

SUSTAINABLE FISHERIES AND AQUACULTURE

IMPACTS

S.C. Sea Grant Consortium Hosts South Carolina and Rhode Island Commercial Fisheries Learning Exchange

Graham Gaines, S.C. Sea Grant Consortium

Steve Richards, Clemson University

Recap: Commercial fishermen from McClellanville and a Clemson Agribusiness Extension Associate joined the S.C. Sea Grant Consortium on a visit to the Commercial Fisheries Development Center in Narragansett, Rhode Island to learn about the center’s apprenticeship program with a goal to develop a similar program to meet South Carolina’s fisheries and aquaculture workforce needs.

Relevance: The Consortium, in partnership with Clemson, is in the process of developing a blueprint for a commercial fisheries training program under National Sea Grant Office’s Food from the Sea research program. This program aims to identify mechanisms and strategies to enhance job opportunities for the next generation of commercial fishers and aquaculturists vital to supplying seafood to American consumers. The trip to Rhode Island helped provide a visual of a successful training program to model.

Response: The four participants met with commercial fisheries associations and professionals to understand the mechanics, financing, and challenges of developing a fisheries training center. The learning exchange included meetings with oyster farming co-op members, a hatchery tour, and a visit with trawl net manufacturers to see fisheries vocational job training in action.

Results: This trip was positively received by the fishermen and lessons learned were shared at a stakeholder meeting with McClellanville fishermen and a town council meeting. Attendees at both meetings were encouraged by the training program prospect and are interested in hosting a training center in McClellanville. Clemson and the Consortium are finalizing a business plan for such a center.

S.C. Sea Grant Consortium Supporting Shrimpers and Removes Marine Debris

Dodie Sanders, Bryan Fluech, Katie Higgins, and Todd Recicar, Georgia Sea Grant

Graham Gaines, Brooke Saari, and Sarah Pedigo, S.C. Sea Grant Consortium

Recap: Trawl2Trash is a new program developed by Georgia Sea Grant in partnership with the Consortium to help commercial shrimpers in Georgia and South Carolina earn money during the offseason by creating bags made from recycled shrimp net material, with the bags then distributed to recreational boaters, anglers, volunteers cleaning up litter in waterways, K-12 students, and the public so they can collect and dispose of marine debris.

Relevance: Trawl nets that are heavily worn, torn and no longer fishable become burdens to fishermen. If disposed of improperly, they can become “ghost fishing gear” or take up space on property. Additionally, many shrimpers, especially deckhands, go months in the offseason without earning income. By creating a product of utility from this

otherwise useless and sometimes harmful debris, shrimpers earn additional income and participate in a broader environmental stewardship effort.

Response: Education and extension specialists with University of Georgia's Marine Extension recognized the problem through discussions with shrimpers and initiated the first Trash2Trawl program in 2020. The success led to greater outreach to South Carolina shrimpers. Consortium staff reached out to communities in Mount Pleasant and Saint Helena, two communities with significant concentrations of shrimpers. Staff aided the shrimpers in the sewing of the nets with drawing templates and helped with payment arrangements.

Results: Eight shrimpers made 400 bags and earned a total of \$8,000 in the Trawl2Trash effort. In 2022, extension specialists from both Sea Grant programs will distribute the bags to recreational boaters, anglers, volunteers cleaning up litter in waterways, K-12 students, and the public so they can collect and dispose of marine debris.

ACCOMPLISHMENTS

S.C. Sea Grant Consortium Develops Mariculture GIS-Based Siting Tool RFP

Zhenlong Li and Cuizhen Wang , University of South Carolina
Sarah Pedigo and Matthew Gorstein, S.C. Sea Grant Consortium
Caitlyn Bierce, College of Charleston

Recap: The Consortium awarded a study group project to the University of South Carolina Geography Department to develop a GIS-based mariculture site mapping tool to aid in selecting appropriate locations for shellfish mariculture leases.

Relevance: Site selection for a mariculture lease must consider regulations, other potential human use conflicts, environmental parameters, and economic feasibility to establish a successful operation. Spatial data regarding regulatory boundaries are currently offered through a few GIS-map applications for prospective aquaculturists in South Carolina. Additional considerations for selecting a site are outside the purview of mariculture regulatory agencies. The lack of multi-perspective information to inform site selection increases uncertainty in operation feasibility, and can hinder industry entrance.

Response: The Consortium engaged with shellfish aquaculture constituents to identify essential site selection factors, stated above. After gathering input from constituents, the Consortium solicited proposals from member institutions and established a partnership with the University of South Carolina to create and host a GIS-based mariculture siting tool.

Results: The Consortium awarded a study group project to the University of South Carolina Geography Department for development of the GIS-based siting tool with completion date estimated January 2023.

S.C. Sea Grant Consortium Develops Aquaculture Toolkit Webpage to Host New Grower Materials

Graham Gaines, Matthew Gorstein, Crystal Narayana, and Sarah Pedigo, S.C. Sea Grant Consortium

Recap: The Consortium updated the S.C. Sea Grant aquaculture webpage to consolidate informational documents and spreadsheet tools for prospective and current aquaculturists to reference when working through a variety of processes to establish an aquaculture operation.

Relevance: The process of establishing an aquaculture operation involves multifaceted and often difficult objectives including identifying an area of water space to lease, completing permitting requirements, creating a profitable business model, and gaining technical knowledge. A basis of information would aid industry entrants in navigating complexities of establishing an operation and lessen uncertainties of pursuing aquaculture in South Carolina.

Response: The Consortium consolidated informational materials into an aquaculture toolkit webpage. The materials include an updated aquaculture permitting guide, a mariculture seed purchase and importation process document, shellfish mariculture finance resources, a cage flipping economics tool developed from a previous study, an oyster farm budget tool, and existing map applications for site selection.

Results: The toolkit has been used to consult with five prospective aquaculturists directly. The webpage enables resources to be accessed freely, and serves as a contact point to Consortium technical assistance.

S.C. Sea Grant Consortium Partners with Coastal Carolina University Researchers to Pursue Aquaculture Research

Juli Harding, Erin Burge, Keith Walters, Robert Young, and William Ambrose, Coastal Carolina University

Graham Gaîne and Sarah Pedigo, S.C. Sea Grant Consortium

Recap: Conversations from initial aquaculture working group meetings developed in response to interest in conducting applied shellfish aquaculture research. As a result, the Consortium has partnered with Coastal Carolina University to complete a Consortium report and submit a collaborative proposal.

Relevance: South Carolina lacks an instate shellfish aquaculture research and training program. Enhancing capacity to conduct research in South Carolina would bolster the sustainable expansion of the industry through supplying relevant science on pathogen mitigation, broodstock development, workforce training, gear development, technology transfer, and seed source.

Response: After initial aquaculture working group meetings, the Consortium engaged with researchers interested in conducting applied shellfish aquaculture research including those of Coastal Carolina University. The team of researchers worked with the Consortium to develop aquaculture R&D investment scenarios suited to South Carolina for completion of a return on investment report. The collaboration led to development and submission of an aquaculture research proposal.

Results: The established partnership stands as steps toward enhancing applied research capacity in South Carolina. If the proposed work is awarded, results would be applicable to aquaculture industries beyond South Carolina and would enhance capacity to increase US protein production.

S.C. Sea Grant Consortium partners with Port Royal Sound Foundation to Provide Technical Assistance to the Mariculture Industry

Chris Kehrer, Port Royal Sound Foundation

Sarah Pedigo, S.C. Sea Grant Consortium

Recap: To support the expanding mariculture industry, the Consortium partnered with the Port Royal Sound Foundation to work toward establishing a public site for technology transfer, and for demonstration of aquaculture techniques to the public.

Relevance: According to a recent Consortium report, the market potential for mariculture oysters in South Carolina is more than triple the current instate production. Existing growers are in a position to expand operations while new growers have potential to emerge and create businesses to capitalize on the demand. To increase production, access to greater quantities of seed will be needed as will training opportunities for new growers.

Response: After introduction of the Consortium's Shellfish Aquaculture Specialist, the Port Royal Sound Foundation (PSRF) shared interest in incorporating aquaculture gear onto the Maritime Center dock as a demonstration of aquaculture techniques. The Consortium worked with PRSF to submit an aquaculture application to deploy floating gear and to demonstrate construction of a low cost floating upweller system that would allow growers to access smaller size seed available through importation or from the instate hatchery, with the goal of increasing access to seed.

Results: While progress with establishing a small demonstration site is underway and the permit is pending, the partnership with PRSF presents an avenue to provide the public with educational content increasing awareness of mariculture practices in South Carolina.

S.C. Sea Grant Enhances Technical Knowledge of Mariculture Practices by Participating in the North Carolina Shellfish Farming Academy

Sarah Pedigo, S.C. Sea Grant Consortium

Recap: The Consortium increased its shellfish aquaculture technical capacity through completion of an aquaculture training program at Carteret Community College, additional Consortium members participated in one course offering and were able to experience a training and applied research program firsthand.

Relevance: Mariculture research and training programs have been implemented in several other states to aid in building capacity for the healthy and sustainable expansion of their shellfish aquaculture industries. While production of mariculture oysters continues to increase in S.C., there are currently no university or public aquaculture training or applied research programs in the state to provide local and immediate information to the industry.

Response: The Consortium worked with North Carolina and Georgia Sea Grant to extend mariculture training curriculum and opportunities to South Carolina by participating in North Carolina's training programs: Fish Camp and the Shellfish Farm Academy.

Results: The Consortium Shellfish Aquaculture Specialist, completed an aquaculture training program which enhanced technical knowledge of shellfish aquaculture best management practices. Two additional Consortium researchers participated in the field-based learning at one course date and also toured the University of North Carolina Wilmington Shellfish Research Hatchery to serve as an introduction to aspects of an aquaculture training program design implemented in other states.

S.C. Sea Grant Consortium Shellfish Aquaculture Specialist Gives Guest Lectures at Universities

Sarah Pedigo, S.C. Sea Grant Consortium

Recap: The Consortium Shellfish Aquaculture Specialist completed guest lectures in college classes on topics including overviews of the aquaculture industry in South Carolina, best management practices used in establishing and maintaining bivalve aquaculture operations, and how oyster aquaculture is considered a sustainable agriculture practice.

Relevance: The aquaculture industry in South Carolina is relatively small with a total of 36 leases comprised of clam and oyster production using on and off bottom techniques. No aquaculture specific training and workforce development programs currently exist in the state, leading to lack of awareness of and access to the industry. Sharing overviews of aquaculture and the status of the industry in South Carolina with students pursuing higher education in environmentally-based fields increases awareness of bivalve aquaculture as a viable career option.

Response: Consortium Shellfish Aquaculture Specialist gave guest lectures to a Marine Policy class at the University of South Carolina and a Sustainability Principles class at Furman University. These guest lectures also served as avenues to share opportunities for students to become involved in Sea Grant programs, fellowships, and research collaborations through the recently developed careers portal.

Results: Students in the college classes were informed about potential career opportunities in the aquaculture industry and well as the role of the S.C. Sea Grant Consortium.

S.C. Sea Grant Consortium Develops Lesson Plan Focused on Biology of Oysters and Associated Ecosystem Services

E.V. Bell and Sarah Pedigo, S.C. Sea Grant Consortium

Recap: The Consortium developed a lesson plan to educate students on the biology of the eastern oyster and associated ecosystem services offered by oysters within estuarine environments.

Relevance: The decline of natural oyster reefs in estuaries of all U.S. coastal states caused from a variety of anthropogenic influences (e.g., overharvest, siltation, pollution) presents a clear need for enhancing education on the role of oysters as keystone species of estuaries. Sharing educational content with students related to real world problems will enhance awareness of environmentally and economically valuable natural resources.

Response: The Consortium aligned with South Carolina State Science Standards to produce educational content for students ranging K-12. Activities include overviews of the oyster anatomy, lifecycle, ecosystem services offered by oysters in natural environments, a demonstration of oyster filtration, and an overview of water quality parameters that students can measure and compare environments with and without oysters present.

Results: The lesson plan has been shared with five educators at public schools and with two state resource agencies who aim to implement activities into curriculum.

A Next Gen Seafood Industry: S.C. Sea Grant Consortium Holds Focus Groups for Workforce Enhancement

Graham Gaines and Matt Gorstein, S.C. Sea Grant Consortium

Recap: In response to a declining commercial fisheries workforce, and to prepare for anticipated federal funds to implement projects that address this decline, South Carolina, North Carolina, and Georgia Sea Grants organized a total of nine focus groups (three in South Carolina) to develop a planning framework for the development and implementation of commercial fishing and aquaculture career development programming in the South Atlantic region.

Relevance: An aging workforce is one of several challenges facing the commercial fishing industry in the Southeast. Variability in operations and structure, lack of training pathways, fragmented industry organizations, and increased costs of entry with little access to resources/capital make this issue particularly challenging. To prepare for and respond to funding opportunities from the Young Fishermen's Development Act, we conducted focus groups to understand facets of the problem and identify solutions from the fishermen's perspective.

Response: Three fishing industry focus groups were held in South Carolina in McClellanville, Georgetown, and Beaufort. Major sectors included commercial shrimpers, crabbers, oyster growers, and fishing associations, with a total of 17 industry participants. Topics addressed included barriers to entry; insurance obstacles; wages; work ethic variation across generations; and race, culture, and heritage.

Results: New ideas and strategies on workforce development were captured, and plans to implement these ideas will be pending funding opportunities. The total economic benefits provided by these focus groups is estimated at \$3,384 based on research incentives received and opportunity costs of time.

S.C. Sea Grant Consortium Works on a Blueprint for a Regional Commercial Fisheries Training Center

Graham Gaines, Matt Gorstein, and April Turner, S.C. Sea Grant Consortium
Steve Richards, Clemson University

Recap: The Consortium and key partners are addressing fisheries workforce training needs through the composition of a feasibility study and business plan for a regional training center in McClellanville, S.C. A town meeting was held which identified the need, will, and potential obstacles for the center. Targeted stakeholder meetings followed which identified the "what, where, when, how" answers. Preliminary steps are being taken, and the business plan is in progress.

Relevance: The South Carolina commercial fishing industry has decreased in participation in recent years due to several local and global factors. Motivations for this project are driven by two factors: a need for facilities, programs, and mechanisms to develop skills necessary to sustain commercial fisheries production in the southeast; and an expression of interest by fisheries stakeholders in McClellanville for assistance in their effort to sustain as a regional seafood and commercial fisheries hub.

Response: Consortium staff built upon years of cooperation with McClellanville community leaders to recognize the opportunity and make decisions through a multi-stakeholder process. A planning team was put together, consisting of representatives from the Town of McClellanville, McClellanville Watermen Association, McClellanville Community

Foundation, Clemson University, an independent fisheries co-op consultant, and Consortium staff.

Results: While the need for workforce enhancement was widely recognized by stakeholders, certain sectors are more suitable to training apprentices than others; e.g. mariculture has more precedent and fewer obstacles than shrimp trawling. Incremental steps will continue towards a workforce training program. Enabling local organizational management capacity, improving insurance options for fishermen, securing waterfront assets for fishermen, and acquisition of a school have been identified as immediate priorities towards the training center.

Regional Effort to Develop a Reef Fish Extension/Communications Outreach Program

Graham Gaines and Matt Gorstein, S.C. Sea Grant Consortium

Scott Baker, North Carolina Sea Grant

Bryan Fluech, Georgia Sea Grant

Angela Collins, Florida Sea Grant

Recap: South Carolina, North Carolina, Georgia, and Florida Sea Grant programs created a position and outreach program aimed at increasing awareness, knowledge, and use of fishing methods that will improve survival of released fish.

Relevance: Sea Grant offices, federal and state agencies, nonprofits, and fishermen themselves strive to collect and understand the best available science for the purpose of promoting stewardship and wise use of recreational species. Yet data collection, analysis and knowledge dissemination regarding federally-managed recreational fisheries is challenging. There is often a disconnect in the information and guidance needed to inform best fishing practices, and messaging and communications regarding stewardship goals needs consistency and a boots-on-the-ground approach.

Response: This program extends best available science directly to the fishermen themselves, and works with fishermen to craft their own communications content to share among their networks. The Reef Fish Extension Agent will visit bait/tackle shops and fisheries events from North Carolina to the Florida Keys, speaking with stakeholders and sharing best practices. Media tours across the region will be arranged to disseminate stewardship-based content across various media outlets.

Results: The new extension/communications position will be an N.C. State Fellow, working under the guidance of the South Atlantic Marine Fisheries Council in Charleston. The position and the outreach programs are funded for four years.

S.C. Seafood Alliance, S.C. Sea Grant Consortium Conduct Commercial Fisheries Infrastructure Needs Assessment

Graham Gaines, S.C. Sea Grant Consortium

Amy MacKown, S.C. Seafood Alliance

Recap: The Consortium has partnered with the South Carolina Seafood Alliance, a professional association representing seafood industry stakeholders across multiple sectors, on a USDA Local Food Promotion Program to conduct a commercial fisheries infrastructure needs assessment.

Relevance: A convergence of obstacles over recent years, including regulatory changes, import substitutes, and declines in working waterfront sites, have transformed the South Carolina seafood sector into a more stressed and vulnerable industry. For South Carolina seafood producers to become more significant providers of regional nutrition and protein, the industry must take stock of its infrastructure and the gaps that work against viable production. This needs assessment aims to identify those needs and gaps.

Response: Seafood business owners, dealers, and fishermen have been interviewed to document the state of seafood production infrastructure and operational needs, including: working waterfront assets, vessels and vessel conditions, value-added production equipment, logistics and other fisheries-related assets and operations. Thus far, freezing and storage space and vessel insurance have been identified as needs that are most critical. Findings will help fishermen, communities, associations and government agencies to prioritize expenses and investments.

Result: Comprehensive surveys with dock owners and fishermen to characterize critical seafood production infrastructure have begun across the state and will provide a report to be used for state spending priorities and grant applications.

Presenting Market Trends in South Carolina Shellfish Mariculture to Interested Stakeholders

Graham Gaines and Matt Gorstein, S.C. Sea Grant Consortium

Marzieh Motallebi, Rob Carey, Sam Cheplick, and Steve Richards, Clemson University

Recap: The S.C. Sea Grant Consortium, along with Clemson University researchers, presented results of a comprehensive suite of mariculture-related market research to an assortment of seafood business leaders and practitioners that detailed trends from seafood producers and consumers.

Relevance: Scaled-up mariculture is still new in South Carolina. The impact of these mariculture industries has not been researched or described in recent years.

Response: Consortium researchers presented a webinar that provided insight into the growth of this industry, which can be used for purposes of private investment, state investment, or business-level decision making, as well as for further research.

Results: Attendees learned about consumer preferences for seafood products, the economic impact of shellfish mariculture in South Carolina, producer needs and opportunities, and future research needs were segments presented during the webinar. Highlights included demographic data on oyster consumers, willingness-to-pay for South Carolina-grown shellfish, and data reflecting that South Carolina's off-bottom oyster mariculture industry contributed over \$8.7 million to the state's economy and supported 130 jobs.

S.C. Sea Grant Consortium Builds Relationships among Commercial Fisheries Support Sectors

Graham Gaines and Matt Gorstein, S.C. Sea Grant Consortium

Steve Richards, Clemson University

Recap: In 2021, S.C. Sea Grant Consortium specialists arranged field visits with representatives from Clemson University, South Carolina Farm Bureau, and oyster, crab, and clam growers to exchange ideas on how the sector

can gain visibility and earn agricultural benefits, including risk reduction for crops and labor.

Relevance: Mariculture governance is often unclear when it comes to regulatory oversight, with National Oceanic and Atmospheric Administration and U.S. Department of Agriculture having roles at the federal level, and state agriculture and marine fisheries agencies splitting roles at the state level. Therefore, aquaculturists have traditionally been left out of policy frameworks that are designed to benefit land-based agricultural entities, despite their commonalities as food growers.

Response: By demonstrating the practice and science of mariculture to particular agricultural professionals, similarities between mariculture and agriculture are observed and can be communicated to help bring agricultural/commodity benefits to mariculturists.

Results: Three representatives from South Carolina Farm Bureau, two senior personnel with Clemson's Agribusiness Program Team, and Consortium staff met with shellfish growers in Beaufort County, Colleton County, and Charleston County to discuss threats to their industries, and to formulate a partnership to address those threats.

S.C. Sea Grant Consortium Conducts Effort to Raise Awareness of Environmental Benefits of the Oyster Mariculture

**Graham Gaines and Matt Gorstein, S.C. Sea Grant Consortium
Amy MacKown, Clemson University**

Recap: The South Carolina Seafood Alliance completed a marketing campaign to benefit the oyster mariculture industry in South Carolina, including a promotional video highlighting the sectors' environmental benefits.

Relevance: This project was a response to needs expressed by the oyster aquaculture industry of South Carolina that economic outcomes were threatened by a lack of public awareness of the industry, its operations and products. One way to support enhanced awareness is by promoting the environmental ethic and sustainability of growing oysters, which is a story that can be told through science.

Response: Multiple partners contributed to the implementation of an outreach campaign. The original design was developed and approved by a committee represented by the S.C. Seafood Alliance, the S.C. Shellfish Growers Association, S.C. Department of Agriculture, and the Consortium.

Results: The Seafood Alliance worked with growers across the state to capture footage of oyster growout operations, worked with the Consortium staff to incorporate best available science into its messaging, and worked with media outlets for endorsement and use of the created content.

S.C. Sea Grant Consortium Leads Shellfish Mariculture Research Working Group to Advance Research and Development

Graham Gaines and Matt Gorstein, S.C. Sea Grant Consortium

Recap: The S.C. Sea Grant Consortium hosted a Shellfish Mariculture Working Group, composed of 18 academic researchers or resource managers, to discuss the need for advancing shellfish mariculture research in South Carolina and identify new opportunities and pathways for advancing the research.

Relevance: The South Carolina shellfish mariculture industry is rapidly growing, increasing from over \$357,000 in wholesale production value in 2012 to approximately \$954,717 in 2021. To supply the science and technical knowledge required to assist the industry in meeting production goals, as well as ensuring that mariculture production continues to be environmentally compatible and proactive in disease avoidance, the Consortium explored the potential for increased research, development, and training capacity among our member institutions and interested academic programs.

Response: With funds from the National Sea Grant Office-funded project Exploring New Aquaculture Opportunities, the Consortium compiled data, potential stakeholders, interested research personnel, and upcoming opportunities. Invitations to join the working group were widely disseminated. Materials were distributed, and a two-hour working group meeting took place to discuss the materials and upcoming opportunities.

Results: Eighteen academic researchers or resource managers representing five research institutions and three departments of the S.C. Department of Natural Resources engaged in the working group. Members from three of the research institutions became involved in subsequent shellfish mariculture trainings and field trips, and three research proposals were developed as a direct result of the working group formation.

S.C. Sea Grant Consortium Provides Social Media Training for Seafood Producers

Graham Gaines, S.C. Sea Grant Consortium

Recap: The S.C. Sea Grant Consortium hosted two social media training sessions for seafood producers in the state to help them develop a social media presence to increase sales directly from supplier to consumer.

Relevance: COVID-19 brought about many changes in seafood consumption behavior and seafood production. Restaurant closings disrupted supply chains and led producers to strengthen alternative marketing and sales strategies. One proven and cost-effective strategy for seafood sales is through increased online engagement, primarily using social media. While some seafood businesses have adequate skills and presence in online marketing, others do not. Therefore, courses for social media marketing were developed to meet industry training needs.

Response: Partnering with S.C. Department of Agriculture and a Trident Technical College instructor, a target skill set and curriculum was developed. A manual for the social media course was also put together for distribution. The opportunity was shared via multiple forms of outreach, and interested businesses signed up for the course.

Results: Seventeen professionals and nine seafood businesses took the two courses to learn how to start and maintain social media accounts on platforms such as Instagram, Facebook, and Twitter. Skills taught included: Monetizing products through platforms; developing continuity between platforms; capturing wide ranging demographics; avoiding high bounce rates; increasing local community involvement and visibility; and creating direct sales payment platforms. Many course attendees have demonstrated increased online engagement and quality of content since taking the course.

S.C. Sea Grant Consortium Provides Identification Tags for Floating Oyster Gear

Graham Gaines, S.C. Sea Grant Consortium

Recap: The S.C. Sea Grant Consortium supplied waterproof and UV-protected cage tags to South Carolina oyster growers who requested identification markers so their floating cages could meet S.C. Department of Health and

Environmental Control's shellfish harvesting regulations.

Relevance: Marine debris, especially from that of commercial fishing and aquaculture gear, is an environmental concern for many oceanic stakeholders and user groups. The relatively high occurrence of storms and hurricanes in the South Atlantic region is a significant driver of marine debris, as gear and equipment can become dislodged and deposited to unknown locations. These tags help farmers protect their property in the event of hurricanes and severe storms.

Response: The Consortium learned about different identification markers at industry trade shows such as Oyster South and reached out to South Carolina growers about their interest and need in them. The Consortium then worked with a private contractor to print the tags with personalized and serialized information unique to each grower.

Results: Five oyster growing operations attached identification tags to a total of 3,430 cages. The tags also help to secure the bonds that oyster growers are required to maintain on all floating gear.

S.C. Sea Grant Consortium Writes Successful Grant Proposal to Develop a Gullah Geechee Seafood Trail

Matt Gorstein, S.C. Sea Grant Consortium

Marilyn Hemingway, Gullah Geechee Chamber of Commerce

Jannie Harriot and Dawn Dawson-House, WeGOJA Foundation

Queen Quet, Gullah Geechee Sea Islands Coalition, Gullah Geechee Fishing Association

Alli Crandell, Coastal Carolina University

Recap: S.C. Sea Grant Consortium develops partnership with the Gullah Geechee Chamber of Commerce and helps them apply for, and get awarded, federal funding to develop a Gullah Geechee Seafood Trail.

Relevance: Identifying strategies to promote equity in sustainable economic opportunity is necessary for maintaining the well-being of coastal communities. Moreover, in an era of climate change, it's critical to address environmental justice issues and to understand the experiences of historically marginalized communities. With lucrative coastal industries like tourism, fishing and harvesting, and seafood dining continuing to grow in South Carolina, it's important to ensure that economic benefits are realized across the social and demographic spectrum.

Response: The Consortium developed a partnership with the Gullah Geechee Chamber of Commerce (Chamber), an organization working to promote businesses owned by Gullah Geechee community members in South Carolina and enhance economic opportunity for the Gullah community. The Consortium collaborated with the Chamber on project ideas that further both organizations' goals. Together, they developed a proposal to establish a Gullah Geechee Seafood Trail to promote seafood businesses owned by Gullah community members and to share stories of maritime cultural heritage.

Results: The S.C. Sea Grant Consortium walked the Gullah Geechee Chamber of Commerce through the registration process for SAM and grants.gov, making it eligible to apply for federal funds. The Consortium identified an appropriate funding opportunity through NOAA's Saltonstall-Kennedy program and helped the Chamber obtain eligibility and write the grant proposal. The Chamber was awarded \$282,000 in grant funding for the project. In 2021, community meetings, kickoff meetings, and one focus group were held.

S.C. Sea Grant Consortium Details Potential Benefits of Increased Shellfish Mariculture Production

Matt Gorstein, Graham Gaines, and Sarah Pedigo, S.C. Sea Grant Consortium
Joey Von Nessen, University of South Carolina

Recap: The S.C. Sea Grant Consortium developed four hypothetical shellfish mariculture research and development investment scenarios in consultation with partners to estimate the return on investment over a 10-year horizon.

Relevance: The growth of the shellfish aquaculture industry in the last few years has led to an increased interest in developing research and development to optimize sustainable shellfish production and survival rates and workforce training programs to adequately train industry entrants in gear handling, shellfish science, and business planning.

Response: The Consortium worked with an economist from University of South Carolina to conduct the return-on-investment analysis and to estimate current unmet demand for mariculture oysters produced in the state. This assessment utilized input-output modeling techniques to estimate the potential return on investment of constructing and operating a shellfish aquaculture research and training program in South Carolina as measured through an economic impact analysis.

Results: Findings, delivered to stakeholders in January 2022, indicate that one out of every five mariculture oysters purchased by South Carolina consumers are produced in the state. The market potential for mariculture oysters in South Carolina is more than triple the current production of existing South Carolina oyster farms. All investment scenarios were estimated to generate positive economic returns in the form of economic output and tax revenue.

S.C. Sea Grant Consortium and Partners Document Economic Contribution of Oyster Mariculture Industry

Matt Gorstein, Graham Gaines, and Sarah Pedigo, S.C. Sea Grant Consortium
Marzieh Motallebi, Rob Carey, and Steve Richards, Clemson University

Recap: S.C. Sea Grant Consortium extension specialists provided expertise in a shellfish mariculture socioeconomic research project to investigate both consumer and producer aspects of the industry and its products.

Relevance: The South Carolina shellfish aquaculture industry, specifically oysters, continues to grow. As this industry is still relatively young, characterizing consumer preferences for S.C. aquaculture products is important for identifying emerging opportunities and/or challenges. Moreover, characterizing the industry from a producer perspective is also vital for tracking industry progress and being proactive in addressing potential barriers to sustainable industry growth.

Response: Researchers from Clemson University received funding from the U.S. Department of Agriculture to assess consumer perceptions of South Carolina aquaculture products, produce a South Carolina shellfish aquaculture industry situation and outlook report, and estimate the total economic contribution of the industry. Consortium extension specialists provided expertise and assistance related to survey design and development of outreach products.

Results: The report found that in 2019 South Carolina's off-bottom oyster mariculture industry contributed over \$8.7 million in output to the state's economy and supported 130 jobs. The total economic contribution includes direct, indirect, and induced impacts. These estimates reflect sales from farmers, related sales at restaurants and

investment expenditures by the farmers themselves for their farms. The presence of the oyster mariculture industry has spillover effects, supporting jobs and generating economic output in multiple sectors.

South Atlantic Red Snapper Research Program Developed and Implemented

Susan Lovelace, S.C. Sea Grant Consortium

Recap: Led by the S.C. Sea Grant Consortium, a steering committee that included the regional Sea Grant directors and representatives of regional fisheries organizations developed a request, evaluated proposals, and selected a project to support the goal of generating an absolute estimate of abundance, with an accompanying measure of uncertainty, for the entire South Atlantic red snapper stock.

Relevance: The recent Gulf of Mexico Great Red Snapper Count was successful in locating the fish in previously unassessed habitat and therefore increasing the expectations of numbers of fish in the basin. Based on this success, Congress appropriated funds to similarly study the fish in the south Atlantic. The estimate will serve as an independent benchmark to inform future stock assessments.

Response: The S.C. Sea Grant Consortium in coordination with Sea Grant directors in the Southeast developed a steering committee made up of state fisheries managers, commercial fishers, federal scientists, and nonprofits to develop and run a competition to support the goal of generating an absolute estimate of abundance, with an accompanying measure of uncertainty, for the entire South Atlantic red snapper stock.

Results: Two proposals were received and, after receiving technical reviews, were assessed. Preference was given to proposals that sought to produce a single absolute estimate of abundance for the entire geographic region. In March 2021, the nearly \$1.5 million project was awarded to Dr. William Patterson, University of Florida, whose objectives include estimating the distribution and density of red snapper in unknown or unconsolidated habitats and estimating the number of red snapper age 2-plus in the study region.

Seafood Direct Marketing Interview Sessions with the Consortium, Clemson Researchers, and Seafood Businesses

Pravin Nath, Clemson University

Graham Gaines and Matt Gorstein, S.C. Sea Grant Consortium

Recap: MBA students and associate professors at Clemson's Marketing Department joined S.C. Sea Grant Consortium staff to interview leaders in the state's seafood businesses to understand the marketing challenges and potential for increased direct marketing of seafood products.

Relevance: The COVID pandemic exposed the vulnerabilities the South Carolina shellfish industry's reliance on restaurants as the primary market/channel for their produce, making it important to explore other marketing opportunities. In addition, trends such as buying local and fresh produce, eating healthy, being sustainable, and an acceptance of direct-to-consumer marketing suggest an unexplored potential for mariculture farmers through creative strategies.

Response: Four MBA students, three faculty, and two S.C. Sea Grant Consortium specialists met with five successful seafood businesses for one-hour Zoom interviews to understand the primary challenges and obstacles to transition to more direct sales of the products.

Results: The discussions helped the students learn of common themes behind successful direct marketing campaigns. The interviews were then used to craft a survey to understand behaviors, attitudes, and willingness-to-pay for direct-to-consumer seafood products.

S.C. Sea Grant Consortium Researchers Developing Tripletail Fish Culture Techniques for Co-production in Shellfish Ponds

Jason Broach, S.C. Department of Natural Resources

Recap: S.C. Sea Grant Consortium researchers successfully established tripletail fish culture techniques and report the first ever observation of a parasitic worm encysted on the brains of the fish.

Relevance: Tripletail are a highly valuable marine finfish for seafood markets, but extensive research is required to develop methods for successful aquaculture of the species. With a fast-growing juvenile phase, limiting wild-caught supply, and high retail value, commercial aquaculture of tripletail could be a lucrative opportunity for aquaculture producers in South Carolina to diversify their production models, particularly in conjunction with shellfish production ponds.

Response: In an effort to establish at least one natural spawning population of tripletail in a recirculating aquaculture system and record spawning frequency and quality over time, tripletail were collected by fisherman and staff at the S.C. Department of Natural Resources.

Results: Researchers successfully established two populations of tripletail in two recirculating aquaculture systems. A reproductive hormone, prostaglandin, was added to the tanks to induce spawning. No spawning events occurred, but hormone efficacy trials will occur during the summer of 2022. Outside the original scope of work, the first-ever observation of a parasite encysted on the brains of the fish, which is important for the overall biology and aquaculture potential of the fish.

S.C. Sea Grant Researchers Examine Influence of Butterflyfish and Coral Genome on Coral Disease

Kara Noonan and Michael Childress, Clemson University

Recap: S.C. Sea Grant researchers observe indicators that four-eye butterflyfish could be important in the process of coral recovery from stony coral tissue loss disease.

Relevance: Marine diseases have caused large scale decreases in coral cover across the Caribbean and are unfortunately projected to increase as sea surface temperatures rise. Identifying the main drivers of disease transmission is essential for our understanding and response to diseases in the future.

Response: S.C. Sea Grant Consortium researchers are seeking to understand the relationship between coral, coral disease, and butterflyfish. This requires tracking the progression and transmission rates of coral disease, analyzing fish community diversity and corallivore foraging behaviors, investigating transmission potential in a controlled laboratory experiment, and genetic sampling of coral colonies.

Results: The four-eye butterflyfish were observed feeding around the tank as opposed to on either healthy or diseased corals, suggesting that diseased tissue that had sloughed off may have been the most readily available food source, as the fish were able to avoid the stinging defenses of the corals. There is some evidence that

butterflyfish may not directly increase infection rates, but instead might be important in the process of disease recovery.

S.C. Sea Grant Consortium Researchers Developing Spotted Seatrout Model Designed for Enhanced Resource Management

Tanya Darden, S.C. Department of Natural Resources

Recap: S.C. Sea Grant Consortium researchers continued designing a spotted seatrout model that more accurately reflects its life history to guide resource managers with decision-making in stock enhancement.

Relevance: Spotted seatrout are especially vulnerable to winter kills, which occur at least once each decade and appear to be the major factor associated with changes in population abundance. Little information is available to guide stock enhancement in facilitating recovery of spotted seatrout populations following these events. Stocking offspring from a small number of broodstock may reduce genetic diversity and effective population size, which are important for the long-term adaptability of a population.

Response: Researchers are developing a demographic and genetic model they hope will provide resource managers in South Carolina with a stock enhancement tool to guide spotted seatrout conservation and restoration following winter cold events.

Results: Consortium researchers have collected genetic data from 650 spotted seatrout samples, calculated spawn and hatchery effective population size, and completed modifying an existing genetic model, incorporating spotted seatrout life history, ecology, and hatchery production.

S.C. Sea Grant Consortium Developing Non-lethal Tool to Aid in Cobia Population Stock Assessments and Restoration

Tanya Darden, S.C. Department of Natural Resources

Recap: South Carolina Sea Grant Consortium researchers continued building a non-lethal tool to sequence cobia genomes to help begin restoration efforts for inshore spawning populations.

Relevance: Cobia is a species of concern in South Carolina due to heavy fishing pressure on the inshore spawning population over the past two decades, and the state has implemented management actions, including harvest reduction and stock enhancement within inshore waters.

Response: Researchers proposed using next-generation sequencing technologies, which are more efficient in screening entire genomes, in an effort to develop a new tool for sex identification of cobia. The development of a non-lethal, minimally invasive tool for sex identification will substantially aid in assessing the restoration of the inshore population by providing easy access to wild population data, as well as increasing hatchery production efficiency.

Results: Despite delays due to COVID, researchers successfully sequenced approximately 96% of the genome for both male and female cobia samples, and identified significant regions of non-overlap between the genomes. Sampling will continue in an effort to develop a non-lethal tool that can be used in stock enhancements and assessments and in sustainable aquaculture.

Researchers Make Progress on Estimation of Atlantic Red Snapper Abundance in Region

William Patterson, University of Florida

Recap: S.C. Sea Grant Consortium researchers are progressing with population size estimates of Atlantic red snapper using remotely operated vehicle and camera-trap samples, and proceeding with integrated model development.

Relevance: Red snapper, *Lutjanus campechanus*, is an ecologically and economically significant reef fish in U.S. Atlantic waters between North Carolina and south Florida, where it has been estimated to be overfished since the early 1970s. Commercial and recreational regulations put in place to rebuild the red snapper stock failed to accomplish that goal, but restrictive management following the passage of the Reauthorized Magnuson-Stevens Fishery Conservation Act in 2006 has caused vocal dissent among various user groups.

Response: S.C. Sea Grant Consortium researchers proposed estimating the population size of Atlantic red snapper independent of the stock assessment, which should be beneficial to future assessments and fisheries management. They plan to produce two independent estimates of age-2-plus Atlantic red snapper population from North Carolina to Florida. One will be based on genetic mark recapture and the other will take advantage of annual Southeast Reef Fish Survey camera-trap sampling along with remotely operated vehicle sampling.

Results: Remotely operated vehicle transect sampling was conducted at 265 sites on the Atlantic shelf from North Carolina to the Florida Keys, including 57 sites where South East Reef Fish Survey camera-trap samples were taken. Red snapper size estimates were extracted from samples to estimate red snapper population size, and current modeling includes analysis of red snapper density and size distributions. Fin-clip samples are being genetically sequenced.

S.C. Sea Grant Consortium Studies Use of Craft Brewery By-products to Fill Nutritional Gaps in Aquaculture Fish Feeds

Aaron Watson, Fabio Casu, and Michael Denson, S.C. Department of Natural Resources

Recap: Consortium researchers investigating the feasibility of developing a by-product from brewery spent grain material for use in high-quality fish feeds see promise for incorporating craft brewery spent grains into feeds for red drum.

Relevance: As world populations continue to increase, so does demand for fish protein. Aquaculture has expanded to fill the growing demand. Aquaculture production often still relies on feed ingredients for protein and lipid sources from wild stocks in the form of fishmeal and fish oil, and the costs of feed can represent more than 50% of the total cost of producing market-size fish. Spent grains from craft breweries represent an underutilized potential source of nutrition for fish feeds.

Response: S.C. Sea Grant researchers are examining the potential use of spent grains from craft breweries in the Charleston, S.C. area as viable ingredients in fish feeds for juvenile red drum. They have partnered with three local craft breweries, collected monthly samples from each brewery, and made significant progress in evaluating the material itself for composition, digestibility, and tolerance in juvenile red drum.

Results: Spent grain samples from each partner brewery were collected and analyzed for nutritional composition.

No significant differences in profiles were observed between the breweries or over time, which suggests mixing the material from multiple breweries will not significantly change the nutritional profile. Data resulting from digestibility trials in the red drum are still being evaluated, but initial results suggest similarities with other minimally processed plant ingredients. Overall, results of the project are promising.