

Quarterly Report – April to July 2026

*Genetic diversity and seed quality of bull kelp (*Nereocystis luetkeana*) cultivated from gametophytes and conventional methods*

Lead Entity: Dr. Angela Korabik

Grant: RFP #2024-06 Kelp Seed Quality Improvement

Project Location: Cordova and Kodiak

Project Start Date: June 1, 2025

Expected End Date: March 31, 2027 (originally September 30, 2026)

Award Amount: \$198,977.82

PROJECT OVERVIEW

With this project, we aim to answer many of the existing questions about alternative seeding methods, effective population size, and local genetic diversity by testing three methods of kelp seeding. We will determine how the seeding method affects the genetic diversity, spool quality, and harvest quality in bull kelp, a species of interest in the Alaska kelp mariculture industry. These methodologies would likely work to support genetic diversity for other commercially grown kelp species given similar modes of reproduction and hatchery techniques used. This project will answer questions of high importance in the policy and regulation of mariculture operations and genetics and test the feasibility of using different seeding methods in hatcheries located in two mariculture regions of interest in Alaska, Kodiak and Cordova.

This project addresses three primary aims regarding kelp genetic diversity as it relates to mariculture in Alaska:

1. Compare genetic diversity of kelp seeded from conventional spore inoculation and controlled and uncontrolled gametophyte culture. Here, we define “controlled parental contribution” as a solution containing equal proportions of gametophytes from each parent sporophyte, and “uncontrolled parental contribution” as a solution containing an undetermined proportion of gametophytes from each parent. We hypothesize that spools seeded from gametophyte cultures of controlled parental contribution will have greater genetic diversity and better reflect the genetic diversity of the original parent population used for culture.
2. Compare the quality of kelp development in gametophyte versus sporophyte-seeded cultures. We hypothesize that gametophyte-seeded cultures will result in better spool coverage and seed quality than spool seeded spores, due to our increased control of density.
3. Compare the parental contribution of parents from Kodiak kelp populations to Cordova. We hypothesize that parental contribution to offspring genetic diversity will be greater in Kodiak than Cordova due to Kodiak’s more exposed location and larger kelp beds.

COMPLETED TASKS

Task 1: Collection and hatchery

Year 1 – 100% complete

Year 2 – 20% complete

- PWSSC collected bull kelp tissue for genetic analysis and seed production from 60 parents in Kodiak, AK and 60 parents in Cordova, AK at two different seasonal time periods (end of summer and mid-autumn).

- PWSSC used sori collected in August 2026 to produce two types of gametophyte cultures: single parent cultures and gametophyte cultures with uncontrolled parental contribution. These two gametophyte solutions will both be used to seed spools.
- PWSSC used collected sori collected in November 2026 to seed spools with traditional, spore-seeding methods.
- PWSSC has cared for seed spools in accordance with best operating practices for kelp hatcheries, checking spools regularly during the hatchery period, and taking photos to track seed spool quality.
- PWSSC has collected tissue from spools (KOD – all treatments, CDV – uncontrolled parent cultures) for genetic analysis when more than 50 sporophytes on the spool have reached a length of 2mm.
- PWSSC has collected morphometric data and tissue for genetic analysis from adult offspring of the KOD treatments outplanted on Alaska Ocean Farms' lease.

Extension work

- PWSSC collected bull kelp tissue for genetic analysis and seed production from 60 parents in Kodiak, AK and 60 parents in Cordova, AK in July 2027.
- PWSSC used sori collected in July 2027 to produce two types of gametophyte cultures: single parent cultures and gametophyte cultures with uncontrolled parental contribution. These two gametophyte solutions will both be used to seed spools.
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Task 2: Outplanting

Year 1 – 100% complete

Year 2 – Not Applicable.

- Alaska Ocean Farms outplanted the Kodiak kelp on February 17, 2026.
- Kelp was harvested from the Alaska Ocean Farms site on July 10, 2026.

Task 3: Genetic Analysis

Year 1 – 90% complete

Year 2 – 0%

Genetic processing for Year 1 has been completed through allele scoring. DNA was extracted from all parental samples, while progeny samples were processed directly using PhireTaq PCR. All parental and progeny samples were amplified using a panel of eight microsatellite markers, prepared for fragment analysis, sequenced, and scored in STRand. See Table 1 for sample numbers and completion status.

A subset of parental samples for Year 2 has been received at UWM, but genetic processing has not yet begun. Samples will undergo DNA extraction, PCR amplification using the same panel of eight microsatellite markers, fragment analysis, allele scoring, data cleaning, and parentage analysis in CERVUS.

Table 1. Year 1 genetic analysis task breakdown and current completion status (%).

Task	Samples / processing	Completion	Status
Samples received at UWM	2 parental plates + 6 progeny plates	100%	Complete
DNA extracted	2 parental plates + 1 progeny plate	100%	Complete
PhireTaq processing	5 progeny plates	100%	Complete
PCR performed	24 × 96-well PCR plates (8 plates × 3 PCRs)	100%	Complete
Shipped to sequencing facility	16 × 96-well plates (8 plates × 2 master mixes)	100%	Complete
Sequencing results received	16 × 96-well plates	100%	Complete
Alleles scored in STRand	8 markers per sample	100%	Complete
Data cleaned	Full dataset	50%	In progress
Paternity analysis in CERVUS	Full dataset	0%	Next step

Task 4: Deliverables

Year 1 – 80% complete

Year 2 – Not started.

- We delivered two progress reports detailing project updates for AMC in January 2026 and April 2026.

ONGOING TASKS

Task 1: Collection and hatchery

- PWSSC is currently analyzing photos and data from the hatchery portion of the experiment to determine how seeding method affects spool quality.
- Gametophyte cultures for Year 2 have been started at PWSSC.

Task 3: Genetic Analysis

The Year 1 dataset is currently being cleaned and quality-checked. Following completion of this step, parentage analysis will be performed in CERVUS to assess parental contributions to the progeny.

Year 2 genetic processing will begin with DNA extraction of the parental samples currently available at UWM. Additional parental and progeny samples will be incorporated as they are received.

Task 4: Deliverables

- This is the third progress report detailing project updates for AMC.

UPDATED TIMELINE AND TASKS

May 25	Jun 25	Jul 25	Aug 25	Sep 25	Oct 25	Nov 25	Dec 25	Jan 26	Feb 26	Mar 26	Apr 26	May 26	Jun 26	Jul 26	Aug 26	Sep 26
Task 1: Supply and Hatchery Prep																
	B		C													
Task 2: Collect parent sori and parent genetic material																
			C			C										
Task 3: Send sporophyte tissue samples to UW Milwaukee																
				C			C							C		
Task 4: Genetic Sequencing @ UW Milwaukee																
					B									I		
Task 5: Gametophyte Culture																
			B				C									
Task 6: Spool Seeding and Cultivation																
						B				C						
Task 7: Collect spool quality data and spool genetic material																
										C						
Task 8: Outplant kelp on farm																
								B						C		
Task 9: Harvest and collect offspring genetic material																
														C		
Task 10: Data analysis																
												B		I		

Mar 26	Apr 26	May 26	Jun 26	Jul 26	Aug 26	Sep 26	Oct 26	Nov 26	Dec 26	Jan 27	Feb 27	Mar 27	Apr 27	May 27
Task 1: Supply and Hatchery Prep														
	B	C												
Task 2: Collect parent sori and parent genetic material														
				C										
Task 3: Send tissue samples to UW Milwaukee														

				C										
Task 4: Genetic Sequencing @ UW Milwaukee														
					I									
Task 5: Gametophyte Culture														
				B	I									
Task 6: Spool Seeding and Cultivation														
				NYS										
Task 7: Collect spool quality data and spool genetic material														
				NYS										
Task 8: Data analysis														
				I										
Task 9: Submit Final Report to Alaska Mariculture Cluster														
				NYS										
Task 10: Fragment Gametophytes and Collect Gametophyte Samples for Analysis														
				NYS										

ADDITIONAL INFORMATION

In our last report, we reported that while the Kodiak treatments were successfully outplanted in January 2026, the Cordova spools were not suitable for outplanting. Since then, the Kodiak treatments were allowed to grow for months, and were finally harvested for data collection in mid-July 2026, completing the experimental work for the first year of this project.

Data analysis is still in progress, but here we have shared some preliminary plots of our data. At the time of outplant, juvenile sporophytes on spools seeded with spores seemed to be longer than spools seeded with gametophytes (Figure 1). Juvenile sporophytes on Cordova spools were shorter than either Kodiak treatment, which may be a result of the extreme contamination issues they faced, but may also indicate a population difference. At harvest, spore-seeded lines again were longer than gametophyte seeded lines, but the large overlap in the interquartile range of each treatment (the main box on the boxplot) may indicate that this difference is not significant (Figure 2). Spore seeded treatments also seemed to produced a higher yield (g/m) than gametophyte seeded treatments (Figure 3). The density results on the other hand show little difference in the mean between the two treatments (Figure 4); however, the density of gametophyte seeded lines does seem to be more consistent and less variable than spore seeded lines, which may be attractive to farmers.

Overall, spore seeded spools this past year seemed to perform slightly better than gametophyte seeded spools, but these differences have yet to be confirmed as statistically significant. A more thorough statistical analysis of the data will be provided in the next quarterly report for this project. Additionally, due to the fact that this was PI Korabik's first time developing gametophyte cultures, it is possible that these differences may not persist into the second year.

Parentage results from genetic analysis are not yet available. Data cleaning and quality control are currently in progress, after which the finalized dataset will be analyzed in CERVUS.

We have also begun work for a second extension to this project, in which we are re-running trials this fall to more rigorously answer our original project questions. Thus far, parent samples for the 2026 trials have been collected, sporulated, and sent to UWM for analysis. Gametophyte cultures are currently being incubated and monitored at PWSSC, with the goal of seeding spools in early to mid October.

FIGURES

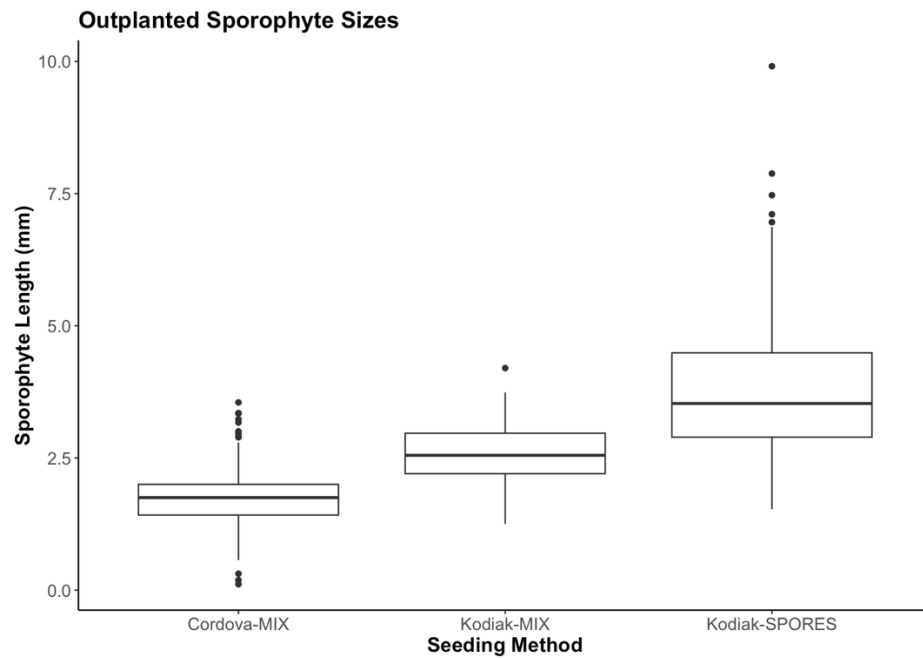


Figure 1. Boxplot of juvenile sporophyte length on spools before outplanting. The Kodiak treatments were measured approximately 1 week before outplanting, while the Cordova treatment was too contaminated to outplant.

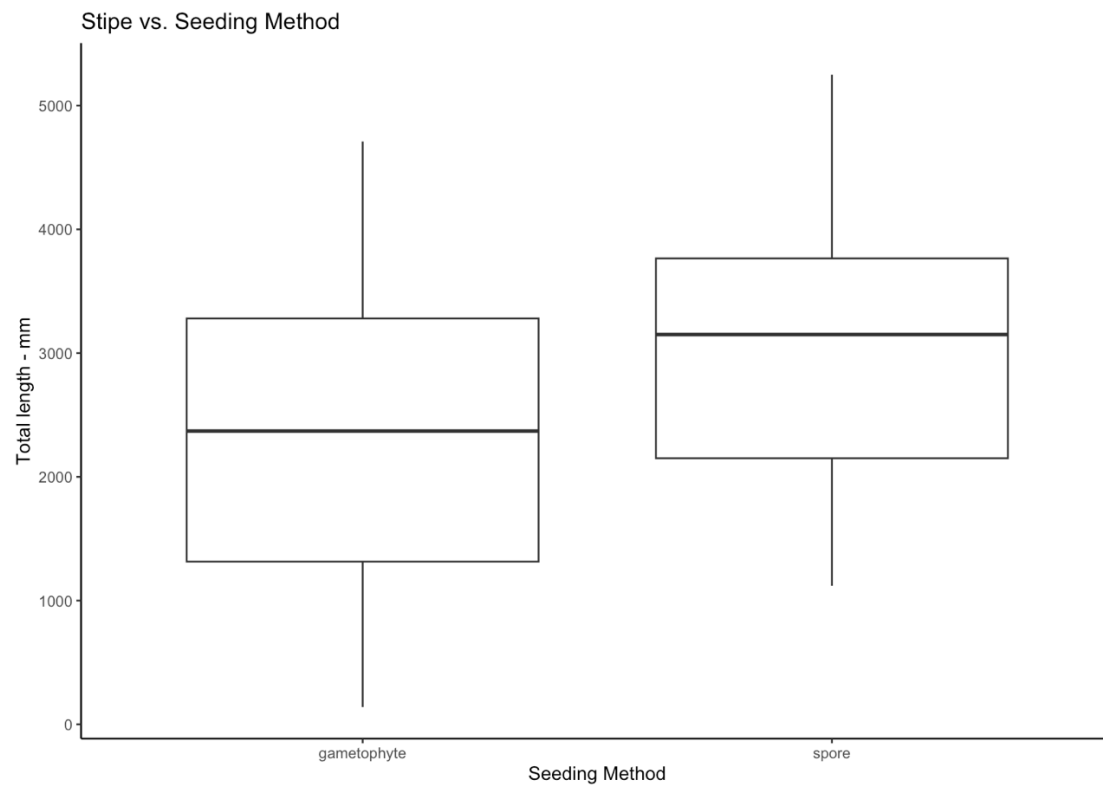


Figure 2. Boxplot of the total length (stipe length + blade length) of bull kelp harvested in July.

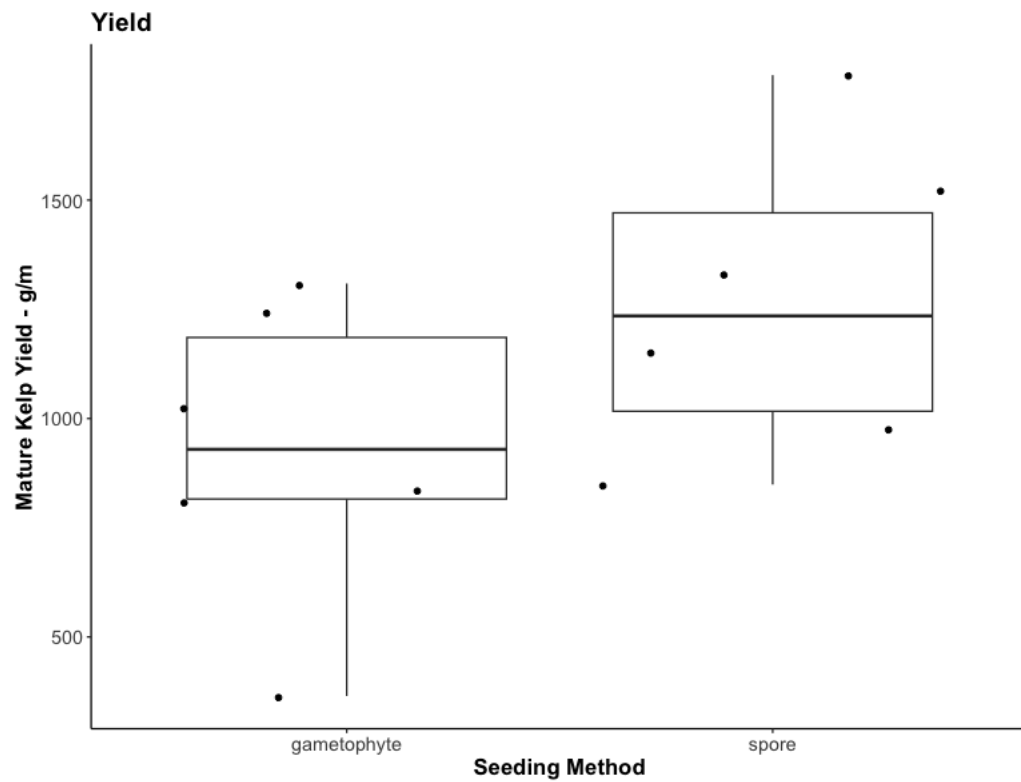


Figure 3. Boxplot of the yield (g/m) of bull kelp harvested in July.

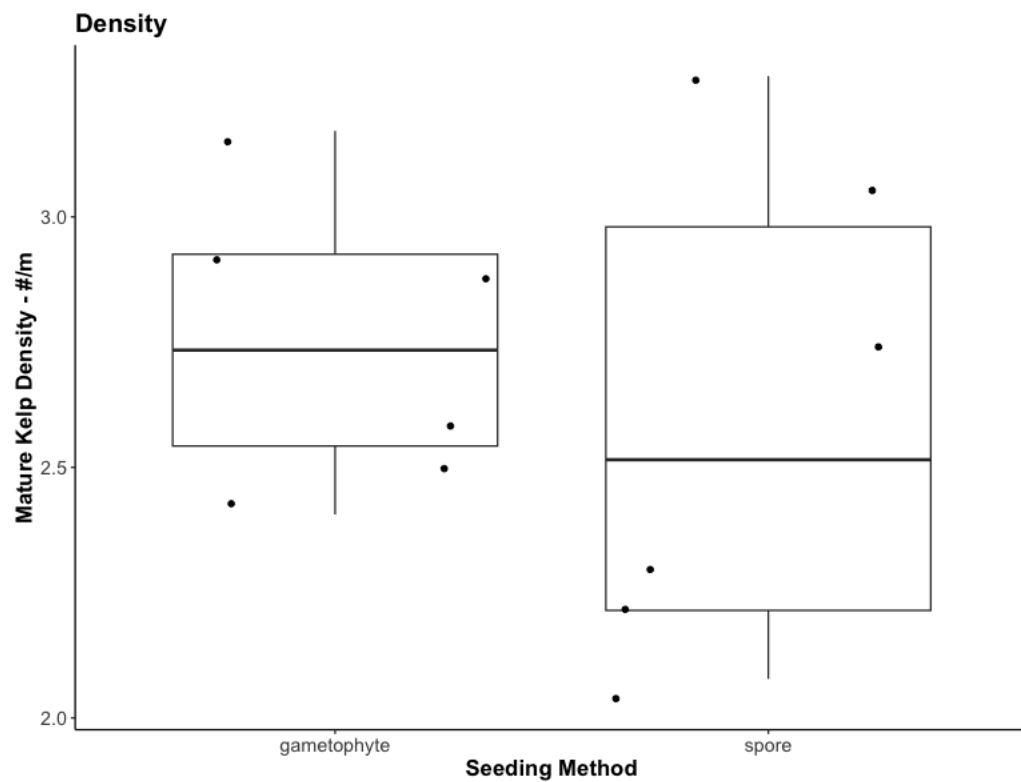


Figure 4. Boxplot of the density (# of individuals per m) of bull kelp harvested in July.