Zebra mussel monitoring in Otsego Lake: Applications for municipal use of lake water

FINAL REPORT TO VILLAGE OF COOPERSTOWN ZEBRA MUSSEL TASK FORCE COMMITTEE

Submitted by

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Summary:

Zebra mussels were first reported in Otsego Lake in 2007. This project provides a baseline on the zebra mussel population now in Otsego Lake. As the larval form of the mussel, veligers, is planktonic (floating in the water column) it gets transported by water currents. This includes getting pulled into water intake pipes. The mussel can then attach to these structures and cause serious economic problems for raw water users as costs associated with retrofits for prevention of fouling and increased maintenance costs accumulate. The Village of Cooperstown gets its water from the lake, thus their intakes are in danger of being fouled by zebra mussels. To prevent this, the village likely will start chlorinating their intake line. However, they do not know when to start and stop chlorinating. This report provides some guidance as to when the mussels will be most likely to foul intake structures.

Zebra mussel veligers are not evenly distributed in the lake in either time or space. Mussels are beginning to reproduce by late May. Small veligers remain present in samples throughout July. Veliger abundances appear to follow a typical bimodal distribution in time. This indicates that an initial reproductive event beginning at the end of May is followed by a second reproductive event in late July. Two synchronous reproductive events in a lake are typical of zebra mussels. However, usually it is the first reproductive event that produces the greatest number of veligers. The pattern in Otsego Lake may be due to the early distribution of mussels coupled with the circulation patterns in the lake. Spatially, the veliger abundances are consistently much higher in the northern half of the lake. They are also much more abundant at moderate depths than at either the surface or the deeper, cooler waters. This is a typical pattern for most zooplankton species.

Funds for this project were provided by the Walter B. Ford Grant Program (equipment, supplies and travel), the B-WET Program administered via the Pennsylvania Sea Grant (supported Dr. Monie's work) and by OCCA and the Zebra Mussel Committee of the Village of Cooperstown (supported Amanda's work). We are thankful to all agencies that showed interest in this work.

Introduction:

Zebra mussels are unique in freshwater habitats in North America in that they produce a truly planktonic larva. Spawning by adult mussels is synchronous. Females release eggs into the water column and shortly afterwards, males release sperm. Fertilization then takes place in the water column. The zygotes formed will float passively in the water during early development (this is the Trochophore stage). Shortly afterwards, the trochophores form a vellum which allow them to maintain position in the water column. These so called *veligers* continue to develop over the next 2 to 4 weeks feeding on suspended particles such as algae, bacteria, and other microscopic organisms. Development stages of immature mussels are typically divided into groups based on shape. Trochophores (80-100 microns) are mostly rounded; D-staged or straight-hinged veligers (90-120 microns); umbonal (120-320 microns) characterized by the appearance of the umbo; and finally pediveligers (250-450 microns) characterized by the presence of a foot. Pediveligers secrete a trailing byssal thread that helps them remain in the water column until they finds a suitable substrate to settle on. Once settled, pediveligers undergo metamorphosis to become juvenile mussels. Juveniles continue to secret byssal threads to firmly attach. Pediveligers, juveniles and even adults can detach themselves and move along the substrate before adults again attach themselves. Juveniles and adults feed by siphoning water into their shell and filter suspended particles from bacteria to filamentous algae size. This filter-feeding activity has changed the function of many invaded lakes - the so called benthification of lakes, whereby energy in the form of food is shifted from the water column to the lake bottom.

Zebra mussels were first reported in Otsego Lake in 2007, and adult mussels were more commonly found in the north end of the lake. By 2009, reports of mussels were coming in from nearly every area of the lake, suggesting a widely distributed population. However, some areas appear to have relatively small numbers of adult mussels. This patchy distribution is typical for zebra mussels.

This project provides a baseline on the zebra mussel population now in Otsego Lake. As the larval form of the mussel is planktonic (floating in the water column) it gets transported by water currents. This includes getting pulled into water intake pipes. The mussel can then attach to these structures and cause serious economic problems. The Village of Cooperstown gets its water from the lake, thus their intakes are in danger of being fouled by zebra mussels. To prevent this, the village likely will start chlorinating their intake line. However, they do not know when to start and stop chlorinating. This report should provide some guidance as to when the mussels will be most likely to foul intake structures.

Objectives:

Spawning events and the length of veliger development are dependent on environmental conditions (temperature, pH, etc.) and availability of quality food. Thus, zebra mussel populations vary in their development from lake to lake. Given that we have no data on veligers for Otsego Lake, only very rough estimates can be made of how this population will respond. Empirical data are needed. This project is non-hypothesis driven. It does, regardless, provide important practical information in a scientifically sound manner. Objectives originally proposed and addressed in this report include:

1) determining the spatial and temporal aspects of larval zebra mussels in Otsego Lake
2) providing a management plan that will dictate when control measures can be effectively deployed.
3) introducing a student researcher to the basics of sound scientific monitoring practices and advanced microscopy techniques.

Methods:

In early June we bought a gas-powered centrifugal pump that allowed us to collect large volumes of water. We needed to run a few preliminary sampling trials designed to determine the optimal amount of water we would need to collect in order to observe reasonable numbers of veligers and to work out any logistic problems. We settled on running the pump for 5 minutes which collected about 250 liters of water in each sample. Sampling began on 8 June and ended on 28 August. We collected samples every week, often 3 days in the week.

For each sample 250 liters of water were pumped through a 63-µm mesh plankton net, and the contents were preserved on the spot with ethanol. We sampled 10 east-west transects covering the north-south axis of the lake (Figure 1). Within each transect, we sampled the left, center and right side of the lake.

Veligers were quantified using a cross-polarizing light microscopy technique. This technique allows veligers to be easily distinguished from other plankton, with the exception of Ostracods (pea shrimp). These can be distinguished from zebra mussel veligers by closer inspection of internal and external morphology. Replicated subsamples were quantified in 1-ml aliquots, and averages of subsamples were used as the sample density. For all statistical analyses, true replicates were based on the sites sampled in the lake.

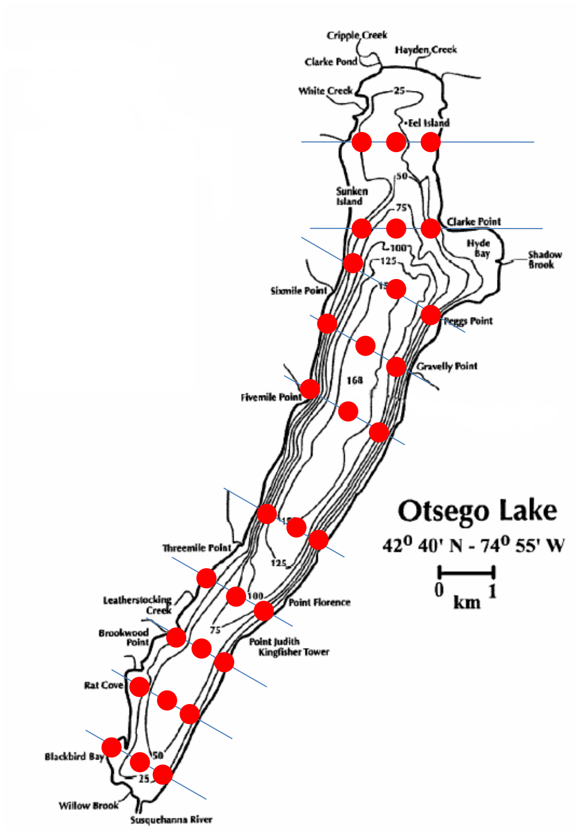

Figure 1. Sampling sites for the veliger study. Transect positions are approximations. Lake image from BFS Annual Reports.

Results:

Zebra mussel trochophores were present in extremely high numbers in our preliminary sampling (3 June). We also found very low numbers of D-stage veligers in these samples. This means that reproduction in the lake likely begins in late May. Early stages of veligers remain present in samples throughout July. Veliger abundances appear to follow a typical bimodal distribution in time. This indicates that an initial reproductive event beginning at the end of May is followed by a second reproductive event in late July (Figure 2). Two synchronous reproductive events in a lake are typical of zebra mussels. However, usually it is the first reproductive event that produces the greatest number of veligers. The pattern in Otsego Lake may be due to the early distribution of mussels coupled with the circulation patterns in the lake. No recent data on lake circulations have been made, so it is difficult to determine if that is indeed a factor here. However, it is clear that veligers remain present in the water column well into September. The 28 August sample still had some D-stage veligers which would not likely reach settling stage for about another 2 weeks.

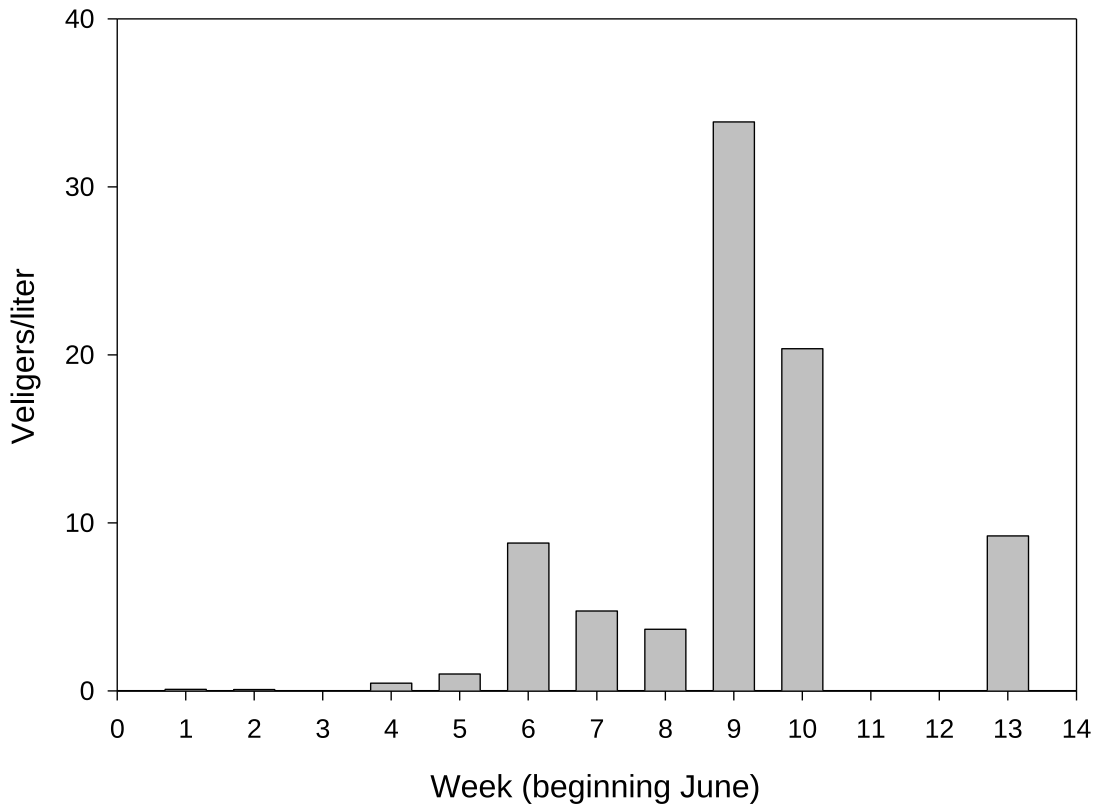

Figure 2. Veliger densities as a weekly mean beginning June (wk1) through end of August (wk13). Weeks 1-4 are all <1 veliger/liter.

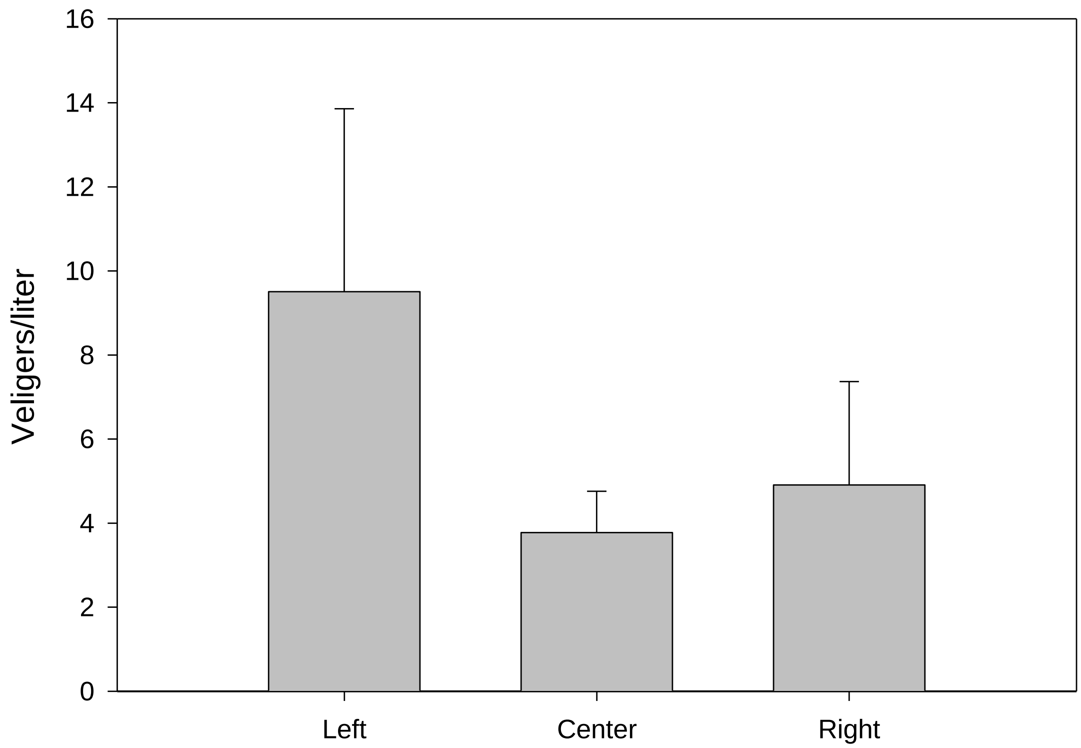

Figure 3. Veliger abundances across the east-west axis of the lake. Data are from week 9 which is typical of other dates and has a high density. The differences are not statistically significant across all dates sampled. Error bars are +1 standard error.

Veligers were not evenly distributed throughout the lake. We were able to analyze whether there was an east-west distribution bias. We could not determine a statistically significant difference in veliger abundances from one side of the lake to another (Figure 3). We were also able to analyze a longitudinal (north-south) distribution of veligers. Here we did observe a statistically significant difference. The transects in the northern half of the lake tend to have higher densities than those transects from the south end of the lake (Figure 4). Transects 4 and 5, which have the highest densities, are located between 3 Mile Point and 5 Mile Point. This is not too unexpected because we believe that the mussels were introduced in the northern end of the lake. Data from other lake systems suggests that the veligers are not transported very far from the source (parent population) in lakes, unlike in rivers. Appropriate samples of the adult population would really be needed to fully support this hypothesis.

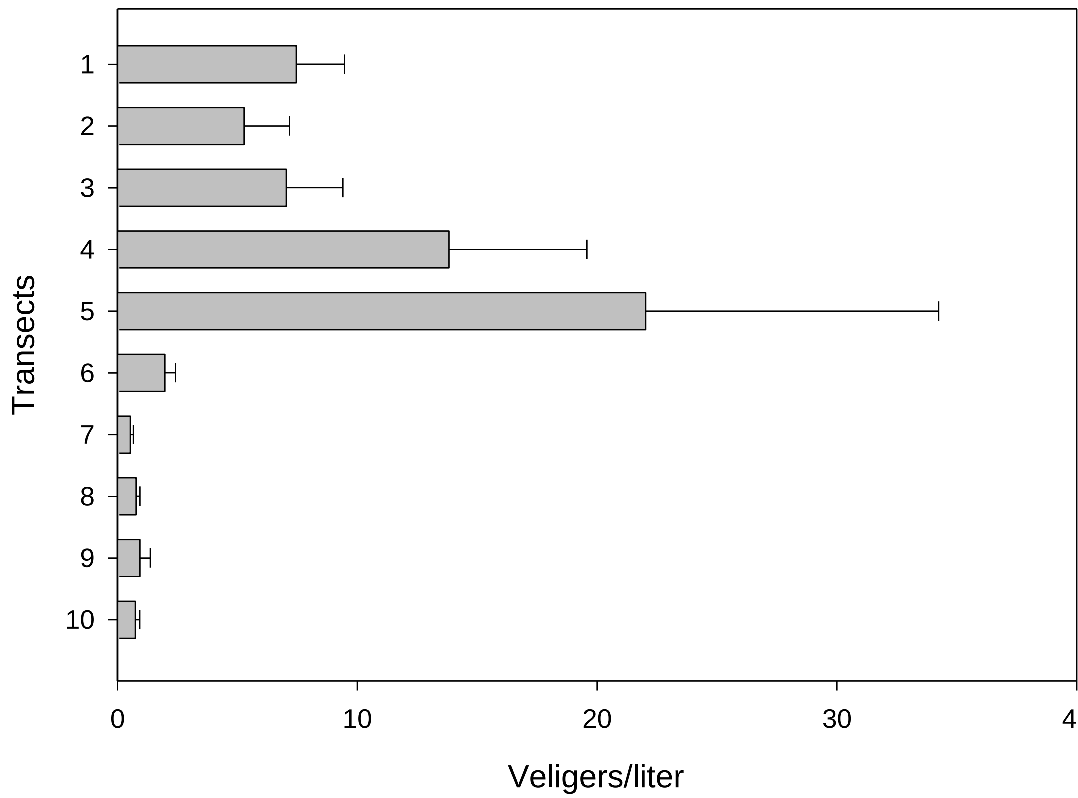

Figure 4. Mean veliger abundances at each transect from week 9, which had high densities but was also typical of this pattern. Transect 1 is the farthest north transect (north of Sunken Island). The error bars are + 1 standard error.

Veligers tend to be found at highest densities at moderate depths in the lake. The differences we observed were not statistically significant, but that may be due to the high variability in the lake along the north-south axis and to the low number of sampling dates for depths. We didn't have the spatial resolution to determine exactly where the maximum densities tend to occur, however, the data suggest that their distribution is depth-dependent (Figure 5).

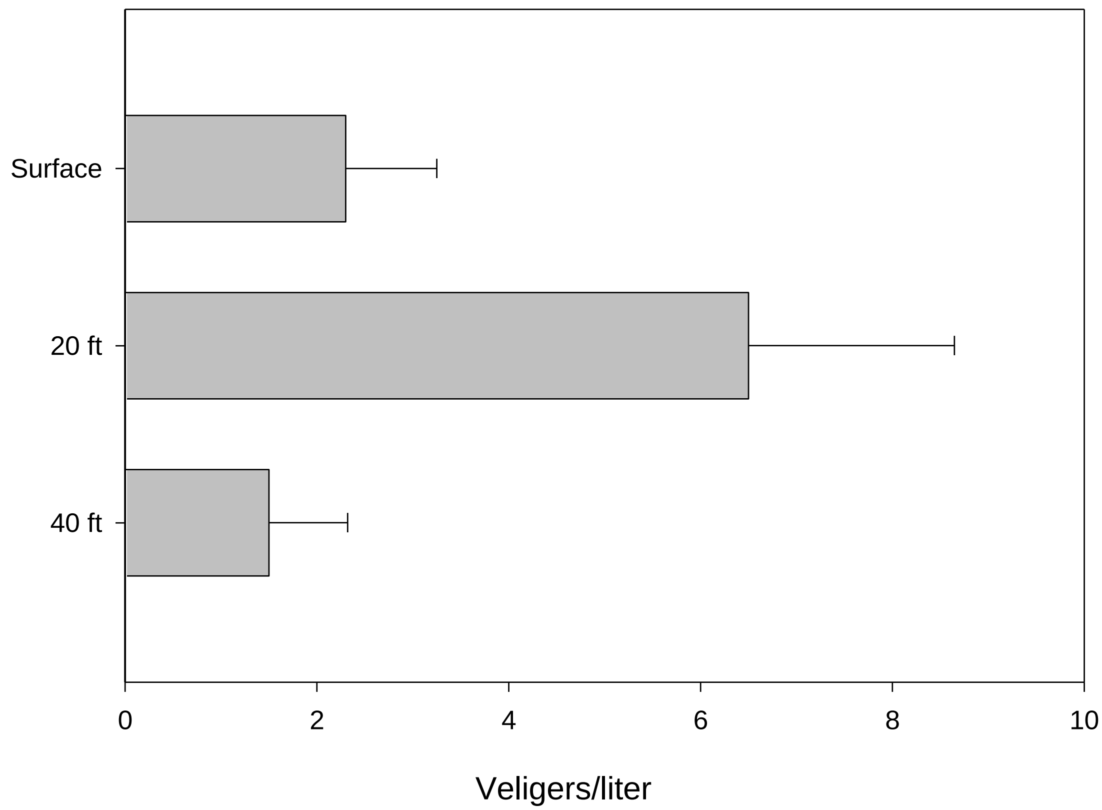

Figure 5. Mean veliger densities (+1 standard error) at three depths. Samples were taken at 5 transects along the lake at 3 different dates. Differences are not statistically significant.

Recommendations:

One of the objectives of the project was to be able to provide some guidance for the Village of Cooperstown as it begins to address how they will deal with the introduction of zebra mussels into Otsego Lake. Because the Village has raw water intakes in the lake, they will certainly have to deal with biofouling of external structures and within the intake pipeline.

The good news is that the Village's intake pipe is located in the south end of the lake. Our data suggest that veliger abundances are relatively low at this end of the lake. The bad news is that the intake sits at a depth where we tended to find highest densities of veligers. Comments from the Volunteer Dive Team confirm that mussels are indeed fouling the intake pipes. The other factor to consider is that veligers are present in the water column beginning in late May and likely through September.

1) The Village should continue to "pig" their pipe to remove any adults mussels in the line. Based on the timing of the veligers appearing in the water column, we suggest that at a minimum that two cleanings take place. Guessing at the growth rate of the mussels that settle on the inside of the intake pipe, significant fouling could begin to occur from the first reproductive event by August. Due to the second reproductive event, the last cleaning should take place as late in the year as is safe for those involved. It should certainly wait until late October. This would give time for the mussels that settled through September to grow enough to be effectively removed by the "pig". If the budget allows, an early spring cleaning would be effective at removing any missed mussels from the previous year. Other data suggest that the mussels do grow slowly through the colder winter months.

2) Residents of Cooperstown and the surrounding towns should be alerted to the possibility that their water intakes are particularly susceptible to fouling by zebra mussels. Homeowners should consider filters all year round, and inspections of their pipes at least yearly. The OCCA website provides a nice source of information for standard household water users.

3) The impact of zebra mussels on lake users and the ecology of the lake can't be predicted without further data on the mussel population.

    A) Veligers should continue to be monitored. Spatial and temporal factors need to be considered when designing monitoring efforts. Our data suggests that depth is a factor to consider. They also suggest that a few sites in the lake are inadequate to estimate abundances.

    B) The adult population needs to be monitored. Given the patchiness of the veligers, it is necessary that an intensive lake-wide effort is needed to determine the spatial pattern of the mussel distribution. The anecdotal data reported by the BFS is not adequate to determine the potential impacts on Otsego Lake. Other data such as size distribution and filtering capacities should also be explored.

Acknowledgements:

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Please do not use these data without permission from Dr. Thomas Horvath.