The 16th International Conference on Shellfish Restoration December 10-13, 2014 Charleston, SC USA

ICSR2014

Restoration in an Ever-Changing World

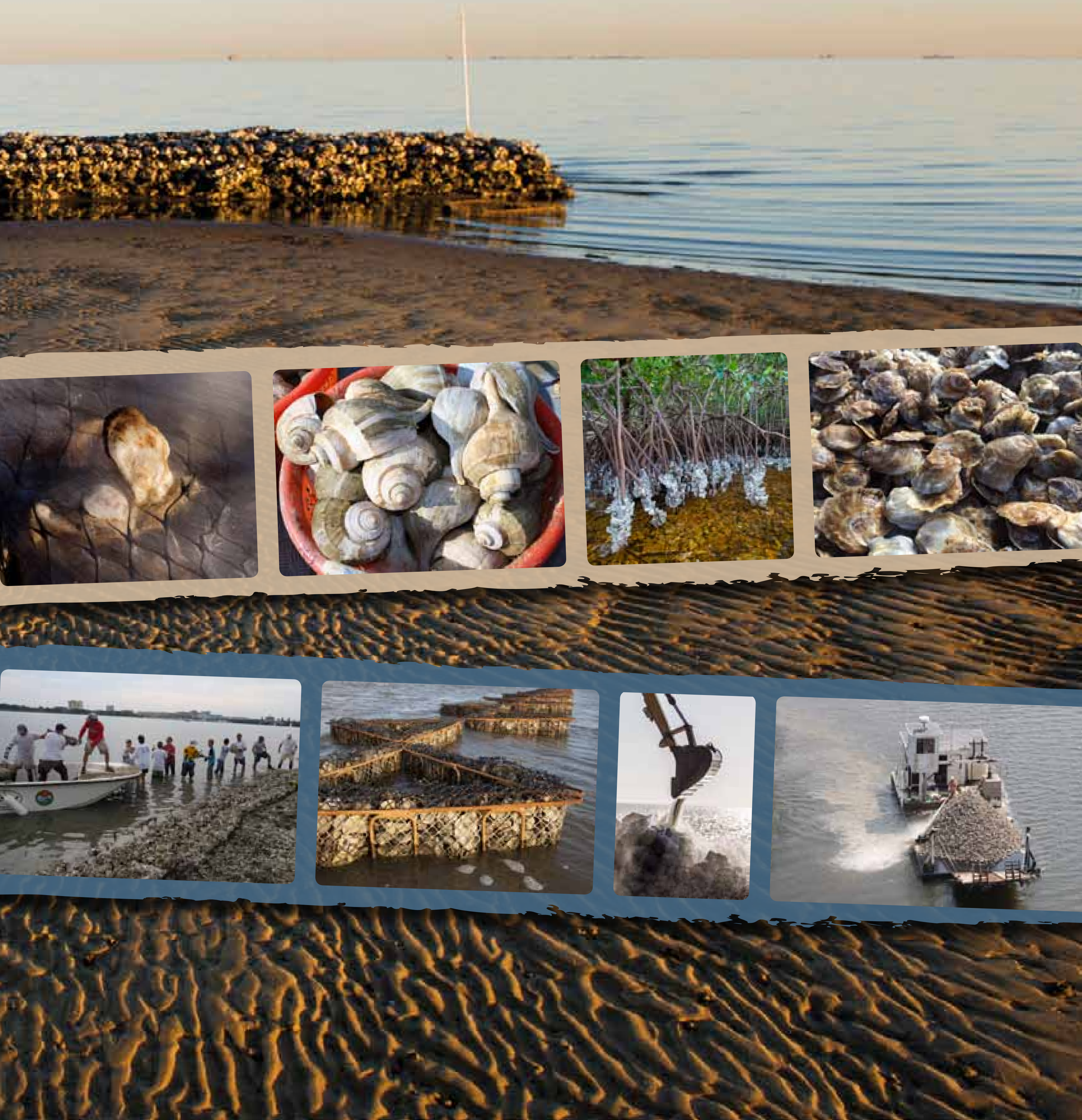

TABLE OF CONTENTS

ICSR2014 Restoration in an Ever-Changing World

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Front cover bottom row, left to right: Nancy Hadley, S.C. Department of Natural Resources; Beth Maynor Young for The Nature Conservancy; Jerod Foster for The Nature Conservancy; Nancy Hadley, S.C. Department of Natural Resources.

Inside, repeated throughout, left to right: Nancy Hadley, S.C. Department of Natural Resources; Chris Judy, Maryland Department of Natural Resources; Ryan Carnegie, Virginia Institute of Marine Science; Jerod Foster for The Nature Conservancy.

Conference Overview

The 16th International Conference on Shellfish Restoration (ICSR'14) provides a forum that draws attention to shellfish restoration, fostering partnerships, initiatives, and the exchange of information necessary to further the science and practice of the field. ICSR'14 emphasizes the use of shellfish restoration to address challenges and opportunities related to coastal development; resource policy, regulation, and management; shellfish diseases; shoreline stabilization; and climate change and ocean acidification.

The first ICSR was held on Hilton Head Island, South Carolina, in 1998. During the conference, we recognized the importance of shellfish as indicators of environmental quality and examined how the health of coastal ecosystems was improved by shellfish restoration. Since then, a great deal of work has been directed at the restoration and enhancement of shellfish populations worldwide, leading to both new challenges and novel techniques. Over 80 oral and poster presentations, plus seven panel sessions, are scheduled to explore the highlighted theme for ICSR'14: "Restoration in an Ever-Changing World."

ICSR'14 continues to showcase community-based projects in the United States, North America, and throughout the world. Morning keynote speakers provide a variety of perspectives on shellfish restoration. The program for each day is a mix of panel sessions and contributed 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.

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Sweet Oysters Baywater

Exhibitors, Co-Chairs, and Steering Committee

ICSR'14 **EXHIBITORS**

This year, ICSR'14 is excited to host exhibitors related to shellfish restoration and aquaculture. Make sure you stop by the Stono Ballroom to visit exhibitors during breakfasts, lunches, breaks, and poster sessions.

Association of National Estuary Programs
1110 Raintree Drive
Charlottesville, VA 22901
Phone: (434) 284-2962
www.nationalestuaries.org
Representative: Lore O'Hanlon, ecolore@aol.com

Bel-Art Products
2024 Broad Street
Pocomoke City, MD 21851
Phone: (410) 957-9500 ext. 1118
www.belart.com
Representative: Eva Winther, ewinther@belart.com

Coastal Environments Incorporated
1260 Main Street
Baton Rouge, LA 70802
Phone: (225) 383-7455
www.coastalenv.com
Representative: Mark Gagliano, mgagliano@coastalenv.com

Reef Innovations Incorporated
1126 Central Avenue
Sarasota, FL 34236
Phone: (941) 330-0501
Representative: Larry Beggs, larry@reefinnovations.com

Riverdale Mills Corporation
P.O. Box 200
Northbridge, MA 01534
Phone: 1-800-762-6374
www.riverdale.com
Representative: Larry Walsh, info@riverdale.com

Sea Grant College Programs, presented by
S.C. Sea Grant Consortium
287 Meeting Street
Charleston, SC 29401
Phone: (843) 953-2078
www.scseagrant.org
Representative: Rick DeVoe, rick.devoe@scseagrant.org

The Nature Conservancy
URI, 215 South Ferry Road
Narragansett, RI 02882-1197
Phone: (401) 874-6121
www.nature.org
Representative: Boze Hancock, bhancock@tnc.org

YSI Incorporated
1700 Brannum Lane
YellowSprings, OH 45387
Phone: (937) 767-7241
www.ysi.com
Representative: Darrin Honius, environmental@ysi.com

ICSR'14 **CO-CHAIRS**

Dorothy L. Leonard, Ocean Equities, LLC
M. Richard DeVoe, S.C. Sea Grant Consortium

ICSR'14 **STEERING COMMITTEE**

Tom Bliss, University of Georgia
Ryan Bradley, S.C. Sea Grant Consortium
Janet Brown, Association of Scottish Shellfish Growers
David Bushek, Rutgers University
Loren Coen, Florida Atlantic University
Jeff Davidson, University of Prince Edward Island
Julie Davis, S.C. Sea Grant Consortium
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Susan Ferris Hill, S.C. Sea Grant Consortium
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Sandy Macfarlane, Coastal Resource Specialists
Betsy Peabody, Puget Sound Restoration Fund
Andrea Sassard, S.C. Sea Grant Consortium
Geoff Scott, University of South Carolina
Susannah Sheldon, S.C. Sea Grant Consortium

Important
Conference Information

REGISTRATION INFORMATION

To participate in any aspect of the conference, you must be registered. Badges are required for all technical and social events. The ICSR'14 Registration Center is located in the Hayne Street Gallery at the DoubleTree Guest Suites on Thursday, Friday, and Saturday. On Wednesday, the Registration Center will be located in the main lobby of the DoubleTree Guest Suites.

MESSAGE CENTER

A message board and general information center is maintained at the ICSR'14 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'14 Registration Center.

WIFI AVAILABILITY

WiFi will be available in your hotel room and in the hotel lobby. It will not be available in any of the conference rooms or facilities.

NEWS MEDIA

Coordination between ICSR'14 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 science writers or the general media. She can be reached through the ICSR'14 Registration Center.

TECHNICAL PROGRAM

ICSR'14 features keynote presentations, panel discussions, and contributed oral and poster presentations on topics related to the five conference themes:

Addressing Challenges to Shellfish Restoration
Incorporating Approaches for Shellfish Restoration
Restoring Shellfish: Implementation, Monitoring, and Lessons Learned
Documenting Goods and Services Provided by Shellfish Populations and Ecosystems
Getting the Word Out

KEYNOTE PRESENTATIONS

Presentations will be made by shellfish experts from the United States. Keynote speakers include:

Michael Rubino, *Director*, Office of Aquaculture, National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Betsy Peabody, *Founder and Executive Director*, Puget Sound Restoration Fund
Peter Malinowski, *Director*, Billion Oyster Project, New York Harbor Foundation

PANEL SESSIONS

The conference will host seven interactive panel sessions. The titles are:

Washington State Shellfish Initiative, Hatcheries and Restoration Efforts
Large-Scale Oyster Restoration in Chesapeake Bay: Challenges and Solutions
East Coast Molluscan Health Management
Interpreting the National Shellfish Sanitation Program: Where Restorers and Regulators Intersect
The Future of Shellfish Restoration in the Face of a Changing Climate
Developing a Restoration Portfolio for Long-Term Oyster Sustainability in the Gulf of Mexico
Coherent Approach to Busycon/Busycotypus Fishery Management along the U.S. Atlantic Seaboard

ORAL AND POSTER PRESENTATIONS

Oral and poster presentations are offered in 13 sessions. More than 80 contributed papers and posters by experts from around the world will be presented. This year, poster presenters will also give two-minute "Rapid Fire Talks" highlighting key take-home points.

Information for Presenters

ORAL PRESENTATIONS

Twenty minutes are allotted for each contributed paper, including time for discussion and change-over between speakers. Session moderators will adhere strictly to these time limitations. Speakers should check-in with moderators 15 minutes prior to session start to make sure your presentation is loaded onto the computer. Each room is equipped with a projector, screen, laptop computer, microphone, and laser pointer.

POSTER PRESENTATIONS

Each poster presenter has access to a tackboard measuring 4' high by 8' wide. Pushpins are provided. Board assignment information will be provided at registration. Posters should be set-up, attended, and removed according to the following schedule:

Registration/Check-in
At Conference Registration Desk

Poster Set-Up
Stono, DT
Thursday, December 11, 8:00 a.m. to 12:00 noon

Poster Authors Present
Stono, DT
Thursday, December 11, 6:00 p.m. to 7:30 p.m.
—AND—
Friday, December 12, 5:15 p.m. to 6:30 p.m.

Poster Removal
Stono, DT
Saturday, December 13, before 12:00 noon

"Rapid Fire Talks"

Each poster presenter will give a two-minute "Rapid Fire Talk". The talks are on both Thursday and Friday before the poster sessions. Poster presenters will be provided with the assigned day of their talk at registration. Poster presenters should check-in with facilitators 10 minutes in advance of the talks.

Talk 1
Harleston, HSG
Thursday, December 11, 5:30 p.m. to 6:00 p.m.

Talk 2
Harleston, HSG
Friday, December 12, 4:45 p.m. to 5:15 p.m.

Schedule of Presentations and Activities

WEDNESDAY, DECEMBER 10, 2014

1:00 p.m. to 4:00 p.m.
Field Trips
Meet in the Palmetto Courtyard

2:00 p.m. to 7:00 p.m.
ICSR'14 Registration
DoubleTree Hotel Main Lobby

7:00 p.m. to 9:00 p.m.
Welcome Reception
Ansonborough/Harleston, Hayne Street Gallery (HSG)

THURSDAY, DECEMBER 11, 2014

7:30 a.m. to 3:30 p.m.
ICSR'14 Registration
HSG

8:00 a.m. to 9:00 a.m.
Continental Breakfast
Stono, DT

9:00 a.m. to 9:30 a.m.
Welcoming Remarks
Ansonborough/Harleston, HSG
"Welcome to Charleston, South Carolina"- Mayor Pro Tem and Councilman Bill Moody, Jr.

"ICSR'14 Welcome"- Dorothy Leonard, Ocean Equities, LLC, and M. Richard DeVoe, S.C. Sea Grant Consortium

9:30 a.m. to 10:00 a.m.
Keynote Presentation
Ansonborough/Harleston, HSG

"Commercial and Restoration Shellfish: A Partnership"
Michael Rubino, Director, Office of Aquaculture, NOAA National Marine Fisheries Service

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

Schedule of Presentations and Activities

10:30 a.m. to 12:10 p.m.
CONCURRENT CONTRIBUTED - SESSION A
Ansonborough, HSG
Techniques for Shellfish Restoration
Moderator: Peter Kingsley-Smith, S.C. Department of Natural Resources

10:30 a.m.

"Utilizing Oyster Castles to Achieve Multiple Oyster Restoration Goals" Lusk, B. W. (1), (1) The Nature Conservancy, 11332 Brownsville Road, Nassawadox, VA 23413, USA

10:50 a.m.

"Estuarine Sculpturing with Induced Oyster Reefs" Gagliano, M. H. (1), S. M. Gagliano (1), (1) Coastal Environments, Inc., 1260 Main Street, Baton Rouge, LA 70802, USA

11:10 a.m.

"Reef Structure with Oysters: A Tool for Coastal Habitats Facilitation" Chowdhury, M. S. N. (1), A. Smaal (1), T. Ysebaert (1), M. S. Hossain (2), (1) IMARES Wageningen, Wageningen University and Research Center, Korringaweg 5, Yerseke, Zeeland 4401 NT, The Netherlands; (2) Institute of Marine Sciences and Fisheries, University of Chittagong, Chittagong 4331, Bangladesh

11:30 a.m.

"Recovering Abandoned Crab Traps for Use as Oyster Reef Substrate in South Carolina, USA" Stone, B. W. (1), P. Kingsley-Smith (1), (1) South Carolina Department of Natural Resources, P.O. Box 12559, Charleston, SC 29422, USA

11:50 a.m.

"Optimizing Intertidal Oyster Reef Restoration by Considering Tidal Elevation in Site Assessment" Ridge, J. T. (1), A. B. Rodriguez (1), N. L. Lindquist (1), J. H. Grabowski (2), F. J. Fodrie (1), (1) Institute of Marine Sciences, University of North Carolina at Chapel Hill, 3431 Arendell St., Morehead City, NC 28557, USA; (2) Marine Science Center, Northeastern University, 430 Nahant Road, Nahant, MA 01908, USA

10:30 a.m. to 12:10 p.m.
CONCURRENT PANEL - SESSION B
Harleston, HSG
"Washington State Shellfish Initiative, Hatcheries and Restoration Efforts"
Panel Chair: Betsy Peabody, Puget Sound Restoration Fund

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




1:30 p.m. to 3:10 p.m.
CONCURRENT CONTRIBUTED - SESSION C
Ansonborough, HSG
Hatcheries and Restoration Aquaculture
Moderator: John Kraeuter, University of New England

1:30 p.m.

"Assessing Oyster Gonadal Development to Maximize Oyster Broodstock Use" Carey, B. (1), S. M. Weschler (1), E. A. Roache (1), D. D. Abbott (1), Z. B. Hoisington (1), D. W. Meritt (1), (1) University of Maryland Center for Environmental Science Horn Point Laboratory Oyster Hatchery, 2020 Horns Point Rd., Cambridge, MD 21613, USA

1:50 p.m.

"Hatcheries: Not the Wal-Mart of the Shellfish Industry" Willey, S. M. (1), A. M. Maynard (1), A. Gower (1), J. Parisi (2), D. W. Meritt (1), (1) University of Maryland Center of Environmental Science Horn Point Laboratory , 2020 Horns Point Road, Cambridge, MD 21613, USA; (2) Oyster Recovery Partnership, 1805A Virginia Street, Annapolis, MD 21401, USA

2:10 p.m.

"Directed Setting of* Crassostrea virginica *Larvae on a Targeted Site in a Tidal Creek; Overwinter Survival and Set in the Second Year" Steppe, C. N. (1), D. W. Fredriksson (2), L. Wallendorf (3), M. Robert (2), (1) U.S. Naval Academy, Department of Oceanography, 572C Holloway Rd., Stop 9D, Annapolis, MD 21402, USA; (2) U.S. Naval Academy, Department of Ocean Engineering, Rickover Hall, Annapolis, MD 21402, USA; (3) U.S. Naval Academy Hydromechanics Lab, Rickover Hall, Annapolis, MD 21402, USA

2:30 p.m.

"Bar Tending—A New Approach to Oyster* (Crassostrea virginica) *Spat Setting" Paul, R. W. (1), K. M. Boyle (2), S. Russell (2), (1) St. Mary's College of Maryland, Department of Biology, 18952 E. Fisher Road, St. Mary's City, MD 20686, USA; (2) Shore Thing Shellfish, LLC, P.O. Box 74, Tall Timbers, MD 20690, USA

2:50 p.m.

"Application of Germplasm Preservation on Oyster Restoration" Yang, H. (1), L. N. Sturmer (2), (1) University of Florida, 7922 N.W. 71st St., Gainesville, FL 32653, USA; (2) University of Florida, 11350 S.W. 153 Court, Cedar Key, FL 32625, USA

1:30 p.m. to 3:10 p.m.
CONCURRENT PANEL - SESSION D
Harleston, HSG
"Large-Scale Oyster Restoration in Chesapeake Bay: Challenges and Solutions"
Panel Chair: Eric Weissberger, Maryland Department of Natural Resources

Schedule of Presentations and Activities

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

3:40 p.m. to 5:20 p.m.
CONCURRENT CONTRIBUTED - SESSION E
Ansonborough, HSG
Genetics and Breeding for Restoration
Moderator: Jonathan Davis, Puget Sound Restoration Fund

3:40 p.m.

"Genetic Tracking of an Eastern Oyster,* Crassostrea virginica *(Gmelin, 1791), Restoration Project in the Lafayette River, Virginia" Turley, B. D. (1), J. Shannon (2), T. Leggett (2), J. McDowell (1), K. Reece (1), (1) Virginia Institute of Marine Science, College of William and Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA; (2) Chesapeake Bay Foundation, P.O. Box 412, Wicomico, VA 23198, USA

4:00 p.m.

"Local Native Oyster Stocks for Restoration: Does Local Adaptation Affect Outplant?" Heare, J. (1), B. Vadopalas (1), J. Davis (2), S. Roberts (1), (1) University of Washington, 1122 N.E. Boat St., Seattle, WA 98105, USA; (2) Puget Sound Restoration Fund, 1122 N.E. Boat St., Seattle, WA 98105, USA

4:20 p.m.

"A Comparison of Breeding Methods for the Olympia Oyster,* Ostrea lurida, *Using Microsatellite Markers" Jackson, K. E. (1), B. Vadopalas (2), S. Roberts (2), (1) University of Washington, 6020 Balustrade Blvd. S.E., Lacey, WA 98513, USA; (2) University of Washington, 1122 N.E. Boat St., Seattle, WA 98105, USA

4:40 p.m.

"Olympia Oyster* (Ostrea lurida) *Restoration in Washington State: The Development of Protocols for Use in Hatchery-Based Production and Restocking Efforts" Davis, J. P. (1), B. Vadopalas (2), B. Allen (1), B. Peabody (3), R. Crim (1), K. Jackson (2), (1) Puget Sound Restoration Fund, 382 Wyatt Way N.E., Bainbridge Island, WA 98110, USA; (2) University of Washington, School of Fisheries and Aquatic Sciences, 1122 N.E. Boat Street, Seattle, WA 98105, USA; (3) Puget Sound Restoration Fund, 590 Madison Ave. N., Bainbridge Island, WA 98110, USA

5:00 p.m.

"Restoration of Flat Oyster Communities in the Offshore Waters of the North Sea" Smaal, A. (1), P. Kamermans (1), H. Sas (2), T. van der Have (3), (1) IMARES, P.O. Box 77, 4400 AB Yerseke, The Netherlands; (2) SASCON, Danie Theronstrt 1091XZ Amsterdam, The Netherlands; (3) BUWA, P.O. Box 365, 4100 AJ Culemborg, The Netherlands




3:40 p.m. to 5:20 p.m.
CONCURRENT PANEL - SESSION F
Harleston, HSG
"East Coast Molluscan Health Management"
Panel Chair: David Bushek, Rutgers University

5:20 p.m.
Concurrent Sessions End

5:30 p.m. to 6:00 p.m.
RAPID FIRE POSTER TALKS - 1
Harleston, HSG
Facilitators: Janet Brown, Association of Scottish Shellfish Growers, and Andrea Sassard, S.C. Sea Grant Consortium

6:00 p.m. to 7:30 p.m.
POSTER SESSION/HAPPY HOUR
Stono, DT

7:30 p.m. to 9:00 p.m.
Evening Meetings (if needed)

FRIDAY, DECEMBER 12, 2014

7:00 a.m. to 3:30 p.m.
ICSR'14 Registration
HSG

7:00 a.m. to 8:00 a.m.
Continental Breakfast
Stono, DT

8:00 a.m. to 8:30 a.m.
KEYNOTE PRESENTATION
Ansonborough/Harleston, HSG
"Modern and Ancient Tales of the Shellfish/Human Convergence"
Betsy Peabody, Founder and Executive Director, Puget Sound Restoration Fund

8:30 a.m. to 8:40 a.m.
Room Transition
Ansonborough/Harleston, HSG

8:40 a.m. to 10:00 a.m.
CONCURRENT PANEL - SESSION G
Harleston, HSG
"Interpreting the National Shellfish Sanitation Program: Where Restorers and Regulators Intersect"
Panel Chair: Sandy Macfarlane, Coastal Resource Specialists

Schedule of Presentations and Activities

8:40 a.m. to 10:00 a.m.
CONCURRENT CONTRIBUTED - SESSION H
Ansonborough, HSG
Restoration Considerations and Alternatives
Moderator: Earl Melancon, Nicholls State University

8:40 a.m.
"Seven Years of Assessing a Living Shoreline of Pre-Fabricated Structures Placed in Terrebonne Bay, Louisiana: The Challenges in a Microtidal, High-Energy, Highly-Subsiding, Highly-Eroding, and Hurricane-Prone Environment" Melancon, E. (1), G. Curole (2), Q. Fontenot (1), (1) Biology Department, Nicholls State University, Thibodaux, LA 70301, USA; (2) Coastal Protection and Restoration Authority of Louisiana (CPRA), 1440 Tiger Drive, Suite B, Thibodaux, LA, USA

9:00 a.m.
"Alternative Oyster Culture in the Gulf of Mexico" Daigle, M. T. (1), N. Pace (2), (1) Louisiana Sea Grant, 205 Sea Grant Building, Louisiana State University, Baton Rouge, LA 70803, USA; (2) Mississippi-Alabama Sea Grant Legal Program, 256 Kinard Hall, Wing E, University, MS 38677-1848, USA

9:20 a.m.
"The Town Pond Restoration - They Dug the Hole, Now What Do We Do?" Griffen, M. (1), D. Leavitt (1), S. Patterson (1), T. Scott (1), (1) Center for Economic and Environmental Development, Roger Williams University, Bristol, RI, USA

9:40 a.m.
"Rhode Island Oyster Restoration: We're Great at Growing Oysters but What Happens Ten Years Later?" Leavitt, D. (1), S. Patterson (1), T. Scott (1), M. Griffen (1), (1) Center for Economic and Environmental Development, Roger Williams University, Bristol, RI, USA

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

10:30 a.m. to 12:10 p.m.
CONCURRENT CONTRIBUTED - SESSION I
Harleston, HSG
Habitat and Ecosystem Services
Moderator: Loren Coen, Florida Atlantic University's Harbor Branch Oceanographic Institute

10:30 a.m.
"Tidal Creek and Substrate Effects on Oyster Reef-Associated Nekton" Funk, T. S. (1), K. O'Shaughnessy (2), K. Walters (3), (1) Coastal Carolina University, 205 Wando River Road, Unit 9F, Myrtle Beach, SC 29579, USA; (2) Coastal Carolina University, 8124 HWY 56, Chauvin, LA 70344, USA; (3) Coastal Carolina University, P.O. Box 261954, Conway, SC 29528, USA




10:50 a.m.

"Is Rugosity on Intertidal Oyster Reefs Related to Spat and Associated Resident Fauna?" Margiotta, A. M. (1), N. Hadley (2), V. Shervette (3), C. Plante (1), D. Wilber (4), (1) College of Charleston, 205 Fort Johnson Road, Charleston, SC 29412, USA; (2) South Carolina Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC 29412, USA; (3) University of South Carolina Aiken, 417 University Parkway, Department of Biology and Geology-SBDG 219A, Aiken, SC 29801, USA; (4) HX5, 664 Old Plantation Road, Charleston, SC 29412, USA

11:10 a.m.

"Mitigating Eutrophication Using Oyster Reef Restoration and Oyster Aquaculture" Kellogg, M. L. (1), A. R. Smyth (1), M. W. Luckenbach (1), R. H. Carmichael (2), B. L. Brown (4), J. C. Cornwell (5), M. Piehler (6), M. S. Owens (5), D. J. Dalrymple (3), C. B. Higgins (4), (1) Virginia Institute of Marine Science, College of William and Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA; (2) Dauphin Island Sea Lab, 101 Bienville Blvd., Dauphin Island, AL 36528, USA; (3) University of South Alabama, Department of Marine Sciences, Mobile, AL 36688, USA; (4) Virginia Commonwealth University, Department of Biology, P.O. Box 842012, Richmond, VA 23284-2012, USA; (5) University of Maryland Center for Environmental Science, Horn Point Laboratory, P.O. Box 775, Cambridge, MD 21613, USA; (6) University of North Carolina – Chapel Hill, Institute of Marine Science, 3431 Arendell Street, Morehead City, NC 28557, USA

11:30 a.m.

"Quantifying Fish and Mobile Invertebrate Production from Conservation and Restoration of Threatened Nursery Habitats" zu Ermgassen, P. (1), J. Grabowski (2), J. Gair (3), S. Powers (4), (1) University of Cambridge, Department of Zoology, Downing Street, Cambridge, Cambridgeshire, CB2 3EJ, UK; (2) Northeastern University, Marine Science Center, 430 Nahant Road, Nahant, MA 01908, USA; (3) University of Cambridge, Institute of Astronomy, Madingley Road, Cambridge, CB3 0HA, UK; (4) University of South Alabama, Dauphin Island Sea Lab, 101 Bienville Blvd., Dauphin Island, AL 36528, USA

11:50 a.m.

"How Much is Enough? Tools to Help Set Goals for Oyster Restoration Based on the Ecosystem Services Returned" Hancock, B. T. (1), B. M. DeAngelis (1), J. Greene (2), (1) The Nature Conservancy, URI Grad. School of Oceanography, 215 South Ferry Rd., Narragansett, RI 02882-1197, USA; (2) The Nature Conservancy, 56 Saint Joseph Street, Suite 1600, Mobile, AL 36602, USA

10:30 a.m. to 12:10 p.m.
CONCURRENT CONTRIBUTED - SESSION J
Ansonborough, HSG
Water Quality and Pollution
Moderator: Geoffrey Scott, University of South Carolina

10:30 a.m.

"Improving the Water Quality and Biodiversity with the Oyster Reef Habitat Restoration in Wellfleet Harbor, MA, USA" Frankic, A. (1), A. Costa (2), D. Bertuna (3), C. Felix (4), (1) Green Harbors Project, UMass Boston, 100 Morrissey Blvd, Boston, MA 02125, USA; (2) Center for Coastal Studies, 5 Holway Avenue, Provincetown, MA 02657, USA; (3) UMass Boston, 100 Morrissey Blvd, Boston, MA 02125, USA; (4) Town of Wellfleet, 180 Upper Troy Road, Fitzwilliam, NH 03447, USA

10:50 a.m.

"SURF-TO-TURF Mussel Compost: Using Bioextraction to Remove and Recycle Nutrients from Budd Inlet, Puget Sound, Washington State" Christy, A. (1), B. Hudson (1), A. Suhrbier (1), (1) Pacific Shellfish Institute, Olympia, WA, USA

11:10 a.m.

"Getting the N Out - A Search for Bioremediation Alternatives to Sewage Treatment" Karney, R. C. (1), E. Green-Beach (1), P. Carey (2), (1) Martha's Vineyard Shellfish Group, Inc., P.O. Box 1552, Oak Bluffs, MA 02557, USA; (2) Wastewater Alternatives, 362 Coburn Avenue, Worcester, MA 01604, USA

11:30 a.m.

"Crassostrea virginica *Restoration in Jamaica Bay, NYC"* Doss, T. (1), K. Bowers (1), J. McLaughlin (2), M. Spina (1), G. J. Rivara (3), (1) Biohabitats, Inc., 855 Bloomfield Ave., Glen Ridge, NJ 07028, USA; (2) New York City Department of Environmental Protection, Bureau of Environmental Planning and Analysis, 59-17 Junction Blvd., Flushing, NY 11373, USA; (3) Cornell University Cooperative Extension of Suffolk County, 423 Griffing Avenue, Suite 100, Riverhead, NY 11901, USA

11:50 a.m.

"Evaluating the Potential of Atlantic Oysters* (Crassostrea virginica) *to Bioaccumulate Contaminants of Emerging Concern in Coastal Embayments" Costa, A. S. (1), M. S. Costa (1), M. Benotti (2), (1) Center for Coastal Studies, 5 Holway Avenue, Provincetown, MA 02657, USA; (2) Batelle, 141 Longwater Place, Norwell, MA 02061, USA

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

1:30 p.m. to 3:10 p.m.
CONCURRENT CONTRIBUTED - SESSION K
Harleston, HSG
Assessment of Function and Metrics and Measures
Moderator: Boze Hancock, The Nature Conservancy




1:30 p.m.

"Monitoring Oyster Restoration in the Maryland Chesapeake Bay: Techniques and Lessons Learned in the Field" Handschy, A. V. (1), K. T. Paynter (1), (1) University of Maryland, 1210 Biology-Psychology, Bldg 144, University of Maryland, College Park, MD 20742, USA

1:50 p.m.

"Incorporating Trophic Analysis into Habitat Assessment of a Restored Oyster Reef" Rezek, R. (1), J. B. Pollack (1), B. Lebreton (2), (1) Texas A&M Corpus Christi, 6300 Ocean Dr., Corpus Christi, TX 78412, USA; (2) University of La Rochelle, LIENSS, UMR 7266 CNRS Universite de La Rochelle Avenue Michel Crepeau, La Rochelle, Poitou-Charentes 17 042 cedex 1, France

2:10 p.m.

"Recruitment Enhancement as an Indicator of Oyster Restoration Success in Chesapeake Bay" Schulte, D. M. (1), R. P. Burke (2), (1) U.S. Army Corps of Engineers, 803 Front Street, Norfolk, VA 23510, USA; (2) Christopher Newport University, Mary Forbes Hall, 2035, Newport News, VA 23606, USA

2:30 p.m.

"Production and Commercial Fishery Value from Oyster Reef Restoration" Humphries, A. T. (1), M. K. LaPeyre (2), (1) U.S. Environmental Protection Agency, Atlantic Ecology Division, 27 Tarzwell Rd., Narragansett, RI 02882, USA; (2) U.S. Geological Survey, Louisiana Fish and Wildlife Cooperative Research Unit, School of Renewable Natural Resources, Louisiana State University AgCenter, Baton Rouge, LA 70803, USA

2:50 p.m.

"Mitigation for Range Impacts: Construction and Development of Long Shoal Oyster Sanctuary in Pamlico Sound, North Carolina" Chappell, W. S. (1), (1) U.S. Navy (NAVFAC), 6506 Hampton Blvd., Norfolk, VA 23508-1278, USA

1:30 p.m. to 3:10 p.m.
CONCURRENT CONTRIBUTED - SESSION L
Ansonborough, HSG
Water Quality and Shoreline Stabilization
Moderator: Jeffrey Davidson, University of Prince Edward Island

1:30 p.m.

"Competition, Commensalism, and Consumption: The Community Ecology of Oyster Reefs and Dermo Disease" Ben-Horin, T. (1), D. Bushek (1), D. Munroe (1), (1) Rutgers University, 6959 Miller Ave, Port Norris, NJ 08349, USA

1:50 p.m.

"An Evaluation of Relic Oyster Reefs in Chesapeake Bay: Implications for Eastern Oyster,* Crassostrea virginica, *Restoration" Schulte, D. M. (1), R. N. Lipcius (2), R. P. Burke (3), D. M. Bruce (4), (1) U.S. Army Corps of Engineers, 803 Front Street, Norfolk, VA 23510, USA; (2) College of William and Mary, Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA 23062, USA; (3) Christopher Newport University, Mary Forbes Hall, 2035, Newport News, VA 23606, USA; (4) NOAA, 904 South Morris Street, Oxford, MD 21403, USA

2:10 p.m.

"The Impact of Environmental Condition on* Crassostrea virginica *Gene Expression" Chapman, R. W. (1), (1) South Carolina Department of Natural Resources, 331 Ft. Johnson Rd., Charleston, SC 29414, USA

2:30 p.m.

"Response of Nekton to Installation of a Living Shoreline on Little St. Simons, GA" Bliss, T. (1), S. Coleman (2), D. Hurley (3), J. Mackinnon (4), C. Lambert (5), (1) University of Georgia Marine Extension Service, 20 Ocean Science Circle, Savannah, GA 31411, USA; (2) Little St. Simons Island, 1000 Hampton Point Dr., St. Simons Island, GA 31522, USA; (3) Sapelo Island National Estuarine Research Reserve, PO Box 15, Sapelo Island, GA 31327, USA; (4) Georgia Department of Natural Resources Coastal Resources Division, One Conservation Way, Brunswick, GA 31520, USA; (5) The Nature Conservancy, 2865 US HWY 17, Darien, GA 31305, USA

2:50 p.m.

"Establishing Oyster* (Crassostrea virginica) *Reefs as a Method to Facilitate the Expansion of* Spartina alterniflora *and Combat Erosion and Habitat Loss on Dynamic Shorelines" Hodges, M. S. (1), S. Czwartacki (1), J. Hulteen (1), N. Hadley (1), (1) South Carolina Department of Natural Resources, Marine Resources Division, 217 Fort Johnson Road, Charleston, SC 29412, USA

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

3:40 p.m. to 4:40 p.m.
CONCURRENT CONTRIBUTED - SESSION M
Harleston, HSG
Large-Scale Restoration in the Chesapeake Bay
Moderator: Dorothy Leonard, Ocean Equities, LLC

3:40 p.m.

"Seabed Mapping and Spatial Data Used in Planning Tributary-Scale Oyster Restoration in the Chesapeake Bay" Bruce, D. G. (1), J. V. Lazar (2), (1) NOAA Chesapeake Bay Office, Cooperative Oxford Laboratory, 904 S. Morris St., Oxford, MD 21654, USA; (2) NOAA Chesapeake Bay Office, 410 Severn Avenue Suite 207A, Annapolis, MD 21403, USA




4:00 p.m.

"Toward Large-Scale Oyster* Crassostrea virginica *Restoration in the Chesapeake Bay" Weissberger, E. J. (1), K. U. Gross (2), K. Muzia (3), W. Slacum (3), A. Sowers (4), S. R. Westby (5), (1) Maryland Department of Natural Resources, 580 Taylor Ave. B-2, Annapolis, MD 21401, USA; (2) U.S. Army Corps of Engineers, CENAB-PP-C, 10 S. Howard St., Baltimore, MD 21201, USA; (3) Oyster Recovery Partnership, 1805A Virginia St., Annapolis, MD 21401, USA; (4) U.S. Army Corps of Engineers, CENAB-Planning, 10 S. Howard St., Baltimore, MD 21201, USA; (5) NOAA Chesapeake Bay Office, 410 Severn Ave., Suite 207A, Annapolis, MD 21403, USA

4:20 p.m.

"Large-Scale Oyster Restoration in the Piankatank River, Virginia and the Chesapeake Bay" Lacatell, A. D. (1), (1) The Nature Conservancy, 530 East Main Street, Suite 800, Richmond, VA 23116, USA

3:40 p.m. to 4:40 p.m.
CONCURRENT CONTRIBUTED - SESSION N
Ansonborough, HSG
Alternative Management Approaches to Shellfish Restoration
Moderator: M. Richard DeVoe, S.C. Sea Grant Consortium

3:40 p.m.

"Sustainable Fishery, Sustainable Habitat: Managing the Delaware Bay Oyster Resource" Bushek, D. (1), K. Ashton-Alcox (1), (1) Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Ave., Port Norris, NJ 08349, USA

4:00 p.m.

"Loch Ryan, Scotland: A Case Study of a Sustainable Native Oyster* (Ostrea edulis) *Fishery Highlighting the Importance of Site Specific Management" Eagling, L. E. (1), E. C. Ashton (1), N. O'Connor (2), D. Roberts (2), (1) Queen's University Belfast, Marine Laboratory (QML), 12-13 The Strand, Portaferry, County Down BT2 1PF, UK; (2) Queen's University Belfast, School of Biological Sciences, Medical Biology Centre, 97 Lisburn Road, Belfast, County Antrim BT9 7BL, UK

4:20 p.m.

"Overcoming Restoration Paradigms: Value of the Historical Record and Metapopulation Dynamics in Native Oyster Restoration" Lipcius, R. N. (1), (1) VIMS, College of William & Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA

4:40 p.m.
Concurrent Sessions End

Schedule of Presentations and Activities

4:45 p.m. to 5:15 p.m.
RAPID FIRE POSTER TALKS - 2
Harleston, HSG
Facilitators: Janet Brown, Association of Scottish Shellfish Growers, and Andrea Sassard, S.C. Sea Grant Consortium

5:15 p.m. to 6:30 p.m.
POSTER SESSION/HAPPY HOUR
Stono, DT

7:00 p.m.
Bus Transportation to Fort Johnson
Meet in the Palmetto Courtyard

7:30 p.m. to 10:00 p.m.
Lowcountry Cookout at Fort Johnson
The Venue is Partially Outdoors—Please Dress Appropriately

SATURDAY, December 13, 2014

7:30 a.m. to 12:00 noon
ICSR'14 Registration
HSG

7:15 a.m. to 8:15 a.m.
Continental Breakfast
Stono, DT

8:15 a.m. to 8:45 a.m.
KEYNOTE PRESENTATION
Ansonborough/Harleston, HSG
"Engaging Our Youth through Ecosystem Restoration"
Peter Malinowski, Director, Billion Oyster Project, New York Harbor Foundation

8:45 a.m. to 9:00 a.m.
Room Transition
Ansonborough/Harleston, HSG

9:00 a.m. to 10:00 a.m.
CONCURRENT PANEL - SESSION O
Ansonborough, HSG
"The Future of Shellfish Restoration in the Face of a Changing Climate"
Panel Chair: Elizabeth Fly, S.C. Sea Grant Consortium




9:00 a.m. to 10:00 a.m.
CONCURRENT PANEL - SESSION P
Harleston, HSG
"Developing a Restoration Portfolio for Long-Term Oyster Sustainability in the Gulf of Mexico"
Panel Co-Chairs: Judy Haner, The Nature Conservancy, and William Walton, Auburn University

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

10:00 a.m. to 11:30 a.m.
CONCURRENT PANEL - SESSION Q
Cooper Room, DT
"Coherent Approach to* Busycon/Busycotypus *Fishery Management Along the U.S. Atlantic Seaboard"
Chair: Robert Fisher, Virginia Sea Grant College Program

10:30 a.m. to 12:10 p.m.
PLENARY CONTRIBUTED - SESSION R
Ansonborough/Harleston, HSG
Shellfish Restoration at the Community and Local Level
Moderator: Sandy Macfarlane, Coastal Resource Specialists

10:30 a.m.

"Relationships Between Oyster Biomass Density and Macrofaunal Community Structure" Kellogg, M. L. (1), P. G. Ross (2), B. Lusk (3), M. W. Luckenbach (1), A. Birch (2), J. Dreyer (1), E. Smith (2), (1) Virginia Institute of Marine Science, College of William and Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA; (2) Virginia Institute of Marine Science, Eastern Shore Laboratory, P.O. Box 350, Wachapreague, VA 23480, USA; (3) The Nature Conservancy, Virginia Coast Reserve, Brownsville, VA 23413, USA

10:50 a.m.

"Olympia Oyster* (Ostrea lurida) *Bed Habitat Restoration - A Puget Sound Case Study for Stock and Habitat Rebuilding, and Examinations of Ecosystem Service" Allen, B. (1), (1) Puget Sound Restoration Fund, 590 Madison Ave. N., Bainbridge Island, WA 98110, USA

11:10 a.m.

"Partnerships in Action for Successful Community-Based Oyster Reef Restoration and Monitoring in Indian River Lagoon, Florida" Palmer, J. B. (1), L. Walters (2), K. Brown (1), (1) Brevard Zoo, 8225 N. Wickham Rd., Melbourne, FL 32940, USA; (2) University of Central Florida, 4000 Central Florida Blvd., Orlando, FL 32816, USA

11:30 a.m.

"Status of Shellfish Stock Enhancement in Alaska: Clams, Crabs, and Others" Hetrick, J. (1), (1) Alutiiq Pride Shellfish Hatchery, Box 369, Seward, AK 99664, USA

Schedule of Presentations and Activities

11:50 a.m.
"Volunteer Shellfish Community Action Programs: Answering the Call" Macfarlane, S. (1), D. Murphy (2), (1) Coastal Resource Specialists, 290 Kingstown Way #379, Duxbury, MA 02332, USA; (2) Barnstable County Cooperative Extension and WHOI Sea Grant, Box 367, Barnstable, MA 02630, USA

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

1:30 p.m. to 3:10 p.m.
PLENARY CONTRIBUTED - SESSION S
Ansonborough/Harleston, HSG
Value of Public Awareness and Training Programs
Moderator: Julie Davis, S.C. Sea Grant Consortium

1:30 p.m.
"A Remote Setting Training Program for Maryland: Making Public/Private Partnerships Work to Stimulate Oyster Aquaculture" Roache, E. (1), S. Weschler (1), D. Webster (2), S. Abel (3), J. Parisi (3), D. Meritt (1), (1) University of Maryland Center for Environmental Science Horn Point Laboratory Oyster Hatchery, 2020 Horns Point Lane, Cambridge, MD 21613, USA; (2) University of Maryland Wye Research & Education Center , P.O. Box 169 , Queenstown, MD 21658, USA; (3) Oyster Recovery Partnership, 1805A Virginia Street, Annapolis, MD 21401, USA

1:50 p.m.
"From Seeds to Shoreline: Engaging Students in Salt Marsh Restoration" Bell, E. V. (1), (1) S.C. Sea Grant Consortium and COSEE SE, 287 Meeting Street, Charleston, SC 29401, USA

2:10 p.m.
"Using a Production-Scale Oyster Hatchery as an Educational Tool" Alexander, S. T. (1), J. A. Alexander (1), J. E. Trommatter (1), E. A. Roache (1), S. M. Willey (1), S. M. Weschler (1), R. Carey (1), D. W. Meritt (1), (1) University of Maryland Center for Environmental Science Horn Point Laboratory, P.O. Box 775, Cambridge, MD 21613, USA

2:30 p.m.
"Engaging High School Students in Oyster Restoration through Hands-On Authentic Learning Opportunities" Malinowski, P. (1), (1) Billion Oyster Project, New York Harbor School, Battery Maritime Building, Slip 7, 10 South Street, New York, NY 10004, USA

2:50
"Youth Engagement in Shellfish Restoration: Student Perspectives" Facilitated by Peter Malinowski, New York Harbor Foundation

3:15 p.m. to 4:00 p.m.
CLOSING PLENARY SESSION and REFLECTIONS
Dorothy Leonard, Ocean Equities, LLC, and M. Richard DeVoe, S.C. Sea Grant Consortium

4:00 p.m.
Conference Adjourns

Poster Sessions

A. Addressing Challenges to Shellfish Restoration

A1. CHARLESTON WATERKEEPER'S RECREATIONAL WATER QUALITY MONITORING PROGRAM: A TOOL FOR WATER QUALITY PROTECTION AND RESTORATION. Carmack, C. A. (1), C. A. Buffum (1), (1) Charleston Waterkeeper, P.O. Box 29, Charleston, SC 29402, USA

A2. SOMETIMES THEY COME BACK AND DISAPPEAR AGAIN (NATURAL CYCLES, SUBSTITUTION, OR WHAT ELSE?). Del Piero, D. (1), (1) Trieste University, via licio Giorgieri 10, Trieste, TS 34127, Italy

A3. APPLICATION OF HABITAT SUITABILITY MODELS FOR OYSTER RESTORATION IN PAMLICO SOUND, NORTH CAROLINA. Eggleston, D. B. (1), B. J. Puckett (1), (1) NC State University, 303 College Circle, CMAST, Morehead City, NC 28557, USA

A4. TRACKING $CaCO_3$ CORROSIVITY AT ALUTIIQ PRIDE SHELLFISH HATCHERY, SEWARD ALASKA. Evans, W. (1), J. Hetrick (2), (1) NOAA Pacific Marine Environmental Laboratory, Seattle, WA, USA; (2) Alutiiq Pride Shellfish Hatchery, Box 369, Seward, AK 99664, USA

A5. DISTRIBUTIONS OF VIRULENT *VIBRIO PARAHAEMOLYTICUS* STRAINS WITHIN SOUTH CAROLINA OYSTERS. Klein, S. L. (1), C. R. Lovell (1), (1) University of South Carolina, 715 Sumter St., Room 401, Columbia, SC 29208, USA

A6. FECAL COLIFORM DENSITIES IN THE GUANA TOLOMATO MATANZAS NATIONAL ESTUARINE RESEARCH RESERVE. Moore, J. G. (1), J. Wade (1), C. L. Cooksey (1), M. Fulton (1), (1) NOAA, NOS, NCCOS, CCEHBR, 219 Ft. Johnson Rd., Charleston, SC 29412-9110, USA

A7. CHALLENGES ASSOCIATED WITH ESTABLISHING AN OYSTER RECYCLING AND REEF RESTORATION PROGRAM. Walters, K. (1), K. Roff (2), C. Martin (3), N. Chambers (4), L. Coen (5), (1) Coastal Carolina University, Dept. of Marine Science, P.O.B. 261954, Conway, SC 29528, USA; (2) Fisher Recycling Grand Strand, 104 Calvert Ct., Pawleys Island, SC 29585, USA; (3) Louisiana State University, Dept. of Oceanography & Coastal Sciences, 1229 Energy Coast & Environment Bldg., Baton Rouge, LA 70803, USA; (4) Chambers Design, 155 Water Street, Brooklyn, NY 11205, USA; (5) Florida Atlantic University, 16007 Waterleaf Lane, Fort Myers, FL 33908, USA

B. Incorporating Approaches for Shellfish Restoration

B1. ADAPTATION OF RESTORATION PRACTICE: USING SUBSTRATE VOLUME AND OYSTER POPULATION METRICS TO DEFINE FUTURE PROJECT OBJECTIVES AND REFINE IMPLEMENTATION. Allen, B. (1), (1) Puget Sound Restoration Fund, 590 Madison Ave. N., Bainbridge Island, WA 98110, USA

B2. SOUTH ATLANTIC RESTORATION METHODS: A COMPARATIVE STUDY. Brown, J. M. (1), H. L. Brown (2), (1) The Nature Conservancy, 1417 Stuart Engals Blvd., Suite 100, Mt. Pleasant, SC 29464, USA; (2) College of Charleston, 221 Hanahan Plantation Circle, Hanahan, SC 29410, USA

B3. PALMETTO PLANTATION OYSTER CASTLE REEF SURVEY. Brown, J. M. (1), S. Harris (2), S. L. Tyson (2), (1) The Nature Conservancy, 1417 Stuart Engals Blvd., Suite 100, Mt. Pleasant, SC 29464, USA; (2) College of Charleston, 66 George Street, Charleston, SC 29424, USA

Poster Sessions

B4. DIRECT SEEDING OF HATCHERY-PRODUCED OYSTER LARVAE ONTO CONSTRUCTED OYSTER REEFS IN THE ST. LUCIE ESTUARY, FLORIDA. Encomio, V. G. (1), J. Thiery (2), (1) Florida Oceanographic Society, 890 N.E. Ocean Blvd., Stuart, FL 34996, USA; (2) Indian River State College, 3209 Virginia Ave., Fort Pierce, FL 34981, USA

B5. AN ALTERNATIVE ROADMAP FOR ENGAGING STAKEHOLDERS IN OYSTER REEF RESTORATION IN THE ACE BASIN NERR, SOUTH CAROLINA, USA. Kingsley-Smith, P. R. (1), B. W. Stone (1), B. P. Keppler (2), J. W. Leffler (2), (1) South Carolina Department of Natural Resources, 217 Fort Johnson Road, P.O. Box 12559, Charleston, SC 29422-2559, USA; (2) ACE Basin NERR, South Carolina Department of Natural Resources, 217 Fort Johnson Road, P.O. Box 12559, Charleston, SC 29422-2559, USA

B6. PRIME REAL ESTATE: VARIED HABITAT COMPLEXITY AND ALTERNATIVE SUBSTRATE MATERIALS. Peters, J. W. (1), M. Jordan (1), (1) NC Division of Marine Fisheries, 3441 Arendell St., Morehead City, NC 28557, USA

B7. ROLE OF PREDATION, HABITAT, AND ENVIRONMENTAL FACTORS ON SOFT-SHELL AND RAZOR CLAMS IN CHESAPEAKE BAY: IMPLICATIONS FOR RESTORATION. Seitz, R. D. (1), C. N. Glaspie (1), M. B. Ogburn (2), A. H. Hines (2), (1) Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA 23062, USA; (2) Smithsonian Environmental Research Center, 647 Contees Wharf Road, Edgewater, MA 21037, USA

C. Restoring Shellfish: Implementation, Monitoring, and Lessons Learned

C1. GROWTH AND SIZE AT SEXUAL MATURITY OF THE CHANNELED WHELK (*BUSYCOTYPUS CANALICULATUS*) AND KNOBBED WHELK (*BUSYCON CARICA*) IN NARRAGANSETT BAY, RHODE ISLAND AND CURRENT STOCK STATUS. Angell, T. E. (1), (1) Rhode Island Division of Fish and Wildlife, 3 Fort Wetherill Road, Jamestown, RI 02835, USA

C2. LONG-TERM MONITORING OF OYSTER REEF AND LIVING SHORELINE PILOT PROJECTS IN SOUTH CAROLINA. Brown, J. M. (1), M. Moore (2), (1) The Nature Conservancy, 1417 Stuart Engals Blvd., Suite 100, Mt. Pleasant, SC 29464, USA; (2) The Nature Conservancy (contractor), 221 Hanahan Plantation Circle, Hanahan, SC 29410, USA

C3. RESTORING OYSTER REEFS IN FLORIDA'S BIG BEND IN THE FACE OF REDUCED FRESHWATER FLOWS: THE ROLE OF DURABLE SUBSTRATE. Frederick, P. C. (1), B. Pine (1), L. Sturmer (2), J. Seavey (3), (1) University of Florida, P.O. Box 110430, Department of Wildlife Ecology and Conservation, Gainesville, FL 32611, USA; (2) University of Florida, Sen. Kirkpatrick Marine Lab, 11350 S.W. 153rd Ct., Cedar Key, FL 32625, USA; (3) University of New Hampshire, School of Marine Science and Ocean Engineering, 24 Colovos Road, Durham, NH 03824, USA

C4. PERFORMANCE EVALUATION OF TWO GROW-OUT METHODS ON THE PREVENTION OF OYSTER SPAT FOULING ON INTERTIDAL FARMED OYSTERS (*CRASSOSTREA VIRGINICA*) IN GEORGIA. Manley, J. (1), T. Bliss (2), (1) University of Georgia Marine Extension Service Shellfish Research Laboratory, 20 Ocean Science Circle, Savannah, GA 31411, USA; (2) University of Georgia Marine Extension Service, 20 Ocean Science Circle, Savannah, GA 31411, USA




C5. WHAT EFFECT DOES pH HAVE ON THE GROWTH OF *TETRASELMIS CHUII* (PLY 429)? Trommatter, J. E. (1), D. W. Meritt (1), L. M. Guy (1), (1) University of Maryland Center for Environmental Science Horn Point Laboratory, 2020 Horns Point Road, Cambridge, MD 21613, USA

D. Documenting Goods and Services Provided by Shellfish Populations and Ecosystems

D1. MONITORING AND COMPARING NEKTONIC COMMUNITIES UTILIZING ARTIFICIAL AND NATURAL OYSTER (*CRASSOSTREA VIRGINICA*) REEFS IN COASTAL GEORGIA. Rinn, S. (1), T. Bliss (2), (1) University of Georgia Marine Extension Service Shellfish Research Laboratory, 20 Ocean Science Circle, Savannah, GA 31411, USA; (2) University of Georgia Marine Extension Service, 20 Ocean Science Circle, Savannah, GA 31411, USA

D2. MARSH RESTORATION AT HARBOUR TOWN GOLF LINKS' 18TH GREEN, HILTON HEAD, SC. Wartko, T. (1), C. Corbitt (1), (1) The Sea Pines Resort, SC, USA

E. Getting the Word Out

E1. COMMUNITY-BASED OYSTER GARDENING, MONITORING, AND RESTORATION IN THE INDIAN RIVER LAGOON, FLORIDA. Anderson, S. (1), J. Palmer (1), (1) Brevard Zoo, 8225 N. Wickham Rd., Melbourne, FL 32940, USA

E2. NOAA'S NATIONAL SHELLFISH INITIATIVE: BUILDING PARTNERSHIPS TO MAXIMIZE THE ECOLOGICAL AND ECONOMIC BENEFITS OF SHELLFISH. Rubino, M. C. (1), S. M. Bunsick (1), S. Morlock (2), R. C. Jones (1), K. McGraw (2), (1) NOAA Fisheries Office of Aquaculture, 1315 East-West Highway, Silver Spring, MD 20910, USA; (2) NOAA Restoration Center, 1315 East-West Highway, Silver Spring, MD 20910, USA

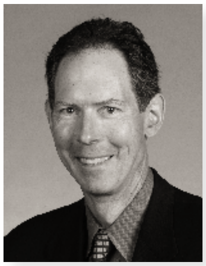
E3. OYSTER RESTORATION PROGRAMMING IN THE INDIAN RIVER LAGOON ESTUARY, FLORIDA: A MULTI-FACETED INITIATIVE FOCUSED ON COMMUNITY-BASED ENVIRONMENTAL STEWARDSHIP. Creswell, L. (1), (1) Florida Sea Grant, 2199 South Rock Road, Fort Pierce, FL 34945, USA

E4. THE NATIONAL ESTUARY PROGRAM (NEP)/NOAA COMMUNITY-BASED RESTORATION PARTNERSHIP: PARTNERS IN OYSTER HABITAT RESTORATION. O'Hanlon, L.H. (1), S. Morlock (2), (1) Association of National Estuary Programs, 1110 Raintree Drive, Charlottesville, VA 22901, USA; (2) NOAA Restoration Center, Community-Based Restoration Program, 1315 East-West Highway, Silver Spring, MD 20910, USA

E5. STAKEHOLDER-DRIVEN OYSTER (*CRASSOSTREA VIRGINICA*) RESTORATION IN THE ACE BASIN, SOUTH CAROLINA. Hulteen, J. S. (1), M. Hodges (1), S. Czwartacki (1), J. Leffler (1), (1) South Carolina Department of Natural Resources, Marine Resources Division, 217 Ft. Johnson Road, Charleston, SC 29412, USA

E6. OYSTER RESTORATION IN AN URBAN ESTUARY: USING "ECO-VOLUNTEERS" TO CONSTRUCT AND MONITOR AN OYSTER REEF IN BRONX, NY. Malinowski, P. (1), A. M. Fitzgerald (2), (1) Billion Oyster Project, New York Harbor School, Battery Maritime Building, Slip 7, 10 South Street, New York, NY 10004, USA; (2) NY NJ Baykeeper, 52 W. Front Street, Keyport, NJ 07735, USA

Keynote Speakers'
Biographies



Michael Rubino
Director
Office of Aquaculture, National Oceanic and Atmospheric Administration,
National Marine Fisheries Service

Dr. Michael Rubino is the director of the Office of Aquaculture in Silver Spring, Maryland. He joined the National Oceanic and Atmospheric Administration (NOAA) in late 2004 to lead NOAA's renewed commitment to marine aquaculture. The office seeks to foster marine aquaculture through policy, science, outreach, and international collaboration. Dr. Rubino represents the Department of Commerce as the vice chair of the Interagency Working Group on Aquaculture, the federal agency coordinating committee under the White House Office of Science and Technology Policy. Prior to joining NOAA, Dr. Rubino was the manager of New Funds Development for the World Bank's Carbon Finance Group. In the 1990s, Dr. Rubino was at the International Finance Corporation, a private sector affiliate of the World Bank, where he developed renewable energy and biodiversity investment funds. Earlier he was the CEO of an aquaculture R&D company and a partner in a shrimp farm in South Carolina. Dr. Rubino also served as vice chair of the State of Maryland's Aquaculture Advisory Committee. He holds a Ph.D. in Natural Resources from the University of Michigan.

Betsy Peabody
Founder and Executive Director
Puget Sound Restoration Fund

Betsy Peabody is founder and executive director of Puget Sound Restoration Fund (PSRF), president of the Pacific Shellfish Institute, and an active player in the Washington Shellfish Initiative. She served on Washington State's Governor-appointed Blue Ribbon Panel on Ocean Acidification (OA) in 2012 and is currently working with the Marine Resources Advisory Council to further investigate OA mitigation and outreach strategies. Before founding Puget Sound Restoration Fund in 1997, Betsy worked for the Puget Sound Water Quality Authority, local governments, the Seattle Aquarium, and other nonprofits on Puget Sound projects. She also served as vice chair of the Bainbridge Island Harbor Commission from 1997-2002. Betsy has a Bachelor's Degree in English from Stanford University—and a decided interest in all things marine.

Peter Malinowski
Director
Billion Oyster Project,
New York Harbor Foundation

Peter Malinowski grew up farming oysters with his parents on the Fishers Island Oyster Farm. He is the founder of the aquaculture and oyster restoration programs at the New York Harbor School. As a teacher he developed a three-year restoration-based Aquaculture curriculum, in which students do the work of raising millions of oysters for a city-wide environmental restoration project. Malinowski and his students designed and built New York Harbor's first Floating Upwelling System (FLUPSY), two floating oyster nurseries, and are currently working in the first marine bivalve hatchery to ever exist in New York City. This fall Pete left Harbor School to run the Billion Oyster Project (BOP) full time with the New York Harbor Foundation. Pete co-founded the project several years ago and now works directly with Harbor School staff and students and other schools to achieve the ambitious restoration and education goals of the BOP, which aims to involve thousands of public school students in the restoration of one billion oysters to New York Harbor over the next 20 years. Pete believes that the science, policy, and history of an ecosystem provide a powerful narrative for teaching and learning. Involving high school students in restoration work through their core academic classes is an excellent tool for engaging young people in school and should be used as an educational resource in any city that happens to exist on or near degraded natural systems.

Panel Session Descriptions

Thursday, December 11, 2014

10:30 a.m. to 12:10 p.m.
CONCURRENT PANEL - SESSION B
Harleston, HSG

"Washington State Shellfish Initiative, Hatcheries and Restoration Efforts"

CHAIR
Betsy Peabody
Puget Sound Restoration Fund

PANELISTS

Betsy Peabody
Puget Sound Restoration Fund

Michael Rubino
Office of Aquaculture,
National Oceanic and
Atmospheric Administration,
National Marine Fisheries Service

Margaret Pilaro Barrette
Pacific Coast Shellfish Growers Association

Jonathan Davis
Puget Sound Restoration Fund

Ryan Crim
Puget Sound Restoration Fund

Josh Bouma
Puget Sound Restoration Fund

DESCRIPTION

The Kenneth K. Chew Center of Shellfish Research and Restoration opened with considerable fanfare at a May 22, 2014 dedication event. The new, state-of-the-art shellfish restoration hatchery, located at NOAA's Manchester Research Station, is a product of the National and Washington Shellfish Initiatives, launched in 2011 with the express purposes of enhancing shellfish resources in coastal waters of the U.S. and Washington State, respectively.

In the subsequent three years, these initiatives have created a dynamic model for:

- Restoring shellfish growing areas plagued by pollution downgrades;
- Increasing the scale and capacity of Olympia oyster restoration efforts; and
- Increasing and optimizing Pinto abalone recovery efforts.

How and why did this happen, and what can be learned from Washington's example?

A panel of presenters with aquaculture, hatchery, and restoration perspectives will describe the forces that led to the Washington Shellfish Initiative and provide technical details on designing and operating two shellfish restoration hatcheries devoted to restoring native shellfish species.

Restoration Aquaculture in Washington State has taken on greater significance in recent years for two reasons. One, recovering native shellfish species in areas that have lost breeding populations requires some degree of hatchery propagation. Two, the number of species requiring hatchery propagation may increase as a result of ocean acidification.

Operating a restoration hatchery within the context of changing ocean conditions involves a gauntlet of challenges, including seawater monitoring, potential ESA listings (in the case of Pinto abalone), and the ever-present need to ensure genetic diversity and eliminate risk of disease. Shellfish Initiatives provide an opportunity for industry, government, research institutions, and nonprofits to pool resources in order to give shellfish and other calcifiers a helping hand.

Panel Session Descriptions

1:30 p.m. to 3:10 p.m.
CONCURRENT PANEL - SESSION D
Harleston, HSG

"Large-Scale Oyster Restoration in Chesapeake Bay: Challenges and Solutions"

CHAIR
Eric Weissberger
Maryland Department of Natural Resources

PANELISTS
Eric Weissberger
Maryland Department of Natural Resources

Romuald Lipcius
Virginia Institute of Marine Science

Anne Handschy
University of Maryland

Donald Meritt
University of Maryland Center for Environmental Science
Horn Point Laboratory

Lisa Kellogg
Virginia Institute of Marine Science

David Schulte
U.S. Army Corps of Engineers

DESCRIPTION

Oyster populations in Chesapeake Bay are at historically low levels. Early oyster restoration efforts in the Bay were small in scale and produced only localized ecosystem benefits. Partnerships among federal and state agencies, nonprofit organizations, and academia allow large-scale restoration efforts to be undertaken in hopes of achieving increased ecosystem services. Several large-scale oyster restoration projects are planned or currently underway in Maryland's Harris Creek, Little Choptank River and Tred Avon River, and Virginia's Great Wicomico, Piankatank, Lynnhaven, and Lafayette rivers. Large-scale oyster restoration faces challenges including disease, regulatory issues, stakeholder conflicts, limited funding, a shortage of cultch, and insufficient resources for monitoring oyster populations and associated ecosystem services. This session will explore these challenges with the goal of developing strategies to overcome them, facilitating large-scale oyster restoration in Chesapeake Bay.




3:40 p.m. to 5:20 p.m.
CONCURRENT PANEL - SESSION F
Harleston, HSG

"East Coast Molluscan Health Management"

CO-CHAIRS
David Bushek
Rutgers University

Ryan Carnegie
Virginia Institute of Marine Science

PANELISTS
David Bushek
Rutgers University

Ryan Carnegie
Virginia Institute of Marine Science

Lori Gustafson
U.S. Department of Agriculture

Nancy Hadley
S.C. Department of Natural Resources

Robert Rheault
East Coast Shellfish Growers Association

Jeff Silverstein
U.S. Department of Agriculture

Leslie Sturmer
University of Florida

William Walton
Auburn University

DESCRIPTION

A recent workshop at the Virginia Institute of Marine Science (VIMS) sponsored by USDA APHIS, Virginia Sea Grant, and New Jersey Sea Grant examined the problems of protecting shellfish health as shellfish transfers increase among East Coast states due to shellfish aquaculture expanding exponentially. A second workshop supported by the National Sea Grant Aquaculture Program will precede the joint Northeast Aquaculture Conference and Exposition and Milford Aquaculture Seminar in Portland, ME this coming January. In an effort to reach a broader audience of stakeholders including shellfish producers, regulators, and pathologists, this panel will review the results from the VIMS workshop and seek input from those attending ICSR that may or may not attend the January workshop. The goal is to develop a regional strategic plan that is acceptable to stakeholders and that maximizes the maintenance of healthy shellfish without stifling growth of this valuable industry.

Panel Session Descriptions

FRIDAY, DECEMBER 12, 2014

8:40 a.m. to 10:00 a.m.
CONCURRENT PANEL - SESSION G
Harleston, HSG

"Interpreting the National Shellfish Sanitation Program: Where Restorers and Regulators Intersect"

CHAIR
Sandy Macfarlane
Coastal Resource Specialists

PANELISTS
Sandy Macfarlane
Coastal Resource Specialists

Michael Pearson
S.C. Department of Health and Environmental Control

Aaron Wozniak
U.S. Department of Health and Human Services, Food and Drug Administration

Michael Hickey
Massachusetts Department of Fish and Game, Division of Marine Fisheries

Peter Malinowski
Billion Oyster Project, New York Harbor Foundation

DESCRIPTION

This panel will explore the relationship between shellfish restoration and public health. Panel members representing resource managers and public health officials at both state and federal levels and restoration practitioners will discuss the respective responsibilities and roles of the Interstate Shellfish Sanitation Conference (ISSC) and shellfish restorers within the framework of the National Shellfish Sanitation Program (NSSP). Panel members will guide an educational process to increase understanding of the ISSC and the NSSP. For the ISSC, topics include: what it is; what it does and does not do; what compliance is defined as; and how compliance is determined. For the NSSP, topics include: what the program is; why it was created and reasons for its existence; how it works; and interpretation. Lastly, the panel will examine the role of shellfish restoration, including restoration in unapproved waters, within this framework and highlight current restoration issues and pathways to move forward.

SATURDAY, DECEMBER 13, 2014

9:00 a.m. to 10:00 a.m.
CONCURRENT PANEL - SESSION O
Ansonborough, HSG

"The Future of Shellfish Restoration in the Face of a Changing Climate"

CHAIR
Elizabeth Fly
S.C. Sea Grant Consortium

PANELISTS
Elizabeth Fly
S.C. Sea Grant Consortium

Robert Rheault
East Coast Shellfish Growers Association

Jonathan Davis
Puget Sound Restoration Fund

Charles Lovell
University of South Carolina

DESCRIPTION

As the impacts of climate change become more and more prominent, the continued success of shellfish restoration will rely on staying at the cutting edge of science and innovation. These impacts will be far-reaching – from sea level rise and ocean acidification to increasing water and air temperatures that affect the health, phenology, and distribution of shellfish. It is becoming increasingly important to ensure restoration projects are designed in such a way to increase their resilience to these impacts. This panel discussion will highlight tools, resources, and examples of partnerships that can help incorporate climate change considerations in restoration work. The discussion will also identify needs and barriers to implementing climate-relevant restoration strategies.

Panel Session Descriptions

9:00 a.m. – 10:00 a.m.
CONCURRENT PANEL - SESSION P
Harleston, HSG

"Developing a Restoration Portfolio for Long-Term Oyster Sustainability in the Gulf of Mexico"

CO-CHAIRS
Judy Haner
The Nature Conservancy

William Walton
Auburn University

PANELISTS
Judy Haner
The Nature Conservancy

William Walton
Auburn University

Just Cebrian
Dauphin Island Sea Lab

Dan Petrolia
Mississippi State University

Chris Blankenship
Alabama Marine Resources Division

Bryan DeAngelis
The Nature Conservancy

DESCRIPTION

This session will explore the concept of an oyster restoration portfolio as a path to long-term oyster sustainability by examining mutually beneficial ecosystem service benefits derived from outcome-driven oyster restoration. Comparisons of ecosystem service benefits between commercially harvested reefs, off-bottom aquaculture, and habitat restoration projects have remained elusive. A recently published *Oyster Habitat Restoration Monitoring and Assessment Handbook* defines common basic metrics used to gauge the success of oyster reef restoration efforts across all project types. A number of secondary metrics (e.g., shoreline stabilization, enhancement of submerged aquatic vegetation) have also been proposed as indicators of restoration success. We will present the common metrics, compare and contrast secondary metrics, and explore the economic benefits of each type of restoration. This will lead into the discussion of an oyster restoration portfolio that incorporates commercial harvests, aquaculture, and habitat restoration in concert to achieve long-term sustainability of this critical resource.




10:00 a.m. – 11:30 a.m.
CONCURRENT PANEL - SESSION Q
Cooper Room, DT

"Coherent Approach to* Busycon/Busycotypus *Fishery Management Along the U.S. Atlantic Seaboard"

CHAIR
Robert Fisher
Virginia Sea Grant College Program

PANELISTS

Robert Fisher
Virginia Sea Grant College Program

Bradley Stevens
University of Maryland Eastern Shore

Richard Wong
Delaware Division of Fish & Wildlife

Bob Glenn
Massachusetts Division of Marine Fisheries

Rick Robins
Chesapeake Bay Packing

Tom Bliss
University of Georgia

DESCRIPTION

Members of the *Busycon* and *Busycotypus* genus of large marine gastropods are found along the Atlantic Coast of North America from Cape Cod, Massachusetts to Cape Canaveral, Florida and are the focus of commercial fisheries throughout their range. In the 1980's, the channeled whelk, *Busycotypus canaliculatus*, and knobbed whelk, *Busycon carica*, were unregulated fisheries within state waters. Biological assessment information for the more accessible knobbed whelk was subsequently used for general whelk fishery management guidelines, and has continued to-date. Most coastal states have existing whelk harvest regulations that are largely based on minimal landing size (MLS), either by shell length or shell width, which varies from state-to-state. In fisheries management, the intent of most MLS is to identify a harvestable size of a given targeted species which allows for juveniles to survive and spawn at least once. The channeled whelk, which has become the more marketable of the species and therefore experiences greater exploitation, has existed as a data-poor resource with little to no biological assessment information available, including size at maturity.

Whelk fisheries along the U.S. East Coast are currently experiencing various resource challenges, such as increasing fishing pressure, decreasing size composition of landed whelk, and declining catch per unit effort, which elicit the need to address these fishery concerns and reevaluate current management regulations. Recent research findings on age, growth, size at maturity, and reproductive potential in the historically data poor channeled whelk populations along the U.S. Atlantic Coast, as well as new findings within knobbed whelk resources, are now available for review. In light of new science-based information, a collaborative effort between industry, academia, and regulatory agencies is needed to address current whelk resource concerns and provide for a coherent approach to whelk fishery management along the U.S. Atlantic seaboard.

Oral and Poster Presentation Abstracts

USING A PRODUCTION-SCALE OYSTER HATCHERY AS AN EDUCATIONAL TOOL. Alexander, S. T. (1), J. A. Alexander (1), J. E. Trommatter (1), E. A. Roache (1), S. M. Willey (1), S. M. Weschler (1), R. Carey (1), D. W. Meritt (1), (1) University of Maryland Center for Environmental Science Horn Point Laboratory, P.O. Box 775, Cambridge, MD 21613, USA

The University of Maryland Center for Environmental Science's Horn Point Oyster Hatchery is one of the largest shellfish culture facilities in North America and produces in excess of 500 million spat on shell annually. These oysters are used in support of a cooperative restoration program with the goal of reestablishing healthy oyster populations to the Chesapeake Bay. For the past two decades, we have been working with our partners, the Oyster Recovery Partnership, Maryland Department of Natural Resources, National Oceanic and Atmospheric Administration, the United States Army Corp of Engineers, and others to achieve this goal.

In addition to spat production, a goal of equal importance to our program is to provide educational opportunities highlighting the importance of oysters to the overall health of the Chesapeake Bay and the fisheries they support. Public understanding and support of our program is paramount to our success. We offer a variety of tours and educational opportunities at our production facility throughout the year geared toward educating visitors from all walks of life including school children (K-12), elected officials, private oyster growers, scientists, media outlets, and many others about the process of oyster restoration. Over the last 10 years we have toured over 18,000 people through our hatchery facilities. Bringing visitors into our facility affords us the unique opportunity to offer experiential environmental education. We believe that incorporating an actual hands on learning experience into a more traditional "show and tell" format increases the probability that the participants will leave our facility with a better understanding of what our hatchery does and why it is important to the Chesapeake Bay.

ADAPTATION OF RESTORATION PRACTICE: USING SUBSTRATE VOLUME AND OYSTER POPULATION METRICS TO DEFINE FUTURE PROJECT OBJECTIVES AND REFINE IMPLEMENTATION. Allen, B. (1), (1) Puget Sound Restoration Fund, 590 Madison Ave. N., Bainbridge Island, WA 98110, USA

The Puget Sound Restoration Fund uses monitoring data from past Olympia oyster (*Ostrea lurida*) stock and habitat rebuilding projects to inform and adapt future restoration practice. As these projects move from pilot-scale into larger actions we have a need to both bring efficiency to implementation, in terms of resources, but also understand the density dependent recruitment process to evaluate stock rebuilding within project sites. Now that some large projects are exceeding 5 years of age, it gives us a great opportunity to examine how settlement substrate "amount" correlates with oyster densities, but also how adult oyster density and abundance modulates juvenile recruitment. Studying the relationship between these factors has adapted our current implementation practice. This poster will show how we measure substrate amount, how these values correlate with oyster population structures in restoration sites, and some empirical population thresholds that produce a marked effect to juvenile recruitment.

OLYMPIA OYSTER (*OSTREA LURIDA*) BED HABITAT RESTORATION - A PUGET SOUND CASE STUDY FOR STOCK AND HABITAT REBUILDING, AND EXAMINATIONS OF ECOSYSTEM SERVICE. Allen, B. (1), (1) Puget Sound Restoration Fund, 590 Madison Ave. N., Bainbridge Island, WA 98110, USA

Restoration partners in Puget Sound are working in 19 priority areas where a strategic and adaptive approach is being employed to restore Olympia oyster bed habitat over large spatial scales. The intent of this program is to rebuild both settlement habitat resources locally and the robust oyster populations that modulate this biogenic habitat. We will




discuss a case from Puget Sound where 10 years of adaptive project work have resulted in declared restoration success, adapted implementation and monitoring approaches, and the potential to examine the ecosystem service benefits of this estuary habitat form.

COMMUNITY-BASED OYSTER GARDENING, MONITORING, AND RESTORATION IN THE INDIAN RIVER LAGOON, FLORIDA. Anderson, S. (1), J. Palmer (1), (1) Brevard Zoo, 8225 N Wickham Rd., Melbourne, FL 32940, USA

Valued at over $3.7 billion, and considered to be one of the most biologically diverse estuaries in the continental United States, the importance of the Indian River Lagoon is undeniable. Continuous inputs of pollution overload the estuary causing the water quality to decline, resulting in algal blooms and deaths of wildlife, including valuable oyster reefs. The Brevard Oyster Gardening Project, launched by Brevard Zoo in partnership with Brevard County, is taking action within our own community to repair the damage done in the Indian River Lagoon. The Brevard County Commissioners funded this project with $150,000 for supplies and training of over 725 volunteer residents to become oyster gardeners. Oysters are filter feeding bivalves that can remove suspended particles from the water at an astonishing rate of nearly 50 gallons of water per day, providing improved water quality throughout the ecosystem. This project was inspired by the oyster reef restoration work by Brevard Zoo, University of Central Florida, and the efforts of 36,000 volunteers, in Mosquito Lagoon using oyster mats to successfully restore 63 reefs to date, returning 4.2 million oysters to the habitat. Within the gardening project, Brevard County residents act as citizen scientists installing oyster habitats on their personal docks and weekly monitoring their progress. Data collected will provide information regarding the survivability and recruitment of oysters in Brevard County for future large scale oyster reef restoration in the Indian River Lagoon. Site selections for three pilot reefs are currently underway to begin constructing oyster reefs to determine the most effective methodology.

GROWTH AND SIZE AT SEXUAL MATURITY OF THE CHANNELED WHELK (*BUSYCOTYPUS CANALICULATUS*) AND KNOBBED WHELK (*BUSYCON CARICA*) IN NARRAGANSETT BAY, RHODE ISLAND AND CURRENT STOCK STATUS. Angell, T. E. (1), (1) Rhode Island Division of Fish and Wildlife, 3 Fort Wetherill Road, Jamestown, RI 02835, USA

The channeled whelk and knobbed whelk occurring in Rhode Island waters have been harvested over the past 125 years as a means to control predation on more economically-important clam and oyster populations (Shaw 1960, Walker 1988); for over 100 years as a food-source bycatch and economic supplement in southern New England lobster and finfish fisheries (DeKay 1843, Davis and Sisson 1978); and over the past approximately 35 years as a directed fishery since the economic viability of predominantly ethnic markets for whelks has increased. In spite of this relatively long history of exploitation, virtually nothing is known regarding the life history traits (growth rates, size-at-maturity) of these whelk species in the northern extent of their range. The Rhode Island Division of Fish and Wildlife initiated a data collection program in 2012 to provide this basic biological information needed for fishery management purposes. Analyses indicate that less than 10% of female and 80-90% of male channeled whelk are mature at current minimum legal size standards; approximately 40-50% of female and 100% of male knobbed whelk are mature at current minimum size standards. A whelk stock assessment using a biomass dynamic model was performed in 2010 and was recently updated to include data through 2013 and resulted in re-estimation of F_{msy}=0.40. High fishing mortality rates above F_{msy}=0.40 result in low biomass; high whelk abundance occurs when the F is less than F_{msy}. The updated target F rate is 0.30. F has risen and is now estimated to be at or above F_{msy} , so overfishing is likely. Biomass remains at or above B_{msy}. Projections indicate however that biomass will fall below B_{msy} if overfishing continues.

Oral and Poster Presentation Abstracts

FROM SEEDS TO SHORELINE: ENGAGING STUDENTS IN SALT MARSH RESTORATION. Bell, E.V. (1), (1) S.C. Sea Grant Consortium and COSEE SE, 287 Meeting Street, Charleston, SC 29401, USA

From Seeds to Shoreline (S2S) is South Carolina's first student-driven salt marsh restoration program and is coordinated by the S.C. Sea Grant Consortium in partnership with the S.C. Department of Natural Resources and the Clemson University Cooperative Extension Service. The S2S program teaches stewardship about the salt marsh ecosystem through seed collection, germination, cultivation, and transplantation of *Spartina alterniflora*, the dominant plant in southeastern salt marshes. Several S2S sites for the transplanting of *Spartina alterniflora* are located behind restored oyster reefs with the goal of supplementing shoreline stabilization and the creation of new habitat. Since the piloting of the program in 2011, S2S has grown from 16 teachers and 700 students to 38 teachers and more than 1,600 students for the 2014-2015 academic school year.

COMPETITION, COMMENSALISM, AND CONSUMPTION: THE COMMUNITY ECOLOGY OF OYSTER REEFS AND DERMO DISEASE. Ben-Horin, T. (1), D. Bushek (1), D. Munroe (1), (1) Rutgers University, 6959 Miller Ave, Port Norris, NJ 08349, USA

Competitive interactions among and between species can profoundly influence disease outbreaks. Hosts often encounter pathogens while feeding, but competitive interactions between hosts for food resources and their associated pathogens have only recently been integrated into studies of disease transmission and pathology. Oyster reefs, their commensal filter-feeding fouling communities, and Dermo disease illustrate this central connection between foraging and transmission. Using a series of mesocosm experiments that varied the density of oysters, the density of the agent of Dermo disease (*Perkinsus marinus*), and the presence of the commensal, filter-feeding tunicate *Molgula manhattensis*, we advanced mechanistic yet general hypotheses of Dermo transmission and pathology based on broadly applicable components of resource competition and feeding biology. We found the prevalence of Dermo disease to rise with increasing per capita dose of *Perkinsus marinus*, but, due to increased competition for suspended particles, fell sharply with increasing oyster density. The presence of commensal tunicates, which were incompetent hosts for *Perkinsus marinus*, diluted seawater densities of this pathogen through the consumption of suspended particles, resulting in lower prevalence and intensity of Dermo disease in oysters. The net result of resource competition and pathogen dilution is challenging to predict in nature, but delivers a new perspective for evaluating the observed emergence and persistence of Dermo disease following the decline of oyster fisheries. Can dense oyster populations and their commensal filter-feeding fouling communities "over-filter" *Perkinsus marinus* and minimize the impact of Dermo disease? The answer to this question will have profound consequences for the conservation and restoration of oyster reefs anywhere Dermo is present.

RESPONSE OF NEKTON TO INSTALLATION OF A LIVING SHORELINE ON LITTLE ST. SIMONS, GA. Bliss, T. (1), S. Coleman (2), D. Hurley (3), J. Mackinnon (4), C. Lambert (5), (1) University of Georgia Marine Extension Service, 20 Ocean Science Circle, Savannah, GA 31411, USA; (2) Little St. Simons Island, 1000 Hampton Point Dr., St. Simons Island, GA 31522, USA; (3) Sapelo Island National Estuarine Research Reserve, PO Box 15, Sapelo Island, GA 31327, USA; (4) Georgia Department of Natural Resources Coastal Resources Division, One Conservation Way, Brunswick, GA 31520, USA; (5) The Nature Conservancy, 2865 US HWY 17, Darien, GA 31305, USA

In Georgia, the use of living shorelines constructed using oyster (*Crassostrea virginica*) shell and native plants to stabilize erosion are being evaluated. Currently, the use of bulkheads and revetments are the common methods used to address erosion. Our study focused on the response of the nektonic community to the establishment of a 92 meter




long living the shoreline on Little St. Simons Island that had previously been protected by a bulkhead. To examine the impact of the living shoreline upon nekton we conducted quarterly sampling for one year prior to bulkhead removal and have completed one year of sampling after installing the living shoreline. Nekton were sampled using three 24m^2 bottomless lift nets for 1 day each season. In addition, oyster density was sampled using 0.25m^2 quadrants along 10 transects before and after installation. Prior to removal of the bulkhead we identified 17 nektonic species (7 crustaceans and 10 fish) for all seasons combined and no oysters were observed. Species identification post construction is ongoing, but currently 24 nekton species (4 crustaceans and 20 fish) have been identified from summer and fall sampling. Oyster density was 22.8 live oysters m^2 six months after establishment with a mean shell height of 20.46 mm. Statistical analysis will be used to determine if any differences exist between the nektonic community before and after installation of the living shoreline.

SOUTH ATLANTIC RESTORATION METHODS: A COMPARATIVE STUDY. Brown, J. M. (1), H. L. Brown (2), (1) The Nature Conservancy, 1417 Stuart Engals Blvd., Suite 100, Mt. Pleasant, SC 29464, USA; (2) College of Charleston, 221 Hanahan Plantation Circle, Hanahan, SC 29410, USA

South Atlantic Restoration Methods: A Comparative Study is an internship project by Hilary Brown for the Masters of Science in Environmental Studies from the College of Charleston. The internship report looks at information and data collected from 11 different agencies working on oyster restoration and living shoreline projects along the South Atlantic in North Carolina, South Carolina, Georgia, and Florida. At the heart of the comparison is a database of information identifying funding sources and trends, monitoring methods, materials used, as well as public outreach efforts. Findings indicate most of the funding for restoration projects comes from federal agencies. Restoration sites are being monitored for one to three years and oyster and shoreline growth are the predominate variables being monitored. Most of the projects utilize oyster restoration over living shoreline and the type of materials used at each site depends on the site energy level. Despite the type of project or location, there is a limited amount of material associated with education, outreach, and awareness. As a part of the study, a practitioners survey is being created that can be distributed to their local public to gain a sense of public awareness about oyster restoration and living shoreline projects. Lastly practitioners are offered suggestions on how to improve communication amongst the science and contractor community.

PALMETTO PLANTATION OYSTER CASTLE REEF SURVEY. Brown, J. M. (1), S. Harris (2), S. L. Tyson (2), (1) The Nature Conservancy, 1417 Stuart Engals Blvd., Suite 100, Mt. Pleasant, SC 29464, USA; (2) College of Charleston, 66 George Street, Charleston, SC 29424, USA

The Palmetto Plantation Oyster Castle Reef was installed by The Nature Conservancy and Boeing volunteers in August 2012 on the northwest bank of the Atlantic Intracoastal Waterway (ICW) northeast of McClellanville, S.C. Site surveys, including shoreline change analyses, sediment grainsize distributions, and oyster recruitment observations, were conducted by the College of Charleston's Geology Department from June 2012 through October 2013 to address the overall goal of enhancing oyster reefs in this area while stabilizing the adjacent shoreline. This goal was accomplished with the reef installation project. Nine site visits were made to the area, 264 sediment samples were analyzed, 852 photographs were taken, seven laser scans were taken, and seven people participated in the surveys. Five control posts were placed in the marsh, and RTK-GPS measurements were used as geodetic control to georectify all data in ArcGIS so that observations, shoreline positions, sediment accumulation patterns, and changes could be documented. Historical shoreline analyses indicate overall accretion in this area, with the period from 2006 to 2013 showing erosion as prominent. Detailed shoreline studies from this project indicate consistent erosion before installation of the reef, and accretion behind the reef in two lobes. Oyster recruitment was almost immediate with clear growth in the second month after installation. The most important colonization and subsequent growth areas are on the front of the reef, the ends of the reef, and on the protected platforms on the front of the reef. Flat surfaces on overturned block ends did not recruit oysters. Oyster growth was highest on the merlons, and in some cases completely closed the gaps between them in just over a year.

LONG-TERM MONITORING OF OYSTER REEF AND LIVING SHORELINE PILOT PROJECTS IN SOUTH CAROLINA. Brown, J. M. (1), M. Moore (2), (1) The Nature Conservancy, 1417 Stuart Engals Blvd., Suite 100, Mt. Pleasant, SC 29464, USA; (2) The Nature Conservancy (contractor), 221 Hanahan Plantation Circle, Hanahan, SC 29410, USA

The Nature Conservancy in South Carolina has established an on-the-ground marine program in the state over the past six years. During those six years TNC, working with a diverse group of partners, has installed multiple small-scale oyster reef and living shoreline pilot projects. The pilot projects have been installed in Winyah Bay's Tom Yawkey Wildlife and Heritage Preserve, Cape Romain National Wildlife Refuge, on Dewee's Island, in the Stono River, and along the shores of Church Creek on Wadmalaw Island. The majority of the installations have been grant funded and most of the grant funds support 12 – 18 months of monitoring post install. TNC is very interested in what is happening to the pilot projects over a longer term. During 2014, TNC contracted the monitoring of our oyster and living shoreline pilot projects that have been installed for at least three years. Marie Moore, working with TNC volunteers, has conducted site visits and collected baseline monitoring data on each of the "long-term" pilot projects. Data collected includes: oyster growth, oyster size classes, marsh vegetation composition and densities, accreting/eroding shoreline, site energy, etc. The poster will present information on materials used, short- and long-term results, lessons learned, and suggested monitoring metrics for other long-term projects.

SEABED MAPPING AND SPATIAL DATA USED IN PLANNING TRIBUTARY SCALE OYSTER RESTORATION IN THE CHESAPEAKE BAY. Bruce, D. G. (1), J. V. Lazar (2), (1) NOAA Chesapeake Bay Office, Cooperative Oxford Laboratory, 904 S. Morris St., Oxford, MD 21654, USA; (2) NOAA Chesapeake Bay Office, 410 Severn Avenue Suite 207A, Annapolis, MD 21403, USA

In the Chesapeake Bay, several large-scale oyster restoration projects are currently being implemented by Federal, State, and non-governmental organizations. The two general restoration methods are 1) construction of substrate reefs on non-shell seabeds and seeding with juvenile hatchery oysters or allowing natural recruitment; and 2) augmentation of natural shell bottom with hatchery oysters. Sustainable and cost effective tributary-scale restoration requires spatial information that addresses physical, biological, regulatory, and cultural constraints. Among these criteria are seabed type, depth, oyster abundance, water quality, fishery management zones, navigation hazards, shellfish sanitation, and potential private property conflicts. In most cases these data do not exist for targeted tributaries, and must be acquired through surveys. We conduct sidescan sonar and acoustic classification surveys to differentiate non-shell seabed suitable for reef construction from viable oyster shell habitats and mud bottoms. Sub-bottom profiling and multibeam sonar bathymetry surveys ensure that sub-surface sediments can support reef construction and that planned reef height will not impinge on minimum depths stipulated in construction permits. Sediment grabs, sounding poles, and diver observations are used to validate acoustic data. Acoustically derived seabed data guides oyster abundance surveys that determine whether existing shell bottoms merit population augmentation. Survey and regulatory datasets are integrated in a GIS environment and used to develop a restoration Blueprint that designates site boundaries and restoration method. All data are stored in geodatabase format and shared among restoration partners.




The largest Blueprint is for the Little Choptank River, MD, and it identifies 1.9 km^2 of bottom for restoration. To date there are three targeted tributaries in Maryland and three tributaries in Virginia that are in various stages of planning and completion.

SUSTAINABLE FISHERY, SUSTAINABLE HABITAT: MANAGING THE DELAWARE BAY OYSTER RESOURCE.
Bushek, D. (1), K. Ashton-Alcox (1), (1) Rutgers University, Haskin Shellfish Research Laboratory, 6959 Miller Ave., Port Norris, NJ 08349, USA

Opinions on sustaining, restoring, and managing oyster populations are often biased by the apparently opposing objectives of conservation and exploitation. “Sustainability” is often used to bridge the differences in goals but successful examples are rare and poorly documented. The New Jersey Delaware Bay oyster resource has been successfully managed for decades, allowing the population, habitat, and fishery to be preserved. Oyster disease decimated the resource and crippled the industry years ago and is still prevalent, yet both have survived through rigorous and intensive adaptive management. The majority of the oyster population resides in the upper half of Delaware Bay although some oysters exist downbay and in tributaries and creeks. The managed fishery occurs on the major oyster beds where the harvest quota is limited to about 2% of the oysters there. Within these beds, natural factors such as disease and predation account for 87% of oyster mortality annually with fishery removals comprising the remainder. To sustain the fishery population, an industry-imposed bushel tax is levied on the harvest and can be used to plant shell to restore the stock by enhancing natural recruitment. Although the resources derived from the bushel tax are limited, shell planting in the Delaware Bay routinely enhances natural oyster recruitment by an average factor of three compared to non-planted areas on the same bed. This positive impact persists for multiple years as oysters continue to set on planted shell and the newly recruited oysters. Because the harvest quota is strictly controlled, a carefully planned shell planting program designed to enhance recruitment ultimately expands and restores habitat, allowing continuation of a limited fishery.

ASSESSING OYSTER GONADAL DEVELOPMENT TO MAXIMIZE OYSTER BROODSTOCK USE. Carey, B. (1), S. M. Weschler (1), E. A. Roache (1), D. D. Abbott (1), Z. B. Hoisington (1), D. W. Meritt (1), (1) University of Maryland Center for Environmental Science Horn Point Laboratory Oyster Hatchery, 2020 Horns Point Rd., Cambridge, MD 21613, USA

Identifying ripe or spawnable brood oysters is critical to any successful oyster hatchery. Various methods have been used to condition brood oysters for spawning and the time required for this is variable. The Horn Point Laboratory (HPL) hatchery typically requires 6 to 8 weeks to get an oyster from winter condition to ripe. Research at the HPL oyster hatchery has attempted to identify parameters that allow for reliable detection of ripe oysters for spawning. In order to determine the most reliable parameters for detection of ripeness, five characteristics were examined each week from a subsample of broodstock. Those characteristics were: general condition, gonadal index, flow, egg quality, and sperm motility. Each characteristic was scored on a 0-4 scale with 4 being the ripest. There were varying correlations between spawning success and the five characteristics recorded. This presentation describes each characteristic and its relationship with successful oyster spawning. The assessment scale was helpful in determining spawning readiness and increasing fecundity from the females spawned. Further refinement of this procedure is underway and if successful should lead to additional improvements in broodstock use for production hatchery operations.

CHARLESTON WATERKEEPER'S RECREATIONAL WATER QUALITY MONITORING PROGRAM: A TOOL FOR WATER QUALITY PROTECTION AND RESTORATION. Carmack, C. A. (1), C. A. Buffum (1), (1) Charleston Waterkeeper, P.O. Box 29, Charleston, SC 29402, USA

State environmental agencies monitor fecal pollution in shellfish harvesting (SFH) waters and manage the areas according to state water quality standards. Although routine monitoring is resource intensive and new monitoring program development by external organizations is a complex process, such an investment contributes to supplementary data necessary for effective water resource management. Charleston Waterkeeper, an environmental nonprofit organization in Charleston, South Carolina, administers a regulatory level Recreational Water Quality Monitoring Program (RWQMP). The RWQMP monitors fecal indicator bacteria, enterococci, at multiples sites in the Cooper River Basin (CRB). The CRB's tidal creeks are frequently used for recreation and SFH by residents and visitors who may be unaware of health risks posed by fecal pollution. The RWQMP is designed to produce quality data to 1) inform the public about the quality of waterways for recreation, and 2) assist in formulation of South Carolina's 303(d) list of impaired waters. The RWQMP operates under a S.C. Department of Health and Environmental Control (DHEC)-approved quality assurance project plan and conducts analysis in a DHEC-certified laboratory, managed in partnership with the College of Charleston Department of Geology. Therefore, all data produced by the RWQMP are regulatory quality. Currently, the RWQMP monitors 15 sites in the CRB weekly from May through October, three of which are classified SFH waters. Data are submitted to DHEC annually for use in the subsequent biennial 303(d) list formulation. The RWQMP anticipates annual expansion in the number of monitoring sites, potentially with additional SFH sites in 2015. Generating a more robust set of quality data serves to both educate the public and provide a valuable resource for water quality management, protection, and restoration.

THE IMPACT OF ENVIRONMENTAL CONDITION ON *CRASSOSTREA VIRGINICA* GENE EXPRESSION. Chapman, R. W. (1), (1) SCDNR, 331 Ft. Johnson Rd., Charleston, SC 29414, USA

Data from the field and laboratory studies in the Eastern oyster indicate that genes that exhibit expression changes in response to water pH and/or temperature involve a large suite of genes related to energy metabolism and growth (including mitochondrial electron transport chain [ETC] involved in ATP production; the focal adhesion complex and associated growth factors responsible for initiating actin polymerization; and actin and associated factors responsible for cell growth, shape, and motility), and genes that are either regulators of Ca^{2+} homeostasis or are influenced by Ca^{2+} and can be involved in biomineralization, including annexins, calmodulin, cavortin (a protein associated with growth of calcium carbonate crystals), EF hand-containing calcium-binding proteins, and carbonic anhydrase which generates bicarbonates and regulates internal pH and shell formation. A study was conducted on three oyster populations in the northern Gulf of Mexico that were assessed for gene expression in 72 samples, oyster genotypes at 8 microsatellite loci, and habitat water quality parameters. The microarray also contained 45 *Perkinsus* genes. The principal components analysis (PCA) showed that *C. virginica* transcriptomes in each population appear to be divided into two discrete clusters and related to the expression levels of *Perkinsus* genes. We mapped the water quality, oyster genotypes, and *Perkinsus* gene expression. The results indicate that *Perkinsus* gene expression accounts for about 45% the explained variation (with parasite cysteine protease explaining more than 10% of the variation), water quality parameters explained 48% (with temperatures and pH as the leading factors), and oyster genotypes accounted for less than 5% of the total variation. These data indicate that easily measured environmental parameters may be able to predict the success of oyster restoration programs.




MITIGATION FOR RANGE IMPACTS: CONSTRUCTION AND DEVELOPMENT OF LONG SHOAL OYSTER SANCTUARY IN PAMLICO SOUND, NORTH CAROLINA. Chappell, W. S. (1), (1) U.S. Navy (NAVFAC), 6506 Hampton Blvd., Norfolk, VA 23508-1278, USA

The Navy supported the construction of oyster habitat within a new state sanctuary designation in Pamlico Sound, North Carolina, as mitigation for re-opening a nearby bombing range. The deepwater habitat was designed and constructed by the North Carolina Division of Marine Fisheries and The Nature Conservancy. It was completed in August 2013 and is now being monitored for three to four years, including the following parameters: (1) oyster size and distribution on reef ball structures, (2) evidence of competition and disease, (3) water clarity on-site vs. off-site, and (4) macrofauna assemblage structure on-site vs. off-site using baiting underwater video stations. Preliminary video results should be available in time for the conference.

REEF STRUCTURE WITH OYSTERS: A TOOL FOR COASTAL HABITATS FACILITATION. Chowdhury, M. S. N. (1), A. Smaal (1), T. Ysebaert (1), M. S. Hossain (2), (1) IMARES Wageningen, Wageningen University and Research Center, Korringaweg 5, Yerseke, Zeeland 4401 NT, The Netherlands; (2) Institute of Marine Sciences and Fisheries, University of Chittagong, Chittagong 4331, Bangladesh

During recent decades the coastal habitats of Bangladesh are severely being threatened by coastal erosion, especially due to sea level rise and tidal surge caused by global warming. The consequences of coastal erosion are manifold and not solely limited to direct habitat loss. Together with habitat loss, ecosystem services such as coastal biodiversity and fisheries productivity, and the intertidal ecosystem as a whole, are affected. To adequately deal with these threats innovative, cost-efficient, and sustainable methods are required for coastal protection that could mitigate the erosion and conserve or restore the coastal habitats and associated biota. In cooperation with a joint Dutch – Bangladesh project (ECOBAS), a research study has been designed to explore the use of ecosystem engineers, particularly oyster, for enhancing coastal habitats in near shore islands of Bangladesh. Various substrate designs are being tested for oyster spat settlement and growth. Circular concrete rings (diameter: 1 m) with 75 cm vertical relief were found as promising substrate where about 160 ind m^{-2} yr^{-1} spat settlement rate were recorded in the Kutobdia Island. Model results indicate that 0.02m^{3}m^{-2}yr^{-1} oyster biomass can grow in prevailing environmental conditions, while the annual growth (length) rate of oyster is 5 cm yr^{-1}. Monthly monitoring of morphological effects indicates that sediment accumulation rate is greater in the tidal flats of artificial reef sites than control sites. The reef structures with oysters are also playing a positive role on mangrove generation and salt marsh succession, as well as habitat facilitation for fishes, shrimps, crabs, and other invertebrates in the tidal flats. The monitoring will be continued until June 2017, which will provide new information on the use of eco-engineers for economic use in combination with coastal habitat restoration or conservation.

SURF-TO-TURF MUSSEL COMPOST: USING BIOEXTRACTION TO REMOVE AND RECYCLE NUTRIENTS FROM BUDD INLET, PUGET SOUND, WASHINGTON STATE. Christy, A. (1), B. Hudson (1), A. Suhrbier (1), (1) Pacific Shellfish Institute, Olympia, WA, USA

When shellfish or plants are cultivated and removed from a natural system for their nutrient removal ecosystem services, it is termed nutrient bioextraction. Nutrient bioextraction can help address eutrophication, low dissolved oxygen, and reduced light availability in the water column. To meet these objectives, the Pacific Shellfish Institute conducted a pilot-scale nutrient bioextraction project using wild set blue mussels (*Mytilus trossulus*) in Budd Inlet, Puget Sound, Washington State. Our purpose was to: 1) implement demonstration systems for nutrient bioextraction;

2) determine the nitrogen removal services of the cultivated blue mussels; 3) assess the feasibility of producing soil compost from the demonstration systems; and 4) increase public awareness and engagement in urban water quality mitigation. In 2013, over 225 nylon straps were placed under three existing dock structures to provide a suitable substrate for mussel recruitment. After four months, over 3,600 kg (8,000 lbs) of mussels were filter-feeding on these straps. Laboratory analysis confirmed a nutrient content of 0.8 -1.2% N equating to the potential removal of 36 kg (80 lbs) of N (ww) from lower Budd Inlet. Mussels were harvested, chipped, and delivered to various facilities for compost trials. This research provided a platform for community outreach focused on improving the understanding of local water quality issues, ecosystem services of shellfish, and nutrient source control. Furthermore, the project facilitated dialogue regarding the use of bioextraction as a potentially viable component of water quality trading schemes for watersheds with TMDLs for nutrients in the region. This work was made possible through U.S. Environmental Protection Agency funds under the Puget Sound Ecosystem Restoration and Protection cooperative agreement to the Washington Department of Ecology.

EVALUATING THE POTENTIAL OF ATLANTIC OYSTERS (*CRASSOSTREA VIRGINICA*) TO BIOACCUMULATE CONTAMINANTS OF EMERGING CONCERN IN COASTAL EMBAYMENTS. Costa, A. S. (1), M. S. Costa (1), M. Benotti (2), (1) Center for Coastal Studies, 5 Holway Avenue, Provincetown, MA 02657, USA; (2) Batelle, 141 Longwater Place, Norwell, MA 02061, USA

Recent studies have detected contaminants of emerging concern (CECs) in ground water, ponds, and coastal embayments. It is unclear what toxicological significance is posed by their occurrence. In the fall of 2014, the Center for Coastal Studies (CCS) in collaboration with 14 other organizations investigated uptake and bioaccumulation of 70 CECs including pharmaceuticals, personal care products, and hormones in Atlantic oysters (*Crassostrea virginicas*) in six coastal embayments in Massachusetts and compared tissue concentrations to concentrations in passive samplers. The results of this study provide information about the potential for bioavailability of these contaminants in the environment and incorporation into the food chain, helping researchers define the environmental impact of CECs.

OYSTER RESTORATION PROGRAMMING IN THE INDIAN RIVER LAGOON ESTUARY, FLORIDA: A MULTI-FACETED INITIATIVE FOCUSED ON COMMUNITY-BASED ENVIRONMENTAL STEWARDSHIP. Creswell, L. (1), (1) Florida Sea Grant, 2199 South Rock Road, Fort Pierce, FL 34945, USA

The Indian River Lagoon (IRL), located along the Atlantic coast of central Florida, is the most bio-diverse estuary in North America and in 1990 was designated an "Estuary of National Significance". The IRL stretches for 156 miles from Ponce de Leon Inlet in Volusia County to Jupiter Inlet in Palm Beach County, and it has an economic value of $3.7 billion, based on commercial and recreational fisheries, real estate value, and ecosystem services. In recent years, an unfortunate synergy of coastal development, canalization, boating, agricultural runoff, and nonpoint source pollution have resulted in a significant decline in water quality and benthic habitats. Oyster coverage that was historically present in the lagoon and its estuaries has declined by more than 75 percent. In response to the dramatic decline in oyster reefs in the lagoon, county governments and non-governmental organizations have initiated oyster restoration programs. The University of Central Florida, Brevard Zoo, Florida Oceanographic Society, Marine Discovery Center of Volusia County, and Martin County accomplished the only large-scale restoration effort placing 30 million pounds of unconsolidated fossilized shell, concrete rubble, and limestone in the St. Lucie Estuary. Florida Sea Grant, Coastal Conservation Association, and IRL county agencies have initiated a suite of community-based oyster restoration programs that have received significant public attention, participation, and recognition. Despite their differences in methods and protocols, all of these programs share components dedicated to youth education, public outreach, and




instilling environmental stewardship. This poster summarizes the many activities that comprise the Indian River Lagoon oyster restoration initiative, a comparison of methodology and monitoring protocols, and highlights successful programs that engage citizen-scientists and youth groups.

ALTERNATIVE OYSTER CULTURE IN THE GULF OF MEXICO. Daigle, M. T. (1), N. Pace (2), (1) Louisiana Sea Grant, 205 Sea Grant Building, Louisiana State University, Baton Rouge, LA 70803, USA; (2) Mississippi-Alabama Sea Grant Legal Program, 256 Kinard Hall, Wing E, University, MS 38677-1848, USA

Alternative oyster aquaculture facilities are increasing in number across the Gulf Coast. In Louisiana, recent regulations have provided oyster farmers with the framework to engage in both on- and off-bottom alternative oyster culture. At the same time, large-scale restoration projects, such as diversions, have the potential to impact areas that have been used successfully for oyster farming in the past. In Alabama, interested parties can now be granted easements for shellfish aquaculture. This panel will discuss the results of a two-year regional research project examining regulations that impact alternative oyster culture, specifically in Alabama and Louisiana, and explore in detail both of the newly developed regulatory schemes and how they will impact engagement in alternative oyster culture. Additionally, the panel will discuss several case studies of other successful alternative culture programs, both in the U.S. and internationally.

OLYMPIA OYSTER (*OSTREA LURIDA*) RESTORATION IN WASHINGTON STATE: THE DEVELOPMENT OF PROTOCOLS FOR USE IN HATCHERY-BASED PRODUCTION AND RESTOCKING EFFORTS. Davis, J. P. (1), B. Vadopalas (2), B. Allen (1), B. Peabody (3), R. Crim (1), K. Jackson (2), (1) Puget Sound Restoration Fund, 382 Wyatt Way N.E., Bainbridge Island, WA 98110, USA; (2) University of Washington, School of Fisheries and Aquatic Sciences, 1122 N.E. Boat Street, Seattle, WA 98105, USA; (3) Puget Sound Restoration Fund, 590 Madison Ave. N., Bainbridge Island, WA 98110, USA

Restoration efforts for Olympia oysters have mainly focused on using Pacific oyster cultch to provide settlement substrates for naturally occurring pediveligers at various Puget Sound sites. In cases where habitat is excellent but oyster recruitment limited, the Puget Sound Restoration Fund (PSRF) has resorted to hatchery production of spat to enable restoration efforts to proceed. A variety of approaches have been used over the last six years to ensure that the genetic variability of seed cohorts is maintained similar to that of broodstock populations when hatchery supplementation is used. First, multiple broodstock from the region or specific embayments targeted for stocking are exclusively used. Second, rearing protocols were developed to produce multiple, family-based larval units using up to 25 individual oysters per family group and collecting larvae on a daily basis and rearing to the spat stage, while maintaining the integrity of family groups. This approach was modified to relax the requirement for family units to be maintained to the spat stage by combining larvae from multiple family units on a daily basis, and rearing mixed families to the spat stage. These protocols were used in consultation with the Washington Department of Fish and Wildlife to produce seed cohorts outplanted to embayments in Puget Sound over the last three to four years. Recent efforts have focused on the development of a dedicated hatchery facility to produce native oyster seed in quantity to supply expanded restoration efforts in Washington State. The analysis of genetic information based on sampling oysters produced from both restoration scale cohorts and commercial production suggests that further modifications may be possible, based on the unique life history and reproductive strategy of the Olympia oyster.

Oral and Poster Presentation Abstracts

SOMETIMES THEY COME BACK AND DISAPPEAR AGAIN (NATURAL CYCLES, SUBSTITUTION, OR WHAT ELSE?). Del Piero, D. (1), (1) Trieste University, via licio Giorgieri 10, Trieste, TS 34127, Italy

In the past 10 years in the Gulf of Trieste (Italy), the razor clam *Ensis minor* disappeared, then reappeared in 2008 after a similar species, *Solen marginatus*, crashed in January due to heavy mortality. *E. minor* flourished in 2011, when at least three successive recruitment events occur. The species is difficult to rear and no restocking seems feasible. The density in 2012 was quite high in spite of a really bad February sea, nevertheless the fishery obtained good economic income. Scarce recruitment was observed in 2013 and no settlement to date in 2014. So up to now *E. minor* is going low but *S. marginatus* is growing in densities again. It's difficult to explain the facts; it could be a natural cycle and some competition between species could take place. But the population density in a beach restoration site (where *E. minor* disappeared, as survey results show in September, 2014) could be a proxy for some tentative explanation: the cycles could be natural but the species revealed no recovery after strong disturbance. The restoration site is unsuitable for the other species, too. There is not only conjunct presence to take into account but conjunct *Ensis* and *Solen* absence to clarify hypothetical adverse effects of restoration and competition problems between species (if any) in unaffected sites.

***CRASSOSTREA VIRGINICA* RESTORATION IN JAMAICA BAY, NYC.** Doss, T. (1), K. Bowers (1), J. McLaughlin (2), M. Spina (1), G. J. Rivara (3), (1) Biohabitats, Inc., 855 Bloomfield Ave., Glen Ridge, NJ 07028, USA; (2) New York City Department of Environmental Protection, Bureau of Environmental Planning and Analysis, 59-17 Junction Blvd., Flushing, NY 11373, USA; (3) Cornell University Cooperative Extension of Suffolk County, 423 Griffing Avenue, Suite 100, Riverhead, NY 11901, USA

This presentation will examine the overall context of restoration in Jamaica Bay and the efforts undertaken to restore a sustainable oyster population in NYC. Oyster restoration is occurring in many areas along the East Coast, but restoring oysters in a degraded urban watershed that is closed to shellfish harvesting is a relatively new concept. The discussion will include different design strategies and monitoring methods involved in the four-year project and summarize the team's observations, and describe future efforts that will be undertaken by NYC to further the idea of creating a sustainable oyster population in Jamaica Bay.

LOCH RYAN, SCOTLAND: A CASE STUDY OF A SUSTAINABLE NATIVE OYSTER (*OSTREA EDULIS*) FISHERY HIGHLIGHTING THE IMPORTANCE OF SITE SPECIFIC MANAGEMENT. Eagling, L. E. (1), E. C. Ashton (1), N. O'Connor (2), D. Roberts (2), (1) Queen's University Belfast, Marine Laboratory (QML), 12-13 The Strand, Portaferry, County Down BT2 1PF, UK; (2) Queen's University Belfast, School of Biological Sciences, Medical Biology Centre, 97 Lisburn Road, Belfast, County Antrim BT9 7BL, UK

The European native oyster (*Ostrea edulis*) has been in decline over the last century due to a combination of overfishing, disease, and poor recruitment. In contrast to most oyster stocks across the U.K., the Loch Ryan oyster fishery, western Scotland, is a prime example of a sustainable fishery. This enclosed population has long been documented, with historical records dating to the 1870s. The fishery's management is unique, having been owned by one family for the past 300 years with a structured lease management and single fishing boat. This study aims to analyse the fishery's long history, and compare this to the current management techniques, which ensure its sustainability. The project will also investigate further methods to guarantee the fishery's future, focusing on management techniques which can be applied to boost other populations nationally. To achieve these aims, fishing log data, oyster population structure,




age, growth, and reproductive cycles are being investigated. The sex ratio is an important factor to consider, as this ratio (along with the oyster bed density), controls the population recruitment potential. The preliminary findings of this investigation suggest that the population in Loch Ryan has a sex ratio of 3:2 (males:females). Over the past two years the average shell length has increased by 10mm, and landings have increased by 12.2 tonnes over the last nine years. This is a result of using rotational relaying beds to allow oysters to grow without being disturbed and creating high density beds to increase the recruitment within the Loch. Such management techniques are relatively simple to implement, and after demonstrating their positive effects in Loch Ryan, these could be implemented in other oyster fisheries.

APPLICATION OF HABITAT SUITABILITY MODELS FOR OYSTER RESTORATION IN PAMLICO SOUND, NORTH CAROLINA. Eggleston, D. B. (1), B. J. Puckett (1), (1) NC State University, 303 College Circle, CMAST, Morehead City, NC 28557, USA

The global decline of many marine species has prompted the application of habitat enhancement, such as oyster and artificial reefs, to rebuild populations. Inadequate scientific information to guide site selection is one of the most common causes of unsuccessful habitat enhancement. We applied a hierarchical optimization approach to selecting the most suitable sites for creation of sub-tidal oyster reefs in Pamlico Sound (PS), North Carolina. Specifically, we conducted: (1) statistical analyses of long-term salinity data in PS to produce a sound-wide salinity GIS layer, (2) hydrodynamic modeling to predict larval export and import, (3) GIS-based exclusion of certain sites, or suitability ranking of non-excluded sites, and (4) field verification of water quality and sediment characteristics. A total of 39% of PS was unsuitable for oyster reef restoration due primarily to shallow water depths and presence of SAV. The most suitable locations were in southwestern and northeastern PS, due primarily to a combination of favorable larval dispersal and sediment characteristics. The GIS-based hierarchical approach used in this study for site selection of oyster restoration was an effective method for: (1) narrowing vast water bodies to a manageable number of sites for further ground-truthing, (2) identifying oyster restoration "hot spots" where the most suitable cells were clustered, and (3) designing oyster restoration strategies to aid in applied management decisions.

DIRECT SEEDING OF HATCHERY-PRODUCED OYSTER LARVAE ONTO CONSTRUCTED OYSTER REEFS IN THE ST. LUCIE ESTUARY, FLORIDA. Encomio, V. G. (1), J. Thiery (2), (1) Florida Oceanographic Society, 890 N.E. Ocean Blvd., Stuart, FL 34996, USA; (2) Indian River State College, 3209 Virginia Ave., Fort Pierce, FL 34981, USA

In the St. Lucie Estuary, massive mortalities of oysters due to extended freshets may lead to lags in recruitment as well. In an effort to restore oyster reef habitat in substrate-limited areas and/or times when recruitment may be equivocal, we tested whether direct, in situ larval seeding can be a viable method of restoration. Constructed reefs were encircled with turbidity curtains and seeded with eyed oyster larvae (2 million larvae per enclosure). Unseeded reefs were left open to the estuary. Seeded reefs had significantly higher spat settlement than unseeded reefs. Subsequent measurements of oyster densities reflected this increased settlement in seeded reefs. We also tested the influence of cultch type and reef height on larval supplementation. Reefs were constructed using mesh bags filled with oyster shell or mixed shell aggregate (MSA). Low profile (10-15 cm height) and high profile (20-30 cm height) 1 m^2 reefs of each cultch type were constructed. Oyster larvae (3.5 million) were added to reefs enclosed by a turbidity curtain. Approximately two weeks after seeding, cultch was retrieved from all reef types (seeded/unseeded, high/low profile, and oyster shell/MSA), and spat were enumerated. Shell from seeded reefs had significantly higher counts of spat compared to unseeded reefs. High profile reefs had significantly higher percentages of cultch with spat. Within seeded reefs, spat counts were 2 times higher on high profile reefs compared to low profile reefs, although results were not statistically significant. Spat settlement was significantly higher on oyster shell compared to MSA. Overall results show that *in situ* larval seeding may be a viable approach to oyster restoration of smaller-scale reefs.

Oral and Poster Presentation Abstracts

TRACKING CaCO$_3$ CORROSIVITY AT ALUTIIQ PRIDE SHELLFISH HATCHERY, SEWARD, ALASKA. Evans, W. (1), J. Hetrick (2), (1) NOAA Pacific Marine Environmental Laboratory, Seattle, WA USA; (2) Alutiiq Pride Shellfish Hatchery, Box 369, Seward, AK 99664, USA

The invasion of human-produced atmospheric CO_2 into the ocean is changing the marine carbon system such that ocean water is becoming more corrosive to calcium carbonate ($CaCO_3$) minerals. These changes have negative effects on shell-forming marine organisms. Shellfish aquaculture facilities on the Oregon and Washington coasts have already been impacted by these human-induced changes in ocean chemistry, and this has resulted in a cause for concern at other aquaculture facilities worldwide. Through a partnership between scientists and stakeholders, chemical sensors are now installed and tracking $CaCO_3$ corrosivity in intake water at the Alutiiq Pride Shellfish hatchery in Seward, Alaska.

IMPROVING THE WATER QUALITY AND BIODIVERSITY WITH THE OYSTER REEF HABITAT RESTORATION IN WELLFLEET HARBOR, MA, USA. Frankic, A. (1), A. Costa (2), D. Bertuna (3), C. Felix (4), A. Koch (4), (1) Green Harbors Project, UMass Boston, 100 Morrissey Blvd, Boston, MA 02125, USA; (2) Center for Coastal Studies , 5 Holway Avenue, Provincetown, MA 02657, USA; (3) UMass Boston, 100 Morrissey Blvd., Boston, MA 02125, USA; (4) Town of Wellfleet, 180 Upper Troy Road, Fitzwilliam, NH 03447, USA

Wellfleet Harbor is a designated Area of Critical Environmental Concern presently supporting an oyster aquaculture industry of 5 million oysters per year. In 1877 this amount of oysters was harvested in just one day by three schooners. Therefore, since the late 1800s this harbor has lost approximately 95% of oyster reef habitats, as well as 65% of salt marsh and 95% of eel grass beds. These three coastal keystone habitats have been thriving historically and ecologically throughout New England's coastal systems providing ecological services in shoreline protection, supporting water quality, biodiversity, fisheries, and coastal resiliency. In 2011 our research team established a two-acre oyster reef restoration site between Duck and Mayo creeks. Research monitoring data and analyses show an increase in biodiversity and oyster population by 90% while established 4.5 million oysters per two acres provided the 70% nitrogen sink improving the water quality in this area. Our pilot project was based on cultching, placing shells throughout the project site to provide a suitable substrate for spat settlements of naturally spawning oysters *Crassostrea virginica*. Our pilot project serves as the first 'no-take shellfish sanctuary' supported by the local community, including the shellfish constable. Preliminary estimates show that this modest oyster habitat restoration provided immediate water quality benefits broader than just nitrogen reduction limits based on federal and state regulations. Our interdisciplinary project has won three prestigious awards: the Mass Recycle Municipal Innovation Award, the 2013 Engineering Excellence Silver Award by the American Council of Engineering Companies, and the 2014 National Award for Public Service. In order to improve our coastal resiliency, our goal is to establish multiple areas of no-take zones as oyster reef and shellfish sanctuaries throughout the Wellfleet Harbor.

RESTORING OYSTER REEFS IN FLORIDA'S BIG BEND IN THE FACE OF REDUCED FRESHWATER FLOWS: THE ROLE OF DURABLE SUBSTRATE. Frederick, P. C. (1), B. Pine (1), L. Sturmer (2), J. Seavey (3), (1) University of Florida, P.O. Box 110430, Department of Wildlife Ecology and Conservation, Gainesville, FL 32611, USA; (2) University of Florida, Sen. Kirkpatrick Marine Lab , 11350 S.W. 153rd Ct., Cedar Key, FL 32625, USA; (3) University of New Hampshire, School of Marine Science and Ocean Engineering, 24 Colovos Road, Durham, NH 03824, USA

The Big Bend region of Florida's Gulf of Mexico coast has lost 66% of its oyster reefs during the last 30yrs, attributable to increasing frequency of low-freshwater flow events and associated high salinities. Loss of entire reef populations of oysters has resulted, followed by a breakup of and spreading of the substrate (8cm vertical loss/yr) by wave




action, leaving no structure suitable for recolonization. This restoration project is focused on the hypothesis that more durable substrate will over the long term allow repeated recolonization events following future unavoidable low-flow induced die-offs. On remnant degraded reefs, we restored reef structure by building four 455 m^2 squares of large limerock cobble (16 - 25 cm diameter, single layer). Each square was surrounded with over 100 damaged clam culture bags (1.2 x 1.2 x 0.2 m) filled with cultch (oyster-encrusted clam shell) and obtained from nearby shellfish aquaculture leases. We compare oyster densities, oyster size, and blue crab densities with untreated control areas within the same degraded reef complex. The offshore bars (88% loss) are formed in chains parallel to the coast and river mouths, are unprotected by barrier islands, and the reefs in their historical configuration and elevation may have served to entrap freshwater behind them much as barrier islands do. Retention of freshwater may turn out to be one of the largest ecosystem services of oyster reefs in this system. This project is funded by the National Oceanic and Atmospheric Administration and The Nature Conservancy.

TIDAL CREEK AND SUBSTRATE EFFECTS ON OYSTER REEF-ASSOCIATED NEKTON. Funk, T. S. (1), K. O'Shaughnessy (2), K. Walters (3), (1) Coastal Carolina University, 205 Wando River Road, Unit 9F, Myrtle Beach, SC 29579, USA; (2) Coastal Carolina University, 8124 HWY 56, Chauvin, LA 70344, USA; (3) Coastal Carolina University, P.O. Box 261954, Conway, SC 29528, USA

Nekton populations dependent on oyster reefs likely are affected by the documented worldwide decline in reef habitat. Along the Myrtle Beach, S.C. shoreline the prevalence of intertidal reefs varies from abundant within protected North Inlet tidal creeks to sparse within impacted swash tidal creeks (e.g., Withers Swash). As part of ongoing efforts to enhance local reefs, recycled shells were used to create shell-bag reefs within inlet (Hog, Murrells, North) and swash tidal creeks (White Point, Singleton, Withers). The first summer after creation nekton attracted to the shell reefs were sampled systematically within all tidal creeks using a variety of approaches. Pinfish and mummichogs comprised 97% of all fish caught within reef minnow traps with numbers dependent on creek type, tidal elevation, and diurnal period. Unexpectedly greater numbers of pinfish were trapped within swash (185±4 cpue) compared to inlet creeks (18±1 cpue). A year after reef creation fishes attracted to natural and restored reefs and mudflat areas along the same tidal creek within North Inlet were sampled in summer. Minnow traps captured greater numbers of mummichogs on natural (12±5 cpue) compared to restored reefs (1±1) or mudflat areas (1±0.4 cpue), but gill nets catches were similar across habitats: 1±0.4, 2±0.7, 1±0.7, respectively. Results suggest baitfish quickly take advantage of restored reefs but likely do not reach natural reef densities until >1 year after construction. Demersal fishes appear to utilize equally natural and restored reef and mudflat habitats.

ESTUARINE SCULPTURING WITH INDUCED OYSTER REEFS. Gagliano, M. H. (1), S. M. Gagliano (1), (1) Coastal Environments, Inc., 1260 Main Street, Baton Rouge, LA 70802, USA

The American Oyster, *Crassostrea virginica*, is the most important reef-building organism of the northern Gulf of Mexico region. Oysters and their reefs provide numerous ecological benefits and services including a delectable seafood, reef habitat and shelter for other finfish and shellfish, shorebird rookeries, water filtering, erosion protection, and carbon sequestration. Reefs make up the sustainable skeletal framework of estuarine ecosystems. Reef growth "seeks out" favorable conditions for the oysters that make up the colony and, thus, determine the ultimate shape of the reef. Oysters are also geological agents that produce calcium carbonate (limestone) rock. Secondary landforms evolve from the transport and reworking of shell valves and particles by waves and currents. Shell liberated from the reefs breaks down into smaller particles ranging in size from gravel to silt. Waves, surge, and currents shape the particles into estuarine landforms (beaches, bars, islands, and banks). Oysters beget oysters. Healthy reefs grow exponentially and may persist for hundreds or even thousands of years. A technique called ReefBlk has been developed for establishing high vertical profile oyster reefs and pre-determining their geometry. ReefBlk projects have been implemented from Matagorda Bay to Pensacola Bay. A joint project by The Nature Conservancy and Coastal Environments, Inc. and funded by a grant from the American Recovery and Reinvestment Act of 2009 will be discussed. The project is located in St. Bernard Parish, Louisiana and was completed in 2012.

THE TOWN POND RESTORATION - THEY DUG THE HOLE, NOW WHAT DO WE DO? Griffen, M. (1), D. Leavitt (1), S. Patterson (1), T. Scott (1), (1) Center for Economic and Environmental Development, Roger Williams University, Bristol, RI, USA

Federal, State, and local non-profit organizations have long recognized the ecological and socioeconomic importance the oyster, *Crassostrea virginica*, represents to coastal communities. Oyster restoration programs in Rhode Island date to the early 1900's and have been making considerable progress and gaining popularity in the past decade. Despite the increase in restoration activities, careful monitoring of restored populations and associated habitat often takes a back seat to efforts of introducing shellfish into estuaries, thus, hindering adaptive management. To better understand both short- and long-term performance of oyster restoration in Rhode Island, we assessed growth, survival, disease, and recruitment over three years in two distinct programs: Roger Williams University's Oyster Gardening for Restoration (2006-present) and the North Cape Shellfish Restoration Program (2003-2008). The two programs have resulted in over 8.5 million seeded oysters in 13 distinct restoration sites in Rhode Island waters including salt ponds, tidal creeks, and open coves in Narragansett Bay. Mean growth of oysters in restoration sites is between 30-50 mm annually with mean survival of 32% and 58% for year one and two+ oysters, respectively. Mortality varies amongst sites and appears to be driven largely by disease. Within current sites, self-sustaining populations are hindered by the lack of recruitment, thus, questioning the economic feasibility of restoration and emphasizing the importance of proper site selection.

HOW MUCH IS ENOUGH? TOOLS TO HELP SET GOALS FOR OYSTER RESTORATION BASED ON THE ECOSYSTEM SERVICES RETURNED. Hancock, B. T. (1), B. M. DeAngelis (1), J. Greene (2), (1) The Nature Conservancy, URI Grad. School of Oceanography, 215 South Ferry Rd., Narragansett, RI 02882-1197, USA; (2) The Nature Conservancy, 56 Saint Joseph Street, Suite 1600, Mobile, AL 36602, USA

Oyster habitat is among the most threatened of marine habitats, with estimates of 85% loss globally (Beck et al. 2011) and 88% loss in the U.S. (zu Ermgassen et al. 2012). A sound knowledge of historic abundance and location of oyster habitat is important for understanding its past influence on bays and estuaries and in demonstrating the potential for restoration into the future. However, the historic abundance alone may not be the most compelling framework for setting restoration goals. In addition, changes in physical conditions and human use patterns often mean that restoring the historic condition of a bay is no longer appropriate or achievable. The concept that key marine habitats provide benefits to society through ecosystem services is well established. Over the last five years there has been a deliberate endeavor to quantify the primary ecosystem services provided by oyster habitat, services such as water filtration, denitrification, and fish production. Quantifying these services provides the potential to set oyster restoration goals for a bay or estuarine system by predicting the amount of oyster habitat required to provide the desired level of services, and will enhance restoration planning and development among communities and stakeholders. The Nature Conservancy, with a scientific advisory team, is preparing a "Practitioners Guide" of the information required to express oyster restoration goals in terms of the ecosystem services gained, as well as developing an interactive web site for practitioner use. The background, scope, and structure of the Practitioners Guide and interactive website will be presented.

MONITORING OYSTER RESTORATION IN THE MARYLAND CHESAPEAKE BAY: TECHNIQUES AND LESSONS LEARNED IN THE FIELD. Handschy, A. V. (1), K. T. Paynter (1), (1) University of Maryland, 1210 Biology-Psychology, Bldg 144, University of Maryland, College Park, MD 20742, USA

The Paynter Lab at the University of Maryland fills an important role in the restoration of oyster populations in the Chesapeake Bay through assessment of restoration areas in the field. This effort incorporates large-area remote sensing surveys, and tracks spat success from planting through adulthood, allowing for analysis of factors affecting the survival of oysters. We conduct three types of monitoring related to spat-on-shell plantings. First, ground truthing of potential restoration sites allows for selection of sites that are hospitable for spat, optimizing survival. Second, short-term post-planting monitoring samples spat four to eight weeks post-planting to measure survival and growth, indicating the success of plantings. Third, patent tong surveys of adult oyster populations sample restored populations at two and five years post-planting. Patent tonging is conducted in collaboration with watermen who work in the Chesapeake Bay. Through these three types of monitoring our lab provides accurate and timely data on restored oyster populations in Maryland and provide a basis for adaptive management. These data form the basis of a decades-long effort to understand the dynamics of restored oyster populations in the Chesapeake Bay.

LOCAL NATIVE OYSTER STOCKS FOR RESTORATION: DOES LOCAL ADAPTATION AFFECT OUTPLANT?
Heare, J. (1), B. Vadopalas (1), J. Davis (2), S. Roberts (1), (1) University of Washington, 1122 N.E. Boat St., Seattle, WA 98105, USA; (2) Puget Sound Restoration Fund, 1122 N.E. Boat St., Seattle, WA 98105, USA

Olympia oysters, *Ostrea lurida*, in Puget Sound, Washington are known to initiate reproduction at a specific temperature threshold. Bays along a latitudinal gradient within the Sound exhibit temporal variation in attaining this temperature. This gradient of habitat types has been shown in recent studies (Savolainen, 2007) to induce the phenomena of local adaptation within semi-sessile and sessile native organisms. Since *O. lurida* is native to the West Coast, it is hypothesized that populations along a latitudinal gradient have become locally adapted to their environment. This adaptation would have important ramifications for conservation and restoration projects within the Puget Sound. To test these differences we set up a reciprocal transplant experiment among three populations from Fidalgo (Northern), Dabob (Central), and Oyster (Southern) bays along a latitudinal axis as well as a fourth bay (Manchester NOAA facility) as a control repository. We monitored growth, survival, and fecundity from August 2013 to August 2014. We observed growth and survival differences among populations. Throughout the spawning season, Southern oyster population produced significantly more brooding oysters at two of the three sites compared to the other two populations. Oyster populations native to these diverse bays may have genetically diverged their spawn timing to conform to environmental conditions within each bay or the Southern population may simply have greater fitness. Through our ongoing research, we intend to determine whether Olympia oyster populations exhibit local adaptation within Puget Sound.

STATUS OF SHELLFISH STOCK ENHANCEMENT IN ALASKA: CLAMS, CRABS, AND OTHERS. Hetrick, J. (1), (1) Alutiiq Pride Shellfish Hatchery, Box 369, Seward, AK 99664, USA

Many of the shellfish populations throughout Alaska are at low abundance. Probable causes are geographical limits of distribution, irregular recruitment, predation, overharvest, and changing oceanographic conditions. Projects have been conducted to use hatchery-produced littleneck clam (*Venerupis staminea*), basket cockles (*Clinocardium nuttallii*), and razor clams (*Siliqua patula*) seed to reestablish local populations. Attempts have also been made at creating spawning sanctuaries and utilizing predator control devices. A major project is underway to evaluate the feasibility of stock enhancement of red king crabs (*Paralithodes camtschaticus*) and blue king crabs (*Paralithodes platypus*). Hatchery technology has been developed and experimental releases have occurred for two seasons. Hatchery technology to produce juvenile seed for the giant red sea cucumber (*Parastichopus californicus*) and the pinto abalone (*Haliotus kamtschatkama*) has been developed and out stocking plans are being considered. A general overview will be presented on the results of each species and plans for future work discussed.

ESTABLISHING OYSTER (*CRASSOSTREA VIRGINICA*) REEFS AS A METHOD TO FACILITATE THE EXPANSION OF *SPARTINA ALTERNIFLORA* AND COMBAT EROSION AND HABITAT LOSS ON DYNAMIC SHORELINES. Hodges, M. S. (1), S. Czwartacki (1), J. Hulteen (1), N. Hadley (1), (1) South Carolina Department of Natural Resources, Marine Resources Division, 217 Fort Johnson Road, Charleston, SC 29412, USA

Shoreline erosion and sedimentation are major concerns for habitat loss and related restoration. Fringing intertidal oysters often protect fragile shorelines in tidal creeks in S.C. In the absence of oysters, significant marsh may be lost, resulting in diminished nursery habitat. The South Carolina Department of Natural Resources (SCDNR) deploys oyster (*Crassostrea virginica*) shells annually to enhance habitat function of estuarine habitats. Restoration and enhancement methods include small-scale community-based reefs through the South Carolina Oyster Restoration and Enhancement (SCORE) Program and large-scale loose shell plantings. These methods have proved to be an effective tool for combating erosion attributable to both natural causes and anthropogenic impacts in a range of coastal environments from tidal creeks to high energy areas along the Intracoastal Waterway. At several sites constructed over three years ago, *S. alterniflora* has expanded significantly seaward (>13 m) into our developing reefs. This marsh vegetative re-growth appears to be associated with the accumulation of soft sediments behind reefs. We have also incorporated the transplanting of eroded marsh culms and volunteer grown grasses to accelerate the rate at which the marsh establishes. Monitoring includes changes in marsh footprint, sediment characteristics, and stem counts.

STAKEHOLDER-DRIVEN OYSTER (*CRASSOSTREA VIRGINICA*) RESTORATION IN THE ACE BASIN, SOUTH CAROLINA. Hulteen, J. S. (1), M. Hodges (1), S. Czwartacki (1), J. Leffler (1), (1) South Carolina Department of Natural Resources, Marine Resources Division, 217 Ft. Johnson Road, Charleston, SC 29412, USA

With funding from the National Estuarine Research Reserve System's (NERRS) Science Collaborative Program, the South Carolina Department of Natural Resources (SCDNR) worked with local stakeholders and volunteers to construct oyster habitat in the ACE Basin NERR using several methods. Small-scale bagged shell and large-scale loose shell planting were two shell-based methods utilized in reef construction. Small-scale reefs allow for community engagement and can be constructed in high energy areas where loose shell may be washed away. Large-scale reefs can be built in low energy areas where it is logistically problematic to transport bags and volunteers. Restoration sites were selected by a stakeholder group comprised of intended users of the ACE Basin watershed. Stakeholder representation included (but was not limited to) local school representatives, fishing groups, industry professionals, community association members, and environmental groups. Bagged shell and loose shell reefs were constructed at 32 sites within the project boundaries. 7,392 bags were deployed at 20 sites, protecting 0.16 acres (1,467 linear feet) of shoreline, satisfying the project goal of 0.12 acres (1,100 linear feet). 27,579 bushels of loose shell were deployed at 12 sites creating 2.97 acres (5,828 linear feet) of oyster habitat, satisfying the project goal of 2 acres (5,800 linear feet). 1,447 volunteers contributed 3,042 hours of time, participating in site selection, shell bagging, reef construction, site monitoring, and education activities. SCDNR has collected baseline data for footprint area, recruitment and early growth, adjacent *Spartina alterniflora* transects, and sediment composition before construction. Restoration success will be assessed using criteria developed by SCDNR based on natural oyster reef characteristics. These criteria include reef footprint retention, larval recruitment, and oyster population development.




PRODUCTION AND COMMERCIAL FISHERY VALUE FROM OYSTER REEF RESTORATION. Humphries, A. T. (1), M. K. LaPeyre (2), (1) U.S. Environmental Protection Agency, Atlantic Ecology Division, 27 Tarzwell Rd., Narragansett, RI 02882, USA; (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

Valuation of ecosystem services can provide a framework for linking ecological restoration interests to the local and global economy. Oyster reefs are in global decline and efforts to restore this habitat and associated ecosystem services are increasing; however, evaluating tradeoffs in returns are necessary to identify optimal investment strategies. Here, we restored over 235 m^2 of oyster (*Crassostrea virginica*) reef in coastal Louisiana and quantified associated production and commercial fishery value through time (~ three years). The restored oyster reefs generally supported a greater overall production of transient and resident fish and invertebrate species, but not facultative residents, and failed to show consistent community-level seasonal patterns or increase through time. Overall, fishery production increased by 56%, or 1.22 kg, for every 10 square meters of restored oyster reef per year, which resulted in an average commercial fishery augmentation of 51%, or $0.84 per 10 square meters per year ($843 per hectare per year). Surprisingly, augmented fish production of the restored oyster reefs failed to increase through time and the commercial fishery value increased only marginally. This study highlights the differential use of habitats and potential for restored oyster reefs to augment fish production and commercial fishery value within a sub-tropical estuary. Valuation of other associated ecosystem services provided by restored oyster reefs should be included in restoration goals for oyster reefs to be considered a cost-effective management tool in this system.

A COMPARISON OF BREEDING METHODS FOR THE OLYMPIA OYSTER, *OSTREA LURIDA*, USING MICROSATELLITE MARKERS. Jackson, K. E. (1), B. Vadopalas (2), S. Roberts (2), (1) University of Washington, 6020 Balustrade Blvd. S.E., Lacey, WA 98513, USA; (2) University of Washington, 1122 N.E. Boat St., Seattle, WA 98105, USA

The Olympia oyster, *Ostrea lurida*, is native to Puget Sound and the West Coast of the United States. Due to overharvesting and water quality decline, the once thriving local population has decreased dramatically. In recent years, there has been an effort to start reestablishing this culturally, ecologically, and economically important animal. While methods have been created to breed genetically diverse, restoration-grade oyster seed, there have been no quantitative studies to evaluate the genetic diversity of seed populations. In this study, seven microsatellite loci were used to evaluate genetic differentiation between oysters destined for restoration projects and wild populations. Pairwise comparisons were also conducted with commercially produced Olympia oysters as an outgroup. Expected heterozygosity, relatedness, allele frequency, and allele counts were analyzed within and between these groups. We saw the highest relatedness in the restoration population. When using allelic differentiation to compare allele frequencies, we found the difference to be highly significant between the wild and restoration populations, but we detected no significant difference between the wild and commercially produced groups. Our results suggest that the breeding method used to produce commercial populations may be an effective method for retention of wild genetic diversity in a hatchery setting, conditioned on periodic genetic monitoring to ensure genetically diverse and compatible restoration populations of Olympia oysters in the future.

GETTING THE N OUT - A SEARCH FOR BIOREMEDIATION ALTERNATIVES TO SEWAGE TREATMENT.
Karney, R. C. (1), E. Green-Beach (1), P. Carey (2), (1) Martha's Vineyard Shellfish Group, Inc., P.O. Box 1552, Oak Bluffs, MA 02557, USA; (2) Wastewater Alternatives, 362 Coburn Avenue, Worcester, MA 01604, USA

In recent years, studies by the Massachusetts Estuaries Program (MEP) have confirmed that high nitrogen loading, especially from onsite septic systems, is the primary driver of the degraded environmental quality observed in many

of the state's estuaries. The MEP studies have developed target Total Maximum Daily Loads (TMDLs) for nitrogen required to reverse eutrophic conditions and restore water quality. Local municipalities have been tasked with developing plans to meet the target nitrogen reductions. Conventional tertiary sewage treatment systems are the likely means to that end. However, because of the high costs for construction and operation of these systems, municipalities are seeking more affordable alternatives. Further, because much of the problematic nitrogen enters the embayments though slow moving groundwater plumes, the damaging impacts of nitrogen will continue for years after the installation of treatment systems. The Martha's Vineyard Shellfish Group is investigating a number of potential methodologies to enhance bioremediation of nitrogen within our local estuaries. Within the environmental, social, and regulatory conditions that exist at various sites, we are exploring the feasibility of using oysters, ribbed mussels *Geukensia demissa*, *Phragmites australis*, Floating Islands, and living shorelines to reduce nitrogen levels in the impaired estuaries. The promises, limitations, and challenges of each option will be discussed.

MITIGATING EUTROPHICATION USING OYSTER REEF RESTORATION AND OYSTER AQUACULTURE.

Kellogg, M. L. (1), A. R. Smyth (1), M. W. Luckenbach (1), R. H. Carmichael (2), B. L. Brown (4), J. C. Cornwell (5), M. Piehler (6), M. S. Owens (5), D. J. Dalrymple (3), C. B. Higgins (4), (1) Virginia Institute of Marine Science, College of William and Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA; (2) Dauphin Island Sea Lab, 101 Bienville Blvd., Dauphin Island, AL 36528, USA; (3) University of South Alabama, Department of Marine Sciences, Mobile, AL 36688 USA; (4) Virginia Commonwealth University, Department of Biology, P.O. Box 842012, Richmond, VA 23284-2012, USA; (5) University of Maryland Center for Environmental Science, Horn Point Laboratory, P.O. Box 775, Cambridge, MD 21613, USA; (6) University of North Carolina – Chapel Hill, Institute of Marine Science, 3431 Arendell Street, Morehead City, NC 28557, USA

A growing body of research suggesting oysters significantly alter nitrogen cycling and improve water quality has enhanced interest in expanding both oyster aquaculture and oyster reef restoration efforts to mitigate the effects of coastal eutrophication. The three primary mechanisms by which oysters can remove nitrogen from the water column are assimilation of nitrogen into oyster tissue and shell, deep burial of nitrogen in sediments, and conversion of dissolved inorganic nitrogen to dinitrogen gas via microbially mediated denitrification. To calculate the extent to which oysters enhance removal, all three nitrogen removal pathways must be evaluated in comparison to a suitable reference site. A careful review of studies examining the effects of the eastern oyster, *Crassostrea virginica*, on nitrogen cycling found that accurate estimation net enhancement in nitrogen removal (= assimilation + burial + denitrification) associated with oyster reef restoration or oyster aquaculture requires collection of site-specific data. Weight normalized nitrogen in oyster tissue and shell is relatively consistent across studies, but assimilation rates can be influenced by site-specific factors that alter oyster growth rates and the ratio of tissue to shell mass. Currently available data are insufficient to estimate long-term burial of nitrogen associated with oysters in aquaculture or on reefs in comparison to a suitable reference site. At present, there is little evidence that oyster aquaculture significantly enhances denitrification rates. However, available data come only from floating raft aquaculture and only from three seasons, precluding calculation of net annual enhancement or reduction in denitrification rates. Data from unharvested oyster reefs provide the strongest support for enhanced denitrification but the magnitude varies widely between studies, seasons, and growing conditions. Before oysters can be used broadly as a means of mitigating eutrophication, a greater understanding of their net effects on nitrogen cycling and of the factors influencing the magnitude of those effects is needed.




RELATIONSHIPS BETWEEN OYSTER BIOMASS DENSITY AND MACROFAUNAL COMMUNITY STRUCTURE.
Kellogg, M. L. (1), P. G. Ross (2), B. Lusk (3), M. W. Luckenbach (1), A. Birch (2), J. Dreyer (1), E. Smith (2), (1) Virginia Institute of Marine Science, College of William and Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA; (2) Virginia Institute of Marine Science, Eastern Shore Laboratory, P.O. Box 350, Wachapreague, VA 23480, USA; (3) The Nature Conservancy, Virginia Coast Reserve, Brownsville, VA 23413, USA

Restored oyster reefs provide habitat for an abundant macrofaunal community, but quantifying the diversity and biomass of this community at the species level is beyond the scope of many monitoring programs. A recent study in The Nature Conservancy's Virginia Coast Reserve sought to identify relationships between oyster abundance and/or biomass on restored reefs and the abundance, biomass, and diversity of reef-associated macrofaunal communities. Eighteen native oyster reefs (16-m^2 each) were constructed using six oyster densities (0, 10, 25, 50, 100, and 250 adult oysters m^{-2}) with three replicates of each density at an intertidal site near Oyster, VA. Between April 2012 and July 2013, a science-based monitoring program assessed oyster abundance and biomass density on these reefs. Samples included both oysters and underlying sediments to a depth of 15 cm. All reef-associated macrofauna retained on a 1-mm sieve were identified to species and their abundance and biomass were determined. Significant positive relationships were found between a variety of macrofauna species and oyster biomass density.

AN ALTERNATIVE ROADMAP FOR ENGAGING STAKEHOLDERS IN OYSTER REEF RESTORATION IN THE ACE BASIN NERR, SOUTH CAROLINA, USA. Kingsley-Smith, P. R. (1), B. W. Stone (1), B. P. Keppler (2), J. W. Leffler (2), (1) South Carolina Department of Natural Resources, 217 Fort Johnson Road, P.O. Box 12559, Charleston, SC 29422-2559, USA; (2) ACE Basin NERR, South Carolina Department of Natural Resources, 217 Fort Johnson Road, P.O. Box 12559, Charleston, SC 29422-2559, USA

Oyster reef restoration projects typically begin with the identification of a problem, such as degradation and loss of habitat or reductions in native biodiversity. Researchers or resource managers with high levels of expertise in their respective fields then identify very specific locations, processes, and strategies to solve this problem. Typically, the next steps are to pursue funding and permits and develop logistical plans, while only engaging community members and other volunteers during the implementation of on-the-ground reef-building efforts. Lacking in this approach are the local knowledge and concerns of residents and visitors who have personal, recreational, or commercial interests in the adversely affected areas. During 2012-2014, the South Carolina Department of Natural Resources secured substantial funding from the National Estuarine Research Reserve System's (NERRS) Science Collaborative project to expand living shorelines in the ACE Basin NERR through the creation of new intertidal oyster reefs. For this project, an alternative restoration roadmap was adopted that more holistically engaged stakeholders. Project staff assembled a large group of community leaders, scientists, and managers to better define the problem for the community and to identify the sites that represented their priorities for restoration. Following this initial workshop, stakeholders worked side-by-side with researchers and managers in the field to evaluate and prioritize sites, and subsequently allocate available oyster reef restoration resources among those sites. Learning from our experiences in the first year, this process was reiterated in the second year. Established goals to protect shoreline, create new habitat, and increase coastal resiliency were met and project participants explored approaches to creating longer-lasting stewardship of these natural resources, beyond the scope of the individual project.

DISTRIBUTIONS OF VIRULENT *VIBRIO PARAHAEMOLYTICUS* STRAINS WITHIN SOUTH CAROLINA OYSTERS. Klein, S. L. (1), C. R. Lovell (1), (1) University of South Carolina, 715 Sumter St., Room 401, Columbia, SC 29208, USA

Seafood associated gastroenteritis caused by the emergent, pandemic pathogen *Vibrio parahaemolyticus* is the number one public health issue for seafood safety in the U.S. The Centers for Disease Control and Prevention estimates approximately 4,500 U.S. infections per year, and over the past 15 years outbreaks have increased in size and frequency. Estimation of total *V. parahaemolyticus* population sizes may employ PCR amplification of the thermolabile hemolysin gene (*tlh*), which encodes a phospholipase A2 and is considered specific for *V. parahaemolyticus*. Determination of virulence is often based on detection of virulence factor genes. Diagnostic molecular markers for *V. parahaemolyticus* pathogenicity include the thermostable direct hemolysin gene (*tdh*), the thermostable direct hemolysin-related hemolysin gene (*trh*), and a marker for the cytotoxic Type III Secretion System (*vscC2*). The distributions of virulent and avirulent strains of *V. parahaemolyticus* in South Carolina oysters are not well known. *Crassostrea virginica* oysters were harvested from two sampling sites in South Carolina. The first site at the Belle W. Baruch Institute for Marine and Coastal Sciences in Georgetown, S.C. is a pristine salt marsh estuary free of human impacts. The comparison site in Beaufort, S.C. is a major oyster producing area. Strains of *V. parahaemolyticus* reared from oysters and the surrounding water were screened using improved PCR primers and protocols for virulence factor genes to determine the distributions and frequencies of virulent *V. parahaemolyticus* strains in South Carolina oysters.

LARGE-SCALE OYSTER RESTORATION IN THE PIANKATANK RIVER, VIRGINIA AND THE CHESAPEAKE BAY. Lacatell, A. D. (1), (1) The Nature Conservancy, 530 East Main Street, Suite 800, Richmond, VA 23116, USA

The Nature Conservancy, state, and federal partners (U.S. Army Corps of Engineers and National Oceanic and Atmospheric Administration) are implementing large-scale oyster restoration projects in two tributaries of the Chesapeake Bay. The presentation will discuss the Chesapeake Bay Protection and Restoration Executive Order and how the oyster restoration projects are working to meet the goals of the Chesapeake Bay Sustainable Fisheries Goal Implementation Team. While the focus of the presentation will primarily be on the 75-acre project in the Piankatank (Virginia), time will be given to differences between restoration goals and management in Maryland and Virginia. The use of alternate substrate, leveraged financing, measuring natural benefits (ecosystem services), balancing sanctuary and rotational harvest areas, industry, and recreational needs as well as managing partner relationships and authorities will be addressed.

RHODE ISLAND OYSTER RESTORATION: WE'RE GREAT AT GROWING OYSTERS BUT WHAT HAPPENS TEN YEARS LATER? Leavitt, D. (1), S. Patterson (1), T. Scott (1), M. Griffen (1), (1) Center for Economic and Environmental Development, Roger Williams University, Bristol, RI, USA

Prior to 1949, Boyd's Marsh was a small coastal pond and pocket marsh system (approximately 40 acres) located off Mount Hope Bay in Portsmouth, RI. However, with the dredging of the shipping channel through Mount Hope Bay and into Fall River, Boyd's Marsh became a depository for the dredge materials excavated and by 1950 was reduced from a coastal pond to a mudflat. By the 1970's, Boyd's Marsh had become a monoculture of *Phragmites australis*, a nonindigenous invasive reed. The combination of dredge fill and plant invasion had converted a healthy functioning ecosystem into a disturbed system with severely reduced diversity. In 2000, a host of federal, state, and local agencies and NGO's, led by the U.S. Army Corps of Engineers, initiated a planning process to restore Boyd's Marsh (now referred to as Town Pond) to its original configuration, based on information generated from 1939. Construction started in 2005 and the flow of tidal waters into the restored coastal pond commenced on September 21, 2007. While the physical reconstruction was completed in 2007, the question remained of when and how will the ecological func-




tions of the coastal pond be restored? To facilitate the biological recovery of the pond, we have been collaborating with the USACE, NOAA, and RIDEM to establish viable oyster beds along the shoreline of Town Pond. The area was prepared with shell cultch and planted with 200,000 juvenile oysters during the fall of 2008. Since then, we have been introducing new oyster seed annually and have been monitoring the results of our efforts. This presentation will cover the successes and failures of our on-going efforts to reestablish the ecological services of a functioning oyster population in Town Pond.

OVERCOMING RESTORATION PARADIGMS: VALUE OF THE HISTORICAL RECORD AND METAPOPULATION DYNAMICS IN NATIVE OYSTER RESTORATION. Lipcius, R. N. (1), (1) VIMS, College of William & Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA

Restoration strategies for native oyster populations rely on multiple sources of information, which often conflict due to the time- and space-varying patterns in demographic rates, abundance, and distribution. In particular, strategies based on metapopulation dynamics/population connectivity and disease resistance have differed significantly, leading to confusion over the optimal strategy. In addition, extant and historical records of abundance and distribution are often at odds, such that potentially valuable restoration sites may be excluded from consideration. This was the case for the Lynnhaven River subestuary of lower Chesapeake Bay, which was previously deemed unsuitable for Eastern Oyster (*Crassostrea virginica*) restoration based on physical conditions, disease challenge, and extant oyster abundance, yet anecdotal information and biophysical modeling suggested that oysters could survive and persist at high abundance. Consequently, we (i) evaluated previously unknown historical data from the 1800s, (ii) used field surveys of oyster recruitment and abundance, physical conditions, and disease presence, and (iii) assessed simulations from biophysical models identifying potential restoration reefs in the metapopulation. Contrary to previous assumptions, there were numerous reef sites that were (i) in the polyhaline zone (salinities of 18.4-22.2) where disease resistance is most likely to evolve, (ii) in areas where oysters existed at high abundance in the late 1800s and early 1900s, (iii) in areas of recent high recruitment and survival, despite consistent and elevated disease challenge, and (iv) connected to the rest of the metapopulation via larval dispersal. These findings demonstrate that assumptions about habitat suitability for oyster restoration based on individual processes can be severely flawed, and that in-depth examination of multiple processes and sources of information are required for oyster reef restoration plans to maximize success.

UTILIZING OYSTER CASTLES TO ACHIEVE MULTIPLE OYSTER RESTORATION GOALS. Lusk, B. W. (1), (1) The Nature Conservancy, 11332 Brownsville Road, Nassawadox, VA 23413, USA

The alternative substrate known as oyster castles provides oyster restoration practitioners with a versatile means of achieving multiple restoration goals. Individual oyster castles can be stacked and interlocked with other oyster castles to construct a wide array of three dimensional reef forms. Since 2008 The Nature Conservancy's (TNC) Virginia Coast Reserve has been using oyster castles as part of its oyster restoration program for site suitability assessment and for building reef structures in areas with energy regimes that are too high for traditional restoration through planted shell cultch. Oyster castles have also been used to rehabilitate old, dead reefs by elevating their surface to a level within the water column which enhances oyster recruitment and survival. Once elevated, these rehabilitated reefs will be able to accrete and grow apace of sea level rise. Projects are planned which will utilize oyster castles for the construction of offshore breakwater reefs intended to attenuate wave energy and provide some level of protection for eroding shorelines. Both completed and planned TNC projects in the coastal bays of Virginia which utilize oyster castles for each of these purposes will be presented and discussed.

VOLUNTEER SHELLFISH COMMUNITY ACTION PROGRAMS: ANSWERING THE CALL. Macfarlane, S. (1), D. Murphy (2), (1) Coastal Resource Specialists, 290 Kingstown Way #379, Duxbury, MA 02332, USA; (2) Barnstable County Cooperative Extension and WHOI Sea Grant, Box 367, Barnstable, MA 02630, USA

Massachusetts municipalities that manage their own shellfish resources often need help in carrying out their propagation responsibilities. Decreased support for shellfish projects and budget shortfalls have led to shellfish departments stretched very thin. Volunteers have stepped up to the plate to help. They maintain upweller systems and field gear and do myriad other tasks as desired by the town shellfish departments. Some groups are long-standing and some are newly formed but all have people who love shellfish, love being outdoors, have diverse skills, and want to "give back" to their community. Towns reap the benefit of free labor and in some cases, financial assistance as well. In May 2013, Barnstable County Marine Extension provided a two-day workshop for volunteers to learn about the intricacies of shellfish culture. Attendance exceeded expectations in number and in towns represented indicating a strong desire for this type of program.

ENGAGING HIGH SCHOOL STUDENTS IN OYSTER RESTORATION THROUGH HANDS-ON AUTHENTIC LEARNING OPPORTUNITIES. Malinowski, P. (1), (1) Billion Oyster Project, New York Harbor School, Battery Maritime Building, Slip 7, 10 South Street, New York, NY 10004, USA

New York City is home to 1.1 million public school students. While it is also home to the best public high schools in the country, the majority of these students do not find great success in high school. A widening achievement gap, disheartening dropout and graduation rates, and poor college retention all speak to a need to find systematic tools for increasing the quality and depth of learning experiences throughout these years. At the New York Harbor School and increasingly at middle schools throughout the city these experiences are coming from oyster restoration. This work has created opportunities for authentic, place-based, scientific inquiry projects. Students at Harbor School design, develop, and carryout short-term research projects to understand how best to cultivate oysters in sub-optimal conditions. In New York Harbor, oysters are scarce and recruitment events are few and far between. There are water quality and disease pressures that limit the life span of oysters and inhibit larval growth and development. Harbor School students are currently conducting analyses on oyster growth and survival at various locations around the Harbor. In other experiments, they are testing responses to depth in the water column, tidal position, and presence of predators. These students create compelling presentations that speak to their deep commitment and engagement in these restoration and research projects. This project can be seen as a model for engaging youth in environmental restoration through their public school classes.

OYSTER RESTORATION IN AN URBAN ESTUARY: USING "ECO-VOLUNTEERS" TO CONSTRUCT AND MONITOR AN OYSTER REEF IN BRONX, NY. Malinowski, P. (1), A. M. Fitzgerald (2), (1) Billion Oyster Project, New York Harbor School, Battery Maritime Building, Slip 7, 10 South Street, New York, NY 10004, USA; (2) NY NJ Baykeeper, 52 W. Front Street, Keyport, NJ 07735, USA

Oysters were once abundant in the Hudson Raritan Estuary surrounding New York City, until over-harvesting, pollution, and disease decimated the population. In the past decade, oyster restoration has come to the forefront of community-based restoration projects in NYC. In the south Bronx, NY/NJ Baykeeper, NYC Parks Department, and the Oyster Restoration Research Partnership have established an "eco-volunteerism" program at our 1-acre restored reef, which allows for volunteers to put on waders, get into the water, and observe the reef as never before using scientific methods to measure oyster growth and mortality. Volunteers have helped to build and monitor the reef. The success of




this project has led to the permanent establishment of the “eco-volunteerism” program, and expansion to other sites. For the past two years, scientific research has focused on using large expanses of loose shell, with spat-on-shell placed on top. As the current scientific project ends, plans are underway for future monitoring and construction programs built around installation and monitoring of oyster cage enclosures. These enclosures are built with cages of spat-on-shell and filled with loose two-year old oysters from a local high school aquaculture program, Urban Assembly New York Harbor School, and allow for us to use native, local oysters in local restoration programs. The project, located in a distinctly urban setting at the confluence of the Bronx River, East River, and Long Island Sound, is adjacent to the nation’s poorest congressional district and one of the world’s largest food distribution centers, Hunts Point Cooperative Market. Funded by a WCS/NOAA Regional Partnership Grant, this is one of many community-based restoration efforts taking place in the Hudson Raritan Estuary.

PERFORMANCE EVALUATION OF TWO GROW-OUT METHODS ON THE PREVENTION OF OYSTER SPAT FOULING ON INTERTIDAL FARMED OYSTERS (*CRASSOSTREA VIRGINICA*) IN GEORGIA.
Manley, J. (1), T. Bliss (2), (1) University of Georgia Marine Extension Service Shellfish Research Laboratory, 20 Ocean Science Circle, Savannah, GA 31411, USA; (2) University of Georgia Marine Extension Service, 20 Ocean Science Circle, Savannah, GA 31411, USA

Large-scale farming of single eastern oysters (*Crassostrea virginica*) in Georgia has not occurred due to perceived poorer quality associated with oyster overset, increased labor costs, and diminished market price. Reproduction and settlement rates of eastern oysters peak in the southeastern United States which creates unique challenges to holding oysters during the spawning period. Environmental factors that adversely impact settling oyster larvae may have limited or no negative impacts on adult oysters and may potentially provide a refuge from oyster spat fouling. Thus settlement patterns of larval oysters are not necessarily indicative of habitat suitability for adult oysters. To address the problem of overset we evaluated regionally established grow-out methods utilizing single oysters in the intertidal zone of two sound systems of Georgia during the natural oyster reproductive season (April-October). Treatments included oysters cultivated in bags on racks at 0.0 ft MLW and bags directly on bottom at stocking densities of 125-132 oysters/bag. Metrics evaluated for each treatment were oyster over-set, shell growth rate and morphology, oyster survival, oyster condition index, site sediment characteristics, and oyster recruitment rates. ANOVA will be used to detect differences between methods for each metric.

IS RUGOSITY ON INTERTIDAL OYSTER REEFS RELATED TO SPAT AND ASSOCIATED RESIDENT FAUNA?
Margiotta, A. M. (1), N. Hadley (2), V. Shervette (3), C. Plante (1), D. Wilber (4), (1) College of Charleston, 205 Fort Johnson Road, Charleston, SC 29412, USA; (2) South Carolina Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC 29412, USA; (3) University of South Carolina Aiken, 417 University Parkway, Department of Biology and Geology- SBDG 219A, Aiken, SC 29801, USA; (4) HX5, 664 Old Plantation Road, Charleston, SC 29412, USA

Habitat vertical complexity is an important physical feature of many marine systems (e.g., rocky intertidal, coral reefs, and bivalve communities) that can influence factors such as predator-prey interactions and recruitment. High vertical structure on intertidal Eastern oyster, *Crassostrea virginica*, reefs is beneficial to both fishery and habitat functions. Quantifying related parameters, such as oyster size frequencies and associated fauna, typically requires destructive sampling (e.g., excavating quadrats). Using the chain method to measure reef rugosity (*Rq*) is an alternative, non-destructive method for quantifying vertical reef structure. We are investigating the relationship between rugosity and factors such as oyster size frequencies, recruitment, and associated faunal assemblages. In summer 2013, experimental trays were deployed at two sites in Charleston Harbor, Charleston, S.C. to examine whether oyster recruitment and associated faunal densities are related to vertical complexity (standardized by *Rq* measures). After twelve weeks, trays were collected and washed. Oyster spat were counted and measured and associated macrofauna were identified, counted, and measured. To date, results indicate that rugosity is related to the abundances of some crab species (e.g., *Eurypanopeus depressus* and *Petrolisthes armatus*), but not others (e.g., *Panopeus herbstii*). To compare these experimental results with natural oyster habitat, rugosity was measured in the summer of 2014 on restored reefs over 0.25 m^2 quadrats before excavation. The excavated quadrats were processed in the same manner as the experimental trays. Results indicate that the rugosity metric can serve as a reliable management tool that characterizes the oyster habitat vertical complexity used by associated macrofauna.

SEVEN YEARS OF ASSESSING A LIVING SHORELINE OF PRE-FABRICATED STRUCTURES PLACED IN TERREBONNE BAY, LOUISIANA: THE CHALLENGES IN A MICROTIDAL, HIGH-ENERGY, HIGHLY-SUBSIDING, HIGHLY-ERODING, AND HURRICANE-PRONE ENVIRONMENT. Melancon, E. (1), G. Curole (2), Q. Fontenot (1), (1) Biology Department, Nicholls State University, Thibodaux, LA 70301, USA; (2) Coastal Protection & Restoration Authority of Louisiana (CPRA), 1440 Tiger Drive, Suite B, Thibodaux, LA, USA

Over the last seven years, of an eight-year project, we have measured multiple metrics in our evaluation of which of three fabricated structures is "best" in shoreline erosion reduction, and also "best" in developing a perpetual living oyster population that could survive as the fabricated structures deteriorate and sink in the soft soils of coastal Louisiana. The project is distributed along three shorelines located on the northwestern shores of Terrebonne Bay. The shoreline protection structures are ReefBlks, A-Jacks, and Gabion Mats. All three structures were installed at all three shorelines in 91 m lengths. Each structure-protected shoreline was paired with a non-structured reference (control) site. We will discuss our metrics, our results to-date, and the challenges we face in a microtidal, high-energy, highly-subsiding, highly-eroding, and hurricane-prone environment. We want to engage the audience in helping us interpret our results, where should we continue focus if we would get funding for additional years of monitoring, and what are the perceived, actual, and potential shortfalls in our metrics interpretations. We want to discuss the possibility that what may work in Louisiana may not work abroad or even in the adjacent Louisiana estuary.

FECAL COLIFORM DENSITIES IN THE GUANA TOLOMATO MATANZAS NATIONAL ESTUARINE RESEARCH RESERVE. Moore, J. G. (1), J. Wade (1), C. L. Cooksey (1), M. Fulton (1), (1) NOAA, NOS, NCCOS, CCEHBR, 219 Ft. Johnson Rd., Charleston, SC 29412-9110, USA

As part of ongoing collaboration projects between the National Centers for Coastal Ocean Science (NCCOS) and the National Estuarine Research Reserve (NERR) system, Guana Tolomato Matanzas (GTM) was chosen as the most recent NERR to assess baseline ecological conditions and potential stressor impacts. The NERR is located along the northeastern coast of Florida (above and below St. Augustine), and the study was conducted during July and August 2014. Sampling occurred at 30 stations throughout the reserve and included water quality parameters, potential stressors, sediment and infauna conditions, and human-health risks (incidence of contaminated seafood and fecal coliform levels in surface waters). Because of the reserve's large size, sampling focused on subtidal portions of the main rivers and excluded tidal creeks and the ocean portion of the northern reserve component. Water samples for fecal coliform microbial contamination were processed at the end of each day at the GTM NERR research facility. Densities ranged from 0 to 334 CFU/100 ml, with a mean value of 34.8 CFU/100 ml for the 30 sites. These data can be used to show changing conditions over time with respect to either natural or anthropogenic inputs.




THE NATIONAL ESTUARY PROGRAM (NEP)/NOAA COMMUNITY-BASED RESTORATION PARTNERSHIP: PARTNERS IN OYSTER HABITAT RESTORATION. O'Hanlon, L. H. (1), S. Morlock (2), (1) Association of National Estuary Programs, 1110 Raintree Drive, Charlottesville, VA 22901, USA; (2) NOAA Restoration Center, Community-Based Restoration Program, 1315 East-West Highway, Silver Spring, MD 20910, USA

The NEP/NOAA CRP provides long-term benefits to living resources and increases citizen stewardship through sustainable habitat restoration within nationally significant estuaries. The partnership is founded on the framework of the NEP where stakeholders develop science-based solutions to environmental problems and promote healthy communities. Nine projects have been funded, restoring oyster, seagrass, and wetland habitats. The oyster projects include Indian River Lagoon "Seeding Eyed Oyster Larvae onto Recycled Shell Reefs" (Florida Oceanographic Society) where oyster populations were "jump started" by seeding reefs *in situ* with hatchery-supplied oyster larvae. The technique was evaluated as a viable and cost-effective alternative to traditional hatchery rearing. Larval seeding was most effective before and after peak natural recruitment and when recruitment was low due to adverse environmental conditions. Shell bag and oyster mat reef restoration techniques were compared for oyster growth and survival success. Results indicated that the mat reef technique had higher colonization and abundance of species than the bag method. The "Mosquito Lagoon Oyster Reef Restoration" (The Nature Conservancy) project restored oyster reef habitats previously damaged by recreational vessel wakes. Dead margins of reefs were mechanically leveled and oyster mats deployed. Stable reefs were reestablished and live oyster recruitment was successful. Seagrasses were observed adjacent to some reefs where not previously observed. The Narragansett Bay "Establishing Oysters into Restored RI Coastal Ponds" (Roger Williams University) project introduced Eastern oysters into a restored coastal pond. Hatchery seed oysters were set on cultch and nursery reared by volunteer oyster gardeners participating in the RI Oyster Gardening for Restoration and Enhancement program. This program recruits landowners to rear juvenile oysters through the first growing season to a size that allows for successful transplantation.

PARTNERSHIPS IN ACTION FOR SUCCESSFUL COMMUNITY-BASED OYSTER REEF RESTORATION AND MONITORING IN INDIAN RIVER LAGOON, FLORIDA. Palmer, J. B. (1), L. Walters (2), K. Brown (1), (1) Brevard Zoo, 8225 N. Wickham Rd., Melbourne, FL 32940, USA; (2) University of Central Florida, 4000 Central Florida Blvd., Orlando, FL 32816, USA

Since 2007, University of Central Florida has been working alongside partners, the Brevard Zoo in particular, to restore intertidal Eastern oyster (*Crassostrea virginica*) reefs in arguably the most biologically diverse estuary in the continental United States, the Indian River Lagoon. These once healthy oyster reefs have seen dramatic impacts due to recreational boating activity causing disarticulated shells to form dead margins, or piles, around the lagoon. In addition to being a danger to boaters, the dead margins move and 'roll' back over the live, healthy reef behind it. By working with community volunteers and using recycled shell to create specially designed oyster restoration mats, the involved organizations have been able to engage and educate over 40,000 volunteers to act for our lagoon. With 68 restored reefs through the use of over 41,000 oyster mats and annual monitoring, this project has introduced habitat for over 4.5 million oysters and countless other species which depend on oysters for survival.

BAR TENDING - A NEW APPROACH TO OYSTER (*CRASSOSTREA VIRGINICA*) SPAT SETTING. Paul, R. W. (1), K. M. Boyle (2), S. Russell (2), (1) St. Mary's College of Maryland, Department of Biology, 18952 E. Fisher Road, St. Mary's City, MD 20686, USA; (2) Shore Thing Shellfish, LLC, P.O. Box 74, Tall Timbers, MD 20690, USA

A major impediment to oyster reef restoration with living oysters is spat-on-shell production. Traditional methods of setting native Eastern oyster (*Crassostrea virginica*) larvae onto oyster shell rely on land-based remote setting tanks that contain shell that has been bagged or placed in cages. These land-based tanks receive larvae that are set onto the shell, and then the spat-on-shell is transported to planting sites. This traditional method is extremely time consuming, labor intensive, may contribute to handling mortality, and can be expensive. Our new, alternative method for setting spat onto shell uses '*in-situ*' setting because it is done 'on site' rather than in land-based tanks and uses a removable enclosure into which oyster shell and larvae are placed. We studied the efficacy of this method in several experiments: preliminary experiments that determined the aeration time needed to distribute larvae through shell piles, field experiments that compared the *in situ* method to the traditional spat setting method, and experiments that used restoration reef balls as alternative substrates to oyster shells. Results from two years of field trials are quite promising and showed no significant difference in setting efficiency between the traditional and in situ methods. Overall, we believe that we have demonstrated that the *in situ* method is a promising alternative to the traditional method because it can be used to: 1) set an equivalent number of spat on shell, 2) possibly reduce spat mortality from handling of shell bags/cages, and 3) produce a single spat on a shell more economically than the traditional method. The application of the *in situ* method will aid in the production of spat-on-shell for both oyster restoration and aquaculture.

PRIME REAL ESTATE: VARIED HABITAT COMPLEXITY AND ALTERNATIVE SUBSTRATE MATERIALS.
Peters, J. W. (1), M. Jordan (2), (1) NC Division of Marine Fisheries, 3441 Arendell St., Morehead City, NC 28557, USA

Since inception in 1995, the North Carolina Division of Marine Fisheries (NCDMF) Oyster Sanctuary Program has focused on developing a network of oyster broodstock sanctuaries throughout N.C. estuaries. This network of harvest-protected artificial oyster reefs has been widely successful in providing larval subsidies to local natural reefs. With the guidance of university research and self-assessment of triumphs and failures, NCDMF has begun to experiment with sanctuary design plans by using a variety of reef-making materials. Settlement material such as Reef Balls, concrete blocks, processed/recycled concrete, limestone marl, assorted precast concrete, basalt, and granite offer a diverse assemblage of settlement options for oyster larvae and varied habitat complexity. New settlement substrate materials will help likely improve reef longevity, oyster abundance, resistance to environmental stressors (i.e., boring sponge), and Essential Fish Habitat. Such designs have been recently implemented in new sanctuary construction (Raccoon Island), and blueprints for two new sites are under development or pending permit approval.

INCORPORATING TROPHIC ANALYSIS INTO HABITAT ASSESSMENT OF A RESTORED OYSTER REEF.
Rezek, R. (1), J. B. Pollack (1), B. Lebreton (2), (1) Texas A&M Corpus Christi, 6300 Ocean Dr., Corpus Christi, TX 78412, USA; (2) University of La Rochelle, LIENSS, UMR 7266 CNRS Universite de La Rochelle Avenue Michel Crepeau , La Rochelle, Poitou-Charentes 17 042 cedex 1, France

Determining the proficiency of constructed habitats in restoring ecological function and facilitating ecological enhancement is a principal aspect of estuarine restoration ecology. With the aim of evaluating functional recovery, we examined temporal trends in trophic structure, species composition, and biomass of epifauna in a newly restored oyster reef (*Crassostrea virginica*) relative to an established natural oyster reef in the Mission-Aransas Estuary, Texas. Oysters and reef-resident epifauna (decapods and fish) were collected seasonally in 2013 to determine density and biomass estimates. Temporal changes in trophic structure were investigated using stable isotope analysis of epifauna and important primary food sources. Bayesian stable isotope mixing models and Bayesian ellipse approaches were used to evaluate and compare the dietary composition of major functional groups and community-wide niche widths between reef types using the siar package in R. Fish and decapod total biomass and multivariate fish and decapod community structure were not significantly different between reef types or seasons. Oyster biomass was significantly greater during the winter sampling period than all other sampling seasons; oyster abundance was significantly higher




during fall and winter sampling periods than in spring and summer. Oyster biomass and abundance were not significantly different between natural and restored reef. Our findings indicate the restored oyster reef was successful in restoring forage habitat, productivity, and nutrient cycling through the support of epibenthic communities with similar composition and functional characteristics as those found on natural oyster reef.

OPTIMIZING INTERTIDAL OYSTER REEF RESTORATION BY CONSIDERING TIDAL ELEVATION IN SITE ASSESSMENT. Ridge, J. T. (1), A. B. Rodriguez (1), N. L. Lindquist (1), J. H. Grabowski (2), F. J. Fodrie (1), (1) Institute of Marine Sciences, University of North Carolina at Chapel Hill, 3431 Arendell St., Morehead City, NC 28557, USA; (2) Marine Science Center, Northeastern University, 430 Nahant Road, Nahant, MA 01908, USA

Quantifying the physicochemical boundaries that define the optimal growth conditions of intertidal foundation species will increase the sustainability and success of restoration activities challenged by future sea-level rise. Using terrestrial lidar to obtain fine-scale measurements of reef growth, we examined sets of 2- and 15-year old oyster reefs (Eastern Oyster, *Crassostrea virginica*) constructed on sandflats over a subtidal-to-intertidal inundation gradient in Back Sound, North Carolina. We developed a model that relates the mean duration of aerial exposure during each tidal cycle to vertical reef growth, which exhibits a strong parabolic growth pattern relative to % aerial exposure. Our model applies where astronomical forcing dominates water level fluctuations and denotes three distinct zones: 1) an abrupt switch from reef deterioration to reef accretion occurs above the critical exposure duration of 10% (approximately mean low water), 2) the reef experiences greatest growth between 20-40% exposure (vertical accretion rates of 2 and 11 cm yr^{-1} for the older and younger reefs, respectively), and 3) a growth ceiling occurs near mean sea level, above which oysters cannot grow. We also see a correlation between tidal elevation and densities, with higher adult densities (>3,000 m^{-2}) occurring near the mid-intertidal. Our model predicts that even under the highest sea-level rise scenarios, intertidal sandflat reefs can persist, while reefs below the critical exposure depth will be lost. In temperate regions where water level fluctuations are strongly controlled by astronomical forcing, these findings will enhance restoration success rates and the delivery of reef-associated ecosystem services if information on % aerial exposure are obtained at the site and incorporated into the design of the restoration project.

MONITORING AND COMPARING NEKTONIC COMMUNITIES UTILIZING ARTIFICIAL AND NATURAL OYSTER (*CRASSOSTREA VIRGINICA*) REEFS IN COASTAL GEORGIA. Rinn, S. (1), T. Bliss (2), (1) University of Georgia Marine Extension Service Shellfish Research Laboratory, 20 Ocean Science Circle, Savannah, GA 31411, USA; (2) University of Georgia Marine Extension Service, 20 Ocean Science Circle, Savannah, GA 31411, USA

Eastern oyster (*Crassostrea virginica*) reef restoration efforts in coastal Georgia include many methods to establish substrate for new oyster recruitment. In Jointer Creek, two artificial reefs were constructed in the intertidal zone. One used bagged oyster shell and oak bundles and the other is constructed of bagged oyster shell. These two artificial reefs were sampled along with adjacent natural reefs using a bottomless lift net. Sites were sampled three days consecutively each season (spring, summer, fall, winter) to determine fish associated with artificial and natural oyster reefs. In our sampling, we have identified 35 species of fish and seven species of crustaceans of different age classes. Some important sport fish identified include spotted sea trout (*Cynoscion nebulosus*), spot (*Leiostomus xanthurus*), southern flounder (*Paralichthys lethostigma*), and rock sea bass (*Centropristis philadelphica*). Data will be analyzed to detect differences between nektonic communities over natural and artificial reefs and between seasons.

Oral and Poster Presentation Abstracts

A REMOTE SETTING TRAINING PROGRAM FOR MARYLAND: MAKING PUBLIC/PRIVATE PARTNERSHIPS WORK TO STIMULATE OYSTER AQUACULTURE. Roache, E. (1), S. Weschler (1), D. Webster (2), S. Abel (3), J. Parisi (3), D. Meritt (1), (1) University of Maryland Center for Environmental Science Horn Point Laboratory Oyster Hatchery, 2020 Horns Point Lane, Cambridge, MD 21613, USA; (2) University of Maryland Wye Research & Education Center , P.O. Box 169 , Queenstown, MD 21658, USA; (3) Oyster Recovery Partnership, 1805A Virginia Street, Annapolis, MD 21401, USA

Public and private seafood production has been practiced in the Chesapeake Bay for more than a century. Maryland has historically been dominated by a public oyster fishery, but with aquaculture using natural reproduction and transferred seed existing in several areas. These collapsed during the mid-1980s leading to efforts to rebuild stocks through various form of aquaculture. Declining harvests of blue crabs during 2010 resulted in the infusion of federal disaster funds. Some of these have been used to develop a training program whereby fishermen are given hands-on instruction in the process of remote setting. Remote setting has been successfully employed on the West Coast of North America to produce seed for oyster aquaculture since the 1970s, but its acceptance in the Chesapeake Bay region has been sporadic. Using Blue Crab disaster funds provided by the National Oceanic and Atmospheric Administration, Maryland Department of Natural Resources contracted with the Oyster Recovery Partnership and the University of Maryland to construct a series of remote setting stations located strategically in oyster producing locations of the state. Training programs were organized to teach growers how to use the systems and care for larvae and spat. During the first four years of the program, 49 individuals have participated resulting in 712 million spat on shell for deployment to their leases. An increase in eyed larvae sales from the Horn Point Laboratory to former participants supports this statement and plans are being developed for further expansion for program year five. The focus of this presentation discusses challenges, data, partnerships, and future expectations associated with this program.

NOAA'S NATIONAL SHELLFISH INITIATIVE: BUILDING PARTNERSHIPS TO MAXIMIZE THE ECOLOGICAL AND ECONOMIC BENEFITS OF SHELLFISH. Rubino, M. C. (1), S. M. Bunsick (1), S. Morlock (2), R. C. Jones (1), K. McGraw (2), (1) NOAA Fisheries Office of Aquaculture, 1315 East-West Highway, Silver Spring, MD 20910, USA; (2) NOAA Restoration Center, 1315 East-West Highway, Silver Spring, MD 20910, USA

In 2011, NOAA launched the National Shellfish Initiative with a dual purpose of stimulating coastal economies and improving ecosystem health. The premise for the initiative is simple: shellfish provide a broad suite of economic, social, and environmental benefits, and these benefits accrue as a result of both commercial aquaculture and shellfish restoration efforts. The initiative leverages NOAA's existing staff, regulatory authorities, and grant programs to further encourage and coordinate both shellfish restoration and environmentally sound commercial shellfish farming. The initiative is building partnerships with states and federal agencies, tribes, industry, restoration groups, academia, and other stakeholders interested in the many benefits that can accrue from having more shellfish beds and shellfish farms in coastal and offshore waters. These benefits include: jobs and business opportunities; habitat for important commercial, recreational, and endangered and threatened species; recovery of populations of native shellfish species; more seafood to meet the growing consumer demand in today's market; nutrient removal and cleaner water; and shoreline protection. The initiative is jointly managed by the NOAA Restoration Center and the Office of Aquaculture at NOAA Fisheries headquarters, with regional Restoration Center staff and Aquaculture Coordinators providing primary points of contact for potential partners. Areas for collaboration include marine planning and permitting; environmental research; restoration and farming techniques; and coordinated and innovative financing. NOAA is an active partner in the Washington State Shellfish Initiative, which was established in late 2011, and is participating in efforts to launch shellfish initiatives with partners in California, Oregon, Connecticut, and other states including Alaska and Hawaii. Ideas for potential collaborations are always welcome. Additional information about the National Shellfish Initiative is available at www.nmfs.noaa.gov/key_issues/17_natl_shellfish_initiative_homepage.html.

AN EVALUATION OF RELIC OYSTER REEFS IN CHESAPEAKE BAY: IMPLICATIONS FOR EASTERN OYSTER, *CRASSOSTREA VIRGINICA*, RESTORATION. Schulte, D. M. (1), R. N. Lipcius (2), R. P. Burke (3), D. M. Bruce (4), (1) U.S. Army Corps of Engineers, 803 Front Street, Norfolk, VA 23510, USA; (2) College of William and Mary, Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA 23062, USA; (3) Christopher Newport University, Mary Forbes Hall, 2035, Newport News, VA 23606, USA; (4) NOAA, 904 South Morris Street, Oxford, MD 21403, USA

A system of newly discovered relic oyster reefs in the Lafayette River, a sub-tributary of the Elizabeth River in Virginia waters of Chesapeake Bay, were mapped and examined via hydro-acoustic surveys with physical sampling done via oyster patent tong using a randomized sampling design over the reefs. The Lafayette River lies in high salinity, high oyster disease (MSX [*Haplosporidium nelson*] and Dermo [*Perkinsus marinus*]) prevalence and intensity waters. These reefs have been abandoned for decades because of a river-wide closure due to a combination of high bacteria levels and environmental contaminants. It is commonly thought that due to the high disease levels, as well as the lack of shell plantings to maintain the habitat, such oyster reefs and their associated populations are incapable of long-term persistence. Our survey revealed a viable oyster population over the reefs, a population which, in general, exceeds newly adopted oyster restoration "metrics for success" designed by a Federal oyster restoration Goal Implementation Team (GIT) composed of Federal, State, and academic oyster restoration practitioners. Lafayette oyster reefs averaged 85.3 g DW/m^2, significantly over the 50 g DW/m^2 established by the GIT, mainly due to the presence of millions of large (> 75 mm length) adults. The persistence of these reefs over a multi-decadal timeframe supports the thesis that oyster restoration projects can be persistent without regular maintenance over long time periods. Additionally, they provide evidence that oyster populations, if unfished, can survive in significant numbers to large (> 75 mm) size in high salinity, high disease prevalent waters.

RECRUITMENT ENHANCEMENT AS AN INDICATOR OF OYSTER RESTORATION SUCCESS IN CHESAPEAKE BAY. Schulte, D. M. (1), R. P. Burke (2), (1) U.S. Army Corps of Engineers, 803 Front Street, Norfolk, VA 23510, USA; (2) Christopher Newport University, Mary Forbes Hall, 2035, Newport News, VA 23606, USA

Eastern oyster (*Crassostrea virginica*) recruitment in the Chesapeake Bay, U.S.A., dropped precipitously as stocks declined (1920s-1985), then collapsed (1986-present). Occasional recruitment spikes occurred, driven primarily by seasonal drought. Recruitment spikes helped sustain the fishery at a small, variable level for years post-collapse, as fishers took advantage of these strong year classes. Historically, oyster recruitment was higher, more reliable, and more stock driven, with weather exerting less, though still significant, influence. Analysis of publicly-available oyster spat (young juvenile oysters) settlement data revealed the reestablishment of a more steady, historic pattern of oyster settlement and recruitment potential in the Great Wicomico River (GWR), where local stocks have been greatly enhanced by a large sanctuary reef network constructed in 2004. In 2012, an oyster shellstring survey in the GWR revealed the highest mean oyster settlement for any Bay tributary since such surveys began nearly 70 years ago. This unprecedented recruitment enhancement is significantly correlated to the large stock on the sanctuary reefs and a strong indicator of restoration success and long-term sustainability, as these reefs are well past the average age of senescence (five years) for restored reefs. With the expansion of large-scale eastern oyster restoration efforts in Maryland's portion of Chesapeake Bay, developing efforts in the northeastern states of Massachusetts, Connecticut, New York, and New Jersey, and similar efforts to restore the Olympia oyster in the Pacific Northwest (Oregon, Washington, British Columbia), these findings are particularly timely and applicable.

ROLE OF PREDATION, HABITAT, AND ENVIRONMENTAL FACTORS ON SOFT-SHELL AND RAZOR CLAMS IN CHESAPEAKE BAY: IMPLICATIONS FOR RESTORATION. Seitz, R. D. (1), C. N. Glaspie (1), M. B. Ogburn (2), A. H. Hines (2), (1) Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA 23062, USA; (2) Smithsonian Environmental Research Center, 647 Contees Wharf Road, Edgewater, MA 21037, USA

Mya arenaria populations in Chesapeake Bay have been declining for several years with a severe decline in the 1990s to record low levels that have been sustained to the present. Declines are likely due to multiple factors including recruitment, predation, habitat loss, disease, and overfishing. We focus on predation by crabs and cownose rays, habitat (structured vs. unstructured), and environmental factors. We surveyed soft-shell clams and other bivalves in various habitats in three Maryland (Eastern Bay, Chester River, and Rhode River-Western shore) and three Virginia (York River, Mobjack Bay, Lynnhaven Bay) tributaries of Chesapeake Bay. In addition, caging studies were conducted with *M. arenaria* in mud, sand, seagrass, and shell-hash habitats in the York River. *M. arenaria* were found in low numbers in Virginia, with 2 *M. arenaria* in fall 2011, 62 *M. arenaria* in spring 2012, 5 *M. arenaria* in spring 2013, and 4 recruits in summer 2013. Similarly, clam densities at Maryland in spring 2012 were higher than fall 2011 densities, and densities declined through fall 2012, after the predation period. *Tagelus plebeius* densities were 5x higher and *M. arenaria* densities 10x higher at Eastern vs. Western shore sites. *T. plebeius* biomass was significantly greater in seagrass habitats than in shell-hash habitats. *T. plebeius* biomass (AFDW) was a function of the numbers of predators and habitat, according to AIC analyses. *M. arenaria* had high mortality in partial cages, stockades, and uncaged plots as compared to caged controls, indicating that crabs are the major predators of soft-shell clams in this system. This suggests that predation and habitat influence clam densities over the long term, with implications for shellfish restoration.

RESTORATION OF FLAT OYSTER COMMUNITIES IN THE OFFSHORE WATERS OF THE NORTH SEA.
Smaal, A. (1), P. Kamermans (1), H. Sas (2), T. van der Have (3), (1) IMARES, P.O. Box 77, 4400 AB Yerseke, The Netherlands; (2) SASCON, Danie Theronstrt 1091XZ Amsterdam, The Netherlands; (3) BUWA, P.O. Box 365, 4100 AJ Culemborg, The Netherlands

Flat oyster communities *Ostrea edulis* have existed in the North Sea, Wadden Sea, and the English Channel. Large-scale fisheries on oysters and subsequent bottom trawling decimated the North Sea stocks. Flat oysters have formed dominant communities in the past, but at present they are hard to find. Oyster reefs provide habitat, food, and shelter for many associated species and may enhance biodiversity. They provide various ecosystem services including sustainable provision of valuable products. In the action plan "Shellfish Reefs at Risk," the flat oyster is an important target species for restoration in European marine waters. Governmental policy aims at restoring shellfish beds, including flat oysters, in the North Sea. The objective of our feasibility study is to identify the conditions that are required for reintroduction of the flat oyster, and to develop a program for field tests at different North Sea sites, as a step towards real scale restoration on selected locations. On the basis of literature, historic data, expert knowledge, and input from stakeholders, a feasibility plan will be developed, focusing on environmental conditions for reintroduction, selection of test sites, identification of Bonamia-free oyster resources, and test methods.

DIRECTED SETTING OF *CRASSOSTREA VIRGINICA* LARVAE ON A TARGETED SITE IN A TIDAL CREEK: OVERWINTER SURVIVAL AND SET IN THE SECOND YEAR. Steppe, C. N. (1), D. W. Fredriksson (2), L. Wallendorf (3), M. Robert (2), (1) U.S. Naval Academy, Department of Oceanography, 572C Holloway Rd., Stop 9D, Annapolis, MD 21402, USA; (2) U.S. Naval Academy, Department of Ocean Engineering, Rickover Hall, Annapolis, MD 21402, USA; (3) U.S. Naval Academy Hydromechanics Lab, Rickover Hall, Annapolis, MD 21402, USA

In mesohaline regions of Chesapeake Bay, recruitment of oysters (*Crassostrea virginica*) is limited by both insufficient settlement substrate and larval supply. To counter this, the procedure of remote setting of larvae, and then transporting spat-on-shell to target habitats has been used successfully to enhance oyster stocks for both aquaculture and restoration. However, certain inefficiencies within this method (e.g., handling of shell, spat mortality during transport) exist. Therefore other methods of seeding targeted sites merit consideration. One method to increase spat production




is to surround targeted substrate with a temporary flexible enclosure and add competent larvae. Larvae are allowed three days to set, after which the enclosure is removed. This was completed successfully in August 2012 in St. Leonard Creek, a tributary of the Patuxent River (St. Leonard, Maryland, U.S.A.). Larval set and recruitment (one month post-set survival) were comparable for treatments both in the enclosure and in shore-side tanks. Over-winter mortality from the 2012 cohort was quantified in May 2013. In July 2013 larvae were set on the site by the same method as the previous year, but without adding fresh shell base. Spat set in treatments inside and outside the enclosure was measured, as was recruitment one month post-set. Initial set in 2013 was substantially lower than in 2012, though this reduced set was observed both in the enclosure and in shore-side tanks. In both years post-set mortality considerably limited recruitment, however set and recruitment was significantly higher than in creek controls. Potential applications for using direct setting as a tool for bottom aquaculture and shellfish restoration will be discussed.

RECOVERING ABANDONED CRAB TRAPS FOR USE AS OYSTER REEF SUBSTRATE IN SOUTH CAROLINA, USA. Stone, B. W. (1), P. Kingsley-Smith (1), (1) SCDNR, P.O. Box 12559, Charleston, SC 29422, USA

Abandoned crab traps are responsible for the bycatch mortality of both target and non-target species, also referred to as "ghost fishing," visual pollution, and damage to sensitive habitats, such as submerged aquatic vegetation or non-vegetated live bottom. Abandoned crab traps are a major source of marine debris in coastal waters along the East Coast, including South Carolina, and continually arise from wanton discard, broken buoy lines, and accidental displacement by storms and large tides. The main goal of the projects presented here is to gather abandoned and donated crab traps in order to re-purpose them as substrate for creating new oyster reefs. In collaboration with researchers from the University of Georgia, a new Marine Debris Tracker smartphone application created by NOAA has been integrated into our crab trap recovery projects, replacing a previous web-based online survey. Our hope is that the greater ease of use of this technology will lead to more reporting and an increased recovery of abandoned traps from the environment. Once recovered, the funnels of abandoned and donated traps are closed in order to prevent further ghost fishing and the traps are coated in a thin layer of cement in order to attract larval oysters. This approach has proven to be very successful in leading to the rapid development of new intertidal oyster reef habitat. Here we present results from a "drop-net" sampling technique used to investigate finfish and invertebrate species habitat utilization of the crab trap reefs compared to adjacent non-reef habitat. Furthermore, we will also present preliminary findings from video surveillance techniques developed to investigate the value of these crab trap-based reefs to shorebirds foraging intertidally.

WHAT EFFECT DOES pH HAVE ON THE GROWTH OF *TETRASELMIS CHUII* (PLY 429)? Trommatter, J. E. (1), D. W. Meritt (1), L. M. Guy (1), (1) University of Maryland Center for Environmental Science Horn Point Laboratory, 2020 Horns Point Road, Cambridge, MD 21613, USA

pH was manipulated in cultures of *Tetraselmis chuii* in order to determine its effects on growth. Six transparent fiberglass flat-bottomed culture tubes were inoculated at a standard stocking density, approximately 30,000 cells/mL. pH was manipulated by injecting CO_2 into the algae culture. pH was continuously monitored using YSI Model SensoLyt® SEA probes. Probes were interfaced with an automated CO_2 injection system, which was used to maintain pH levels for the duration of the experiment. All cultures were inoculated and allowed to grow under experimental conditions for 96 hours. This procedure was replicated five times. Results indicate that *Tetraselmis chuii* cultures achieved the densest cultures at pH levels in the 7.0 to 8.0 range. Cultures maintained in the 6.0-6.5 and 8.5 range exhibited reduced growth. Further testing is needed to determine more precise optimal conditions to achieve the greatest growth.

Oral and Poster Presentation Abstracts

GENETIC TRACKING OF AN EASTERN OYSTER, *CRASSOSTREA VIRGINICA* (GMELIN, 1791), RESTORATION PROJECT IN THE LAFAYETTE RIVER, VIRGINIA. Turley, B. D. (1), J. Shannon (2), T. Leggett (2), J. McDowell (1), K. Reece (1), (1) Virginia Institute of Marine Science, College of William and Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA; (2) Chesapeake Bay Foundation, P.O. Box 412, Wicomico, VA 23198, USA

The hydrodynamics of the Elizabeth, James, and Lafayette rivers in Virginia are dependent upon each other, and the oysters in the region have been assumed to be closely related due to the large dispersal potential of oysters; however, the magnitude of relatedness between the oysters in these rivers is unknown. The Chesapeake Bay Foundation is testing the predictions of a hydrodynamic model that suggests the Lafayette River will retain oyster larvae spawned there until settlement. Two genetically distinct strains of Eastern Oyster, *Crassostrea virginica*, were planted on two reefs separately in the Lafayette River, Virginia during the summer of 2013 as part of an ongoing restoration project and to test the hydrodynamic model. The genotypes of newly settled oysters in the Lafayette River are compared to the planted strains and to adult populations in the southern Chesapeake Bay. It is expected that the spat will be more closely related to the planted oysters or oysters in the Lafayette River. Settlement is being monitored via weekly shell-string surveys and citizen scientists who maintain spat collectors at their docks within the Lafayette River. Tissue samples are being obtained from both the shell-strings and spat collectors for genetic testing with a panel of molecular markers. Shell-string and spat collector results and initial genotyping results will be presented from 2013 and 2014. This study will provide useful information about genetic connectivity in the lower Chesapeake Bay rivers and the contribution of planted oysters to restoration efforts. Additionally, the data will help determine the utility of the hydrodynamic model as decision-making tool for evaluating different restoration strategies in the Lafayette River.

CHALLENGES ASSOCIATED WITH ESTABLISHING AN OYSTER RECYCLING AND REEF RESTORATION PROGRAM. Walters, K. (1), K. Roff (2), C. Martin (3), N. Chambers (4), L. Coen (5), (1) Coastal Carolina University, Dept. of Marine Science, P.O.B. 261954, Conway, SC 29528, USA; (2) Fisher Recycling Grand Strand, 104 Calvert Ct., Pawleys Island, SC 29585, USA; (3) Louisiana State University, Dept. of Oceanography & Coastal Sciences, 1229 Energy Coast & Environment Bldg., Baton Rouge, LA 70803, USA; (4) Chambers Design, 155 Water Street, Brooklyn, NY 11205, USA; (5) Florida Atlantic University, 16007 Waterleaf Lane, Fort Myers, FL 33908, USA

The relatively recent recognition that oysters functionally are threatened or extinct in many coastal U.S. regions has resulted in a push to establish programs designed to restore or enhance native oyster reefs. Restoration efforts typically involve one of a number of approaches calculated to return native shell to potential reef sites, although approaches not relying on shell are gaining in popularity. Any effort faces numerous challenges ranging from acquisition to final placement of shell that are similar and unique to existing or past restoration programs. Both manageable and intractable challenges associated with development of the Coastal Oyster Recycling and Restoration Initiative (CORRI) in the Myrtle Beach, S.C. region are described to open a dialogue with the intent of standardizing practices and removing obstacles associated with reef restoration. Mechanics (e.g., pick-up or drop-off) and economics (e.g., tax incentives, landfill charges) of shell acquisition, existing and future roles for agencies and volunteers (e.g., territoriality, liability), required state and federal permitting, and reef construction considerations (e.g., shell transport, site access) are addressed. The sharing of experiences should facilitate future formation of restoration programs capable of the sustained, concerted, and effective efforts required to address an historic loss of oyster reefs.




MARSH RESTORATION AT HARBOUR TOWN GOLF LINKS' 18TH GREEN, HILTON HEAD, SC. Wartko, T. (1), C. Corbitt (1), (1) The Sea Pines Resort, SC, USA

This innovative project is the first of its kind to be permitted in South Carolina. The marsh restoration prevents erosion while promoting natural ecosystem processes that work with natural soils, marsh grasses, and the tidal flows from the Calibogue Sound. The project included installation of more than 20,000 marsh grass plants, was constructed from water side to avoid impacts to the golf facility and use, and imported 2,000 cy of sand fill from an upland source. The project was developed by Cary Corbitt, Sea Pines Resort VP of Sports and Operations, engineered by Olsen Associates, Inc., and installed by Cape Romain Contractors, Inc. in October 2011 and to date the project is on track to provide targeted results.

TOWARD LARGE-SCALE OYSTER *CRASSOSTREA VIRGINICA* RESTORATION IN THE CHESAPEAKE BAY.
Weissberger, E. J. (1), K. U. Gross (2), K. Muzia (3), W. Slacum (3), A. Sowers (4), S. R. Westby (5), (1) Maryland Department of Natural Resources, 580 Taylor Ave. B-2, Annapolis, MD 21401, USA; (2) U.S. Army Corps of Engineers, CENAB-PP-C, 10 S. Howard St., Baltimore, MD 21201, USA; (3) Oyster Recovery Partnership, 1805A Virginia St., Annapolis, MD 21401, USA; (4) U.S. Army Corps of Engineers, CENAB-Planning, 10 S. Howard St., Baltimore, MD 21201, USA; (5) NOAA Chesapeake Bay Office, 410 Severn Ave., Suite 207A, Annapolis, MD 21403, USA

Early oyster restoration efforts in Maryland's portion of Chesapeake Bay were small in scale. Few areas were closed to harvest, and only a small fraction of suitable bottom was rehabilitated. The alignment of federal and state oyster restoration initiatives facilitated coordination among federal and state agencies, non-profit organizations, and academia on large-scale oyster restoration projects. The first large-scale joint project is the restoration of 377 acres of oyster bar in Harris Creek. Spat on shell is planted on areas with suitable bottom, and reefs are constructed on areas with marginal bottom. Reefs are being built at two heights (15 and 30 cm) and of several different substrates (clam shell, mixed shell, granite, and fossilized oyster shell). Following construction, reefs are planted with spat on shell. As of 2013, 188.6 acres of bottom were constructed and/or planted. The project is on track for completion in 2015, taking a total of four years and $31M. Extensive monitoring is planned to assess reef construction and rehabilitation success, and to inform future large-scale restoration efforts.

HATCHERIES: NOT THE WAL-MART OF THE SHELLFISH INDUSTRY. Willey, S. M. (1), A. M. Maynard (1), A. Gower (1), J. Parisi (2), D. W. Meritt (1), (1) University of Maryland Center of Environmental Science Horn Point Laboratory, 2020 Horns Point Road, Cambridge, MD 21613, USA; (2) Oyster Recovery Partnership, 1805A Virginia Street, Annapolis, MD 21401, USA

Recent advances in cultchless production have caused increased demand for seed oysters. Cultchless seed are individual oysters grown predominantly for the half-shell market. Growers can buy seed from hatcheries or purchase larvae and produce cultchless seed themselves. Most hatcheries or seed suppliers have websites that contain basic information such as price, seasonality, or stocks available, but for the novice grower, this information can be problematic. Novice growers may find communication with the hatchery difficult. The more detail growers can provide to the producer the easier it will be to determine exactly what type of seed is needed and when the hatchery may be able to produce it. Every competent hatchery or seed producer wishes to provide the highest quality seed to meet the needs of the growers. Experience at the Horn Point hatchery has shown us that some growers (and even some producers) find it difficult to ask for or provide the information needed to make seed purchase a smooth process. Hatcheries should not be considered the Wal-Mart of the shellfish industry. Most require some lead time in order to produce the product that their customers need. This lead time can be extensive (a month or more). Discussing these supply issues should lead to a better understanding and promote a good supplier/grower relationship. A simple questionnaire that identifies examples of confusing interactions has been developed and will be explained.

APPLICATION OF GERMPLASM PRESERVATION ON OYSTER RESTORATION. Yang, H. (1), L. N. Sturmer (2), (1) University of Florida, 7922 N.W. 71st St., Gainesville, FL 32653, USA; (2) University of Florida, 11350 S.W. 153 Court, Cedar Key, FL 32625, USA

Oyster reef habitat is a critical component of coastal estuaries, serving a wide range of important economic, cultural, and ecological roles. In the Atlantic and Gulf of Mexico coastal regions of the United States, Eastern oysters *Crassostrea virginica* have declined from their historic levels. Increasing threats, such as reduction of freshwater input to estuaries, diseases, hurricanes, oil spills, and climatic change, have resulted in large-scale restoration plans for this species. Together with these efforts, a germplasm repository of oysters could serve as a bank of genetic diversity and allow for continued adaptive genetic variation within natural populations. Furthermore, populations could be regenerated when needed. Cryopreservation is the technology required for germplasm preservation. Since its invention, this technology has been applied to humans as a clinical treatment for infertility and to livestock as necessary tools for breeding programs. For oysters, cryopreservation has been studied in eight *Ostreidae* species; the germplasm materials for cryopreservation include sperm, oocytes, embryos, and trochophore larvae. In a recent study with the Pacific oyster *Crassostrea gigas*, thawed cryopreserved larvae successfully developed into mature adults and spawned. With the Eastern oyster, cryopreservation has been studied for sperm and larvae preservation. A sperm cryopreservation protocol has been established and has been used for creation of self-fertilized lines by combining with non-lethal sperm collection to improve aquaculture strains. Currently, it is feasible to establish a sperm repository for oyster germplasm using these techniques. Additional studies on cryopreservation of oocytes, embryos, or larvae are needed to develop comprehensive repositories in the future for addressing genetic biodiversity, conservation, and resource management in the restoration of oyster reef habitat.

QUANTIFYING FISH AND MOBILE INVERTEBRATE PRODUCTION FROM CONSERVATION AND RESTORATION OF THREATENED NURSERY HABITATS. zu Ermgassen, P. (1), J. Grabowski (2), J. Gair (3), S. Powers (4), (1) University of Cambridge, Department of Zoology, Downing Street, Cambridge, Cambridgeshire, CB2 3EJ, UK; (2) Northeastern University, Marine Science Center, 430 Nahant Road, Nahant, MA 01908, USA; (3) University of Cambridge, Institute of Astronomy, Madingley Road, Cambridge, CB3 0HA, UK; (4) University of South Alabama, Dauphin Island Sea Lab, 101 Bienville Blvd., Dauphin Island, AL 36528, USA

Quantification of ecosystem services is increasingly valuable for conservation and restoration decision-making. Oyster reefs are important nursery grounds, but this service is challenging to quantify due to common ontogenetic shifts in habitat use by many species and difficulties in establishing habitat usage. We reviewed available literature on the increased abundance of juvenile fish and mobile crustaceans in *Crassostrea virginica* reefs in the United States, and modeled the growth and mortality of these species to provide estimates of gross and net production, and uncertainty in production values. Nineteen species were found to be recruitment enhanced by oyster reefs in the northern Gulf of Mexico, compared to 12 in the South and Mid Atlantic. Crustaceans were a more important component of the estimated enhancement in the northern Gulf of Mexico than in the South and Mid Atlantic and total enhancement of species was significantly greater in the northern Gulf of Mexico. We discuss the implications of our results and some of the possible drivers for differences between the two regions.

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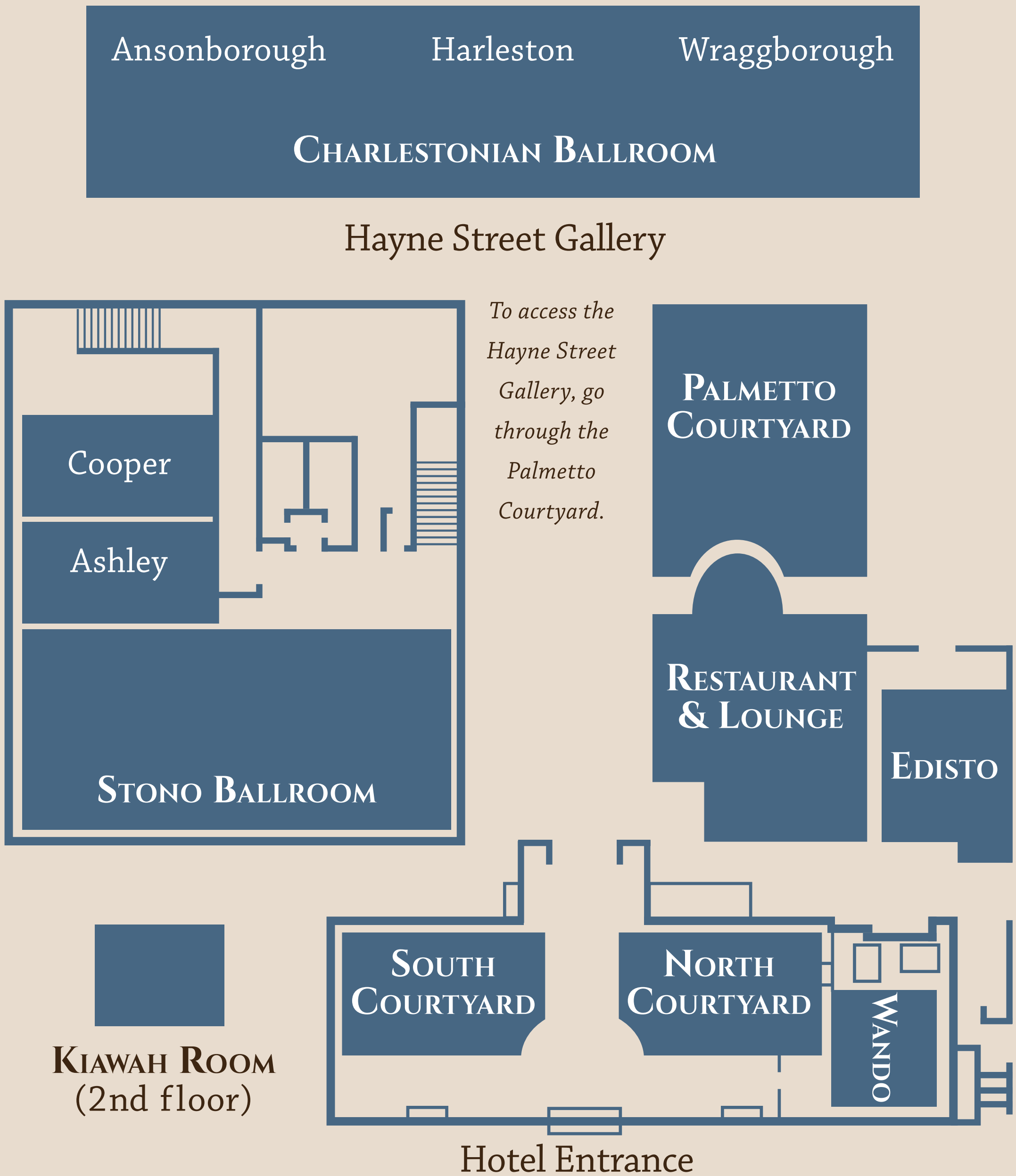
INTERNATIONAL CONFERENCE ON SHELLFISH RESTORATION

ICSR2014

Location Map for DoubleTree Guest Suites and Hayne Street Gallery

Meeting Facilities



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