Kelp Seed Quality Improvement - RFP #: 2024-06

Gametophyte hatchery initiative: expanding research for gametophyte generation and direct seeding techniques for kelp mariculture in Alaska.

Lead Entity: Alutiiq Pride Marine Institute (Chugach Regional Resources Commission)

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Project Location: Seward, AK
Project Start Date: 5/1/2025
Expected End Date: 9/30/2026
Award Amount: $176,541

Project Overview

Problem statement

Seeding kelp farms with meiospores results in variable sporophyte density, is limited in genetic traceability, and may result in reduced growth performance compared to gametophyte seeding; a method which Alaska currently lacks in capacity, while there is a concerted effort from other regions world-wide in implementing this technology in kelp farm seeding.

Solution

Three things need to come together in order for gametophyte propagation to be an effective and advantageous resource for seeding kelp farms in Alaska: 1) optimized protocols in culturing and seeding gametophytes specific to Alaskan kelp strains and species, 2) equipment, knowledge and capacity for research and commercial seed production, and 3) knowledge of population genetic processes and policy change in permitting. This project aims to contribute to all three by 1) ground proofing growth parameters for efficient gametophyte cultivation and testing direct seeding methods at two sites in Kachemak bay, 2) growing the capacity of the gametophyte lab at APMI and refining protocols with dedicated culture space and incubation equipment, and 3) cataloging genetic samples for the Alaska Department of Fish and Game to use in assessing genetics.

Project Update

Summary of work to date

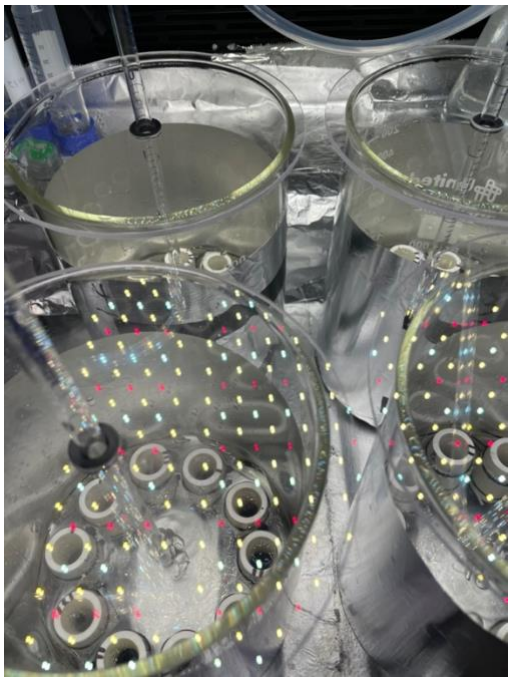
May/April

After securing an aquatic resource permit from ADF&G, work began with a field collection of *Saccharina latissima* sori from Jakolof Bay to establish a gametophyte stock to test seasonal

propagation for annual stock culturing. A high spore density of >400,000 spores /ml was used in an effort to establish a rapid accumulation of gametophyte biomass, and the treatment of aeration vs no aeration was tested on germination (starting densities were chosen based chapter two of Protocols for Macroalgal Research). The high starting density induced a stress in the gametophyte culture with aeration which resulted in stunted growth and altered morphology, while cultures without aeration resulted in total termination of gametophytes. The surviving stock survives to this day although the stunted morphology persists despite attempts at rescuing the stock. Much time was spent planning experiments for the summer, and completing a density-growth experiment planned under the JIP grant.

July/August

Several experiments were attempted over summer in the run-up to the outplant experiment planned for the end of October. Firstly, an experiment designed to test reproductive success on gametophyte seeded spools based on the density of inoculation. This was conducted on 40, 1" diameter PVC spools wrapped in seeding twine, placed in beakers with central aeration under white light in an incubator at 10 C. 3 ground gametophyte density treatments were painted onto the seed twine, with one spool per beaker seeded only with female gametophytes to test sperm transport in the beakers. The spools were incubated for 4 weeks with water changes twice a week. Germanium dioxide was emitted in the beginning as it reduces fertility, however, despite filtering efforts before inoculation, sufficient diatoms persisted and overtook the gametophytes. No valuable data was collected on induction. A wave-tank experiment planned under a JIP grant was adapted in our plans to test attachment of direct-seeded sporophytes under different intensities of oscillatory water motion. Temperature data from a kelp site in Jakolof bay in 2024, and a theoretical wave model based on past wind data and mapped fetch were used to establish relevant conditions in the tank, where small increments vertically in the wave tank



Gametophyte spool experiment.

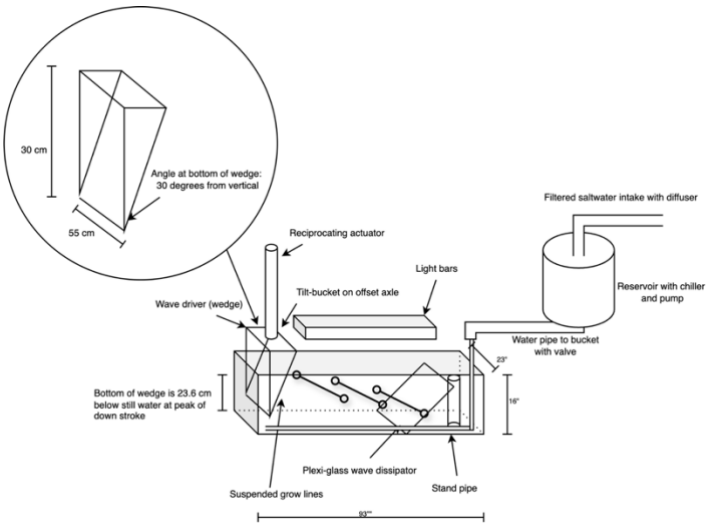
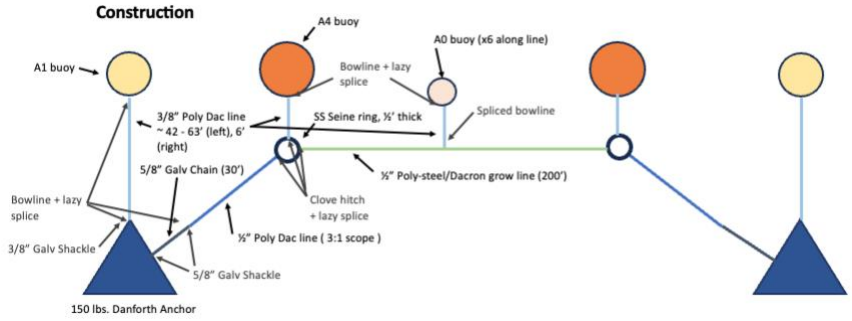


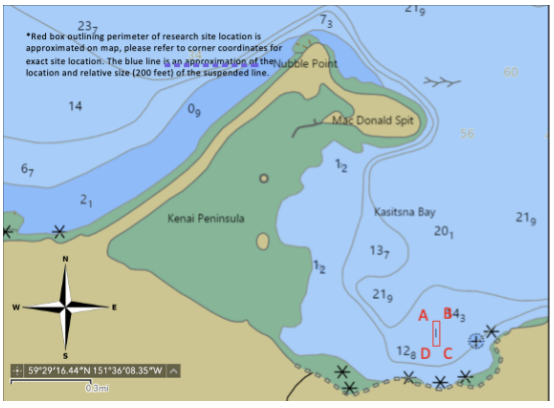
Diagram of experimental wave tank system.

correspond to the wave action juvenile kelp would experience at this site in rough seas at 7 feet under the surface. Construction delays prevented us running this experiment before the outplant experiment, while currently we have: an insulated tank with wave dissipator, scaffolding for lights and wave driving mechanism, water chiller, custom welded wave driver, reciprocal actuator, conductivity tape for measuring wave height, side mounting units to fix the ropes to, and inlet pipes with minimal turbulence. We are finishing the electrical box which is currently being wired before finishing the programming and fixing the components to the tank for testing. This experiment has been postponed to early November.

September/October

The outplant experiment is underway. Farm structure gear (anchors, lines, buoys, etc.) have been acquired and are ready for deployment. *S. latissima* sori were collected in September to seed spools with meiospores forming our control. Gametophyte spools have been painted, been induced to reproduce, and are growing in the nursery, while gametophytes in tumble culture are being induced to form sporophytes for direct seeding. We have acquired monitoring loggers including HOBO loggers, Lowell tilt meters, and a Spot Buoy supplied by NOAA, which will be calibrated for deployment in the coming days. Permits are finalized for the outplant experiment including a Special Use Permit under the Critical Habitat Management Plan in Kachemak bay (ADF&G), and a Submerged Land Use Permit (DNR). Our NOAA collaborators are still on board to manage the site and provide a vessel for out planting, although there is a risk of funding cuts and their help is contingent on the opening up of the federal government. Our deployment plan is reliant on their help through vessel and lab support, however alternative resources could be used including charter and/or collaboration with our partnering farmers at

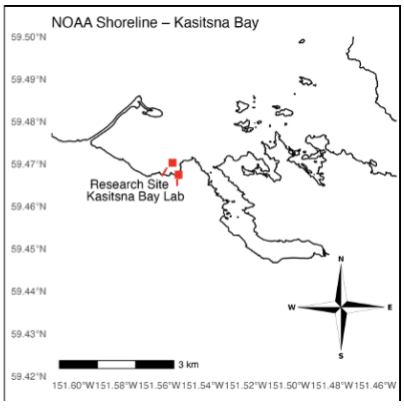




Site corner coordinates

A)
59.4720° N
151.5575° W
B)
59.4720° N
151.5567° W
C)
59.4698° N
151.5567° W
D)
59.4698° N
151.5575° W

The research site is ~800 by 150 ft, allowing for the kelp line and anchor scope with margin.



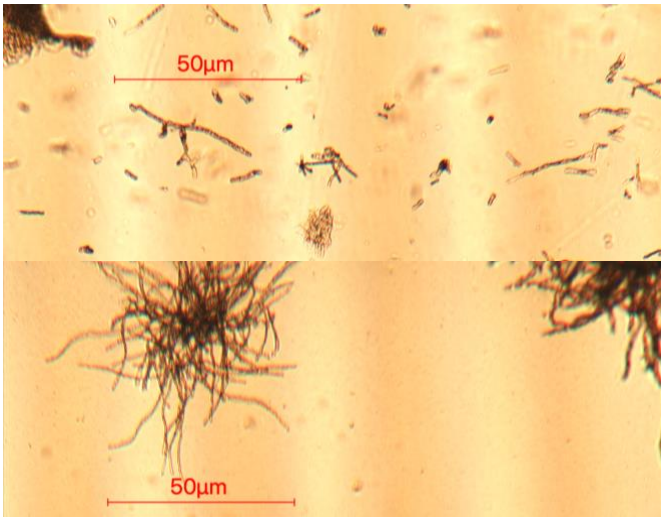
Spinnaker Sea farms. An additional sori collection has been made to establish new gametophyte stocks to assess protocols in the Seaweed Bioreactors which will also provide gametophyte genetic samples for the ADF&G genetic lab, which currently only have sporophyte samples from our collection.

Above diagram: Construction plan for the single line arrays to be deployed at a test-site location in Kasitsna bay, and on the lease worked by Spinnaker Seafarms in Jakolof bay.

Next steps

We will execute the deployment and seeding of the two test sites in Kachemak bay by the end of the month, with contingency for early November if need be due to inclement weather. In mid-November we will begin an experiment in direct collaboration with Dan Gossard at Woods Hole Oceanographic Institute utilizing the wave tank. In December we will assess the relative growth rate of gametophytes of different size classes, utilizing mixed sex cultures of the same initial starting biomass filtered by size class, and the interaction of fragmentation regime. In addition, we plan on utilizing photographs of clonal fragments to document growth of different size classes.

Additional photos



Gametophytes after (top) and before (bottom) manual fragmentation.

Industrial Plankton Seaweed Bioreactor. Each module houses one, 2 liter culture chamber with