EXECUTIVE SUMMARY
Asian clams have been known to exist in Lake George for more than five years. A considerable amount of work has been accomplished in an effort to manage this species. Large scale benthic barrier mat deployments have helped reduce the populations in a number of locations. The initial effort relied on reports from the literature to understand the basic ecology of Asian clams. While this information is useful for a general understanding, it can be misleading with respect to timing of reproduction and growth rates due to local environmental conditions. With this in mind, a two year study was conducted to examine two major questions related to Asian clam communities:

1. When do Asian clams reproduce in Lake George?
2. How fast do Asian clams grow in Lake George?

To examine reproduction, Asian clams were collected from 3 locations (Boardwalk, Park Lane and Chelka Lodge) on a weekly basis, dissected and examined for the presence of juveniles using cross-polarized microscopy. In 2014, 20 clams were collected weekly from mid-June through the end of October. In 2015, 25 clams were collected from early-May (2 weeks post ice-out) through mid-December. Concurrent with the reproduction study, approximately 200 clams were collected and photographed in the lab using a Cannon flatbed scanner. Images were subjected to image recognition and analysis to determine the length and width of each clam.

These data were statistically analyzed for growth rates and population structure. The reproduction study revealed that, in Lake George, Asian clams consistently begin to reproduce in mid-June with the reproduction season typically ending by mid-November. However, clams at the Chelka Lodge study site differed, starting reproduction earlier (early-May) and ending later (mid-December). The reproductive status (active/inactive based on the presence of juveniles in the gills) was strongly correlated with the size of the clam. The smallest reproductively active clam was 10.55mm, however, less than 3% of the clams that were 13mm and smaller were actively reproducing.

The growth rate study compared clam size frequency histograms over time to determine the growth rate for the population. When comparing histograms from year to year there was evidence of recruitment in 2014 and no clear evidence of recruitment in 2015. The lack of recruitment in 2015 could be due to the harsh winter before the observational year or some other environmental factor(s). In 2015, the growth rate was approximately 0.2-0.3mm per week. Knowing this growth rate provides insight about the age of clams that are collected from Lake George. Due to recruitment of a new population in 2014, it was not possible to calculate an accurate growth rate with these methods during that year. Future research focused on the exact cause(s) and implications of reproductive success/failure are now recommended.

Major findings of this study include: 1. The Asian clam reproduction season in Lake George consistently begins mid-June and ends ~mid-November; 2. The typical growth rate for Asian clams during the study period was between 0.2 and 0.3 mm per week.
REPRODUCTION AND GROWTH OF ASIAN CLAMS IN LAKE GEORGE

3-10-16
Presenters: Jeremy Farrell & Sandra Nierzwicki-Bauer
Rensselaer’s Darrin Freshwater Institute
Asian Clams In Lake George

- Discovered in 2010
- Testing and examination of control efforts 2010
- Tremendous effort to control this species
  - Benthic Barriers
    - Test in Lake George Village (2010)
    - Norowal, Middleworth Bay, Lake George Village (2011)
    - Glen Bernie (2013)
    - Roger’s Rock (2015)
  - Suction Harvesting
    - Middleworth Bay (2011)
- In-Lake transport study conducted 2014
General Ecology Questions To Inform Treatment Efforts

• When do Asian clams reproduce in Lake George?
  – 20-25 clams collected each week from three locations (Boardwalk, Park Lane and Chelka)
  – Clams measured, dissected and examined for presence of fertilized juvenile clams in the gills
  – If juveniles present an estimate of the abundance of juveniles in four categories (1-10, 11-100, 101-500, >500)

• How fast do Asian clams grow in Lake George?
  – Collect ~200 clams per site per week
  – Use desktop scanner to collect images of clams
  – Image recognition and processing to measure clams
Reproduction

Chelka

Park Lane Boardwalk

[Image of a person using a microscope]

[Image of a map showing Chelka and Park Lane Boardwalk]
Timing of reproduction for analyzed clams from the Boardwalk location in both 2014 and 2015. Each week between 20-25 clams were measured and dissected, dots and triangles indicate the percentage of clams that had juvenile clams present in their gills.
Timing of reproduction for analyzed clams from the Park lane location in both 2014 and 2015. Each week between 20-25 clams were measured and dissected, dots and triangles indicate the percentage of clams that had juvenile clams present in their gills.
Timing of reproduction for analyzed clams from the Chelka location in both 2014 and 2015. Each week between 20-25 clams were measured and dissected, dots and triangles indicate the percentage of clams that had juvenile clams present in their gills.
Reproduction By Size Class

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<tbody>
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<td>Boardwalk</td>
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<td>Park Lane</td>
<td></td>
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<td>Chelka</td>
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<td>&gt;10mm</td>
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<td>4%</td>
<td>5%</td>
<td>10-15mm</td>
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<td>&gt;15mm</td>
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<td>25%</td>
<td>&gt;15mm</td>
<td>44%</td>
<td>45%</td>
<td>&gt;15mm</td>
<td>55%</td>
<td>70%</td>
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Reproductively inactive - Actively reproducing
Reproduction By Size Class (mm)

Percent of reproducing clams per 1mm bin during the main breeding season (July-October) for all of the locations.
Proportion of the relative abundance of juveniles in reproductively active clams in each of the 2mm size class bins, regression lines plotted for the 1-10 and 500+ juvenile abundances.
Reproduction Summary

- 3579 clams were dissected
  - 710 clams were reproductively active
  - 2869 clams were not reproductively active
- Earliest date for observed reproduction was May 4
- Reproduction consistently starts by mid to late June
- Latest date for observed reproduction was December 9
- Size range for clams dissected in this study was 6.3-26.2mm
- Smallest clam that was reproductively active was 10.55
Population Structure to Infer Growth Rate

Population structure data collected scans of 200 clams
Population Structure

Monthly time series of the population structure of Asian clam community in 2014 (dark blue) and 2015 (light blue)
Monthly time series of the population structure of Asian clam community in 2014 (black) and 2015 (red)
Monthly time series of the population structure of Asian clam community in 2014 (black) and 2015 (red)
Monthly time series of the population structure of Asian clam community in 2014 (black) and 2015 (red)
In 2014 there was clear evidence of successful reproduction in the population size structure, Consequently the data does not fit to a linear regression well (low $R^2$) and the slopes are low to negative except at Chelka where no evidence of reproduction was evident.

In 2015 a smaller size class of clams were never present in the weekly histograms. The clams fit well with a linear regression (high $R^2$) and the slope of the regression is equal to the growth rate per week.
Growth Rate Summary

• Scans of clams were conducted for three sites for two years

• 2014
  – Successful recruitment was evident at Boardwalk and Park Lane as evidenced by comparison of population structure in August and September
  – Limited successful recruitment was evident at the Chelka site, the growth rate for the Asian clam population was approximately 0.2mm per week

• 2015
  – Limited successful recruitment was evident at each of the sites, the growth rate for the Asian clam population was approximately 0.2mm per week at Park Lane and 0.3mm per week at Chelka and Boardwalk
Take Away Points to Inform Management Efforts

- Asian clams typically begin to reproduce in Lake George during mid to late June
- Asian clams typically end the reproduction season in Lake George during mid to late November
- Asian clams, as small as 10.55mm were observed as reproductively active (however clams under 13mm were less than 3% reproductively active)
- Asian clams typically grow between 0.2-0.3mm per week during the growing season in Lake George
Thank You!

• Organizations
  – Lake George Association
  – LGACRRTF
  – Lake George Waterkeeper
  – Fund for Lake George
  – Lake George Park Commission
  – Lake Champlain Basin Program
  – NYSDEC
  – Etc

• People
  – Steve Resler, Dave Winkler, Charlotte Caldwell, Annabelle Fiest, Jack Girrard, Rene Loeffel, Jacob Meyers, Alex Pezzouli, Angie Zhang, Diana Ahrens, Shannon Traver, Greg Niguidula