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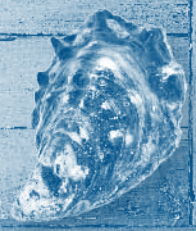


No. 13

Agenda at a Glance

ICSR2010 WED NOV 17

Welcome to ICSR 2010

ICSR2010 THUR NOV 18

7:30	8 :30	9 :30	10 :30	11 :30	NOON	1 :30
	Continental Breakfast 7:30 - 8:30 *(Stono, DT)*	Welcome, Keynote and Plenary Presentations 8:30 - 10:00 *(Harleston, Wraggborough, HSG)*	Break 10:00-10:30	Plenary Contributed **Session A** 10:30 - 12:10 *(Harleston, Wraggborough, HSG)*		Lunch 12:10 - 1:30 *(Courtyard Tent)*

Conference Registration *Hayne Street Gallery (HSG) 7:00 - 3:30*

ICSR2010 FRI NOV 19

7:30	8 :30	9 :30	10 :30	11 :30	NOON	1 :30
	Continental Breakfast 7:30 - 8:45 *(Stono, DT)*	Plenary Presentations 9:00 - 10:00 *(Harleston, Wraggborough, HSG)*	Break 10:00-10:30	Plenary Panel Session 10:30 - 12:00 *(Harleston, Wraggborough, HSG)*		Lunch 12:00 - 1:30 *(Courtyard Tent)*

Conference Registration *Hayne Street Gallery (HSG) 7:00 - 3:30*

ICSR2010 SAT NOV 20

7:30	8 :30	9 :30	10 :30	11 :30	NOON	1 :30
	Continental Breakfast 7:30 - 8:45 *(Stono, DT)*	Plenary Presentations 9:00 - 10:00 *(Harleston, Wraggborough, HSG)*	Break 10:00-10:15	Plenary Contributed **Session E** 10:15 - 3:30 *(Harleston, Wraggborough, HSG)*		Lunch 12:15 - 1:30 *(Courtyard Tent)*

Conference Registration *Hayne Street Gallery (HSG) 7:00 - Noon*

3 :30 4 :30 5 :30 6 :30 7 :30 8 :30 9

ECSGA BMP Workshop
3:00 to 5:00
(Fort Johnson)

Welcome Reception
7:00 - 9:00
(Harleston, Wraggborough,HSG)

Conference Registration *Hayne Street Gallery (HSG) 4:00 - 7:00*

2 :30 3 :30 4 :30 5 :30 6 :30 7 :30 8 :30 9

Plenary Contributed **Session B**
1:30 - 5:00
(Harleston, Wraggborough, HSG)

Break
3:10 - 3:40

Plenary Contributed **Session B** continued until 5:00

Poster Session/ Happy Hour
5:30 to 7:00
(Stono, DT)

Workshop: **Shellfish Restoration Best Management Practices**
7:00 to 9:00
(Wraggborough, HSG)

2 :30 3 :30 4 :30 5 :30 6 :30 7 :30 8 :30 9

Concurrent Contributed **Session C**
1:30 - 4:20
(Harleston, HSG)
Concurrent Contributed **Session D**
1:30 - 5:00
(Wraggborough, HSG)

Break
3:10 - 3:40

Session C continued until 4:20

Session D continued until 5:00

Poster Session/ Happy Hour
5:00 to 6:00
(Stono, DT)

Lowcountry Cookout
7:00 to 9:00
(Charleston Maritime Center, Downtown Charleston)

6:15 Transportation to Lowcountry Cookout

2 :30 3 :30 4 :30 5

Plenary Contributed **Session E** continued until 3:30

Future Directions Session
3:30 - 4:30
(Stono, DT)

Conference Adjourns

Conference Overview

The 13th International Conference on Shellfish Restoration, held in historic Charleston, South Carolina from November 17-20, 2010, provides an opportunity for resource managers, shellfish farmers, community activists, historians, and anthropologists to exchange ideas and information to help restore molluscan shellfish populations while improving water quality and the environmental health of our estuarine and coastal ecosystems. The restoration of shellfish populations and degraded coastal ecosystems is of international concern: in the past, ICSR has attracted participants from many other nations and spawned similar meetings in Ireland, France, The Netherlands, and most recently, Prince Edward Island, Canada. In celebration of the 25th anniversary of the first ICSR, this conference highlights the progress that has been made in shellfish restoration over the past 25 years, and how these efforts have shaped the role of shellfish restoration for the future. Contributed oral and poster presentations address "the past, the present, and the future" of shellfish restoration efforts, and how this history relates to community stewardship, public awareness, and education.

In response to the Deepwater Horizon oil spill disaster in the Gulf Coast of the United States, a special panel will be convened on the situation and response taken to protect shellfish and shellfish habitat. We recognize the tragedy that has recently fallen on shellfish resources and the industry it supports in the Gulf region, and have elicited the best information to assist in restoration efforts.

This year's conference consists of over 70 invited and contributed oral and poster presentations, sessions, and workshops. The mornings will feature internationally recognized plenary speakers, and the afternoons will include sessions organized around theme areas. The conference hotel is located in the historic market area in downtown Charleston, and the schedule features lengthy breaks, lunches, and social events to allow for extensive professional interaction and collaboration.

ICSR'10 **SPONSORS**

S.C. Sea Grant Consortium
Georgia Sea Grant College Program
Interstate Shellfish Sanitation Conference
Maine Sea Grant College Program
Maryland Sea Grant College Program
NOAA Restoration Center
Community-Based Restoration Program
New York Sea Grant
Rhode Island Sea Grant Program
The Nature Conservancy

ICSR'10 **ORGANIZING COMMITTEE**

Dorothy L. Leonard, Ocean Equities, LLC
M. Richard DeVoe, S.C. Sea Grant Consortium
Elaine L. Knight, S.C. Sea Grant Consortium
Susan Ferris Hill, S.C. Sea Grant Consortium
Katherine Luciano, S.C. Sea Grant Consortium
William Rickards (ret.), Virginia Sea Grant College Program

ICSR'10 **STEERING COMMITTEE**

William D. Anderson (ret.), S.C. Department of Natural Resources
David Bushek, Rutgers University
Bill DuPaul, Virginia Institute of Marine Science
John Ewart, University of Delaware Sea Grant Marine Advisory Service
Gef Flimlin, Rutgers Cooperative Extension Service
Peter Kingsley-Smith, S.C. Department of Natural Resources
John Kraeuter, Rutgers University
Mark Luckenbach, Virginia Institute of Marine Science
Sandy Macfarlane, Coastal Resource Specialists
Robert Rheault, East Coast Shellfish Growers Association
Geoffrey Scott, NOAA-NOS-CCEHBR
LaDon Swann, Mississippi-Alabama Sea Grant Consortium

Important Conference Information

No. 13

REGISTRATION INFORMATION
To participate in any aspect of the conference, you must be registered. Badges are required for all technical and social events. The registration center is located in the conference room lobby of the Hayne Street Gallery at the DoubleTree Guest Suites on Thursday, Friday, and Saturday. On Wednesday, the registration desk will be located in the main lobby of the DoubleTree Hotel.

MESSAGE CENTER
A message board and general information center will be maintained at the ICSR'10 Registration Center. Anyone who needs to leave a message for you may call the DoubleTree Guest Suites at (843) 577-2644 and ask that a message be given to the ICSR'10 Registration Center.

NEWS MEDIA
Coordination between ICSR'10 and the news media will be facilitated by Susan Ferris Hill, S.C. Sea Grant Consortium Director of Communications. Please notify Susan if you will be presenting information that is noteworthy for the science or general media. She can be reached through the ICSR'10 Registration Center.

TECHNICAL PROGRAM
ICSR'10 will feature keynote presentations, panel discussions, special sessions, and contributed oral and poster presentations on topics related to the four conference themes:

Shellfish Resource Restoration, Enhancement, and Management

Shellfish Habitat Restoration, Enhancement, and Management

Water Quality and Public Health Issues in Shellfish Restoration

Shellfish Restoration Projects – Community Strategies and Lessons Learned

Important Conference Information

KEYNOTE AND PLENARY SESSIONS

Presentations will be made by shellfish experts from the United States and Ireland. Confirmed speakers include:

Eric Schwaab, *Assistant Administrator for Fisheries*, National Oceanic and Atmospheric Administration, 1315 East-West Highway, Silver Spring, MD, USA 20910.

Gavin Burnell, *Director*, Aquaculture and Fisheries Development Centre (AFDC), University College Cork, Cooperage Building, Distillery Fields, North Mall, Cork, Ireland.

Boze Hancock, *The Nature Conservancy - NOAA National Partnership Coordinator*, University of Rhode Island Narragansett Bay Campus, South Ferry Road, Narragansett, RI, USA 02882.

Chuck Hopkinson, *Director*, Georgia Sea Grant College Program, University of Georgia, 220 Marine Sciences Building, Athens, GA, USA 30602.

Gef Flimlin, *Marine Extension Agent and Associate Professor*, Rutgers Cooperative Extension of Ocean County, 1623 Whitesville Road, Toms River, NJ, USA 08755.

Teri King, *Water Quality Specialist*, Washington Sea Grant, P.O. Box 488, Shelton, WA, USA 98584.

PANEL SESSION

The topic of this session will be:

Impacts of the Deepwater Horizon Gulf of Mexico Oil Spill on Shellfish and Shellfish Habitat

ORAL AND POSTER PRESENTATIONS

Oral and poster presentations are offered in 8 sessions.
More than 70 contributed papers and posters by experts from around the world will be presented.

Information for Presenters

No. 13

ORAL PRESENTATIONS
Twenty minutes are allotted for a contributed paper, including discussion and change-over time between speakers. Session moderators will adhere strictly to these time limitations. Speakers should check in with moderators at least 15 minutes prior to session start. Projection equipment available will include PowerPoint projectors and a screen. Speakers are encouraged to take advantage of the preparation/preview room with both PowerPoint projector and screen available from 7:30 a.m. to 5:00 p.m. daily in the Ashley Room.

POSTER PRESENTATIONS
Each poster presenter will be provided with a foam core tackboard measuring 4' high by 8' wide. Boards will be assigned by number. Posters should be set up, attended, and removed according to the following schedule:

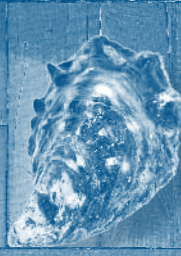
Registration/Check-in
At Conference Registration Desk

Poster Set-Up
Stono Room
Thursday, November 18, noon to 3 p.m.

Poster Authors Present
Thursday, November 18, 5:30 p.m. to 7:00 p.m.
Friday, November 19, 5:00 p.m. to 6:00 p.m.

Poster Removal
Saturday, November 20, *before* 12:00 noon

Schedule of Presentations and Activities



WEDNESDAY, NOVEMBER 17

3:00 p.m. to 5:00 p.m.

East Coast Shellfish Growers Association Best Management Plan/Individual Farm Code of Practice Development Seminar at S.C. Department of Natural Resources, Marine Resources Research Institute Building 8, 217 Fort Johnson Road, Charleston.

South Carolina Shellfish Growers Association will hold its annual meeting immediately following the seminar in the auditorium of the same building.

4:00 p.m. to 7:00 p.m.
ICSR'10 Registration
DoubleTree Hotel Main Lobby

7:00 p.m. to 9:00 p.m.
Welcome Reception
Harleston/Wraggborough Rooms, HSG

THURSDAY, NOVEMBER 18

7:00 a.m. to 3:30 p.m.
ICSR'10 Registration
HSG

7:30 a.m. to 8:30 a.m.
Continental Breakfast
Stono, DT

8:30 a.m. to 9:00 a.m.
Welcoming Remarks
Harleston/Wraggborough Rooms, HSG
"ICSR'10 Welcome"- Dorothy Leonard, Ocean Equities, LLC, and M. Richard DeVoe, S.C. Sea Grant Consortium

9:00 a.m. to 9:30 a.m.
Keynote Presentation
Harleston/Wraggborough Rooms, HSG
Eric Schwaab, NOAA Assistant Administrator for Fisheries

9:30 a.m. to 10:00 a.m.
PLENARY PRESENTATION
Harleston/Wraggborough Rooms, HSG

"Nature Plus Nurture: An Irish Approach to Sustainable Restoration of a Coastal Shellfish Population" Burnell, G. (1), T. Griffin (2), F. O'Donncha (3), J. Maguire (4), V. O'Donovan (5), S. Murphy (6), M. Hartnett (7), (1,2) University College Cork, Aquaculture and Fisheries Development Centre, Cooperage Building, Distillery Fields, North Mall, Cork, Ireland, (3) National University of Ireland, Galway, University Road, Galway, Ireland, (4) Daithi O'Murchu Marine Research Station, Gearhies, Bantry, Co. Cork, Ireland, (5) BIM - Irish Sea Fisheries Board, An Cuilin, An Daingean, Co. Kerry, Ireland, (6) Valentia Harbour Fisheries Society Ltd.,Valentia Harbour, Co. Kerry, Ireland, (7) Marcon Computations International Ltd., Galway, Ireland.

10:00 a.m. to 10:30 a.m.
Break
Stono, DT

10:30 a.m. to 12:10 p.m.
PLENARY CONTRIBUTED SESSION A
Harleston/Wraggborough Rooms, HSG

"Shellfish Resource Restoration, Enhancement, and Management: Restoration Using Hatchery Technologies"
Moderated by William Rickards, Virginia Sea Grant (ret.)

10:30 a.m.

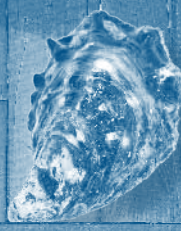
"A Comparison of Relative Fecundity and Egg Quality in Oysters (Crassostrea virginica) of Different Ages from Northern Chesapeake Bay" Lane, H.A. (1), V. Politano (2), S.T. Alexander (3), E. Vlahovich (4), H.N. Koopman (5), D.W. Meritt (6), K.T. Paynter (7), (1,2) University of Maryland, Biology Building 144, Room 1210, College Park, MD, USA 20742, (3,4) University of Maryland Center for Environmental Science, P.O. Box 775, Cambridge, MD, USA 21613, (5) University of North Carolina Wilmington, 601 South College Road, Wilmington, NC, USA 28403, (6) University of Maryland Center for Environmental Science, P.O. Box 775, Cambridge, MD, USA 21613, (7) University of Maryland, 0105 Cole Field House, College Park, MD, USA 20742.

10:50 a.m.

"In Situ Setting of Hatchery-Reared Eyed Larvae on a Restored Crassostrea virginica Bar" Steppe, C.N. (1), S.R. Westby (2), D. Johannes (3), P.W. Tagan (4), (1) U.S. Naval Academy, Oceanography Department, 572C Holloway Road, Annapolis, MD, USA 21402, (2,3) Chesapeake Bay Foundation, 6 Herndon Avenue, Annapolis, MD, USA 21403, (4) U.S. Naval Academy, Oceanography Department, 572C Holloway Road, Annapolis, MD, USA 21402.

11:10 a.m.

"Hatchery-Based Shellfish Production in Zanzibar, Tanzania" Kite-Powell, H.K. (1), R. Karney (2), J. Brawley (3), A. Yberg (4), (1) Woods Hole Oceanographic Institution, Marine Policy Center, MS 41, Woods Hole, MA, USA 02543, (2) Martha's Vineyard Shellfish Hatchery, 220 Weaver Lane, Vineyard Haven, MA, USA 02568, (3) Saquish Scientific, Bay View Road, Duxbury, MA, USA 02332, (4) Island Creek Oysters, 296 Parks Street, Duxbury, MA, USA 02332.



11:30 a.m.

"Shellfish Hatchery in Zanzibar? Inshallah! (God-Willing)" Karney, R. (1), J. Brawley (2), D. Grossman (3), N.S. Jiddawi (4), H.L. Kite-Powell (5), S.J. Shaaban (6), A. Yberg (7), (1) Martha's Vineyard Shellfish Group, Inc., P.O. Box 1552, Oak Bluffs, MA, USA 02558, (2) Saquish Scientific, 18 Bay View Road, Duxbury, MA, USA 02332, (3) David Grossman Photography, 61 Moulton Road, Duxbury, MA, USA 02332, (4) Institute of Marine Sciences, UDSM, Box 668, Zanzibar, Zanzibar NA, Tanzania, (5) Marine Policy Center, Woods Hole Oceanographic Institution, Mail Stop 41, Woods Hole, MA, USA 02543, (6) Institute of Marine Sciences, UDSM, P.O. Box 668, Zanzibar, Zanzibar NA, Tanzania, (7) Island Creek Oysters, 5 South Pasture Lane, Duxbury, MA, USA 02332.

11:50 a.m.

"Restoration of Biogenic Reefs of* Modiolus modiolus*: The Potential for Enhancing Recruitment Using Hatchery Produced Seed" Fariñas-Franco, J.M. (1), D. Roberts (2), (1) Queen's University Belfast Marine Laboratory, 12, The Strand, Portaferry, Northern Ireland, UK BT221PF, (2) Queen's University Belfast School of Biological Sciences, Medical Biology Building, 97 Lisburn Road, Belfast, Northern Ireland, UK BT9 7BL.

12:10 p.m.
Plenary Session Ends

12:10 p.m. to 1:30 p.m.
Lunch (provided)
Courtyard Tent

1:30 p.m. to 5:00 p.m.
PLENARY CONTRIBUTED SESSION B
Harleston/Wraggborough Rooms, HSG
"Shellfish Restoration, Enhancement, and Management: Impacts of Water Quality"
Moderated by Peter Kingsley-Smith, S.C. Department of Natural Resources

1:30 p.m.

"Oyster (*Crassostrea virginica*) Monitoring in the St. Lucie Estuary" Parker, M.L. (1), S.P. Geiger (2), (1,2) Fish and Wildlife Research Institute, 100 8th Avenue SE, St. Petersburg, FL, USA 33701.

1:50 p.m.

"Differences in the Gaping Response and Hemolymph pH of the Eastern Oyster,* Crassostrea virginica*, and the Asian Oyster,* Crassostrea ariakensis*, When Exposed to Hypoxic and Anoxic Environments" Lombardi, S.A. (1), K.T. Paynter (2), (1) University of Maryland, Biology Psychology Building-144, College Park, MD, USA 20742, (2) University of Maryland, 0105 Cole Field House, College Park, MD, USA 20742.

2:10 p.m.

"Changing Acidity in Estuaries and Coastal Zones: The Effect of Lower pH and Saturation State on Recruitment and Survivorship of Juvenile Bivalves" Green, M.A. (1), L. Hubacz (2), G. Waldbusser (3), (1,2) Saint Joseph's College of Maine, 278 Whites Bridge Road, Standish, ME, USA 04084, (3) Oregon State University, 104 COAS Administration Building, Corvallis, OR, USA 97331.

2:30 p.m.

"Nitrogen Removal and Sequestration Capacity of a Restored Oyster Reef" Kellogg, L. (1), J.C. Cornwell (2), M. Owens (3), K.T. Paynter (4), (1,2,3) University of Maryland Center for Environmental Science – Horn Point Laboratory, 2020 Horns Point Road, Cambridge, MD, USA 21613, (4) University of Maryland, 0105 Cole Student Activities Building, College Park, MD, USA 20742.

2:50 p.m.

"Florida Clam Culture Industry's Response to the Deepwater Horizon Oil Spill" Sturmer, L.N., University of Florida, P.O. Box 89, Cedar Key, FL, USA 32625.

3:10 p.m. to 3:40 p.m.
Break
Stono, DT

3:40 p.m.

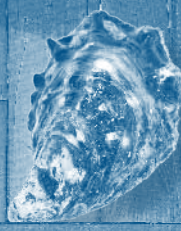
"Oysters, Oil, and Diversions: Louisiana's Response to the Deepwater Horizon Oil Spill and its Potential Implication in Future Coastal Wetlands Restoration Plans" Melancon, E.J., Biology Department, Nicholls State University, Thibodaux, LA, USA 70301.

4:00 p.m.

"Cooling Oysters Within the New 10 Hour Required Time Frame from the Environment to 50 Degrees or Below in a Refrigerated Storage Area" Lane, R.M. (1), M.L. Jahncke (2), (1,2) Virginia Seafood AREC, 102 S. King Street, Hampton, VA, USA 23669.

4:20 p.m.

"A Non-Profit Oyster (Crassostrea virginica) Restoration Effort in Boston Harbor, Which Has Undergone Significant Change Since Extinction Over 60 Years Previously" Jay, A.T. (1), M.S. Brevard (2), R. Bradshaw (3), (1) Massachusetts Oyster Project For Clean Water, 67 Old Rutherford Avenue, Charlestown, MA, USA 02129, (2) Massachusetts Oyster Project For Clean Water, 10 Canterbury Street, Worcester, MA, USA 01610, (3) Massachusetts Oyster Project For Clean Water, 63 Palfrey Street, Watertown, MA, USA 02472.



4:40 p.m.

"Best Practices for Shellfish Restoration: Developing Guidelines for Restoration While Protecting Public Health" Macfarlane, S. (1), D. Leonard (2), (1) Coastal Resource Specialists, P.O. Box 1164, Orleans, MA, USA 02653, (2) Ocean Equities, LLC, 776 Rolling View Drive, Annapolis, MD, USA 21406.

5:00 p.m.
Plenary Session Ends

5:30 p.m. to 7:00 p.m.
Poster Session/Happy Hour
Stono, DT

7:00 p.m. to 9:00 p.m.
WORKSHOP
Wraggborough Room, HSG
"Shellfish Restoration Best Management Practices (BMPs) Workshop"
Convened by Sandy Macfarlane, Coastal Resource Specialists, and Dorothy Leonard, Ocean Equities, LLC

FRIDAY, NOVEMBER 19

7:00 a.m. to 3:30 p.m.
ICSR'10 Registration
HSG

7:30 a.m. to 8:45 a.m.
Continental Breakfast
Stono, DT

9:00 a.m. to 10:00 a.m.
PLENARY PRESENTATIONS
Harleston/Wraggborough Rooms, HSG

9:00 a.m. to 9:30 a.m.

"Developments in Shellfish Restoration from the Perspective of the Conservancy, with Strategic Advances for the Near Future" Hancock, B., The Nature Conservancy, URI Narragansett Bay Campus, South Ferry Road, Narragansett, RI, USA 02882.

9:30 a.m. to 10:00 a.m.

"The Deepwater Horizon Event: Lessons for Future Ecosystem Management and Restoration Efforts" Hopkinson, C., Georgia Sea Grant College Program, 220 Marine Sciences Building, University of Georgia, Athens, GA, USA 30602.

10:00 a.m. to 10:30 a.m.
Break
Stono, DT

10:30 a.m. to 12:00 Noon
PLENARY PANEL SESSION
Harleston/Wraggborough Rooms, HSG
"Impacts of the Deepwater Horizon Gulf of Mexico Oil Spill on Shellfish and Shellfish Habitat"
Moderated by M. Richard DeVoe, S.C. Sea Grant Consortium, and Dorothy Leonard, Ocean Equities, LLC

Noon to 1:30 p.m.
Lunch (provided)
Courtyard Tent

1:30 p.m. to 4:20 p.m.
CONCURRENT CONTRIBUTED SESSION C
Harleston Room, HSG
"Shellfish Restoration, Enhancement, and Management: Restoration and Enhancement Assessments"
Moderated by William Anderson (ret.), S.C. Department of Natural Resources

1:30 p.m.

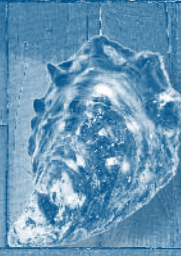
"Assessment of Eastern Oysters,* Crassostrea virginica*, at an Environmental Enhancement Project Area in Lake Worth Lagoon, Florida" Scarpa, J. (1), S.E. Laramore (2), (1,2) Harbor Branch Oceanographic Institute at Florida Atlantic University, Aquaculture and Stock Enhancement Program, 5600 US Hwy 1 North, Fort Pierce, FL, USA 34946.

1:50 p.m.

"Native Oyster Restoration in Scotland, the Wider Perspective" Brown, J.H. (1), E.C. Ashton (2), (1,2) The Institute of Aquaculture, University of Stirling, Stirling, Scotland, UK FK9 4LA.

2:10 p.m.

"Restoration of Native Oyster (*Crassostrea gryphoides*) of Pakistan" Siddiqui, G. (1), Z. Ayub (2), (1,2) Centre of Excellence in Marine Biology, University of Karachi, Karachi, Sindh, Pakistan 75270.



2:30 p.m.

"Enrichment of the Flat Oyster (Ostrea chilensis) in Tasman Bay, New Zealand: Summary of Research Outcomes" Brown, S.N. (1), S.J. Handley (2), D.R. Schiel (3), (1,2) National Institute of Water and Atmospheric Research Ltd, P.O. Box 893, Nelson, New Zealand 7040, (3) University of Canterbury, Private Bag 4800, Christchurch, Canterbury, New Zealand 8140.

2:50 p.m.

"Black-Lip Pearl Oyster (Pinctada margaritifera) Spat Stocking Densities at CMI Arrak Oyster Hatchery in Majuro, Marshall Islands" Ozbay, G. (1), A. Jackson (2), T. Aini (3), (1) Delaware State University, College of Agriculture and Related Sciences, Dover, DE, USA 19901, (2) Delaware Department of Natural Resources and Environmental Control, Aquatic Resources Education Center, Smyrna, DE, USA 19977, (3) College of Marshall Islands, Cooperative Research and Extension, Majuro, MH, RMI, 96960.

3:10 p.m. to 3:40 p.m.
Break
Stono, DT

3:40 p.m.

"Stock Enhancement of Abalone,* Haliotis asinine, *in Sagay Marine Reserve: Baseline Assessment of Wild Population and Establishment of Release Strategies" Lebata-Ramos, J.H. (1), E.F. Doyola-Solis (2), J.B. Abrogueña (3), J. Sumbing (4), H. Ogata (5), (1,2,3,4) Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC/AQD), Tigbauan, Iloilo 5021, Philippines, (5) Stock Enhancement Technology Development Center, National Research Institute of Aquaculture, Tsui-ura, Kami-ura, Oita 879-2602, Japan.

4:00 p.m.

"Three Years After: What About* Callista Chione *Restoration Plans?" Del Piero, D., Trieste University Life Sciences Department, via Giorgieri 10 c/o ed. M., Trieste, TS, Italy 34127.

4:20 p.m.
Concurrent Session Ends

1:30 p.m. to 5:00 p.m.
CONCURRENT CONTRIBUTED SESSION D
Wraggborough Room, HSG
"Ecological Services of Shellfish Habitat"
Moderated by Mark Luckenbach, Virginia Institute of Marine Science (VIMS)

1:30 p.m.

"Conducting Large-Scale Intertidal Oyster (Crassostrea virginica) Restoration as Mitigation in South Carolina Estuarine Waters" Hodges, M.S. (1), W.D. Anderson (2), N.H. Hadley (3), H.P. Dyar (4), (1,2,3,4) S.C. Department of Natural Resources, Marine Resources Center, 217 Fort Johnson Road, Charleston, SC, USA 29412.

1:50 p.m.

"Effects of Shoreline Reef Creation on Edge Erosion, Marsh Resilience, and Nekton Assemblages in South Louisiana" La Peyre, M., U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unit, School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA, USA 70803.

2:10 p.m.

"Ecodynamic Solutions for the Protection of Intertidal Habitats: The Use of Oyster Reefs" Ysebaert, T. (1), B. Walles (2), J. Dijkstra (3), M. de Vries (4), T. Bouma (5), K. Troost (6), E. van Zanten (7), P. Herman (8), A. Hibma (9), (1,2) IMARES – Institute for Marine Resources and Ecosystem Studies, P.O. Box 77, 4400 AB Yerseke, The Netherlands, (3,4) Deltares, P.O. Box 177, 2600 MH Delft, The Netherlands, (5) Netherlands Institute of Ecology (NIOO-KNAW), Centre for Estuarine and Marine Ecology, Korringaweg 7, 4401 NT Yerseke, (6) IMARES – Institute for Marine Resources and Ecosystem Studies, P.O. Box 77, 4400 AB Yerseke, The Netherlands, (7) Rijkswaterstaat Zeeland, P.O. Box 5014, 4330 KA Middeburg, The Netherlands, (8) Netherlands Institute of Ecology (NIOO-KNAW), Centre for Estuarine and Marine Ecology, Korringaweg 7, 4401 NT Yerseke, (9) Van Oord Dredging and Marine Contractors BV, P.O. Box 8574, 3009 AN Rotterdam, The Netherlands.

2:30 p.m.

"Ribbed Mussels for Shoreline Protection? An Update from New Jersey" Bushek, D. (1), D. Kreeger (2), L. Whalen (3), J. Moody (4), A. Padeletti (5), (1) Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ, USA 08349, (2,3) Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE, USA 19801, (4) Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ, USA 08349, (5) Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE, USA 19801.

2:50 p.m.

"Differentiating the Impact of Physical and Biotic Contributions of the Oyster, Crassostrea virginica, to the Benthic Reef Community" Kesler, K.E. (1), V.A. Politano (2), H.A. Lane (3), K.T. Paynter (4), (1,2,3) University of Maryland, Biology Building 144, College Park, MD, USA 20742, (4) University of Maryland, Cole Field House, Room 0105, College Park, MD, USA 20742.

3:10 p.m. to 3:40 p.m.
Break
Stono, DT

3:40 p.m.

"Scope for the Restoration of Biogenic Reefs of* Modiolus modiolus *in Strangford Lough, Northern Ireland: Making Dreams Come True" Roberts, D. (1), L. Allcock (2), J. Fariñas (3), E. Gorman (4), C. Maggs (5), A. Mahon (6), D. Smyth (7), E. Strain (8), J. Strong (9), (1) Queen's University, Biological Sciences, Belfast, Northern Ireland, UK BT9 7BL, (2) Martin Ryan Institute, University of Galway, Galway, Ireland, UK G 1, (3,4) Queen's University Marine Laboratory, 12, The Strand, Portaferry, Northern Ireland, UK BT22 1PF, (5) Queen's University, Biological Sciences, Belfast, Northern Ireland, UK BT9 7BL, (6,7) Queen's University Marine Laboratory, 12, The Strand, Portaferry, Northern Ireland, UK BT22 1PF, (8) Queen's University, Biological Sciences, Belfast, Northern Ireland, UK BT9 7BL, (9) AFBINI, Newforge Lane, Belfast, Northern Ireland, UK BT9 5PX.

4:00 p.m.

"Oyster Castles: A New Tool for Site Evaluation and Intertidal Oyster Reef Habitat Restoration and Enhancement in Multiple U.S. East Coast States" Stone, B.W. (1), P. Kingsley-Smith (2), B. Lusk (3), B. Truitt (4), J. Brown (5), M. Faherty (6), G. Lorber (7), (1,2) S.C. Department of Natural Resources, 217 Ft. Johnson Road, Charleston, SC, USA 29422, (3,4) The Nature Conservancy, 11332 Brownsville Road, Box 158, Nassawadox, VA, USA 23413, (5) The Nature Conservancy, 960 Morrison Drive Suite 100, Charleston, SC, USA 29413, (6) Mass Audubon/Wellfleet Bay Wildlife Sanctuary, P.O. Box 236, State Highway Route 6, South Wellfleet, MA, USA 02663, (7) Allied Concrete Company, 1000 Harris Street, Charlottesville, VA, USA 22903.

4:20 p.m.

"A Novel Sampling Method for Investigating Utilization of Natural, Restored and Enhanced Oyster Reef Habitats by Nektonic Organisms" Joyce, R.E. (1), P.R. Kingsley-Smith (2), W.A. Roumillat (3), M.J.M Reichert (4), S.A. Arnott (5), (1) Grice Marine Laboratory, College of Charleston, 205 Fort Johnson Road, Charleston, SC, USA 29412, (2,3,4,5) Marine Resources Research Institute, S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29422.

4:40 p.m.

"Nekton Utilization of Created Oyster Reefs in Intertidal and Shallow Subtidal Habitats of North Carolina" Wilgis, T. (1), M.H. Posey (2), T. Alphin (3), (1,2,3) University of North Carolina Wilmington, Department of Biology and Marine Biology, 601 South College Road, Wilmington, NC, USA 28403.

5:00 p.m.
Concurrent Session Ends

5:00 p.m. to 6:00 p.m.
POSTER SESSION/HAPPY HOUR
Stono, DT

6:15 p.m.
Transportation to Lowcountry Cookout
7:00 p.m. to 9:00 p.m.
LOWCOUNTRY COOKOUT
Charleston Maritime Center, Downtown Charleston, S.C.

SATURDAY, NOVEMBER 20

7:00 a.m. to Noon
ICSR'10 Registration
HSG

7:30 a.m. to 8:45 a.m.
Continental Breakfast
Stono, DT

9:00 a.m. to 10:00 a.m.
PLENARY PRESENTATIONS
Harleston/Wraggborough Rooms, HSG

9:00 a.m. to 9:30 a.m.

"The Power of the Volunteer in Community-Based Shellfish Restoration" Flimlin, G. (1), C. Muscio (2), R. Bushnell (3), (1,2) Rutgers Cooperative Extension of Ocean County, 1623 Whitesville Road, Toms River, NJ, USA 08755, (3) ReClam The Bay, Inc., 1623 Whitesville Road, Toms River, NJ, USA 08755.

9:30 a.m. to 10:00 a.m.

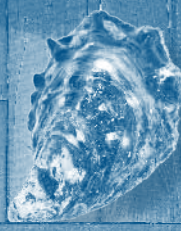
"Rowing 101: Getting Everyone Into the Boat, Selecting the Correct Oar, and Pulling in the Same Direction for the Entire Race" King, T., Washington Sea Grant, P.O. Box 488, Shelton, WA, USA 98584.

10:00 a.m. to 10:15 a.m.
Break
Stono, DT

10:15 a.m. to 3:50 p.m.
PLENARY CONTRIBUTED SESSION E
Harleston/Wraggborough Rooms, HSG
"Shellfish Restoration – Lessons Learned and Community-Based Restoration Strategies"
Moderated by Gef Flimlin, Rutgers Cooperative Extension, John Ewart, University of Delaware Sea Grant Marine Advisory Program, and Bryan DeAngelis, NOAA Restoration Center/NMFS

10:15 a.m.

"Several Large or Several (More) Small: Designing Marine Reserve Networks for Oyster Restoration" Puckett, B.J. (1), D.B. Eggleston (2), (1,2) Center for Marine Sciences and Technology, N.C. State University, NC, USA 28557.



10:35 a.m.

"The Hawkesbury River Estuary – Devastation and Resurrection" McLeod, D., Glenlg Shellfish, 19 Russell Street, Adelaide, South Australia 5000, Australia.

10:55 a.m.

"Oyster Reef Height Determines Reef Persistence in Chesapeake Bay" Colden, A.M. (1), R.N. Lipcius (2), (1,2) Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA, USA 23062.

11:15 a.m.

"Evidence of Self-Organization and Underlying Environmental Control of Spatial Pattern in Intertidal Oysters: Implications for Restoration" Luckenbach, M.W. (1), P.G. Ross (2), (1,2) Virginia Institute of Marine Science, Eastern Shore Laboratory, P.O. Box 350, Wachapreague, VA, USA 23480.

11:35 a.m.

"What's in a Name? A Summary of the History of the Olympia Oyster* (Ostrea lurida Carpenter 1864) *on the West Coast of the United States, and Recent Advances in Research and Restoration" McGraw, K.A., NOAA Restoration Center, F/HC-3 SSMC-3 Room 15862, 1315 East-West Highway, Silver Spring, MD, USA 20910.

11:55 a.m.

"The Decline in Landings of Wild Commercial Bivalves in the Northeast United States after 1980" MacKenzie, C.L. (1), M.L. Tarnowski (2), (1) N.E. Fisheries Science Center, NOAA, NMFS, James J. Howard Marine Science Center, 74 Magruder Road, Highlands, New Jersey, USA 07732, (2) Maryland Department of Natural Resources Shellfish Division, Tawes State Office Building, B-2, 580 Taylor Ave., Annapolis, MD, USA 21401.

12:15 p.m. to 1:30 p.m.
Lunch (provided)
Courtyard Tent

1:30 p.m.

"Increasing the Capacity for Oyster Restoration Through Community Involvement" Czwartacki, S. (1), N.H. Hadley (2), M.S. Hodges (3), H.P. Dyar (4), A.D. Kreutzer (5), H.M. Benton (6), (1,2,3,4,5,6) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

1:50 p.m.

"The Mobile Bay Oyster Gardening Program: Bringing the Reef to the People" Waters, P.J., Alabama Cooperative Extension System/MS-AL Sea Grant, 4170 Commanders Drive, Mobile, AL, USA 36615.

2:10 p.m.

"Restoring Shellfish to Improve Our Coasts, Support Green Jobs, and Boost the Economy" Morlock, S., NOAA Restoration Center, 1315 East-West Highway, Silver Spring, MD, USA 20910.

2:30 p.m.

"A Summary of the 2010 West Coast Native Oyster Workshop: Lessons Learned from the Field" Adams, K.W., NOAA Restoration Center, 7600 Sand Point Way NE, Building 1, Seattle, WA, USA 98115.

2:50 p.m.

"Shellfish Restoration: Assessing Needs, Opportunities, and Outcomes" Landry, T. (1), B. Leung (2), M. Ouellette (3), (1) Department of Fisheries and Oceans, 343 University Avenue, Moncton, New Brunswick, Canada E1C 9B6, (2) McGill University, Stewart Biology Building, Montreal, Quebec, Canada H3A 1B1, (3) Department of Fisheries and Oceans, 343 University Avenue, Moncton, New Brunswick, Canada E1C 9B6.

3:10 p.m.

"Landscape Setting and Substrate Depth Determine Outcomes of Intertidal Oyster Reef Restoration: Trends, Insights, and New Directions from a Decade-Old Restoration Study" Fodrie, J.F. (1), A.B. Rodriguez (2), J.H. Grabowski (3), N.L. Lindquist (4), (1,2) Institute of Marine Sciences, University of North Carolina at Chapel Hill, 3431 Arendell Street, Morehead City, NC, USA 28557, (3) GMRI, 350 Commercial Street, Portland, ME, USA 04101, (4) Institute of Marine Sciences, University of North Carolina at Chapel Hill, 3431 Arendell Street, Morehead City, NC, USA 28557.

3:30 p.m.
Plenary Session Ends

3:30 p.m. to 4:30 p.m.
"Future Directions" Session
Stono, DT

4:30 p.m.
Conference Adjourns

Poster Sessions

A. Shellfish Resource Restoration, Enhancement, and Management

A1. TIMING IS EVERYTHING: THE COMPLEXITIES OF OPERATING AN OYSTER HATCHERY. Radcliffe, M.W. (1), R. Carey (2), L.M. Guy (3), C. Abbott (4), S.T. Alexander (5), J. Baynard (6), E.A. Roache (7), E. Vlahovich (8), S.M. Weschler (9), D.W. Meritt (10), (1,2,3,4,5,6,7,8,9,10) University of Maryland Center for Environmental Science Horn Point Laboratory, P.O. Box 775, Cambridge, MD, USA 21613.

A2. THE HOTNESS FACTOR: RECOGNIZING COMPETENCY OF *CRASSOSTREA VIRGINICA* LARVAE TO MAXIMIZE SPAT PRODUCTION IN A RESTORATION HATCHERY. Alexander, S.T. (1), E. Vlahovich (2), C. Abbott (3), J. Baynard (4), R. Carey (5), L.M. Guy (6), M.W. Radcliffe (7), E.A. Roache (8), S.M. Weschler (9), D.W. Meritt (10), (1,2,3,4,5,6,7,8,9,10) University of Maryland Center for Environmental Science Horn Point Laboratory, P.O. Box 775, Cambridge, MD, USA 21613.

A3. POPULATION DYNAMICS OF THE EASTERN OYSTER (*CRASSOSTREA VIRGINICA*) IN THE NORTHERN GULF OF MEXICO. Eberline, B.S. (1), J.F. La Peyre (2), T.M. Soniat (3), M.K. La Peyre (4), (1) School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA, USA 70803, (2) Cooperative Aquatic Animal Health Research Program, Department of Veterinary Science, Louisiana State University Agricultural Center, Baton Rouge, LA, USA 70803, (3) Department of Biological Sciences, University of New Orleans, New Orleans, LA, USA 70148, (4) U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unit, School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA, USA 70803.

A4. MAPPING THE EFFECTS OF THE HORN POINT OYSTER HATCHERY: USING A PRODUCTION FACILITY TO INFLUENCE OYSTER PRODUCTION AND RESTORATION. Roache, E.A. (1), C. Abbott (2), S.T. Alexander (3), J. Baynard (4), R. Carey (5), L.M. Guy (6), M.W. Radcliffe (7), E. Vlahovich (8), S.M. Weschler (9), D.W. Meritt (10), (1,2,3,4,5,6,7,8,9,10) University of Maryland Center for Environmental Science Horn Point Laboratory, P.O. Box 775, Cambridge, MD, USA 21613.

A5. DEVELOPING SUSTAINABLE OYSTER BEDS AND EXPANSION WITHOUT THE USE OF CHEMICALS. Stavrum, K.M., Independent Shellfish Growers of Washington State, P.O. Box 82, Nahcotta, WA, USA 98637.

A6. *CSI* HUMBOLDT - THE CASE OF THE MISSING OYSTER: RESTORATION OF THE NATIVE OYSTER *OSTREA LURIDA* IN HUMBOLDT BAY, CALIFORNIA, A PROGRESS REPORT ON LOCAL EFFORTS. Koeppel, R. (1), J.A. Koeppel (2), A. Carter (3), S.F. Craig (4), (1,2) Humboldt State University, 1616 Williams Street, Eureka, CA, USA 95501, (3) Charleston Southern University, 9200 University Blvd, Charleston, SC, USA 29406, (4) Humboldt State University, 1 Harpst Street, Arcata, CA, USA 95521.

A7. HIGH PREDATION MAY HINDER RESTORATION OF NATIVE OYSTERS IN NORTH HUMBOLDT BAY, CALIFORNIA. Koeppel, J.A. (1), S.F. Craig (2), A. Carter (3), (1) Humboldt State University, 1616 Williams Street, Eureka, CA, USA 95501, (2) Humboldt State University, 1 Harpst Street, Arcata, CA, USA 95521, (3) Charleston Southern University, 9200 University Blvd., Charleston, SC, USA 29406.

A8. PRELIMINARY STUDY INVESTIGATING NON-SPECIFIC IMMUNE RESPONSE IN HATCHERY RAISED WILD BLACK-LIP PEARL OYSTER (*PINCTADA MARGARITIFERA*). Ozbay, G., Delaware State University, College of Agriculture and Related Sciences, Dover, DE, USA 19901.

A9. MATHEMATICAL MODEL OF ALTERNATIVE STABLE STATES IN NATIVE OYSTER POPULATIONS. Lipcius, R.N. (1), W.C. Jordan-Cooley (2), L.B. Shaw (3), J. Shen (4), J. Shi (5), (1) Department of Fisheries Science, Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA, USA 23062, (2) Department of Mathematics, The College of William and Mary, Williamsburg, VA, USA 23187, (3) Department of Applied Science, The College of William and Mary, Williamsburg, VA, USA 23187, (4) Department of Physical Sciences, Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA, USA 23062, (5) Department of Mathematics, The College of William and Mary, Williamsburg, VA, USA 23187.

A10. BAY SCALLOP SURVIVAL IN VARYING HABITAT TYPES IN CHESAPEAKE BAY. Glaspie, C.N. (1), R.D. Seitz (2), (1,2) Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA, USA 23062.

B. Shellfish Habitat Restoration, Enhancement, and Management

B1. OYSTER REEFS AS A RESTORATION TOOL: DO REEF STRUCTURE, PHYSIOCHEMICAL CONDITIONS, AND WAVE ENERGY ENVIRONMENT AFFECT REEF SUSTAINABILITY? Casas, S.M. (1), J.F. La Peyre (2), M. La Peyre (3), (1,2) Department of Veterinary Science, 111 Dalrymple Building, Louisiana State University Agricultural Center, Baton Rouge, LA, USA 70803, (3) U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unit, School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA, USA 70803.

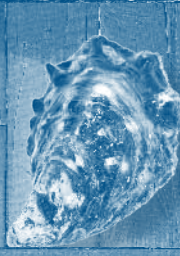
B2. EXPERIMENTAL RESTORATION OF BIOGENIC REEFS OF THE HORSE MUSSEL, *MODIOLUS MODIOLUS*. Smyth, D., Queen's University Belfast, School of Biological Sciences, 97a Lisburn Road, Belfast, County Antrim, Northern Ireland, UK BT9 7BA.

B3. EFFECTS OF FRAGMENTATION ON THE DISTRIBUTION AND BIODIVERSITY OF *MODIOLUS MODIOLUS* IN STRANGFORD LOUGH, NORTHERN IRELAND. Mahon, A.M., The Queen's University Belfast, Queen's University Marine Laboratory, 12, The Strand, Portaferry, Co. Down, Northern Ireland, UK BT22 1PF.

B4. THE EFFECTS OF OYSTER HARVEST ON THE TROPHIC DYNAMICS AND HABITAT QUALITY OF OYSTER REEFS IN COASTAL LOUISIANA. Beck, S. (1), M. La Peyre (2), (1) School of Renewable Natural Resources, Louisiana State University AgCenter, 132 Renewable Natural Resources Building, LSU Campus, Baton Rouge, LA, USA 70803, (2) U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unit, School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA, USA 70803.

B5. OYSTER REEF DEVELOPMENT ON CONSTRUCTED STRUCTURES USED FOR SHORELINE EROSION CONTROL IN LAKE BARRE, LOUISIANA, USA. Melancon, E.J. (1), M.A. Linson (2), G.P. Curole (3), (1,2) Nicholls State University, Biology Department, Thibodaux, Louisiana, USA 70301, (3) Office of Coastal Protection and Restoration, Thibodaux Field Office, 1440 Tiger Drive, Suite B, Thibodaux, LA, USA 70301.

B6. REVIEW OF THE RESTORATION ACTIVITIES OF THE EASTERN OYSTER (*CRASSOSTREA VIRGINICA*) RESOURCES OF MISSISSIPPI FOLLOWING THE DEVASTATION OF HURRICANE KATRINA. Gordon, J.S. (1), J. Mitchell (2), (1,2) Mississippi Department of Marine Resources, 1141 Bayview Avenue, Biloxi, MI, USA 39530.



B7. EXPERIMENTAL RESTORATION OF AN INTERTIDAL OYSTER REEF IN WELLFLEET, CAPE COD, MA: EVALUATING THREE REEF MATERIALS. Faherty, M.S. (1), R. Buchsbaum (2), (1) Mass Audubon/Wellfleet Bay Wildlife Sanctuary, P.O. Box 236, 291 State Highway Route 6, South Wellfleet, MA, USA 02663, (2) Mass Audubon, 346 Grapevine Road, Wenham, MA, USA 01984.

B8. EXPLORING THE ROLE OF RIBBED MUSSELS (*GEUKENSIA DEMISSA*) IN SALTMARSH STABILIZATION. Moody, J. (1), D. Bushek (2), D. Kreeger (3), (1,2) Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ, USA 08349, (2) Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE, USA 19801.

C. Water Quality and Public Health Issues in Shellfish Restoration

C1. DO TIDAL CREEK SYSTEMS CLOSED TO SHELLFISH HARVEST PROVIDE A SANCTUARY FUNCTION FOR *CRASSOSTREA VIRGINICA*? Alphin, T.D. (1), M.H. Posey (2), A.L. Markwith (3), (1) University of North Carolina Wilmington, Center for Marine Science, 5600 Marvin K. Moss Lane, Wilmington, NC, USA 28409, (2) University of North Carolina Wilmington, 601 South College Road, Wilmington, NC, USA 28403, (3) University of North Carolina Wilmington, Center for Marine Sciences, 5600 Marvin K. Moss Lane, Wilmington, NC, USA 28409.

D. Shellfish Restoration Projects—Community Strategies and Lessons Learned

D1. SCORE: 10 YEARS OF COMMUNITY-BASED HABITAT RESTORATION. Kreutzer, A.D. (1), N.H. Hadley (2), M.S. Hodges (3), H.P. Dyar (4), (1,2,3,4) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

D2. USING A COMMUNITY RESTORATION PROGRAM TO INCREASE PUBLIC AWARENESS OF SHELLFISH RESOURCE ISSUES. Dyar, H.P. (1), N.H. Hadley (2), M.S. Hodges (3), A.D. Kreutzer (4), (1,2,3,4) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

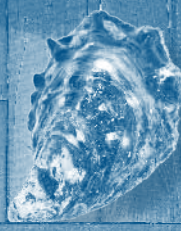
D3. DEVELOPMENT OF VOLUNTEER-FRIENDLY FISH SAMPLING METHODS FOR USE ON INTERTIDAL OYSTER REEFS. Hadley, N.H. (1), V.R. Shervette (2), H.M. Benton (3), (1) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412, (2) University of South Carolina, Department of Environmental Health Sciences, PHRC 401, 921 Assembly Street, Columbia, SC, USA 29208, (3) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

D4. OPTIMIZING ENHANCEMENT AND RESTORATION STRATEGIES USING COMPARISONS OF OYSTER (*CRASSOSTREA VIRGINICA*) REEF DISTRIBUTIONS MAPPED OVER A MULTI-DECADAL TIMESCALE IN SOUTH CAROLINA, USA. Schulte, K.E. (1), W.D. Anderson (2), G.M. Yianopoulos (3), P.R. Kingsley-Smith (4), R.F. Van Dolah (5), (1,2,3,4,5) S.C. Department of Natural Resources, Marine Resources Division, P.O. Box 12559, Charleston, SC, USA 29422.

D5. MARKETING A SUCCESSFUL OYSTER SHELL RECYCLING PROGRAM. Varnam, S.M. (1), S. Taylor (2), G. Allen (3), L. Henry (4), C. Braddy (5), (1) North Carolina Division of Marine Fisheries, P.O. Box 769, 3441 Arendell Street, Morehead City, North Carolina, USA 28557, (2) North Carolina Division of Marine Fisheries, 127 Cardinal Drive, Wilmington, NC, USA 28405, (3) North Carolina Division of Marine Fisheries, 1021 Driftwood Drive, Manteo, NC, USA 27954, (4) North Carolina Division of Marine Fisheries, 1107 Highway 64 East, Columbia, NC, USA 27925, (5) North Carolina Division of Marine Fisheries, P.O. Box 1507, Washington Square Mall, Washington, NC, USA 27889.

D6. SOUTHEAST OYSTER EXPLOSION – TNC DEVELOPING HUMAN RESOURCES TO RESTORE OUR NATURAL RESOURCES: AN OVERVIEW OF THE NATURE CONSERVANCY'S (TNC) MARINE WORK IN THE CAROLINIAN INTEGRATED SEASCAPE FROM NORTH CAROLINA TO FLORIDA. Brown, J. (1), A. Birch (2), C. Lambert (3), A. McCall (4), M. Conley (5), (1) The Nature Conservancy – SC Chapter, 960 Morrison Drive, Suite 100, Charleston, SC, USA 29414, (2) The Nature Conservancy – FL Chapter, 201 North Riverside Drive, Indialantic, FL, USA 32903, (3) The Nature Conservancy – GA Chapter, U.S. Highway 17-Butler Island, Darien, GA, USA 31305, (4) The Nature Conservancy – NC Chapter, 701 West Ocean Acres Drive, Kill Devil Hills, NC, USA 27948, (5) The Nature Conservancy – SC Chapter, 960 Morrison Drive, Suite 100, Charleston, SC, USA 29414.

Keynote Speaker's *Biography*



Eric Schwaab, M.S.

Eric C. Schwaab was appointed as the Assistant Administrator for Fisheries at the National Oceanic and Atmospheric Administration in February 2010. He oversees the management and conservation of marine fisheries and the protection of marine mammals, sea turtles, and coastal fisheries habitat within the United States exclusive economic zone. The National Marine Fisheries Service protects and preserves the Nation's living marine resources through scientific research, fisheries management, law enforcement, and habitat conservation. Eric brings more than 25 years of experience in local, state, and federal natural resource management. He has spent the majority of his career at the Maryland Department of Natural Resources, where he began as a natural resources police law enforcement officer in 1983. During this time, he served as director of the Maryland Forest Service; director of the Maryland Forest, Wildlife, and Heritage Service; and director of the Maryland Fisheries Service.In 2003, he left the Maryland Department of Natural Resources to serve as resource director for the Association of Fish and Wildlife Agencies until 2007. He then returned to the Maryland Department of Natural Resources as the deputy secretary. He also served as a member of the U.S. Department of Commerce Marine Fisheries Advisory Committee from 2005-2010. Eric holds an undergraduate degree in Biology from McDaniel College and a masters degree in Environmental Planning from Towson University.

Gavin Burnell, Ph.D.

Abstract

NATURE PLUS NURTURE: AN IRISH APPROACH TO SUSTAINABLE RESTORATION OF A COASTAL SHELLFISH POPULATION. Burnell, G. (1), T. Griffin (2), F. O'Donncha (3), J. Maguire (4), V. O'Donovan (5), S. Murphy (6), M. Hartnett (7), (1,2) University College Cork, Aquaculture and Fisheries Development Centre, Cooperage Building, Distillery Fields, North Mall, Cork, Ireland, (3) National University of Ireland, Galway, University Road, Galway, Ireland, (4) Daithi O'Murchu Marine Research Station, Gearhies, Bantry, Co. Cork, Ireland, (5) BIM – Irish Sea Fisheries Board, An Cuilin, An Daingean, Co. Kerry, Ireland, (6) Valentia Harbour Fisheries Society Ltd.,Valentia Harbour, Co. Kerry, Ireland, (7) Marcon Computations International Ltd., Galway, Ireland.

Valentia Harbour, Co. Kerry, has been the site of a valuable King Scallop (*Pecten maximus*) fishery since the 19th century. Increased mechanisation of the fishery since the 1930's resulted in a higher catch per unit effort for this fishery with vessels capable of catching "150 dozen fish per day." Such high catch rates were unsustainable and ultimately led to the collapse of the fishery. This was reflected in consistently poor catch statistics in the 1970's and 1980's. Attempts to regenerate this fishery since 1991 have included a variety of measures such as restocking programmes, technical conservation measures, scallop stock assessments, and the development of hydrodynamic and transport models to identify patterns of larval dispersal within the harbour and surrounding locations. However, each strategy, when implemented as a sole regeneration measure, has been ineffective. It has become increasingly clear that several, simultaneously implemented approaches may be necessary to regenerate this fishery. The current "ecosystem approach," using local broodstock and "going with the flow" of the bay, will try to build a sustainable fishery based upon the carrying capacity of the harbour and in sympathy with other local stakeholders. It involves a collaborative research project between the Valentia Harbour Fishery Society, three national research centres; the Daithi O'Murchu Marine Research Station (DOMMRS), the Aquaculture and Fisheries Development Centre, National University of Ireland at Galway, and Bord Iascaigh Mhara (BIM). The data generated will be used to modify and calibrate a hydrodynamic and transport model. This tool will inform management of the scallop fishery by allowing the cooperative members to quantify the restoration risks and to place the broodstock in a site that optimises larval retention and ultimately improves settlement on artificial collectors. This project is part supported by the Beaufort Marine Research Award an Ecosystems Approach to Fisheries Management with the support of the Marine Institute, funded under the Marine Research Sub-Programme of the National Development Plan 2007–2013.

Biography

Gavin Burnell is currently Professor and Acting Head of Department in the School of Biological, Earth, and Environmental Sciences (BEES), University College Cork. The central theme of his research relates to molluscan aquaculture and fisheries. A recent Marine Institute project (2003 – 2006) proposed management scenarios for Irish Sea mussel seed and he currently coordinates a Marine Institute "Beaufort Project" (2007 – 2013) that is concerned with an ecosystem approach to fisheries and aquaculture management. These and other projects have resulted in over 50 papers in refereed scientific journals, five books, and over 70 technical or magazine articles; the latter aim to bridge the gap between applied research and the aquaculture and fishing industries. Gavin has also edited conference proceedings and contributed chapters to books. In his spare time he is editor-in-chief for Aquaculture International, serves as founding member on the Board of AQUATT (a knowledge management company), and referees grant applications for the Norwegian Research Council.

Plenary Speakers'

Abstracts and Biographies

Boze Hancock, Ph.D.

Abstract

DEVELOPMENTS IN SHELLFISH RESTORATION FROM THE PERSPECTIVE OF THE CONSERVANCY, WITH STRATEGIC ADVANCES FOR THE NEAR FUTURE. Hancock, B., The Nature Conservancy, URI Narragansett Bay Campus, South Ferry Road, Narragansett, RI, USA 02882.

Filter-feeding bivalves, particularly oysters, have the ability to regulate the functioning of nearshore ecosystems. Because of the importance of shellfish as ecosystem engineers, The Nature Conservancy has been actively involved in conservation and restoration of shellfish habitats for over a decade. During the last 10 years a series of partnerships with NOAA's Community-Based Restoration Program has resulted in 54 shellfish restoration projects nationwide through that vehicle alone. This level of investment has necessitated developing a strategic framework for advancing the field of shellfish restoration in the U.S.A. and beyond. It has also been a catalyst for bringing together a coalition of shellfish restoration practitioners in an informal 'Shellfish Network' to help guide developments. The shellfish network identified the need for a global assessment of habitat forming shellfish which was completed in 2009. The report concluded that around 85% of shellfish habitat has been lost globally and presents recommendations for the future. With this level of loss, restoration is a necessity and the scale of restoration needs to be increased as rapidly as possible. Recent developments in the U.S. have increased the scale of restoration in several areas and have catalyzed an ecosystem-level view of restoration. This has raised the question of how much shellfish habitat should be restored. The Nature Conservancy and partners are developing a framework for answering this question based on the level of ecosystem services that are provided by the shellfish habitat. In this way the target for restoration can be set by considerations such as the number of shellfish needed to provide the water filtration to regulate water quality in an estuary, or how much shellfish habitat is needed to increase fish production sufficiently to rebuild stocks or sustain a fishery. In the past many shellfish restoration projects have been implemented in waters that are not approved for harvest. These are often the areas that stand to gain the most from the ecosystem services provided by restored shellfish populations. These areas are also attractive because they are protected from fishing, the major threat to shellfish. The use of unapproved waters for shellfish restoration is viewed differently by regulators responsible for public health and seafood safety in different areas. An important project is currently being undertaken by the Interstate Shellfish Sanitation Conference to reconcile some of these differences and develop 'best management practices' for shellfish restoration. Given the importance of bivalves in the nearshore ecosystem, the compromised state of many of the coastal bays and estuaries, and the extent of global declines in shellfish habitat, it is important that the framework for shellfish conservation and restoration is advanced as quickly as possible.

Biography

Boze Hancock is The Nature Conservancy-NOAA National Partnership Coordinator, based at the University of Rhode Island's Bay Campus. Boze has over 20 years of experience in marine research, working on the ecology, fisheries, restoration, and management of coastal marine resources. For many years he worked in the tropical and temperate Indian and Southern oceans of Western Australia, researching the fisheries ecology of marine invertebrates, primarily molluscs, and advising the fishing industry and fisheries managers. In 2004 Boze moved to Rhode Island and took up a position as coordinator of the North Cape Shellfish Restoration Program, a multi-species program to restore bay scallop and Eastern oyster populations, and to enhance quahog populations in Narragansett Bay and the coastal salt ponds in Rhode Island. He joined The Nature Conservancy (TNC) in 2007 as coordinator of the organization's partnership with the National Oceanic and Atmospheric Administration (NOAA) Community-Based Restoration Program. In this position Boze provides technical support to the numerous project managers and teams that contribute to this partnership, acts as the contact person between NOAA and the field teams, and ensures that results and developments in the field are available to the relevant project managers.

Chuck Hopkinson, Ph.D.

Abstract

THE DEEPWATER HORIZON EVENT: LESSONS FOR FUTURE ECOSYSTEM MANAGEMENT AND RESTORATION EFFORTS. Hopkinson, C., Georgia Sea Grant College Program, University of Georgia, 220 Marine Sciences Building, Athens, GA, USA 30602.

From the very outset of the Deepwater Horizon Oil Spill, Georgia Sea Grant and the University of Georgia have been at the forefront of research and response efforts relating to the disaster. When concerns existed about the potential impact to the East Coast, Georgia Sea Grant collaborated with other South Atlantic Sea Grant programs, including South Carolina, North Carolina and Florida, gathering input from the region's top physical oceanographic, petrochemical and chemical oceanographic experts on how and in what form oil could be transported from the Gulf of Mexico to South Atlantic waters. The program has also worked closely with state legislators in developing a monitoring system to check for the presence of oil in Georgia's waters and coastal ecosystem and is currently sampling sponges as part of this regime. On August 17, Georgia Sea Grant released a report which reinterpreted data published by the National Incident Command on the oil budget of the spill. The report was featured prominently in many major broadcast and radio news programs, as well as international print media outlets throughout August and September. In looking toward the future, Dr. Hopkinson will discuss offshore oil drilling and the increasing vulnerability of coastal systems near and remote to catastrophic oil spills. He will use the Deepwater Horizon oil spill to exemplify how the East Coast can be vulnerable to spills that occur in the Gulf of Mexico, as a result of ocean circulation and the potential depth of the leak.

Biography

Chuck Hopkinson is the director of the Georgia Sea Grant College Program and a professor of Marine Sciences at the University of Georgia. Chuck earned both his master's and doctoral degrees in marine sciences at Louisiana State University, and he has a broad background in coastal marine and resource issues in Georgia, the Southeast, and nationally. He directed the Land-Margin Ecosystem Research and the Long-Term Ecological Research projects on Plum Island Sound in Massachusetts, and has worked as a marine scientist at the Marine Biological Laboratory-Woods Hole, the University of Stockholm, and the University of Georgia. Chuck has considerable experience in the biochemistry of marsh-dominated coastal ecosystems with an emphasis on human activity, climate change and sea-level rise, knowledge which has recently enabled him to provide guidance on the long-term fate of oil in the Gulf of Mexico following the Deepwater Horizon oil spill.

Gef Flimlin, M.S.

Abstract

THE POWER OF THE VOLUNTEER IN COMMUNITY-BASED SHELLFISH RESTORATION. Flimlin, G. (1), C. Muscio (2), R. Bushnell (3), (1,2) Rutgers Cooperative Extension of Ocean County, 1623 Whitesville Road, Toms River, NJ, USA 08755, (3) ReClam The Bay, Inc., 1623 Whitesville Road, Toms River, NJ, USA 08755.

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 sixth 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 the new oyster reef that has been established by the program. In the last 2 years, 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 170 volunteers of which there are about 60 very active people growing shellfish, doing 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.

Biography

Gef Flimlin received his B.S. degree in Biology in 1974 from St. Peter's College and his M.S. degree in Marine and Environmental Science from the C.W. Post Center of LIU in Brookdale, NY, in 1978. He currently works as a marine extension agent and an associate professor with tenure at Rutgers Cooperative Extension in New Jersey. Gef belongs to a number of shellfish associations, including the East Coast Shellfish Growers Association, the New Jersey Shellfisheries Association, the World and U.S. Aquaculture Societies, and the National Shellfisheries Association.

Teri King, M.S.

Abstract

ROWING 101: GETTING EVERYONE INTO THE BOAT, SELECTING THE CORRECT OAR, AND PULLING IN THE SAME DIRECTION FOR THE ENTIRE RACE. King, T., Washington Sea Grant, P.O. Box 488, Shelton, WA, USA 98584.

Rowing is both a team and individual sport. The more people in the boat, the more rewarding the experience. But how do you find enough rowers to fill the boat? Help them find the best seat and row all together to the finish line? Community involvement in water quality restoration and protection faces the same challenges. Through innovative and engaging programs like Sound Science, Clean and Simple, Blue Thumb Gardening, and Bivalves for Clean Water we are constantly gathering new team members and reinvigorating veterans. These programs provide community members with the skills necessary to restore our polluted waterways and prevent further degradation. Together, we are pushing away from the dock and rowing in unison, gliding across the bay—an exhilarating experience.

Biography

Teri King is a Marine Water Quality Specialist with Washington Sea Grant (WSG). For the past 19 years she has been working with communities in the Pacific Northwest on pollution abatement, seafood safety, and shellfish culture. She manages a multitude of citizen monitoring efforts and outreach networks within Hood Canal and Puget Sound. Recognized for her leadership in the Hood Canal region, she was selected to serve on the Ecosystem Coordination Board by the Puget Sound Partnership. Her most recent program, 'Bivalves for Clean Water,' provides a unique opportunity for tideland owners to better understand their role as ecosystem managers. Before joining the WSG team in 1990, Teri worked as a fisheries biologist for the Washington Cooperative Fish and Wildlife Research Unit on the control of invasive aquatic plants and salmon habitat issues and for Alaska Sea Grant to determine the carrying capacity of shellfish aquaculture operations in Southeast Alaska. She completed her graduate work at the University of Washington.

FRIDAY, NOVEMBER 19

10:30 a.m. to 12:00 Noon

Plenary Panel Session

Harleston/Wraggborough Rooms, HSG

Impacts of the Deepwater Horizon Gulf of Mexico Oil Spill on Shellfish and Shellfish Habitat

Moderators

M. Richard DeVoe
S.C. Sea Grant Consortium

Dorothy L. Leonard
Ocean Equities, LLC

Panelists

Earl Melancon
Professor, Department of Biology
Nicholls State University
Thibodaux, LA

Kris Benson
Marine Habitat Resource Specialist
NOAA Restoration Center
Galveston, TX

Leslie Sturmer
Shellfish Aquaculture Extension Specialist
University of Florida
Cedar Key, FL

Ed Cake
President
Gulf Environmental Associates
Ocean Springs, MS

John Tesvich
President
AmeriPure Oyster Company
Franklin, LA

Robert Van Dolah
Director, Marine Resources Research Institute
S.C. Department of Natural Resources
Charleston, SC

Chris Nelson
Vice President, Oyster Procurement,
R&D, Governmental Affairs
Bon Secour Fisheries
Bon Secour, AL

Chuck Hopkinson
Director, Georgia Sea Grant
University of Georgia
Athens, GA

Impacts of the Deepwater Horizon Gulf of Mexico Oil Spill on Shellfish and Shellfish Habitat

Officials with the US Department of the Interior and NOAA, in cooperation with the co-trustees for natural resources affected by the BP/Deepwater Horizon oil spill, have initiated the injury assessment and restoration planning phase of the Natural Resource Damage Assessment (NRDA). The NRDA is a multi-phase legal process to determine the type and amount of restoration needed to compensate the public for harm to natural resources and their human uses as a result of the spill.

Much of the initial "pre-assessment" phase has already occurred. During that phase, trustees collected time-sensitive data, reviewed scientific literature about the oil and its impact on coastal resources, and made initial determinations regarding the resources that have been injured and the appropriate restoration actions that can be taken to address them. During the "injury assessment and restoration planning" phase, trustees will assess the nature and amount of injuries and develop a restoration plan. The trustees' goals are to recover from responsible parties damages equal to what will be necessary to return the environment to the conditions that would have existed if the oil spill had not occurred ("baseline conditions") and to recover compensation on behalf of the public for the diminished value of the injured resources from the time of the injury until restoration is achieved. By regulation, these two phases will be followed by a "restoration" phase, during which the trustees will work with the public to implement and monitor restoration projects.

Under NRDA, as outlined by the Oil Pollution Act of 1990, the trustees have authority to identify potential restoration projects and will solicit public comment on these projects before finalizing the restoration plan. The public may also have opportunities to provide hands-on assistance in selected restoration projects. The full extent of potential injuries is currently unknown and may not be known for some time. However, according to the Notice of Intent, as of August 19, the trustees had documented oil on more than 950 miles of shoreline, including salt marshes, sandy beaches, mudflats, and mangroves. The restoration planning process will further refine the total impact of this spill on the Gulf.

This panel will examine some of these questions and issues and offer perspectives on the need and the nature of any shellfish-related restoration efforts that might be considered. Questions exist concerning how the oil, its derivatives during the aging process, and dispersants are impacting oysters from the south (Gulf of Mexico) as increasing volumes of freshwater flow from the north (from up-estuary diversions), a phenomenon that may pose a significant double threat to the resource and the industry that depends upon it, according to Earl Melancon, one of the panelists. He suggests that additional potential impacts to post-set subtidal oysters impacted by the oil spill might include (1) the inability to sell the product because of taste, at least for a few weeks until purged once the source is stopped, (2) the potential to interfere with gonadal re-development after being so weak from spawning, (3) the potential to suffocate the oysters with thick oil, and (4) the potential to make oil or surfactant covered oysters inhospitable for spat setting.

Oral and Poster Presentation Abstracts

A SUMMARY OF THE 2010 WEST COAST NATIVE OYSTER WORKSHOP: LESSONS LEARNED FROM THE FIELD. Adams, K.W., NOAA Restoration Center, 7600 Sand Point Way NE, Building 1, Seattle, WA, USA 98115.

The 2010 West Coast Native Oyster Workshop was held in Suquamish, Washington, in September 2010. The meeting was the third in a series of workshops dedicated to restoring the Olympia oyster. Scientists and restoration practitioners met to share information about the current state of Olympia oyster restoration efforts; including identifying research needs to guide future restoration efforts. This presentation summarizes some of the results of the workshop, as well as discussions on preliminary ten-year goals for Olympia oyster restoration on the West Coast, and new guidelines and methods for achieving those goals. Previous meetings have proven very productive and have resulted in, among other things, a special peer-reviewed volume on Olympia oysters in a scientific journal, confirmation of the taxonomic status of the Olympia oyster (as *Ostrea lurida*), demonstrations on making concrete settling tiles, providing a venue where new and unpublished information is available and shared, and allowing for in-depth discussions. Proceedings from the 2010 Olympia oyster workshop will not be available until 2011, but this conference provides an opportunity for communicating some of the most important outcomes of the workshop.

THE HOTNESS FACTOR: RECOGNIZING COMPETENCY OF *CRASSOSTREA VIRGINICA* LARVAE TO MAXIMIZE SPAT PRODUCTION IN A RESTORATION HATCHERY. Alexander, S.T. (1), E. Vlahovich (2), C. Abbott (3), J. Baynard (4), R. Carey (5), L.M. Guy (6), M.W. Radcliffe (7), E.A. Roache (8), S.M. Weschler (9), D.W. Meritt (10), (1,2,3,4,5,6,7,8,9,10) University of Maryland Center for Environmental Science Horn Point Laboratory, P.O. Box 775, Cambridge, MD, USA 21613.

The University of Maryland Center for Environmental Science Horn Point Laboratory's oyster hatchery has been in operation since 1976. The primary mission of the Horn Point hatchery is production of disease free oyster spat for restoration. Since 2000, over two billion hatchery-produced spat on shell have been deployed to various restoration sites in Chesapeake Bay. After the 1993 Oyster Roundtable, oyster restoration came to the forefront and the Horn Point Hatchery became the centerpiece for producing and supplying spat on shell. Many factors influence an oyster larva's ability to successfully metamorphose into a spat. It is important that only larvae that are ready to undergo settlement are selected for use in setting systems. Historically, larval size has been the primary factor in selecting larvae for setting. However, if size alone is used to make the settlement determination, poor sets may result. We have developed an assessment technique we refer to as the hotness factor to assist in identifying larvae that are competent to be introduced into setting tanks. This hotness factor takes into account larval size, size of eyespot, and presence of an active foot and is used by hatchery personnel to assess larval competency. Through utilization of this technique, and other advancements in the hatchery, overall setting efficiencies have increased by an order of magnitude in the last 5 years. We believe utilization of this factor by hatchery operators or remote setters may help maximize spat production in a cost-efficient manner.

DO TIDAL CREEK SYSTEMS CLOSED TO SHELLFISH HARVEST PROVIDE A SANCTUARY FUNCTION FOR *CRASSOSTREA VIRGINICA*? Alphin, T.D. (1), M.H. Posey (2), A.L. Markwith (3), (1) University of North Carolina Wilmington, Center for Marine Science, 5600 Marvin K. Moss Lane, Wilmington, NC, USA 28409, (2) University of North Carolina Wilmington, 601 S. College Road, Wilmington, NC, USA 28403, (3) University of North Carolina Wilmington, Center for Marine Sciences, 5600 Marvin K. Moss Lane, Wilmington, NC, USA 28409.

North Carolina, like many other states, is experiencing a rapid increase in shellfish closures for areas that have historically been very productive harvest bottom. In the northern portions of coastal NC (where oysters are predominantly

subtidal) the restoration of oysters (*Crassostrea virginica*) involves cultch plantings and the establishment of no-take sanctuaries to act as larval sources. In southeastern NC (where oyster populations are predominantly intertidal), however, there are a large number of shallow tidal creek systems and bays that are suggested to act as default sanctuaries because they are closed to harvest. Here we examine several characteristics of the oyster populations in these systems as a test of the hypothesis that moderately impacted systems free of harvest pressure provide a sanctuary function for the adjacent areas. Specifically, we will be evaluating density, size demography, sex ratios, and condition index among tidal creek systems that vary in background nutrient levels and development among the watersheds. In New Hanover County, NC, there are several tidal creek systems with varying anthropogenic impacts and conditions. These systems tend to respond relatively quickly to changes in the local watershed. This study evaluated the change in oysters in both the lower and upper regions of the tidal creek systems. Preliminary data show a shift in sex ratios, with oysters in the large size class dominated by males, as well as differences in condition index between sites and among creeks.

THE EFFECTS OF OYSTER HARVEST ON THE TROPHIC DYNAMICS AND HABITAT QUALITY OF OYSTER REEFS IN COASTAL LOUISIANA. Beck, S. (1), M. La Peyre (2), (1) School of Renewable Natural Resources, Louisiana State University AgCenter, 132 Renewable Natural Resources Building, LSU Campus, Baton Rouge, LA, USA 70803, (2) U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unit, School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA, USA 70803.

Shellfish reefs have recently been identified as one of the most endangered aquatic habitats. Oyster reefs in particular provide diverse ecological services in estuaries, including the creation of refuge and foraging habitat for numerous organisms and maintenance of water quality. Oyster harvest may result in changes to structural habitat complexity, but the extent of these changes and how they affect resident macrofauna is unclear and has not been thoroughly examined. Oyster management in Louisiana provides a unique opportunity to study the effects of oyster harvest on oyster reef communities through the designation of harvested and un-harvested oyster reef areas. This study was designed to compare resident community structure, reef structural complexity, and condition of resident fish species and to assess the trophic dynamics and habitat quality of reefs across coastal Louisiana at heavily harvested sites (Caillou Lake and Black Bay), and an un-harvested site (Sabine Lake) during the spring and summer of 2010. A site containing both reef types (Calcasieu Lake) will be sampled in the fall of 2010. Resident macrofauna were collected using modified sampling trays filled with on-site oyster substrate. Data from April/May 2010 indicate differences in species abundance ($P < 0.01$) and richness ($P = 0.02$) between sites, the highest occurring at Caillou Lake and the lowest at Sabine Lake. Causative factors (water quality and substrate characteristics) are still under investigation. Stable isotope analysis of dominant species will be used to compare the trophic structure of resident reef communities between sites. Given the importance of oyster reefs in supporting estuarine ecosystems, it is essential to clarify if and how oyster harvest affects oyster reef habitat value and resident community food web characteristics.

SOUTHEAST OYSTER EXPLOSION—TNC DEVELOPING HUMAN RESOURCES TO RESTORE OUR NATURAL RESOURCES: AN OVERVIEW OF THE NATURE CONSERVANCY'S (TNC) MARINE WORK IN THE CAROLINIAN INTEGRATED SEASCAPE FROM NORTH CAROLINA TO FLORIDA. Brown, J. (1), A. Birch (2), C. Lambert (3), A. McCall (4), M. Conley (5), (1) The Nature Conservancy – SC Chapter, 960 Morrison Drive, Suite 100, Charleston, SC, USA 29414, (2) The Nature Conservancy – FL Chapter, 201 North Riverside Drive, Indialantic, FL, USA 32903, (3) The Nature Conservancy – GA Chapter, U.S. Highway 17-Butler Island, Darien, GA, USA 31305, (4) The Nature Conservancy – NC Chapter, 701 West Ocean Acres Drive, Kill Devil Hills, NC, USA 27948, (5) The Nature Conservancy – SC Chapter, 960 Morrison Drive, Suite 100, Charleston, SC, USA 29414.

Shellfish are fundamental building blocks in the estuaries where they occur, providing ecosystem services for both natural and human environments. In addition, shellfish can significantly impact the local and regional economies. Yet shellfish reefs and beds are one of the most globally impacted of all marine ecosystems. Individually and collectively these are strong cases for the need to conserve and restore shellfish at all scales wherever they occur. The Nature Conservancy (TNC) is committed to their restoration and established a Shellfish Restoration Network in 2004 to enhance the overall coordination of restoration by the Conservancy and its partners. Today, TNC is spearheading numerous shellfish restoration projects throughout the US and the world in cooperation with many partners. Across the Carolinian Seascape, from North Carolina to Florida, we have started to coordinate our restoration efforts across the five states to share restoration techniques, successes and challenges. Our future work requires even more collaboration across this Seascape if we are to realize the large scale restoration goals necessary to restore this species and habitat. Continued communication across state boundaries and among diverse partners will be the key to overcoming this challenge. The tide is right for oyster reef restoration success and we are committed to rising to the challenge!

NATIVE OYSTER RESTORATION IN SCOTLAND, THE WIDER PERSPECTIVE. Brown, J.H. (1), E.C. Ashton (2), (1,2) The Institute of Aquaculture, University of Stirling, Stirling, Scotland, UK FK9 4LA.

This presentation will briefly introduce the history of the native oyster (*Ostrea edulis*) in Scotland and the UK and report on recent work being instigated to try to restore the benefits of this once ubiquitous species to Scotland. This work was funded by contributions from Scottish Natural Heritage, Scottish Aquaculture Research Forum and The Crown Estate, which itself highlights the multiplicity of interests in this species but also possibly accounts for difficulties in taking the work forward. Comparisons will be useful for similar initiatives in other parts of the world, and we hope this presentation will promote discussion on best approaches to restoration and obtaining funding.

ENHANCEMENT OF THE FLAT OYSTER (*OSTREA CHILENSIS*) IN TASMAN BAY, NEW ZEALAND: SUMMARY OF RESEARCH OUTCOMES. Brown, S.N. (1), S.J. Handley (2), D.R. Schiel (3), (1,2) National Institute of Water and Atmospheric Research Ltd, P.O. Box 893, Nelson, New Zealand 7040, (3) University of Canterbury, Private Bag 4800, Christchurch, Canterbury, New Zealand 8140.

Habitat enhancement methods were investigated to increase productivity of a subtidal flat oyster (*Ostrea chilensis*) population in a central New Zealand fishery. Field monitoring identified a distinct seasonal peak in larval availability during summer, and manipulative field experiments demonstrated increased oyster recruitment and benthic community diversity on enhanced habitat. The relevance of the research results are discussed in the context of both fishery enhancement and ecological restoration.

RIBBED MUSSELS FOR SHORELINE PROTECTION? AN UPDATE FROM NEW JERSEY. Bushek, D. (1), D. Kreeger (2), L. Whalen (3), J. Moody (4), A. Padeletti (5), (1) Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ, USA 08349, (2,3) Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE, USA 19801, (4) Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ, USA 08349, (5) Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE, USA 19801.

Coastal estuaries are threatened by a multitude of natural and anthropogenic factors including sea level rise, storm surges, boat wakes, development, and pollution. Shellfish restoration provides some opportunities to improve coastal waters and protect valuable tidal marshes. Commercially harvested shellfish provide income to many local communi-

ties and furnish many ecological services. Commercially harvested shellfish are regulated to protect human health. Non-commercial species provide some of the same ecological services, but are of less direct economic value and pose no direct risk to human health. The dominant species of interest for restoration along the East Coast of the US is *Crassostrea virginica*, and 'oyster gardening' has become an important tool. Recently, New Jersey banned all restoration of commercial shellfish in contaminated waters, even for research. Previously, we proposed ribbed mussels as a non-commercial species that may provide ecological benefits similar to those provided by oysters. Our efforts to incorporate ribbed mussels into living shorelines focused mainly on stabilizing eroding salt marshes, and for that goal we have achieved some success. However, others have touted our project as ecologically equivalent to oyster restoration without appropriate scientific documentation. While ribbed mussel enhancement provides a promising tactic for living shorelines, it is not a replacement for oyster reefs that fill a distinct niche in the mosaic of coastal habitats. More research is needed to evaluate the role of ribbed mussels in living shorelines, develop culture methods (e.g., 'mussel gardening'), optimize seeding protocols, and quantify their ecological benefits. Our constructed living shorelines have achieved some important successes, but statements about the impacts of ribbed mussels without scientific evidence misinform the debate over shellfish restoration in closed waters.

OYSTER REEFS AS A RESTORATION TOOL: DO REEF STRUCTURE, PHYSIOCHEMICAL CONDITIONS, AND WAVE ENERGY ENVIRONMENT AFFECT REEF SUSTAINABILITY? Casas, S.M. (1), J.F. La Peyre (2), M. La Peyre (3), (1,2) Department of Veterinary Science, 111 Dalrymple Building, Louisiana State University Agricultural Center, Baton Rouge, LA, USA 70803, (3) U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unit, School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA, USA 70803.

Reefs created by the Eastern oyster, *Crassostrea virginica*, provide a variety of ecological services including habitat creation, water quality maintenance, and shoreline stabilization. They can act as natural breakwaters, absorbing wave energy and slowing shoreline erosion, and are thus an additional tool in coastal restoration. Few data exist to support managers in determining where reefs may be more sustainable, and ultimately, more effective in shoreline protection. This project examined the effects of reef structure (narrow: 25 x 0.7 x 1.5 m, and wide: 25 x 0.7 x 3 m) and energy environment (low and medium) on reef sustainability in three locations (northwest, northeast, and south Caillou Lake, LA), with locations used as a proxy for different physicochemical conditions (salinity, total suspended solids, and chlorophyll a). Nine reefs were created in February 2009 using oyster shell, and oyster density, mortality, and size distribution estimated seasonally. By June 2010, no significant differences in oyster density by energy environment or reef structure were found. Spat recruitment occurred primarily in May and September 2009, with highest recruitment in the southernmost location, closest to the Gulf of Mexico, while as of the end of July little recruitment has occurred in 2010. As a consequence, reefs in the south had the greatest densities of spat settlement by the end of the first summer, but because they had elevated fall and winter mortalities, no differences in oyster density by location were found by June 2010. Frequency of size distribution differed between locations and sampling times; overall the southern location displayed a more even distribution. Long-term sustainability will continue to be monitored to determine inter-annual variation in oyster density and size distribution.

OYSTER REEF HEIGHT DETERMINES REEF PERSISTENCE IN CHESAPEAKE BAY. Colden, A.M. (1), R.N. Lipcius (2), (1,2) Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA, USA 23062.

The success of native oyster, *Crassostrea virginica*, restoration efforts in Chesapeake Bay has been limited by several factors, including the loss of constructed reef habitat due to sediment accumulation. Recent field experiments indicate that initial reef height influences reef persistence, and theoretical models suggest that there may be thresholds in

reef height leading either to degraded or to persistent reef states. In addition, reef construction is expensive and reef materials are limited, so it is important to optimize the use of reef materials. We constructed two sets of reefs of six different heights (0.05, 0.1, 0.2, 0.3, 0.4, and 0.5 m) in the Great Wicomico River and Lynnhaven River system, two sub-estuaries of lower Chesapeake Bay. This range of reef heights encompassed the heights that are typical of previous restoration efforts throughout Chesapeake Bay. The reefs were monitored for oyster recruitment, sediment accumulation, and visually using ROV imaging. After 4-6 weeks, several of the low-relief reefs (0.05 and 0.1 m) were completely covered with sediment, whereas taller reefs (0.3-0.5 m) were persisting and had successful oyster recruitment. There appears to be a reef height threshold of 0.2-0.3 m that determines degradation or persistence of reefs. Therefore, we recommend that taller reef structures (> 0.3 m) be built to ensure reef persistence and self-sustainability.

INCREASING THE CAPACITY FOR OYSTER RESTORATION THROUGH COMMUNITY INVOLVEMENT. Czwartacki, S. (1), N.H. Hadley (2), M.S. Hodges (3), H.P. Dyar (4), A.D. Kreutzer (5), H.M. Benton (6), (1,2,3,4,5,6) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

The South Carolina Department of Natural Resources is responsible for the management of public trust oyster resources in SC, including restoration and enhancement. Given limitations in manpower and funding, combined with increased harvesting and other impacts to resources, current management efforts may not be adequate to maintain sustainable resources. This project seeks to increase our capacity for oyster restoration by removing the temporal restriction imposed by the spatfall season and by supplementing our limited workforce with community volunteers. Waterfront communities and individual dock-owners are enlisted to fill mesh bags with recycled oyster shells and hang them from docks during the summer months. Bags are retrieved after the normal planting season and the spatted shell is used to enhance late season or after-season shell plantings. A single bag can plant up to one square meter of shoreline. In the pilot phase of this study, more than 145 volunteers bagged and deployed 951 bags of shell (264 bushels) from 40 docks, which were used to create 0.19 acres of oyster habitat. An added benefit to the program is the opportunity to increase public awareness and affect behavioral changes which may improve water quality and reduce physical impacts to oyster reefs.

THREE YEARS AFTER: WHAT ABOUT *CALLISTA CHIONE* RESTORATION PLANS? Del Piero, D., Trieste University Life Sciences Department, via Giorgieri 10 c/o ed. M., Trieste, TS, Italy 34127.

In spite of the skepticism that arose about *C. chione* restoration plans as conducted by fishermen organizations in 2006-2007 in the Gulf of Trieste (Northern Italy), it seems that some results have been achieved. In particular, the growth of the molluscs sampled in July 2010 was quite good and the strong limitation to the fishery in the restored site obtained the result to build up a profitable clam reservoir to be exploited. The next challenge will be to evaluate the contribution of these to the recruitment.

USING A COMMUNITY RESTORATION PROGRAM TO INCREASE PUBLIC AWARENESS OF SHELLFISH RESOURCE ISSUES. Dyar, H.P. (1), N.H. Hadley (2), M.S. Hodges (3), A.D. Kreutzer (4), (1,2,3,4) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

One of the original goals of the DNR's South Carolina Oyster Restoration and Enhancement (SCORE) Program is to educate the public on the importance of oysters in our ecosystems. Since our inception in 2001 we have utilized a variety of techniques and educational activities to achieve that goal. Our website is our largest outreach tool; it is accessible to everyone and contains a brief background of our program, an introduction to oyster biology, tutorials on water

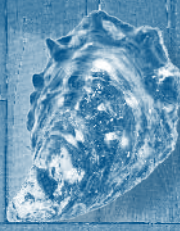
quality and lesson plans for teachers on oyster habitat. We also do outreach events where we go into classrooms and work with schools to create a "hands-on" learning experience for students. Our most common school event involves an "oyster reef dissection," where we take small oyster reef bags into classrooms and teach students about multiple aspects of the reef. We have also worked with school art clubs to create reef murals. The most interactive experiences involve individuals or groups going out into the real world and participating in monitoring and sampling. Our water quality monitoring program entails participants testing water quality at sites around Charleston, SC on a weekly or biweekly basis, any day or time they please. We have also recently implemented a volunteer-friendly fish sampling program where groups of students learn different sampling techniques while exploring what lives around the reefs. Since the beginning of SCORE (2001), we have pulled together over 150 partners and schools to collaborate and maximize efforts of habitat restoration. Education and outreach has played an important role in increasing our volunteer base which now numbers 10,388 (and growing), and serves as an example of the possible impact on other restoration programs.

POPULATION DYNAMICS OF THE EASTERN OYSTER (*CRASSOSTREA VIRGINICA*) IN THE NORTHERN GULF OF MEXICO. Eberline, B.S. (1), J.F. La Peyre (2), T.M. Soniat (3), M.K. La Peyre (4), (1) School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA, USA 70803, (2) Cooperative Aquatic Animal Health Research Program, Department of Veterinary Science, Louisiana State University Agricultural Center, Baton Rouge, LA, USA 70803, (3) Department of Biological Sciences, University of New Orleans, New Orleans, LA, USA 70148, (4) U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unite, School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA, USA 70803.

With commercially and ecologically valuable oyster populations declining worldwide, there is a great need for clear understanding of the multiple factors that affect oyster population dynamics. This is especially true of Eastern oyster populations in coastal Louisiana that have been, or will be exposed to impacts from the Deepwater Horizon oil spill (DHOS). We examined the population dynamics of the Eastern oyster (*Crassostrea virginica*) in the northern Gulf of Mexico using field experiments. Specifically, this project was initiated to identify which factors drive natural recruitment, growth, and mortality rates, how the rates change over an annual cycle and among size classes (not applicable to recruitment), and how these factors change along a salinity gradient in Breton Sound, LA. Seed and market-sized oysters in both open and closed cages resting on the bottom, as well as recruitment plates suspended in the water column, were monitored at four sites in Breton Sound, LA, across a gradient of salinity (Site A: ~5 ppt, B: ~10 ppt, C: ~15 ppt, D: ~20 ppt). Initial results from April to July 2010 show diminution in the original salinity gradient (Site A: ~0-1ppt, B: ~1 ppt, C: ~1 ppt, D: ~2 ppt) due to open freshwater diversion structures from the Mississippi River in response to DHOS. Furthermore, between April and July 2010, no recruitment occurred, and average oyster condition decreased at all sites. This project will continue through 2011 to monitor impacts of the oil spill on Eastern oyster populations and identify the multiple factors that contribute to Eastern oyster population dynamics.

EXPERIMENTAL RESTORATION OF AN INTERTIDAL OYSTER REEF IN WELLFLEET, CAPE COD, MA: EVALUATING THREE REEF MATERIALS. Faherty, M.S. (1), R. Buchsbaum (2), (1) Mass Audubon/Wellfleet Bay Wildlife Sanctuary, P.O. Box 236, 291 State Highway Route 6, South Wellfleet, MA, USA 02663, (2) Mass Audubon, 346 Grapevine Road, Wenham, MA, USA 01984.

Mass Audubon is working with The Nature Conservancy, NOAA, and the Town of Wellfleet on the first-ever attempt in Massachusetts to restore a wild-set oyster reef on intertidal flats owned by Mass Audubon. We are testing shell culch, reef balls, and oyster castles in terms of density and survival of the growing oysters as well as the diversity of inverte-



brates on the treatments. Preliminary results indicate a high density of oysters set on the three experimental materials in July of 2009, and that the diversity of other organisms increased quickly relative to control sites when materials were placed on the restoration site. Several challenges face this project, including sedimentation, winter ice, disease, predators, and the effects of freeze-thaw cycles on the reef materials. This presentation will focus on these challenges as well as the goals and measures of success for the project, the experimental methods being used, preliminary results, and future directions of the restoration.

RESTORATION OF BIOGENIC REEFS OF *MODIOLUS MODIOLUS*: THE POTENTIAL FOR ENHANCING RECRUITMENT USING HATCHERY PRODUCED SEED. Fariñas-Franco, J.M. (1), D. Roberts (2), (1) Queen's University Belfast Marine Laboratory, 12, The Strand, Portaferry, Northern Ireland, UK BT221PF, (2) Queen's University Belfast School of Biological Sciences, Medical Biology Building, 97 Lisburn Road, Belfast, Northern Ireland, UK BT9 7BL.

In Strangford Lough (Northern Ireland) the horse mussel *Modiolus modiolus* (L.) forms subtidal biogenic reefs of high biodiversity and productivity in an otherwise muddy seabed. Recent reports showed widespread damage to the *M. modiolus* reefs, particularly in the Lough's North Basin. This study contributes to current *M. modiolus* reef restoration efforts (http://www.qub.ac.uk/research-centres/ModiolusRestorationResearchGroup/) by investigating the viability of a *M. modiolus* reseeding program using laboratory produced spat. Air exposure was successfully used to induce spawning in *M. modiolus* and the full embryonic and larval cycle from fertilized egg to pediveliger larvae was recorded for the first time using European *M. modiolus* stocks. An investigation of natural recruitment levels in several *M. modiolus* populations was also conducted in order to assess the potential to enhance natural recruitment using hatchery produced seed. A total of 6 sampling stations representative of the 2 existing types of *M. modiolus* communities were selected. Population size frequency distribution structure was bi-modal. Natural recruitment in the moderately impacted beds of the South Basin was higher than in North Basin areas. Spat collectors consisting of *M. modiolus* and scallop shell, commercial spat collectors and clumps of live *M. modiolus* were deployed and checked for spat. Recruitment was positive in the live *M. modiolus* clumps while no spat was found attached to the shells and artificial materials. These results confirm previous field and laboratory observations showing that *Modiolus modiolus* spat is rarely found outside the complex matrix created by the live adult mussels. These findings must be considered should a reseeding program be attempted.

LANDSCAPE SETTING AND SUBSTRATE DEPTH DETERMINE OUTCOMES OF INTERTIDAL OYSTER REEF RESTORATION: TRENDS, INSIGHTS, AND NEW DIRECTIONS FROM A DECADE-OLD RESTORATION STUDY. Fodrie, J.F. (1), A.B. Rodriguez (2), J.H. Grabowski (3), N.L. Lindquist (4), (1,2) Institute of Marine Sciences, University of North Carolina at Chapel Hill, 3431 Arendell Street, Morehead City, North Carolina, USA 28557, (3) GMRI, 350 Commercial Street, Portland, ME, USA 04101, (4) Institute of Marine Sciences, University of North Carolina at Chapel Hill, 3431 Arendell Street, Morehead City, North Carolina, USA 28557.

Well-developed *Crassostrea virginica* reefs enhance water quality, supply habitat for associated organisms, stabilize shorelines and provide fishing communities a harvestable resource. Intertidal reef accretion is the sum of processes that add oyster biomass (recruitment, growth), as well as physical (mechanical harvest, storms, hypoxia) and biological (predation, disease, biofouling, bioerosion) processes that inhibit reef development. In 2010, we assessed the evolution of 15-year-old restored *C. virginica* reefs (initially 3mx5mx0.3m) inside the Rachel Carson NERRS (NC) using traditional and state-of-the-art (laser scanning) methods. Our data indicate that intertidal reef quality – measured as live oyster density (current max: > 3,000 individuals/m^2), volume change (current max = 3x initial), and vertical relief (current max = 0.75 m) – is regulated by the landscape setting in which reefs were located (proximity to vegetated

habitats), as well as the depth that reefs were initially deployed. In particular, reefs constructed on broad mudflats and above spring-tide low water have performed significantly better than reefs in other settings. Mechanistically, landscape and depth factors are related to flux rates (larvae, food) and the distribution of oyster predators, bioeroders and biofoulers. Our continued research exploits these reefs as the focal point of an interdisciplinary examination—including new reef construction—of the historical, biological, physical, chemical and geological processes that regulate intertidal oyster-reef ecosystems along the central NC coastline. We propose that intertidal restoration should be guided by principles that maximize potential oyster recruitment and growth and minimize destructive processes that vary across landscapes and depths.

BAY SCALLOP SURVIVAL IN VARYING HABITAT TYPES IN CHESAPEAKE BAY. Glaspie, C.N. (1), R.D. Seitz (2), (1,2) Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA, USA 23062.

The bay scallop (*Argopecten irradians)* was decimated in many parts of the Chesapeake Bay due to habitat loss in the early 1930s. Coinciding with recent efforts to restore the Chesapeake Bay, many seagrass beds are reappearing, leading to efforts to reintroduce species such as the bay scallop. This study tested survival of bay scallops in the Lynnhaven River system under natural rates of predation in three different habitat types: the seagrass *Ruppia maritima*, the alga *Gracilaria sp.*, and sand. Scallops were free-seeded or tethered in the field in 0.5 m^2 plots at densities reflecting those found in natural populations. Predator exclusion devices were placed on some of the plots to isolate the effects of cownose ray predation. After an average of 5.20 ± 0.24 hours, scallops were collected and mortality was recorded. Survival was higher in *R. maritima* than in *Gracilaria* or sand. Cownose ray exclusion devices had no significant effect on bay scallop mortality, suggesting that, for the scale of this study, ray predation was negligible. Low predation rates in seagrass suggest that reintroduction of the bay scallop to this area of Lynnhaven may be possible if such vegetated habitats are targeted.

REVIEW OF THE RESTORATION ACTIVITIES OF THE EASTERN OYSTER (*CRASSOSTREA VIRGINICA*) RESOURCES OF MISSISSIPPI FOLLOWING THE DEVASTATION OF HURRICANE KATRINA. Gordon, J.S. (1), J. Mitchell (2), (1,2) Mississippi Department of Marine Resources, 1141 Bayview Avenue, Biloxi, MI, USA 39530.

On August 29, 2005, Hurricane Katrina devastated the coastal areas of the North Central Gulf of Mexico, including the Mississippi Gulf Coast. It was estimated that over 90% of that year's oyster (*Crassostrea virginica*) crop was destroyed by the storm, along with much of the critical infrastructure of the Mississippi coast. The various restoration activities undertaken by the Mississippi Department of Marine Resources on the Eastern oyster resources of Mississippi following this devastation will be reviewed.

CHANGING ACIDITY IN ESTUARIES AND COASTAL ZONES: THE EFFECT OF LOWER PH AND SATURATION STATE ON RECRUITMENT AND SURVIVORSHIP OF JUVENILE BIVALVES. Green, M.A. (1), L. Hubacz (2), G. Waldbusser (3), (1,2) Saint Joseph's College of Maine, 278 Whites Bridge Road, Standish, ME, USA 04084, (3) Oregon State University, 104 COAS Administration Building, Corvallis, OR, USA 97331.

Sediments in nearshore regions can be undersaturated with respect to calcium carbonate during certain periods of the year and/or in specific locales in the region immediately adjacent to the sediment water interface (SWI) where shallow burrowing juvenile bivalves congregate following settlement. Here we investigate the effects of saturation state at the SWI on recruitment and survivorship of settling marine bivalves. When bivalves transition from their pelagic larval phase to their benthic juvenile stage they have the ability to evaluate carbonate saturation state (or some indicator

thereof) and either burrow or reject sediments based on this cue. Laboratory experiments show that when sediments are undersaturated with respect to aragonite, at levels of saturation state commonly documented in coastal deposits, transitioning juvenile bivalves (200 μm) will 'reject' the sediment and not burrow. If more saturated sediments are not available, we show that dissolution of the animals shell causes extensive mortality to settling recruits. Field studies show that by adding small amounts of $CaCO_3$ to inter-tidal mud, the pH and saturation states can be raised relative to the surrounding deposit. In a 30 day field experiment we significantly increased bivalve recruitment by raising the pH (0.3) and saturation state (2X) of surface sediments through buffering with crushed shell ($CaCO_3$). The buffering of intertidal mud by returning shell material (or other $CaCO_3$ forms) may be a valuable management tool for increasing recruitment of native bivalve populations to certain areas and/or by substantially increasing survivorship of transplanted seed. Increased economic value of enhanced recruitment to certain regions, coupled with the ecosystem services a robust clam population provides, could make sediment buffering a profoundly important best management practice not currently employed.

DEVELOPMENT OF VOLUNTEER-FRIENDLY FISH SAMPLING METHODS FOR USE ON INTERTIDAL OYSTER REEFS. Hadley, N.H. (1), V.R. Shervette (2), H.M. Benton (3), (1) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412, (2) University of South Carolina, Department of Environmental Health Sciences, PHRC 401, 921 Assembly Street, Columbia, SC, USA 29208, (3) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

A widely touted benefit of oyster restoration is establishment of quality habitat for fish and motile invertebrates, but this is rarely verified after reef construction. The South Carolina Oyster Restoration and Enhancement (SCORE) community restoration program has established multiple restoration sites over a ten year period. Recently we have evaluated a suite of restoration metrics at SCORE sites as indicators of restoration success. However, these metrics do not include any parameters for habitat use by transient or resident finfish or larger motile invertebrates. This project utilized high-school and college students and volunteers to construct and test a suite of fishing gear on intertidal oyster reefs in order to develop fish-sampling methods suitable for implementation by volunteers. Seven gear types were tested in summer 2009, with up to 36 trials per gear type. A total of 72 different taxa were identified in these sampling trials, with different gear types collecting an average of 0.3 to 1,416 specimens per fishing trial. Gear were deployed on oyster reefs and adjacent shorelines lacking structure, providing some preliminary data on faunal diversity on and around these intertidal habitats. Students developed guidelines for gear construction, fishing protocols, and two simple guides for fish identification and completed a survey to gauge the "volunteer friendliness" of the different gear types. Methods developed by this project will be utilized to sample existing and future SCORE sites and natural oyster reefs as we strive to broaden our suite of metrics for evaluating restoration success.

CONDUCTING LARGE-SCALE INTERTIDAL OYSTER (*CRASSOSTREA VIRGINICA*) RESTORATION AS MITIGATION IN SOUTH CAROLINA ESTUARINE WATERS. Hodges, M.S. (1), W.D. Anderson (2), N.H. Hadley (3), H.P. Dyar (4), (1,2,3,4) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

South Carolina's Department of Natural Resources (SCDNR) is being subcontracted by the SC State Ports Authority to conduct large-scale oyster (*Crassostrea virginica*) restoration in Charleston Harbor, SC, as mitigation for seaport expansion. This 5 year project has provided an efficient and cost effective mitigation tool for estuarine habitat enhancement in South Carolina since few projects meet mitigation goals for these environments. It is important that this project is overseen by a responsible resource agency so that performance success criteria are incorporated to insure that habitat goals are reached. Sections of each prospective reef footprint throughout the harbor are constructed and either

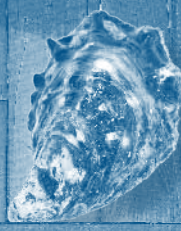
expanded, enhanced or abandoned based on quantitative monitoring results. Eight acres of vertical reefs (~102,000 U.S. bushels) will be completed by project end. To date, 83,218 bushels of oyster shells (6.79 acres) have been planted at 21 sites. Newly-constructed reefs are monitored for a minimum of three years to verify successful reef development and allow timely adaptive management. Success criteria for constructed reefs is based on a characteristic natural reef density (F1 strata) with an average density of 1,416 oysters/m^2 and ~1,926 bushels of live oysters/acre. Additional success measures include percentage of footprint retention, recruitment potential (larval supply) and shoreline stabilization. Another component of the mitigation project, the South Carolina Oyster Restoration and Enhancement Program (SCORE) works with community volunteers to establish small scale oyster habitat. The SCORE bagged-shell reefs can be constructed in high energy areas where loose shell might be washed away. A goal of 0.625 acres of reefs will be completed by project end. To date, a total of 0.45 acres of reef has been constructed at four sites with the assistance of 872 volunteers.

A NON-PROFIT OYSTER (*CRASSOSTREA VIRGINICA*) RESTORATION EFFORT IN BOSTON HARBOR, WHICH HAS UNDERGONE SIGNIFICANT CHANGE SINCE EXTINCTION OVER 60 YEARS PREVIOUSLY.
Jay, A.T. (1), M.S. Brevard (2), R. Bradshaw (3), (1) Massachusetts Oyster Project For Clean Water, 67 Old Rutherford Avenue, Charlestown, MA, USA 02129, (2) Massachusetts Oyster Project For Clean Water, 10 Canterbury Street, Worcester, MA, USA 01610, (3) Massachusetts Oyster Project For Clean Water, 63 Palfrey Street, Watertown, MA, USA 02472.

The Eastern oyster (*Crassostrea virginica*) has a long Boston history. Oyster shell is in the mortar of the Old State House and the crowd threw shells in the Boston Massacre. With the construction of the first Charles River Dam a 1904 report discusses the extinction of the oyster in the last quarter of the 1800's, mentioning silt and pollution as possible etiologic agents. Recognizing the oysters' well-documented filtering abilities, a group of citizens formed a non-profit with the goal of restoring the oyster to the estuaries of Boston Harbor to help improve water quality and increase biodiversity. An oyster reef can shelter over 100 other species while improving the aquatic environment for key plants including eelgrass. Over the ensuing two years, the Massachusetts Oyster Project for Clean Water has obtained permits and begun pilot placements at the mouth of the Charles River. Over time, the organization is refining its techniques to improve survival and reduce predation. Their experience indicates that oysters can survive and grow in Boston Harbor. The group has not yet shown reproduction or established functioning reefs. The organization has found that the program is generating broad support with most harbor constituents and abutters. It is serving as a tool to educate the community about waste water treatment, water quality, and biodiversity while reconnecting people with the Harbor. While oysters alone will not be able to clean the Harbor, they could be an additional cost-effective tool to be used as part of a comprehensive waste water program. The presenter will share data on growth and survival as well as lessons learned through the programs operations.

A NOVEL SAMPLING METHOD FOR INVESTIGATING UTILIZATION OF NATURAL, RESTORED AND ENHANCED OYSTER REEF HABITATS BY NEKTONIC ORGANISMS.
Joyce, R.E. (1), P.R. Kingsley-Smith (2), W.A. Roumillat (3), M.J.M Reichert (4), S.A. Arnott (5), (1) Grice Marine Laboratory, College of Charleston, 205 Fort Johnson Road, Charleston, SC, USA 29412, (2,3,4,5) Marine Resources Research Institute, S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29422.

For the past decade, oysters have been recognized as "ecosystem engineers" that generate important ecological services, including habitat provision for nektonic organisms (e.g., adult finfish, certain crustaceans). Most previous studies investigating this role of intertidal oyster reefs in South Carolina have compared the nektonic assemblages on natural reefs, salt marshes, mud bottom and subtidal oyster shell habitats using trawls, habitat trays and lift nets. These sam-



pling methods, while effective, involve some degree of habitat disturbance. The present study employed a novel, non-destructive sampling method to compare the nektonic assemblages associated with intertidal oyster reefs (natural, restored and enhanced) with those of neighboring soft sediment habitats at three sites in South Carolina. This method involved the release of a suspended stop-net which rapidly encircled those organisms present in study plots at high tide. Nektonic organisms collected as the tide receded were identified, enumerated, measured and wherever possible released alive. Each site comprised two study plots measuring 120m^2; an experimental plot of structurally-complex habitat and an adjacent control plot that lacked structural complexity. Experimental plots differed in substrate type (oyster "castles", oyster shell bags and natural oyster reef) and age (1 to 7+ years). Sites were sampled from February 2010 through November 2010 targeting daytime negative low tides. Abundances of nektonic organisms were higher in experimental plots compared to control plots and generally increased over time with increasing water temperature. Higher species diversity was observed for the experimental plot at two of the three study sites. At the remaining site, diversity did not differ significantly between treatments. Differences in diversity between treatments across sites may be explained by habitat age.

SHELLFISH HATCHERY IN ZANZIBAR? INSHALLAH! (GOD-WILLING). Karney, R. (1), J. Brawley (2), D. Grossman (3), N.S. Jiddawi (4), H.L. Kite-Powell (5), S.J. Shaaban (6), A. Yberg (7), (1) Martha's Vineyard Shellfish Group, Inc., P.O. Box 1552, Oak Bluffs, MA, USA 02557, (2) Saquish Scientific, 18 Bay View Road, Duxbury, MA, USA 02332, (3) David Grossman Photography, 61 Moulton Road, Duxbury, MA, USA 02332, (4) Institute of Marine Sciences, UDSM, Box 668, Zanzibar, Zanzibar NA, Tanzania, (5) Marine Policy Center, Woods Hole Oceanographic Institution, Mail Stop 41, Woods Hole, MA, USA 02543, (6) Institute of Marine Sciences, UDSM, P.O. Box 668, Zanzibar, Zanzibar NA, Tanzania, (7) Island Creek Oysters, 5 South Pasture Lane, Duxbury, MA, USA 02332.

In January 2010, with funding from the McKnight Foundation African Grants Program and the Island Creek Foundation, efforts were begun to construct and operate a pilot bivalve shellfish hatchery on the East African island of Zanzibar. The shellfish hatchery, believed to be the first on the East African coast, is part of a larger project to develop a decentralized, local village aquaculture industry producing domestic product for the island population. The initial hatchery trials involve the commercially important blood ark cockle, *Anadara antiquata*. The shellfish hatchery, based on the design of the Martha's Vineyard Shellfish Group hatchery, was built in an outdoor alley space provided by the Zanzibar Institute of Marine Science in Stone Town. The equipment and some of the piping were prefabricated in Duxbury, MA, air freighted to the city of Dar es Salaam on the Tanzanian mainland, and then transported via a traditional dhow sailboat across the channel to the Island. Hatchery construction and operation has proven challenging in a developing country with unreliable infrastructure and a scarcity of technical equipment. Despite unexpected delays, in early March, within a week of getting the shipped materials released from customs and electrical power restored following a three month long outage, our pilot hatchery was constructed and largely functional. Test tubes of phytoplankton cultures grew amazingly quickly in the strong equatorial sunlight and we soon had sufficient algae to begin ripening broodstock. In the six months since construction, we have successfully demonstrated an ability to maintain large volumes of cultured algae, ripened one group of broodstock and had one successful spawning. In anticipation of hatchery seed production, concomitant field nursery culture investigations are underway.

NITROGEN REMOVAL AND SEQUESTRATION CAPACITY OF A RESTORED OYSTER REEF. Kellogg, L. (1), J.C. Cornwell (2), M. Owens (3), K.T. Paynter (4), (1,2,3) University of Maryland Center for Environmental Science – Horn Point Laboratory, 2020 Horns Point Road, Cambridge, MD, USA 21613, (4) University of Maryland, 0105 Cole Student Activities Building, College Park, MD, USA 20742.

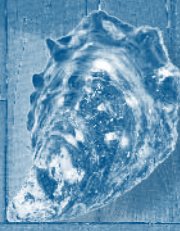
Oyster reefs provide habitat for an abundant and diverse reef-associated community. Both oysters and the reef-associated community sequester nitrogen, phosphorus and carbon in the form of animal tissue and shell. In addition, oysters modify biogeochemical cycles by filtering large quantities of organic matter from the water column. The majority of this material is either used directly for growth and maintenance or deposited on the sediment surface as feces and pseudofeces. Because Maryland's oyster restoration efforts in Chesapeake Bay have utilized shallow-water environments (4-6 m), these reefs concentrate organic material in aerobic environments with limited light levels, conditions conducive to efficient removal of nitrogen by microbially-mediated denitrification. Denitrification rates are likely to be further enhanced by the high abundances of deposit-feeding organisms found on restored oyster reefs. Our ongoing work compares denitrification rates and nutrient sequestration capacities of a restored reef (Choptank River, MD; oyster age: 3-7 yr; oyster density 100 m^{-2}) to an adjacent non-restored site. Denitrification rates are assessed by bringing 0.13 m^2 sections of restored oyster reef and its associated macrofauna into the laboratory and directly measuring net fluxes of di-nitrogen. Once laboratory incubations are complete, macrofauna retained on a 0.5-mm mesh sieve are identified and counted and their total biomass and nitrogen content is assessed. Preliminary results suggest that reef restoration can enhance denitrification rates by an order of magnitude and sequestration capacity by many orders of magnitude.

DIFFERENTIATING THE IMPACT OF PHYSICAL AND BIOTIC CONTRIBUTIONS OF THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA*, TO THE BENTHIC REEF COMMUNITY. Kesler, K.E. (1), V.A. Politano (2), H.A. Lane (3), K.T. Paynter (4), (1,2,3) University of Maryland, Biology Building 144, College Park, MD, USA 20742, (4) University of Maryland, Cole Field House, Room 0105, College Park, MD, USA 20742.

Complex reef structure provides organisms with refuge, habitat, and food sources. While the benefits of the structure created by oysters have been well studied, it is not clear how the biotic input of biodeposits and the physical contributions of shell production differentially contribute to the development of the oyster reef community. This study attempted to separate and quantify the contributions of live oysters and shell structure to the reef community. We compared the abundance of reef organisms on small reefs composed of live oyster clumps to those composed of dead oyster shell clumps. Live oyster clumps were collected from restored oyster reefs in the Chester River, MD, after which associated flora and fauna were removed. Half of the oyster clumps were kept alive while the oysters in the other clumps were sacrificed, tissue completely removed and their valves glued together to resemble live oyster clumps. The clumps were arranged on trays so that the rugosity for live and shell treatments was the same. Ten trays of each of treatment were placed in the Patuxent River, MD, on June 30 and July 3 2009. Three trays of each treatment were removed in October 2009 to perform a preliminary assessment of the experiment. All fauna on the clumps was identified to the lowest possible taxa. The abundance of each taxa was determined and biomass and biodiversity will be assessed. MANOVA analysis of abundance data showed that there was no difference in taxa abundance between live oyster clumps and oyster shell clumps. This preliminary assessment surprisingly shows that the physical structure created by oysters may be more important than the biodeposits they create in determining reef community abundance.

HATCHERY-BASED SHELLFISH PRODUCTION IN ZANZIBAR, TANZANIA. Kite-Powell, H.K. (1), R. Karney (2), J. Brawley (3), A. Yberg (4), (1) Woods Hole Oceanographic Institution, Marine Policy Center, MS 41, Woods Hole, MA, USA 02543, (2) Martha's Vineyard Shellfish Hatchery, 220 Weaver Lane, Vineyard Haven, MA, USA 02568, (3) Saquish Scientific, Bay View Road, Duxbury, MA, USA 02332, (4) Island Creek Oysters, 296 Parks Street, Duxbury, MA, USA 02332.

Seafood is a primary source of protein on Zanzibar, Tanzania, and wild capture fisheries are overexploited and in decline. Shellfish farming is an ecologically sound way to increase the yield of seafood protein from coastal waters. Wom-



en in Zanzibar's coastal villages have limited opportunities for economic development. Seaweed farming has been carried out on the island, primarily by women, since the late 1980s, and has provided a significant economic boost to women in coastal villages. Shellfish farming is a natural extension of or complement to seaweed farming; and since it targets a local market, it is less susceptible to external economic forces. This project introduces shellfish hatchery and shellfish growout techniques to Zanzibar, and plans to engage several hundred women in coastal villages in generating up to 100,000 kg of shellfish meats per year from hatchery-raised shellfish. This activity will provide a sustained and improved income stream for women shellfish farmers on the island. A central aspect of the project is the construction of a small shellfish hatchery to support increased production by shellfish farmers. Together with the training capacity built by the project in local organizations and in the villages themselves, this work is developing a new, ecologically and economically sustainable source of protein for local consumption and income for women in coastal villages.

HIGH PREDATION MAY HINDER RESTORATION OF NATIVE OYSTERS IN NORTH HUMBOLDT BAY, CALIFORNIA. Koeppel, J.A. (1), S.F. Craig (2), A. Carter (3), (1) Humboldt State University, 1616 Williams Street, Eureka, CA, USA 95501, (2) Humboldt State University, 1 Harpst Street, Arcata, CA, USA 95521, (3) Charleston Southern University, 9200 University Blvd., Charleston, SC, USA 29406.

Oyster reefs serve an important role in estuarine ecosystems. Their shells create a complex habitat that serves as a home for future generations of oysters, other sessile invertebrates, and fishes. Native oysters, *Ostrea lurida*, were historically abundant in Humboldt Bay. The populations have failed to rebound from over-harvesting and destructive harvest practices that disrupted existing reef structure. Early attempts to farm native oysters were unsuccessful, which lead to attempts to farm *Crassostrea virginica* in Humboldt Bay. Importing *C. virginica* is thought to have introduced the predatory oyster drill, *Urosalpinx cinerea*. In order to determine why these populations have not rebounded, we examined predation as a potential limiting factor on native oysters in north Humboldt Bay, California. In 2008 and 2009, juvenile oysters were cultured using adults from the local population at the Telonicher Marine Laboratory. Plastic tiles seeded with juvenile *O. lurida* were assigned to one of three treatments: (1) open to predation, (2) caged with stainless steel mesh to exclude predators, or (3) fenced, which allowed predators access while controlling for possible cage effects. Results showed that the mean survivorship of juvenile *O. lurida* in caged treatments was significantly greater than treatments open to predation (open and fenced cage control). The predominant predators at one site were *U. cinerea*, which were abundant at the site. In 2010 we repeated the study using one-year old oysters. As with the juvenile oysters, survival was significantly greater in treatments protected from predation. Our study suggests that mortality from predation may hinder restoration efforts in Humboldt Bay, California.

***CSI* HUMBOLDT - THE CASE OF THE MISSING OYSTER: RESTORATION OF THE NATIVE OYSTER *OSTREA LURIDA* IN HUMBOLDT BAY, CALIFORNIA, A PROGRESS REPORT ON LOCAL EFFORTS.** Koeppel, R. (1), J.A. Koeppel (2), A. Carter (3), S.F. Craig (4), (1,2) Humboldt State University, 1616 Williams Street, Eureka, CA, USA 95501, (3) Charleston Southern University, 9200 University Blvd, Charleston, SC, USA 29406, (4) Humboldt State University, 1 Harpst Street, Arcata, CA, USA 95521.

The Olympia oyster, *Ostrea lurida* (Carpenter) the native oyster of the Pacific coast of North America, was overexploited and commercially extinct throughout its range by 1930. Early efforts to sustain the fishery failed. The loss of this valuable ecosystem service provider is evident in many bays and estuaries along the Pacific coast. It continues to exist in low population numbers within Humboldt Bay, California today. However, very little is known about the factors limiting the recovery of *Ostrea lurida*. Local efforts to restore *O. lurida* began in 2006 with the funding of the City of Arcata, California Native Oyster Project. Three types of artificial substrate—quarry rock, shell bags, and artificial col-

lectors—were placed at four experimental sites in North Humboldt Bay. These were monitored for evidence of natural recruitment by *O. lurida* over the summers of 2007 and 2008. No recruitment was identified at any of these sites. In the face of no recorded natural recruitment occurring and to facilitate the continuing research, culture of oyster spat from native oyster stocks was conducted for three successive years at the Telonicher Marine Laboratory of Humboldt State University at Trinidad, California. Culture results were highly successful with the spawning and recruitment of two successive generations of *Ostrea lurida*. The Atlantic oyster drill, *Urosalpinx cinerea*, has been identified in high numbers at two of these sites. Recent research indicates a suite of predators may be keeping *Ostrea lurida* numbers low. Studies to identify effects from fouling and tidal height are ongoing. Initial results indicate there was no difference in growth or survival of *O. lurida* at different tidal heights.

SCORE: 10 YEARS OF COMMUNITY-BASED HABITAT RESTORATION. Kreutzer, A.D. (1), N.H. Hadley (2), M.S. Hodges (3), H.P. Dyar (4), (1,2,3,4) S.C. Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC, USA 29412.

The South Carolina Department of Natural Resources established the South Carolina Oyster Restoration and Enhancement program (SCORE) ten years ago with the goal of enlisting volunteers to recycle oyster shell and construct oyster reefs. By using volunteers to build the reefs, the SCORE program educates the public on the ecological benefits provided by oysters while also restoring valuable habitat. To date, the SCORE program, working with over 80 community partners, has enlisted over 10,000 volunteers who have contributed 30,000 hours to the project. These volunteers, ranging in age from 8 to 80, have participated in shell recycling, shell bagging, reef building, reef assessments, and water quality monitoring. Over the past 10 years, these volunteers worked to fill over 30,000 mesh bags with 500 tons of recycled shells. Those bags have been deployed to build more than an acre of oyster habitat at 37 sites spanning 200 miles of coastline. Due in part to the stability afforded by the mesh bag and in part to careful site selection, SCORE reefs have a remarkable success rate, with at least 80% of SCORE reefs comparing favorably to natural oyster reefs after only 2-4 years. SCORE reefs have also been demonstrated to stabilize shorelines and foster marsh grass expansion. In 2010, SCORE celebrated its 10^{th} anniversary by undertaking its largest project to date. In just one summer, 174 volunteers contributed 520 hours to deploy 4,310 shell bags at one site on Daniel Island, SC, and have created the largest uninterrupted SCORE reef covering 0.15 acres of shoreline.

EFFECTS OF SHORELINE REEF CREATION ON EDGE EROSION, MARSH RESILIENCE, AND NEKTON ASSEMBLAGES IN SOUTH LOUISIANA. La Peyre, M., U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unit, School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA, USA 70803.

With coastal Louisiana experiencing land loss in excess of 30 km^2 yr^{-1} managers are seeking tools to increase marsh resilience, enhance shore stability, and support estuarine productivity. Enhancement and creation of shellfish reefs have been suggested as one tool to accomplish all three goals, but limited data exist to guide decision-makers in determining how, when, and where created shoreline reefs in coastal Louisiana would benefit these critical estuarine components. Several recent, on-going, and new projects in coastal Louisiana provide some insight, but also highlight some of the key questions that need to be explored further. Two years of data at a project examining the effects of reef size and location (i.e., physicochemical variables, proximity to Gulf of Mexico, energy) have found that our created short fringing reefs in Terrebonne, LA, failed to reduce shore erosion, and only showed enhanced support of resident reef nekton, regardless of location, size, or water quality. Lack of shore protection may be due to the small size of the reefs, construction material, and large wave fetch; reefs provide new habitat for resident nekton, but may not enhance

transient nekton abundances due to small size of the reefs, and/or their location adjacent to productive salt marsh. Monitoring on this project continues to examine development of the reefs and provision of ecosystem services over time. New projects involve placement of fringing bio-engineered reefs with more vertical structure, in different locations, and of much larger size. Data from all projects will help identify which factors (i.e., reef structure, physicochemical parameters) are most important in determining the success of created or enhanced fringing oyster reefs in supporting coastal protection.

SHELLFISH RESTORATION: ASSESSING NEEDS, OPPORTUNITIES AND OUTCOMES. Landry, T. (1), B. Leung (2), M. Ouellette (3), (1) Fisheries and Oceans Canada, Aquaculture and Coastal Ecosystems Section, Gulf Fisheries Centre, Moncton, NB, Canada E1C 9B6, (2) McGill University, Stewart Biology Building, Montreal, QC, Canada H3A 1B1, (3) Fisheries and Oceans Canada, Aquaculture and Coastal Ecosystems Section, Gulf Fisheries Centre, Moncton, NB, Canada E1C 9B6.

Shellfish restoration is an activity with a long history in Atlantic Canada, as in other parts of the world. The goals of these restoration efforts are generally in response to alleviate the pressures of overexploitation, disease outbreaks, inter-specific competition and habitat alterations. More specifically, however, the goals of restoration activities can be characterized into three basic components with varying functions; 1) economical, 2) ecological, and 3) cultural. The needs, opportunities and outcomes of the activities will be dependant on the setting of these components. While these goals are reasonable, actual shellfish restoration activities are often conducted in isolation from other activities and have been largely driven by lobbying efforts. This approach has severe limitations in evaluating the large-scale values and outcomes of restoration projects. We suggest a more ecosystem-based approach, which considers a holistic assessment of the inputs into the system as well as the outputs in relation to shellfish restoration productivity. This view takes into account economical, ecological and cultural objectives, but also considers them at a broader societal scale. In order to improve the process of justifying and evaluating the ecosystem services from restoration projects, we propose to develop a mass balance model to fully integrate the various drivers in the coastal environment, with special attention on the shellfish industries.

A COMPARISON OF RELATIVE FECUNDITY AND EGG QUALITY IN OYSTERS (*CRASSOSTREA VIRGINICA*) OF DIFFERENT AGES FROM NORTHERN CHESAPEAKE BAY. Lane, H.A. (1), V. Politano (2), S.T. Alexander (3), E. Vlahovich (4), H.N. Koopman (5), D.W. Meritt (6), K.T. Paynter (7), (1,2) University of Maryland, Biology Building 144, Room 1210, College Park, MD, USA 20742, (3,4) University of Maryland Center for Environmental Science, P.O. Box 775, Cambridge, MD, USA 21613, (5) University of North Carolina Wilmington, 601 South College Road, Wilmington, NC, USA 28403, (6) University of Maryland Center for Environmental Science, P.O. Box 775, Cambridge, MD, USA 21613, (7) University of Maryland, 0105 Cole Field House, College Park, MD, USA 20742.

Relative fecundity (# eggs spawned) and egg quality (measured as egg total lipid content [ETLC] and egg fatty acid composition [EFAC]) were determined for oyster (*Crassostrea virginica*) populations from the Maryland portion of the Chesapeake Bay (Choptank [3 and 9y] and Magothy Rivers [4 and 11y]). One-hundred individuals were induced from each population, eggs were counted and analyzed for ETLC (n=38) and EFAC (n=32). 32 young and 41 old oysters from the Choptank spawned while 20 young but only 4 old oysters from the Magothy spawned. No significant relationship was found between relative fecundity and shell height ($P > 0.05$) or oyster age ($P > 0.05$). The older oysters had no more ETLC than young oysters ($P=0.058$, 3.7%lipid±1.5 vs. 2.8%lipid±1.2, respectively). However, the older oysters from the Magothy (n=4) had significantly more ETLC than the other three populations ($P=0.0059$, 5.3%lipid±1.1 vs. 2.9%lipid±0.9, respectively). A significant negative relationship was observed between ETLC and relative

fecundity (P=0.019). Significant differences were observed in the EFAC of eggs by population (global R=0.368), indicating a possible difference in resource partitioning to eggs by group, despite the geographic proximity between sites within rivers. These data suggest that resources allocated to egg production may be finite; the number of eggs produced may be inversely proportional to lipid reserves within eggs, and the EFAC may not be directly related to environmental conditions. Individuals that spawned successfully were not of the same "ripeness level" or "condition," and difficulty was experienced in spawning the old Magothy oysters. Considering the lack of consistency in pre-spawning oyster condition and the difficulty experienced when inducing spawning, the trends observed in this study should be confirmed under more controlled conditions and with additional populations.

COOLING OYSTERS WITHIN THE NEW 10 HOUR REQUIRED TIME FRAME FROM THE ENVIRONMENT TO 50 DEGREES OR BELOW IN A REFRIGERATED STORAGE AREA. Lane, R.M. (1), M.L. Jahncke (2), (1,2) Virginia Seafood AREC, 102 S. King Street, Hampton, VA, USA 23669.

The objective of this study is to determine cooling rates of harvested shellstock oysters in typical harvest, handling and storage containers/conditions when refrigeration begins. Beginning in 2011, states including Virginia must implement regulatory plans to control for *Vibrio parahaemolyticus* and *Vibrio vulnificus* in shellstock oysters. First, receipt oyster dealers shall implement, document, and verify that internal oyster temperatures have been cooled to a temperature ≤ 50 °F within 10 hours. Virginia implementation is from May 1 until September 31. Oysters not cooled in this time frame will be sold only for shucking. Data loggers will be inserted in oysters to collect oyster meat temperature at incremental time frames. Data loggers will record environmental temperatures of the refrigerated space. Data created will graphically show the record of oyster and environmental temperatures from harvest to refrigeration. Oyster temperatures will be monitored from dockside to processor refrigeration in cages or loose piles in refrigerated trucks. Oyster cooling rates in other containers may also be considered, depending upon handling methods of cooperating groups. Procedures include working with industry members to place data loggers in the harvested oysters, mark the oysters with colored duck tape, and place them at the center of container or pile. Procedures also include noting and recording the time and day the logger was placed into the oysters and the type of container used, as well as where and how the oysters will be transported to refrigerated storage and the time and date when oysters are removed from refrigeration. Compiled data and recorded notes will be used to develop temperature profiles under different methods of refrigeration to determine under what conditions oysters can be cooled to 50 °F or below within 10 hours.

STOCK ENHANCEMENT OF ABALONE, *HALIOTIS ASININA* IN SAGAY MARINE RESERVE: BASELINE ASSESSMENT OF WILD POPULATION AND ESTABLISHMENT OF RELEASE STRATEGIES. Lebata-Ramos, J.H. (1), E.F. Doyola-Solis (2), J.B. Abrogueña (3), J. Sumbing (4), H. Ogata (5), (1,2,3,4) Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC/AQD), Tigbauan, Iloilo 5021, Philippines, (5) Stock Enhancement Technology Development Center, National Research Institute of Aquaculture, Tsui-ura, Kami-ura, Oita 879-2602, Japan.

The lucrative returns brought by abalone fisheries have caused overexploitation and decline of the wild population. In the Philippines, successful production of the donkey's ear abalone *Haliotis asinina* in the hatchery has led to the development of different grow out techniques. However, production of abalone in aquaculture facilities does not benefit the marginalized fisherfolks who comprise a majority of the fisheries sector. This study aimed to enhance abalone population in Carbin Reef Sagay Marine Reserve through release of hatchery-bred juveniles produced from SEAFDEC Aquaculture Department. Prior to the release, a 13-month baseline assessment of the wild population was conducted. Results showed a decreasing abalone density from March 2007 to March 2008. Preference of abalone of dead branching corals with epiphytic algae was also observed. To test the viability of hatchery-bred abalone in the wild, 1000

diet-tagged abalone, 2.1-3.0 cm shell length (SL) were brought to the site, acclimated and released. Initial findings during the acclimation process showed that higher mortality was observed in abalone smaller than 3.0 cm SL. Mortality was highest on the day of transport (13.27%) which decreased until day 3 (0.30%). Abalone stayed inside or on the transport pipes until day 7, during which they moved to the corals and other available shelters on the reef. From the recaptures, hatchery-bred abalone showed higher growth rate (0.27±0.04 cm mo^{-1}) than the wild ones (0.13±0.04 cm mo^{-1}). Hatchery-bred abalone were recaptured until 513 days post release. Results of this preliminary release trial revealed that hatchery-bred abalone are viable for release in the wild and can survive with its conspecifics following certain conditions and given an appropriate habitat.

MATHEMATICAL MODEL OF ALTERNATIVE STABLE STATES IN NATIVE OYSTER POPULATIONS. Lipcius, R.N. (1), W.C. Jordan-Cooley (2), L.B. Shaw (3), J. Shen (4), J. Shi (5), (1) Department of Fisheries Science, Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA, USA 23062, (2) Department of Mathematics, The College of William and Mary, Williamsburg, VA, USA 23187, (3) Department of Applied Science, The College of William and Mary, Williamsburg, VA, USA 23187, (4) Department of Physical Sciences, Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA, USA 23062, (5) Department of Mathematics, The College of William and Mary, Williamsburg, VA, USA 23187.

The native oyster population in Chesapeake Bay has been the focus of three decades of restoration attempts, which have generally failed to rebuild the population and oyster reef structure. Recent restoration successes and field experiments suggest that initial reef height offsets heavy sedimentation and promotes high recruitment, resulting in alternative stable states of reefs. We summarize the empirical evidence for alternative stable states in oyster populations, and implement a mathematical model consisting of three differential equations that represent volumes of live oysters, dead oyster shells (= accreting reef), and sediment. We show that multiple nonnegative equilibria can exist for live oyster, accreting reef, and sediment volume at an ecologically reasonable range of parameter values, such that the initial height of oyster reefs determines which equilibrium is reached. These findings suggest that oyster reefs must be built high enough to surpass thresholds of alternative states.

DIFFERENCES IN THE GAPING RESPONSE AND HEMOLYMPH PH OF THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA*, AND THE ASIAN OYSTER, *CRASSOSTREA ARIAKENSIS*, WHEN EXPOSED TO HYPOXIC AND ANOXIC ENVIRONMENTS. Lombardi, S.A. (1), K.T. Paynter (2), (1) University of Maryland, Biology Psychology Building-144, College Park, MD, USA 20742, (2) 0105 Cole Field House, University of Maryland, College Park, MD, USA 20742.

Crassostrea virginica and *Crassostrea ariakensis* are morphologically and taxonomically similar, yet exhibit different anoxic tolerances. Previous studies have shown that *C. virginica* lived significantly longer than *C. ariakensis* in anoxic waters, and anecdotal evidence suggested that *C. ariakensis* tended to gape earlier and wider than *C. virginica*. This study experimentally tested the gaping response of *C. virginica* and *C. ariakensis* as well as assessed the pH of the water in which the oysters were immersed after anoxic exposure. Additionally, we assessed the hemolymph pH of both species when we blocked natural gaping responses. We found that *C. ariakensis* gaped significantly more often and wider than *C. virginica*. We also found a significant negative correlation between the frequency of gaping and the pH of the water in which the oysters were immersed. Additionally, when we prevented the oyster from gaping, inducing a hypoxic environment, *C. ariakensis*'s hemolymph became significantly more acidic than that of *C. virgincia*. These data suggest that gaping in *C. ariakensis* may be a mechanism to purge acidic metabolic byproducts that may begin to quickly accumulate when the oyster is exposed to low oxygen environments. However, there is likely a fitness trade-off

associated with gaping, since gaping exposes tissues to predation. Overall, these findings suggest that *C. virginica* and *C. ariakensis* exhibit different responses to anoxia and help explain the adaptations responsible for *C. virginica*'s well documented anoxic tolerance.

EVIDENCE OF SELF-ORGANIZATION AND UNDERLYING ENVIRONMENTAL CONTROL OF SPATIAL PATTERN IN INTERTIDAL OYSTERS: IMPLICATIONS FOR RESTORATION. Luckenbach, M.W. (1), P.G. Ross (2), (1,2) Virginia Institute of Marine Science, Eastern Shore Laboratory, P.O. Box 350, Wachapreague, VA, USA 23480.

Large-scale spatial patterns in the distribution of populations can be driven by localized interactions (self-organization), underlying environmental forcing, or a combination of the two. Identifying the scale-dependence of observed patterns can elucidate the roles of these classes of mechanisms and inform conservation and restoration efforts. We used 1-m^2 resolution digital aerial imagery to map the size and distribution of natural and restored intertidal oyster (*Crassostrea virginica*) reefs in a mid-Atlantic coastal lagoon. Reef perimeters were outlined and spatial patterns (Ripley's K) and reef size distribution examined across spatial scale in relation to bathymetry. Modal size of the natural reefs in this system is approximately 5 m^2 and reefs are over dispersed on scales of 3 – 4 m (reflecting over dispersion among nearest neighbors) and under dispersed at scales above 10 m (reflecting underlying environmental control). Frequency distribution of reef sizes followed a power-law relationship over two orders of magnitude—suggesting self-organization at these scales. Landscapes with obvious differences in bathymetry varied in their overall abundance of oysters and spatial pattern of reefs, suggesting an influence of underlying environmental factors in shaping oyster distribution patterns at these scales. In contrast, mean size of shell plants for reef restoration in the region exceeds 150 m^2. The spatial pattern of oyster abundance and biomass on these restored reefs, however, reflects the dispersion patterns observed in natural reefs, suggesting a pattern of self-organization at smaller scales resulting from localized food depletion and a pattern at larger scales controlled by hydrographics and, thus, food supply. These findings lead to the recommendation that reef restoration efforts should mimic natural spatial patterns in the placement of limited shell resources.

BEST PRACTICES FOR SHELLFISH RESTORATION: DEVELOPING GUIDELINES FOR RESTORATION WHILE PROTECTING PUBLIC HEALTH. Macfarlane, S. (1), D. Leonard (2), (1) Coastal Resource Specialists, P.O. Box 1164, Orleans, MA, USA 02653, (2) Ocean Equities LLC, 776 Rolling View Drive, Annapolis, MD, USA 21406.

The combination of declining populations of molluscan shellfish with increasing awareness of shellfish as an integral component and bellwether of estuarine health, especially with respect to nutrient loading, have led coastal states to initiate diverse shellfish restoration programs. Shellfish harvested for interstate consumption necessitates adhering to the National Shellfish Sanitation Program (NSSP) as set forth through the Interstate Shellfish Sanitation Conference (ISSC). Restoration programs include: planting shellfish, habitat improvement, land use actions (stormwater and wastewater mitigation, watershed planning), community action programs (shellfish gardening, volunteer programs) and using shellfish to improve water quality. However, the diversity of programs, methodologies, monitoring and educational components have resulted in a patchwork approach with no clear guidelines for managers to follow. Of paramount concern to public health managers is the potential for human illness when areas, restricted for harvest through the NSSP, are used for shellfish restoration programs. Yet, shellfish, through their filtering capacity, can help to restore areas to harvestable water quality and natural resource managers want to use the vast acreage for restoration programs. While managers recognize a pressing need for educational and operational guidelines to best utilize the potential benefit of increasing restoration of shellfish while protecting the public, none exists and education and protocols for public health safeguards are urgently needed. This workshop seeks to identify issues that could present obstacles to shellfish restoration and open dialogue and suggest solutions that may reflect different points of view.

Oral and Poster Presentation Abstracts

THE DECLINE IN LANDINGS OF WILD COMMERCIAL BIVALVES IN THE NORTHEAST UNITED STATES AFTER 1980. MacKenzie, C.L. (1), M.L. Tarnowski (2), (1) N.E. Fisheries Science Center, NOAA, NMFS, James J. Howard Marine Science Center, 74 Magruder Road, Highlands, New Jersey, USA 07732, (2) Maryland Department of Natural Resources Shellfish Division, Tawes State Office Building, B-2, 580 Taylor Ave., Annapolis, MD, USA 21401.

Over the past 30 years, the wild-caught bivalve fisheries in the northeastern United States have experienced dramatic declines, both in terms of landings and number of harvesters. Within the territorial waters of representative states from Maine to Virginia, landings fell in all four of the major shellfisheries: bay scallops (93%), oysters (90%), softshell clams (67%), and hardshell clams (22%). While in some cases there were regional shifts in the relative share of production (e.g. the majority of hardshell clam landings in 1980 were from New York, but by 2004 Connecticut was the leading producer), overall there was a net decline in harvests. Since 1980, the collapse of wild-caught harvests was particularly acute in the Chesapeake/Delmarva region. Maryland, once a major supplier of oysters and softshell clams, lost over 95% of its production, and Virginia landings of oysters and hardshell clams plunged 85% to 90%. Concomitant with these plummeting catches was the departure of harvesters from the shellfisheries. The number of full-time oyster harvesters in Maryland fell from 2,246 in 1980 to 244 in 2009, and Virginia licenses for both oyster and hardshell clam harvesting declined 73%. Similarly, the number of hardshell clam diggers dropped by 75% and softshell clam diggers by 100% in Raritan Bay, New Jersey. To date, these tremendous losses have only been partially compensated for by increasing aquaculture production. Within the span of a generation of fishermen, the landings of wild-caught bivalves of the northeastern United States, along with the associated economic benefits and cultural traditions of these fisheries, have drastically faded, with profound implications for the waterfront communities they supported.

EFFECTS OF FRAGMENTATION ON THE DISTRIBUTION AND BIODIVERSITY OF *MODIOLUS MODIOLUS* IN STRANGFORD LOUGH, NORTHERN IRELAND. Mahon, A.M., The Queen's University Belfast, Queen's University Marine Laboratory, 12, The Strand, Portaferry, Co. Down, Northern Ireland, UK BT22 1PF.

In the 1970's, the horse mussel *Modiolus modiolus* was reported to have formed extensive areas of biogenic reefs in Strangford Lough, Northern Ireland. These intricate structures provided refuges for many sessile and mobile fauna proving highly diverse with records of over 300 species within the reef matrix and substrate below. *M. modiolus* was therefore a major feature which contributed to Strangford Lough's designation as a Special Area of Conservation (SAC). However, in the 1990's, surveys showed that the reefs had been severely fragmented through physical disturbance. The *Modiolus* Research Restoration Project (MRRP) was initiated in 2008 with the aims of assessing the current status of *M. modiolus* and restoring the reefs back to favourable conservation status. The current status of the *M. modiolus* reefs was mapped in terms of distribution, densities and biodiversity. Potential for natural recovery as well as recovery through the use of trial restoration experiments and restoration techniques were examined. Survey results have indicated a substantial reduction in the area occupied by *M. modiolus* reefs since the 1970's and further deterioration within the last 10 years. The numbers of associated species have also decreased, such as a previously co-dominant bivalve species *Chlamys varia* and the Queen scallop *Aequpectin opercularis*. In turn, sponges such as *Spanioplan armaturum* and *Iophon hyndmani* which were common on these species are also greatly reduced along with some tunicates and polychaetes. This study has shown that fragmentation of a *M. modiolus* reef ecosystem will most likely lead to an overall reduction in biodiversity.

WHAT'S IN A NAME? A SUMMARY OF THE HISTORY OF THE OLYMPIA OYSTER (*OSTREA LURIDA* CARPENTER 1864) ON THE WEST COAST OF THE UNITED STATES, AND RECENT ADVANCES IN RESEARCH AND RESTORATION. McGraw, K.A., NOAA Restoration Center, F/HC-3 SSMC-3 Room 15862, 1315 East-West Highway, Silver Spring, MD, USA 20910.

The Olympia oyster, *Ostrea lurida*, was once very abundant in estuaries along the West Coast of the United States, serving as ecologically important habitat, as well as a food source for Native American tribes for millennia. The only native oyster species along the West Coast, it was greatly overexploited during the California gold rush and afterwards, resulting in a general collapse of the commercial fishery. One brief exception was the culture of the Olympia oyster in Puget Sound, WA, which ushered in several decades of successful oyster production; however, other factors, including pollution from pulp mills, sedimentation from timber harvests, urbanization , and introduction of the Pacific oyster (*Crassostrea gigas* Thunberg, 1793), led to a decline in native oyster populations there. Currently only a few growers culture and harvest very small numbers of Olympia oysters for the half-shell trade. 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 incorporation of the most current scientific information into project planning and implementation has been very effective and is key to the successful recovery of the Olympia oyster on the West Coast.

THE HAWKESBURY RIVER ESTUARY – DEVASTATION AND RESURRECTION. McLeod, D., Glenlg Shellfish, 19 Russell Street, Adelaide, South Australia 5000, Australia.

This presentation describes the destruction and restoration of a locally significant oyster farming industry in eastern Australia, highlighting the impact of disease and the role of alternative, substitute species. During the early years of this decade, the Hawkesbury estuary in central New South Wales (NSW), Australia, produced around 13 - 14% of total NSW 'Sydney Rock Oyster' (*Saccostrea glomerata*) output and was the third largest contributor to State production. Then QX disease struck in 2004, and within 12 months production had plunged to zero and 4 years of stock was lost —an economic and social disaster for an industry that had flourished for over a century and a close-knit rural community, including the bankruptcy of all 23 local family-owned oyster farming businesses. Recovery and restoration has taken the form of an initial programme of environmental clean up, followed by the introduction of both QX resistant Sydney Rock Oysters and triploid Pacific oysters (*Crassaostrea gigas*). The energetic involvement of the Hawkesbury growers in the State government-led recovery programme is detailed, with the estuary showing strong signs of recovery by 2010.

OYSTERS, OIL AND DIVERSIONS: LOUISIANA'S RESPONSE TO THE DEEPWATER HORIZON OIL SPILL AND ITS POTENTIAL IMPLICATION IN FUTURE COASTAL WETLANDS RESTORATION PLANS. Melancon, E.J., Biology Department, Nicholls State University, Thibodaux, LA, USA 70301.

The Deepwater Horizon explosion and release of millions of gallons of oil into the Gulf of Mexico forced the state of Louisiana to take significant and drastic measures to protect its marshes from oiling. One of those decisions was to open all Mississippi River diversions to maximum capacity, introducing massive volumes of freshwater into the estuaries. Although those efforts to keep oil out of the marshes have generated mixed opinions on success or failure, one consequence is undeniable, the impact of the diversions on the oyster populations. Oysters have died in great num-

bers. The massive oyster mortalities due to the introduction of river water is a forecast of what may eventually occur as Louisiana moves ahead in its plans and goal of developing coastal wetlands. The state also has a goal of sustaining its fisheries while developing that plan. Can the two goals co-exist? Can local, state, and federal agencies and NGOs continue to profess the importance of creating living oyster reef for shoreline erosion control while also professing the need for the introductions of massive volumes of freshwater into the estuaries through diversions? These and other questions are addressed.

OYSTER REEF DEVELOPMENT ON CONSTRUCTED STRUCTURES USED FOR SHORELINE EROSION CONTROL IN LAKE BARRE, LOUISIANA, USA. Melancon, E.J. (1), M.A. Linson (2), G.P. Curole (3), (1,2) Nicholls State University, Biology Department, Thibodaux, Louisiana, USA 70301, (3) Office of Coastal Protection and Restoration, Thibodaux Field Office, 1440 Tiger Drive, Suite B, Thibodaux, LA, USA 70301.

300 linear feet of each of three constructed erosion control structures, Gabion Mats, A-Jacks and ReefBlks, were placed along a fast-eroding *Spartina alterniflora* shoreline to assess their ability to develop a living oyster reef to eventually take over erosion control functions as the structures inevitably deteriorate. The project has 8 years of monitoring life and we present the first two years of oyster reef development results and one year of erosion control information. After two years, oyster populations have become well established on all three structure types. Oyster population variability within and between structure types is due primarily to its shape, vertical relief, or lack of it, and tidal inundation frequency. Oyster population link frequencies by the second winter were approaching similarity to natural intertidal populations. Preliminary estimates of oyster densities per square meter by the second winter ranged from 2 to 4 times that of natural intertidal oyster populations. The greatest impediment to oyster reef development may be due to the fouling hooked mussel, *Ischadium recurvum*. The mussel attached in great numbers by the second year and has literally coated the surface of oyster populations. The initial post-construction shoreline analysis suggests that the Gabion Mat, ReefBlk, and A-Jack structures are lowering shoreline erosion rates at all reaches. The average shoreline erosion rate behind the structures was only -2 ft/yr (-0.6 m/yr), significantly less than the -16 ft/yr (-5 m/yr) in the pre-construction interval.

EXPLORING THE ROLE OF RIBBED MUSSELS (*GEUKENSIA DEMISSA*) IN SALTMARSH STABILIZATION. Moody, J. (1), D. Bushek (2), D. Kreeger (3), (1,2) Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ, USA 08349, (2) Partnership for the Delaware Estuary, One Riverwalk Plaza, 110 South Poplar Street, Suite 202, Wilmington, DE, USA 19801.

Marsh erosion is a major concern for estuaries as increasing storm severity, boat wakes, and sea-level rise threaten shorelines. The ribbed mussel *Geukensia demissa* is a prominent component of the Delaware Bay estuarine ecosystem, where it is typically associated with the lower edge of marshlands in close association with the marsh grass *Spartina alterniflora*. The deposition of nutrient-rich feces from these mussels enhances production of *S. alterniflora*, creating levees along the marsh edge which trap sediments, enhancing vertical accretion. Lateral inland marsh movement threatens the ability of the marsh to create these natural levees. The physical structure formed by aggregations of ribbed mussels may provide stability to the marsh edge, but there is a dearth of information concerning the relationship between *G. demissa* and coastal erosion. To test the hypothesis that *salt marsh shoreline erosion decreases as mussel density increases within an energy regime*, mussel demographics, mass transport potential, and annual lateral shoreline movement were quantified along shorelines of the Delaware Estuary (n = 12 sites). The potential relationships between these factors are being evaluated within and among study sites. The aim is to characterize demographics of ribbed mussels that stabilize shorelines under different energetic conditions. Results will help determine the potential role of using marsh mussels as a living shoreline fortification to reduce coastal erosion and permit natural accretion of the marsh surface.

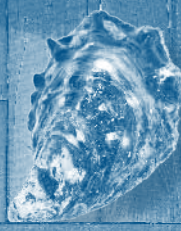
RESTORING SHELLFISH TO IMPROVE OUR COASTS, SUPPORT GREEN JOBS, AND BOOST THE ECONOMY.
Morlock, S., NOAA Restoration Center, 1315 East-West Highway, Silver Spring, MD, USA 20910.

Since 1996, NOAA's Community-based Restoration Program has funded more than 1,500 on-the-ground restoration projects throughout the nation. These funds support a wide range of restoration projects, large and small, for a variety of habitat types. Restoration of bivalve shellfish reefs and beds is an important facet of this program, and is gaining momentum as novel restoration approaches are developed and communities recognize the valuable ecosystem services provided by shellfish in addition to their role as a fishery resource. NOAA is working with many partners to implement and expand shellfish restoration projects, as well as to conduct strategic planning to optimize restoration and provide outreach on the importance of these efforts. In 2009, NOAA received funding through the American Recovery and Reinvestment Act to stimulate the economy and invest in green jobs through marine and coastal habitat restoration, including shellfish restoration. Healthy coastal habitats are critical to the recovery and sustainability of the U.S. economy. Coastal areas generate more than 28 million jobs in the United States. Commercial and recreational fishing employs 1.5 million people and contributes $111 billion to the nation's economy. This presentation discusses the shellfish restoration funding opportunities through NOAA and our partners; accomplishments NOAA and partners have achieved with shellfish restoration since 1996; and how we are building on those efforts and lessons learned to implement larger-scale shellfish restoration with Recovery Act funding to restore our coasts, economy, and communities.

BLACK-LIP PEARL OYSTER (*PINCTADA MARGARITIFERA*) SPAT STOCKING DENSITIES AT CMI ARRAK OYSTER HATCHERY IN MAJURO, MARSHALL ISLANDS.
Ozbay, G. (1), A. Jackson (2), T. Aini (3), (1) Delaware State University, College of Agriculture and Related Sciences, Dover, DE, USA 19901, (2) Delaware Department of Natural Resources and Environmental Control, Aquatic Resources Education Center, Smyrna, DE, USA, 19977, (3) College of Marshall Islands, Cooperative Research and Extension, Majuro, MH, RMI, 96960.

The Black-lip pearl oyster (*P. margaritifera*) is native to the lagoons and shallow coastal waters (~1 to 40 meters) of the Marshall Islands. The lack of a reliable supply of spat is the main hurdle to the development of the local pearl industry. Although it is possible to raise spat in the lagoons, mortality rates tend to be excessive and growth rates are highly variable. Hatchery rearing can offer consistent results but requires resources and trained personnel. Therefore, it is important to determine the optimal densities at which spat can be raised in the hatchery to make best use of those resources. This study was conducted at the Arrak Campus of the College of Marshall Islands to investigate larval growth and survival under three different stocking densities (500, 1,000, and 2,000 larvae per tank) in simple rearing tanks (52" x 28" x 12", 71 gallons). Oyster larvae were collected at 3 weeks old (0.47±0.069 mm) from the initial larval tanks using a 53 µm mesh size filter. Densities were determined using three 2 ml sub-samples and the larvae were stocked into the nine rearing tanks using a randomized block design. The oysters were fed with freshly cultured micro-algal mixtures (*Isochrysis galbana*, *Pavlova lutheri*, *Chaetocerus muelleri*, and *Tetraselmis suecii*) according to the three density treatments and depending on the growth stage. At 6.5 weeks, the average spat sizes in the three different stocking densities (500, 1,000, and 2,000 oysters) were, respectively, 2.29±0.868, 2.52±0.746, and 2.41±0.791 mm. At 2 months, average sizes were 3.49±1.475, 2.94±0.948, and 2.69±0.803 mm and survival rates were 60.6±3.86%, 51.03±10.70%, and 75.32±30.14%, respectively. Oyster growth after 2 months was higher in tanks stocked with 500 oysters, while moderate survival was obtained at this stocking density. Tanks stocked with 2,000 oysters gave the lowest growth but higher survival. The only significant difference ($P \leq 0.05$) noted was oyster growth in the 500 tanks after 2 months. Although we obtained lower growth rates than some of the previous studies utilizing optimal microalgal densities, our survival was much higher for all treatments. Even though continuous monitoring and other technological advantages were not available, the careful daily maintenance and a regular supply of quality microalgal diets would seem to enable the CMI Hatchery to achieve a reliable supply of oyster spat. Careful management and well-trained personnel are likely to be more important than high-end equipment to the success of their program.

Oral and Poster Presentation Abstracts



PRELIMINARY STUDY INVESTIGATING NON-SPECIFIC IMMUNE RESPONSE IN HATCHERY RAISED WILD BLACK-LIP PEARL OYSTER (*PINCTADA MARGARITIFERA*). Ozbay, G., Delaware State University, College of Agriculture and Related Sciences, Dover, DE, USA 19901.

This preliminary study was conducted at the Arrak Campus of the College of Marshall Islands to investigate post-nucleation (pearl nucleus implantation) non-specific immune response in hatchery raised and wild black-lip pearl oysters. Thirty one wild pearl oysters and thirty one hatchery-raised oysters were collected from Majuro lagoon. Wild pearl oysters collected in this study were slightly larger than the hatchery raised oysters. Six oysters from each group were used as controls without application of surgical pre-nucleation procedure. Hemocyte samples were collected from the abductor muscle of each oyster pre-nucleation. Nucleation of the oysters was completed with small freshwater pearls as the nuclei and mantle tissue from a donor oyster. Oysters were then monitored for two weeks for nuclei rejection and general health. After two weeks, hemocyte samples were again collected. Hemocyte counts were initially attempted using an educational microscope but there were suspect variations in the counts. Therefore, hemocyte samples were held at -80°C for additional testing. Using a Rhino Vet 360 Refractometer, total blood protein concentrations were obtained. Nucleation by an untrained hand resulted in high mortality and low nucleus retention: 26 oysters survived; 15 hatchery-raised, 7 of which rejected their nuclei, and 11 wild, 5 rejected nuclei. Oyster total blood protein results showed slight increase in overall total protein concentration indicating a potential increase its stress response. While both oyster groups showed an increase in levels of total blood protein, wild oysters had a slightly larger response (Δ 0.05g/100ml). This study provided limited information on the non-specific immune functions of oysters used in this study. Future study using larger sample sizes along with trained technical support and testing tools (i.e. q-PCR) is suggested for conclusive decision on non-specific immune response of hatchery raised and wild oysters.

OYSTER (*CRASSOSTREA VIRGINICA*) MONITORING IN THE ST. LUCIE ESTUARY. Parker, M.L. (1), S.P. Geiger (2), (1,2) Fish and Wildlife Research Institute, 100 8th Avenue SE, St. Petersburg, FL, USA 33701.

In Florida, oysters occur in nearly all estuarine and nearshore waters exhibiting suitable salinity regimes. Along the Atlantic coast, oysters are generally confined within bays and lagoons such as the St. Lucie estuary. Those waters, and other coastal waters in southeast Florida, have experienced altered patterns of water delivery and quality as a result of water management practices. In particular, the redirection of freshwater out of inland basins and into coastal waters has altered both the timing and range of salinity variation in these waters. Because of their wide distribution, historical context, and essential habitat value, the Eastern oyster (*Crassostrea virginica*) has been chosen as a target species for monitoring the success of the Comprehensive Everglades Restoration Plan (CERP). Oyster monitoring in the St. Lucie estuary was initiated in early 2005 and included the following parameters: oyster distribution and abundance, reproductive development, recruitment, and prevalence and intensity of the oyster disease *Perkinsus marinus* (dermo). These biological measures, along with several water quality parameters, were monitored at nine stations (or reefs) within the St. Lucie estuary. Results indicate that when salinities fell within suitable ranges, oysters in the estuary exhibited characteristics typical of a healthy Florida oyster population. However, anthropogenic events, such as prolonged freshwater releases into the estuary to manage inland water levels, often forced salinity values below tolerable ranges in the estuary. Oyster populations were negatively impacted by these low-salinity events and in extreme cases these events resulted in the complete loss of live oysters from all sampled stations in the estuary.

SEVERAL LARGE OR SEVERAL (MORE) SMALL: DESIGNING MARINE RESERVE NETWORKS FOR OYSTER RESTORATION. Puckett, B.J. (1), D.B. Eggleston (2), (1,2) Center for Marine Sciences and Technology, N.C. State University, NC, USA 28557.

Marine reserve networks are a potentially powerful management tool for restoring populations, such as Eastern oyster (*Crassostrea virginica*); however, the design of reserve networks within the single large or several small (SLOSS) debate remains unclear. We integrated demographics and larval connectivity of an oyster reserve network in Pamlico Sound, NC, within a metapopulation framework to (1) identify source and sink reserves, (2) determine the potential for network persistence (i.e., $\lambda \geq 1$), and (3) evaluate the tradeoffs of increasing reserve size or number on network connectivity. Mark-recapture studies, fecundity analyses, and larval dispersal simulations were conducted to parameterize a spatially-explicit metapopulation model of the existing network and assess design strategies. The relative contribution of reserves to the network (λ_C) ranged from 0.6 to 15.1, indicating the presence of "source" and "sink" reserves. The intrinsic growth rate of the existing reserve network (λ) was 0.7 ± 0.1 due, primarily, to limited network connectivity. Increasing the number of reserves by 2 and 4 times increased network connectivity by 80-90% relative to doubling or quadrupling the area of existing reserves. These results suggest that while the oyster reserve network in Pamlico Sound is not currently self-sustaining, increasing the number, as opposed to size, of reserves within the network may be a more effective strategy to improve network connectivity.

TIMING IS EVERYTHING: THE COMPLEXITIES OF OPERATING AN OYSTER HATCHERY. Radcliffe, M.W. (1), R. Carey (2), L.M. Guy (3), C. Abbott (4), S.T. Alexander (5), J. Baynard (6), E.A. Roache (7), E. Vlahovich (8), S.M. Weschler (9), D.W. Meritt (10), (1,2,3,4,5,6,7,8,9,10) University of Maryland Center for Environmental Science Horn Point Laboratory, P.O. Box 775, Cambridge, MD, USA 21613.

Successful operation of an oyster hatchery involves a series of complicated but related components each with their own specific requirements. Much has been written about how to accomplish these individual tasks but little has been written about the importance of insuring that those tasks are performed at the right time. Failure to achieve this will result in a reduced level of production. This paper divides these tasks into three broad general categories: algal production, larval production, and spat production and deployment and comments on ways to insure proper coordination. Larval production incorporates broodstock collection, conditioning, and spawning as well as the actual rearing of oyster larvae. In most hatcheries it also includes some sort of settlement system for the production of oyster spat. Algal production, an often underemphasized component of any productive hatchery, consists of stock culture maintenance, mass algal culture, and larval feeding. Spat production and deployment techniques may vary but all include some sort of settlement system whereby larval oysters are allowed to metamorphose into spat and ultimately deployed to some sort of grow-out system. Each of these three components requires different equipment and techniques in order to be successful. This paper describes both the temporal and spatial requirements for basic oyster hatchery operation and discusses factors important in their coordination.

MAPPING THE EFFECTS OF THE HORN POINT OYSTER HATCHERY: USING A PRODUCTION FACILITY TO INFLUENCE OYSTER PRODUCTION AND RESTORATION. Roache, E.A. (1), C. Abbott (2), S.T. Alexander (3), J. Baynard (4), R. Carey (5), L.M. Guy (6), M.W. Radcliffe (7), E. Vlahovich (8), S.M. Weschler (9), D.W. Meritt (10), (1,2,3,4,5,6,7,8,9,10) University of Maryland Center for Environmental Science Horn Point Laboratory, P.O. Box 775, Cambridge, MD, USA 21613.

From New England to the Gulf of Mexico, the University of Maryland's Center for Environmental Science Oyster Hatchery located at Horn Point has greatly affected oyster aquaculture and restoration throughout the East Coast.

This state of the art facility has been at the forefront of oyster aquaculture since the mid 1990's, steadily improving oyster rearing techniques to reach optimum spat production. Although spat are primarily used in a cooperative oyster restoration strategy, the HPL Oyster hatchery also provides larvae, spat on shell, and expertise for use in research, demonstration, outreach, educational projects, and individuals and groups interested in private aquaculture ventures. These cooperative acts have sparked an interest throughout the public and its representatives of the importance of re-establishing healthy oyster populations. By doing so, it has created a future for our program and broadened oyster restoration across the Mid-Atlantic. This paper describes the potential span of influence that one accommodating facility may have on the surrounding area and highlights successful examples of how beneficial cooperative projects can be.

SCOPE FOR THE RESTORATION OF BIOGENIC REEFS OF *MODIOLUS MODIOLUS* IN STRANGFORD LOUGH, NORTHERN IRELAND: MAKING DREAMS COME TRUE. Roberts, D. (1), L. Allcock (2), J. Fariñas (3), E. Gorman (4), C. Maggs (5), A. Mahon (6), D. Smyth (7), E. Strain (8), J. Strong (9), (1) Queen's University, Biological Sciences, Belfast, Northern Ireland, UK BT9 7BL, (2) Martin Ryan Institute, University of Galway, Galway, Ireland, UK G 1, (3,4) Queen's University Marine Laboratory, 12, The Strand, Portaferry, Northern Ireland, UK BT22 1PF, (5) Queen's University, Biological Sciences, Belfast, Northern Ireland, UK BT9 7BL, (6,7) Queen's University Marine Laboratory, 12, The Strand, Portaferry, Northern Ireland, UK BT22 1PF, (8) Queen's University, Biological Sciences, Belfast, Northern Ireland, UK BT9 7BL, (9) AFBINI, Newforge Lane, Belfast, Northern Ireland, UK BT9 5PX.

A major feature for listing Strangford Lough, Northern Ireland, as a Special Area of Conservation (SAC) under the EC Habitats Directive is the sublittoral *Modiolus modiolus* biogenic reefs. Recent surveys indicated a decline in these reef communities. The Northern Ireland Department of Agriculture and Rural Development (DARD) and the Department of Environment (DOE) approved a *Modiolus* Biogenic Reef Restoration Plan in 2005. Short-term elements of the plan were to map and protect remaining reefs and assess whether conditions were favorable for restoration using pilot scale translocation experiments. The medium term objective is to monitor whether natural recovery is occurring and the long-term objective is to restore the reefs. However, because horse mussels are long-lived, recovery will take time —there is no quick fix. A *Modiolus* Restoration Research Group, funded jointly by DARD and DOE, was established by Queen's University in 2008 to monitor the mussels and undertake research to provide recommendations for the ultimate objective of reef restoration. The Group will report in March 2011. Progress can be followed at http://www.qub.ac.uk/research-centres/ModiolusRestorationResearchGroup. Key outputs from the research group to date have been to establish: 1) distributional maps for use by the departments to protect remaining reefs; 2) the 'quality' of remaining reefs in terms of biodiversity and mussel recruitment; 3) a hatchery to culture seed mussels for restoration experiments; and 4) an experimental reef where restoration trials are taking place. The establishment of the experimental reef in March of this year has been particularly exciting as mussels trans-located from poor sites to the reef are showing clear signs of recovery. This experimental site is unique internationally; the only equivalent reefs are those in the USA used to re-establish native American oysters.

ASSESSMENT OF EASTERN OYSTERS, *CRASSOSTREA VIRGINICA*, AT AN ENVIRONMENTAL ENHANCEMENT PROJECT AREA IN LAKE WORTH LAGOON, FLORIDA. Scarpa, J. (1), S.E. Laramore (2), (1,2) Harbor Branch Oceanographic Institute at Florida Atlantic University, Aquaculture and Stock Enhancement Program, 5600 US Hwy 1 North, Fort Pierce, FL, USA 34946.

Eastern oysters, *Crassostrea virginica*, at an environmental enhancement project area (Snook Islands [SI], limestone riprap) in Lake Worth Lagoon, Florida, were compared to oysters at two natural beds (Ibis Isle [IbIs] and MacArthur Park [MP]) from March 2008 to February 2010. Oysters were sampled monthly for condition index, reproduction,

recruitment, growth, and disease status; density was assessed semiannually. Average live oyster density in the fall of year one at SI (54/m^2) was similar to MP (42/m^2), but lower than IbIs (291/m^2). In year two SI was similar (186/m^2) to both natural sites (MP=132/m^2, IbIs=208/m^2). Condition index (CI) of oysters varied during the monitoring period (1.21-4.24), but the mean CI (±s.d.) for the entire period was similar between sites (SI=2.98±0.55, MP=2.91±0.71, IbIs=2.54±0.47). Bi-modal reproduction (late-spring/early-summer and fall) was evident at SI in both years, but only in year one at MP and IbIs. Recruitment was monitored using shell strings and was highest overall at SI (10.4±16.3 spat/shell) compared to IbIs (3.9±9.0 spat/shell) and MP (0.8±1.0 spat/shell). Final shell height of recruited juveniles was less at SI (34 mm) compared to the IbIs (51 mm) and MP (46 mm) in year one, but similar in year two (SI=37; IbIs=38; MP=41 mm). Mean Dermo intensity for the entire period was low (SI=0.9±0.7, IbIs=1.0±1.0, MP=1.1±1.0 Mackin scale units) with an overall mean prevalence at SI of 59%, IbIs of 67% and MP of 66%. In general, oysters and oyster density at the environmental enhancement project area (SI) were comparable to the natural beds. Lake Worth Lagoon contains patches of healthy oyster populations that can be expanded by providing substrate and relying on natural recruitment.

OPTIMIZING ENHANCEMENT AND RESTORATION STRATEGIES USING COMPARISONS OF OYSTER (*CRASSOSTREA VIRGINICA*) REEF DISTRIBUTIONS MAPPED OVER A MULTI-DECADAL TIMESCALE IN SOUTH CAROLINA, USA. Schulte, K.E. (1), W.D. Anderson (2), G.M. Yianopoulos (3), P.R. Kingsley-Smith (4), R.F. Van Dolah (5), (1,2,3,4,5) S.C. Department of Natural Resources, Marine Resources Division, P.O. Box 12559, Charleston, South Carolina, USA 29422.

In South Carolina, extensive tidal creeks and intertidal flats support ecologically- and economically-important oyster populations. Effective restoration and sustainable management of these harvested oyster populations demand accurate information on their current and historic areal extent and distribution. Over the past century, three major oyster mapping efforts have been undertaken. In the 1890s, survey maps of reef locations and transect lengths were compiled, while the mid-1980s ground assessment included reef area and additional attributes. Since 2003, the SCDNR, in collaboration with the NOAA CSC and USGS, has used geo-rectified multispectral ¼ m resolution digital aerial imagery and GIS applications to conduct a state-wide assessment of the distribution and areal extent of South Carolina's intertidal oyster reefs. The accuracy of this latest assessment is being further enhanced using high resolution (20 megapixel), low altitude (< 400ft) imagery captured from a helicopter. Here we present comparisons between 1980s and contemporary oyster distribution maps for three areas in South Carolina to illustrate the effectiveness of this approach for identifying changes in oyster distribution. Areas of loss present potential targets for habitat restoration through the addition of new substrate. Changes in oyster reef distribution were clearly visible and in many cases changes in the areal extent of reefs could be quantified. The latest maps, however, only contain reliable information on oyster reef condition for areas that have been flown by helicopter or visited by boat, and reef condition can change yearly. With the increasing availability of high quality aerial imagery, the possibility exists to identify changes in oyster density and vertical relief. Maintaining an up-to-date statewide database for reef distribution and condition is a goal for the future.

RESTORATION OF NATIVE OYSTER (*CRASSOSTREA GRYPHOIDES*) OF PAKISTAN. Siddiqui, G. (1), Z. Ayub (2), (1,2) Centre of Excellence in Marine Biology, University of Karachi, Karachi, Sindh, Pakistan 75270.

Pakistan is a maritime country, bordering the northern Arabian Sea with a coastline of about 1000 km. The coast is semi-arid with very little mangrove-covered area. It is adversely affected by geomorphological changes caused by oceanic currents, waves and tidal oscillation, and strong winds during monsoon season at the land-water interface. As

a result, shoreline erosion/accretion brings sand into the creeks and increases the turbidity, which reduces primary productivity, affecting benthic filter feeders such as oyster, mussels and clams. Furthermore, upsloping, high salinities, presence of oxygen minimum zone, shifting of the Indus Delta eastward, and man-made stresses have added to the problem. Nine species of edible oysters, representing genus *Crassostrea*, *Saccostrea* and *Ostrea* are known to occur in the coastal waters of Pakistan. The species of edible oyster *Crassostrea* are presently almost at the verge of extinction. There is no commercial exploitation of these oysters in the country or mass mortality due to any disease. The spatfall of these oysters is very low, consequently the natural development of new stocks is highly unlikely in future. There is considerable information on the reproductive patterns and the spawning seasons of Pakistani oysters. Thus, the restoration of self-sustaining oyster populations can be based upon hatchery production, targeting on maintaining existing biodiversity as much as possible. Therefore, a restoration project is designed towards initiating baseline surveys to establish the status of *Crassostrea gryphoides* population and recruitment and developing techniques for rearing of oysters and their spat on an experimental scale in the pilot hatchery.

EXPERIMENTAL RESTORATION OF BIOGENIC REEFS OF THE HORSE MUSSEL, *MODIOLUS MODIOLUS*.
Smyth, D., Queen's University Belfast, School of Biological Sciences, 97a Lisburn Road, Belfast, County Antrim, Northern Ireland, UK BT9 7BA.

Sub-littoral reefs of the horse mussel, *Modiolus modiolus*, were one of the main features used to establish the designation of Strangford Lough, Northern Ireland, as a Marine Nature Reserve. In the 1990s it was discovered that the reefs had experienced significant damage. As a result, a programme of restoration research was initiated in February 2008 by the statutory authorities; the aims are focused on developing techniques to restore the reef feature back to a Favourable Conservation Status. A common feature of damaged bivalve reefs is the loss of relief which, if restored, can enhance recovery of reef structure and function (Schulte *et al*., 2009). Shell cultch has been used over many years to enhance oyster settlement, particularly in the USA where it is now common practice to deploy cultch in raised mounds. Based on this model an experiment has been established in an area of damaged horse mussel reefs to test the hypothesis that mussels, like oysters, on elevated reefs perform better than those that are not elevated. This poster describes the process involved in setting up the experiment from gaining statutory permissions to the deployment of 10 tonnes of aged *Pecten maximus* shell on the approved restoration site and the translocation of 6,000 *M. modiolus*. Initial survey work after 5 months has shown the translocated mussels to be well established and in apparent good health with the beginnings of an extensive reef matrix and associated fauna.

DEVELOPING SUSTAINABLE OYSTER BEDS AND EXPANSION WITHOUT THE USE OF CHEMICALS.
Stavrum, K.M., Independent Shellfish Growers of Washington State, P.O. Box 82, Nahcotta, WA, USA 98637.

This poster will present the damage caused by the use of chemicals and show side-by-side comparisons with growth from no chemicals and nature compared to the death and destruction of oysters right beside one of our members. The methods used have had tremendous results in luring spat back for a natural set. These studies have been done over a 5-year period and are used by all 327 of the members of the Independent Shellfish Growers of Washington State. The author also has created a crop of natural set Olympic oysters using these methods.

***IN SITU* SETTING OF HATCHERY-REARED EYED LARVAE ON A RESTORED *CRASSOSTREA VIRGINICA* BAR.** Steppe, C.N. (1), S.R. Westby (2), D. Johannes (3), P.W. Tagan (4), (1) U.S. Naval Academy, Oceanography Department, 572C Holloway Road, Annapolis, MD, USA 21402, (2,3) Chesapeake Bay Foundation, 6 Herndon Avenue, Annapolis, MD, USA 21403, (4) U.S. Naval Academy, Oceanography Department, 572C Holloway Road, Annapolis, MD, USA 21402.

Since the late 1990's numerous oyster bars have been built in Chesapeake Bay to both improve water quality and enhance the *Crassostrea virginica* fishery. In areas in which natural spat set may be limited by salinity or spawning stock, restoration sites have been seeded with spat-on-shell, made by setting hatchery-reared eyed larvae onto shells in tanks. However, transporting shell to hatcheries and spat-on-shell to restoration sites proves both expensive and logistically challenging, suggesting the need for an additional restoration tool that requires less materials handling. In this study we demonstrated the feasibility of setting larvae *in situ* by surrounding the reef with a flexible temporary structure to prevent larval loss from the target site. In three replicate trials, hatchery-reared eyed larvae were added to an enclosure that surrounded a newly-constructed reef in Blackwalnut Creek (Annapolis, Maryland USA). Larvae were allowed approximately 72 hours to settle, and physical parameters were measured every 15 minutes for the duration of the study. Oyster settlement in the enclosed reef was then compared with spat set in concurrent trials that included both a traditional tank located at the study site, as well as upstream and downstream controls. Preliminary results suggest that this method may be a plausible alternative to traditional spat-on-shell setting procedures at appropriate restoration sites. Potential avenues for scaling up the protocol and using the method for seeding other reef substrata are discussed.

OYSTER CASTLES: A NEW TOOL FOR SITE EVALUATION AND INTERTIDAL OYSTER REEF HABITAT RESTORATION AND ENHANCEMENT IN MULTIPLE U.S. EAST COAST STATES. Stone, B.W. (1), P. Kingsley-Smith (2), B. Lusk (3), B. Truitt (4), J. Brown (5), M. Faherty (6), G. Lorber (7), (1,2) S.C. Department of Natural Resources, 217 Ft. Johnson Road, Charleston, SC, USA 29422, (3,4) The Nature Conservancy, 11332 Brownsville Road, Box 158, Nassawadox, VA, USA 23413, (5) The Nature Conservancy, 960 Morrison Drive Suite 100, Charleston, SC, USA 29413, (6) Mass Audubon/Wellfleet Bay Wildlife Sanctuary, P.O. Box 236, State Highway Route 6, South Wellfleet, MA, USA 02663, (7) Allied Concrete Company, 1000 Harris Street, Charlottesville, VA, USA 22903.

Declining Eastern oyster (*Crassostrea virginica*) populations and habitat loss have prompted oyster restoration and enhancement efforts in many Atlantic and Gulf Coast states. South Carolina oyster populations produce high levels of natural recruitment such that the provision of suitable substrate has been extremely effective in creating new oyster reef habitat. Traditional planting of natural oyster shell in recent years has, however, become increasingly difficult due to increased demand and costs, creating considerable interest in the viability of alternative substrates to support oyster recruitment. Oyster castles, cradle-to-cradle certified concrete structures that generate high levels of habitat complexity, are currently being used in multiple US East Coast states (Virginia, South Carolina and Massachusetts) as a means of small-scale oyster reef habitat enhancement, as an assessment tool for trouble-shooting unsuccessful restoration efforts, and for evaluating sites for future enhancement and restoration. Oyster castles were first deployed on the Eastern Shore Peninsula, Virginia, in 2008. Additional Virginia sites were established in 2009 and 2010 (2500 castles total in Virginia to date) and 500 oyster castles were also deployed in Wellfleet Bay, Massachusetts in 2009. In South Carolina, 8 individual arrays of 13 oyster castles were deployed at 3 field sites in July 2009 with the help of volunteers, including local fishermen, under the guidance of SCDNR and TNC staff. Oyster survival and growth data, the impacts of the oyster castles on shoreline erosion and the comparative development of smooth cordgrass (*Spartina alterniflora*) in experimental vs. control plots will be presented for the SC oyster castles. The success of current oyster castle projects together with future applications for this alternative substrate will also be discussed.

FLORIDA CLAM CULTURE INDUSTRY'S RESPONSE TO THE DEEPWATER HORIZON OIL SPILL. Sturmer, L.N., University of Florida, P.O. Box 89, Cedar Key, FL, USA 32625.

In response to the threat of the Deepwater Horizon oil spill, the clam farming industry in Florida, located primarily along the Gulf of Mexico coast, prepared for potential impacts. From Day 14, members of the state task force met weekly with state agency and university representatives via conference call to discuss plans and concerns. Clam farmers also participated in area contingency planning sessions with Unified Command. Aquaculture leases were identified as environmentally sensitive areas and given a top tier designation for protection. Alternative countermeasures were identified with the US Coast Guard to protect open-water leases in lieu of traditional booming strategies. The state shellfish agency (Department of Agriculture and Consumer Services, DACS) collected pre-impact samples for baseline characteristics and developed an emergency regulatory response should hydrocarbons from the oil spill reach Florida estuaries. For reopening criteria, it was determined that sensory evaluations would be coupled with analytical tests of affected shellfish for contaminants. As of Day 126, none of the shellfish harvesting areas in Florida were closed due to the presence of oil products. The industry's biggest challenge was ensuring buyers and consumers that shellfish were safe. Misinformation about conditions in Gulf waters unnecessarily affected the industry. In response, a *Florida Gulf Safe* promotional campaign was initiated by the DACS Division of Marketing, which featured a seafood hotline with daily reports. HOW (Harvest from Open Waters) training conducted by University of Florida faculty for wholesalers and processors provided additional evidence of the safety of Gulf seafood. The program utilized a Hazard Analysis and Critical Control Point (HACCP) approach with sensory and analytical screening for verification. Program results and lessons learned by the clam culture industry during this disaster will be presented.

MARKETING A SUCCESSFUL OYSTER SHELL RECYCLING PROGRAM. Varnam, S.M. (1), S. Taylor (2), G. Allen (3), L. Henry (4), C. Braddy (5), (1) North Carolina Division of Marine Fisheries, P.O. Box 769, 3441 Arendell Street, Morehead City, North Carolina, USA 28557, (2) North Carolina Division of Marine Fisheries, 127 Cardinal Drive, Wilmington, NC, USA 28405, (3) North Carolina Division of Marine Fisheries, 1021 Driftwood Drive, Manteo, NC, USA 27954, (4) North Carolina Division of Marine Fisheries, 1107 Highway 64 East, Columbia, NC, USA 27925, (5) North Carolina Division of Marine Fisheries, P.O. Box 1507, Washington Square Mall, Washington, NC, USA 27889.

Since its inception in 2003, North Carolina's Oyster Shell Recycling Program has grown to be a successful oyster shell recycling effort on the East Coast, boasting 126 public drop-off sites, 74 restaurant participants and 40 volunteers, covering 27 counties in the state. More than 110,053 bushels of shell over the past 7 years have been donated for use in state oyster rehabilitation efforts. The majority of the shell collected to date comes from restaurants (56.8%). Public contributions (37%), and festivals (6.3%) have significantly increased in recent years. The state's successful recycling program can be attributed to collaborative efforts between the NC Division of Marine Fisheries, the NC General Assembly (funding and recently passed laws: GS 105-130.48 tax credit; 130A-309.10(f) landfill ban; and GS 136-123(b) beautification projects ban), county government solid waste and health departments, private waste companies, restaurants, the public, and volunteers who help collect the shells from drop-off sites and restaurants. Marketing this joint effort creates partnerships among many different agencies and entities and engages citizens, increasing the awareness of the oyster shell recycling program. In return this process increases the volume of shell collected, enhances public and restaurant awareness and participation, and fosters volunteer support and collaboration between government agencies. Media outreach plays a key role as well. Promoting a program like this benefits all users. It's a program that everyone can wrap their fingers around. It not only provides the additional shell material for oyster habitat restoration projects, but increases fish habitat, reduces solid waste in landfills, and enhances public awareness of the importance of a healthy oyster population to the state's marine and estuarine resources.

THE MOBILE BAY OYSTER GARDENING PROGRAM: BRINGING THE REEF TO THE PEOPLE. Waters, P.J., Alabama Cooperative Extension System/MS-AL Sea Grant, 4170 Commanders Drive, Mobile, AL, USA 36615.

The Mobile Bay Oyster Gardening Program (MBOGP) is a volunteer-driven program focusing on education, restoration/enhancement, and research. Gardeners are waterfront property owners who have an interest not only in the culinary attributes of the Eastern oyster, *Crassostrea virginica*, but also its ecological value. Each Gardener tends four (4) gardens, and produces an average of 1,000 oysters for restoration each season. Weekly maintenance expectations, predator recognition, and introduction to ongoing regional research are addressed in training workshops prior to each season. Communication with Gardeners, Adopters, and Sponsors is facilitated through the monthly MBOGP Newsletter, the MBOGP website (www.oystergardening.org), and site visits. Area high school marine biology classes work closely with MBOGP, providing students hands-on opportunities in their communities. A new Adopt a Garden program initiated for the 2010 season has created oyster gardening opportunities for stakeholders and students who live away from the coast, but recognize the critical role of the oyster in the Bay's ecology. The adoption fee supports one garden (250 oysters) for one season for which the Adopter receives all the benefits (newsletters, speakers, tours, etc.) afforded a Gardener or Sponsor. In spite of the oil spill disaster, MBOGP decided to continue preparations for the 2010 season, adopting modifications to the maintenance schedule. The modifications would allow continued maintenance while eliminating direct contact with the oysters by Gardeners in the event their area fell under advisories issued by the Alabama Department of Public Health. MBOGP was extremely fortunate that less than a week after Gardeners picked up their spat, the well cap was secured and a minimum amount of weathered oil penetrated the Bay.

NEKTON UTILIZATION OF CREATED OYSTER REEFS IN INTERTIDAL AND SHALLOW SUBTIDAL HABITATS OF NORTH CAROLINA. Wilgis, T. (1), M.H. Posey (2), T. Alphin (3), (1,2,3) University of North Carolina Wilmington, Department of Biology and Marine Biology, 601 South College Road, Wilmington, NC, USA 28403.

Oysters (*Crassostrea virginica*) along the Atlantic and Gulf coasts of North America are recognized as key components of the coastal ecosystem, providing habitat for transient and resident fauna, affecting particulate concentrations in overlying waters, reducing wave energy along sensitive shorelines and influencing local biogeochemical cycling. With a decline in oysters along the Atlantic coast, there is increased attention to restoring reefs through shell planting efforts. However, the lack of long-term monitoring using standardized methodologies that target both population and ecosystem functions has been an impediment to assessing the success of many restoration projects. As part of a larger study, we compared created reefs of varying sizes and ages in intertidal and shallow subtidal habitats with natural reference reefs to assess use by nektonic organisms. We applied standardized monitoring metrics to assess created and natural reef utilization by transient, facultative, and resident nekton. Differences between created and reference reefs and the influence of reef patch design, landscape features, and reef development on nekton utilization will be discussed. The presentation will provide a comparison among different restoration designs and provide information on habitat function in a standardized form that can be compared among similar studies.

ECODYNAMIC SOLUTIONS FOR THE PROTECTION OF INTERTIDAL HABITATS: THE USE OF OYSTER REEFS. Ysebaert, T. (1), B. Walles (2), J. Dijkstra (3), M. de Vries (4), T. Bouma (5), K. Troost (6), E. van Zanten (7), P. Herman (8), A. Hibma (9), (1,2) IMARES – Institute for Marine Resources and Ecosystem Studies, P.O. Box 77, 4400 AB Yerseke, The Netherlands, (3,4) Deltares, P.O. Box 177, 2600 MH Delft, The Netherlands, (5) Netherlands Institute of Ecology (NIOO-KNAW), Centre for Estuarine and Marine Ecology, Korringaweg 7, 4401 NT Yerseke, (6) IMARES – Institute for Marine Resources and Ecosystem Studies, P.O. Box 77, 4400 AB Yerseke, The Netherlands, (7) Rijkswaterstaat Zeeland, P.O. Box 5014, 4330 KA Middeburg, The Netherlands, (8) Netherlands Institute of Ecology (NIOO-KNAW), Centre for Estuarine and Marine Ecology, Korringaweg 7, 4401 NT Yerseke, (9) Van Oord Dredging and Marine Contractors BV, P.O. Box 8574, 3009 AN Rotterdam, The Netherlands.

Coastal erosion represents a serious threat along many coastlines, and will become more serious due to human-induced changes and climate change. In the Oosterschelde (SW Netherlands), intertidal areas disappear at a fast rate after realization of the Delta works. Reduction in tidal flat area and elevation result in loss of valuable habitats and undermine the coastal defense as dikes become less protected from waves and currents. Within the innovation program Building with Nature, we investigate the use of biogenic reefs as one of the possible measures for stabilizing tidal flats in the Oosterschelde. The biogenic reef solution uses the concept of ecosystem-engineering as promising measure for sustainable coastal protection. Ecosystem engineering (= modification of abiotic environment due to biological activity) is an important mechanism in shaping estuarine landscapes. Ecosystem engineers, such as oyster reefs, influence tidal flow and wave action and, in doing so, modify patterns of sediment deposition. To establish a sustainable oyster reef, a stable substrate is required that allows for recruitment of juvenile oysters while minimizing shell loss from waves and currents. If successful, the artificial reefs will develop to a living oyster reef. Based on experiments, gabions filled with oyster shells of the Pacific oyster *Crassostrea gigas* were selected as suitable substrate. A small-scale experiment done in 2009 with reefs of 12x4 m showed promising results: (1) gabions filled with oyster shells are stable structures, (2) a reduction in erosion behind the reefs was observed and (3) settlement of oyster larvae was observed. In summer 2010 we scaled up the experiment and built three reefs of 200x10 m. A monitoring program is conducted to evaluate the ecomorphological impact of the reefs and their effectiveness to reduce erosion of intertidal areas. We present the concept and show the first results derived from the pilot experiments.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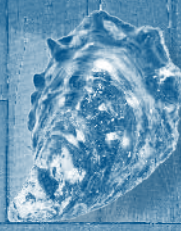

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