30th MILFORD AQUACULTURE SEMINAR

February 8-10, 2010

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Milford CT, 1937
Photo by J. Luchor

In Cooperation With
U. S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Milford Laboratory
Milford, Connecticut 06460

Abstract Printing Supported by the Cooperative State Research, Education and Extension Service (CSREES), U. S. Department of Agriculture, under Grant Number 2007-38500-18589 awarded to the Northeastern Regional Aquaculture Center at the University of Maryland at College Park

30TH MILFORD AQUACULTURE SEMINAR

COURTYARD BY MARRIOTT

780 BRIDGEPORT AVE

SHELTON CT 06484

AGENDA

Monday, February 8th

Interactions of Shellfish Aquaculture and the Environment: Focus on the Northeastern U.S.

12:30-4:30 pm	P. 1	Habitat impacts of shellfish aquaculture	Robert Rheault ECSGA
	P. 2	Addressing the interaction of shellfish aquaculture activity and submerged aquatic vegetation: Implications for resource managers and industry	Tessa Getchis CT Sea Grant
	P. 3	Quantifying ecosystem interactions of molluscan aquaculture: The challenge of linking glass -fiber filters to global finance	Gary Wikfors NOAA Milford Lab
	P. 4	Effects of clam farming on motile fauna: Preliminary results from New Jersey and Virginia	John Kraeuter Rutgers Haskin Shellfish Lab
	P. 5	Heavy metals in farmed oysters and clams from the Atlantic Coast of the U.S.	Dale Leavitt Roger Williams University

Poster Social and 30th Anniversary Celebration

7:00-10:00 pm	P. 6	Field trials of genetic lines of bay scallops (*Argopecten irradians*)	Joseph Choromanski NOAA Milford Laboratory
	P. 7	Metal concentrations in the sediment of the lower Housatonic River estuary	Joshua Conklin SCSU
	P. 8	Prevalence of disease, growth abnormalities and tissue metal contents in Eastern oysters along the Connecticut coastline	Gabriel N. Geist Sound School
	P. 9	Determining the feasibility of phycobilins as a substitute for Red Dye 40	Dominik Luckey BRAVAS
	P. 10	Chronic toxicity of diphenhydramine hydrochloride (Benadryl™) to fatmucket mussels	Jeffery R. Meinertz USGS
	P. 11	A new Aquatic Diagnostic Laboratory at Roger Williams University	Roxanna Smolowitz Roger Williams University
	P. 12	DNA-based research with bay scallops: A collaboration between NOAA and Yale University with an outreach component	Sheila Stiles NOAA Milford Laboratory
	P. 13	Recent progress in selective breeding of the bay scallop, *Argopecten irradians*	Sheila Stiles NOAA Milford Laboratory

Tuesday, February 9th

8:00- 8:30 am		CONTINENTAL BREAKFAST	
8:30- 8:50		Opening remarks, welcome and introduction	Walter Blogoslawski and Chris Brown NOAA Milford Laboratory
8:50- 9:10	P. 14	Focus on sustainability: Advancing a new federal policy for marine aquaculture	Michael Rubino NOAA Aquaculture Prog.
9:10- 10:00	P. 15	Effectiveness of restocking and stock enhancement in Florida: Case studies with common snook, red drum and bay scallops	Ken Leber Mote Marine Laboratory
10:00- 10:15	P. 16	Strategies to restore oyster populations in two salt ponds on Martha's Vineyard	Richard Karney Martha's Vineyard Shellfish Group
10:15- 10:30	P. 17	The power of the volunteer in community based shellfish restoration	Gef Flimlin Rutgers Coop. Extension
10:30- 10:45		BREAK	
10:45- 11:00	P. 18	An overview of the history, recent research, and restoration of the Olympia oyster (*Ostrea lurida* Carpenter 1864) on the west coast of the United States	Kay McGraw NOAA Restoration Center
11:00- 11:15	P. 19	Status of oyster culture in the Chesapeake	Standish Allen VIMS
11:15- 11:30	P. 20	Measuring ecological impact of shellfish cultivation and harvest - experimental design and effects on benthic biota	Ronald Goldberg NOAA Milford Laboratory

11:30-11:45 am	P. 21	Measuring ecological impact of shellfish cultivation and harvest - effects on sediment biogeochemistry	Shannon Meseck NOAA Milford Laboratory
11:45-12:00	P. 22	The effects of biogenic oyster reefs on infaunal and epifaunal community structure in Rhode Island estuaries	Todd Massari Roger Williams University
12:00-1:15		WORKING LUNCH	
1:15-1:30	P. 23	FLUPSY observations and measurements, an update: Quantifying interactions with the local environment	Mark S. Dixon NOAA Milford Laboratory
1:30-1:45	P. 24	Quantifying the ecological interactions of a commercial oyster nursery: Observations from mesocosms	Yaqin (Judy) Li NOAA Milford Laboratory
1:45-2:00	P. 25	A preliminary trial of the use of adult surrogates to determine hemocyte-immune status of oyster seed in a FLUPSY-based nursery	April Croxton NOAA Milford Laboratory
2:00-2:15	P. 26	Homeostatic capabilities of oyster hemocytes exposed to acidic conditions *in vivo* and *in vitro*	Gary Wikfors NOAA Milford Laboratory
2:15-2:30	P. 27	Overview of aquaculture drug approvals and the Upper Midwest Environmental Sciences Center	Jeffery R. Meinertz USGS
2:30-2:45	P. 28	Are disease-resistant lines superior performers in Rhode Island oyster farms?	Kathryn Markey University of Rhode Island
2:45-3:00	P. 29	Disseminated neoplasia in hard clams (*Mercenaria mercenaria)* aquacultured in Massachusetts	Roxanna Smolowitz Roger Williams University

3:00-3:15 pm	P. 30	Potential mechanisms by which a prospective probiotic bacterium can improve survival of oyster larvae (*Crassostrea virginica*): Competitive exclusion or immune regulation	Diane Kapareiko NOAA Milford Laboratory
3:15-3:30		BREAK	
3:30-3:45	P. 31	Interstate Shellfish Sanitation Conference (ISSC) *Vibrio* management plans, how they impact industry	Michael Hickey MA Div. of Mar. Fisheries
3:45-4:00	P. 32	An update on the status of food safety legislation pending before Congress	Brian Ronholm Congresswoman Rosa L. DeLauro's office
4:00-4:15	P. 33	Advances in methods for the detection of *Vibrio parahaemolyticus* in seafood samples	Marta Gomez-Chiarri University of Rhode Island
4:15-4:30	P. 34	Multi-faceted research on high pressure processed hard clams (*Mercenaria mercenaria*) for commercial application	Gef Flimlin Rutger's Coop. Extension
4:30-4:45	P. 35	Industry response to FDA's proposed raw oyster ban	Robert Rheault ECSGA
4:45-5:00		Discussion	Panel
		DINNER ON YOUR OWN	
7:00-10:00		**East Coast Shellfish Growers Association Meeting**	

Wednesday, February 10th

8:00-8:30am		CONTINENTAL BREAKFAST	
8:30-8:45	P. 36	30 years of the Milford Aquaculture Seminar	Walter Blogoslawski NOAA Milford Laboratory
8:45-9:15	P. 37	Seventy-five years of observations of the shellfisheries	Clyde MacKenzie NOAA; James J. Howard Marine Sciences Lab.
9:15-9:30	P. 38	Update on ECSGA activities in 2009	Robert Rheault ECSGA
9:30-9:45	P. 39	Navigating the permitting process for shellfish aquaculture and related activities in Long Island Sound	Tessa Getchis CT Sea Grant
9:45-10:00	P. 40	Best management practices for the US East Coast shellfish aquaculture industry: An industry-driven approach	Sandy Macfarlane Coastal Resource Spec.
10:00-10:15	P. 41	Overview of the 'International Workshop on Bioextractive Technologies for Nutrient Remediation'	Julie Rose NOAA/Long Island Sound Office
10:15-10:30		BREAK	
10:30-10:45	P. 42	Energy efficiency improvements in algal growth systems	Hans Drenkard SCSU, ISIS Program
10:45-11:00	P. 43	Handling strategies for bay scallops, *Argopecten irradians irradians*, grown in semi-static cultures	James Widman NOAA Milford Laboratory
11:00-11:15	P. 44	Creating a tetraploid broodstock for the bay scallop, *Argopecten irradians*	Amandine Surier Martha's Vineyard Shellfish Group

11:15- 11:30 am	P. 45	A description of the culture techniques employed in the husbandry of *Hippocampus reidi*, the long snout seahorse, in the Sound School Fish Production Facility	Gina E. Biondi Sound School
11:30- 11:45	P. 46	Evaluation of the intraspecific competition of *Crassostrea virginica* in a high density cage system	Gerald Ramos BRAVAS
11:45- 1:00		WORKING LUNCH	
1:00- 1:15	P. 47	Mussel culture on long lines on Cape Ann, Massachusetts - an update	Ted Maney Salem State College
1:15- 1:30	P. 48	Results of pilot commercial-scale offshore mussel farming in southern New England	Scott Lindell MBL
1:30- 1:45	P. 49	A sound idea for defeating Eider duck predation on mussel farms	Dana Morse Maine Sea Grant
1:45- 2:00	P. 50	Epibionts on the siphons of softshell clams *Mya arenaria* in a FLUPSY: Species, prevalence, and management	Joseph Buttner Salem State College
2:00- 2:15	P. 51	Working towards consensus: Application of shellfish carrying capacity in management of Rhode Island aquaculture	Carrie Byron University of Rhode Island
2:15- 2:30		BREAK	

2:30- 2:45	P. 52	Possible impact of an algal bloom of *Cochlodinium polykrikoides* on juvenile bay scallops (*Argopecten irradians irradians*) in Nantucket Harbor	Valerie A. Hall Maria Mitchell Association
2:45- 3:00 pm	P. 53	Toxin changes in *Alexandrium fundyense* after passage through the digestive system of the Eastern oyster *Crassostrea virginica*	Barry Smith NOAA Milford Laboratory
3:00- 3:15	P. 54	Hazard assessment of amnesic shellfish poisoning in New England	Soledad Fuentes NOAA Milford Laboratory
3:15- 3:30	P. 55	Shrimp farming in the Northeastern United States - let's culture our local species!	Acacia Alcivar-Warren Env. Genomics, Inc.
3:30- 3:45		Closing remarks of the 30th MAS	Walter Blogoslawski NOAA Milford Laboratory

HABITAT IMPACTS OF SHELLFISH AQUACULTURE. **Robert Rheault.** East Coast Shellfish Growers Association, 1121 Mooresfield Road, Wakefield, RI 02879. bob@moonstoneoysters.com

Ecosystem services associated with shellfish aquaculture include; improvements to water clarity and quality, removal of nutrients, benthic-pelagic coupling, and improvements to benthic habitat. The habitat impacts are associated with increases in complexity and the total surface area of emergent, firm substrate. This results in increased epifaunal abundance of organisms that require firm substrate such as bryozoans, tunicates, and macroalgae. The structure also provides refugia for juvenile fish and small crustaceans, especially those species that are associated with rocky and cobble habitats (eg. scup, black sea bass, tautog, lobster, crabs). The combination of increased food and protection from predators allows better survival and faster growth. These are characteristics associated with essential fish habitat predicting that shellfish aquaculture not only acts as a fish attracting device, but also helps increase secondary productivity and can help restore important fish nursery habitat.

In many New England coastal waters, rocky and cobble habitat has been buried in silt associated with deforestation, loss of barrier vegetation, agriculture, eutrophication and road runoff. Limited habitat availability may be contributing to the declines in these species that utilize these nursery sites. Shellfish aquaculture may be a method to restore some of this critical structured habitat.

UNDERSTANDING THE INTERACTION BETWEEN SHELLFISH AQUACULTURE AND SUBMERGED AQUATIC VEGETATION **Tessa Getchis**[1], **Jamie M.P. Vaudrey**[2], and **Cori M. Rose**[3]. [1]University of Connecticut, Sea Grant Extension Program and Department of Extension, 1080 Shennecossett Road, Groton, CT 06340-6048; [2]University of Connecticut, 1080 Shennecossett Road, Groton, CT 06340; [3] U.S. Army Corps of Engineers, Regulatory Division, 696 Virginia Road, Concord, MA 01742. tessa.getchis@uconn.edu

Bivalve shellfish production represents a large and growing segment of the United States (U.S.) and global seafood industry with nearly 20% of domestic and 27% of worldwide aquaculture production being attributed to shellfish aquaculture. Although production is increasing, there is uncertainty with respect to the ecological effects of aquaculture practices, which threatens to constrain further development. This uncertainty has led to both local and sweeping national changes to the manner in which shellfish aquaculture is regulated and the husbandry standards by which shellfish producers must adhere to in the U.S. and elsewhere.

A major concern of coastal zone managers is the potential for shellfish aquaculture to inflict adverse impacts on estuarine habitats such as submerged aquatic vegetation (SAV). SAV is a significant habitat which provides important ecological functions such as stabilization of fine sediments, recycling of nutrients into biologically available forms, and serving as shelter and foraging grounds for a diverse assemblage of aquatic fishes, invertebrates, and birds. Similar benefits can be derived from shellfish and shellfish aquaculture, and in addition, bivalve shellfish can improve water quality for eelgrass growth by removing excess nutrients, and clarity by filtering phytoplankton and fine particulate matter. However, adverse effects, particularly to this critical habitat have resulted from long-term deployments of aquaculture gear.

Shellfish and shellfish aquaculture have the potential to affect submerged aquatic vegetation in a number of direct and indirect ways by altering the physical, chemical and biological characteristics of the SAV and the environment that it grows in. The potential direct effects include breakage of plants due to the presence of the gear used to contain or harvest shellfish and reduced SAV biomass due to shading of plants situated directly under the culture gear. One of the key potential indirect effects on SAV that can result from intensive shellfish culture is chemical changes in the water column and benthic environment due to shellfish feces and pseudofeces generation. Bivalves can contribute to an increase in organic and inorganic nutrients which may be detectable through changes in the nutrient content of SAV tissue and increased macroalgae biomass. Macroalgae biomass may also be increased through entrapment of floating macroalgae by aquaculture structures. Macroalgae can shade SAV, reducing the total light received by the plants. Coupled with shading from cultivation gear, this can create an environment detrimental to the survival of SAV.

The overlap of shellfish aquaculture activity and eelgrass is not unique to our region, but has been observed throughout the coastal U.S. The "competition" for space between SAV and shellfish aquaculture exists because areas suitable for eelgrass growth are also often suitable for shellfish growth and direct harvest. Several recent and ongoing studies to be reviewed at this workshop are elucidating the interaction of shellfish aquaculture and SAV in the coastal environment, and as a result, management strategies are being developed that consider both the ecological and societal value of submerged aquatic vegetation and shellfish aquaculture.

QUANTIFYING ECOSYSTEM INTERACTIONS OF MOLLUSCAN AQUACULTURE: THE CHALLENGE OF LINKING GLASS-FIBER FILTERS TO GLOBAL FINANCE.

Gary H. Wikfors[1], Karen Rivara[2], Mark S. Dixon[1], Yaqin (Judy) Li[1], Shannon L. Meseck[1], Julie M. Rose[1], April N. Croxton[1], Lisa Milke[1] and **Barry C. Smith[1].** [1]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460; [2]Aeros Cultured Oyster Co., 10273 North Bayview Road, Southold, NY 11971. gary.wikfors@noaa.gov

Increasing global demand for seafood will be met by increased aquaculture production. Aquaculture's economic imperative should maximize the overall benefits to humanity of this shift in food sourcing, including minimizing consequent environmental degradation. Molluscan shellfish -- oysters, clams, mussels, and scallops -- as suspension-feeders that obtain nutrition directly from phytoplankton primary production, are considered to have environmental benefits beyond human food value. These commercially-valued shellfish remove phytoplankton, and other suspended particles and associated nutrients, from the water, thereby improving water quality in often-turbid, eutrophic coastal waters. Concerns remain, however, about how intense shellfish filtration may change plankton ecology supporting higher trophic levels and how benthic habitats may be impacted by biodeposits in the vicinity of an intensive shellfish farm.

In cooperation with the Aeros Cultured Oyster Company, the Milford Laboratory has initiated a multi-disciplinary study of these issues at the Aeros nursery site in East Creek, Riverhead, New York. Starting with a conceptual model that balances material inputs, outputs, and by-products of the oyster-growing process, we have sampled and quantified physical, chemical, and biological variables in nursery inflow and outflow locations, as well as elsewhere in the East Creek estuary (here is where the glass-fiber filters enter into the equation). Initial measurements revealed large natural variation in all input parameters controlling oyster responses, in terms of respiration, feeding, and biodeposition; in other words, the environmental interactions of the shellfish farm are controlled by natural diurnal, tidal, and seasonal changes in the ecosystem. We have taken two basic approaches to obtaining realistic measurements of these interactions: *in situ* planktonic mesocosms to separate diurnal plankton responses from influences of sediment and tides, and high-frequency monitoring (15-min intervals) of physical, chemical, and biological variables at nursery inflow and outflow points. Further, we are measuring physiological variables in oysters to determine environmental stresses and oyster responses. These measurements and analyses are currently underway and will be completed in 2010.

The initial model was designed to balance material inputs, outputs, and products, with a particular focus on nitrogen as this element is linked with eutrophication and environmental degradation in coastal waters. In the coming year, with collaborators, we will attempt to integrate Dynamic Energy Budget (DEB) modeling into the study and also use our data to run FARM™ carrying-capacity model simulations. This latter model also provides nitrogen-credit outputs, linking back to financial value of eutrophication mitigation. The final result of the current study is intended to be a protocol for estimating the plankton, nutrient, and water-quality consequences of various levels of shellfish aquaculture activity in a given water body – a portable, environmental- assessment tool.

EFFECTS OF CLAM FARMING ON MOTILE FAUNA: PRELIMINARY RESULTS FROM NEW JERSEY AND VIRGINIA.

John N. Kraeuter[1], **Mark W. Luckenbach**[2], **David Bushek**[1] and **Allan Birch**[2]. [1]Haskin Shellfish Research Lab, Rutgers University, 6959 Miller Avenue, Port Norris, NJ 08349; [2]Eastern Shore Lab., Virginia Institute of Marine Science, College of William and Mary, PO Box 350, Wachapreague, VA 23480. kraeuter@hsrl.rutgers.edu

Aquaculture of hard clams, *Mercenaria mercenaria*, has increased since its beginning in the mid 1970's to become the most extensive form of mollusk production on the east coast. High density culture of clams could alter bottom habitats, affect natural communities, increase filtration and modify nutrient cycling. In addition, predator exclusion nets and harvest techniques may affect infaunal, epifaunal and demersal assemblages in the vicinity of the farm. Little is known about the details of these alterations. This study investigates the effects on the macrobiota of intertidal/shallow subtidal clam culture in two commercial sites (New Jersey and Virginia) where culture has taken place for a number of years. The infauna, epifauna, epiflora associated with the clam culture sites was sampled in spring, summer and fall. In addition to control sites, samples were obtained from areas that had been recently harvested, and those that had been planted for over a year. The preliminary data from the fyke net and haul seine samples for fish and crustaceans show few differences in abundance and species richness among the control, harvested and clam sites. Data from suction dredge and core samples are being processed.

HEAVY METALS IN FARMED OYSTERS AND CLAMS FROM THE ATLANTIC COAST OF THE U.S. **Dale F. Leavitt** and **Stephen K. O'Shea.** Roger Williams University, One Old Ferry Road, Bristol, RI 02809. dleavitt@rwu.edu

Cadmium (Cd) and mercury (Hg) are trace metals that occur naturally in the marine environment at very low levels but have been noted in higher than background levels in areas where anthropogenic inputs have occurred. Although living organisms have no physiological requirements for these metals, they are bioconcentrated by some marine animals via a variety of uptake pathways following environmental exposure. Cd and Hg can pose significant health risks to living organisms, including humans, when concentrated to a degree that impacts normal physiological processes. Although the threshold for observed effects from exposure to these trace metals varies by species, chemical status of the metal, and availability from the environment, the risk, particularly to human health, is high enough to warrant guidelines and limits to exposure that range from exposure advisories to legally defined limits.

Public awareness of the risk of eating seafood, due to Cd and Hg contamination, has been heightened in recent years with the publication of information concerning levels in many species of marine fish and shellfish. The Codex Alimentarius has recently implemented a 2ppm (wet weight) Cd threshold for bivalve molluscs, while Hong Kong has implemented a 1ppm standard. The U.S. EPA and FDA jointly published a health advisory in 2004 warning women who might become pregnant, women who are pregnant, nursing mothers and young children to limit their consumption of fish and shellfish due to Hg levels in the tissue. When association members staffed an East Coast Shellfish Grower's Association booth at the Big E, a multi-state exposition showcasing farmed products in the northeast, the single most frequently asked question was about the level of Hg in farmed shellfish and the health risk from consuming them! Unfortunately, farmers do not have the appropriate information available concerning Hg or other trace metals in Atlantic Coast farmed shellfish to reply to the public's inquiries and to reduce their concerns about consuming shellfish. We are attempting to provide that information.

Shellfish, and especially oysters, are very good scavengers of trace metals from the marine environment; to the point where, even under natural conditions, levels of cadmium in Pacific oyster (*Crassostrea gigas*) soft tissue can approach 4.0 ppm, on a wet weight basis. The natural ability of the oyster to concentrate heavy metals has lead to proposed and realized bans on the international transport and marketing of oysters for human consumption, based on a 1 or 2 ppm cadmium limit for human intake. Because oyster farming and wild harvest in the U.S. is an important component to our national seafood production and has the potential to grow significantly, any limits to the expansion of markets for seafood products produced in the U.S. will significantly impact the continued expansion of the regional aquaculture industry.

This presentation will report on the progress of a study aimed at measuring the levels of trace metals in farmed northern hard clams (*Mercenaria mercenaria*) and farmed American oysters (*Crassostrea virginica*) from sites distributed along the Atlantic coast of the U.S. We have focused primarily on cadmium and mercury but also have investigated other trace metals that may be selectively concentrated in shellfish and that may pose a potential human health risk if consumed in high enough quantities. This research is a direct result of the threat that shellfish consumption will be regulated to the point where our lack of knowledge about the bioconcentration and dynamics of these metals will impact the marketability of our farmed seafood products. With the proper information, farmers can inform the public as to the safety of their product and can counter improper information that may be propagated in the public media.

FIELD TRIALS OF GENETIC LINES OF BAY SCALLOPS (*ARGOPECTEN IRRADIANS*). **Joseph Choromanski, Sheila Stiles** and **Dorothy Jeffress.** U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460. joseph.choromanski@noaa.gov

Bay scallops from three selected genetic lines were compared for growth and survival in three areas of Long Island Sound. Line MS08-1 was from a mass spawn of broodstock obtained from Martha's Vineyard. The other lines, SE08-1HI and SE08-1LO were selected for high or low growth rates, respectively, through several generations. Field trials were conducted in the Niantic River, at the Bridgeport Aquaculture School's grow-out site, and at the NMFS Milford tank-farm site. A set of three tiered cages were deployed at each site in August of 2008, each containing the three lines for study. The cages were sampled for growth and survival just before water temperatures dropped below 10° C, and then again after the winter as soon as temperatures reached 10° C.

The initial sampling in October of 2008 showed very good survival at the Niantic (80 – 95%) and Milford (89 -97%) sites. Sampling for the Bridgeport site was not possible until early December when this site also showed very good survival (78 – 95%). Growth for all lines in Niantic averaged over 2 mm. wk^{-1}, with the selected high line showing a significant difference compared to the other lines. The Milford site supported the lowest mean growth rate overall, with no significant difference calculated between any of the groups. The Bridgeport site averaged just under 2 mm of growth per week and also showed a significant difference between the selected high line when compared to the other two lines.

Overwintering survival for two of the three lines at the Bridgeport sites was similar in that the mass spawn and selected high line were at 50% respectively. Scallops from the selected low line came through the winter with a much better survival of 77%. These results were repeated at the Milford site with the mass spawn and selected high line at about 40% while the selected low line did appreciably better at 72.5%. The Niantic site cages were lost for sampling, although recovered much later with no surviving scallops. The survival trends at the Bridgeport and Milford sites continued through the summer of 2009. The selected low line showed much better survival of about 33% compared to 2.5% for the mass spawn and high lines in Bridgeport and 5% for both lines in Milford. While initial sampling indicated an advantage in growth rates for the selected high line at all sites, sample numbers were too small to properly assess growth differences of the lines at the end of the study period. The higher survival of the selected line for low growth will be a useful attribute for further selection studies.

METAL CONCENTRATIONS IN THE SEDIMENT OF THE LOWER HOUSATONIC RIVER ESTUARY. **Joshua Conklin** and **Vincent T. Breslin**. Department of Science Education and Environmental Studies, Southern Connecticut State University, 501 Crescent St, New Haven, CT 06515. breslinv1@southernct.edu

The Housatonic River is 149 miles long and drains portions of the states of Massachusetts, New York and Connecticut. Sections of the river watershed are characterized by multiple historical and current sources of metal contaminants including industrial and municipal wastewater discharges, marinas, landfills, agricultural lands, and roadways. It has been estimated that the lower Housatonic River estuary produces one-third of all the seed oysters which are a vital part of Connecticut's commercial shellfish industry. This study was designed to determine the variation of sediment types and sediment metal concentrations in the southernmost portion of the Housatonic River. Sediment samples were collected during the summer 2008 from the river using a ponar grab at 31 stations and analyzed for sediment grain size, loss on ignition, and metal concentrations (copper, chromium, iron, lead, nickel and zinc). Results showed a range of sediment types, from coarse sands to silt. Fine to coarse sand dominated the river channel areas while fine sand and silt were the predominant sediment types located in the river coves and near shore marsh channels. A range of sediment loss on ignition (0.58 – 13.2%) and sediment metal concentrations (Cu 6.3 – 685 mg/kg; Cr 14 – 125 mg/kg; Fe 0.33 – 4.89%; Pb 11- 135 mg/kg; Ni 11.4- 68 mg/kg; and Zn 11.3 – 896 mg/kg) were measured. Although sediment metal concentrations varied greatly, they generally reflected differences in sediment type. Higher metal concentrations were associated with high loss on ignition, well sorted, fine-grained sediment. Comparisons with NOAA Status & Trends sediment quality guidelines showed that it is likely that adverse effects are occurring to benthic organisms in the lower Housatonic River due to the presence of high sediment metal concentrations.

PREVALENCE OF DISEASE, GROWTH ABNORMALITIES AND TISSUE METAL CONTENTS IN EASTERN OYSTERS ALONG THE CONNECTICUT COASTLINE.

Gabriel N. Geist[1], **David Oshana**[2], **Inke Sunila**[3] and **Vincent T. Breslin**[2]. [1]The Sound School Regional Vocational Aquaculture Center, 60 South Water Street, New Haven, CT 06519; [2]Department of Science Education and Environmental Studies, Southern Connecticut State University, 501 Crescent Street, New Haven, CT 06515; [3]Connecticut Department of Agriculture, Bureau of Aquaculture and Laboratory Services, 190 Rogers Avenue, Milford, CT 06460. 17geist@comcast.net

The Eastern oyster (*Crassostrea virginica*) is an important economic resource for the Connecticut shellfish industry. These organisms lead a sessile, benthic life, attached to hard substrate in estuaries and grow to a market size of 7-10 cm in 2-3 years. Heavy metals and other pollutants in Long Island Sound (LIS) oysters have been documented at sites on the Connecticut coast as part of NOAA's National Status and Trends Mussel Watch Program since 1986. Previous studies have also documented higher metal contents in sediments in western LIS, with a corresponding decrease in concentrations toward eastern LIS. This study examines trends in the incidence of heavy metal contamination (copper, iron and zinc) in the tissues of the Eastern oyster (*Crassostrea virginica*) from five sites in LIS and the corresponding prevalence of pathological changes such as inflammatory responses, mucus production in gill regions, parasitic burden, degeneration of digestive cells and neoplasia in oysters from those sites. These pathological changes have been observed in oysters from LIS as part of the State of Connecticut Bureau of Aquaculture's ongoing shellfish health monitoring program that has been in practice since 1997, however, no systematic effort to compare the incidence of heavy metals in oyster tissue with the prevalence of these conditions in the oyster population has been attempted. Oysters (n=50 for pathology studies; n=12 for tissue metal studies) were sampled during November-December 2008 from three locations in the lower Housatonic River estuary, one location in New Haven harbor and one location in the lower Menunketesuck River in Westbrook. Oyster tissue dry weight, condition index and shell length were determined for each oyster at each location. Sediment samples were collected using a ponar grab from each site and analyzed for grain-size, metals and loss on ignition (LOI). Sediment metal concentrations varied across locations and were correlated with sediment grain-size and sediment LOI. Oyster tissue copper contents also varied across the sites and ranged from 1510 ± 549 mg/kg (dry weight) at Housatonic River site 1 to 250 ± 90 mg/kg in New Haven harbor. Differences in oyster tissue metal contents were not attributed solely to differences in sediment composition (grain-size and metal contents). Prevalence of MSX infection across all sites was generally low and was found to be less than 3%. The prominent degenerative change observed during this study was ceroidosis due to the accumulation of ceroid droplets and/or lipofuchsin pigment. Both substances result from decaying cells and prevalence of ceroidosis was observed in 42% of the specimens examined. Hemodynamic and fluid derangements were evidenced by edema (55.3%) in the mantle, gills and tissues surrounding the stomach epithelia. Both ceroid and edema conditions show a west (higher) to east (lower) trend but do not directly correlate with sediment metals or sediment physical properties (LOI or grain-size).

DETERMINING THE FEASIBILITY OF PHYCOBILINS AS A SUBSTITUTE FOR RED DYE 40. **Dominik Luckey** and **Kirk Shadle.** Bridgeport Regional Aquaculture Science and Technology Education Center, 60 Saint Stephens Road, Bridgeport, CT 06605. kshadle@bridgeportedu.net

Red dye 40 is a commonly used "azo" food dye. Documented testing shows that red dye 40 causes' allergic reactions in some consumers and it has also been linked to behavioral problems in children. The Rhodophyta *Chondrus crispus*, Irish moss, contains the phycobiliprotein phycoerythrin, which gives the algae its red color. *C. crispus* is eaten whole throughout the world and is also an ingredient in yogurt and many dairy products. An algae-based food coloring can provide a suitable alternative for manufacturers as a substitute for red dye 40. To isolate the phycoerythrin for testing, the *C. crispus* is macerated with distilled water at a concentration of 1 mg of fresh weight *C. crispus*/2mL of distilled water. To separate the phycoerythrin from the remaining biomass, the sample was spun in a centrifuge at 20,000 rpm for 20 minutes. Sample purification is achieved through sublimation, thus separating the phycoerythrin from the distilled water. The sublimated samples are reconstituted to a desired concentration of .1g/.25mL of distilled water. Wavelength absorbance of the reconstituted samples and the pure red dye 40 at a concentration of 2 drops/2mL of distilled water are analyzed on the UV/VIS spectrophotometer and the results are compared. Baseline testing of the pure red dye 40 provides a wavelength absorbance ranging from 498 to 504nm. It is anticipated that the test results will demonstrate similar results from the phycoerythrin samples.

CHRONIC TOXICITY OF DIPHENHYDRAMINE HYDROCHLORIDE (BENADRYL™) TO FATMUCKET MUSSELS. **Jeffery R. Meinertz, Theresa M. Schreier, Karina R. Hess,** and **Jeffry A. Bernardy.** U.S. Department of the Interior, U.S. Geological Survey, Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Road, La Crosse, WI 54603. jmeinertz@usgs.gov

The study was conducted to determine if growth and survival of the freshwater mussel, *Lampsilis siliquoidea*, continuously exposed to diphenhydramine hydrochloride (DH) in a flow-through test system are significantly different from the growth and survival from unexposed (control) *L. siliquoidea*. The test system and study parameters were designed with guidance given in the American Society for Testing and Materials Designation E 2455-06, *Standard Guide for Conducting Laboratory Toxicity Tests with Freshwater Mussels*. Twenty eight largemouth bass (*Micropterus salmoides*) were infested with glochidia from 3 adult *L. siliquoidea* mussels. Fifteen days later, newly transformed mussels were siphoned from the bottom of the aquaria. The following day, 40 mussels were transferred to each of the 60 test chambers (250 mL beakers, water volume, 200 mL) containing a 4 mm layer of silica sand. The 60 chambers were divided into 10 blocks of 6 test chambers in a 2 X 3 configuration. Each of the 6 test chambers within a block were randomly assigned to 1 of the 6 treatment groups so that each treatment group is represented only once in each block. The treatment groups included a control group and 1 of 5 groups exposed to DH at nominal concentrations of 0.5, 2.5, 12.5, 50, and 100 µg/L. Water (20°C) flowed continuously through each test chamber and a food suspension prepared daily with various algae flowed continuously through each chamber. Chambers assigned for exposure had solutions of DH flowing continuously through them for 28 days. DH concentrations were measured throughout the trial. After 28 days, the numbers of mussels surviving were assessed. Length was measured for mussels surviving through the 28-day exposure period.

The overall mean recovery of live and dead mussels from the test chambers was 88.5%. For each treatment group, survival ranged from 75.5% in the 12.5 µg/L group to 86.0% in the 2.5 µg/L group. Survival of mussels in the control group was not significantly different than survival of mussels in the exposed groups. Mean shell length ranged from 742 µm for mussels in the 100 µg/L group to 781 µm for mussels in the 0.5 µg/L group. Growth of mussels in the control group was not significantly different than growth of mussels in the exposed groups. In conclusion, the survival and growth of *Lampsilis siliquoidea* was not impacted by continuous exposure to DH concentrations $\leq$ 121 µg/L for 28 days.

A NEW AQUATIC DIAGNOSTIC LABORATORY AT ROGER WILLIAMS UNIVERSITY.
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Roger Williams University (RWU) was established in the 1960's. Marine biology was one of the major courses of study at the University then, and continues to be a major focus at the University today. RWU has established a shellfish hatchery and is developing and an ornamental fish aquaculture program. Research into problems facing the aquaculture industry is a focus at the university. As part of the commitment to support the industry, the university, with the help of state and federal funds built a new facility which houses the expanded shellfish hatchery and an new aquatic diagnostic laboratory. The aquatic diagnostic laboratory is directed by Dr. Roxanna Smolowitz who has several years of experience in aquatic animal disease research and disease diagnosis. The new laboratory will provide disease diagnostic services to the aquaculture community in the northeast U.S. State of the art testing methods will be used including quantitative PCR as well as the more traditional methods of disease diagnosis such as histopathological analysis. The laboratory will accept submissions starting in March, 2010.

RECENT PROGRESS IN SELECTIVE BREEDING OF THE BAY SCALLOP, *ARGOPECTEN IRRADIANS.* **Sheila Stiles, Joseph Choromanski** and **Dorothy Jeffress.**
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Declines in natural populations of bay scallops, *Argopecten irradians,* have led to an interest in aquaculture and breeding to increase production. This interest has been fueled by an unstable wild fishery, high value, high consumer acceptance, and rapid growth rates. Early responses to selective breeding in a previous study indicated the potential for genetic improvement. A more recent investigation was initiated approximately 5 years ago. Responses to selection for growth were measured in a bidirectional selection study of bay scallops over several generations. The original stock was collected from a population native to Connecticut. Selection was conducted by choosing the largest and the smallest scallops in shell height within each generation. Comparisons were made of fast- growing (high line) scallops with the slow-growing (low line) scallops. Early indications were similar to previous results that showed modest responses which varied in different generations. Overall, scallops from the fast growing line were larger than those from the slow growth line, but not always with a significant difference; in other years or phases of development they differed very significantly, by almost twice the mean size. In addition, comparison of growth with a non-selected line showed a larger size of scallops in the fast growth selected line at the same age. Other factors, however, contributed to variation in the responses influenced by rearing conditions, such as density. Another selected generation to be evaluated is currently in an early stage of development. Other related studies will be described on selection for phenotypic markers which may be associated with growth, and possible differences in genetic variation such as in mtDNA from selected lines.

DNA-BASED RESEARCH WITH BAY SCALLOPS: A COLLABORATION BETWEEN NOAA AND YALE UNIVERSITY WITH AN OUTREACH COMPONENT **Sheila Stiles**[1], **Joseph Choromanski**[1], **Dorothy Jeffress**[1], **Nancy M. Kerk**[2], and **Gisella Caccone**[3]. [1] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460; [2]Yale Center for Genomics and Proteomics, DNA Analysis Facility, 21 Sachem Street, New Haven, CT 06511, [3]Yale Molecular Systematics and Conservation Genetics Lab, Environmental Science Center, 21 Sachem Street, New Haven, CT 06511.
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Natural populations of bay scallops, *Argopecten irradians*, a commercially and recreationally valuable species, have declined significantly in some areas of the Northeast, such as Long Island Sound in Connecticut, over the past several years. One approach to addressing this marked decline is to understand and exploit genetic variation for improving growth and survival. Marker-assisted selection can be used in aquaculture as is similarly done in agriculture. Bay scallops, as other bivalve mollusks, also are important components in ecosystems, as part of the food web and as filter feeders. We investigated genetic variability in scallops so that we could develop strategies to increase production of aquacultured bay scallops, by identifying and characterizing genetic differences.

A DNA-based research collaboration using bay scallops as model organisms was initiated with an outreach component between geneticists from the National Oceanic and Atmospheric Administration (NOAA) and Yale University. NOAA scientists supplied bay scallops representing several geographic populations and selectively bred genetic lines encompassing Connecticut, Massachusetts and New York. In addition, these scientists, with two teaching assistants, assisted with sampling, morphometrics measuring and DNA processing and also provided lab tours, a boat trip and a manual on scallop genetics and biology for background reference information. Yale geneticists coordinated a three week Science Collaborative Hands-On Learning and Research (SCHOLAR) program with students from Career High School in New Haven, who learned about DNA by studying the scallops when working with human and other mammalian material was not feasible. This program was followed by a 1-week teachers' biotechnology training program with a focus on DNA from scallops. Additionally, Yale furnished lab space, molecular instrumentation, supplies, bioinformatics, and overall experience and expertise for DNA isolation, processing and sequencing for the project.

This collaborative project revealed that mitochondrial DNA from various scallop populations differed with respect to geographic origins. Such differences can be used as profiles and molecular tags for marker identification in restoration efforts. These hands-on activities were successful for the outreach program and provided a science training opportunity with a practical application which potentially could contribute to restoration and enhancement of the bay scallop. Future studies are planned for continuing the collaboration.

FOCUS ON SUSTAINABILITY: ADVANCING A NEW FEDERAL POLICY FOR MARINE AQUACULTURE. **Michael Rubino** and **Susan M. Bunsick.** U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Aquaculture Program, 1315 East-West Highway, Silver Spring, MD 20910. michael.rubino@noaa.gov

In September 2009, Dr. Jane Lubchenco, Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator, announced the agency's intent to develop a comprehensive national policy for sustainable marine aquaculture. The new policy will address the breadth of aquaculture activities at the National Oceanic and Atmospheric Administration (NOAA), including marine finfish and shellfish for food and other products as well as aquaculture techniques used to help restore valuable wild fisheries and habitat. NOAA's Aquaculture Program will play a key role in the development and implementation of the new policy which will guide the agency's regulatory and management decisions, including aquaculture research priorities and the regulation of aquaculture in federal waters.

From a national perspective, a compelling case can be made for growing more seafood in the United States. Aquaculture already supplies almost half of the world's seafood and the United Nations Food and Agriculture Organization projects that most future increases in seafood supply must come from aquaculture. The United States is a major consumer of aquaculture products, but only a minor producer. Currently, 84% of the nation's seafood is imported, and half of that is from aquaculture. U.S. aquaculture, both freshwater and marine, supplies about 5% of the U.S. seafood supply.

EFFECTIVENESS OF RESTOCKING AND STOCK ENHANCEMENT IN FLORIDA: CASE STUDIES WITH COMMON SNOOK, RED DRUM AND BAY SCALLOPS. **Ken Leber.** Mote Marine Laboratory and Aquarium, 1600 Ken Thompson Parkway, Sarasota, FL 34236. kleber@mote.org

Marine fisheries agencies, universities and research organizations in Florida and other parts of the USA and beyond are evaluating use of hatchery-based stock enhancement technology. Restorative efforts aimed at the recovery of depleted populations require considerable depth of analysis on effects and effectiveness stocking, including ecological, genetic and health consequences of interactions between hatchery and wild stocks. A quantitative and responsible approach is required for effective development of strategies for integrating restocking efforts with traditional methods of fishery management. As one example, release-recapture studies involving red drum in Tampa Bay and common snook in Sarasota Bay have yielded extensive data regarding fingerling size and timing at release, release habitat, release magnitude, post-release mortality and movement among and into wild populations. Responsible marine stock enhancement, including work designed to replenish bivalve mollusk stocks, is an iterative process that requires an understanding of the integrity of hatchery organisms and interactions of cultured and wild stocks.

STRATEGIES TO RESTORE OYSTER POPULATIONS IN TWO SALT PONDS ON MARTHA'S VINEYARD. **Richard C. Karney**[1], **William Bassett**[1], **Paul Bagnall**[2], **Isaiah Scheffer**[3] and **Tom Osmers**[4]. [1]Martha's Vineyard Shellfish Group, Inc., PO Box 1552, Oak Bluffs, MA 02557; [2]Edgartown Shellfish Department, PO Box 5158, Edgartown, MA 02539; [3]Chilmark Shellfish Department, Beetlebung Corner, Chilmark, MA 02535; [4]West Tisbury Shellfish Department, PO Box 278, West Tisbury, MA 02575. mvsg@comcast.net

The wild oysters on Martha's Vineyard occur as relatively isolated populations in brackish salt ponds along the southern coast of the island. These individual ponds are closed to the Atlantic most of the time by barrier beaches that are breached three or four times during the year either naturally by storm events or with backhoes to lower pond levels and improve flushing.

In the mid 1990's Edgartown Great Pond, the largest, experienced a major die-off of its oyster population. Whatever the cause for the initial die-off (an algal bloom and low dissolved oxygen were suspected), by 1996 samples of Edgartown Great Pond oysters were positively diagnosed with the oyster disease Dermo. Despite regular, sometimes heavy, natural sets, the majority of the oysters recruited in the pond succumbed to Dermo. However, by the early 2000's, the pond's oyster population was slowly recovering despite the continued presence of Dermo. Suspicions that the unique breeding isolation of the pond's oysters under the constant selection pressure of the disease was resulting in a Dermo resistant oyster strain were supported by a study in which hatchery-spawned offspring of survivor oysters from Edgartown Great Pond survived 17-19% better than a non-resistant control group.

Oysters in Tisbury Great Pond, site of another Island oyster fishery, first tested positive for Dermo in 1999. Dermo spread rapidly in Tisbury Great Pond and by the summer of 2001, at least 95% of the oysters in the pond perished. Similar to what occurred in Edgartown, a remnant population has survived and the number of oysters is slowly increasing.

In 2008 and 2009, efforts to increase the numbers of oysters in Edgartown and Tisbury Great Pond were expanded utilizing the naturally developed resistant oysters. The multifaceted program utilizes a number of both established and new experimental management methods to help repopulate the ponds. The conventional restoration methods employed include the planting of cultch, deployment of bottom and suspended shell bag collectors, and the seeding of hatchery-spawned single oysters set on microcultch, and remote-set spat on shell. In addition we are experimenting with several new strategies:

1) Deployment of broodstock in floating "spawning sanctuaries" to increase spawning potential in the pond.

2) Hanging shellbags from the "spawning sanctuary" floats to increase the density of spat collection.

3) Attempting to bypass the remote-setting tank systems by depositing eyed-larvae directly on the new cultch beds in the pond.

4) Outlawing the harvest of larger oysters that have survived exposures to Dermo.

THE POWER OF THE VOLUNTEER IN COMMUNITY BASED SHELLFISH RESTORATION. **Gef Flimlin**[1], **Cara Muscio**[1], and **Rick Bushnell**[2]. [1]Commercial Fisheries and Aquaculture, Rutgers Cooperative Extension, 1623 Whitesville Road, Toms River, NJ 08755; [2]357 North 7th Street, Surf City NJ 08008. flimlin@aesop.rutgers.edu

The Barnegat Bay Shellfish Restoration Program (BBSRP) is a jointly run community based shellfish restoration program that is coordinated by Rutgers Cooperative Extension of Ocean County and the NJ Department of Environmental Protection Bureau of Shellfisheries. Now in its fifth year, the program educates and trains volunteers in shellfish biology, aquaculture, estuarine water quality, watershed impacts, seafood safety and data collection. It grows both hard clams, *Mercenaria mercenaria*, and the American oyster, *Crassostrea virginica*, from 2-3mm to field plantable size. These seed are placed on bay bottom or on the new oyster reef that has been established by the program. In the last year, an oyster spat on shell process has also been added to the program for planting on a constructed reef.

At face value, the program looks like an attempt to restore the bay with shellfish when in fact, it is designed to use the volunteer to educate the public about environmental involvement and stewardship. Once the public "buys into" the concept that there are tiny shellfish in the bay, they will then change their behavior in the uplands surrounding the bay to lessen their impact on the estuary and to become part of the public process to improve local and state actions within the watersheds.

The program has trained over 150 volunteers of which there are about 60 very active people growing shellfish, having outreach at fairs and festivals, providing hands-on education, and helping to raise funds to keep the BBSRP going. The volunteers have formed their own non-profit organization that has raised over $75,000, instituted an award-winning public art and science education program that received a NJ Tourism Award, brought environmental education to lots of summer visitors, and sent the kids home to be "Clambassadors."

Without the innovation, dedication and enthusiasm of the volunteers, the program would not be the immensely successful endeavor that it now is.

AN OVERVIEW OF THE HISTORY, RECENT RESEARCH, AND RESTORATION OF THE OLYMPIA OYSTER (*OSTREA LURIDA* CARPENTER 1864) ON THE WEST COAST OF THE UNITED STATES. **Katherine A. McGraw.** U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, NOAA Restoration Center, 1315 East West Highway, Silver Spring, MD 20910. kay.mcgraw@noaa.gov

Extensive populations of the Olympia oyster (*Ostrea lurida* Carpenter 1864) once inhabited the estuaries along the west coast of North America, and were not only ecologically important habitats, but served for thousands of years as items of cultural significance and a dependable food source for Native American tribes. Early white settlers on the Pacific coast also appreciated the distinctive flavor of the very small oysters and began harvesting them in increasing amounts as their numbers grew. Olympia oysters were greatly overexploited during the California gold rush and afterwards (ca. 1850 – 1915), resulting in failure of the commercial fishery everywhere on the west coast, except in Puget Sound, Washington.

The establishment of the Puget Sound oyster industry overlapped the general demise of the commercial fishery elsewhere and ushered in several decades of successful culture of the Olympia oyster in Washington State; however, other factors (e.g., pulp mills, water pollution, sedimentation from timber harvests, lack of sufficient cultch material, and introduction of the non-native Pacific oyster, along with several non-native predators) eventually led to a decline in the native oyster populations there. By the 1960s, the commercial fishery for Olympia oysters essentially ceased to exist in Puget Sound, and in 2000 *Ostrea lurida* was finally listed as a species of concern by the Washington Department of Fish and Wildlife. Today only remnant populations of native oysters remain along the Pacific coast, and there are only a handful of oyster growers in Puget Sound, Washington who still cultivate and sell relatively small amounts of Olympia oysters for the half-shell trade. Even in Willapa Bay, Washington, which historically had a substantial population of *Ostrea lurida* and a thriving fishery, it is estimated that only about 1200 Olympia oysters are harvested yearly; the main commercial species in the state now is the non-native Pacific oyster, *Crassostrea gigas*.

In recent years restoration projects funded by the NOAA Restoration Center and other agencies and organizations have been implemented in all west coast states to address the severe decline of the Olympia oyster. There has also been a significant increase in research on *Ostrea lurida*, publication of studies in peer-reviewed journals, and dissemination of results in workshops and scientific meetings. The collaboration among scientists, restoration practitioners, and oyster growers, combined with the application of the best current information in project planning and implementation, has been very effective and is key to the successful recovery of the Olympia oyster on the west coast.

STATUS OF OYSTER CULTURE IN THE CHESAPEAKE. Standish K. Allen, Jr.
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Oyster culture in the Chesapeake Bay can be classified in three general categories, each growing significantly over the last five years: public restoration and commercial intensive and extensive culture. Restoration aquaculture is practiced principally in Maryland waters through the efforts of the Oyster Recovery Partnership (ORP). Through ORP, the Horn Point Oyster Hatchery at the University of Maryland's Center for Environmental Science has placed nearly a billion oyster spat on bars in the Maryland portion of the Bay in 2009. Much of the increase in production lately has been through improvements in husbandry rather than capacity. Except for a short period of funding for a specific restoration project in Virginia, restoration efforts are more associated with substrate and seed movement rather than oyster culture per se. For commercial aquaculture, the scenario is reversed – Virginia accounts for nearly all of commercial oyster culture and Maryland, very little – at least at present. In Virginia, intensive oyster culture consists of growing singles largely for the half-shell market, although at least two firms are trying to raise "single" oysters for shucking. The number of market oysters grown intensively has increased 10-fold since 2005: from less than a million to nearly ten million in 2008, probably more in 2009. Demand for seed production for single oyster cultivation has grown accordingly, and two new hatcheries began operations in 2009, with several clam hatcheries also now producing some oyster seed. In general, the demand for seed has been more or less satisfied, although there are still issues with delivery time. The greatest potential for growth in oyster culture in the Chesapeake Bay lies in extensive "spat-on-shell" production, essentially the same techniques used in the Pacific Northwest for the bulk of their production and Maryland, for restoration. In Virginia, a NOAA funded project to examine the economics of spat-on-shell aquaculture spurred interest among planters and packers. In principal, eyed larvae are purchased from commercial hatcheries, set in private setting tanks, and planted on private leased grounds. Demand for eyed larvae has increased from around 20 million in 2005 to about 2 billion in 2009. Spat-on-shell production becomes more feasible with the use of genetically improved strains, as well as triploidy, both also important for half-shell production. Generally, demand for eyed larvae vastly exceeds the supply, especially if demand from groups interested in experimenting with spat-on-shell, e.g., waterman, is considered. Eyed larvae production for restoration, as practiced in Maryland, is not even on the radar screen for Virginia. Interestingly, the Maryland legislature has recently recognized the potential for commercial aquaculture in their part of the Bay and begun enabling legislation to allow this to happen. For spat-on-shell culture, Maryland represents a sleeping giant, particularly because they have been practicing this kind of oyster culture for restoration and have infrastructure to allow start-up production. Some here in the Chesapeake think that production can get up to the millions of bushels again through commercial aquaculture.

MEASURING ECOLOGICAL IMPACT OF SHELLFISH CULTIVATION AND HARVEST – EXPERIMENTAL DESIGN AND EFFECTS ON BENTHIC BIOTA.

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Mechanical harvest of oysters and clams using dredges clearly affects the benthos, but the extent and rate of ecological recovery are not well understood for different habitats and types of gear. We reviewed topical literature and developed a synthesis document that focused on the biological, chemical, and physical effects of dredging. To study the effects of bottom drag oyster gear and hydraulic clam dredges on the sea floor, we conducted a field experiment with an industry partner on leased shellfish beds in Long Island Sound. We measured changes in abundance and biodiversity of benthic fauna and sediment chemistry on the clam and oyster beds by sampling sites before dredging, and then in a time-series after dredging. Additional control sites that were not dredged were also sampled. Epibenthic mobile macrofauna were sampled on the beds with a 1-meter beam trawl. Preliminary biological results indicate patchy distribution with high abundance and biodiversity of benthic organisms that did not change markedly after the experimental dredging events. Beam trawl catches before and after dredging included many invertebrate and about eight juvenile finfish species. Results of this study will document how shellfish cultivation affects habitat ecology and may suggest further management practices that might be employed by the industry.

MEASURING ECOLOGICAL IMPACT OF SHELLFISH CULTIVATION AND HARVEST - EFFECTS ON SEDIMENT BIOGEOCHEMISTRY. **Shannon L. Meseck, Renee Mercaldo-Allen, Ronald Goldberg, Jose Pereira, Paul Clark, Catherine Kuropat,** and **George Sennefelder.** U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460. shannon.meseck@noaa.gov

Numerous studies have been designed to investigate effects on benthic organisms when mechanical-harvesting methods are used to harvest clams and other shellfish. Benthic-community recovery rates can vary greatly depending upon the type of gear and the habitat; however, little research has been done to examine the chemical effects that dredging has on the habitat. A field experiment examining both the benthic-biota and chemical effects of hydraulic dredging was conducted with an industrial partner who leases shellfish beds in Long Island Sound. Sediment core samples were collected periodically from replicate sites before and after harvest, and control sites were left unharvested. In sediment pore water porosity, hydrogen sulfide concentrations, dissolved total ammonia, pH, and dissolved oxygen were measured. We also collected particulate samples for grain-size analysis and particulate carbon, nitrogen, and sulfur. Preliminary results suggest that there was no significant difference between sites that were dredged and those that were not dredged for pH, dissolved oxygen, total ammonia fluxes, and hydrogen sulfide concentrations. There was, however, seasonal variability in these parameters that was significant ($p=0.02$). The chemical data indicate that the seasonal variability in this system had a larger influence than the effects of hydraulic dredging.

THE EFFECTS OF BIOGENIC OYSTER REEFS ON INFAUNAL AND EPIFAUNAL COMMUNITY STRUCTURE IN RHODE ISLAND ESTUARIES.

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The Eastern oyster (*Crassostrea virginica*) is an ecologically important species that provides multiple ecosystem services, including the potential to increase complex habitat for resident marine fauna. The objective of this study was to determine if the presence of restored oyster reefs in Narragansett Bay (RI, USA) had significant effects on sediment nitrogen and carbon, and the abundance and diversity of benthic infaunal invertebrates, mobile epifaunal invertebrates, and finfish. During the summer of 2009, oyster reef (OR) and non-oyster reef (NOR) control sites were sampled on a biweekly basis using a combination of baited traps and benthic core samples. These data were used to determine if there were any differences in sediment characteristics and community structures of the OR and NOR sites. Time series data were also analyzed to determine if the community structure of these habitats significantly changed over the course of the summer sampling period. This study aims to evaluate the role of *C. virginica* biogenic reefs as an effective tool to restore coastal and estuarine habitats along the Atlantic coast.

FLUPSY OBSERVATIONS AND MEASUREMENTS, AN UPDATE: QUANTIFYING INTERACTIONS WITH THE LOCAL ENVIRONMENT. **Mark S. Dixon**[1], **Gary H. Wikfors**[1], **Karen Rivara**[2], **Yaqin (Judy) Li**[1], **Shannon L. Meseck**[1], **Julie M. Rose**[1], **April N. Croxton**[1], **Lisa Milke**[1], and **Barry C. Smith**[1]. [1]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460. [2]Aeros Cultured Oyster Co., 10273 North Bayview Road, Southold, NY 11971. mark.dixon@noaa.gov

A second field season using modified and new sampling methods to examine the ecosystem interactions of a FLUPSY-based oyster nursery has yielded new insights as well as raised new questions. Long-term automated sensors with data logging capabilities, mesocosm "bag experiments," more sophisticated detection instruments, an estuarine transect, and cellular and biochemical measures of oyster stress were added to complement more traditional water quality and sediment measurements taken in the East Creek estuary, Riverhead, New York, during 2008.

Automated sensors, collecting data every fifteen minutes over several multi-week deployments, placed directly at the FLUPSY inflow and outflow locations, allowed the continuous collection of water-quality data. Preliminary results indicate that the FLUPSY has no effect on the dissolved oxygen in water being returned to the system. Chlorophyll *a* values of inflow and outflow water were virtually identical over the time periods measured, but deployments were late in the season when oysters were not growing.

Data from 2 mesocosm trials comparing isolated inflow water and outflow water to tidal estuary water indicate that the importance of nutrient recycling is dependent upon the planktonic communities present relative to tidal influences. Results also indicate that oysters in the FLUPSY were largely impacting phytoplankton in the 5-20 μm size fraction. Microzooplankton grazing activity had a much larger impact than oyster grazing on phytoplankton dynamics, particularly overnight. Direct measurements during one mesocosm trial indicate that chlorophyll *a* in the estuary undergoes expected diel fluctuations, while the values in the inflow water mesocosms declined slightly over time and the values in the outflow water mesocosms declined to a greater extent over the same time. This, again, demonstrates the effect of the grazing community on the phytoplankton in the isolated water.

An estuarine transect nutrient assessment indicated that nitrate in the system is supplied largely from the freshwater end of the estuary and is more stable in the saltwater end.

These results confirm the earlier view that the effect of the relatively small-scale FLUPSY in the East Creek ecosystem is negligible compared to other ecosystem drivers of phytoplankton and nutrient dynamics. The more refined sampling methods, however, have provided valuable information about the ecological consequences of the FLUPSY and enclosed oysters.

QUANTIFYING THE ECOLOGICAL INTERACTIONS OF A COMMERCIAL OYSTER NURSERY: OBSERVATIONS FROM MESOCOSMS.

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To quantify ecological interactions of shellfish aquaculture, a multidisciplinary study was undertaken in East Creek, Riverhead, NY, a small, shallow embayment of the Great Peconic Bay where commercial oyster nursery culture using a FLUPSY takes place. Previous measurements at this site had revealed large temporal (tidal and diel) variability in oyster feeding activities, as well as in the biological and chemical properties of water flowing in and out of the FLUPSY. Thus, mesocosm experiments were conducted to obtain measurements of plankton and nutrient dynamics without tidal effects. *In situ,* triplicate 90- L mesocosms (plastic bags) were filled with FLUPSY inflow and outflow water, incubated at the FLUPSY site and compared with surrounding bay water. Phytoplankton, microzooplankton, and water chemistry were monitored every 3 hours for 27 hours. The variable-fluorescence metric, Fv/Fm, was also measured to probe the physiological status of phytoplankton.

The first mesocosm experiment conducted in July 2009 captured a phytoplankton community dominated by *Peridinium quinquecorne*, a rare dinoflagellate not previously reported in the northeast USA. Nutrients in all mesocosms were depleted within the first 6 hours, indicating very limited recycling and implying low phytoplankton grazing by micro- and mezozooplankton. Total chlorophyll *a* (chl *a*) decreased initially, but recovered at the end of the experiment. The chl *a* increased to a greater extent in the inflow than the outflow water, indicating that phytoplankton may be stressed after passing through the FLUPSY system.

The second mesocosm experiment was conducted in September 2009 when a more common and diverse phytoplankton community was present, including a harmful dinoflagellate, *Cochlodinium polykrikoides*. Unlike the first experiment, nutrients in the mesocosms were not depleted, indicating substantial recycling. This was further verified by the high abundance and steady increase in microzooplankton in the mesocosms. The observed 30-80% reduction of phytoplankton >2 um could be attributed to microzooplankton grazing. Fv/Fm at the beginning of the experiment was significantly higher for the inflow than outflow water, indicating phytoplankton physiological stress after passing through the FLUPSY. The phytoplankton community recovered from this stress in 6 hours as indicated by increased Fv/Fm. Similar growth of phytoplankton in inflow and outflow mesocosms at the end of experiment further indicated the recovery of phytoplankton in the outflow water after passing through the FLUPSY.

Results from the two mesocosm experiments indicated that variability in the interaction of the FLUPSY system and surrounding water column is largely driven by the plankton community which, in turn, is influenced by other environmental factors. The results indicate that measurements of high temporal frequency are necessary to quantify shellfish aquaculture ecological interactions.

A PRELIMINARY TRIAL OF THE USE OF ADULT SURROGATES TO DETERMINE HEMOCYTE-IMMUNE STATUS OF OYSTER SEED IN A FLUPSY-BASED NURSERY.
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In recent years, Floating Upwelling Systems (FLUPSYs) have been used as shellfish nursery systems in highly-productive coastal waters. Successful production in these systems is dependent upon environmental factors (e.g., water quality and food availability), including possible environmental stressors. Hemocyte immune-function analyses have been used to determine the effects of environmental stressors on bivalve populations in both field and laboratory studies. Previous experiments investigating oyster hemocyte responses to varying temperature and feeding regimes established immune profiles of bivalves to characterize oyster populations as stressed or unstressed as a result of the experimental conditions. The current study examined the immune status of adult oysters deployed for one week in a commercial FLUPSY located in the Great Peconic Bay, NY, and a control group maintained at the Milford Laboratory. Adult oysters were used as a proxy to determine whether or not environmental stressors were being experienced by juvenile oysters within the FLUPSY.

Flow-cytometric techniques were used to measure hemocyte types, viability, and phagocytic activity in both control and deployed oysters. Results indicate that neither oyster treatment (lab control or deployed) experienced significant changes in hemocyte characteristics or phagocytic activity. There was, however, a significant increase in percentage of dead hemocytes in control oysters held at the Milford lab, which can be attributed to heavy rainfall during the study period. A review of water-quality measurements collected from data sondes deployed at the FLUPSY indicates that oyster seed in the FLUPSY were not likely to have been stressed by environmental conditions during the adult-oyster deployment. This preliminary study was successful in establishing a protocol to measure a baseline level of stress in juvenile oysters caused by this system. Currently, we are developing a more intensive data collection protocol to compare changes in water-quality parameters over tidal cycles with hemocyte characteristics and immune functions.

HOMEOSTATIC CAPABILITIES OF OYSTER HEMOCYTES EXPOSED TO ACIDIC CONDITIONS *IN VIVO* AND *IN VITRO*. **Gary H. Wikfors[1], Carsten A. Krome[2],** and **Shannon L. Meseck[1].** [1]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460; [2] Christian-Albrechts-Universität Kiel, Leibniz-Institut für Meeresforschung, Kiel, GERMANY. gary.wikfors@noaa.gov

Shell construction in the Eastern oyster (*Crassostrea virginica*) has been shown recently to be mediated by granular hemocytes, circulating cells with diverse functions. Oysters occur in diverse habitats wherein variation in external pH may result from microbial respiration in surrounding sediments, and internal pH may become acidic as a result of true hypercapnia – respiratory carbon-dioxide build-up in the serum during tidal exposure. We hypothesized, therefore, that oysters likely have homeostatic mechanisms to maintain conditions within the hemocytes allowing calcium-carbonate crystallization to occur over a wide range of extracellular pH conditions. The present study, thus, investigated physiological capacity of these cells to respond to extracellular acidification, especially concerning pH and calcium homeostasis. Adult Eastern oysters exposed to pH 6.7 seawater for a period of 9 days showed a sustained decrease in hemolymph pH, but no changes in intracellular hemocyte pH, which remained at control values near 7.2 throughout all measurement days (0, 3, 6, 9) of the exposure period. Intracellular calcium, however, declined significantly on day 9 of the experiment in acid-exposed oysters, compared to controls. To further document the equilibration process within hemocytes exposed to low extracellular pH, a flow-cytometric method was developed to demonstrate immediate reaction of granular hemocytes to low extracellular pH. When exposed to pH 6.7 seawater, hemocytes showed an immediate drop in intracellular pH. These values subsequently increased steadily and were no longer significantly different than initial values after 10 min. Incidentally, similar results were obtained for oysters kept out of water for 6 hr to simulate tidal emersion and sampled periodically; hypercapnia dropped serum pH to 6.8, but hemocyte internal pH remained at control values.

These results demonstrate high capacity in granular hemocytes to maintain intracellular pH, despite sharp and sustained decreases in extracellular pH. It appears, therefore, that reduction in shell production is not attributable to low pH within these cells. The loss of intracellular calcium concentration in response to seawater acidification may represent, however, a decrease in calcium concentration in cellular compartments normally responsible for calcium-carbonate crystal formation. These results, and methods developed, may contribute to a better understanding of how commercially-important molluscan shellfish may respond to Ocean Acidification resulting from atmospheric carbon-dioxide increases.

OVERVIEW OF AQUACULTURE DRUG APPROVALS AND THE UPPER MIDWEST ENVIRONMENTAL SCIENCES CENTER.

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Lack of U.S. Food and Drug Administration (FDA) approved aquaculture drugs dramatically reduces the efficiency and increases the cost of public fish production in the United States. Drug companies are reluctant to undertake any significant efforts to gain approval of aquaculture drugs because the market potential for these products is below the potential annual sales target for their research investment. It is estimated that a drug company will expend about 10 years of effort and $12 million to develop a single drug for one use in one animal species. In the 1990s, only 3 approved therapeutic drugs and one anesthetic were available to fish culturists for restricted use. The therapeutic drugs could be used on only about 12 of the 56 freshwater fish species cultured by U.S. public aquaculture facilities and only for a few of the 8 to 10 major bacterial diseases of cultured freshwater fish. As part of a consortium of drug sponsors, federal and state natural resource agencies, government research laboratories, and non-governmental organizations, the U.S. Geological Survey's Upper Midwest Environmental Sciences Center (UMESC) has provided scientific leadership, research, and unique facilities to generate data required for gaining FDA approval of potential aquaculture drugs to address this issue. The UMESC has a diverse group of scientists skilled to address FDA data requirements for 4 of the 6 technical sections that must be fulfilled in order for a drug to be approved by the FDA for aquaculture use. The technical sections that UMESC fulfills include (1) Animal Safety, (2) Drug Efficacy, (3) Environmental Safety, and (4) Human Food Safety. To accomplish these tasks UMESC conducts studies to (1) determine the drug concentrations and exposure durations that are not detrimental to the fish, (2) determine the drug concentrations and exposure durations that are effective in reducing the mortality of diseased fish, (3) determine the fate of the drug after use and if environmental concentrations of the used drug are detrimental to aquatic organisms, and (4) determine if drug residues residing in the fillet tissue of exposed fish are safe for human consumption. All studies conducted to address those determinations are conducted with strict compliance to provisions of the Good Laboratory Practices Act.

ARE DISEASE-RESISTANT LINES SUPERIOR PERFORMERS IN RHODE ISLAND OYSTER FARMS? **Kathryn R. Markey**[1], **Dale Leavitt**[2], **Karin Tammi**[2], and **Marta Gomez-Chiarri**[1] [1]Department of Fisheries Animal and Veterinary Sciences, University of Rhode Island, 20A Woodward Hall, 9 East Alumni Avenue, Kingston, RI 02881; [2]Department of Biology and Marine Biology, Roger Williams University, One Old Ferry Road, Bristol, RI 02809. kmar520@gmail.com

The oyster aquaculture industry in Rhode Island has been increasing since 1995. The diseases dermo, MSX, and Juvenile (*Roseovarius*) Oyster Disease (JOD/ROD) can severely affect wild and cultured populations of the Eastern oyster, *Crassostrea virginica*. The development of disease-resistant/tolerant lines through selective breeding is one technique used to manage these diseases. Hybrid lines are also used as a method to increase genetic diversity and productivity by exploiting hybrid vigor. Currently, no published data exist on the performance of selected lines in Rhode Island. This study evaluated the performance of one selectively bred disease-resistant/tolerant oyster (NEH, Northeastern High-Survival), in comparison to a local wild stock (GHP, Green Hill Pond), and a hybrid cross (HYB) of the two. Oysters were deployed to four shellfish farms, two in Narragansett Bay (NB1 & NB2) and two in coastal salt ponds (CP1 & CP2), in June of 2008 and 2009. Line performance was evaluated based on total volume (L), average oyster shell height (mm; n=100/line/farm), and mortality. Data shows that differences in performance exist among farms, lines, and year classes. Performance was mainly driven by mortality due to JOD for the 2008 year class; oysters at CP1 had the greatest total volume and the lowest cumulative mortality ($\leq$37%), while oysters at NB2 had the lowest volume and the greatest mortality (70-91%). For the 2009 year class, performance was driven by a combination of growth and mortality; total volume was similar between farms. Mortality of juvenile oysters was high at all farms and within all lines for the 2009 year class, with NB1 oysters experiencing the highest mortalities ($p<0.001$). Differences among lines showed that the NEH oysters from the 2008 year class had the lowest mortality in comparison to HYB and GHP ($p<0.001$) at the Narragansett Bay farms, where disease pressure from JOD was high. Oysters at the Narragansett Bay farms were larger in size than oysters at the coastal pond farms ($p<0.001$). A significant interaction between farm and line was detected for oyster size in both the 2008 and 2009 year classes ($p<0.001$). For the 2009 year class, the interaction among the lines within the four farms showed that the lines grew differently at each farm. As opposed to the results observed during 2008, in which NEH grew larger than all other strains at all farms with the exception of NB1, NEH oysters outperformed all other lines only at CP1. Overall, the disease resistant line NEH showed superior growth performance and survival than the local GHP stock and the hybrid at most farms and years. In particular, NEH oysters from the 2008 year class had the highest percentage of oysters reaching market size at the end of the second year at all farms resulting in the highest value. The superior performance of NEH in some Rhode Island farms, especially in the presence of disease pressure from JOD, indicates that Rhode Island shellfish farmers should consider this line.

DISSEMINATED NEOPLASIA IN HARD CLAMS (*MERCENARIA MERCENARIA*) AQUACULTURED IN MASSACHUSETTS. **Roxanna Smolowitz**[1], **Diane Murphy**[2,3], and **Dale Leavitt**[1]. [1]Roger Williams University, One Old Ferry Road, Bristol, RI 02809; [2]Cape Cod Cooperative Extension, Box 367, Barnstable, MA 02630; [3]Woods Hole Oceanographic Institution Sea Grant, 193 Oyster Pond Road, MS #2, Woods Hole, MA 02543. rsmolowitz@rwu.edu

Neoplasia, or an abnormal proliferation of cells in an organism, is an uncommon finding in bivalve mollusks; however there are a few exceptions. *Mya arenaria*, the soft shell clam, has been diagnosed with two types of neoplasia, hemocytic sarcoma and a tumor of gonadal origin. A proliferation of neoplastic cells of unknown origin, similar to hemocytic sarcoma, has also been reported in blue mussels (*Mytilus edulis*), cockles (*Cerostoderma edule*) and Eastern oysters (*Crassostrea virginica*). Hemocytic sarcoma, as characterized in the soft shell clam, presents at about 2 years of age and the majority of affected animals die within the year. High percentages of affected soft shell clams have been annually identified in Fairhaven, MA; but in other locations along the coast of MA, the condition routinely is found in only 2 to 4% of the population. Association with pollution has long been proposed as either a cause of, or a promoter, of tumor occurrence, especially in animals at the Fairhaven site. However, no real evidence for the involvement of pollution in expression of the condition has been seen at other sites. Epizootics of this disease, with subsequent demise of the soft shell clam population have been noted in wild clams both in Martha's Vineyard and in the Chesapeake Bay. In Canada, an epizootic of the disease occurred in cultured animals. While working on disease projects involving *Mercenaria mercenaria* (hard clams), a hemocytic sarcomatous-like condition was identified in young (1 to 2 year old), aquacultured hard clams from several areas of Cape Cod. As in soft shell clams, from areas other than Fairhaven, and as in other types of bivalves, this condition while causing the death of affected clams has never been identified as a significant cause of mortality in hard clam populations. In the summer of 2009, that changed. Aquacultured clams from areas in Wellfleet, MA, showed high mortality in 1 to 2 year old cultured animals from several leases. Affected animals had no signs of QPX disease. Moribund clams un-earthed themselves and laid on the surface of the culture plots. Animals were collected and examined grossly and microscopically. Grossly, the animals were thin, but occasionally showed a firm, whitish swelling in various areas of the body. Histologically, greater than 90% of the animals collected from the surface of the plots exhibited moderate to severe, disseminated tumorous-like cells similar to those seen in hemocytic sarcoma of soft shell clams. Additionally, animals sampled from the population still buried in the sediment showed disease prevalences of 40%. While the origin of the neoplastic cell, and the cause of this condition is not known in hard clams, the occurrence of significant mortality in cultured stocks shows that a hemocytic sarcoma-like condition is capable of causing significant mortality in populations of hard clams.

POTENTIAL MECHANISMS BY WHICH A PROSPECTIVE PROBIOTIC BACTERIUM CAN IMPROVE SURVIVAL OF OYSTER LARVAE (*CRASSOSTREA VIRGINICA*): COMPETITIVE EXCLUSION OR IMMUNE REGULATION. **Diane Kapareiko[1], Gary H. Wikfors[1], Jennifer H. Alix[1], Eric Schott[2], Harold J.Schreier[2], Dennis McIntosh[3], Jessica M. Rash[3]** and **Oluchi Ukaegbu[4].** [1]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460; [2]Center of Marine Biotechnology, 701 E. Pratt Street, Suite 236, University of Maryland Biotechnology Institute, Baltimore, MD 21202; [3]Department Agriculture and Natural Resources, Delaware State University, 1200 N. DuPont Highway, Dover, DE 19901; [4]Department Biological Sciences, Delaware State University, 1200 N. DuPont Highway, Dover, DE 19901. diane.kapareiko@noaa.gov

Environmentally-friendly methods for controlling microbial pathogenesis in aquaculture with probiotic bacteria are becoming increasingly preferred over use of chemical means, such as disinfectants or antibiotics. Recent research at the Milford Laboratory has shown that naturally-occurring bacteria isolated from the digestive glands of adult oysters, *Crassostrea virginica*, may be used as potential probiotic candidates in oyster larviculture. Probiotic candidate selection was based upon the Kirby Bauer Disc Diffusion Method, in which zones of inhibition suggested competitive exclusion of a known shellfish larvae pathogen (B183). In challenge studies, survival of 2-day old oyster larvae supplemented with probiotic candidate OY15 (*Vibrio sp.*) was similar ($p<0.3883$) to that of control larvae (no added bacteria), indicating no harmful effects. Further, addition of OY15 to oyster larvae challenged with B183 significantly improved survival ($p<0.0141$) compared to the pathogen alone. An *in vitro* study to determine the effects of OY15 or the pathogen B183 upon oyster hemocytes and their immune functions demonstrated immuno-stimulation of oyster hemocytes by OY15 and immune-suppression by B183, suggesting an immuno-modulation mechanism for OY15.

To further test for competitive exclusion, molecular methods were used to determine effects of probiotic candidate OY15 upon the diversity of the microbial community associated with the culture of oyster larvae. Two-day old oyster larvae were supplemented with OY15 for 48 hours prior to challenge with pathogen B183. Larvae and culture water were sampled before pathogen challenge, and 1, 3 and 5 days post challenge, for bacterial diversity using 16S rRNA sequence data. Results revealed diverse, but different bacterial communities associated with oyster larvae and culture water. Addition of OY15 did not significantly change the diversity of the bacterial community associated with the oyster larvae, suggesting no selective retention or exclusion of different bacteria within larvae. OY15 16S rRNA sequences were detected in larval and water preparations one day post treatment but could not be detected on day three; pathogen B183 could not be detected one day post-challenge. These results suggest that OY15 and B183 activities do not appear to influence bacterial communities within larvae or culture water, reinforcing the interpretation that immune-modulation is the main mechanism by which OY15 protects larvae from pathogenesis.

INTERSTATE SHELLFISH SANITATION CONFERENCE (ISSC) *VIBRIO* MANAGEMENT PLANS, HOW THEY IMPACT INDUSTRY. **Michael Hickey.**
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An overview will be provided concerning ISSC actions to date regarding the status of implementation of the ISSC *Vibrio vulnificus* (Vv) Management Plan and proposed alternatives to FDA Vv regulations, the *Vibrio parahaemolyticus* (Vp) Control Plan and other related activities.

AN UPDATE ON THE STATUS OF FOOD SAFETY LEGISLATION PENDING BEFORE CONGRESS. **Brian Ronholm**. Congresswoman Rosa L. DeLauro's Office, 2262 Rayburn HOB, Washington, DC 20515. brian.ronholm@mail.house.gov

The House passed their version of food safety legislation (H.R. 2749) on July 30, 2009. Among other things, the bill would reform the food safety system at the Food and Drug Administration (FDA) by requiring: foreign and domestic food facilities to have safety plans in place to identify and mitigate hazards; a minimum inspection frequency for foreign and domestic facilities and require certain foreign foods to be certified as meeting U.S. food safety requirements. The Senate is working on their version of the bill, having passed the bill out of committee on December 18, 2009. The Senate reportedly intends to take up the bill on the floor in early 2010 after completion of the health care reform bill. Separate from food safety legislation, the FDA announced on November 13 that it would work with the oyster industry to examine the process for oyster harvesters to access adequate controls in reducing illnesses and death due to oysters contaminated with *Vibrio vulnificus* (Vv). The pursuit toward implementing a Vv risk management plan that achieves this intended public health benefit is a valid one and the FDA engaging the industry on the issue is an appropriate step.

ADVANCES IN METHODS FOR THE DETECTION OF *VIBRIO PARAHAEMOLYTICUS* IN SEAFOOD SAMPLES. **Marta Gomez-Chiarri** and **Annie M. Cox.** University of Rhode Island, Department of Fisheries, Animal and Veterinary Sciences, 20A Woodward Hall, 9 East Alumni Avenue, Kingston, RI 02881. gomezchi@uri.edu

Vibrio parahaemolyticus is a gram-negative enteropathogenic marine *Vibrio* that is capable of causing disease in humans, from mild gastroenteritis to severe debilitating dysentery. Infections of the gastrointestinal tract are usually due to consumption of raw shellfish. Because of recent outbreaks, the Interstate Shellfish Sanitation Conference (ISSC) has adopted a control plan for human pathogenic vibrios. Adequate management should rely on sensitive and accurate detection of pathogenic *Vibrio parahaemolyticus*. Here, we will review recent advances in methods used for the detection of *V. parahaemolyticus* in seafood samples, including the most probable number (MPN), chromogenic medium, the colony overlay procedure, DNA colony hybridization, and several methods based on the use of the polymerase chain reaction. Several of these methods differentiate between pathogenic and environmental (non-pathogenic) strains based on the presence of two virulence factors that have been found to be associated with most pathogenic strains. These are a thermally stable direct acting hemolysin (*tdh*) and a thermally stable direct acting–related hemolysin (*trh*). A third gene (thermolabile hemolysin or *tlh)* is common to non-pathogenic and pathogenic strains, and is used as a species specific marker for *V. parahaemolyticus*. We will also present results from a study in which we have used one of such methods to determine levels of *V. parahaemolyticus* in oysters and water samples from several Rhode Island farms during the summer of 2009, and discuss implications for the shellfish industry.

MULTI-FACETED RESEARCH ON HIGH PRESSURE PROCESSED HARD CLAMS (*MERCENARIA MERCENARIA*) FOR COMMERCIAL APPLICATION. **Gef Flimlin.** Commercial Fisheries and Aquaculture, Rutgers Cooperative Extension, 1623 Whitesville Road, Toms River, NJ 08755. flimlin@aesop.rutgers.edu

Post harvest treatment of food products utilizing high pressure processing is a technology which is gaining continuous examination. Researchers and extension professionals at Rutgers University have been evaluating market impact, organoleptic profiles, bacteriological changes, viral deactivation, and physiological changes for about 8 years. The process is now moving into the transference of this technology into the commercial sector for retail and restaurant sales, as well as food service applications. The work is being done to provide a value-added product in the marketplace which could expand sales for harvesters and growers.

INDUSTRY RESPONSE TO FDA'S PROPOSED RAW OYSTER BAN. Robert Rheault.
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On October 17, 2009 the FDA announced at the Interstate Shellfish Sanitation Conference that they intended to mandate Post Harvest Processing (PHP) of all Gulf oysters from April through October to eliminate approximately 13 deaths annually attributed to *Vibrio vulnificus*. The FDA determined that efforts to reduce illnesses and deaths had been inadequate and further measures mandating onboard refrigeration were unlikely to be effective in reaching the target of a 60% reduction in illness.

For several years the FDA has had an official policy discouraging the consumption of raw shellfish. Industry groups fear that mandated PHP will be extended to East and West Coast states to control summer outbreaks of illnesses related to *Vibrio parahaemolyticus* and *V. vulnificus* in clams and oysters. Given the high costs of Post Harvest Processing equipment and the importance of summer markets to the survival of both producers and raw bars, such a mandate would have profound impacts on our industry.

In order to prevent the FDA from mandating such draconian requirements it is important for industry to take aggressive steps on several fronts.

- We must implement and enforce aggressive time-temperature controls at all levels of the supply chain to ensure that *Vibrio* bacteria don't multiply in the shellfish between the time they are harvested and the time they are consumed.
- We must demonstrate our willingness to self-regulate, and ensure that a few bad actors don't ruin our markets and our reputation for providing wholesome, nutritious sustainable seafood.
- We need to step up public education efforts to remind at-risk, immune-compromised individuals that they should not be consuming <u>any</u> raw foods (especially shellfish).
- We need to educate our Congressional delegations about how the FDA's proposed actions will impact our industry.

30 YEARS OF THE MILFORD AQUACULTURE SEMINAR. Walter J. Blogoslawski.
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In 1975, a small group of shellfish farmers and aquaculture scientists gathered at a meeting organized as the "Hatchery Disease Meeting" to discuss specific disease problems. The success of that first meeting led to a request for an annual meeting with the goal of assisting the fledgling aquaculture industry. The first five meetings were held at the Milford Laboratory, but eventually attendance increased sufficiently that the Milford Lab facilities were no longer adequate. In 1986 the meeting moved to the Howard Johnson's in Milford where the conference was held for the next eleven years and became a 2-day event starting the tradition of a poster social with raw, cultured shellfish served the evening before the scientific presentations began. In 1997 the meeting moved to a yet larger venue (Quality Inn, New Haven). With the construction of two Connecticut Magnet high schools that taught marine aquaculture, we invited students to present their research results. The 26th meeting moved from New Haven to Meriden, CT (Four Points by Sheraton), which could accommodate over 200 people. After meeting in Groton, CT in conjunction with Northeast Aquaculture Conference and Exposition (NACE) for the 27th, the meeting moved back to Meriden for two years before returning to the Milford area to celebrate the 30th at the Courtyard Marriott in Shelton, CT.

The scope of the meeting has widened tremendously over the years to accommodate the burgeoning technical, scientific, and financial information available to a growing industry. Business participation has expanded from owners and operators of aquaculture establishments to include banking and insurance interests. Scientists have found the meeting an effective platform to present their latest efforts. Universities and technical high schools are well represented and the meeting provides a forum for government representatives to explain their services. Academic and commercial aquaculturists in this region and around the world have come to view the Milford Laboratory and our annual Seminar as a reliable source of innovative science. Ongoing field and laboratory research has led to a steady stream of applications on a number of fronts, contributing to improved management of pathogens, effective cultivation technology, and more fully-informed conservation of wild stocks.

Over the years the MAS has provided opportunities to partner with other organizations or scientific programs such as Juvenile Oyster Disease Workshop (26th), NACE (27th), Best Management Practices for Shellfish Aquaculture (29th), NRAC sponsored Interactions of Shellfish Aquaculture and the Environment (30th) as well as numerous meetings of the East Coast Shellfish Growers Association. Thirty meetings later, with well over 100 participants, the Milford Aquaculture Seminar has become a premier forum for the sharing of problems, ideas, and solutions in this rapidly expanding and important trade.

SEVENTY-FIVE YEARS OF OBSERVATIONS OF THE SHELLFISHERIES. **Clyde L. MacKenzie, Jr.** U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, 75 Magruder Road, Highlands, NJ 07732. clyde.mackenzie@noaa.gov

The shellfisheries consist of gathering, processing and marketing the estuarine mollusks—oysters, hard clams, soft clams, bay scallops and blue mussels—and offshore (oceanic) mollusks—sea scallops, surf clams, and ocean quahogs. The estuarine mollusks have been harvested by fishermen (usually men) walking to their beds from shore or by using dredges, tongs or dip nets from boats. During the 1800s, the harvests for oysters and the estuarine clams began on a substantial scale. In the 1870s, the bay scallop fishery began, and in the late 1970s, the mussel fishery began. Some recreational harvesting of the estuarine mollusks has also occurred. The offshore gathering of the sea scallops and the clams began on substantial scales after the mid-1940s.

The oyster fishery along the U.S. East Coast that had become large in the late 1800s and early 1900s (around 20 million bushels were produced each year) became steadily smaller after that, mainly due to a lack of demand for oysters and since the late 1950s from a lack of supply because oysters had large, persistent mortalities from diseases. The oyster industry along most of the U.S. Gulf Coast has not declined, though market demand for its oysters, rather than supply, has consistently limited its production through history. Hard clam production has remained at a more consistent level than that for oysters, and it has been buoyed by production from hatchery-growout farms mainly in New Jersey, Virginia, South Carolina, and Florida. Maine is the largest producer of soft clams; in the 2000s, its average landings have been about a third as large as those during the 1970s. After 1987, bay scallop landings have fallen sharply following years of annually-consistent coast-wide landings since the fishery began.

In 2007, the landings of the offshore mollusks, a total of 147 million pounds of meats, exceeded those of the estuarine mollusks, 75 million pounds of meats, by about two-fold. The taking of the offshore mollusks is tightly controlled by the U.S. Regional Management Councils that use data collected by NOAA Fisheries vessels. The vessels determine the quantities of the mollusks present: surveys of sea scallops are conducted once every year, and the surf clams and ocean quahogs once every three years.

A description of the fisheries will be presented by listing a series of personal observations over the past 75 years besides some previous historical documentation.

UPDATE ON ECSGA ACTIVITIES IN 2009. Robert Rheault. East Coast Shellfish Growers Association, 1121 Mooresfield Road, Wakefield, RI 02879. bob@moonstoneoysters.com

The past year has been active and formative for the ECSGA. We have enjoyed significant growth in our membership, our budget and in our effectiveness at the political level. We continue to advocate effectively for shellfish research funding, attracting support for *Vibrio* research and shellfish genetics, and we helped secure funding for aquaculture research at the Northeast Fisheries Science Center.

Our top legislative priorities for 2010 include:

- funding for a USDA ARS Shellfish Breeding Center,
- fighting FDA efforts to ban the sale of raw Gulf oysters,
- fixing the Clean Water Act to close the loophole for non-point source pollution
- and marketing assistance.

The Shellfish Breeding Center is a USDA-ARS initiative involving six East Coast states. The Center would leverage existing breeding programs and intellectual talent by adding three ARS geneticists at URI to coordinate coastwide breeding efforts and perform analysis of the genome to identify markers associated with disease resistance and growth.

Two ARS breeding experts would work in the mid-Atlantic to direct and expand breeding and growout trials in NJ, MD and VA. Cooperative agreements would help fund expanded spawning and growout trials for more lines and crosses in ME, RI, NJ, MD, VA and NC.

The ECSGA hosted a highly-acclaimed marketing event in March called *Romancing the Clam* in Savannah, Ga. The event featured four species of clams, seven chefs from around the country and eleven regional recipes. All of this was captured on video which can be seen on YouTube or purchased on DVD.

We have totally revamped our website www.ECSGA.org so that it is now more attractive and user friendly.

We have completed our two-year effort to craft Best Management Practices appropriate for East Coast shellfish growers and are following up by developing ways to make these more useful for growers as a marketing tool. We also took an active role in advising the World Wildlife Fund efforts to craft sustainability standards that should lead to an eco-label certification.

We continue to remain active on many fronts, providing comment on many bills and initiatives including: Organic Standards for cultured shellfish, Ocean Policy, Offshore Aquaculture, climate change and ocean acidification, and FDA activities.

We coordinated testimony for congressional hearings on the Clean Water Act, highlighting the impacts of non-point source pollutants to our growing waters.

Each January we visit dozens of Senators and Congressmen in DC and host (with help from growers from the Gulf and West Coasts) a Congressional Reception.

NAVIGATING THE PERMITTING PROCESS FOR SHELLFISH AQUACULTURE AND RELATED ACTIVITES IN LONG ISLAND SOUND. **Tessa Getchis[1], Kristen Bellantuono[2], David Carey[3], Shannon Kelly[3], Cori M. Rose[4]** and **Paula Kullberg[4].**
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The regulatory process for marine aquaculture and research with aquatic organisms in Connecticut involves application review by state and federal agencies, as well as an advisory role for municipal shellfish commissions. As such, the process can become complex and burdensome if the applicant does not understand what is expected of them when completing an application.

The Connecticut Aquaculture Permitting Workgroup, a partnership among Connecticut Sea Grant, the Connecticut Department of Agriculture/Bureau of Aquaculture, Connecticut Department of Environmental Protection and the U.S. Army Corps of Engineers/New England District, has updated its outreach materials to inform applicants of the requirements of the various types of marine aquaculture and shellfisheries permits and licenses. This information is laid out in the 2010 version of "A Guide to Permitting Marine Aquaculture in Connecticut" which can be located at: http://web2.uconn.edu/seagrant/publications/aquaculture/permitguide.pdf, as well as on the sites of the state and federal regulatory agencies.

There are a number of changes to this year's guide including policies related to importing and transplanting shellfish for commercial and other purposes (e.g. restoration and enhancement efforts) and the permitting of structures in Long Island Sound.. This presentation will focus on those policy changes and provide a brief overview for the permitting process for these activities.

Prospective producers may contact the local aquaculture extension agent for information on getting started in aquaculture, or visit Online Guide to Marine Aquaculture in Connecticut: http://web2.uconn.edu/seagrant/whatwedo/aquaculture/index.php. Individuals who have a completed business plan and wish to apply for an aquaculture permit or expand an existing aquaculture operation should consult with the State Aquaculture Coordinator (Director of the Bureau of Aquaculture) prior to initiating an application. One-on-one consultations can be requested. Those interested in working with aquaculture structures (bags, cages, longlines, predator netting, etc.) should plan ahead, as applications for structures may require extensive review by state and federal, and potentially local agencies.

Anyone seeking to use shellfish for research, educational, restoration or fishery enhancement purposes is required to have a license or permit. Individuals seeking to lay cultch or use structures to contain shellfish should seek the guidance of the State Aquaculture Coordinator. The type of documentation needed depends on the work to be conducted. Those interested in importing shellfish larvae, seed or broodstock into the State are required to have the animals screened for disease by the State Shellfish Pathologist. A brief overview of required permits and licenses can be found in *Guidelines for Utilizing Aquatic Organisms for Scientific/Educational Purposes in Connecticut* available at: http://web2.uconn.edu/seagrant/publications/aquaculture/aquause.pdf.

BEST MANAGEMENT PRACTICES FOR THE US EAST COAST SHELLFISH AQUACULTURE INDUSTRY: AN INDUSTRY-DRIVEN APPROACH. **Gef Flimlin**[1], **Sandy Macfarlane**[2]*, **Ed Rhodes**[3] and **Kathy Rhodes**[4]. [1]Commercial Fisheries and Aquaculture, Rutgers Cooperative Extension, 1623 Whitesville Road, Toms River, NJ 08755; [2]Coastal Resource Specialists, Orleans, MA 02653; [3]Philips Foods, 1215 East Fort Ave., Baltimore, MD 21230; [4]East Coast Shellfish Growers Association, 49 Reed Street, Milford, CT 06460. sandymac@capecod.net

A Code of Practice and a set of model Best Management Practices for the East Coast shellfish aquaculture industry has been an urgently needed priority activity. Stakeholder-driven Codes and BMPs can lead to greater industry environmental accountability, reduce multi-user conflicts, improve production efficiency, instill consumer confidence in products and result in a higher degree of self-regulation that can yield economic benefits to the industry and a better product for the consumer. The East Coast Shellfish Growers Association initiated a broad-based stakeholder workshop process inviting growers, regulators, academia, NGOs, and the public to discuss issues and suggest solutions. We convened 18 workshops from Maine to Florida over a two-year period.

Oysters, clams, mussels and scallops are raised on primarily small farms employing less than 10 individuals although there are some larger vertically integrated farms. The industry is diverse – geographically, and economically but it is also remarkably similar. Gear and maintenance procedures are site specific and species-specific but within species, the gear and how it is handled is rather standard. Unlike land-based farming, shellfish aquaculture is primarily practiced in leased state waters. There are exceptions where farmers actually own the territory they are farming but the majority of farmers operate under a lease system. Because the farmers are privatizing public lands through a lease process, they are under more scrutiny than other users of the public coastal zone.

The workshops have resulted in a compilation of farming issues and ways to address them. In addition to a Code of Practice and BMP manual, the team is developing a farm-specific template for farmers to use as an operations plan. Documentation of operations in this manner can lead to improved farm efficiency, greater acceptance of the product in the market and enhanced consumer confidence.

OVERVIEW OF THE INTERNATIONAL WORKSHOP ON BIOEXTRACTIVE TECHNOLOGIES FOR NUTRIENT REMEDIATION. **Julie M. Rose[1,2], Mark Tedesco[2]** and **Gary H. Wikfors[1].** [1]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460; [2]U.S. Environmental Protection Agency, Long Island Sound Office, 888 Washington Blvd Suite 9-11, Stamford, CT 06901. julie.rose@noaa.gov.

The *International Workshop on Bioextractive Technologies for Nutrient Remediation in Long Island Sound*, held December 2009 in Stamford, CT, explored new technologies to improve water quality by reducing nutrients in Long Island Sound. An overabundance of nutrients in coastal waters has been linked to hypoxia, a condition in which low dissolved oxygen threatens the health of living marine resources in the Sound. The workshop explored the potential use of cultured shellfish and seaweed to remove phytoplankton and reduce inorganic dissolved nutrients. Harvest of shellfish and seaweed biomass will remove associated nutrients directly from the water body, rather than blocking loading from the watershed, the atmosphere, and other external sources. The new technologies are intended to complement existing nitrogen control efforts, including upgrading wastewater treatment plants or reducing fertilizer applications, as part of a comprehensive watershed management plan for Long Island Sound. The workshop joined experts in seaweed and shellfish cultivation, integrated multi-trophic aquaculture (IMTA), resource economics, and coastal modeling with local partners to discuss the potential benefits of these technologies to the Sound and other urban estuarine environments. The agenda included a series of speakers describing recent advances in this field as well as an extensive panel discussion of local scientists and resource managers discussing the opportunities and challenges to bringing bioextractive technologies to the Sound. The workshop was sponsored by the Long Island Sound Study (LISS) with the assistance of the National Oceanic and Atmospheric Administration, the New England Interstate Water Pollution Control Commission, and the University of Connecticut.

Among the topics discussed were several of direct relevance to shellfish farmers. A model has been constructed to project biodeposition dynamics of bivalve suspension culture. Such models, in combination with knowledge about sediment biogeochemistry and benthic-pelagic coupling of nutrient fluxes, can be used to estimate denitrification rates resulting from shellfish filtration and biodeposition activities. Bivalves have been used as particle-clearance components in successful, ongoing IMTA projects in several places in the world. Use of suspension culture of mussels to mitigate coastal eutrophication is being expanded on the coasts of Sweden in an integrated ecological and economic context that may support eventual realization of "ecosystem services" value from shellfish aquaculture elsewhere. Preliminary model runs for the Long Island Sound region indicate that increased shellfish aquaculture has the potential to substantially reduce the occurrence of hypoxia in western Long Island Sound.

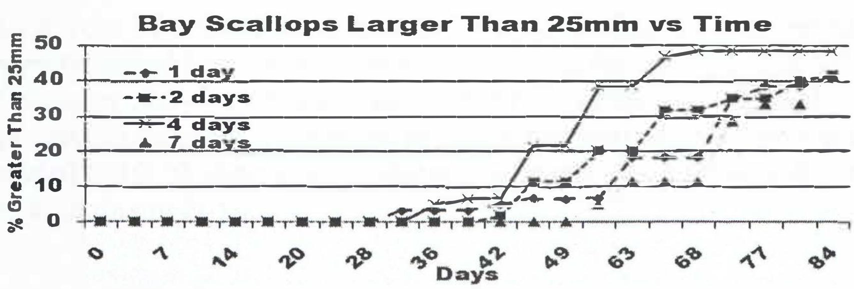
ENERGY EFFICIENCY IMPROVEMENTS IN ALGAL GROWTH SYSTEMS. **Hans Drenkard**[1] and **David Veilleux**[2]. [1]Southern Connecticut State University Institute for Science Instruction and Study (ISIS), 501 Crescent Street, New Haven, CT 06515; [2] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460. thsphys@optonline.net

The Northeast Fisheries Science Center's Milford Laboratory developed methods for and has maintained semi-continuous microalgal cultures for many years. In the mass culture room, light is provided by a bank of continuously operated eight foot fluorescent tubes. A recent energy audit identified the algal production system as having potential for increased energy efficiency. The objectives of this project were to find the specific light spectra utilized by the algal species, identify a light emitting diode (LED) system with light output equal to the current system and to develop a cost recovery analysis. Geometric and spectral factors were considered to determine the LED arrangement and quantity. A prototype LED array was fabricated and a light meter used for comparison to the current fluorescent system. The prototype delivered light energy equivalent to the existing system and is available for future testing of algal growth rates.

HANDLING STRATEGIES FOR BAY SCALLOPS, *ARGOPECTEN IRRADIANS IRRADIANS*, GROWN IN SEMI-STATIC CULTURES.
James C. Widman Jr., David J. Veilleux and **Mark Dixon.** U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460. james.widman@noaa.gov

One of the major impediments to successful single season bay scallop aquaculture in the northeastern U.S. is the limited length of the natural growing season. A short growing season results in smaller bay scallop adductor muscles, reducing the product yield. Overwintering scallops would allow additional growth in the following season, however winter is a period of dormancy and they can use up their energy reserves. This results in variable survival rates; a gamble most entrepreneurs are not willing to risk. Rhodes and Widman (1984) have shown that a 50mm shell height bay scallop yields a 3g adductor muscle while a slightly larger 62.5mm scallop doubles the adductor muscle yield. Six gram bay scallop adductor muscles are acceptable to the consumer since they are similar to the smaller scallops that are commercially harvested from the traditional fishery. As an alternative to overwintering scallops, we are exploring the use of an enclosed shellfish nursery to produce larger 25mm bay scallop seed prior to the growing season in the spring. Deploying 25 mm scallop seed at the beginning of the growing season in suitable environments should yield 6g or larger adductor muscles suitable for a single season crop.

Frequent handling of scallops during culture reduces their growth. We conducted an experiment to determine the optimal handling strategy for bay scallops grown in semi-static cultures. Scallops were held in buckets which received a water change at a schedule of either every one, two, four or seven days. Scallops were kept in different water volumes based on a ratio of 15L of seawater per day and handled as follows: 15L – changed daily, 30L – every 2 days, 60L – every 4 and 105L every 7 days. For the duration of the experiment each system was fed the equivalent of 500 cells/ml of Ply-429, *Tetraselmis chui*, and the equivalent volume of Chaet-B, *Chaetoceros neogracili*. A computer automated demand feeding system was used to maintain constant algal cell concentrations throughout the experiment. Thirty scallops were haphazardly placed into each of four replicate treatments in 1 μm filtered 22°C seawater. Scallops with an initial mean shell height of 10.8±1.3mm grew to mean shell heights ranging from 19.0 – 21.2mm in 35 days. Once scallops obtained a shell height of 25mm they were "harvested" from each system. The experiment was terminated at 84 days and 20-77% of the scallops had reached a target 25mm harvest size. We found that scallops held in the systems that were changed every 4 days had average survival, the fastest growth rates and greatest number reaching 25mm.



CREATING A TETRAPLOID BROODSTOCK FOR THE BAY SCALLOP, *ARGOPECTEN IRRADIANS*. **Amandine Surier[1], Richard Karney[1], Ximing Guo[2], Yongping Wang[2]** and **Emma Green-Beach[1].** [1]Martha's Vineyard Shellfish Group, 220 Weaver Lane, Tisbury 02568 MA, [2]Haskins Laboratory, Rutgers University, 6959 Miller Avenue, Port Norris, NJ 08349. amandine_surier@hotmail.com

In previous studies, chemically induced triploid bay scallops have shown increased growth, height and enlarged adductor muscle when compared with their diploid counterparts. However, because chemicals are used, they are not approved for human consumption. Only "natural" triploids produced using a tetraploid broodstock would gain FDA approval.

To create a tetraploid broodstock, a triploid group (F1) was first produced, in 2007, with a 400µM solution of 6-DMAP. Flow cytometry showed that F1 was 70% triploid on average. The scallops were overwintered in bottom cages in Katama Bay, MA.

In the spring of 2008, 72% of the F1 scallops tested were still triploids. In the months of July and August, 650 scallops from the F1 triploid population were tested for ploidy and monitored for gonad development. Approximately 5% of the triploid group showed some signs of sexual maturation.

In August, 22 "ripe" triploids were spawned 3 times yielding 5, 15 and 5 million eggs. Most triploid scallops spawned as female only. The eggs were fertilized with diploid sperm (F2) and treated with 6-DMAP to inhibit first polar body. Mortality was extremely high at the larval stage with an 89% abnormality at Day 1 and 97% mortality at Day 7. A few thousand scallops survived passed the setting stage.

In October 2008, flow cytometry analysis on individual 1-2mm scallops showed that the F2 population was 66% 2N, 29% 3N and 5% 4N. Out of 225 samples, 12 scallops were positively identified as 4N. The production of tetraploids for the bay scallop *Argopecten irradians* is a worldwide first. The F2 as well as the survivors from the F1 3N population were overwintered in bottom cages in Katama Bay, MA.

In the spring of 2009, assessment of the F1 and F2 population revealed high winter mortalities in F1 (98%) but only 25% mortality in the potential tetraploids F2. F2 was kept in quarantine until large enough to be sampled. Flow cytometry did not show any surviving 4N in the F2 population.

Triploid individuals from F1 and F2 were spawned 4 times during the summer season 2009. Although eggs were obtained from both F1 and F2 triploids, the embryos did not survive fertilization and 1st polar body inhibition with 6-DMAP. An attempt at inducing 4N with heat (35° treatment) proved unsuccessful, embryos survived but were all 2N. We were not able to replicate the results of 2008. A chemically induced 3N group was produced at the end of the season for further attempts in 2010.

A DESCRIPTION OF THE CULTURE TECHNIQUES EMPLOYED IN THE HUSBANDRY OF *HIPPOCAMPUS REIDI,* THE LONG SNOUT SEAHORSE, IN THE SOUND SCHOOL FISH PRODUCTION FACILITY. **Gina E. Biondi, Aldis K. Berezowskyj, Alessandra L. Garofano, Stuart W. Mattison, Angel G. Santiago,** and **John J. Roy.** Sound School Regional Aquaculture Center, 60 South Water Street, New Haven, CT 06519. hawk1959@att.net

Few if any marine species are not influenced by anthropogenic factors. The detrimental effects of capture fisheries by the marine ornamental trade on wild stocks of many species of finfish and invertebrates have been well documented. As the popularity of saltwater aquariums has grown, the demand for organisms that are distinctive or unique in body conformation has increased. Unfortunately, high mortality rates are often associated with the capture, transportation and acclimation of wild caught specimens. Among those creatures included in this category are members of the family Syngnathidae. In particular the fragile nature and finicky habits of wild caught seahorses, *Hippocampus sp*., makes them a species that seldom survives long in aquaria.

Students at the Sound School Regional Aquaculture Center currently have two populations of seahorses under culture, *H. erectus* and *H. reidi* in the fish production laboratory. Initiation of the husbandry protocol for *H. erectus* began three years ago; that methodology has been adapted to conform to the requirements of *H. reidi* during the past year. The culture of both species takes place in a state-of-the art aquarium rack re-circulating system. The system initially held three tanks whose dimensions were 122 x 31 x 33 cm, 125-liter glass tanks. One 53 x 39 x 92 cm, 190-liter acrylic tank was added and plumbed into the original system. The acrylic tanks were used to house the *H. erectus* adults; the adult population of *H. reidi* has been divided into two of the 125L glass tanks. Tank assignments were made when species specific courtship rituals and space requirements were considered.

The adult long snout seahorses have demonstrated mating behavior - males changing colors and performing the "bowing" motion that is indicative of courtship and females have responded in kind. Each tank of seahorses has had individuals that have paired. Successful mating has occurred with two sets of broodstock. Thus far this year, three hatches have occurred in the *H. reidi* tanks; two broods from one pair and a single hatch from the second pair. The young have been collected and a variety of husbandry methods and culture systems have been fabricated and employed. To date no young have survived past week eight, and we continue to make modifications in both the feeding regimes and to culture vessels in an effort to produce viable juveniles.

Potentially, the production of *H. reidi* in aquaculture facilities has a two-fold benefit. First, the demands on natural populations should lessen with the availability of farmed stock. Second, the likelihood of survival of the cultured seahorses in tanks is greatly increased. Propagation of these animals using aquaculture techniques eliminates many of the stressors involved in wild capture and transport, better readies the animals for commercially produced feeds and allows for the development of populations not exposed to parasites potentially vectored by wild caught individuals. It is hoped that the efforts of the students at the school will one day result in semi-continuous production of captive-bred long snout seahorses.

EVALUATION OF THE INTRASPECIFIC COMPETITION OF *CRASSOSTREA VIRGINICA* IN A HIGH DENSITY CAGE SYSTEM. **Gerald Ramos** and **Kirk Shadle.** Bridgeport Regional Aquaculture Science and Technology Education Center, 60 Saint Stephens Road, Bridgeport, CT 06605. kshadle@bridgeportedu.net

Determining intraspecific competition within a high-density cage culture of *Crassostrea virginica*, the Eastern oyster, is critical for achieving optimum cage design and thus, growth potential. The cages are comprised of six grow-out sleeves arranged in either a vertical, triple stack or horizontal, double stack. The control cage is a single stack of grow-out sleeves. These cages were stocked with equal sleeve biomass concentration of ~55 mm individuals, on June 12, 2009. The cages were then placed in 10m -12m water depth at 41° 6.791' N, 73° 15.190' W. The cages remained undisturbed until total biomass sampling was conducted between October – December 2009. Intraspecific competition was evaluated through sleeve based population growth rates, mortality rates and individual height at time of mortality. Preliminary data indicates that cage design has contributed a substantial impact on the growth potential of the population. Individual sleeve performance is currently being evaluated and analyzed.

MUSSEL CULTURE ON LONG LINES ON CAPE ANN, MASSACHUSETTS – AN UPDATE. **Ted Maney[1], Mark Fregeau[1], Joseph K. Buttner[1], Scott Weston[1]** and **Bill Lee[2].** [1]Northeastern Massachusetts Aquaculture Center and Department of Biology, Salem State College, Salem, MA 01970 and [2] F/V Ocean Reporter, 25 Pleasant Street, Rockport, MA 01966. tmaney@salemstate.edu

Over the last 3 years, the staff at the Northeastern Massachusetts Aquaculture Center, NEMAC, has investigated the potential for subtidal culture of the blue mussel, *Mytilus edulis*. In 2006, one long line set-up was deployed in 10 meters (MLW) of water off Hodgkin's Cove in Gloucester, MA. The set-up consisted of six mussel lines suspended from floats 6 meters below the surface water to avoid fouling with boat traffic. The set-up was designed to keep the mussel lines 2 meters off the bottom to limit exposure to potential predators. Mussels and gear were routinely monitored by divers and video. After 15 months, mussels grew to a mean size of 61.1 mm SL, weighing as much as 10 kg/rope.

The project was expanded in 2008 to include two deeper sites (>21m) at nearby Rockport: Folly Cove and Sandy Bay. Six mussel lines were deployed at each site (Folly Cove, Sandy Bay, Hodgkin's Cove) with similar gear arrangements and mussel densities (~1000 mussels/m). Mussel lines off the Rockport sites were 10 m in length, while off Hodgkin's Cove they were 2 m. Mussel seed averaged 6.2-6.9 mm SL. Observations at the new sites continued to reveal rapid growth, excellent survival rates and good acceptance by other users. These on-going studies have led to modifications in gear design and identified issues concerning spat collection. Data indicate that blue mussel culture in the waters off Cape Ann is viable and has commercial potential. We look to establish an offshore experimental/demonstration site.

RESULTS OF PILOT COMMERCIAL-SCALE OFFSHORE MUSSEL FARMING IN SOUTHERN NEW ENGLAND. **Scott Lindell**[1], **Greg Mataronas**[2], **Mike Marchetti**[3], **Richard Karney**[4], **Bill Silkes**[5], **John Murt**[1], **Kara Maloney**[1], **Janice Simmons**[1], **Alec Gale**[6], **Tim Broderick**[6], and **Richard Langan**[7]. [1]Marine Biological Laboratory, 7 MBL Street, Woods Hole, MA 02543; [2]Sakonnet Point Fisheries, LLC, 26 California Road, Little Compton, RI 02837; [3]F/V Captain Roberts Fisheries, Inc., 3119 Post Road, Wakefield, RI 02879; [4]Martha's Vineyard Shellfish Group, Inc., P.O. Box 1552, Oak Bluffs, MA 02557; [5]Salt Water Farms, LLC, 165 Tidal Drive, North Kingstown, RI 02852; [6]4B Deer Hill Road, Vineyard Haven, MA 02568; [7]University of New Hampshire, 35 Colovos Road, Durham, NH 03824. slindell@mbl.edu

Based on results from 2008/2009 of investigation of mussel growth and pea crab surveys at twelve offshore sites in RI and MA, we installed four subsurface longlines for suspended mussel culture in the fall or 2009. These 500-foot longlines each support 200 ten-foot long mesh socks filled with mussel seed at densities ranging from 100 to 160 seed per foot. The average length of the seed was 24mm when deployed for growout in October and November. Initial growth rates averaged 3mm per month for November and December. No pea crabs have been found in the seed nor in subsequent samples. Market-sized mussels are expected to be harvested in the summer of 2010.

The longlines were deployed and are managed by active local fishermen from their lobster and scalloping boats. To facilitate the deployment from small boats we used plow anchors (250kg) instead of more traditional concrete block anchors (4,000kg). Lessons from our experience in permitting, engineering, socking seed, and managing the lines will be shared.

A SOUND IDEA FOR DEFEATING EIDER DUCK PREDATION ON MUSSEL FARMS.
Erick Swanson[1], Dana L. Morse*[2], Cliff Goudey[3], Patti Reilly[4], and **Ken Ekstrom**. [1]Maine Cultured Mussels, Inc., PO Box 224, Mount Desert, ME 04660; [2]Maine Sea Grant College Program / Univ. of Maine Cooperative Extension, 193 Clark's Cove Road, Walpole, ME 04573; [3]C.A. Goudey & Associates, 21 Marlboro Street, Newburyport, MA 01950; [4]ENTRIX 47 Main Street, Seal Harbor, ME 04675. erick.swanson@myfairpoint.net.

The common eider (*Somateria mollissima*) is the largest duck in the northern hemisphere, and it is one of the most devastating predators of cultured blue mussels (*Mytilus edulis*) in the northeast US and Canada. Given eiders' voracious appetites, and their tendency to move in large flocks, they can destroy suspended or bottom-grown mussel farms in a very short time. As such, predation losses by ducks and predator deterrence are major impediments to profitability for domestic mussel producers. Given that roughly 48 million pounds of blue and greenshell mussels were imported into the US in 2005 from Canada, Chile and New Zealand, US mussel producers could stand to benefit strongly from functional equipment and strategies to deter damage from eiders and other sea ducks.

The current project focuses on the design, production and testing of a spar-type buoy equipped with an audio playback system, rechargeable power source, and underwater transmitter, together with appropriate controls for programming, as employed on a longline mussel farm in Blue Hill Bay, Maine. Sounds of a chase boat and other disruptive noises were recorded and transferred to the playback module. Buoys have been deployed in the winters of 2008-2009 and 2009-2010. Results thus far indicate that an acoustic buoy is a highly effective deterrent, especially when combined with other deterrents such as chasing, and gives the farmer a certain amount of protection during heavy weather or other times when a presence on the farm site is impossible. Even further, the buoy is now considered as equipment essential to the protection of the farm against predation. As Mr. Swanson puts it "I wouldn't consider going into the winter without them."

Challenges remain with respect to the ease of changing batteries, and the ability of the recharging system to withstand damage from adverse weather conditions, especially ice. In addition, improvements can be made in the ease of recording the precise chase boat. Nonetheless, the addition of the buoy to the roster of deterrents has made an undeniably positive impact with respect to decreasing predation by eiders, and ultimately the profitability of the farm.

EPIBIONTS ON THE SIPHONS OF SOFTSHELL CLAMS, *MYA ARENARIA,* IN A FLUPSY: SPECIES, PREVALENCE, AND MANAGEMENT. **Joseph Buttner**[1], **Ryan Fisher**[1], **Mark Fregeau**[1], **Scott Weston**[1] and **Inke Sunila**[2]. [1]Northeastern Massachusetts Aquaculture Center and Department of Biology, Salem State College, Salem, MA 01970; [2]State of Connecticut, Department of Agriculture, Bureau of Aquaculture, 190 Rogers Avenue, Milford, CT 06460. jbuttner@salemstate.edu

Floating Upweller Systems (FLUPSYs) are used extensively to grow bivalve mollusks, including softshell clams, *Mya arenaria*. Softshell clams, unlike hard clams or oysters, do not possess the ability to close their shells completely, making their siphons susceptible for colonization by epibionts when grown without substrate. A routine histopathology examination revealed the presence of epibionts on softshell clams maintained in a FLUPSY at the Northeastern Massachusetts Aquaculture Center. Prevalence of epibionts increased from 0% on day 35 to > 95% of clams on day 69 post introduction into the FLUPSY. Some siphons were so heavily colonized that it potentially interfered with feeding. Presence of epibionts on transplanted clams may introduce harmful organisms. To promote clam health and to address regulatory concerns, methods were developed to manage the infestation.

The protocol included four control and four test silos from the FLUPSY setup as pairs and stocked on the same day with ~60,000 clams (3-6 mm SL). All silos received a normal rinse of freshwater 2-3 times per week. In addition to the normal rinsing, test silos and clams received a one hour bath in a tank filled with freshwater provided at a 1-2 L/min flush to maintain salinity at < 0.6 ppt. After 4 to 6 weeks, clams were removed and replaced with a new cohort of 3-6 mm SL clams. To facilitate comparison with earlier data, ~2,000 clams were held in a 19 L bucket positioned within the silo and managed as the silo (control or test) to 70 days. Each pair of silos cycled through four 'runs' between 15 May and 29 October 2009. Clams were sampled weekly, fixed and stored. Preserved clams were examined macroscopically, microscopically and histologically for epibionts.

Survival of clams in all silos approached 100% and average size did not differ between treatments. Macroscopically, freshwater-treated clams and silos were noticeably less infested than controls. Microscopically, clams examined after approximately nine weeks in the FLUPSY had siphons infested primarily by hydroids (>95% of organisms observed) and included nematodes, turbellarians and urochordates. Prevalence of hydroid epibionts in the test groups ranged from 6-20%, while in control groups prevalence ranged from 68-100% colonization. According to histology, test clams examined at approximately eight weeks post introduction to the FLUPSY had far fewer, often necrotic epibionts. Structure of the distal layer of the periostracum differed significantly between freshwater-treated and control clams. Control clams exhibited several distal layers instead of a single thin distal layer. Invertebrates with pedal disks (hydroids, barnacles) attached directly to the siphons and were embedded in extra distal layers of the periostracum. This resulted in cavernous structures that harbored other epibionts.

Data indicate that rapid transit time through the FLUPSY (< 6 weeks) and one hour freshwater treatment appeared to be a simple and effective method to minimize colonization by epibionts on softshell clams grown in a FLUPSY. Furthermore, rinsed clams did not develop extra distal periostracum layers on their siphons, suggesting that the extra layers were a response to epibionts.

WORKING TOWARD CONSENSUS: APPLICATION OF SHELLFISH CARRYING CAPACITY IN MANAGEMENT OF RHODE ISLAND AQUACULTURE.

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Oyster farming is growing rapidly in Rhode Island, expanding in a six year period (2001-2007) from a $300,000 industry on 18 farms to a $1.6 million industry on 30 farms. This expansion has wild clam harvesters concerned about the loss of fishing grounds. In response to this resource use conflict, the RI Marine Fisheries Council, which comments to the state aquaculture permitting authority (Coastal Resource Management Council (CRMC)) on aquaculture lease applications, announced that they would refuse to consider any new aquaculture leases until a long-term aquaculture plan was in place. The fundamental question is what, if any, limits should be placed on shellfish aquaculture in RI? The CRMC revitalized its Working Group on Aquaculture Regulations (WGAR), which consists of representatives from the aquaculture and wild harvest industries, regulators, academicians, and non-governmental organizations. The WGAR reviewed several issues of importance for a long-term aquaculture plan: water quality, disease, aquatic nuisance species, physical impacts of aquaculture gear, essential fish habitat, carrying capacity, and discussed a future ecosystem approach to aquaculture. The issue that drew unanimous interest was carrying capacity – what is the ecological carrying capacity for oyster aquaculture in Narragansett Bay and RI's coastal ponds? We present a framework for determining carrying capacity through ecosystem modeling and stakeholder involvement that can be used to guide management of shellfish aquaculture. This framework aims to minimize user conflicts in RI's heavily used coastal waters and is transferrable to other densely populated coastal areas.

POSSIBLE IMPACT OF AN ALGAL BLOOM OF *COCHLODINIUM POLYKRIKOIDES* ON JUVENILE BAY SCALLOPS (*ARGOPECTEN IRRADIANS IRRADIANS*) IN NANTUCKET HARBOR. **Valerie A. Hall[1,2], Peter B. Boyce[1]** and **Robert S. Kennedy[1].** [1]Maria Mitchell Association, 4 Vestal Street, Nantucket, MA 02554; [2] School for Marine Science and Technology, University of Massachusetts Dartmouth, 706 South Rodney French Boulevard, New Bedford, MA 02744. vhall@umassd.edu

In 2009 an extensive algal bloom of the dinoflagellate *Cochlodinium polykrikoides* occurred in Nantucket Harbor and surrounding areas of Nantucket Sound in August and September. This organism is known to be toxic to juvenile shellfish in controlled laboratory conditions. During the algal blooms, we observed the following: 1) mortality of small (3–5 mm) juvenile bay scallops in spat bags set in the Head of Nantucket Harbor where the bloom was visually the most dense was at least 52% compared to the usual 1% or less that we have found in other areas of the Harbor and in previous years; 2) spat bags set in the Head of the Harbor on 15 August and checked two months later had no scallops, a result we have not seen at this location over the past five years; and 3) scallops collected from spat lines set on 15 June and caged at Pocomo Point west of the Head of the Harbor on 17 September during an algal bloom, had 39% mortality when they were checked three weeks later on 6 October, compared to less than 2% mortality in similarly caged scallops of the same age in the previous five years. While we cannot say for certain that these three unusual incidents of high mortality were caused by the observed *Cochlodinium* bloom, we suspect there is some relationship and plan to develop studies to better understand this relationship in Nantucket Harbor over the next few years if the algal blooms continue.

TOXIN CHANGES IN *ALEXANDRIUM FUNDYENSE* AFTER PASSAGE THROUGH THE DIGESTIVE SYSTEM OF THE EASTERN OYSTER *CRASSOSTREA VIRGINICA*.

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Marine biotoxin-monitoring programs designed to assure the wholesomeness of seafood products are increasing around the world. Research investigating the toxigenic micro-organisms, their consumption by shellfish, digestion and/or survival can aid in refining toxin-management programs. Better understanding of toxin uptake and purging dynamics may contribute to more precise, streamlined, and cost effective seafood safety programs.

Differences in toxin profiles between shellfish feeding on toxigenic microalgae and the algae themselves have been attributed mainly to post-ingestive metabolism. Our own previous research, and that of others, has shown survival of intact, viable HAB cells in biodeposits of bivalves that had fed on these microalgae. In a laboratory study, the hypothesis was tested that viable HAB cells defecated by a mollusc would have the same toxin profile as before ingestion, which would be consistent with post-ingestive metabolic conversion of algal biotoxins within the oyster. Using an example organism, the cyst-forming, toxin-producing dinoflagellate *Alexandrium fundyense* Balech, changes in toxin content were studied before and after consumption by the Eastern oyster (*Crassostrea virginica* Gmelin). Paralytic Shellfish Toxins (PSTs), a group of similar but slightly differing compounds, were measured in vegetative cells and temporary cysts before feeding and directly after passage through the digestive system of the oysters, as well as within oyster tissues.

Oysters accumulated toxins from digestion of both vegetative cells and temporary cysts. One treatment tested for uptake of toxins directly from the water (oysters and *A. fundyense* cells were separated by a screen), but PSTs were not accumulated from the water by oysters. There were no significant changes in total, per-cell toxicity, after passage through the oyster alimentary canal. There were, however, significant changes in toxin composition of surviving *A. fundyense* cells following gut passage. Vegetative cells and temporary cysts from fecal pellets had increased amounts of saxitoxin (STX) and decreased gonyautoxin-4 (GTX4) per cell, compared to these cells prior to gut passage. Results show that changes in toxin profile can occur within *A. fundyense* cells during gut passage through a grazer. Following gut passage, temporary cysts showed better survival in the feces than vegetative cells, which is consistent with the hypothesis that temporary-cyst formation is a survival strategy against grazing.

HAZARD ASSESSMENT OF AMNESIC SHELLFISH POISONING IN NEW ENGLAND. **M. Soledad Fuentes** and **Gary H. Wikfors.** U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460. maria.soledad.fuentes@noaa.gov

Blooms of diatoms from the genus *Pseudo-nitzschia* have been associated with Amnesic Shellfish Poisoning (ASP), which results from ingestion by human consumers of shellfish contaminated with the neurotoxin, domoic acid. Production of domoic acid by *Pseudo-nitzschia* spp. is extremely variable, depending upon species, strain, and physiological status of the population. This toxin variability makes monitoring and management of shellfish-harvesting activities very challenging. Presence of *Pseudo-nitzschia* spp. in the water does not necessarily indicate that domoic acid is being produced that could contaminate shellfish and make them unfit for human consumption.

Even though populations of *Pseudo-nitzschia* are endemic to northern New England coastal waters where mussel aquaculture is a growing industry, no ASP event has been detected so far. Aquaculture and other human practices may, however, change water chemistry, specifically increasing copper inputs locally, which may induce domoic acid production. It is, therefore, crucial to assess risk of ASP contamination of cultured mussels as this industry develops.

During the summer 2009, field samples were collected, in both Hampton, New Hampshire (Isles of Shoals farm) and Cape Cod, Massachusetts (proposed farming sites). Seawater samples were enriched and screened for *Pseudo-nitzschia* using traditional techniques (light microscopy) and also molecular techniques (PCR using genus-specific primers). *Pseudo-nitzschia* spp. cells were detected in both places, and clones of two species were isolated. The two *Pseudo-nitzschia* species were identified by amplifying and sequencing the internal transcriber spacer 1 (ITS1). Both of these clones were shown to be capable of producing domoic acid under specific conditions. We have not, however, detected domoic acid in field samples.

These results confirm the presence of *Pseudo-nitzschia* spp. capable of producing domoic acid in current and proposed mussel-aquaculture sites in New England, underscoring the need to understand the environmental triggers controlling up-regulation of this neurotoxin to ensure that ASP is not an inadvertent consequence of aquaculture or other human practices in this region.

SHRIMP FARMING IN THE NORTHEASTERN UNITED STATES – LET'S CULTURE OUR LOCAL SPECIES! **Acacia Alcivar-Warren** and **William B. Warren.** Environmental Genomics, Inc. (EGI), 6 Sunrise Drive Suite 101, Southborough, MA 01772. acacia@onehealthgenomics.com.

Shrimp farming in the United States is based on specific pathogen-free (SPF) *Litopenaeus vannamei* produced by the U.S. Marine Shrimp Farming Program funded by the USDA and maintained at the Oceanic Institute in Hawaii. *L. vannamei* aquaculture is limited mostly to southern states. Originally from the Pacific coast of Latin America, *L. vannamei* is now cultured globally particularly in Southeast Asia for export to the US and other western markets. Availability of recirculation system technology should make it possible to develop shrimp aquaculture in the U.S. and may help reduce the seafood trade deficit, now at over US$3.5 billion yearly, and address concerns about ecological impact of shrimp farming, food safety, and global food security issues. Unfortunately, today, most SPF shrimp is sold to companies that export it to tropical countries, without quarantine, where it is grown to market size on coastal farms using water of unknown quality standards before exporting it back to the US for sales at supermarket chains and restaurants.

Environmental Genomics, Inc. is inviting collaborators for an industry partnership to develop shrimp farming in the Northeast based on our local favorite species, the Atlantic, cold-water, northern shrimp, *Pandalus borealis*. An important food resource, *P. borealis* live at depths of between 10 and 500 m, usually on soft muddy bottoms, in waters between 2°C and 14°C. This fishery has declined in recent years and there are concerns about overexploitation of resource, deterioration of ecological environment, product quality and safety, and fishing impact on stock abundance. Fishing of *P. borealis* in the Northeast is restricted to 2-3 months per year, and there is potential for aquaculture development to make it available to local communities throughout the year. Development of a new local aquatic species for aquaculture development would provide employment for local communities and opportunities for new businesses based on commercialization of fresh seafood.

Today, little is known about the population genetic diversity, disease and chemical pollutant load of *P. borealis* in northeastern United States. A baseline genetic and pollutant database for *P. borealis* is being established by EGI. Efforts to promote scientific research, extension and application of research results for further aquaculture development of *P. borealis* in the Northeast should be increased. Availability of a local shrimp species for aquaculture would generate income for small producers by promoting consumption of safe, locally-produced shrimp. Moreover, *P. borealis* would be a unique species for comparative genomics studies to understand the genetic basis of cold temperature tolerance and sex determination.