Advancing a Dual-Function Soil Amendment for Carbon Sequestration and Soil Health using Alaska-Grown Kelp and Glacial Rock Flour

Quarter 2 Progress Report

Project: Advancing a dual-function soil amendment for carbon sequestration and soil health using Alaska-grown kelp and glacial rock flour

Funder: Southeast Conference – Alaska Mariculture Cluster Grant

Implementing Organization: Alaska Center for Energy and Power

Reporting Period: October 1, 2025 - September 30, 2026

Project Lead: Gwen Holdmann, Alaska Center for Energy and Power

Project Overview

The goal of this project is to develop, test, and evaluate a novel soil amendment that combines Alaska-grown kelp and glacial rock flour (GRF). The concept builds on Alaska's natural abundance of marine macroalgae and GRF to produce a blended product that enhances soil fertility while capturing and storing atmospheric carbon dioxide (CO_2) through both organic and mineral pathways.

The dual-function amendment is envisioned to: 1) Provide a sustainable, value-added product that enhances soil health; 2) Support regenerative agriculture practices; 3) Contribute to measurable carbon sequestration (through kelp-derived organic matter and enhanced weathering of GRF); and 4) Create potential revenue streams for Alaska mariculture producers via a unique premium product.

Summary of Progress

Progress on Task 1: Greenhouse Trial - Soil Fertility and Plant Response Trials

Goal: Initiate controlled greenhouse trials to evaluate the effects of different amendment formulations on soil fertility and crop performance.

As of April 20, 2026, we have completed four rounds of greenhouse trials and a fifth has been initiated. To stay consistent for trials from Quarter 1, for all trials, the soil was collected at the University of Alaska Fairbanks Experimental Farm site in Fairbanks, Alaska. Recent field use including additives and crops is unknown. In each trial, butterhead lettuce was grown in peat moss for 7-10 days before transplantation into treatment soils. Artificial day lengths were 16 hours, temperature was kept at approximately 70ºF and humidity was kept at 70%. The GRF used was from the same location as in the Quarter 1 report, and the kelp used was food grade milled sugar kelp from Kachemak Kelp Hub.

Soil Health Analysis

Soil Samples from Trial 1 were sent to Ward Laboratories for Phospholipid Fatty Acid (PLFA) analysis. Samples treated with GRF had noticeably higher total living microbial biomass (TLMB) than samples without. We cannot speak to a larger trend as these were the first samples we have acquired, but this result remains promising. Additionally, both treated samples had higher TLMB, total bacteria, and total fungi biomasses than the control samples.

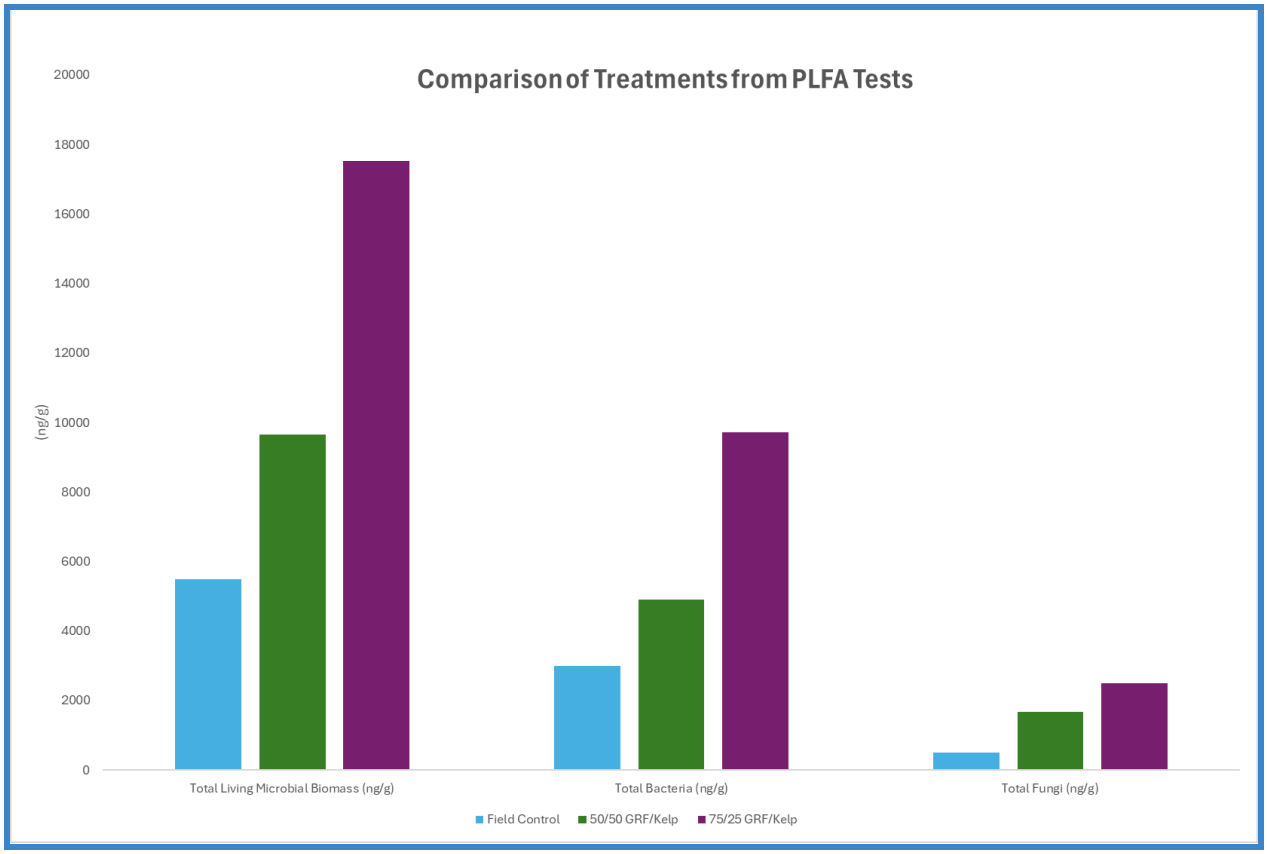

Figure 1. Comparison of PLFA test results. Samples from Trial 1. Given that each treatment only had one sample sent to the lab, these results cannot be taken as scientifically sound nor statistically significant. However, anecdotal evidence from this test reveals promising results from application of GRF and/or Kelp.

Testing other kelp fertilizers: Sea2Sprout Collaboration

Trial 4 included only liquid kelp treatments. One treatment received 40 mL/week of Sea2Sprout from Kachemak Kelp Hub, a product that is in early stages of commercialization. This treatment was diluted as per instructions on the bottle: 1:100 with water. Treatment 2 received 40 mL /week of kelp extract, which was made by stirring 10% w/v dried sugar kelp from Kachemak Kelp Hub in purified water for 7 days, straining through cheese cloth, and diluting the final liquid 1:3 with purified water.

Figure 2. Liquid kelp product testing using homemade kelp extract and Kachemake Kelp Hub Sea2Sprout biostimulant product.

Both treatments, as well as control plants, were tested in field soils and in peat moss. All plants developed dried and brown leaf tips, with rings potentially indicating a fungus. As this included the control plants, we anticipate that the kelp treatments were not the cause of this issue. We were surprised as our other trials have not had this issue. Investigation of this is ongoing and soil samples are currently being processed at Ward Laboratories from both Trial 3 and Trial 4.

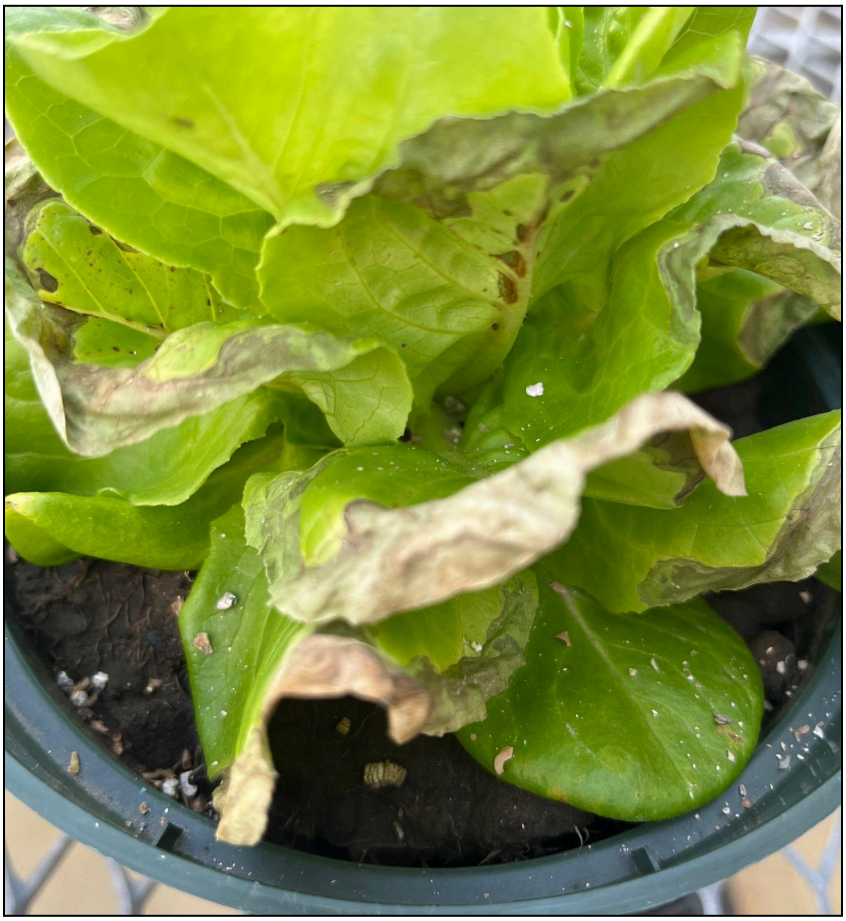

Figure 3. A struggling lettuce plant from Trial 4 that we anticipate has a fungus.

Progress on Task 2: Laboratory Testing - Controlled CO_2 Sequestration Experiments

Goal: Replicate and adapt laboratory-based enhanced weathering experiments originally conducted by Dr. Rosing and colleagues to quantify the CO_2 sequestration potential of Alaska GRF under local soil conditions.

Carbon Sequestration Analysis

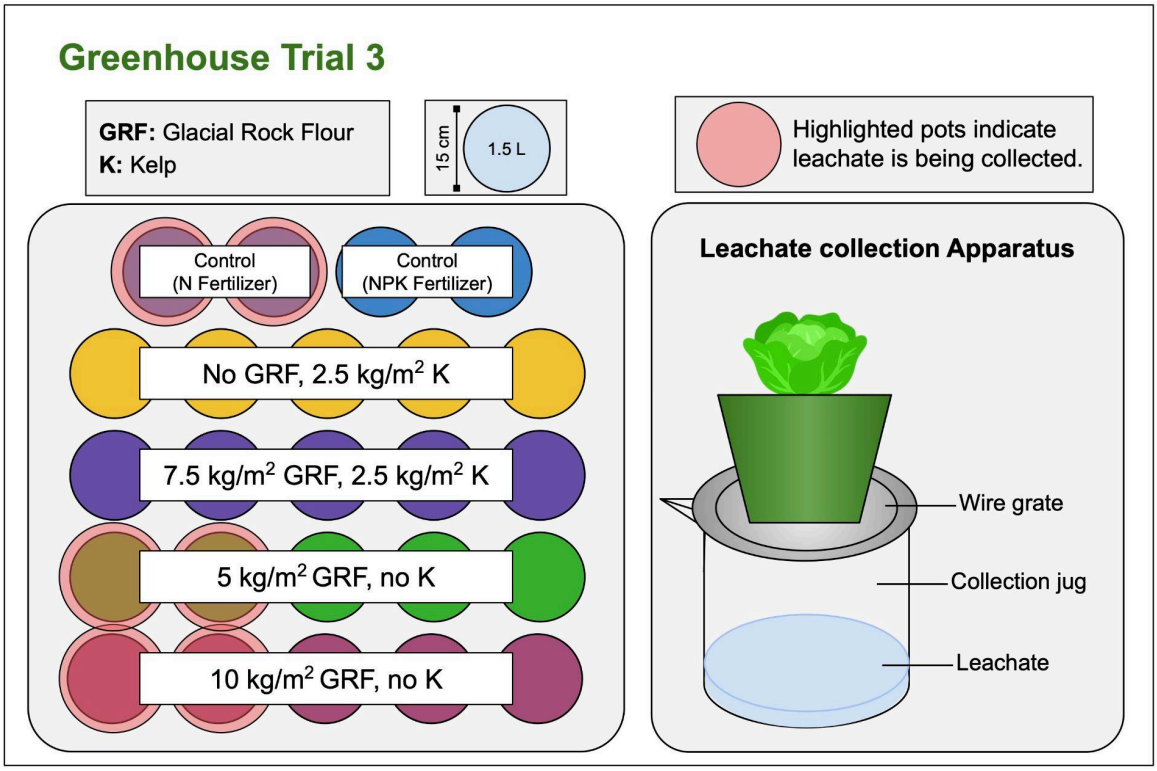

Figure 2. Trial 3 is currently ongoing and includes leachate collection under some plants in order to measure carbon capture using mineral concentration in the leachate as a proxy.

Trial 3 treatments were set up with a leachate collection apparatus that we will use to analyze exchangeable cation concentrations to determine the carbon sequestration levels of enhanced weathering with the GRF. The set up mimics the mesocosms developed by Reershimius et al.[1]

Figure 3. Trial 3 Leachate Collection Apparatus. Leachate and soils were collected on March 23, 2026 for testing via ICP-MS. Results are pending.

We are in the process of testing for carbon dissolution rates via ICP-MS by working with the Critical Minerals Laboratory at the Institute of Northern Engineering at UAF. Soil samples were sent to the lab on March 23, and we hope to have results by April 25 to begin carbon sequestration analysis.

Progress on Task 3: Market Readiness, Lifecycle Assessment, and mCDR Hub Strategy

Goal: Prepare the kelp-glacial flour product for future development, adoption, and broader climate relevance concurrently with Tasks 1 and 2. This includes a lifecycle assessment (LCA) to evaluate the net climate benefit of the amendment, and the application of a customer discovery framework modeled after the NSF I-Corps program to explore product-market fit, user needs, and commercialization strategies. Additionally, begin to develop a strategic roadmap for a broader Marine Carbon Dioxide Removal (mCDR) hub in Alaska.

The project has brought on Magnus De Witt and Neil McMahon to provide expertise and complete a rigorous life cycle assessment (LCA). They have experience in performing LCAs and will be able to support this project by providing this deliverable. As noted above, Trial 3 samples have been sent to the Critical Minerals Laboratory at INE/UAF where they will be analyzed for cation content as a proxy for CO_2 dissolution. Once tested, Welsh will be able to mathematically determine the CO_2 sequestration via enhanced weathering, and provide this data to aid in the LCA.

Overall Progress

This project is on track, with milestones completed or in progress as expected. In Quarter 1 we successfully completed two greenhouse trials, and NSF I-Corps training, and began planning for summer field trials. In Quarter 2, we have completed two more greenhouse trials and are making progress on a fifth. We solidified plans for summer field trials, established a framework for a life cycle assessment of the GRF, and we are in the process of determining carbon sequestration from weathering of GRF.

Next Steps

1) Determine carbon dioxide removal via ICP-MS from leachate in Trial 3.
2) Complete LCA.
3) Develop roadmap for CDR potential in Alaska, focusing on use of GRF for CDR.
4) Initiate summer field trials with Calypso Farms in Fairbanks, Alaska.

Conclusion

At the second quarter milestone, we have completed Task 1 and extended its scope to include summer field trials. We have made progress on Task 2 and while the lab work has taken more time than expected, we are prepared to move forward with this as soon as we can. We have also made progress on Task 3, and have a plan for completion of the LCA and strategic roadmap. We believe this project will provide a resource and direction for future work with kelp and GRF soil amendments across Alaska, and are on track to provide impactful deliverables at the end of the funding period.