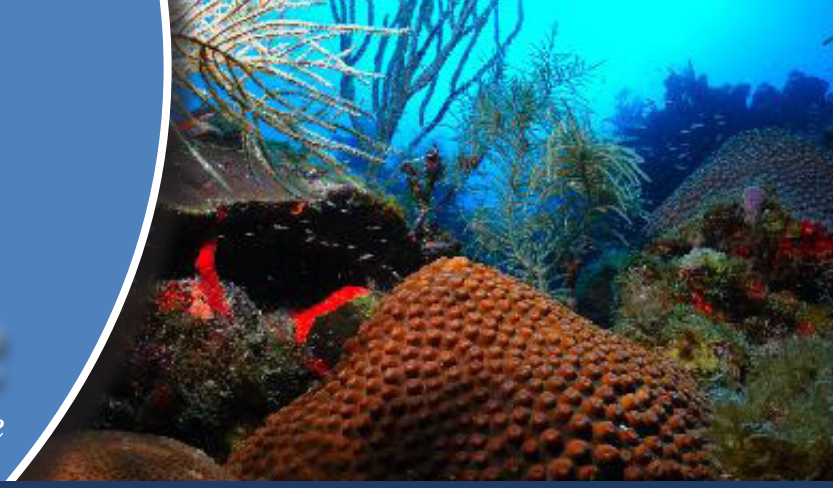
# HABITAT HOTLINE Atlantic

2019 Annual Issue



## HEALTHY FISHERIES NEED HEALTHY HABITAT

## Marine Aquaculture Along the Atlantic Coast and Beyond

In the face of increased harvest pressure on wild finfish and shellfish, marine aquaculture has the capacity to fill the demand for these resources. The challenge at hand is to do so without sacrificing the ecological integrity and function of areas where aquaculture activity is sited. While negative impacts are inevitable, they can be minimized by using best management practices and compensated for by leveraging species' biological characteristics. This edition of the *ASMFC Habitat Hotline Atlantic* highlights programs that seek to increase our understanding of aquaculture's influence on local habitats through nutrient extraction, species interactions, and facility design.

State updates are focused on aquaculture activity. Shellfish are the most common organisms being cultured, but some states are also culturing finfish, algae, and "live rock." A common challenge for all states is the siting process and conflict resolution among competing stakeholder groups.

I invite you to explore marine aquaculture along the Atlantic coast and beyond.

*Marek Topolski, MD DNR*
*Habitat Committee Chair*

## Aquaculture and the Needy Fish: An Introduction to the Fishy Aspects of Farming the Sea

*Kent Smith, Florida FWC*

A table of diners enjoying a few dozen boutique oysters at a raw bar on Atlantic Beach. Summer flounder and striped bass ambushing juvenile menhaden on the down current side of an oyster lease in Delaware Bay. Seagrass sprouting around clam bags in the Indian River Lagoon. What do all these events have in common you ask? They are all linked to the burgeoning aquaculture industry and the effects that related activities have on the species managed by the Atlantic States Marine Fisheries Commission (ASMFC). Most basically,

*— continued on page 2*

*Classic oysters on the 1/2 shell. Photo credit: Florida Department of Agriculture and Consumer Services*

### In This Issue

# Aquaculture along the coast

*Oyster bags ready for deployment. Photo credit: Florida Department of Agriculture and Consumer Services*

aquaculture is the rearing of aquatic animals or the cultivation of aquatic plants for food. While oyster and hard clam aquaculture has been practiced and refined over the years, relatively new marine algae, finfish, and live rock efforts are expanding in waters supporting ASMFC species. The effects of these activities are concerning to many, but marine spatial planning efforts are incorporating aquaculture expansion into regional coastal management plans. So what's all the fuss about?

Fish farming is one of the earliest known forms of aquaculture. Fish ponds in China produced carp for local consumption some 1000 BCE during the Zhou Dynasty. Aquaculture in coastal systems is a more recent development, but has long been practiced by people around the world to provide consistent high quality seafood that is easily accessible to local populations. The Romans farmed oysters in coastal lagoons before 100 CE. In Asia, line aquaculture to grow shellfish and algae has been a common practice for a century. Many forms of aquaculture were developed after overharvest of local wild stocks, when people recognized the need to ensure continued production of important food sources. As long as humans have practiced aquaculture, there have been beneficial and problematic effects of these activities on native fish, shellfish, and submerged aquatic vegetation and other habitats.

Concerns related to various kinds of modern aquaculture in our open waters abound. Nets, cages, support structures, and other materials are lost in storms and become marine debris. Much of this material has to be durable, so plastic is used extensively. Plastics break down into micro-particles that remain in the environment for years. Some webbing and nets can entangle marine species, like birds and mammals, or become entangled in sensitive marine habitats like branching corals or oyster reefs. Pen-reared fish can be vectors of disease for migrating wild fish of the same species, and waste products can negatively affect water quality of ambient waters. Escaped fish or shellfish brought in from other regions can lead to genetic pollution of local stocks or establishment of non-native species competing with native stocks. Areas used for aquaculture can interfere with vessel navigation or usurp public accessibility. Yet, despite these issues, benefits of these practices remain.

Animals and plants grown and harvested in aquaculture provide a consistent source of seafood for an ever-growing human population, taking some of the pressure off wild stocks traditionally harvested by fishermen. When sited properly, the structure provided by aquaculture acts as shelter for wild species and attachment habitat for fouling communities, augmenting the productivity of a system. Shellfish aquaculture (oysters and clams) can lead to improved clarity of ambient waters, and seagrass has been shown to colonize areas around active shellfish lease sites. Many of the ecological functions of habitat-creating species, like oysters, are provided by their culture, and help support important wild fish and their habitats.

Aquaculture is part of our present and future estuarine, coastal, and marine landscapes. Coastal resource managers are working to address the more problematic issues of this industry, while enhancing the beneficial components for native fish and plant communities. Management efforts will continue to incorporate aquaculture into everything from ecological functions of communities in estuaries, to broad scale marine spatial planning into the foreseeable future. Understanding the various ways in which this is being done is the focus of this issue of the ASMFC *Habitat Hotline Atlantic*.

*Floating oyster baskets on a lease. Photo credit: Florida Department of Agriculture and Consumer Services*

## *Restorative Aquaculture: Can Farming Shellfish and Seaweed Provide Habitat Benefits?*

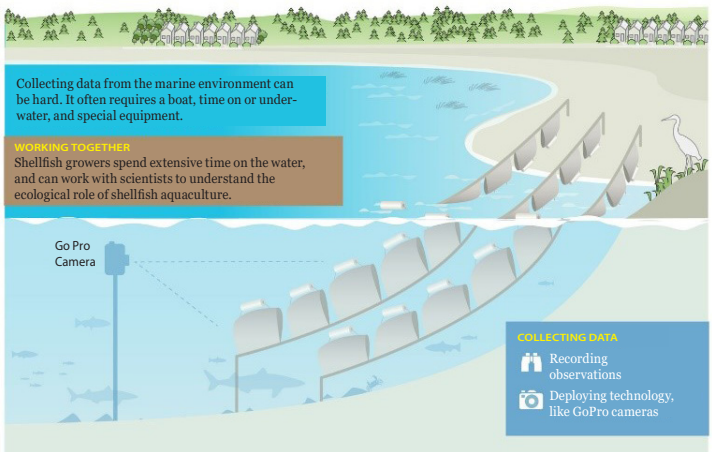
*Robert Jones, Dr. Seth Theuerkauf, and Tiffany Waters, TNC*

While aquaculture is often associated with water quality pollution, invasive species introductions, and destruction of important coastal habitats, increasing evidence suggests that well designed and managed aquaculture – particularly of shellfish and seaweeds – can provide ecosystem services, such as habitat benefits for fish and other marine life.

Working with key partners, The Nature Conservancy (TNC) is exploring the habitat value of shellfish and seaweed aquaculture through synthesis of global-scale science and on-the-ground projects that address information gaps. The goal is to inform strategic development of aquaculture in a manner that aids in ecosystem recovery, rather than causing ecological harm.

### A Look Below Water: *Assessing habitat utilization of shellfish gear in Washington State and Massachusetts*

Among all the ecosystem services provided by shellfish aquaculture, its role in providing nursery habitat for fish is one of the least understood. In the Puget Sound in Washington State and at Duxbury and Cotuit Harbors in Massachusetts, we are collaborating with private shellfish farmers and scientific partners to analyze fish utilization of shellfish farms using GoPro cameras. These cameras are recording videos of how fish and other marine species are using the farm gear, which are then analyzed by National Oceanic and Atmospheric Association (NOAA) researchers to assess the abundance of fish, crabs, and other species in shellfish farms relative to unfarmed habitats.




*Shellfish growers, together with TNC, academic, government, and tribal partners, are using GoPro cameras to better understand how species utilize shellfish farms as habitat relative to natural habitat. This research aims to increase understanding of the ecological role of shellfish aquaculture and opportunities to improve the environmental performance of aquaculture practices. Image credit: TNC Washington*

*Drone flies over Hog Island Oyster Company's farm. Photo credit: Torrey Johnson*

### Flying Over Water: *Understanding the interactions between seagrass and shellfish aquaculture in California*

In California, 90% of eelgrass habitat has been lost since the 1850s. Concern over aquaculture's potential impacts to this critically important habitat is a primary regulatory issue for shellfish aquaculture. Creating a complex regulatory challenge, eelgrass has been observed by oyster growers to expand into adjacent shellfish farms and grow in and around the gear. In Tomales Bay, the University of California Santa Cruz, Hog Island Shellfish Company, and TNC are using aerial drones as an inexpensive way to monitor eelgrass growth and assess the impacts of shellfish aquaculture operations on eelgrass. One hypothesis we are investigating is whether increased light penetration due to oyster water filtration and/or nutrient deposition from oysters are contributing to eelgrass growth around oyster farms. With the collaborative efforts from industry and scientific institutions, this project will help fill knowledge gaps in seagrass-shellfish interactions and create opportunities to develop shellfish farms that could foster eelgrass growth. Additionally, the team is creating a drone monitoring protocol that can be used directly by industry or other citizen scientists to monitor tideflats and eelgrass habitat over time.

### The Big Picture: *Global-scale synthesis science*

In addition to the on-the-ground studies demonstrating the habitat value of shellfish and seaweed aquaculture, two recent synthesis studies by Alleway *et al.* (2019) and

Gentry *et al.* (2019) document a diversity of ecosystem services from aquaculture. Where benefits have been observed, wildlife habitat provision has included a variety of mechanisms, such as the provision of physical structure that can serve as refuge for fish and invertebrate species, or food resource subsidies and novel forage opportunities for wildlife. Gentry *et al.* (2019) reviewed 129 studies describing positive effects of mariculture on ecosystem services, 20 of which pertained specifically to habitat. It was clear that a wide variety of species live or gather in and around mariculture farms. Some studies even documented enhanced production, instead of just attracting animals from nearby habitats. Regional effects such as increased spawning biomass and shifting predator behavior were described as well.

There is still a lot to learn about the habitat benefits or impacts of aquaculture dependent upon a number of factors. Our future science efforts will take a more in-depth look at the habitat benefits of shellfish and seaweed aquaculture. In addition to quantifying habitat benefits based from existing literature, we are working to understand the ecological processes and mechanisms whereby aquaculture can provide these benefits and the enabling conditions for these benefits. To ensure the delivery of habitat value, it is important to understand the synergies and trade-offs between various habitat impacts at different scales, and how these impacts are dependent on the interaction of multiple factors, such as species cultivated, siting of the farm, cultivation intensity, and gear utilized.

By providing scientific information that quantifies the ecosystem services of aquaculture, we aim to inform public policy and regulatory decision-making. In the United States, the Army Corps of Engineers, NOAA, and state resource managers each play critical roles assessing the environmental effects of proposed aquaculture operations. A primary function of the regulatory review processes is, and should be, to ensure that aquaculture operations do not have any unacceptable levels of environmental impact and where they do, require measures to reduce and mitigate negative impacts. As increased scientific evidence demonstrates the ecosystem services of aquaculture operations, it may also be possible for regulatory reviews such as those required by the National Environmental Policy Act, NOAA Fisheries Essential Fish Habitat Consultations, and the Army Corps of Engineers Public Interest Reviews to incorporate positive ecosystem service values of aquaculture into decision-making.

## *Combining Shellfish and Seaweed Aquaculture in Bioextraction of Nutrients in Long Island Sound*

*Nelle D'Aversa, NYSDEC*

Nutrient bioextraction utilizes shellfish and seaweed aquaculture to remove excess nutrients that could have otherwise led to algal blooms, hypoxia, and related water quality impairments that harm marine life. In 2018, New England Interstate Water Pollution Control Commission (NEIWPCC), New York State Department of Environmental Conservation (NYSDEC), and the Long Island Regional Planning Council partnered to start the Nutrient Bio-extraction Initiative (Initiative). The goal of the Initiative is to explore the potential for using nutrient bioextraction to reduce excess nitrogen and improve water quality in New York and Connecticut surface waters while supporting the aquaculture industry. The primary source of funding for the Initiative is from the Long Island Sound Study.

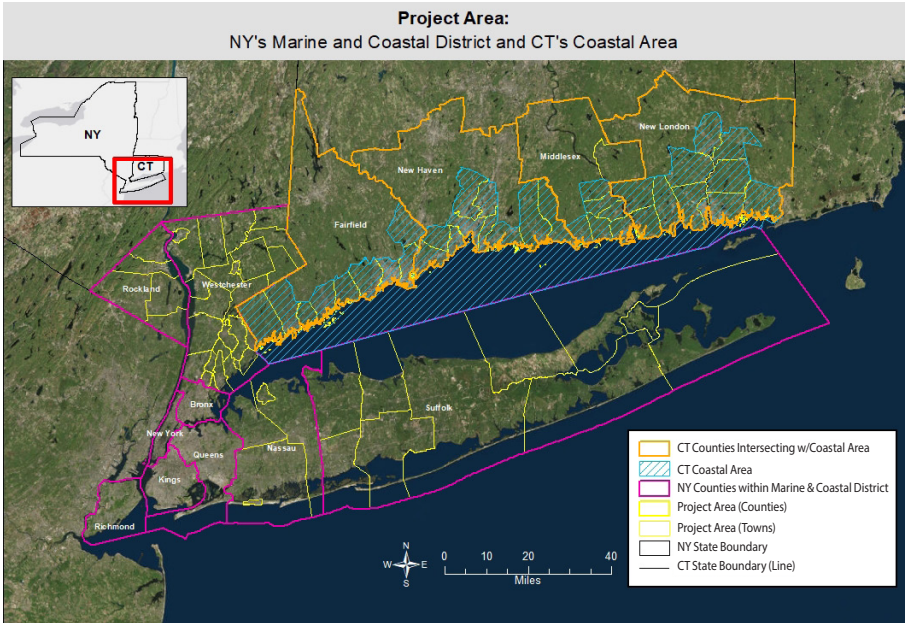
The project is part of a larger nitrogen reduction strategy for the Long Island Nitrogen Action Plan (LINAP) that aims to reduce nitrogen loading in Long Island's surface and ground waters and improve water quality in coastal waters. The NYSDEC and the Long Island Regional Planning Council partnered with Suffolk and Nassau Counties in Long Island to lead the LINAP effort.

### *Nutrient Bioextraction Pilot Projects*

The Initiative is planning and developing nutrient bioextraction pilot projects using seaweed in order to assess the efficacy of, and cultivation costs associated with, bioextraction in urban Long Island waters. A pilot growth and nutrient uptake study of a cold weather brown algal species, sugar kelp (*Saccharina latissima*), will be conducted during the growing season of 2019-2020 in Great South Bay, New York. Sugar kelp absorbs and stores nitrogen from surrounding water during its winter and spring growth periods and, thus, is useful as a 'bioextractor' in waters polluted by surrounding urban area discharges.

This project is a pilot of future efforts that aim to maximize yield of kelp, nutrient extraction, and related ecosystem services, while minimizing impact on human activities such as recreational boating and shellfish harvest.

*Adelphi University professor examining sugar kelp growth as part of the Hempstead Bay research project. Photo credit: Nelle D'Aversa*




*GIS-based nutrient bioextraction siting tool project area. Photo credit: Nelle D'Aversa*

### *Shellfish Aquaculture Guidance Document*

The permitting process for shellfish aquaculture was identified as one of the main concerns of the aquaculture industry. NYSDEC is working to develop a comprehensive guidance document for shellfish aquaculture permitting that will support the growth of the shellfish aquaculture industry by helping prospective, new, and existing aquaculture farmers better understand the laws, policies, and permitting processes applicable to marine shellfish aquaculture in New York.

### *Siting Tool*

A geographic information systems (GIS)-based siting tool is currently being developed to identify suitable sites for bioextraction operations within New York's marine and coastal district and Connecticut's coastal area. The siting tool is being developed in two phases: Phase 1 – quality assurance project plan development, data collection, and development of an ArcGIS online interactive map; and Phase 2 – data analysis. Data collected in Phase 1 will be analyzed using a weighted sum overlay approach that will ultimately result in priority areas identified as suitable for nutrient bioextraction operations. The project will result in a publicly-available ArcGIS Online interactive map hosted on the Long Island Sound study website with relevant data on natural resources, navigation, existing aquaculture, and potential use conflicts. Additionally, the results of the weighted sum overlay analysis will be made available to resource managers, program managers, and other stakeholders at state, regional, and local levels to be used in future decision making regarding bioextraction and the role it can play in reducing nitrogen in Long Island Sound and the southern shore of Long Island.

For more information on bioextraction, please visit: *https://www.dec.ny.gov/docs/water_pdf/bioextractionfs.pdf*

*https://protect2.fireeye.com/url?k=22c5d628-7ee3e273-22c72f1d-000babd905ee-66cd0877a0b28a7f&u=http://longislandsoundstudy.net/our-vision-and-plan/clean-waters-and-healthy-watersheds/nutrient-bioextraction-overview/*

## *Growing Innovative Aquaculture in the Waters of Hawai'i*

*Kate Taylor, NOAA Fisheries Pacific Islands Regional Office*

Hawai'i has been a leader in aquaculture innovation for over 800 years. Native Hawaiians, for example, are thought to be the first islanders in the Pacific to build *loko i'a* (fishponds), which were part of an integrated farming system designed to provide a steady and self-sufficient source of food in this remote region. Guided by this history of innovation, current fishpond practitioners and

*Standing on the He'eia fishpond wall, looking across the fishpond to the Ko'olau Mountains. The coastal area of the He'eia ahupua'a is now filled with residential communities that increase runoff into the fishpond waters. Photo credit: Kate Taylor, NOAA Fisheries*

the growing aquaculture industry are working in tandem to increase food security and economic opportunities in Hawai'i in an environmentally responsible way.

Fishponds have always been an important component of Hawaiian culture. Native Hawaiians understood that the health of a fishpond was directly related to the health of the larger ecosystem. What's more, traditional land management practices revolved around the concept of *mauka* to *makai* (mountains to ocean). Early Hawaiians divided up each island into pie-shaped land divisions called *ahupua'a*, each of which typically encompassed a watershed. At the top of the *ahupua'a* was an upland freshwater source in the mountains. This freshwater source would flow downstream through forests and fertile agricultural land, making its way to the fishpond and out to the ocean. The *ahupua'a* contained all of the resources Hawaiians needed for daily life: water for drinking and irrigation; plants for food, clothing, canoes, houses, and weapons; and fish for eating. A master fisherman and master farmer helped to oversee the *ahupua'a*, enforcing necessary restrictions such as prohibitions on fishing during specific seasons or the gathering and cultivating of certain plants. These restrictions ensured the community remained in balance with the land and sea, an essential element in native Hawaiian's land management practices.

Hundreds of fishponds once existed across Hawai'i, but, over the years, most have fallen into disrepair. There has been a resurgence in the last decade to restore these ancient aquaculture systems. Today, Hawaiian cultural practitioners, the State of Hawai'i, NOAA, and other partners have restored about a dozen to operational levels.

He'eia Fishpond, located on the windward side of O'ahu, is one of the few restored fishponds left in the islands. He'eia Fishpond and the surrounding estuary is part of the National Estuarine Research Reserve System (NERRS), a network of 29 coastal sites across the United States designated to protect and study estuarine systems. NOAA manages the He'eia NERR in partnership with the State of Hawai'i through the University of Hawai'i's Institute of Marine Biology. The He'eia site, led by an innovative Management Plan, seeks to integrate traditional knowledge of the *ahupua'a* with contemporary scientific research, monitoring, and training.

Built 600 – 800 years ago, the wall surrounding He'eia Fishpond is over a mile long. To build this wall, thousands of community members would have gathered together, passing rocks and coral hand-to-hand and interlocking the materials together. Along the wall are unique sluice gates that both allow juvenile fish to swim into the fishpond and prevent larger fish from swimming out. The heavy rains falling on this green and lush side of the island filter down through the forest and wetlands into the fishpond. The freshwater transports nutrients that stimulate the growth of algae, which the ponds' herbivorous fish readily eat. Once the fish reach a harvestable size, they can easily be caught with dip nets or seines.

While the current aquaculture industry in the U.S. Pacific Islands Region is far more technologically advanced than He'eia Fishpond and other traditional fishponds, it shares a major commonality: the goal of achieving safe, secure, and sustainable seafood. Today, the region produces a wide variety of crustaceans, finfish, mollusks, and algae for consumption, with most of the production occurring in Hawai'i. The U.S. Department of Agriculture reports the aquaculture sales of Hawai'i totaled $76.4 million in 2017, of which algae contributed $35.1 million.

Up the road from He'eia Fishpond is Moli'i Fishpond, another operating fishpond that's helping grow Hawaiian aquaculture into a multimillion dollar business. Managed by Kualoa Ranch, Moli'i Fishpond raises fish and oysters to sell onsite and to local retailers. It was the first operation in the state to be certified by the Hawai'i Department of Health to sell oysters. The ranch began growing oysters to help control excessive growth of invasive algae that was harmful to the fishpond's harvestable fish. The oysters rapidly grow in the warm, nutrient-rich water and reach market size in about six months. During that time, each

oyster can filter as much as 50 gallons of water a day, cleaning the water and creating an environment where the fish can thrive.

Some 200 miles away on the Island of Hawai'i, innovation is in the water at the State's Hawai'i Ocean Science and Technology (HOST) Park—home of the world's first successful Ocean Thermal Energy Conversion (OTEC) plant. To run the OTEC plant, both cold deep water and warm surface water from offshore are pumped onshore. Since the plant pumps up more water than they it use, more than 40 other businesses have sprung up in HOST Park to access the pristine and nutrient-rich seawater. The majority of these companies focus on aquaculture and are growing everything from abalone to algae to seahorses to shrimp.

Hawai'i Island has also been expanding cutting-edge research and development on new aquaculture gear and technology, including open ocean finfish aquaculture. In 1999, Hawai'i, with assistance from NOAA's Sea Grant Program, became the first place in the world with a commercially operating ocean-lease, offshore cage aquaculture system. Blue Ocean Mariculture, also located at HOST Park, has demonstrated that responsible offshore fish farming can be environmentally sustainable. Its open ocean marine finfish farm, the only one in operation in the United States, produced 900,000 pounds of Hawaiian kanpachi (almaco jack, *Seriola rivoliana*) in 2017. The fish produced at Blue Ocean serve seafood markets in the islands, as well as on the mainland.

Building off of the success of aquaculture business in the park and the need to meet growing seafood demands, the State of Hawai'i and University of Hawai'i partnered to bring HATCH, the world's first aquaculture-specific small business accelerator, to HOST Park. In 2019, the accelerator selected 13 companies from over 100 applications to participate in its program. The program brings in mentors and investors to provide educational and business opportunities to help drive participant growth throughout the course of the 15-week program.

The selected companies provide a variety of services and solutions to the aquaculture industry. For example, one innovative company, Symbrosia, is working to find an ocean-based solution to a land-based problem. This company is helping to address climate change by developing a system to produce Hawaiian limu (algae, *Asparagopsis taxiformis*) as a cattle feed supplement. Livestock contribute a very significant source of methane to the atmosphere, representing about 4% of total global greenhouse gas emissions. Studies have shown that when limu replaces just 2% of cattle feed, there is a 99% reduction in the methane production of cattle. It seems that after 800 years, the philosophy of *mauka* to *makai* is still alive and well.

*View of the He'eia Fishpond wall. The coastal area of the He'eia ahupua'a is now filled with residential communities that increase runoff into the fishpond waters.*
*Photo credit: Kate Taylor, NOAA Fisheries*

# Atlantic Coastal Fish Habitat Partnership Update

## Massachusetts DMF Eelgrass Team Receives the 2019 Melissa Laser Fish Habitat Conservation Award

*Dr. Lisa Havel, Atlantic Coastal Fish Habitat Partnership*

*Kent Smith (ACFHP Chair, far left), Mark Rousseau (MA DMF, left), and Jim Gilmore (ASMFC Chair, far right) present the Melissa Laser Fish Habitat Conservation Award to Tay Evans (MA DMF, right). Photo credit: L. Leach, ASMFC*

The 2019 Melissa Laser Fish Habitat Conservation Award was presented by Kent Smith, Atlantic Coastal Fish Habitat Partnership (ACFHP) Chair, and Mark Rousseau, Massachusetts Division of Marine Fisheries (MA DMF), to Tay Evans, Jillian Carr, Kate Frew, and Alex Boeri of MA DMF on October 28th at the 78th Annual ASMFC Meeting in New Castle, New Hampshire. Ms. Evans was there to accept the award on behalf of all recipients, collectively known as the DMF Eelgrass Team. The Team is responsible for the restoration of over 20 acres of eelgrass habitat in Massachusetts between 2004 and 2019. This is one of the largest and most successful eelgrass restoration programs in New England. The Team has perfected planting and monitoring methods, yet still work toward optimizing its methods for efficiency. This Team also assesses the effectiveness of conservation boat moorings, which have been funded in part by ACFHP. Conservation moorings have the capacity to lessen damage to eelgrass beds if installed and maintained properly. The Team's work early in the adoption of this technology was critical in identifying best management recommendations for these moorings before their widespread use.

The Team's eelgrass work exemplifies ACFHP's mission of accelerating restoration of native estuarine habitats. Its passion is unparalleled, spending hundreds of hours underwater while still finding time to communicate about its work and provide technical assistance to towns and researchers embarking on eelgrass studies and restoration. The Team's collaborations are leading to improved assessments of the blue carbon value, as well as the genetic diversity and resilience of eelgrass. It is because of its unwavering commitment to the restoration of this habitat, and persistence in the face of damaging winter storms, bioturbation, and macroalgae that Boston Harbor's eelgrass is flourishing.

The Melissa Laser Award was established in 2012 in memory of Dr. Melissa Laser, a biologist with the Maine Department of Marine Resources and active member of the ACFHP Steering Committee. Melissa dedicated her career to protecting, improving, and restoring aquatic ecosystems both locally in Maine and along the entire Atlantic coast. For more information on the Melissa Laser Award, please visit: *https://www.atlanticfishhabitat.org/melissa-laser-fish-habitat-conservation-award/.*

### Support ACFHP

There are many ways you can support ACFHP, including donating directly to our cause, indirectly via AmazonSmile, and by purchasing specific RepYourWaters merchandise, including hats and t-shirts.
To learn more, visit our webpage: *http://www.atlanticfishhabitat.org/donate/*

# Updates from Around the Coast

## NEW HAMPSHIRE

*Robert Atwood, NH F&G*

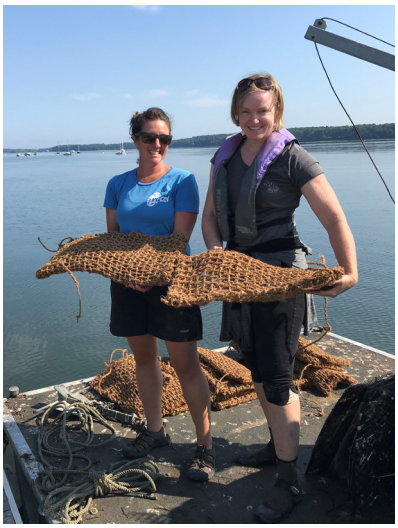
Currently, New Hampshire has 36 aquaculture licenses for species including oysters, blue mussels, steelhead trout, and a variety of seaweed. The majority of aquaculture in New Hampshire is for oyster, with 26 licenses in 2019. Oyster farming in New Hampshire has grown from less than six acres in 2010 to 75.7 acres in 2019. In 2018, the total harvest of oyster in New Hampshire was 439,497 oysters for a value of $311,039.

*Map of Little Bay, New Hampshire. The yellow polygons are oyster farms. The yellow/black squares are oyster upwellers. Image credit: Robert Atwood, NH F&G*

### *TNC Oyster Restoration Program Partnering with Oyster Farmers in New Hampshire*

*Alix Laferriere and Brianna Group, TNC*

In 2019, TNC in New Hampshire partnered with oyster farmers in Little Bay to pilot new methods of growing oysters for restoration in Great Bay Estuary. TNC purchased 10,000 "uglies," or adult oysters not for market, from two oyster farmers (Virgin Oyster Co. and Choice Oysters). These oysters were deployed on TNC's Nannie Island restoration site in Great Bay where they will filter water and reproduce, contributing those ecosystem services to the system. Monitoring of the deployed oysters will occur in late 2019 and 2020 to determine the success of purchasing and deploying "uglies" for restoration.



*Laura Brown, owner and operator of Fox Point Oysters, and Alix Laferriere, Coastal and Marine Director for TNC in New Hampshire, holding bags made of a biodegradable coconut fiber. These bags are filled with oyster seed for grow out on Fox Point oyster farm. These oysters are being grown as a pilot for restoration. Photo credit: Brianna Group, TNC*

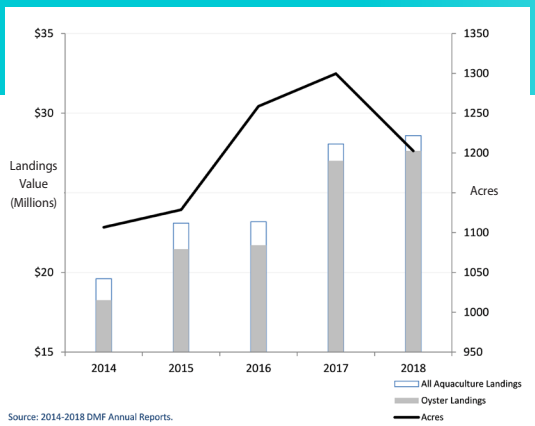
Additionally, TNC has contracted with three oyster farmers (Choice Oysters, Fox Point Oysters, and Bay Point Oysters) to raise seed (about ½" in size) for restoration. Farmers received the seed in biodegradable coconut fiber bags and will manage the oysters for a period of 8 – 10 weeks, tracking their management of the oysters throughout the season. At the end of the season, the oysters will be measured and counted to determine success of the pilot and then be placed on one of TNC's restoration sites in Great Bay. By partnering with oyster farmers in Great Bay Estuary, TNC can explore additional methods of raising oysters for restoration moving forward.

## MASSACHUSETTS

*Mark Rousseau, MA DMF*

Marine aquaculture occurs in 31 of the Commonwealth's 78 coastal communities, and the MA DMF is responsible for issuing permits for all marine aquaculture activity. Farmed products currently being cultivated include sugar kelp, horseshoe crab (for wild population enhancement), oyster, quahog, soft-shell clam, razor clam, surf clam, blue mussels, and bay scallops. Coastal marine aquaculture continues to experience steady growth, with the value of aquaculture landings increasing by more than 30% over the last five years. Oyster aquaculture continues to be the biggest economic driver, comprising more than 90% of the total landings value during this time, despite a slight recent decline in the total number of permitted aquaculture acreage.

As marine aquaculture continues to expand in coastal areas, it becomes even more important for resource agencies and the aquaculture industry to maintain a




*Total landings, oyster landings, and total acreage under cultivation, 2014-2018. Figure credit: MA DMF*

*Cape Cod oyster grow out operation. Photo credit: MA DMF*

balance between aquaculture development and the protection of coastal resources and uses. With funding from a NOAA/ASMFC grant in 2018, MA DMF collaborated with the University of Massachusetts Boston's School for the Environment to draft a Massachusetts Aquaculture Permitting Plan (MAPP). The draft MAPP includes a GIS map of Massachusetts aquaculture lease sites, an outline of potential environmental impacts associated with aquaculture, and a permitting roadmap. Building on this effort, MA DMF received additional NOAA/ASMFC grant funding in 2019 to develop a web interface to streamline aquaculture permitting. The project, entitled "The Massachusetts Aquaculture Permitting Plan Web Interface to Streamline Aquaculture Permitting," is scheduled for completion in 2020. In January 2020, MA DMF will host a Northeastern University postdoctoral graduate intern funded through a National Science Foundation grant on a project to develop best management practices for the coexistence of oyster aquaculture and eelgrass in Massachusetts. This project will incorporate the input of multiple stakeholders, including the Massachusetts Shellfish Initiative (*http://www.massshellfishinitiative.org/*), established in 2017 to identify and address shellfish industry challenges. Additional information on marine aquaculture activity in Massachusetts can be found on the MA DMF, and Massachusetts Department of Agricultural Resources websites.

## RHODE ISLAND

*Julia Livermore and Anna Gerber-Williams, RI DEM*

Rhode Island has had an active aquaculture industry since 1975. The industry has expanded substantially since then to include farms for oysters (*Crassostrea virginica, Ostrea edulis*), clams (*Mercenaria mercenaria, Mya arenaria, Ensis directus*), bay scallops (*Argopecten irradians*), blue mussels (*Mytilus edulis*), and kelp (*S. latissima, Laminaria digitata*) in both Narragansett Bay and within the coastal ponds. The lead permitting agency for aquaculture is the Rhode Island Coastal Resources Management Council (CRMC), though the Department of Environmental Management (DEM) weighs in heavily throughout the process and conducts all enforcement via a Memorandum of Understanding with CRMC. Refer to the CRMC aquaculture page for documentation: *http://www.crmc.state.ri.us/aquaculture.html.*

DEM's Division of Marine Fisheries recently developed, and continues to improve, the approved aquaculture leases in a Rhode Island interactive map and mapping tool available at: *http://ridemgis.maps.arcgis.com/apps/webappviewer/index.html?id=8beb98d758f14265a84d69758d96742f.* This tool shows where all existing aquaculture sites are leased, along with other layers of importance, including known areas of past submerged aquatic vegetation.

Of late, Rhode Island's aquaculture applicants have faced increasing public opposition to proposed aquaculture lease sites due to poor project siting and sparse data on which to base siting decisions. While some opposition has been based on human uses, important biological features including submerged aquatic vegetation, areas of native species habitat, etc. also create siting challenges. Consequently, the Division of Marine Fisheries is working on developing new and expanding existing spatial datasets to minimize user conflicts and protect valuable habitat. The Division of Marine Fisheries is also working to create a siting protocol geared at protecting habitat and preventing conflicts with long-term research and monitoring efforts. These tools will be geared for prospective aquaculturists to use in preparing comprehensive project applications and to simplify the review process for Rhode Island permitting agencies. The new protocol and enhanced public spatial

data availability will serve to improve siting and ease of applying for aquaculture leases; simplify the siting process by reducing use conflicts, biological and human; and streamline the permitting process for all parties involved (government agencies, growers, and the public) by curtailing uncertainty and increasing transparency.

With the growing aquaculture industry in Rhode Island, permitting agencies must adapt to an increasing variety of applications (e.g. different growing methods, gear types, and habitat), which makes the use of a standard protocol essential to properly assess new applications. Thus, the development of a siting protocol has been a primary focus for the Division of Marine Fisheries Habitat Team in 2019 and will continue into 2020.

## NEW YORK

*Julia Socrates, NYSDEC*

New York has had a thriving commercial aquaculture industry for decades. The majority of New York's marine aquaculturists grow oysters, although there is also one that grows clams and a few that have grown shrimp and fish in the past. Nearly half of all of New York's commercially harvested oysters, and a significant portion of clams, come from aquaculture. All of the oysters are grown using "off bottom" techniques where they are grown in racks or cages. This method provides protection to the growing oysters and reduces the disturbance of the surrounding habitat. "On bottom" aquaculture, used for clam farming in New York, is a method where baby "seed" clams are planted/scattered in the sediment, as they would grow naturally, and requires dredging the designated area repeatedly in order to check on their growth and to harvest them. New York's aquaculture facilities are also producing millions of "seed" clams and oysters to be planted/scattered in various shellfish sanctuaries around Long Island as part of Governor Coumo's Long Island Shellfish Restoration Project.

As new and innovative types of aquaculture are developed, scientists, industry members, and government agencies will need to work together to answer questions about the impacts that these aquaculture types and methods will have on the environment and public health. Aquaculturists in different parts of the country, for example, have started to experiment with growing kelp instead of more traditional organisms like shellfish. The information gathered from those experiments, as well as from experiments performed by industry members and scientists in New York, will help answer important questions about the feasibility and impacts of attempting new types of aquaculture in the state. Local and state laws or regulations may need to be amended to incorporate new types of aquaculture once they are determined to not be harmful to the environment and public health.

Setting up an aquaculture business can be an arduous task, especially when it comes to permitting. NYSDEC is working on creating a guidance document for aquaculture permitting in New York to help lay out a path for interested parties. Since aquaculture permits are required from multiple government agencies, the guidance document will help explain the permitting process and identify the various permits needed, based on the type and location of the intended aquaculture operation. Federal, state, and local governments have a responsibility to preserve and protect local species and habitats, while also protecting the rights of citizens and aquaculture industries.

## NEW JERSEY

*Russ Babb, NJDEP*

New Jersey has a long-established shellfish aquaculture industry. The hard clam aquaculture industry dates back to the 1970s, and the culture of oysters is recognized as the oldest form of aquaculture ever practiced in New Jersey. Today, the Delaware Bay's wild oyster population is inhibited by disease. Shrewd management has created a sustainable harvest program, albeit at lower levels when compared to historic highs. The oyster disease commonly known as Dermo (caused by the waterborne protozoan parasite *Perkinsus marinus*) is the primary cause for depressed wild populations. This disease is host-specific and does not affect humans but does cause elevated mortality of wild oysters. While wild oyster harvests declined significantly following the onset of MSX (1950s) and Dermo (1990), catch levels have stabilized at over 100,000 bushels per year, providing a steady supply of market oysters. Despite this stable supply, the regional and national demand for New Jersey cultured oysters continues to rise.

Shellfish aquaculture in New Jersey is divided broadly into two main categories: (1) non-structural or "traditional" on-bottom shellfish culture; and (2) structural aquaculture that uses gear or equipment to contain shellfish for

*Oyster bed exposed at the low tide. Photo credit: Shutterstock/AG Technology Solutions*

cultivation purposes. These structures, all of which require Army Corps of Engineers and State permitting, typically include rebar racks, plastic (mesh) bags, and cages, as well as buoys, floats, and poles marking structures. Structural aquaculture generally involves the tending and harvesting of purchased (hatchery-produced, not wild) oyster "seed" as it is grown to market size in bags, cages, or other containment structures. Relative to the long history of traditional aquaculture in New Jersey, structural aquaculture (i.e., utilizing permit-requiring culture gear) is still considered a new practice.

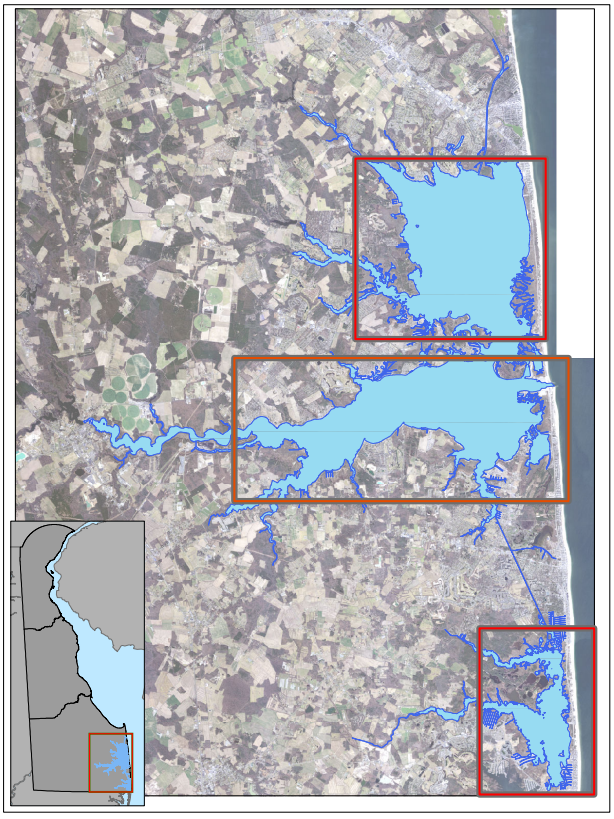
Similar to a number of neighboring states, given the advent of structural aquaculture, New Jersey has struggled in some areas to adequately update regulations in order to accommodate contemporary changes as industry adapts from traditional to structural aquaculture methods. In response to an increased level of public scrutiny regarding lease siting, permitting of structural farms, access and protection of the state's public trust, the New Jersey Department of Environmental Protection's (NJDEP) Marine Fisheries Administration has focused on evaluating and improving the shellfish aquaculture management and permitting process. This recognition led to the creation of a multi-agency state and federal partnership known as the New Jersey Shellfish Aquaculture Working Group (SAWG). The objectives of the SAWG include: (1) learning and understanding what each agency's role is for shellfish aquaculture, (2) developing stronger communication between the permitting authorities, (3) providing cohesive communication between the agencies and stakeholders, and (4) identifying areas where streamlining of the permitting process is possible and/or appropriate. SAWG is currently working to develop priorities and a work plan to address the goals above. The plan will include engagement of stakeholders and will develop a list of action items to address the needs of the shellfish aquaculture community. In 2015, SAWG's capacity became overwhelmed by the federal listing of the rufa red knot (*Calidris canutus rufa*) as threatened, which had a direct impact on existing structural shellfish aquaculture in Delaware Bay. Progress on the goals outlined above was delayed for over two years due to the listing, but SAWG was reconstituted in 2018 and continues to work towards improving the regulatory process for shellfish aquaculture. The state's Marine Fisheries Administration, in coordination with the state's Shellfisheries Councils, is also focused on creating an improved GIS lease siting tool that preemptively weighs and evaluates various established protocols, such as natural habitat productivity, potential user group conflicts, ease of patrol for enforcement, water classification, etc.

One prime example of the state's role in navigating between environmental issues alongside pressures to develop the industry is the red knot/oyster farm interactions encountered in the Delaware Bay. On April 1, 2016, the U.S. Fish and Wildlife Service (Service) issued a Programmatic Biological Opinion (PBO) regarding impacts from structural aquaculture in Delaware Bay to the red knot, which is federally listed as threatened under the Endangered Species Act. The PBO, which was developed by the Service along with the New Jersey Division of Fish and Wildlife (NJDFW) and the New Jersey Department of Agriculture (NJDA), is available on the Service's website at *https://www.fws.gov/northeast/njfieldoffice/endangered/redknot.html*.

Delaware Bay is the single most important migration stopover for the red knot, supporting an estimated 50 – 80% of all rufa red knots during the month of May. Notwithstanding the overall importance of Delaware Bay to the red knot, NJDFW, NJDA, and Army Corps of Engineers, in consultation with the Service, undertook an assessment of best available data regarding the relative levels of red knot use across the action area as well as an assessment of where oyster farming was most concentrated. A few oyster farms became established in the early 1990s and larger areas were established by the state in 2012. Given the red knot's listing in 2014, the agencies undertook an assessment to determine if a reasonable way to minimize conflicts between red knots and aquaculture might be subdividing the action area. In one portion of the action area, oyster aquaculture farms would be clustered, facilitated, and expanded, recognizing that there would be localized adverse effects to red knots in this portion. In the other portion of the action area, red knot conservation and recovery would be prioritized over development of new oyster farms, partially as a compensatory mitigation measure to offset red knot impacts in the other (aquaculture) portion. The PBO covers

all Army Corps of Engineers authorizations for structural aquaculture of native bivalves over a 10-year period along approximately 6.5 miles of Delaware Bay shoreline on the Cape May peninsula. The PBO also includes a framework of conservation measures (CMs) developed and adopted by the agencies, with input from both growers and conservation groups. By looking at the "big picture" of both industry and the red knots, the framework attempts to minimize conflicts by dividing the action area into two complementary management zones. In the northern segment – where tidal flats are narrower and red knot use is highly concentrated – the emphasis is on conservation. In the southern segment – where flats are wider and knot use is somewhat less concentrated – the emphasis is on providing sufficient space, flexibility, and support for aquaculture expansion. The agencies' shared objective was and is to provide a thoughtful solution for both protecting key red knot habitats and supporting smart growth in aquaculture.

The red knot-aquaculture oversight program also includes an adaptive management process that requires the implementing agencies to conduct adaptive management and requires that the group meets at least annually for the life of the PBO (10-year period) to review any new scientific and commercial data. At their discretion, the agencies may include other stakeholders or experts in these meetings and/or in preparation for these meetings. The specifics of the CMs may be adjusted if it is determined, based on new data or new reviews of existing data, that modified or alternative management practices can: (a) reduce adverse effects to red knots; (b) benefit the aquaculture industry without increasing adverse effects to red knots; or (c) both. From fall 2016 through spring 2017 the agencies also established a Stakeholder Committee (SC) with members balanced between aquaculture and red knot interests, which is meant to increase stakeholder involvement. The agencies issued a guidance document, laying out preliminary roles and duties for the SC. The intent was for the SC to function independently and primarily through consensus. The SC is free to set its own logistics, procedures, priorities, and agendas. Each year, the agencies sponsor and attend a meeting of the SC and provide training in structured decision making, adaptive management, and consensus building as well as assisting in the coordination of science meetings and symposiums, which affords an opportunity for a broad group of agency representatives and stakeholders to review new research on aquaculture, red knots, and horseshoe crabs (*Limulus polyphemus*). While this governance process is still being improved, it has helped manage the user conflict issues, has allowed for continued use of these areas for oyster farming, and has safeguarded access for the red knot to a critical habitat during their migration.



*Delaware's Inland Bays locations, with boxes noting (north to south) Rehoboth Bay, Indian River Bay, and Little Assawoman Bay. Map credit: DNREC*

## DELAWARE

### *Shellfish Aquaculture in Delaware's Inland Bays*

*Zina Hense, DNREC*

The shellfish aquaculture program in Delaware's Inland Bays has been steadily building from December 2017, when the first lease in the bays was issued. As of summer 2019, one scientific and 10 commercial aquaculture leases have been issued, totaling 51 acres. The shellfish aquaculture is limited to Eastern oysters and hard clams. Eastern oysters are the only shellfish that have been planted thus far, and the Bays' first aquaculture oysters were harvested and sold in September 2018. The market share in oysters for Delaware is increasing, as of late summer and fall 2019, additional growers have entered the market and sold their oysters.

## MARYLAND

*Marek Topolski, MD DNR*

Beginning in 2009, Maryland initiated a comprehensive overhaul of how it engaged with and supported shellfish aquaculture. Resources have been dedicated to creating opportunities and incentives for watermen and entrepreneurs to invest in commercial shellfish aquaculture businesses. The past decade has seen sweeping changes which include:

- Restructuring leasing laws
- Expanding law enforcement capabilities
- Consolidating permitting authority and industry development efforts at Maryland Department of Natural Resources (MD DNR)
- Establishing a division at MD DNR focused on Aquaculture and Industry Enhancement *https://dnr.maryland.gov/fisheries/Pages/aquaculture/index.aspx*
- Working with the Army Corps of Engineers to streamline federal permitting
- Establishing an online Shellfish Aquaculture Siting Tool *https://dnrweb.dnr.state.md.us/fisheries/aquatool/aquatool.asp*
- Creating shellfish aquaculture loan programs *https://marbidco.org/_pages/programs_loans/loan_programs.htm*
- Implementing Oyster Aquaculture Education and Training Programs

Maryland's efforts to provide opportunity and incentivize private investment in the commercial shellfish aquaculture industry are having a positive impact. MD DNR has issued 297 new shellfish aquaculture leases on 6,037 acres since the new leasing program was implemented. MD DNR has another 125 shellfish lease applications pending approval on nearly 2,261 acres. Currently, there are a total of 444 active shellfish aquaculture leases on 7,114 acres in Maryland. Shellfish growers have been actively planting and harvesting millions of Eastern oysters (*C. virginica*) on their leases. In addition to fostering economic activity, the increased abundance of oysters provides additional habitat for invertebrates and finfish, as well as localized improvements to water quality.

## VIRGINIA

*Tony Watkinson, VMRC*

As documented in the most recent Virginia Shellfish Aquaculture - Situation and Outlook Report (*https://www.vims.edu/research/units/centerspartners/map/aquaculture/index.php),* the shellfish aquaculture industry in Virginia continues to grow, adding significant value to the Commonwealth's seafood marketplace. Today, watermen harvest both hard clams and oysters from the Commonwealth's public resources, albeit at rates diminished from historic levels. At the same time, Virginia's watermen farmers are providing additional quantities of quality shellfish to consumers. Based on a survey completed during the first quarter of 2018, the 2017 farm gate value for Virginia shellfish aquaculture was $53.4 million. Of that total, $37.5 million was from hard clams and $15.9 million from oysters. However, oysters are the most rapidly developing sector of Virginia's shellfish aquaculture.

***Oyster** (C. virginica) **Aquaculture***

As reflected in the Situation and Outlook Report, the use of aquaculture practices for oysters have been adopted, as a result of increased oyster disease and predation, which utilize only hatchery-produced seed and larvae. There are two methods of hatchery-based oyster aquaculture production in Virginia, intensive culture (containerized) and extensive culture (spat-on-shell). Both typically use genetically improved stocks and triploid, or "spawnless" oysters. Industry reports the sterile triploid seed is more viable from a commercial standpoint, as the oysters grow faster and do not diminish in quality with seasonal spawning.

Intensive culture methods use cultchless, or single seed, oysters containerized for predator protection. Containerization varies but generally consists of bottom cages, racks, and in some cases, floats. Intensive oyster culture requires more labor in gear and product maintenance and is generally considered more expensive. However, the end result is a consistent and high quality product that has the ability to obtain a higher price in the boxed and half shell markets.

Extensive culture is also referred to as remote setting or spat-on-shell. The primary advantage of spat-on-shell cultivation is that it requires less labor and fewer materials

than single oyster cultivation. Therefore, this method is a more economically feasible option for producing large quantities of local oysters for use by Virginia's oyster processors. Oyster eyed larvae purchased from the hatchery are transported to setting sites, struck on containerized oyster shells, and ultimately planted directly on the bottom. Because spat-on-shell cultivation produces oysters grown in clusters (similar to wild-caught oysters), the primary product is predominantly oysters for shucking rather than single oysters for half-shell consumption.

The spat-on-shell process has been enhanced since its start in 2008. Improvements in the quality of eyed larvae coming out of the hatcheries and optimized remote setting methods have cut in half the number of eyed larvae required per bushel of shell.

***Hard Clam** (M. mercenaria) **Aquaculture***

The Situation and Outlook Report further notes that clam aquaculture is a relatively mature aquaculture industry that has dominated wild clam harvest in Virginia for more than a decade. Clams are not as low salinity tolerant as oysters. Thus, the majority of clam production comes from the higher salinity areas on the Eastern Shore of Virginia, including both bayside and seaside. Clams burrow into the sediment, which makes the production methods much different than oyster culture. There is a standard method used for clam aquaculture in Virginia in which beds are planted in plots and covered with mesh net for predator protection. Planting to harvest is a two year process, longer than in oyster aquaculture.

***Shellfish Ground Leasing***

One of the important factors contributing to the success of Virginia's shellfish aquaculture industry is the Commonwealth's long history of leasing state-owned bottomlands for shellfish culture. The natural oyster beds were mapped in the 1890s and are held in trust for the benefit of the citizens of the Commonwealth; however, submerged tidal bottomlands that were not considered to be natural oyster beds have been leased by the Commonwealth for private shellfish production for over 100 years. The leasing system was originally intended to support the transfer of small oysters from good seed producing areas to better growing areas and to allow a leaseholder to improve grounds, that did not have appropriate substrate to support oyster recruitment through the placement of shells to support the strike of

## *Aquaculture and ASMFC*

*Pat Campfield, ASMFC*

In 2018 and 2019, congressional funds were provided to ASMFC to issue a request for proposals in cooperation with NOAA Fisheries to support projects that develop aquaculture infrastructure, education, and techniques that are transferable within our jurisdiction. Eleven projects are underway and a request for proposals was initiated for a third year of projects in 2020. Activities funded to date range from pilot projects for new aquaculture species like bay scallops, to training fishermen and other coastal citizens, to work in the aquaculture sector. Selection of funded projects for 2020 will be announced in April.

Coinciding with the distribution of request for proposals, an ASMFC Aquaculture Committee was formed to share information regarding aquaculture interests and programs for each of our member states, and discuss aquaculture issues and challenges for the Commission. The Committee's primary purpose is to facilitate communication and better understand the research needs of the states when funding becomes available. State members provide input to the development of requests for proposals and serve as proposal technical reviewers. Coordination of interstate issues, such as tracking shellfish seed transport, is also a core role for the Committee. In addition, the Committee has a role in developing consensus statements, when possible, for states to use or expand upon position statements when dealing with specific state aquaculture issues that arise. However, issues related to permitting, siting, production, or other criteria developed by the states are not within the Commission's purview.

A new Habitat Management Series publication, *Aquaculture Impacts to Fish Habitat along the Atlantic Coast* will soon be published by ASMFC. The publication was produced by members of the Habitat Committee, in consultation with aquaculture experts in the state and federal fisheries agencies. The publication explores the impacts of various aquaculture activities on fish habitat, and provides state-specific resources and further reading. Look out for a press release on the publication in the coming weeks.

wild oyster larvae. These original uses relied on wild natural oyster populations. The recently developed intensive and extensive culture methods, as well as clam aquaculture now occur on the leases authorize over State-owned bottomlands.


*The Shellfish Mariculture Demonstration Center located at the North Carolina State Center for Marine Sciences and Technology in Morehead City. Photo credit: Trish Murphey*

### *The Virginia Marine Resources Commission (VMRC)*

VMRC manages the leasing program as well as authorization for aquaculture activities. Currently, Virginia leases 133,722 acres within 5,501 separate leases ranging in sizes of less than one acre to hundreds of acres. All lease requests are subject to a public interest review, including a public notice and marking the boundaries of the proposed lease bottom prior to a decision to grant or deny the lease request. Each lease is issued for 10 years. Once an area is leased, cages and nets that do not exceed 12" in height from the substrate are authorized by regulation and can be placed on a lease subject to certain requirements. For example, the structures cannot affect navigation nor can any structures be placed on submerge aquatic vegetation. Structures extending more than 12" from the bottom may be authorized by a general permit and any floating aquaculture structures must be approved through an individual permit process. Any lease request or permit application that is protested must be considered at a public hearing by the full Commission consisting of the Commissioner and eight citizen members appointed by the Governor.

### *Aquaculture Conflicts*

As aquaculture activities have expanded, complaints of use conflicts have also increased. The deployment of the nets and cages and the regular working of the lease areas is generally where the conflicts occur with others wanting to utilize the same shallow water areas.

In summer 2018, the Office of the Secretary of Natural Resources established a Clam and Oyster Aquaculture Work Group, with its principal purpose to identify clam and oyster aquaculture-related user conflicts on Virginia waterways and to explore potential solutions.

As a result of the work group efforts, legislation was enacted in 2019 to establish new factors for lease reviews and transfers. In addition, new fees were established for lease applications, transfers, and renewals. Also, as a result of recommendations from the work group the VMRC has established an Aquaculture Management Advisory Committee. The Committee is currently working to identify guidelines for those factors necessary for lease renewal.

## *NORTH CAROLINA*

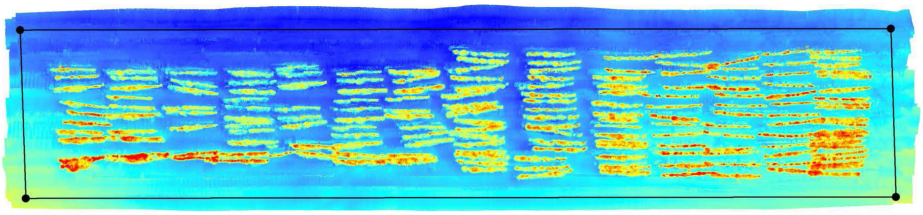
*Jimmy Johnson and Trish Murphey, APNEP*

### *The North Carolina Shellfish Initiative*

In the last quarter of 2018, North Carolina became the first state in the southeast to join a national effort that demonstrates the social, economic, and environmental importance of shellfish. The National Shellfish Initiative through NOAA is designed to increase the population of shellfish in the nation's coastal waters. This initiative will advance the state's work to promote sustainable seafood, shellfish restoration, and protect and improve water quality. The new state initiative prioritizes four goals: job creation, protection of water quality, protection of shellfish health, and sustainable management. This initiative reflects the significance of shellfish conservation and the industry's benefits to the coastal economy. North Carolina is the sixth state in the country to follow the federal model.

### *Swan Island Oyster Reef Complete*

The North Carolina Department of Environmental Quality's (NC DEQ) Division of Marine Fisheries completed its construction of the Swan Island Oyster Sanctuary this past July. The completion of this 40-acre site is the culmination of a three-year project funded by the North



*A sonar scan of the Swan Island Oyster Sanctuary site indicates higher ridges in red. Image credit: NC DMF*

*There are between 134,000 and 200,000 acres of seagrass beds in coastal North Carolina, according to the state's Department of Environmental Quality. Photo credit: Adobe Stock*

Carolina General Assembly as part of the Senator Jean Preston Oyster Sanctuary Network. Nearly 105,000 tons of marl and 25,000 tons of granite were used to complete the three-year project. The Senator Jean Preston Oyster Sanctuary Network will ultimately consist of 15 separate sanctuary sites. The network is part of an overall strategy to restore the native oyster populations in North Carolina. Oysters in the sanctuaries will not be open to harvest. However, these oyster reefs will support numerous finfish species, and are open to hook and line fishing. In the overall strategy these reefs will help build up oyster populations by providing a sanctuary for adult oysters, that are then able to spawn and seed other nearby areas that may be harvested.

### *Submerged Aquatic Vegetation*

The Albemarle Pamlico National Estuary Partnership (APNEP) and many other partners, including the Division of Marine Fisheries, the U.S. Coast Guard, and citizen scientists, have been working this summer in a collaborative effort to collect data that will ground truth aerial photographs of submerged aquatic vegetation taken by North Carolina Department of Transportation via flights over the coastal region in June. This aerial imagery will be used to create a new map of submerged aquatic vegetation extent and density in the region, which will be compared with earlier maps to help us to assess if the extent or density of seagrass is changing over time. Since 2001, an Albemarle-Pamlico submerged aquatic vegetation partnership has collaborated with the long-term goal of determining where the region's underwater grasses are located, and any changes over time. It is important to monitor underwater grasses because submerged aquatic vegetation is one of the best indicators of coastal environmental quality.

## *SOUTH CAROLINA*

*Ben Dyar, SC DNR*

A study is underway to examine the social carrying capacity for mariculture development on the South Carolina coast. This two-year study, concluding in 2020, is funded by the South Carolina Sea Grant Consortium and is being conducted by Clemson University's Department of Parks, Recreation and Tourism Management. The advisory committee includes South Carolina Department of Natural Resources (SC DNR), South Carolina Department of Health and Environmental Control – Ocean and Coastal Resource Management, South Carolina shellfish growers, South Carolina Sea Grant Consortium, and waterway user representatives. The goals of the project are to identify issues, factors, variables, and attributes influencing stakeholder (i.e., coastal homeowners, tourists, recreational

*Dr. Tim Ellis (left) and Stacey Feken (right) with APNEP ground-truthing submerged aquatic vegetation in the Cape Hatteras area of North Carolina. Photo credit: Kelsey Ellis*

boaters, and recreational anglers/shellfishers) perceptions and attitudes towards the expansion of oyster mariculture, and then to develop a set of indicators that will serve as the basis for measuring social carrying capacity and societal acceptance of mariculture. Social values of the coastal landscape will be mapped using Public Participation GIS (PPGIS) to determine thresholds in order to assess the social carrying capacity and societal acceptability of potential management actions for oyster mariculture development in coastal South Carolina. Ultimately, the project will develop and deliver research results designed to provide utility to permitting and regulatory agencies, shellfish grower associations, and other organizations that work directly with mariculture farmers.

## *FLORIDA*

*Portia Sapp, FDACS*

Currently, hard clam and oyster aquaculture using floating cages, flow-through raceways for nurseries, and on-bottom/water column leases are the primary focus of aquaculture efforts in Florida's estuaries. A burgeoning "live rock" industry supplying native limerock, which naturally recruits invertebrates and algae when placed on offshore lease sites, to aquarium hobbyists is also part of the aquaculture picture in this state. On-shore, recirculating tanks, closed loop raceways, and inshore ponds are currently used for shrimp, pompano, coral, sturgeon, and marine fish aquaculture. In an interesting effort, Atlantic salmon production is being considered in South Florida in recirculating tanks into which cool ground water is pumped.

Commercial marine aquaculture in the State of Florida is primarily managed by the Florida Department of Agriculture and Consumer Services (FDACS) – Division of Aquaculture:

*https://www.freshfromflorida.com/Divisions-Offices/Aquaculture*.

FDACS manages marine aquaculture through a certification process:

*https://www.freshfromflorida.com/Agriculture-Industry/Aquaculture/Aquaculture-Certificate-of-Registration*

and Best Management Practices:

*https://www.freshfromflorida.com/Agriculture-Industry/Aquaculture/Aquaculture-Certificate-of-Registration/Aquaculture-Best-Management-Practices*.

FDACS is currently engaged in a marine spatial siting project with the NOAA National Centers for Coastal Ocean Sciences to find areas that may be suitable for offshore aquaculture in Florida state waters. They are coordinating an interagency working group for this project, consisting of various state and federal partners including the Florida Fish and Wildlife Conservation Commission (FL FWC).

Some aspects of aquaculture activities managed by FDACS are also managed by the FL FWC, such as activities that have the potential to impact wild stocks (e.g., net pen culture).


## *Acknowledgements*

**HABITAT PROGRAM MISSION**

*To work through the Commission, in cooperation with appropriate agencies and organizations, to enhance and cooperatively manage vital fish habitat for conservation, restoration, and protection, and to support the cooperative management of Commission managed species.*

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