVED:Novak, Smith				
STATION	09	10		
ARRIVAL TIME AT STATION	1:10	3:25		
LOCATION	Port Byron	North Port Byron		
PHYSICAL CHARACTERISTICS				
Width (meters)	20	20		
Depth (meters)	0.3	03		
Current speed (cm per sec.)	125	91		
Substrate (%)				
Rock (>25.4 cm, or bedrock)	-	10		
Rubble (6.35 - 25.4 cm)	40	30		
Gravel (0.2 – 6.35 cm)	30	30		
Sand (0.06 – 2.0 mm)	20	20		
Silt (0.004 – 0.06 mm)	10	10		
Embeddedness (%)	30	20		
CHEMICAL MEASUREMENTS				
Temperature (°C)	25.0	26.0		
Specific Conductance (umhos)	177	194		
Dissolved Oxygen (mg/l)	10.4	10.3		
pH	8.8	8.8		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	20	49		
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	present			
algae - diatoms	present			
macrophytes or moss	present	present		
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X		
Plecoptera (stoneflies)				
Trichoptera (caddisflies)	X	X		
Coleoptera (beetles)	X	X		
Megaloptera(dobsonflies,alderflies)	X			
Odonata (dragonflies, damselflies)		X		
Chironomidae (midges)	X	X		
Simuliidae (black flies)		X		
Decapoda (crayfish)				
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)				
Other				
FIELD CONDITION	good	good		

Appendix I. BIOLOGICAL METHODS FOR KICK SAMPLING

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

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

C. Sampling. Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that the dislodged organisms are carried into the net. Sampling is continued for a specified time and for a specified distance in the stream. Rapid assessment sampling specifies sampling 5 minutes for a distance of 5 meters. The net contents are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol.

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

E. Organism Identification. All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species, and the total number of individuals in the subsample is recorded on a data sheet. All organisms from the subsample are archived, either slide-mounted or preserved in alcohol. Following identification of a subsample, if the results 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. This is the total number of species or taxa found in the sample. Expected ranges for 100-specimen subsamples of kick samples in most streams in New York State are: greater than 26, non-impacted; 19-26, slightly impacted; 11-18, moderately impacted; less than 11, severely impacted.

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

3. Biotic index. The Hilsenhoff Biotic Index is a measure of the tolerance of the organisms in the 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 purposes of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. 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 the Quality Assurance document (Bode et al., 1996). Ranges for the levels of impact are: 0-4.50, non-impacted; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted; and 8.51-10.00, severely impacted.

4. Percent Model Affinity is a measure of similarity to a model non-impacted community based on percent abundance in 7 major groups (Novak and Bode, 1992). Percentage similarity is used to measure similarity to a community of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other. Ranges for the levels of impact are: >64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and <35, severely impacted.

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NYS DEC technical report, 89 pp.

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

Lenat, D. R. 1987. Water quality assessment using a new qualitative collection method for freshwater benthic macroinvertebrates. North Carolina DEM Tech. Report. 12 pp.

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

Appendix III. LEVELS OF WATER QUALITY IMPACT IN STREAMS.

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

1. Non-impacted

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

2. Slightly impacted

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

3. Moderately impacted

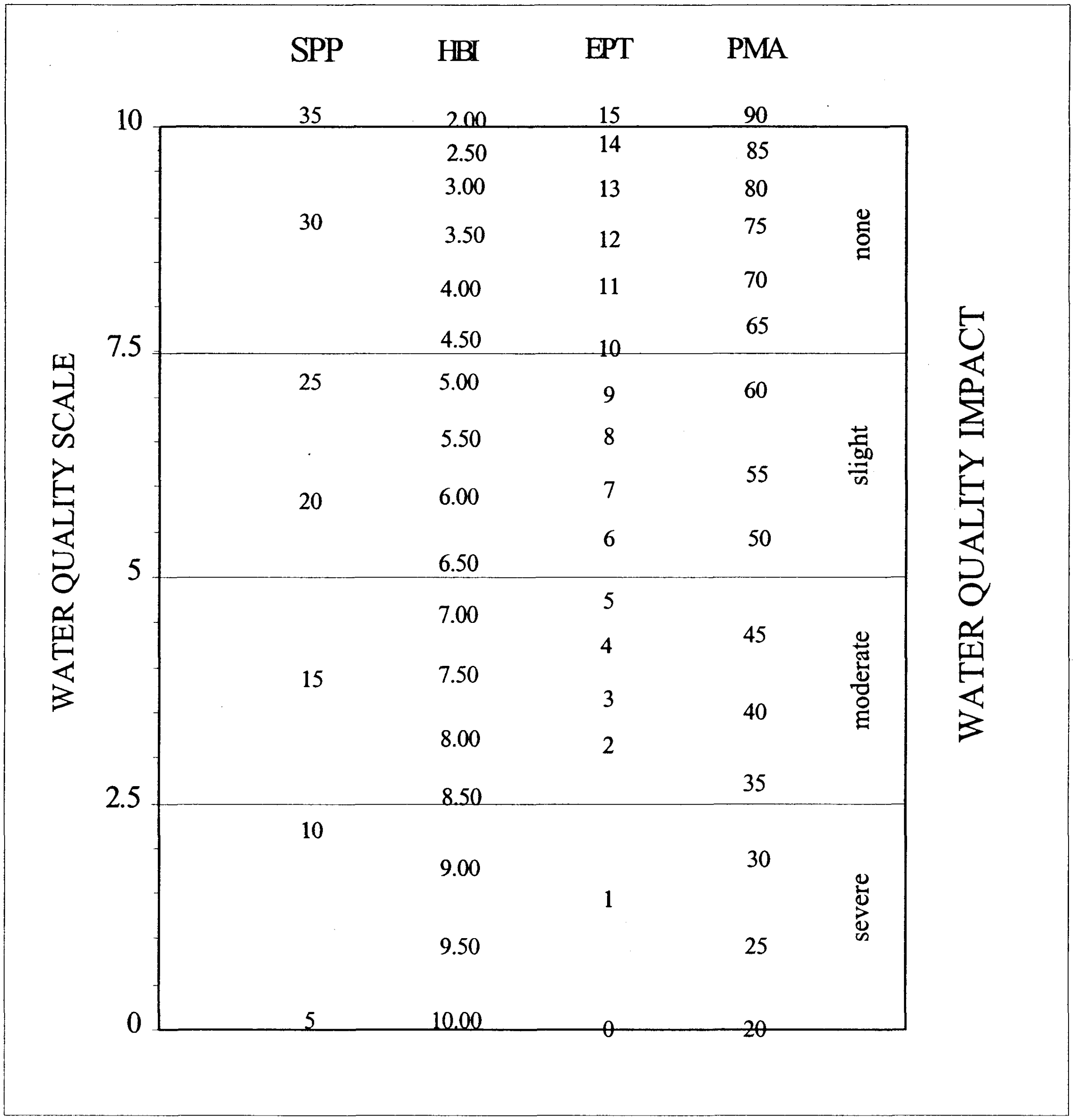
Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50.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

4. Severely impacted

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

Appendix IV. BIOLOGICAL ASSESSMENT PROFILE OF INDEX VALUES

The Biological Assessment Profile of index values, developed by Mr. Phil O'Brien, Division of Water, NYS DEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the four indices defined in Appendix II are converted to a common 0-10 scale as shown in the figure below.



To plot survey data, each site is positioned on the x-axis according to river miles from the mouth, and the scaled values for the four indices are plotted on the common scale. The mean scale value of the four indices represents the assessed impact for each site.

Appendix V.
WATER QUALITY ASSESSMENT CRITERIA

for non-navigable flowing waters

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

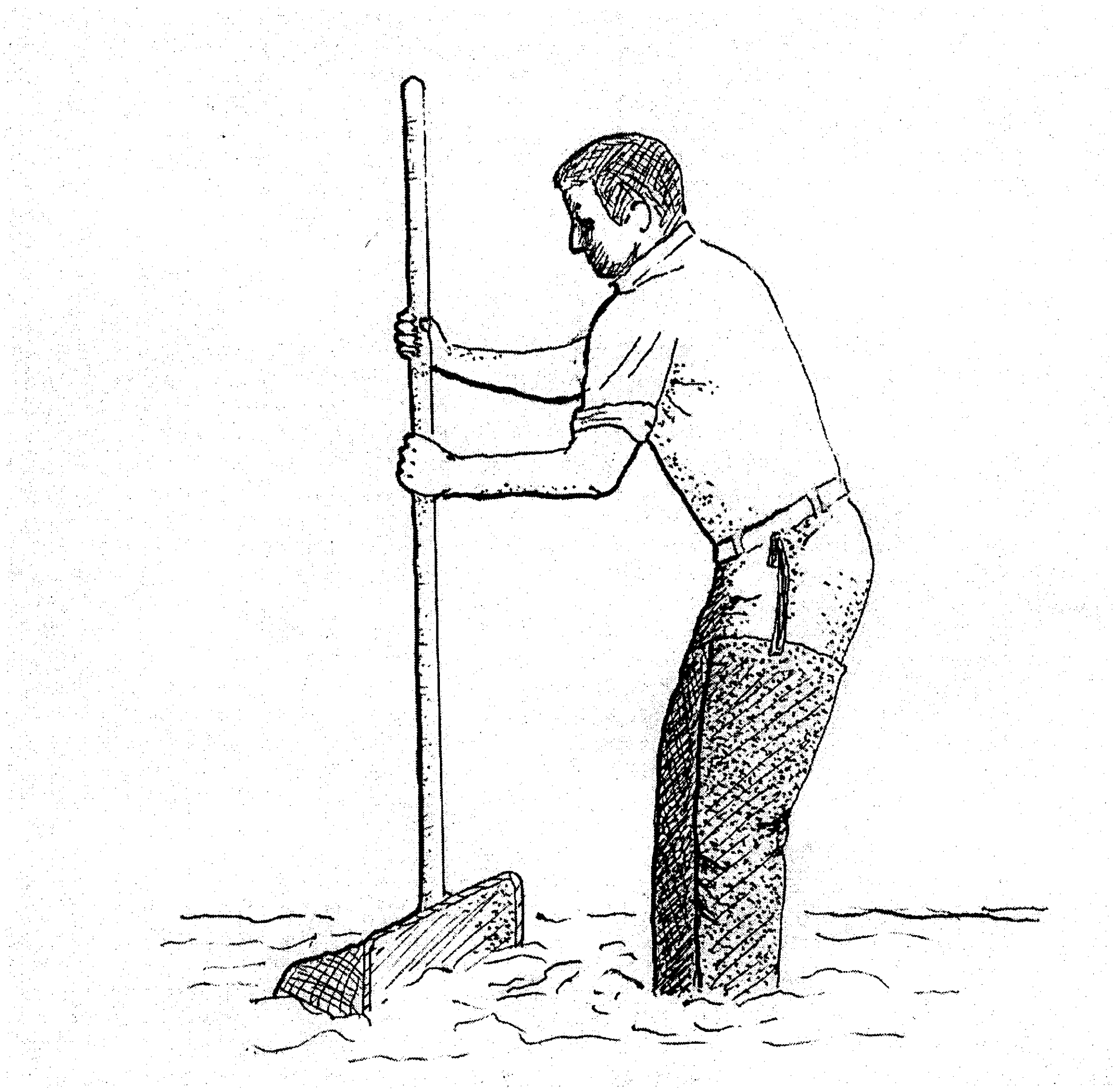
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

WATER QUALITY ASSESSMENT CRITERIA
for navigable flowing waters

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

Appendix VI.

THE TRAVELING KICK SAMPLE



← current

Rocks and sediment in the riffle are dislodged by foot upstream of a net; organisms dislodged are carried by the current into the net. Sampling is continued 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 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 and water pennies. Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.

BEETLES

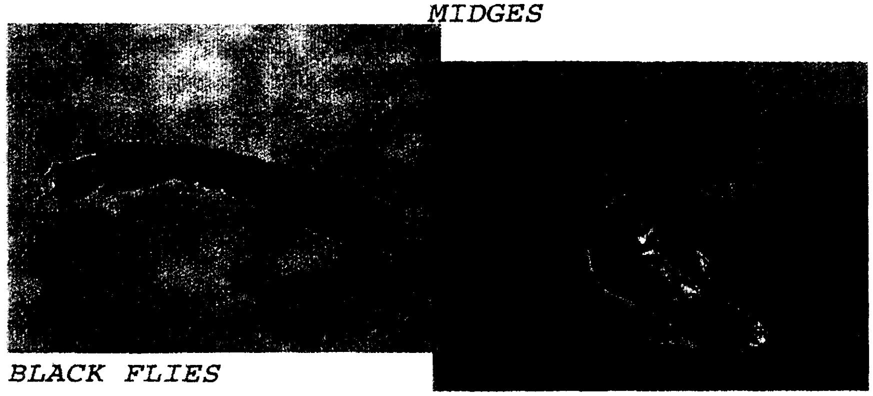
Appendix VII. B.

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

WORMS

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

SOWBUGS

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

APPENDIX VIII. THE RATIONALE OF BIOLOGICAL MONITORING

Biological monitoring as applied here 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:

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

Limitations

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

APPENDIX IX. GLOSSARY

assessment: a diagnosis or evaluation of water quality

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

biomonitoring: the use of biological indicators to measure water quality

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

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

EPT value: the number of species of mayflies, stoneflies, and caddisflies in a sample

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

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

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

tolerant: able to survive poor water quality

APPENDIX X. METHODS FOR IMPACT SOURCE DETERMINATION

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

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

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

Limitations These methods were developed for data derived from 100-organism subsamples of traveling kick samples from riffles of New York State streams. Application of the methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

NATURAL

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

NONPOINT NUTRIENTS, PESTICIDES

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

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

SEWAGE EFFLUENT, ANIMAL WASTES

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

	SILTATION					IMPOUNDMENT									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	5	-	-	-	-	-	
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Caenis/Tricorythodes</u>	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. EFFECTS OF LAKE OUTLETS AND IMPOUNDMENTS ON AQUATIC INVERTEBRATE COMMUNITIES

Lakes, ponds, and impoundments have pronounced effects on the invertebrate faunas of their outflows. Although each outflow is dependent on the characteristics of the lake, most outflows share the following traits:

1. Species richness is nearly always lower below lake outlets. Due primarily to the lack of upstream communities to provide a resource for colonization and drift, lake outlet communities often have only about 60% of the number of species found in comparable non-impacted segments. EPT richness is often only 30% of that found at non-impacted sites. Biotic index values and percent model affinity values are also depressed (see below).

2. Several types of invertebrate communities are found downstream of impoundments. Invertebrates which are commonly numerous below lake outlets include Simulium (black fly larvae), Cheumatopsyche or Hydropsyche (filter-feeding caddisflies), Nais (worms), Gammarus (crustacean), Rheotanytarsus (midges), Stenelmis (riffle beetles) Sphaerium (fingernail clams), or Platyhelminthes (flatworms). To date, 8 community types have been identified from streams in New York State.

3. A marked succession of species often occurs over a short distance. Productivity may be initially high below the lake, but usually decreases a short distance downstream. Plankton carried downstream from the lake increases the biomass immediately downstream, primarily of organisms which feed by filtering plankton, such as certain caddisflies, black flies, and midges. This enriching effect does not persist very far downstream, as the plankton is diminished, and communities below this may have very low productivity.

4. Lakes with cold-water hypolimnion releases limit the fauna additionally by interference with life cycles of aquatic insects such as mayflies, stoneflies, and caddisflies. Because the temperature of hypolimnetic releases is usually very cold, the downstream communities are often limited to midges, worms, black flies, snails, and sowbugs.

5. Water quality assessments of impoundment-affected sites usually indicate slight or moderate impact. Of 25 lake-affected stream sites across New York State, the following index means and ranges were obtained: species richness: 17 (7-24); EPT richness: 4 (0-12); Hilsenhoff biotic index: 5.83 (4.48-8.22); Percent Model Affinity: 45 (24-67). Correct interpretation of these assessments should reflect that although the resident fauna is affected, the impact is usually not a pollutional impairment. However, faunal effects caused by hypolimnion releases should be considered temperature-related and anthropogenic.

6. Corrective action for data judged to be affected by lake outlets is the adjustment of the water quality assessment up one category (e.g., slightly impacted to non-impacted) to reflect genuine water quality.