SESSION G - RESTORATION CASE STUDIES & ISSUES

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Dr. Michael Hodges - SOUTH CAROLINA OYSTER RESTORATION AND ENHANCEMENT PROGRAM: CREATING COASTAL STEWARDS THROUGH DIRTY WORK
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Dr. Ray Grizzle - EASTERN OYSTER *Crassostrea virginica* REEF RESTORATION IN NEW HAMPSHIRE, USA: MOVING TOWARDS DESIGN CRITERIA FOR RECRUITMENT-LIMITED POPULATIONS

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Co-Authors: Yuka Kutsumi, Department of Natural Resources, Cornell University, Ithaca, NY 14850

Dr. Ashlee Lillis - CLAMOUR ON THE REEF: CHARACTERIZING HABITAT – ASSOCIATED UNDERWATER SOUNDSCAPES FROM AN ECOLOGICAL PERSPECTIVE
Co-Authors: David Eggleston, Del Bohnenstiehl

Dr. Mark Borelli - THE POTENTIAL USE OF A PHASE MEASURING SIDESCAN SONAR TO QUANTIFY OYSTER POPULATIONS

INCORPORATING BMPS IN SHELLFISH AQUACULTURE AND RESTORATION PROGRAMS: DEMONSTRATING SOCIAL AND ENVIRONMENTAL RESPONSIBILITY

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Commercial shellfish aquaculture in New England, as practiced today, is relatively young. Shellfish growers use the same waters as many other groups, potentially leading to multiple conflicts. Unlike land-based farmers who own farm property, shellfish growers lease public waters; many eyes watch their every move. The numerous societal benefits from shellfish aquaculture may not be clear and public perception may be influenced by a lack of knowledge or understanding about the commercial activity. Yet shellfish restoration enjoys widespread acceptance and support especially from those who recognize biological and societal benefits of shellfish aquaculture. However, there are conflicts with these activities as well. Best Management Practices, a tool used to resolve conflicts, have been developed for both commercial shellfish aquaculture and shellfish restoration. Incorporating best practices demonstrates that the commercial farmer is serious about what he/she is doing and making the best effort possible to grow shellfish in an environmentally and socially conscionable manner, being a “good neighbor” while also growing an economically viable business. Incorporating BMPs in a restoration program demonstrates careful project planning with appropriate state or local control officers, that their project has state approval and adheres to the requirements of the National Shellfish Sanitation Program. In both cases BMPs lead to public confidence that the projects are conducted to the highest benefit possible including an addition of shellfish to the waters, providing ecological services, community awareness, environmental integrity and public education.

SOUTH CAROLINA OYSTER RESTORATION AND ENHANCEMENT PROGRAM: CREATING COASTAL STEWARDS THROUGH DIRTY WORK

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The South Carolina Oyster Restoration and Enhancement (SCORE) Program, a community-based habitat restoration program, has been engaging community volunteers in hands-on restoration activities since 2001. We strive to engage volunteers of all ages, backgrounds, and abilities with the objective of increasing awareness of environmental issues and inspiring further stewardship. By allowing volunteers to get their hands dirty (literally and figuratively) building oyster reefs, we connect them to their environment and empower them to take action on its behalf. In addition to the core goal of constructing oyster reefs, the program also includes water quality monitoring, shell recycling and salt marsh restoration. Since its inception, SCORE has engaged more than 25,000 volunteers in stewardship activities. Volunteers have bagged more than 1,100 tons of oyster shell and constructed more than 3 acres of oyster habitat at 76 different locations along the South Carolina coast. In the last 5 years, 38 schools have participated in growing *Spartina* seedlings for transplanting behind the oyster reefs. The program also hosts field trips by local school groups to investigate biodiversity on the oyster reefs through fish sampling and other hands-on activities. The SCORE program works with as many as 40 local schools each year, spreading the “oyster message” to more than 2,000 students annually.

EASTERN OYSTER *Crassostrea virginica* REEF RESTORATION IN NEW HAMPSHIRE, USA: MOVING TOWARDS DESIGN CRITERIA FOR RECRUITMENT-LIMITED POPULATIONS

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Wild oyster populations in many estuaries in the northeastern US are far below historic levels, and annual recruitment is widely variable spatially and temporally. With respect to oyster restoration efforts, these estuaries are thought to be both substrate- and recruitment-limited, and restoration projects typically include addition of hard substrate followed by spreading juvenile oysters ("spat seeding") produced in a hatchery onto the surface of the reef. In summer 2013, we sampled with patent tongs a total of sixteen restoration sites that had been completed between 2000 and 2013. Restoration success ranged from almost complete loss of substrate and spat-on-shell (mainly due to sedimentation) to live oyster populations similar to nearby relatively healthy natural reefs. Analysis of natural spat set data from 2013 indicated that restoration sites that were within 1 km of a healthy natural reef had significantly and substantially higher spat densities than those more distant. Subsequent studies on three reefs in 2014 using spat collectors further supported this relationship. Collectively, these data suggest that restoration success may be enhanced by focusing on sites near healthy natural reefs.

WHAT DOES LOCAL ADAPTATION LOOK LIKE FOR AN EVOLUTIONARY BET HEDGER, THE EASTERN OYSTER Crassostrea virginica?

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Eastern oysters (*Crassostrea virginica*) have a bet-hedging life history whereby high genetic diversity and high fecundity support a recruitment sweepstakes with winners determined partly by a good match between phenotype and post-settlement microhabitat. Oyster restoration 'best practices' have mostly focused on genetic diversity with respect to minimizing hatchery bottlenecks and maximizing survivorship of outplanted oysters. Restoration oysters will have maximum impact on population abundance if they survive longer, are highly fecund, and produce offspring with broad environmental tolerances. Are these adaptive traits that we can expect from a hatchery-produced oyster? Does it depend on what broodstock were used and how many were spawned? Surprisingly, few data exist on the magnitude of genetic bottlenecks during hatchery production of eastern oysters, and even fewer data are available on the importance of genetic diversity for long-term fitness related performance of hatchery-produced oysters. We will review the available data, present new estimates of genetic effects from hatchery production using both wild and aquaculture broodstock, and interpret these data in light of the oysters bet-hedging life history. Our results suggest that wild oyster populations contain both tolerant generalist oyster phenotypes and less plastic specialist phenotypes because of evolutionary processes occurring every generation. When the goal is a sustainable reproductive reef, we argue that restoration efforts need to plan for bet-hedging, just as the oyster has for millennia, by maximizing the genetic diversity of planted oysters.

CLAMOUR ON THE REEF: CHARACTERIZING HABITAT-ASSOCIATED UNDERWATER SOUNDSCAPES FROM AN ECOLOGICAL PERSPECTIVE

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Despite their influence on a range of marine ecological processes such as larval settlement, reproduction, and predator-prey interactions, the ambient soundscapes of most marine habitats have not been characterized. Different seafloor habitats produce distinct soundscapes due to differences in the composition of physical and biological sound sources. To investigate oyster reef soundscape patterns we comprehensively measured the sounds of oyster reef and soft bottom areas in Pamlico Sound, NC, USA, and applied characterized the acoustic variability. Short- and long-term acoustic sampling across the estuary found distinct acoustic patterns in reef habitats compared to surrounding areas, with reefs producing high sound levels within frequencies dominated by snapping shrimp signals and the vocalizations of reef-dwelling fish. Compared to soft bottoms, oyster reefs had consistently higher sound pressure levels and higher acoustic diversity index values. The spectral dissimilarities between the two types of habitats were consistent over the summer and fall sampling season and across three sampling years, but the acoustic signal strength differed between reef sites and is likely related to differences in reef characteristics. This study establishes a possible ecological function of oyster reef soundscapes as a reliable indicator of habitat-type and habitat quality, and also highlights the need to study the drivers of soundscape variation in oyster reefs. Further investigations of the relationships between the acoustic and ecological patterns and processes are necessary to assess to evaluate the potential adverse effects of anthropogenic noise on oyster reefs, and to incorporate passive acoustic monitoring to restoration efforts.

THE POTENTIAL USE OF A PHASE-MEASURING SIDESCAN SONAR TO QUANTIFY OYSTER POPULATIONS.

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A pilot project to determine the efficacy of using a phase-measuring sidescan sonar to quantify adult oyster populations is underway. Previous attempts to use a traditional, ultra-high dual-frequency sidescan sonar (operating frequencies: 600/1600 kHz) have proven difficult. The output data from these instruments produce relative intensity values as opposed to absolute values. This makes comparisons from survey to survey, and within individual surveys, problematic for the purposes of identifying adult oysters in life position within cultch mounds. These mounds are comprised of quahog shells placed to provide hard substrate for oyster growth. An ultra-high, dual-frequency phase-measuring sidescan sonar (540/1600 kHz) has recently been acquired and initial data are promising.

Phase-measuring sidescan sonars collect coincident bathymetry and sidescan sonar (backscatter) imagery. The backscatter imagery for these instruments is similar to that of traditional sidescan as it stores relative intensity data to produce images of the seafloor. However, the bathymetric data has been shown in initial tests to allow investigators to discern between relatively flat beds of newly deposited cultch mounds and older cultch mounds with adult oysters in life position. These bathymetric data coupled the co-located backscatter imagery could provide a rapid, rigorous method to quantify oysters in intertidal and subtidal environments.