Small-scale Oyster Restoration in Barnegat Bay, NJ: Comparative Seeding Methods

Jessica A. Baez[1], Christine M. Thompson[1], Steven Evert[2], Dave Ambrose[2]
[1]Marine Science Department, School of Natural Sciences and Mathematics, Stockton University, Galloway, NJ 08205
[2]Stockton University Marine Field Station, Port Republic, NJ 08241

Introduction

The Barnegat Bay (BB) watershed is an eutrophic environment that harbors an array of important species, including a rich history of shellfish. Eastern oysters (*Crassostrea virginica*), a foundation species once known to inhabit BB, have severely declined due to pollution, overfishing, and salinity changes. When abundant, the oyster beds were important benthic-pelagic systems creating complex substrate and significant vertical relief while influencing resource availability, improving water quality, and dissipating wave energy. Shellfish, in general, enchance nutrient flux in the Chesapeake Bay (oysters) and Long Island Sound (ribbed mussels).[1] By restoring oyster beds in BB on a small scale researchers can determine if the site and approaches are suitable for large-scale restoration in the lower BB.

Two oyster seeding methods were piloted for restoration on a two-acre research lease in the lower BB watershed and tested for ecological enhancement, growth, and survival each spring and fall for approximately one year after planting. In July 2016, 150 bushels of disease-resistant remotely-set spat-on-whelk shell (SOWS) were planted on a one half acre of the lease. In November 2016, 150 bushels of natural-set Mullica River seed (MRT) were transplanted to a one-half portion of the lease. Oyster growth and survival from both planting methods were assessed in Fall 2016, Spring 2017, and Fall 2017.

Methods

Restoration Site (Fig. 1)

- Research Lease is located in lower portion of BB in Little Egg Harbor/Tuckerton area.
- This is the first oyster restoration project in this area. The site is located in approved year-round harvesting waters and is permitted by the State of NJ.

SOWS Remote-Set Planting

- *June 2016:* 150 bushels of whelk shell were set with **4 million larvae** of Haskins Northeastern High Survival Resistant Line (NEHSRL).
- Initial planting densities averaged **32 +/- 8 spat per whelk shell** (12.6% set ratio).
- *July 2017* : Vessel transplanted to Tuckerton Reef ≈ 3.5 weeks after set
- Monitored *October 2016, May 2017, October 2017*

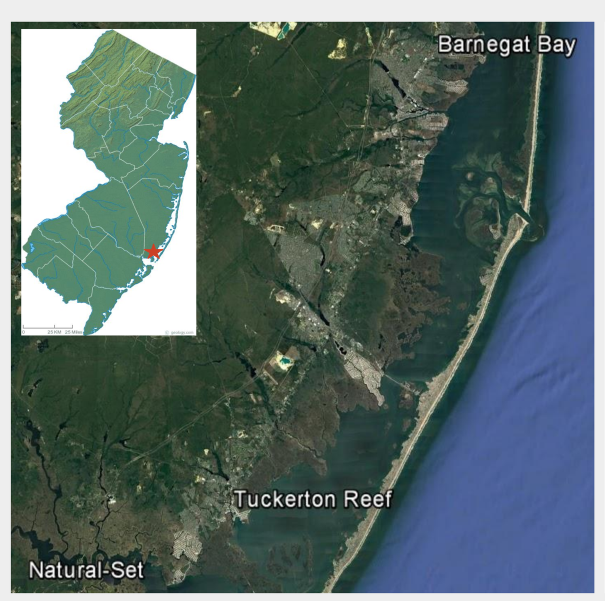


Figure 1. The research lease, Tuckerton Reef, was selected during Fall 2015 in lower Barnegat Bay and was absent of live oysters or shell predeployment. Average salinity at the site was an average of 26 across each sampling event. Temperature averaged 18°C in May and October. Dissolved oxygen was high at 90-100% saturation.

MRT Natural-Set Transplanting

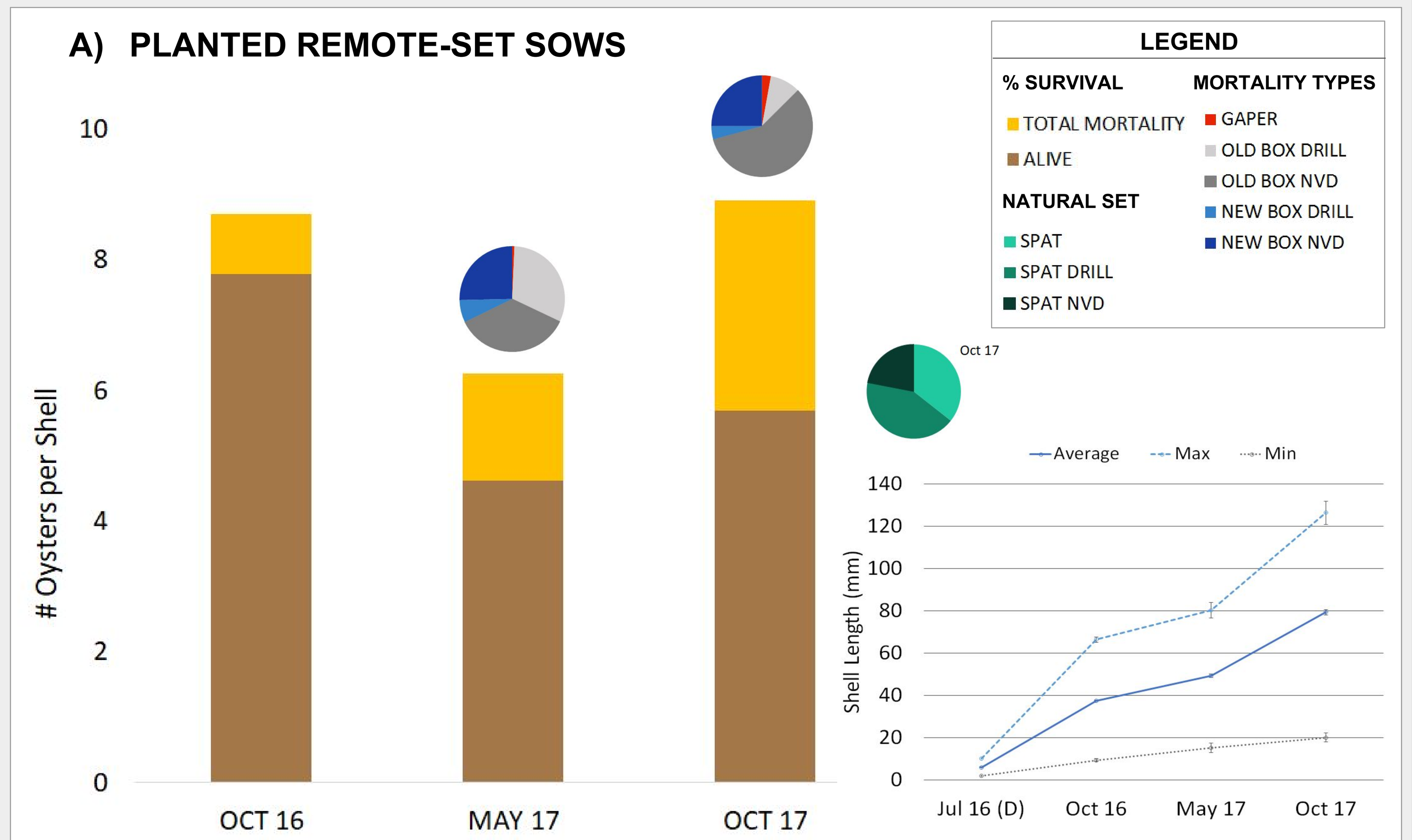
- *November 2016*: 150 bushels natural-set oysters were dredged from the seed beds of the Mullica River (MR) and vessel transplanted to Tuckerton Reef, approximately 10 miles north of the MR.
- Initial planting volume averaged **374 +/- 53 live oysters per ¼ bushel**.
- Monitored *May and October 2017*

Reef Monitoring

- Water quality was measured at each sampling location using a YSI sonde.
- SOWS sampled using hand tongs, MRT sampled using oyster dredge. Sub-sampled volumes were standardized to ½ to 1 bushel depending on oyster size.
- Each sample was sieved to 5 mm for oyster-related biodiversity assessments.[2]
- The reef was monitored using typical bed-health assessment techniques; measured live oysters, old versus new box, gapers, and drill predation notes where possible. Natural set spat were recorded when observed.
- Calculating post-transplant survival per bushel (MRT) or per shell (SOWS) standardized the data to be directly comparable to similar studies on oyster reefs.
- Oysters from both methods are being tested for disease prevalence (MSX and Dermo).

Results

SOWS were initially much smaller than the MRT seed, but grew almost 20 mm larger than average MRT after the first year. The MRT population reveals different size classes reflecting the original population structure and did not achieve as high a growth rate.



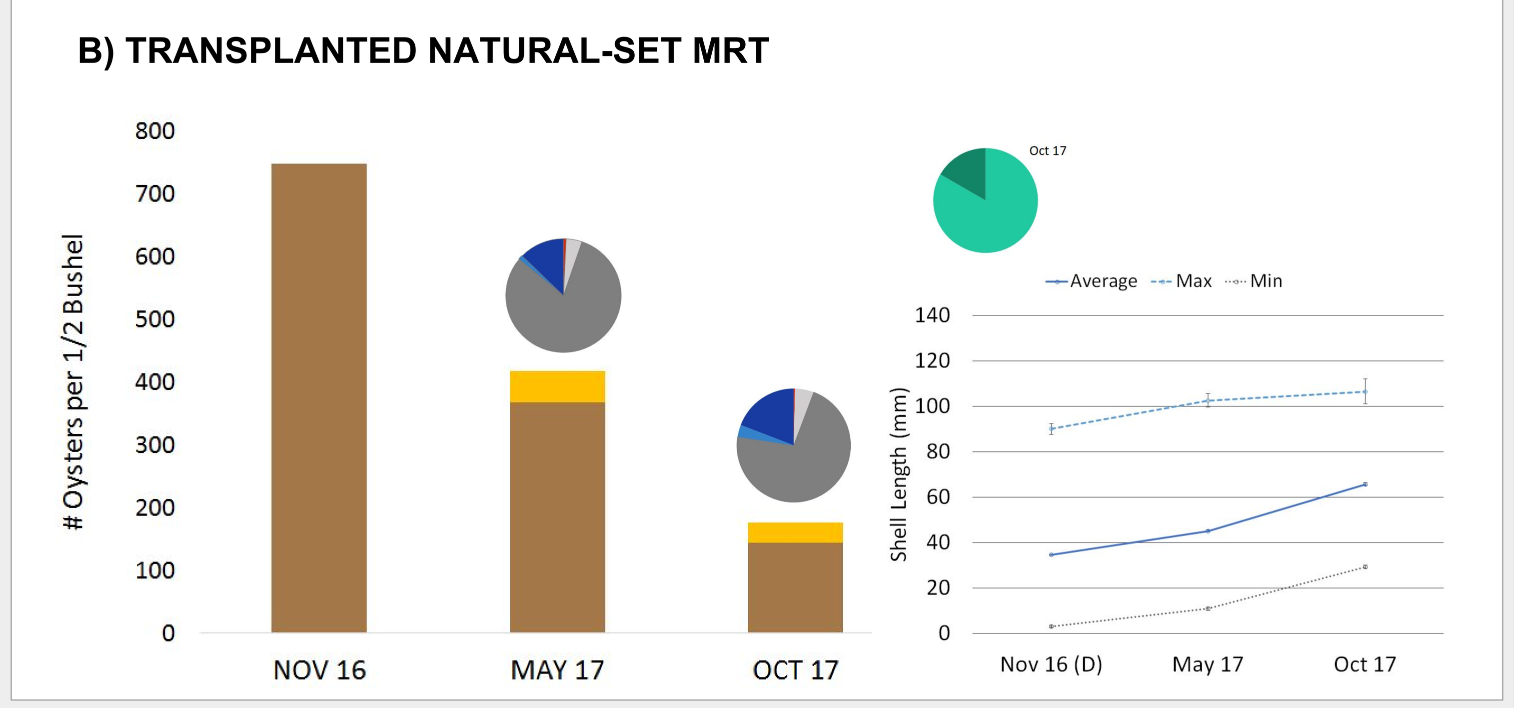


Figure 2. Oyster survival of (A) SOWS and (B) MRT oysters are indicated by number live and dead oysters per whelk shell (SOWS) and per ½ bushel volume (MRT). Pie charts reveal proportion of dead oysters in each category (see methods) and condition of natural set observed in Oct 17. Line graph depicts growth of SOWS and MRT oysters sampled at deployment (D) and subsequent monitoring events. Average size, maximum, and minimum oyster sizes (mm) were averaged from 4 subsamples at each location.

Table 1. Summary of oyster survival, natural set observed, and evidence of predation with both planting methods. Initial survival represents the first assessment after shell was planted on the reef, total survival is based on densities of shell at time of planting.

	SOWS Based on Shell	MRT Based on Volume
Initial Survival	**24%** (Jul 16-Oct 16)	**49%** (Nov 16-May 17)
Survival (> 1 year)	**73%** (Oct 16 - Oct 17)	**39%** (May - Oct 17) → < SOWS
Total Survival Success	**17%** (2016-17)	**19%** (2016-17)
Natural Set	**0.15** oysters per shell (Oct 17)	**0.75** oysters per ½ bushel (Oct 17)
Signs of Oyster Drill Predation	Decreased after year 1	Low at both sampling dates

References
[1] http://www.nj.gov/dep/barnegatbay/docs/BarnBay-REPS.pdf
[2] **See Oral Presentation Nov 07, 2017 10:45 AM - 11:00 AM 552AB: Small-scale oyster restoration in Barnegat Bay, NJ: Oyster Survival and Habitat Monitoring.** Thompson CM, Evert S, Modjeski A.

Acknowledgements
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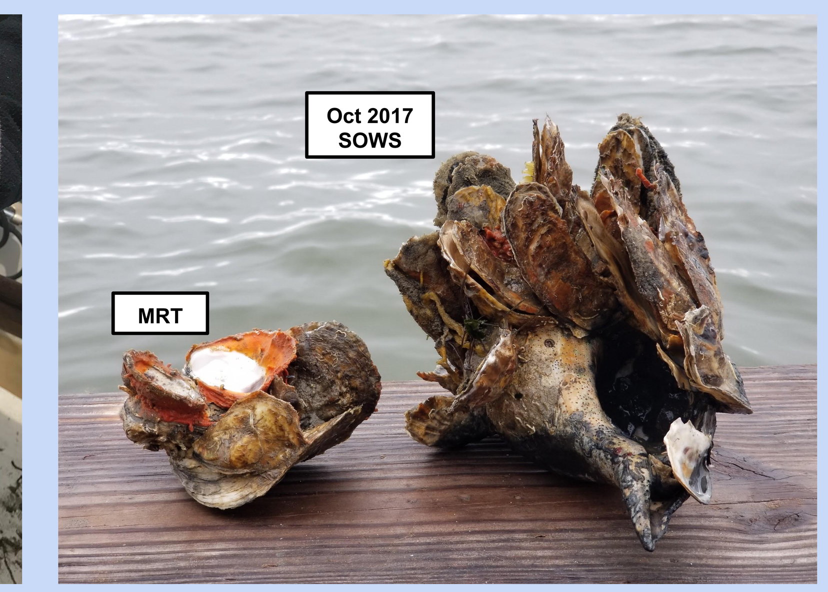
Conclusions

Growth

- SOWS showed higher growth compared to MRT satisfying the objective of ecological enhancement[2] by its complex substrate and vertical relief.
- MRT started with several size classes (max size at deployment represents > 1 year olds), SOWS represent a single cohort. Individual shell counts and measurements for MRT had high standard deviation as a result.
- **Discussion:** SOWS vertical shell orientation exposed individuals to increased tidal flow. This may have contributed to its higher max shell length because of the resource availability off the bottom (Fig. 2).



On the right, a planted remote-set spat-on-whelk shell (SOWS) subsample has significantly more vertical relief and complex substrate compared to a transplanted natural-set Mullica River seed (MRT). SOWS growth can be observed from May 2017 (left) to October 2017 (right).

Survival

- MRT had higher initial survival, decreased after year 1.
- SOWS had higher survival > 1 year (Oct 16-Oct 17).
- Overall (planting → year 1) survival was similar.
- **Discussion:** MRT size classes included older individuals more adapted to environmental stressors in transplant environment. SOWS mortality reflected spatial competition.

Natural Set and Predation

- Planted SOWS experienced natural set in 2016 ≈ 50 spat per bushel
- Both oyster types experienced natural set in 2017.
- All MRT natural set spat mortality was the result of drill predation.
- Oyster drill predation decreased over time on SOWS.
- **Discussion:** MRT had smaller overall shell lengths and spat would be more susceptible to oyster drill predation. SOWS had higher drill mortality, possibly due to its vertical relief.

Comparing Restoration Methods

- Survival and growth are difficult to directly compare between methods because of the different shell types, cohorts, and volumes sampled.
- October 2017 MRT survival may be underestimated as larger oysters take up more volume of a bushel. As shells grew, subsampling MRT by volume resulted in fewer oysters per bushel as there were no standard units to assess individual clusters.
- Remote-setting larvae includes more resources, time, and personnel, but may provide the potential benefits of a disease-resistant strain.
- Transplanting natural seed oysters may cost less, but takes from one resource to create another. Final reporting will include a cost-benefit analysis of these approaches.