GREAT SACANDAGA LAKE ASSESSMENT PROGRAMS FOR 2009

prepared for

Great Sacandaga Lake Association
&
The Great Sacandaga Lake Advisory Council

By

Lawrence W. Eichler, Research Scientist
Tiffini M. Burlingame, Research Associate

&
Charles W. Boylen
Associate Director

Darrin Fresh Water Institute
5060 Lakeshore Drive
Bolton Landing, NY 12814
(518) 644-3541

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Acknowledgements

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Executive Summary

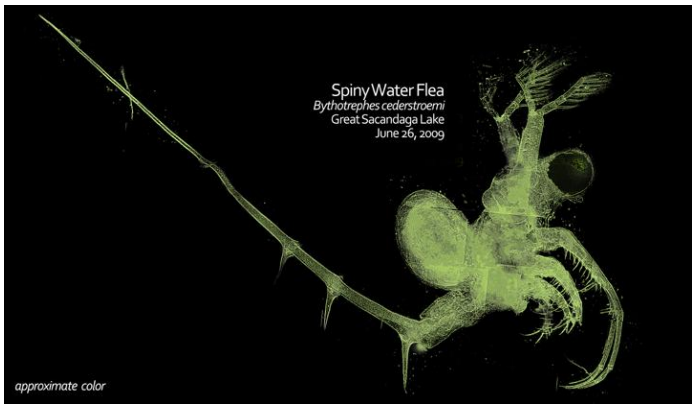
In 2009, the Great Sacandaga Lake Assessment Program focused on bacterial water quality as an indicator of the suitability of the lake waters for contact recreation (i.e. swimming and wading) and invasive species as a result of the introduction of an invasive crustacean zooplankter, the Spiny waterflea. Results of these two components of the assessment program for the basis of the current report.

The Great Sacandaga Lake Coliform Monitoring Program (GSLCMP) collected water samples from suspected contamination sources and heavily used recreational venues throughout the lake basin. The purpose of these collections was to locate possible sources of bacterial contamination to Great Sacandaga Lake and provide the information, in a timely fashion, to local and state regulatory agencies for remedial action. Twelve to 15 shoreline locations were sampled during each sampling cycle. Sample collection occurred monthly in July and August. The time interval coincides with the period of maximum population density and intensity of recreational use. Two primary measurements were made for each sample: Total Coliform (TC) and Fecal Coliform (FC) Bacteria. These bacteria serve as indicators of the presence of animal or human waste. The presence of elevated levels of these bacteria indicates potentially disease-causing protozoans, bacteria and other microorganisms may be present in the water.

Interim reports on the bacterial testing programs were released approximately monthly throughout the sampling season. Results from the current study indicate that bacterial levels in Great Sacandaga Lake are more than adequate for all intended uses. Elevated bacterial levels, however, were observed in 2009 in Kennyetto Creek at its' intersection with NYS Route 30. While none of the 2009 bacterial samples from Kennyetto Creek exceeded single sample standards set by the NYS Dept. of Health standards for swimming or wading, all samples exceeded the 5 sample average limits. Follow-up investigations along Kennyetto Creek are warranted to determine the source or sources for the bacteria. In 2008, a NYS DEC investigation concluded that no single source was

responsible, but a diffuse group of non-human sources were likely. Overall, bacterial results indicated exceptionally high water quality throughout Great Sacandaga Lake.

In the Fall of 2008, the Spiny waterflea, (*Bythotrephes cederstroemi*) an invasive member of the zooplankton community was first reported in Great Sacandaga Lake. This small crustacean invaded the Great Lakes in the mid 1980's, where it competes with native zooplankton for available resources. Zooplankton are the base of numerous food webs, including those which control the growth and abundance of gamefish such as trout, perch and walleyed pike. While the effect the Spiny waterflea are having on the ecosystems of the Great Lakes region is uncertain, these crustaceans compete directly with young perch and other small fish for food, such as native zooplankton. Fishermen are already having problems with this animal clogging reels and rod guides. Spiny water fleas also reproduce rapidly. During warm summer conditions each female can produce up to 10 offspring every two weeks. As temperatures drop in the fall, eggs are produced that can lie dormant all winter, but are ready to hatch in the Spring.



Spiny waterflea were encountered throughout Great Sacandaga Lake in 2009. These invasive zooplankton were present in small numbers at most locations, with the outlet area near Conklingville Dam producing the fewest. The majority of specimens were found in deeper waters from 6 to 8 meters depth in July and 8 to 10 meters depth in August. The distribution of spiny waterflea appears to be limited by lack of dissolved oxygen in the deeper waters of the lake, where less than 2 ppm dissolved oxygen is present from August thru September at depths greater than 12 meters. Native zooplankton abundance, biomass and average size were substantially lower in 2009 when compared to results from 2003 and 2004. While the sample size is very limited to reach conclusions, this decline may be attributed to the invasion of Great Sacandaga Lake by the Spiny

waterflea, a species known to prey on other zooplankton. Perhaps the most encouraging result of the zooplankton survey was the extremely limited numbers of Spiny waterflea reported at the Conklingville Dam or outlet site. Lack of large numbers of this invasive species in the outlet area may signal limited release of this species to other waterbodies. The ultimate impact of the spiny waterflea on native populations will only be confirmed by future assessments.

Background

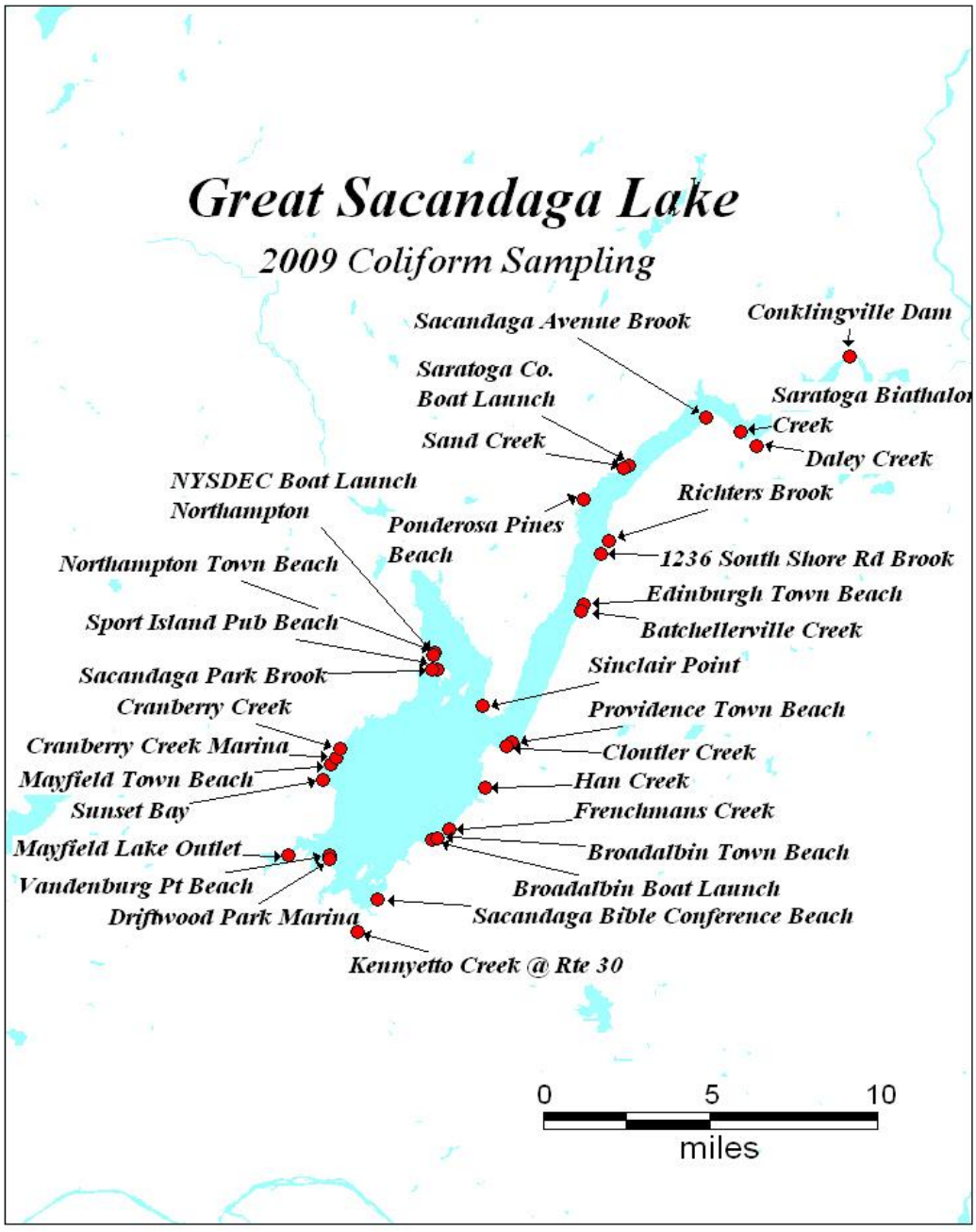
At the request of the Great Sacandaga Lake Association and the Great Sacandaga Lake Advisory Council, the Darrin Fresh Water Institute (DFWI) collected water samples in 2007, 2008 and 2009 to evaluate bacterial water quality in Great Sacandaga Lake. The initial project was a two-year program designed to largely duplicate the five-year lake water quality study of Rowell (1996) conducted in 1991 – 1995. The objective of the Rowell study was to develop a longitudinal baseline assessment of bacterial water quality, determine the concentration of selected metal contaminants in Great Sacandaga Lake gamefish and gather some basic water quality data. In 2009, the program focus shifted to zooplankton abundance with the introduction of the invasive Spiny waterflea (*Bythotrephes cederstroemi*). The DFWI program was designed to take advantage of other water quality assessments, including water quality and plankton studies by Mills et al. (2004) and the ongoing water chemistry data collections by association volunteers and the Adirondack Watershed Institute (AWI 2009). The current report focuses on bacterial and zooplankton test results for 2009.

Methods

Bacterial Assessments

The Great Sacandaga Lake Coliform Monitoring Program (GSLCMP) collected water samples from suspected contamination sources and heavily used recreational venues throughout the lake basin. The purpose of these collections was to locate possible sources of bacterial contamination to Great Sacandaga Lake and provide the information, in a timely fashion, to local and state regulatory agencies for remedial action. Twelve to 15 shoreline locations were sampled during each sampling cycle. Sample collection occurred monthly in July and August. The time interval coincides with the period of maximum population density and intensity of recreational use. Two primary measurements were made for each sample: Total Coliform (TC) and Fecal Coliform (FC) Bacteria. These bacteria serve as indicators of the presence of animal or human waste. The presence of elevated levels of these bacteria indicates potentially disease-causing protozoans, bacteria and other microorganisms may be present in the water.

Figure 1. Bacterial sampling locations for 2009.



All samples were collected according to NYS DOH protocols for contact recreation sampling. Samples were collected in sterile containers provided by the DFWI laboratory which is certified nationally and by New York State for environmental bacterial testing (NELAC Lab ID # 10719). Samples were collected in water depths of approximately 1

meter. Sample bottles were submerged to a depth of 0.5 meters and inverted to fill with care taken to not collect surface films. All samples were stored on ice and returned to the laboratory within 6 hours of collection. All bacterial analyses were conducted at the DFWI laboratory in Bolton Landing, NY.

Sampling sites were chosen in consultation with the Great Sacandaga Lake Association (GSLA), Great Sacandaga Lake Advisory Council (GSLAC), DEC, towns and villages, other regulatory agencies and citizens groups. DFWI personnel were also prepared to assist local regulatory authorities with location of bacterial sources, working closely with county and local authorities to locate and correct sources of contamination should they occur. Follow-up investigations by the NYS Department of Health, NYS Department of Environmental Conservation and county and local government personnel are encouraged at sites with elevated fecal coliform levels.

New York State Department of Health has determined maximum allowable bacterial levels for contact recreation (swimming, wading, etc.). A table of these bacterial concentrations is included (Table 1). When these maximum bacterial levels are exceeded, the New York State Department of Health is empowered to close the location to bathing until the problem or problems are corrected. These levels are used by the DFWI to determine appropriate responses to various bacterial concentrations found during sampling. A table of these responses is included (Table 2).

Table 1. New York State coliform bacteria standards for bathing beaches.

Maximum Allowable Levels of Coliform Bacteria in Waters Used for Contact Recreation (NYS Dept. of Health)		
Bacterial Test	**Max. 5 Sample Mean**	**Max. Single Result**
Total Coliform	**2400 per 100 mls**	**5000 per 100 mls**
Fecal Coliform	**200 per 100 mls**	**1000 per 100 mls**

Interpretation of data to determine and locate sources of contamination (human or other warm-blooded animal) requires more than just current bacterial levels. Knowledge of past history of the site, weather, geology of the area, drainage patterns, and some information on human activities in the area are also useful. To differentiate between

human waste and that produced by other warm-blooded animals, it is sometimes helpful to refer to the ratio of fecal coliform to fecal streptococcus bacteria (FC/FS). An FC/FS ratio of 4 or greater is generally considered indicative of contamination of human origin. Fecal Streptococcus (FS) Bacteria abundance will be determined for any resample locations.

Table 2. Action Levels of the Proposed Coliform Monitoring Program

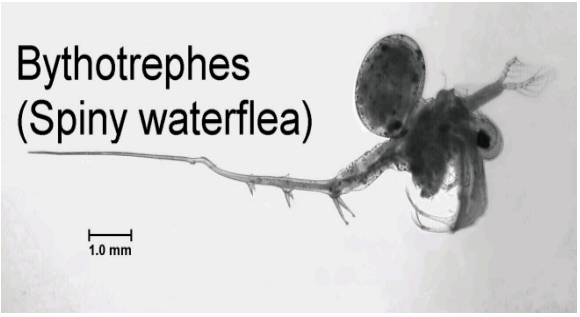
In order to respond effectively to contamination problems detected during the Coliform Monitoring Program, the following actions will occur:

1. *If 200 or more fecal coliform bacteria per 100 milliliters are reported, the site will be resampled during the next sampling cycle.*

2. *If 400 or more fecal coliform bacteria per 100 milliliters are reported, the site will be resampled within 24 to 48 hours. The data for both samples will be reported to the town or village where the contamination is located.*

Reporting for the GSLCMP took the form of biweekly interim reports provided electronically to project cooperators. Cooperators included state and local regulatory agencies (NYSDEC, HRBRRD), town and village authorities and concerned local citizens. Rapid dissemination of bacterial testing results is key to effective remediation.

Zooplankton Assessments



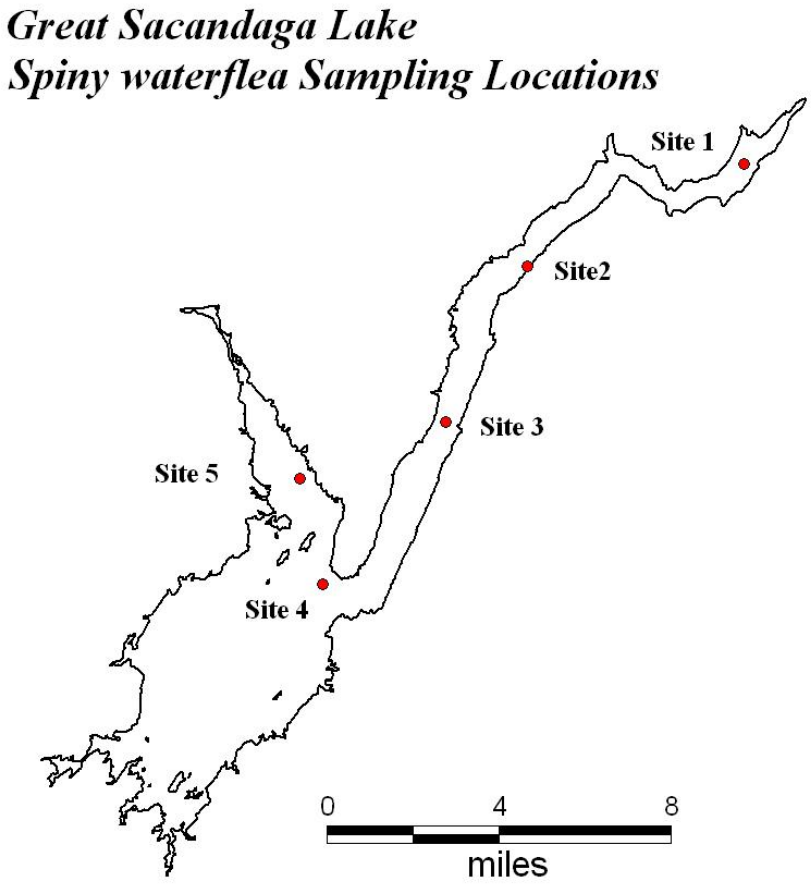
In the Fall of 2008, the Spiny waterflea, (*Bythotrephes cederstroemi*) an exotic invasive member of the zooplankton community was first reported in Great Sacandaga Lake. This small crustacean invaded the Great Lakes in the mid 1980's, where it competes with native zooplankton for available resources. Zooplankton are the base of numerous food webs, including those which control the growth and abundance of gamefish such as trout, perch and walleyed pike. While it is not absolutely certain what effect the Spiny waterflea are having on the ecosystems of the Great Lakes region, the animals compete directly with young perch and other small fish for food, such as native zooplankton. Fishermen are already having problems with this animal clogging

reels and rod guides. Spiny waterflea also reproduce rapidly. During warm summer conditions each female can produce up to 10 offspring every two weeks. As temperatures drop in the fall, eggs are produced that can lie dormant all winter, but are ready to hatch in the Spring.

Mills et al. (2004) reporting on the zooplankton community of Great Sacandaga Lake, concluded: "At present, the water quality conditions for Great Sacandaga Lake suggest a low productive high water quality ecosystem. The zooplankton community suggests that the fish community of Great Sacandaga Lake is either predatory dominated (whereby predators subsist on few prey) or the lake has a predator population in balance with its prey." The fact that Spiny waterflea was not reported in 2004 coupled with the possibility that this species may disrupt the delicate predator/prey balance dictates gathering of information on the zooplankton population of Great Sacandaga Lake. Results of the zooplankton assessment can be compared to results from 2003- 2004 to characterize changes in the zooplankton population of Great Sacandaga Lake. Negative impacts to the native zooplankton population as a result of the introduction of Spiny waterflea can be quantified and the potential for impacts to the fish population characterized.

Zooplankton samples will be collected by hose integration of the water column from the surface to 1 meter above the lake bottom. Between 100 and 200 liters of water were concentrated through a 45um mesh net, with the majority of samples duplicated. Monthly samples were collected from 5 locations (Figure 2, Table 3) during the period of summer stratification, June, July & August. Profiles of temperature and dissolved oxygen were also recorded at the time of zooplankton sample collection. The DFWI coordinated with Dr. Lars Rudstam of the Shackelton Point Biological Field Station of Cornell University for identification and enumeration of zooplankton present in preserved samples. The objective of the sample collection is to gather data on the distribution and relative abundance of zooplankton species in Great Sacandaga Lake, with a focus on the Spiny waterflea.

Figure 2. Zooplankton sampling locations for 2009.



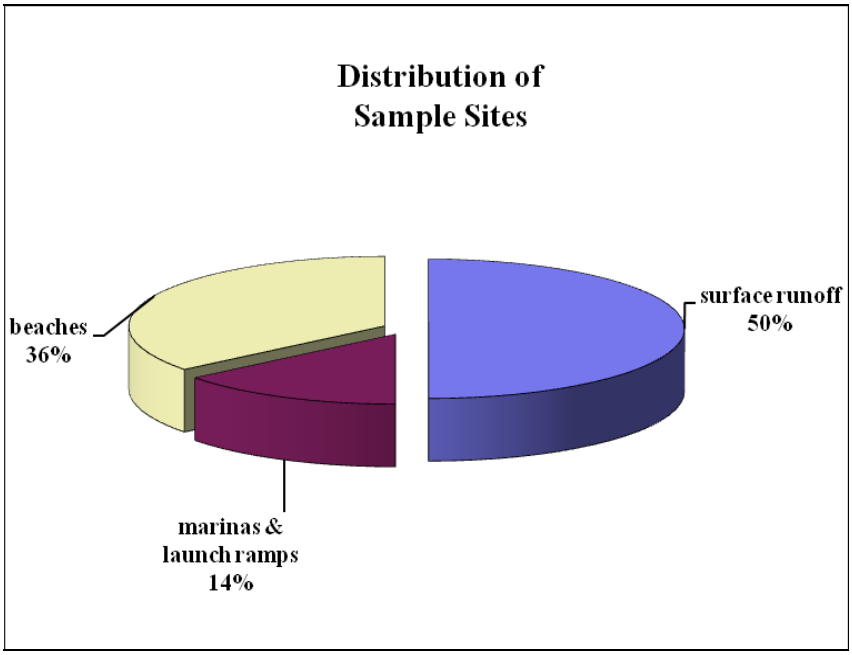
- Table 3. Zooplankton survey site names and locations

Site Number	Site Name	Maximum Depth (m)
Site 1	Conklingville Dam	15
Site 2	Saratoga County Boat Launch	20
Site 3	Batchellorville Bridge	14
Site 4	Main Lake @ Sinclair Point	13
Site 5	Northwest Arm	11

Results and Discussion

The Great Sacandaga Lake Coliform Monitoring Program (GSLCMP) collected 42 water samples from 36 sample points throughout the lake basin (Figure 1 and Appendix A). From 12 to 15 shoreline locations were sampled during each monthly sampling cycle. Sampling efforts focused on locations used for contact recreation (e.g. swimming or wading), marina locations or locations likely to produce bacterial contamination such as runoff sites or agricultural areas. Sample collection was dominated by runoff sites given the propensity for these areas to have elevated bacterial levels (Figure 3). The GSLCMP began in July and concluded in August 2009. The time interval coincides with the period of maximum population density and intensity of recreational use.

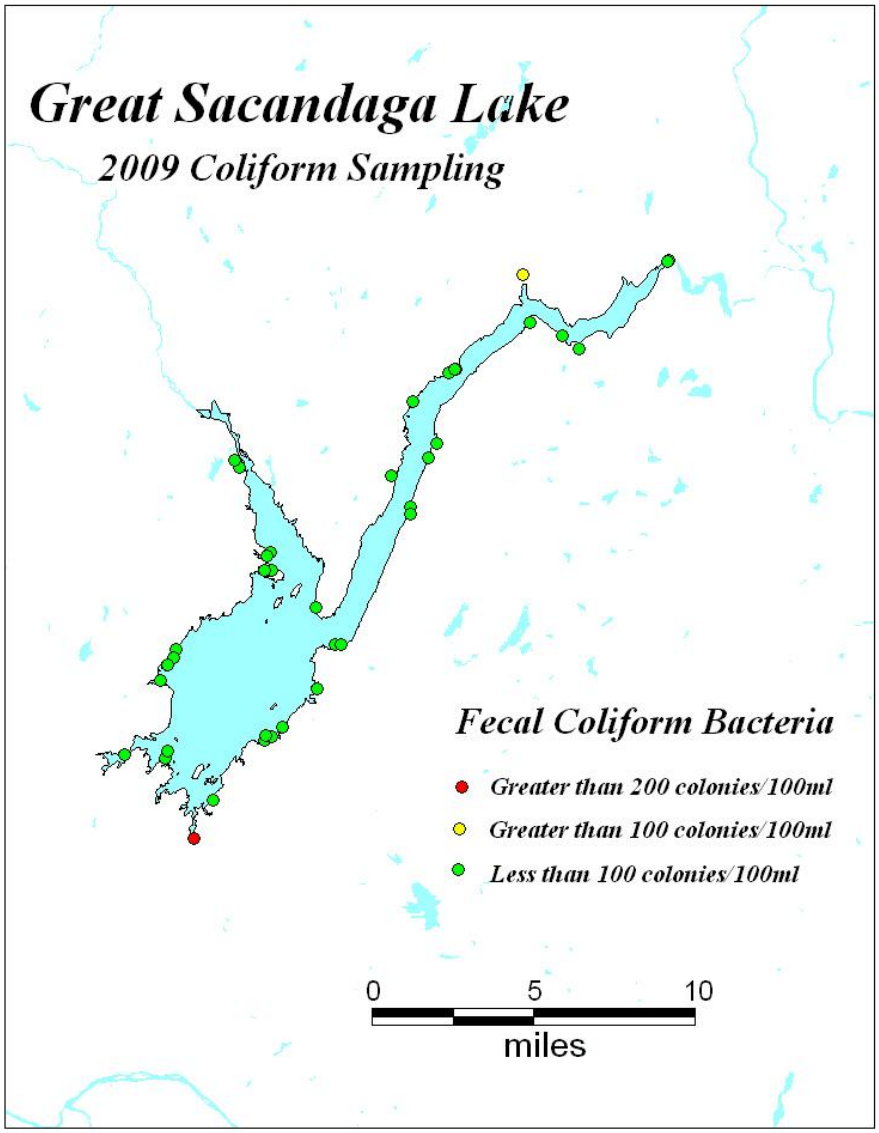
Figure 3. Distribution of bacterial sampling sites.



For all samples collected, 40% of samples had fecal coliform levels less than 10 colonies per 100 ml and 88% of samples had fecal coliform levels less than 100 colonies per 100 ml (Figure 4). For total coliform, 76% of samples had levels less than 100 colonies per 100 ml and 83% of samples were less than 200 colonies per 100 ml of sample. None of the sites sampled exceeded single sample limits for contact recreation. Samples from only one

location (Kennyetto Creek @ Route 30) exceeded five sample average contact recreation limits in 2009. Ratios of Fecal Coliform bacteria to Fecal Streptococcus bacteria for Kennyetto Creek in 2009 suggest a non-human source. The Kennyetto Creek drainage includes the Village of Broadalbin as well as livestock pastures, which may account for elevated levels of coliform bacteria. All indications are that the water quality of Great Sacandaga Lake exceeds all standards for swimming or wading.

Figure 4. Relative bacterial abundance for all sampling sites.



Zooplankton Results

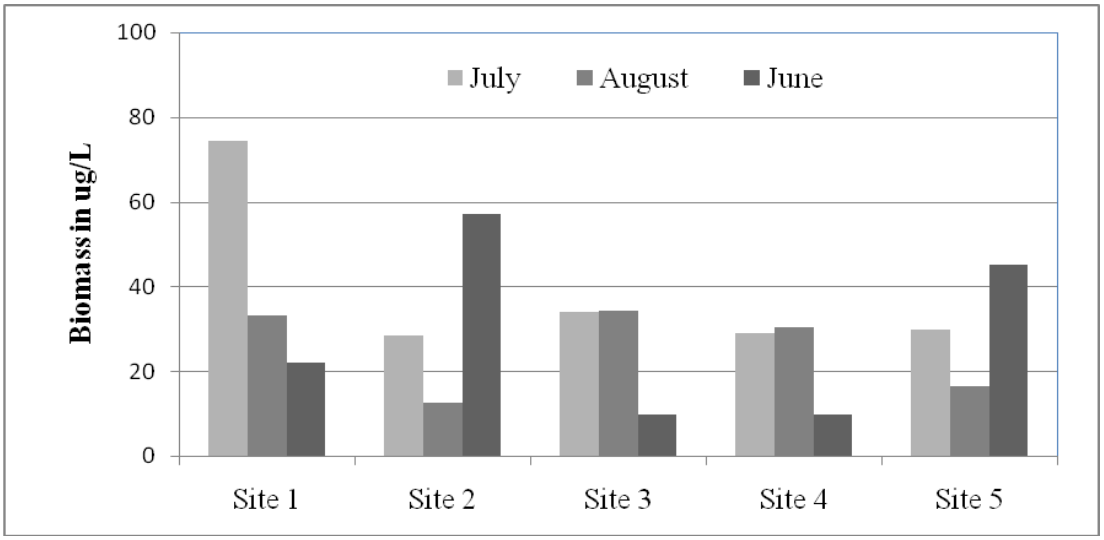
Eighteen species of crustacean zooplankton were identified in Great Sacandaga Lake in 2009 (Table 4, Appendix B). The cladoceran community was dominated by *Holopedium gibberum, Bythotrephes cederstroemi, Bosmina longirostris, D. mendotae*, and *Daphnia pulicaria*. Both calanoid and cyclopoid copepods were present; the dominant calanoid copepods were *Epischura lacustris* and *Diaptomus minutes* while the most prevalent

Table 4. Zooplankton species present in Great Sacandaga Lake.

	2003	2004	2009
Cladocerans			
Alona sp.			x
Bosmina longirostris	x	x	x
Bythotrephes cederstroemi			x
Camptocercus		x	
Ceriodaphnia		**x**	
Chydorus sphaericus	x	x	x
Daphnia mendotae	x	x	x
Daphnia pulicaria	x	x	x
Diaphanosoma sp.	x	x	x
Eubosmina	x	x	
Holopedium gibberum	x	x	x
Leptodora kindtii	x	x	
Polyphemus pediculus	x	x	
Calanoid Copepods			
Diaptomus ashlandi			x
Diaptomus minutus	x	x	x
Diaptomus oregonensis	x	x	x
Diaptomus sicilis	**x**		x
Diaptomus sp.s			x
Epischura lacustris	x	x	x
Immature calanoid copepodid	x	x	x
Cyclopoid Copepods			
Acanthocyclops sp.			x
Diacyclops thomasi	x	x	x
Immature cyclopoid copepodid	x	x	x
Mesocyclops edax	x	x	x
Tropocyclops prasinus	x	x	x
Nauplii (Immature copepodid)	x	x	x

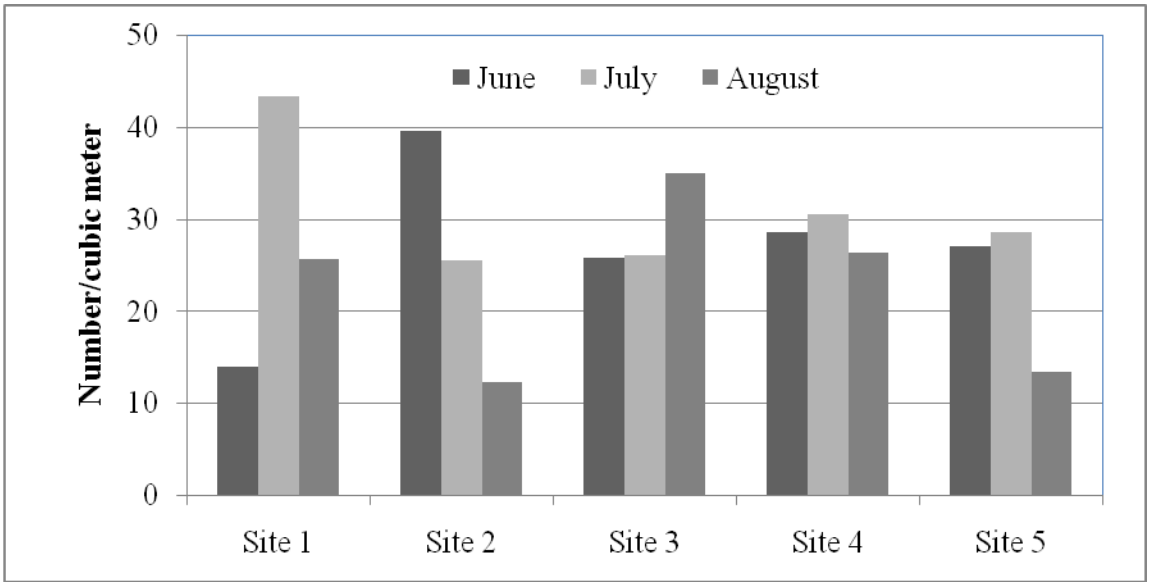
cyclopoid copepods were *Mesocyclops edax, Diacyclops thomasi* and *Tropocyclops prasinus*. Relative abundance of zooplankton species was highly variable over the survey area and between dates (Figures 5 & 6). Mean zooplankton biomass for all months was 32 micrograms per liter (µgr/L), a substantial decline from results reported by Cornell in 2003 and 2004; 94 and 113 µgr/L, respectively. Peak biomass for 2009 occurred in July (112 µgr/L) at site 1, the outlet or Conklingville Dam site (Figure 5). This population was dominated by the copepod *Epischura lacustris* (43 µgr /L). In 2003 biomass peaked in August, while in 2004 the biomass peak was reported in September. During 2004, zooplankton biomass was higher at the Main Lake site during the early and late season, May-July and November, while higher at the Northeast Arm site (inlet) in August and September. Similar results were observed in 2009.

Figure 5. Zooplankton biomass results for Great Sacandaga Lake for 2009.



A large number of small zooplankton were observed at site 2, the Saratoga County Boat Launch area, in June (Figure 6), although this value decreased in July, and reached its minimum numbers in August, similar to results observed in 2004. Peak densities for 3 of the 5 sites occurred in July. Site 3, the Batchellorville Bridge site, had a maximum abundance in August. Zooplankton densities were fairly stable through the summer

Figure 6. Zooplankton counts for Great Sacandaga Lake for 2009.



season at sites 3 and 4, the Batchellorville Bridge site and the Main Lake at Sinclair Point site.

Zooplankton mean body size was substantially smaller in 2009, 0.34 mm lakewide, than in prior surveys, even when the large bodied invasive Spiny waterfleas (mean 2.4 mm) were recorded in the samples. Zooplankton mean body size in 2003 and 2004 was generally between 0.74 and 0.88 mm. While the sample size is very limited to make conclusions, it appears that smaller individuals and lower biomass were reported in 2009 than in either 2003 or 2004. This shift toward dominance by the smaller zooplankton species may be attributed to the invasion of Great Sacandaga Lake by the spiny waterflea, a species known to prey on other zooplankton.

Spiny waterflea (Figure 7 & Table 5), were present at all five sampling locations spanning the length of Great Sacandaga Lake, however extremely limited numbers were observed for the outlet area (site 5; Conklingville Dam. Site 4, located in the main lake at Sinclair Point, produced the greatest numbers of spiny waterflea, 48 individual per cubic meter of lake water. Sites 2, 3 and 5 reached maximum abundance in June while site 4

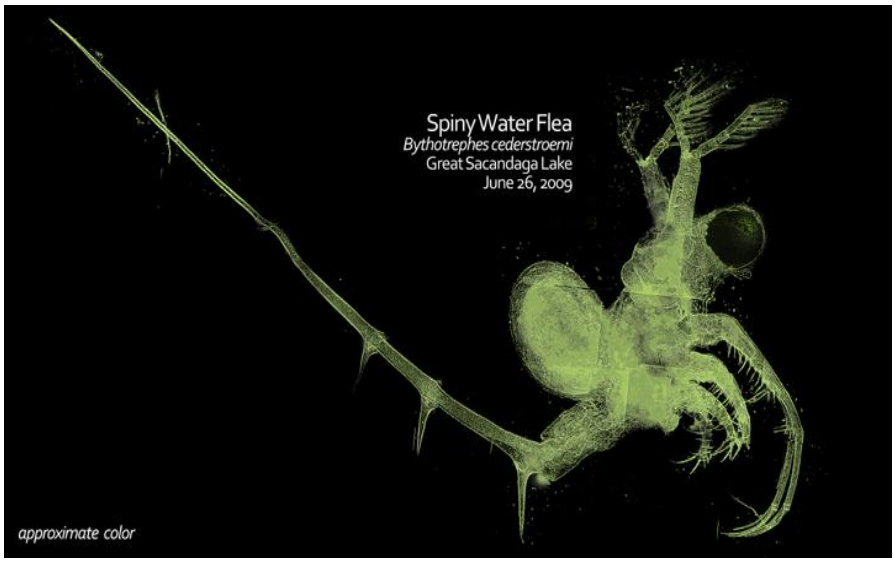


Figure 7. Spiny waterflea ((*Bythotrephes cederstroemi*) from Great Sacandaga Lake.

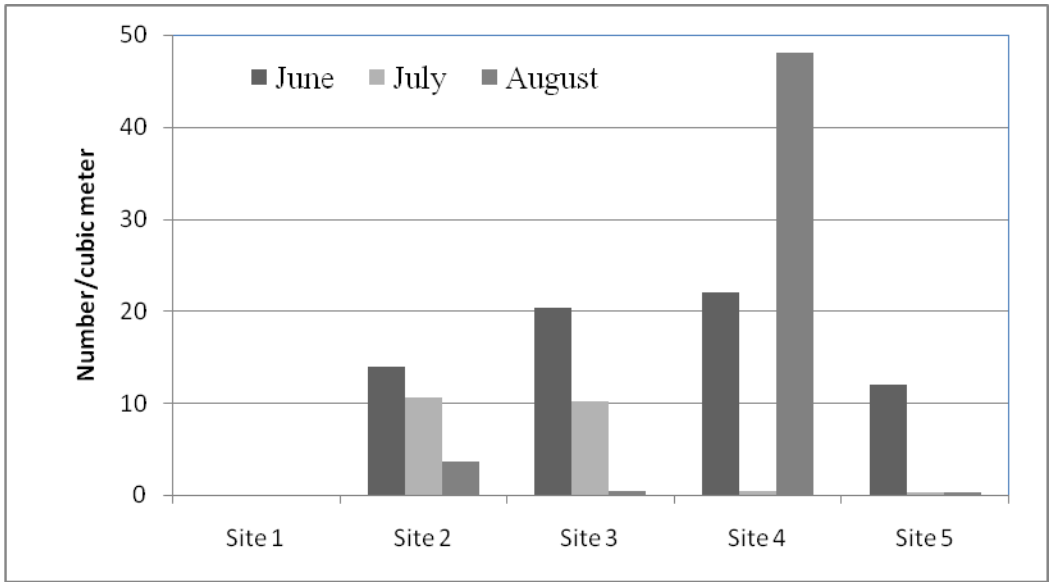
produced the greatest number of spiny waterflea in August. The majority of specimens were found in deeper waters from 6 to 8 meters depth in July and 8 to 10 meters depth in August. Our initial reaction was that these invasive zooplankton were present in small numbers, confirmed by actual counts from Cornell (Table 5).

Table 5. Relative abundance of spiny waterflea at Great Sacandaga Lake sampling locations.

	Spiny waterflea abundance (#/m^3)		
	June	July	August
Site 1	P	0.0	0.0
Site 2	P	10.6	3.6
Site 3	20.3	10.2	0.5
Site 4	22.0	0.1	48.0
Site 5	12.0	0.0	0.0

P = *present in field observations but not of sufficient numbers to be included in zooplankton counts.*

Figure 8. Relative spiny waterflea (*Bythotrephes cederstroemi*) **abundance for all sampling sites.**



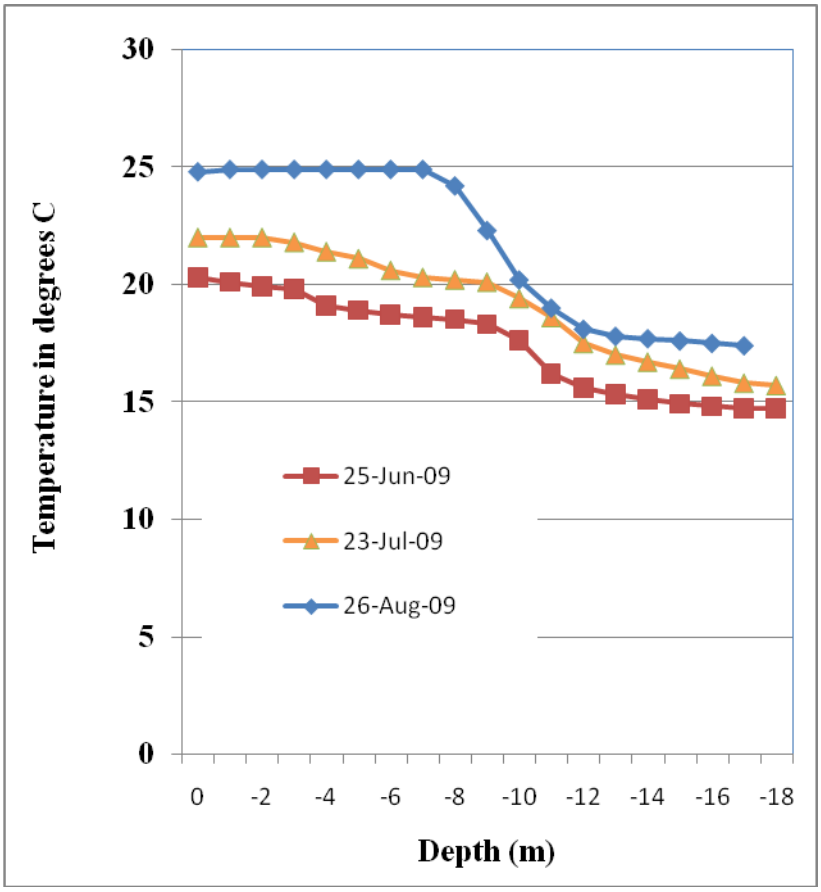
Perhaps the most encouraging result of the zooplankton survey was the extremely limited numbers of spiny waterflea reported at site 1, the Conklingville Dam or outlet site. Lack of large numbers of this invasive species in the outlet area may signal limited release of this species to other waterbodies.

Temperature and Dissolved Oxygen

Typical for many northern temperate lakes, two periods of thermal stratification (dimictic) are observed in Great Sacandaga Lake. During the winter months, inverse thermal stratification occurs, with near zero temperatures at the lake surface, increasing to approximately 4^{o}C near the lake bottom in water depths in excess of 20 meters. In the Spring of the year, April and May, near isothermal conditions exist throughout the lake. By late-June, a thermocline or zone of rapid temperature change becomes established at all sites between 9 and 11 meters (Figure 9). By July, a thermocline was well established at a depth of approximately 10 meters throughout the lake. In August, the thermocline, also known as the metalimnion, covered from 8 to 12 meters depth. Additional profiles of temperature and dissolved oxygen collected by Paul Smiths College (AWI, 2009)

show that by September, the thermocline moves deeper, as deep as 14 meters. The final sampling in October showed no thermal stratification in the lake.

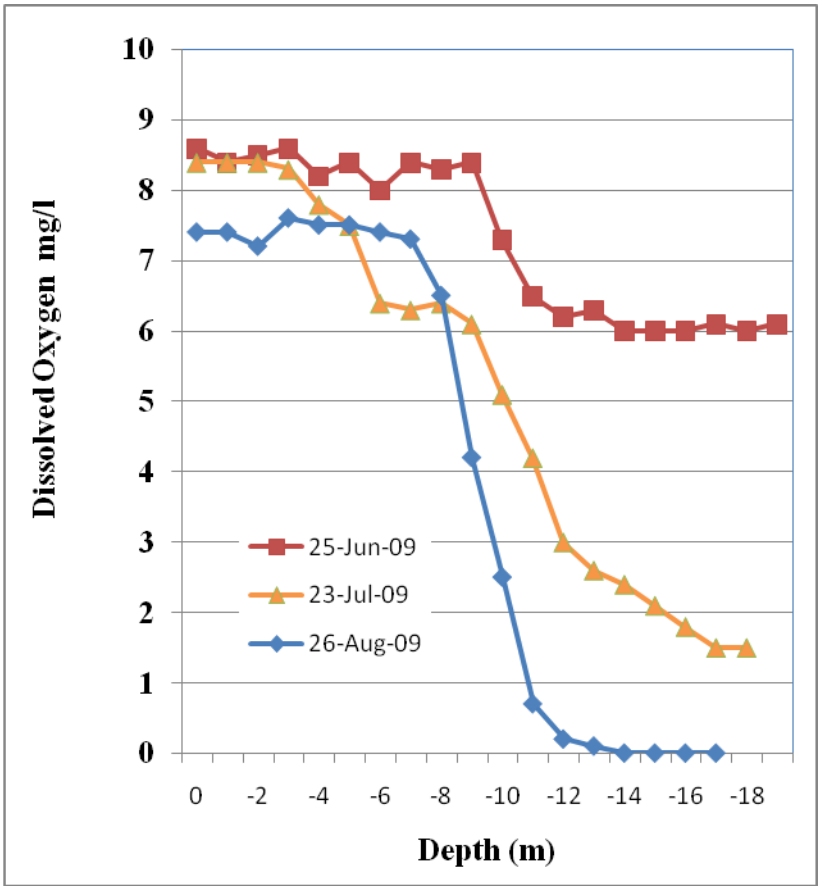
Figure 9. Temperature profiles for the Main Lake site on Great Sacandaga Lake for 2009.



The concentration of dissolved oxygen in lakewaters follows the cycle of thermal stratification (Figure 10). Thermal stratification cuts off the primary source of oxygen to the lake, the atmosphere, which results in a steady decline in the availability of oxygen in the deeper portions of the lake during the late summer (Figure 10). The decomposition processes occurring in the sediments of the lake bottom require oxygen, which is supplied by the overlaying waters. As more organic matter in the form of decomposing phytoplankton is supplied to the sediment bacteria, the demand for oxygen becomes greater. Where substantial dissolved oxygen declines are seen in hypolimnetic (deep) waters, it is often indicative of greater productivity (algal growth) occurring in the

epilimnetic waters. Oxygen levels less than 2 ppm generally limit the portion of the water column where zooplankton can survive. In August, any areas of Great Sacandaga Lake greater than 10 meters simply do not have enough oxygen for zooplankton to survive, thus limiting the zone where Spiny waterflea may be present.

Figure 10. Dissolved oxygen profiles for the Main Lake site on Great Sacandaga Lake for 2009.



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Appendix A.

Great Sacandaga Lake

Coliform Assessment Program Results for 2009

Results are listed alphabetically by town

Definitions

TC – Total Coliform Bacteria
FC – Fecal Coliform Bacteria
TNTC – Too Numerous to Count
CONF – Confluent growth of target bacteria
MAT – Confluent growth of non-target bacteria
? – High background, referring to non-target growth of bacteria interfering with counts of target bacteria
lt – Less than
LA – Laboratory accident preventing enumeration of bacteria

2009 GREAT SACANDAGA LAKE COLIFORM MONITORING PROGRAM

SITE	DATE	TC/100ml	FC/100ml	NOTES
	Town Of Broadalbin			
Broadalbin Town Beach	21-Jul-09	18	6	no bathers, light rain, clear
Frenchmans Creek	18-Aug-09	320	80	Moderate flow, cool, brown
Hans Creek	18-Aug-09	250	60	Moderate flow, cool, brown
NYSDEC Broadalbin Boat Launch	21-Jul-09	44	18	choppy, warm
Sacandaga Bible Conference Beach	18-Aug-09	8	6	No bathers, slight turbidity
	Town of Day			
Allentown Creek	18-Aug-09	790	104	Moderate flow, cool, clear
Bell Brook	18-Aug-09	47	8	Moderate flow, cool, clear
Daley Creek	18-Aug-09	48	3	Moderate flow, warm, brown
Saratoga Co. Boat Launch	21-Jul-09	12	9	cool, slight turbid
Sacandaga Avenue Brook	21-Jul-09	30	10	Moderate flow, cool, clear
Sand Creek	21-Jul-09	15	5	Moderate flow, cold
Saratoga Biathlon Creek	21-Jul-09	41?	21	light rain, brown, high flow
Turner Road Creek	18-Aug-09	18	1	Warm, low flow, clear
	Town of Edinburgh			
Batchellerville Creek	18-Aug-09	112	58	Low flow, cool, clear
Creek @ 1236 South Shore Rd.	18-Aug-09	92	7	Cold, clear, moderate flow
Edinburgh Marina Boat Launch	18-Aug-09	26	6	Warm, clear
Edinburgh Town Beach	21-Jul-09	21	15	closed, no bathers, calm
Edinburgh Town Beach	18-Aug-09	92	26	30+ geese, warm, cloudy
Ponderosa Pines Beach	21-Jul-09	7	1	no bathers, light rain, clear
Richters Brook	18-Aug-09	120	31	Low flow, cool, clear
	Town of Hadley			
Conklingville Dam	21-Jul-09	12	5	light rain, clear
	Town of Mayfield			
Cranberry Cove Marina	18-Aug-09	28	8	Warm, slightly turbid
Cranberry Creek	18-Aug-09	124	54	Low flow, brown
Driftwood Park Boat Launch	18-Aug-09	30	20	Warm, algae bloom
Gordons Brook	18-Aug-09	64	15	Cold, clear, moderate flow
Kennyetto Creek @ Route 30	21-Jul-09	770	490	Moderate flow, brown
Kennyetto Creek @ Route 30	24-Jul-09	500	290	Low flow, brown
Kennyetto Creek @ Route 30	18-Aug-09	960	550	Low flow, warm, brown
Kennyetto Creek @ Route 30	25-Aug-09	2200	450	Moderate flow, cold, brown
Mayfield Lake Spillway	21-Jul-09	81	13	Moderate flow, slight turbid
Mayfield Town Beach	21-Jul-09	15	3	no bathers, calm
Sunset Bay	21-Jul-09	17	4	choppy
Vandenberg Point Swim Area	21-Jul-09	32	18	no bathers, choppy
Vandenberg Point Swim Area	18-Aug-09	53	48	Bathers, slight turbidity

2009 GREAT SACANDAGA LAKE COLIFORM MONITORING PROGRAM

SITE	DATE	TC/100ml	FC/100ml	NOTES
	Town of Northampton			
Northville Town Beach	21-Jul-09	11	10	no bathers, clear
NYSDEC Northampton Beach	21-Jul-09	24	17	1 bather, calm, clear
State Boat Launch Northampton+A8	21-Jul-09	23	11	brown, foam
Sacandaga Beach/Sport Island Pub	21-Jul-09	31	15	no bathers, 1 duck
Sacandaga Park Brook	21-Jul-09	73	27	low flow, slight turbid
Sinclair Point	18-Aug-09	22	2	Waves to 1 ft., slight turbidity
	Town of Providence			
Cloutler Creek	18-Aug-09	88	1	Low flow, cool
Providence Town Beach	21-Jul-09	4	lt 1	No bathers, clear

Appendix B.

Zooplankton Assessment Program Results for 2009

Site:	site 1		
Date of sampling:	6/26/2009		
Volume filtered (L):	114		
Depth(m):	0-14		
Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.1320	0.3320	0.1288
Cyclopoid copepodids	1.1884	0.3638	0.7817
Diacyclops thomasi	0.5282	0.5148	0.7307
Diaptomus minutus	0.3961	0.7977	0.6514
Mesocyclops edax	0.7923	0.5727	1.8487
Nauplii	10.9595	0.1880	18.0298
Total spp	13.9965	0.2557	22.1711
Site:	site 2		
Date of sampling:	6/26/2009		
Volume filtered (L):	136		
Depth(m):	0-18		
Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Acanthocyclops	0.3668	0.5570	0.6418
Calanoid copepodid	0.7337	0.7660	0.8156
Cyclopoid copepodid	2.2010	0.4018	1.7780
Diacyclops thomasi	1.8342	0.4406	1.5505
Diaptomus minutus	3.3015	0.7377	3.1768
Diaptomus oregonensis	1.1005	0.8393	1.1346
Mesocyclops edax	2.9347	0.4726	3.6065
Nauplii	27.1460	0.1790	44.5217
Total spp	39.6185	0.3045	57.2253
Site:	site 3		
Date of sampling:	6/26/2009		
Volume conc.(L):	148		
Depth(m):	0-12		
Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bythotrephes	0.0203	2.2893	2.3595
Calanoid copepodid	0.5081	0.4423	0.3650
Cyclopoid copepodid	2.0325	0.3327	0.8265
Diacyclops thomasi	2.3713	0.4129	1.5563
Diaptomus minutus	0.8469	0.7246	2.2016
Mesocyclops edax	0.3388	0.6425	0.7440
Nauplii	19.3089	0.1803	1.3797
Tropocyclops prasinus	0.3388	0.4445	0.2672
Total spp	25.7656	0.2480	9.6997

Summary Statistics

Site:	site 4
Date of sampling:	6/26/2009
Investigator:	L. Eichler
Volume conc.(L):	182
Depth(m):	0-11

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bythotrephes	0.0220	2.1970	2.6847
Calanoid copepodid	0.2752	0.4400	0.1589
Cyclopoid copepodid	2.2014	0.3619	1.1101
Diacyclops thomasi	2.2014	0.4359	1.6556
Diaptomus minutus	0.2752	0.7020	0.6295
Holopedium	0.5504	0.4905	0.8433
Mesocyclops edax	1.1007	0.5093	1.2143
Nauplii	22.0143	0.1834	1.6228
Total spp	28.6406	0.2440	9.9192

Summary Statistics

Site:	site 5
Date of sampling:	6/26/2009
Investigator:	L. Eichler
Volume conc.(L):	167
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.6002	0.2195	0.2117
Bythotrephes	0.0120	2.6260	2.1977
Cyclopoid copepodid	2.4010	0.3555	1.0349
Daphnia mendotae	0.6002	0.6535	0.8963
Diacyclops thomasi	1.2005	0.4647	0.9899
Diaptomus minutus	0.3001	0.7450	0.6866
Holopedium	2.7011	0.8050	35.2182
Mesocyclops edax	1.5006	0.6060	2.8164
Nauplii	17.7071	0.1725	1.1912
Total spp	27.0228	0.3082	45.2428

Lake sampled:	Great Sacandaga
Site:	site 1
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	114
Depth(m):	0-14

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Alona	0.3521	0.3310	0.0214
Bosmina longirostris	1.0563	0.3253	1.1267
Calanoid copepodid	3.1690	0.5659	5.0034
Cyclopoid copepodids	0.7042	0.3815	0.4067
Diacyclops thomasi	3.5211	0.6846	7.8419
Diaptomus minutus	4.9296	0.7863	15.0926
Diaptomus oregonensis	0.3521	0.6300	0.5513
Diaptomus sp.	2.8169	0.9964	15.6360
Epischura lacustris	1.7606	1.3024	43.2392
Holopedium	0.7042	0.6440	2.4834
Mesocyclops edax	1.0563	0.8690	7.3531
Nauplii	17.6056	0.2015	1.6452
Tropocyclops prasinus	9.1549	0.5399	11.3960
Total spp	47.1831	0.5085	111.7970

Lake sampled:	Great Sacandaga
Site:	site 2
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	144
Depth(m):	0-18

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bythotrephes	0.0139	2.3145	1.6205
Calanoid copepodid	0.0053	0.6117	0.0103
Cyclopoid copepodid	0.0106	0.3708	0.0056
Diacyclops thomasi	0.0460	0.5433	0.0637
Diaptomus minutus	0.0124	0.7983	0.0400
Diaptomus oregonensis	0.0053	0.7727	0.0156
Diaptomus sp.	0.0071	1.0150	0.0404
Holopedium	0.0018	0.9750	0.0199
Mesocyclops edax	0.0089	0.6164	0.0159
Nauplii	0.1080	0.1520	0.0059
Tropocyclops prasinus	0.0106	0.4815	0.0106
Total spp	0.2300	0.4971	1.8484

Lake sampled:	Great Sacandaga
Site:	site 3
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	148
Depth(m):	0-12

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bythotrephes	0.0136	2.5860	2.1594
Calanoid copepodid	1.4228	0.4859	1.5376
Cyclopoid copepodid	1.2195	0.4042	0.6447
Diacyclops thomasi	1.6260	0.5661	2.6597
Diaptomus minutus	2.0325	0.7333	5.5032
Diaptomus oregonensis	0.8130	0.7713	2.4024
Diaptomus sicilis	0.4065	0.9030	1.9810
Epischura lacustris	1.6260	0.7039	10.7645
Mesocyclops edax	2.0325	0.5829	3.0338
Nauplii	15.8537	0.2069	1.8406
Tropocyclops prasinus	2.0325	0.4837	1.9756
Total spp	29.0786	0.3857	34.5023

Lake sampled:	Great Sacandaga
Site:	site 4
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	182
Depth(m):	0-11

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Alona	0.1651	0.2360	0.0025
Bythotrephes	0.00003	2.3270	0.0031
Calanoid copepodid	0.4953	0.4443	0.3772
Cyclopoid copepodid	0.9906	0.3460	0.4754
Diacyclops thomasi	0.4953	0.4750	0.4255
Diaptomus minutus	3.1370	0.8215	10.8806
Diaptomus oregonensis	1.1558	0.8057	3.3785
Holopedium	0.1651	0.4890	0.2251
Mesocyclops edax	3.7975	0.4723	3.1562
Nauplii	15.1899	0.1725	0.9802
Tropocyclops prasinus	0.6604	0.4600	0.5209
Total spp	26.2521	0.3483	20.4250

Lake sampled:	Great Sacandaga
Site:	site 5
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	151
Depth(m):	0-9

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.1982	0.1950	0.0699
Cyclopoid copepodid	4.1612	0.3403	1.7065
Daphnia mendotae	0.6002	0.6535	0.8963
Diacyclops thomasi	0.7926	0.4433	0.5414
Diaptomus minutus	0.7926	0.7983	2.7653
Diaptomus oregonensis	0.3963	0.9960	2.2193
Epischura lacustris	0.5945	0.8987	3.6750
Holopedium	0.9908	0.4788	1.4326
Mesocyclops edax	3.5667	0.5577	5.5735
Nauplii	16.6447	0.1892	1.5136
Tropocyclops prasinus	0.3963	0.5060	0.3962
Total spp	28.5337	0.3217	19.8934

Lake sampled:	Great Sacandaga
Site:	site 1
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	114
Depth(m):	0-14

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Calanoid copepodid	1.0563	0.4953	1.1067
Chydorus sphaericus	0.3521	0.2900	0.0214
Cyclopoid copepodids	1.0563	0.4503	0.7587
Daiptomus sp.	0.7042	0.9775	3.8742
Diacyclops thomasi	4.9296	0.6224	9.4331
Diaptomus ashlandii	0.3521	0.8390	1.1188
Diaptomus minutus	4.2254	0.7483	12.5268
Diaptomus oregonensis	1.0563	0.8803	4.5507
Holopedium	0.3521	0.2960	0.1016
Mesocyclops edax	0.3521	0.3590	0.1660
Nauplii	23.5915	0.1664	1.6626
Tropocyclops prasinus	1.4085	0.5350	1.8068
Total spp	39.4366	0.3589	37.1275

Lake sampled:	Great Sacandaga
Site:	site 2
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	136
Depth(m):	0-17

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bythotrephes	0.0073	2.9560	1.7131
Calanoid copepodid	1.2106	0.5497	1.4387
Cyclopoid copepodid	4.4387	0.3560	2.0905
Diacyclops thomasi	6.8599	0.6587	14.6747
Diaptomus minutus	3.6317	0.8349	13.0519
Diaptomus oregonensis	2.4211	0.7823	7.9847
Diaptomus sp.	1.2106	0.8900	4.7083
Mesocyclops edax	1.6141	0.7028	4.0479
Nauplii	25.4219	0.1552	1.3849
Tropocyclops prasinus	4.0352	0.4966	4.2084
Total spp	50.8511	0.3908	55.3031

Lake sampled:	Great Sacandaga
Site:	site 3
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	148
Depth(m):	0-12

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bythotrephes	0.0068	1.9950	0.5145
Calanoid copepodid	1.6260	0.4801	1.4833
Cyclopoid copepodid	1.2195	0.4000	0.6447
Diacyclops thomasi	0.6098	0.4710	0.6097
Diaptomus minutus	1.4228	0.8307	5.1439
Diaptomus oregonensis	1.4228	0.8174	5.0334
Epischura lacustris	1.0163	0.9430	12.8566
Mesocyclops edax	2.8455	0.5671	3.7361
Nauplii	10.7724	0.2091	1.1399
Tropocyclops prasinus	2.2358	0.4933	2.2646
Total spp	23.1775	0.4246	33.4268

Lake sampled:	Great Sacandaga
Site:	site 4
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	182
Depth(m):	0-11

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bythotrephes	0.0000	2.2920	0.0031
Calanoid copepodid	1.4860	0.4911	1.4634
Cyclopoid copepodid	1.1558	0.3781	0.6404
Diacyclops thomasi	1.9813	0.6413	4.0375
Diaptomus minutus	4.7881	0.8622	19.4504
Diaptomus oregonensis	1.8162	0.7719	5.0934
Diaptomus sicilis	0.1651	0.9490	0.7009
Epischura lacustris	0.3302	0.6460	0.9448
Mesocyclops edax	2.6417	0.5107	2.6438
Nauplii	19.4827	0.1977	1.7552
Tropocyclops prasinus	0.9906	0.4282	0.7116
Total spp	34.8377	0.4008	37.4445

Lake sampled:	Great Sacandaga
Site:	site 5
Date of sampling:	7/24/2009
Investigator:	L. Eichler
Volume conc.(L):	151
Depth(m):	0-9

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.5945	0.2370	0.3049
Cyclopoid copepodid	4.7556	0.3391	1.9918
Diacyclops thomasi	1.5852	0.4521	1.5054
Diaptomus minutus	0.7926	0.7042	1.8797
Diaptomus oregonensis	0.1982	0.8690	0.8412
Epischura lacustris	0.7926	1.4907	24.0869
Holopedium	1.3871	0.5566	4.3408
Mesocyclops edax	2.1797	0.5828	3.7482
Nauplii	16.2484	0.1680	1.0574
Tropocyclops prasinus	0.1982	0.4430	0.1144
Total spp	28.7318	0.3217	39.8707

Lake sampled:	Great Sacandaga
Site:	site 1
Date of sampling:	8/27/2009
Investigator:	L. Eichler
Volume conc.(L):	138
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.9091	0.2592	0.5828
Calanoid copepodid	5.2727	0.4801	5.0692
Cyclopoid copepodids	1.0909	0.2897	0.3637
Diacyclops thomasi	0.5455	0.4213	0.4153
Diaptomus minutus	4.1818	0.7647	13.8157
Diaptomus oregonensis	0.9091	0.7042	2.3349
Diaptomus sp.	0.7273	0.8535	2.6992
Epischura lacustris	0.3636	1.0255	3.8842
Nauplii	11.6364	0.1850	0.9536
Tropocyclops prasinus	2.3636	0.4895	2.1590
Total spp	28.0000	0.4091	32.2776

Lake sampled:	Great Sacandaga
Site:	site 2
Date of sampling:	8/27/2009
Investigator:	L. Eichler
# 1 L samples:	
Volume conc.(L):	100
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Calanoid copepodid	0.0229	0.4624	0.0208
Cyclopoid copepodid	0.0138	0.3273	0.0053
Daphnia pulicaria	0.0031	1.3435	0.0462
Diacyclops thomasi	0.0031	0.5445	0.0031
Diaptomus minutus	0.0092	0.6955	0.0220
Diaptomus oregonensis	0.0092	0.9533	0.0459
Holopedium	0.0015	0.5410	0.0021
Mesocyclops edax	0.0015	0.5430	0.0014
Nauplii	0.0764	0.2063	0.0082
Tropocyclops prasinus	0.0107	0.4749	0.0096
Total spp	0.1513	0.3866	0.1645

Lake sampled:	Great Sacandaga
Site:	site 3
Date of sampling:	8/27/2009
Investigator:	L. Eichler
Volume conc.(L):	138
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.2182	0.2500	0.1818
Calanoid copepodid	1.3091	0.5405	1.5872
Cyclopoid copepodid	6.3273	0.3370	2.7235
Diacyclops thomasi	2.6182	0.4752	2.3401
Diaphonasoma sp.	0.2182	0.6280	0.2556
Diaptomus minutus	1.5273	0.7203	3.7247
Diaptomus oregonensis	1.3091	0.8567	6.5017
Epischura lacustris	1.5273	1.1937	24.0134
Holopedium	0.2182	0.3110	0.0629
Mesocyclops edax	3.2727	0.4896	3.2320
Nauplii	15.0545	0.1938	1.2962
Tropocyclops prasinus	2.6182	0.4709	2.2492
Total spp	36.2182	0.3904	48.1683

Lake sampled:	Great Sacandaga
Site:	site 4
Date of sampling:	8/27/2009
Investigator:	L. Eichler
Volume conc.(L):	125
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.8006	0.2795	0.7550
Bythotrephes	0.0400	2.3248	5.1048
Calanoid copepodid	2.0016	0.4948	2.0588
Cyclopoid copepodid	10.0080	0.3438	4.1378
Diacyclops thomasi	0.4003	0.4300	0.2312
Diaptomus minutus	4.8038	0.7412	14.5434
Diaptomus oregonensis	2.0016	0.7838	6.2136
Holopedium	2.0016	0.7816	12.9049
Mesocyclops edax	10.8086	0.4566	7.4458
Nauplii	19.6157	0.1919	1.5990
Total spp	52.4820	0.3871	54.9943

Summary Statistics

Lake sampled:	Great Sacandaga
Site:	site 5
Date of sampling:	8/27/2009
Investigator:	L. Eichler
# 1 L samples:	
Volume conc.(L):	136
Depth(m):	0-8

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.0019	0.3220	0.0016
Calanoid copepodid	0.0093	0.4914	0.0094
Cyclopoid copepodid	0.0280	0.3072	0.0102
Diaptomus minutus	0.0149	0.7139	0.0371
Diaptomus oregonensis	0.0112	0.9232	0.0551
Diaptomus sicilis	0.0019	1.2350	0.0161
Epischura lacustris	0.0075	1.0220	0.1101
Holopedium	0.0037	1.1525	0.0644
Mesocyclops edax	0.0336	0.4818	0.0292
Nauplii	0.0841	0.1873	0.0063
Total spp	0.1962	0.4130	0.3395

Lake sampled:	Great Sacandaga
Site:	site 1
Date of sampling:	8/27/2009
Investigator:	L. Eichler
Volume conc.(L):	138
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.3636	0.3935	0.5576
Calanoid copepodid	4.3636	0.4324	3.0810
Cyclopoid copepodids	1.4545	0.3168	0.5204
Diacyclops thomasi	0.7273	0.4730	0.7000
Diaptomus minutus	4.0000	0.7174	11.0513
Diaptomus oregonensis	0.1818	0.7950	0.5777
Epischura lacustris	0.5455	1.3597	14.5309
Nauplii	8.7273	0.1891	0.8478
Tropocyclops prasinus	3.0909	0.4376	2.1689
Total spp	23.4545	0.4090	34.0357

Lake sampled:	Great Sacandaga
Site:	site 2
Date of sampling:	8/27/2009
Investigator:	L. Eichler
Volume conc.(L):	138
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bythotrephes	0.0073	1.7840	0.4125
Calanoid copepodid	1.9636	0.4341	1.5308
Cyclopoid copepodid	3.9273	0.3472	1.7210
Diaptomus minutus	1.7455	0.7194	5.1121
Epischura lacustris	0.4364	1.4290	10.7594
Holopedium	0.2182	0.7070	0.8272
Mesocyclops edax	0.8727	0.6180	1.9315
Nauplii	13.7455	0.1974	1.3160
Tropocyclops prasinus	1.5273	0.5007	1.6210
Total spp	24.4436	0.3387	25.2316

Lake sampled:	Great Sacandaga
Site:	site 3
Date of sampling:	8/27/2009
Investigator:	L. Eichler
Volume conc.(L):	138
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.2909	0.2100	0.1026
Bythotrephes	0.0001	2.9440	0.0165
Calanoid copepodid	2.6182	0.5046	2.6596
Cyclopoid copepodid	7.2727	0.3301	2.9217
Diacyclops thomasi	0.8727	0.4407	0.8291
Diaptomus minutus	0.8727	0.9197	4.2892
Epischura lacustris	0.5818	0.8490	3.3034
Mesocyclops edax	4.3636	0.4638	3.2319
Nauplii	14.8364	0.1895	1.3517
Tropocyclops prasinus	2.0364	0.4879	1.9132
Total spp	33.7455	0.3347	20.6190

Lake sampled:	Great Sacandaga
Site:	site 4
Date of sampling:	8/27/2009
Investigator:	L. Eichler
Volume conc.(L):	125
Depth(m):	0-10

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Acanthocyclops	0.0010	0.6600	0.0025
Bythotrephes	0.0560	2.1180	5.4150
Calanoid copepodid	0.0031	0.4317	0.0022
Cyclopoid copepodid	0.0245	0.3305	0.0096
Diacyclops thomasi	0.0041	0.5362	0.0059
Diaptomus minutus	0.0234	0.6795	0.0527
Diaptomus oregonensis	0.0092	0.7479	0.0281
Epischura lacustris	0.0020	0.9790	0.0184
Holopedium	0.0061	0.9415	0.0695
Mesocyclops edax	0.0224	0.4586	0.0167
Nauplii	0.0601	0.2043	0.0057
Total spp	0.2120	0.8683	5.6261

Lake sampled:	Great Sacandaga
Site:	site 5
Date of sampling:	8/27/2009
Investigator:	L. Eichler
Volume conc.(L):	136
Depth(m):	0-8

Species and Group Statistics

Species	Density (#/L)	Avg Size (mm)	Biomass (ug/L)
Bosmina longirostris	0.3668	0.2150	0.1294
Calanoid copepodid	0.7337	0.4168	0.5786
Cyclopoid copepodid	2.9347	0.3018	0.8889
Daphnia pulicaria	0.1834	0.6300	0.2149
Diacyclops thomasi	0.1834	0.3350	0.0522
Diaptomus minutus	2.2010	0.6696	5.1736
Diaptomus oregonensis	0.9171	0.8332	3.3057
Diaptomus sicilis	0.3668	0.7950	1.1983
Epischura lacustris	0.9171	0.8372	5.3455
Holopedium	1.4674	0.7660	11.5087
Mesocyclops edax	3.4850	0.4744	3.0946
Nauplii	12.8393	0.1970	1.1938
Total spp	26.5957	0.3779	32.6841