

# Aquaculture Highlights

2025

Pacific oysters in Washington. Credit:  
NOAA Fisheries.



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Northwest Fisheries Science Center scientist Ken Cain and sablefish farmed at NOAA's Manchester Facility. Cain's team leads innovations in vaccines for healthy fish, novel methods for sterility induction, and lowering the cost for early-stage sablefish development and grow-out of single-sex cultures. These innovations lower genetic risk and environmental impact while driving forward the sablefish aquaculture industry. Credit: Megan Ewald for NOAA.



Farmed seafood is good for people, the economy, and the planet.

# Home-grown Seafood

Our mission is to provide science, services, and policies that create conditions for opportunity and growth of sustainable U.S. aquaculture.



Sugar kelp farming. Credit: Megan Ewald for NOAA Fisheries.

The NOAA Aquaculture Program is dedicated to advancing U.S. aquaculture through cutting-edge science, communications, and policies.

The NOAA Aquaculture Program spans the NOAA Fisheries Office of Aquaculture, NOAA Fisheries science centers and regional offices, the Oceanic and Atmospheric Research

National Sea Grant College Program (Sea Grant), and the National Ocean Service National Centers for Coastal Ocean Science.

Produced responsibly, as it is in the United States, farmed seafood is good for people, good for the economy, and good for the planet. Seafood, wild and farmed, is one of the best sources of nutrients essential for human well-being.

Compared to farming on land, aquaculture is an incredibly resource-efficient means to produce protein. It's also the fastest-growing food production system globally.

While the United States lags in global aquaculture production, Americans have an appetite for farmed seafood. Each year, we import around \$15 billion worth of seafood farmed in other countries. This appetite presents an opportunity.

Aligned with the Executive Order "Restoring American Seafood Competitiveness," NOAA supports restoring American seafood competitiveness and strengthening domestic seafood production.

By championing aquaculture, we are positioning the United States to become a world leader in farmed seafood.

#### Aquaculture Program Strategic Goals:

- Manage sustainably and efficiently.
- Lead science for sustainability.
- Educate and exchange information.
- Support economic viability and growth.

NOAA's Aquaculture Program

*The National Aquaculture Act of 1980 established aquaculture as a national policy priority for the United States and created an Interagency Subcommittee on Aquaculture.*

# Aquaculture Opportunity Areas

Aquaculture Opportunity Areas are called for in the May 2020 Executive Order “Promoting American Seafood Competitiveness and Economic Growth” and support the 2025 Executive Order “Restoring American Seafood Competitiveness.”



## Southern California and the Gulf of America (formerly Mexico)

This year, NOAA identified 13 Aquaculture Opportunity Areas totaling more than 21,000 acres in U.S. federal waters of the Gulf of America and off Southern California.

This marks the United States’ most significant effort to support offshore aquaculture development. NOAA experts identified 10 Aquaculture Opportunity Areas potentially suitable for finfish, shellfish, and seaweed farming in Southern California and three in the Gulf.

The 13 AOAs were selected through extensive spatial modeling and environmental review and represent the tip of the iceberg of

opportunities in U.S. waters. While aquaculture developments are not limited to AOAs, operations sited within these areas benefit from potentially more efficient siting, permitting, and environmental review.

Baseline environmental surveys in the Gulf of America will provide detailed data on the benthic environment of these areas. By shouldering the investment for surveys that are expensive to conduct at these depths, NOAA is supporting future farm applicants in the Gulf.

By identifying Aquaculture Opportunity Areas, NOAA is developing seafood solutions and paving the way toward a sustainable and productive future.

## Alaska

The Aquaculture Opportunity Area identification process in Alaska is focused on shellfish and seaweed aquaculture in state waters. It does not include finfish aquaculture.

It reached a key phase this year, publishing the preliminary results of the marine spatial planning study to identify draft Aquaculture Opportunity Area options.

The draft options resulted from extensive public input and spatial analysis, and cover approximately 18,000 acres over 10 study areas in southwest, southcentral, and southeast Alaska.

An updated spatial model, based on public comments and new data sources, will likely narrow the scope of the study area options.



Click or Scan to  
View Maps

The most comprehensive marine spatial  
planning effort conducted in U.S. waters.

Gulf of America

Southern California

Alaska



Credit (left to right): Megan Ewald for NOAA Fisheries; Courtesy of Javier Infante, NOAA Fisheries.

*An AOA is a defined geographic area that NOAA has evaluated through both spatial analysis and the programmatic National Environmental Policy Act (NEPA) process that may be environmentally, socially, and economically appropriate to support multiple commercial aquaculture operations.*



Still day on the Gulf. Credit: NOAA.



## NOAA addresses the scientific barriers to marine aquaculture

# Scientific Solutions

In 2025, NOAA aquaculture experts published a diverse portfolio of more than 20 peer-reviewed articles, reports, and technical memos.

### Peer-reviewed journal highlights

- Measures of habitat quality for black sea bass using oyster aquaculture cages, *North American Journal of Aquaculture*
- Strategies to deter Pacific herring from aquatic farm infrastructure, *North American Journal of Aquaculture*
- Proof-of-concept for sterility induction in sablefish (*Anoplopoma fimbria*) via a scalable immersion-based gene silencing approach, *Aquaculture*
- Primordial germ cell specification and early developmental cell states in Pacific oyster, *BMC Genomics*
- Mothers know best: Maternal signaling boosts larval resilience under ocean acidification conditions, *Aquaculture*



Floating oyster bags. Credit: LaDon Swann.

### Technical Guide to Marine Aquaculture Gear

This guide serves as an orientation to aquaculture gear systems for decision-makers conducting environmental reviews for aquaculture permitting and management. It aims to support scientifically sound decision-making while making the permitting process more efficient for the industry. A complementary workshop for NOAA staff provided a forum to discuss needs related to marine mammal and sea turtle interactions with marine aquaculture gear.



NOAA Sea Grant's Fiscal Year 2025 National Investment of:

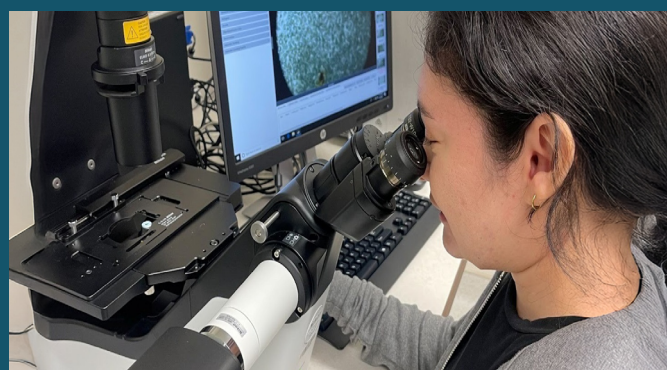
\$11.9 million established more than 37 research and extension projects, involving more than 17 species, helping to optimize U.S. aquaculture.

We do this through in-house research at NOAA, through grants and cooperative agreements with Sea Grant and other partners, and by coordinating research with other federal agencies.

## Baseline environmental surveys in Gulf of America Aquaculture Opportunity Areas chart the course for offshore development.

NOAA invested in two offshore surveys using new autonomous underwater vehicles and ship-based methods. This investment helps inform siting and unlocks lower-cost options for permit applicants.

<p>1</p> <h3>Preventing Wildlife Entanglement</h3> <p>Using marine spatial planning, NOAA is conducting 3D simulation of marine mammal and sea turtle entanglements to reduce risk at farms.</p>	<p>2</p> <h3>Developing Improved Oyster Seed</h3> <p>Researchers are developing genetically distinct oyster lines and pioneering new technologies to produce resilient oysters designed for Alaska environments.</p>	<p>3</p> <h3>Northwest Aquaculture Permitting Guides</h3> <p>Guides for shellfish aquaculture permitting in Oregon and Washington (published in English and Spanish) help growers get farms in the water.</p>	<p>4</p> <h3>Marine Spatial Planning for Aquaculture Siting</h3> <p>NOAA experts published an article in <i>Bulletin of Marine Science</i> detailing innovative spatial planning methods for aquaculture siting in U.S. waters.</p>
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## Cooperative Institute Fostering Aquaculture Marketing and Research

In 2025, NOAA initiated the process of establishing a new Congressionally directed Cooperative Institute that will have a broad geographic scope and emphasize advancing aquaculture through bold research and marketing.

Kate Gomez-Rangel looks for oyster gametes at Alaska Fisheries Science Center Mariculture Research Hatchery. Credit: NOAA.



### Workshops for Aquaculture Siting and Coastal Planning

NOAA, working with Sea Grant, held a conference on coastal planning tools in Honolulu, Hawaii, to help advance sustainable aquaculture through digital planning tools.



### Northeast Oyster Breeding Center spawns the next generation.

NOAA and the U.S. Department of Agriculture scaled up selective breeding of oysters by cultivating seed from 16 families for grow-out on partner farms.

Advancing science  
that helps seafood  
growers.

# Aquaculture Advances

## 19 Scientific Publications Supporting Aquaculture Opportunity Area Identification

To inform the programmatic environmental impact statements that identified Aquaculture Opportunity Areas in California and the Gulf of America, NOAA invested in 19 new scientific products.

These scientific journal articles and technical memos were developed on topics including biosecurity and disease, genetic risk, engineering, economics, and other areas that leverage cutting-edge science. These resources will help ensure the highest level of sustainability in aquaculture development.

A few highlights from these resources include:

- A global review of protected species interactions with marine aquaculture, *Review in Aquaculture*
- Science Advice for Genetic Effects from Finfish Aquaculture in Southern California and the Gulf of Mexico, NOAA Technical Memorandum.
- Toward a better use of fisheries data in spatial planning, *Fish and Fisheries*
- Economic information for Aquaculture Opportunity Areas off Southern California, NOAA Technical Memorandum.



Bull kelp. Credit: NOAA Fisheries.

### Mapping wild seaweed beds in Alaska

NOAA mapped 140 seaweed beds, covering 37+ square miles, to help growers meet state guidelines and guide planning.

## AI Meets Aquaculture to Study Hawaiian Monk Seal Interactions With Net Pens



NOAA is collaborating with Blue Ocean Mariculture in Hawaii using remote cameras and artificial intelligence to study endangered monk seals' behavior around aquaculture net pens. The cameras collected more than 700 videos, which were cut into 10-minute clips for AI analysis. This work will inform future wildlife mitigation recommendations.

Seal recorded at Blue Ocean Mariculture.  
Credit: NOAA Fisheries.

Our cutting-edge science fuels  
aquaculture advances.





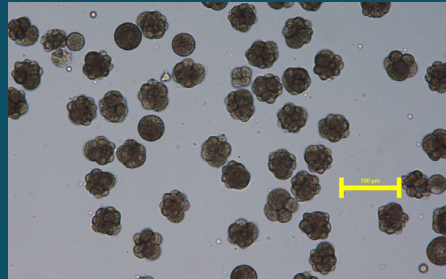
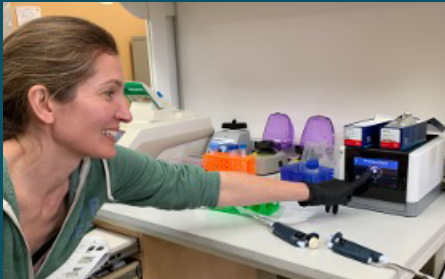
Biosecurity and Disease



Omics for Aquaculture



Mitigating Risks to Wildlife



## Cells and Shells: New research into early oyster development gives insight into potential sterility methods

Triploid oysters have an extra chromosome that makes them effectively sterile, but also potentially more vulnerable to stressful conditions like warming oceans and disease.

A new study from NOAA scientists and collaborators at the University of Washington sheds light on early oyster development. Researchers successfully identified a suite of candidate genes that show promise for their role in identifying cells that will become reproductive cells (gametes).

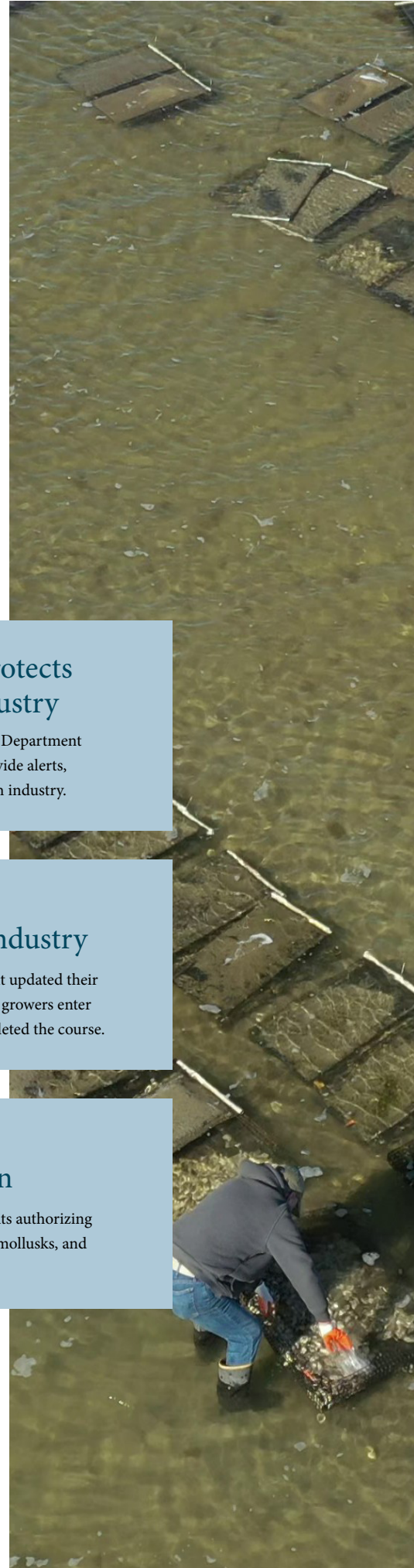
This could pave the way for new oyster sterility induction techniques—hopefully an alternative to more environmentally sensitive triploids.

Mackenzie Gaverty and oyster cleavage-stage oyster embryos (left and center). Credit: NOAA Fisheries. Pacific oysters. Credit: Erik o'Brien and Kodiak Ocean Bounty.



Eugenio Piñeiro Soler holds a sea cucumber farmed as part of an integrated multi-trophic aquaculture system at NOAA Manchester facility. Credit: NOAA Fisheries.

# Aquaculture Partnerships



## SoundToxins Programs protects Washington's shellfish industry

Washington Sea Grant and the Washington State Department of Health monitor harmful algal blooms and provide alerts, protecting the state's \$270 million annual shellfish industry.



## Training growers for Massachusetts's shellfish industry

Woods Hole Oceanographic Institution Sea Grant updated their Fundamentals of Shellfish Farming class, helping growers enter the industry. Since 2008, 348+ people have completed the course.



## Integrated multi-trophic aquaculture demonstration

NOAA helped coordinate federal and state permits authorizing new technology co-culturing native fish, bivalve mollusks, and macroalgae species in Alabama state waters.

Photos (top to bottom):

Credit: Ashli Blow for Washington Sea Grant.

Credit: Poonam Narotam for Woods Hole Oceanographic Institution Sea Grant.

Credit: Angelos Apeitos for University of Southern Mississippi.

(Center) Credit: Lance Cheung for U.S. Department of Agriculture

In 2024,  
Sea Grant's  
federal  
investment in  
aquaculture  
generated:

\$133.4 million  
in economic  
impact or  
benefit.\*

529 businesses  
created or  
sustained.

1,775 jobs  
created or  
sustained.



Mark Shirley and John Sonnier with farmed crawfish. Credit: Louisiana State University AgCenter.

## \$100 million drought response for Louisiana's crawfish industry

Louisiana Sea Grant worked with the U.S. Department of Agriculture to help the crawfish industry recover from severe drought and heat in 2023.

By documenting harm to crawfish from excessive temperatures, the program secured over \$100 million in disaster relief for

farmers in the state.

The funding provided economic relief to growers, prevented long-term declines in production, and preserved the economic vitality of this industry that has great cultural and economic value in Louisiana.



In 2024, Sea Grant projects published 54  
aquaculture journal articles\*

\*Direct results of Sea Grant work between February 1, 2024, and January 31, 2025, reported by Sea Grant programs in June 2025.

\*Reported to the Sea Grant Collection at the NOAA Library and published between January 1, 2024, and December 31, 2024.





# Growing Efficiency

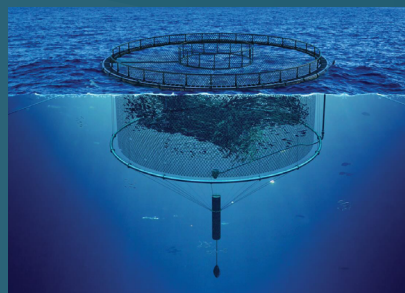
The National Aquaculture Act of 1980 established aquaculture as a national policy priority for the United States.

NOAA works to improve regulatory efficiency, supporting Executive Order 13921 “Promoting American Seafood Competitiveness and Economic Growth.”



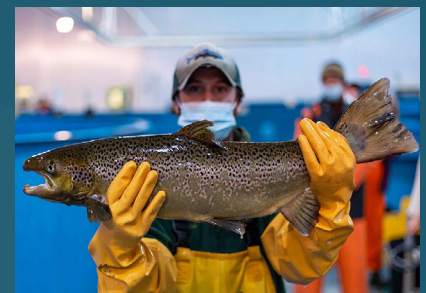
**Helping Great Lakes fish farmers navigate aquaculture regulations.**

The National Sea Grant Law Center and Great Lakes Aquaculture Collaborative published “Aquaculture Regulation in the Great Lakes,” offering clarity for fish farmers.



**Coordination and efficiencies for permitting two aquaculture pilot projects.**

NOAA provided expert and efficient interagency support that led to the issuance of two final interagency permits for the Velella Epsilon project off the coast of Florida and the Blue Fields project off the island of Hawaii.



**Promoting aquatic animal health through interagency partnership.**

The National Aquatic Animal Health Plan, which addresses national disease reporting and prevention, made great strides this year. NOAA collaborators have made strong contributions to this cross-agency effort.

Credit (left to right): Minnesota Sea Grant; Ocean Era, Inc; U.S. Department of Agriculture.

## New California aquaculture permitting guide enhances transparency

The “Guide to Leasing, Permitting, and Authorizing Commercial Aquaculture Operations off the California Coast” assists those seeking information about permitting and other requirements for new commercial aquaculture projects, or the expansion of existing aquaculture operations in state or federal waters off the coast of California.



Educating and exchanging information

# Growing Support

Negative public perception is too often a limiting factor for aquaculture development. Science communication and education are powerful tools to foster support for aquaculture.

## Putting faces to seafood farmers with “Tide to Table”

NOAA’s “Tide to Table” series profiles members of the aquaculture community who provide valuable jobs and increase access to sustainably sourced seafood.

This communications campaign serves as a powerful bridge between the complex science of marine aquaculture and the everyday consumer. By profiling individual growers—from oyster farmers in Mississippi to kelp harvesters in Connecticut—the campaign highlights the best of the industry, transforming policy and science into relatable stories of coastal heritage and working waterfronts.



In 2025, “Tide to Table” moved from an annual to a year-round series.



Credit: Holy Ground Oysters.



Workforce development



Educating consumers



Science outreach

Eighteen web stories in 2025 received thousands of views.

Stories on topics like remote sensing, genetic risk, aquaculture gear, and more translated highly technical topics for the general public.



Student viewing phytoplankton. Credit: Megan Ewald for NOAA.

## Training 50 future seafood farmers in Washington State

In 2025, NOAA and Washington Sea Grant introduced 50 Seattle-area middle schoolers to seafood farming career paths.

Over 3 days, students learned about shellfish and seaweed biology, took water quality measurements, conducted beach surveys, and learned about the science of seafood farming. The camp was held at the Puget Sound Skills Center—a high school program equipping students for maritime careers.



Aquaculture educators. Credit: Zack Gold for NOAA.

## Great Lakes Aquaculture connects fish growers and consumers

Sea Grant's Great Lakes Aquaculture Collaborative created a website to connect consumers directly to freshwater fish farmers.

[FreshFishFinder.org](https://FreshFishFinder.org)

Youth workforce development not only inspires future seafood industry leaders, it shapes current seafood consumers. More than 85 percent of the seafood Americans eat is imported from other countries. The best way to grow appreciation for local seafood is to learn about it.

Digging for clams and meeting seafood farmers in person set the stage for students to have conversations about aquaculture around the dinner table. We suspect they may also advocate for more American-farmed seafood on their plates!

The Aquaculture Information Exchange, an online community maintained by Virginia Sea Grant with support from NOAA, strengthened its role as an online hub for aquaculture knowledge.



Grew to 2,000 members



Recorded 21,000+ page views



Grew its online resource library



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