Survey for Invasive Benthic Macroinvertebrates in the Four Western Finger Lakes

Final Report

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Introduction

The Finger Lakes (Figure 1) are a collection of eleven lakes in Western New York that provide major ecological and economic benefit to the surrounding region, including recreation, agriculture, and potable water supplies (Watershed Assessment Associates 2014). The four westernmost Finger Lakes (Conesus, Hemlock, Canadice, and Honeoye) have a range of uses. Hemlock and Canadice are located within the Hemlock-Canadice State Forest (Halfman and O'Neill 2009) and are primarily water supplies for the City of Rochester. To maintain their water quality they are protected by various use restrictions. Due to their small size, non-centralized location, and stringent regulation, these two lakes are essentially unstudied and have little historical data for comparison to their current environmental and ecological states.

Conversely, Conesus and Honeoye are open to a variety of uses; their shorelines have been heavily developed for private interests ranging from housing to large-scale agriculture. Conesus has been heavily impacted by agriculture in its watershed; nutrient-rich runoff has caused eutrophication and general water quality degradation (Somarelli et al. 2005). Honeoye is also highly impacted by its surrounding community. The combination of its small size, shallow depth, and nitrogen-limitation has subjected it to extreme water quality degradation (Halfman and O'Neill 2009). While there are ongoing long-term water quality studies occurring in both of these lakes, their overall ecological health is poorly understood.

One of the primary biotic concerns in the Finger Lakes is the growing presence of aquatic invasive species. According to the USGS (2014) Nonindigenous Aquatic Species database for the state of New York, there appear to be eight primary invasive species in the region that may be present in the four lakes targeted in this study: *Corbicula fluminea (*Asian Clam), *Dreissena polymorpha* (Zebra Mussel), *Dreissena bugensis* (Quagga Mussel), *Bithynia tentaculata* (Faucet Snail), *Bellamya* (formerly *Cipangopaludina*) *chinensis malleata* (Chinese Mystery Snail), *Viviparus georgianus* (Banded Mystery Snail), *Echinogammarus ischnus* (Euryhaline Amphipod), and *Hemimysis anomala* (Bloody Red Shrimp). Some of these species are reported to have detrimental effects on the health of some native benthic macroinvertebrates (Sandland et al. 2014; Ilarri et al. 2014; Halpin et al. 2013; Kang et al. 2007).

A survey of the seven eastern-most Finger Lakes (Otisco, Skaneateles, Owasco, Cayuga, Seneca, Keuka and Canandaigua) was conducted in 2012 to assess benthic macroinvertebrate community structure and identify the presence of invasive species (Watershed Assessment Associates 2014). Seven exotic macroinvertebrate taxa were found in one or more of these lakes,

including the all of the species mentioned above except *V. georgianus*. *D. polymorpha* and *E. ischnus* were the most widespread.

Species descriptions

D. polymorpha was introduced to the Great Lakes from the Ponto-Caspian region in the late 1980s, establishing itself as a dominant and nuisance species. Its rapid spread incapacitated water treatment plants, causing millions of dollars in damage, repair, and control efforts every year. These mussels can quickly out-compete native mollusks and crustaceans due to their rapid reproduction, high rates of nutrient uptake, and capability to colonize any hard surface, including other shellfish (Burdick 2005). When *D. polymorpha* becomes the dominant shellfish in a lake, it can cause major shifts in community composition by changing the structure of the lake bottom and reorganizing the flow of nutrients in the water (Souza et al. 2014). This systemic restructuring creates opportunities for other invasive macroinvertebrates. For instance, *E. ischnus* uses the space between dreissenid mussels for shelter (Kang et al. 2007). Watershed Assessment Associates (2014) recently confirmed the presence of zebra mussels in the eastern Finger Lakes for the first time, but their abundance in the western four lakes is still in question. Sightings in Conesus, Honeoye, and Hemlock have been reported, but none yet in Canadice.

D. bugensis, another mussel from the Ponto-Caspian region and similar to *D. polymorpha*, filters large amounts of water and can cause massive changes in nutrient flow and community structure after becoming established (Aldridge et al. 2014; Souza et al. 2014). Some organizations view *D. bugensis* as potentially more problematic than *D. polymorpha* because it has started to spread more quickly and out-competes its relative in areas where they both occur (Aldridge et al. 2014). It has been recorded in five of the seven eastern Finger Lakes, but has not yet been reported in the four lakes in my study (Watershed Assessment Associates 2014)

C. fluminea is one of the most common invasive bivalves in the world (Illari et al. 2014). It has demonstrated the ability to influence both benthic communities in bodies of water where it is established, likely through change in benthic structure provided by its hard, ridged shell, as well as by affecting how suspended matter is moved from the water column to the benthos (Illari et al. 2014; Souza et al. 2014). It has been recorded in four of the seven eastern Finger Lakes (Watershed Assessment Associates 2014) but not in the four western Finger Lakes.

B. tentaculata, originally from Europe, is a long-established (late 1800s) invasive snail in the Great Lakes region. It is potentially most damaging because it is an intermediate host for trematodes, such as *Cyathocotyle bushiensis*, *Sphaeridiotrema globulus*, and *S. pseudoglobulus* that cause high mortality rates in native waterfowl (Sandland 2014). It has only been recorded in two of the eastern Finger Lakes, has been recorded a number of times in the City of Rochester and nearby waterways (USGS 2014), but has not been reported in the four western Finger Lakes.

B. chinesis malleata is an invasive snail from Asia which has become established in over half of the United States since it was initially observed in a San Francisco food market in the 1890s (Chaine et al. 2012; Harried et al. 2014). While *B. chinesis malleata* is widespread and tends to occur at relatively high population densities, very little is known about its overall effects on other populations and the overall ecosystem after it becomes established (Chaine et al. 2012; Harried et al. 2014). It has been recorded in two of the eastern Finger Lakes (Watershed Assessment Associates 2014), but none of the four western Finger Lakes.

V. georgianus is a snail native to the Mississippi River system that, since the 1960s, has expanded out of its historical range into much of the eastern and upper midwestern United States (Bury et al. 2007). Despite its range and long-time status as an invasive species, very little is known about its effects on the systems it is introduced to. *V. georgianus* has been found in Lake Ontario and Lake Erie, as well as along the Erie Canal, but has not been previously found in any of the Finger Lakes (USGS 2014).

E. ischnus was introduced into the Great Lakes from the Ponto-Caspian region in the early 1990s and has been recorded in each of the seven eastern Finger Lakes (Watershed Assessment Associates 2014). *E. ischnus* does not appear to be able to establish itself or out-compete native species except in areas where *Dreissena* spp. have restructured lake substrates. Under these conditions, *E. ischnus* has been able to establish healthy populations and displace native amphipods (Kang et al. 2007). It has not been reported in the four western Finger Lakes.

H. anomala is a recently introduced mysid in the Great Lakes region that also comes from the Ponto-Caspian region; its effects in the Great Lakes and other aquatic systems are still unknown, but its introduction has been linked to decreases in native cladoceran and copepod abundances in European water bodies (Halpin 2013). Notably, it is a near-shore predator, unlike the major native, pelagic invertebrate zooplankton predators offshore, potentially increasing predation pressure in previously unexploited regions of lakes (Halpin 2013). In the Finger Lakes, it has only been recorded in Seneca Lake (Watershed Assessment Associates 2014); however, it is widespread throughout the northeastern United States, is well established in Lake Ontario and Lake Erie, and has the potential to be in the western Finger Lakes (USGS 2014).

The objective of our study was to determine the frequency of occurrence of the invasive species described above at 16 sites in each of the four western Finger Lakes (Figures 2-4).

Methods

From July 15 to August 19, each lake was sampled along eight transects extending perpendicularly from the shoreline. Transect locations were determined by delineating the catchments around each lake using StreamStats (USGS 2012) and choosing the eight largest catchments by area, as determined by GIS. On each transect, one benthic sample was taken in the littoral zone near shore, and one in the post-littoral zone in deeper water just beyond the submersed aquatic macrophyte beds. Semi-quantitative sampling for benthic macroinvertebrates was conducted with a dome suction sampler that covered an area of 0.165 m^2 (Haynes et al. 2005). The dome was placed on the surface of the lakebed by SCUBA divers, and an air lift system was run for approximately 30 seconds to collect the sample from inside the dome.

The air lift system was built using a 24” piece of 2” PVC pipe as a base, attached to a 45º Y-joint, with the angled end of the joint attached to a trigger and a low-pressure air hose that connected to a first-stage regulator and a SCUBA tank. A straight attachment connected to a 36”, 1.5” PVC pipe which was attached to one of two lengths of 1.5” pool hose, one for shallow water (5-8 ft) near shore and the other for deep water (9-15 ft) beyond the macrophyte beds.

Each sample was washed through a “filtration tower” made from a stack of four five-gallon plastic buckets with their bottoms replaced by (in descending order of size) chicken wire (~1” mesh), fencing wire (¼” mesh), aluminum window screen (~1 mm mesh), and a 595µm sediment sieve. Organisms were placed initially into a labeled container with soda water (to relax them), followed by 10% buffered formalin to fix their tissues. Samples were transported to the

laboratory, and after 24 hours were transferred into fresh containers of 80% ethanol and stored until they were processed.

In the laboratory, samples were washed again through a 595 μm sieve to remove fine particulate matter. Each sample was evenly distributed over a sorting tray, and water was added to allow it to be picked through easily. If the sample had too much material to be able to easily pick through, it was separated into multiple trays. Each tray was then looked through for 10 minutes, with all potentially invasive organisms removed and identified. All amphipods were removed from the tray and more closely examined under a dissecting microscope because identification of the exotic *E. ischnus* requires careful observation to distinguish it from native *Gammarus* spp. (Peckarsky et al. 1990). Invasive species were indentified using photographs and descriptions obtained from the Internet. If the organisms were invasive, their number was recorded, they were placed into vials for reference, and their frequency of occurrence across the 16 sites in each lake was calculated.

Results

Three potentially invading species (*C. fluminea*, *E. ischnus*, *H. anomala*) were not found in any of the four western Finger Lakes, while five invasive species were collected in two or more of them. While relatively few individuals of these five species were collected (Table 1), they were found at 6.5-56.5% of the 64 sites sampled (Table 2). At the shallow (N=32) and deep (N=32) sites in the four lakes, *D. polymorpha* was the most sampled invasive species, found at 47.0 $\pm$ 21.3% (SD) and 56.5 $\pm$ 16.0% of the sites, respectively. *D. bugensis* was found at 28.3 $\pm$ 6.5% of the shallow sites and 43.8 $\pm$ 12.5% of the deep sites. *V. georgianus*, *B. chinensis malleata* and *B. tentaculata* were found only in Conesus and Honeoye Lakes. *V. georgianus* averaged 19.0 $\pm$ 8.5% and 25.5 $\pm$ 17.7% at the shallow (N=16) and deep sites (N=16) in the two lakes, respectively. *B. chinensis malleata* averaged 6.5 $\pm$ 9.2% and 13.0 $\pm$ 0.0% at the shallow and deep sites, and *B. tentaculata* averaged 6.5 $\pm$ 9.2% and 12.5 $\pm$ 17.7% at the shallow and deep sites, respectively.

Discussion

D. polymorpha and *D. bugensis* were well established in Lake Ontario by 1990 and 1999, respectively (Haynes et al. 2005), and reports of their presence in the Erie Canal and one or more of the eastern Finger Lakes came soon after. They are now well established in the four western Finger Lakes. *V. georgianus*, *B. chinensis malleata* and *B. tentaculata* were found only in the most "disturbed" of the four western Finger Lakes, (Conesus and Honeoye with the most developed shorelines and watersheds (residential and agricultural disturbances, respectively), but they were not found in Hemlock and Canadice Lakes with forested, protected watersheds. Whether the relative lack of invasive species in Hemlock and Canadice is due to land use practices and water quality protection or to good fortune is unknown. The good news from this study is that unlike the eastern Finger Lakes there is no evidence yet of *C. fluminea*, *E. ischnus* and *H. anomala* in the western Finger Lakes. We recommend periodic monitoring of the four western Finger Lakes in the future to examine changes in abundance and frequency of the five invasive species found in this study and to look for the three species we did not find but are reported in the eastern Finger Lakes.

Literature Cited

Aldridge, D. C., S. Ho, and E. Froufe. 2014. The Ponto-Caspian quagga mussel, *Dreissena rostriformis bugensis* (Andrusov, 1897), invades Great Britain. Aquatic Invasions 9:529-535

Burdick, A. 2005. Out of Eden: An Odyssey of Ecological Invasion. Farrar, Strauss and Giroux: New York, USA.

Bury. J. A., B. E. Sietman, and B. N. Karns. 2007. Distribution of the non-native viviparid snails, *Bellamya chinensis* and *Viviparus georgianus*, in Minnesota and the first record of *Bellamya japonica* from Wisconsin. Journal of Freshwater Ecology 22:697-703.

Chaine, N. M., C. R. Allen, K. A. Fricke, D. M. Haak, M. L. Hellman, A. Kill, K. T. Nemec, K. L. Pope, N. A. Smeenk, B. J. Stephen, D. R. Uden, K. M. Unstad, and A. E. Vanderham. 2012. Population estimate of Chinese mystery snail (*Bellamya chinensis*) in a Nebraska reservoir. BioInvasions Records 1:283-287.

Halfman, J. D., and K. O'Neil. 2009. Water Quality of the Finger Lakes, New York: 2005-2008. Finger Lakes Institute: Geneva, New York, USA.

Halpin, K. E., B. T. Boscarino, L. G. Rudstam, M. G. Walsh, and B. F. Lantry. 2013. Effect of light, prey density, and prey type on the feeding rates of *Hemimysis anomala*. Hydrobiologia 720:101-110.

Harried, B. K. Fischer, K. E. Perez, and G. J. Sandland. 2015. Assessing infection patterns in Chinese mystery snails from Wisconsin, USA using field and laboratory approaches. Aquatic Invasions 10:169-175.

Haynes, J. M., N. A. Tisch, C. M. Mayer, and R. S. Rhyne. 2005. Benthic macroinvertebrate communities in southwestern Lake Ontario following invasion of *Dreissena* and *Echinogammarus*: 1983 to 2000. Journal of the North American Benthological Society 24:148-167

Ilarri, M. I., A. T. Souza, C. Antunes, L. Guilhermino, and R. Sousa. 2014. Influence of the invasive Asian clam *Corbicula fluminea* (Bivalvia: Corbiculidae) on estuarine epibenthic assemblages. Estuarine, Costal and Shelf Science 143:12-19.

Kang, M., J. J. H. Ciborowski, and L. B. Johnson. 2008. The influence of anthropogenic disturbance and environmental suitability on the distribution of the nonindigenous Amphipod, *Echinogammarus ischnus*, at Laurentian Great Lakes coastal margins. Journal of Great Lakes Research 33:198-210.

Peckarsky, B. 1990. Freshwater Macroinvertebrates of North America. Cornell University Press: Ithaca, New York, USA.

Sandland, G. J., R. Gillis, R. J. Haro, and J. P. Pierce. 2014. Infection patterns in invasive and native snail hosts exposed to a parasite associated with waterfowl mortality in the upper Mississippi River, USA. Journal of Wildlife Diseases 50:125-129.

Somarelli, J. A., J. C. Makarewicz, R. Sia, and R. Simon. 2007. Wildlife identified as major source of *Escherichia coli* in agriculturally dominated watersheds by BOX A 1R-derived genetic fingerprints. Journal of Environmental Management 82:60-65

Souza, R., A. Novais, R. Costa, and D. L. Strayer. 2014. Invasive bivalves in fresh waters: Impacts from individuals to ecosystems and possible control strategies. Hydrobiologia 735: 233-251.

USGS. 2012. The StreamStats program for New York. [Online.] United States Geological Survey. Available at http://water.usgs.gov/osw/streamstats/new_york.html. Accessed 30 January 2015.

USGS. 2014. US Geological Survey Nonindigenous Aquatic Species. [Online.] Nonindigenous Aquatic Species Program, Gainesville, FL, USA. Available at: http://nas.er.usgs.gov/queries/SpeciesList.aspx?Group=&Sortby=1&state=NY Accessed 5 September 2014.

Watershed Assessment Associates. 2014. 2012 Eastern Finger Lakes Benthic Aquatic Invertebrate Assessment. Watershed Assessment Associates, Schenectady, New York, USA.

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Table 1. Number of individuals of invasive species collected in eight paired shallow and deep water sites in each of the four western New York Finger Lakes: Conesus, Honeoye, Canadice and Hemlock.

		Lake	**Conesus**		**Honeoye**		**Canadice**		**Hemlock**	
Common Name	**Scientific Name**		**Shallow**	**Deep**	**Shallow**	**Deep**	**Shallow**	**Deep**	**Shallow**	**Deep**
Zebra Mussel	*Dreissena polymorpha*		3	4	2	5	4	3	6	6
Quagga Mussel	*Dreissena bugensis*		2	4	2	4	3	2	2	4
Banded Mystery Snail	*Viviparum georgianus*		2	1	1	3	0	0	0	0
Chinese Mystery Snail	*Cipangopaludna chinensis malleata*		0	1	1	1	0	0	0	0
Faucet Snail	*Bithynia tentaculata*		1	0	0	2	0	0	0	0
Euryhaline Amphipod	*Echinogammarus ischnus*		0	0	0	0	0	0	0	0
Bloody Red Shrimp	*Hemimysis anomala*		0	0	0	0	0	0	0	0
Asian Clam	*Corbicula fluminea*		0	0	0	0	0	0	0	0

Table 2. Percent frequency of invasive species collected in eight paired shallow and deep water sites in each of the four western New York Finger Lakes: Conesus, Honeoye, Canadice and Hemlock.

		Lake	Conesus		Honeoye		Canadice		Hemlock	
Common Name	**Scientific Name**		**Shallow**	**Deep**	**Shallow**	**Deep**	**Shallow**	**Deep**	**Shallow**	**Deep**
Zebra Mussel	*Dreissena polymorpha*		38	50	25	63	50	38	75	75
Quagga Mussel	*Dreissena bugensis*		25	50	25	50	38	25	25	50
Banded Mystery Snail	*Viviparum georgianus*		25	13	13	38	0	0	0	0
Chinese Mystery Snail	*Cipangopaludna chinensis malleata*		0	13	13	13	0	0	0	0
Faucet Snail	*Bithynia tentaculata*		13	0	0	25	0	0	0	0
Euryhaline Amphipod	*Echinogammarus ischnus*		0	0	0	0	0	0	0	0
Bloody Red Shrimp	*Hemimysis anomala*		0	0	0	0	0	0	0	0
Asian Clam	*Corbicula fluminea*		0	0	0	0	0	0	0	0

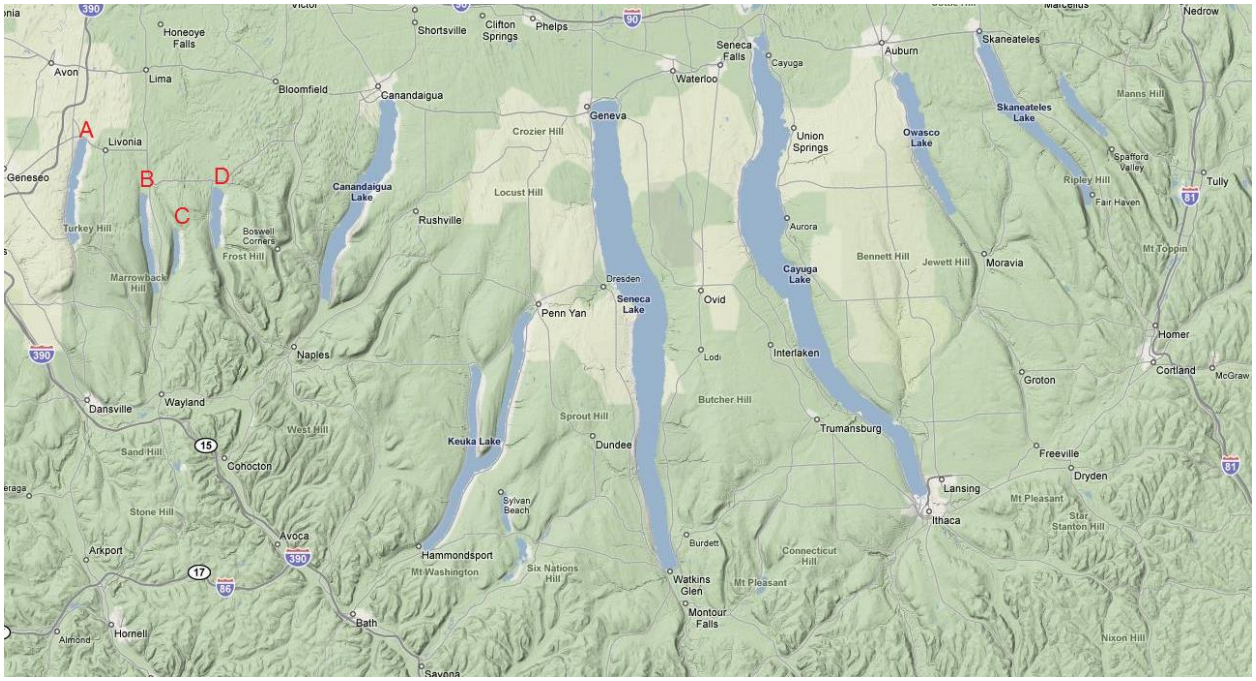

Figure 1: Map of the Finger Lakes region with the target lakes labeled (Conesus-A, Hemlock-B, Canadice-C, and Honeoye-D)

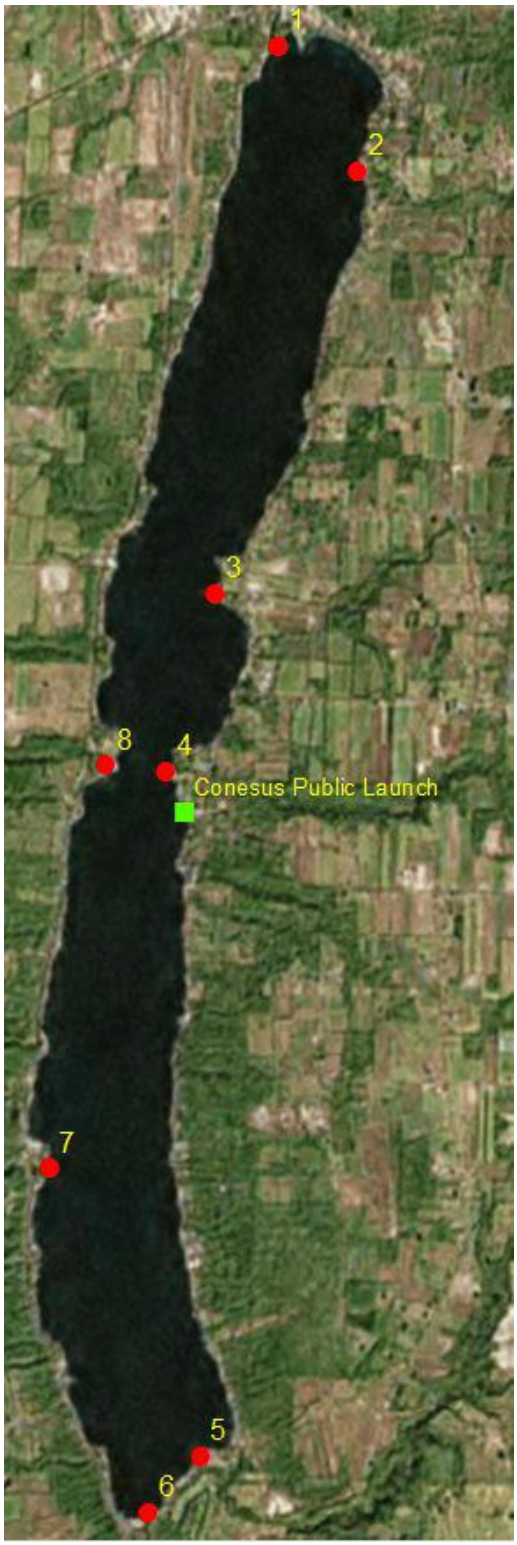

Figure 2. Locations of sampling transects in Conesus Lake.

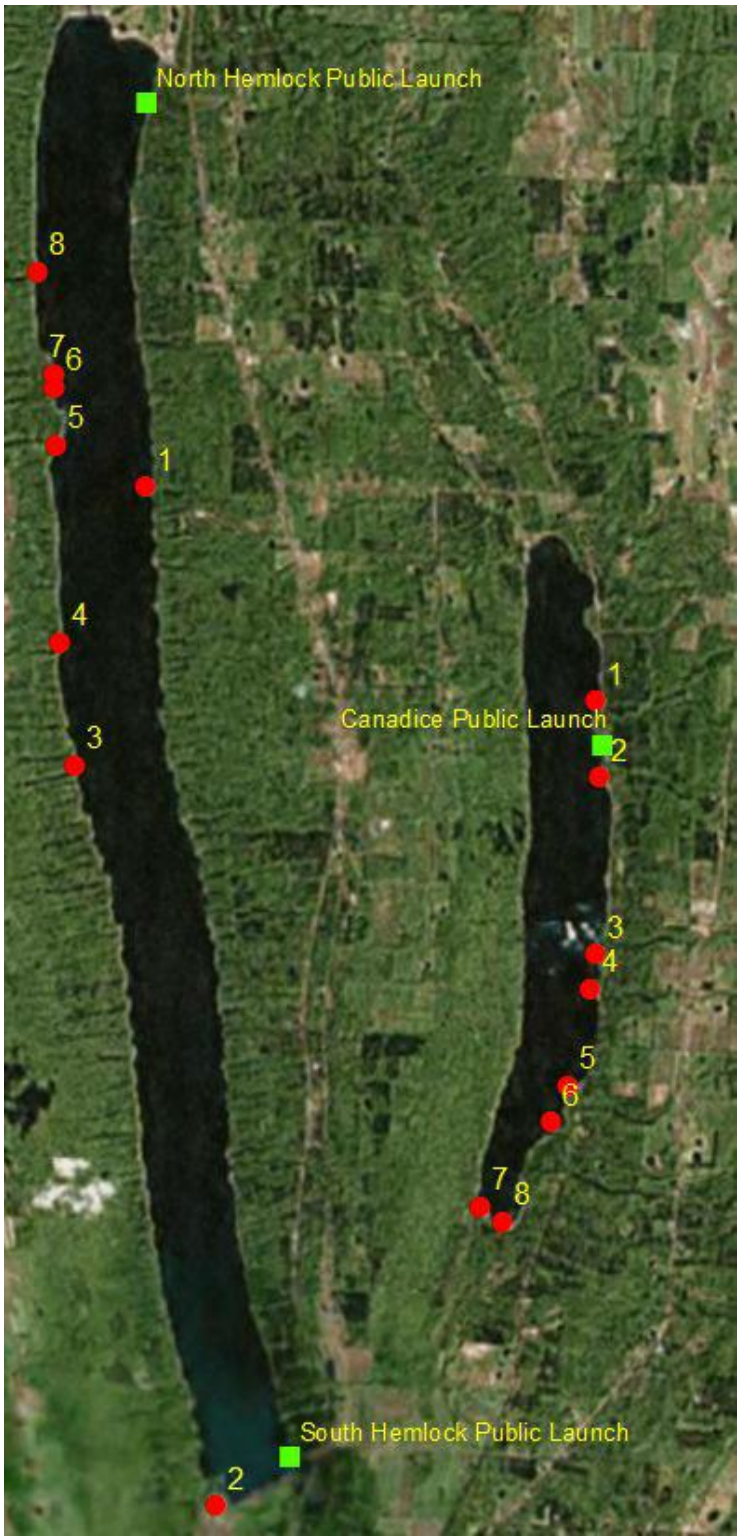

Figure 3. Locations of sampling transects in Hemlock and Canadice Lakes.

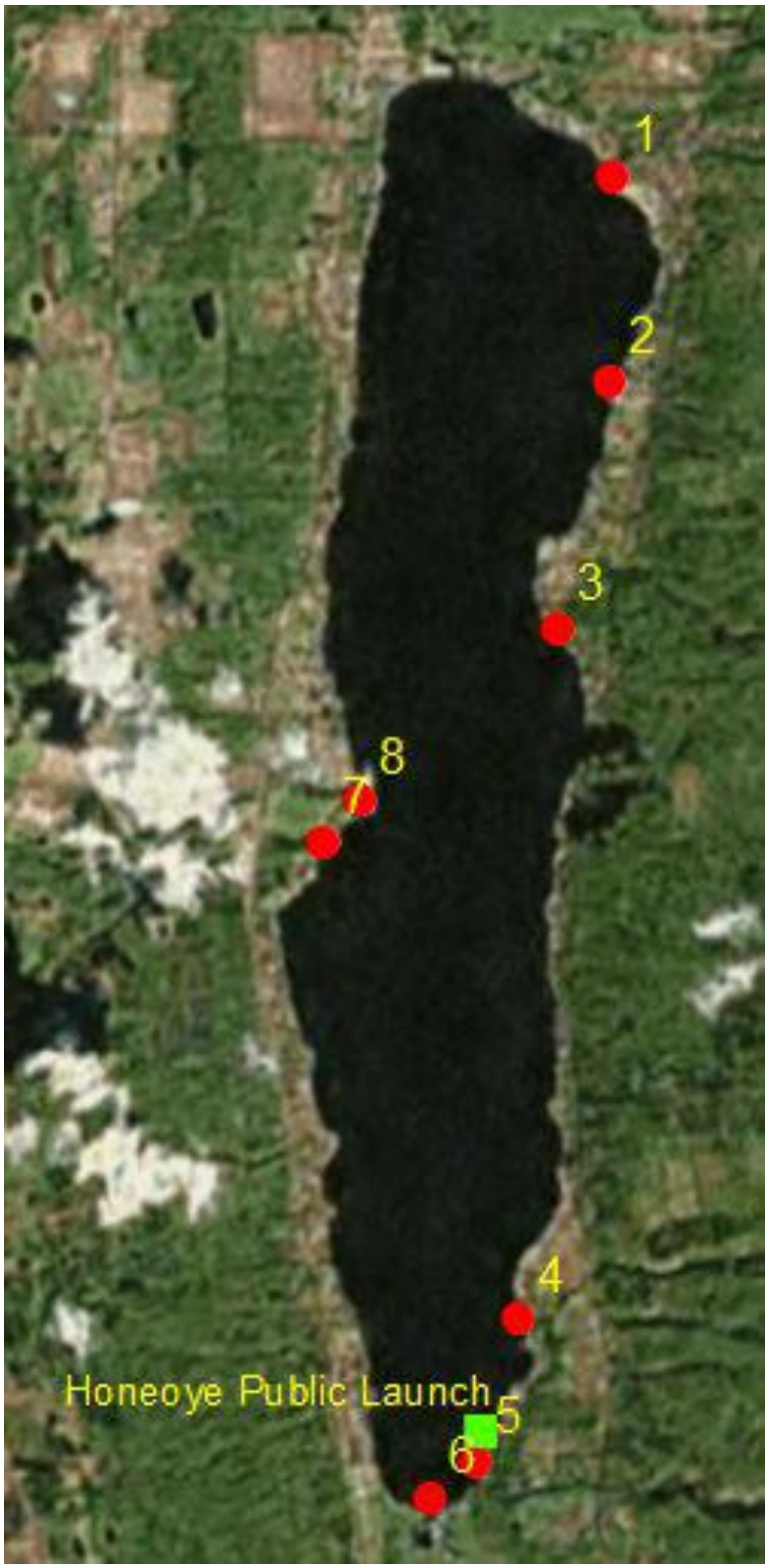

Figure 4. Locations of sampling transects in Honeoye Lake.