Examining a Living Community: Hard Clams and Phytoplankton in Great South Bay

NYSG researchers have assessed the relationship among hard clams, phytoplankton and zooplankton, showing that hard clams are not the driving force they once were in Long Island bay food webs. A clam restoration program has been initiated based on the finding that clam filtration can shift phytoplankton populations to species that support strong juvenile clam growth.

Hard Clams: Historically a significant species

The hard clam (*Mercenaria mercenaria*) is an important economic and ecological species that has significantly declined in Great South Bay, NY. Hard clams are suspension feeders that obtain their nutrition by filtering plankton from the water. During the 1970s when the bivalves were much more abundant, they filtered a large fraction of the total volume of water in Great South Bay. Due to this intensive grazing activity, they most likely altered the composition of the plankton community. Researchers suspected that this community alteration had a positive benefit to the clams by actually improving the quality of their food.

Hard clams no longer dominate the benthic community and consequently, the phytoplankton composition, primary production, trophic structure and rate of nutrient cycling may have been altered. Additionally, recent evidence suggests that hard clams are growing slower in Great South Bay than they did in the past, potentially due to brown tides that can inhibit feeding, or changes in the plankton community due to variable plankton size and type. It is thought that these combined conditions could lead to poor hard clam production resulting in low fecundity, poor recruitment and longer exposure of juvenile hard clams to predation making it difficult for hard clam populations to recover.

Mercenaria mercenaria from Great South Bay examined in the laboratory. Photo by Steve Tettelbach

Looking at Trophic Interaction

Stony Brook University researchers Drs. Robert Cerrato, Glenn Lopez, Darcy Lonsdale, Roger Flood and Robert Armstrong from the Marine Sciences Research Center, and Dr. Jeffrey Levinton from the Department of Ecology and Evolution teamed up for this project. They examined the trophic interactions among phytoplankton, zooplankton, and hard clams to assess whether intensive grazing by hard clams shifts the composition of the plankton community toward species of different nutritional quality.

The team used a multi-beam echosounder to map three field sites along the Bay--Copiague, Babylon, and Patchogue--to identify sediment type and biotype. The team also characterized the existing biofiltration conditions and hard clam growth in the field. The focal point of this study was the experiments conducted in 400-liter tanks

where adult clam and copepod abundance was manipulated in order to observe possible changes to the plankton community. Phytoplankton composition, zooplankton grazing, and hard clam growth were also measured.

Analysis of plankton samples showed that the composition of phytoplankton varied with the site, but most of the chlorophyll biomass was represented by the less than 5 μm size fraction. Dilution experiments showed that zooplankton grazing was capable of removing all the primary production most of the time at all three sites. Plankton characterization suggests that food quality was highest in Copiague and lowest in Patchogue. The observed juvenile hard clam response was consistent with this observation. Juvenile growth at Copiague was 7 times greater than at Patchogue. In Copiague, where growth under ambient conditions was high, juvenile growth declined by 57% in the treatment with high adult clam grazing, suggesting that juveniles were competing with adults for food.

In the other two locations, where growth under ambient conditions was moderate to poor, juvenile growth improved by 60 to 200% in treatments with high adult clam grazing. Examination of several physiological measures on a set of adult clams exposed to water from the treatments verified that observed increases in juvenile growth were related to food quality rather than quantity.

Manipulation of adult copepod densities was not successful since adult copepods in the tanks were protected from large grazers and increased in all treatments. Hard clams were effective phytoplankton predators on the eggs and early naupliar stages of copepods, suggesting that clams can also alter plankton structure indirectly by feeding on other grazers. Overall, these results suggest that intense grazing by hard clams can have a positive effect on the nutritional value of the plankton.

Based on these results, this research team believes that the reduction in clam abundance in Great South Bay has propelled the hard clam population and its associated ecosystem into a fundamentally different state. In the past, intense grazing by hard clams exerted enough control on the plankton assemblage to maintain a positive feedback loop. However, at present, zooplankton grazers are consuming most of the phytoplankton production in the Bay, and hard clams and other benthic suspension feeders exert little control.

Research results aid shellfish restoration efforts

These results have an important implication for hard clam restoration in Great South Bay. Restoration scenarios that involve planting small seed clams with low filtration capacity would not immediately alter the dynamics of the food web. As a result, processes now inhibiting the recovery of hard clams (e.g., low fecundity, poor growth, poor recruitment, high mortality) would also work against such restoration attempts. Instead, planting a large number of adult clams (and/or other benthic suspension feeders) might be a preferable strategy because it has the potential of restoring the plankton to an assemblage that promotes greater hard clam production.

Based on results from this, and other NYSG funded research, state and county organizations have included hard clams and other bivalve filter feeders in their management plans. New York State's Comprehensive Wildlife Conservation Plan added hard clams, blue mussels, ribbed mussels, oysters, and bay scallops to their list of species of greatest conservation need. The Peconic Estuary Program (PEP) and South Shore Estuary Reserve (SSER) management plans cite the importance of filter feeders in estuarine systems and recommend enhancing shellfish stocks "to fulfill ecological functions."

There are several restoration programs across Long Island that are benefiting from this work. The Nature Conservancy is sponsoring a large scale reseeding of chowder and other adult-sized clams in Great South Bay and Peconic Estuary. Suffolk County is running the largest scallop reseeding program attempted anywhere in the country. It is a four-year, $1.8 million dollar effort to restore bay scallop populations in the Peconic Estuary. In May 2005, Suffolk County announced a major

aquaculture initiative to restore scallops, oysters and hard clams to the Peconic Estuary. In addition to the economic benefits of aquaculture, the County Executive justified the program because it "will augment spawning potential of natural populations of shellfish" and "will exert a positive influence on water quality by helping to prevent harmful brown tide blooms."

Students

Two scholars were supported on this project, both for their MS degrees. Ms. Amy Streck completed her degree in May of 2003 and is currently working for the National Marine Fisheries Service, Conservation and Education Division, in Silver Spring, MD.

Ms. Rebecca Marzeck completed her degree in August of 2003 and is currently working at Haskins Shellfish Laboratory, NJ.

Publications

Marzec, R. 2003. Predation on Early Life Stages of the Calanoid Copepod Acartia tonsa (Dana) by the Northern Quahog (*Mercenaria mercenaria* L.). MS Thesis, Stony Brook University, Stony Brook, NY. 72pp.

Schlenk, C. 2004. New insights about south shore estuary hard clams. *Coastlines* 33(3): 8-9.

Streck, A. 2003. Feedbacks Resulting from Changes in *Mercenaria mercenaria* Abundance in Great South Bay, New York. MS Thesis, Stony Brook University, Stony Brook, NY. 56pp.