



Review letter on Running Tide's Catalog of Environmental Exposures

8. June 2023

Client: Running Tide

Deloitte: Running Tide has requested Deloitte to issue a review letter regarding Running Tide's Technologies Ocean CDR: Catalog of Environmental Exposures.

Disclosure

Please note that this is only a review letter, since not all factors which may be important to its topic have been looked at in depth. Further inspection could lead to another discussion and conclusion than is covered here. For this reason, Deloitte does not take any responsibility for assumptions or decisions which are taken on the basis of this review letter.

Contents

- Protocol document title 3**
- Background 3**
- Document purpose 4**
- PELAGIC ECOLOGY 5**
- PELAGIC ECONOMIC ACTIVITY 6**
- BENTHIC ECOLOGY 6**
- BENTHIC ECOLOGY ACTIVITY 6**
- EARTH SYSTEM IMPACTS 7**
- Evaluation 7**

Protocol document title: Running Tide Technologies Ocean CDR: Catalog of Environmental Exposures

Background: Running Tide is developing a technology focused on removing carbon from the atmosphere (fast carbon cycle) and transferring it to the ocean floor (slow carbon cycle). Sequestration scales are expected to be on the order of 100’s to 1000’s of years depending on depth and ocean basin. The carbon removal from atmosphere to the ocean floor will be conducted by deploying of passive drifting organic material hereafter named “carbon buoys” designed to passively float for a designated period at the ocean surface after which they will lose buoyancy and sink rapidly to the ocean floor within a period of few hours.

To test this, a pilot study will take place in the Atlantic Ocean to the South of Iceland in 2023. The goals of the Icelandic Pilot are contextualized within Running Tide’s broader program of research as stated in RUNNING TIDE’S TECHNOLOGIES OCEAN CARBON REMOVAL RESEARCH ROADMAP (March 2023)¹ where a more specific explanation of the scientific program can be found.

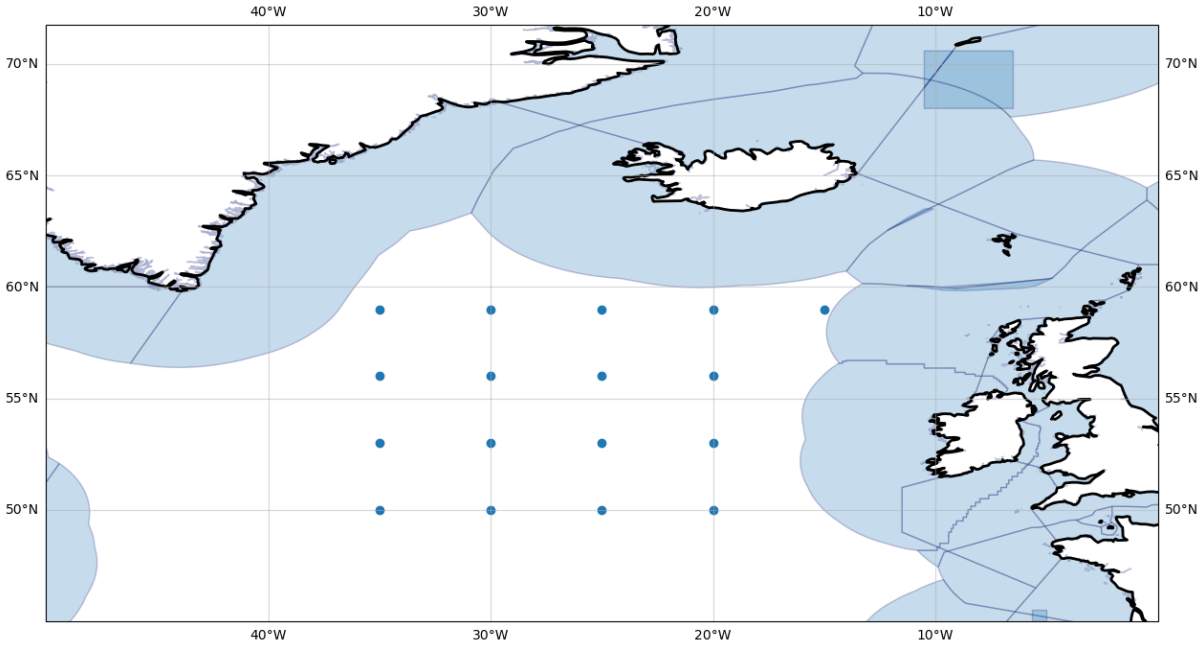


Figure 1. The region where carbon removal deployments will take place. Blue points show the deployment locations in 2023. Each point is assessed as part of an impact assessment to gain a coarse view of variance in impact based on location. A detailed prediction is generated for each individual deployment, considering carbon removal suitability and potential impacts on sensitive regions. Locations that are deemed unfavourable for carbon removal or may have adverse effects on sensitive areas are excluded.

¹ <https://www.runningtide.com/blog-post/ocean-carbon-removal-research-roadmap>

For best practice purposes, Running Tide partnered with Ocean Visions Expert Team, for evaluating Running Tide Technologies for open ocean kelp farming for carbon sequestration. Ocean Vision Expert Team and Running Tide communicated on a biweekly – to monthly basis since the formation of the Ocean Vision Team in January 2021. The findings were published that same year.² Recommendations by Ocean Vision were considered during the preparation of Running Tide’s Catalog of Environmental Exposures.

Additionally Running Tide partnered with Deloitte sustainability and carbon experts based in Iceland, to review its Catalog of Environmental Exposures, to increase transparency and verifiability. Deloitte and Running Tide held weekly to monthly meetings since the partnership was initiated in January 2023 until the final document was submitted to Deloitte for a final review.

Document purpose: The purpose of Running Tide’s Technologies Ocean CDR: Catalog of Environmental Exposures document, is to give an overview of potential environmental exposures that may arise from the proposed carbon removal methodology. The document is intended to be used on a project specific bases to perform an environmental impact assessment (EIA).

Running Tide has developed an exposure classification meant to assess potential exposure that may lead to environmental impact or produce environmental harm. It additionally provides guidance on how to determine the risk associated with that impact or harm. Running Tide categorized their assessment of environmental exposures into six sections:

1. Pelagic ecology
2. Pelagic economic activity
3. Benthic ecology
4. Pelagic ecology
5. Benthic ecology activity
6. Earth system impacts.

Running Tide evaluated exposures to these factors on the basis of the underlying knowledge and the general consensus on these and classified as:

Speculative exposures are hypothetical in nature and are either proposed as exposures by our own teams or mentioned as a possibility in the literature. Speculative exposures are not supported by substantial rigorous analysis, consensus, or relevant empirical evidence.

Substantiated exposures are either presented with supporting evidence and/or analysis in multiple peer-reviewed publications or identified by governing bodies in governmental publications. Substantiated exposures do not yet have consensus, and there may be some publications and bodies of work that offer alternative hypotheses or results.

Consensus exposures are strongly supported with empirical evidence, rigorous analyses, and widely accepted as an exposure across researchers, governmental agencies, and industry.

The exposures are listed below along with Running Tides assessment on the scientific consensus of their impact.

² Ocean Visions Expert Advising and Evaluation Team for Running Tide Technologies, Inc. Progress Report 1. Preprint at (2021).

PELAGIC ECOLOGY

Exposure	Classification	Mitigation provided
Shading of light due to floating carbon buoys	Consensus	Yes
Direct introduction of invasive species	Consensus on some species, speculative on others	Yes
Novel connective	Consensus	Yes
Physical exposures to foreign substances	Consensus on plastic, speculative on non-plastic	Yes
Chemical exposure to foreign substances	Consensus	Yes
Physical harm to marine mammals	Consensus	Yes
Ecological trapping of Fin fish	Substantiated	Yes
Nutrient reallocation and drawdown	Consensus	Yes
Introduction of novel metabolites	Speculative	No, as research on novel compounds in surface waters is insufficient. Quantification of effect on macroalgal growth is suggested.
Stimulation of epifauna and calcifiers	Substantiated	No, but quantification measures suggested.
Organic carbon perturbation	Substantiated	No, but quantification measures suggested.
Alkalinity perturbation	Consensus	Yes
Allelopathy	Speculative	No, as this phenomenon is unknown in the open ocean. Quantification of effect on macroalgal growth is suggested.
Addition of atmospheric volatile compounds (VOCs)	Speculative	No, as VOCs from open ocean macroalgae and their accumulation is unknown. Quantification of effect on macroalgal growth is suggested.

PELAGIC ECONOMIC ACTIVITY

Exposure	Classification	Mitigation provided
Navigational hazards	Speculative	No, as there is no evidence of interaction between organic materials such as carbon buoys and commercial vessel traffic.
Interference with commercial fishing	Substantiated	Yes

BENTHIC ECOLOGY

Exposure	Classification	Mitigation provided
Altered benthic topography	Substantiated	No, as carbon buoys are made of mostly non-ocean floor materials and are small compared to natural variations in abyssal surface roughness.
Phytodetritus perturbation	Consensus	Yes
Bundle deposition disturbances	Substantiated	No, as this depends on sediment properties like grain size and compaction. Suggested quantification of this is provided.
Pollution transport	Substantiated	No, but quantification measures suggested.
Organic carbon perturbation	Consensus	Yes
Increased oxygen consumption	Consensus	Yes
Dissolved inorganic carbon (DIC) Perturbation	Consensus	Yes
Metabolic compound perturbation	Consensus	Yes
Alkalinity perturbation	Consensus	Yes
Introduction of foreign substances	Consensus	No but quantification measures suggested.

BENTHIC ECOLOGY ACTIVITY

Exposure	Classification	Mitigation provided
Interactive with commercial fishing	Speculative	No, as this effect is considered marginal.
Interference with deep sea mining	Speculative	No, as this effect is considered marginal.

EARTH SYSTEM IMPACTS

Exposure	Classification	Mitigation provided
Direct albedo perturbation	Substantiated	No but quantification measures suggested.
Halomethane release	Substantiated	No but quantification measures suggested.
Ventilation of metabolic greenhouse gasses	Speculative	Not provided as no proven deep-ocean-to-atmosphere methane pathway exists. Quantification measures are however suggested.

Evaluation

The exposure list which has been prepared in collaboration with external team of experts in the field is comprehensive, and no major gaps are evident at this stage. Citations to relevant literature provided were applicable.

The above list illustrates that there is not a clear consensus across the scientific literature on the exposures and associated risks resulting from exposures to projects such as those proposed by Running Tide.

During the pilot stage, an emphasis should be made on monitoring factors that may pose environmental risk. The continuation of Running Tide monitoring during further scales up depends on knowledge building during the pilot study.

A continued revision of the peer reviewed literature is advised. However, factors where there is consensus on environmental risks due to exposures should be monitored in all projects. The frequency and methods of monitoring of the various exposures can be developed and revised during the pilot stage which may guide future project design document (PDD) development and monitoring plans.

The assessment of risk associated to these exposures provides an appropriate scope for an EIA.