Virginia Sea Grant Awarded $1.9M for Aquaculture Hatchery Production:

Enhancing commercial sustainability of Eastern oysters and clams

Virginia produces more aquacultured hard clams than any other state in the nation, and is first on the East Coast in the production of Eastern oysters, the most rapidly developing sector of Virginia's shellfish aquaculture industry. To maintain the lead, Virginia was awarded more aquaculture research funds—$1.9 million—than any other state in the 2017 National Sea Grant $9.3 million aquaculture research competition. Four projects are being launched on the Eastern Shore of Virginia, and at the Virginia Institute of Marine Science (VIMS).

Representing VIMS, the headquarters of Virginia Sea Grant (VASG), Congressman Rob Wittman (VA-District 1) noted, "Virginia is a leading innovator in the emerging industry of aquaculture and I am proud to have VIMS, a major research contributor, in the First Congressional District. Before coming to Congress, I spent 20 years as a shellfish specialist monitoring water quality and environmental health issues in the watershed — so these issues are extremely important to me. Investing in aquaculture is critical to not only seafood production, but also to our economy. This work directly and indirectly supports the local economy by providing key research that allow industries that rely on the bay to thrive."

"Coastal communities face unique challenges that only federal-state joint partnerships, such as the Sea Grant Program, can solve," added Congressman Scott Taylor (VA District 2). "I am proud to support this program and look forward to its continued success in promoting the economic and environmental wellbeing of our coastal communities." District 2 includes VIMS' Eastern Shore Laboratory and many leaders and Sea Grant partners from Virginia's aquaculture industry.

In recent years, shellfish hatcheries of the East and Gulf Coasts have been plagued by limitations to production, the causes of which are unclear. While harmful algal blooms (HABs), and altered seawater carbonate chemistry have received much attention, scientific evidence that either of these contributes significantly to the limitation of hatchery production remains scarce. Emerging evidence has suggested that the production problems have their source in the community of microorganisms that populates the hatcheries. This has prompted broader exploration of the influence of hatchery water clean-up strategies, in addition to carbonate chemistry and HABs, on hatchery environments and oyster and clam larval health.

The four projects detailed below were funded by NOAA's National Sea Grant Aquaculture Initiative to research these impediments to hatchery production and aquaculture opportunities.

VASG's director Dr. Troy Hartley says," Virginia's national leadership in shellfish aquaculture comes from an innovative industry sector working collaboratively with the world-class research, science and technological capacity of Virginia's universities. This collaborative research is exactly how we will maintain our national position in the market place, and in advancing the state of the knowledge."

NOAA announced 32 research grants totaling $9.3 million for projects around the country to further develop the nation's marine and coastal aquaculture industry, and it received 126 proposals requesting nearly $58 million in federal funds.

Sea Grant's investment in aquaculture research, outreach and education programs continues to produce results for coastal communities and their economies. Between February 2016 and January 2017, Sea Grant invested $9 million in aquaculture research, technology transfer, and outreach, and reported $90 million in economic impacts, including support of 900 businesses and 1,800 jobs.

For a full list and short descriptions of the 32 grant projects, visit the NOAA Sea Grant website
http://seagrant.noaa.gov/News/Article/ArtMID/1660/ArticleID/1656/Sea-Grant-awards-2017-aquaculture-grants

Virginia Sea Grant received funding for the following projects:

1. **Enhancing Commercial Sustainability in the Hatchery Production of Eastern Oysters and Clams. $998,942**

The objective of this work will be to identify technical or biological strategies that can be rapidly implemented by industry to support healthy hatchery microbiomes and optimize larval growth and survival. In collaboration with commercial entities, the project team will analyze microbiomes, carbonate chemistry, and HABs to determine effects of routine hatchery water clean-up methods on several components of the growing system.

Outreach activities will include workshops on water quality and microbiome management for the Virginia aquaculture community, hatchery forums to be conducted in association with national conferences, and distribution of protocols to the community for detection of disease causing bacteria in hatchery systems, that would empower pathology laboratories to better serve industry in this key area.

VIMS professor and Project Leader Ryan Carnegie says, "Overcoming limitations to hatchery production of shellfish is the biggest production challenge this industry has today. Understanding which among many potential factors, in which combinations, are affecting these animals is our challenge as researchers in addressing it. Success will require a large team bringing wide expertise

to bear on the questions from different angles, and this is exactly our approach. Our results will improve hatchery production in Virginia and have relevance to shellfish aquaculture everywhere it occurs."

2. **Can carryover effects improve oyster aquaculture production? $149,998**

Overharvesting, habitat deterioration, and parasitic diseases have significantly diminished wild populations of oysters in the Chesapeake Bay with devastating consequences for oystermen and wild harvest industries in the region. Following the lead of the hard clam industry, and in response to the decline of the wild oyster fishery, a significant transition to oyster aquaculture has taken place. The development of domesticated oyster lines in the 1990s and early 2000s and the production of triploid oysters, with a doubled growth rate over wild diploids, started a revival of the Eastern oyster economy, and the subsequent growth of Virginia's oyster aquaculture industry has been an incredible success story. The 2015 farm-gate value of the hatchery-based oyster industry alone is $16 million. The industry forecast continues to project expansion in oyster plantings and sales, but this is contingent on a consistent production of oyster seed and larvae for intensive and extensive culture.

Efforts to support the growing Virginia (VA) oyster aquaculture industry and remove impediments must look for opportunities for potential production gain, and ways to optimize hatchery and grow-out practices. Additionally, the recovering industry will benefit from adaptive management tools to prevent catastrophes like the Pacific Northwest shellfish hatchery die-offs (75% production failure) as climate change continues to affect water quality.
This project will address these critical needs by asking: how do hatchery conditions affect grow-out of oysters under different environmental conditions among growers' leases?

Virginia Institute of Marine Science professor and Principal Investigator for this project, Emily Rivest says, "The water conditions that young oysters experience is impactful, with effects lasting into adulthood. We are excited to be working with Oyster Seed Holdings to see if we can apply what we have learned in laboratory studies to help improve production of the Virginia oyster aquaculture industry, from hatchery to farm to plate."

Project partner:
Oyster Seed Holdings, Inc. - Michael Congrove

3. **Identifying strategies to minimize impacts of harmful algal blooms on performance and survival of triploid oysters cultured in Lower Chesapeake Bay. $149,902**

The Eastern oyster (*Crassostrea virginica*) is a keystone species in the Chesapeake Bay because of its tremendous economic and ecologic importance. Decades of habitat destruction, overfishing, pollution, and disease have devastated wild Bay oyster populations, and in response to the decline, a rapidly expanding aquaculture industry has developed in the region using primarily fast-growing, disease-resistant triploid oyster strains (Hudson & Murray 2016).

The shellfish aquaculture industry in 2014 and 2015, respectively, generated nearly $56 million and $50 million in revenue within Virginia alone, with oysters comprising 30 percent ($17.1 million) and 33 percent ($16-million) of these farm gate values (Hudson & Murray 2015, 2016).

Oyster production employs hundreds of individuals annually and represents the most rapidly developing sector of VA's aquaculture industry, and VA remains first on the East Coast of the U.S. for oyster aquaculture production. In addition to their tremendous economic value, oysters provide critical ecosystem services by creating habitat structure for a diverse community of organisms. They also increase water quality—a single oyster can filter up to 50 gallons per day—and form a critical link in food webs in the Bay (Wilberg et al. 2013).

Following a century of decline, recent increases in cultured oyster landings have been very encouraging. The regional oyster culture industry faces significant challenges in the near-term, however. Longstanding professional interactions between Virginia Institute of Marine Science (VIMS) researchers and local oyster culturists suggest a strong potential for negative impacts, from a variety of emerging environmental stressors, on the performance and survival of oysters during grow-out in natural estuarine habitats. Two, toxic harmful algal bloom (HAB) species, *Cochlodinium polykrikoides* (CPOLY) and *Alexandrium monilatum* (AMON), form widespread late summer blooms in the southern Chesapeake Bay including in many areas where oysters are planted for grow-out (Fig. 1). CPOLY has bloomed almost annually for at least many decades, whereas while here is evidence that it was present a few years in the 40's and 60's, AMON emerged as a dominant bloom species during 2007 with unprecedented expansion in bloom intensity, duration, and range during 2015-16.

The overall objective of this two year investigation is to develop recommendations for best management strategies for aquaculture industry members working in different types of locations (i.e. high-flush or low-flush, and intertidal and/or subtidal) who find that their growing areas are impacted by blooms of CPOLY and/or AMON.

"We hope to identify ways that oyster growers might be able to minimize the impact of these blooms on their valuable product" said lead PI Kimberly S Reece.

Project Partners:
VIMS Marine Advisory Services: Karen Hudson - khudson@vims.edu, Shellfish Aquaculture Extension Specialist
Big Island Aquaculture: Bruce Vogt
Chessie Seafood & Aquafarms: Tommy Legget
Mobjack Bay Seafood Inc. & Ward Oyster Co.: John Vigliotta

4. Genetic, physiologic, and culture characterization of new *Mercenaria mercenaria* breeding stocks. $149,650

Production of the hard clam *Mercenaria mercenaria* is a major industry. The Eastern Shore of Virginia, with farm sales estimated at $32.3 million dollars in 2015, is leading the nation in clam production. The present success of the industry is reaching a saturation point in Virginia as suitable habitat is constrained by environmental conditions in which cultured broodstock can be raised.

This project would establish new brood stock lines from wild populations living at the extremes of the natural range of *M. mercenaria*. These lines would be characterized for diversity, tolerances to temperature and salinity, and growth characteristics using standard aquaculture practices. The central goal would be to provide and maintain well-characterized breeding stock for industry and selective breeding programs.

Director of VIMS's Eastern Shore Laboratory and principal investigator for this award Richard Snyder says, "This funding will allow VIMS to support and advance the hard clam aquaculture industry in Virginia, building on a legacy of research and development that was largely responsible for the birth of this industry."

5. Commercializing intensive copepod culture: a transformational foundation essential for increasing domestic production of high-value marine finfish. $221,643

Of aquaculture, which now accounts for about half of the world's overall fisheries production, marine finfish currently only totals about 10 percent of production. Reasons for this disparity are myriad, but often the critical impediment to marine fish culture is the difficulty of rearing the animals through their larval phase. And although most high-value, emergent commercial marine species require, or significantly benefit from the incorporation of *copepod nauplii* as a first live feed in the hatchery, mass culture of copepods for use in commercial aquaculture has been limited due to the high cost and inconsistency of production, and their limited storage and transport ability.

The Virginia Seafood Agricultural Research Station and Extension Center (AREC) at Virginia Tech (VT) in partnering with collaborators at the University of Southern Mississippi (USM), the University of Florida (UF), and Reed Mariculture Inc. secured a combined award of $994,954 to conduct research on copepod production as a first live feed in hatcheries. Reliable, small- or medium-scale culture protocols for several copepod species, while of significant importance to the aquaculture industry, have been notoriously difficult to achieve. These are needed for small-scale larviculture situations.

The partnership has proposed to integrate their research, education, and outreach expertise into a collaborative national project focusing on the live feeds constraint in the hatchery production of many economically important marine species relevant across the entire U.S. Principal Investigator for the Virginia Tech AREC portion of the project, which received $221,643, Michael Schwarz says, "Through this new multi-institutional collaboration, we will leverage the expertise that is being developed, and optimize production systems and culture parameters towards facilitating and implementing copepod mass production at the producer level."

6. Overcoming impediments to shellfish aquaculture through legal research and outreach. $210,000

More than half of the population of the continental United States resides in coastal communities. These popular shorelines are also increasingly home to shellfish aquaculture operations. A variety of conflicts can arise as states seek to encourage the development or expansion of shellfish aquaculture. Nearby landowners may dislike the look of aquaculture racks near the shoreline, and recreational users of the water may resent losing use of the waters dedicated to aquaculture. Each of these conflicts creates the potential for opposition and legal challenges to the industry.

The regulatory landscape facing the aquaculture industry can also be confusing and complicated. Industry members may be frustrated with their state's process associated with obtaining the required permits, consents, zoning variances, and other approvals

required before their operations can commence. In addition, a nearby ecosystem may be home to protected species, which can further complicate and hamper the regulatory process.

The Virginia Coastal Policy Center at William & Mary Law School, as part of a multi-institutional, national collaboration lead by the National Sea Grant Law Center, has won an award to support shellfish aquaculture across the United States. Drawing on the expertise of the Sea Grant Legal Network, including attorneys in the Rhode Island, Virginia, Georgia, and California Sea Grant Programs, the collaboration will address three objectives identified by the National Sea Grant College Program:

1. Identifying priority law and policy barriers to the expansion of shellfish operations in coastal communities around the country;
2. Conducting legal research and analysis on the laws, regulations, and policies impacting shellfish aquaculture operations to improve understanding of the legal framework; and
3. Implementing outreach programming in partnership with shellfish industry members to equip industry members, state agencies, and other stakeholders with tools to overcome common barriers.

The Virginia Coastal Policy Center's Principal Investigator for the project, Elizabeth Andrews, says, "We are pleased to have this opportunity to work with attorneys from across the country to analyze potential barriers to shellfish aquaculture operations in our coastal communities. By facilitating an open dialogue about these challenges, we hope to help forge a path forward to overcome them."

National Comment:

Secretary of Commerce Wilbur Ross said, "This country, with its abundant coastline, should not have to import billions of pounds of seafood each year. These grants will promote aquaculture projects that will help us reduce our trade deficit in this key industry."

The grants were awarded through two competitions to help spur the development and growth of shellfish, finfish, and seaweed aquaculture businesses. The projects include basic and applied research to improve efficient production of seafood, permitting of new businesses, management of environmental health issues, and economic success of aquaculture businesses.

"Public-private partnerships play a vital role in advancing sustainable domestic aquaculture and increasing food security," said Jonathan Pennock, director of NOAA Sea Grant. "Industry is working alongside researchers on each of these projects, which will help expand businesses, create new jobs and provide economic benefits to coastal communities."

Outreach activities will include workshops on water quality and microbiome management for the Virginia aquaculture community, hatchery forums to be conducted in association with national conferences, and the distribution of a system of rules that will govern the detection of disease carrying bacteria in hatchery systems. This would empower pathology laboratories to better serve the industry in this key area.

Virginia Sea Grant is a seven-university, federal-state partnership whose Charter calls for us to enable integration, collaboration, and leveraging of our collective coastal and marine capacity to address pressing societal problems in Virginia, the region and nation. Our federal funding comes from the National Oceanic and Atmospheric Administration, with matching funds from the Commonwealth, including the dues that each partner institution pays. As a broker of scientific information, VASG works with resource managers, businesses, communities, and other stakeholders to provide and apply the best science available.

For additional information or images, or to contact someone for comment, you can also reach out to the Virginia Sea Grant Communications Center Manager Ian Vorster: igvorster@vims.edu