GULF SHELLFISH INSTITUTE
Research for Sustainable Aquaculture & Healthy Ecosystems

ASSESSING PERFORMANCE OF THERMALLY SELECTED NORTHERN HARD CLAMS (*Mercenaria mercenaria*) DURING GROWOUT ON COMMERCIAL LEASES IN CEDAR KEY, FLORIDA

FINAL REPORT

FLORIDA SEA GRANT

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Project Update

Status:

With the assistance of local clam farmers, staff at the Gulf Shellfish Institute have completed their project to the best of their abilities to assess performance of thermally selected northern hard clams (*Mercenaria mercenaria*) during growout on commercial leases.

Progress:

Thermally selected and unselected *Mercenaria mercenaria* seed were successfully deployed at Dog Island in Cedar Key, and thermally selected seed were deployed at Gulf Jackson in Cedar Key. To diversify lease sites, provide more robust data collection, and increase the probability of survival of clams through hurricane season, thermally selected and unselected clams outplanted at Joe Island in Tampa Bay were also monitored. Replicate 4 mm nursery bags were stocked at 10,000 seed/bag and sampled for initial size and weight. Bags were sampled two months post-planting to assess growth (length and weight) and survival and restocked into 10 mm bags in Cedar Key and 5 mm bags in Tampa Bay. Hurricane presence and resulting damage prevented additional sampling of clams in Cedar Key, but we were able to sample Tampa Bay clams five months post-planting to assess growth, survival, and condition.

Water quality data were recorded at Dog Island from June through August, including monitoring through Tropical Storm Debby, and graphed using HOBO software. All other data were statistically analyzed using R v4.3.2 (R Core Team, 2023). Gulf Jackson length, weight, and survival data, as well as Joe Island condition index data, were analyzed with Welch two sample t-tests. Dog Island and Joe Island length and weight data were analyzed with two-way ANOVA's. Hard clam survival between treatments could not be statistically tested at Dog Island in August, as only one value was available per treatment, but survival over time at Joe Island was analyzed through a two-way ANOVA with a Tukey's HSD post-hoc test.

Delays in meeting objectives:

The most significant deterrence in completing project goals was the impact of three storms, most notably Hurricane Helene, which prohibited seed monitoring in Cedar Key past August. This hurricane also limited water quality monitoring, as the water quality logger at the low-salinity lease site (Gulf Jackson) was lost in the storm before data could be retrieved, and the logger at the high-salinity lease site (Dog Island) could not be redeployed after the storm. Access to Cedar Key was limited and ability to reach project leases was not possible following Hurricane Helene, but the farmers surmised that experimental seed bags were either lost or intermixed, rendering treatment or replicate identification unclear.

Another project challenge was coordinating with the farmers to properly maintain isolated replicates and comparable treatments. Gulf Jackson was unable to receive unselected seed, which were not available at the time of deployment of thermally selected seed. During sampling two months post-planting, Dog Island replicate bags for each treatment were combined before individual bags could be sampled and averaged. Therefore, only singular datapoints or subsamples could be collected for each treatment. During the course of this project, methods were established with farmers, and more precise, adequately replicated results could be expected if this project were to be repeated with another generation of thermally selected and unselected lines of hard clams.

Accomplishments

Title: Assessing performance of thermally selected northern hard clams during growout on commercial leases.

Recap: A line of northern hard clams selected for thermal tolerance were outplanted on multiple shellfish leases to assess growth and survival in comparison to conventional, unselected lines of northern hard clams.

Relevance: Previous GSI research determined the commercially valuable northern hard clam, *Mercenaria mercenaria*, is susceptible to thermal stress, often associated with summer marine heatwaves. Therefore, selective breeding efforts were initiated to culture thermally tolerant hard clams that may have superior growth and survival, compared to conventional lines of hard clams, when faced with environmental stressors. Improving clam stock abundance, diversity, and resilience could support local clam farmers and promote productivity of the Florida shellfish industry.

Response: Thermally selected and unselected *Mercenaria mercenaria* seed were deployed over three lease sites with varying environmental conditions. GSI staff worked alongside local clam farmers to outplant and monitor seed growth, survival, and health, as well as record site-specific water quality. This study examined if and when selective breeding efforts may become a profitable endeavor for the shellfish aquaculture industry and how site selection affects performance of juvenile northern hard clams.

Results: Gulf Jackson thermally selected seed grew in terms of both length and weight from outplanting to two-months post-planting ($P < 0.001$; $P < 0.001$) and survival was 45.29% of the initial stocking density. Dog Island seed displayed significant growth, both in terms of weight

and length, over time and between treatments, with unselected seed measuring longer and heavier than selected seed after two months of outplanting (all $P < 0.001$), and survival from June to August was estimated to be 55.2% in selected seed and 66.75% in unselected seed.

At Joe Island, clams grew over time in terms of length ($P < 0.001$) and weight ($P < 0.05$), and thermally selected seed were of greater size ($P < 0.001$) and mass ($P < 0.001$). There were no differences in condition index ($P = 0.2585$) between treatments at five months post-planting. Survival of unselected seed decreased from 46.60% in August to 25.73% in December, while thermally selected seed survival stayed relatively high, from 59.91% in August to 49.26% in December.

Tools, Technologies or Informational Services

Thermally challenged stocks of northern hard clams were established in this project to improve the thermal tolerance of an ecologically and economically valuable bivalve species. *Mercenaria mercenaria* hard clam production is a $14.3 million industry in Florida (FDACS 2020) that is vulnerable to increasingly frequent, intense, and lasting marine heatwaves. Elevated temperatures are often coupled with additional environmental stressors that can harm bivalve growth, survival, and reproductive output. This project aimed to improve the resiliency of northern hard calms through the initial step of raising first generation (F1) offspring of adults exposed to a simulated marine heatwave. The goal is to continue this project by creating F2 offspring from thermally challenged F1's that will ideally be more tolerant of adverse environmental conditions, such as heatwaves and elevated water temperatures.

Elaborated Results and Discussion for Final Report

Results:

Gulf Jackson thermally selected seed grew in terms of both length and weight from outplanting to two-months post-planting ($P < 0.001$; $P < 0.001$), from a mean shell length of 7.63 ± 0.08 mm to 13.60 ± 0.13 mm and from an individual wet weight, estimated from the whole weight of 50 clams/sample, of 0.13 ± 0.00 g to 0.74 ± 0.01 g. Survival two-months post-planting was 45.29% of the initial stocking density, which was considered on par with average survival of unselected seed (*pers. comm. with the Gulf Jackson clam farmer, Joseph Cannon*).

Dog Island seed displayed significant growth, both in terms of weight and length, over time and between treatments, with unselected seed measuring longer and heavier than selected seed after two months of outplanting (all $P < 0.001$). Survival between treatments could not be statistically tested in August, as only one value was available per treatment, but survival from outplanting in June to August was estimated to be 55.2% in thermally selected seed and 66.75% in unselected seed.

At Joe Island in Tampa Bay, clams grew over time in terms of shell length ($P < 0.001$) and weight ($P < 0.01$ from July and August to December; $P < 0.05$ from July to August), and thermally selected seed were of greater size ($P < 0.001$) and mass ($P < 0.001$) than unselected seed. There were no differences in condition index ($P = 0.2585$) between unselected and thermally selected seed sampled from Joe Island five months post-planting. Survival of unselected seed dropped off from 46.60% in August to 25.73% in December, while survival of thermally selected seed stayed relatively high, from 59.91% in August to 49.26% in December.

However, unselected seed were stocked at an incorrect, higher density, which could have negatively affected growth and survival.

Unfortunately, data collection and analysis were severely impacted by the tropical storms this fall. Some replicate clam bags were dislodged and lost during Tropical Storm Debby in the beginning of August, but water quality was logged at Dog Island through this storm, with drastic declines in temperature and salinity recorded. Hurricanes Helene and Milton impacted the area at the end of September and beginning of October with storm effects still lingering. For example, the Dog Island farmer still has not been able to check on the status of experimental bags since the last monitoring in August.

Discussion:

Growth trends at both Dog Island and Joe Island indicate that selected and unselected seed grow at similar rates in the first few months of growout, but outplanting size, stocking density, and water quality during outplanting could influence future growth and survival. At Dog Island, thermally selected seed were outplanted in June while control seed were planted a month earlier, resulting in larger initial size and more growth time. Being planted a month earlier may have also reduced stress, and therefore mortality, of unselected seed. At Joe Island outplanting, thermally selected seed were initially 10 ± 0.68 mm while unselected seed were 6.74 ± 0.14 mm in mean shell length, but both treatments exhibited similar growth from June to December (9.49 mm and 9.66 mm, respectively). Thermally selected seed may be outperforming unselected seed in Tampa Bay, but with limited data and replication in the early months of growth, it is difficult to conclude whether observed differences are due to initial stocking size or density or a treatment effect. However, it will be interesting to assess whether trends continue over time and in the next generation of selectively bred northern hard clams.