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ABSTRACTS OF TECHNICAL PAPERS

Presented at the 101st Annual Meeting

NATIONAL SHELLFISHERIES ASSOCIATION

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ORAL PRESENTATIONS

POSTER PRESENTATIONS

TROPHIC TRANSFER AND HABITAT USE OF OYSTER (*CRASSOSTREA VIRGINICA*) REEFS IN SOUTHWEST FLORIDA USING STABLE ISOTOPE ANALYSIS: ARE OYSTER REEFS USED FOR REFUGE, FOOD OR BOTH? **Holly A. Abeels, Aswani K. Volety, Ai Ning Loh,** and **S. Gregory Tolley**. Florida Gulf Coast University, 10501 FGCU Blvd. South, Fort Myers, FL, 33965, USA.

Oyster reefs provide spawning and feeding habitat, as well as shelter from predators, for many resident and transient species. This study examined whether these reef-resident species use the oyster reefs just as a refuge and feeding area, are directly feeding on the oysters themselves, or are engaging in both activities. Stable isotope analyses were used to determine the trophic transfer and establish the food sources of species found on oyster reefs. Two oyster reef sites in the Estero Bay Aquatic Preserve, Florida were chosen, both of which experience varying levels of freshwater inflow. Study sites were sampled quarterly starting in April 2008 to examine seasonal differences in trophodynamics. Preliminary results based on stable carbon and nitrogen isotopes analyses of reef-resident organisms suggest that crab species are consuming benthic microalgae and sinking particulates trapped by oyster reefs; shrimp species are consuming benthic microalgae growing on reefs, and fish species are consuming shrimp and crabs. This suggests that reef resident species are using the oyster reefs mainly as a refuge and rely on other food sources associated with the reefs but do not directly consume the oysters themselves.

MARKET ACCEPTANCE OF THE SUNRAY VENUS CLAM (*MACROCALLISTA NIMBOSA*) CULTURED IN FLORIDA. **Charles Adams[1], Leslie Sturmer[2],** and **John Scarpa[3].** [1]University of Florida, PO Box 110240, Gainesville, FL, 32611, USA; [2]University of Florida, PO Box 89, Cedar Key, FL, 32625; USA; [3]Harbor Branch Oceanographic Inst., 5600 US 1 North, Ft. Pierce, FL, 34946, USA.

The sunray venus clam is being considered as an alternative species for commercial hard clam growers in Florida. Current trial production efforts appear successful. Hatchery and growout costs appear to be similar to hard clams. However, the market acceptance of the cultured sunray venus clam needs to be demonstrated within the Florida market area. A group of four restaurants agreed to participate in a market acceptance study: one each in Cedar Key, Apalachicola, Gainesville, and Bronson. Each restaurant received a given number of cultured sunray venus clams each week for a period of four weeks. The chefs in each restaurant were allowed to serve the clams utilizing any preparation manner they chose and to charge any price they wished. The wait staff were instructed to ask each patron who consumed the clams to complete a brief tableside survey. The survey solicited the patron's reaction to various attributes of the sunray venus clam they just consumed, as well as some respondent demographic information. The survey findings provide insight into the acceptance of cultured sun ray venus clams as a viable seafood product and the willingness of consumers to purchase the product again. This information will help growers assess the viability of sunray venus clams as an alternative candidate culture species.

POPULATION AND FISHERY DYMANICS OF BLUE CRABS *CALLINECTES SAPIDUS* IN A SUBESTUARY OF CHESAPEAKE BAY. **Robert Aguilar, Eric G. Johnson, Anson H. Hines, Paige M. Roberts, Michael R. Goodison,** and **Margaret A. Kramer**. Smithsonian Environmental Research Center, Box 28, Edgewater, MD, 21037, USA.

In recent years, overexploitation and habitat degradation have contributed to precipitous declines in the spawning stock and juvenile recruitment of Chesapeake Bay (CB) blue crabs. Based on fishery-independent surveys and catch reports, fishery managers have a good understanding of population size and exploitation for CB as a whole. However, little is known about population and fishery dynamics at smaller scales, such as the tributary. To this aim, a mark-recapture experiment was conducted in the Rhode River, a small mesohaline subestuary of upper CB, during 2005-2008 to estimate: 1) population size; 2) exploitation rate; 3) tag-reporting rate; 4) fishery composition. To date, over 40% of tags have been reported. Exploitation rates were high throughout most of the study period, but comparable with Baywide estimates. Tag-reporting rates were also high for all fishery sectors, indicating a high level of cooperation with most fishers. The recreational catch was a considerable component of overall harvest (~20-35% per year), much larger than previous Baywide estimates. Population size estimates were generally consistent among years and increased in precision over the study period. These data provide an important understanding of the complex nature of the blue crab fishery.

CHARACTERIZATION OF MICROBIAL COMMUNITIES AND IMMUNE SYSTEM RESPONSES ASSOCIATED WITH SHELL DISEASE IN THE AMERICAN LOBSTER, *HOMARUS AMERICANUS*. **Bassem Allam, Alistair Dove, Anne McElroy, Gordon Taylor,** and **Mark Fast**. Stony Brook University, Dana Hall 155, Stony Brook, NY, 11794, USA.

Epizootic shell disease syndrome (ESD) is known to affect lobsters (*Homarus americanus*) in eastern Long Island Sound (ELIS) and the near shore waters of southern New England. This study was designed to investigate the pool of potential pathogens residing on the carapace of wild asymptomatic and symptomatic lobsters, its composition, seasonal dynamics and activity. Simultaneously, we explored several immune parameters in lobsters with and without ESD. Lobsters were collected from ELIS and from two sites where ESD prevalence is low: western Long Island Sound (WLIS) and Maine. Results demonstrated spatial and temporal variations in microbial activities. Similarly, results also showed spatial and temporal differences in defense related factors among

symptomatic and asymptomatic lobsters. Overall, diseased lobsters displayed lower phagocytic rates and lower oxidative burst in circulating hemocytes, and higher levels of bacteraemia. Furthermore, both symptomatic and asymptomatic lobsters from ELIS were immunodeficient when compared to their WLIS and Maine counterpart. These investigations also allowed the detection of defense-related factors in lobster exoskeleton including phenoloxidase-like molecules and antimicrobial compounds. While the cause of ESD remains unknown, the differences in disease prevalence between ELIS and WLIS might be linked to the lower performance of both internal and exoskeletal defenses in ELIS lobsters.

DEVELOPMENT OF FUNCTIONAL GENOMICS TOOLS FOR THE INVESTIGATION OF HARD CLAM-QPX INTERACTIONS. **Bassem Allam**[1], **Mickael Perrigault**[1], and **Arnaud Tanguy**[2]. [1]Stony Brook University, Dana Hall 155, Stony Brook, NY, 11794-5000, USA; [2]Université de Paris 6, Station Biologique, Roscoff, Roscoff, 29682, France.

Over the last decade, several northeastern states have suffered severe losses in wild and cultured hard clam stocks due to a fatal disease caused by Quahog Parasite Unknown (QPX). Recent studies comparing different broodstocks demonstrated the genetic origin of clam resistance toward QPX. Further progress in understanding factors affecting QPX disease development is limited by the lack of information regarding clam immune response toward the infection. In this study, different approaches were used to identify and quantify differentially expressed genes in infected clams. These investigations generated a large amount of genetic information that was used to develop the first hard clam expression microarray. Results allowed the identification of several genes that are modulated by the exposure to QPX or that represent promising potential markers of clam resistance toward the parasite. Sequencing effort is ongoing to generate additional genetic information and to increase the number of sequences spotted on the microarray. This approach is expected to allow the discovery of biomarkers and molecular mechanisms characteristic of both resistance to, and dysfunctions caused by, QPX; and has the potential to lead to the development of test systems that are cost- and time-efficient for the screening and selection of clam stocks.

LARGE SCALE OYSTER RESTORATION IN THE MARYLAND PORTION OF THE CHESAPEAKE BAY: SITE SELECTION, PLANTING AND MONITORING. **Steven M. Allen** and **Stephan Abel.** Oyster Recovery Partnership, 1805 A Virginia St, Annapolis, MD, 21401, USA.

Oyster restoration in the Maryland portion of the Chesapeake Bay is a topic often subject to public scrutiny. Each tributary of the Chesapeake has its own set of challenges that need to be surmounted for a restoration strategy to prove successful. Unfortunately, there is no manual to guide our efforts. Most of the current restoration effort has focused in areas of lower salinity. The goal of this strategy is to maximize survival and ecosystem services. Future restoration practices aim to focus on areas that have a higher likelihood of receiving natural spat-sets. The ideal outcome is a self sustaining natural system; to reach that goal, hatchery produced seed will be needed to jumpstart populations.

The Oyster Recovery Partnership is a non-profit organization founded in 1994 to accomplish the goals set forth by Maryland's Oyster Roundtable Action Plan. We currently use adaptive management practices to enhance restoration efficiencies. With our partners, NOAA, MDDNR, ACOE, MWA and UMD, we are continuously refining our techniques to restore areas with the best potential of success. In recent years, we have combined the practical knowledge of watermen with modern technologies to determine restoration sites.

ENVIRONMENTAL IMPACTS ON SHELLFISH CONDITION AND GROWTH: IMPLICATIONS FOR LARVAL SOURCES AND POPULATION MAINTENANCE. **Troy Alphin, Martin Posey, Anne Markwith,** and **Sara Colosimo.** University of North Carolina Wilmington, 601 South College Road, Wilmington, NC, 28403, USA.

Oyster (*Crassostrea virginica*) populations in the estuarine systems of southeastern North Carolina are predominantly intertidal while oyster populations in northern coastal areas are subtidal. North Carolina's Fishery management plan (FMP) promotes the creation of no-take oyster sanctuaries to restore and enhance oyster populations in surrounding areas. Currently the only permanent sanctuaries have been established in areas where the oyster population is subtidal. Many of the critical estuarine oyster habitats (tidal creeks and back marsh areas) along the southern portion of the coast have been closed to shellfishing due to runoff from surrounding development. These areas have been suggested to function as sanctuaries since no shellfishing occurs and larvae are assumed to recruit to adjacent, open areas. Here we look at oyster condition and a variety of reef characteristics among tidal creeks systems to help determine if these areas serve as sanctuaries in a manner equivalent to sanctuaries in areas of higher water quality. Data suggests that portions of these creeks may function to provide larvae to the surrounding habitats, but the reservoir may be shrinking through time as these areas are impacted by runoff and condition of oysters declines.

FISH AND CRABS: EXPLOITATION OF MARINE RESOURCES ON THE EUROPEAN ATLANTIC FACADE DURING PREHISTORIC TIMES. Esteban Alvarez Fernández[1], Dupont Catherine[2], Nathalie Desse-Berset[3], Yvon Dréano[3], and **Raquel Fernandez García[4].** [1]IIIPC-University of Cantabria, Av- de los Castros S/N. Edificio Interfacultativo de la Univ. Cantabria, Santander, Cantabria, 39005, Spain; [2]University of Rennes 1, Bâtiment 24-25, University Rennes 1 – Campus Beaulieu 74205CS, Rennes, Ille-et-Villaine, 35042, France; [3]University Nice Sophia-Antipolis, Valbonne, Alpes Maritimes, 06103, France; [4]University of Cantabria, Av. de los Castros SN. Edif Interfacultativo, Santander, Cantabria, 39005, Spain.

On the Atlantic facade of Europe, the earliest evidence of the exploitation of marine resources by hunter-gatherer groups goes back to the late Middle Paleolithic (50,000 BP). It is at this time, but above all, in the Early Upper Paleolithic (36,000 BP) when the first remains of marine molluscs are found in archaeological deposits. However, as well as these sea animals, the human groups procured other kinds of resources which are found in smaller numbers at prehistoric sites: marine mammals, crabs and other crustaceans, sea urchins, fish, etc. In this communication we present the available information about the exploitation of crabs and fish, obtained through the latest archaeozoological research carried out at different sites located along the Atlantic coast of Europe, and based on taxonomic, quantitative and taphonomic studies. Information is also given about fishing and gathering strategies followed by human groups, and on the size of the specimens, reconstructed from the anatomical parts of the animals preserved in the archaeological deposits. Finally, a summary is made of the evolution in the exploitation of crabs and sea fish on the Atlantic façade between the Upper Paleolithic and the Chalcolithic (c. 36,000-3,800 BP).

FIRST ARCHAEOLOGICAL DATA ON THE EXPLOITATION OF THE GOOSENECK BARNACLE *POLLICIPES POLLICIPES* (GMELIN, 1790) IN EUROPE. Esteban Alvarez Fernández. IIIPC, University of Cantabria, Av. de los Castros S/N. Edificio Interfacultativo, Santander, Cantabria, 39005, Spain.

Barnacles of the species *Pollicipes pollicipes* (Phylum: Arthropoda, Supraclass: Crustacea; Class: Cirripedia; Order: Pedunculata; Family: Scalpellidae; Genus: *Pollicipes*) are crustaceans living on wave-beaten rocky substrates in the inter-tidal and low-shore zones on the coasts of Atlantic Europe and North Africa (the area covered at high tide and uncovered at low tide, and the permanently covered area, respectively). At the present time, the exploitation of this species is economically important, especially in northern Spain where this sea-food is highly valued, as well as expensive. However, the gathering of this resource, which is carried out manually by the *percebeiros* or ''gooseneck barnacle fishers'' entails great risks. The exploitation of gooseneck barnacles is, however, not a recent activity, as evidence of it has been seen in southwest Europe in the Mesolithic (about 8000 BP), and above all from the early Neolithic (about 6000 BP). This paper analyses the archaeological evidence of barnacles (*tergum*, *scutum* and *carina*, calcareous plates located in the *capitulum*) that have been found at two Spanish Neolithic sites; one located in the north of the Iberian Peninsula (Los Gitanos Cave, in Cantabria) and the other in the south (El Zafrín, on Congress Island in the Chafarinas Islands).

SEARCHING FOR SOLUTIONS: IMPEDIMENTS TO SHELLFISH HATCHERY PRODUCTION IN THE PACIFIC NORTHWEST, USA. Kevin Amos[1] and **Dan Cheney[2].** [1]National Oceanic & Atmospheric Administration (NOAA), 1315 E-West Hwy., SSMC #3-13th Fl., Rm. 13113, Code:F, Silver Spring, MD, 20910, USA; [2]Pacific Shellfish Institute, 120 State Ave. NE #142, Olympia, WA, 98501, USA.

Bivalve molluscan hatcheries and wild spat sets have been severely impacted the past few years in the Pacific Northwest. Significant mortalities in shellfish hatcheries are due to bacterial infections of *Vibrio tubiashii*, ocean acidification, and a combination of unknown environmental factors. This situation has reached emergency proportions as shellfish hatchery operators consider the very real possibility of going out of business. Consequently, growers who depend on hatcheries and wild set seed will be unable to meet buyers' demands in the coming years. In response to this emergency, the NOAA Aquaculture Program, in co-operation with the Pacific Coast Shellfish Growers Association and the Pacific Shellfish Institute, has brought together growers and researchers to develop a strategic research plan to investigate these problems. Information will be presented on the status of the plan development and implementation.

MANAGEMENT STRATEGIES OF EAST COAST STATES CONCERNING INTERSTATE SHELLFISH TRANSPORT. William D. Anderson. South Carolina Department of Natural Resources, 217 Fort Johnson Road, Charleston, South Carolina, 29412, USA.

Movement of shellfish has a long history along the east coast of North America. Beginning in the 1800s, large quantities of *Crassostrea virginica* seed were transferred among states followed by interstate commerce in *Mercenaria mercenaria* broodstock and seed. The success of hard clam aquaculture has created new field grow-out techniques, a robust industry and numerous state regulations pertaining to shellfish importation and pathogen issues. Importing and exporting states have developed different disease and genetic entry requirements. In addition, divergent certification requirements have confused the industry and testing laboratories. Nevertheless, as a general consensus, east coast states have three basic management strategies: (1) reduce the risk of importing shellfish diseases, endeavoring to prevent pathogens from spreading to cultured and wildstock shellfish, (2) inhibit the

importation of exotics and non-target species, and (3) allow seed and broodstock importation in order to sustain a healthy shellfish aquaculture industry. This presentation reviews east coast states' policies concerning the importation of indigenous molluscan shellfish into their natural waters for the purpose of holding or cultivation and updates results of the East Coast Interstate Shellfish Seed Transport Workshop held in Charleston, SC in February, 2002 — including regulatory perspectives on highly specific PCR assays vs. tissues-section histology.

COMMERCIAL SINGLE OYSTER AQUACULTURE IN SOUTH CAROLINA. William D. Anderson. South Carolina Department of Natural Resources, 217 Ft. Johnson Road, Charleston, SC, 29422, USA.

In an effort to diversify the wild-stock oyster industry and take advantage of market opportunities, a cooperative fisheries development program in South Carolina supported five commercial shellfishermen growing hatchery raised seed oysters.

Demand for locally grown single oysters has increased in the state over the past few years substantiated by increasing harvests of wild cultivated single oysters during a five year period. Development of single oyster aquaculture, in conjunction with the state's clam aquaculture infrastructure, should provide diversification and a branded product with local appeal.

This presentation describes several techniques–how large hatchery raised single oysters are deployed in containers, floats, bottom plants and in saltwater ponds. The greatest problem concerns fouling of large hatchery seed by naturally occurring oyster spatfall.

EVALUATION OF HOUSEKEEPING GENES, VERY IMPORTANT CRITERIA IN MEASURING GENE EXPRESSION. Mebrahtu Tewelde Araya[1], Ahmed Siah[1], Dante Mateo[1], Frederick Markham[1], Patty Mckenna[1], Gerry Johnson[1], and **Franck C.J. Berthe[2].** [1]University of Prince Edward Island, 550 University Avenue, Charlottetown, Prince Edward Island, C1A 4P3, Canada; [2]European Food Safety Authority, N. Palli 5/A, Largo, Parma, I-43100, Italy.

Gene expression studies have opened a tremendous field of investigation in biological research over the last decades. Expression of genes is most frequently quantified by real-time PCR (RT-qPCR), as this method has proved to be highly sensitive. One of the critical steps, however, in comparing transcription profiles is the availability of selected housekeeping genes. Expression of these genes should be fairly stable across the condition under study so that they provide a baseline for gene expression comparison. Such a baseline is better established upon a set of few housekeeping genes. In our study, nine candidate genes were used, these include ribosomal RNA (18S, S-15, S-18 and L-37), beta actin, ubiquitin, receptor activated C kinase (RACK) and elongation factor 1 and 2, in order to determine the most stable housekeeping genes, after haemocytes of *Mya arenaria* had been subjected to *Vibrio splendidus* for two hours. Our results showed that EF-1, S-18 and ubiqitin appear to be the most stable genes for this experimental condition. On the other hand, both 18S and beta actin, the most widely used housekeeping genes, turned out to be the least stable. This demonstrates the absolute need for preliminary assessment of housekeeping genes in gene expression studies.

***MERCENARIA* IN FLORIDA: SPECIES INTERACTIONS AND IMPLICATIONS. William S. Arnold.** Florida Fish and Wildlife Conservation Commission, 100 Eighth Avenue SE, Saint Petersburg, FL, 33701, USA.

Both the northern (*Mercenaria mercenaria*) and the southern (*M. campechiensis*) hard clam are common constituents of Florida's coastal bays and estuaries, and the two species readily hybridize in the field. However, there are substantial ecological and economic differences between the two pure species, and the hybrids add another level of complexity to the mix. I will review 20 years of research regarding the ecology of each genotype class, discussing distribution patterns, growth rates, habitat preferences, susceptibility to disease, and the implications of these traits to the ecological and economic function of the *Mercenaria* complex. In particular, I will consider introductions and transplants resulting from scientific investigations and aquaculture activities, and I will evaluate how those activities have potentially altered the role of *Mercenaria* in coastal ecosystems with a consideration of the continued existence of *M. campechiensis* as a distinct species.

MARTEILIOSIS DEVELOPMENT IN TWO BIVALVE SPECIES IN DIANA LAGOON (CORSICA, FRANCE). Isabelle Arzul, Jean-Philippe Herbourg, Bruno Chollet, Maeva Robert, Céline Garcia, Jean-Pierre Joly, and **Marc Bouchoucha.** IFREMER, Av. de Mus de Loup, La Tremblade, 17390, France.

Diana Lagoon, located on the eastern coast of Corsica (France) is an interesting site for conducing studies on marteiliosis epidemiology because of the simultaneous presence of the protozoan *Marteilia refringens*, flat oysters *Ostrea edulis*, and mussels *Mytilus galloprovincialis*, two bivalve species known as hosting this parasite.

In order to follow the development of the parasite within the lagoon, 30 individuals of mussels and oysters were collected monthly from June to December 2007 for histological examination. For each infected bivalve, infection intensity and parasite development stages were recorded as well as their location within the digestive tract. Salinity and temperature were also monitored monthly.

None of the flat oyster was found infected by *Marteilia refringens* on the study period. On the contrary, all mussel samples appeared infected with 1 to 24 (/30) parasitized individuals.

Maximum detection frequency and infection intensity were observed in August suggesting that these two parameters answer to the same stimuli. The different parasite stages were observed in all samples but refringent stages were mainly reported in August. Although no mortality was reported in mussels, prevalence decreased drastically between August and September traducing a massive release of parasites in the lagoon at this time.

MOLECULAR CHARACTERIZATION OF PARASITES OF THE GENUS *PERKINSUS* PRESENT IN CLAMS FROM FRENCH PRODUCTION AREAS. **Isabelle Arzul, Justine Michel, Bruno Chollet, Maeva Robert, Céline Garcia, Laurence Miossec,** and **Cyrille François.** IFREMER, Av. de Mus de Loup, La Tremblade, 17390, France.

Production of clams is the third most important bivalve production in France and was estimated at 3400 metric tons in 2001 among which 60% came from aquaculture and 40% from fisheries.

Surveillance of clam diseases mainly relies on histology and thioglycolate culture, two techniques allowing detection of parasites of the genus *Perkinsus* but not specific enough to determine the parasite species.

Based on a previous study aiming at estimating distribution and prevalence of perkinsosis in France, we selected 34 infected clams from four different producing areas in order to characterize the parasite species.

Molecular characterization was done by PCR-RFLP targeting the ITS region as described by Abollo *et al*. (2006). Sixteen PCR products were cloned and 10 to 20 clones per individual were selected for PCR-RFLP to test potential intra individual polymorphism. 23 clones, including the ones which yielded non expected restriction profiles, were finally selected for sequencing.

All the obtained sequences displayed 99 to 100% of homology with *Perkinsus olseni* confirming the presence of this protozoan in at least four different French marine areas (Golfe du Morbihan, Thau, Leucate, Arcachon). Polymorphism between clones obtained from a same clam or from different clams did not appear geographic dependent.

SHELLFISH RESTORATION: YES WE CAN! **Kathryn Ashton-Alcox[1], Eric Powell[1], Russell Babb[2], Jason Hearon[2], Richard Cole[3],** and **Gulnihal Ozbay[4].** [1]Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA; [2]NJ Department of Environmental Protection, 1670 E. Buckshutem Road, Millville, NJ, 08332, USA; [3]Delaware Department of Natural Resources and Environmental Control, Dover, DE, 19901, USA; [4]Delaware State University, Dover, DE, 19901-2277, USA.

The Delaware Bay shell planting program coordinated by its Oyster Revitalization Task Force in cooperation with the U.S. Army Corps of Engineers and the oyster industries of New Jersey and Delaware have a 2005 -2007 track record of successfully enhancing the oyster population and stabilizing the shell resource. Details have been documented in previous talks and reports. Assessments for 2008 are ongoing and should be complete by early 2009. From 2005 to present, nearly 1.5 million bushels of shell were planted on 242 acres of NJ and DE state oyster grounds at a total cost of $5 million dollars in federal money. Matching funds from local sources in NJ and DE exceeded the 1:3 ratio goal. Anticipated oyster harvest in 2008 and 2009 from the 2005 planting is 87,379 bu, valued at $3.5 million using the 2007 price of $40/bu. Estimated economic impact is $20.9 million: a return on investment of $70 for each $1 of federal money. The 2006 plants are projected to return $38 for each $1 invested and the 2007-2008 programs are anticipated to be just as successful. Valuable ecological services are being provided by a shell budget in equilibrium as a result of these plantings.

POPULATION STRUCTURE AND GENETIC DIVERSITY IN WILD AND CULTURED, *MERCENARIA MERCENARIA*. **Patrick Baker[1], James Austin[1], Brian Bowen[2], Leslie Sturmer[1],** and **Shirley Baker[1].** [1]University of Florida, 7922 NW 71 Street, Gainesville, FL, 32653, USA; [2]University of Hawaii, PO Box 1346, Kanohe, HA, 96744, USA.

The northern quahog, *Mercenaria mercenaria*, is harvested commercially throughout its native range from Canada, to Florida, USA, and is cultured in several areas. We examined a mitochondrial COI gene fragment from ten geographical locations across the range of this species. The *M. mercenaria* samples comprised a single evolutionary lineage, despite a geographical discontinuity in the northern part of its range. North of North Carolina, genetic diversity decreased with latitude, which is consistent with a post-glacial range expansion. There was also evidence for modest population structure with partitions in North Carolina, and Massachusetts. We failed to find any evidence of a partition at Cape Canaveral, Florida, which has been observed for other taxa. This result, combined with a lack of genetic distinction for Gulf of Mexico samples, is consistent with the thesis that Gulf of Mexico *M. mercenaria* represent a recent invasion or introduction. Genetic diversity of wild stocks was compared to twelve cultured *M. mercenaria* stocks in Georgia and Florida. Genetic diversity across hatchery stocks tended to be lower than across wild stocks, which may be explained by artificial selection for the *notata* shell color phenotype, and does not necessarily reflect other selective breeding efforts.

EVALUATION OF HYBRID CLAMS (*M. MERCENARIA* AND *M. CAMPECHIENSIS*) FOR FLORIDA AQUACULTURE: RESULTS OF LABORATORY CHALLENGES. **Shirley M. Baker[1], Leslie N. Sturmer[1],** and **John Scarpa[2].** [1]University of Florida/IFAS, 7922 NW 71st St, Gainesville, FL, 32653, USA; [2]Harbor Branch Oceanographic Institute at Florida Atlantic University, 5600 US North, Ft. Pierce, FL, 34951, USA.

The northern quahogs, *Mercenaria mercenaria*, is an important aquaculture species in the state of Florida. Over the past decade, mortality events resulting from hurricanes, low salinities, and, potentially, high water temperatures, have affected production. The local southern quahog *Mercenaria campechiensis* may offer improved production characteristics and hybridizes readily with the northern hard clam. Therefore, a rigorous examination of parental species and their crosses under laboratory (this study) and commercial conditions has been initiated. Commercial growout size seed (10 mm shell width) of parental species and their crosses, representing two families, were exposed to salinities of 15 or 25 ppt and hypoxic or normoxic dissolved oxygen levels with temperature held constant at 32°C (90°F) for 28 days. Observations of clam mortality were conducted at 24 hour intervals. Survival analyses indicate that *M. mercenaria* x *M. campechiensis* crosses performed better under stressful conditions than did the parental species or the reciprocal cross. In addition, one family performed better than the other family, indicating a genetic basis for future selection processes. Challenges will be repeated for market size clams (25 mm shell width). Supported by USDA Special Research Grant.

THE EPIDEMIOLOGICAL STATUS OF PAV1, AND THE EFFECTS OF INFECTION ON CARIBBEAN SPINY LOBSTER (*PANULIRUS ARGUS*) CONDITION, OLFACTION, AND PREDATION RISK. **Donald C. Behringer[1], Mark J. Butler, IV[2],** and **Jeffrey D. Shields[3].** [1]University of Florida, 7922 NW 71st Street, Gainesville, FL, 32653, USA; [2]Old Dominion University, Norfolk, VA, 23529, USA; [3]Virginia Institute of Marine Science, P.O. Box 1346, State Road 1208, Gloucester Point, VA, 23062, USA.

PaV1 is the first viral disease known from lobsters, and it alters the behavior and ecology of this species in fundamental ways. Most remarkable is that healthy lobsters, which are normally social, chemically detect and avoid diseased conspecifics. This behavior, along with lethargy in infected lobsters, may break the expected density dependence of infection. We suspected that this lethargy resulted from depletion of metabolic reserves and tested this through field measurements of lobster nutritional condition and found significantly lower hemolymph protein levels among diseased lobsters. Infected lobsters were also less frequently recaptured compared to healthy lobsters in tag-recapture studies, leading us to believe that their lethargy may have exposed them to higher predation rates. We tested this theory using tethered healthy and diseased lobsters and found significantly greater predation among those infected with PaV1. In turn, we used mesocosms to test whether healthy lobsters, capable of chemically detecting and avoiding disease and predator odors, avoided one mortality risk over the other. When presented with two shelters, one with a diseased lobster and one open, in the presence of a predator (octopus) alarm odor, healthy lobsters will forego the benefits of group defense rather than risk infection with this deadly virus.

POTENTIAL EFFECTS OF CATASTROPHIC CYANOBACTERIA BLOOMS ON CARIBBEAN SPINY LOBSTER POPULATION DYNAMICS IN FLORIDA BAY USA. **Donald C. Behringer[1]** and **Mark J. Butler, IV[2].** [1]University of Florida, 7922 NW 71st Street, Gainesville, FL, 32653, USA; [2]Old Dominion University, Norfolk, VA, 23529, USA.

Shallow hard-bottom found in Florida Bay is an ideal nursery habitat for juvenile lobsters. However, this region has been subject to cyanobacteria algae blooms; the most recent in 2007. In many areas covered by the bloom 100% of the shelter-forming sponges that lobster use were eliminated. These sponge die-off events provide a unique natural experiment in which to study the effects of shelter limitation on population dynamics and also provide insight into how habitat-driven changes in population distributions alter disease dynamics. For example, juvenile lobsters are susceptible to a lethal virus (PaV1) which is spread through close contact in this normally social species. However, healthy lobsters detect and avoid cohabitation with infected conspecifics, which reduces transmission. The effectiveness of this behavior has never been tested in a shelter-limited system, where competition for limited shelters might counterbalance disease avoidance. Our results revealed that shelter loss initially increased aggregation but the effect diminished as lobsters dispersed. We also found that in the presence of a diseased lobster, competition ensued and the initial shelter resident was displaced 5x more often compared to trials with two healthy lobsters, but when multiple lobsters vied for shelter, healthy and diseased lobsters co-occupied shelters increasing transmission risk.

POPULATION GENETICS OF BAY SCALLOPS (*ARGOPECTEN IRRADIANS*): A HISTORY OF LONG-DISTANCE DISPERSAL AND RANGE EXPANSION. **Theresa Bert[1], Ami Wilbur[2], William Arnold[1],** and **Anne McMillen-Jackson[1].** [1]Florida Fish and Wildlife Conservation Commission, 100 Eighth Ave. SE, St. Petersburg, FL, 33701, USA; [2]University of North Carolina, 601 South College Road, Wilmington, NC, 28403, USA.

Analysis of allozyme data demonstrated that bay scallops in the Florida Gulf have a dynamic population genetic structure that ranges from panmictic to highly subdivided. A core subpopulation exists in northwest Florida waters. Peripheral subpopulations are more genetically variable over time and between locations. Florida

Bay has a unique subpopulation genetically differentiated from all others in the Florida Gulf. All Florida Gulf subpopulations are genetically differentiated from Atlantic subpopulations. Mitochondrial DNA restriction fragment patterns (mtDNA RFLPs) also showed that outlier subpopulations were more distantly related than core subpopulations, but specific collections had notably high or low nucleotide or haplotype diversity values and the core subpopulation was not genetically homogeneous over time. Nested clade analysis revealed a history of long-distance dispersal and, more recently, population expansion, principally in the Florida Gulf. Two of the three haplotypes groups had similar evolutionary histories of long-distance dispersal followed by population or range expansion in the Florida Gulf. A third haplotype group had a less definable evolutionary history. Our analyses also supported some subspecies distinctions, revealed that the North Carolina subpopulation was a mixture of *A.i. irradians* and *A.i. concentricus*, and indicated that Florida Gulf bay scallops should be managed at the regional subpopulation level.

STONE CRAB (GENUS *MENIPPE*) POPULATION GENETIC STRUCTURE: A REVIEW, AND THINGS TO COME. Theresa Bert and **Anne McMillen-Jackson.** Florida Fish and Wildlife Conservation Commission, 100 Eighth Ave. SE, St. Petersburg, FL, 33701, USA.

Two stone crab species inhabit the southeastern North Atlantic Ocean and Gulf of Mexico. *Menippe mercenaria* inhabits the Caribbean, south Florida, and North Carolina; *M. adina* inhabits the Gulf of Mexico from Mississippi to Veracruz state. Diagnostic coloration, allozyme alleles, and mitochondrial DNA restriction fragment patterns (mtDNA RFLPs) show that these two species hybridize extensively in northwestern Florida in a broad area at the junction of their respective ranges and that some mtDNA evolution or selection has occurred in this hybrid zone. A relict area of hybridization exists in the Atlantic Bight. There, populations have the coloration of *M. mercenaria* or *M. mercenaria*-like hybrids and allozyme allele frequencies at diagnostic loci influenced only somewhat by *M. adina* alleles. However, mtDNA RFLPs are fixed for the *M. adina* haplotype and allele frequencies at one allozyme locus differ significantly from those of either pure species. The characteristics of these two hybridization regions are likely due to differences in their locations relative to the pure-species distributions. Genetic evidence for selection of unique allozyme alleles and mtDNA haplotypes suggests that hybrids are differentiating from the parental species. We plan to reanalyze these data using new computer programs and to also include microsatellite DNA data.

AN INNOVATIVE APPROACH TO DETECTING WASTEWATER INFLUENCE ON OYSTERS. Peter J. Biancani[1], Ruth Camichael[1], Allen Aven[1], Kevin Calci [2], William Burkhardt III[2], and **Joshua H. Daskin[3].** [1]University of South Alabama/Dauphin Island Sea Lab, 101 Bienville Blvd, Dauphin Island, AL, 36528, USA; [2]FDA, Dauphin Island, AL, 36528, USA; [3]Brandeis University, Waltham, MA, 02454, USA.

Waste water treatmentplants (WTP) in coastal areas discharge nutrients and microbes into near-shorewaters. We measured effects of WTP effluent on oyster growth, survival, andconcentrations of fecal coliform and male specific bacteriophage (MSB) inoyster tissue and receiving waters in Mobile Bay, AL. To link biological responses in oysters to WTP effluent, wemeasured N and C stable isotope ratios in samples of WTP effluent, oystertissue, and suspended particulate matter (SPM) in receiving waters. We comparedconcentrations of fecal coliform and MSB in oyster tissues and receiving waters with concentrations in WTP effluent. Oyster growth and survival did not change with proximity to WTP outfall. WTP effluent, however, imparted a characteristically light ∂^{15}Nvalue (–3.78‰), which was conveyed to SPM and transplanted oysters. Stable isotope ratios in SPM andoysters increased with distance from the outfall as effluent was diluted by Baywater. Similarly, MSB andcoliforms in oyster tissues were highest at sites closest to the outfall. MSB concentrations were significantlycorrelated with ∂^{15}N values, suggesting MSB was a better indicatorof wastewater influence than coliforms. Used in combination, N stable isotope ratios and MSB are potentiallypowerful indicators of wastewater exposure for shellfish.

ABILITY AND PREFERENCE OF *ARGOPECTEN IRRADIANS IRRADIANS* LARVAE TO SETTLE ON VARIOUS SAVS. Dennis M. Bonal. C. W. Post Campus of Long Island University, 720 Northern Blvd, Brookville, NY, 11548-1300, USA.

Eelgrass (*Zostera marina*) is believed to be the primary substrate for recruitment of larval bay scallops, *Argopecten irradians irradians* (Lamarck, 1819). In the Peconic Bays of eastern Long Island, NY and other areas along the East Coast of the United States, however, eelgrass coverage has declined drastically in recent years. This trend may be partially responsible for observed declines in bay scallops stocks in these same areas. In New York, ongoing restoration efforts have contributed to an increase in bay scallop populations over the past few years – which raises the question of what substrate(s) could be acting as a substitute for eelgrass? During summer 2008, the ability of scallop pediveliger larvae to settle onto eelgrass in the laboratory was compared to settlement rates on five locally common macroalgal species: *Codium fragile*, *Gracilaria tikvahiae*, *Spyridia filamentosa*, *Ulva lactuca*, and *Dasya baillouviana.* Results are discussed along with potential implications for restoration efforts.

MOLECULAR CHARACTERIZATION OF A *CALLINECTES SAPIDUS* REOVIRUS AND DEVELOPMENT OF TOOLS TO MONITOR ITS PRESENCE IN WILD AND IN CAPTIVE CRABS. **Holly A. Bowers[1], Ammar Hanif[1], Gretchen A. Messick[2],** and **Eric J. Schott[1].** [1]UMBI, 701 East Pratt Street, Baltimore, MD, 21202, USA; [2]NOAA-NCCOS, 904 S. Morris Street, Oxford, MD, 21654, USA.

The blue crab, *Callinectes sapidus*, is the foundation of the most significant fishery of four Atlantic states. In Chesapeake Bay, where the dockside value of blue crab is over $50 million annually, the blue crab population has been in a decade-long decline, triggering severe fishing restrictions and a declaration by the US Department of Commerce that the fishery is a disaster. In the face of decreasing harvests, crabbers can increase the value of their catch by producing soft-shell crabs. Crabs in soft-shell production facilities, however, frequently suffer mortality of 25% or more. We have evidence that a reovirus may be associated with a majority of these mortalities. Using a low-sensitivity method, we detect reovirus genomic RNA in over 60% of soft-shell mortalities, but only ~3% of healthy hard-shell crabs. In order to address major questions about the transmission and prevalence of this virus, which we term CsRV1, a more sensitive detection method is needed. To this end, we cloned a segment of the RNA genome of the virus. Based on the 1.3 kb sequence, we have developed an Rt-PCR-based assay to detect the virus, and will apply this assay in prevalence studies and in experimental transmission research.

INDUCED ACID STRESS RESPONSE IN *VIBRIO PARAHAEMOLYTICUS:* PRE-ADAPTATION IN HIGH NaCl INCREASES SURVIVAL AT LOW pH. **E. Fidelma Boyd.** University of Delaware, 328 Wolf Hall, Newark, DE, 19716, USA.

Vibrio parahaemolyticus is a natural inhabitant of estuarine marine waters and is the leading cause of seafood-associated bacterial gastroenteritis in the world, due to the consumption of contaminated shellfish. *V. parahaemolyticus* is a moderate halophile growing at 0.5M to 1.5M NaCl, which is an absolute requirement for survival. Our knowledge of the underlying mechanisms by which this organism proliferates in fluctuating saline environments is unknown. By bioinformatic analysis, we identified putative genes involved in the osmotic stress response and show that the large number of osmotic stress systems enhances *V. parahaemolyticus*' ability to grow in fluctuating saline environments. Our overall hypothesis is that the ability to grow at high NaCl concentrations also cross protects against other stresses the organism may face in its different niches (marine environment and human host). When *V. parahaemolyticus* enters the human host it must traverse the high acid of the stomach and bile conditions of the intestine before it infects. We determined the cross-protective effects of growth at high NaCl concentrations to survival in low pH conditions and high bile concentrations. Our data will establish that the large compendium of osmotolerant genes is critical for survival under varying stress conditions.

THE EFFECT OF *PERKINSUS MARINUS* INFECTION ON THE POPULATION STRUCTURE OF HARVESTED AND UNHARVESTED OYSTER REEFS IN MOBILE BAY, ALABAMA. **Yolanda J. Brady[1], F. Scott Rikard[2], Richard K. Wallace[1],** and **Dennis J. Donegan[1].** [1]Auburn University, 203B Swingle Hall, Auburn University, AL, 36849, USA; [2]Auburn Universtiy, 150 Agassiz Street, Dauphin Island, AL, 36528, USA.

A two-year field study investigated the effect of *Perkinsus marinus* on oyster population dynamics at six harvested and unharvested reefs. Oyster population size structure was analyzed semi-annually at each reef. Concurrently, *P. marinus* prevalence and infection intensity was determined by Ray's FTM whole-oyster analysis from collected oysters. Mortality was monitored monthly in replicate bags of oysters deployed at each reef.

Unharvested reefs had higher densities of oysters in all size classes. Shifts in size structure on both reef types were variously attributed to recruitment, harvesting, and mortality associated with disease and predation. Prevalence of *P. marinus* was not significantly different between reef types ($P > 0.05$) but infection intensity was significantly higher ($P < 0.0001$) in oysters on unharvested reefs during four of the five sampling periods. Adult oyster mortality attributed to *P. marinus* was significantly affected ($P < 0.0001$) by reef type. Drought conditions provided optimal salinity conditions for the predatory oyster drill, *Stramonita haemastoma*, significantly impacting oyster population structure on both reef types.

In the absence of significant predation, oyster populations on unharvested reefs are sustained at high densities with only the largest oysters succumbing to *P. marinus* infection. Harvesting of larger oysters may reduce *P. marinus* disease intensity but reduces available substrate for recruitment.

ENHANCING COMPETITIVENESS OF U.S. SHRIMP AQUACULTURE THROUGH INNOVATIVE SCIENTIFIC RESEARCH. **Craig L. Browdy[1], Jesus A. Venero[2], Al D. Stokes[3],** and **John W. Leffler[2].** [1]Novus International Corp., 5 Tomotley Court, Charleston, SC, 29407, USA; [2]South Carolina Department of Natural Resources, 211 Sawmill Creek Road, Bluffton, SC, 29910, USA; [3]South Carolina Department of Natural Resources, 211 Sawmill Creek Road, Bluffton, SC, 29910, USA.

In February 2008, the National Oceanic and Atmospheric Administration (NOAA) and the National Institute of Standards and Technology (NIST) sponsored a workshop to identify technology gaps to sustainable shrimp aquaculture in the United States. A working group including producers, suppliers, and scientists prepared a roadmap that was discussed and improved in a facilitated workshop. Participants focused on emerging biofloc

technologies that have been demonstrated to support high production rates while minimizing environmental impacts. Participants from industry, academia, government, and non-governmental organizations shared ideas in a series of breakout sessions to develop a prioritized list of technology gaps as a basis for discussions on research needs and opportunities. This presentation summarizes the current state of the art in super-intensive shrimp production in the US while addressing the technology gaps identified at the workshop and listed in order of priority: 1) Systems Engineering and Life-Support, 2) Genetic improvement and seed supply, 3) Feeds and feeding, 4) Health and biosecurity, 5) Value-added products, and 6) Bio-economic modeling. By defining and prioritizing technology gaps, multidisciplinary collaborations can be facilitated that can contribute to improved environmental sustainability, production consistency, and economic profitability of biofloc-based production systems for marine shrimp.

ASSESSING SELECTED PACIFIC OYSTER STOCKS FOR DISEASE RESISTANCE IN TOMALES BAY, CALIFORNIA. **Colleen A. Burge[1], Carolyn S. Friedman[1], Paul G. Olin[2], Terry Sawyer[3], John Finger[3],** and **Drew Alden[4].** [1]University of Washington, Box 355020, Seattle, WA, 98195, USA; [2]University of California Davis, One Shields Avenue, Davis, CA, 95616, USA; [3]Hog Island Oyster Company, 20215 Highway 1, Marshall, CA, 94940, USA; [4]Tomales Bay Oyster Company, P.O. Box 296, Point Reyes Station, CA, 94956, USA.

Summer seed mortalities (SSM) of Pacific oysters, *Crassostrea gigas*, have occurred in Tomales Bay, California for 13 of the past 15 years, and an oyster herpesvirus (OsHV) has been identified and associated with SSM in Tomales Bay as early as 1995 (earliest test date). OsHV has been associated with mortalities in larvae and/or seed oysters in New Zealand, France, and Spain and has been detected in oysters from multiple Asian countries. Differential survival has been reported among stocks reared in Tomales Bay, indicating that some stocks may have natural resistance to OsHV. Oysters selected for OsHV resistance may provide oyster growers with stocks with increased survival. Potentially OsHV resistant Pacific oyster families were produced in April and July of 2008 at the Bodega Marine Laboratory from survivors of SSM in Tomales Bay. Three families of oysters produced from the April 2008 spawn were planted at two sites in Tomales Bay and monitored from June-September 2008 for mortality, disease (OsHV and other diseases), and growth compared to a control stock. Growth and mortality of the April and July 2008 (planted Fall of 2008) spawns will be monitored through Summer of 2009 to judge the utility of these oysters as farm product.

EUTROPHICATION IN COASTAL ECOSYSTEMS: WHAT IS THE ROLE OF BIVALVE SHELLFISH AQUACULTURE VERSUS LAND-BASED POLLUTION? **JoAnn M. Burkholder.** North Carolina State University, 620 Hutton Street, Suite 104, Raleigh, NC, 27606, USA.

This analysis compares the contribution of bivalve shellfish aquaculture versus land-based pollution to eutrophication in coastal ecosystems, with emphasis on North American waters. Based upon case studies, intensive bivalve shellfish aquaculture has sometimes caused serious localized water quality degradation in poorly flushed embayments and lagoons. Overall, however, bivalve aquaculture in many areas is a minor contributor to pollutant loadings in comparison to land-based sources. At present, nearly two-thirds of the U.S. population resides within a 50-mile radius of a coastline, urbanization is rapidly increasing, and at least 60% of this country's coastal rivers and bays are moderately to severely degraded by nutrient pollution and associated microbial pathogens, mostly from land-based urban and agricultural sources. Among the resulting impacts are increased hypoxia, high-biomass and/or toxic algal blooms, loss of critical habitat, increased shellfish disease, and reduction of shellfish recruitment and survival. Shellfish aquaculturists should continue to work to reduce nutrient inputs to coastal waters from their operations. In turn, and considering that shellfish aquaculture is essential to meet the seafood demands of the rapidly increasing global human population, there is a pressing need for resource managers and policy makers to increase protection of shellfish aquaculture operations from land-based nutrient pollution.

MISUSE OF PCR FOR SURVEILLANCE OF PROTISTAN PATHOGENS IN MOLLUSCS. **Eugene M. Burreson.** Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA, 23062, USA.

Polymerase chain reaction (PCR) assays are useful tools for pathogen surveillance, but they are only proxy indications of pathogen presence in that they detect a DNA sequence. To be useful for detection of actual infections, PCR assays must be thoroughly tested for sensitivity and specificity and ultimately validated against a technique, typically histology, which allows visualization of the parasite in host tissues. There is growing use of PCR assays for pathogen surveillance, but too often the assumption is made that a positive PCR result verifies an infection in a tested host. This assumption is valid only if the assay has been properly validated for the geographic area and for the hosts examined. Researchers should interpret unvalidated PCR assay results with caution.

UNDERSTANDING THE BASIS OF OYSTER DISEASE REFUGIA IN DELAWARE BAY. **David Bushek, Susan Ford, Iris Burt, Brenda Landau,** and **Emily Scarpa.** Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

Despite significant impacts of the oyster diseases MSX and Dermo, Delaware Bay oysters continue to support a viable fishery and represent an important ecological resource. As part of a larger study to examine how host genetics, population dynamics and the environment interact with disease organisms to structure the oyster population, we investigated whether disease refugia exist in the upper reaches of the estuary and if so, how they function. We compared exposure to pathogens with infection development in putative refugia versus non-refugia sites, and we challenged offspring from these sites to MSX and Dermo using a known susceptible stock as a control. Results indicate that Dermo is widespread throughout the Bay, and is often abundant at very upbay and upriver sites where disease mortality is clearly lower. The MSX parasite was present at all sites, but much less abundant in the low-salinity sites. Challenge experiments indicate higher resistance to infection development and mortality in Delaware Bay oysters regardless of source when compared to the susceptible control stock. With less disease mortality in refugia, how has natural selection been able to produce disease resistance in oysters at these sites? Financial support provided by NSF EID Award 0622672.

PCR DISEASE DIAGNOSTICS: PROMISING CORRECT RESULTS AND PITFALLS CONFOUNDING RESEARCH. **David Bushek** and **Susan Ford.** Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

Advances in molecular biology have enhanced the understanding of biology and our ability to address countless unanswered questions in many ways. The application of molecular tools to the understanding of host-parasites interactions has benefited tremendously. More and more, we see PCR assays being developed to detect and quantify parasite infections. Comparisons of these new assays with the more traditional "gold standard" assays (e.g., histology) often show greater sensitivity of the molecular assays. If such a pattern is true, then which method really is the "gold standard"? We reviewed more than a dozen published and unpublished studies that have compared the performance of PCR-based diagnostic assays for molluscan bivalve pathogens with the more traditional methods. Studies were selected based on whether or not the comparison allowed us to quantify true and false positives, and true and false negatives using each assay as the standard. Our particular interest was in identifying the factors that affected agreement between the two types of tests. The factors examined included pathogen species, infection intensity, season of collection and assay protocol, and all affected the degree of congruence between assays.

CAN MEASUREMENTS OF GENE EXPRESSION LEVELS ON PACIFIC OYSTER SPAT PREDICT THEIR GROWTH AND SURVIVAL IN THE FIELD? **Mark Camara[1], Nicolas Taris[2], R. Paul Lang[3],** and **Chris Langdon[3].** [1]USDA- Agricultural Research Service, 2030 SE Marine Science Drive, Newport, OR, 97365, USA; [2]USDA-Agricultural Research Service, 2030 SE Marine Science Drive, Newport, OR, 97365, USA; [3]Oregon State University, 2030 SE Marine Science Drive, Newport, OR, 97365, USA.

We tested whether survival after heat shock or gene transcription in juvenile oysters predicts field performance in *Crassostrea gigas* using a combination of laboratory and field experiments. In the lab, we measured juvenile survival after heat shock on juveniles from 46 families and then deployed unstressed siblings in Yaquina Bay, Newport, OR. In a separate experiment, we heat-shocked another 25 juveniles from four low-surviving and four high-surviving families of the same cohort and measured the mRNA concentrations of 14 genes.

There were no significant family-level correlations between juvenile survival after heat shock and subsequent survival, yield, or weight. The mRNA concentration of galectin was greater in low-surviving families before heat shock, whereas those of cystatin B at each sampling time and of glutathione S-transferase omega at 24 h after heat shock were greater in high-surviving families. The concentrations of heat shock protein 27, catalase, prostaglandin E receptor, galectin, an unidentified mRNA BQ426658 and superoxide dismutase mRNA were significantly correlated with survival and average weight in the field. We conclude that assays measuring gene transcription in whole bodies of juveniles hold promise for predicting performance of *C. gigas* families planted in coastal waters.

GENETIC DIVERSITY OF WILD, NATURALIZED, AND SELECTIVELY BRED POPULATIONS OF THE PACIFIC OYSTER (*CRASSOSTREA GIGAS*) ASSESSED USING AFLP MARKERS. **Mark C. Camara.** USDA-Agricultural Research Service, 2030 SE Marine Science Drive, Newport, OR, 97365, USA.

The Pacific oyster (*Crassostrea gigas*) is widely cultured on the west coast of the USA. The species was repeatedly and extensively introduced from Myagi region of Japan as seed after the only native oyster species, *Ostrea concaphila* was commercially extirpated, but naturalized only in a small number of estuaries with sufficiently high water temperatures to allow spawning and sufficiently retentive hydrodynamics to prevent free-swimming larvae from being flushed into the open ocean. After the cessation of seed importation, these naturalized populations became the foundation of aquaculture production using first wild-caught and later hatchery-produced seed. Recently, closed breeding populations have been established and subjected to artificial selection for enhanced growth and survival.

I analyzed the distribution of genetic diversity within and among wild populations in Japan, naturalized populations in the Pacific Northwest, and selectively bred strains from the Molluscan Broodstock Program using amplified fragment length polymorphism (AFLP) genetic markers. Prelimary analyses indicate that although historical accounts indicate that the source of seed introduced into Pacific Northwest estuaries was the Myagi region, most of the naturalized populations in these bays are more genetically similar to wild populations from the Midori region, but selectively bred stocks are more similar to Myagi stocks.

NITROGEN STABLE ISOTOPES IN THE SHELL OF *MERCENARIA MERCENARIA* TRACE WASTEWATER INPUTS FROM WATERSHEDS TO ESTUARINE ECOSYSTEMS. **Ruth H. Carmichael[1], Theresa Hattenrath[2], Ivan Valiela[3],** and **Robert Michener[4].** [1]Dauphin Island Sea Lab, 101 Bienville Boulevard, Dauphin Island, AL, 36528, USA; [2]Stony Brook, Stony Brook University, Southampton, NY, 11968, USA; [3]Marine Biological Laboratory, 7 MBL Street, Woods Hole, MA, 02543, USA; [4]Boston University, 5 Cummington Street, Boston, MA, 02215, USA.

We tested the usefulness of $\delta^{15}N$ values in the organic matrix of whole shells from *Mercenaria mercenaria* as tracers of anthropogenic nitrogen inputs to coastal ecosystems. $\delta^{15}N$ values in shell from transplanted and native clams reflected %-wastewater contributionto estuaries, but were 2.3–2.5 ‰ lighter than $\delta^{15}N$ values in softtissues. Low and high stringency acidification methods were tested todefine parameters for reliable $\delta^{15}N$ determination in shell. Accuracy of $\delta^{15}N$ values depended on recovering a sufficientquantity of organic N from shell (~ 70 µg) and was not altered by acidification methods. Reliable $\delta^{15}N$ values were obtained with as little as 80mg of shell and100 µl of acid. When analyzed in individual shellgrowth bands in native adults, $\delta^{15}N$ values followed changes in N sources to coastal ecosystems across years. Results suggest $\delta^{15}N$ values in shell recorded spatial and temporal changes in N sources, showing an offset from soft tissues likely due to differences in N assimilation among tissues. This approach may be applied (in living bivalves or ancient middens) to trace N entry to coastal systems by allowing biogeochemical and biological data to bealigned for greater spatial and temporal accuracy.

PROBLEMS WITH USING PCR DIAGNOSTICS AS A BASIS FOR MANAGEMENT: *MERCENARIA MERCENARIA* AS A CASE STUDY. **Ryan B. Carnegie** and **Eugene M. Burreson.** Virginia Institute of Marine Science, Route 1208 Greate Road, Gloucester Point, VA, 23062, USA.

Polymerase chain reaction (PCR) assays are powerful tools for detection of shellfish pathogens, but their use can pose a complicated problem with respect to disease management: how to interpret PCR-only evidence of parasite presence, particularly when generated in new hosts or geographic locations. While visual techniques such as histopathology for many pathogens, and Ray's fluid thioglycollate medium assays for *Perkinsus* species, are preferred, use of visual assays is not always possible, like when very small seed need to be certified as disease-free prior to interstate transfers. In our laboratory, this issue arose when *Perkinsus chesapeaki* was detected by PCR in *Mercenaria mercenaria* that were too small for RFTM, and it has still not been satisfactorily solved. The emerging issue of PCR diagnosis and management of disease in *M. mercenaria* will be presented as a case study to highlight fundamental difficulties in the use and interpretation of PCR and the relevance to management. This case study will underscore a basic point: that as much as possession of new and more sensitive diagnostic tools will improve disease management, an improved understanding of host and geographic ranges of known pathogens, and vigilant surveillance for new, emerging diseases, will improve it more.

COMPARISON OF PROTEIN AND ENZYME PROFILES IN SUPERNATANTS OF *PERKINSUS OLSENI*, *PERKINSUS CHESAPEAKI*, AND *P. MARINUS* CULTURES. **Sandra M. Casas, Yanli Li,** and **Jerome F. La Peyre.** Louisiana State University Agricultural Center, Baton Rouge, LA, 70803, USA.

Despite of the impact of Perkinsosis on molluscan fisheries worldwide, the mechanisms of pathogenicity of *Perkinsus* species remain largely unexplored. A number of potential virulence factors have been proposed for *P. marinus* but their specific roles in pathogenesis have yet to be demonstrated; while virulence factors of other *Perkinsus* species are not reported. An initial analysis of cell-free supernatants of *P. olseni* and *P. chesapeaki* cultures in comparison to *P. marinus* cultures was therefore done. Protein separation by sodium dodecylsulfate-polyacrylamide gel electrophoresis (SDS-PAGE) and silver staining revealed the presence of 20, 28 and 33 bands in *P. marinus*, *P. olseni* and *P. chesapeaki* culture supernatants respectively with molecular weights ranging from 28 to 255 kDa. API-ZYM system indicated that each species released a number of hydrolytic enzymes and that while most of the enzymes were produced by all three species their relative concentrations appeared to be unique to each species. Finally, gelatin SDS-PAGE showed that contrary to an earlier report, *P. chesapeaki* culture supernatants possess proteolytic activities characterized by at least three bands of 93, 31 and 23 kDa. Follow-up studies are needed to determine the contribution of extracellular proteins to the virulence of *Perkinsus* species in their respective hosts.

RECENT PROGRESS IN THE NEW ENGLAND SHELL DISEASE INITIATIVE. **Kathleen Castro.** University of Rhode Island, Fisheries Center, 40 A East Farm Road, Kingston, RI, 01881, USA.

The New England Lobster Research Initiative (NELRI) has pulled together some of the most prominent lobster researchers in the country to address lobster shell disease. The Initiative allocated

$2.3 million for nine research and two monitoring projects beginning in 2006. The NELRI is examining lobsters, disease agents, and the surrounding habitats to determine how the disease affects lobsters and what makes them susceptible to it. The NERLI is organized as one cohesive project allowing for maximum collaboration and sharing of results. Progress to date on observations in the field will be discussed, comparing the previous hypotheses with the ongoing research results. This overview will set the stage for the subsequent talks in the session.

DETECTION OF ATYPICAL *MARTEILIA REFRINGENS* IN MUSSELS, *MYTILUS EDULIS* IN FRANCE. **Celine Garcia, Isabelle Arzul, Maeva Robert, Bruno Chollet, Jean-Pierre Joly, Laurence Miossec,** and **Cyrille François.** IFREMER, Mus du Loup, La Tremblade, Charente Maritime, 17390, France.

In course of investigation on mussel mortalities by the network Repamo in Normandie (France), an atypical *Marteilia*-like parasite was observed in several individuals in 2004 and 2008. This parasite was mainly observed in histology in connective tissues of mantle, labial palps and gills whereas *Marteilia* sp. is classically a parasite of the mollusc digestive gland. The presence of this parasite was associated with a severe infiltration of affected tissues. Molecular characterization confirmed this *Marteilia*-like parasite belonged to the species *Marteilia refringens*. This *Marteilia* was detected in fall and only in a particular area of Normandie called Baie des Veys. The detection frequency of this parasite was relatively high (between 30 and 56%) in the different samples; *Marteilia refringens* is generally observed on French mussels but at low infection level and rarely associated with mortality. This particular location of the parasite can raise some questions: is it a different parasite? Is it a new development cycle or just an erratic migration of the parasite? Which factors are involved in this particular development? Do mussels present a different susceptibility to *Marteilia refringens* in this area? Does it present a risk for the French mussel culture?

EXPLORING SUMMER MORTALITY DISEASE PHENOTYPES IN *CRASSOSTREA GIGAS* THROUGH GENE EXPRESSION. **Maxine L Chaney** and **Andrew Y Gracey.** University of Southern California, 3616 Trousdale Parkway, Los Angeles, CA, 90089, USA.

Exploration of gene expression using microarray technology is important because it can facilitate disease classification, diagnosis and prognosis. This is possible by identifying correlated expression patterns common to individuals sharing a similar disease phenotype. The Pacific oyster *Crassostrea gigas* suffers from summer mortality syndrome (SMS), a field manifested disease phenotype that has no known predictors. Individuals who survive a mortality event must have some physiological traits in common. If those that died perished from the same insult, they must have some expression patterns in common and would be different from those who survived. To test this, I tracked two hundred oysters through the summer in 2007 to capture an SMS event. 2007 turned out to be a low mortality year at Totten Inlet, WA, and very few of my oysters perished. Nonetheless, the gene expression profiles of those individuals who did die point to a down regulation of a handful of genes largely functioning in cellular transport. Comparison of expression signatures from field animals collected in 2008 provides more information on the disease characteristics of SMS. Further evaluation of lab generated stress profiles will identify the role of abiotic stress in these field samples.

A TRANSCRIPTOMIC ANALYSIS OF LAND USE IMPACTS ON THE OYSTER, *CRASSOSTREA VIRGINICA*, IN THE SOUTH ATLANTIC BIGHT. **Robert W. Chapman[1], Annalaura Mancia[2], Marion Beal[1], Artur Veloso[3], Charles Rathburn[3], Anne Blair[4], Denise Sanger[5], A. F. Holland[4], G. W. Warr[2],** and **Guy Didonato[6].** [1]SCDNR, 331 Ft. Johnson Road, Charleston, SC, 29412, USA; [2]Medical University of South Carolina, 331 Ft. Johnson Road, Charleston, SC, 29412, USA; [3]College of Charleston, 331 Ft. Johnson Road, Charleston, SC, 29412, USA. [4]NOAA/NOS, 331 Ft. Johnson Road, Charleston, SC, 29412, USA; [5]South Carolina Sea Grant, 331 Ft. Johnson Road, Charleston, SC, 29412, USA; [6]NOAA/NOS, 331 Ft. Johnson Road, Charleston, SC, 29412, USA.

Increasing utilization and human population density in the coastal zone is widely believed to place increasing stresses on the resident biota, but conformation of this belief is some what lacking. In this paper we will present data on the phenotypic adjustments of a resilient organism (oysters) to landuse practices in the surrounding watershed, using advanced molecular tools (microarrays) and machine learning algorithms. We will demonstrate that such an approach can reveal subtle and meaningful shifts in oyster transcript profilesin response to land use and contaminant legacy. In addition we will show that 1) classical biochemical markers of contamination such as metallothioneins, P-450, GST etc are not robust indicators of overall stress, while genes involved in the digestive, energy production and transcription/translation machinery are more modulated by and predictive of environmental conditions and 2) despite restriction on release into the environment, contaminant such as Hg, DDT and Cr are impacting gene expression in oysters and at levels far below current water quality standards.

PERIODIC MATRIX MODEL TO EVALUATE MANAGEMENT STRATEGIES FOR BAY SCALLOP (*ARGOPECTEN IRRADIANS*) POPULATIONS. **Marnita M. Chintala** and **Glen B. Thursby.** U.S. EPA, 27 Tarzwell Drive, Narragansett, RI, 02882, USA.

Within the last twenty years total harvests of bay scallops (*Argopecten irradians*) have dwindled in the southern New England region, and one of the reasons often cited for this decline is drastic

changes to their habitat, specifically eelgrass. To counteract these declines, bay scallop restoration efforts are underway and have met with limited success. We developed a model to examine the effects of current management efforts (direct seeding, spat bags and spawner sanctuaries) and habitat distributions on bay scallop populations. This specific model is a spreadsheet-based, size-structured model developed using Microsoft Excel. The model is a deterministic, density independent, periodic population matrix model with a one-year time step (12 monthly sub-matrices). The data for size specific survival and fecundity were taken from existing literature. The model was evaluated using field survey data from Lagoon Pond, Martha's Vineyard, MA. Output from the model mirrored the size class distribution from these field surveys. The periodic matrix approach allows us to incorporate seasonality in both the biological parameters and the management strategies, as well as adjust habitat distributions. The model was developed for New England, but will be adjusted to apply to Mid-Atlantic, Southeastern U.S., and the Gulf of Mexico.

VARIOUS FORMS AND STAGES OF SHELL DISEASE IN THE AMERICAN LOBSTER SHARE A COMMON BACTERIAL PATHOGEN IN THEIR LESIONS. **Andrei Chistoserdov[1], Robert A. Quinn[1], Sai Laxmi Gubbala[1],** and **Roxanna Smolowitz[2].** [1]University of Louisiana at Lafayette, P.O. Box 42451, Lafayette, LA, 70504-2451, USA; [2]New England Aquarium, Central Wharf , Boston, MA , 02110-3399, USA.

The bacterial communities in epizootic and impoundment shell disease (ESD and ISD) lesions were analyzed by molecular approaches. One bacterium, *Aquimarina* '*homaria*', was detected in all lesions. Severe cases of ESD had diverse communities including a *Marinosulfuromonas* sp. in lesions of all lobsters collected during an outbreak of ESD in Kittery, ME, and a *Pseudoalteromonas* sp. in lesions from all other locations. Two more bacteria were frequently encountered in severe ESD lesions (tentatively *Tenacibaculum* and *Psychromonas* spp.). In contrast to late stages of ESD, communities of ISD and early stages of ESD lesions were simpler and more similar to each other. They always contained another bacterium (tentatively assigned to *Cardiobacteriaceae*) in addition to *A*. '*homaria*'. We conclude that due to its ubiquity in ESD lesions *A*. '*homaria*' is a pathogen causing shell disease in the American lobster. ISD lesions start primarily in pits on the shell surface and are likely promoted by environmental factors (poor nutrition, pollutants). The temperature and environmental pollutants (e.g. alkylphenols) may play an important role in weakening the shell matrix in areas other than the pits around the sensory apparatus and tegmental gland ducts resulting in spreading lesions in and between pits leading to ESD.

HEAT SHOCK PROTEIN (HSP70) EXPRESSION IN DERMO TOLERANT/RESISTANT OYSTERS AFTER HEAT SHOCK AT SUBLETHAL AND LETHAL TEMPERATURES: A COMPARISON OF GOOD, MODERATE AND MODERATE/POOR PERFORMING FAMILIES. **Fu-lin E. Chu, Eric D. Lund, Paul Littreal,** and **Kate Ruck.** Virginia Institute of Marine Science, College of William and Mary, Rt. 1208 Great Road, Gloucester Point, VA, 23062, USA.

The thermal tolerance and heat shock protein (Hsp70) expression in good and moderate/poor performing families of *Crassostrea virginica* were compared. They were heat shocked for 1 hr at 41, 42, 43, or 44°C, and their mortalities were monitored up to 10 days. Surviving oysters were assayed for Hsp 70 levels in gill tissues, condition index (CI), and *Perkinsus marinus* infection intensity. Generally, the good family groups had better survival at the sublethal temperature 41°C than moderate/poor family group. The CI decreased in moderate/poor family group post- heat shock but not in the good family group. Preliminary results from Hsp70 analysis reveal that: (1) the Hsp69 isoform increased in the moderate and good groups at all heat shock temperatures compared to the initial levels, and (2) the Hsp72 isoform expression either decreased or increased among heat shock temperatures in both moderate and good groups.

FEMALE LOBSTER MATURITY AND REPRODUCTIVE CYCLE: ITS IMPLICATION IN THE FISHERY MANAGEMENT. **Michel Comeau.** Fisheries and Oceans Canada, P.O. Box 5030, Moncton, New Brunswick, E1C 9B6, Canada.

A good knowledge of the female size at onset sexual maturity (SOM) and reproductive cycle is essential for a sound management of the lobster fisheries. The SOM is often used as a biological reference point to define the minimal legal size. Between 1994 and 2006 the SOM was established for 12 sites in the Gulf of St. Lawrence (sGSL). Another important regulation of the lobster fisheries that relate to the female reproductive cycle is the protection of berried females. In the sGSL, four of the five Lobster Fishing Areas (LFA) have a spring season prior to the annual molting and spawning. With such timing, primiparous females with a one-year reproductive cycle, and multiparous females that spawn in successive years, which can represent up to 20% of the females, are fully protected from the fishery. However, in LFA 25 (early August-early October) harvesters can catch females with a one-year reproductive cycle and multiparous females before they can release their eggs and be protected. To establish the level of mature females in their egg-extrusion year caught in the commercial catch in LFA 25, an investigation of the female reproductive condition was carried out on a weekly basis between 2002 and 2006.

STONE CRAB (GENUS *MENIPPE*) RECRUITMENT: EVIDENCE FOR NURSERY GROUNDS. Charles Crawford, Theresa Bert, and **Anne McMillen-Jackson.** Florida Fish and Wildlife Conservation Commission, 100 Eighth Ave. SE, St. Petersburg, FL, 33701, USA.

Many crustaceans with widespread distributions have generalized recruitment areas spanning large portions of the species' range. Stone crabs (genus *Menippe*) occur in harvestable numbers throughout Florida Gulf of Mexico (Gulf) shallow waters. In Florida, ovigerous females are found throughout the range but newly metamorphosed (post-settlement) juveniles are concentrated in nearshore areas that are offshore from large, relatively pristine estuaries, swamps, and sloughs. High numbers and proportions of juveniles of all sizes and of females also occupy these locations. The percentages of ovigerous females in these areas can be higher than those found elsewhere. Water clarity is low, salinity usually ranges 25-32‰, and planktonic and epibenthic organisms are abundant. These areas seem to serve as stone crab nursery grounds where females concentrate to spawn, larvae metamorphose and settle, and juveniles grow and mature. Post-settlement and larger juvenile stone crabs are found elsewhere, but never in the numbers that occupy these areas. Surrounding areas have higher percentages of subadult and adult stone crabs that support intense regional fisheries. We suggest that these recruitment areas are the principal suppliers of stone crabs for the southwest and northwest Florida stone crab fisheries. They should be protected to maintain the viability of these fisheries.

EFFECTS OF CALCIUM DISODIUM EDTA ON MANGANESE TOXICITY IN MITOCHONDRIA AND NERVOUS SYSTEM OF *CRASSOSTREA VIRGINICA*. Sherine Crawford, Elsie Lagares, Claudette Saddler, Dahniel Samuel, Margaret A. Carroll, and **Edward J. Catapane.** Medgar Evers College, 150 Carroll Street, Brooklyn, NY, 11225, USA.

Excessive manganese produces Manganism, similar to Parkinsons. Manganese may impair dopamine production, disrupt dopamine receptors and increase oxidative stress. p-Aminosalicylic acid (PAS) alleviates Manganism, but its mechanism of action is unknown. *Crassostrea virginica*, has a manganese-sensitive dopaminergic system innervating the gill. PAS, an anti-inflammatory drug with chelator activities, prevented loss of dopamine in manganese treated animals and protected against adverse affects of manganese on O2 consumption. PAS actions are thought due to its chelating effects. We compared PAS efficacy with calcium disodium EDTA. Animals were exposed to manganese with EDTA for 3 days. Biogenic amines in cerebral and visceral ganglia, and gill were measured by HPLC. EDTA protected against effects of manganese. In other experiments mitochondria were treated with EDTA or another chelator, diaminocyclohexanetetraacetic acid (DACH)in the presence of manganese. Manganese decreased mitochondrial respiration. Pretreating mitochondria with EDTA blocked it. Adding EDTA to manganese treated mitochondria reversed the toxic effects. DACH was ineffective in blocking or reversing actions of manganese and had its own inhibitory effects on respiration. The study shows the EDTA was an effective blocker against the toxic effects of manganese and provides evidence that ameliorating effects of PAS on Manganism is related to its chelating actions.

DEVELOPMENT AND APPLICATION OF A QUANTITATIVE PCR (QPCR) ASSAY TO ASSESS THE LIFE HISTORY OF *HEMATODINIUM*, A PARASITIC DINOFLAGELLATE, AND ITS IMPACT ON TANNER CRAB POPULATIONS IN ALASKA. Lisa M. Crosson[1], Carolyn S. Friedman[1], and **J. Frank Morado[2].** [1]University of Washington, Box 355020, Seattle, WA, 98195, USA; [2]National Oceanic and Atmospheric Administration, 7600 Sand Point Way NE, Seattle, WA, 98115, USA.

Bitter crab syndrome, caused by a parasitic dinoflagellate of the genus *Hematodinium*, is a fatal disease of several commercially important decapods, including Tanner, *Chionoecetes bairdi*, and snow, *C. opilio*, crabs of Alaska. Both Bering Sea stocks are considered depleted and data demonstrating weak recruitment suggests future forecasts for these stocks to remain poor. To more closely follow disease progression and investigate the life history of *Hematodinium*, we developed a quantitative PCR (QPCR) assay. QPCR is a more sensitive and rapid method than conventional PCR which only detects presence/absence of the parasite. Our QPCR assay will allow us to quantify *Hematodinium* loads in crabs, seawater, and sediments enabling more precise monitoring of the effects of *Hematodinium* on size frequencies and general population trends as well as identification of potential vectors or reservoirs of this important parasite, thereby providing key life history information. The results will greatly aid managers in assessing disease dynamics and impacts and could provide alternative harvesting strategies to minimize losses due to *Hematodinium* infections.

THE INFLUENCE OF BOAT HULL ANTIFOULING AND CLEANING STRATEGIES ON RECRUITMENT OF AQUATIC INVASIVE SPECIES. Carolynn Culver[1], Leigh Taylor Johnson[1], Henry M. Page[2], and **Jenifer E. Dugan[2].** [1]University of California Cooperative Extension, Marine Science Institute, University of California, Santa Barbara, CA, 93106-6150, USA; [2]U.C. Santa Barbara, Marine Science Inst., University of California, Santa Barbara, CA, 93106-6150, USA.

Aquatic invasive species (AIS) pose considerable risks to marine ecosystems and coastal communities. Boat hulls are a primary vector for the spread of AIS, making harbors an important source. The efficacies of a variety of hull coatings and hull cleaning practices in controlling AIS and other fouling organisms are under debate in California. To inform these

discussions, we conducted a field experiment to evaluate recruitment responses of AIS and other fouling species to 1) substrates with hull coatings and 2) hull cleaning best management practices (BMPs) for California. We tested fiberglass panels coated with copper-based antifouling paint, non-toxic epoxy and non-toxic siliconized epoxy in two California harbors. Hull cleaning BMPs were applied to a subset of panels during the peak season of recruitment of fouling organisms. After this time, all panels were cleaned and redeployed for another month. The type and amount of fouling were assessed each time BMPs were applied and at the end of the experiment. We will discuss our findings and their implications for applying various boat hull antifouling strategies to control the recruitment of AIS and for current policies regarding boat hull coatings and hull cleaning practices in California.

EARLY DETECTION AND MONITORING OF AQUATIC INVASIVE SPECIES: EVALUATION OF METHODS FOR FRESHWATER EURASIAN (QUAGGA AND ZEBRA) MUSSELS IN CALIFORNIA. Carolynn Culver[1] and **Daniel Daft[2].** [1]University of California Cooperative Extension, Marine Science Institute, University of California, Santa Barbara, CA, 93106-6150, USA; [2]City of San Diego Water Department, 5530 Kiowa Drive, La Mesa, CA, 91942-1331, USA.

Early detection and monitoring are valuable tools in the prevention and management of invasive aquatic species. Established populations of the invasive zebra and quagga mussels, *Dreissena polymorpha* and *D. bugensis* respectively, were recently found in California. Cost effective early detection approaches are now critically needed to minimize further spread of these mussels. Likewise, managers of infested California water bodies require monitoring programs to manage these AIS. The protocols currently recommended for monitoring these AIS in California use hard substrates. However, our observations indicated that filamentous substrates, including those successfully used for monitoring marine invertebrates, may be more effective in detecting these invasive mussels. To evaluate the efficacy of different monitoring techniques, we compared settlement of quagga mussels on two hard (PVC flat pieces and pipe) and two filamentous (scrub brushes and pads) substrates, as well as the ease and cost of applying each method. The methods varied significantly in efficacy, and also in the costs and effort required for initial set-up and continued examination of the substrates. We will discuss the pros and cons associated with each of these techniques and implications for their use by volunteer and agency monitoring programs.

EFFECTS OF DIET, STOCKING DENSITY, AND SUBSTRATE ON SURVIVAL AND GROWTH OF HATCHERY-CULTURED RED KING CRAB (*PARALITHODES CAMTSCHATICUS*) JUVENILES IN ALASKA, USA. Benjamin Daly[1], James Swingle[2], and **Ginny Eckert[1].** [1]University of Alaska Fairbanks, 201 Railway Ave, Seward, Alaska, 99664, USA; [2]Alutiiq Pride Shellfish Hatchery, 101 Railway Avenue, Seward, Alaska, 99664, USA.

Juvenile red king crab (*Paralithodes camtschaticus*) mass rearing was conducted in Seward, Alaska, USA in a king crab stock enhancement feasibility study. Hatchery raised red king crab juveniles were cultured from larvae of 12 ovigerous females collected from Bristol Bay, Alaska. Instars were cultured in nursery grow out containers in two phases: (1) C1-C3 juveniles and (2) C3-C6 juveniles. Experiments lasted for 42 and 44 days, respectively, and tested effects of various diets, stocking densities, and substrates on survival and growth. Artificial substrates were added to reduce cannibalism in both experiments. Feed types, stocking density, and substrate had significant impacts on survival and growth. Diets that yielded highest survival to C3 did not promote highest growth. Increasing stocking density decreased survival and growth. Artificial substrate increased survival potentially due to a reduction in cannibalism. These results suggest that culturing red king crab juveniles at lower stocking densities in the presence of artificial substrate provides good survival. The development of efficient culture methodologies will allow hatchery raised king crabs to be used by other researchers to investigate early life history of red king crab and is critical for the evaluation of a stock enhancement program.

SHIFTING THROUGH TIME: OYSTERS AND SHELL RINGS IN PAST AND PRESENT SOUTHEASTERN ESTUARIES. Richard F. Dame. Coastal Carolina University, 180 Ashley Avenue, Charleston, SC, 29403, USA.

Oysters and oyster reefs are important components in rich and productive southeastern US marsh-estuarine ecosystems. Ecological research has shown that when these complex systems are impacted they may reorganize into another alternate state. Such a shift of bivalve dominated marsh-estuarine ecosystems may have happened on a large scale eons ago. Beginning about 4500 B.P., coastal Native Americans built oyster shell rings on the landward side of sea islands. Their construction is thought to symbolize the conversion of nomadic hunter-gatherers to coastal fisherfolk and is considered a pivotal stage in the evolution of pre-European culture. By 3000 B.P., the shell rings were abandoned and the Native Americans dispersed.

The Fig Island 1 and Sewee shell ring systems near Charleston, SC are analyzed using ecological comparisons with modern oyster systems, published archaeological and geological data, as well as reverse engineering approaches. In just a few years, the Indians built the Fig Island 1 shell ring using over 1.5 billion oysters;

enough oysters to filter a water volume the size of North Inlet, SC 6-8 times per day. This exercise examines how the prehistoric system might have shifted in response to the massive removal of oysters to build shell rings.

INFORMING MANAGERS: EFFECTS OF POT STRESS ON FEMALE SURVIVAL AND LARVAL VIABILITY IN MULTIPLE CLUTCHES OF BLUE CRABS. **Kelly M. Darnell, M. Zachary Darnell, Ruth McDowell, Ray Golden,** and **Daniel Rittschof.** Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC, 28516, USA.

Current North Carolina and most commercial blue crab (*C. sapidus*) fishery regulations allow the harvest of pot-caught newly mature females, ovigerous (sponge) females and mature females that are between clutches. After some length of time, sponge crabs in pots become stressed and remove (scrub) their eggs. Especially in warm months, most pot-caught sponge crabs display some level of scrubbing. Pot-caught sponge crabs were collected from the North River, NC pot fishery. Hand-caught females were collected from the Rachael Carson Estuarine Research Reserve in Beaufort, NC. Crabs were held individually in the immediate subtidal in minnow traps half-buried in the sediment. We assessed the effect of pot stress on female survival and compared egg size, clutch viability, and the duration of larval survival without food through up to 5 clutches for hand-caught crabs and pot-caught crabs with no, low, intermediate and high levels of scrubbing. Adult female survival was 80 to 100% in all scrubbing categories. Egg size, embryo viability, and larval survival were comparable in all groups. These data suggest immediate release of sponge crabs from pots may be a viable fishery management strategy.

INFORMING MANAGERS: SPAWNING BIOLOGY OF BLUE CRABS. **M. Zachary Darnell** and **Daniel Rittschof .** Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC, 28516, USA.

Blue crabs, *Callinectes sapidus*, are a valuable commercial species along the Atlantic and Gulf Coasts. Management of the fishery is more effective if managers are provided with a thorough understanding of blue crab spawning biology. To examine lifetime clutch production, mating pairs were collected near Beaufort, NC. After mating, females were held subtidally in individual, partially-buried minnow traps. Crabs were fed daily and checked weekly for presence and condition of eggs. Monitoring continued until death. Under these conditions, crabs produced up to seven clutches of eggs over 1-2 spawning seasons and survived up to 394 days. Time to first clutch and interval between clutches were positively correlated with carapace width, which was negatively correlated with water temperature on the day of terminal molt. Data on time to first clutch, clutch production interval, and mature lifespan were used to model lifetime clutch production and estimate total reproductive output for six size classes of crabs. We estimate that most female blue crabs in NC produce between 2-8 clutches of eggs, depending on size. Additionally, it appears that most size classes of crabs have similar reproductive potential. These findings should assist managers in developing management plans that maximize economic return to fishermen while ensuring sustainability of the resource.

HYPOOSMOTIC CELLULAR VOLUME REGULATION IN BIVALVES: EFFECT OF CALCIMIMETICS. **Lewis E. Deaton.** University of Louisiana at Lafayette, P. O. Box 42451, Lafayette, LA, 70504, USA.

Exposure of the tissues of osmoconforming molluscs to a decrease in the osmotic concentration of the ambient medium results in an osmotic gain of water. To regulate cellular volume, the cells release amino acids (AA) to bring the cytoplasm into osmotic equilibrium with the extracellular fluid. The mechanisms involved in the control of the release of AA are unknown. AA release is increased by removal of Ca^{++} from the medium and phorbol esters; La^{+++} inhibits release. Calcium-sensing receptor proteins (CaR) control of secretion of parathyroid hormone (PTH); a decrease in the ambient concentration of Ca^{++} stimulates PTH secretion. This regulatory pathway is potentiated by phorbol esters and blocked by La^{+++}. Calcimimetics are agonists for CaR. To investigate the role of CaR in volume regulation, we exposed the ventricles of *Crassostrea virginica* acclimated to 1000 mOsm seawater (SW) to either 500 mOsm SW or 500 mOsm SW containing 1 mg/ml of the calcimimetic Sensipar. Ventricles in 500 mOsm SW released 4.7 + 3.0 μmol/g dry wt AA; ventricles in 500 mOsm SW + sensipar released 17.7 + 2.8 μmol/g ($n = 6$). These results implicate CaR in the initiation and control of AA release during hypo-osmotic cellular volume regulation in bivalves.

USE CONFLICT CHALLENGES FACING PACIFIC NORTHWEST SHELLFISH CULTURISTS. **Bill Dewey.** Taylor Shellfish Company, 130 SE Lynch Road, Shelton, WA, 98584, USA.

User conflicts associated with increased residential development on coastal shorelines are more and more prevalent for shellfish culturists. These conflicts arise when new residents unaccustomed to working waterfronts move to shorelines with historic shellfish culture operations or when there is a change in crops or culture methods. They also arise when shellfish culturists attempt to locate new operations adjacent to previously developed shorelines with established water dependent uses. Some common types of user conflicts include: aesthetic impacts, noise, lights, odd hours of operation, physical interference with recreational or commercial fishing and market impacts from cultured product. Outreach and education by shellfish growers can be effective at

reducing the user conflicts. Comprehensive land-use planning processes can also reduce user conflicts preserve existing shellfish culture operations and provide opportunity for growth. Washington State shellfish growers are working at the local, state and federal level to reduce user conflicts. These efforts include outreach and education as well as seeking policy and legislation supportive of comprehensive land-use planning for existing and prospective shellfish growing areas. At the federal level this includes efforts to ensure reauthorization of the Coastal Zone Management Act includes aquaculture planning for state waters and the preservation of working waterfronts.

FACTORS IMPACTING CONDITION AND SPAWNING OF THE NORTHERN QUAHOG (*MERCENARIA MERCENARIA*): IMPLICATIONS FOR RESTORATION. **Michael H. Doall[1], Dianna K. Padilla[1],** and **Carl Lobue[2].** [1]Stony Brook University, 650 Life Sciences Building, Stony Brook, NY, 11794-5245, USA; [2]The Nature Conservancy, Long Island Chapter, 250 Lawrence Hill Road , Cold Spring Harbor, NY, 11724, USA.

Spawner sanctuaries, harvest-free areas planted with high densities of adult clams, are currently being used to restore self-sustaining populations of *Mercenaria mercenaria* (L.) to Great South Bay, NY. To evaluate and guide this restoration effort, we have monitored the condition and spawning of transplanted clams since April 2004. While we have found that transplanted clams spawn, recondition, and spawn again in subsequent years, we have also observed large interannual variability in levels of condition index. The higher the condition attained by the end of fall (mid-December), the greater the peak in condition the following spring. Across years and populations from 2004 to 2007, condition at the end of fall explained ~89% of the variance in spring peak condition. Condition in 2008 was lower than predicted by this regression, probably due to a massive bloom of the 'brown tide' alga *Aureococcus anophagefferens* during the spring and summer of 2008. These data suggest that environmental conditions during fall impact the condition and spawning of hard clams the following spring and summer. Furthermore, phytoplankton conditions during spring, including the presence of brown tide blooms, may further impact condition and spawning.

EVIDENCE FOR THE BLUE CRAB PARASITE, *HEMATODINIUM* SP. IN COASTAL BAY BENTHOS. **Joanna R. Donaldson[1], Ammar Hanif[2], Holly A. Bowers[2], Joseph Pitula[1], Gretchen A. Messick[3],** and **Eric J. Schott[2].** [1] University of Maryland, Eastern Shore, Carver Hall, Princess Anne, MD , 21853, USA; [2]UMBI, 701 East Pratt St, Baltimore, MD, 21202, USA; [3]Cooperative Oxford Lab, 904 S. Morris Street, Oxford, MD, 21654, USA.

In mid-Atlantic coastal bays of North America, blue crab (*Callinectes sapidus*) populations suffer episodic mortalities associated with infections by the parasitic dinoflagellate *Hematodinium* sp. These outbreaks recur seasonally and are geographically localized, suggesting that there are environmental or biotic reservoirs of the parasite. An ecosystem-wide search for *Hematodinium* sp. by microscopic or culture-based methods is impractical. DNA-based detection, however, provides a sensitive and flexible methodology for detecting parasites in virtually any sample from which DNA can be extracted. Our previous work used real-time PCR, targeting parasite ribosomal RNA genes, to document *Hematodinium* sp. infections in blue crab hemolymph. The hemolymph assay, targeting the small subunit rRNA gene (SSU), was not specific enough for analysis of water and sediment, which harbor hundreds of free-living dinoflagellate species that may possess SSU genes similar to that of *Hematodinium* sp. We therefore developed an assay targeted to the more species-specific, but sometimes variable, ITS region of the rRNA gene cluster. Using this assay, we have documented evidence of *Hematodinium* sp. in DNA extracted from sediment of parasite hotspots in a Delaware coastal bay. Further work is underway to determine if the PCR signal originates in a cyst bed or in meiofauna.

***VIBRIO PARAHAEMOLYTICUS* ILLNESS PREVENTION EFFORTS.** **Robin Downey.** Pacific Coast Shellfish Growers Association, 2023 E. Sims Way #235, Pt. Townsend, WA, 98368, USA.

The naturally occurring marine bacteria, *Vibrio parahaemolyticus*, is the cause of increasing illnesses associated with the consumption of raw oysters across the U.S. The National Shellfish Sanitation Program, under the U.S. Food and Drug Administration, has developed a general control plan intended to eliminate illness outbreaks and minimize sporadic illnesses associated with *V. parahaemolyticus*. That plan requires all states determined to be at-risk from *V. parahaemolyticus* to develop specific control methods to eliminate or minimize illnesses caused by the bacteria. This presentation will trace the history of monitoring and control efforts and environmental conditions since the 1997 illness outbreaks on the West Coast, followed the next year on the West, Gulf and East Coasts, that triggered expanded national monitoring and control efforts. Particular focus will be on Washington, the largest producer of farmed oysters in the U.S., identified as one of the largest contributors to these illnesses. Accordingly, Washington has been on the leading edge of developing monitoring and control plans. These efforts may lead to expanded understanding of the conditions that promote *V. parahaemolyticus* in the environment, as well as what is needed in the way of improvements in post-oyster harvest practices.

DISEASES AFFECTING DIPLOID *CRASSOSTREA ARIAKENSIS* AND *C. VIRGINICA* OYSTERS REARED IN QUARANTINED MESOCOSMS RECEIVING AMBIENT WATERS FROM THE CHOPTANK RIVER, MD OR THE INDIAN RIVER LAGOON, FL. **Christopher F. Dungan[1], John Scarpa[2], Ryan B. Carnegie[3], Christopher J. Kelly[4], Carol B. Mccollough[1], Roger I.E. Newell[4], Susan Laramore[2], Nancy A. Stokes[5], Kristina M. Hill[5],** and **Eugene M. Burreson[5].** [1]Cooperative Oxford Laboratory, 904 S. Morris Street, Oxford, MD, 21654, USA; [2]Harbor Branch Oceanographic Institution at Florida Atlantic University, 5600 North Highway. 1, Fort Pierce, FL, 34946, USA; [3]Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346, Gloucester Point, VA, 23062, USA; [4]University of Maryland Center for Environmental Science, P.O. Box 775, Cambridge, MD, 21613, USA; [5]Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346, Gloucester Point, Virginia, 23062, USA.

We assessed relative susceptibilities of native *C. virginica* and *C. ariakensis* Suminoe oysters to pathogens endemic in temperate, mesohaline Chesapeake Bay waters or polyhaline, sub-tropical Florida-Atlantic waters. Diploid sibling oyster spat cohorts of both species were reared in effluent-quarantined mesocosms receiving ambient waters from the Choptank River, Maryland (four years) or the Indian River Lagoon, Florida (one year), and assayed periodically for diseases. MSX disease was never detected in any oyster from either experimental site. Dermo disease was acquired by members of both oyster species at both experimental sites, but infections never reached a lethal intensity level in any tested oyster. DNA of a previously unrecognized *Bonamia* sp. was detected by PCR assays of tissues from both oyster species exposed to Florida-Atlantic waters. Maximum PCR prevalences of 44% and 15% were respectively detected among *C. ariakensis* and *C. virginica* oysters sampled during June 2007. From July 2007 samples analyzed by both PCR and histopathology, *Bonamia* sp. DNA was detected by PCR in 14% of tested *C. ariakensis* oysters, and infections were confirmed histologically among 11%. During the same sampling iteration, *Bonamia* sp. DNAs were detected by PCR in 5% of tested *C. virginica* oysters, but no infections were confirmed histologically.

KING CRAB AQUACULTURE AND ENHANCEMENT IN ALASKA. **Ginny L. Eckert[1], Ben Daly[1], James Swingle[2], Celeste Leroux[1], Jeff Hetrick[2],** and **Sara Persselin[3].** [1]University of Alaska Fairbanks, 17101 Point Lena Loop Road, Juneau, AK, 99801, USA; [2]Alutiiq Pride Shellfish Hatchery, 101 Railway Avenue, Seward, AK, 99664, USA; [3]National Marine Fisheries Service, 301 Research Court, Kodiak, AK, 99615, USA.

The Alaska King Crab Research Rehabilitation and Biology (AKCRRAB) program was formed in 2006 with the goal of investigating the feasibility of stock enhancement of Alaskan king crab species for the purpose of population rehabilitation. Commercial harvest of Alaskan king crab was for decades active and lucrative. However, many stocks declined drastically over 20 years ago and have not rebounded, even in the absence of fishing. We are studying the early life history of red and blue king crab (*Paralithodes camtschaticus* and *Paralithodes platypus*) to develop methods and determine feasibility of hatchery rearing at the Alutiiq Pride Shellfish Hatchery. In 2007, experiments yielded overall survival to the first juvenile stage of less than 1 % for both species. As a result, we varied diets, handling, density, water flow, and water quality in 2008 and were able to provide an average survival of 31% to the glaucothoe stage and 10% to the first juvenile stage. This success in hatchery-scale production demonstrates that king crab can be cultured on a large scale in the hatchery in Alaska. The next step will be to determine the potential for outplanting success.

ELEMENTAL COMPOSITION OF THE JUVENILE SHELLS OF THE FLORIDA BAY SCALLOP, *ARGOPECTEN IRRADIANS CONCENTRICUS* AND THE NORTHERN QUAHOG, *MERCENARIA MERCENARIA* AS AFFECTED BY DIET. **William Noland Elsaesser[1], Norman J. Blake[1],** and **Sandra E Shumway[2].** [1]University of South Florida, College of Marine Science, 760 7th St. S, St. Petersburg, FL, 33701, USA; [2]University of Connecticut, Groton, CT, 06340, USA.

Biogenic carbonates have received much attention in the recent past due to their potential as proxies of environmental change. However, due to the multiple influences on the chemical composition of these carbonates, it is vital to understand the degree to which each effector has in order to accurately interpret collected data. This research examines the elemental composition differences of the juvenile shells of both *Argopecten irradians concentricus* and *Mercenaria mercenaria* as affected by diet. All specimens were reared under strict salinity (30 ± 2 ‰) and temperature (28°C) parameters; but received different single algal species diets, a mixture of all algal species, or were not fed (starvation control). Shells were randomly selected at different growth intervals and, after preparation, analyzed using inductively coupled plasma – optical emission spectrometry (ICP-OES) to obtain elemental concentration data. All data was transformed to element to calcium ratios for comparison. Results indicate a strong relationship between Si/Ca and Fe/Ca ratios and diet received, but elements such as Mg and Mn (commonly used as environmental indicators) do not differ significantly in relation to diet. This study is an important examination of one biological influence on shell chemistry.

UPDATE ON RE-EMERGENCE OF VIBRIOSIS IN SHELLFISH HATCHERIES AND NURSERIES. **Ralph A. Elston, Karen Humphrey,** and **Ildiko Polyak.** AquaTechnics, 455 West Bell Street, Sequim, WA, 98382, USA.

During 2007, we documented the re-emergence of a severe episode of vibriosis caused by *Vibrio tubiashii* in shellfish hatcheries. During continuing studies in 2008, we have identified chronic and

sporadic outbreaks at the N.E.L.H.A. site in Hawaii, the west coast of N. American and elsewhere. The west coast episode in 2007 appeared to be driven by unusually warm sea surface temperatures (SST), in conjunction with intermittent upwelling. Shifts in key oceanic and estuarine water chemistry parameters that have negatively affected natural and farmed early life stage shellfish seem to have also occurred, but these are incompletely known and need further elucidation. Environmental conditions may favor outbreaks of vibriosis, but the disease has caused documented losses since at least the 1970s.

In summer 2008, along the west coast of N. America, SSTs were in a more or less typical range until mid-summer, followed by a warming event, that was associated with another lesser vibriosis event. There is a need to standardize and upgrade sanitation procedures for hatchery and nursery production facilities. In addition, water quality standards for the rearing of healthy bivalve larvae and juveniles are needed, along with improved prevention methods for vibriosis and better application of known management controls.

MICROALGAL CELL SURFACE CARBOHYDRATES AS RECOGNITION SITES FOR PARTICLE SORTING IN SUSPENSION FEEDING BIVALVES. **Emmanuelle Pales Espinosa[1], Mickael Perrigault[1], J. Evan Ward[2], Sandra E. Shumway[2],** and **Bassem Allam[1].** [1]Stony Brook University, Challenger Hall 141, Stony Brook, NY, 11794-5000, USA; [2]University of Connecticut, Groton, CT, 06340, USA.

Cell surface carbohydrates play important roles in cell recognition mechanisms. Recently, we provided evidence that particle selection in suspension-feeding bivalves can be mediated by interactions between carbohydrates associated with particle surface and lectins present in mucus covering bivalve feeding organs. In this study, FITC-labeled lectins were used to characterize carbohydrate moieties on the surface of microalgae species and evaluate the effect of oyster mucus on lectin binding. These analyses revealed that Con A bound to *Isochrysis sp*. while *Nitzschia closterium* reacted with PNA and PEA. *Rhodomonas salina* cell surface was labeled with PNA and Con A and *Tetraselmis maculata* cell surface reacted with PNA, PEA and Con A. Pre-incubation of microalgae with mucus decreased the binding of FITC-labeled lectins revealing that lectins present in mucus competitively blocked binding sites. This decrease was prevented when mucus-coated microalgae were washed with specific carbohydrates. Information generated during these investigations was used to design a feeding experiment that exposed oysters *Crassostrea virginica* to Con A-labeled and unlabeled *Isochrysis* sp. Results demonstrated that lectin-labeled algae were preferentially rejected in oyster pseudofeces. This work provides insights into the carbohydrate specificity of lectins implicated in the selection of microalgae species.

RECENT STRUGGLES OF WEST COAST COMMERCIAL HATCHERIES TO PRODUCE PACIFIC OYSTER LARVAE. **Benoit Eudeline[1], Alan Barton[2],** and **Chris Langdon[3].** [1]Taylor Shellfish Inc, 701 Broad Spit Road, Quilcene, WA, 98376, USA; [2]Whiskey Creek Shellfish Hatchery, 2975 Netarts Bay Road, Tillamook, OR, 97141, USA; [3]Oregon State University, 203 Southeast Marine Science Drive Newport, OR, 97365, USA.

Much of the West Coast shellfish industry depends on hatchery production of larvae; however, environmental conditions in the ocean off the Oregon and Washington coasts and adjacent Hood Canal have recently severely impacted production of oyster larvae. In the last few years, increased areas and intensities of deep acidic hypoxic water have been reported in those regions, contributing to the formation of ''dead zones''. Coastal upwelling can bring this deep hypoxic water to the surface waters of coastal bays and into hatcheries. These changes in seawater properties influence complex chemical interactions, many of which are not fully understood. However, recent research has identified at least three potential stressors adversely affecting oyster larvae: 1) low pH of incoming hatchery water is commonly associated with high larval mortalities and acidic seawater may increase dissolution rates of aragonitic larval shells; 2) rapid heating to 25°C of upwelled cold water may exacerbate problems with gas super-saturation that may adversely affect oyster larval growth; and 3) increased prevalence of the pathogenic bacterium *Vibrio tubiashii* in hatcheries has been positively linked to massive larval mortality events. Hatcheries have responded by undertaking research to better understand these stressors and implementing seawater treatment and management protocols to reduce their effects.

MEMBRANE TEMPLATE SYNTHESIS OF MICRO-SCALE SINGLE CRYSTAL CALCITE STRUCTURES. **Michael R. Falvo[1], Dmitry Spivak[1],** and **R. Lloyd Carroll[2].** [1]University of North Carolina, Chapel Hill, NC, 27599, USA; [2]West Virginia University, Morgantown, WV, 26506, USA.

The calcite spine of the sea urchin and the stacked plates of abalone nacre are striking examples of the beautiful hierarchical single crystal structures biomineralization processes produce. Curved surfaces, round pores and spicules structurally unrelated to the natural habit of the inorganic crystal, are formed by organisms through coordination of several mineralization mechanisms. Two of the strategies organisms use to control inorganic crystal growth are spatial confinement of the reaction and localization of reaction components to the volume of interest. Improvising on these strategies, we have fabricated nano-scale and micro-scale single crystal hierarchical calcite structures. These structures are fabricated through controlled crystallization within the pores of polycarbonate track etched membranes via a diffusion-limited vapor-solution interaction. These structures have two distinct structural regimes: (1) oriented micro/nanorod arrays emerging from (2) a base rhomboid crystal. Electron diffraction data indicate

that these structures are single crystals. Scanning electron microscopy data showing the morphological features of the distal ends of the rods also indicate they have crystalline orientation consistent with the base rhomboid crystal. These results inform current questions in biomineralization including the requirement of a transient amorphous stage to facilitate single crystalline structure in confined volumes.

THE PHYLOGEOGRAPHY OF THE BLUE CRAB *CALLINECTES SAPIDUS:* GENETIC VARIATION TO THE MAX. Xiaojun Feng[1], Patrick M. Gaffney[2], Ernest P. Williams[1], and **Allen R. Place[1].** [1]Center of Marine Biotechnology, 701 E. Pratt Street, Baltimore, MD, 21202, USA; [2]College of Marine and Earth Studies, 700 Pilottown Road, Lewes , DE, 19958, USA.

The blue crab, *Callinectes sapidus*, inhabiting estuarine and near shore environments from Nova Scotia to northern Argentina is one of the most economically important fishery species in the United States. However, few population genetics studies have been done despite this. By using a 627-bp genetic marker, which is a fragment of the mitochondrial gene ND2, our lab investigated the blue crab's genetic diversity and population structure along the Atlantic and Gulfcoasts. Samples were taken across multiple years and included sub populations from Massachusetts, New Jersey, the Chesapeake Bay, North Carolina, and the Gulf of Mexico. The nucleotide diversity and gene diversity within all subpopulations were high,>0.010 and >0.95, respectively. Pairwise subpopulation Fst values were generally low, <0.010, very likely due to high diversity within samples.Only 2 samplings had significant Fst values (0.011-0.059) in comparisons with other subpopulations. Both spatial and temporal based AMOVAs showed >99% variation was from within subpopulations. A blue crab genetic pool across the North American continent was implied. Large population sizes, strong geneflows, and a very high mutation rate in ND2 gene could all play roles in it.

MITOCHONDRIAL DNA HETEROPLASMY IN BLUE CRAB *CALLINECTES SAPIDUS*. Xiaojun Feng, Ernest P. Williams, and **Allen R. Place.** Center of Marine Biotechnology, 701 E Pratt Street, Baltimore, MD, 21202, USA.

Mitochondrial DNA and microsatellite markers are the two most commonly used molecular markers in the study of animal population genetics. However, very few studies have been reported on the phenomenon of mitochondrial DNA heteroplasmy in animals. Our laboratory determined the blue crab (*Callinectes sapidus*) mitochondrial genome and recently observed heteroplasmy (more than one sequence). In order to investigate this further, our lab cloned and sequenced three separate DNA fragments (part of the genes ND2, ND4 and CO1) from blue crab mitochondrial genome on a three-member crab family. Dozens of different DNA sequences have been observed for each gene fragment in each animal. For each gene in each animal we found a dominant haplotype with higher than 50% occurrence. Most of the heteroplasmic sequences included a dominant sequence that coded for the same protein but we did observe sequences containing nonsynonymous substitutions and even stop codons. The mother and the offspring always share the identical dominant haplotypes and never exclusively shared asequence isotype with the father. This indicates that the offspring's mitochondrial genotype is passed on from the mother and heteroplasmy is not a result of genetic material transferred from the father, but probably results from mutations.

COMPARISON OF DIAGNOSTIC TECHNIQUES FOR THE DETECTION OF MOLLUSCAN PATHOGENS. Antonio Figueras, Pablo Balseiro, and **Beatriz Novoa.** IIM CSIC, Eduardo Cabello 6, Vigo, Pontevedra, 36208, Spain.

Five different clam species of trade interest cultured in Galicia (*Ruditapes decussatus*, *Ruditapes philippinarum*, *Venerupis pullastra*, *Venerupis rhomboides* and *Donax trunculus*) were used for the comparison of different *P. olseni* diagnostic techniques. Results of a nested PCR assay for the diagnosis of *P. olseni* are compared with those obtained using two classical methods of diagnosis proposed by the Office International des Epizooties (OIE) in the Manual of Diagnostic Tests of Aquatic Animals, histology and incubation on Ray's fluid thioglycollate medium (RFTM). Moreover, the same samples were analyzed by two different laboratories. Comparissons with the results of similar approaches used on Bonamia and Marteilia diagnoses will be presented.

EFFECTS OF CLIMATIC VARIABILITY AND COMMERCIAL FISHING ON OYSTER POPULATIONS IN A SOUTH TEXAS ESTUARY. Mark Fisher[1], Hae-cheol Kim[2], and **Jennifer Beseres Pollack[2].** [1]Texas Parks & Wildlife Department, 702 Navigation Circle, Rockport, TX, 78382, USA; [2]Texas A&M University-Corpus Christi, 6300 Ocean Drive, Unit 5869, Corpus Christi, TX, 78412, USA.

We investigated a 20 year time series of fishery-independent oyster abundance and environmental data (temperature, salinity, dissolved oxygen and turbidity) collected from Aransas Bay, Texas, to determine whether oyster biology and population dynamics are affected by climate-induced long-term variability. We have identified three distinct periods (or phases) that exhibit different patterns of mortality: the first includes a period when the abundance of dead shells dominated over the number of live oysters (1992-1993); the second includes a period when live oysters slightly outnumbered dead shells (1996-1997); and the third includes a period where live oysters demonstrated a slow recovery that was overlapped by a slow increase in the number of dead shells (1997-2002). Interestingly, the first period seems to be repeated by present years (2007-2008) with dead shells demonstrating an

increasing trend relative to live oysters. We investigated environmental stressors and subsequent responses in oyster biology and population dynamics using univariate and multivariate statistical analyses for each period. Additionally, we used time series analysis to investigate long-term variability (e.g., decadal-level variability) other than El Niño Southern Oscillation (ENSO) which governs local climate systems in the southwestern United States. Effects of commercial fishing were also considered.

GENOTYPE X ENVIRONMENT INTERACTIONS FOR PRODUCTION TRAITS IN *CRASSOSTREA VIRGINICA* GROWN IN VIRGINIA. A.S. Frank-Lawale [1], L Degremont[2], and **S.K. Allen, Jr.[1].** [1]Virginia Institute of Marine Science, 1206 Greate Road, Gloucester Point, VA, 23062, USA; [2]Institut Français pour la Recherche et l'Exploitation de la MER (IFREMER), Ronce les Bains, La Tremblade, 17390, France.

The culture of oysters from hatchery spawned genetically improved stocks in Virginia has increased dramatically over the past ten years. These animals are grown in a wide range of salinities and temperatures which in turn influence the disease pressure to MSX and Dermo as well as their potential for growth. Thus, the two main breeding objectives for the industry (disease resistance and fast growth rate) are controlled, to a large extent, by the environment. Consequently, it is essential to investigate the magnitude of genotype by environment interactions, which, if found, will require a site specific selection strategy. The study was conducted over a four year period with two separate cohorts of 49 and 53 full sib families reared for two years each. Each family was deployed in two sites, a medium and a low salinity, with high and low disease pressure. 3200 oysters from each of the 102 full-sib families were used in this trial: 800 animals per site for natural disease challenge and 800 for growth trials. Survival and growth data were collected twice a year throughout the testing period. Results show significant rank changes between environments and steps are being taken to develop lines specific to salinity zones.

DEVELOPMENT OF DISEASE RESISTANCE IN BLACK ABALONE. Carolyn S. Friedman, Nathan Wight, Lisa Corsson, and **Glenn VanBlaricom.** University of Washington, Box 355020, Seattle, WA, 98107, USA.

Withering Syndrome, WS, is a bacterial disease of abalone caused by a *Rickettsia*-like organism, WS-RLO, resulting in up to 99% losses of black abalone in central and southern California, including San Nicolas Island, SNI. Since 2002, abalone densities have increased 2.5x compared to the minimum in 2001. We exposed juvenile black abalone from SNI (WS selection) and Carmel (no WS selection) to RLO-infected red abalone and monitored them for 17 months. More exposed abalone from Carmel died from WS than did those from SNI ($p < 0.05$), while no differences in survival were observed between control groups ($p > 0.05$). Microscopic examination suggests that resistance may be more related to the host response to initial infection than to the ability to resist infection. During this study, we observed a novel bacterium, morphologically distinct from but shares the same tissue tropism, as the WS-RLO. Microscopic examinations suggest pathogenic potential for this novel bacterium. However, based on a second study in which these same groups of abalone were exposed only to WS-RLO, similar losses were observed in both groups after only seven months. These data further illustrate disease resistance in the SNI populations but also suggest that the new bacterium may dampen losses associated with the WS-RLO.

SENSORY CHARACTERIZATION PROGRAM FOR, *MERCENARIA* SPP. Laura Garrido, Leslie Sturmer, and **Steve Otwell.** Food Science & Human Nutrition Department and Florida Sea Grant Program, University of Florida, Gainesville, FL 32611

A new 'sensory characterization' program is being developed for hard clams *Mercenaria* spp. based on established protocol with screened and trained panelists. The intent is to provide a non-bias, science-based tool to help direct commercial practices and decisions for marketing and maintaining product standards. Initial efforts have developed rating scales and standards for aquacultured clams from Florida and two other states based on profiling differences and unique attributes for appearance, texture, basic tastes, aroma and flavors. This program can be used by investigators assessing product quality and shelf-life, or commercial interests trying to distinguish products by location, season, or process. Users can be trained with established standards and actual products to rate and describe the unique character of the products in question. Popular use could lead to local product distinctions or appellations that stimulate and attract consumer interests.

THE PACKAGING AND TRANSPORTATION OF MOLLUSCAN SHELLFISH Victor Garrido. Department of Food Science and Human Nutrition, University of Florida, Gainesville, FL, 32611.

This presentation will discuss the different requirements and recommendations for packaging and product specification used by the molluscan shellfish industry throughout the world. An emphasis on the US market, either produced or exported to the US will be discussed.

COMPARISON OF INTERTIDAL OYSTER POPULATIONS BETWEEN A ROCK BREAKWATER AND A NATURAL REEF IN LOWER BARATARIA ESTUARY. Nicholas Gaspard[1] and **Earl Melancon[2].** [1]T. Baker Smith, Inc., P. O. Box 2266, Houma, LA, 70361, USA; [2]Nicholls State University, P.O. Box 2021, Thibodaux, LA, 70310, USA.

Three intertidal oyster habitats in the southern high-salinity portion of the Barataria Estuary were sampled monthly for a year; the Windward and Leeward sides of a rock breakwater and a

natural reef. These down-estuary sites may have the potential to be sources of larvae for recruitment to up-estuary populations killed during excessive freshwater events. Therefore, the goal was to determine if a rock breakwater and a natural intertidal oyster reef were functioning similarly in reference to oyster density, recruitment and population structure.

Oyster standing crop per square meter taken in winter was greatest on the windward side, 792 ± 11 oysters, followed by the natural reef, 162 ± 3 and then the leeward, 148 ± 2. However, mean live oyster size indicated a significantly different pattern ($F_{2, 11853} = 5566.5$, $P < 0.001$) with the densely populated windward site having a mean live oyster length of only 9.4 ± .2mm indicating high mortality at a young age. Leeward mean live oyster length was 17.8 ± .3mm while the natural reef's mean live oyster length was 42.0 ± 3mm. But examination of articulated boxes and valve scars suggest that at times the leeward side does potentially resemble a natural reef.

CHARACTERIZATION OF PROSTAGLANDIN PATHWAY GENES OF THE PACIFIC OYSTER (*CRASSOSTREA GIGAS*): EVIDENCE FOR A ROLE IN IMMUNE RESPONSE. Mackenzie Gavery and **Steven Roberts.** University of Washington, 1122 NE Boat Street, Seattle, WA, 98105, USA.

Prostaglandins are oxygenated derivatives of polyunsaturated fatty acids with important roles in reproduction, ion transport, and immune response. While there is evidence for prostaglandins in invertebrates, information on the functional role of prostaglandins in bivalves is lacking. Recent transcriptomic studies examining the immune response in Pacific oysters (*Crassostrea gigas*) reveal upregulation of a gene encoding a receptor for prostaglandin E2. In order to characterize the role of the prostaglandin pathway in oyster immune function a series of challenge experiments were carried out with gene expression patterns of the prostaglandin receptor characterized and prostaglandin E2 levels measured using Enzyme Linked Immunoassays (EiA). In addition, bioinformatic approaches were used mine genomic databases for other molecules in the bivalve prostaglandin pathway. Results from Vibrio exposures indicate that at 24 hours after initial exposure, receptor expression increased and corresponding levels of prostanglandin E2 decreased, suggesting increased prostaglandin binding with the receptor. Bioinformatic analysis identified a gene fragment homologous to cyclooxygenase, an enzyme responsible for the initial conversion of arachidonic acid in the prostaglandin pathway. Results from the challenge experiments as well as a genetic characterization of the prostaglandin pathway enzymes in bivalves will be presented.

THE COMBINED EFFECTS OF SUB-OPTIMAL TEMPERATURE AND SALINITY ON THE VIABILITY OF *PERKINSUS MARINUS*, A PROTISTAN PARASITE OF THE EASTERN OYSTER *CRASSOSTREA VIRGINICA*. Whitney Gayle, Sandra Casas-Liste, Megan K. La Peyre, and **Jerome F. La Peyre.** Louisiana State University Agricultural Center, Baton Rouge, LA, 70803, USA.

The combined effects of low temperature and salinity on the viability of *Perkinsus marinus*, a protistan parasite of the eastern oyster (*Crassostrea virginica*) were determined. The in vitro viability of *P. marinus* held at 7, 15 and 25 psu and exposed to 2, 10 and 25°C was determined. After 90 days, low temperature alone failed to significantly decrease *P. marinus* viability at 25 and 15 psu (10 °C); and reduced viability at 25 and 15 psu only minimally (> 60% viability) at 2 °C. In contrast, when exposed to 7 psu, viability was significantly reduced at both 2 and 10°C (10°C: 5% ± 1; 2°C: 0 %). Low temperature alone failed to significantly decrease *P. marinus* viability when salinity remained above 15 psu; clearly, the combined effects of low temperature and low salinity will be required to eliminate *P. marinus* infections in vivo. This work was funded by the Louisiana Sea Grant Undergraduate Research Opportunities Program.

THREE YEARS AND COUNTING: PROTRACTED BAY SCALLOP RECRUITMENT PERIODS MAY BE THE NORM IN ONE SOUTH FLORIDA POPULATION, RATHER THAN THE EXCEPTION. Stephen P. Geiger, Sarah P. Stephenson, William S. Arnold, and **Melanie L. Parker.** Florida Fish & Wildlife Conservation Commission, 100 8th Avenue SE, Saint Petersburg, FL, 33701, USA.

Recruitment of bay scallops (*Argopecten irradians*) has been monitored continuously in the Anclote River estuary since October of 1997. Paired recruit collectors (Vexar™-lined 1/2 bushel citrus bags) at each of 12 stations were soaked for two months. Each half of the pair was retrieved, inspected for spat, and replaced with a new bag in alternating months. Recruits were collected in 150 of the 171 collection periods and were collected monthly for twelve or more consecutive months five times during the eleven year study. The longest, 38 consecutive collections, was ongoing as of November 2008. The average recruit rate was 0.249 spat bag^{-1} day^{-1} and the maximum rate for a collection period was 5.49 spat bag^{-1} day^{-1}. The maximum rate of a single collector was 22.02 spat bag^{-1} day^{-1}. During most collections, spat less than 5 mm SH were observed, indicating recent settlement. Recruitment was usually at a minimum in June through August, and peaked in both December and April. Local populations probably supply most of these recruits, particularly seasonal peaks, but coastal currents transporting larvae from sub-populations both north and south of the study area may also contribute to the continuous, low-level supply of recruits.

LIFE-HISTORY ASPECTS OF STONE CRABS (GENUS *MENIPPE*): SIZE AT MATURITY, GROWTH, AND AGE. **Susan Gerhart[1]** and **Theresa Bert[2].** [1]National Oceanic and Atmospheric Administration, 263 13th Avenue S, St. Petersburg, FL, 33701, USA; [2]Florida Fish and Wildlife Conservation Commission, 100 Eighth Avenue SE, St. Petersburg, FL, 33701, USA.

We estimated size at sexual maturity, growth rate, and size at age of stone crabs (genus *Menippe*) from west-central Florida waters using a 15-year database. Crusher-claw propodus length (PL):carapace width (CW) allometry indicated that 50% morphological maturity (CW50) occurred at 70 mm CW for males and 60 mm CW for females. Female physiologically maturation (gravid) and functional maturation (ovigerous) followed the morphological maturation pattern. The CW_{50} was significantly smaller than mean size at behavioral maturity (participation in mating) in males (86 mm CW), but not in females (62 mm CW). In both sexes, PL:CW allometry also shifted at 30-35 mm CW; thus we defined three life stages: small juvenile, large juvenile, and adult. Male PL:CW allometry increased throughout adulthood but large-juvenile and adult PL:CW allometry was the same in females. Molt frequency decreased with increasing size in both sexes. Molt increment increased with increasing size in males but increased only up to 50 mm CW in females. Adult males and females molt annually in cycles dictated by female reproduction. Males enter the commercial fishery during age three and females during age four. Females reproduce prior to entering the fishery, but most males do not.

POPULATION GENETICS OF INTRODUCED AND NATIVE POPULATIONS OF THE ASIAN GREEN MUSSEL, *PERNA VIRIDIS*. **Matthew R. Gilg.** University of North Florida, 1 UNF Drive, Jacksonville, FL, 32224, USA.

The green mussel, *Perna viridis*, is native to the Indo-Pacific but has been discovered in a number of locations in the Western Hemisphere over the last two decades. The first known introduction was to Trinidad in 1990 which was followed by introductions to Venezuela, Jamaica, the Gulf and Atlantic coasts of Florida and Georgia. The present study compared DNA sequence variation among several introduced and native populations to address the questions of whether all of the introduced populations in the Caribbean and the United States originated from a single source, and whether genetic variation was lower in introduced populations as predicted by a founder effect. A 650 bp region of the mitochondrial gene cytochrome oxidase subunit I was sequenced and compared among populations. All introduced populations were genetically similar suggesting they stemmed from a single source population. Furthermore, genetic variation was typically lower in the introduced populations compared to native populations suggesting a founder effect.

VISUALIZATION OF AN ION TRANSPORTING EPITHELIUM IN *BALANUS AMPHITRITE* USING CORRELATIVE MICROSCOPY: POTENTIAL FUNCTION IN BIOMINERALIZATION AND OSMOREGULATION. **Neeraj V. Gohad[1], G. H. Dickinson[2], B. Orihuela[2], D. Rittschof[2],** and **Andrew S. Mount[1].** [1]Clemson University, Clemson, SC, 29634, USA; [2]Duke University Marine Laboratory, Beaufort, NC, 28516, USA.

Balanomorph barnacles, including *Balanus amphitrite*, are a unique suborder of crustaceans typified by their calcified exterior, which provides protection to the sessile juvenile and adult. Biomineralization is mediated by a mantle epithelium that appears to be involved in calcium uptake and the secretion of a calcified organic matrix. Larval and adult balanomorphs tolerate a wide range of salinities and it is hypothesized that active ion transport is the primary mechanism for osmoregulation. We observed that adults produce an electrolyte-rich secretion emanating from the junction of the basis and parietal plates. Further study of this region using silver staining microscopic techniques, verified by SEM/EDS, revealed a chloride permeable mantle epithelium. A distinctive and repeatable pattern of chloride permeable epithelia was seen in all *B. amphitrite* life stages. Active ion transport by chloride epithelia was confirmed in nauplius and cypris larvae through the use of DASPMI, a mitochondrial vital stain, visualized with LSM. We suggest that the observed chloride permeable epithelia facilitates biomineralization via calcium uptake from the mantle cavity and ionic regulation via active transport.

FECUNDITY AND EMBRYO DIAMETER OF PRIMIPAROUS AND MULTIPAROUS BLUE CRAB, *CALLINECTES SAPIDUS*, IN MISSISSIPPI WATERS. **Darcie Graham[1], Harriet Perry[1], Patricia Biesiot[2],** and **Richard Fulford [3].** [1]The University of Southern Mississippi - Gulf Coast Research Laboratory, 703 E. Beach Drive, Ocean Springs, MS, 39564, USA; [2]The University of Southern Mississippi, 118 College Drive #5018, Hattiesburg, MS, 39406, USA; [3]The University of Southen Mississippi - Gulf Coast Research Laboratory, 703 E. Beach Drive, Ocean Springs, MS, 39564, USA.

Blue crabs support large commercial and recreational fisheries. Understanding the reproductive biology of this species is vital to the management of this fishery. Recent evidence has shown that female blue crabs have the ability to spawn up to eight broods in a single spawning season, with as many as 18 broods over their lifespan. The present study was conducted to determine if fecundity and egg diameter varied by brood type (primiparous vs. multiparous) and collection season (Spring vs. Summer/Fall). Ovigerous crabs were obtained during the 2006 spawning season (March – September) from commercial crab traps in Pascagoula, MS. The mean fecundity of all crabs collected was 2.8×10^6 eggs with a mean embryo diameter of 253.2 μm. There was a positive relationship between fecundity and female size. When equal-sized primiparous

and multiparous crabs were compared, there was no significant difference in fecundity. While there was no difference in embryo diameter between brood types, Spring embryos were approximately 10% larger in diameter than those collected in the Summer/Fall. The results of this study will increase the understanding of the reproductive capacity of female blue crabs, providing useful information to help maintain a sustainable fishery.

MONITORING FITNESS OF CAGED FRESHWATER MUSSELS TO PRIORITIZE STREAMS FOR RESTORATION IN SOUTHEASTERN PENNSYLVANIA. Matthew W. Gray[1], Danielle A. Kreeger[2], and **Angela Padeletti[2].** [1]Drexel University, 838 N 25th Street, Philadelphia , PA, 19130, USA; [2]Partnership for the Delaware Estuary, One Riverwalk Plaza, Suite 202, 110 South Poplar Street, Wilmington, DE, 19801, USA.

Freshwater mussels were once abundant and diverse throughout the Delaware Estuary where they provided numerous ecological benefits. Declines in both species diversity and abundance have been precipitous, and they are currently listed as the most imperiled taxa across North America. Accompanying their decline is a loss of important functional services. Unionids dominate the ecology of streams where they are abundant through their filter feeding, redistribution of nutrients, and stabilization of substrates. Since they are sessile and long-lived, they are useful indicators of environmental conditions. Their success depends on high water and habitat quality, as well as fish hosts, and so the revitalization of these animals can serve as a driver for ecosystem restoration. A key prerequisite for restoration is to determine which streams can sustain viable populations. Seven candidate streams in southeastern Pennsylvania were contrasted as suitable habitat for reintroduction by monitoring their condition and biochemical composition five times throughout a one-year period. Condition index varied significantly among streams (mean = 31-56) with some streams that harbor no mussels supporting similar fitness as source streams, suggesting that they are suitable for restoration.

GENETIC DIFFERENCES AMONG OYSTER (*CRASSOSTREA VIRGINICA*) POPULATIONS ACROSS A GRADIENT OF DISEASE HISTORY ON MARTHA'S VINEYARD, MASSACHUSETTS. Emma Green-Beach, David Bushek, and **Ximing Guo.** Rutgers University, 6959 Miller Avenue, Port Norris , NJ, 08349, USA.

The island of Martha's Vineyard, Massachusetts contains several small estuaries, three of which once harbored economically viable populations of the eastern oyster *Crassostrea virginica*. Dermo disease, caused by *Perkinsus marinus*, began causing mass mortality in the early 1990s, but its appearance in the different systems was staggered across a decade, creating a natural experiment in which each population has a different temporal history of exposure to Dermo disease. Using these three estuaries plus a fourth that has no history of Dermo disease, we tested the hypothesis that genotype frequencies have shifted in response to disease pressure over time. Oysters were collected monthly from May to October of 2008. Ray's fluid thioglycollatemedium assay showed that average disease intensity of a population generally decreased with increased exposure to Dermo. DNA from these oysters is currently being typed for both 'neutral' microsatellite loci and loci previously linked with disease resistance genes. Oysters from Delaware Bay, NJ and Great Bay, NH will serve asoutgroups for comparisons. Results are expected to indicate that genotype frequencies of resistant loci are affected by continued exposure to the disease on Martha's Vineyard.

DEPURATION OF BREVETOXINS IN TWO COMMERCIALLY IMPORTANT SPECIES OF SHELLFISH; *MERCENARIA MERCENARIA* AND *CRASSOSTREA VIRGINICA*. Andrew Griffith[1], Aswani Volety[1], Sandra Shumway[2], Michael Parsons[1], and **Jose Barreto[1].** [1]Florida Gulf Coast University, 10501 FGCU Boulevard, S., Fort Myers, FL, 33965-6565, USA; [2]University of Connecticut, 1080 Shennecossett Road, Groton, CT, 06340, USA.

The eastern oyster, C*rassostrea virginica* and Northern quahog, *Mercenaria mercenaria* are two species of economic and ecological significance in coastal areas along the eastern sea board of the United States and Gulf of Mexico. Commercial industries for these species, especially within the state of Florida, are relatively large. *Crassostrea virginica* is also a keystone species in marine ecosystems because oyster reefs provide habitat for numerous marine organisms. The purpose of this experiment is to build upon the already established body of knowledge on effects of *Karenia brevis* on various species of shellfish and to provide an understanding of the kinetics of brevetoxins within shellfish tissue and give an indication of just how long brevetoxins remain in these organisms after a bloom event. Individuals were exposed to *Karenia brevis* at a bloom concentration (100,000 cells per liter) for one week. After exposure, animals were transferred into clean water for depuration. Individuals were sampled periodically for brevetoxin in tissues to determine the rate of depuration using a competitive indirect Enzyme Linked Immunosorbent Assay (ELISA). The results of this experiment will provide a better understanding of the kinetics of brevetoxins within shellfish tissue, and this will have management implications for harvesting of shellfish post-*K. brevis* conditions.

SOUTH CAROLINA'S RECREATIONAL SHELLFISH AQUACULTURE PROGRAM: CREATING WATER QUALITY STEWARDS. Nancy Hadley. SC Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, 29412, USA.

South Carolina has recently completed a pilot program to evaluate the feasibility of instituting a recreational shellfish aquaculture permit. From a resource management viewpoint this is seen

as a way of engaging waterfront property owners and giving them a vested interest in water quality. Public interest in the project has been high and SCDNR hopes to implement a full scale program by Fall 2009. Results from the pilot program will be presented as well as details of proposed permit conditions.

MODELING CIRCULATION AND TRANSPORT PATHWAYS FOR OYSTER LARVAE IN DELAWARE BAY. D.B. Haidvogel, J. Wilkin, and **J. Wang.** Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, New Brunswick, NJ, 08901, USA.

As part of a collaborative project, supported by the National Science Foundation Ecology of Infectious Diseases (NSF EID) program, we have developed a three-dimensional circulation model of the Delaware Bay. The model, based upon the Regional Ocean Modeling System (ROMS), is forced by observed tidal, riverine and atmospheric fluxes. Validation of tidal heights, and current and tracer fields, for a target period in 1984 shows quantitative agreement between the model simulations and concurrent observations. Reconstruction of passive particle trajectories has been used to infer transport pathways of larvae of eastern oysters (*Crassostrea virginica*) and MSX and Dermo disease pathogens. Initial results of these drifter release experiments also agree qualitatively with known oyster larval distribution patterns and as such provide a starting point for development of understanding of genetic exchange in Delaware Bay oyster populations. In addition to further model validation, we have recently added oyster larvae behavior to the particle tracking analysis, and begun to explore the impacts of past and potential future changes to circulation patterns in the Bay.

NANTUCKET'S NUB CONTROVERSY: CAN SHELL MORPHOMETRY BE USED TO DETERMINE AGE AND LEGALITY OF FALL-SPAWNED BAY SCALLOPS IN THE COMMERCIAL FISHERY? Valerie A. Hall[1], Bradley G. Stevens[1], Peter B. Boyce[2], and **Robert S. Kennedy[2].** [1]School for Marine Science and Technology, University of Massachusetts Dartmouth, 706 South Rodney French Boulevard, New Bedford, MA, 02744, USA; [2]Maria Mitchell Association, 4 Vestal Street, Nantucket, MA, 02554, USA.

Nantucket possesses one of the last commercially viable populations of bay scallops, *Argopecten irradians*. Landings in 2007-2008 were higher than the previous two seasons, but in fall 2008 the population consisted almost entirely of immature "seed" (from early summer 2008) and "nubs" (from September 2006 or 2007), heralding a fishing disaster. Nubs have a short fall growing season, forming a spring growth ring < 10 mm from the hinge. Massachusetts defines legal bay scallops as having a well-defined growth ring. In October 2008, Massachusetts Division of Marine Fisheries required that this be located ≥ 10 mm from the hinge, making nubs illegal to harvest. Nubs are thought to spawn first in their second summer after adding a second growth ring in spring. In 2008, it was diffuse, possibly due to mild winter temperatures. In one study, 30-50% of second-year nubs survived until the commercial season. Scallopers believe these spawned and should be harvested. Currently, no methods exist to distinguish first and second-year nubs, short of histology. We explore techniques, using known-age scallops, for use by fishermen and managers to distinguish legal from illegal nub scallops, comparing shell morphometrics, GSI, gonad color, and histology.

THE EFFECT OF RED TIDE BLOOM HISTORY ON THE GENE FREQUENCY OF PARALYTIC SHELLFISH POISIONING (PSP) RESISTANCE IN POPULATIONS OF THE SOFTSHELL CLAM, *MYA ARENARIA*. Scott Hamilton, Laurie Connell, and **Amber Bratcher.** University of Maine, 5735 Hitchner Hall, Orono, ME, 04469, USA.

Atlantic Canadian populations of the softshell clam, *Mya areanaria*, develop resistance upon repeated exposure to blooms of the paralytic shellfish poison (PSP) producing toxigenic algae *Alexandrium* spp. This resistance is correlated with a mutation in the region of the sodium channel pore gene that binds saxiton (STX), the principle component of paralytic shellfish toxins (PSTs). This point mutation results in a specific amino acid change that is responsible for the resistance.

While previous studies have distinguished selected clam populations as primarily sensitive or resistant using a burrowing index, only a small percentage of locations have been significantly tested by genotyping a fraction of individual clams within the population. In this study, we surveyed the resistance genotype of *M. arenaria* populations from fourteen locations found along the northeast coast of North America. The region of the sodium channel pore gene in which the mutation is found was sequenced and the populations were compared for percent of homozygous (resistant or sensitive) and heterozygous individuals. These data were then compared with the PSP history of the area. Results of this survey may effect regional shellfishery management decisions as well as those of biotoxin monitoring programs.

SHELLFISH AQUACULTURE AND BEST MANAGEMENT PRACTICES. John A. Hargreaves. Aquaculture Assessments LLC, 6950 Boone Drive, Baton Rouge, LA, 70808, USA.

Best Management Practices (BMPs) have been defined historically as structural and operational techniques to minimize or prevent the effects of non-point source pollution in an effort to protect water quality. Thus, BMPs for stormwater runoff, forestry, and agriculture can protect water quality for shellfish aquaculture. The scope of BMPs has expanded to include environmental impacts more broadly, including resource use efficiency and social impacts. BMPs tend to focus on near-field, local-scale, short-term,

farm-level, and reversible impacts. Arguably, the most important environmental impacts of shellfish aquaculture are far-field, large-scale, long-term, and irreversible, for which BMPs have not been developed or implemented and which may be more amenable to solution through policy-oriented approaches. BMPs for shellfish aquaculture have focused on facility operation and management and minimizing user conflicts. The BMPs most likely to be implemented are those that simultaneously improve environmental and economic performance. BMPs can reduce costs, reduce wastes, and increase efficiency of resource use. They can also be used to avoid regulations or achieve regulatory compliance. BMP programs can be used as components of environmental certification programs, codes of conduct, purchasing policies by seafood buyers, and regulatory programs. Effective implementation of BMPs requires a flexible approach to achieving environmental goals and independent verification of results.

A TRANSCRIPTIONAL REGULATOR, VTPR, CONTROLS *VIBRIO TUBIASHII* METALLOPROTEASE EXPRESSION. **Hiroaki Hasegawa** and **Claudia C Hase.** Oregon State University, 105 Magruder Hall, Corvallis, Oregon, 97331, USA.

Vibrio tubiashii, a causative agent of severe shellfish larval disease, produces multiple extracellular proteins including a metalloprotease (VtpA) as potential virulence factors. We previously reported that VtpA is toxic for Pacific oyster (*Crassostrea gigas*) larvae. Here, we show that extracellular protease production by *V. tubiashii* was reduced at higher temperatures. In addition, *V. tubiashii* produced less extracellular protease in M9 media supplemented with glucose (or sucrose) compared to succinate. A LuxR family of transcriptional regulator, VtpR, plays a pivotal role in *V. tubisahii vtpA* expression. We document that VtpR activates VtpA production based on: (i) a VtpR-deficient *V. tubiashii* mutant did not produce extracellular proteases, (ii) the mutant showed reduced expression of a *vtpA-lacZ* fusion, and (iii) VtpR activated *vtpA-lacZ* in a *V. cholerae* heterologous background. Moreover, we show that VtpR activated the expression of an additional distinct metalloprotease gene (*vtpA2*). In addition, the VtpR-deficient mutant showed reduced expression of the *V. tubiashii* hemolysin gene compared to the wild-type strain. The VtpR-deficient *V. tubiashii* mutant also had effects on bacterial motility and was less pathogenic to oyster larvae. Together, these findings establish that the *V. tubiashii* VtpR protein functions as a global regulator controlling an array of potential virulence factors.

EFFECT OF PHOTOAUTOTROPHIC AND HETEROTROPHIC BIOFLOC COMMUNITIES ON PRODUCTIVITY OF PACIFIC WHITE SHRIMP *LITOPENAEUS VANNAMEI* FED A PLANT-BASED DIET IN SUPERINTENSIVE, ZERO-WATER EXCHANGE SYSTEMS. **Jason Haveman[1], Jesus A. Venero[1], Beth L. Lewis[1], Alisha Lawson[1], Andrew Shuler[1], Craig L. Browdy[2],** and **John W. Leffler[1].** [1]South Carolina Department of Natural Resources, 211 Sawmill Creek Road, Bluffton, SC, 29910, USA. [2]Novus International, 5 Tomotley Court., Charleston, SC, 29407, USA.

Superintensive biofloc-based shrimp production systems coupled with plant-based diets offer the potential to address many of the challenges facing U.S. shrimp farmers. In addition to waste management benefits, microbial biofloc provides supplemental nutrition that may be essential to complement plant-based diets. Most intensive shrimp raceways are greenhouse-enclosed, but this creates additional energy costs. We attempted to differentiate the effects on shrimp productivity of a light-dependent, mixed photoautotrophic-heterotrophic biofloc community from that of a strictly heterotrophic community which could be maintained in insulated, energy-efficient buildings. Pacific white shrimp *Litopenaeus vannamei* were stocked into side-by-side greenhouse raceways at 278 shrimp/m^2. One raceway was covered with a black polyethylene tent to occlude sunlight while the other raceway remained exposed. Epifluorescent microscopy documented the absence of photoautotrophs from the dark raceway while the light raceway maintained a healthy mixed community. Shrimp in both raceways were fed a complete plant-based extruded diet without chemical binders. Shrimp productivity in the 'light' raceway was only slightly better, averaging 17.5 g with 78% survival and FCR = 1.97, while shrimp in the 'dark' raceway averaged 17.0 g with 70% survival and FCR = 2.33. The necessity of greenhouses to maintain photoautotrophic communities may need to be reconsidered.

MICROALGAL CULTURE METHODS: A COMPARATIVE LOOK AT PRODUCTION SCALE TECHNOLOGIES UTILIZED IN BIVALVE AQUACULTURE. **Curtis D. Hemmel** and **Ryan L. Gandy.** Bay Shellfish Co., P.O. Box 289, Terra Ceia, FL, 34250, USA.

The consistent production of high quality microalgae is an essential component of a successful commercial bivalve hatchery. This concept was central in the selection of a continuous algal production system for the Bay Shellfish Co. hatchery. During a search for an efficient algae system, multiple hatcheries both domestic and abroad were visited. These experiences have enriched us with a wealth of information on how other hatcheries have arrived at their version of the essential microalgae production system. The culture methods encountered have ranged from batch to continuous culture along with the hybridization of these two methods. This presentation compares these technologies to

develop an understanding of the advantages and disadvantages of each. Within this comparison both successful and unsuccessful examples will be presented. The goal is to use our experience and that of others to present the various microalgae culture methods available and to foster a discussion on this subject.

A HALF CENTURY ASSESSMENT OF NORTHERN QUAHOG, *MERCENARIA MERCENARIA*, GROWTH IN NARRAGANSETT BAY, RHODE ISLAND. **Kelly M. Henry[1]** and **Scott W. Nixon[2].** [1]Louisiana State University, 3207 Energy, Coast, and Environment Building, Baton Rouge, LA, 70803, USA; [2]University of Rhode Island, South Ferry Road, Narragansett, RI, 02882, USA.

During the last several decades, the waters of mid Narragansett Bay, Rhode Island have increased in temperature and decreased in chlorophyll concentration, and it is possible that these changes affected the growth and success of a common benthic filter feeder, the northern quahog, *Mercenaria mercenaria*. We determined recent hard clam growth rates through a sclerochronological analysis and compared them to the rich historical record of Narragansett Bay growth rates in order to understand how these opposing changes influenced hard clam growth. We found no significant differences in short-term growth between 1985 and 2000. Long-term juvenile growth showed a significant decrease between the 1960's and 1990s, while long-term adult (mature) growth showed a significant increase over this same time period. While it is not clear why the changes in juvenile and adult growth rates differ, it appears as though the decrease in chlorophyll concentration, together with a change in phytoplankton community composition, increasing water temperature, and an increase in predator abundance may all have influenced hard clam growth between the 1960s and the 1990s.

OYSTERS AS INDICATORS IN SUB-TROPICAL DRY CLIMATES. **Heidi Hertler[1], Graciela Ramírez-Toro[1],** and **Danielle Kreeger[2].** [1]Inter American University of Puerto Rico, P.O. Box 5100, San Germán, Puerto Rico, 00683, USA; [2]Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 200, Wilmington, DE, 19801, USA.

Suspension-feeding bivalves are regarded as excellent biological indicators of aquatic community health, but there is limited information about tropical and sub-tropical species in this function. We examined population size structure and physiological condition of two sub-tropical oysters (*Isognomon alatus* and *Crassostrea rhizophorae*) in areas with varying water quality around Puerto Rico. Data suggest that oysters fare better in less disturbed, clearer water as compared to eutrophied areas where food availability may be greater. This is important because suspension-feeding bivalves are often keystone organisms in aquatic food webs. Any impact to the population of these animals can, in turn, greatly affect the ecology and "health" of a system. In addition, by including oysters as representatives of the micoparticle > suspension-feeder trophic pathway, we significantly strengthen our overall ecosystem assessment. We hope to craft recommendations for using one or both of these organisms as key bioindicators for assessing the status of subtropical aquatic communities.

MOLECULAR CHARACTERIZATION OF THE ODH POLYMORPHISM IN BAY SCALLOPS, *ARGOPECTEN IRRADIANS*. **Sarah Hess** and **Maureen K. Krause.** Hofstra. University, 114 Hofstra University, Hempstead, NY, 11549-1140, USA.

Octopine dehydrogenase activity is related to a scallops' capacity for burst swimming, a predator escape response during which the rate of glycolysis may increase over 400 fold from rest. The Atlantic bay scallop, *Argopecten irradians*, relies to a great extent on anaerobic fermentation via the octopine pathway to supply energy during burst activity, with up to 88% of ATP production derived from glycolysis. Odh is polymorphic in New York and Connecticut bay scallop populations, with two common alleles as determined by allozyme electrophoresis, and evidence from past studies suggest that these alleles may exhibit functional differences. In this study we isolated the *Odh* bay scallop gene and characterized the nucleotide sequence variation for bay scallop *Odh* alleles in order to address the hypothesis that the *Odh* polymorphism is maintained by natural selection. Bay scallop *Odh* is highly conserved with *Odh* from two *Pecten* species, and exhibits silent and amino acid substation differences among alleles. Because the tertiary structure for *Pecten maximus* is known and substrate and inhibitor binding sites well characterized, amino acid sequence variation for *A. irradians* ODH can be used to predict functional biochemical consequences of allelic variation.

SURVIVAL OF RED KING CRAB (*PARALITHODES CAMTSCHATICUS*) JUVENILES IN NATURAL AND ARTIFICIAL SUBSTRATE. **Willow Hetrick.** University of Hawaii at Manoa & Alutiiq Pride Shellfish Hatchery, Seward Alaska, 101 Railway Avenue, Seward, AK, 99664, USA.

Survival of red king crab (*Paralithodes camtschaticus*) juvenile stages (C1-C3) in natural and artificial substrates were tested at the Alutiiq Pride Shellfish Hatchery in Seward, Alaska from June 4th - July 14th, 2008 as part of a broader stock enhancement feasibility study by the Alaska King Crab Research, Rehabilitation and Biology Program (AKCRRAB). Structurally complex habitats, found in natural ecosystems, provide shelter and protect from predation and cannibalism during critical life stages. Understanding settlement tendencies and substrate preference is essential for king crab stock enhancement. C1 juvenile crabs were placed in aquaria with natural rock, shell, and plastic filtration media for 40 days to determine survival and growth rates, measured by wet

weight and carapace width. Survival to stage C3 juvenile was the highest (34%) in the artificial substrate, lowest (24%) in the shell substrate, and intermediate (27%) in the rock substrate. There was no significant difference in the wet weight and carapace width ($p>0.05$) of the treatments, perhaps due to the short length of the trial in relation to the species slow growth rates. Further research is needed to understand optimal substrate conditions for juvenile crabs and determine the importance of conserving crucial habitats easily disturbed by human activities.

UNDERSTANDING *BONAMIA* PARASITES BY EXPLORING THEIR PHYLOGENY, THEIR HOSTS, AND THEIR PAST. Kristina M. Hill[1], Nancy A. Stokes[1], Delonna M. White[1], Steve C. Webb[2], Marina A. Kroeck[3], Dorothy W. Howard[4], Kim S. Reece[1], P.M. Hine[5], Ryan B. Carnegie[1], and **Eugene M. Burreson[1].** [1]Virginia Institute of Marine Science, College of William and Mary, PO Box 1346, Gloucester Point, VA, 23062, USA; [2]Cawthron Institute, 98 Halifax Street East, Private Bag 2, Nelson, Nelson, 7042, New Zealand; [3]Insituto de Biología Marina y Pesquera, Almirante Storni, Güemes 1030, San Antonio Oeste, Rio Negro, 8520, Argentina; [4]USDOC/NOAA/NOS/NCCOS, Cooperative Oxford Laboratory, 904 S. Morris St., Oxford, MD, 21654-1323, USA; [5]73 rue de la Fee au Bois, Fouras, 17450, France.

Protistan oyster parasites in the genus *Bonamia* (phylum Haplosporidia) are increasingly being observed in new hosts and locations. Phylogenetic exploration of this genus is proceeding on two fronts. First, we are generating more ribosomal internal transcribed spacer (ITS) region sequences, and using ribosomal intergenic spacer (IGS) region and cytochrome oxidase I (COI) gene sequences in analyses to increase phylogenetic resolution. Second, we are characterizing the *Bonamia* diversity in new hosts as well as in archival samples of ''microcell''-infected oysters from the pre-molecular era. Phylogenetic analyses based on small subunit (SSU) rRNA gene and ITS region sequences continue to indicate that many, though not all, of the newly observed parasites are closely related to *Bonamia exitiosa* and *Bonamia roughleyi*, indicating a wide global distribution of what may be a single parasite species. Most intriguing is the potential presence of this parasite, as demonstrated using *in situ* hybridization, in archival samples: in experimental *Ostrea edulis* from Chincoteague Bay, MD, identified as *Bonamia ostreae* in 1961; and in *Crassostrea gigas* from Kaneohe Bay, Hawaii, identified as *Mikrocytos mackini* in 1972. Ironically, as host and geographic distributions of *Bonamia* spp. become better resolved, the origins of individual *Bonamia* spp. become less certain.

GENETIC STRUCTURE OF NATIVE AND INTRODUCED POPULATIONS OF THE CHARRU MUSSEL *MYTELLA CHARRUANA*. Eric A. Hoffman, Nancy K. Gillis, and **Linda J. Walters.** University of Central Florida, 4000 Central Florida Boulevard, Orlando, FL, 32816, USA.

We investigated the genetic structure of the invasive marine mussel *Mytella charruana* and compared variation from invasive populations to variation found within native populations. We sequenced 722 bp of the mitochondrial *COI* gene from 64 *M. charruana* samples from four invasive populations (southeastern USA) and 71 samples from two natural populations (Ecuador, Columbia). We constructed the phylogenetic relationship among all haplotypes and compared diversity measures among all populations. We found higher levels of nucleotide diversity in invasive populations than in native populations, although the number of haplotypes was greater in the native populations. Additionally, mismatch distribution analyses resulted in a pattern indicative of population admixture for the invasive populations. Conversely, mismatch distributions of native populations resulted in a pattern indicative of populations in static equilibrium. Our data present compelling evidence that the *M. charruana* invasion resulted from admixture of at least two populations, which combined to form higher levels of genetic diversity in invasive populations. Moreover, our data suggest that one of these populations originated from the Caribbean coast of South America. Overall, this study provides an analysis of genetic diversity within invasive populations and explores how that diversity may be influenced by the genetic structure of native populations.

UNDERSTANDING DISEASE RESISTANCE IN ESTUARINE POPULATIONS AND RESPONSE TO CLIMATE CHANGE. Eileen E. Hofmann[1], John Klinck[1], David Bushek[2], Susan Ford[2], Ximing Guo[2], Eric Powell[2], Dale Haidvogel[2], John Wilkin[2], and **Dennis Hedgecock[3].** [1]Old Dominion University, 4111 Monarch Way, Norfolk, VA, 23508, USA; [2]Rutgers University, Port Norris, NJ, 08349, USA; [3]University of Southern California, 3616 Trousdale Parkway, AHF 107, Los Angeles, CA, 90089, USA.

Delaware Bay oyster (*Crassostrea virginica*) populations are influenced by two lethal parasites that cause Dermo and MSX diseases. As part of the NSF Ecology of Infectious Diseases (EID) initiative a program has been developed for Delaware Bay with the objectives of understanding how oyster population genetics and population dynamics interact with the environment and these parasites to structure the host populations and how these interactions might be modified by climate change. Laboratory and field studies undertaken in this program have focused on identifying genes related to MSX and Dermo disease resistance, potential regions for refugia and the mechanisms that allow them to exist, the phenotypic and genotypic differences in oysters from putative refugia and high-disease areas, and the space and time variability in

the effective size of the spawning populations. These data provide inputs to oyster genetics, population dynamics and larval growth models, which are interfaced with a three-dimensional circulation model developed for Delaware Bay. Reconstruction of Lagrangian particle tracks is used to infer transport pathways of oyster larvae and MSX and Dermo disease pathogens. This presentation describes results from the laboratory, field and modeling studies and provides directions for understanding long term changes in Delaware Bay oyster populations.

ARCHAEOLOGICAL EVIDENCE FOR PREHISTORIC INTENSIFICATION OF PISMO CLAM EXPLOITATION. **H.B. Thakar Hucks.** University of California, Santa Barbara, University of California, HSSB, Santa Barbara, CA, 93106-3210, USA.

As modern humans grapple with the repercussions of their extensive environmental impacts, archaeologists are increasingly looking to the past to understand the nature and extent of prehistoric human's impact on the environment. Thus, an emerging focus among coastal archaeologists centers on elucidating the inter-relationships between human subsistence and intertidal ecology that mediated prehistoric human's impact on intertidal resources. The potential for human predation to significantly impact intertidal resources is dependent on the relative economic importance of those prey species. Economic intensification of shellfish exploitation is traditionally identified archaeologically by a reduction in the absolute abundance and mean shell size/age of the preferred species over time. Coastal archaeologists from all over the world have affirmed these patterns as clear indications of economic intensification in exploitation of rocky intertidal mollusks. However, recent investigation of archaeological deposits at CA-SCRI-480 revealed an anomalous density of a sandy intertidal species, *Tivela stultorum*. Statistically significant variation in the size and number of clams harvested through time indicates that key differences in the ecology and life history of pismo clams affects the archaeological signature of economic intensification. This research demonstrates the necessity of a species-specific approach to the conception of prehistoric intensification of shellfish exploitation.

OYSTER SPAT (*CRASSOSTREA VIRGINICA*) SETTLE AT DIFFERENT PENETRATION DEPTHS AND CULTCH TYPES IN AERATED AND NON-AERATED TREATMENTS. **Victoria D. Ippolito** and **John Supan.** Louisiana State University, South Stadium Road, Baton Rouge , LA, 70803, USA.

The objective of this study was to test cultch type (whole oyster shell, crushed oyster shell and limestone) and penetration depth (top, middle and bottom) of oyster spat (*Crassostrea virginica)* settlement in aerated and non-aerated treatments. Approximately 350,000 larvae from the same hatchery-reared brood were added to two aerated and two non-aerated containers each with three cultch types seven inches deep. After 96 hours, volumetrically equal samples (180 ml water displacement) of each cultch type were collected at each depth, placed in labeled bags and subsequently examined for spat set with a dissecting scope at 10-30x. Significantly more spat set on the bottom ($F_{15} = 24.8$, $p = 0.0002$) and at mid-depth ($F_{15} = 14.22$, $p = 0.0018$) in aerated treatments compared to non-aerated treatments. Whole ($t_{15} = -6.44$, $p < 0.0001$) and crushed ($t_{15} = 5.32$, $p < 0.0001$) oyster shell attracted significantly more spat than limestone. This study showed that oyster spat set more evenly across cultch depth in aerated treatments compared to non-aerated treatments. Spat settlement deceases with depth in non-aerated treatments. Overall, spat set on limestone the least and whole oyster shell the most. These results serve useful applications in the remote setting of oyster larvae on alternative cultch.

AN EXTENSIBLE FRESHWATER MUSSEL BIOGEOGRAPHY DATABASE FOR MISSISSIPPI USING ARCHAEOLOGICAL DATA. **Paul Jacobs, Evan Peacock,** and **Joseph Greenleaf.** Mississippi State University, P.O. Box AR, Mississippi State, MS, 39762, USA.

Freshwater mussel (Bivalvia: Unionidae) shell remains have been reported from many archaeological sites in Mississippi. A recent synthesis of data provides range maps for over sixty species, including several new records and range extensions, as well as information related to population structures as they existed prior to modern impacts. The database of these freshwater mussels is both searchable and extensible, so that additional samples may be added continually, with concurrent updating of range maps and attendant assemblage information. A major advantage of the database is the incorporation of photographs of specimens taken from multiple angles, aiding in the identification of difficult species. Additionally, qualified experts, through the issuing of login permits may edit and supplement database entries from their own PCs.

FIELD ASSESSMENT OF BLUE CRAB RESTOCKING IN UPPER CHESAPEAKE BAY. **Eric Johnson[1], Anson Hines[1], Margaret Kramer[1], Michael Goodison[1], Robert Aguilar[1], Heather Soulen[1], Paige Roberts[1], Yonathan Zohar[2],** and **Oded Zmora[2].** [1]Smithsonian Environmental Research Center, P.O. Box 28, 647 Contees Wharf Road, Edgewater , MD, 21037, USA; [2]Center of Marine Biotechnology, University of Maryland Biotechnology Institute, 701 E. Pratt Street, Baltimore, MD, 21202, USA.

The blue crab population and spawning stock in Chesapeake Bay have declined precipitously with strong evidence that the population is currently recruitment limited. Restocking has been proposed as one potential tool, in concert with protected areas, habitat restoration and traditional fishery management to achieve stock recovery. We summarize the results of a multi-year study designed to assess the potential of enhancing local populations of

blue crabs with hatchery-reared juveniles and to identify key factors that maximize survival of hatchery-reared juveniles following release. During 2002-2008, we released 53 cohorts of 1,000-25,000 hatchery-reared juveniles into nursery habitats of the upper Chesapeake Bay. Survival of released crabs varied among release sites, seasons, years and stocking densities. Overall survival was high (15%), but was highest in early spring and late fall releases when predation was lowest. Cohorts released in spring grew to maturity within the season of release; whereas cohorts released in summer and fall over-wintered and matured in their second year. Key next steps in our ongoing assessment are to assess fishery impacts on restocking success and to evaluate the cost-effectiveness of restocking relative to alternative strategies. Overall, our results continue to indicate that the potential for restocking with this species is encouraging.

TOWARDS BIOMIMETIC CERAMIC COATINGS: CELLULAR ASPECTS OF OYSTER SHELL BIOMINERALIZATION. Mary Beth Johnstone[1], Karolyn M. Hansen[2], Neeraj V. Gohad[1], Douglas C. Hansen[2], and **Andrew S. Mount[1].** [1]Clemson University, Clemson, SC, 29634, USA; [2]University of Dayton Research Institute, Dayton, OH, 45469, USA.

The molluscan shell formation process is a promising model for development of bio-inspired ceramics for a wide variety of applications in fields as varied as nanotechnology and nanofabrication to name a few. Using a method similar to flat pearl formation, metal alloy disks placed *in vivo* between the mantle, a shell promoted the deposition of successive uniform layers of folia onto implant surfaces. The resulting coating mimics folia formed in shell which is comprised of laterally flattened crystal laths that fuse to form highly ordered folia sheets These layers form on the surface of a substantial substrate membrane and are capped with a similar membrane which acts as a substrate for the next layer of folia deposition. We observed that cells initiate folia formation by depositing membrane bound nanoparticles containing crystals onto the substrate. Early folia formation commences with the formation of unorganized mineral patches over the entire membrane surface. The capping membrane originates from plasma membrane bearing vesicles which originate from hemocytes at the mineralization front.

A BIOINFORMATICS APPROACH FOR DISCOVERING SHELL MATRIX PROTEINS. Mary Beth Johnstone, Margaret E. Staton, Chris Saski, and **Andrew S. Mount.** Clemson University, Clemson, SC, 29634, USA.

The acidic proteins derived from molluscan shell are among the most unusual proteins known. They are heavily processed post-translationally and post-secretory, attributes which have made standard biochemical characterization problematic.

We recently identified folian, an acidic family of phosphoproteins in oyster shell primarily comprised of Asp, Gly and phosphorylated serine, at roughly 30 mol% each. Discrete protein identification using standard protein characterization methods has been difficult due to the high weight percent phosphate which contributes to the *folian* family hetereogeneity. Using a bioinformatics approach, a virtual "perlscript" probe was constructed to a 20 amino acid N-terminal sequence previously determined for a 48 kDa folian phosphoprotein and was used to search against available EST databanks for C*rassostrea* oyster species. The identified EST sequence, when translated, contained the N-terminal probe sequence and substantial Asp-Ser rich domains. The full transcript was determined by screening a mixed *Crassostrea virginica*/*Crassostrea gigas* BAC library with 10X coverage; Southern analysis revealed that two copies of the protein exist in the genome. The protein has an estimated molecular weight of 34 kDa and contains 41% Asp, 31% Ser, 8% Glu with a theoretical pI of 2.37. This study demonstrates that bioinformatics is a powerful tool for identifying novel proteins.

PREHISTORIC OVER-EXPLOITATION OF *MERCENARIA* SPP. IN THE SOUTHEASTERN USA. Douglas S. Jones, and **Irvy R. Quitmyer.** University of Florida, P.O. Box 117800, Gainesville, FL, 32611, USA.

Human-induced changes in natural or pristine ecosystems of the Americas are thought to have occurred after European contact and colonization. However, age class determination of *Mercenaria* spp. shells using annual shell growth increments provides evidence for the over-exploitation of this resource at six pre-Hispanic archaeological sites from Florida, Georgia, and South Carolina. The data show that hard clams were collected at such a high intensity that the average age of their populations was significantly reduced. This occurs where there is evidence for hard clam harvest during the peak period of reproduction. Evidence of human sedentism and intensive use of hard clams may have also contributed to the decline in population age class structure. Further, modern age class data of three managed hard clam populations show a positive effect in those populations. These data span over 2,000 years of hard clam exploitation along the southeastern coast of North America.

THE SEXUAL PREFERENCE OF *PERKINSUS MARINUS*. Joshua Kauffman, Doug Zemeckis, and **David Bushek.** Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

In the Eastern oyster *Crassosstrea virginica*, Dermo disease, caused by *Perkinsus marinus*, intensifies with age and therefore tends to remove larger, older animals from the population. Because oysters are protandric, populations shift from predominantly male to predominantly female as a cohort ages and the oysters grow. Therefore, all else being equal, Dermo disease should have a

greater impact on females than males. This effect could be amplified or reduced, if *P. marinus* shows an affinity for one gender over the other, which could consequently affect reproductive success of the population. To determine if such an affinity exists, we used standard RFTM culture methods to compare Dermo disease between male and female Delaware Bay oysters (n = 200) paired by size during July 2008. A two-factor ANOVA indicated no difference in Dermo infection prevalence or intensity among males and females when size was factored out. These results indicate that Dermo acts without bias to gender, simplifying the application of Dermo impacts when modeling populations of the Eastern oyster. Funding provided by NSF REU supplement to grant OCE-0622672.

THE ESE-CBA PLAN: A COMPREHENSIVE, INTEGRATED APPROACH TO ASSESSING THE BENEFITS OF OYSTER REEF RESTORATION. **M. Lisa Kellogg[1], H. Ward Slacum[2], Kennedy T. Paynter[1], Stephan Able[3], Steven M. Allen[3], Linda S. Barker[4], William Boicourt[5], David Bruce[6], Bob Conkwright[7], Jeff Cornwell[5], Brad Gentner[8], Lee Karrh[4], Jay Lazar[6], Doug Lipton[1], Don Meritt[5], Tom O'connell[4], Howard Townsend[6],** and **Mark Trice[4].** [1]University of Maryland, 3270 Biology Psychology Building, College Park, MD, 20742, USA; [2]Versar, Inc., Columbia, Maryland, 21045, USA; [3]Oyster Recovery Partnership, Annapolis, MD, 21401,USA; [4]Maryland Department of Natural Resources, Annapolis, MD, 21401, USA; [5]University of Maryland Center for Environmental Science, Cambridge, MD, 21613, USA; [6]NOAA Chesapeake Bay Office, Oxford, MD, 21654, USA; [7]Maryland Geological Survey, Baltimore, MD, 21218, USA; [8]Gentner Consulting Group, Silver Spring, MD, 20901, USA.

Increasingly, the goals of oyster reef restoration efforts include restoration of the ecosystem services once provided by healthy oyster populations. When oyster reef restoration is undertaken solely for enhancement of commercial fishing, the cost-benefit analysis entails a straightforward comparison of the discounted stream of restoration costs to the increase in net present value of the resulting harvest. When restoration is undertaken to restore ecosystem services, net benefit measurement is much more complicated, requiring the incorporation of non-market use values (e.g., recreational fishing over reefs) and non-use values (i.e., value of the existence and health of reefs to non-users).

Recently, a comprehensive, integrated approach to assessing the benefits of oyster reef restoration was developed for restoration activities in the upper Choptank River, Maryland, USA. The Ecosystem Services Evaluation and Cost Benefit Analysis (ESE-CBA) Plan was developed by a multi-investigator, multi-agency team with the goal of providing: (1) a comprehensive assessment of the ecosystem services provided (including seston removal, nutrient dynamics, secondary production, fish and decapods use), (2) an assessment of the non-market value of restored oyster reefs to user and non-user groups and (3) a detailed cost-benefit analysis that will provide guidance for future management and funding decisions.

SHELLFISH HARVEST AREA DECISION-MAKING USING GIS, REMOTE SENSING, AND PREDICTIVE MODELS. **R. Heath Kelsey[1], Geoffrey I. Scott[2], Dwayne E. Porter[3], Thomas C. Siewick[2],** and **Don Edwards[3].** [1]NOAA (JHT Inc), 904 S. Morris Street, Oxford, MD, 21654, USA. [2]NOAA, 219 Ft. Johnson Road, Charleston, SC, 29412, USA. [3]University of South Carolina, Arnold School of Public Health University of South Carolina, Columbia, SC, 29208, USA.

Currently many states use precipitation information to regulate periodic closures of conditionally approved shellfish harvest areas, based on a presumptive relationship between rainfall and bacteria concentration. We evaluate this relationship in four South Carolina estuaries and suggest new predictive models that integrate remote sensing precipitation data with additional environmental and climatic data. Model comparisons using Akaike's Information Criterion, 10-fold cross validation, and model r-square values show substantial and consistent improvements using integrated precipitation, salinity, and water temperature data as predictors. These models may be useful for shellfish area closure regulation support. The model development approaches used here may also be useful in estimating bacteria concentration at beaches, and can form the basis of real time estimates and forecast predictions of bacteria levels.

ISOLATING KEY CONTRIBUTORS OF MICROBIAL BIOFLOC TO *LITOPENAEUS VANNAMEI* GROWTH: HOW DO BIOFLOC TAXONOMIC GROUPS AFFECT GROWTH WHEN PROVIDED AS DIETARY SUPPLEMENTS? **Megan R. Kent[1], Craig L. Browdy[2], Jesus A. Venero[3], Andrew Shuler[4], Gloria Seaborn[5], Colden Battey[5],** and **John W. Leffler[4].** [1]College of Charleston, 205 Fort Johnson Road, Charleston, SC, 29412, USA; [2]Novus International, Inc., 5 Tomotley Court, Charleston, SC, 29407, USA; [3]South Carolina Department of Natural Resources, 211 Sawmill Creek Road, Bluffton, SC, 29910, USA; [4]South Carolina of Natural Resources, 217 Fort Johnson Road, Charleston, SC, 29412, USA; [5]NOAA-NOS, 219 Fort Johnson Road, Charleston, SC, 29412, USA.

Goals of this study were to isolate the microbial taxa providing supplemental nutrition to shrimp in biofloc production systems. Monocultures of diatoms (*Amphiprora* sp.; *Thalassiosira weissflogii*), a cyanobacterium (*Synechococcus bacillarus*), and an eustigmatophyceae (*Nannochloropsis salina*) species characteristic of raceway systems at the Waddell Mariculture Center were grown axenically and harvested with a continuous centrifuge. Intact floc from a completely heterotrophic community was also collected. The resulting pastes were incorporated into a plant-based pelleted feed. An equivalent, complete feed was manufactured as a control.

Juvenile shrimp (1.2g ± 0.2g) stocked at a density of 400/m^3 were maintained in a clear water recirculating system with five replicate tanks per treatment. After 35 days shrimp growth, survival rate, and food conversion rate (FCR) were measured to determine the influence of the supplements on shrimp productivity. Diets were then prepared that incorporated algal pastes derived from monocultures into feeds that were nutrient-deficient in protein, essential fatty acids or vitamins. This experiment evaluated which specific nutritional deficiencies could be overcome by supplemental algal consumption. After 35 days shrimp productivity was measured to evaluate the nutritional contribution provided by the algae. Results enable the development of shrimp feeds that by fully integrating natural productivity can be specifically formulated for biofloc systems.

LONG-TERM VARIATION OF *PERKINSUS MARINUS* INFECTION IN GULF OF MEXICO OYSTERS. Yungkul Kim and **Eric N. Powell.** Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349-3167, USA.

As part of the NOAA's National Status and Trends Mussel Watch Program, oysters were sampled each winter along the Gulf of Mexico for 22 years (1986-2007). Oysters were analyzed for length, sex, reproductive stage, prevalence and weighted prevalence of the oyster pathogen *Perkinsus marinus*. Long-term mean and median weighted prevalences were highest at Brazos River in Texas followed by East Matagorda Bay in Texas, Joseph Harbor in Louisiana, Copano/Aransas Bay in Texas, all in the northwestern Gulf. The long-term prevalence was also highest at Brazos River in Texas followed by Cedar Key in Florida in the northeastern Gulf. Oysters from the Mississippi River Tiger Pass in Louisiana had the lowest mean weighted prevalence and prevalence. The long-term Gulf-wide mean weighted prevalence was highest in 1997 followed by 1989, whereas the median weighted prevalence was highest in 1989 followed by 1997, both years being under La Niña events. For the long-term Gulf-wide prevalence, it was highest in 1986 followed by 1989. The lowest Gulf-wide weighted prevalences and prevalence were obtained either during or right after the extended El Niño period, suggesting the close relationship between the *P. marinus* epizootics in the Gulf and the long-term climatic changes.

MICROSPORIDIOSIS IN WILD-CAUGHT PINK SHRIMP, *FARFANTEPENAEUS DUORARUM*, IN THE INDIAN RIVER LAGOON, FLORIDA, USA. Yasunari Kiryu, Jan H. Landsberg, Rich Paperno, Jeffrey T. Sauer, and **Agustin P. Sebastian.** Florida Fish and Wildlife Conservation, 100 8th Avenue SE, St. Petersburg, FL, 33701, USA.

In early February 2005, the Florida Fish and Wildlife Conservation Commission's (FWC) Fish and Wildlife Research Institute (FWRI) received reports regarding diseased pink shrimp, *Farfantepenaeus duorarum*, in the northern basins of the Indian River Lagoon (IRL) on Florida's east coast. Shrimp were reported having purplish-mauve coloration on the cuticle with large white "cotton-like" cysts in the muscle. Shrimp fishermen suggested that there was a marked increase in the prevalence of the disease (5–20% of their catch infected) in 2005 compared to previous years (1–5% of their catch infected). In March 2006, we initiated monthly monitoring of pink shrimp at six fixed stations to determine the prevalence of the disease in the IRL. A total of 4179 pink shrimp were screened grossly for "cotton-like" cysts, externally visible as white opaque patchy areas under the carapace. Analysis of shrimp samples, by wet mount light microscopy, histological observations, and from transmission electron microscopy of the abdominal muscle, revealed infections by the microsporidian, *Agmasoma duorara*, known to cause "cotton" or "milk" shrimp disease. Microsporidia along with granulomas were found in the skeletal muscle, gonad and hepatopancreas. A total of 0.69% of the shrimp examined were found to be positive for microsporidia.

MUSSEL POWERED LIVING SHORELINES FOR SALT MARSH EROSION CONTROL. Danielle A. Kreeger[1], David Bushek[2], Angela T Padeletti[1], Joshua Moody[2], and **Laura Whalen[1].** [1]Partnership for the Delaware Estuary, 110 South Poplar Street, Suite 202, Wilmington, DE, 19801, USA; [2]Rutgers University, 6959 Miller Avenue, Port Noris, NJ, 08349, USA.

Tidal marshes are a hallmark feature of the Delaware Estuary where they are suffering severe erosion due to sea level rise and other factors. The goal of the Delaware Estuary Living Shorelines Project (DELSI) is to enhance and protect marshes using intertidal shellfish reefs to "soft armor" eroding edges. Erosion appears most severe in areas having few ribbed mussels (*Geukensia demissa*), which can form dense aggregations at the seaward fringe of marsh grass. Natural substrates such as coconut fiber logs and shell bags have been deployed to trap sediments and support the development of shellfish communities by providing structure that will attract natural recruitment of mussels. Treatments were established along an energy gradient near the mouth of the Maurice River, NJ. Early monitoring indicated that several treatments rapidly enhanced sedimentation and edge stability, and mussels began to colonize them. We are now quantifying physical and biological responses to the installations relative to controls and costs. We also plan to test whether seeding mussels onto treatments enhances recruitment and accelerates establishment of mussel-based communities. Ultimately, DELSI should provide a new tactic to help control shoreline erosion and protect vital marsh habitats with mussel populations, which also furnish other important ecosystem services.

NURSERY HABITATS OF THE FLORIDA STONE CRAB, *MENIPPE MERCENARIA*: EFFECT ON MEGALOPAL METAMORPHOSIS AND INTRA-COHORT CANNIBALISM. **Lisa S. Krimsky** and **Charles Epifanio.** University of Delaware, 700 Pilottown Road, Lewes, DE, 19958, USA.

The Florida stone crab, *Menippe mercenaria*, is an economically and ecologically important species, however, there is relatively little known about its early life history stages. We examined the effects of putative cues on metamorphosis from the megalopa stage to the first juvenile stage, as well as the prevalence of intra-cohort cannibalism among stone crab megalopae and the social behaviors of first stage juveniles. Our study showed that there was a significant effect on metamorphosis in experimental groups exposed to cues associated with *Sargassum fluitans*, rubble from stone crab habitat, *Crassostrea virginica*, and biofilms associated with the oyster. Furthermore, we provide evidence for metamorphic responses to water-soluble chemical cues, as well as biochemical and physical cues associated with different substrata. Our results also show that stone crab megalopae are highly cannibalistic and that the rate of cannibalism is dependent on density and the presence of an alternate food source. Early instar juveniles also exhibit anti-social behavior, which is coherent with our cannibalism results. Overall, our results indicate that both physical and chemical cues are important factors in facilitating the settlement and metamorphosis of *M. mercenaria* larvae in juvenile nursery habitat and those responses may help to minimize intra-cohort cannibalism.

TECHNOLOGY AND RESEARCH ADVANCES FOR THE PRODUCTION OF MARINE SHRIMP IN RECIRCULATING AQUACULTURE SYSTEMS. **David D. Kuhn[1], Gregory D. Boardman[1], Lori Marsh[1], Addison L. Lawrence[2],** and **George J. Flick, Jr.[1].** [1]Virginia Tech, 418 Durham Hall, Blacksburg, VA, 24061, USA; [2]Texas A&M System, AgriLife Research Laboratory, Port Aransas, TX, 78373, USA.

Historically, aquaculture of *Penaeus spp.* has been limited to ponds in tropical coastal regions because these shrimp require salt water and warm temperatures. However, recent advances in recirculating aquaculture have made it more practicable to culture marine shrimp (*Litopenaeus vannamei*) using indoor recirculating aquaculture systems. For example, in southern Virginia, a recently constructed 30,000 square foot shrimp farm, Virginia Shrimp Farms Inc. (VSF), has been producing live shrimp for markets in New York City. University researchers from Virginia Tech and Texas A&M have been collaborating with VSF on numerous research projects to help this industry increase production levels, while improving environmental sustainability. Among the projects that will be covered in this presentation are: (1) treatment of fish effluent using bioreactors to produce bacterial protein to replace fishmeal in shrimp feed, (2) acute and chronic toxicity of ammonia, nitrite, and nitrate to *L. vannamei*, and (3) effectiveness of commercially available bacteria to improve nitrification. Ultimately, it is hoped that this research will enable the U.S. shrimp industry to competitively produce high quality shrimp, using environmentally sustainable technologies.

THE MINERALS INVOLVED IN LOBSTER SHELL VULNERABILITY. **Joseph G. Kunkel[1], Michael J. Jercinovic[1],** and **Wolfram Nagel[2].** [1]University of Massachussetts Amherst, 221 Morrill Science Center, Amherst, MA, 01003, USA; [2]Ludwig Maximillian University, Pettenkoferstr. 12 , München, Bavaria, D-80336, Germany.

The American lobster, *Homarus americanus*, cuticle is invested with calcium and phosphatidic minerals which normally result in an invulnerable surface that is replaced on a regular schedule. Vulnerabilities, developed due to changes in the external environment, may prevent the mineral structures from functioning properly. We characterize the mineral fine structural of the cuticle surfaces including the general outer surface plus the secretory and neuronal canals and the solubility of these structures under varying environmental conditions. An electron microprobe is used to establish the mineral fine structure of cuticle and a non-invasive ion probe is used to map the flux of ions and oxygen in and out of the normal and lesioned cuticle. A calcite layer is dynamically in equilibrium with seawater. This layer increases its dynamic flux in lesioned cuticle. Solubilization of calcium carbonate results in calcium efflux and simultaneous proton influx due to combination with carbonate to form soluble bicarbonate. Lower pH enhances calcium and proton fluxes. Oxygen influx into lesions, feeding the polyphenol oxidase reaction, is not detected unless the calcite layer is breached. There are weaknesses in the fine structure of the mineral surfaces that provide areas of preferred attack by microbes. (Supported by RI-SeaGrant)

ESTABLISHING SPF STOCKS OF BAIT SHRIMP *LITOPENAEUS SETIFERUS* AND DEMONSTRATION OF LOW COST MATURATION AND LARVAL SYSTEMS NECESSARY FOR COMMERCIALIZATION OF U.S. BAIT SHRIMP PRODUCTION. **Alisha D. Lawson[1], Jason Haveman[1], John W. Leffler[2], Beth L. Lewis[1], Jesus A. Venero[1], Al Stokes[1],** and **Craig L. Browdy[3].** [1]South Carolina Department of Natural Resources, 211 Sawmill Creek Road, Bluffton, SC, 29910, USA; [2]South Carolina Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, 29412, USA [3]Novus International Corp., 5 Tomotley Court, Charleston, SC, 29407, USA.

This project produced specific pathogen free broodstock of *Litopenaeus setiferus* to establish a commercial bait shrimp industry. F1 nauplii were produced from artificially inseminated spawners collected off the coast of Charleston SC in 2006 and 2007. Following disease testing and larval culture, broodstock were produced in WMC ponds. Families were reared individually,

tagged and grown to broodstock size. F2 SPF broodstock were separated by sex in tanks receiving UV treated seawater linked by a recirculation system. Temperature was maintained to minimize male reproductive tract melanization. Photoperiod was manipulated using dawn/dusk simulators. Beginning two weeks after eyestalk ablation, each morning females with mature ovaries were sourced and moved to the all male tank for mating. Following mating females were moved to covered spawning tanks. Fertile spawns were moved into larval rearing tanks. Maturation and spawning efforts produced four million nauplii over a period of 3.5 months. Few or no signs of male reproductive tract degeneration were observed. The larval rearing system consisted of six 1,000 L fiberglass tanks and two 10,000 L water treatment reservoirs. Larvae were fed a mixed diet, based upon larval stages. At PL_7 to PL_{12}, larvae were harvested and distributed to commercial producers for bait shrimp production trials.

DEVELOPMENT OF SUSTAINABLE, COMMERCIALLY VIABLE "ORGANIC" SHRIMP PRODUCTION BY INTEGRATING PLANT–BASED FEEDS WITH MICROBIAL BIOFLOC COMMUNITY STRUCTURE. **John W. Leffler[1], Jesus A. Venero[1], Andrew J. Ray[2], Beth L. Lewis[1], Alisha Lawson[1], Jason Haveman[1],** and **Craig L. Browdy[3].** [1]South Carolina Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, 29412, USA; [2]South Carolina Department of Natural Resources, 211 Sawmill Creek Rd., Bluffton, SC, 29910, USA. [3]Novus International Corp., 5 Tomotley Court, Charleston, SC, 29407, USA.

Commercially viable shrimp production in the U.S. requires year round crops, minimal water use, negligible nutrient release, biosecurity, and systems capable of supporting very high shrimp densities. Researchers at the Waddell Mariculture Center have developed shrimp production systems that efficiently achieve each of these goals. The rich microbial community processes wastes internally and provides supplemental nutrition or growth enhancement factors to the shrimp. The low environmental impact of greenhouse-based, super-intensive, zero-exchange, microbial biofloc technologies permit them to be considered for certification under USDA Organic Agriculture standards. Through a series of diet studies, we have shown that non-fishmeal/fish oil feeds are practical, but perform equivalently only in the presence of biofloc communities. Deficiency diet studies show that biofloc can provide shrimp with both vitamins and essential fatty acids. Recent research efforts have attempted to comprehensively integrate different microbial community structures with specially designed organically certifiable diets. While some biofloc communities enhance growth, others that support an abundance of cyanobacteria may reduce shrimp productivity. Low technology settling tanks have been used successfully to manage community structure and significantly improve shrimp productivity. While both mixed photoautotrophic-heterotrophic and completely heterotrophic communities enhance shrimp growth, evidence favoring one over the other is contradictory.

MANAGEMENT OF MICROBIAL BIOFLOC COMMUNITIES USING SETTLING TANK CLARIFIERS IN SUPER-INTENSIVE, ZERO-EXCHANGE SHRIMP PRODUCTION SYSTEMS. **Beth L. Lewis[1], Craig L. Browdy[2], Andrew J. Ray[1], Alisha Lawson[1], Andrew Shuler[1], Jesus A. Venero[1], Luis Vinatea[1],** and **John W. Leffler[1].** [1]South Carolina Department of Natural Resources, 211 Sawmill Creek Road, Bluffton, SC, 29910, USA; [2]Novus International, Inc., 5 Tomotley Court, Charleston, SC, 29407, USA.

Superintensive, zero exchange, greenhouse-based shrimp systems offer many advantages for U.S. shrimp farmers including economic efficiency, multiple crops per year, inland siting, reduced pollutant effluents, and supplemental nutrition. Water quality management is dependent upon the rich microbial community that dominates these systems. In both raceways and large outdoor tanks, studies at the Waddell Mariculture Center have used settling tank clarifiers to manipulate this ''biofloc'' community. ''Cropping'' removes biofloc particles from the water column by allowing particles to settle out, periodically removing the resultant sludge, and returning effluent back into the system. Weekly measurements demonstrated that the clarifiers can effectively remove up to 58% ($P < 0.001$) of volatile suspended solids (VSS). Although VSS is the most informative measure of clarifier effectiveness, a field parameter that required less time was essential for daily management decisions. We found that turbidity, although a complex parameter, was an effective management tool. In addition, photosynthetically active radiation (PAR) is another efficient method for daily clarifier management. By reducing suspended solids, a clarifier can increase light penetration, increase net oxygen production, and enhance the algal community dynamics. We have demonstrated that proper biofloc management through cropping can significantly increase shrimp production by 41% ($P = 0.001$) and reduce the feed conversion ratio (FCR) by 31% ($P = 0.002$).

IS IT POSSIBLE TO RESTORE *MERCENARIA MERCENARIA* TO GREAT SOUTH BAY, NY AFTER 30 YEARS OF DECLINE? **Carl Lobue[1], Chris Clapp[1], Mike Doall[2], Tom Carrano[3],** and **Emily Goldner[3].** [1]The Nature Conservancy, 250 Lawrence Hill Road, Cold Spring Harbor, NY, 11724, USA; [2]Stony Brook University, Stony Brook University, Stony Brook , NY, 11790, USA; [3]Brookhaven Township, One Independence Hill, Farmingville, NY, 11738, USA.

The Nature Conservancy in collaboration with town, county, state, and federal agencies has expanded efforts to restore self sustaining hard clam, (*Mercenaria mercenaria*) populations in Great South Bay, which have been declining for three decades. Past population surveys compared to published stock-recruitment

relationships suggest that vast portions of the bay have been recruitment limited. Restoration work has emphasized rebuilding reproductive potential by stocking a network of spawner sanctuaries with adult clams relocated from nearby estuaries. Since 2004, over three million adult clams have been stocked on a network of 50 sites. Environmental conditions have varied annually. In 2006 and 2007, clam condition and gonad ripeness indices showed that spawning was good. We estimate that about 1.8 million stocked adult clams were in place and alive during summer of 2007. Recent surveys show a 4,000% increase in juvenile clam abundance in the central bay, bolstered by a strong 2007 year class. These results suggest that the project scale and design were sound. However in 2008 the most severe brown tide on record plagued the entire bay and spawning was minimal. Efforts have been set in motion maintain the spawner sanctuary network and protect the 2007 year class to the extent possible in hopes of further expanding the population's reproductive potential.

MANAGING INVASIVE SPECIES IN THE SOUTHERN GULF OF ST. LAWRENCE. Andrea Locke and **Thomas Landry.** Fisheries and Oceans Canada, P.O. Box 5030, Moncton, NB, E1C 9B6, Canada.

Non-indigenous species have been reported in the southern Gulf of St. Lawrence since at least 1840, but an unprecedented rate of invasion was observed in the decade from 1994 to 2004 with the establishment of nine non-indigenous species. These include several species of particular importance to shellfish as predators, competitors, or fouling taxa. Major adverse effects of four species of tunicate (*Ciona intestinalis, Styela clava, Botrylloides violaceus, and Botryllus schlosseri*) have been observed on suspended blue mussel (*Mytilus edulis*) aquaculture. An intensive management effort mainly addresses a subset of the possible vectors, and mitigation of fouling impacts. Management of European green crab (*Carcinus maenas*) involves trapping to protect specific fisheries resources. Successes, failures, and management approaches will be discussed.

NUTRIENT SEQUESTRATION IN MACROALGAE ASSOCIATED WITH CLAM CULTURE: POTENTIAL NUTRIENT TRADING CREDIT FOR AQUACULTURE. Mark Luckenbach. Virginia Institute of Marine Science, College of William & Mary, P.O. Box 350, Wachapreague, VA, 23480, USA.

In hard clam (*Mercenaria mercenaria*) culture, clams are planted in bottom sediments at high density ($\sim$ 500 clams m^{-2}) and covered with predator exclusion nets. These nets frequently become fouled with macroalgae which can reduce flow and food supply to the clams. Consequently, culturists often incur the expense of removing this macroalgae from the nets. Interested in the potential of these macroalgae to sequester nutrients, we collected monthly quantitative samples throughout the growing season from replicate nets on a commercial clam farm in Chesapeake Bay. All algae were identified to species, wet- and dry-weight biomass determined and total nitrogen, phosphorus and carbon content measured. Macroalgal biomass was dominated by *Ulva lactuca*, *Gracillaria* sp., *Ceracium rubrum* and *Agardhiella subulata* and at peak abundances exceeded 6 metric tons in dry weight. Our results provide estimates of the annual budgets of N, P and C sequestered in macroalgae on a clam farm and suggest that removal of the algae to appropriate upland locations would result in substantial nutrient removal from the estuary. As coastal states develop nutrient trading programs to protect coastal waters, these findings should help position the clam aquaculture industry to receive credits for harvest and removal of the macroalgae.

THE ROLE OF MUSSELS IN OPEN-WATER, INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA) IN THE BAY OF FUNDY. Bruce A. MacDonald[1], Shawn M.C. Robinson[2], Fred H. Page[2], Gregor K. Reid[2], Thierry Chopin[1], and **Matthew Luitkus[1].** [1]University of New Brunswick, Tucker Park Campus, Saint John, NB, E2L 4L5, Canada; [2]Department of Fisheries & Oceans, St. Andrews, NB, E5B 2L9, Canada.

An open-water IMTA project in the Bay of Fundy, Canada, is successfully making the transition from pilot project to the commercial scale production of co-cultured species (e.g. kelps, blue mussels) at Atlantic salmon sites. One measure of IMTA sustainability is nutrient recovery in the form of harvestable biomass and several challenges need to be overcome before the outcome can be assessed. In order to validate this approach of nutrient recovery the co-cultured extractive species need to be grown at biomasses that are complimentary to the nutrient inputs. In addition to evaluating the appropriate culture scales for the extractive species, there are many other temporal and spatial factors to consider. One of the components of this project is to evaluate blue mussels (*Mytilus edulis*) as remediators of the impacts of excess particulate matter with this species possessing many desirable characteristics to achieve this goal. Recent studies have been undertaken to quantify the enhanced particle loads associated with salmon feeding activity, mussels feeding and absorption efficiency, and relationships between the quality of suspended particles, faeces characteristics, and deposition rates. In this presentation, we will provide data on mussel uptake and absorption efficiencies discuss the implications for a modeling approach for this system.

DO SURFACE STRUCTURES PROMOTE REPRODUCTION IN NORTHERN QUAHOGS, *MERCENARIA MERCENARIA*? Clyde L. MacKenzie, Jr. Sandy Hook Marine Sciences Laboratory, 74 Magruder Road, Highlands, NJ, 07732, USA.

Dense concentrations of projecting plant and animal structures on the bottoms of estuaries may enhance reproduction in bivalves, such as northern quahogs, *Mercenaria mercenaria*, and bay

scallops, *Argopecten irradians*. During the spawning season, the structures likely keep their sperm and eggs concentrated. The sperm would stimulate more females to spawn. Similarly, the fertlilization rate would be higher because the sperm and eggs are held together. The stuctures also protect the subsequent juveniles from predation. On structure-free bottoms, the sex products would be scattered and diluted and fewer larvae would likely result. Eelgrass, *Zostera marina*, recognized as an essential component in bay scallop habitats, used to be present in the large bays that produced both northern quahogs and bay scallops: Katama, Narragansett, Peconic, Great South, Raritan, Barnegat, Chincoteague, Bogue and Core Sounds, and Indian River. The tubes of the amphipod, *Ampelisca abdita*, that project 2-2.5 cm above the bottom in widespread, dense mats, in Raritan Bay, NJ, might act to enhance the reproduction of northern quahogs by maintaining the concentrations of the sperm and eggs. Raritan Bay had relatively few northern quahogs before the amphipod tubes appeared in the late 1970s or 1980s, but they have since been abundant.

COASTAL DEVELOPMENT IMPACTS ON SHELLFISH HARVEST: THE NORTH CAROLINA EXAMPLE. Michael A. Mallin. University of North Carolina Wilmington, 5600 Marvin K. Moss Lane, Wilmington, NC, 28409, USA.

Coastal development is seen as an economic boon by many; however, this rapid and often poorly planned growth has come at a cost, a significant loss to commercial shellfishing. In the early 1980s, the commercial harvest of clams and oysters in North Carolina yielded over $14 million of revenue; this income dwindled to less than $4.5 million by 2005. A major reason for the decreases in catch and revenue has been a large increase in the amount of shellfishing waters closed because of pollution by fecal bacteria. For five North Carolina coastal counties, linear regression analyses showed that the loss in usable shellfishing acreage is directly related to coastal population growth ($r^2 = 0.71$, $p < 0.001$). We studied six estuarine watersheds and compared the results with land use and demographic factors. The magnitudes of fecal bacteria counts in these creeks were strongly correlated with total land area draining into the creeks, human population of the watersheds, percent of developed land in the watersheds and especially the percent of impervious surface coverage within the watersheds ($r = 0.975$, $p = 0.005$). The study also showed that the only two watersheds still open to shellfishing had less than 10% impervious surface coverage.

OYSTER RESTORATION IN THE MID ATLANTIC: BEATING A DEAD HORSE? Roger Mann, Juliana M. Harding, and **Melissa Southworth.** Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA, 23062, USA.

Oyster restoration for ecological purposes require that resultant populations be self-sustaining. Many efforts have tried to achieve this goal, and while some short-term success has been observed, there has not been a single effort to date that has produced a substantial change in demographics that has been self maintaining for many years in combination with balanced production of habitat to insure continuance. Habitat (shell) budgets are probably the key to this challenge. We present a series of calculations in which we vary recruitment and mortality rates of a target population, and examine how these affect the rate of shell (habitat) accretion when the latter is corrected for loss by taphonomic processes. The truncated age demographic caused by disease driven mortality rates precludes the addition to the habitat pool through mortality of large numbers of old oysters. Positive accretion cannot be maintained with a truncated age structure except in the presence of extraordinary recruitment. So the effort fails. The same calculations provide the opportunity to pose the question, ''how much do we have to decrase mortality / increase disease tolerance to develop positive accretion rates and potentially reverse these dismal results?''

FLOATING OYSTER (*CRASSOSTREA VIRGINICA*) GARDENS FACILITATE OYSTER RECRUITMENT AND PROVIDE HABITAT IN DELAWARE'S INLAND BAYS: THE COMPARATIVE VALUE OF OYSTER CLUSTERS AND LOOSE SHELL. Frank Marenghi and **Gulnihal Ozbay.** Delaware State University, 1200 North DuPont Highway, Dover, DE, 19901, USA.

We evaluated the ecosystem services, specifically regarding habitat value, provided by floating oyster (*Crassostrea virginica*) aquaculture gear, or 'gardens,' in eutrophied, turbid, and periodically hypoxic conditions within Delaware's Inland Bays. We examined abundance and diversity of macro-epifauna with respect to three replicated treatments: live oyster clusters, disarticulated oyster shell, and controls, a float with no shells or oysters. We also studied the effects of two cleaning regimes (biweekly and monthly) on species assemblages and growth and survival of oysters and monitored basic water quality parameters. Over 40 species of fishes and invertebrates have been collected in direct association with floating oyster gardens, greatly contributing to the diversity of the native ecological community. Many of these species have commercial or recreational importance and are habitat-limited in the Inland Bays estuary due to direct and indirect loss of tidal wetlands, oyster reefs and seagrass beds, particularly important as juvenile feeding and staging areas. Furthermore, newly settled juvenile oysters have been found for the first time within floating oyster gear in the man-made, residential canal systems. Measurable effects like these coupled with continuing community involvement makes oyster gardening a vital component of the oyster restoration effort in Delaware.

JUVENILE OYSTER DISEASE, A (MANAGEABLE) CURSE FOR OYSTER AQUACULTURE IN RHODE ISLAND. **Kathryn R. Markey[1], Dale Leavitt[2], Karin Tammi[2],** and **Marta Gomez-Chiarri[2].** [1]University of Rhode Island, 20A Woodward Hall, Kingston, RI, 02881, USA; [2]Roger Williams University, Roger Williams University, Bristol, RI, 02809, USA.

Juvenile oyster disease (JOD) has been a recurrent problem for farmers in Rhode Island in recent years. In June 2008, oysters from three strains (Rutgers University NEHY, a wild strain from Green Hill Pond, Rhode Island, and a hybrid cross of NEHY and GHP) were deployed in four farms. Performance was evaluated every three or four weeks for 20 weeks. NEHY was the best performer in Narragansett Bay ($p < 0.05$), while no difference in performance between strains was observed in the coastal ponds. Clinical signs of JOD were observed starting in early August in all strains at all locations, but timing and scale of mortality varied significantly with location and strain. Significantly higher mortalities were observed in bay farms compared to the coastal ponds. Mortalities averaging more than 20% for each sampling period were observed at one of the bay farms starting in early August and continued at a consistent rate until October. Mortalities due to JOD were significantly delayed at the other bay farm, going from less than 6% for each sampling period until September to more than 18% for October. The greatest contributing factor to differences in performance was JOD, with NEHY oysters showing relatively less susceptibility.

DISTRIBUTION AND LIFE HISTORY CHARACTERISTICS OF *OSTREOLA EQUESTRIS*. **Anne L. Markwith, Martin H. Posey,** and **Troy D. Alphin.** University of North Carolina-Wilmington, 5600 Marvin K Moss Lane, Wilmington, NC, 28409, USA.

The crested oyster, *Ostreola equestris*,is one of North Carolina's native oysters, though it is relatively unknown compared to *Crassostrea virginica*. Recent interest in this small, cryptic oyster is due to the discovery of a previously unknown *Bonamia* sp. parasite in North Carolina waters. It is thought that *O. equestris* may be a reservoir for this disease, which could impact restoration efforts as well as potential non-native oyster introduction. Very few studies have focused on the biology of the crested oyster post-1950s. This study addresses some of the gaps in its biology looking at occurrence along the southeastern North Carolina coast, including both habitat and several life history characteristics (i.e. size distribution, condition index, reproductive period, and disease incidence). *Ostreola equestris* occurred at all randomly selected sites, subtidally and intertidally, with sizes ranging from spat to 40+mm. This is contrary to previous literature reports which indicated that *O. equestris* occurs only in clear subtidal waters. Additionally, these findings also indicate greater abundances than previously reported. Size, condition, and aspects of reproduction significantly differed not only between sites but also among the habitats, suggesting considerable spatial variability in natural populations of this species.

***IN VIVO* HOST-PATHOGEN INTERACTION BETWEEN SOFTSHELL CLAM HAEMOCYTES AND TWO *VIBRIO SPLENDIDUS* STRAINS.** **Dante Mateo[1], Aleks Spurmanis[2], Ahmed Siah[1], Mebrahtu Araya[1], Franck Berthe[3], Gerry Johnson[1],** and **Spencer Greenwood [1].** [1]Atlantic Veterinary College, University of Prince Edward Island, 550 University Avenue, Charlottetown, PEI, C1A 4P3, Canada; [2]National Research Council, 550 University Avenue, Charlottetown, PEI, C1A 4P3, Canada; [3]European Food Safety Authority, Largo N. Palli 5/A, Parma, Parma, I-43100, Italy.

Host-pathogen interaction models are valuable for understanding the pathogenicity of shellfish diseases. We report *in vivo* responses of *Mya arenaria* haemocytes against two *V. splendidus* strains. Responses were measured 24h *after* injecting to the adductor muscle either an endemic wild-type strain (7SHRW) or a strain associated with oyster mortalities (LGP32-GFP). Changes in haemocyte structure (percentage of rounded cells) were assessed microscopically. Changes in number of cells and profiles of haemocyte subpopulations were analysed through flow-cytometry based on two parameter scatter and Lysotracker staining. Also, the relative expression of β-actin was assessed by Q-PCR.Increased higher numbers of haemocytes and percentages of rounded cells were found in both infected groups, however, values from the group infected with LGP32-GFP were significantly higher ($p < 0.01$). Forward *vs.* side scatter profiles revealed 2 haemocyte subpopulations. The group of larger and more complex cells exhibited significantly higher levels of lysosomal staining ($p < 0.001$). Following infection with LGP32-GFP, both subpopulations merged into a single continuous group and their lysosomal content significantly decreased ($p < 0.05$). No significant changes were observed in response to 7SHRW. Significant up-regulation of β-actin expression ($p < 0.001$) was found in response to LGP32-GFP, probably associated to the cytoskeleton changes. Our data suggest specific modulation of bivalve responses against pathogenic bacteria including severe degranulation and, probably, haematopoiesis.

AGE STRUCTURE OF THE CARIBBEAN SPINY LOBSTER, *PANULIRUS ARGUS*, IN A MARINE PROTECTED AREA IN THE FLORIDA KEYS. **Tom Matthews[1], Kerry Maxwell[1], Rodney Bertelsen[1],** and **Charles D. Derby[2].** [1]Florida Fish and Wildlife Conservation Commission, 2796 Overseas Highway., Suite 119, Marathon, FL, 33050, USA; [2]Georgia State University, P.O. Box 4010, Atlanta, GA, 30302, USA.

We histologically determined lipofuscin content in eyestalk neural tissue to estimate the age of Caribbean spiny lobsters (*Panulirus argus*) in the Western Sambos Ecological Reserve, a marine protected area within the Florida Keys National Marine

Sanctuary. Neurolipofuscin-based age estimates indicate that the age structure of the lobster population within the Reserve is older than in an adjacent unprotected area. Monte Carlo simulations of the age-distribution based on the size-frequency distribution, suggest that lobsters outside of the Reserve were predominately 1-2 years old while many lobsters in the Reserve are older. The size structure of lobsters within and outside the Reserve was similar except for a few larger lobsters within the Reserve. Additionally, the percentage of female lobsters involved in reproduction is greater in the Reserve, which is consistent with previous observations of the role of age in reproduction.

WHO HAS MADE THE MOST IMPACT ON SHELLFISH SAFETY - THE SCIENTIST OR THE REGULATOR? Dorothy-Jean McCoubrey. Dorothy-Jean & Associates Ltd, 5 Lemonwood Place, Manurewa, Auckland, 2105, New Zealand.

The public no longer trust the scientists or government departments! In recent years there have been an increasing number of food safety crises – BSE, Salmonella in eggs and E Coli 0157 in hamburgers. Such events have caused a decline in deference to scientists and government departments on food supply issues – a UK survey found that 71% of consumers believed that the government was withholding information about the link between BSE and CJD. Shellfish have always been enjoyed as food source, but we know filter feeders can cause illness. Society has always tried to manage this risk, whether by traditional folk wisdom or by complex scientific and regulatory measures. Unfortunately, these have not been effective in preventing illness, and there is international evidence that there are flaws in the National Shellfish Sanitation Program. We need to assess dynamics between science and public policy to protect the consumer and regain their confidence. A New Zealand case study area was used to gain insight into the issues and then compared with those affecting the microbial safety of oysters stocks prior to harvest at a national and international level.

TARGETING NEW VECTORS THAT CONTRIBUTE TO THE INTRODUCTION AND SPREAD OF NON-NATIVE MARINE SPECIES. Maia McGuire[1] and **Alan Power[2].** [1]University of Florida, 150 Sawgrass Road, Bunnell, FL, 32110, USA; [2]University of Georgia, 30 Ocean Science Circle, Savannah, GA, 31411, USA.

Non-native marine species have traditionally been introduced through the commercial shipping trade, either in ballast water or as adults attached to ship hulls. The rate of new introductions is increasing as coastal populations and recreational water users increase. In recent decades, the role of recreational boaters and home aquarium owners in introducing and spreading non-native marine species has been recognized. The Charru mussel, *Mytella charruana*, was found in central Florida in 2004 and appeared in large numbers at a marina in Sunbury, GA in 2006. In 2008, these mussels were found in South and North Carolina. We will present size and reproduction data for Charru mussels in GA. Recreational ''transient'' boaters are thought to be a potential means for transporting these and other mussels and sessile marine organisms from one location to another. Additionally, releases of aquarium specimens are believed to have resulted in the introduction of several marine species into US coastal waters. Regional outreach programs targeting recreational boaters and aquarium owners will be presented. In addition to preventing the introduction and spread of non-native marine species, we hope to raise awareness among coastal residents who might be in a position to notice new introductions of these animals.

POPULATION GENETIC STRUCTURE AND PHYLOGEOGRAPHY OF THREE SYMPATRIC PENAEID SHRIMP SPECIES IN THE WATERS OF THE EASTERN UNITED STATES. Anne L. McMillen-Jackson and **Theresa M. Bert.** Florida Fish and Wildlife Conservation Commission, 100 Eighth Avenue SE, St. Petersburg, FL, 33701, USA.

Comparative analyses of patterns of population genetic structure and phylogeography of sympatric species can elucidate the relative structuring influence of intrinsic and extrinsic factors. We characterized patterns for three penaeid shrimp species that inhabit the marine waters of the eastern United States - pink shrimp (*Farfantepenaeus duorarum*), brown shrimp (*F. aztecus*), and white shrimp (*Litopenaeus setiferus*) - using sequence analysis of the mtDNA control region. These species have similarities (e.g., geographic range, estuarine dependence) and differences (e.g., habitat preferences and centers of abundance, migration behaviors and physiological tolerances) that might influence their patterns of population genetic structure and phylogeography. All three species showed high levels of mitochondrial DNA diversity and apparently experienced historic but non-concurrent periods of sudden population expansion. However, subtle and distinct species-specific differences were evident. Pink shrimp and brown shrimp showed no phylogenetic or geographic structuring of haplotypes. In contrast, white shrimp showed significant phylogenetic structure, with two distinct haplotype lineages and two less-differentiated sublineages, significant geographic structuring of haplotypes, and some regional grouping of lineages and haplotypes. We propose that the distinction of the white shrimp pattern is due in part to a relative instability of population size in white shrimp compared to the other species.

THE FLORIDA BLUE CRAB FISHERY: A NEW ERA OF EFFORT MANAGEMENT. Anne L. McMillen-Jackson. Florida Fish and Wildlife Conservation Commission, 100 Eighth Avenue SE, St. Petersburg, FL, 33701, USA.

Blue crabs (*Callinectes sapidus*) constitute one of Florida's most valuable commercial fisheries. Until recently, regulations focused principally on gear specifications and harvest prohibitions by crab

size and reproductive state. On July 1, 2007, the Blue Crab Limited Entry Endorsement Program was instituted by the Florida Fish and Wildlife Conservation Commission (FWC). This program established separate endorsements for the hard-shell and soft-shell fisheries; limits on the number of endorsements allowed in each fishery, and landing minimums to qualify for an endorsement; limits on the number of traps allowed per fisherman and a requirement that all traps have an FWC-issued tag; and fees for both blue crab endorsements and trap tags. A major result of the effort management program was the elimination of latent effort in the blue crab fishery; the number of endorsements issued for the commercial harvest of blue crabs decreased from more than 5,000 during the 94/95 fishing season to 1,168 for the 07/08 season. The new regulations will be discussed with regard to their effects on fishery characteristics, blue crab population dynamics, and the collection of data for stock assessments.

EXPLORING ADAPTIVE OYSTER FISHERY STRATEGIES IN A RIVER DIVERSION OUTFALL AREA. Earl Melancon. Nicholls State University, P.O. Box 2021, Thibodaux, Louisiana, 70310, USA.

The Barataria estuary is a good example of the national wetlands crises that Louisiana is experiencing. The Davis Pond water diversion is the estuary's cornerstone project to reintroduce Mississippi River water as an effort to maintain fresh to low salinity wetland habitats by reducing salinity encroachment from the Gulf of Mexico. Over the course of years while working in the Barataria estuary, oyster data and commercial fishing observations suggest that water diversions and oyster fisheries can co-exist. To accomplish this coexistence, diversion managers, and oystermen must develop management strategies that address the needs of both. Seasonal influences of salinity on oyster survival, rate of oyster shell growth to eventually produce a seed or sack product, the fuel and labor associated with a seed or sack fishery, and the ability to cope with the potential of fouling by the hooked mussel, *Ischadium recurvum*, are all matters of economic importance to an oysterman. I present potential resource management options for fishermen who have oyster leases located in a diversion plume environment.

HISTOCHEMICAL ANALYSIS OF CARBONIC ANHYDRASE ACTIVITY IN AMERICAN LOBSTERS (*HOMARUS AMERICANUS*) AFFECTED BY EPIZOOTIC SHELL DISEASE. Norman J. Meres. George Mason University, 4400 University Drive, Fairfax, VA, 22030, USA.

Carbonic anhydrase activity was histochemically measured in American Lobsters *(Homarus americanus)* taken from waters in coastal Rhode Island as part of the New England Lobster Health Initiative. Lobster epidermis was fixed, and frozen sections were fluorescently stained with dansylamide. Epifluorescent images were evaluated for mean optical density. Preliminary studies indicate that carbonic anhydrase activities were similar in lobsters affected with Epizootic Shell Disease when compared to lobsters that appeared to be unaffected by the disease.

CRUSTACEANS AS INDICATORS OF ECOSYSTEM HEALTH. Gretchen Messick[1], J. Jacobs[1], R. Lee[2], T. Walters[2], K. Brinkley[2], S. Cho[2], M. Frischer[2], E. Schott[3], S. Chung[3], and **R. Wood[1].** [1]NOAA-CCHEBR-COL, 904 S. Morris Street, Oxford, MD, 21654, USA; [2]Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA, 31411, USA; [3]UMBI-COMB, University of Maryland, , Baltimore, MD, 21202, USA.

The NOAA/NOS Oxford Lab, in cooperation with Federal, State and academic partners, is implementing an integrated biotic ecosystem assessment on sub-watersheds in Chesapeake Bay. Two goals are to: 1) establish a suite of bio-indicators that are sensitive to ecosystem change and 2) establish effects of varying land uses on water quality and subsequent health of living resources. Connecting changes at the sub-cellular level through pathological change in the organism, to subsequent population level impacts will allow for the realization of assessing the impact of specific anthropogenic influences on living resources, and thus ecosystem health. Indicators under evaluation in blue crabs include population- community composition, shell disease, gill epibionts, protists, bacteria, virus, vitellogenin levels, and changes in gene expression. Indicators are in various stages of development, some proving to be more useful that others. Initial results include high prevalence of a previously unknown potential protist parasite, significant variation in shell disease and gill ciliates among rivers and presence of virus, microsporidian and gregarines in tissues. The overall goal of this assessment is to provide regional managers and decision makers with the information necessary to make informed decisions on the environmental influence of altering land use patterns.

TEMPORAL AND SPATIAL ESTIMATES OF EFFECTIVE POPULATION SIZE IN DELAWARE BAY OYSTERS. Coren A. Milbury, Susan E. Ford, Dave Bushek and **Ximing Guo.** Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

Effective population size (N_e) is one of the most important aspects in population and evolutionary genetics, and reflects changes in genetic variance due to genetic drift. Yearly variation in genotypic and allelic frequency in oyster spat provides us with a means to estimate the number of parent oysters that have contributed to recruitment. We studied temporal and spatial variations in N_e for eastern oyster (*Crassostrea virginica*) populations in Delaware Bay. Based upon salinity regimes, the bay was arbitrarily divided into three spatial sampling regions (upper, middle, and lower). Temporal samples were composed of yearlings collected in 2005 and newly set oysters sampled in 2006 and 2007; two recruitment sets were collected at a lower bay sampling site in

2007. Approximately 96 oysters for each recruitment set and each sampling region were genotyped for twelve microsatellite markers. Estimates of N_e were completed by both moments-based and pseudo-likelihood temporal analyses. Preliminary results indicate low estimates of N_e with considerable spatial and temporal variability.

MODULATION OF GENE EXPRESSION IN HAEMOCYTES FROM *OSTREA EDULIS* IN RESPONSE TO AN IN VITRO *BONAMIA OSTREAE* INFECTION. Benjamin Morga, Isabelle Arzul, Segarra, Faury, Bruno Chollet, and **Renault.** IFREMER, Avenue Mus du loup, La Tremblade, Poitou Charentes, 17390, France.

Bonamiosis due to the parasite *Bonamia ostreae* is a disease affecting the flat oyster *Ostrea edulis*. *Bonamia ostreae* is a protozoan, affiliated to the order of Haplosporidia and to the phylum of Cercozoan. This parasite is mainly intracellular, infecting haemocytes, cells notably involved in the defence mechanisms of the oyster.

Suppression subtractive hybridisation cDNA library was performed to identify genes differently expressed (up or down-regulated) during an *in vitro* infection of haemocytes by *Bonamia ostreae*. Several genes of interest have been identified including genes involved in cytoskeleton, respiratory chain, membrane receptors, detoxification, regulation proteins and immune system. Real time PCR tests were performed to study the relative expression of these candidate genes during an *in vitro* infection of haemocytes by purified parasites. The elongation factor alpha was selected as housekeeping gene.

Infection seems to particularly favour expression of genes including actin related protein, filamin, liporeceptor, mitogen-activated protein kinase (MAPK organizer 1) and omega glutathione-s-transferase (OGST). Interestingly, genes involved in defence mechanisms like SOD, tetraspanin or TIMP appeared down-regulated suggesting that parasite escape degradation by inhibiting expression of such genes.

These results contribute to better understand how the parasite installs and survives within haemocytes.

SEX RATIO IN DELAWARE BAY OYSTER POPULATIONS: PROTANDRY, POPULATION DYNAMICS, AND FISHERY MANAGEMENT. Jason M. Morson, Eric N. Powell, Kathryn A. Ashton-Alcox, Yungkul Kim, and **Rebecca Marzec.** Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

The sex ratio of oysters is determined by a dynamic interplay between recruitment and mortality as 75% of the animals are thought to be protandric hermaphrodites. Sex is thought to be determined by a two allele system with MF animals being permanent males and FF animals protandric. Theoretically, the relationship stabilizes the sex ratio of large animals at 3:1, but also sensitizes the species to overfishing because fishing targets females as does disease. We examine the state of the sex ratio in Delaware Bay oyster populations. Bay-wide, the percent female is 48%, significantly below a 1:1 ratio. Bay-wide, animals >75 mm are 75% functional females. This is the expected 3:1 ratio. Small animals in many populations are 0% female, consistent with the expectation that all animals are born functional males. The data support the theorized MF/FF sex determination system in crassostreids and exclude options where FF animals would be permanent females. Simultaneous hermaphrodites comprise 1.2% of the population, but the fraction declines with increasing size, suggesting that these animals were caught during the protandric switch. Overall, animals exposed to fishing are 64% female. Thus, the fishery and Dermo disease exert a disproportionate impact on female mortality.

SHELLFISHERIES AND MARINE BIOTOXINS: A REVIEW OF THE SOURCES, TOXINS, AND DETECTION METHODS. Steve Morton. NOAA/NOS, 331 Fort Johnson Road, Charleston, South Carolina, 29410, USA.

All coastal areas of the United States are at risk for potential outbreaks of harmful algal blooms, commonly referred to as red tides. These blooms, at times, may contain naturally occurring marine biotoxins. Depending on location, shellfisheries are at risk for contamination of a number of these toxins including saxitoxin, domoic acid, brevetoxin, and okadaic acid. Human ingestion these toxins can cause the human syndromes of paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), neurotoxic shellfish poisoning (NSP) and diarrheic shellfish poisoning (DSP). This presentation will give an overview of these toxins, their source organisms and detection methods available for each toxin class. New and emerging classes of toxins recently discovered will also be discussed.

THE MINERALIZATION FRONT OF THE EASTERN OYSTER IS CELLULAR. Andrew S. Mount[1], Neeraj V. Gohad[1], Mary Beth Johnstone[1], Karolyn M. Hansen[2], and **Douglas C. Hansen[2].** [1]Clemson University, Clemson, SC, 29634, USA; [2]University of Dayton Research Institute, Dayton, OH, 45469, USA.

Eastern oyster immune blood cells will adhere and subsequently deposit complex polycrystalline assemblies onto polished metal alloy surfaces, all of which occurs in the absence of a pre-formed organic matrix. We have achieved first order control over shell formation as demonstrated by the calcification of complex shell layers on a variety of metal alloy and glass test surfaces. These experiments have enabled us to visualize the earliest onset of controlled biomineralization by hemocytes, the circulating immune cells of the oyster. Contrary to the matrix-mediated paradigm, we have observed that a pre-formed organic matrix is *not* the first event in biomineralization, but rather all of shell formation is mediated almost exclusively by the organism's blood cells.

EFFECTS OF CHELATING AGENTS ON MANGANESE AND CADMIUM ACCUMULATIONS IN GILL OF *CRASSOSTREA VIRGINICA*. **Soren Murray, Mona Yates, Yamel Perdomo, Margaret A. Carroll,** and **Edward J. Catapane.** Medgar Evers College, 1150 Carroll Street, Brooklyn, NY, 11225, USA.

In humans, excess manganese causes Manganism, similar to Parkinsons disease. Cadmium adversely affects kidney, liver and lung by inducing apoptotosis or carcinogenesis. Cadmium pollution is widespread in aquatic environments. Marine animals accumulate cadmium and manganese. p-Aminosalicylic acid (PAS), an anti-inflammatory drug with chelating ability. alleviate Manganism, but the mechanism of action is unknown. PAS reduces manganese, but not cadmium accumulations in oyster gill. Sodium EDTA (EDTAna) was moderately effective in reducing cadmium accumulations. In clinical setting, calcium EDTA (EDTAca) is preferred for metal chelation therapy. This study compared efficacies of chelating agents on manganese and cadmium accumulations. After 10 hour incubation with manganese or cadmium *Crassostrea virginica* gill received three day treatments with metal chelators, diaminocyclohexanetetraacetic acid (DACH), EDTAna or EDTAca. Manganese and cadmium levels were measured with an Atomic Absorption Spectrophotometer. All three chelating agents reduced manganese accumulations. DACH was most effective, followed by EDTAca and EDTAna. High but not low concentrations of EDTAna moderately reduce cadmium accumulations. EDTAca was significantly more effective in reducing cadmium accumulations. The study shows chelators are effective in reducing manganese and cadmium accumulations and supports the hypothesis the mechanism of action of PAS in treatment of Manganism is related to its chelating abilities.

DISPERSAL PATTERNS OF OYSTER LARVAE AT DELAWARE BAY: A MODELING STUDY. **Diego A. Narvaez[1], John M. Klinck[1], Eileen E. Hofmann[1], Eric N. Powell[2], John Wilkin[2],** and **Dale B. Haidvogel[2].** [1]Old Dominion University, 4111 Monarch Way, 3rd floor, Norfolk, VA, 23508, USA; [2]Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

As with many marine invertebrates, Eastern oyster (*Crassostrea virginica*) larvae develop while freely drifting in the water. Currents as well as larval vertical migration determine the ultimate settlement location. Thus, both physical and biological processes and their interaction determine the likely settlement location from any release point. A numerical model (ROMS) is configured for Delaware Bay to determine the estuarine circulation in response to winds and river discharge. Water-following Lagrangian floats in the model are modified to include larval growth and vertical migration in response to food, temperature and salinity. Model simulations follow larvae from a number of release points (reefs) over a time span (2 to 4 weeks) sufficient for them to mature (attain a length of 330 micron) at which point they sink and attach to the bottom. We evaluate the relative importance of physical and biological processes in larval dispersal by comparing simulations with and without larval growth and behavior. The results show that behavior and growth have an important influence on the settlement pattern of larvae, and thereby, the pattern of distribution of recruitment and genetic dispersal over Delaware Bay.

EFFECTS OF P-AMINOSALICYIC ACID ON THE NEUROTOXICITY OF MANGANESE ON THE DOPAMINERGIC INNERVATION OF GILL OF THE BIVALVE MOLLUSC, *CRASSOSTREA VIRGINICA*. **Michael Nelson, Turkesha Huggins, Roshney Licorish, Margaret A. Carroll,** and **Edward J. Catapane.** Medgar Evers College, 1150 Carroll Street, Brooklyn, NY, 11225, USA.

Excess manganese causes Manganism in people, a Parkinsons-like disease. p-Aminosalicylic acid (PAS), an anti-inflammatory drug with chelating properties, is an effective treatment of Manganism, but its mechanism of action is unknown. Gill lateral cilia of *Crassostrea virginica* have a dopaminergic-serotonergic innervation. Dopamine is excitatory within ganglia, but inhibitory at gill, causing cilio-inhibition. Treatments with manganese disrupt the dopaminergic innervation of gill. We examined acute and short-term effects of PAS, EDTA and acetylsalicylic acid (ASA) on effects of manganese on gill innervation. Beating of lateral cilia were measured by stroboscopic microscopy of preparations with ipsilateral visceral ganglia (VG) attached. For acute experiments the cerebrovisceral connective innervating the VG was stimulated using suction electrodes. For short-term experiments animals were treated by removing their right shells and placing them in containers containing manganese, PAS, or PAS plus manganese and tested by superfusion of VG with dopamine. Applying PAS and EDTA to gill blocked effects of manganese; ASA did not. Short-term manganese treatments impaired the dopaminergic, cilio-inhibitory system which was decreased by cotreating with PAS. The study shows PAS protects against effects of manganese. The mechanism of action of PAS in alleviating Manganism may be more related to its chelating abilities than anti-inflammatory actions.

BIOGEOCHEMICAL RESPONSES OF SHALLOW WATER SEDIMENTS TO ENRICHMENT BY EASTERN OYSTER (*CRASSOSTREA VIRGINICA*) BIODEPOSITS. **Roger I.E. Newell[1], Rebecca R. Holyoke[2],** and **Jeffrey C. Cornwell[1].** [1]University of Maryland Center for Environmental Science, 2020 Horns Point Road, PO Box 775 Cambridge, MD, 21613, USA; [2]University of Delaware, Lewes, DE, 19958, USA.

Ecosystem responses to shellfish aquaculture are difficult to quantify experimentally in large well-mixed coastal systems. Using eastern oysters held sub-surface in rafts, we assessed the influence of biodeposition on nitrogen regeneration and burial in three sheltered shallow creek sites in Chesapeake Bay, USA. There were

strong temporal variations in the composition and quantity of oyster biodeposits. Increases in total organic carbon content and declining C:N ratios in sediments increased anaerobic respiration, leading to increased iron sulfide concentrations, but no increases in aerobic respiration were observed. Gradual increases in surface sediment nitrogen and pore water ammonium were not fully expressed at the sediment-water interface, as benthic microalgae modulated nitrogen release with active ammonium uptake during light periods. Reduced microalgal uptake during dark periods sometimes permitted increased microbial denitrification. Our studies in poorly flushed tidal creeks indicated that oyster biodeposition can have deleterious effects on sediment biogeochemistry. Future studies must tackle the daunting problem of quantifying such processes in more open, well-flushed systems where adequate water currents could widely disperse biodeposits over receiving sediments. Only by measuring the entire ecosystem response, rather than focusing on sediments immediately surrounding the bivalves, can the net balance between possible positive and negative effects be quantified.

WIND-FORCED RECRUITMENT DYNAMICS OF THE BLUE CRAB *CALLINECTES SAPIDUS*. **Matthew B. Ogburn**[1] and **Richard B. Forward, Jr.**[2]. [1]Savannah State University, 3219 College Street, Savannah, GA, 31404, USA; [2]Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC, 28516, USA.

The relative estuarine abundance of blue crab *Callinectes sapidus* postlarvae was monitored using settlement on ''hog's hair'' collectors for 10 y in a North Carolina, USA estuary. The total number of postlarvae collected each year was significantly correlated ($r^2 = 0.71$; one outlier removed) with catch per unit effort (CPUE) in the NC hard crab fishery (lagged two years to account for time to maturity). This relationship improved ($r^2 = 0.91$) when the six days of highest relative abundance were removed each year, suggesting that the seasonal mean abundance was more important in determining CPUE than the few episodic high abundance events that occurred each year.

Blue crab postlarvae recruit to estuarine nursery habitats during downwelling-favorable wind events that coincide with nighttime flood tides. Although spawning takes place from late spring to fall, postlarval recruitment is highest from mid-August to October during a period of downwelling-favorable winds known as ''mariners' fall''. We are evaluating the extent to which interannual variability in the strength and duration of downwelling winds during mariners' fall explains the seasonal variability in relative postlarval abundance and, in turn, CPUE in the NC hard crab fishery.

TRANSCRIPTIONAL RESPONSES OF *MYTILUS CALIFORNIANUS* TO ACUTE Cu AND Cd EXPOSURE. **Florence Pi.** University of Southern California, 3616 Trousdale Parkway, Los Angeles, CA, 900890371, USA.

Mytilus spp. have long been used as sentinel organisms for monitoring the health of coastal watersheds. Due to their sessile and filter-feeding nature, mussels can be exposed to multiple toxicants arising from runoff from land and harbors into coastal regions. Historically, research has quantified the effect of such toxicants on mussels at an organismal level, for example, by measuring LC_{50} values. Almost all organisms respond to physiological perturbations through the differential expression of genes whose function serves to offset the debilitating effects of the stressor. We present a microarray-based screen of differentially expressed genes in *M. californianus* exposed to 0.0125-0.25 ppm Cu or 0.01-0.22 ppb Cd. Expression changes were tracked over 6 time-points during 2 days. Temporal and pathway analysis of the expression data were employed to highlight the timing and activation of specific responses to heavy metal exposure. These data provide complementary insights into the molecular effects of toxicant exposure on the health of mussels.

RESTORING OUR PAST WITH MUSSEL POWER IN THE FRESHWATER PORTION OF THE DELAWARE ESTUARY WATERSHED. **Angela T. Padeletti**[1], **Danielle A. Kreeger**[1], **Catherine M. Gatenby**[2], **Steven G. Hughes**[3], **Roger L. Thomas**[4], **Rosemary Malfi**[4], and **Heidi Wood-Tucker**[3]. [1]Partnership for the Delaware Estuary, 110 South Poplar Street, Suite 202, Wilmington, DE, 19801, USA; [2]U. S. Fish and Wildlife Service, 400 E. Main Street, White Sulphur Springs, WV, 24986, USA; [3]Cheyney University of Pennsylvania, 1837 University Circle, P.O. Box 200, Cheyney, PA, 19319, USA; [4]Acadamy of Natural Sciences, 1900 Ben Franklin Parkway, Philadelphia, PA, 19103, USA.

Freshwater mussels are the most imperiled animal group in the Delaware Estuary watershed, with all but a few of our native species in danger of being extirpated. In 2007, the Freshwater Mussel Recovery Program was launched to restore mussel population biomass, diversity, and resilience through a mix of conservation, reintroduction, and range expansion. In Southeastern Pennsylvania, the program is targeting streams found suitable for reintroduction by following the health of caged mussels (Gray, Poster). Reintroduction will be achieved by seeding streams with hatchery reared juvenile mussels and transplanting reproductively active adults. Broodstock of the lightfoot mussel (*Elliptio complanata*), along with prospective fish hosts for their larvae, were collected from two study sites and taken to Cheyney University. In the lab, approximately 165 of 508 pumpkinseed (*Lempomis gibbosus*), white suckers (*Catostomus commersonii*), and banded killfish (*Fundulus diaphanous* & *F. heteroclitus*) were successfully infested in 2008. While none of the glochidia metamorphosed, lessons learned in the hatchery tests, including a preference for

American eels as hosts, should lead to successful production of >10,000 seed mussels in 2009. By reintroducing freshwater mussels into receptive streams where populations have been lost, we will fill open niches, boost population resilience, and enhance multiple ecosystem services.

P53, UBIQUITIN AND AHR IN SOFTSHELL CLAM HAEMOCYTES EXPOSED TO PAH/FUNGICIDE MIXTURE. **Julie Pariseau** and **Ahmed Siah.** University of Prince Edward Island, 550 University Avenue, Charlottetown, Prince Edward Island, C1A 4P3, Canada.

Our previous studies have shown a link between the level of p53 gene expression and the ploidy status of clams displaying haemic neoplasia. However, the environmental causes remain by far unravelled. The aim of this study is to quantify the expression of p53, AhR (aryl hydrocarbon receptor) and ubiquitin gene expressions in relation with xenobiotics exposure in softshell clams (*Mya arenaria*). Clams sampled from the field were exposed to 0.5 mg of benzo [*a*] pyrene and 0.4 mg of chlorothalonil and mancozeb for 72 hours. For more accurate results, some genes were evaluated to find the most stable genes. Our results showed that S18 and EF1 are the most stable housekeeping genes for the control clams, while S18 and L37 are the most stable housekeeping genes for the treated clams. Our data showed that the expression of p53 increased after 48 hours of exposure, however it decreased after 72 hours of exposure. Furthermore, the expression of AhR increased during the exposure and was significantly different in clams exposed after 72 hours. Further studies need to be undertaken in order to understand the exact nature of the correlation between xenobiotics exposure and the pattern of p53 and AhR gene expressions.

EFFECT OF DISSOLVED OXYGEN STRESS ON STABLE ISOTOPE VALUES (C and N) IN THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA*. **Heather Patterson[1], Anne Boettcher[1],** and **Ruth Carmichael[2].** [1]University of South Alabama, 307 University Boulevard, Mobile, AL, 36688, USA; [2]Dauphin Island Sea Lab, 101 Bienville Boulevard, Dauphin Island, AL, 36528, USA.

There are a number of external (environmental) and internal (biological) factors that can affect stable isotope fractionation in bivalves. Previous studies have shown that tissue physiology, temperature, and ontogeny can shift fractionation values from the accepted standards (0-1‰ for $\delta^{13}C$ and 2-5‰ for $\delta^{15}N$, from food source to consumer). These studies suggest stable isotope fractionation may serve as a proxy to detect environmental stress, but many factors remain to be defined. Importantly, the environmental and biological factors that affect fractionation may confound stable isotope-based interpretation of trophic relationships or anthropogenic effects on ecosystems. To better understand the interaction among specific factors for bivalves, we opted to measure changes in nitrogen and carbon stable isotope fractionation in oyster tissues in response to differences in both dissolved oxygen (DO) concentration and food availability. Lab (and uncontrolled field) incubations were performed under three oxygen conditions (anoxic, hypoxic, and normoxic) and two feeding regimes. Experiments were run on both juvenile and adults and three tissue types (gill, gut gland, and adductor muscle) were sampled. Differences in stable isotope ratios among tissues and treatments were compared across time. This study will provide important data about oyster ecology, physiology, and guide future oyster restoration efforts.

***PERKINUS MARINUS* LEVELS IN HATCHERY-PRODUCED OYSTERS PLANTED ON MANAGED RESERVES IN MARYLAND.** **Kennedy Paynter[1]** and **Steven M. Allen[2].** [1]University of Maryland, 0105 Cole Field House, College Park, MD, 20742, USA; [2]Oyster Recovery Partnership, 1805 Virginia Avenue, Annapolis, MD, 21401, USA.

The oyster parasite, *Perkinsus marinus*, which causes the disease commonly called Dermo, has caused widespread oyster mortalities in the Chesapeake Bay for the last several decades and has been regarded as one of the main roadblocks to oyster restoration. Since the virulence of Dermo is positively correlated with salinity, managed reserves have been planted in low salinity regions in Maryland. In these areas, where the salinity typically ranged from 5 to 15‰, hatchery-produced oysters grew well, showed low levels of Dermo and low mortality despite being in the water three or four years. Oysters planted in the Chester and Choptank rivers showed generally low weighted prevalences while those in the Patuxent showed much higher infection intensities at only slightly higher salinities. For instance, for oysters planted in 2005, mean WP was 0.48 in the Chester, 0.11 in the Choptank, but 2.55 in the Patuxent in oysters planted in 2006. Important differences in maximum salinities and/or local infection levels apparently exist between the Patuxent and the othersites that account for these differences. These results suggest vast areas of currently unproductive oyster bars in Maryland might be made productive through an active oyster culture program without substantial threat from Dermo.

FRESHWATER MUSSEL BIOGEOGRAPHY IN THE TOMBIGBEE RIVER DRAINAGE AS REVEALED BY ARCHAEOLOGICAL SHELL. **Evan Peacock.** Mississippi State University, P.O. Box AR, Mississippi State, MS, 39762, USA.

Freshwater mussel (Bivalvia: Unionidae) shells are a common constituent of archaeological sites in the eastern United States. Biogeographical data derived from ancient shell assemblages have been used to extend the known ranges of several species in different states. Over the last several decades, excavations have taken place at many archaeological sites in the Tombigbee River drainage of eastern Mississippi and western Alabama, along streams ranging

from very small tributaries to the main river stem. These collections allow for the drainage-wide characterization of species ranges and population structures. In particular, a new assemblage from a site on the lower Tombigbee River in Clarke County, Alabama, is described and several new range extensions noted.

EFFECTS OF ENVIRONMENTAL FACTORS ON *MERCENARIA MERCENARIA* IMMUNITY, QPX SURVIVAL AND HOST-PATHOGEN INTERACTIONS. **Mickael Perrigault[1], Soren F. Dahl[1], Qianqian Liu[1], Jackie L. Collier[1], Debra Barnes[2],** and **Bassem Allam[1].** [1]Stony Brook University, Dana Hall 155, Stony Brook, NY, 11794-5000, USA; [2]New York State Department of Environmental Conservation, East Setauket, NY, 11733, USA.

Environmental factors significantly modulate host-pathogen interactions by affecting both pathogen virulence and host ability to resist infections. QPX (quahog parasite unknown) is a parasite of the hard clam *Mercenaria mercenaria*. Our previous investigations demonstrated the impact of temperature on clam defense parameters (e.g., ROS production, phagocytosis, hemocyte counts) and on immune responses following QPX challenge. Effects of environmental factors on clam defense and QPX were further investigated. Lab-controlled experiments were performed to evaluate the effects of salinity and dissolved oxygen on hard clam immunity. Naturally- and experimentally-infected clams were maintained at two different salinities (30‰ and 18‰) and two dissolved oxygen concentrations (6 mg/L and 3 mg/L). Various cellular and humoral defense parameters were assessed and tissues were dissected and preserved at -80°C for the measurement of the expression of immune-related genes. Additionally, the effect of temperature and salinity on QPX survival was investigated *in vitro*. Results demonstrated that all environmental parameters tested affect clam defense parameters and their modulation in response to QPX infection. Moreover, QPX showed higher survival at low temperature and low salinity *in vitro*. Additional results from these ongoing experiments are still being collected and will be presented.

POPULATION TRENDS OF BLUE CRABS IN COASTAL WATERS OF THE NORTHERN GULF OF MEXICO. **Harriet Perry[1], Ralf Riedel[1], Guillermo Sanchez , Leslie Hartman[2], Stevens Heath[2], Vince Guillory[3],** and **Harry Blanchet[3].** [1]The University of Southern Mississippi - Gulf Coast Research Laboratory, 703 E. Beach Drive, Ocean Springs, MS, 39564, USA; [2]Alabama Department of Conservation and Natural Resources, Dauphin Island, AL, 36528, USA; [3]Louisiana Department of Wildlife and Fisheries, Bourg, LA, 70343, USA.

Long-term, fishery-independent data were used to examine trends in abundance for juvenile blue crabs in coastal waters of Mississippi, Alabama, and Louisiana. The use of standardized sampling methodologies and laboratory protocols facilitated analysis of data. Declining trends in abundance of blue crabs in trawl survey data were evident in all three states. There was no evidence of recruitment failure based on catches of early stage juveniles in seines and beam plankton nets in Mississippi or Alabama. Catches of post-settlement crabs in trawls in Louisiana showed no indication of a declining trend.

Similarity of results from all states provides evidence that broad-scale environmental processes are operating to regulate population levels. Juvenile blue crab abundance in the northern Gulf of Mexico appears to be correlated with long-term, climate-related hydrological regimes. High catches of juvenile crabs occurred during periods of increased river flow, low salinity, and a high frequency of southeast winds. These conditions increase refuge availability and alter predator-prey dynamics. Lowest abundances have occurred over the last several years, a period characterized by unprecedented change in habitat (catastrophic storms, cumulative effect of man-made alterations), and an unfavorable climatic regime (e.g., low river flow, high salinity, and a low frequency of southeast winds).

THE FACILITATION OF SEAGRASS (*ZOSTERA MARINA*) GROWTH AND PRODUCTIVITY BY *MERCENARIA MERCENARIA* VIA LIGHT AND NUTRIENT STRESS ALLEVIATION. **Bradley J. Peterson, John Carroll, Charles C. Wall,** and **Christopher J. Gobler.** Stony Brook University, 239 Montauk Highway, Southampton, NY, 11968, USA.

Seagrasses and suspension feeders are both critical ecosystem engineers in estuaries. Seagrass beds are important structural habitats and suspension feeders, when abundant, can control phytoplankton densities. In a series of mesocosm experiments, the effects of environmentally realistic densities of hard clams on the growth of eelgrass in a eutrophied environment were examined. Experimental treatments with bivalves consistently had significantly lower chlorophyll *a* concentrations, and showed significant increases in light penetration. Eelgrass growth and productivity was consistantly higher in the treatments with the highest density of bivalves compared to a control without bivalves. The data indicate that clearance of the water column and the subsequent increase in light penetration by suspension-feeding bivalves facilitated the growth of eelgrass. In addition, field manipulative experiments were conducted to determine the extent that hard clams could enhance eelgrass growth *in situ*. In estuarine regions with lower sediment N content, hard clam additions yielded significantly higher eelgrass productivity when artificially shaded. Combined with prior research, these finding have important implications for the conservation of estuarine seagrass habitats and shellfish populations, specifically suggesting that healthy populations of suspension-feeding bivalves can serve as a control on estuarine eutrophication and can help restore degraded, light-limited seagrass habitats.

IN VITRO INHIBITION OF *PERKINSUS MARINUS* PROLIFERATION BY ANIDULAFUNGIN, A GLUCAN SYNTHESIS INHIBITOR. Jerome F. La Peyre, Yanli Li, and **Sandra Casas.** Louisiana State University Agricultural Center, Baton Rouge, LA, 70803, USA.

Cell wall synthesis in protozoan parasites of the genus *Perkinsus* offers a target for chemotherapy because host cells have no comparable cell wall. There is, however, limited information on the cell wall composition of *Perkinsus* species. Using an empirical approach, the effects of anidulafungin, a noncompetitive inhibitor of (1,3)-β-D-glucan synthase, on the viability and proliferation of *P. marinus* isolates from the Gulf and Atlantic coasts were determined *in vitro*. *P. marinus* viability decreased with increasing concentrations of Anidulafungin (32-1000 μg/ml), and its proliferation was inhibited at concentrations of or greater than 125 μg/ml. Interestingly, anadulafungin had no effect on the enlargement of *P. marinus* isolates in ARFTM indicating that 1,3-β-D-glucan is likely a major cell wall component of trophozoites but not of hypnospores. The effectiveness of anidulafungin against *P. marinus* in infected eastern oysters remains to be determined.

GENERATION TIME AND THE STABILITY OF SEX-DETERMINING ALLELES IN OYSTER POPULATIONS AS DEDUCED FROM A GENE-BASED POPULATION DYNAMICS MODEL (DYPOGEN). Eric N. Powell[1], John M. Klinck[2], Eileen E. Hofmann[2], and **Dennis Hedgecock[3].** [1]Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA; [2]Old Dominion University, IRB1, 3rd Floor, Norfolk, VA, 23529, USA; [3]University of Southern California, 3616 Trousdale Parkway, Los Angeles, CA, 90089-0371, USA.

In the cupped oyster *Crassostrea*, sex may be determined by a single gene of major effect with two alleles, a dominant male allele M and a recessive protandrous allele F; FFanimals are protandrous and MF animals are permanent males. We investigate the possibility that reduced generation time brought about by disease might jeopardize retention of the M allele using DyPoGen. When generation time declines, MF males have lower lifetime fecundity and the frequency of the M allele declines and is eventually lost. The probability of loss is modulated by population abundance. Simulations suggest that a dominant M allele stabilizes the female-to-male ratio when generation time is long. As generation time shortens, random mortality and genetic drift overcome the weak stabilizing selection on the M allele. Disease and exploitation have significantly shortened oyster generation time in recent decades. One consequence may be to jeopardize the retention of the M allele. Alternatives to protandry include an F-dominant protandric allele and protandry restricted to the MF heterozygote. Protandry restricted to the MF heterozygote maintains sex-ratio stability better than the alternatives, suggesting that determination of sex by a dominant M allele with female protandry may not be the most stable evolutionary strategy.

SNPS IN A MATRIX METALLOPROTEINASE GENE IN THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA*. Dina A. Proestou and **Marta Gomez-Chiarri.** University of Rhode Island, 9 East Alumni Avenue, 20A Woodward Hall, Kingston, RI, 02881, USA.

Single nucleotide polymorphisms (SNPs) are the marker of choice for association studies. Due to the impact of disease on populations, association studies are performed to identify genetic markers for resistance. Many markers derive from genes involved in immunity. One such gene family is the matrix metalloproteinases (MMPs). MMPs are found in a range of taxa and function in several physiological processes. We have characterized an oyster matrix metalloproteinase, Cv1MMP, and analyzed sequences from four *C. virginica* strains or populations for variation. The Cv1MMP gene spans 8,350 bp and contains 1593 bp of coding sequence divided into 11 exons. Thus far, 15 SNPs with a rare allele frequency and 10% have been identified in exons 1-4 and 18 have been identified in exons 7-11. Of the 33 SNPs identified, 13 are non-synonymous. The frequency of SNPs across this gene is one every 40 bp, while non-synonymous SNPs are observed every 95 bp. In addition, a variable-number repeat with 3 allelic forms was detected. SNP frequencies reported here are comparable to those observed in vertebrate MMPs. A link between specific polymorphisms and disease has been demonstrated for some vertebrate MMP SNPs, underscoring the potential use of oyster MMP SNPs in association studies and marker-assisted selection.

METAPOPULATION DYNAMICS OF OYSTER RESERVES IN PAMLICO SOUND, NC. Brandon J. Puckett and **David B. Eggleston.** North Carolina State University, Morehead City, NC, 28557, USA.

Major declines in Eastern oyster populations have prompted the establishment of oyster reserves as a restoration tool. Here, we integrated oyster reserve demographics and connectivity in Pamlico Sound (PS), NC within a theoretical metapopulation framework to determine (1) the relative contribution of each reserve to the network (λ_C), (2) the potential for reserves to persist as a connected network (i.e., $\lambda \geq 1$), (3) the network-level benefits of increasing reserve size, and (4) the optimal allocation of resources for increasing reserve size. Mark-recapture studies, fecundity analyses, and larval dispersal simulations were conducted to parameterize a spatially-explicit stage-based matrix metapopulation model. The relative contribution of reserves to the network (λ_C) ranged from 0.6 to 2.7, indicating the presence of ''source'' and ''sink'' reserves. The intrinsic growth rate of the reserve network (λ) was 0.55. To ensure metapopulation persistence (i.e., $\lambda \geq 1$), the cumulative reserve footprint must be increased in size by 30-360% depending on the allocation of resources among reserves. The metapopulation framework applied in this study suggests that while oyster reserves in PS are currently inadequate to ensure their persistence, some reserves contribute disproportionately to the

reserve network and should therefore receive priority for resource allocation.

PROTOZOAN AND METAZOAN COMMUNITIES ASSOCIATED WITH SHELL LESION AND HEALTHY SHELL SURFACES OF THE AMERICAN LOBSTER (*HOMARUS AMERICANUS*) AFFLICTED BY EPIZOOTIC SHELL DISEASE. **Robert A. Quinn[1], Andrei Y. Chistoserdov[1],** and **Roxanna Smolowitz[2].** [1]University of Louisiana at Lafayette, P.O. 42451, Lafayette, LA, 70504-2451, USA; [2]New England Aquarium, Central Wharf, Boston, Massachusetts, 02110-3399, USA.

The esthetic appearance is a major factor in successful marketing of shellfish. The presence of lesions caused by shell disease and epibiotic growth of large metazoans may dramatically decrease the marketable value of commercially important crustacean species. We investigated the presence of eukaryotic epibionts (larval metazoans and protozoans) on the healthy shell and epizootic shell disease (ESD) lesions of the American lobster using molecular approaches. Only one out of six lobsters contained detectable eukaryotes on healthy shell surfaces. These eukaryotes were stramenopiles and a lobster commensal copepod. Unlike surfaces of healthy carapace, the eukaryotic communities of ESD lesions were highly diverse and variable for different individual lobsters as well as locations from which lobsters were collected. The only organism consistently found in all lesions was a bacteriovorous nematode *Geomonhystera disjuncta*. Metazoans were a highly diverse group and included bryozoans, nematodes, copepod crustaceans, flat worms, barnacles, arthropods and mollusks. Microscopic eukaryotes were represented by fungi and diverse stramenopiles. Although many identified eukaryotes are parasites or pathogens of various aquatic organisms, no correlation was observed between any specific pathogen and the occurrence of ESD. It also appears that eukaryotic communities from ESD lesions are unable to colonize healthy shell surfaces.

SHELL MIDDENS AS ARCHIVES OF PALEOBIOLOGICAL AND PALEOENVIRONMENTAL DATA. **Irvy R. Quitmyer** and **Douglas S. Jones.** University of Florida, P.O. Box 117800, Gainesville, FL, 32611, USA.

Shell middens contain the remains of vertebrate and invertebrate resources that are associated with human subsistence activities. The oldest of these deposits found in the southeastern United States date to the mid-Holocene (ca. 6,000 BP) and represent a sampling of the aquatic biota from a variety of habitats. We present a case study of modern and zooarchaeological clams (*Mercenaria* spp.) from Litchfield Beach, South Carolina to illustrate the kinds of data that may be found in these pervasive coastal deposits. We use a well established chronological record of seasonal incremental shell formation to identify season of hard clam harvest and over-exploitation from 16 middens excavated from the Litchfield Beach Estuary. This represents a 2,000-year history of hard clam use and misuse of this significant resource.

TRANSCRIPTIONAL PROFILE OF THE PENAEID SHRIMP *LITOPENAEUS VANNAMEI* TO HYPOXIA AND HYPERCAPNIC HYPOXIA. **Charles K. Rathburn[1], K.G. Burnett[1], P.S. Gross[2], A.B. Veloso[1], M. Beal[3], M. Cook[4],** and **L. E. Burnett[1].** [1]College of Charleston, 205 Fort Johnson Road, Charleston, SC, 29412, USA; [2]Medical University of South Carolina, 331 Fort Johnson Road, Charleston, SC, 29412, USA; [3]NOAA, 331 Fort Johnson Road, Charleston, SC, 29412, USA; [4]Hollings Marine Laboratory, 331 Fort Johnson Road, Charleston, SC, 29412, USA.

Many crustaceans inhabit estuarine ecosystems where they are frequently exposed to hypoxia. High levels of CO_2 (hypercapnia) often occur in the presence of hypoxia, and both factors may impair the abilities of crustaceans to maintain optimal metabolic processes, preserve acid-base balance, and uphold immune defense against pathogens. Many of the strategies employed by marine crustaceans to cope with hypoxia and hypercapnia involve changes in the transcription and translation of sets of genes, some of which may be uniquely linked to these stressors and some of which may be components of a common stress response in shrimp. In the present study, we tested the hypothesis that stress responses of *Litopenaeus vannamei* to hypoxia and hypercapnic hypoxia are represented by unique transcriptional profiles as compared to normoxia and each other. Shrimp were held for either 4 hours or 24 hours ($n = 9$ per treatment and timepoint). RNA isolated from hepatopancreas of individual animals was hybridized to custom oligonucleotide microarrays containing 22,000 unigenes expressed in *L. vannamei*. The results should contribute to a more detailed understanding of shared and unique gene sets involved in the crustacean stress response to environmental change. Supported by NSF IBN-0212921 and NOAA OHH at HML.

CROSS-BREEDING FOR IMPROVED DISEASE RESISTANCE IN EASTERN OYSTERS, *CRASSOSTREA VIRGINICA*. **Paul Rawson[1], Scott Lindell[2], Ximing Guo[3],** and **Inke Sunila[4].** [1]University of Maine, 5751 Murray Hall, Orono, ME, 04469, USA; [2]Marine Biological Laboratory, 7 MBL Street, Woods Hole, MA, 02543, USA; [3]Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA; [4]Connecticut Bureau of Aquaculture, PO Box 97, Milford, CT, 06460, USA.

Disease is one of the most serious impediments to the increased production of cultured eastern oysters, *Crassostrea virginica*. Oyster culture in New England is impacted by MSX, SSO, Dermo and *Roseovarius* oyster disease (ROD). Although MSX and Dermo resistant stocks are available, they do not fare well when challenged by ROD. Similarly, ROD-resistant stocks have poor survival when challenged with Dermo. Using a common-garden

field trial, we ask whether combined resistance to MSX, Dermo, and ROD can be realized through interline crossing between currently available genetically improved stocks and whether oysters selected from local natural environments in southern New England that have survived heavy, annual disease pressure will survive well, grow better and yield more than currently available lines. Seed oysters were deployed in June, 2007 and growth, mortality and yield have been monitored over two seasons at eight sites from New Jersey to Maine. We have observed additive effects on survival and heterosis for growth and yield among the interline crosses we constructed. Further, at some sites one new local stock performed as good as the other disease-resistant stocks in our field trial. These results are encouraging for the production of disease-resistant stocks that perform well throughout the northeast.

DIFFERENCES IN SHRIMP *LITOPENAEUS VANNAMEI* PRODUCTION AND MICROBIAL DYNAMICS AS THEY RELATE TO DIETARY PROTEIN SOURCE AND SOLIDS MANAGEMENT IN MINIMAL EXCHANGE SUPERINTENSIVE CULTURE SYSTEMS. **Andrew J. Ray[1], Craig L. Browdy[2], Beth L. Lewis[1], Jesus A. Venero[1], Luis Vinatea[1], Andrew Shuler[1],** and **John W. Leffler[1].** [1]South Carolina Department of Natural Resources, 211 Sawmill Creek Road, Bluffton, SC, 29910, USA; [2]Novus International, Inc., 5 Tomotley Court, Charleston, SC, 29407, USA.

There are nutritional limitations in the ability of plant products to replace fishmeal and fish oil in shrimp feeds. We are exploring the prospect that plant-based diets may provide shrimp production values similar to that of fish-based feeds. This may be possible due to the nutritional benefits of the dense microbial community present in minimal exchange super-intensive culture systems. Juvenile (1.31 ± 0.06 g) Pacific White Shrimp (*Litopenaeus vannamei*) were stocked in 24 outdoor tanks at a density of 325/m^2. Shrimp in half the tanks were fed a commercial fishmeal-based diet while shrimp in the remaining tanks received a plant-based diet. No solids were removed from one-third of the tanks, tilapia cropped solids from one-third of the tanks, and settling chambers were used with the remaining tanks. Shrimp mean weight and total shrimp biomass at harvest were significantly greater ($P < 0.001$ and $P = 0.003$) and FCR significantly less ($P = 0.006$) in tanks with settling chambers. No significant difference could be detected between the fish diet and the plant diet in terms of shrimp biomass ($P = 0.169$) and FCR ($P = 0.161$). These results demonstrate that plant-based diets can produce results equivalent to fish-based diets and that shrimp production can be increased significantly by managing solids.

MANAGING *PERKINSUS MARINUS* THROUGH FRESHWATER INFLOWS TO ESTUARIES. **Sammy M. Ray[1]** and **Thomas M. Soniat[2].** [1]Texas A&M University at Galveston, Fort Crockett, Galveston, TX, 77553, USA; [2]University of New Orleans, Lakefront, New Orleans, LA, 70148, USA.

The protozoan parasite *Perkinsus marinus* (= *Dermocystidium marinum*) is a major cause of mortality of eastern oysters (*Crassostrea virginica*). The disease is more prevalent in high salinity waters where it limits the distribution of its host. A natural control of *P. marinus* is provided by adequate freshwater inflows into estuaries. The maintenance of proper salinities to control *P. marinus*, support oyster production, and sustain other estuarine-dependent species is becoming more challenging as fresh water is diverted from estuaries to farms, cities and industries.

REPRESENTATIONAL DIFFERENCE ANALYSIS OF QPX RESISTANCE IN *MERCENARIA MERCENARIA*. **Spiro Razis[1], Maureen K. Krause[1],** and **Bassem Allam[2].** [1]Hofstra University, 114 Hofstra University, Hempstead, NY, 11549-1140, USA; [2]Stony Brook University, Endeavour Hall, Stony Brook, NY, 11794-5000, USA.

Mortality due to QPX epizootics in hard clams, *Mercenaria mercenaria*, varies considerably, with more southerly populations exhibiting lower survival than more northerly populations. This suggests that certain clam populations possess genetic and immunological differences that confer the ability to resist QPX infection. This study tests the hypothesis that if there is a genetic basis for disease resistance among clam strains, then clam strains with varying resistance to QPX disease will express different genes involved in their immune response. Streamlined Representational Difference Analysis was used to attempt to isolate those genes expressed in resistant clams that are not expressed in susceptible clams. RDA analysis resulted in a single expressed product after hybridization of cDNA from susceptible QPX-challenged clams from Florida with QPX resistant and QPX-challenged clams from New York. This fragment appears to represent a unique transcript from the QPX-resistant clams. While further characterization of the full length coding sequence and expression analyses are underway, the initial ~300 bp sequence shows no significant homology to known protein sequences, although there is extremely weak homology to *Mus musculus* kallikrein, a member of the serine protease family known to play a role in the innate immune response of bivalve molluscs.

MOLECULAR IDENTIFICATION AND DISCRIMINATION OF *PERKINSUS* SPECIES: IMPLICATIONS FOR DEVELOPING MANAGEMENT STRATEGIES AND ASSESSING INTRODUCTION RISKS. **Kimberly S. Reece[1], Jessica Moss[1], Gail P. Scott[1], Eugene M. Burreson[1], Christopher F. Dungan[2], Barbara J. Sheppard[3], James Coleman[3], Geoff Liggins[4], Ben K. Diggles[5], Sandra Casas[6], Jerome F. La Peyre[6], Antonio Villalba[7],** and **Judith Upston[4].** [1]Virginia Institute of Marine Science, The College of William and Mary, Rt. 1208, Gloucester Point, VA, 23062, USA; [2]Maryland Dept. of Natural Resources, Cooperative Oxford Laboratory, Oxford, MD, 21654, USA; [3]College of Veterinary Medicine, University of Florida, Gainesville, FL, 32611, USA; [4]Cronulla Fisheries Research Centre, Cronulla, NSW, 2230, Australia; [5]DigsFish Services Pty Ltd., Bribie Island, Queensland, 4507, Australia; [6]Louisiana State University Agricultural Center, Baton Rouge, LA, 70803, USA; [7]Centro de Investigaciones, Xunta de Galicia, Aptdo.13, Vilanova de Arousa, 36620, Spain.

Conventional diagnostic techniques such as Ray's fluid thioglycollate assays and histological examinations generally cannot confidently differentiate among *Perkinsus* species. Therefore, identification and discrimination of species is currently based largely on genetic data. We used molecular detection techniques and phylogenetic analyses, combined with field and laboratory studies, to reveal a wealth of information regarding *Perkinsus* species host and geographic distributions. Several new species were identified, and others that were previously described as distinct species due to presumed limited host and geographic ranges were synonymized. *Perkinsus olseni* has a very broad host and geographic range, while current information suggests that other species such as *P. chesapeaki*, *P. mediterraneus*, *P. honshuensis*, and *P.beihaiensis* may have relatively restricted distributions. A survey of wild bivalves in Chesapeake Bay indicated that *P. marinus* infections occur almost exclusively in oysters and *P. chesapeaki* is primarily a parasite of clams. Several different *Perkinsus* species were detected by screening of oysters proposed for introduction to Chesapeake Bay and clams being imported into Florida for the aquarium trade. Overall, results emphasize the need for accurate identifications to properly assess risks of unintentional introductions of new *Perkinsus* species, and to develop informed management strategies for minimizing effects of these parasites.

PHAGE AS A POSSIBLE INTERVENTION FOR *VIBRIO TUBIASHII* IN SHELLFISH HATCHERIES. **Gary P. Richards.** USDA, Agricultural Research Service, James W.W. Baker Center, Dover, DE, 19901, USA.

Vibrio tubiashii is a bacterial pathogen that is highly lethal to larval and juvenile shellfish. It has dramatically reduced the production of bivalve seed stock for commercial shellfish growers on the U.S. West Coast. A potential remediation plan was developed to isolate and characterize a phage against *V. tubiashii*. Phages are bacterial viruses that are being increasingly used in food processing to rid products of bacterial contamination. For instance, the addition of *Listeria* phages to meat products has been accepted by the U.S. FDA as an intervention against *Listeria* contamination to reduce human illness. There are two general types of phages: lytic and lysogenic. Lytic phages offer some promise as a remediation for *V. tubiashii* in shellfish hatcheries. Although phages against some *Vibrio* species have been isolated, there are no known phages against *V. tubiashii*. This presentation recaps our plan and progress over the past year to develop specific assays for *V. tubiashii* phages in seawater, to pick and confirm presumptive virus plaques, to introduce phages in hatchery settings, and to monitor *Vibrio* levels using our novel (COPP) assay for total vibrios. The viability of the West Coast shellfish industry may well depend on success in controlling this important pathogen.

ANTIOXIDANT STATUS OF OYSTERS AND SUSCEPTIBILITY TO PATHOGENS AND ENVIRONMENTAL STRESSORS. **Amy H. Ringwood, Brett Froelich, Vanessa Ogint, Kristi Doyle, Melissa McCarthy,** and **James D. Oliver.** University of North Carolina - Charlotte, 9201 University City Boulevard, Charlotte, NC, 28223, USA.

Estuarine ecosystems are characterized by a variety of environmental conditions that may affect antioxidant status. The purpose of these on-going studies is to characterize how factors such as temperature and hypoxia can affect the levels of glutathione (the most abundant thiol antioxidant in all cells) and important antioxidant enzymes such as superoxide dismutase and catalase (important pathways for metabolizing superoxide and peroxide radicals) in oysters, *Crassostrea virginica*. While production of free radicals is an important mechanism for killing bacteria and other pathogens, antioxidant responses are essential for insuring that excess free radicals are reduced to non-toxic compounds. Therefore, environmental conditions that compromise antioxidant status can increase the risks for developing elevated bacterial concentrations and increased parasitic loads, as well as increased susceptibility to contaminants or algal toxins. The antioxidant status of oysters exposed to hypoxic conditions from both field and laboratory exposures was evaluated along with the bacterial and Dermo levels. These studies indicate that reduced antioxidant capacity was associated with higher bacterial levels and Dermo in the tissues, and increased susceptibility to toxins. Reduced antioxidant capacities should be regarded as a major risk factor that would make oysters especially susceptible to bacteria (including human pathogens) and environmental stressors.

INFORMING MANAGERS: ASSESSMENT OF BLUE CRAB SPAWNING STOCK. **Daniel Rittschof, Margaret Goldman, Matthew Ogburn, M. Zachary Darnell, Ruth McDowell,** and **Kelly M. Darnell.** Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC, 28516, USA.

Accurate assessment of the spawning stock should be important in informing fisheries management decisions. Blue crab behavior and life history makes assessment of spawning stock complex. In North Carolina, female blue crabs undergo their terminal molt and mate from March through November. After a variable amount of time, the crabs' ovaries mature and they extrude their first clutch of eggs. Crabs maturing in the upper estuary move from low (< 20) salinity to high (> 22) salinity to release their first clutch of eggs. Crabs in good habitat then forage and produce subsequent clutches of eggs, moving seaward with each subsequent clutch. Thus, spawning crabs will build up in high salinity areas. The spawning population peaks in August/September with some crabs releasing their first clutch and others releasing their second or higher clutch. We find that using blue crab bycatch data from monthly gill net surveys may be a good way to estimate blue crab spawning stock. These data show the monthly pattern of spawning stock movement from low to high salinity and the build-up of spawning stock in high salinity waters. The pattern in spawning females is well correlated with the return of blue crab megalopae from the coastal ocean to a tidally driven estuary.

CHARACTERIZING THE RESPONSE OF *VIBRIO TUBIASHII* TO CHANGES IN ENVIRONMENTAL CONDITIONS USING A PROTEOMIC APPROACH. **Steven Roberts, Tatyana Marushchak,** and **Sam White.** University of Washington, 1122 NE Boat Street, Seattle, WA, 98105, USA.

Vibrio tubiashii has reemerged as a deadly oyster pathogen along the Pacific coast of the US. Hatcheries have been impacted by vibriosis resulting in a lack of seed for many farms. Although larvae are most commonly affected, adult shellfish may also be susceptible. In order to better understand the functional response of *Vibrio tubiashii* to changes in environmental conditions, a series of culture experiments were performed. These experiments involved growing *V. tubiashii* while altering parameters such as temperature, pH, microbial community, and presence of oysters. Two-dimensional protein electrophoresis was carried out in order to identify differentially expressed proteins. In addition, gene expression analysis was carried out on select genes. Results indicate several factors can influence expression of products involved in virulence and pH alters protein expression in *Vibrio tubiashii*. These combined data provide a better understanding of how changes in the environment could potentially impact future outbreaks of *V. tubiashii* and suggest modifications of current culture techniques could minimize the mortality events associated with vibriosis in the future.

ANALYSIS OF GENES ISOLATED FROM PLATED HEMOCYTES OF THE PACIFIC OYSTER. **Steven Roberts**[1] and **Rick Goetz**[2]. [1]University of Washington, 1122 NE Boat Street, Seattle, WA, 98105, USA; [2]University of Wisconsin, 600 E. Greenfield Avenue, Milwaukee, WI, 53204, USA.

A complementary deoxyribonucleic acid library was constructed from hemocytes of *Crassostrea gigas* that had been plated on poly-lysine plates for 24 hours. From this library, 2,198 expressed sequence tags (ESTs) of greater than or equal to 100 bp were generated and analyzed. A large number of genes that potentially could be involved in the physiology of the oyster hemocyte were uncovered. They included proteins involved in cytoskeleton rearrangement, proteases and antiproteases, regulators of transcription and translation, cell death regulators, receptors and their associated protein factors, lectins, signal transduction proteins, and enzymes involved in eicosanoid and steroid synthesis and xenobiotic metabolism. Based on their relationship with innate immunity, the expression of selected genes was analyzed by quantitative polymerase chain reaction in gills from bacterial-challenged oysters. Several genes observed in the library were significantly upregulated by bacterial challenge including interleukin 17, astacin, cystatin B, the EP4 receptor for prostaglandin E, the ectodysplasin receptor, c-jun, and the p100 subunit of nuclear factor-kB. *C. virginica* homologs of some of the *C. gigas* genes uncovered in the ESTs were obtained by aligning the ESTs against the assembled *C. virginica* ESTs.

THE EFFECTS OF VARIOUS TYPES OF FREEZING ON THE BACTERIAL CONTENT OF OYSTERS. **Gary Rodrick.** University of Florida**,** Department of Food Science and Human Nutrition**,** Gainesville, FL, 32611, USA.

The freezing of selected types of seafood is a common practice in the seafood industry and this processing aid is easily integrated into processing plants. Various methods of freezing have been used in the seafood industry and include blast freezing and freezing with carbon dioxide, and liquid nitrogen. The effects on the bacterial content and in particular *Vibrio vulnificus* on oysters of these three methods will be discussed. In addition, the effects of various lengths of frozen storage on the bacterial content of oysters will be discussed.

OCCURRENCE AND ANTIMICROBIAL DRUG RESISTANCE OF POTENTIAL BACTERIAL PATHOGENS FROM SHELLFISH IN GRENADA. **Adria I. Rodriguez** and **Harry Hariharan.** St. George's University, P.O. Box 7, St. George's, Grenada, Grenada.

Molluscs and other shellfish make up a significant part of the aquaculture products and the economy of Grenada. The objective of this study was to gather information about the presence of

potential human pathogens, and to determine the antimicrobial susceptibility patterns of the bacterial isolates.

A total of 80 shellfish consisting of 30 clams, 30 oysters, and 20 queen conchs was obtained and examined by culture of whole soft tissue, intestines, and/or meat. Selective media was used with the aim of isolating various bacteria, particularly the members of *Vibrionaceae*, and *Salmonella*. The isolates obtained were identified based on phenotypic properties, including reactions obtained with API bacterial identification strips. Of 62 isolates, 18 were identified with >90% probability including *Vibrio alginolyticus, Enterobacter sakazakii*, *Shewanella putrefaciens*, *Stenotrophomonas maltophilia*, and *Escherichia coli*.

Antimicrobial drug susceptibility tests on 51 isolates using a standard disk diffusion method against 11 drugs demonstrated resistance to β-lactam drugs and aminoglycosides, while no resistance to fluoroquinolones and to a potentiated sulfonamide was observed.

In conclusion, this preliminary study on shellfish in Grenada revealed the presence of potential human pathogens, as well as bacteria which may cause mortality in shellfish.

THE ROLE OF PARTICLE SURFACE CHARACTERISTICS IN PARTICLE SELECTION IN EASTERN OYSTERS (*CRASSOSTREA VIRGINICA*) AND BLUE MUSSELS (*MYTILUS EDULIS*). **Maria Rosa[1], J. Evan Ward[1], Sandra E. Shumway[1], Emmanuelle Pales-Espinosa[2], Bassem Allam,** and **Gary H. Wikfors[3].** [1]University of Connecticut-Avery Point, 1080 Shennecossett Road, Groton, CT, 06340, USA; [2]Stony Brook University, Stony Brook, NY, 11794, USA; [3]NOAA, National Marine Fisheries Service, Northeast Fisheries Science Center, 212 Rogers Avenue, Milford, CT, 06460, USA.

Suspension-feeding bivalve molluscs have long been recognized as an integral part of benthic ecosystems, playing a vital role in nutrient cycling and seston composition. It has been shown that bivalves are capable of preferentially ingesting particles based upon nutritive value; however, little is known about the mechanisms upon which bivalves rely to differentiate between particles. The surface properties of particles and the presence of epiparticulate and epicellular compounds have been proposed as factors that mediate the selection process.

In this study, we focus on the effects of surface properties on selection by suspension-feeding bivalves. The eastern oyster (*Crassostrea virginica*, pseudolamellibranch) and blue mussel (*Mytilus edulis*, filibranch), which represent two differing gill architectures, were used. Mussels and oysters were fed pairs of synthetic (10 μm) particles with different surface characteristics, and all biodeposits were collected. Characteristics quantified were surface charge (electrophoretic mobility and zeta potential), wettability (using contact angles), and ''stickiness'' (tendency to flocculate). Flow cytometric analyses were used to determine the proportion of particles rejected as pseudofeces and egested as feces. Our data will help elucidate the mechanisms used by bivalves to differentiate among food and other particles in the natural environment.

THE FUTURE IS NOW: IMPLEMENTING NOAA'S 10-YEAR PLAN FOR MARINE AQUACULTURE. **Michael Rubino** and **Susan Bunsick.** National Oceanic & Atmospheric Administration (NOAA), 1315 East-West Highway. SSMC#3 13th Fl., Room 13117, Code:F, Silver Spring, MD, 20910, USA.

As a federal agency under the U.S. Department of Commerce, the National Oceanic and Atmospheric Administration (NOAA) has a rich tradition in aquaculture research including landmark studies on the biology and reproduction of shellfish and finfish, habitat use and restoration, environmental impact assessment, and fish pathology. Since 2004, through a renewed emphasis on all aspects of marine aquaculture, NOAA has shined a national spotlight on the need for additional U.S. aquaculture research and production. The agency's goal is to create opportunities for marine aquaculture to ensure that the industry develops in a predictable, environmentally compatible, and sustainable manner. Adopted in 2007, NOAA's 10-Year Plan for Marine Aquaculture outlines four goals to expand U.S. commercial aquaculture and stock replenishment activities. They are:

- Establish a comprehensive regulatory program for marine aquaculture;
- Foster development of commercial marine aquaculture and replenishment of wild stocks;
- Increase public understanding of marine aquaculture; and
- Increase collaboration and cooperation with international partners.

SEX RATIOS AS A FUNCTION OF SIZE IN *CRASSOSTREA VIRGINICA* OF DELAWARE BAY. **Judith Sarkodee-adoo[1], Eileen Hofmann[2], Eric Powell[3],** and **Kathy Ashton-Alcox[3].** [1]Florida A & M University, Martin Luther King Jr. Boulevard, Tallahassee, FL, 32307, USA; [2]Old Dominion University, 4111 Monarch Way, 3rd floor, Norfolk, VA, 23508, USA; [3]Rutgers University, 6959 Miller Avenue, Port Norris, New Jersey, 08349, USA.

The eastern oyster, *Crassostrea virginica*, is protandric; individuals are initially male, and as they mature, they often function as females. Protantrism has implications for the male:female ratio and reproductive ability in *C. virginica* populations. This study focused on determining the relationship between sex ratio and size (age) in the *C. virginica* population within the New Jersey portion of Delaware Bay. In June 2008, a time corresponding to maximum gamete maturation, nearly 7,000 oysters were sampled from 20 oyster beds. The oysters were measured and binned into 10-mm size classes. Sex was determined for a subset of 1733 *C. virginica* from seven contiguous oyster beds. The majority, 867(50.03%),

were male, 764 (44.08%) were female, 62 (3.58%) were hermaphrodites, and 40(2.31%) were undetermined. Analyses of this data showed that the proportion of male *C. virginica* individuals was inversely related to oyster size for this population. The size differential between male and female oysters in this region has implications for harvesting, which tends to select larger individuals. This selectivity, coupled with other factors, such as disease, may contribute to declining oyster broodstock.

CILIATE XENOMAS IN *CRASSOSTREA VIRGINICA* FROM GREAT BAY, NH. Emily E. Scarpa, Susan Ford, William Saidel, Ximing Guo, and **David Bushek**. Rutgers, The State University of New Jersey, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

Despite the abundance of information about several parasites of eastern oysters (C*rassostrea virginica*), relatively little is known about xenomas, which are caused by *Sphenophyra*-like ciliates and occasionally reported during routine histological examination. Xenomas are hypertrophic lesions that are found on the gills of marine and freshwater bivalve molluscs. Since 1997, xenomas have been periodically observed at high prevalence during routine histological examination of *C. virginica* from Great Bay, New Hampshire. A meta-analysis of annual samples collected between 1997 and 2007 indicated an increase in prevalence during this period, which could signal an emerging disease problem. The present study seeks to gather baseline epizootiological data and to characterize both the ciliates and the xenomas that they form. Samples collected monthly from June through November 2008 indicated a sigmoidal increase in prevalence from 2–50% indicative of a seasonal pattern. Samples from infected oysters were preserved for histology, electron microscopy and genetic analysis. Results will provide fundamental data on basic epizootiological relationships as well as the ciliate's taxonomic affiliations so that future research can illuminate the cause and effect of the unusual abundance of xenomas in oysters from Great Bay.

EASTERN OYSTER *CRASSOSTREA VIRGINICA* GROWTH, REPRODUCTION AND HEALTH IN LAKE WORTH LAGOON, FLORIDA. John Scarpa[1], Susan Laramore[1], and **Alessandra Medri[2].** [1]Harbor Branch Oceanographic Institute at Florida Atlantic University, 5600 US Highway 1 North, Fort Pierce, FL, 34951, USA; [2]Palm Beach County - Environmental Resources Management, 2300 North Jog Road, 4th Floor, West Palm Beach, FL, 33411, USA.

Lake Worth Lagoon (LWL) in Palm Beach County, Florida is a shallow estuarine habitat significantly influenced by human activities. Two natural beds (MacArthur State Park and Ibis Isle) and a man-made boulder breakwater (Snook Island) in the LWL have been monitored monthly since March 2008 for eastern oyster, *Crassostrea virginica*, growth, reproduction, recruitment and health to provide data for ecosystem management. Water temperature ranged from 20–22°C in April to 28–33°C in August. Salinity was >27 ‰ until Tropical Storm Fay passed over the area in mid-August depressing salinities 9–20 ‰. Recruitment has been constant and low (≤ 2 spat/shell) at all sites with a major peak (42 spat/shell) in September at Ibis, while prolonged (June-September, 10–30 spat/shell) at Snook Island. Recruitment patterns may reflect hydrology; Snook Island is central in the LWL whereas the other sites are peripheral. Dermo levels were below 1 (Mackin scale) in March, increasing in the summer before decreasing in September; prevalence was 40–100%. Newly recruited oysters grew from about 10 mm in May to 43 mm in November. Lake Worth Lagoon is a productive system with patches of healthy oyster beds that may be expanded with substrate, but may be easily lost without constant environmental stewardship.

SALINITY TOLERANCE OF THE SUNRAY VENUS CLAM *MACROCALLISTA NIMBOSA*. John Scarpa[1], Susan E. Laramore[1], Michelle Harangody[1], and **Leslie N. Sturmer[2].** [1]Harbor Branch Oceanographic Institute at Florida Atlantic University, 5600 U.S. Highway 1 North, Fort Pierce, FL, 34946, USA. [2]University of Florida, Cedar Key, FL, 32625, USA.

The sunray venus clam *Macrocallista nimbosa* is being evaluated as a potential new aquaculture species to diversify the hard clam culture industry in Florida. In this study, the salinity tolerance of larvae and early juveniles was examined. Two-day old larvae were exposed to salinities of 15, 20, 25, 30, 35, and 40 ‰ for four days. Juveniles (avg wt = 19 mg, avg length = 4.7 mm) were exposed to salinities of 10, 20, 30 and 40 ‰ for three weeks. All juvenile clams in the 10 ‰ treatment died by the end of week 1. After three weeks, survival at 30 ‰ (81%) was significantly greater than at 40 ‰ (55%), but not from 20 ‰ (69%). Interestingly, family 85 exhibited significantly lower survival (50%) as compared to families 61 (74%) and 55 (81%). Growth (% whole wt change) for surviving clams showed a similar pattern to survival, including family effect. These results indicate that the optimum salinity for growth and survival of sunray venus clam early juveniles is 30 ‰. Additionally, the differences found between families imply potential for increasing growth and survival through selective breeding. Larvae results will be reported. Supported by Florida Sea Grant.

CULTURE OF HARD CLAM HYBRIDS (*MERCENARIA MERCENARIA*, *M. CAMPECHIENSIS*): HATCHERY TO FIELD-NURSERY. John Scarpa[1], Leslie N. Sturmer[2], William Arnold[3], Stephen Geiger[3], and **Shirley M. Baker[2].** [1]Harbor Branch Oceanographic Institution at Florida Atlantic University, 5600 U.S. Highway 1 North, Fort Pierce, FL, 34946, USA; [2]University of Florida, Cedar Key, FL, 32625, USA; [3]Florida Fish & Wildlife Conservation Commission, St. Petersburg, FL, 33701, USA.

The Florida hard clam culture industry is based primarily on the "notata" variety of the northern hard clam *Mecenaria mercenaria*, which may not be suited for some Florida environments.

The local southern hard clam *M. campechiensis* may have suitable production characteristics for Florida environments and readily hybridizes with *M. mercenaria*, but is known to gape during refrigerated storage. Therefore, an examination of production characteristics of these species and their hybrids has been undertaken. Cultured *M. mercenaria notata* and wild *M. campechiensis* were used as broodstock. Five separate single-parent crosses were accomplished. Nuclear DNA amounts in larvae, as measured by flow-cytometry using DAPI stain, differed slightly (six fluorescent units) between the parental species, but hybrids sometimes exhibited values of only one parental type. Allozyme marker analysis indicated that in two of the crosses, at least one parental clam was a hybrid, thus making DNA amounts unsuitable for identifying hybrids. This genetic analysis reflects the difficulty of using visual characteristics to differentiate between species that naturally hybridize. Survival among the remaining three families in land-based nursery culture using raw seawater ranged from 73-82%. Approximately 670,000 seed (shell length 7.9-13.1 mm) were planted in the field for continued culture comparison. Supported by USDA-CSREES.

SHELLFISH DEPURATION. **Keith Schneider.** University of Florida, Department of Food Science and Human Nutrition, Gainesville, FL, 32611, USA.

Shellfish can concentrate contaminants present in water column in which they are grown. Several of these organisms (i.e., *Vibrios*) are known to cause illness when consumed. This risk may be reduced by applying an appropriate post-harvest treatment such as depuration. Depuration is a traditional method for cleansing and refreshing live molluscan shellfish by exposing them to clean seawater under controlled conditions for up to 48 hours. The traditional methods of disinfection of seawater that the molluscan shellfish are exposed to include ultraviolet light, ozone, chlorine compounds, and iodophores. Various seawater parameters such as salinity, temperature, oxygen concentration and flow rates are important in order to promote the pumping rates of the filter feeding mollusk. Studies have shown that certain bacteria are purged, while others are not. These differences are well known but are not well understood. The different types of depuration and parameters will be compared and discussed for selected molluscan shellfish.

DIAGNOSIS OF OYSTER DISEASES USING HISTOLOGICAL AND MOLECULAR TECHNIQUES. **Jacquelyn Shelton** and **Marta Gomez-Chiarri.** University of Rhode Island, 9 East Alumni Avenue, Woodward Hall, Kingston, RI, 02881, USA.

Diagnostic techniques that are fast, effective, sensitive, specific, and affordable are crucial to the management of eastern oyster populations. We have used several published diagnostic techniques, including culture, histology, and polymerase chain reaction (PCR) to test for the presence of *Perkinsus marinus* (dermo disease), *Haplosporidium nelsoni* (MSX disease), and *Roseovarius crassostreae* (Juvenile Oyster Disease, JOD) in 60 Rhode Island oysters. For the diagnosis of *P. marinus*; PCR, histology, and tissue Ray's Fluid Thioglycollate Media (RFTM) assays showed 83% concordance, with 3% RFTM positive, histology/PCR negative, 5% PCR negative, RFTM/histology positive, and 8% histology negative, RFTM/PCR positive cases. These results indicate that, although PCR showed higher specificity than RFTM, it may not always detect low level, localized infections. Histology and PCR showed 100% concordance in the diagnosis of *H. nelsoni* infections (13% prevalence in selected sites). Presence of clinical signs characteristic of JOD correlated with the presence of *R. crassostreae*. Successful detection of *R. crassostreae* by PCR required culture of several dilutions of shell swabs, picking of several colonies, and isolation of bacterial DNA. Validation of these diagnostic techniques in different laboratories will aid in effective monitoring of disease in cultured and wild oyster populations.

EXOTIC *PERKINSUS* SP. INCLUDING *PERKINSUS OLSENI* FOUND IN ORNAMENTAL REEF CLAMS, *TRIDACNA* SPP., IMPORTED INTO THE USA FROM THE INDO-PACIFIC FOR SALE TO THE GENERAL PUBLIC. **Barbara J. Sheppard[1], Debabrata Mahapatra[1], Kimberly Reece[2],** and **James K. Coleman[1].** [1]University of Florida, 2015 SW 16th Avenue, Building 1017, Box 110880, Gainesville, FL, 32611, USA; [2]College of William and Mary, Chesapeake Bay Hall, N112, Gloucestor Point, VA, 23062, USA.

The recent discovery of *P. olseni* in the imported ornamental reef clam, *Tridacna crocea*, in both a research (Sheppard and Phillips 2008) and home aquarium setting (Sheppard and Dungan, in press) confirmed some degree of incursion of exotic *Perkinsus* species into the USA. The current study surveyed seven groups of Tridacnid clams (*T. derasa* from Micronesia, *T. maxima* from Vanuatu, *T. crocea* from Vietnam, *T. derasa* from Cook Islands, *T. crocea* from Phan Thiet Vietnam, and *T. maxima* from Vietnam) purchased from aquatic stores available to the public. The Vietnamese *T. crocea* and Phan Thiet Vietnamese *T. crocea* groups, but not other groups, were confirmed positive for *Perkinsus* sp. by thioglycollate incubations, histopathology, and positive PCR product formation using *P. olseni* and *Perkinsus* genus-specific primers. A 732 nucleotide base pair region concensus sequence (Genebank EU871715.1) was generated for the new *Perkinsus* sp. Vietnam isolate encompassing the ITS1 (partial), 5.8S ribosomal RNA gene, and ITS2 (partial). The sequence had a maximum identity of 96.7 % with *P. olseni* (Genebank U07701) and phylogenetically grouped with *P. olseni*. *Tridacna crocea* appeared to carry a dual infection with a known *P. olseni* and a new *Perkinsus* sp. as yet unidentified (*P. olseni* 'Vietnam').

GENETIC STRUCTURE OF BAY SCALLOP POPULATIONS IN NORTH CAROLINA COASTAL WATERS. **Mark Sherman** and **Ami E. Wilbur.** University of North Carolina at Wilmington, Center for Marine Science, Wilmington, NC, 28409, USA.

In recent years, bay scallops (*Argopecten irradians*) in North Carolina have been the focus of increasing concern due to declining abundance. The decline has been attributed to a combination of natural and anthropogenic factors. While these factors have not completely eradicated bay scallops from North Carolina waters, they have likely upset the natural connections between local aggregations that were, at one time, sufficient to keep bay scallop abundance high throughout the region. The level of genetic differentiation among bay scallop populations in North Carolina coastal sounds has been investigated with mitochondrial DNA and microsatellite analyses; however, the two techniques yielded contradicting results. Mitochondrial DNA analysis revealed significantly differentiated populations among large water basins along the North Carolina coastline including two adjacent sounds, where gene flow was expected to be relatively high. However, microsatellite analysis did not support the distinction of the two adjacent sounds and revealed little structure across the whole region. To clarify the matter, we have initiated a genetic survey using amplified fragment length polymorphism (AFLP). Scallops (N = 50-60) were collected from ten sites from eight sounds, including the four water basins previously studied as well as intermediate systems. Genetic analysis is ongoing, and the results will be discussed.

THE "100 LOBSTERS" PROJECT: A COOPERATIVE PROJECT ON EPIZOOTIC SHELL DISEASE IN THE AMERICAN LOBSTER. **Jeffrey Shields[1], Kathleen Castro[2],** and **Jessica Moss[1].** [1]VIMS, VIMS, Gloucester Point, VA, 23062, USA; [2]University of Rhode Island, University of Rhode Island Fisheries Center, Kingston, RI, 02881, USA.

The appearance and prevalence of epizootic shell disease in the American lobster (*Homarus americanus*) has been devastating to the industry in the coastal waters of New England. In response, research has been initiated in order to understand the roles of the environment, pathogens, and pollutants in the ecology and etiology of the disease. A comprehensive project is underway in which carapace, tissues, and hemolymph from 100 lobsters collected from waters of Rhode Island will be studied. The project will be used to compile and propagate data for analyses by the researchers involved, and we hope to make the data available to the public through a web-based data repository. Currently, duplicate samples from this and ongoing lobster shell disease studies are being housed in a tissue bank at VIMS. The developing tissue bank and web-based data repository and instructional tools will be invaluable to both the scientific community working on this disease as well as to members of the lobster industry.

BLUE MUSSELS (*MYTILUS EDULIS*) CULTIVATION IN ITS COLDEST ENVIRONMENT IN NORWAY. **Knut Sivertsen,** Finnmark University College, Follums vei 31, N-9509 Alta, Norway.

Blue mussels are commercially cultivated in three fjords in Troms and Finnmark Counties in North Norway. The fjords Lyngen and Altafjord have summer temperatures above 10°C for about tree months at summer time, and may reach 14°C in July/August. At Porsangerfjord the temperature reach above 10°C for about two months at summer time and rarely exceeds 12°C. The mussels settle at July or August and the shell length reach in mean 2-3 mm the year of settlement in all three fjords. Blue mussels grow about 20 mm a year the following two years in Lyngen and Altafjord. The growth occurs mainly from July to October. In the colder Porsangerfjord the growth is about 15 mm the summer next to the settlement year and about 12 mm the second summer. A lot of the blue mussels have stunted growth, and the growth rates of the mussels in the Porsangerfjord nearly do not exceed the growth rates of stunted shells. Living at its northernmost and coldest area in Porsangerfjord close to the Barents Sea and the Arctic the temperature is too low and growth season too short to keep a high growth rate here.

FLUID DYNAMICS AFFECTS THE OUTCOMES OF BLUE CRAB - HARD CLAM INTERACTIONS. **Delbert L. Smee[1], Marc Weissburg[2],** and **Matthew C. Ferner[3].** [1]Texas A&M - Corpus Christi, 6300 Ocean Drive, Unit 5800, Corpus Christi, TX, 78412, USA; [2]Georgia Institute of Technology, 310 Ferst Drive, Atlanta, GA, 30332, USA; [3]University of California -Davis, P.O. Box 247, Bodega Bay, CA, 94923, USA.

Top-down forces are important in many systems, but it is widely accepted that stressful or harsh environments diminish predator foraging ability. Many studies have shown that predator foraging abilities decline monotonically as environmental stress increases, but these results are often based on single-species experiments performed in controlled laboratory environments. We performed a manipulative field experiment to determine how fluid dynamics affect the outcomes of predatory interactions using blue crabs and hard clams as a model system. It is well established that both crabs and clams are best able to detect each other in slow flows with low turbulence. In sharp contrast, our results indicate that blue crabs are most successful foragers at intermediate flow velocity and turbulence levels, despite a reduction in the crabs' ability to detect chemical signals emanating from prey in these flow conditions. Crab predation was lowest in sites with the slowest and fastest flows. Clams successfully detected and avoided crabs in slow flows, while in fast flows, blue crabs were unable to locate their prey. Our results suggest that environmental conditions may not cause a monotonic change in predation rates when these conditions simultaneously affect the behaviors of both predators and prey.

EXAMINING THE EFFECTS OF PREDATOR EXCLUSION STRUCTURES ASSOCIATED WITH GEODUCK AQUACULTURE ON MOBILE BENTHIC MACROFAUNA IN SOUTH PUGET SOUND, WASHINGTON. **Rachel Smith**[1] and **P. Sean McDonald** [2]. [1]Northwestern University, 2205 Tech Drive O.T. Hogan Hall Room 2-144, Evanston, IL, 60208, USA; [2]Western Washington University, 1900 Shannon Point Road, Anacortes, WA, 98221, USA.

Intertidal aquaculture of geoduck clams (*Panopea abrupta*) is a rapidly expanding industry in Puget Sound, Washington. We examined the effects of predator exclusion structures associated with geoduck aquaculture on mobile benthic macrofauna. Species abundance and diversity were assessed on structured and unstructured habitats; surveys revealed significantly more graceful crab (*Cancer gracilis*) in unstructured habitats, and significantly more staghorn sculpin (*Leptocottus armatus*) in structured habitats. Diets of *L. armatus* occupying both habitat types were evaluated in relation to tide level. Stomachs of *L. armatus* were significantly more full on ebbing than flooding tides for both habitats, indicating that sculpin migrate into intertidal areas to forage. However, results for small sculpin (52-81 mm TL) were equivocal, and these fish may use the complex structured habitat for refuge in addition to foraging. A significant difference in sculpin diet was observed between habitats, which is attributed to increased variability in prey composition in the structured habitat. Infaunal polychaetes were the main prey in unstructured habitats, while sculpin consumed more epibenthic gammarids in structured habitats. Predator exclusion structures used in geoduck aquaculture appear to alter the composition of macrofaunal communities relative to unstructured areas and affect the dietary patterns of *L.armatus*.

COMPARATIVE HISTOPATHOLOGY OF SHELL DISEASE IN AMERICAN LOBSTERS (*HOMARUS AMERICANUS*) AND FOUR SPECIES OF CRAB FROM COASTAL WATERS OF THE NORTHEASTERN U.S. **Roxanna Smolowitz**[1], **Jackie Defaveri**[2], **Robert A. Quinn**[3], and **Andrei Y. Chistoserdov**[3]. [1]New England Aquarium, Central Wharf, Boston, MA, 02110, USA; [2]Marine Biological Laboratory, Woods Hole, MA, 02536, USA; [3]University of Louisiana at Lafayette, Lafayette, LA, 70504, USA.

Lesions of Epizootic Shell Disease (ESD) in the American lobster (*Homarus americanus*) are compared to shell disease lesions in lobsters from Canada and in lobsters with impoundment shell disease (ISD). ESD lesions are also compared to shell lesions sampled from four types of crabs collected from the coastline of Massachusetts (spider crab, *Libinia emarginata*; Atlantic rock crab, *Cancer irroratus*; green crab, *Carcinus maenas*; and the horseshoe crab, *Limulus polyphemus*). ESD lesions appear to be more aggressive than lesions identified from ISD lesions and enzootic shell disease lesions in lobsters fro Maine. The lesions in all crabs examined are markedly different from lesions associated with shell disease in lobsters and reflect the different microscopic morphology of the carapace in crabs. In lobsters, bacteria are the predominate organism identified at the leading edge of infection, but other organisms are often found within the lesions including nematodes, algae, and various protistian organisms.

ENVIRONMENTAL MONITORING, DISEASE SURVEYS, AND OYSTER HUSBANDRY FOR THE MANAGEMENT OF *PERKINSUS MARINUS* IN THE GULF OF MEXICO. **Thomas M. Soniat**[1] and **Sammy M. Ray**[2]. [1]University of New Orleans, Lakefront, New Orleans, LA, 70148, USA; [2]Texas A&M University at Galveston, Fort Crockett, Galveston, TX, 77553, USA.

In the absence of an effective, practical therapeutic agent against *Perkinsus marinus*, perkinsosis in eastern oysters can only be managed. Successful control requires sampling on appropriate spatial and temporal scales, the ability to anticipate trends, and flexible options for management. Since infection progresses down to up estuary, epizootics at lower sites provide an early warning of threats to oysters at the mid-estuarine locus of commercial production. Likewise, epizootics at low latitudes portend threats to the major commercial oyster populations of the northern Gulf. Monitoring must also be appropriate to the dominant annual and inter-annual scales to which *P. marinus* responds. The annual cycle of disease, in which highest levels of disease in late summer are correlated with high temperature, is captured by quarterly sampling. The inter-annual cycle, in which the highest levels of disease during La Niña events are correlated with high salinity, requires decadal monitoring. Options for disease management include harvesting oysters before they are killed by disease, operating along a broad salinity gradient which ensures oyster survival in both wet and dry years, and promoting fast oyster growth which favors host over parasite.

GROWTH OF PACIFIC WHITE SHRIMP *LITOPENAEUS VANNAMEI* FED DIETS CONTAINING DIFFERENT LEVELS OF SOY PROTEIN CONCENTRATE REARED UNDER CLEAR WATER SYSTEM. **Daranee Sookying** and **D. Allen Davis.** Auburn University, 203 Swingle Hall, Auburn University, Auburn, AL, 36849, USA.

The objective of this study was to demonstrate the growth response of *Litopenaeus vannamei* fed practical diets containing different levels of Soy Protein Concentrate in substitution of Soybean meal, when reared in the clear water condition. Two trials were carried out at the E.W. Shell Fisheries Research Station in Auburn, Alabama and Claude Peteet Mariculture Center in Gulf Shores, Alabama.

In the first trial, six dietary treatments containing increasing percentages of SPC (0%, 5%, 10%, 20%, 40%, and 40% with additional fish soluble) were randomly assigned with four replications

per treatment. Juvenile shrimps were stocked at 15 animals per aquarium during an eight week feeding trial. In the second trial, four dietary treatments contained increasing level of SPC (0%, 4%, 8%, and 12%) were randomly assigned with three replications per treatment. Juvenile shrimp were stocked into the tanks at a density of 15 shrimp per tank during a 12 week trial. Daily feed inputs were calculated, based upon an expected weight gain per week and an expected feed conversion ratio.

At the end of the experiment, growth, survival, and feed conversion ratio from both systems will be determined and compared to examine the variation performance of Pacific white shrimp.

INTENSIVE OYSTER CULTURE IN VERY SHALLOW ESTUARIES: BIODEPOSITION VERSUS FLUSHING RATES AS LONG-TERM MANAGEMENT CONSIDERATIONS. Melissa Southworth, Roger Mann, Erin Reilly and **Juliana M. Harding.** Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA, 23062, USA.

Intensive oyster culutre in trays or cage structures in shallow estuaries result in a rain of fecal and pseudofecal material to the benthos. Accumulation of such material can result in oxygen depletion and drastic changes in the benthic community. Given the combination of high productivity and standing stock of phytoplankton, a shallow water-column at the vast majority of culture sites, and the modest tidal excursions and associated flushing rates to disperse fecal and pseudofecal material, the Chesapeake Bay presents particularly difficult challenges to potential culture operations. We present data from a working oyster farm illustrating rates of fecal production, based on oyster density, size and estimates of filtration rate, and deposit re-suspension rates based on the difference between estimated and measured rates of deposit accumulation. Based on these observations, we examine the major driving forces in dispersal processes, and consider how they may be incorporated into both the permitting procedure for oyster farms and on-site best management practices.

ANALYSIS OF OYSTER PHYSIOLOGICAL PERFORMANCE AND HABITAT QUALITY IN HAVERSTRAW BAY, LOWER HUDSON RIVER. Adam Starke, Jeffrey Levinton, and **Michael Doall.** Stony Brook University, CR 97, Stony Brook, NY, 11794, USA.

We are performing a study of physiological performance of the eastern oyster in Haverstraw Bay, which historically supported oyster populations but is nevertheless suboptimal for maximum growth. Results from this study have highlighted the importance of understanding the various environmental parameters that influence somatic tissue and shell growth. Analysis of tissue and shell growth, reproduction, mortality, disease and condition index observations of oysters across a series of localities within the Haverstraw Bay identified a gradient of potentially ideal habitat conditions with increased tissue growth and reproductive potential to the south of Haverstraw Bay.

A physiological index based upon shellgrowth, recruitment potential, and disease is developed for each site seeking maximal shell and tissue growth and minimal disease prevalence. Using a GIS and available environmental data, extension of this index from sites to areas across the Haverstraw Bay will lay a foundation for creation of a habitat suitability index.

A UNIVERSITY-COMMUNITY PARTNERSHIP FOR SHELLFISH ASSESSMENT AND MANAGEMENT. Bradley G. Stevens. University of Massachusetts, Dartmouth, School of Marine Science and Technology, New Bedford, MA, 02744, USA.

Coastal communities in Massachusetts are responsible for determining the status of shellfish resources and managing their harvest, yet managers often do not have the funds or training to assess shellfish abundance and condition. With funding from a UMASS community service grant, we conducted an assessment of quahog abundance at a site in New Bedford Harbor that was considered to be a significant source of local recruitment under high pressure for industrial development. Work was conducted by graduate students in a Survey Sampling class, in cooperation with the New Bedford Shellfish Constable, and with assistance from local high school students. The work was conducted over four days during two periods of low tide. Using clam rakes, 120 quadrats of 0.25 m^2 were sampled systematically at 5 m intervals within two 50 x 30 m grids. Mean density was 20.2 ($\pm$ 1.8) clams and 1.375 ($\pm$ 0.07) kg per m^2, or 201,700 ($\pm$18,170) clams and 13,750 ($\pm$ 730) kg per ha. The high precision of these estimates (CV = 0.045) demonstrates that cooperative assessment programs can be highly successful, and ours could be a model for other coastal communities. A project report provided recommendations and methodology for shellfish managers to conduct similar surveys.

LETHAL AND SUBLETHAL EFFECTS OF EPIZOOTIC SHELL DISEASE IN AMERICAN LOBSTERS. Bradley G. Stevens. University of Massachusetts, Dartmouth, 706 S. Rodney French Boulevard, New Bedford, MA, 02744, USA.

A quantitative disease index (QDI) has been developed for American lobsters. Sixty-four lobsters with various stages of epizootic shell disease (ESD) were collected in traps from Buzzards Bay, MA, in October and November, 2007. Digital photographs of the exoskeleton were made monthly for a year, and areas of diseased shell were measured with an image processing system. Diseased areas were standardized to percent shell area using a published regression equation for shell area vs carapace length (CL). At least nine (15%) of the diseased lobsters died during molting due to the inability to separate the new shell from the old exuvium. Among those that molted successfully ($n = 33$), there was

a significant negative relationship between disease severity and growth. Molt increments were significantly correlated with both QDI (negative) and CL (positive), whereas % growth was negatively correlated with QDI, but poorly correlated with CL. These data demonstrate that ESD can cause significant impacts to lobster populations via both lethal (death during molt) and sublethal effects (reduced growth).

THE INFLUENCE OF REARING METHOD ON PINTO ABALONE, *HALIOTIS KAMTSCHATKANA*, GROWTH AND SURVIVAL AS IT RELATES TO RESTORATION IN WASHINGTON STATE. **Bethany C. Stevick[1], Carolyn Friedman[1], Kristina Straus[1], Brent Vadopalas[1], Don Rothaus[2],** and **Glenn VanBlaricom[1].** [1]University of Washington, 1122 NE Boat Street, Seattle, WA, 98105, USA; [2]Washington Department of Fish and Wildlife, 16018 Mill Creek Boulevard, Mill Creek, WA, 98102-1296, USA.

The pinto abalone, *Haliotis kamtschatkana*, is the northernmost abalone species in the eastern Pacific and is the predominant abalone found in Washington State. Excessive harvest was thought to reduce abalone numbers and populations have continued to decline and exhibit recruitment failure, despite fisheries closures in British Columbia, Canada, and Washington State in 1990 and 1994, respectively. A captive rearing program has been established in Washington as an integral component of efforts for successful restoration. Previous pilot studies using captively bred abalone indicated that those reared in habitat-enriched environments exhibited behavioral differences from those reared conventionally, and that using larger individuals at time of outplanting led to greater success in the wild. The next logical step is to investigate the influence of rearing method on abalone survival in the wild. We plan to compare survival and growth between juvenile abalone reared under conventional aquaculture methods and in habitat-enriched environments for six months, prior to a one year outplant study. A finding that a habitat-enriched rearing environment increases survivorship and growth of outplanted abalone will have significant implications for pinto abalone restoration in Washington State and serve as a model for abalone restoration globally.

ANALYSIS OF GENETIC STRUCTURE WITHIN AND AMONG REMNANT POPULATIONS OF THE OLYMPIA OYSTER, *OSTREA CONCHAPHILA*. **David A. Stick[1], Chris Langdon[1], Michael A. Banks[1],** and **Mark D. Camara[2].** [1]Oregon State University, COMES, HMSC, 2030 SE Marine Science Drive, Newport, Oregon, 97365, USA; [2]USDA-ARS, 2030 SE Marine Science Drive, Newport, Oregon, 97365, USA.

The Olympia oyster, *Ostrea conchaphila*, is the only oyster species native to the Pacific Northwest. Historically, this species ranged from Southeastern Alaska southward through Baja, California in densities capable of supporting both tribal subsistence fisheries and large commercial harvest operations. Over-exploitation, habitat degradation, and competition and predation from non-native species have drastically depleted these densities and extirpated many local populations. Ecological benefits provided by oyster reef habitats and the species' historical significance has fueled numerous restoration/supplementation efforts of the Olympia oyster. However, these efforts are proceeding without a clear understanding of existing genetic structure among populations, which could be substantial as a consequence of limited dispersal and/or anthropogenic impacts resulting in localized genetic bottlenecks or population admixture due to transplantation. We have recently developed a number of microsatellite DNA markers in *O.conchaphila* and have used these to identify genetic differentiation among and within major geographical regions associated with the oyster's original range. Some ongoing restoration efforts are utilizing hatchery-propagated oysters to supplement extant populations. We further demonstrate that these efforts have the potential to inadvertently alter the genetic composition of recipient populations. This is the first reported evidence of genetic population structure for the Olympia oyster.

DEVELOPING, DESIGNING, AND OPERATING A ZERO EXCHANGE BIO-FLOC BASED SHRIMP PRODUCTION SYSTEM. **Al D. Stokes, John W. Leffler, Jesus A. Venero,** and **Craig L. Browdy.** South Carolina Department of Natural Resources, 211 Sawmill Creek Road, Bluffton, SC, 29910, USA.

Shrimp farmers in the US face several challenges including record low shrimp prices, an abbreviated one crop production season, potential storm interference, high land costs, biosecurity concerns, pond effluent permit requirements and strict regulations pertaining to the importation of non-indigenous shrimp stocks. Researchers at the Waddell Mariculture Center are working to develop intensive shrimp production technology to meet these challenges. The raceway shrimp production system is covered by a greenhouse to provide light for the algal community and biosecurity. The raceway has a center HDPE wall to assist in directing water flow generated by oxygenated seawater injection around the raceway. Air diffusers keep heavy food/algal particles in suspension, assisting in the creation of a dense bio-floc suspension composed of bacteria, photoautotrophs and nitrifying bacteria. This system operates with zero water exchange except to replace evaporation. Mechanical filtration removes a portion of the biofloc biomass. The biofloc community recycles nutrients within the system, stabilizes water quality, and supplies supplemental nutrition to the shrimp. The system relies on pumps, blowers, and oxygen generators to move and aerate water. The production system operates most efficiently if multiple production raceways are connected and operated as one system.

HUMAN DIMENSIONS OF SHELLFISH AQUACULTURE: RECOMMENDATIONS FOR RESEARCH AND PRACTICE. **Susan C. Stonich.** University of California, Santa Barbara, CA, 93106, USA.

Over the last several decades the cultivation of filter-feeding bivalve shellfish – clams, mussels, oysters, and scallops – has risen significantly, part of the explosive growth of aquaculture which currently accounts for more than 30% of the global supply of fish, crustaceans, and shellfish. This growth has been accompanied by significant controversies related to aquaculture's environmental, social, and public health impacts. These criticisms have affected public perception and consumption of shellfish despite the fact that shellfish culture has been widely identified as one of the most "sustainable" aquaculture technologies. This paper outlines the human dimensions of shellfish aquaculture and addresses the current challenges to shellfish aquaculture that can be addressed by social science research and practice. It is particularly concerned with consumer knowledge and public (mis)perceptions of shellfish farming; growing social/community conflicts accompanying expansion and intensification of shellfish cultivation; and the inadequate attention to, and integration of, the social dimensions of "sustainable" shellfish aquaculture. It ends with specific recommendations for interdisciplinary and multi-stakeholder-based research and practice designed to address these complex challenges. Especially important is research that integrates "perception of risk" studies (generally conducted by social scientists) and "scientific risk assessment" (generally carried out by managers, technicians, and planners).

SEA URCHIN, BEYOND PREDATION AND NUTRITION. **Victoria Stosel.** California State University, Los Angeles, 5151 State University Drive, Los Angeles, CA, 90032, USA.

Sea urchin provides a smaller meat package than many intertidal species utilized by maritime adapted populations. As a food choice sea urchin should be a low priority due to a small meat yield. Nevertheless, shell middens around the world contain high densities of sea urchin fragments, indicating heavy aboriginal exploitation. Sea urchins are also found in places of ritual significance, such as the Sanctuary of Demeter and Kore located on the Acrocorinth, Greece and a burial cave in the Aleutian Islands. This paper reviews the variety of contexts in which urchins are found and reassess their unsuspected significance.

EMERGING PATHOGENESIS OF *VIBRIO PARAHAEMOLYTICUS*. **Mark S. Strom, Rohinee N. Paranjpye,** and **Eric D. Landis.** Northwest Fisheries Science Center, NOAA Fisheries Service, 2725 Montlake Boulevard. E., Seattle, WA, 98112, USA.

Vibrio parahaemolyticus (Vp) is a marine bacterium capable of causing severe gastroenteritis in humans, usually through the consumption of raw shellfish. Before 1995, Vp-vibriosis was sporadic and caused by a relatively heterogeneous population of the bacterium. Since then, outbreaks have become more epidemic, with foci of infections traced to oysters harvested from single or geographically linked sites. Initial outbreaks in India and Asia were traced to a single pandemic serotype O3:K6. This strain spread eastward and has been implicated in outbreaks in South America and the U.S. Gulf Coast region. While most outbreaks were attributed to a single pandemic Vp O3:K6 serotype, other serotypes have been implicated in distinct geographical areas, including O4:K12 (U.S. Pacific Northwest) and O6:K18 (Alaska). Current risk assessment models are based on the presence of the virulence-associated gene *tdh*, yet illnesses have been attributed to *tdh*- isolates or have occurred in the apparent absence of significant numbers of Vp. Using phenotypic, genetic, and genomic comparison methods such as multi-locus sequence typing (MLST), we are examining the hypothesis that a set of highly-pathogenic clones of Vp with increased pathogenic potential have recently emerged, and examining whether emergence is correlated with specific environmental parameters.

CREATING A "FLORIDA-FRIENDLY" HARD CLAM THROUGH INDUSTRY-DRIVEN APPLIED RESEARCH PROJECTS. **Leslie N. Sturmer [1], Shirley Baker[2], Denise Petty[2],** and **John Scarpa[3].** [1]University of Florida IFAS, 11350 SW 153rd Court, Cedar Key, FL, 32625, USA; [2]University of FL, 7922 NW 71st Street, Gainesville, FL, 32653, USA; [3]Harbor Branch Oceanographic Institute at Florida Atlantic University, 5600 U.S. Highway 1 North, Ft. Pierce, FL, 34946, USA.

The Florida hard clam culture industry is a dramatic success story with over 350 small-scale businesses providing an economic impact of $49 million. Yet, it has expanded primarily through increased acreage and number of growers rather than increased productivity. Over the past decade, mortality events resulting from hurricanes, low salinities, and, potentially, high water temperatures have affected production. Recently, a growers' organization obtained federal funds through the U.S. Department of Agriculture to support applied research addressing these concerns. A statewide taskforce identified needs and set priorities to direct research efforts. For example, the local southern quahog *Mercenaria campechiensis* may offer improved production characteristics and hybridizes readily with the cultured northern hard clam *M. mercenaria*. Therefore, a rigorous examination of parental species and their crosses under commercial conditions has been initiated with industry partners. Other industry-driven projects developed to better understand mortality events include: 1) deployment of temperature data loggers in clam bags at multiple leases to provide detailed, broad coverage of water temperatures, 2) health surveys of cultured clams from commercial leases, and 3) assessment of lease substrate properties using a soils-based approach. Annual workshops allow researchers to present findings/progress and obtain feedback from industry members.

EVALUATION OF THE SUNRAY VENUS CLAM *MACROCALLISTA NIMBOSA* UNDER FIELD NURSERY AND GROWOUT CULTURE CONDITIONS IN FLORIDA. Leslie N. Sturmer[1], John Scarpa[2], Leroy Creswell[3], and **Susan E. Laramore[2].** [1]University of Florida IFAS, 11350 SW 153rd Court, Cedar Key, FL, 32625, USA; [2]Harbor Branch Oceanographic Institute at Florida Atlantic University, 5600 U.S. Highway 1 North, Ft. Pierce, FL, 34946, USA; [3] University of Florida, 8400 Picos Road, Ft. Pierce, FL, 34945, USA.

The sunray venus clam *Macrocallista nimbosa* was commercially fished in Florida during the 1970s. Although natural growth rates were estimated to be high, its patchy distribution limited commercial exploitation. The sunray venus clam is now being evaluated as a potential new aquaculture species to diversify the hard clam culture industry in Florida. In this study, production performance under field nursery and growout conditions was examined. Approximately 118,000 hatchery-produced sunray venus seed (9-18 mm shell length, SL) were field-nursed in soft bottom bags or hard cages at densities of 100-550/ft^2. After 42-119 days, survival ranged from 32-94% with 0.12-0.25 mm/day SL growth. Sunray venus juveniles (27 mm SL; 10 mm shell width, SW) were further cultured in hard cages at densities of 42-55/ft^2. After 11 months, sunray venus (61-67 mm SL, 22-23 mm SW, 30-37 grams total weight, 8.1-9.1 condition index) were harvested for market perception tests. Survival ranged from 50-82%. Production performance of sunray venus grown in soft bags, soft bags with internal frames, and bottom plants for a year at densities of 38-70/ft^2 will also be reported. To date, field nursery and growout culture methods for sunray venus clams are exhibiting little difference from hard clam methods.

SEASONALITY DURING MIOCENE AND PLIOCENE WARM CLIMATE INTERVALS AS RECORDED IN FOSSIL *MERCENARIA* AND *CHESAPECTEN* SHELLS. Donna Surge and **Ann E. Goewert.** University of North Carolina, 104 South Road, CB #3315, Chapel Hill, NC, 27599-3315, USA.

Projections of future global warming predict Earth's mean surface temperature will increase 2-4.5°C by 2100 (IPCC, 2007); therefore, the study of greenhouse climates in the relatively recent geologic past is critically important. The Intergovernmental Panel on Climate Change (2001) indicated "that one would need to return to the early Pliocene…or even the Miocene…to find a climate that is warmer than today by more than 2°C." Fossil shells of the hard clam, *Mercenaria*, and the scallop, *Chesapecten*, from the Mid Miocene Climate Optimum and Middle Pliocene Warm Interval along the US Middle Atlantic Coastal Plain potentially contain valuable paleoclimate information providing insights for 21st century warming.

We combined isotope analysis and sclerochronology to estimate temperature through shell growth. Mid-Miocene *M. ducateli* and *C. coccymelus* shells and mid-Pliocene *M. corrugata* and *C. jeffersonius* shells were analyzed. Growth temperatures in *M. ducateli* ranged from 18.0-34.4°C and were consistent with temperatures estimated from *C. coccymelus*. Estimated temperature from *M. corrugata* ranged from 6.4 to 19.8°C, similar to *C. jeffersonius*. Our data reflect warmer temperatures and diminished mid-latitude seasonality during the Mid Miocene Climate Optimum relative to the Middle Pliocene Warm Interval.

LOUISIANA'S PUBLIC OYSTER FISHERY LIMITED ENTRY PROGRAM. John Tesvich[1], and **John Supan[2].** [1]AmeriPure Oyster Company, Inc., 30300 Highway 23, Buras, LA, 70041, USA; [2]Louisiana State University, 227c Sea Grant Building, Baton Rouge, LA, 70803, USA.

A Louisiana oyster industry initiative in the 2008 regular legislative session established a new "Seed Ground Vessel Permit." The new permit will for the first time institute a limited entry program to Louisiana's public oyster fishery. Louisiana's oyster industry produces over half of the commercial landings of the Eastern Oyster (*Crassostrea virginica*) in the United States. Oyster production in Louisiana is year-round and has two components – one is the open public fishery, where licensed harvesters catch and sell directly from public reefs during proscribed seasons; the other is the harvest from privately leased water bottoms of the state. Over the past decade, the hardships and negative economic impacts experienced within other Gulf Coast fisheries has changed the demographics of the oyster producing sector in Louisiana, as well as in other Gulf Coast states. The shift in fishery demographics has caused an apparent increase in fishing pressure on Louisiana's public reefs, with much of the increase coming from out-of-state boats. The drive for the limited entry program in Louisiana comes approximately four years after the state of Texas established its limited entry program for oyster harvest.

PROGRESS IN RESTORATION OF NEW YORK BAY SCALLOP POPULATIONS. Stephen Tettelbach[1], Christopher F. Smith[2], R. Michael Patricio[2], Kevin Cahill[2], Jeff Chagnon[2], Josh Clauss[2], Neal Stark[2], Ali Donargo[2], Scott Hughes[2], and **Kim Tetraul[2].** [1]C.W. Post Campus of Long Island University, 720 Northern Boulevard, Brookville, NY, 11548, USA; [2]Cornell Cooperative Extension of Suffolk County, 423 Griffing Avenue, Riverhead, NY, 11901, USA.

Bay scallop (*Argopecten irradians irradians*) fisheries in eastern Long Island, New York have remained at 1-2% of historical levels since the last brown tide bloom decimated populations in 1995. We believe the primary reason for the lack of natural recovery of bay scallop stocks is that densities and numbers of bay scallops in most local embayments have been too low to permit high rates of successful fertilization during spawning. In our current work, we have stocked 250,000 to >500,000 scallops each Fall, from 2006-2008, in lantern nets suspended from longlines in Orient Harbor.

Survival rates of 36-50% until the following June has resulted in high numbers of concentrated, spawning adults. Larval recruitment in Orient Harbor increased 3-15X following spawning of our planted scallops compared to the two years before our restoration efforts; juvenile and adult scallop densities in Orient Harbor increased by 13.5X and 3X, respectively, over the same time period. In other unplanted areas, populations did not increase following our restoration efforts in Orient Harbor. These results strongly suggest that spawns of our planted scallops have contributed to increased population sizes in the Orient Harbor area. We anticipate a measurable increase in commercial bay scallop landings in Fall 2008.

DEVELOPMENT OF NON-LETHAL SAMPLING TECHNIQUES FOR OCTOPUS. **Rachel Thompson[1], Shawn Larson[2], Roland Anderson[2],** and **Steven Roberts[1].** [1]University of Washington, 1122 NE Boat Street, Seattle, WA, 98105, USA; [2]Seattle Aquarium, 1483 Alaskan Way, Seattle, WA, 98101, USA.

Octopuses are an important part of our marine ecosystem and provide excellent scientific models to examine behavior and cellular processes. In addition, octopus are major attractions to aquariums and are a preferred food product in some regions. Several species including the Giant Pacific octopus have experienced declines in population levels. These declines hav been attributed to several factors including the deterioration of habitat caused by pollution and large scale climate processes. In order to develop techniques to better evaluate the physiological condition of octopus, non-invasive sampling methods were examined to determine potential effectiveness. Methods include analysis of protein expression in epidermal mucus and associated microbial diversity. Hemolymph analysis was also investigated. Specific methods will be described as well as preliminary results on how modifying environmental conditions affect the expression of new biomarkers. The long-term goal of this research is to provide tools to better assess octopus physiological status in the wild and in captivity.

MICROSATELLITES REVEAL REGIONAL CONNECTIVITY AND SOME LOCALIZED SELF-RECRUITMENT IN THE SPINY LOBSTER *PANULIRUS ARGUS*. **Michael D. Tringali** and **John Hunt.** Florida Fish & Wildlife Conservation Commission, 100 Eighth Avenue S.E., St. Petersburg, FL, 33701, USA.

In an analysis of population connectivity in the spiny lobster (*Panulirus argus*), 12 microsatellite loci were used to genotype specimens from Bermuda, North Carolina, the Bahamas, Fort Pierce FL, Key Largo, FL, Dry Tortugas, Panama City FL, St. Kitts, and St. Croix. Significant differences between allelic distributions were observed for 11 of the 36 tested pairs. Five significant tests involved St. Kitts and the Bahamas, respectively; four involved Key Largo, and three involved St. Croix. Significant q values were observed between some pairs; notably, all q values involving the Bahamas sample were high. There was evidence of spatial structure among individual genotypes in factor maps – the principal axis accounted for 36% of the total variance and dimensional ordination was associated with sample membership in several cases. Little if any spatial overlap was observed among members of samples from the Bahamas, St. Croix, St. Kitts, and Key Largo, respectively. Our results indicate that spiny lobsters are interconnected by gene flow in locations along the coastal United States. However, differences in allele frequencies, trends in fixation indices, and spatial discreteness of genotypes among the above-noted sample locations provides preliminary evidence for a degree of regional or perhaps localized self-recruitment in some areas.

ULTRASTRUCTURAL MORPHOLOGY OF *HEMATODINIUM* SP. FROM THE BLUE CRAB *CALLINECTES SAPIDUS*. **Sue Tyler** and **Gretchen Messick.** NOAA - CCHEBR - COL, 904 S. Morris Street, Oxford, MD, 21654, USA.

The mission of the Cooperative Oxford laboratory is to evaluate and identify actions that will protect, restore and secure the health of threatened coastal marine ecosystems. *Hematodinium* spp. are parasitic syndinid dinoflagellates that invade hemolymph and other tissues of crustacean hosts causing epizootics in commercially important crustaceans around the world. *Hematodinium* sp. infects and kills blue crabs *Callinectes sapidus* from high salinity waters along the Atlantic and Gulf coasts of USA including the Chesapeake Bay. Little is known about how *Hematodinium* spp. stresses crustaceans to become moribund and die. Most dinoflagellate life cycles involve heteromorphic stages. The life cycle of *Hematodinium* sp. in blue crabs has not been fully described despite documentation of several morphologically distinct stages of the parasite observed with light microscopy. The purpose of this study is to utilize Scanning and Transmission electron microscopy to elucidate the finer ultra structural detail and morphology of different life stages of the parasite in the blue crab. As more stress is being placed on fragile coastal ecosystems, it is becoming more important to understand the life cycle of organisms and provide scientists and managers with more information to make informed decisions regarding management strategies.

THE EFFECT OF COLD EXPOSURE ON MORTALITY IN THE ASIAN GREEN MUSSEL *PERNA VIRIDIS*: IMPLICATIONS FOR POTENTIAL RANGE EXPANSION. **Alyson Urian** and **Matt Gilg.** University of North Florida, 1 UNF Drive, Jacksonville, FL, 32224, USA.

Cold tolerance is an important limiting factor in the range expansion of tropical exotic species. This study examined the effects of cold exposure on mortality in *Perna viridis*. Experiments

were conducted on two size classes: new recruits (15-45mm) and individuals that had survived at least one winter (75-105mm). Mussels were exposed to two sub-optimal water temps (10°C, 3°C) and three sub-optimal air temperatures (7°C, 0°C, -10°C) for 30 days and two hours, respectively. Control mussels were maintained at 14°C.

There was no significant difference in mortality between sizes when exposed to sub-optimal water temperatures. Exposure to 10°C water temperatures elicited a two-fold decrease in average time to death. All mussels exposed to 3°C water died within 24 hours. Significant differences in mortality between sizes were observed during aerial exposures. Small mussels lived longer than large mussels at 14°C, and vice versa at 7°C. Average time to death at 0°C air temperature was nearly 50% quicker than controls for small mussels, while no significant difference was observed for large mussels. All mussels exposed to -10°C air died within 48 hours. Based on these data, green mussels are expected to experience winter die-offs as far south as Georgia and northern Florida.

HOST-PATHOGEN INTERACTIONS AND PROTEOLYTIC ACTIVITY IN *PERKINSUS MARINUS* CHALLENGED EASTERN OYSTERS. **Caitlin F. Vaughn, Dina A. Proestou,** and **Marta Gomez-Chiarri.** University of Rhode Island, 9 East Alumni Avenue, 20A Woodward Hall, Kingston, RI, 02881, USA.

Matrix metalloproteinases (MMPs) have been implicated in important physiological processes in vertebrates. In oysters, MMPs play a role in immunity, hemocyte migration, and shell formation. The ability to accurately measure oyster MMP activity is fundamental to understanding their functions in host-pathogen interactions and innate immunity. One challenge to characterizing MMP activity *in vivo* is the confounding effect of pathogens, which have proteases that can interfere with measurements of MMP activity. Increases in proteolytic activity in oyster serum after challenge with *Perkinsus marinus* were coupled with decreases in oyster MMP protein, suggesting that parasite proteases may degrade oyster MMPs. In order to understand these interactions, we are developing tools to differentiate host responses to challenge from parasite protease activity, such as screening synthetic substrates and inhibitors for *P. marinus* extracellular protein and oyster MMP activity. Preliminary results from substrate profiling experiments suggest that oyster MMPs degrade similar substrates as vertebrate MMP-12 and -13, while inhibitor studies show that they are inhibited by 1,10-phenanthroline but not the broad-spectrum MMP inhibitor GM6001. Finding the best substrates and inhibitors will allow us to look at the individual contributions of both host and pathogen proteases, ultimately leading to a better understanding of disease in oysters.

SEASONAL DYNAMICS OF *PERKINSUS MARINUS* DISEASE, REPRODUCTION AND RECRUITMENT OF OYSTER, *CRASSOSTREA VIRGINICA*, IN SW FLORIDA ESTUARIES. **Aswani K. Volety[1], Lesli Haynes[1], Lacey Smith[1], Brooke Denkert[1], Patricia Sime[2], Patricia Goodman[2],** and **Peter H. Doering[2].** [1]Florida Gulf Coast University, 10501 FGCU Boulevard, Fort Myers, FL, 33965, USA ; [2]South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, FL, 33406, USA.

Alterations in freshwater inflow, resulting from watershed development and water management practices, have impacted salinity and water quality within southwest Florida estuaries, thereby affecting responses of valued ecosystem components, such as oysters. This study investigated the effects of seasonal changes, watershed management, freshwater inflows, and salinities on oyster responses in the Caloosahatchee River, Florida. Significant relationship exists between freshwater inflows and salinities in the estuary (R^2 69 - 84%). Prevalence and intensity of *Perkinsus marinus* infection varied over the sampling period and decreased with increase in freshwater inflows and lower salinities. While the prevalence tended to be high (0 – 100%), mean intensity was low (~1.5/5.0). While oyster spat were flushed downstream during high flow seasons, recruitment and juvenile oyster survival was low due to predation during drought years. It appears that the lower intensity of disease may be due to the interactive effects of temperature and salinity. Inflows between 500 and 3,500 cubic feet per second would result in optimal salinities that would support and enhance oyster reefs in the Caloosahatchee estuary. Reduced freshwater inflows into the estuaries during the spawning months (May – October) will facilitate the spat recruitment onto oyster reefs.

SIZE DEPENDENT SUSCEPTIBILITY OF JUVENILE *MERCENARIA MERCENARIA* MORTALITY AND SHELL GROWTH TO OCEAN ACIDIFICATION. **George G. Waldbusser[1], Mark A. Green[2],** and **Heather Bergschneider[1].** [1]University of Maryland Center for Environmental Science, One Williams Street, P.O. Box 38, Solomons, MD, 20688, USA; [2]Saint Joseph's College of Maine, 278 Whites Bridge Road, Standish, ME, 04084, USA.

Coastal and estuarine habitats are susceptible to acidification from a variety of anthropogenic sources including atmospheric carbon dioxide, changes to freshwater input, acid rain, and eutrophication/respiration in coastal waters. Increased acidity results in decreased availability of calcium carbonate for shell forming organisms. Furthermore, coastal sediment porewater is usually more acidic than overlying water resulting in decreased availability of calcium carbonate. Therefore, shell-forming, sediment-dwelling bivalves must build shell in biogeochemically unfavorable conditions.

We have utilized experimental laboratory techniques to quantify mortality and shell growth of the hard clam *Mercenaria*

mercenaria under different levels of acidity. Measurements of mortality and calcification were made on juvenile *M. mercenaria* from 0.2 mm to 2.0 mm under three different levels of acidity. Mortality was measured in experimental cores over roughly two weeks where the acidity was manipulated within a thin layer of sediment. Shell growth/dissolution was measured by alkalinity change in bottle incubations due to calcium carbonate precipitation over hours. Both mortality and calcification were negatively affected by increased acidity, and these effects were less pronounced in larger juveniles. The implications of these findings will be discussed in terms of coastal acidification and population dynamics of these ecologically and commercially important bivalves.

SESSILE INVASIVE SPECIES ON INTERTIDAL OYSTER REEFS IN FLORIDA. **Linda Walters[1], Matthew Gilg[2], Ethan Nash[1], Kimberley Schneider[1],** and **Eric Hoffman[1].** [1]University of Central Florida, 4000 Central Florida Boulevard, Orlando, FL, 32816, USA; [2]University of North Florida, Jacksonville, FL, 32224, USA.

On the east coast of central/north Florida, two non-native, sessile species (charru mussel *Mytella charruana*, green mussel *Perna viridis*) have recently been documented on intertidal reefs of the eastern oyster *Crassostrea virginica*. While the numbers of *Perna* remain low on these oyster reefs, the number of oyster reef-dwelling *Mytella* initially increased exponentially after the invasion in the Indian River Lagoon (central Florida) in 2004 to the current distribution in which *Mytella* is found almost exclusively on man-made, submerged structures in north Florida. To understand these patterns, we have run experiments to: 1) determine how well *Mytella* survives when exposed to air in the laboratory, and 2) recruitment preferences of mussels on natural (shells of oysters, *Mytella*, ribbed mussels) versus man-made (tile, wood, plexiglass) substrates in the field. Small *Mytella* (shell length: < 19 mm) were able to survive 24 hours out of water at 21° C, while larger individuals survived after four days of continuous air exposure. New recruits of *Mytella* and *Perna* preferentially settled on natural materials, including oyster shells. These data, combined with numerous other studies on the biology and ecology of these non-natives, will be essential for managers charged with protecting oyster reef ecosystems.

FIELD TEST OF TRIPLOID OYSTERS, *CRASSOSTREA VIRGINICA*, ON MASSACHUSETTS SHELLFISH FARMS: FIRST YEAR PERFORMANCE. **William C. Walton[1]** and **Diane C. Murphy[2].** [1]Auburn University, Auburn University Shellfish Laboratory, 150 Agassiz Street, Dauphin Island, AL, 36528, USA; [2]Cape Cod Cooperative Extension & Woods Hole Sea Grant, 1 Railroad Avenue, Barnstable, MA, 02630, USA.

In response to increased interest in raising triploid native oysters, *Crassostrea virginica*, by Massachusetts shellfish farmers, we initiated a comparative field test of triploid and diploid oysters, spawned and reared at a local hatchery coincidentally. Twelve shellfish farmers accepted delivey of > 6 mm oyster seed in July 2008 and raised them using common gear and techniques. At a minimum, each farmer began with six replicate bags (each stocked with ~500 oysters), each of triploid and diploid oysters, which were cultured in dual level racks. We present the results of our initial sampling ~5 months after deployment. Analysis of samples is currently underway, but there were clear differences in survival and growth even after five months due to both ploidy and rack level. There were also striking differences among sites. While triploidy is generally thought to provide improved performance due to sterility, these differences suggest that triploid oysters may perform better under certain culture conditions even in the first year.

CONSTRUCTION OF A HIGH-DENSITY GENETIC LINKAGE MAP OF EASTER OYSTER (*CRASSOSTREA VIRGINICA*) AND MAPPING OF DISEASE-RESISTANCE GENES. **Yongping Wang** and **Ximing Guo.** Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ , 08349, USA.

The identification and mapping of disease-resistance genes are important for marker-assisted selection. We constructed a high-density genetic linkage map and used it to identify disease-resistance genes in the eastern oyster *Crassostrea virginica*. A backcross family was produced and deployed for field exposure to diseases. Oysters were sampled before (100) and after (100) a mortality episode that was primarily caused by Dermo. Fourteen selected amplified fragment length polymorphism (AFLP) primer pairs were screened in the mapping family producing 1,656 fragments with776 segregating. A total of 356 co-dominant markers were screened, of which 201 (158 MS and 43 SNPs) segregated. All segregating markers, 776 AFLPs and 201 co-dominants, were used to build a sex-average map with JoinMap 4.0 using a CP model. The resulting map consisted of 914 markers in 10 linkage groups in accordance to the haploid number. The map had a total genetic length of 1051 cM, with an average marker interval of 1.15 cM. Markers showing significant post-mortality shifts in genotype frequency formed 13 clusters on the genetic map, suggesting the shifts are not random but linked to disease-resistance genes and there are at least thirteen loci involved in Dermo-resistance in the eastern oyster.

AN OVERVIEW OF RECENT SHELLFISH INITIATIVES AND ACTIVITIES IN NORTH CAROLINA. **Ami E Wilbur.** University of North Carolina Wilmington, 5600 Marvin K. Moss Lane, Wilmington, NC, 28409, USA.

The combination of over-fishing, habitat degradation, predators, and disease have locally extirpated populations or drastically reduced numbers of the eastern oyster, *Crassostrea virginica* in

many of North Carolina's estuaries. Restoration, largely through protection and habitat reconstruction, has been a focus, first under the auspices of the State Oyster Rehabilitation Program, and more recently under the supervision of the Resource Enhancement Section of the NC Division of Marine Fisheries. Additional and cooperative partnerships with other state, federal, university, and NGOs groups have expanded these efforts and oyster landings have shown a notable increase since 2000. Other activities, including NC Sea Grant's Fisheries Resource Grant program (since 1994), Oyster Shell Recycling program (since 2003), North Carolina Shellfish Growers Association (since 1995), the Under Dock Oyster Culture (UDOC since 2005) North Carolina Hatchery Program (since 2005), and statewide settlement monitoring (since 2005) have heighten awareness of the oyster's importance to coastal ecosystems and foster interest in aquaculture. Recent legislative initiatives have increase support for the oyster sanctuary program, expanded existing research programs to include shellfish, and allocated funds for the construction of a shellfish research hatchery to further support efforts to restore and enhance NC shellfish resources.

RECOMBINANT *MYTILUS EDULIS* HISTONE H1 EXHIBITS ANTIMICROBIAL ACTIVITY. Dionna Williams and **Maureen Krause.** Hofstra University, Hofstra University, Hempstead, New York, 11549, USA.

Innate immunity represents an evolutionarily conserved defense system in metazoan animals, and as such it is hypothesized that specific protein-mediated mechanisms are broadly phylogenetically distributed and derive from highly conserved proteins. The linker histone Histone 1 (H1) is historically classified according to its DNA binding role in chromatin formation, but several recent studies indicate that histones, including H1, display antimicrobial activity in taxa as diverse as shrimp and humans. Here, a putative antimicrobial role has been assigned to histone H1 from the blue mussel, *Mytilus edulis*. The gene encoding H1 protein was successfully amplified from both genomic DNA and cDNA in *M. edulis* yielding a 570 nucleotide sequence encoding an inferred 190 amino acid protein. The recombinant protein (meH1) was successfully expressed and isolated, yielding a 22 kD protein that matches the predicted size. Preliminary data from mobility shift and antimicrobial functional assays suggest that meH1 binds DNA and inhibits bacterial growth of both gram positive and gram negative bacteria (*M. luteus* and *E. coli*, respectively). The potential for the characterization and extracellar localization of endogenous H1 in mussel hemocytes is currently under study. Our data lend support to the hypothesis that histones may be an integral and well conserved component of the innate immune response in metazoans.

THE GENETIC DIVERSITY OF BLUE CRAB MEGALOPAE ENTERING THE CHESAPEAKE BAY AND THE POTENTIAL NEED FOR CROSS-STATE FISHERIES REGULATIONS. Ernest Williams and **Allen R Place.** University of Maryland Biotechnology Institute, 701 East Pratt Street, Baltimore, MD, 21202, USA.

Megalopae of the blue crab *Callinectes sapidus* enter into the Chesapeake bay as a discreet swarm following pelagic larval development. Although the physical characteristics of these swarms have been studied their genetic makeup has not been investigated. We took a small sampling of 32 megalopae in the summer of 2006 from the mouth of the Chesapeake Bay during a nocturnal swarm and isolated DNA from each individual. The samples were then genotyped using a mitochondrial marker inside the ND2 open reading frame as well as four microsatellite loci. The individuals were genetically distinct with only two groups of two megalopae sharing the same ND2 sequence and none sharing microsatellite alleles at all four loci, which is similar to previous samplings of adult and juvenile crabs. The megalopae were also statistically different from a winter dredge sampling of adults by DNR in January 2006 and a sampling of juveniles in the summer of 2007. These data show that ingressing populations of blue crabs represent multiple spawnings and are similar in diversity to extant populations. Also, these data support the hypothesis that spawnings from different estuaries mix during pelagic larval development.

SALINITY TOLERANCE OF *ARGOPECTEN IRRADIANS AMPLICOSTATUS* FROM THE UPPER LAGUNA MADRE, TEXAS. Kim Withers and **Jacqueline Staggs.** Texas A&M University-Corpus Christi, 6300 Ocean Drive, Unit 5866, Corpus Christi, TX, 78412, USA.

The distribution of *Argopecten irradians amplicostatus*, the subspecies of bay scallop indigenous to Texas, is largely restricted to the hypersaline Laguna Madre. Upper Laguna Madre populations "boom" about every 10 years, and there appears to be a relationship between slight declines in annual mean salinity and increased population size. "Stress" experiments were conducted to determine the salinity tolerance of the subspecies. Scallops were collected from salinities ranging from 35 to 45 PSU and acclimated to laboratory conditions for two weeks at 35-36 PSU and 25° C. In an initial experiment 5, 10, 20, 30, 40, 50, 60 PSU at 25° C were tested. In two subsequent modified experiments, 20, 25, 30, 35, 40, 45, 50 PSU at 25° C were tested. Mortality was swift at 5, 10 and 60 PSU, occurring within 24 hrs. Mortality was also 100% at 20 PSU but the time varied between experiments. Mortality at 25 PSU varied. Mortality at 50 PSU was 70%. This subspecies appears to be adapted to higher salinities with little or no mortality between 30-45 PSU. The ability to withstand salinities higher and lower than this range may be related to scallop size.

CRYOPRESERVATION OF GAMETES, EMBRYOS, AND LARVAE IN SHELLFISH. **Huiping Yang** and **Terrence R. Tiersch.** Aquaculture Research Station, Louisiana State University Agricultural Center, 2410 Ben Hur Road, Baton Rouge, LA, 70803, USA.

Cryopreservation is a useful technique that can be applied to preservation of endangered species, maintenance of specific strains or lines for breeding programs, and preservation of genetic resources for biodiversity. The first successful sperm cryopreservation was in fowl in 1949. For shellfish, sperm cryopreservation was first reported in the Pacific oyster *Crassostrea gigas* in 1971. To date, there are a total of 44 research papers published on cryopreservation in molluscan species, and 17 in crustacean species. The mollusks include oysters, mussels, clams, and abalones, and the crustaceans include shrimps and crabs. The materials used for cryopreservation were sperm, oocytes, embryo, and early swimming larvae. As a general rule, cryopreservation involves a series of steps including sample collection, sample extension (dilution), cryoprotectant selection, cooling, storage, thawing, use for fertilization and viability evaluation. Development of protocols for cryopreservation requires suitable choices at each step and consideration of the interactions among factors. Currently, the protocols described in the published reports of shellfish cryopreservation vary significantly, and there are no reports of application in commercial production. Future research should focus on development of standardized and reliable protocols for high post-thaw viability and high-throughput application.

POPULATION GENETICS OF BENTHIC CRUSTACEANS: CAN WE TALK ABOUT SELECTION NOW? **Bree K. Yednock** and **Joseph E. Neigel.** University of Louisiana at Lafayette, 300 East St. Mary Boulevard, Lafayette, LA, 70504, USA.

For the past 25 years, the paradigm for the population genetics of benthic crustaceans has been that gene flow resulting from planktonic dispersal is the dominant microevolutionary force acting on genetic population structure. One corollary of this assumption is that gene flow overpowers selection such that local adaptation cannot occur. A second corollary is that genetic differentiation among populations with planktonic dispersal is caused by physical oceanographic barriers that prevent dispersal. Challenges to this assumption have come from two directions. First, it is now widely recognized that planktonic larvae do not necessarily imply widespread, effective dispersal. Larval behavior, coupled with spatial and temporal heterogeneity in oceanographic conditions, can result in much shorter dispersal distances than would be expected from passive particles. Second, population genetic surveys of crustacean species have revealed genetic patterns that are difficult to explain under a paradigm of high gene flow. We review these findings, present the evidence for natural selection as an explanation, and consider the implications for conservation and management.

ASSESSMENT OF OYSTER SHELL STRUCTURAL PROPERTIES FOR THE DEVELOPMENT OF 'GREEN' COMPOSITE MATERIALS. **Yuhchae Yoon[1], Andrew S. Mount[2], Douglas C. Hansen[1],** and **Karolyn M. Hansen[1].** [1]University of Dayton Research Institute, Dayton, OH, 45469, USA; [2]Clemson University, Clemson, SC, 29634, USA.

The delicate and extremely efficient natural materials produced by organisms in the process of bio-mineralization are widely recognized as inspiration for new novel materials because of their unique properties and their hierarchical order often over several length scales. The molluscan shell formation process is a promising model for development of bio-inspired composites for a wide variety of applications in fields as varied as adaptive surface coatings, corrosion inhibition, hybrid composite materials and more. Recently, a novel mechanism for biomineralization and shell formation in the Eastern oyster (*Crassostrea virginica*) has been elucidated that involves a cellular-mediated process that had previously been unknown. Polycrystalline calcitic mineral deposition by oyster blood cells has been demonstrated in the laboratory with the resultant formation of ceramic films and multilayer coatings on various metallic substrates. In the present study, we now characterize the native oyster shell material in terms of electrochemical and thermal properties in order to determine the potential for using oyster composite material as 'green' environmentally-friendly coatings.

A SEXUAL COMPARISON OF PROSTAGLANDIN E TITERS IN DIPLOID VERSUS TRIPLOID *CRASSOSTREA VIRGINICA*. **Esther Young, Shana Garrett, John Supan,** and **John Lynn.** Louisiana State University, 107 LSB, Baton Rouge, LA, 70803, USA.

Prostaglandin E (PGE) titers have been correlated with ovarian maturation and estradiol concentrations in diploid *Crassostrea virginica* (Lynn *et al.*, 2006). In this research, prostaglandin E (PGE) titers associated with male and female diploid and triploid non-reproductive *C. virginica* were assayed using Prostaglandin E Metabolite EIA kits (Cayman Chemicals). Diploid and triploid *C. virginica* were grown to the same average height and weight at the Sea Grant Bivalve Hatchery in Grand Isle, LA. In March, hemolymph was taken from 23 diploid and 23 triploid *C. virginica*. Hemolymph samples were frozen in liquid nitrogen, and transported to a laboratory in Baton Rouge, LA for analysis of PGE titers. Sampled oysters were measured for height, weight, sex and assessed for gonadal condition. In both diploid and triploid *C. virginica*, females predominated the sex ratio. There was a higher incidence of indifferent gonads in the triploid cohort and a greater number of diploid males. Triploid male and female oysters showed decreased PGE titers than diploid males or females. In indifferent *C. virginica*, PGE titers were higher for triploids than diploids, but approximately equal to triploid females. We hypothesize lower PGE levels in triploid *C. virginica* may reflect low fecundity observed in triploid populations.

POSITIVE SELECTION IN BIG DEFENSIN OF THE EASTERN OYSTER (*CRASSOSTREA VIRGINICA*). Haiyang Yu, Xiaoxue Wang, and **Ximing Guo.** Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08345, USA.

Big defensin (BD) is an antimicrobial peptide (AMP) that was first discovered in hemocytes of the Japanese horseshoe crab. It has remarkable microbicidal activity against Gram-positive, Gram-negative bacteria and fungi. A gene similar to BD has been identified in the eastern oyster (*Crassostrea virginica*). To further characterize the oyster BD gene, we sequenced its full-length cDNA in 30 oysters from diverse geographical populations. Alignment of the sequences revealed 21 single-nucleotide polymorphisms (SNPs) in the 369 bp coding region, or about one SNP per 18 bp. Of these, 19 SNPs were non-synonymous, and only two were synonymous. The surprisingly high non-synonymous:synonymous (Dn/Ds) ratio, 9.5, suggests that the BD gene is under strong positive selection in the eastern oyster. To determine whether the selection was due to MSX and Dermo diseases (caused by *Haplosporidium nelsoni* and *Perkinsus marinus*, respectively), we selected one synonymous and five non-synonymous SNPs for association studies. Genotyping assays are being designed and optimized using allele-specific amplification. Before and after disease-inflicted mortality samples have been collected for association studies. We hope to determine whether certain alleles of BD can survive the diseases better than others, therefore confirming their role in disease resistance in the eastern oyster.

ASSESSING GENETIC DIVERSITY AND INDIVIDUAL ASSIGNMENT FOR SELECTED AND WILD POPULATIONS OF EASTERN OYSTER USING MICROSATELLITE MARKERS. Hong Yu and **Ximing Guo.** Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

Twelve microsatellites were used to study genetic variation and divergence in five selected and two wild populations. The selected populations included Haskin NEH (NEH), Haskin CROSBreed (XB06), Andrews DEBY (DB05), Frank M Flower's stock (FMF06) and University of Maine stock (UMFS), and the wild populations were from Delaware Bay (DBW) and Connecticut (CTW). Forty-eight individuals were analyzed from each population. The average number of allele per locus ranged from 4.7 to 15.3 and average expected heterozygosity from 0.631 to 0.808 across populations. Allelic richness was significantly lower in selected (4.6 – 7.4) than in the wild (14.8 – 14.9) populations. Bayesian self-assignment of the seven populations was achieved with 12 microsatellites and at 93% accuracy. Incorrect assignment mostly occurred in the wild populations. Combining the two wild populations increased the assignment accuracy to 99.4%. When the wild populations were removed, the selected populations were self-assigned at a high accuracy of 99.7% with only seven markers. In addition, progeny from two selected populations (FMF and NEH) were tested and assigned to their parental populations at 100% accuracy using the five selected lines as references. Our study shows that all selected populations have significantly reduced genetic diversity and can be distinguished with microsatellite markers.

OVER-WINTER MORTALITY OF SELECTED AND NON-SELECTED JUVENILE *MERCENARIA*. Chester B. Zarnoch. Baruch College, City University of New York, 17 Lexington Avenue, Box A-0506, New York, NY, 10010, USA.

The northern quahog, *Mercenaria mercenaria*, aquaculture industry in the Northeast US and Atlantic Canada often experiences significant loss of juveniles during the over-winter period. The causes of these mortalities remain poorly understood. Recently, Bricelj *et al*. (2006) has found progressive mortality of juvenile clams held at 1°C in laboratory trials. In addition, greater mortality was observed in selected *Notata* variety clams than clams produced from native broodstock. A field study was conducted in order to further evaluate differences in mortality between selected and non-selected juvenile clams and to identify changes of proximate biochemical composition during the over-winter period. Selected and non-selected hard clams were produced in a hatchery, cultured similarly through the growing season, and planted in sediment filled boxes that were sampled during the over-winter period. Mortality increased as the winter progressed and then stabilized in the spring. Selected clams had significantly greater mortality (47.9%) than non-selected (25.18%). Both varieties experienced significant decreases (ANOVA; $P < 0.0001$) in carbohydrate and protein content. Surviving selected clams showed greater growth than the non-selected in early spring. This study corroborates the results of previous laboratory trials and provides additional evidence for genotype dependent over-winter mortality.

MAPPING QUANTITATIVE TRAIT LOCI AFFECTING DERMO AND MSX INFECTION IN THE EASTERN OYSTER *CRASSOSTREA VIRGINICA*. Liusuo Zhang, David Bushek, Susan E. Ford, and **Ximing Guo**. Rutgers University, 6959 Miller Avenue, Port Norris, NJ, 08349, USA.

Dermo and MSX, caused by the parasites *Perkinsus marinus* and *Haplosporidium nelsoni*, respectively, are two major diseases of the eastern oyster. Quantitative trait loci (QTL) associated with infection by both diseases were identified and mapped in an F2 family. The family was deployed for field exposure to both diseases, and 94 individuals with varying degrees of MSX and Dermo infection were genotyped with 460 AFLPs (amplified fragment length polymorphisms) and 92 microsatellite markers. Linkage analysis produced integrated and sex specific maps with 10 linkage groups in accordance with the haploid number. The integrated map contained 422 markers with a total length of 1070 cM. Sex-specific maps (200 markers and 766 cM for male, and 162 markers and 982 cM for female) were used for composite interval mapping.

Two QTLs affecting Dermo infection were identified on the male map. Three suggestive QTLs for MSX infection were identified, one on the female and two on the male map. Two of the MSX-infection QTLs were mapped to the same regions as two Dermo-infection QTLs identified in another study with laboratory-based challenges. Our results suggest that some loci may influence both MSX and Dermo infections in the eastern oyster.

***IN SITU* DETERMINATION OF BIODEPOSITION BY THE EASTERN OYSTER *CRASSOSTREA VIRGINICA* IN AN INTER-TIDAL SYSTEM, ATLANTIC CANADA.** **Yi Zhou[1], Jonathan Grant[1], Lin Lu[1], André L. Mallet,** and **Jeff Barrell[1].** [1]Dalhousie University, 1355 Oxford Street, Halifax, Nova Scotia, B3H 4J1, Canada; [2]Mallet Research Services Ltd., 4 Columbo Drive, Dartmouth, Nova Scotia, B2X 3H3, Canada.

Inter-tidal coast zone are an important habitat for many suspension feeding bivalve species, such as oyster, mussel, and clam, which may play a pivotal role in benthic-pelagic coupling in this system. So far, little work has been designed for in situ determination of biodeposition by suspension-feeding bivalves in intertidal zone. The objective of the present work was to design an *in-situ* method to measure biodeposition by intertidal suspension-feeding bivalves; also, to understand the role of the intertidally cultured Eastern oyster *Crassostrea virginica* in material and nutrient cycling in an intertidal system, Saint Simon Bay, Atlantic Canada; and to understand the potential interaction between oysters and eelgrass (*Zostera marina*). Results showed that the *in situ* method designed for intertidal-oyster biodeposition in the present study was effective and feasible. The biodeposition rates of the Eastern oyster *C. virginica* were relatively high, and exhibited marked seasonal variation. The allometric relationship between biodeposition rate (BDR; g/ind·d) and dry tissue weight (W; g/ind) of *C. virginica* was modeled using the formula: $BDR = aW^b$. Being an important intertidal cultured species in Saint Simon Bay, the large-scale aquaculture of *C. virginica* may play an important role in benthic-pelagic coupling in Saint Simon Bay ecosystem.