RÖST MARINE RESEARCH CENTER

Carbon to Sea Initiative

Iceland Ocean Climate Science Joint Learning Opportunity:

Field Research Overview

This document provides a high-level overview of the planned ocean climate research activities proposed for the summer of 2025. The purpose of the document is to provide relevant context for applicants to the Iceland Ocean Climate Science Joint Learning Opportunity as they plan their research proposals. This does not comprise the full extent of their research, technology or decision-making process and is intentionally simplified for clarity and reference. Also note that this plan is subject to change and pending feedback from regulators.

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Background

To protect the environment and avoid the worst effects of climate change, we must remove billions of tons of carbon dioxide (CO_2) from the air this century alongside drastically reducing carbon dioxide pollution.

Unfortunately, too much carbon pollution in the air is causing big problems for our marine environment because large amounts of that excess CO_2 then naturally gets absorbed into the ocean. As a result of excess carbon pollution, the ocean is becoming more acidic, sea levels are rising, and ocean wildlife is suffering. Carbon dioxide removal (CDR) refers to a broad set of approaches to reduce the amount of carbon dioxide in the air. While climate scientists are clear that a lot of CDR will be needed, it's too early to say which approaches will ultimately be implemented.

Scientists are evaluating whether working with the ocean's natural mechanisms for removing CO_2 from the air could contribute to addressing climate change. In fact, the ocean holds more than fifty times the amount of carbon dioxide than the atmosphere, and it's absorbing more every day. Now scientists are asking if we can work with these natural processes to safely and effectively draw down carbon dioxide from the air.

Based on the safety and efficacy demonstrated to date, researchers in Hvalfjörður are proposing a small, highly controlled research study to generate knowledge about Ocean Alkalinity Enhancement (OAE).

OAE is inspired by the natural weathering of rocks, which regulates atmospheric CO_2 on millennial timescales. OAE is a promising approach for removing and permanently storing excess CO_2 as bicarbonate, a stable form already present in large quantities in the ocean. CDR via OAE takes place in two steps: 1) first by increasing the alkalinity (thereby reducing acidity) and decreasing the partial pressure of CO_2 in the surface ocean; 2) second by allowing air-sea gas exchange to equilibrate the new ocean state with the atmosphere over time.

The ocean chemistry behind OAE is well studied and understood, but to evaluate this method's potential for success, research in the field is needed. This effort aims to contribute to the field of ocean climate science with the field research described.

A. Field Research Overview

Ocean Alkalinity Enhancement (OAE) field research is scheduled for this summer in Hvalfjörður, Iceland. This will be conducted by the Research Team outlined in the Request for Proposal (Organizations & Team Members) and in the Terms & Conditions.

Dates and details are subject to change due to uncontrollable factors such as weather, feedback and direction from regulators, and other unforeseen circumstances. Any substantial changes will be communicated via email from the JLO Management Team to all applicants as soon as possible.

This research builds on several waves of site characterization studies, including Regional Ocean Model System development ([C]Worthy), Baseline Data Collection of the physics, biogeochemistry, and pelagic and benthic biology (Marine and Freshwater Institute of Iceland), Dual Tracer Release Experiment ([C]Worthy) foundational feasibility, regulatory and site evaluation research (Röst), and ongoing community engagement (Röst). *Important Note for JLO Applicants: Please direct all communications to* jlo@rostrannsoknir.is *who can coordinate with the above Research Team if necessary.*

The purpose of this research is to advance our scientific and technical understanding of OAE with two studies, described below:

Fluorescent Dye Study

Prior to the OAE study, the Research Team will conduct a study on dispersion and local ocean currents, tentatively scheduled for May 2025. The dispersion of the ecologically-safe, fluorescent Rhodamine WT dye will be traced using aerial photography via drones; while dye concentrations will be estimated using a combination of the drone products and real-time monitoring using towed fluorometers with Rhodamine WT calibrated sensors. Observations from this study are expected to provide valuable hydrodynamic data that can then be used for validation and improvement of our near-field ocean models. The dye is completely harmless and often used for research to understand ocean physics; the color will dissipate completely in 1-2 days.

OAE Pilot Study

The OAE pilot study, or “field research” is slated for July 2025. In this study, the Research Team plans to disperse a purified form of alkalinity (NaOH), diluted with freshwater to a concentration of 4.5%. This dilution helps to match the density of seawater to keep the alkalinity at the surface where it is more favorable for air-sea gas exchange. The dispersal mechanism is finely-controlled, monitoring the flow rate (approximately ~60 L/min) and concentration of the materials, and responding to the currents in the receiving water to ensure effective delivery. The slow and controlled release is planned for a period of 96 hours and designed to not exceed environmental thresholds. The solution will also be combined with freshwater that is saturated with two tracers used in scientific research - SF_6 gas and Rhodamine WT - to aid in tracking and measurement.

The added alkaline solution, dispersion outfall, mixing zone, and near & far fields will be monitored by members of the Research Team aboard a vessel, while continuous measurements will be taken from a tethered buoy and sensor suite stationed near the pier and release site. This setup will allow us to stop or adjust additional rates as needed. High-frequency SF_6 measurements will be used to trace alkalinity dispersal both spatially and temporally. The Research Team will measure key seawater chemistry parameters, including pH, dissolved inorganic carbon (DIC), partial pressure of carbon dioxide (pCO2), total alkalinity (TA), salinity, and more - before, during, and after the OAE pilot study.

In addition to physical, biogeochemical, and biological baseline data collected to characterize the system throughout the year (see Section G below), trial-specific biological monitoring will begin two weeks before the study to establish a comparative baseline, and continue during and for two weeks after the end of the study. Ecotoxicology studies with NaOH have also been conducted to inform the field research planning, e.g., to ensure that dosing does not exceed biologically harmful thresholds. As the alkaline solution is added to the system, it rapidly falls below any harmful thresholds within seconds to minutes (depending on the strength of the currents). As a reference, the resulting pH in the nearfield will not exceed the levels commonly found in alkaline-enhanced bottled drinking water.

Figure 1: Overview of the completed, ongoing and planned monitoring, modeling, and research activities in Hvalfjörður

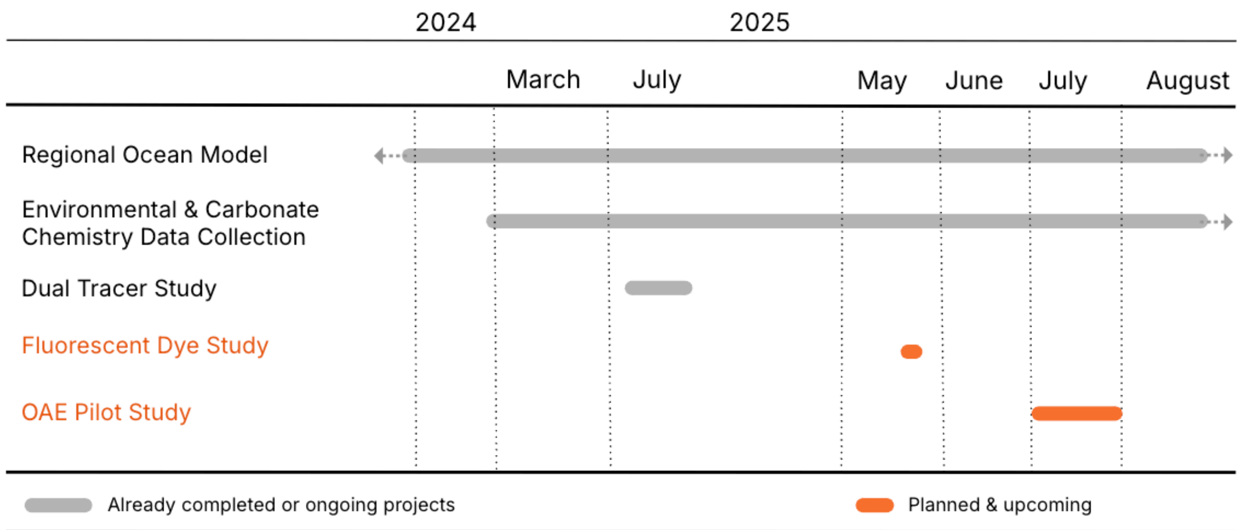


Table 1: Summary of ongoing and planned baseline monitoring activities in Hvalfjörður

Activity	Lead	Description	Dates
Baseline Environmental and Carbonate Chemistry Data Collection* **Independent of the field research*	The Marine and Freshwater Institute (MFRI)	**(20 total) Monthly vessel-based surveys at 10-12 stations throughout the fjord.** Underway profiling sensors: CTD, oxygen. Surface sensors: pCO_2, pH, CTD, oxygen. Water samples at surface and depth: DIC, ^{13}C, TA, pH, nutrients. Profiling sensors: pH, T, S, D, and turbidity and PAR. Benthic: sediment metals (at two stations only). **Five moorings deployed for 1 year throughout the fjord.** Each mooring is equipped with a CTD, ADCP, and (4/5) moorings with pH sensors.	Ongoing, surveys commenced in April 2024 Continuous since April 2024
Baseline Environmental and Carbonate Chemistry Data Collection* **Independent of the field research*	The Marine and Freshwater Institute (MFRI)	Boat-based, shore-based, and dive-based surveys of benthic, pelagic, and coastal ecosystems. Including fish, benthos, macroalgae, phytoplankton and zooplankton sampling.	Seasonal collection depending on parameter, ongoing since April 2024

Table 2: Summary of planned field research activities in Hvalfjörður

Activity	Lead	Description	Dates
Near-field Baseline Data Collection	Röst, [C]Worthy	Pier-based continuous measurements via stationary sensor package (pCO_2, CTD).	Sensor package: Continuous, since December 2024** ***some disruptions from extreme weather*
		Ca, Na, Mg, TA and DIC samples from the pier, background underway and discrete samples at one near- and one far-field CTD station.	Shortly before alkalinity addition
Fluorescent Dye Study[1]	[C]Worthy	A total of 1000L (2L of 20% dye, 998L water) is released during three distinct tidal periods of 10 min each.	May 2025, 1-2 days
OAE Pilot Study[1]	[C]Worthy	96-hour release of 4.5% aqueous solution of NaOH at a rate of 60L/min from a pier-based diffuser, alongside SF_6 and Rhodamine WT dye.	July 2025 (Daily, during 96 hours release + 10 days following end of release)
Biological Monitoring[1]	Carbon to Sea, Röst	Biological water samples collected off the pier and CTD equipped with a chl-α sensor deployed over a small boat.	14 days before, during, and 14 days following end of release

[1]*For more monitoring information see section D below*

B. Preparedness for Field Research

The OAE pilot study comes after years of scientific research and review at the lab and mesocosm scale on the efficacy and safety of Ocean Alkalinity Enhancement. In the Guide to Best Practices in Ocean Alkalinity Enhancement Research, the authors outline the seawater carbonate chemistry considerations, assess technical aspects, summarize laboratory and mesocosm experiments, and provide best practices for field experiments and modeling considerations for OAE research. The extensive water quality and environmental monitoring standards of the field research are based on this guidance and more fully described in the Carbonate Chemistry and & Environmental Monitoring Overview (Section D).

Critically, prior experiments suggest that NaOH based OAE has very limited effect on plankton communities, including fish larvae. Importantly, these experiments simulated much more extreme perturbations with NaOH than what this study aims to do.

Relevant Studies:

1. *Ferderer, A., Chase, Z., Kennedy, F., Schulz, K. G., and Bach, L. T.: Assessing the influence of ocean alkalinity enhancement on a coastal phytoplankton community, Biogeosciences, 19, 5375–5399,* https://doi.org/10.5194/bg-19-5375-2022*, 2022.*
2. *Goldenberg, S. U., Riebesell, U., Brüggemann, D., Börner, G., Sswat, M., Folkvord, A., Couret, M., Spjelkavik, S., Sánchez, N., Jaspers, C., and Moyano, M.: Early life stages of fish under ocean alkalinity enhancement in coastal plankton communities, Biogeosciences, 21, 4521–4532,* https://doi.org/10.5194/bg-21-4521-2024*, 2024.*
3. *Ramírez, L., Pozzo-Pirotta, L. J., Trebec, A., Manzanares-Vázquez, V., Díez, J. L., Arístegui, J., Riebesell, U., Archer, S. D., and Segovia, M.: Ocean Alkalinity Enhancement (OAE) does not cause cellular stress in a phytoplankton community of the sub-tropical Atlantic Ocean, EGUsphere [preprint],* https://doi.org/10.5194/egusphere-2024-847*, 2024.*

Finally, because of the sponsorship and leadership by non-profit organizations (Carbon to Sea, Röst), the study will inherently be distanced from commercial interests seeking to promote a particular technology or methodology. The sponsoring organizations strive to be ‘outcome-agnostic’ and commit to sharing results publicly for maximum transparency to the field regardless of whether they are favorable or unfavorable towards the efficacy and safety of ocean alkalinity enhancement.

C. Research Location

Figure 2: Hvalfjörður in proximity to Reykjavik & the release location at the pier at Miðsandur

D. Carbonate Chemistry & Environmental Monitoring Overview

Intensive carbonate chemistry and ocean physics monitoring will take place from the pier, via a tethered buoy, an uncrewed surface vessel, and a survey vessel (approximately eight hours of shipboard sampling per day). This monitoring will begin several days before the NaOH release, and continue for 10 days following the end of the release).

Environmental monitoring includes both water quality (nutrients, particulates, light attenuation) and biological parameters (pelagic and benthic species abundance and diversity) that build on the baseline data collected throughout the year (and the carbonate chemistry and ocean physics monitoring) with additional monitoring ramping up ahead of the field research. Intensive environmental monitoring will begin two weeks before the NaOH release, to establish a comparative baseline, and continue with additional sampling during the NaOH release and for 14 days after the NaOH release ends. All continuous sensor-based measurements will take place throughout the duration of the experiment, while all vessel-based underway and discrete sampling takes place during daytime hours for the duration of the study.

Measurement and monitoring takes place in different areas relative to the release and designed to inform a range of research questions. Definition of relevant terms:

- **Outfall**: Monitoring at the outfall provides real-time feedback for operational control of the dispersal systems.
- **Mixing Zone**: Monitoring in the mixing zone is likely to offer the highest expected signal detectability to measure carbonate chemistry, ocean physics, particulates, water quality and environmental parameters for compliance purposes. Expected ~150 m in diameter from outfall, to be refined based on dye tracer release and tidal conditions at time of release.
- **Near-field**: Area in which signal is still likely to be detectable, but diluting towards background variability. Expected to extend approximately ~1 km from the pier, to be refined based on dye tracer measurements as well as discrete and continuous measurements at the time of release.
- **Far-field**: Waters beyond near-field zone, up to ~10 km from the pier approximately, where it is likely to detect the inert gas tracer only (SF_6) but no carbonate chemistry signals. Specific sets of measurements will be taken in unperturbed areas where no SF_6 tracer is measured.

Table 3: Summary of planned measurement & monitoring activities for the Iceland Ocean Climate Science field research

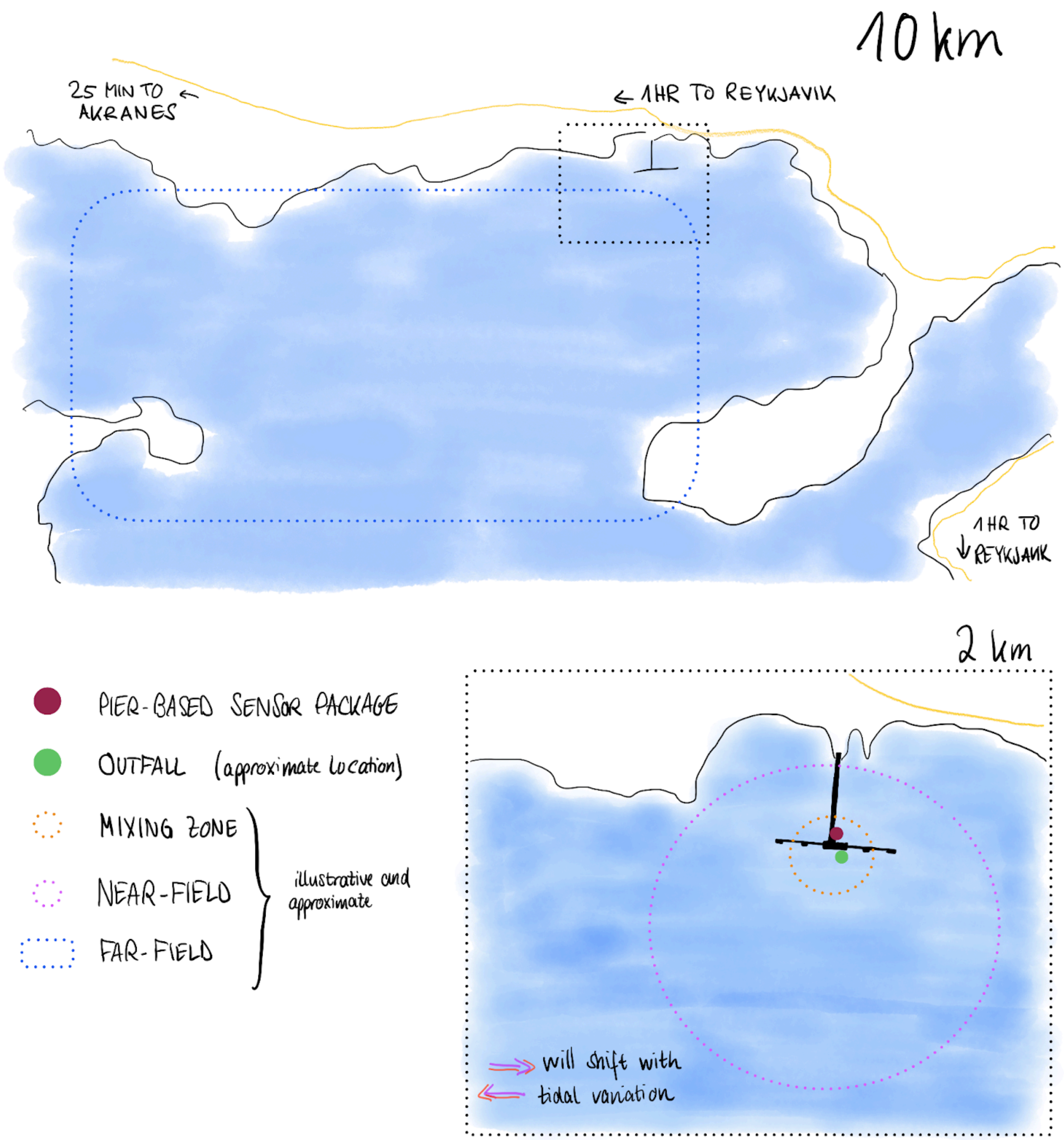
Location or Platform	Parameter	Type of Measure-ment	Sensor (if applicable)	Description
Dye Release				
Mixing Zone	Current velocity via ADCP	Continuous	Nortek Signature 1000	Bottom mounted, upward facing.
Aerial	Georeferenced imagery	N/A	Micasense RedEdge-MX Dual camera and Zenmuse L2 LiDAR camera	Two drones, equipped with RGB and multispectral cameras respectively.
Small motorized boat	Rhomadine WT CTD Turbidity	Continuous	YSI EXO 1	1 sonde towed behind the boat at the surface. 1 sonde deployed in TOYO fashion for depth profile.
NaOH release				
Effluent In pipe, before outfall	Temperature, Conductivity, Pressure	Continuous	*tbd*	Used for feedback and dosing control, to be finalized based on permit requirements.

Location or Platform	Parameter	Type of Measure-ment	Sensor (if applicable)	Description
	Turbidity	Continuous	*tbd*	
	pH	Continuous	*tbd*	
	Flow rate	Continuous	*tbd*	
Outfall In water, attached to diffuser	pH	Continuous	*tbd*	Used for feedback and dosing control, to be finalized based on permit requirements.
	Turbidity	Continuous	*tbd*	
Mixing Zone Bottom-mounted	Current velocity via ADCP	Continuous	Nortek Signature 1000	Bottom mounted, upward facing.
Mixing Zone Pier-based sensor package	CTD	Continuous	Sea-Bird SBE37-SMP MicroCat	
	pCO_2	Continuous	Pro-Oceanus CO2 CV	
	Total Alkalinity	Continuous	Contros HydroFIA TA	Seawater is pumped into a flow-through system on the pier from the same location as the in-situ pCO_2 sensor.
	Rhodamine, Turbidity, Chl-α Fluorescence	Continuous	YSI EXO 1	
	Macro fauna			Visual observation for whales and dolphins, seals, or seabirds near the operational site. Prior reports of known cetacean movements will also be monitored.
Mixing Zone Tethered platform	pH CTD Oxygen	Continuous	Sea-Bird SeapHOx	
	Suspended Particles	Continuous	LISST-Tau	The instrument measures suspended particles (PIC, brucite, POC, sediments, etc.) using particulate beam attenuation at 650 nm.

Location or Platform	Parameter	Type of Measure-ment	Sensor (if applicable)	Description
	Particulate Inorganic Carbon	Continuous	LISST-PIC	Additional at the same depth as the other sensors, using a cross-polarized beam transmissometer at 650 nm to measure PIC concentrations.
	Rhodamine WT, Turbidity, Chl-α Fluorescence	Continuous	YSI EXO 1	
Near-field Uncrewed Surface Vessel* **See section E for additional details*	Wind speed Air temp Barometric *p* Relative humidity	Continuous	GIII MaxiMet	Met station upgrade on Base model DataXplorer Open Ocean Robotics USV.
	360° visible spectrum image Infrared spectrum image	Continuous	FLIR Boson	
	pCO_2	Continuous	Pro Oceanus CO2 Pro CV ATM	Strapped to hull to allow for air and surface water measurement.
	pH	Continuous	ANB OC300	Strapped to hull.
	Current velocity	Continuous	Nortek Signature 500 ADCP	Downward facing on hull.
	CTD Dissolved Oxygen Chl-α Fluorescence Rhodamine fluorescence Backscatter		RBR *concerto3*, RBR*tridente*	On profiling winch (25 - 50m).
Near- and far-field Vessel - underway	Temperature, Salinity	Underway	Thermosalinograph	
	SF_6	Underway		Using a specially designed system equipped with a gas extraction unit and a gas chromatograph (GC) with an electron capture detector (ECD), measuring concentrations from pumped surface water.

Location or Platform	Parameter	Type of Measure-ment	Sensor (if applicable)	Description
	Alkalinity *p*CO_2 pH	Underway	Contros HydroFIA	
Near- and far-field Vessel - CTD stations (2 near field, 2 far field, daily, 6 depths)	CTD depth profiles (including PAR, tbd) Chl-α Fluorescence	Continuous at 4 CTD stations	Sea-Bird CTD rosette	12 Niskin bottles of 8 L each will be deployed to collect samples from up to six different depths.
	SF_6	Discrete		Measured on shore each night using a purge and trap SF_6 system; concentrations determined using a GC-ECD.
	Alkalinity DIC	Discrete		Samples will be preserved immediately after sampling, partially analyzed in the evening using the underway systems, partially analyzed in laboratory facilities afterwards.
	Ca, Mg & Na, particle imaging	Discrete		Na, Ca, and Mg concentrations will be measured via ICP-OES (inductively coupled plasma optical emission spectroscopy), and particle imaging will be conducted via SEM (scanning electron microscopy).
Near- and far-field Pier and Vessel - CTD stations (1 near field, 1 far field, 1 in unperturbed zones, every 2nd day, 3 depths)	Ammonia, nitrite, nitrate, phosphate	Discrete		Samples will be filtered and analyzed on the vessel or in laboratory facilities.
	Plankton	Discrete		Chl a and pheophytin sample filters frozen until laboratory analysis; Plankton ID samples from Niskin bottles and vertical zooplankton net tows preserved and stored in refrigerator, analysis via Flowcam, flow cytometry and/or microscopy.
Benthic near- field (minimum of 1 before, 1 during, 1 after)	Fauna	Discrete		Grab samples will be collected, preserved, and analyzed. A drop camera with light will be used for benthic surveys.

Figure 3: Illustrative drawings of planned research locations at ~10km and ~2km scales



E. Uncrewed Surface Vessel Sensor Overview

As referenced in the monitoring overview above, an emerging monitoring methodology will be deployed to collect additional data from the field research using an Uncrewed Surface Vessel (USV). If demonstrated successfully, USV deployed sensor technology has the potential to greatly decrease the costs associated with biogeochemical monitoring using currently widely accepted methods and lay the foundation for greater scaled deployment. The survey vessel will allow us to collect high fidelity data to complement samples and measurements from buoys and research vessels. It will be operated by a specialist from the pier.

The USV planned for deployment in this field research is the Open Ocean Robotics DataXplorer™ USV (base-model) with the following specifications:

- Upgraded weather station: Gill MaxiMet multi-parameter weather station, *wind speed and direction, air temp, barometric pressure, relative humidity*
- Single beam (depth, speed in water)
- 360 visible spectrum cameras
- FLIR Boson infrared spectrum camera
- AIS transceiver & radar reflector

The USV will be augmented with a suite of additional sensors, designed to collect and process data in real time.

Custom Sensor Integrations for MRV Data Acquisition:

- Profiling winch with slipring & conducting cable
- Nortek Signature 500 ADCP
- RBR Concerto^3 CTD (Conductivity, Temperature, Pressure) ODO (Optical Dissolved Oxygen) + RBR Tridente (Chl-a, backscatter, Rhodamine)
- ANB OC300 pH sensor
- Pro-Oceanus CO_2 Pro CV Atmosphere

F. Site Characterization

Background

Oceanography

Hvalfjörður is a breathtaking threshold fjord located about 40 kilometers north of Iceland´s capital city. The fjord is approximately 35 km long, 3.5 km wide, and 15–50 m deep, with a counterclockwise circulation marked by deep inflow along the southern shore and surface outflow along the northern shore. Tidal ranges vary from 1.5 meters at neap tide up to a maximum of 4.5 meters at spring tide. Sea surface temperatures can range from 0°C in winter to 10°C in summer. Average salinity in the fjord is 33–34 PSU, with little stratification in winter and variable stratification from April to October. The fjord's major freshwater input sources include the rivers Laxá í Kjós, Brynjudalsá and Botnsá. Currently, no discharge data is available for these rivers (*a potential opportunity for JLO applicants to address*).

Prior to this research project, little information on the fjord's hydrodynamic structures has been published. However, a nested, high-resolution Regional Ocean Model (ROMS) has been developed for the purpose of this field research and may be available upon request.

Biology, ecology, and fisheries

The aforementioned rivers that run into Hvalfjörður are important for recreational fishing, particularly for salmon and sea trout fishing. Demersal fisheries in Hvalfjörður are limited, mainly occurring at the fjord's mouth. Historically, Icelandic scallop and blue mussels have been harvested in specific areas, while crab fishing has become more widespread in recent years, with decapod crab prevalence well-documented. Although knowledge of the fjord's role as a nursery ground for demersal stocks is limited, data from long-line fisheries suggest a high proportion of juvenile cod remain in the fjord for up to 2-3 years. Pelagic fish are typically absent in fishable quantities in Hvalfjörður; though herring populations may utilize the fjord for overwintering and nursery habitats.

Benthic maerl beds, composed of corralline red algae, are aggregated throughout the fjord; while intertidal macroalgae grow seasonally along the fjord. Zooplankton, such as copepods and krill, seasonally inhabit the fjord and are important for stock fish species. Whales, particularly humpback, minke, and other porpoise populations utilize the fjord; while harbour and gray seals can commonly be spotted from shore. Limited historical quantitative data regarding plankton communities or algal blooms is available, but is now being established through baseline data collection.

The tolerance of marine life to high concentrations of NaOH has been tested by independent scientific labs using international standard procedures. These tests were performed on different forms of marine life — including phytoplankton, fish and shellfish — as well as through different phases of development such as larval or reproductive stages. These thresholds helped us design research to stay well below any concentration, volume or duration thresholds that would impact marine life.

Public Data Sources

Below is a list, including links, to publicly available data in Iceland:

- The Icelandic Meteorological Office (*Veðurstofa Íslands*, *Mogt*)
- The Marine and Freshwater Institute (*Hafrannsóknastofnun*)
- The Icelandic Road and Coastal Administration (*Vegagerðin*)
- The Icelandic GeoSurvey (*ÍSOR*)
- The Icelandic Coast Guard (Landhelgisgæsla Íslands)
- Icelandic Institute of Natural History (*Náttúrufræðistofnun*)

Additional Site Information

Figure 5: A map of southern Iceland showing points of interest and the research area (Hvalfjörður).

Research Vessels

One vessel will be chartered for the field work, estimated at approximately 15 meters long and 7 meters wide. Bench space may be available. One smaller work boat (*e.g., a Zodiac*) may also be available during the field research, but will be primarily used for transportation between ship and shore. Please specify what, if any, shipboard space / personnel may be needed for your research.

Akranes / BREIÐ
Akranes is a town located about 30 minutes by car from the release site. BREIÐ, a multi-use workspace and storage facility, is located in Akranes.

Release site / pier
The release site is located in a semi-enclosed bay situated near the head of the fjord. The pier at Miðsandur is a tall, long, T-shaped pier strong enough to drive cars on. A small pierhouse, used for maintenance and electricity, sits on the pier and is spacious enough to house some scientific equipment and scientists, and can be utilized for breaks. This is the primary work site that will be used during the 2025 field research.

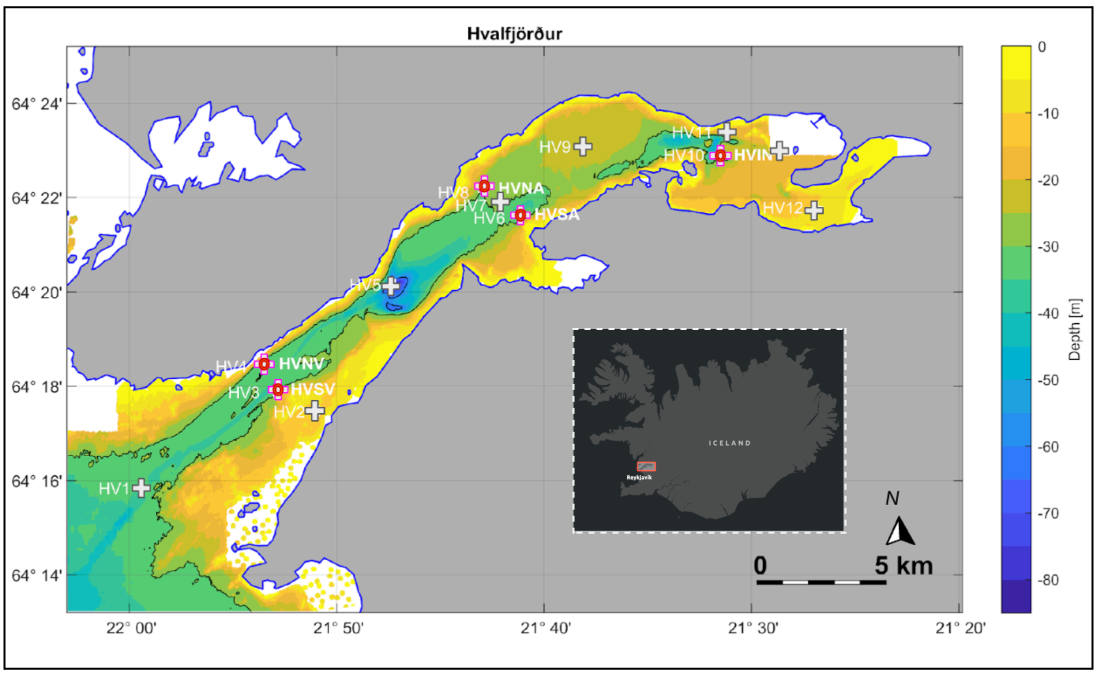
Figure 6: Shore level and aerial views of release site / pier

G. Summary of Baseline Data Collection

In 2023, Carbon to Sea Initiative and Röst Marine Research Center released a Request For Proposals (RFP) to conduct a robust baseline data collection regime. A call for research proposals yielded nine, high-quality proposals which were then reviewed by a panel of science and industry experts. After deliberations, the proposal from the Marine and Freshwater Institute of Iceland (MFRI) was selected. The resulting interdisciplinary oceanographic research plan (2024-2025) aims to collect vital measurements that will be used to characterize the variability, seasonality, and the chemical, physical, and bioecologic properties of Hvalfjörður. This rich portrait of the fjord will not only inform the scope and potential of this scientific research, but will also deepen Iceland's understanding of their own unique and ecologically important waters, with significant contributions to the public domain. The research being conducted by the MFRI is on-going, but preliminary results are outlined below:

Fifteen of 20 planned oceanographic cruises were completed from April 2024 to February 2025 by the Marine and Freshwater Institute of Iceland. Twelve Conductivity, Temperature, Depth (CTD) survey stations were initially designated along the fjord to be sampled regularly, though sampling plans were adjusted to be more efficient as the cruises progressed, reducing the stations to 10. Concurrently, five moorings were deployed in the fjord in April 2024 and will remain deployed until after the field research.

Figure 7. Location of Moorings (pink circles) and CTD stations (pink and white crosses).



Direct collection of plankton and fish species is included in the baseline measurements research plan using tow nets and trawls, respectively, for species identification and abundance estimations purposes. Later in 2025, benthic and pelagic algal communities will be sampled more frequently, with emphasis on the spring algae bloom. FlowCams and discrete water samples for eDNA analysis are currently being processed to produce a quantitative community assessment at three survey stations. Additionally, chlorophyll-α

and phaeopigment measurements made from discrete water samples will be used to estimate seasonal changes in phytoplankton biomass.

Table 4: Summary of Baseline Data

Category	Parameter	Frequency and Sampling Type	Data Currently Available
Oceanography & Plankton	**CTD** **Oxygen** **ADCP** **pH** pCO_2	Continuous logging ***5 Mooring locations*** Deployed since April 2024 (pCO2 deployed at pier)	**April 2024-Feb. 2025:** CTD, oxygen, ADCP **May 2024-Feb. 2025:** pH **Nov. 2024-Jan. 2025:** pCO_2
	CTD **Oxygen** **Fluorescence-** (Chl-α) **PAR**	Survey sampling ***Vessel-based sampling stations (10-12)*** Approx. 20 cruises with increased frequency around spring bloom (10 - 30 day intervals)	**April 2024-Feb. 2025:** CTD, oxygen, Chl-α, PAR
	Oxygen, pH, Salts, DIC **Nutrients** **Ammonium** **Total Alkalinity** eDNA*	Discrete water sampling ***3-6 samples per station*** Samples taken at 1-3 depths	**April 2024-Nov. 2024:** Salts, oxygen, Nutrients, TA, DIC **April 2024-July 2024:** pH, Ammonium **eDNA are still waiting for processing*
	Phytoplankton community structure at *selected depths*	Discrete water sampling and FlowCam ***2-3 samples per cruise***	**April 2024-January 2025:** FlowCam and chlorophyll
Benthic	**Grab sampling** **Tow Camera** **Maerl Beds** **Beam trawl**	Selected, seasonal station sampling ***100 grab samples; 5 drop frames; dive-based samples; 20 trawl transects***	**Some sampling from October 2024*** *Grab, tow, and beam
Pelagic *(Fish, zooplankton, algae)*	**Acoustic** measurements **Small gear** and **Hand** sampling	Seasonal sampling ***Boat and shorebased sampling along fjord***	**Sampling began in October 2024,** *and will be more frequent after March 2024.*

Descriptions of the type of data being collected as part of the baseline measurements project. ***Most datasets are available for the time period between April 2024 and November 2024 as of January 2025. Processing of datasets is ongoing****. All datasets listed above will be quality assured by or before September of 2025. Additional preliminary baseline data can be shared as collected when needed. All data will be made publicly available on an open source platform after final calibrations and quality assurances are completed by the MFRI.* ***Please contact Röst if you have any questions about the baseline data.***

H. Ongoing Community Engagement

The summer 2024 study and the activities planned in May and July 2025 have been discussed with and will continue to be iterated with government authorities, institutions, residents, and various stakeholders. Past engagements include a Public Meeting in June 2024, an open presentation during a symposium held at the University of Iceland, meetings with various government ministries, meetings with conservation and community groups, as well as fishing associations.

The Research Team is committed to ongoing engagement with members of the public and welcomes community focused proposals in the Joint Learning Opportunities to further catalyze public engagement within the Icelandic community. To keep current with the activities at Röst Marine Research Center, updates will be posted to the website https://rostrannsoknir.is.