ACORN (Asian Clam On the RuN)

Understanding in-lake transport of Asian clams

Report to the Lake George Park Commission
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Asian clam distribution in Lake George has been somewhat limited to a number of localized areas. The transmission of clams from one location to another is of particular concern given the desire to restrict Asian clam inhabited areas to as few locations as possible. The goals of this series of experiments were to examine the potential transport of clams within the Lake from one location to another. This research project focused on three modes of transport. The first mode of transport examined was related to anthropogenic activity; boat anchor sediment transport and boat propwash transport. The second mode of transport examined was through natural means. Three experiments were carried out to identify what impact natural wave action has on Asian clam transport. Second, an experiment was conducted to identify the amount of transport potential of Asian clams from within the water column via floating or use of a byssal thread. A third experiment was conducted that studied plant material as a potential transport mechanism. Lastly, experiments were performed to provide preliminary information on the settling rates of juvenile Asian clams.

1 BOAT ANCHOR EXPERIMENT

1.1 INTRODUCTION

Boat anchors have the inherent ability to collect some amount of sediment and transport it from one area where a boat is anchored to another area within the Lake. In an event that a boat anchors in an Asian clam inhabited location and moves the sediments to a non-populated location, sediments on the boat anchor would serve as a potential vector for transport if Asian clams are associated with the sediments. The potential of this process being a transport vector was tested with a series of experiments with the ultimate goal of answering the question, "**Can Asian clams be transported with sediments associated with anchors**?"

1.2 MATERIALS AND METHODS

Surveys were undertaken at four locations (Chelka Lodge, Norowal Marina, Pine Point and Park Lane Motel). At each site anchors were deployed and retrieved, sediments were washed off of the anchor, retained and preserved for analysis in the lab. In the lab, sediments were

microscopically examined for the presence of Asian clams. The likelihood of transport was calculated by identifying what percentage of the anchors that were deployed had Asian clam (adults or juveniles).

1.3 Results

It was determined that Asian clams were associated with anchor sediments. Microscopic (>2mm) and macroscopic (up to ~12mm) Asian clams were found in the sediments on anchor pulls. The percent of samples that contained Asian clams was related to the population size and abundance in each location. Asian clams were found frequently in locations where populations were very dense, at Pine Point (80%) and Park Lane Motel (70%). The anchor sediments were less likely to contain Asian clams where the populations were smaller, Chelka Lodge (10%) and clams were not found in anchor sediments at Norowal Marina (0%).

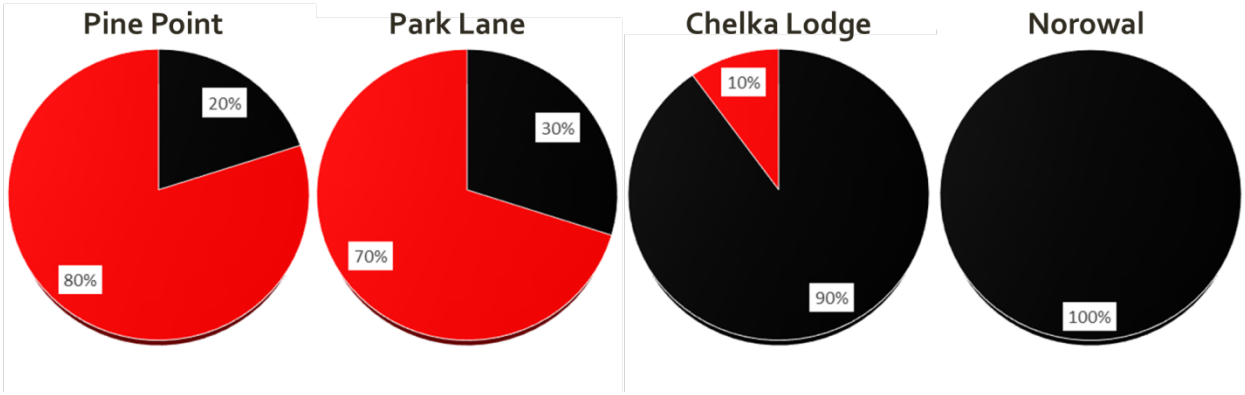

Figure 1. Percent of samples with Asian clams in anchor sediments at different locations within Lake George. Percentages generally correlated with the abundance of clams at each location.

1.4 Implications

These data demonstrate that Anchor sediments from Asian clam inhabited areas can pose a vector for in-lake transport of the species.

2 Propwash Experiment

2.1 Introduction

Boat traffic through Asian clam inhabited areas was proposed as a potential method for Asian clams to spread throughout the lake. The vector proposed is that the clams would be suspended in the water column after being scoured from the sediments. The closest surrogate of this mechanism was to measure the distance clams would travel from a motor of a stationary

boat that was put into gear for 30 seconds. The goal of this experiment was to **"Determine the distance clams travelled due to propwash"**.

2.2 Materials and Methods

In shallow water (1.5m) parallel to the shore at the Chelka Lodge site a benthic barrier mat with distance markings (in 2m increments) was placed on the lake bottom. A boat was tied to the dock so that when the motor was put into gear the boat would not move but the sediments that come into contact with the propwash would move. Three trials were performed where a group of 50 clams were placed approximate 0.25m from the propeller in the propwash area and the engine was put into gear for 30 seconds. All clams on the benthic barrier mat were recovered and the distance traveled within 2 meter increments was recorded. A second setup that included sediments with the population of clams was performed but was not successful because the sediments were too light to be retained only to the confines of the mat.

2.3 Results

In each of the three trials of the propwash experiment all of the clams that were retrieved were within 4 meters of the engine. An average of 89% of the clams from the experiments were recovered, some clams were observed immediately outside of the matted area but were not quantified because they were not within the controlled area. The average abundance of the identified clams in the 0-2 meters zone from the engine during the three trials was 26%. The percentage in the 2-4 meter zone was 74% and no clams were found beyond that area. Size class analysis revealed that clams as large as 15-16mm in size can be transported at least 0-2 meters from the prop. Additionally that clams 14-15mm in size can be transported 2-4 meters from the prop.

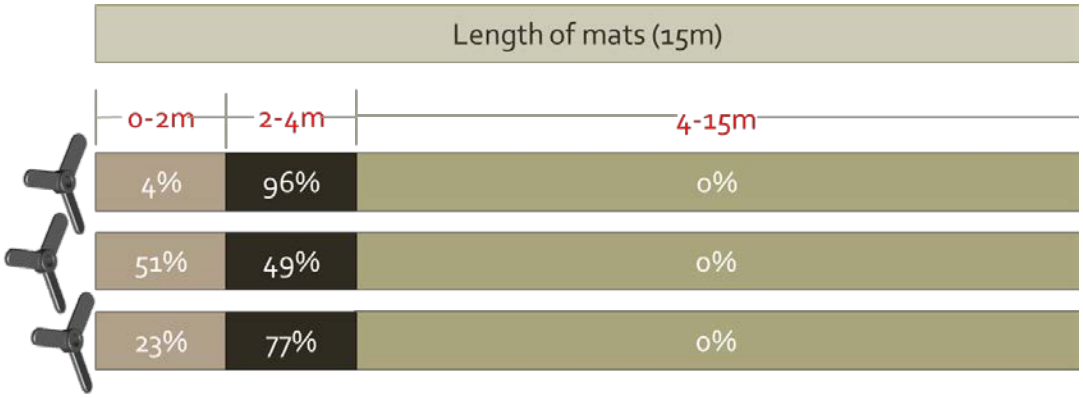

Figure 2. Distances travelled by Asian clams from a revving boat engine.

2.4 Implications

The results of this experiment imply that while boat propwash may have some effect on Asian clam movement it is not likely a primary mechanism for long range transport in the lake.

3 Plant Matter Experiment

3.1 Introduction

When littoral zone plants die their biological mass tends to float to the surface and are carried with the water/wind to potentially distant locations. We hypothesized that Asian clam juveniles may use this floating plant mass as a vector for transport over long distances within Lake George. The goal of this experiment was to answer the question, **"Are plants a transport mechanism for Asian clams?"**.

3.2 Materials and Methods

Two approaches were employed for studying the plant matter and Asian clam relationship in Lake George. First, in areas where Asian clams were found a canoe transect survey was conducted where all plants floating on the water surface were collected. The plants were returned to the lab and examined microscopically to determine if any Asian clams were associated with the floating plant mass. Second, in conjunction with a point intercept rake toss survey in Asian clam inhabited areas, all of the plants were collected and examined microscopically to determine if Asian clams were present in the collected plant material.

3.3 Results

No live Asian clams were found in the canoe transects for senesced plants. Asian clams were found in the plants from the point intercept survey at each of the locations, Shepard Park Beach, Middleworth Bay and Norowal Marina.

3.4 Implications

These data imply that Asian clams may use plant material as a transport vector. While this method has been verified there was very little evidence to conclude that this is a primary vector for the dispersal of Asian clams in Lake George.

4 WAVE ACTION LOCAL DISPERSAL EXPERIMENT

4.1 INTRODUCTION

The distance Asian clams can move along the bottom sediments is unknown for the conditions in Lake George. When Asian clams spawn, juveniles can be released into the water column where they are suspended for some amount of time or can be deposited immediately adjacent to the parent clam. This experiment examines the scenario where juvenile clams are released into the sediments directly and transported with wave action. The goal of this experiment was to answer the question, **"How far can Asian clam juveniles be found from an Asian clam bed?"**.

4.2 MATERIALS AND METHODS

Diver transects identified edges of Asian clam beds in three areas, Chelka Lodge, North end of Boon Bay and Park Lane motel. Once established, sediments were collected from the edge of the bed into the non-inhabited area with collection of 10 sediment samples every 5 feet for a total distance of 50 feet from the edge of the clam bed.

4.3 RESULTS

At the Boon Bay North location the survey was conducted parallel to shore in approximately 3-5 feet water depth. Sediments in this location were mostly a sandy substrate. Juvenile clams were identified in the sediments at distances of 30, 40, 45 and 50 feet from the edge of the bed.

At the Chelka Lodge site the survey was conducted perpendicular to shore in approximately 3-15 feet. The substrate was muddy. No juveniles were present in the sediments collected.

At the Park Lane site the survey was conducted perpendicular to shore in depth from approximately 3 to 12 feet. The substrate in this area was predominantly dominated by macrophytes. Juvenile clams (>2mm) were identified in the samples 10, 20, 30, 35 and 45 feet from the edge of the Asian clam bed.

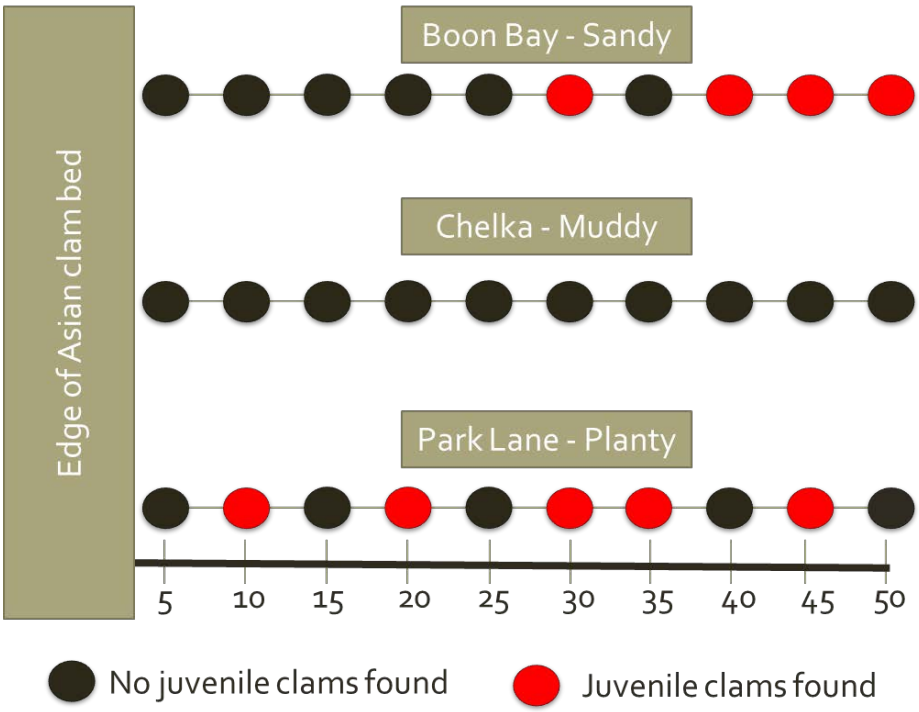

Figure 3. Distances travelled by Asian clams from the edge of Asian clam beds in three locations in Lake George.

4.4 Implications

The results of this experiment suggest that Asian clam juveniles can be transported at least 50 feet from known Asian clam beds. This may be a primary vector for transport of Asian clams. This information will be used in developing a more detailed understanding of the current distribution of Asian clams in Lake George, once the development of a detailed circulation model is established.

5 Water Column Transport Experiment

5.1 Introduction

Juvenile Asian clams can spend some amount of time in the water column after they are released from the parent clam. The amount of time would be impacted by water conditions. This experiment was designed to determine whether and when juvenile clams settle out of the water column into bins at varying distances and depths from a primary clam population. Therefore, the goal of this experiment was to answer the question, **"Are Asian clams transported from the water column into new locations?"**.

5.2 Materials and Methods

Rubbermaid bins (20'' (l) X 14'' (w) x 8'' (h)) were filled with approximately 4 inches of sieved sand. The sand was taken from near the Lake George Park Commission Boat Wash Station in the Town of Lake George and sieved with a 2mm screen. Bins were placed at Park Lane Motel and Chelka Lodge in identical styles of deployment. The style of deployment was triplicate bins at five depths (1, 1.5, 2, 2.5, 3 meters) within an Asian clam zone. Bins were retrieved on a monthly interval, sediments were sieved with a 2mm screen and all biota present within the bins was recorded. The bins were removed and sieved on a rotating replacement schedule such that after the first month only the first bin of each depth was collected, sieved and replaced; on the second month the first and second bin of each depth was collected sieved and replaced. On the third and subsequent months all bins were collected, sieved and replaced. The samples were visually analyzed in the lab and live clams were measured.

5.3 Results

Asian clams were found in 28% of the sampled bins over the duration of the experiment. The distribution of clams were predominantly in the bins at depths 2 meters or greater. Size ranges of these clams were between 2.93-10.82mm. Greater than 50% of the clams that were present in the bins were 6mm or larger. This indicates that large clams are able to access the water column for dispersal. The largest clam found was 10.82mm when collected and the bin it was found in was collected after 30 days of deployment. Assuming a conservative growth rate of 0.1mm/day the minimum size of a water column transported clam is 7.82mm.

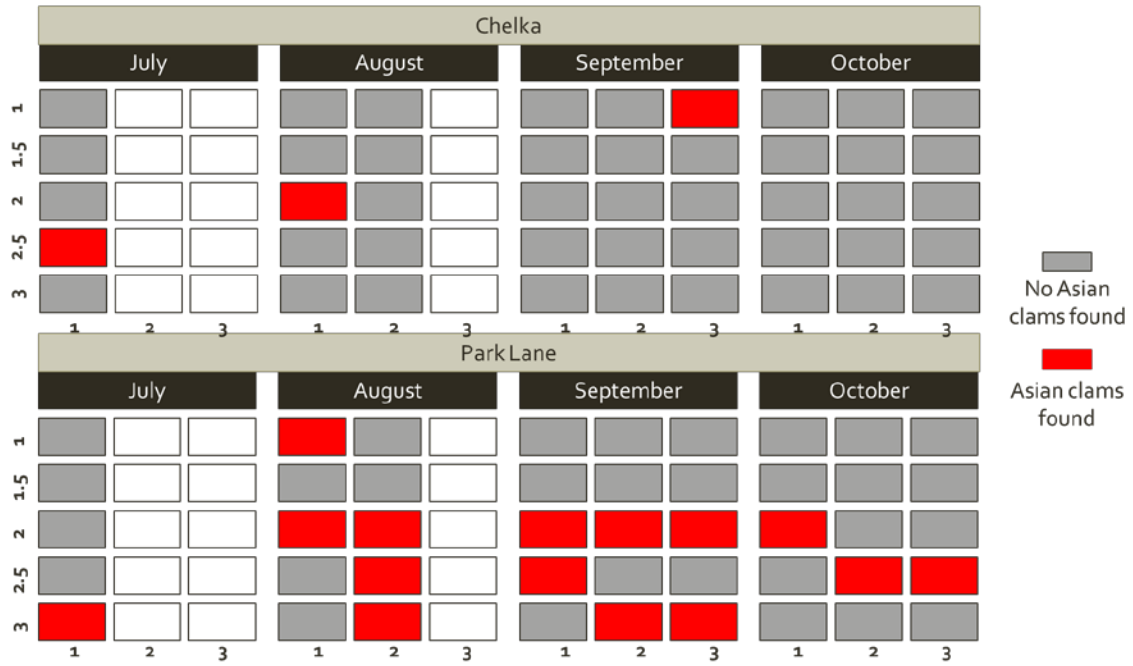

Figure 4. Relative depths in meters (y-axis) and replicate number (x-axis) for each month of the water column transport into bins experiment. Boxes colored red indicate Asian clams

successfully were transported into the bin, grey boxes indicate no Asian clams occupied the bins that month and white boxes indicate the bins were not scheduled to be retrieved.

5.4 Implications

Asian clams can clearly be moved in the water column for the distances (0-20m) demonstrated with the experiments presented here. The size of the clams in the bins was somewhat surprising, large clams (10mm) are somehow suspended at least 8 inches in height which can allow them to move into adjacent habitat. While it was not studied, it remains possible that juvenile clams can use a byssal thread attached to free floating particles.

6 Veliger Settling Velocity Experiment

6.1 Introduction

Prior to this study the settling rate of juvenile clams was not known. The settling rate is important for model development for predicting Asian clam transport. A model based on circulation patterns within Lake George would require this information in order to predict potential transport to new locations. The goal of this experiment was to answer the question, **"What amount of time is required for juvenile Asian clams to settle?"**.

6.2 Materials and Methods

Asian clams were collected from the Park Lane site and juvenile clams were dissected and removed from the gills of the adult clams and placed into 50ml plankton settling chambers. The settling chambers used for these experiments had a reservoir "false" bottom so that the settled portion could be removed and analyzed and the non-settled portion could be retrieved and analyzed. Five trials of settling dissected juveniles were executed for each of the time trials of 15 seconds, 30 seconds 45 seconds, 1 minute, 5 minutes and 10 minutes. A similar experiment was then carried out on a shaker that was set to 180 revolutions per minute. Settled and non-settled juveniles were enumerated and the ratio between the two was considered to be the settling percentage for use in calculating the settling rate.

6.3 Results

This experiment provided a percent settled value at each point examined. A logarithmic trend line from these points significantly fits the data with r squared value of greater than 0.94 for both experimental set ups. This trend provides the settling rate that can be used in models for Asian clam spread. Basically, after one minute 95-96% of the clams were settled from the water column in both the still and shaker experiments. The shaking trials were somewhat faster in settling, likely due to a vortex effect forcing the juvenile clams down produced by the shaker.

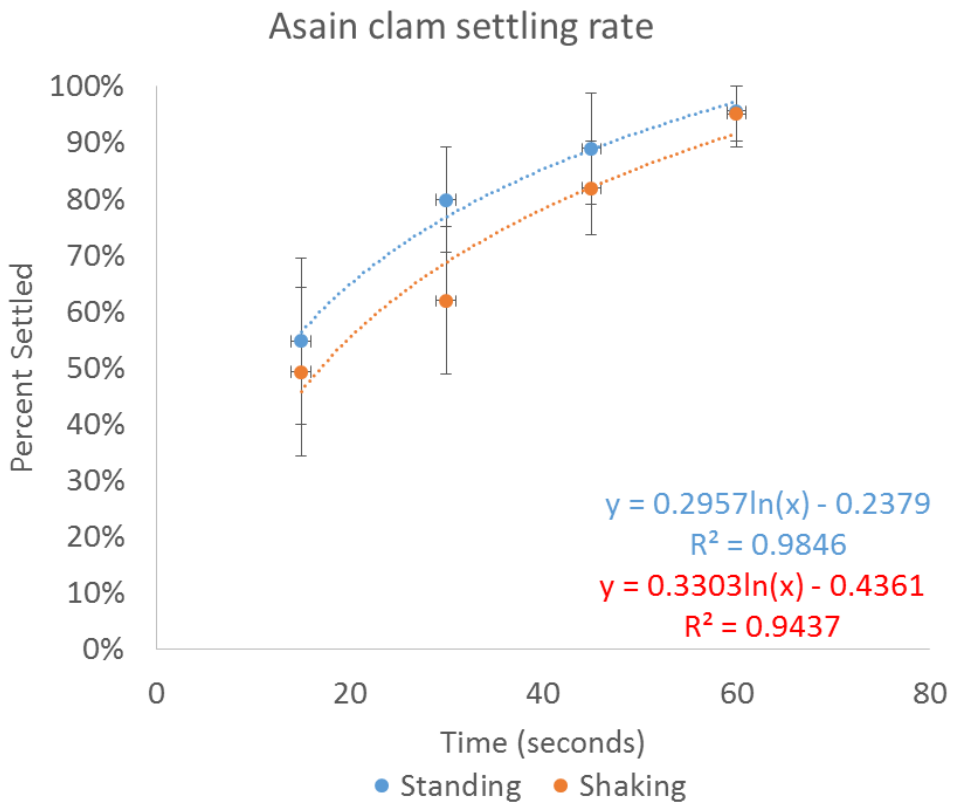

Figure 5. Calculated settling rates for juvenile Asian clams. 95% - 96% of the juveniles settled within 60 seconds.

6.4 Implications

The data reported here provides the generalized rate for juvenile Asian clam settling. This information could potentially be used in conjunction with circulation models to determine the likely area of spread based on flow patterns and settling rates.

7 Summary

The transport of Asian clams within Lake George were studied and a greater understanding of the relative threats of each type of transport are reported here.

- Anthropogenic vectors
  - Anchor sediments from Asian clam inhabited areas can pose a vector for in-lake transport of the species
  - While boat propwash may have some effect on Asian clam movement it is not likely a primary mechanism for long range transport in the lake
- Natural vectors
  - Asian clams may use plant material as a transport vector. However, this unlikely to be a primary transport vector for the dispersal of Asian clams in Lake George

    - Asian clam juveniles can be transported at least 50 feet from known Asian clam beds
    - Asian clams can clearly be moved in the water column for the distances (0-20m) demonstrated with the experiments presented here
- Settling rate
    - The data reported here provides the generalized rate for juvenile Asian clam settling

While the study presented here provided a detailed analysis and conclusions of Asian clam transport mechanisms in Lake George it also generated new avenues to pursue. The future direction of Asian clam transport research on Lake George could include:

1. What is the importance of byssal threads for Asian clam movement combined with water column turbulent flows?
    a. Rationale: Based on initial studies and literature reviews movements of large clams are a possible vector for transport of Asian clams. Our recent study has shown large (at least 7.8mm) Asian clams have accessed the water column to move. Literature values have shown clams use byssal thread to move in water at water 10-20cm/s speeds. A robust examination of Asian clam movement in Lake George would quantify the movement capabilities under different flow regimes.
    b. Approach:
        i. Asian clam accessing the water column- Known numbers of clams (of known size) will be placed in an area surrounded by edging (plastic or metal) that will prevent through the sediment migration of the clams. The movement of clams from the seeded area by turbulent flow or attachment via byssal threads to particles will be studied. Rates of movement will calculated monthly based on size and location. In adjacent areas Asian clams of different sizes will be collected, brought to the lab and tested for byssal thread production using methods described in the Prezant and Chalermwat (1983) and Rosa et al (2014) studies.
        ii. Characterization of Flow in study areas selected above. We propose to use an ADCP (Acoustic Doppler Current Profiler) to characterize water flow at our study site areas. This could provide data on the direction, amount and timing of water flow that is impacting transport of clams. This data can be used to build a predictive model of where the population may eventually be deposited.
2. Do Asian clams exist in Lake George in locations with appropriate substrate, at depths greater than 2 meters?
    a. Rationale: The lake wide survey conducted annually by the LGPC and its partners provides an excellent distribution of the Asian clams in shallow waters, however it does not explore water deeper than about 2 meters. In Lake Tahoe Asian clams have been found in depths exceeding 70 meters, therefore to better understand the

distribution of Asian clams in Lake George and the depths at which they can occur additional survey work is recommended.

b. Approach:
    i. Based on new bathymetry and backscatter data obtained from the Jefferson Project, we now have access to more accurate depth profiles and substrate types (hardness, etc). Using this information in areas near current locations with shallow water Asian clam populations, we can determine the most appropriate locations for deeper water SCUBA surveys for Asian clams.
    ii. Once identified as described above (1), carry out additional surveys for Asian clams to provide a more complete understanding of the distribution of Asian clams at greater depths in Lake George.