California Department of Fish and Wildlife Environmental Enhancement Fund Grant Program
FINAL PROGRESS REPORT

Kelp Forest Restoration at Timber Cove in Greater Farallones National Marine Sanctuary

Date: July 1, 2025

Project Title: Kelp Forest Restoration at Timber Cove in Greater Farallones National Marine Sanctuary

Agreement No.: Q2275066

Grant Term: September 21, 2022 – June 30, 2025

Grantee: Greater Farallones Association

FISCAL REPORT

Fund Source	Amount Awarded	Total Amount Reimbursed
CDFW EEF Grant Funds	$173,672.00	$173,668.08
Matching Funds	$341,234.00	$341,234.00
Agreement Totals	$514,906.00	$514,902.08

PROGRAM/TECHNICAL REPORT

Brief Summary of Work Performed September 21, 2022 to June 31, 2025:
Insert narrative or bulleted list of activities performed.

- **Task 1 – Project Management and Administration**
  - GFA managed all project management and administrative tasks, including coordinating all on-the-ground restoration and monitoring work, securing permits, managing payments to commercial urchin divers and a subcontract to Moss Landing Marine Labs, and all work associated with invoicing and payments, and submitting progress reports.
- **Task 2 – Deploy Sensors, Subtidal Surveys, Kelp Canopy Surveys**
  - We conducted subtidal surveys and kelp canopy surveys consistently throughout the project period at Timber Cove to capture data on the implementation and effectiveness of urchin removals and outplanting. A mooring with oceanographic sensors was deployed in Year 2.
- **Task 3 – Urchin Removals**
  - Two commercial urchin divers removed urchins at Timber Cove within and around existing kelp beds and in areas of high historical kelp canopy persistence. To date, they

have removed 55,694 lbs (an estimated 500,294 urchins).

- **Task 4 – Outplanting**
  - In 2024, we outplanted bull kelp spores in concentrated spore bags and in 2025 we outplanted spore bags and twine cultured with bull kelp sporophytes.
- **Task 5 – GIS and Data Analysis**
  - We have analyzed data sets from subtidal surveys, kelp canopy surveys and the oceanographic sensors.

During the previous reporting period September 21, 2022 - April 30, 2023, we applied for a Scientific Collection Permit with California Department of Fish and Wildlife and a permit from Greater Farallones National Marine Sanctuary (GFNMS) to disturb the sea floor by installing restoration site infrastructure, outplanting and deploying moorings. We also facilitated various project planning discussions to lay out the timeline and activities for the 2023 field season.

During the previous reporting period, May 1, 2023 - July 31, 2023, we mapped the kelp canopy area at Timber Cove using small UAS or drones to capture early season kelp forest growth and our dive team completed a refresher on PISCO protocols. We purchased necessary supplies and finished remaining state and federal environmental compliance consultations and approvals. We have been collaborating with commercial urchin fishermen to outline an urchin removal plan for Timber Cove. In the next reporting period, we will be conducting urchin removals, outplanting, surveys and potentially deploying two moorings at Timber Cove.

During the previous reporting period, August 1, 2023 - October 31, 2023, we received federal and state permits to conduct research on restoration activities. Two commercial urchin divers, Erik Owen and Mark Gmeiner, began urchin removals in Timber Cove. To date, they have removed 17,072 lbs of urchins. Our team of NOAA divers conducted surveys of the pilot restoration areas and initial results show that urchin density was reduced from approximately 24 urchins per square meter to less than 4 urchins per square meter. GFA purchased a fish buyer's license and bought the urchins directly from the divers. Dandy Fish Company offloaded and weighed all urchins, then transported them to West Marin Compost. Our team subsampled urchin landings to dissect urchins, collect morphometrics and approximate bycatch. Due to some delays in receiving our permits, we did not deploy sensors or conduct outplanting in Timber Cove, however these activities will occur in 2024.

During the previous reporting period, Jan 1, 2024 - March 31, 2024, we processed data and led a field science review of activities conducted in 2023 to go over lessons learned to inform 2024 efforts, and we began bull kelp cultures at Bodega Marine Lab in preparation for outplanting efforts. We also worked

with Far Western Archeological Group to plan the archeological surveys at Fort Ross Cove, Timber Cove, Ocean Cove, and Gerstle Cove.

During the previous reporting period, Jan 1, 2024 - March 31, 2024, we conducted 3 beach surveys at Timber Cove. These monthly surveys help us capture bull kelp wrack abundance, description, size; percent cover of other materials on the beaches adjacent to our restoration sites.

During the previous reporting period, January 1, 2024 - March 31, 2024, we began culturing bull kelp at Bodega Marine Lab for outplanting in Timber Cove in the summer. No kelp has been outplanted at Timber Cove yet. We received 40 juvenile bull kelp individuals from our collaborators at Moss Landing Marine Labs (MLML) on January 15, 2024. These individuals had been grown at MLML from bull kelp sori collected from Russian Gulch in Jenner, CA by our CDFW collaborators. The 40 individuals were initially placed in 2 square outdoor tumble culture tanks. As they grew, the individuals were “crowned”, meaning their pneumatocyst was cut in half to allow them to tumble throughout the tank instead of floating on the surface. Individuals were eventually split between 3 square outdoor tumble cultures and 2 trough outdoor tumble cultures to avoid overcrowding and optimal growth. Once most of the individuals were reproductive, on April 1, 2024, we inoculated 2 indoor tanks to begin the next generation of lab grown bull kelp. As per our MLML collaborators’ recommendations, we inoculated twine for outplanting on April 15, 2024 so that the bull kelp has about 8-10 weeks of growth before outplanting. As of July 29, 2024, we have 120 juvenile sporophytes growing in our tanks for the next generation of lab grown kelp. These individuals are still young and have not formed pneumatocysts yet.

During the previous reporting period April 1, 2024 - June 30, 2024, we worked with commercial urchin divers to remove 1,472 lbs. from Timber Cove. We also began doing video surveys of 30 x 2 m transects so we can estimate urchin density more often and faster (though less accurately). We trained the commercial urchin divers in the video survey protocol so they can help increase our capacity to estimate urchin densities even when our team is unable to dive. We continued to track the health of urchins via dissections, and we performed a beach survey each month.

During the previous reporting period July 1,2024 - September 30,2024, we worked with two commercial divers to remove just over 28,000 lbs of urchins from Timber Cove over approximately 69 dive days. In July, we worked with RECON Offshore to conduct archeological surveys of Timber Cove in order to deploy moorings with sensors. Moorings were deployed on September 4. We conducted kelp canopy surveys using a drone on September 16. In August-September, we conducted subtidal ecosystem surveys at Timber Cove, with dive teams deploying from the Research Vessel Fulmar. On August 29-30,

we installed the outplanting infrastructure and outplanted sori in soral bags, which are mesh bags. On September 9, we installed invertebrate recruitment modules.

During the previous reporting period October 1, 2024 - December 31, 2024, we retrieved the mooring deployed at Timber Cove and began processing data and information to inform project results and dissemination.

Deliverables

Task	Description	Deliverables	Expected Completion Dates	Completed (Yes/No) *	Date submitted to CDFW
1	Project Management and Administration	Quarterly Progress Reports	Due within 30 days following each calendar quarter (March, June, September, December) after grant execution	Yes	30 days following each calendar quarter (March, June, September, December)
		Quarterly Invoices	Due within 30 days following each calendar quarter (March, June, September, December) after grant execution	Yes	30 days following each calendar quarter (March, June, September, December)
		Copies of Executed Subcontracts	Due with next Quarterly Progress Reports upon completion of Subcontracts	NA	
		Copies of Permits	Due with next Quarterly Progress Reports upon completion of Permits	Yes	
		Submit Project Data	**June 30, 2025**	Yes	July 1, 2025
		Final Progress Report	**June 30, 2025**	Yes	July 1, 2025
		Final Invoice	**April 1, 2025**	Yes	March 31, 2025
2					
3					

***If no, summarize in Problems/Delays and Lessons Learned section below**

Problems/Delays and Lessons Learned:
We experienced delays in the project related to environmental compliance, weather and vessel scheduling/availability. Permitting delayed the deployment of the sensors until 2024 after we were able to conduct archeological surveys. Weather delayed urchin removals in 2024, which pushed back our time table to outplant bull kelp from June to August. Despite these setbacks, we were able to accomplish the majority of our planned work.

Project Benefits and Results:
We included results from our surveys at Timber Cove and Fort Ross Cove for comparison below. We have seen a significant increase in kelp canopy cover and in kelp stipes at Timber Cove from 2023-2024, with both our drone-base canopy surveys and satellite imagery confirming a +1500% increase in kelp canopy cover (Figures 1-2). Urchin removal efforts were focused on protecting and expanding kelp patches (Figure 3). Initial surveys in 2025 show bull kelp recruits, particularly around the outplanting modules (Figure 4), an increase in stipe density (figure 5) and urchin densities that stayed low (<5 urchins/m2) over the winter (Figure 6). We also observed a slight increase in red abalone at Timber Cove (Figures 7-8). Overall, these data are indicative of successful kelp restoration progress and outcomes. In September, we deployed a mooring with sensors for temperature, salinity and dissolved oxygen (DO), as well as a SOFAR buoy to track wind and wave intensity, at Timber Cove (Figure 8). Data collected from these sensors show that temperature and DO are higher at the surface, while salinity is lower. These data help us lay a baseline for environmental and oceanographic conditions conducive for the increase in kelp growth observed at Timber Cove in the late summer and fall of 2024. This will help us better understand long-term trends and short-term responses to stressors. Through funding from another project, we intend to continue collecting data at this site for at least another year.

Figure 1. Orthomosaic of Timber Cove showing an increase in kelp canopy from approx. 350 sq m in September of 2023, to approx. 5,700 sq m in September of 2024. Drone flights are flown using a Phantom 4 pro, 20 MP camera at 120 m altitude.

Figure 2. Kelp canopy extent from PlanetScope satellite imagery with a 3 meter resolution in 2023-2024. For each year, at least five cloud-free images from September were processed with a convolutional neural network to identify kelp presence. The results were composited into a single annual map using a majority filter, where pixels classified as kelp in >= 50% of the images were labeled as kelp in the final map.

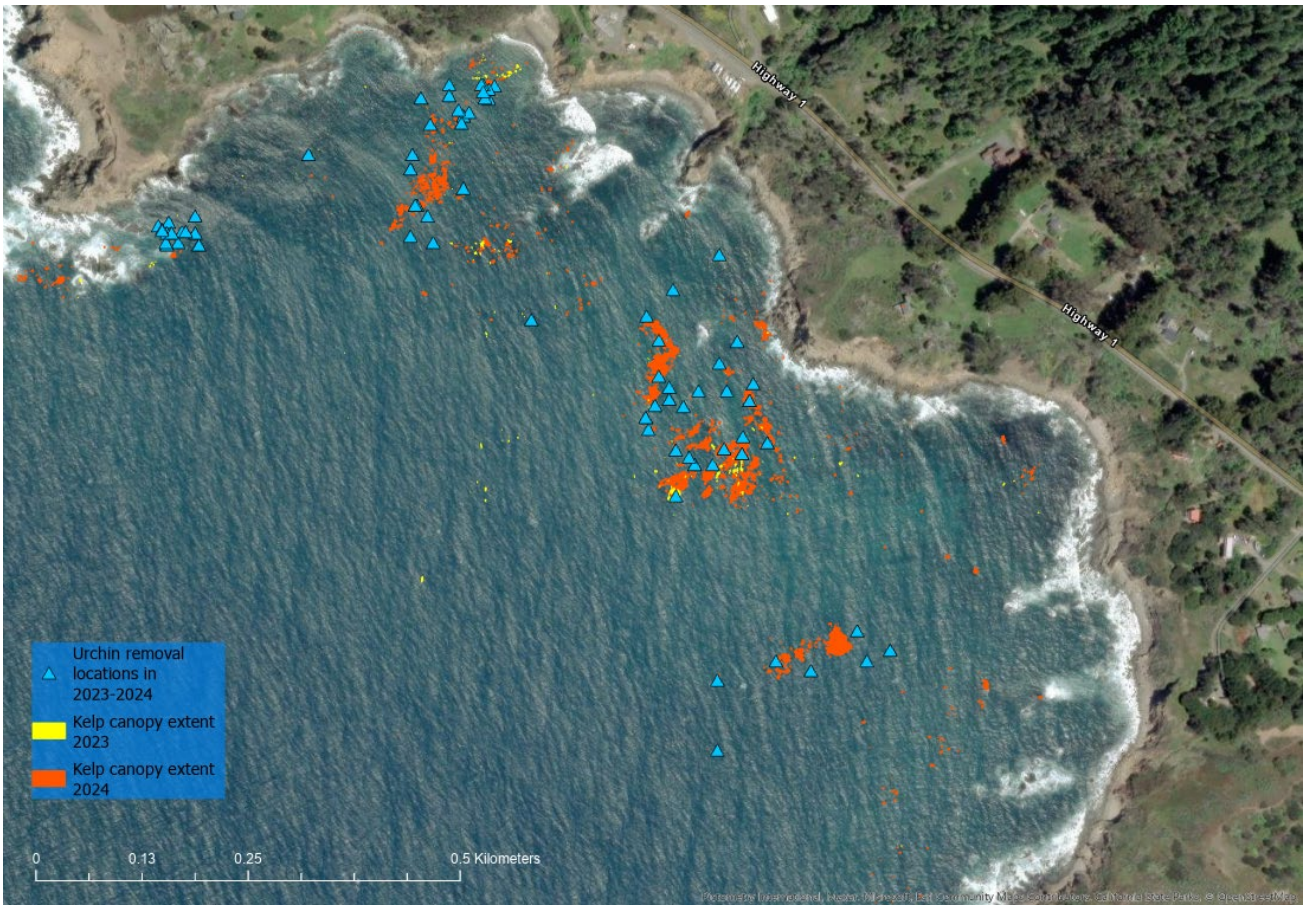

Figure 3. Urchin removal locations at Timber Cove shown in comparison to areas of new kelp canopy growth.

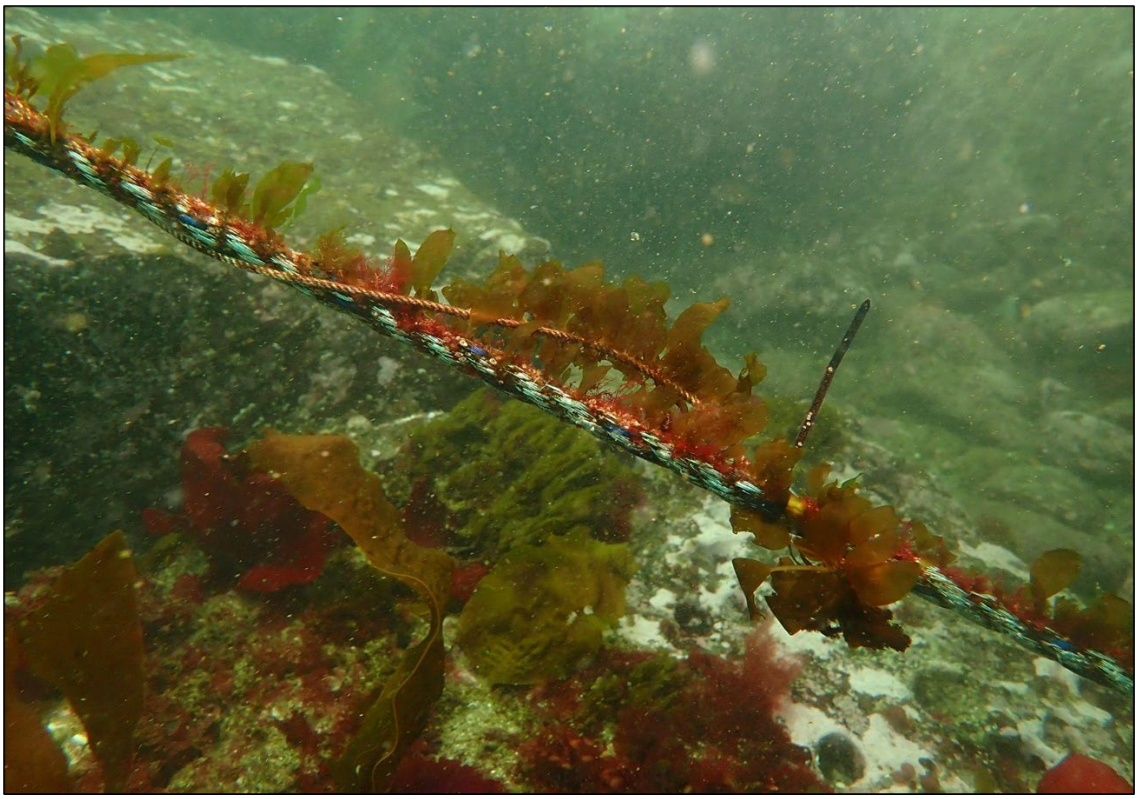

Figure 4. Bull kelp sporophytes growing on outplanted twine.

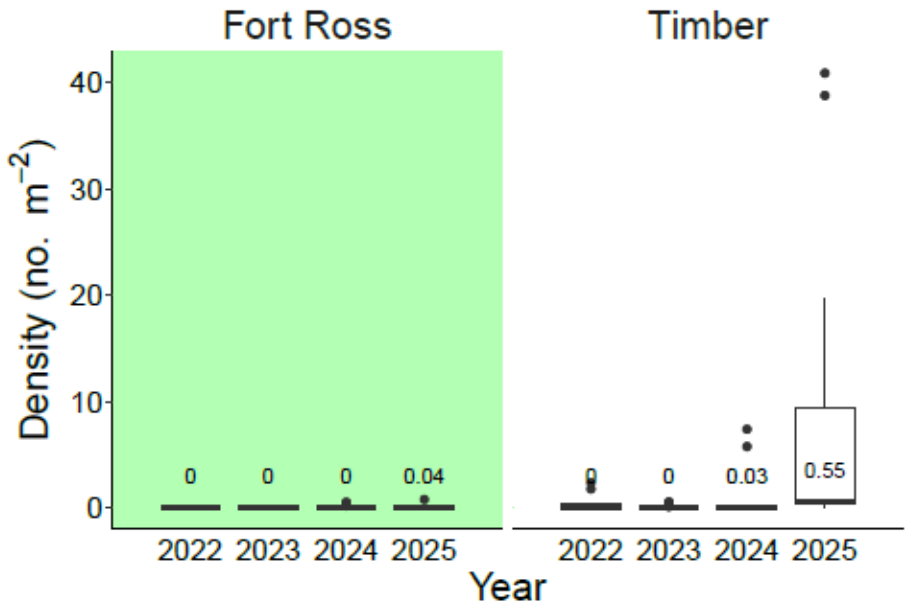

Figure 5. Distribution of bull kelp densities per site over time. Labels on boxes indicate medians. The upper and lower hinges correspond to the first and third quartiles. Whiskers extend to 1.5x the interquartile range. Data outside the whiskers (outliers) are shown as points. Survey type differed between years.

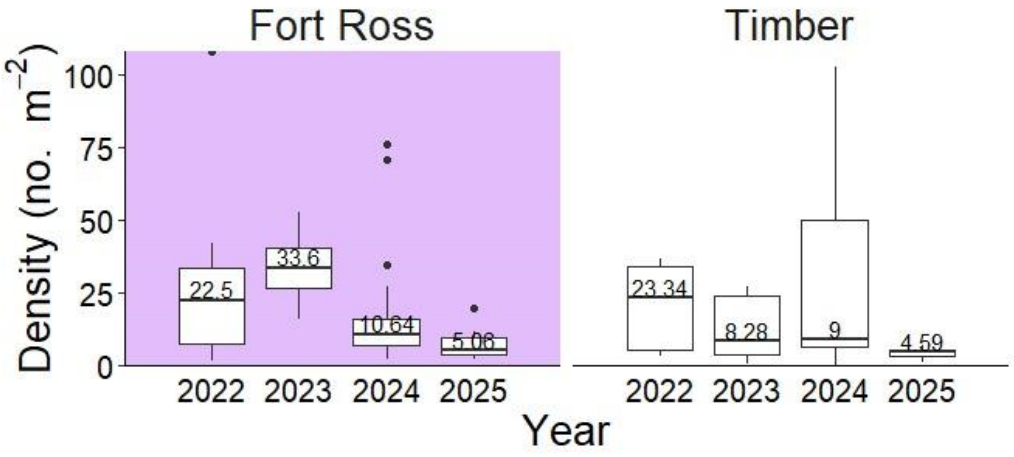

Figure 6. Distribution of purple sea urchin densities over time as measured in subtidal transects at Fort Ross Cove and Timber Cove per year since 2022. Labels on boxes indicate medians. The upper and lower hinges correspond to the first and third quartiles. Whiskers extend to 1.5 * the interquartile range. Data outside the whiskers (outliers) are shown as points. Survey type differed slightly between years.

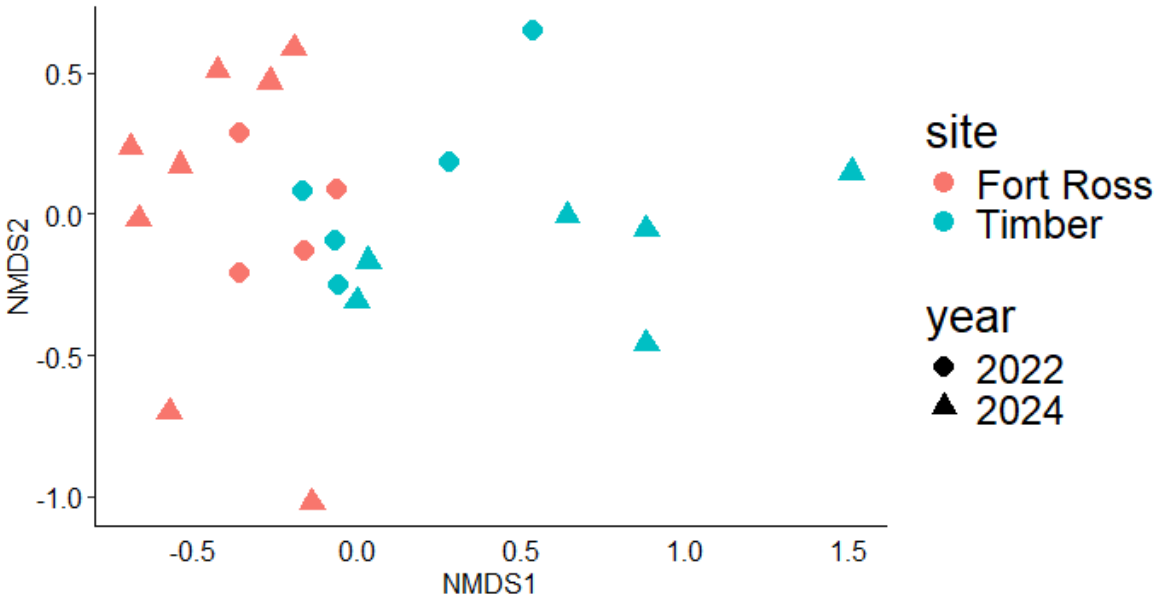

Figure 7. Nonmetric multidimensional scaling plot showing relative changes in benthic community composition at Fort Ross and Timber coves from 2022 to 2024 as measured in 30 x 2 m subtidal scuba surveys. Fish are not included. Points closer together indicate more similar communities. Of note are the outlying points on the right representing communities at Timber Cove where kelp and abalone have increased.

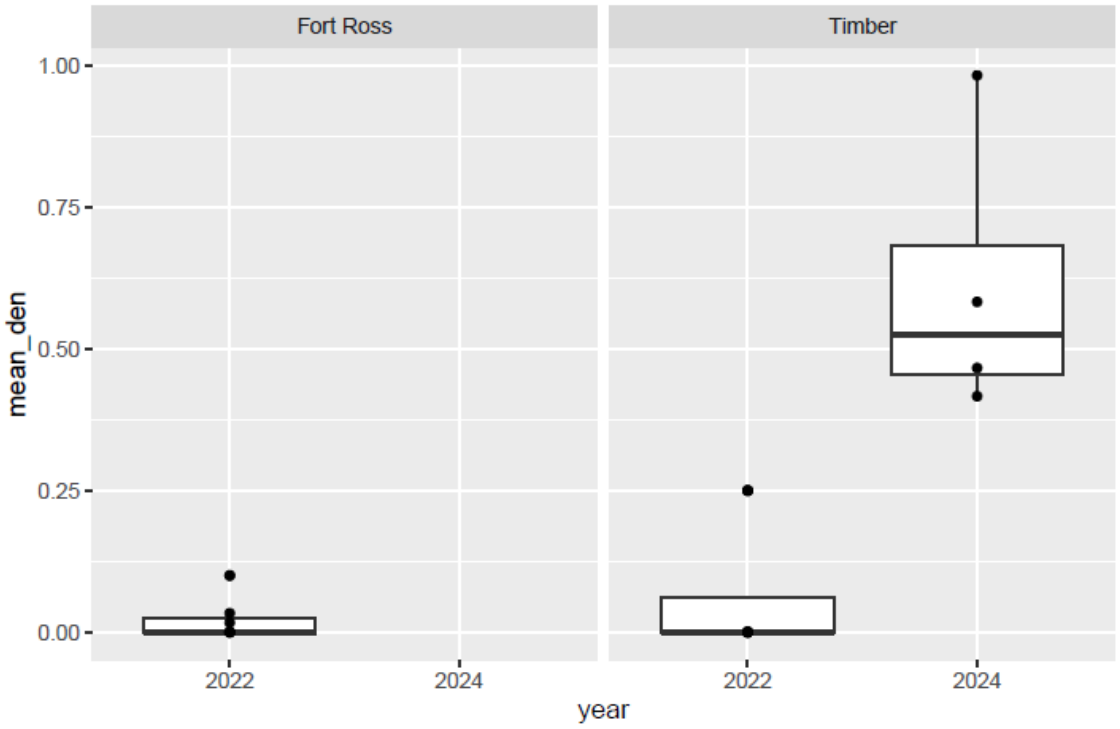

Figure 8. Box plots showing an increase in red abalone population densities at Timber Cove from 2022 to 2024 in comparison to Fort Ross Cove.

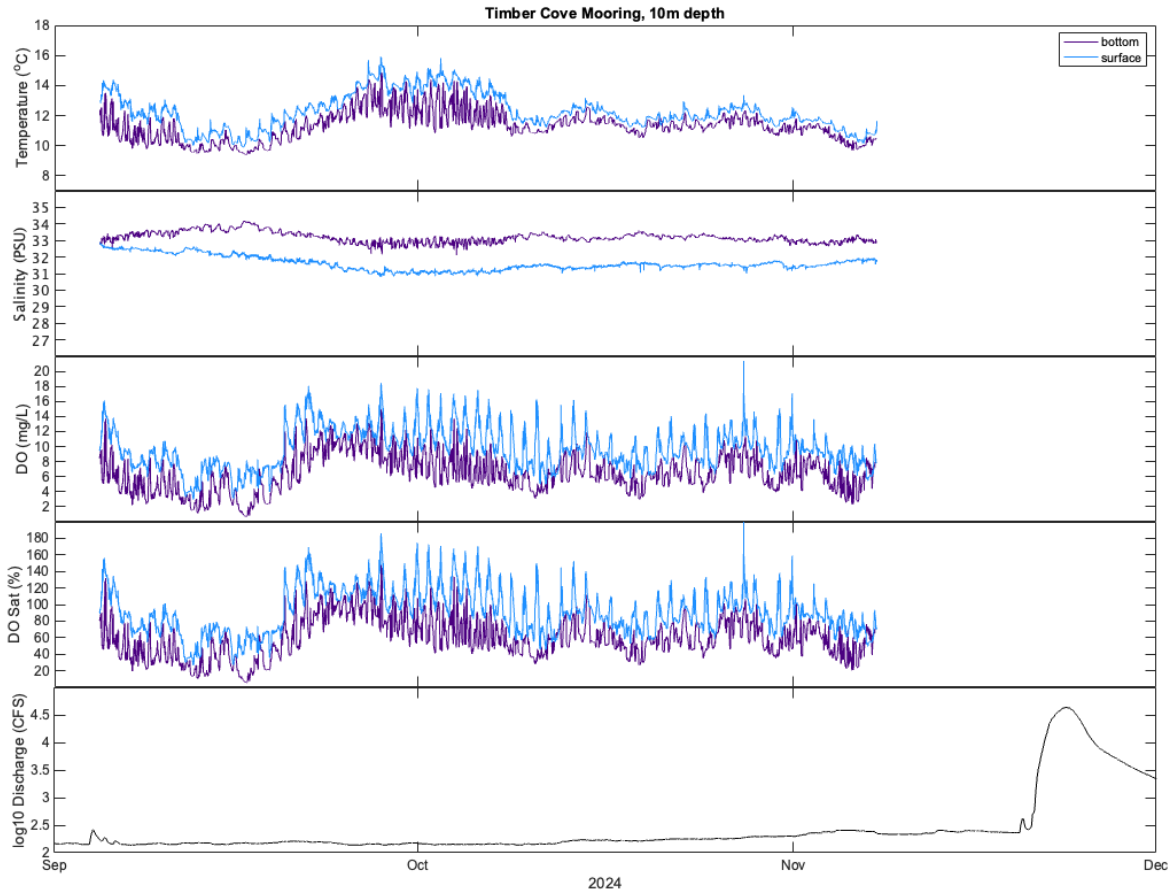

Figure 8. Graph showing temperature, salinity and dissolved oxygen at Timber Cove from sensors mounted at the top of a mooring and at the bottom (~10 m depth), with discharge from the nearest US Geological Survey gauge for context.

Estimated Co-benefits achieved to date:

(Provide narrative description of any applicable Co-benefits achieved during the project, such as: water quality improvements; water storage; wildlife impacts; etc… here.)

With increased kelp forest habitat, we are likely to see increased shelter and foraging areas for numerous fish and invertebrates. In particular, we expect to see increases in red urchins and red abalone, both of which have significant ecological, economic and cultural importance.

Summarize Benefits to Disadvantaged Communities (if applicable):

(Provide narrative description of benefits to disadvantaged communities, if applicable.)

N/A

Objectives

Project Objective (as stated in Grant Agreement)	**Objective met or exceeded? (Yes/No)***
This project seeks to transition urchin barrens back to kelp forests by reducing purple urchin populations (Strongylocentrotus purpuratus). The Sonoma-Mendocino Bull Kelp Restoration Plan, developed by Greater Farallones Association (GFA) and based on recommendations from the Greater Farallones Sanctuary Advisory Council, outlines an overarching restoration strategy that focuses on establishing a network of kelp refugia, or 'oases', along the coastline to replenish bull kelp spore availability and support broad scale recovery. This Project will focus on restoration at Timber Cove, one of the four priority kelp restoration sites the Grantee has identified in Greater Farallones National Marine Sanctuary. Coastal communities, fishermen, and Tribes in northern California have been heavily impacted by kelp forest loss through the collapse of commercial and recreational fisheries. Restoring kelp forest habitat at key locations along the coast is the first significant step towards long-term recovery and resilience. The Grantee will use awarded NOAA funds for restoration in the second year of this project.	Yes

*If No, please explain in Issues and Lessons Learned section below

Issues and Lessons Learned

We had several lessons learned, including (1) to always allow a long lead time (6 months to a year) for permitting and environmental compliance - we had not expected to need to do archeological surveys in the sanctuary, which was a significant expense and delay to the project; (2) not to rely on the availability of a large vessel to conduct our surveys, most diving activities can be done from a small boat deployed

by shore; and (3) always have a backup plan in case weather and ocean conditions do not cooperate.