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National Shellfisheries Association

Quarterly Newsletter

2018 (3)

President's Message



Greetings from Vacationland! I can't believe we are already knocking on Fall's door. It feels like I was just in Seattle with many of you at the 110th Annual Meeting. I hope you have been productive with your research and field seasons this summer. It has been a hot summer here in Maine, but you

won't hear me complaining because winter is right around the corner. Registration for the 111th Annual Meeting is open and can be found at www.shellfish.org. Remember that this year is a Triennial meeting with our good friends the World Aquaculture Society and the Fish Culture Section of the American Fisheries Society. We are the lead organization this go around, so it is important when you register to indicate that you are a member of NSA.

A number of important dates are now on the horizon. Nominations for the Honored Life Member, David H. Wallace, and Neil Bourne – Ken Chew Awards are due **November 1st**. Students, research grant award applications (Melbourne R. Carriker, Michael Castagna, and George R. Abbe) are due on or **before November 1st**. Student Endowment Fund Travel Award applications are due on **November 1st**. Advisors, please encourage your students to apply for these awards. Application instructions for all awards can be found at www.shellfish.org/student-members.

We were all saddened with the news of the passing of Neil Bourne. Neil was a pioneer in shellfish biology and a member of the NSA for 58 years, and his contributions to the development of aquaculture will stand as a testament to his vision and talent.

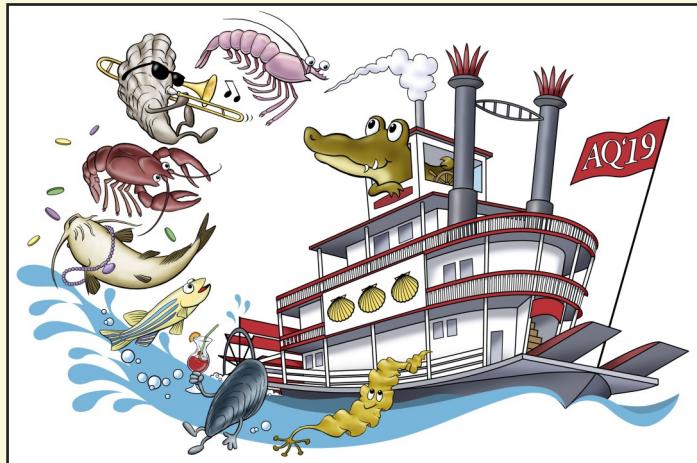
As always, thank you for being members of the National Shellfisheries Association. The rest of the EXCOM and I appreciate that you have chosen to share your time and research with the NSA. We are here for you to ensure that this association is first-rate and able to provide annual meetings, an award-winning *Journal*, and the avenue for industry, research, and policy to come together and share ideas.

Until next time, enjoy the last few weeks of summer.

Steven Allen, President

DON'T FORGET TO REGISTER

<http://www.was.org/meetings>



The abstract deadline has passed.
(Poster space still available)
Contact Sandy Shumway & Jay Parsons

In this issue:

- **In Memoriam, Neil Bourne**
- **JSR Special Monograph**
- **2017 Castagna Student Research Update**
- **Oyster Growing in Mississippi**
- **Florida Big Bend Shellfish Trail**

2017 Michael Castagna Student Research Grant Update

Evan Durland, Oregon State University

"The genetic contribution to larval fitness in the Pacific oyster Crassostrea gigas and long-term genomic response to domestication"

The Pacific oyster (*Crassostrea gigas*) is one of the most widely farmed shellfish species worldwide, and supports a \$205M per year aquaculture industry on the US west coast. Recently, the combined effects of seasonal upwelling and anthropogenic ocean acidification (OA) have resulted in oceanic conditions with high dissolved CO₂ (pCO₂), low pH, and an increased solubility of calcium carbonate. These conditions are harmful to bivalve shellfish, especially during larval stages when shell calcification is most vulnerable to external conditions. Since 2008, the oyster industry in the Pacific northwest (PNW) has been negatively impacted by OA-influenced upwelling, dramatically reducing the production of juvenile oysters, or 'seed', from hatcheries, and negatively impacting the industry overall.



In the past decade, many research projects have focused on the physiological response of oyster larvae to acidified conditions and calcification has been identified as a key component contributing to the vulnerability of oyster larvae to acidified seawater. Little work, by comparison, has been devoted to the investigation of the role of genetics in determining larval fitness and resiliency to high pCO₂ seawater. Since 1996, Oregon State University has

conducted a selective breeding program for oysters, the Molluscan Broodstock Program (MBP), which is currently in its 7th generation of selection to improve field traits of *C. gigas* planted at commercial sites across the PNW. Until recently, larval traits have not been a selection metric for this breeding program, but, beginning around 2010, commercial hatcheries that partnered with MBP reported that larvae spawned from these selected stocks outperformed wild lines when cultured during periods of heavy upwelling. My research focuses on comparing the relative fitness of oyster larvae spawned from naturalized 'wild' stocks in the PNW to that of MBP pedigreed lines in ambient (400 ppm) and high (1600 ppm) pCO₂ seawater, and changes in genetic composition of these larval pools throughout the 22 days from egg fertilization to juvenile settlement.

In 2015, two genetically diverse pools of MBP and wild Willapa larvae were created by pairing male and female oysters from 19 families of 5th and 6th generation MBP broodstock and 25 wild oysters from Willapa Bay, resulting in 95 individual crosses per fertilized egg pool. Shortly after fertilization, eggs were transferred to static, 10-liter culture units filled with either ambient or high pCO₂ seawater (5x per treatment group), stocked at 20 larvae mL⁻¹ and cultured through settlement, 22 days later. Water was changed every 48 hours and cultures were

fed a mix of the microalgae *Isochrysis galbana* (C-iso) and *Chaetoceros gracilis*. From day 16 post-fertilization, pediveliger larvae (> 240 µm) were induced to set with epinephrine at every water change (day 16, 18, 20). Larval samples for survival, size, and morphology were taken throughout the culture period and additional larval subsamples were preserved in ethanol for later DNA extraction and analysis. The entire experiment was repeated in 2016, recreating a highly similar genetic pool from MBP families and utilizing a new population of wild Willapa oysters.

Similar to numerous previous studies, early larval development (≤ 48 hours post fertilization) was negatively affected by high pCO₂ seawater: larvae in these cultures had increased rates of shell malformations and were smaller, on average, than their ambient pCO₂ counterparts. Mid-veliger larval performance (days 6-16 post fertilization) was largely uniform among all groups in both experiments; growth and survival of these larvae did not differ owing to genetic background or rearing environment (pCO₂ level). For the first 16 days of larval culture, in both experiments, wild and MBP larvae were largely comparable; neither group displayed increased rates of growth or survival in either seawater treatment. Differences in larval performance between broodstock groups became apparent, however, at the conclusion of the experiments (day 22), after metamorphosis and settlement. Across both experiments, MBP larval groups resulted in 55% more spat that were 8% larger, on average, than wild groups in ambient conditions and 37% more spat that were 24% larger than wilds in high pCO₂ culture replicates. This contrast between perceived performance during veliger stages and ultimate settlement results suggests that external phenotypes such as size and survival during much of veliger development (days 6-16) may mask underlying physiological indices of fitness. Furthermore, these findings corroborate the previous anecdotal evidence from commercial hatcheries and suggest that MBP broodstock yield larvae that are, on average, more robust in hatchery/laboratory conditions in general (stable 25°C seawater, abundant food), which may afford them increased resilience to additional stressors such as high pCO₂ seawater.

These interpretations of phenotypic results are consistent with genotypic changes in these groups as well. A pooled sequencing analyses (Pool-seq) of genome-wide single nucleotide polymorphism (SNP) in early veliger larvae (48 hours post fertilization) and settled spat (22 days post fertilization) from both broodstock groups and seawater pCO₂ conditions suggests that MBP stocks produce more genetically 'stable' larvae than wild genotypes overall. In MBP groups about 20% fewer alleles changed in frequency between these time points, relative to wilds, irrespective of seawater treatment. Additionally, wild larval groups had about two times more SNP changing in frequency under high pCO₂ conditions relative to MBP, suggesting a differential genetic vulnerability to acidified seawater.

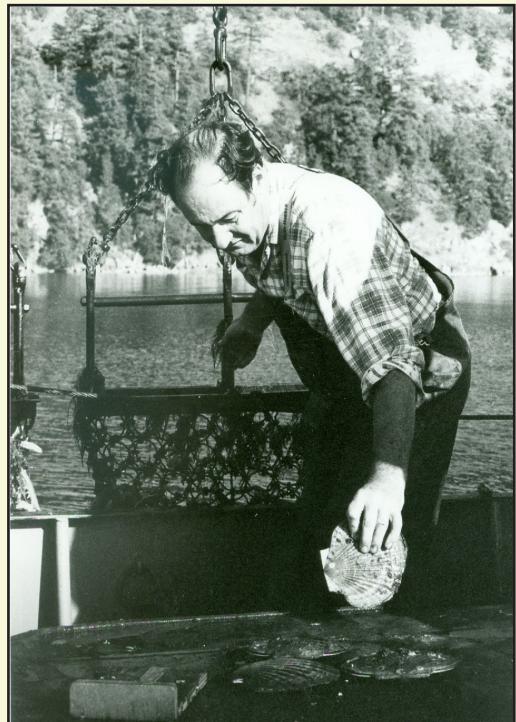
Much remains to be investigated with regard to the mechanisms underpinning the increased performance of MBP larvae and their resiliency to acidified conditions, but these results highlight the importance of genetics as a variable component of larval oyster fitness. It is worth remembering that the physiological 'distance' from genotype to phenotype is substantial, it is my hope that these results will provide a framework for future work to expand upon them and investigate the complex path that connects the two.

Neil Fitzroy Bourne (1929-2018)

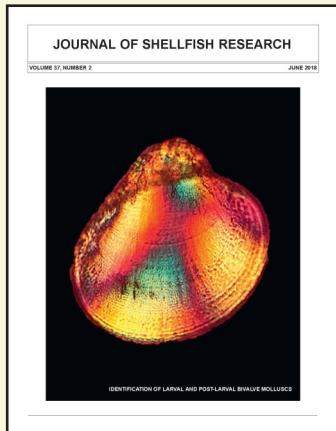
Another icon lost. Neil passed away on July 21st in Nanaimo. A full 'In Memoriam' will appear in a future issue of *JSR*. The following brief summary of Neil's background courtesy of Leslie Barton.

Neil's sphere of influence was considerable and his contributions lasting. Neil joined the Fisheries Research Board in 1959, working from St. Andrews Biological Station. In 1965 he moved west and joined the Pacific Biological Station where he worked on many species of molluscs and was responsible for the molluscan culture program. Neil took a secondment from Fisheries in the mid-1970s to the Canadian International Development Agency, serving as Director of the Fisheries Training Program at the University of the South Pacific in Fiji. Neil and family returned to Nanaimo in 1976 where he continued to make lasting contributions to the aquaculture industry of BC. Neil served on the executives of many societies and associations, including that of the National Shellfisheries Association from 1974 to 1983 serving as President from 1981 to 1982. Neil retired from public service in 1994, embarking on his second career as Emeritus Research Scientist, providing mentorship and support on a regular basis until as early as last month. Neil's obituary can be found at: <https://www.nanaimobulletin.com/obituaries/Neil-Fitzroy-Bourne/>

Neil was predeceased by his daughter, Dianne and his wife, Jean. He is survived by sons Don (Mindy) Jim and daughter Mary (Bob). Also four grandchildren and one great-grand child. Per Neil's request, there will be no service. Contributions made in his memory can be donated to the Nanaimo Hospital Foundation, 1200 Dufferin Crescent, Nanaimo, BC V9S 2B7, Canada.



Mission Completed: Identification of Larval and Post-larval Bivalve Molluscs



The most recent ("extra freebie") special issue of the *Journal of Shellfish Research* is a special volume dedicated to the identification of larval and early post-larval bivalve molluscs. This comprehensive opus should serve as an invaluable reference for identifying the early life history stages of over 50 species of bivalve molluscs isolated from plankton and benthic samples from a spectrum of marine, estuarine and freshwater environments.

Forty-five years ago, a subset of the authors of the two papers in this special issue had a vision of picking up where Paul Chanley and Jay Andrews left off with their classic article on "Aids for identification of bivalve larvae of Virginia" published in *Malacologia* in 1971. These and other colleagues cultured under laboratory conditions the larvae and/or post-larvae of a myriad of bivalve molluscs. Most of these species were from environments along the east coast of North America and include the majority of the commercially important species in this region. Their goal was to put together a monograph in which consistently-oriented, disarticulated shell valves of the larval and post-larval stages of these bivalve molluscs were imaged under a scanning electron microscope in an effort to accurately document shell morphologic and morphometric features that could be used to assist in the routine identification of the early life history stages of a wide spectrum of bivalves.

The first paper in this special volume represents a realization of that 45-year-old vision of several of the authors who are still alive, as well as a number of our dear colleagues who are sadly no longer with us and are sorely missed, but who join us as authors on this work which would never have materialized were it not for them. The resulting monograph includes 195 plates of scanning electron micrograph sequences of the disarticulated shell valves of laboratory-reared larval and post-larval stages of 56 species of bivalves. The second paper in this special issue presents representative polarized light images of birefringence patterns of various developmental stages of 40 of the larval/post-larval bivalve species contained in the collection of vials in which the larvae/post-larvae had been stored over the approximate 4 decades (remarkably, a large quantity of the vials in which the ethanol had evaporated contained specimens whose shell valves could be imaged to highlight the birefringence patterns of the larval and post-larval shells). In addition, molecular (PCR) techniques were used to sequence many of the dried-out specimens and they successfully identified 10 of these 40 species with matches in GenBank. The results demonstrate that optical techniques to highlight birefringence patterns on larval and post-larval bivalve shells and molecular (PCR) techniques can be effective for systematic classification and genetic sequencing purposes even after preserved specimens that were originally stored in ethanol have subsequently dried out and been stored for considerable lengths of time.

**Rich Lutz
Jake Goodwin**

The Florida Big Bend Shellfish Trail

By: Carol McQueen

Levy County Board of County Commissioners received a grant award of \$20,000 from The Conservation Fund to produce The Big Bend Shellfish Trail Map. One of five collaborative grants awarded across the Big Bend counties—Dixie, Jefferson, Levy, and Taylor—the funding encouraged partnerships to strengthen the region's economic vitality while simultaneously ensuring the ongoing health of its natural resources. The Big Bend Shellfish Trail officially opened on October 21st, 2017.



Photo courtesy of University of Florida/IFAS

"A number of partners participated in the creation of Florida's first Shellfish Trail Map and the largest trail of its kind in the United States. This project will showcase our working waterfront communities and encourages economic growth in Levy County and in the Big Bend Region," said Levy County Commissioner, John Meeks.

Over the past two years, Levy County Visitors Bureau implemented the project by developing a map and website that features a section of the Big Bend region that includes Levy, Dixie, Taylor, and Jefferson Counties. The trail will provide people with information about where to buy and eat local shellfish, and how to take an active role in protecting water quality and habitat for shellfish industries within the Big Bend Region. The trail highlights where recreational scalloping is allowable; where to learn about commercial production of clams and oysters; the location of recreational boat ramps, and the locations of working waterfronts in this region. The trail locates shellfish vendors, restaurants, seafood markets, marinas, bait & tackle shops, provides information on working waterfronts, and identifies key areas to protect water quality and habitats.

The grant was provided by The Conservation Fund, a national organization that makes conservation work for America with support from the Richard King Mellon Foundation. Earlier research on the region's economy demonstrated the critical link between the area's incredible land and waters and its economic health. The Conservation Fund created the grant program to enhance this connection and support the needs expressed by the region's leaders.

"The Big Bend Shellfish Trail is a wonderful educational and economic resource for the nearby communities," said Lauren Day, Florida Representative with The Conservation Fund. "We are thrilled to celebrate its completion with Levy County and its residents, and we applaud the efforts that went into creating this unique asset that will celebrate and strengthen the area's distinctive community character and natural resources."

"The Big Bend Shellfish Trail Map will encourage support of local jobs and businesses, such as clam farmers, oystermen, crabbers, shrimpers, accommodations, restaurants, shops, and all service industries. By bringing more people into the region to participate along the Gulf Coast trail our communities will see economic growth due to visitor participation and buying of local shellfish products," said Carol McQueen, Director of Levy County Visitors Bureau.



Photo courtesy of University of Florida/IFAS

Leslie Sturmer, University of Florida IFAS Extension, Statewide Shellfish Specialist said; "Oyster trails can be found in many coastal states, such as Alabama, Maine, and Virginia. There is even a clam trail in New Jersey, but nowhere in the nation is there a shellfish trail. This project showcases the diversity of our shellfisheries and aquaculture industries along the Big Bend of Florida."

For more information on the Big Bend Shellfish Trail and download the map,

visit: <http://www.visitnaturecoast.com/big-bend.php>

Abstracted from Cedar Key News, September 22, 2017



The Future of Oyster Growing in Mississippi

Off-bottom oyster farming (where oysters are contained in some type of mesh bag or basket and kept up off the bottom) is relatively new on the US Gulf Coast, with a boom in interest, investment, and production. With research and Extension funding from State and National Sea Grant Programs, Alabama, Louisiana, and Florida have developed new industries in coastal communities in the region. In Alabama, there are currently fifteen commercial oyster farms, which harvested at least 2.8 million oysters in 2016 with a wholesale value of \$1.96 million, providing about 20 full-time and 10 part-time jobs. In 2017, the Auburn University Shellfish Lab alone provided 42 million oysters for farms in Louisiana, Alabama, Florida, and others. In Louisiana, five farms are now in production with three harvesting product regularly. Over three dozen farms in Florida have been recently established with farms now harvesting in Pensacola, Wakulla, and Cedar Key.



Draining oyster seed. Photo credit: Bill Walton

In Mississippi, the Mississippi-Alabama Sea Grant Consortium partnered with the Mississippi Department of Marine Resources, the Alabama Cooperative Extension System, and Auburn University to offer the fourth class of Oyster Farming Fundamentals, with the first three based in Alabama, and this fourth offering being the first based in Mississippi. Over 20 Mississippi coastal residents enrolled in May, and they spent five Saturdays putting in the hard work to learn about off-bottom oyster farming.



Class installing gear off Deer Island.
Photo credit: Rusty Grice

This class is not your typical slideshow and textbook class; there are no exams and no grades. Instead, this class focuses on practical, hands-on training, skills, and knowledge needed to permit and operate an off-bottom oyster farm successfully. The course was broken down into four basic “chapters” of what one needs to know 1) before you start, 2) to start an oyster farm, 3) to operate an oyster farm and, 4) to make the most of the oyster farm.

The first chapter included the basics of oyster biology (with a visit to a local oyster hatchery), an explanation of what off-bottom oyster farming is and why it's an opportunity now in the Gulf of Mexico, and an introduction to business planning. The second chapter covered the information that participants will need to start an oyster farm, including site selection, gear options, and the basics of permitting. The third chapter was spent in the waters off Deer Island in the State's training area, where participants learned by helping put gear in the water and learned about grading, splitting, and controlling the bio-fouling on oysters and gear through regular air-drying. The fourth chapter continued the basics of operating an oyster farm, including harvest requirements, protecting public health, storm preparation and mitigating hazards, and inventory management. The fifth chapter wrapped up the “classroom” portion of the course, giving participants some tools to make the most of an oyster farm, including marketing and branding, distribution, best management practices, and a lesson in estimating seed counts.

The class, however, isn't over. To give participants the best opportunity to see what is involved with oyster farming, each participant was given about 10,000 oyster seed (retained on 6-mm mesh) to raise within a dedicated training area within the Deer Island Oyster Park (much like a business park for oyster farmers). Each farmer was loaned a 100 yard “run” of oyster-farming gear to raise those seed through next spring. While they will continue to get advice and input, each farmer will have the opportunity to make their own decisions about how to raise those oysters, with feedback from the instructors – and to learn from that experience.

As the oysters grow, the participants will be getting real-world experience, making decisions (on both about how to care for their seed and if they want to forge ahead as commercial oyster farmers), and getting a sense of the work involved. Ultimately, the course is intended to allow each of these participants to make a well-informed decision about whether oyster farming is for him or her. By this time next year, some of these participants will be commercial oyster farmers, bringing some of Mississippi's best oysters to market!

Bill Walton
Auburn University



Trainees stocking their training runs with oyster seed.
Photo credit: Bill Walton

Recruits' Corner

Fellow Recruits,

We hope you are having a productive field season. Before the summer gets away from us, here are a few reminders of key deadlines and opportunities.

First, the **Abstract Submission Deadline** for the **111th Annual Meeting in New Orleans** (March 7-11, 2019) has already past, but there is always room for another poster. Contact Sandy Shumway if you still want to participate. This is a Triennial meeting, held in collaboration with the World Aquaculture Society, the Fish Culture Section of the American Fisheries Association, and the National Aquaculture Association. Researchers from around the world will be attending, and it is a great place to network and present your work. Abstract submission and registration this year are located on the World Aquaculture Society website (link at www.shellfish.org). There will be several student-focused activities, including a career panel and student reception. When you register for the meeting, do not forget to indicate that you are a graduate student, and would like your presentation judged. Second, we encourage you all to apply for an NSA SEF travel award. The award can help cover lodging, registration, travel, or all of the above, so why not apply? **Deadline for the SEF travel award is earlier than usual this year, November 1st.**



Second, start thinking about your application to the other NSA scholarships for some flexible project funding. Information is available online, <https://www.shellfish.org/student-members>, and the **deadline for all grant applications is November 1st.**

As usual, please email Erin (erin_roberts@my.uri.edu) or Laura (lhs3@uw.edu) with any ideas or concerns.

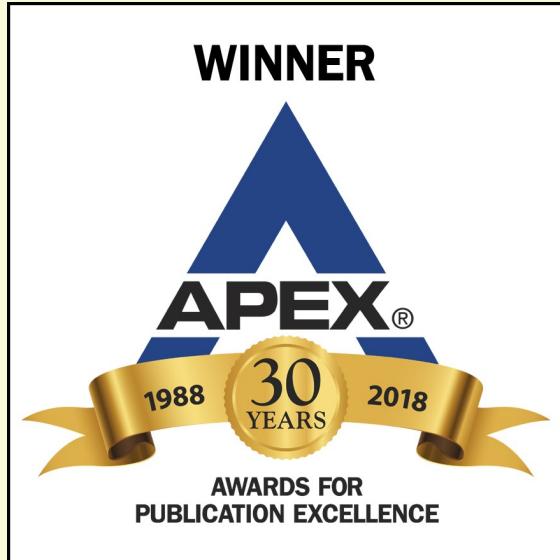
Laura & Erin

SAVE THE DATE

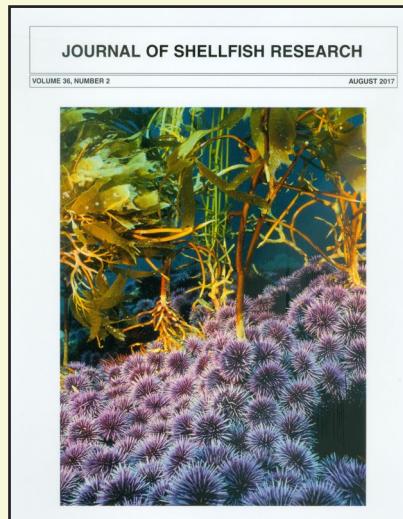


**112th Annual NSA Meeting
Radisson Hotel Baltimore
Downtown-Inner Harbor
March 29 - April 2, 2020**

The *Journal of Shellfish Research* was awarded its 10th APEX Award for Publication Excellence!



Your photo could be here!



The *Journal* is always looking for photos for consideration as covers. Send your photos to Sandra.shumway@uconn.edu. Must be in vertical orientation, high resolution - and in focus!

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Upcoming Events

72nd Annual Pacific Shellfish Growers Association Conference & Tradeshow:

Sept 18-20, 2018. Blaine, Washington (USA). For more information: <http://pcsga.org/annual-conferences>

4th International Symposium on Manila clam (*Ruditapes philippinarum*): Sept 28-30, 2018. Dalian, China. For more information: <http://www.imcs18.org/en/index.html>

For more information on these conferences:

www.was.org

Aquaculture 2020: Feb 9-12. Honolulu, Hawaii USA

Aquaculture 2022: Feb 27-Mar 3. San Diego, California, USA

Aquaculture America 2023: Feb 19-22. New Orleans, Louisiana, USA

If you would like to announce a meeting, conference, workshop, or publication that might be of interest to NSA members, please contact the *QNL* Editor, LeRoy Creswell (creswell@ufl.edu).

