

Running Tide 2023 Iceland Experiment Overview

Version 1.1 - Jul 14, 2023

Below we outline the experiments that Running Tide has planned, started in 2023 and are part of the work related to the research permit issued by the government of Iceland on July 8, 2022 (“**the permit**”) to research and test Running Tide’s Carbon Removal System (“**the system**”). For each experiment, we outline the purpose and goals and how we aim to reach those goals. The substrate used in these experiments are individual pieces of woody biomass (woodchips) coated with alkaline materials (calcium carbonate and/or calcium oxide).

Please note that experiments might be added to this from time to time. In those cases, an updated version will be shared. Updates are highlighted in yellow.

More details can be provided on request.

For any questions, please contact:

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Overview of in progress and planned experiments in and around Iceland

Deepsea Benthic Experiment #2	
Status	In preparation (target start date: September 5, 2023)
Purpose	To actively monitor the ecological and environmental impact and degradation of carbon buoy materials on the seafloor.
Method	Terrestrial biomass-based buoys and <i>Saccharina latissima</i> will be sunk to the seafloor (approximately 2600 m) in a benthic lander system with a camera connected to Ocean Networks Canada cable infrastructure. Camera images and data from sensors will be transmitted back in near real-time, providing information on visitation by larger organisms, visible changes to buoys over time, and environmental conditions. In addition, water and radial sediment samples will be recovered during ROV visitation to the study site. After approximately one year, the benthic lander will be recovered and materials analyzed.
Reporting plan	Data will be made available to Running Tide through ONC’s Oceans 3.0 system in near-real time after a commissioning period of about one month. Running Tide will prepare status reports. This collaborative project will likely result in formal presentations and publications from both ONC and RT.
Notes	In partnership with Ocean Networks Canada

Deepsea Benthic Experiment #1	
Status	In progress (Start date: June 15, 2023)
Purpose	To test the degradation rate of carbon buoy materials on the deep seafloor and monitor impact to the deep benthos.
Method	Terrestrial biomass, <i>Ulva lactuca</i> , and <i>Saccharina latissima</i> will be sunk to the seafloor (approximately 4000m) during the Polarstern Hausgarten Cruise, along with <i>Sargassum</i> , as part of a collaboration with researchers at the Alfred Wegener Institute for Polar and Marine Research. The study site will be revisited after one year to collect sediment samples, subsamples of the sunk material, and other environmental variables using sensors. The study site may be revisited after a second year pending the first year results.
Reporting plan	This collaborative project will ideally result in a publication driven by Running Tide's academic partners. Regardless, Running Tide will summarize results after the one year sample collection and analysis is complete.
Notes	In partnership with the Alfred Wegener Institute for Polar and Marine Research.

Iceland Coastal Benthic Experiment	
Status	In progress (since June 14th, 2023)
Purpose	To actively monitor the impact of deposited biomass on the benthic environment.
Method	Substrate is deposited in nets (100kg wet weight each) at the bottom of Hvalfjörður at 30m depth. Water and sediment samples will be collected routinely to monitor the effects of the substrate on the benthic environment at the sediment interface. This includes analysis of ocean and sediment chemistry, composition of microbial communities, as well as epifauna and infauna. Samples will also be collected at a control plot in the same area.
Reporting plan	This 8 month long experiment will have a mid-way report and a final report.
Notes	This is one of multiple benthic experiments Running Tide is conducting this year. They will be conducted in several locations at varying depths down to the abyssal zone.

Iceland Carbonate Dissolution #1

Status	In progress (Start date: May 17, 2023)
Purpose	To determine the dissolution, dilution, and potential impact of LKD (lime kiln dust, CaO) deployment in the surface ocean.
Method	LKD coated substrate will be placed in the ocean and water sampled with high frequency following the deployment. Analysis of alkalinity and trace metals will be used to estimate the environmental impact of the substrate coating over time in a more controlled manner than is possible in an open ocean deployment.
Reporting plan	Study report.
Notes	This is a pilot study for Iceland Carbonate Dissolution #2. Iterations of the experiment are expected.

Iceland Carbonate Dissolution #2

Status	In preparation (target start date: Q1/Q2 2024)
Purpose	To understand the comparative transport of substrate, trajectory buoys, and dissolved alkalinity, as well as the dissolution rate and addition of trace metals in open ocean environments.
Method	<p>LKD and rhodamine coated substrate and trajectory buoys will be deployed in an exposed area. Measurements of DIC, pH, and TA taken in the plume post-deployment will be compared against baseline values collected prior to the deployment to determine whether changes to surface ocean chemistry can be detected. Furthermore, trace metal concentration and dissolution will be measured.</p> <p>To address questions about the differences between buoy trajectories and substrate trajectories the trajectory of the substrate will be determined using aerial imagery and in-situ rhodamine dye measurements ultimately comparing to the GPS coordinates of the trajectory buoys.</p>
Reporting plan	Study report several months after experiment finishes.
Notes	

Open Ocean Ulva Growth	
Status	In progress (start date: week of June 5)
Purpose	To understand growth rates and potential of <i>Ulva lactuca</i> in open ocean conditions. To collect water samples to enable us to recreate the ocean environment for continued lab studies.
Method	Cotton rope seeded with <i>Ulva lactuca</i> will be placed in ocean observation platforms with cameras and deployed in the open ocean. Four observation platforms with two cages each will be deployed at a time. Images will be automatically captured four times per day during float time and images analyzed manually and using machine vision for <i>Ulva</i> growth. Water samples will be collected at the deploy site and analyzed for N, P, Fe, and salinity.
Reporting plan	Summary report of results to be prepared late summer early fall (after 2-3 months of float time).
Notes	We expect between 5-6 repetitions of this experiment.

Open Ocean Carbon Removal System Deployments	
Status	In progress (start date: May 15)
Purpose	To understand the immediate environmental impacts of deploying Running Tide's carbon removal system on the surface layer of the ocean. To understand the transport, dispersion, and sinking of the substrate. To understand and quantify the net carbon impact of deploying Running Tide's system. To gather real world in-situ data to train our oceanographic models.
Method	Substrate will be deployed far off shore (~190 Nm) in batches of 500-1000 bone dry metric tons (BDMT) of substrate (estimated 40-60% moisture content). Multiple material samples will be collected prior to deployment and analyzed for carbon content and moisture, as well as ash content. Moisture will also be analyzed continuously as the deployment vessel is loaded using a moisture sensor. Deployment site will be selected based on weather and current forecast using Running Tide's prediction models. Water samples will be collected at the deployment site before (baseline) and after deployment. Trajectory buoys will be deployed alongside the material to track dispersion and ocean currents. Ocean observation platforms with samples of the substrate will be deployed to track float time. Weather allowing, aerial photographs (drone) of deployed material will be captured right after deployment to visually analyze dispersion. Net carbon impact will be calculated according to Running Tide's framework protocol using data gathered in the field, material samples, and other inputs defined in the protocol.
Reporting plan	Regular updates on results of deployments (water chemistry, dispersion and sinking, net carbon removed). End of season final report on experiment outcomes.
Notes	

Overview of completed experiments and experiments being processed

Open Ocean Sensor Suite Deployment	
Status	Processing (start date: December 2, 2022)
Purpose	To gather real world in-situ data to train our oceanographic models. To gather and analyze water samples in similar areas to where deployments will take place.
Method	Deploy our suite of sensors (trajectory buoys and ocean observation platforms) mimicking a research deployment without substrate. Map trajectory data from sensors to oceanographic models. Train machine learning models to analyze data from observation platforms for sinking rate calculations. To gain information on ocean conditions around future deployment sites, TA, pH and conductivity values are obtained from seawater samples collected at time of sensor deployment.
Reporting plan	Final report under way.
Notes	