Benefits of Alaska's Growing Mariculture Industry

Mariculture has both environmental and economic benefits. Some are universal and others depend on the type of mariculture being practiced.

Environmental Benefits

Water Quality

In places with high levels of runoff from urban areas and agriculture, water filtration by shellfish farms draws down excess nutrients and improves overall water quality and decreases the risk of low or no oxygen zones.

Aquatic plants, including seaweed and kelp species, can help filter organic and non-organic nutrients in marine waterbodies.

Habitat Creation

Physical structures associated with aquatic farms may create three-dimensional midwater and surface habitat for wild species such as foraging fish and crustaceans, which may benefit their populations.

Buffer for Ocean Acidification

As seaweed and kelp species absorb carbon dioxide, they may buffer certain shell-forming creatures from the corrosive impacts of ocean acidification under certain oceanographic conditions.

Economic Benefits

Revenue Opportunity

Mariculture has the potential to bring increased revenue to coastal communities around Alaska. As this industry continues to grow there's never been a better time to get involved in mariculture in Alaska!

Commercial Value

In 2021, the commercial value of the mariculture industry in Alaska was estimated at just under $3 million (Alaska Sea Grant, *State of Mariculture*). Currently, the majority of this commercial value is related to oyster cultivation. However, the seaweed industry alone has the potential to experience incredible growth over the next 20 years.

Compatible Seasons

Certain types of mariculture are compatible with Alaska's existing seafood industry in many ways including multi-purpose equipment and technologies. Another example of compatibility is that cultivation and growing seasons for kelp species often fit within the offseason of some Alaska fisheries.

You can get involved in mariculture in many ways; farming, processing, hatcheries, market and product development, and sales!

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Photo Courtesy of Alaska Seafood

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NOAA Fisheries
fisheries.noaa.gov/alaska/aquaculture/alaska-region-aquaculture

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Alaska Aquaculture Permitting Portal
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Benthic Impacts of Kelp Farms

How might kelp farms affect life on the sea floor?

Although research on kelp farms in the United States is as young as the industry, it is reasonable to believe that kelp farming provides many positive benefits to the local ecosystem and the environment.

Reducing Greenhouse Gas Emissions

Kelp farming may contribute to efforts to capture and sequester carbon in our atmosphere, mitigating the effects of global warming. For example, as it grows, kelp removes CO_2 from the ocean. It may then be used for fertilizers which have a lower carbon footprint than synthetic fossil-fuel derived fertilizers. Red and brown seaweeds can also be fed to animals, which research suggests may reduce the animals' greenhouse gas emissions. As mariculture continues to develop, we will continue to learn more about these climate impacts!

Shading the sea floor

The degree that a kelp farm shades the floor depends on water depth and clarity, wave action, current, and kelp density. One study of a Swedish farm at 5m (15 feet) depth found that during peak growth, the kelp significantly shaded the floor but it did not change the oxygen, nutrients or number of mobile animals on the floor. Generally, most Alaska kelp farms are located at depths of between 50-100 feet, which may result in less shading.

Genetic Diversity of Wild Kelp

Research into the genetic diversity of Alaska's wild populations is ongoing, with the purpose of assessing the risk posed by farming. In the meantime, ADF&G has taken a conservative approach to protect against alterations to native genetic diversity, requiring that broodstock (parent plants) consist of 50 individuals and be collected within 50 km by water of the farm.

A multi-year project is just taking off in Alaska to study these impacts and provide more clear guidance for regulators.

What kind of impacts might mariculture have on benthic environments?

Slowing ocean acidification

A consequence of increased levels of carbon dioxide in our atmosphere is that ocean acidity increases as the ocean absorbs CO_2. Ocean acidity poses unique challenges to shell forming organisms (e.g., crabs, oysters, clams and mussels). For example, crabs have less energy to grow and stave off disease. Research on potential impacts to Alaska bivalves is ongoing but research elsewhere has shown that, in some ocean conditions, kelp can significantly decrease acidity in the water column as it uses CO_2 to grow.

Creating Habitat

Studies in other parts of the U.S. and the world have found that an aquatic farm may provide important habitat for fish and invertebrate species, including as nursery habitat for early life stages. Research on Alaska farms is ongoing.

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Photo Courtesy of Alaska Sea Grant

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2

Help Keep Mariculture in Alaska Marine Mammal Free!

What is marine mammal entanglement?

Entanglement is when a marine mammal becomes wrapped in either marine debris or gear associated with a marine activity, such as fishing line.

This will limit an animal's movement, weigh it down, and can result in serious injury or mortality.

It is possible for a marine mammal to become entangled in mariculture gear in Alaska. While currently there are no documented reports of marine mammal interactions with mariculture farms in Alaska, mariculture gear poses an inherent entanglement risk to marine mammals.

The level of entanglement will depend on where and how much mariculture gear exists in sensitive areas, the type of gear in the water, and the dynamics and behavior of the marine mammal populations in the area.

There are a number of ways we can all keep marine mammals free from mariculture gear!

★ **Consciously and consistently maintain your aquatic farm.** Most mariculture gear needs to be under tension to maintain location and prevent snarling of equipment, which also helps prevent entanglement. Proper tension will depend on consistent maintenance and could be impacted by storms. Remember, **marine debris is one of the major causes of marine mammal entanglement!**

★ **Carefully consider site suitability for an aquatic farm.** The permitting process for a farm site requires that overlap between potential mariculture sites and marine mammal habitat is examined for impact before a lease is issued.

★ **Get familiar with the statutes, regulations, policies, and guidelines that are in place** to protect wildlife or their habitats "from being significantly impacted" by mariculture farms. (Sec. 16.40.105.)

Always report entangled, injured, or stranded marine mammals to the right source!

NOAA Fisheries
Stranding Hotline:
(877) 925-7773

Alaska SeaLife Center:
(888) 774-7325

Want to learn more? Visit us:

The Alaska Mariculture Alliance at alaskamariculture.org
See also NOAA Fisheries' recommended best management practices to minimize impacts to marine mammals and mariculture farms.

Photo Courtesy of Dmitry Kokh

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Kelp Cultivation: Lessons from Kodiak

Thank you to all of the partners that make this work possible!

Partners make this project possible:

University of Alaska
Principal Investigator: Dr. Michael Stekoll, UAF

Woods Hole Oceanographic Institute

Blue Evolution

Kodiak Island Sustainable Seaweed

Kodiak Kelp Company

TendOcean

C.A. Goudey and Associates

GreenWave

Alaska Fisheries Development Foundation

F/V Savage

Kelson Marine

University of Connecticut

Marine Biological Laboratory, Woods Hole Oceanographic Institute

Learn more about research on seaweed production at-scale:

Hauke L. Kite-Powell, Erick Ask, Simona Augyte, David Bailey, Julie Decker, Clifford A. Goudey, Gretchen Grebe, Yaoguang Li, Scott Lindell, Domenic Manganelli, Michael Marty-Rivera, Crystal Ng, Loretta Roberson, Michael Stekoll, Schery Umanzor & Charles Yarish (2022) Estimating production cost for large-scale seaweed farms, Applied Phycology, 3:1, 435-445, DOI: 10.1080/26388081.2022.2111271

Lean more about ARPA-E and the Kodiak project:

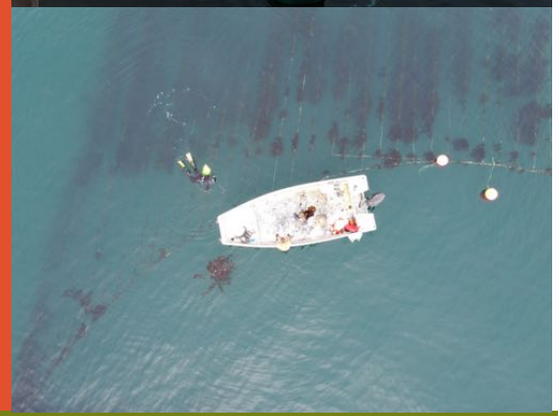
U.S. Department of Energy
Advanced Research Projects Agency-Energy (ARPA-E)
Macroalgae Research Inspiring Novel Energy Resources (MARINER)

Project Background

Led by the University of Alaska Fairbanks, this 4-year project focused on the integrated cultivation and harvest system design of kelp farms with the goal to increase efficiency and/or reduce costs. This project was funded by the U.S. Dept. of Energy (DOE), Advanced Research Projects Agency-Energy (ARPA-E) which is interested in the scalable production of macroalgae for potential future use as a biofuel.

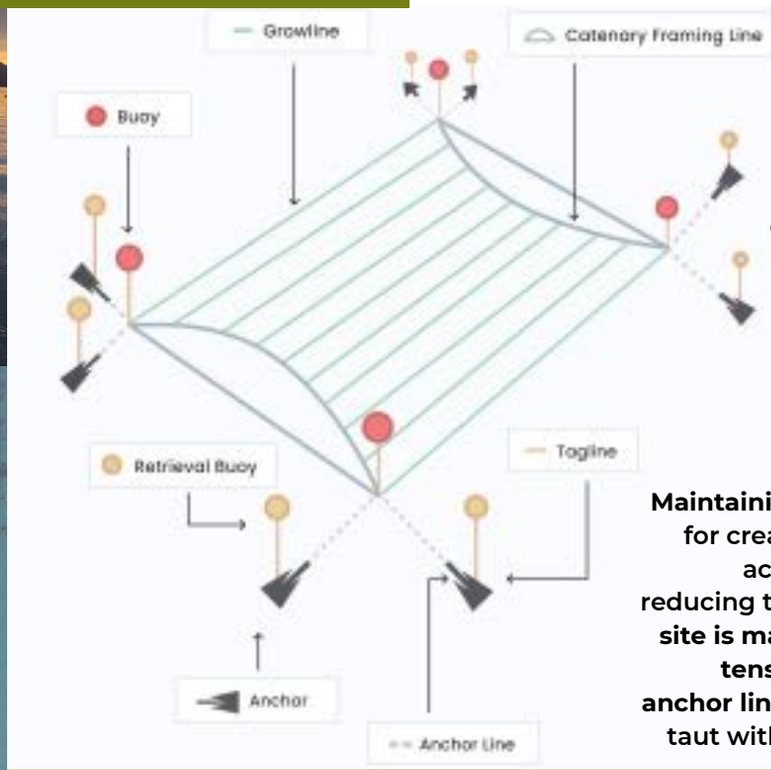
The intent of this project was to design replicable farms that are cost-effective systems for growing sugar kelp. Through innovative technology and practical solutions, the project team's objective was to reduce costs associated with kelp farming. Test sites for this project were identified in New England and Kodiak, Alaska.

The first outplanting at the Kodiak farm site took place in the fall of 2019. Since then, the project team has learned a lot about growing kelp! The goal of the project is to integrate all aspects of kelp farming into the test site. From seed production to harvest and reseeding, these efforts look at the many ways we can best grow sugar kelp in Alaska's productive waters. There is still more to come with this project! This is a fist look at some of the techniques and gear used at the Kodiak farm site.



Farm system: Catenary Array

Designed by Cliff Goudey at TendOcean, the catenary array is designed to maintain tension across a farm structure. This design has been used at the demonstration site in Kodiak. Although the diagram below, provided by project partner GreenWave, is not an exact rendition of the array in Kodiak, it generally depicts the catenary array design.



The Kodiak site includes three different buoy types (not all depicted in the diagram):

Polyform A-5: 10 x $252 = $2,520

Polyform A-2: 15 x $72 = $1,080

Spar Buoys: 4 x $2000 = $8,000

Where the polyforms act as retrieval buoys, the more dynamic spar buoys frame the farm array. Distance between buoyancy is approximately 100 ft.

C-links: 220 x $4 = $880
These c-links (not pictured) provide connections between the lines on the array where needed.

Maintaining tension is important for creating consistent growth across the array as well as reducing tangling. **Tension at this site is maintained with deadeye tensioners on each of the 8 anchor lines.** The system is pulled taut with the help of hydraulics.

Site Overview

Location: Kodiak, Alaska

Area: 17 acres

Current speed: ~0.5 knots

Bottom type: soft

Depth: 55-80 feet

High nutrient levels: >5 umol nitrate (most of the season)

Not exposed to ocean swell (fetch is ~10 miles)

Seed

The cost of seed depends on the hatchery and the transportation costs. For this project, seed was $1/ft which totaled around $44,000 for the entire array.

Generally, outplanting occurs between end of October and middle of November.

Yield

Max: 19 lbs/ft, from subsampling

Average: 4.8 lbs/ft, average across the entire farm

Typically, the kelp is harvested in early May.

Total annual harvest: from 100,000 to 170,000 lbs

Mariculture and Fishing: Complementary Industries

Will mariculture activity interfere with fisheries?

By state law, aquatic farm locations cannot conflict with established fishing activity.

- Established uses, including fishing, have priority over proposed farm sites. (5 AAC 41.240).
- Before approving a lease and operation permit application, agencies seek input on the proposed farm site from local fishery managers, local organizations, and the general public.
- In some cases, conflicts can be mitigated, for example farms can remove most buoys and other structures prior to the fishing season if there is an expected hindrance to the fishery.

Aquatic farms may even benefit fishing areas...

Acting as cover from prey species, kelp farms may attract forage fish and invertebrates eaten by the fishery's target species. Find out more by checking out the *Benefits of Alaska's Growing Mariculture Industry* fact sheet!

In fact, the seasonality of aquatic farming presents an opportunity to both farm and fish:

- Commercial fishing boats adapt well to kelp farming or working with oyster gear.
- Most work on kelp farms takes place during the shoulder season of commercial salmon fisheries (kelp is outplanted in the fall and harvested in the spring) while most work on oyster farms is during the summer, making it compatible with winter fisheries.

Mariculture also presents new market opportunities

- Mariculture is a unique opportunity for tourism. For example, in Maine, many oyster farmers give tours of their farms and share their products with visitors. Integrating mariculture and tourism can benefit both industries by increasing sales and creating connections between the mariculture industry and Alaska's visitors!
- The market is growing. Buyers of kelp are incorporating it into food ingredients (e.g., salsa and spices) and beauty products. Products in development include animal feed, biostimulants, and compostable plastics.

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Photo Courtesy of Alaska Sea Grant

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Shellfish Farming on Alaska's Coast: Exploring Scale

What do we mean when we say 'scaling up'?

As scale relates to shellfish farming and cultivation in Alaska, it is a question of appropriate number or density of shellfish for a given farm within a local ecosystem.

We want to know the largest amount of shellfish a farm can produce in a given lease area without causing significant harm to the surrounding environment.

Thinking about scale brings up questions like...

1. What is an appropriate size for a shellfish farm in Alaska?
2. Farmed shellfish like oysters eat phytoplankton just like native shellfish... will farmed shellfish out-compete the locally present species?
3. Is there an ecological or social threshold, or carrying capacity, for successful operations?
4. How do we minimize risk of Pacific oysters entering or integrating with the nearshore environment in Alaska?

The answers to these questions are specific to location...

The point at which cultivated shellfish in an area would drastically change the balance of an ecosystem is very site specific. Characteristics like farm size and ecosystem area size really matter.

Here in Alaska, most shellfish mariculture sites are relatively small (on average around 13 acres) compared to the bays, inlets, straits, and waterbodies they are located in so **there is not an immediate concern of resource depletion or outcompeting other organisms that eat phytoplankton.**

In addition, state regulations minimize the amount of surface area within a bay that may be leased to aquatic farms to 1/3 or less of a bay, bight, or cove (11 AAC 63.050).

What about shellfish farms in other parts of the ocean?

There are some studied locations, such as Tracadie Bay, Prince Edward Island, Canada and the Ría de Arousa in Spain, where the size and prevalence of shellfish farming has altered the surrounding ecosystems.

However, the relative scale at which shellfish farming takes place in Alaska is small. **Potential impacts can be identified and prevented under the current permitting process requirements**, which provide for public comment and agency scrutiny for proposed sites.

Alaska has over 30,000 square miles of shoreline.

Currently, authorized aquatic farms (shellfish and aquatic plant farms) only make up around 1,200 acres of Alaska's waters, which is roughly 2 square miles.

While not all of the state's shoreline area will be suitable for aquatic farms, Alaska has a large ocean space relative to other places for marine activities, such as mariculture, to take place.

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Photo Courtesy of Alaska Seafood

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