Follow-up Survey for Asian clams (*Corbicula fluminea*) in Owasco Lake, Cayuga County, NY

A Report to the Cayuga County Soil and Water Conservation District, Cayuga County Dept. of Planning and Development, and the Owasco Lake Asian Clam Task Force

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10 September 2012

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Executive Summary

We surveyed targeted areas of Owasco Lake, Cayuga County, NY, to determine the presence, general distribution, and limited information on abundance and population size structure of Asian clams (*Corbicula fluminea*) in July of 2011. We were requested to repeat the survey in July 2012, with the intention of increasing the precision of the survey results. As in 2011, survey methods were qualitative and based on previous sampling conducted by us and by members of the Owasco Lake Asian Clam Task Force. Surveys were conducted by divers with the assistance of the Owasco Lake Asian Clam Task Force and Cayuga County. Spot checks were conducted at points along the lake shore that were possible sites for Asian clams based on depth and sediment profiles.

Asian clams were once again found to be limited to the very northern portion of the lake in a shallow bank composed mainly of sand and silty sand. Although 2011 estimates placed the areal extent of the population at about 123 acres (49.8 hectares), in this survey we estimate that Asian clams occupy an area of no more than 160 acres (64.8 hectares). The area occupied by clams is shallow, approximately 3-8 feet (0.9-2.4 m) deep in some areas and mostly free of vegetation. The clam population is slightly deeper in the sandy area south of Emerson Park beach, maximum depth achieved during our survey was 10 feet (3 m) and the population is certainly shallower than that.

Clams in the densest assemblage, west of the Owasco River / Owasco Lake outlet, had a mean density of just less than 429 per m^2 and a maximum density of approximately 1535 per m^2. Lengths of these clams ranged from just over 6 mm to nearly 19 mm, some obviously young of the year or young second year clams but some that had clearly overwintered. The population was dominated by young clams suggesting once again that winter mortality has been significant but that the clams surviving the winter have reproduced. Conditions for survival in Owasco Lake are discussed as are supplemental data on clam size and population structure.

Management of lake levels may be the most prudent means for eradication unless there is a deeper water refuge as yet unidentified. If lake levels could be reduced by 5 or 6 feet and were accompanied by a cold winter with ice cover of 18-24 inches, we believe that most of the current invasion of Owasco Lake could be eradicated. Discussion on possible mitigation is provided.

Acknowledgments

We were assisted greatly by the following people:

Bruce Natale, Cayuga County Dept. of Planning and Development
Michele Wunderlich, Cayuga County Dept. of Planning and Development
Ed Wagner, Owasco Town Supervisor, Cayuga Community College, Auburn Doubledays, Owasco Lake Asian Clam Task Force and Vessel Captain
Dick Coalson, Owasco Lake Asian Clam Task Force
Don Seitz, Auburn Skin Divers
Katie Jakaub, Owasco Lake Inspector
Robert Brower, Institute for the Application of Geospatial Technology at Cayuga Community College

Partial funding for this project is supported by a grant/cooperative agreement from the U.S. Department of the Interior, Fish and Wildlife Service.

Introduction

Staff of Cayuga County contacted Mr. Resler and Dr. Marelli in the summer of 2012 to inquire about representatives of the Darrin Fresh Water Institute repeating the 2011 Asian clam survey of Owasco Lake and once again providing training in surveying and identifying the clams. The local Asian Clam Task force, in addition to their preliminary surveys of 2011, had conducted additional sampling in the northwest portion of the lake. We had recommended doing this in our 2011 report to further or more accurately define the deeper limit of Asian clams and the total areal coverage in the lake. The DFWI team was once again composed of Steve Resler, InnerSpace Scientific Diving, Dr. Dan Marelli, Scientific Diving International and Brett D'Arco, graduate student at DFWI. Our intent was to resurvey the Asian clam population, better define its depth distribution, geographic boundaries and make observations on the population structure in the lake. We also proposed to again estimate the density of Asian clams in the targeted area and to provide information on how to identify, sample and survey for Asian clams. Finally we proposed to provide information about the environments inhabited by Asian clams in Owasco Lake.

Methods

Targeted areas of Owasco Lake, Cayuga County, NY, were surveyed for the presence and general distribution of Asian clams (*Corbicula fluminea*) July 30-August 2, 2012. Survey methods were qualitative and based on preliminary sampling conducted by the members of the Owasco Lake Asian Clam Task Force as well as the survey conducted by the DFWI team in 2011. A series of shore based points were chosen and assigned geographical reference data. Points were located every 1/8 (0.125) mile (0.2 km) along the shoreline to the east and south and also to the west and south starting where the Owasco River / Owasco Lake outlet leaves the lake. An additional mile of shoreline was added to each end of the target area in an effort to fully survey the Asian clam population. Origin points of every ¼ (0.25) mile (0.4 km) were chosen to conduct surveys and additional origin points were held in reserve in case a finer detail was required in an area. Surveys were conducted by divers with the assistance of the Owasco Lake Asian Clam Task Force, which provided a vessel, captain, and volunteer divers.

At the preselected origin points the survey team navigated close to shore but the assumption was that the deeper limit was most important, so transects usually began in water depths of approximately 1 meter (3.3 ft). A dive team entered the water and followed a compass bearing provided by the surface data collector (Brett D'Arco of DFWI). Brett chose a bearing that was approximately perpendicular to the lake shore and communicated this with the dive team. Brett followed the dive team in a kayak flying a diver down flag. The team carefully swam along the bearing that represented the transect and conducted a qualitative survey progressing from shallow to deeper water. Along the transect divers fanned the bottom sediments or sieved sediments every few feet using a 1 mm sieve to search for Asian clams. When the dive team determined that the distribution of Asian clams had stopped a signal was given to the surface data collector and the end point was identified using a hand held GPS unit. Divers made every attempt to be conservative so that we were confident in the end points. Relative numbers of clams seen were recorded by the surface data collector as were the starting and ending depths of each survey. Substrate type was qualitatively determined by the dive team as was vegetative abundance and presence of native clams. Surveys were conducted on days one, two, and three.

Following completion of transects we conducted spot checks on the site just south of Burtis Point on the east side of the lake. In 2011 we had determined that this was the only other suitable site for Asian clams based on substrate type in the north end of the lake. At all sites representative samples of native clams and snails were collected for later identification.

On day three we conducted quantitative sampling for Asian clams in an area west of the Owasco Lake outlet. Similar quantitative sampling had occurred in the same region of the lake in 2011, but 2012 samples were collected approximately 100 meters nearer to shore than in 2011. Once again the goal was to demonstrate the methods for conducting quantitative density surveys and also demonstrate a method for collecting finer scale distributional data. At each of 15 haphazardly chosen sites in the study area we tossed a ¼ m^2 quadrat into the water. We gathered geographical reference data for the center of the quadrat and then took sediment cores from 3 haphazardly chosen points within the quadrat. The coring device consists of a length of 3" ID PVC schedule 40 pipe with an end cap that has a ½" hole drilled through it. The area of the core is 45.6 cm^2 or 1/219.3 of a square meter and the core is taken to a depth of 10 cm. Coring is done by pushing the core tube into the substrate, covering the tube with the cap, placing a finger over the vent hole and withdrawing the contents. Contents were retained whole in the field and transported to the biology lab at Cayuga County Community College. In the lab the samples were sieved using a 1 mm sieve and materials retained on the sieve placed in sorting trays. A team of volunteers sorted all mollusks and Asian clams from the sieve contents. Both live and recently dead Asian clams were counted and the length of each live clam was measured to the nearest 0.1 mm. Other mollusks were retained to add to knowledge about the native fauna. Core data were used to generate density estimates and produce a size frequency plot for the population.

Finally on day four we conducted a qualitative survey along a line to the west side of the Owasco Lake outlet and going from south to north. The purpose was to gather more information on size of the clams and populations structure as well as information on numbers of live clams versus recently dead ones. Because the transect extended from deep to shallow across an elevation change of nearly 1 meter it also allowed comparison of the population structure in the transition zone from outside a prominent bar feature, on the bar and inside of the bar. Five stations were sampled and each had 5 haphazard replicates taken for a total of 25 samples. For each replicate a diver dragged a sieve bucket through the sediment twice and sieved the contents in the field. All material retained by the sieve was collected in bags and returned to the DFWI lab in Bolton Landing, NY. In the lab each sample was analyzed for number of living and recently dead Asian clams and the length of each living clam was measured to the nearest 0.1 mm.

Survey data was plotted using Google Earth by importing the gpx file from the hand held GPS unit used in the field. Transects were created by connecting the start and end point taken by the surface data collector. The transects were then given a color scheme, red for Asian clam presence and black for no Asian clam presence). Areal extent of the Asian clam population was

estimated by drawing a polygon via heads up digitizing. The shoreline was traced for the landward edge of the area and the ends of the transects were used to determine the lakeward edge. The boundary used to delineate presence or absence of Asian clams was half way between a transect with clams and one without. Coring data was plotted by using the outer most points, taken by the surface data collector, to create a polygon representing the coring area. The areas were given a color scheme based on the year sampling occurred. The sieve transect was created by connecting the points of the first and last sieve taken by the surface data collector.

Results and Discussion

Living Asian clams were located at the northern end of Owasco Lake in shallow water of depths ranging from 3 to just less than 10 feet (0.914 to 3.05 m). There are basically two population groups in the lake, one to the east of the Owasco Lake outlet and one to the west of the outlet.

Sediments in the northwest portion of the lake are sandy inshore and sandy with silt in the deeper areas. At approximately 10 feet of depth (actually probably closer to 10.3 feet since the diving depth gauges are calibrated in feet of seawater) the sediment becomes soft and rooted vegetation becomes prominent. The western population is the largest in areal distribution and extends to a greater depth in the lake, probably because of the profile of the lake bottom and the available sandy sediment in this area. The western population is also the densest in terms of numbers of Asian clams per unit of bottom area.

In the northeastern part of Owasco Lake sediment is sandy inshore but becomes more silty and softer offshore more quickly than on the western side. As a result vegetation becomes more prominent in shallower areas on the eastern side. Normally this would mean that Asian clams would not occur in the softer, sediments and vegetation. However beneath the soft sediments and vegetation in the northeast region of the lake is a hard clay layer which is may be the result of sediment input from Sucker Brook for thousands of years. The clay layer allows Asian clams to be supported near the surface of fine sediments where they can respire and feed from the water column and survive in this marginal habitat. We have observed the same phenomenon in Lake George where bedrock is overlain by soft sediments or where rhizome mats of the pipewort plant, *Eriocaulon septangulare* occur.

In 2011 we estimated that Asian clams occupied a total of approximately 123 acres (49.8 hectares. Our survey probably missed some of the low density population in the northeast portion of the lake near Sucker Brook and also some of the deeper animals in the northwest portion of the lake. We currently estimate that no more than 160 acres (64.8 hectares) of lake bottom contain Asian clams but that in much of that area the density is very low. The vast majority of the population continues to reside in the sandy sediments south of Emerson Park beach.

A spot check of the cove south of Burtis Point along the eastern lake shore did not locate any Asian clams nor did we locate empty shell in this area. It is our belief that the population has not been transported to the Burtis Point area.

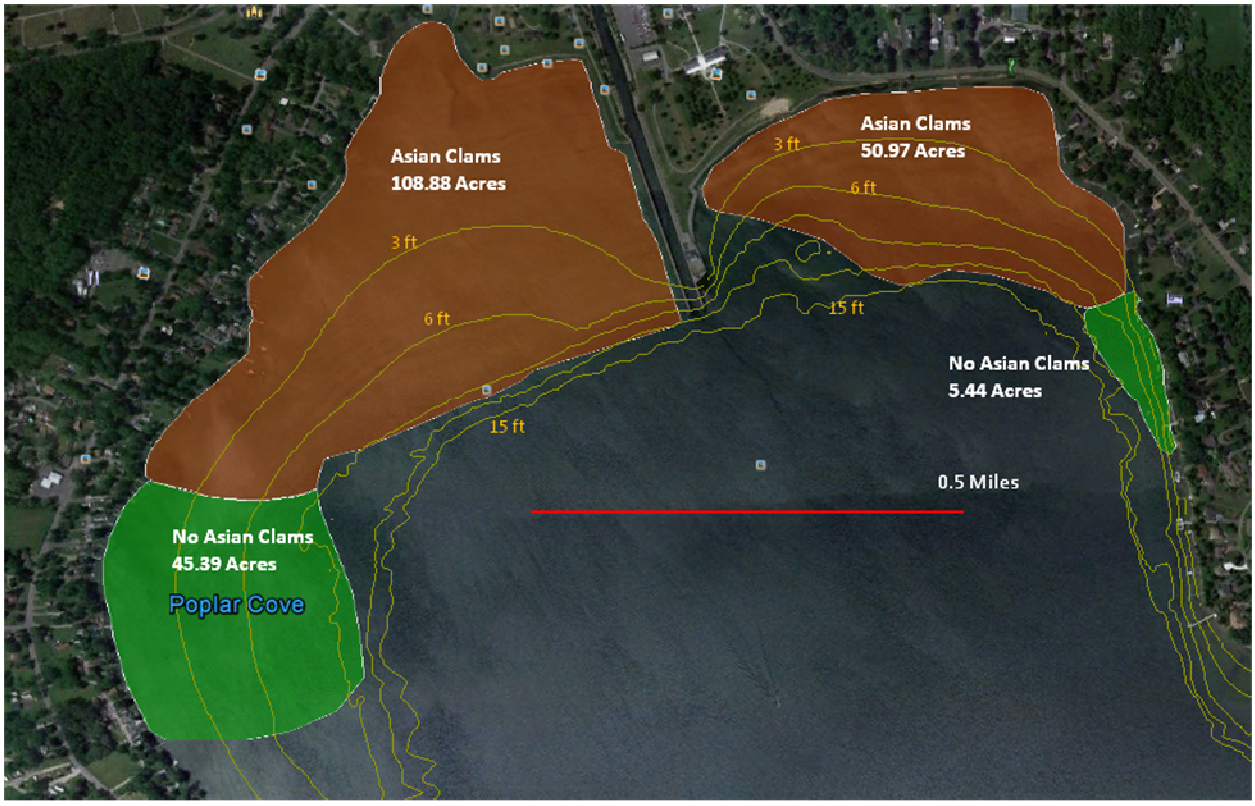
To generalize the environment occupied by Asian clams, bottom sediments in the northern end of Owasco Lake are mainly sand and silty sand in the shallow areas of the lake. As the bottom becomes deeper sediments become finer, softer and populated with rooted plants and algae. No clams were found in the softer plant choked sediments with the exception of those underlain

by clay near Sucker Brook. We did not do a formal aquatic plant survey but Owasco Lake seems to have typical communities for lakes of this latitude. The green alga *Chara* forms dense patches in many areas that we surveyed.

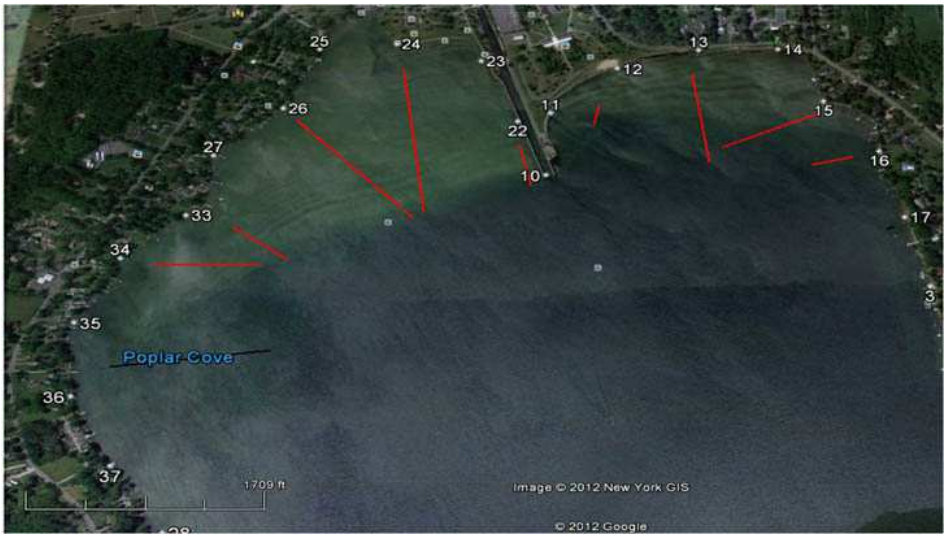
Northern Owasco Lake estimated Asian clam distribution. Depth contours are in 3 foot increments.

The areal distribution of the Asian clam population in Owasco Lake is approximately 160 acres (49.8 hectares). This is somewhat misleading since the areal estimates interpolate between data points and the actual extent of the clam population is most likely smaller than 160 acres. Raw presence and absence data collected during transects may be valuable in understanding where clams were found versus where the graphical chart interprets where clams may be.

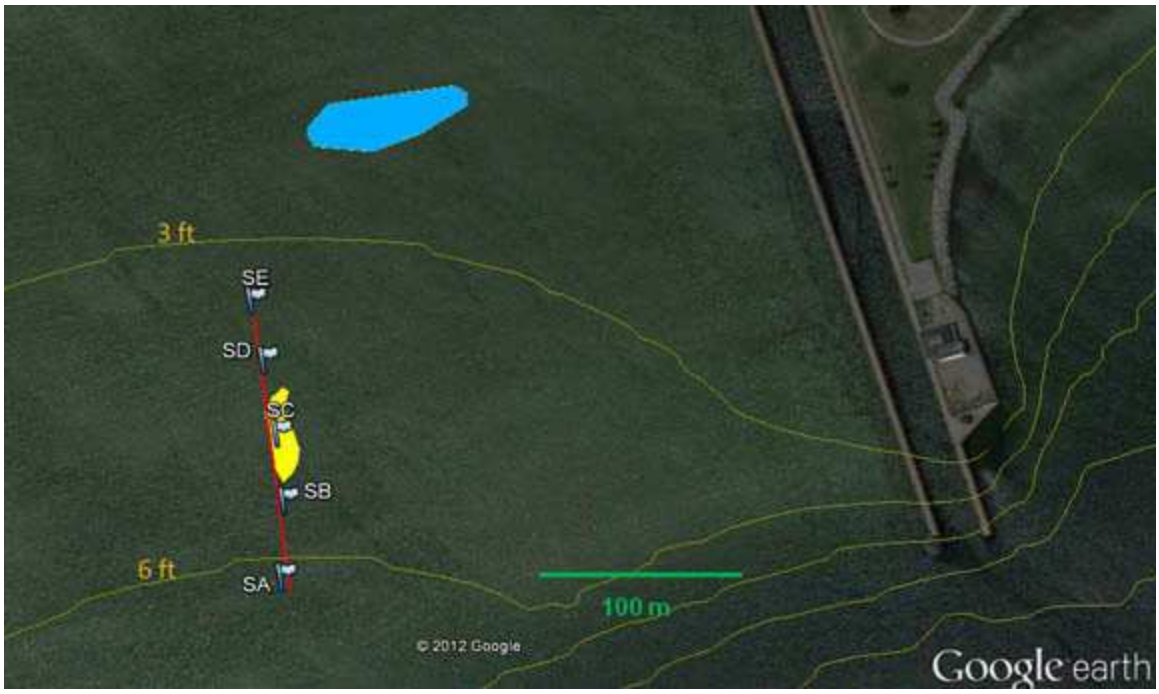
Asian clam transect data 2011. Red indicates presence of clams.



Northern Owasco Lake estimated Asian clam distribution. Depth contours are in 3 foot increments.

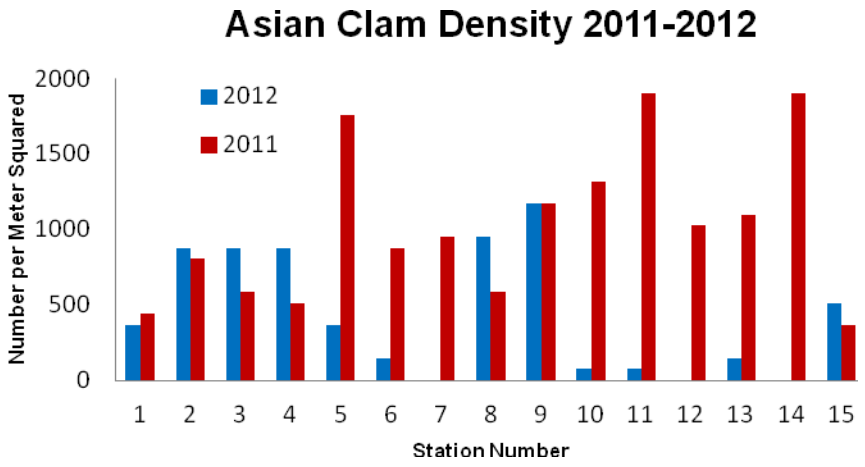


Asian clam transect data 2012. Red indicates presence of clams.



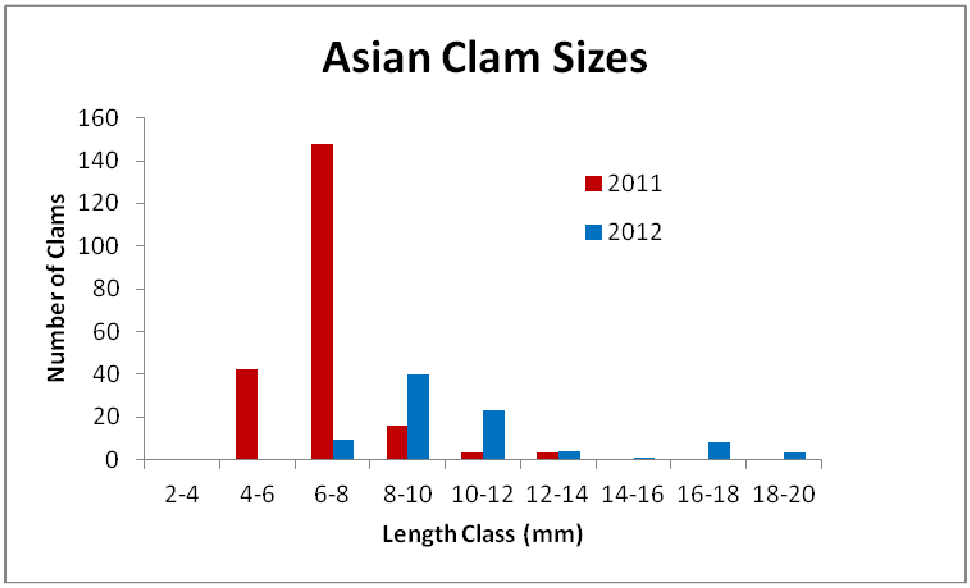
The yellow area represents the core sampling area for 2012. The teal area represents the core sampling area for 2012. The red line shows the transect along which the sieve samples were taken.

Mean Asian clam density in the quantitative sample area was 428.81 per m^2. In 2011 we reported a mean density of over 1018 clams per m^2, supporting our general observation that Asian clam density is lower compared with 2011. The core data had quite a bit of variance and in fact 16 of the 45 cores had zero clams in them. Highest density in an individual core was 1534.96 per m^2 Once again our conclusion is that there are occasional dense centers of population in Owasco Lake but overall the population is much less dense than populations reported from other high latitude lakes such as Lake George.



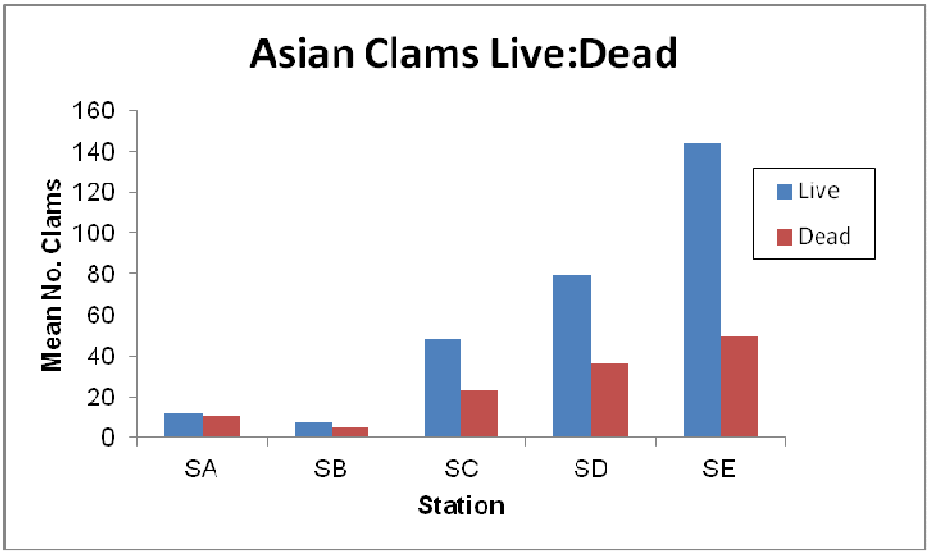
Quantitative Sampling Data 2011-2012 Mean Clams Per Station

The lengths of clams collected during the coring study ranged from 6.4 to 18.66 mm (0.25 to 0.73 in) and had a mean size of 10.66 mm (0.42 in). Asian clams in Owasco Lake are generally larger in 2012 than they were in 2011. Once again there were a number of empty shells including recently dead clams where shells were still connected or articulated.



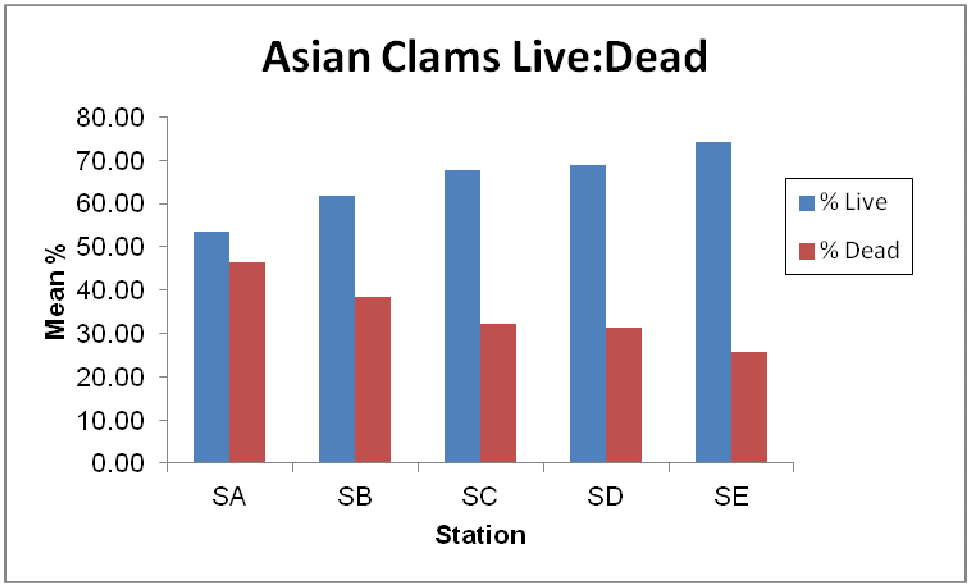
Size-frequency Plot of Asian Clams 2011-2011

The qualitative transect data revealed some very interesting information about the Owasco Lake Asian clam population. We collected 2071 Asian clams, 1453 of which were live and the mean ratio was 70.16% live to 29.84% dead clams. But plotting the ratio along the transect axis from deep to shallow revealed that there was an effect of location on the abundance of Asian clams and also on the ratio of live to dead clams. Numbers of all clams increased as samples got closer to shallow water, but the rate of increase for live clams was much more rapid. These results would certainly be significant if analyzed using linear regression.



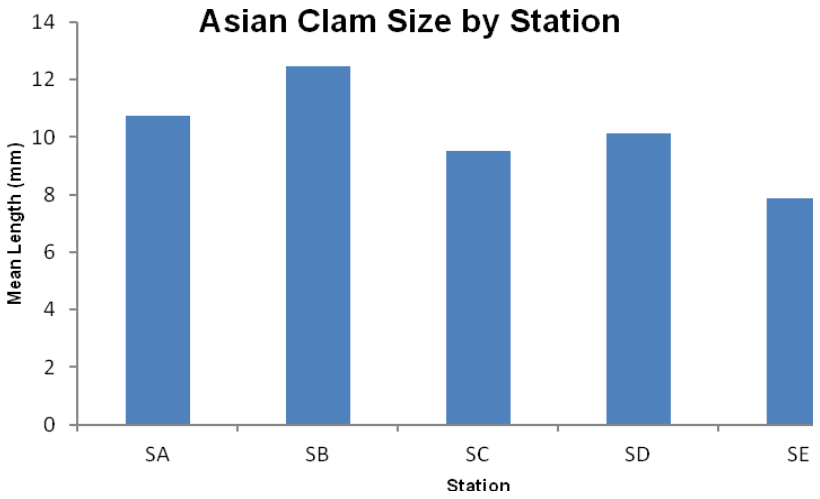
Mean Number of Live and Dead Asian Clams by Sample Site, 2012

When the percentage of living clams versus dead clams was plotted by station number the mean ratio also demonstrated a consistent increase from the deeper end of the transect, approximately 54% to the shallower end where the live:dead ratio was over 74%.



Mean Percentage of Live and Dead Asian Clams by Sample Site, 2012

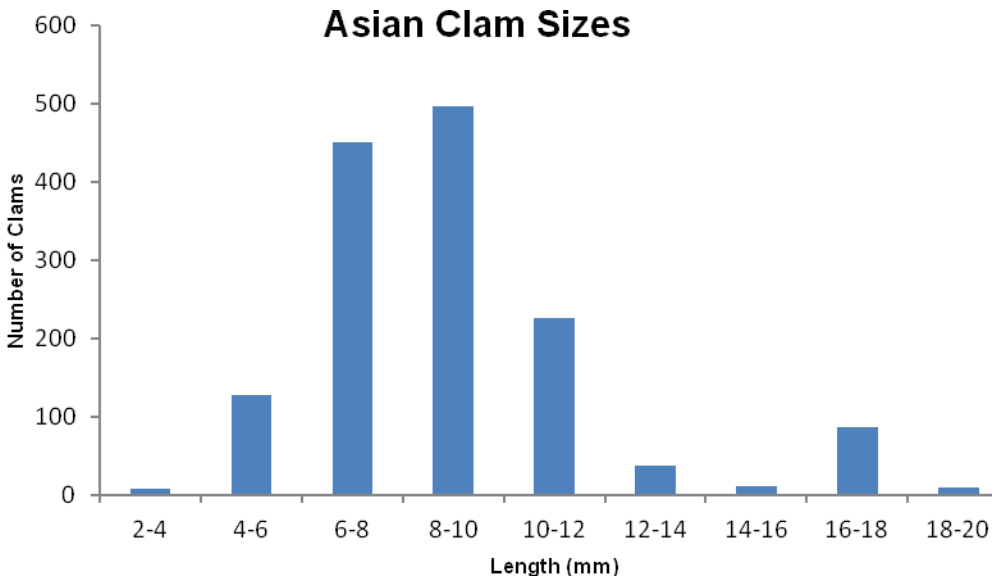
When the mean size of the clams along the transect was examined it became clear that size was also related to sample site and that the mean size of the population in length decreased as site got shallower. These results are surely significant as an analysis of variance could demonstrate because calculated standard errors reveal very little variance in the data. The only outlier would be site SB, where clam density was least and variance in shell length was



Mean Size of Live Asian Clams by Sample Site, 2012

greatest. Site SB located on a significant sand bar feature that seems to be a difficult place for Asian clams to live, probably as a result of the dynamic aspect of the substrate when impacted by boat wakes and wind waves. Considering all of the data for the transect together they suggest that abundances increase and size decreases as water depth decreases or as the transect moves towards Emerson Park beach. To us this suggests that smaller clams are being transported shoreward to areas where mortality was undoubtedly greatest during the late fall 2011 to early spring 2012.

Finally, we plotted the length-frequency of all 1453 Asian clams collected on the transect. The population structure is informative and supports our observation that Asian clams are larger in Owasco Lake in 2012. These data suggest two size or age cohorts in Owasco Lake, a small population with a mean length distributed around 16-18 mm and a smaller cohort with a mean length distributed around 6-10 mm. In 2011 we did not observe the larger cohort, although they were probably there in low numbers, and the smaller cohort was distributed around a length class of 6-8 mm, slightly smaller than the clams younger clams we sampled in 2012. These data suggest that the 2011 smaller cohort has grown up but also that it has suffered significant cold weather mortality. The smaller cohort undoubtedly represent young of the year i.e., spawned in 2012. That they are slightly larger may indicate that conditions were more favorable for growth in 2012.



Length-Frequency Plot of Live Asian Clams, 2012

The 2011 Asian clam population was also dominated by young of the year. Data continue to suggest that there is massive winter mortality in the population but that a portion of the population survives to reproduce in the spring. Our hypothesis is that Asian clams are able to tolerate the cold winter lake temperatures by living in areas that are protected by groundwater, either in the form of springs or sheet flow through porous soil or above impervious substrates from higher elevations. As mentioned in the 2011 report, the Asian clam is at or near the northern end of its available range in the Finger Lakes and Great Lakes region, but our

experience in Lake George leads us to theorize that certain habitats are available for and conducive to invasion of Asian clams. Sediment character (grain size) is important, but equally important in this climate zone appears to be the presence of groundwater sources seeping into the water body. Groundwater temperature at the latitude of Owasco Lake is probably in the range of the lower 50s F. This seems cold in the summer, but may be essential to survival of some of the Asian clam population in the winter. This may be why there are large numbers of empty shells in the lake sediments but very few large clams. Groundwater seepage may support the winter refugia, as we suspect they and anti-icing circulators do in Lake George.

One issue that we addressed in 2011 was the depth distribution of the Asian clams in Owasco Lake. Additional data collected by task force members and data gathered during the 2012 survey by the DFWI and task force team allow us more confidence in the distribution of the population at the north end of the lake, which should factor into decisions on mitigating the threat.

While smaller, younger live clams were found in relatively high numbers in sandy areas nearer shore and larger older clams were more prevalent in areas farther from shore, larger empty clam shells are also distributed throughout the sandy sediments in the northwestern part of the lake offshore of Emerson Park. This relatively dynamic sandy area with winnowing and slightly shifting sands does not ordinarily provide an ideal substrate for the attachment and survival of zebra mussels (*Dreissena polymorpha*). Zebra mussels do however readily attach to both empty and live Asian clam shells. We observed significant numbers of zebra mussels attached to live and empty clam shells during our 2011 survey of the area. We did not conduct a quantitative survey of zebra mussels in the area, however, it appears that the quantity of zebra mussels attached to empty and live clam shells is substantially higher in 2012 than in 2011. The many tens of thousands of live and empty clam shells in the shallow area near Emerson Park provide a highly suitable attachment substrate and also a source of necessary calcium for the settlement and survival of juvenile zebra mussels. Once established on an Asian clam shell the zebra mussel colony will continue to grow in size unless killed by winter ice. This is cause for concern, as significantly high numbers of zebra mussels attached to clam shells are not aesthetically pleasing, and the sharp edges of live mussel shells and empty shells and shell fragments may render this area unsuitable for primary contact recreation such as wading or other important uses involving physical human contact with the substrate.

Typical Attachment of Zebra Mussels (*Dreissena polymorpha*) to a *Corbicula* Shell

As part of the survey we identified other mollusks within the survey area. Information on other mollusks in Owasco Lake will be important in future lake surveys, research, and public outreach efforts. We did not locate any shells or live animals of the native mussels *Pyganodon grandis* or *Lampsilis radiata radiata*, which is of some concern. *P. grandis* and *L. radiata radiata* were reported as occurring in Owasco Lake by Harman and Berg (1970).

Mollusks of Owasco Lake

Bivalves

Sphaeriidae

Pisidum compressum	Ridgeback peaclam
Pisidium nitidum	Shiny peaclam
Pisidium casertanum	Ubiquitous peaclam
Sphaerium striatinum	Striated fingernailclam
Sphaerium nitidum	Arctic fingernailclam

Unionidae

Pyganodon grandis	Giant floater
Lampsilis radiata radiata	Eastern lampshell

Gastropods

Campeloma decisum	Pointed campeloma
Viviparus georgianus	Banded mysterysnail
Bellemya chinensis	Chinese mysterysnail
Pleurocera acuta	Sharp hornsnail
Planorbella campanulata	Bellmouth rams-horn
Physa spp.	
Valvata spp. (at least 2 species)	

Management

As we indicated in our 2011 report and discussions with members of the Owasco Lake Asian Clam Task Force, management of lake level may be the most prudent and least expensive means for eradication unless there is a deeper water refuge as yet unidentified. If lake levels could be reduced by 5 or 6 feet and were accompanied by a cold winter with ice cover of 18-24 inches, we believe that much of the current invasion of Owasco Lake could be eliminated. Subsequent spring or early summer surveys would confirm the success of the strategy. If lake drawdown alone does not eradicate Asian clams, limited benthic barrier matting may be considered concurrently with another lake drawdown during the winter of 2012-2013.

Benthic barrier mats might be used to eliminate populations that occur in the deeper areas of the northwest region of the lake. Under the most optimistic scenario those clams would not be affected by a drawdown combined with the typical winter ice cover and they are probably also being protected by ground water flow that keeps the minimum temperatures high enough for clams to survive. Benthic mats have been used in Lake George, NY and in Lake Tahoe, NV to smother and eliminate those populations. Benthic barrier matting is designed to lower dissolved oxygen in substrate to the point where the clams are suffocated. To ensure that the more waterward populations of clams are not provided an opportunity to spawn and establish new populations in the shallower near shore areas where they had been eliminated during the winter

through water level drawdown and freezing, mats could be deployed immediately after winter ice-out before water temperatures increase to the point where they become reproductively active and have the opportunity to reproduce.

There are several reasons why the deployment of benthic barrier mats in the early springtime immediately after ice-out is favored over the deployment of mats during the late fall or early winter. Water temperatures immediately after ice-out have been near freezing for several months and remain low. The density of rooted benthic vegetation extending above the substrate would be significantly lower during this time because most of it would have died off during the fall and winter and not yet regrown, nor would new plant growth be established. Certain rooted vegetation would also have been dormant for several months. And metabolic activity of benthic organisms living in or otherwise using the substrate would be substantially lower. This would significantly reduce the amount of methane gas that would be produced through decomposition under benthic barrier mats. The production of methane creates gas "bubbles" under the mats, lifting them from the bottom and allowing greater volumes of water and the exchange of oxygen and other gases under them. This is an important consideration in the process of determining when to mat benthic areas. Mats are traditionally held down or ballasted using iron rebar or sandbags. These materials weigh down and seal the edges of the mats. Benthic mats that are not securely ballasted and are partially lifted from the substrate also mimic the effects of a "bellows" as they are moved slightly up and down by slight pressure changes created by surface waves and wave troughs passing over the mats. This "bellows" effect pumps water in and out from under the benthic mats. The mats therefore require considerable maintenance to ensure they lie as flat as possible over the substrate and to ensure their edges are adequately sealed by ballast to reduce exchanges of water from under and outside of the mats and to ensure that volumes of water and gases under the mats are limited. Our experiences and the results of our monitoring of benthic mat techniques in Lake George indicate that levels of mat maintenance are significantly reduced by deploying benthic barrier mats as early as possible after ice-out, when less organic material is available for decomposition, rather than later in the spring or summer season when aquatic vegetation is growing rapidly and populations of benthic organisms are higher. However, along with adequate maintenance, deploying mats during the late summer through early fall can also be successful when there would be considerably more organic material under the mats that would use up available levels of oxygen, while also producing relatively high levels of ammonia through the decomposition of plant and animal matter, further providing an inhospitable environment for Asian clams and other organisms under the mats. Because deploying mats during this season would result in higher volumes of gases resulting from decomposition, the mats would require considerably more maintenance to purge gases from under the mats than would be required by deploying them immediately after ice-out.