

Using positive interactions between bivalves and seagrass to improve water quality and restore essential fish habitat in coastal North Carolina: Phase II



Contract: 5145

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Prepared for: **Albemarle-Pamlico National Estuary Partnership**, 1601 MSC Raleigh, NC 27699-1601

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at CHAPEL HILL



Summary: We investigated the use of hard clams (*Mercenaria mercenaria*) as a restoration technique for the recovery and growth of eelgrass (*Zostera marina*) habitat. Hard clams were introduced into eelgrass meadows at Oscar Shoal (Back Sound) and Herring Shoal Island (Pamlico Sound) in May 2013 (with paired control sites). Following clam deployment, we made seasonal measurements of sediment and seagrass nutrient content, seagrass aboveground biomass, seagrass growth, and seagrass reproductive output (in conjunction with a small-scale, 2010 experiment). We recorded some evidence of sediment nutrient enrichment via decreased C:N ratios in clam-addition plots, although changes in nutrient content were not observed in seagrass tissues themselves (above or below ground). Despite dramatic seasonal cycles in eelgrass production, we also observed a significant response in aboveground biomass and individual plant growth following the addition of clams in the spring/summer of 2013. As measured in 2011, reproductive effort was higher in plots that received clam subsidies relative to plots that were used as controls (further reproductive effort measurements to be made in spring 2014 with regard to 2013 clam deployments). Collectively, these data suggest that positive bivalve-seagrass interactions may be an effective tool for strengthening the function and resiliency of North Carolina seagrass meadows.

Scope of work: This project expanded upon a previously successful, small-scale restoration project in North Carolina (NC) that confirmed a novel and beneficial interaction between hard clams (*Mercenaria mercenaria*) and eelgrass (*Zostera marina*). That study indicated clams are able to improve the condition and accelerate the recovery of degraded seagrass meadows via the fertilization of sediments (via the deposition of organic-rich feces and pseudofeces), as well as improved water clarity due to biofiltration. We restored approximately 1 acre of clam populations within seagrass meadows at sites in Back (0.5 acre) and Pamlico Sounds (0.5 acre) to spur eelgrass recovery in fragmented and stressed beds. As both hard clam populations and eelgrass meadows are facing numerous threats, there were compelling reasons to develop novel and effective restoration strategies for these species.

Specifically, we deployed >500,000 hard clams (15-20 mm shell length) in two disturbed seagrass meadows in Back Sound (Oscar Shoal) and Pamlico Sound (Herring Shoal Island). We anticipated that fertilization resulting from hard clam feces and pseudofeces should spur the growth of eelgrass rhizomes and shoots. Originally, we planned to acquire clams in two methods: first, through local aquaculturists, and second, by paying local fishermen to supply some of the clams. Ultimately, we were unable to find a cost-effective method for buying ~50 mm clams from local fishermen, and therefore we purchased all seed clams from Jimmy Morris (shellfish aquaculture) in Carteret County, NC. Clams were deployed at a density of 160 clams m<sup>-2</sup>, encompassing a total area of 1,600 m<sup>2</sup> at Oscar Shoal and 1,600 m<sup>2</sup> at Herring Shoal Island. Hard clams were introduced into patchy or nearly bare eelgrass patches in May, 2013, once water temperatures rose above 20°C (crucial for seed clam survival). Marker poles were erected to designate 4 “restored” clam patches as well as 4 “non-restored reference sites” at each regional site). Educational signs were deployed at boat ramps near restoration site to advise the public about seagrass function and threats.

Following clam additions (May), monitoring occurred two times (May, July) to evaluate a number of structural and functional metrics of restoration success, including: (a) clam survivorship/growth, (b) eelgrass shoot growth and seagrass patch expansion, and (c) eelgrass biomass/nutrient content. During each monitoring event, 3 replicate samples (series of cores, surface counts, and quadrat excavations) per “restored” or “non-restored reference” site were collected (N = 48 during each sampling interval). During the summer (July), we also conducted seagrass scarring assays to measure shoot growth within “restored” and “reference” plots. Methods used to monitor clam survival/growth and seagrass condition between “restored” or “reference” sites followed from standard published protocols (mostly core-based approaches) and our own previous clam-seagrass restoration. We also quantified the impact of clam restoration on N cycling and estuarine primary production by working with a NSF-funded undergraduate (via IMS’s REU program) to conduct laboratory mesocosm experiments during the summer of 2013 (see attached ppt and pdf file).

Results & discussion (Measures of contract performance, project deliverables completed): The timing of our clam deployment was slightly delayed to contractual administration and the need for warmer water temperatures. However, we were successful in deploying >500,000 clams at our study sites during May 2013. Furthermore, we successfully collected/processed cores and mapped seagrass patch distribution (using a 160 point-intercept approach in each plot) in May and July, 2013.

During these sampling events, we made the following measurements: sediment nutrient content, seagrass nutrient content, seagrass growth rates, seagrass shoot density, and seagrass cover. Sediment and seagrass nutrient content data are still being analyzed (samples run but data not fully processed and QAQCed), but we have already documented a statistically significant increase in seagrass growth inside “restored” plots relative to “reference” plots. At Oscar Shoal, shoot growth was 25% greater inside “restored” plots, while at Herring Shoal Island, shoot growth was 10% greater inside “restored” plots. A complete explanation of our findings to date (including data graphs) is included in the attached ppt files (sent as ppt and pdf files).

Final budget, including total APNEP funds used: \$74,745.58

Leverage committed in RFP/Scope: \$0

Final leverage reported: \$0

Match committed in RFP/Scope: \$77,816.58

Final match reported: \$76,503.62

Project partners and contributors: Albemarle-Pamlico National Estuarine Partnership (<http://www.apnep.org/>); North Carolina Coastal Reserve and National Estuarine Research Reserve (<http://www.nccoastalreserve.net/>); North Carolina Sea Grant (<http://www.ncseagrant.org/>); Coastal Studies Institute (<http://csi.northcarolina.edu/>)

Technical support: Abigail, Poray, Laura Alexander, Corey Adams, Michelle Brodeur, Riley Brady, Alexia Pool, Sara Coleman, Grey Reading, John McCord, Danielle Abbey, Stacy Zhang, Ian Kroll

GPS coordinates of project site(s): Oscar Shoal N34°42'13", W76°35'31" and N34°43'03", W76°33'55"; Herring Shoal Island N35°48'17", W75°34'02"

Acres restored: At Oscar Shoal, 0.4 acres restored, impacting a 7 acre seargass bed; At Herring Shoal Island, 0.4 acres restored, impacting a 3 acre seagrass bed.

Electronic copy of printed materials, handouts, signage, and other communications materials: 2 ppt files are attached (ppt and pdf versions) reflecting talks given during the 2013 Institute of Marine Sciences REU Presentations and 2013 State of the Sounds Symposium. Also included (as a pdf file), a public education sign deployed at boat ramps in close proximity to restoration sites.

Photographs (if applicable) to accompany the text in the report: Included in attached ppt files (ppt and pdf versions).

Recommendations for further working on issues addressed by the contract: N/A (we are too early in the data collection phase to make any recommendations. By the summer of 2014, we will contact APNEP with a further explanation of project findings and potential next steps).

**Optional (But Strongly Encouraged!) Project Completion Components**

Online resources: <http://www.unc.edu/ims/fodrie/research.htm>;  
[http://www.apnep.org/c/document\\_library/get\\_file?uuid=ff344117-06df-4d1c-97ee-7b3b82f2a24c&groupId=61563](http://www.apnep.org/c/document_library/get_file?uuid=ff344117-06df-4d1c-97ee-7b3b82f2a24c&groupId=61563);

Also refer to attached presentations.

Note: John McCord of the Coastal Studies Institute (CSI) spent a day taking pictures, recording video, and interviewing Abigail Poray, and intends to post a story about this project on the CSI website.