Unravelling the role of kelp forests in coastal carbon sequestration

Caitlin Blain & Nick Shears

George Mason Centre for the Natural Environment

University of Auckland

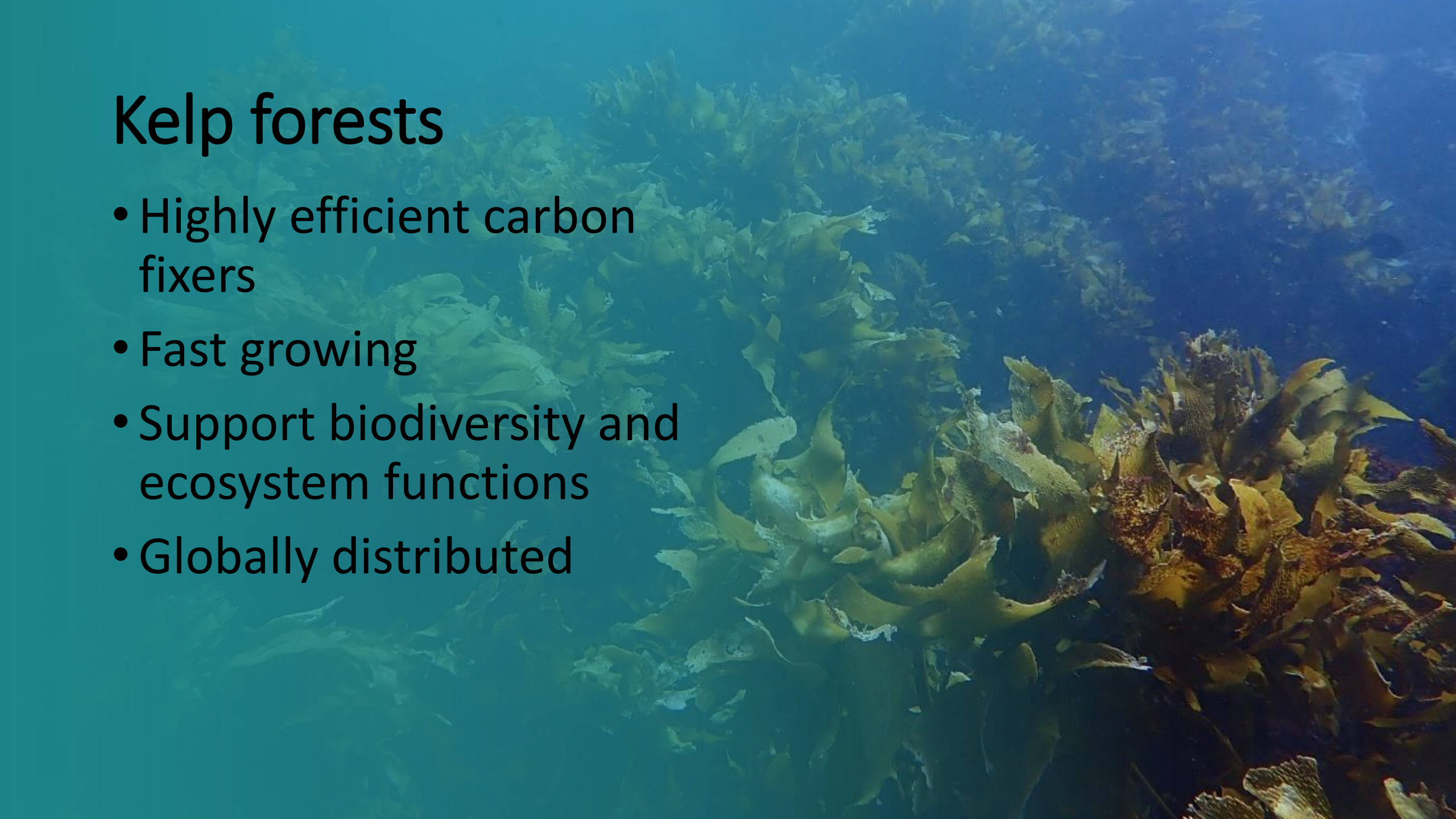
THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

Photo: Nick Shears

LIVE OCEAN FOUNDATION

Kelp forests

- Highly efficient carbon fixers
- Fast growing
- Support biodiversity and ecosystem functions
- Globally distributed



Valuation of kelp forest ecosystem services in the Falkland Islands: A case study integrating blue carbon sequestration potential

Daniel T. I. Bayley[‡], Paul Brickle[‡], Paul E Brewin[‡,§], Neil Golding[‡], Tara Pelembe[‡]

‡ South Atlantic Environment Research Institute, Stanley, Falkland Islands

Report

Current Biology

Blue Growth Potential to Mitigate Climate Change through Seaweed Offsetting

Substantial blue carbon in overlooked Australian kelp forests

Karen Filbee-Dexter[1,2] & Thomas Wernberg[1,2,3]✉

ity and

FORENSIC CARBON ACCOUNTING: ASSESSING THE ROLE OF SEAWEEDS FOR CARBON SEQUESTRATION[1]

Catriona L. Hurd[2]

Seaweed ecosystems may not mitigate CO_2 emissions

John Barry Gallagher[1,*], Victor Shelamoff[1] and Cayne Layton[1,2]

[1]Institute for Marine and Antarctic Studies, University of Tasmania, 20 Castray Esplanade Battery Point, TAS 7004, Australia
[2]Centre for Marine Socioecology, University of Tasmania, Hobart TAS 7001, Australia
*Corresponding author: tel: +61476521330; e-mail: JohnBarry.Gallagher@utas.edu.au.

Commentary

Ocean Forests Hold Unique Solutions to Our Current Environmental Crisis

Karen Filbee-Dexter[1,2,3,*]

Kelp carbon sink potential decreases with warming due to accelerating ...

by K Filbee-Dexter · 2022 · Cited by 1 — Cycling of organic carbon in the ocean has the potential to mitigate or exacerbate global climate change, but…

Abstract | Introduction | Results | Discussion

sitn.hms.harvard.edu
https://sitn.hms.harvard.edu › flash

How Kelp Naturally Combats Global Climate Change

4/07/2019 — As we decrease our use of fossil fuels, carbon sinks such as kelp forests will play a key role in getting us to net zero emissions.

environment-review.yale.edu
https://environment-review.yale.edu › ...

Kelp Forests Reveal Hidden Potential for Blue Carbon Sequestration

2/05/2022 — As a kelp forest deteriorates, it releases sequestered carbon dioxide back into the atmosphere, and the kelp forests become a source of carbon ...

MIT Technology Review
www.technologyreview.com

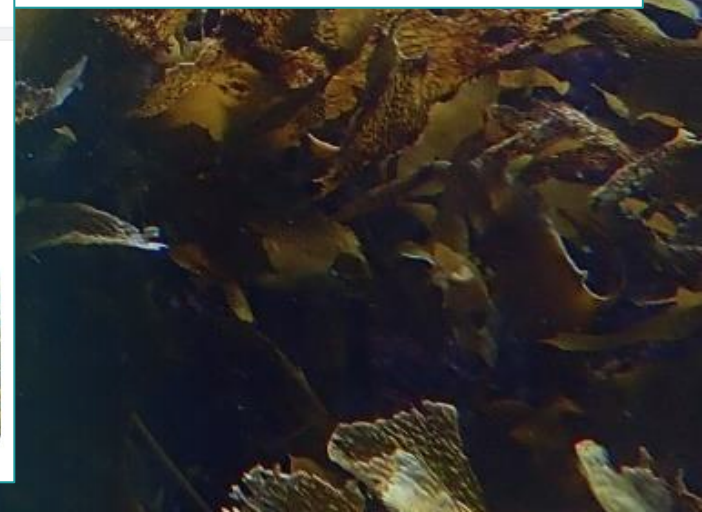
Companies hoping to grow carbon-sucking kelp may be ...

19/09/2021 — Crumley says that huge fleets of semi-autonomous vessels growing kelp could suck up around a trillion tons of carbon dioxide and store it ...

The Conversation
https://theconversation.com › kelp-...

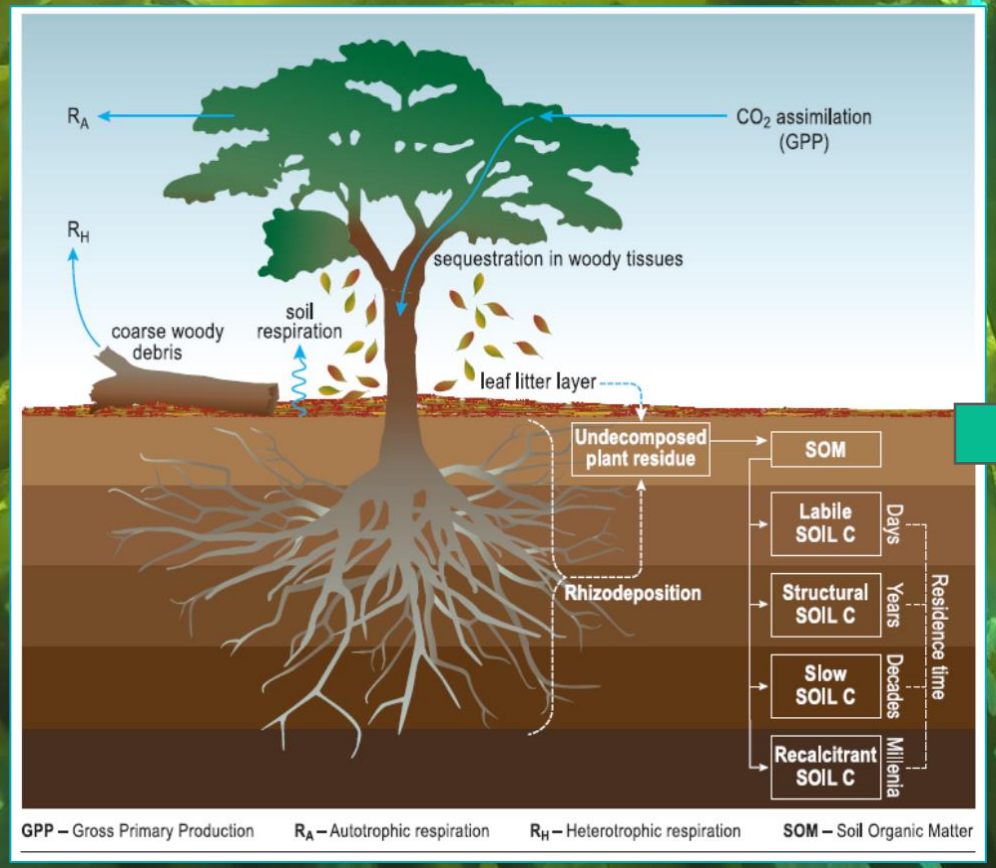
Kelp won't help: why seaweed may not be a silver bullet for carbon storage ...

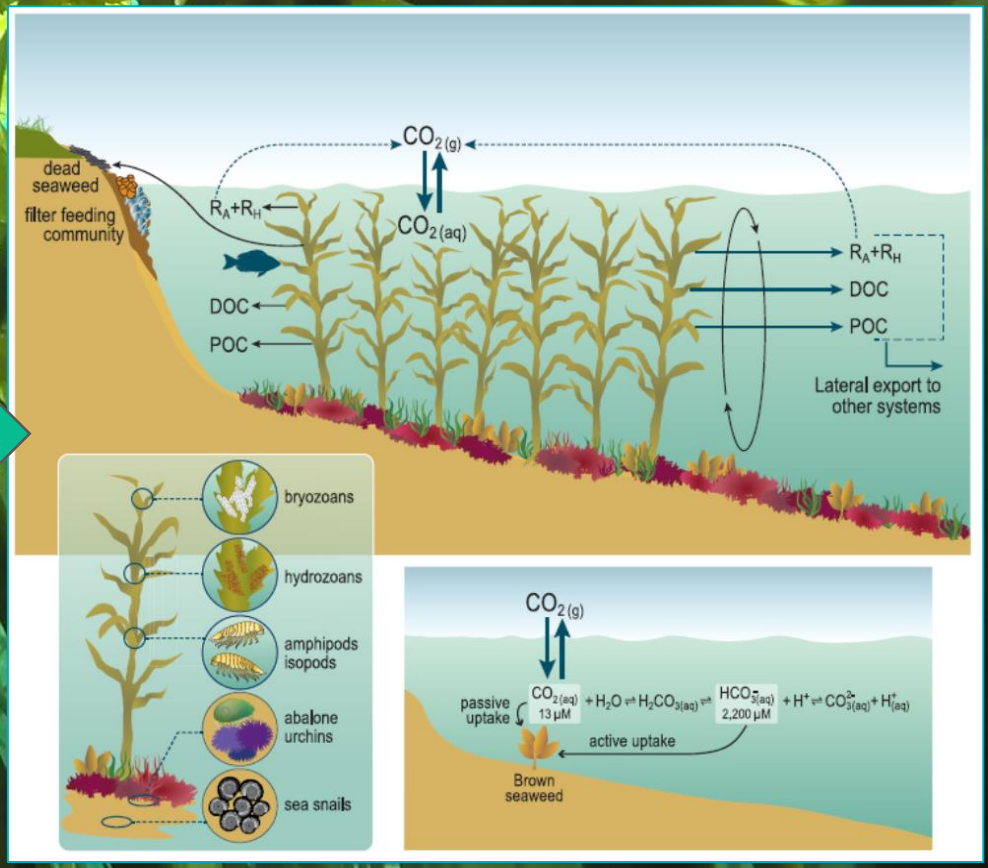
10/03/2022 — There were good reasons to look to coastal seaweed as an important global carbon sink. Some species can grow as much as 60 centimetres per ...



Forests of the sea

Hurd et al. 2022 Journal of Phycology

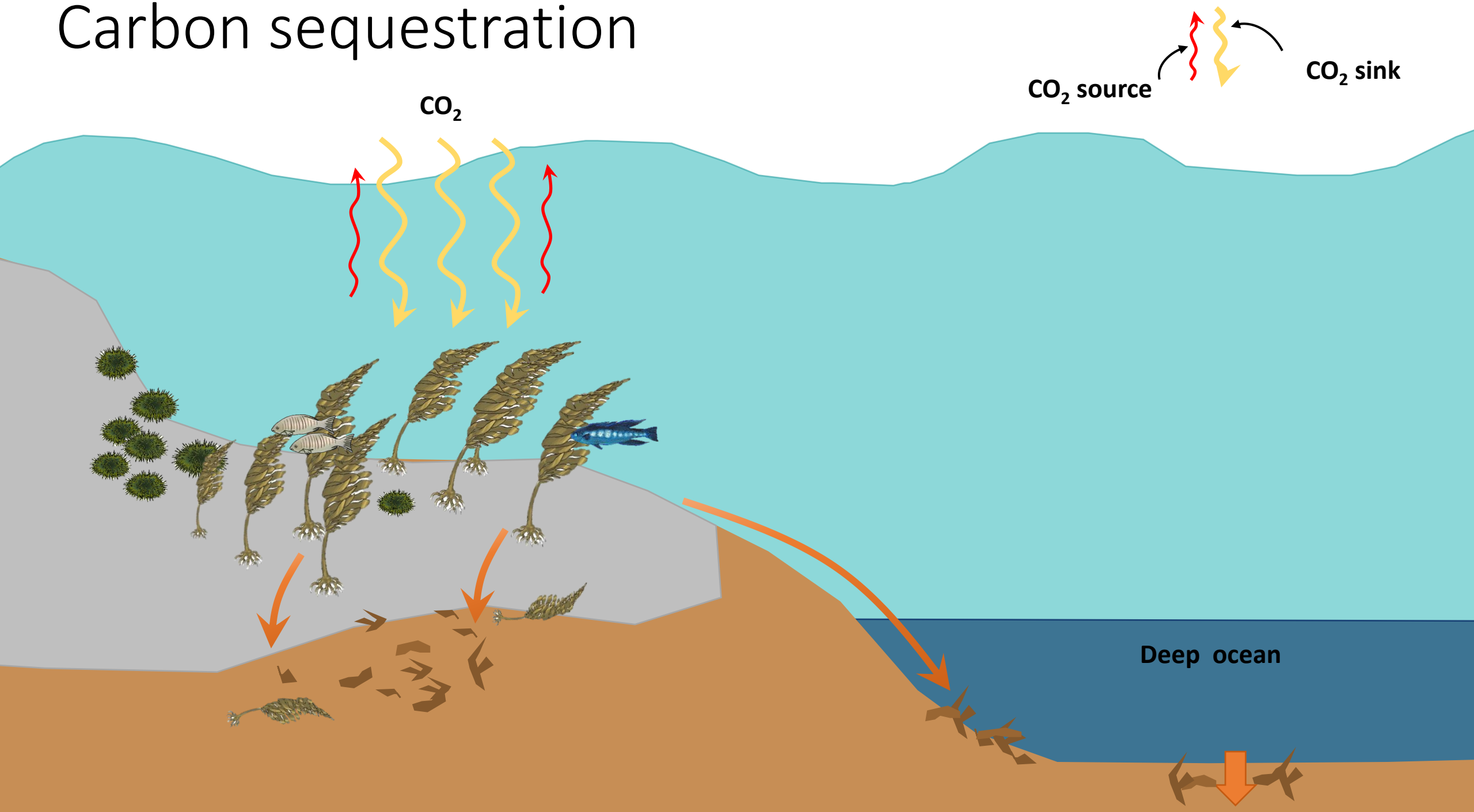




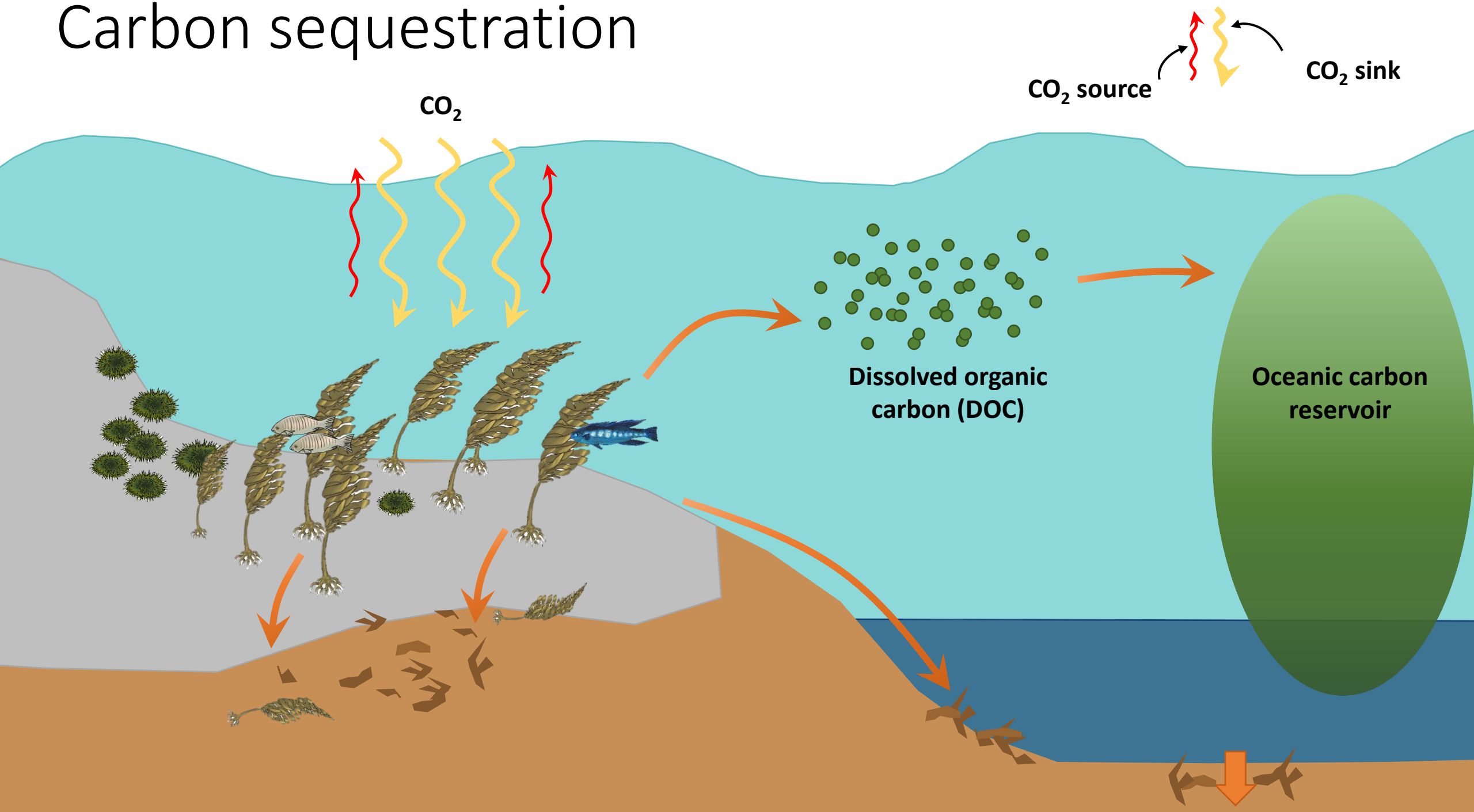
Forests of the sea

Can kelp forests mitigate CO_2 emissions?

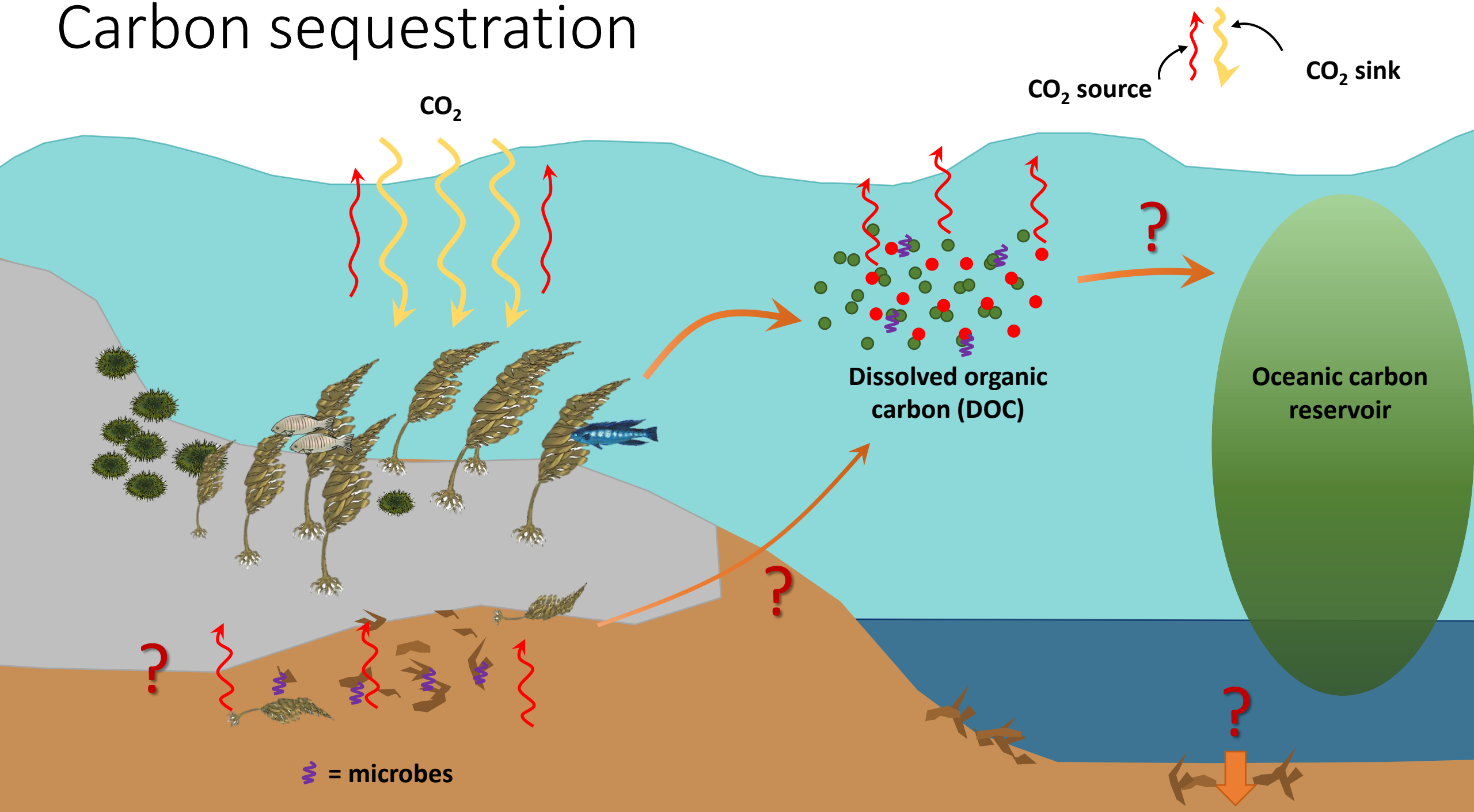
Carbon sequestration



Carbon sequestration



Carbon sequestration



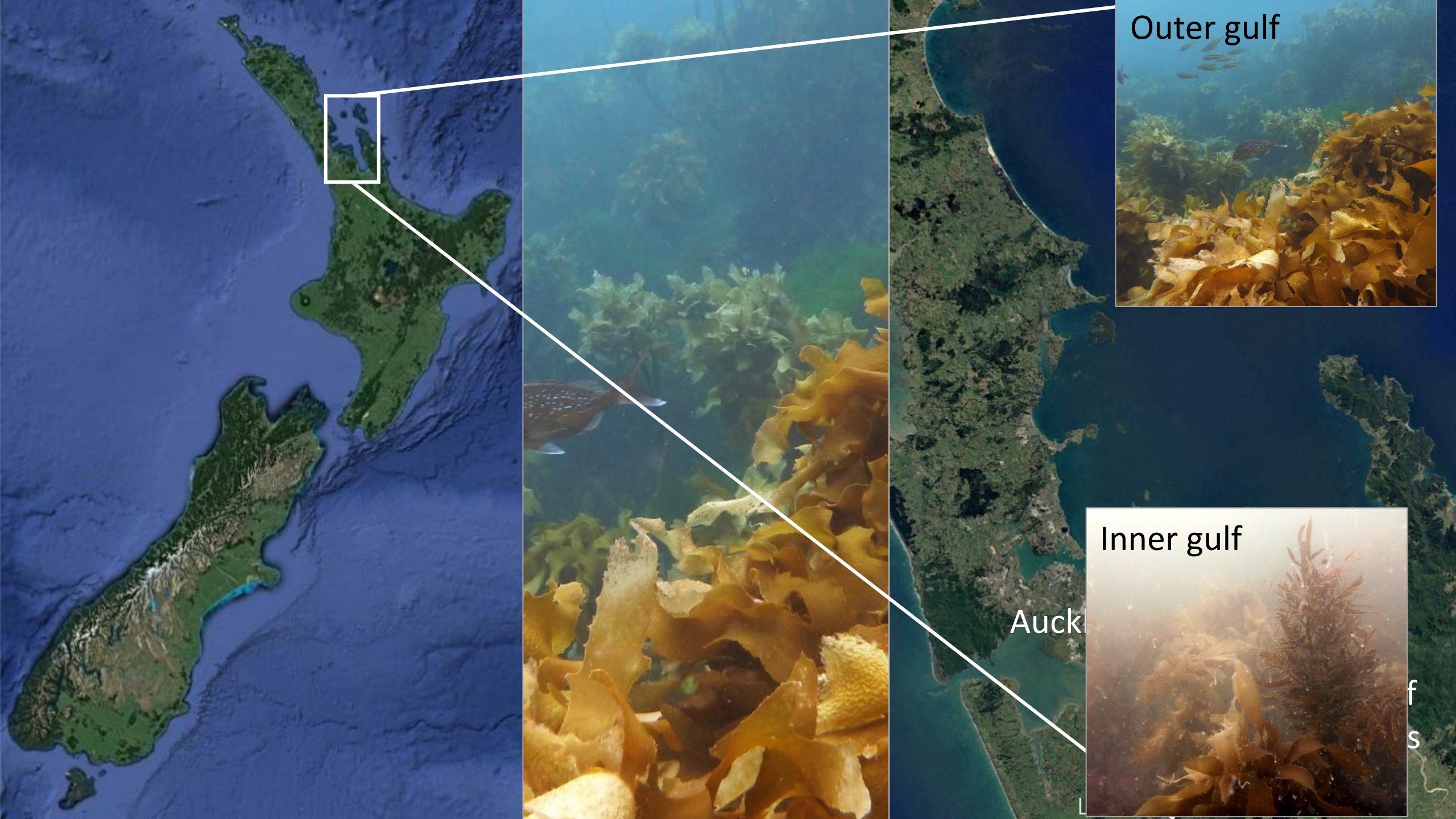
Can kelp forests mitigate CO_2 emissions?

1. How much carbon is being fixed and released by kelp forests?

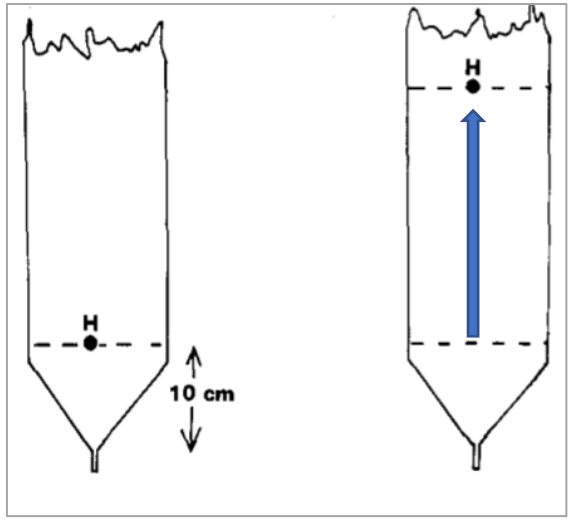
Photo: Nick Shears

Kelp forests in New Zealand

- *Ecklonia radiata*
- Distributed from the shallow subtidal to ~ 35 m depth
- Heavily impacted by unbalanced grazing pressures and coastal darkening

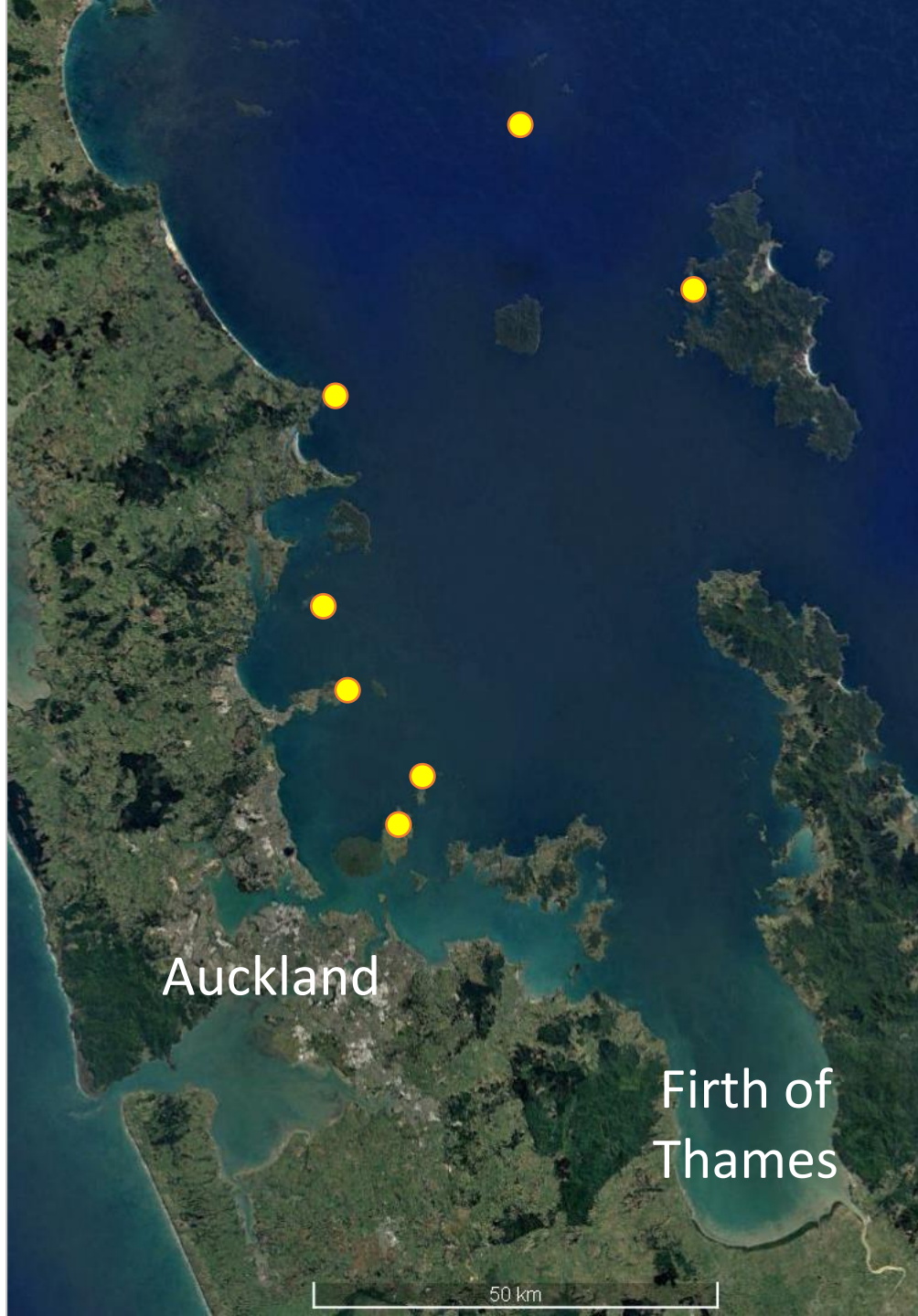

Outer gulf
Inner gulf

1. Biomass accumulation

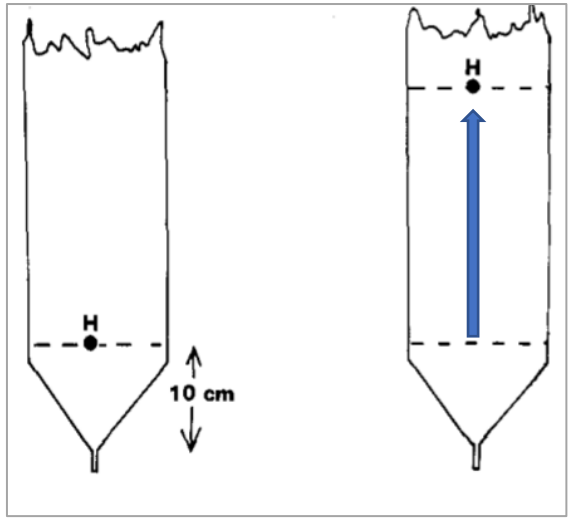


Mann & Kirkman 1981

2. Modelled NPP



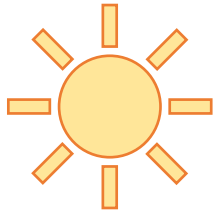
1. Biomass accumulation



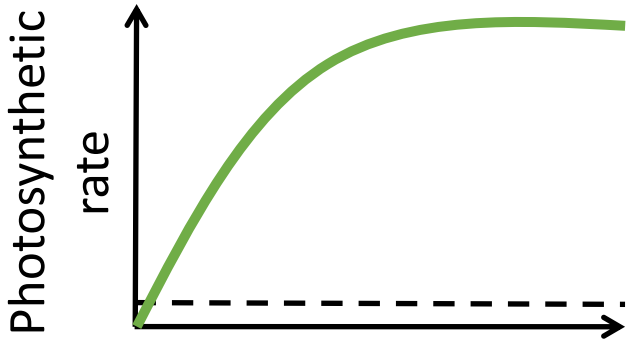
Mann & Kirkman 1981

2. Modelled NPP

$$NPP = (P_{max} * 1 - e^{(-\alpha E/Pmax)} - R_d) * b$$

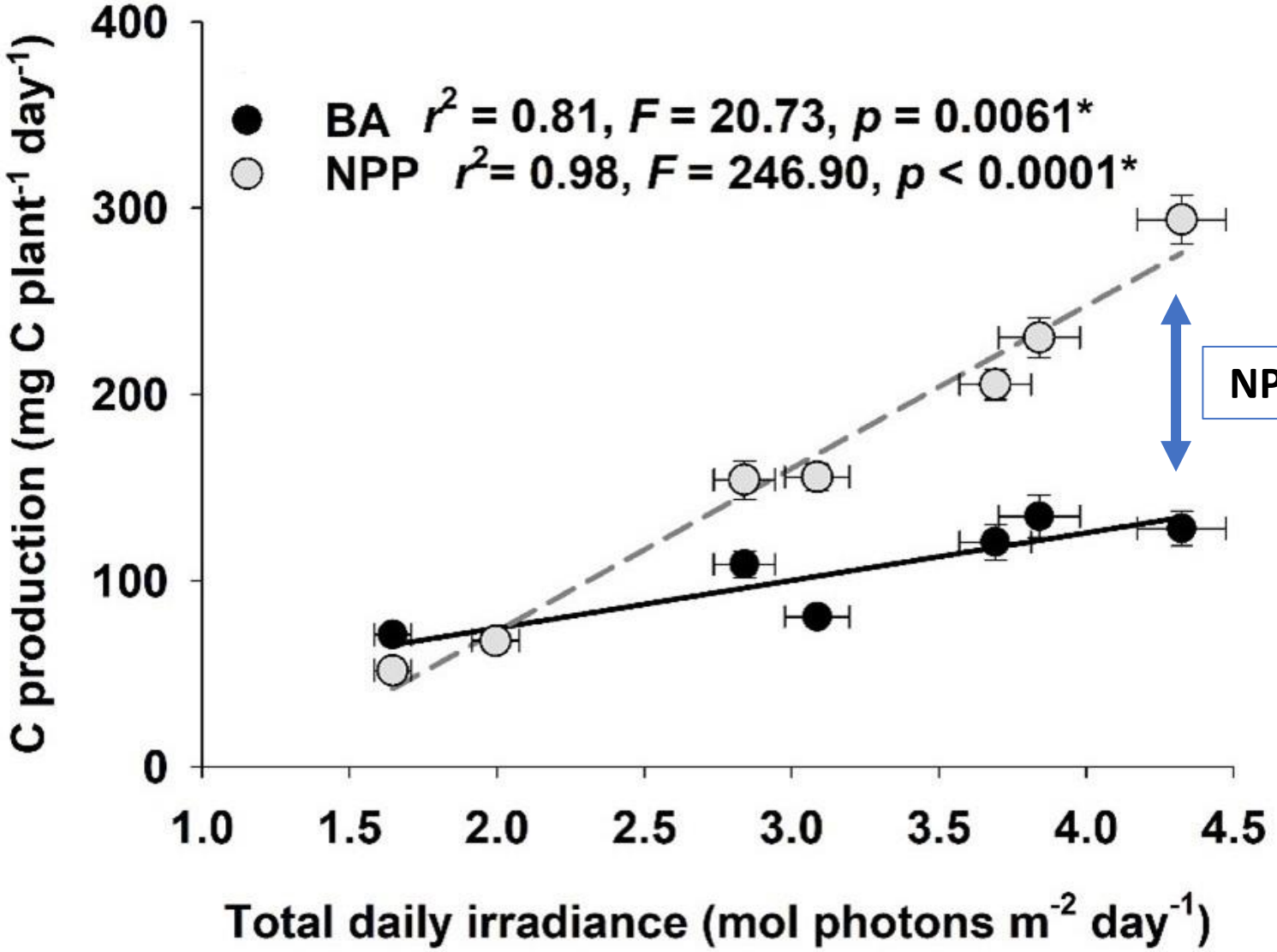


Benthic irradiance



Biomass

Photo: Paul Caiger



NPP – BA = DOC

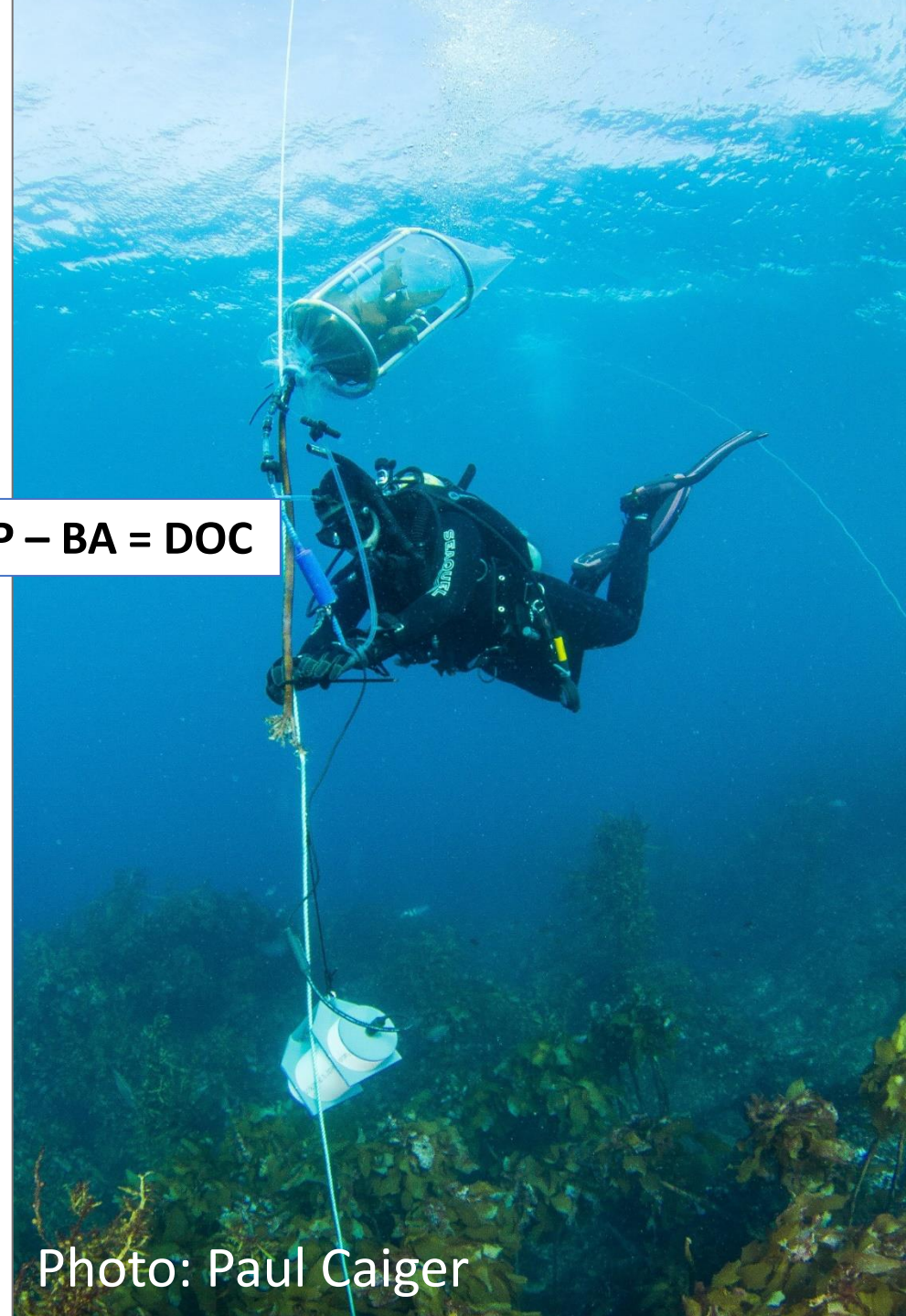
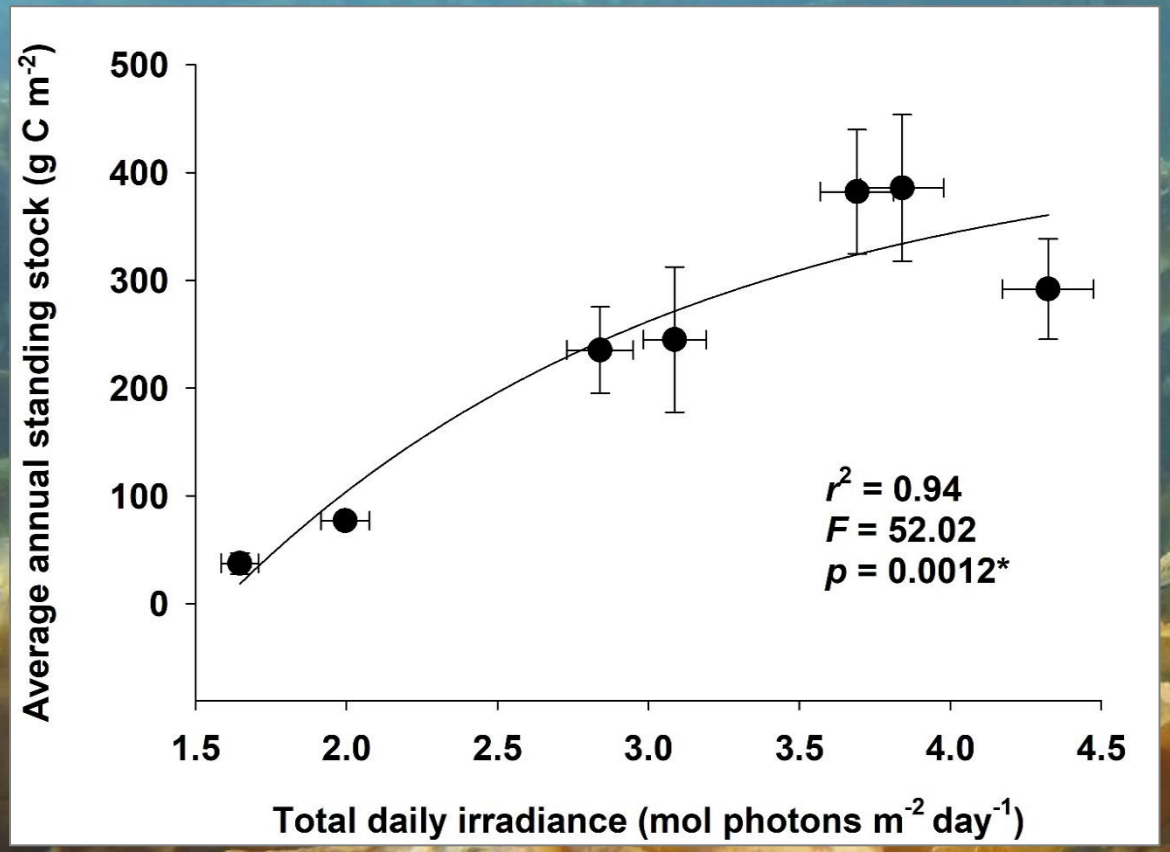
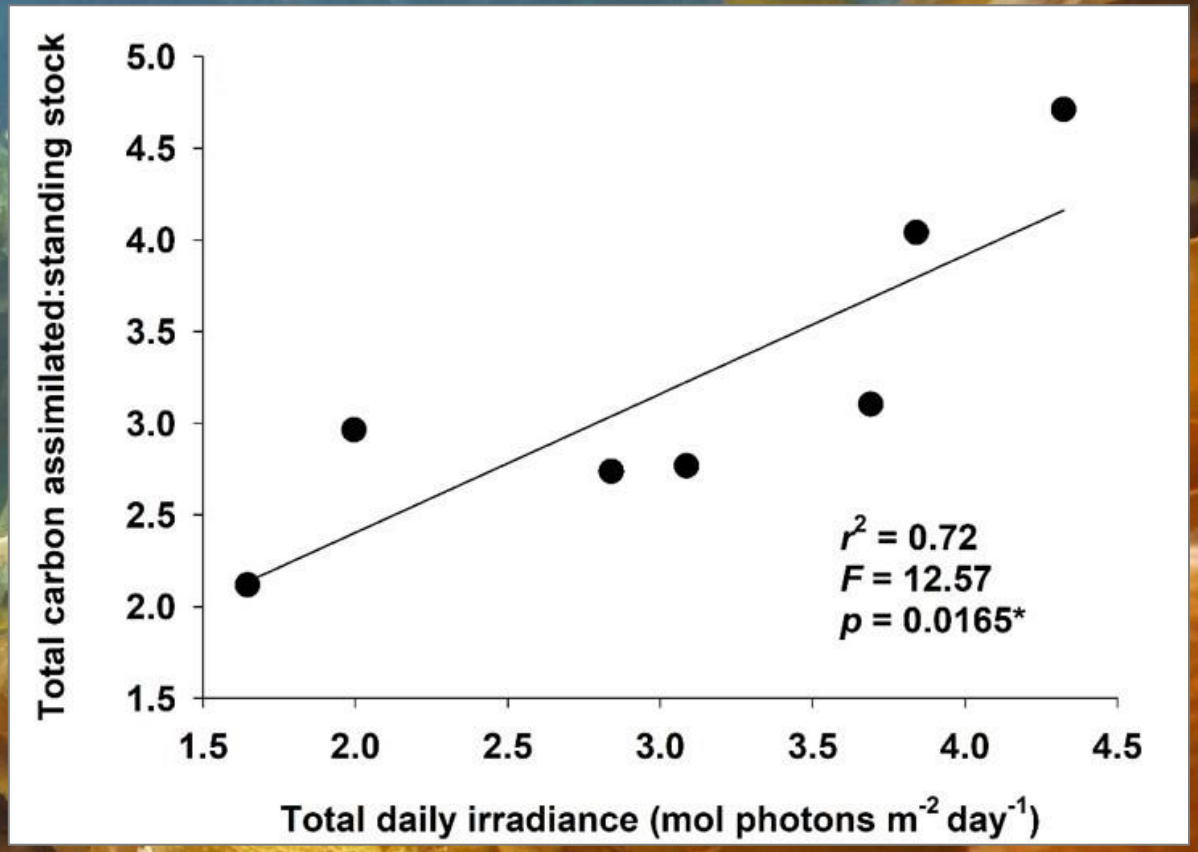


Photo: Paul Caiger

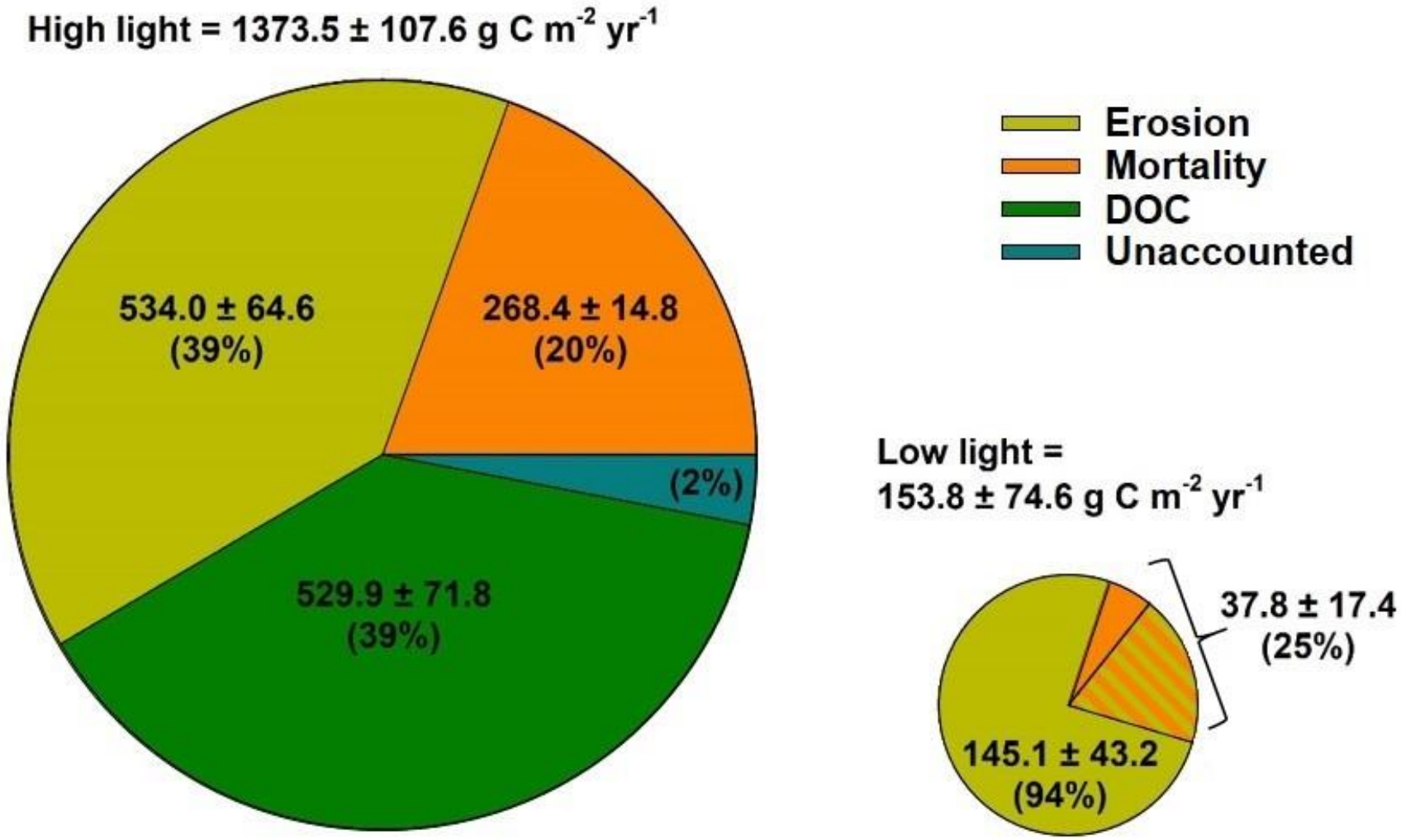
Blain et al. 2021 Global Change Biology





Blain et al. 2021 Global Change Biology

Blain et al. 2021 Global Change Biology



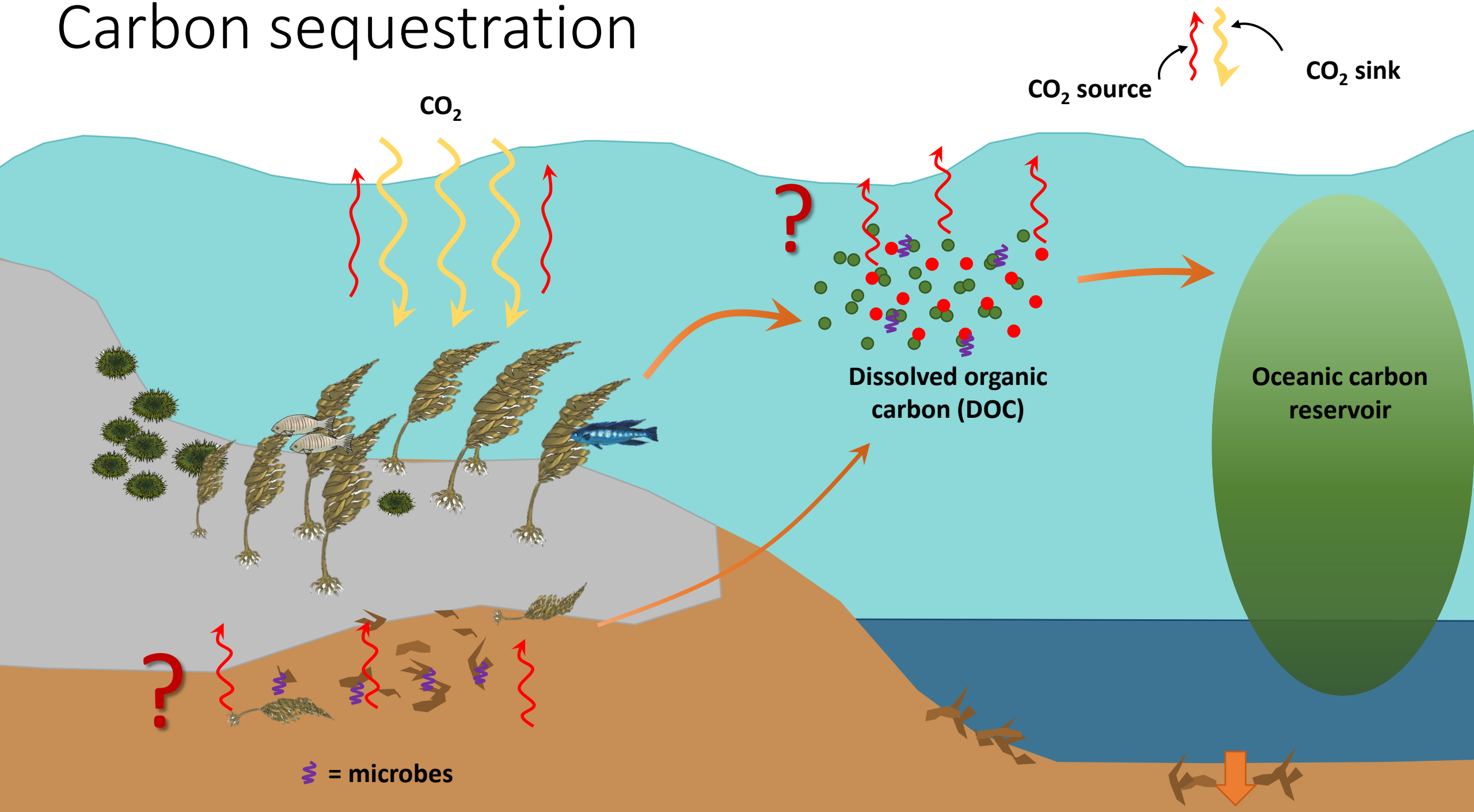
So where does it go?

Can kelp forests mitigate CO_2 emissions?

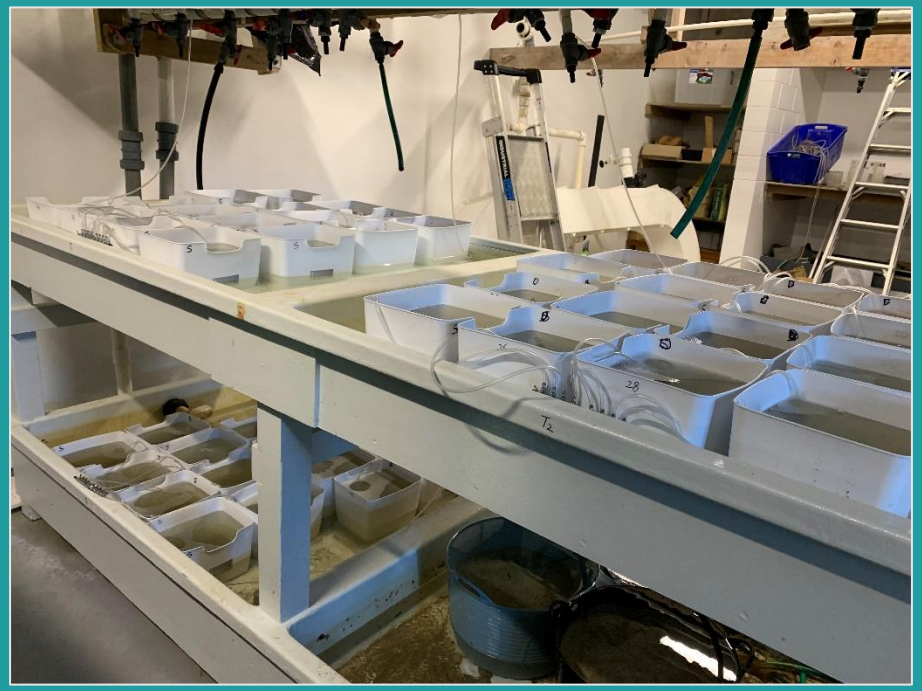
1. How much carbon is being fixed and released by kelp forests?

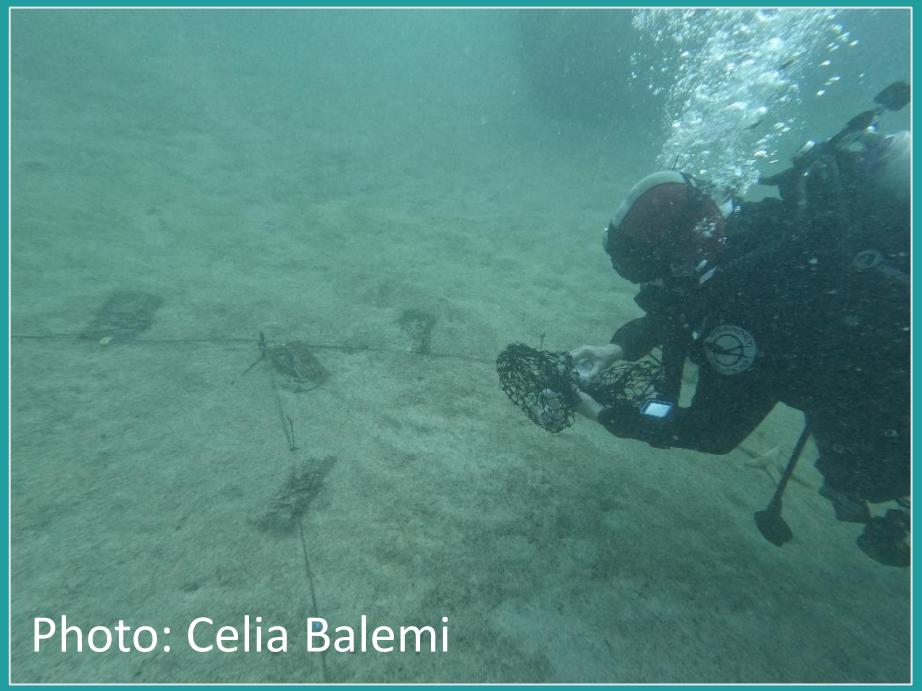
2. What is the longevity and fate of carbon released by kelp forests?

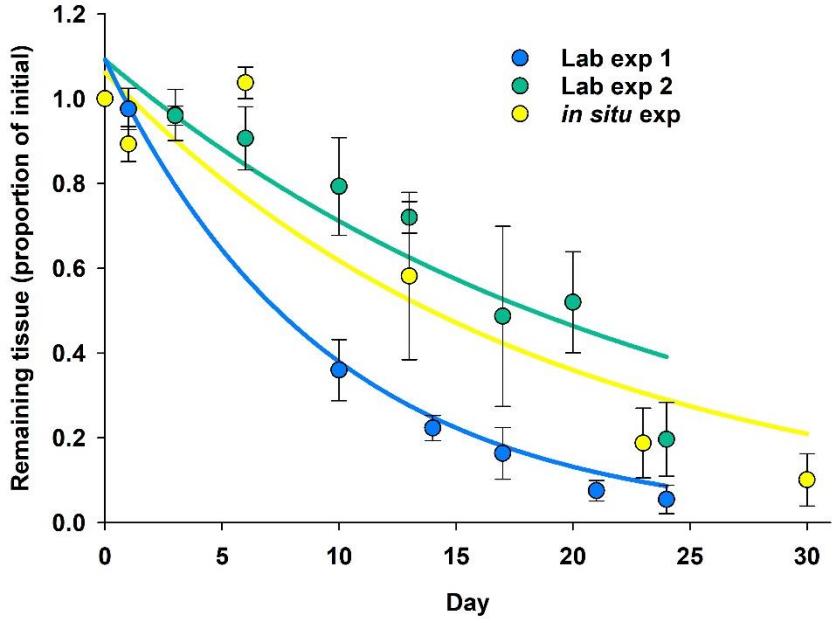
Carbon sequestration

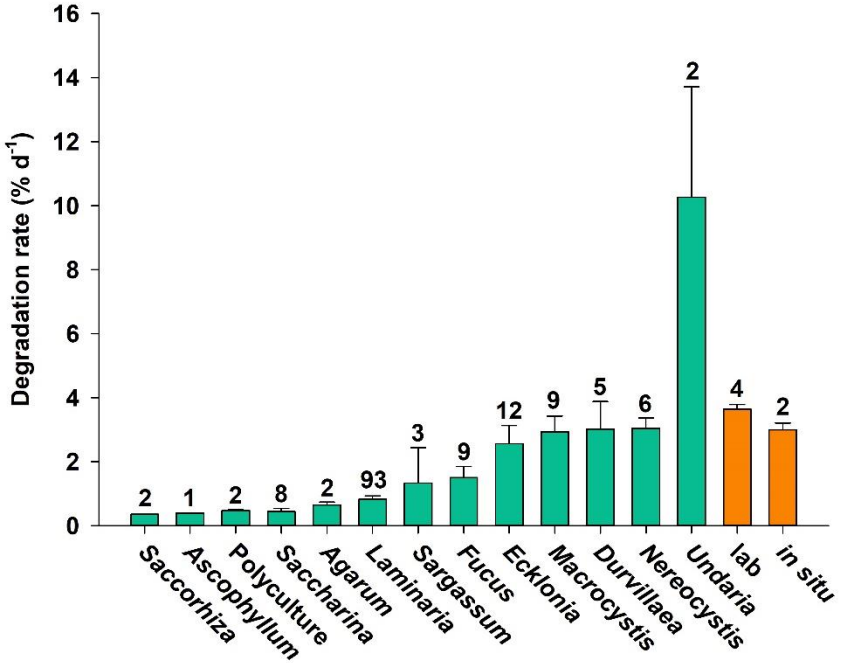


Kelp tissue degradation

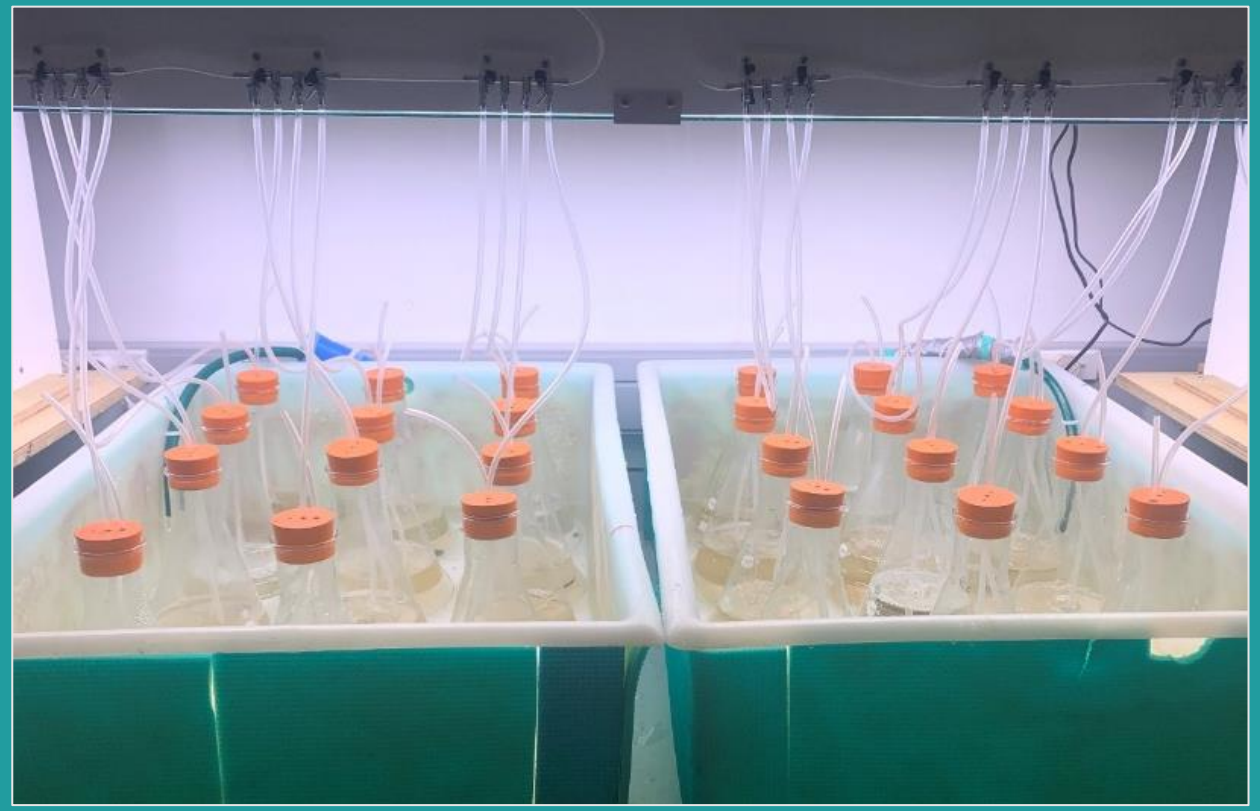


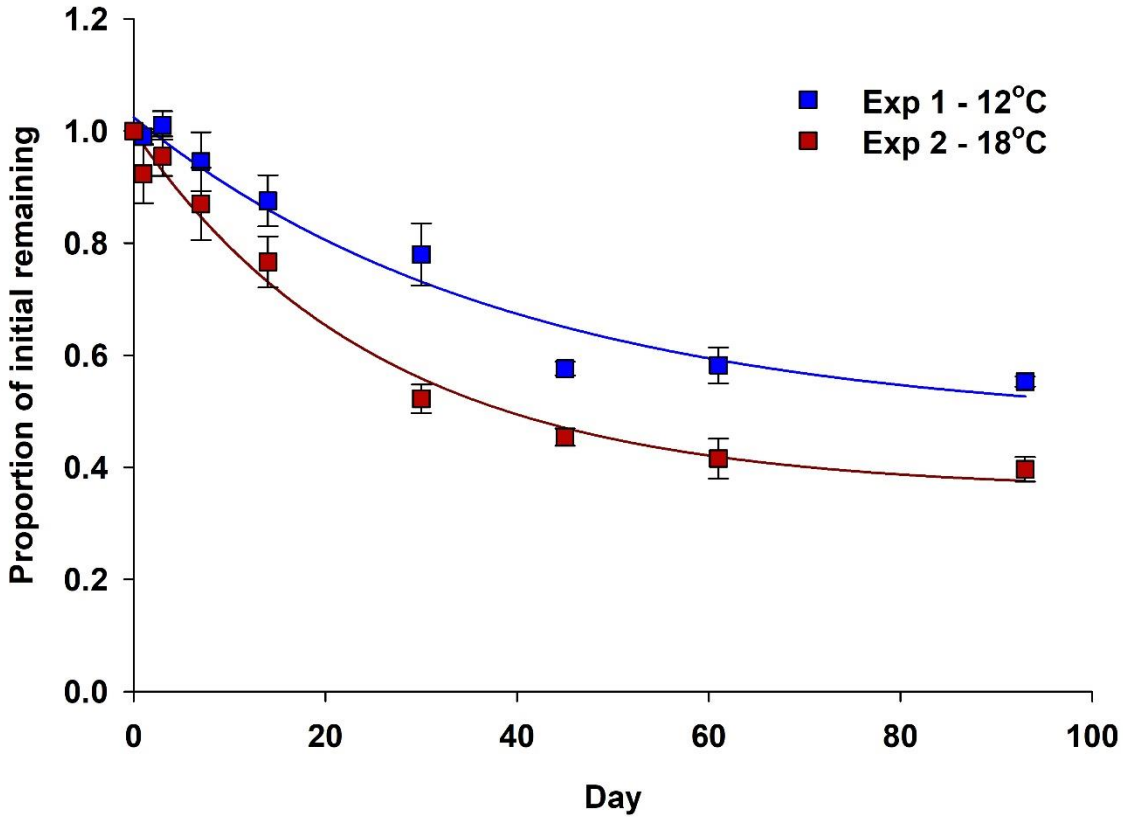




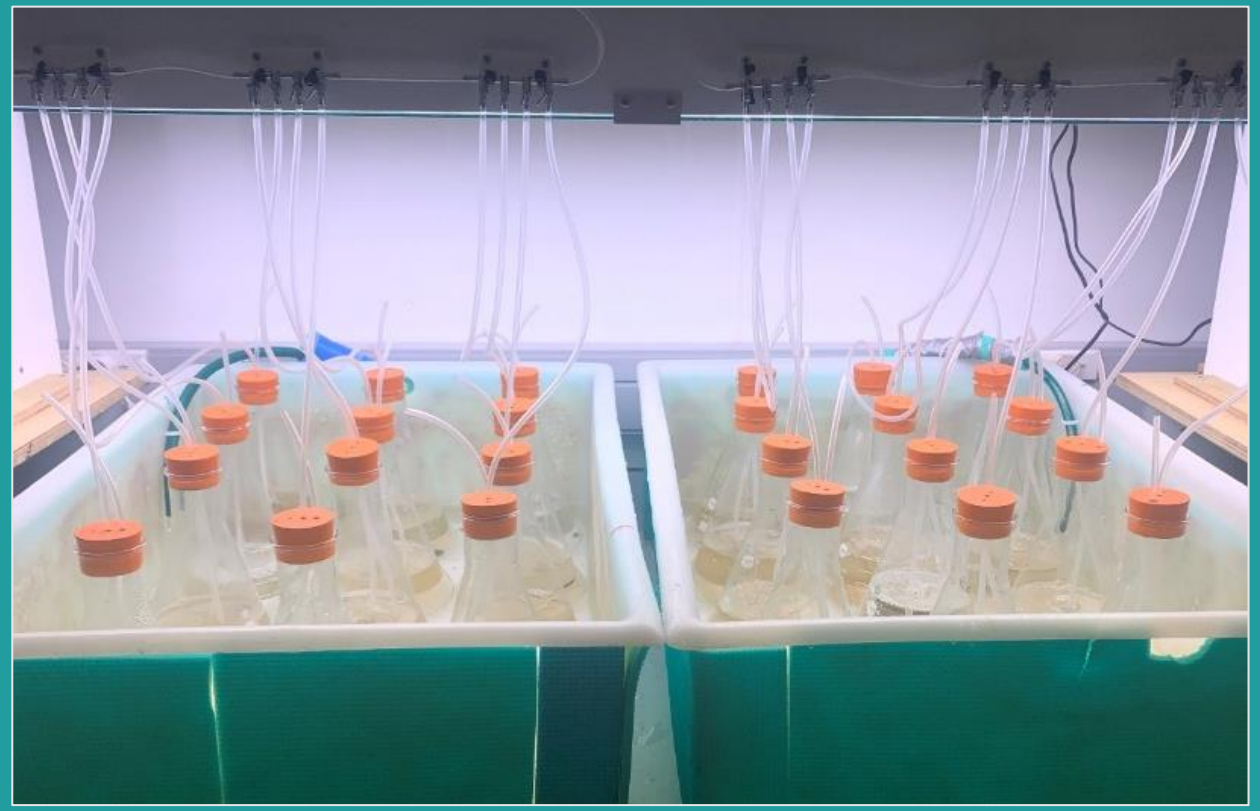


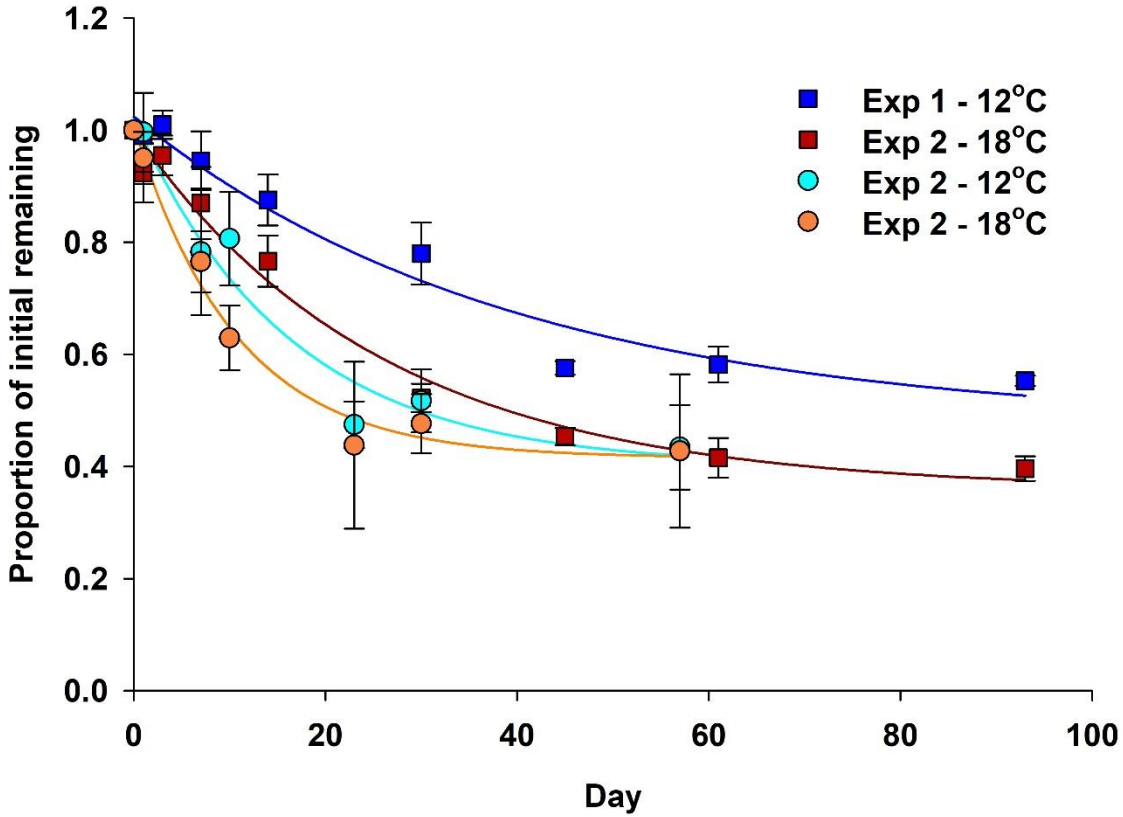
Kelp DOC degradation



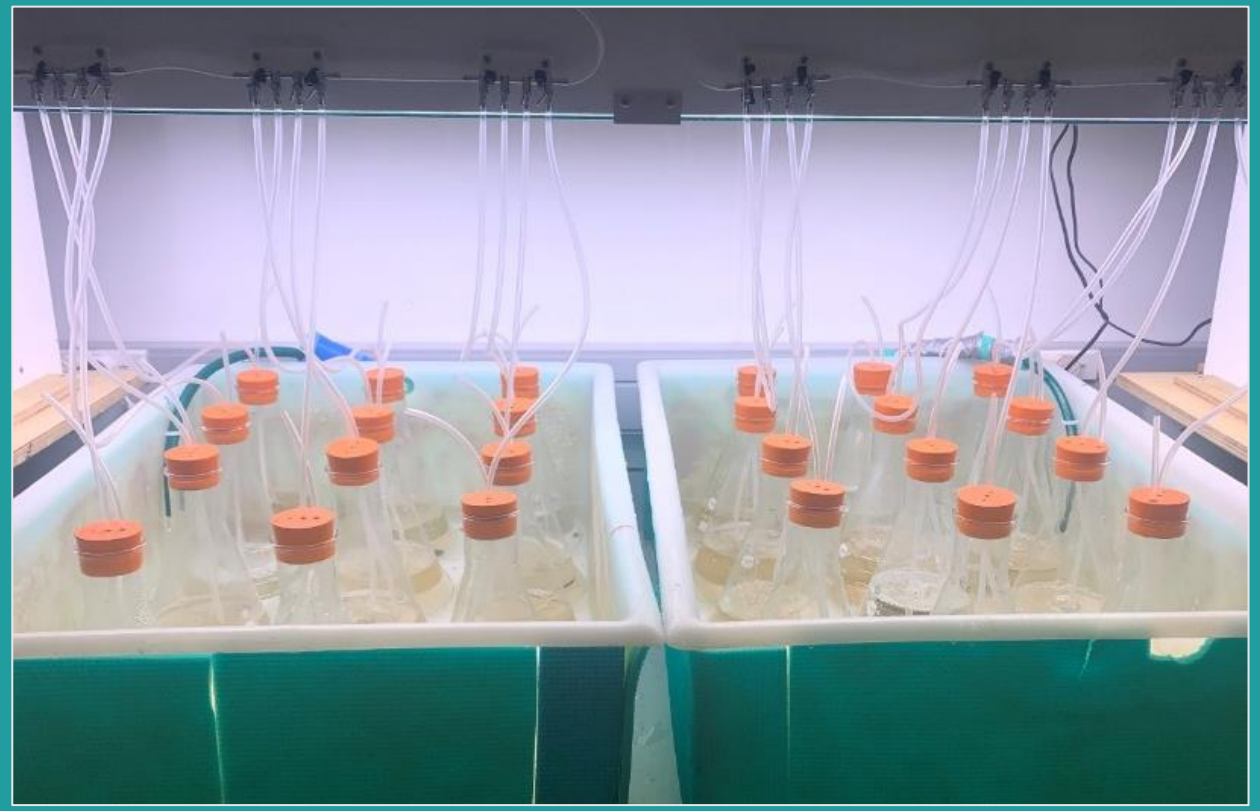


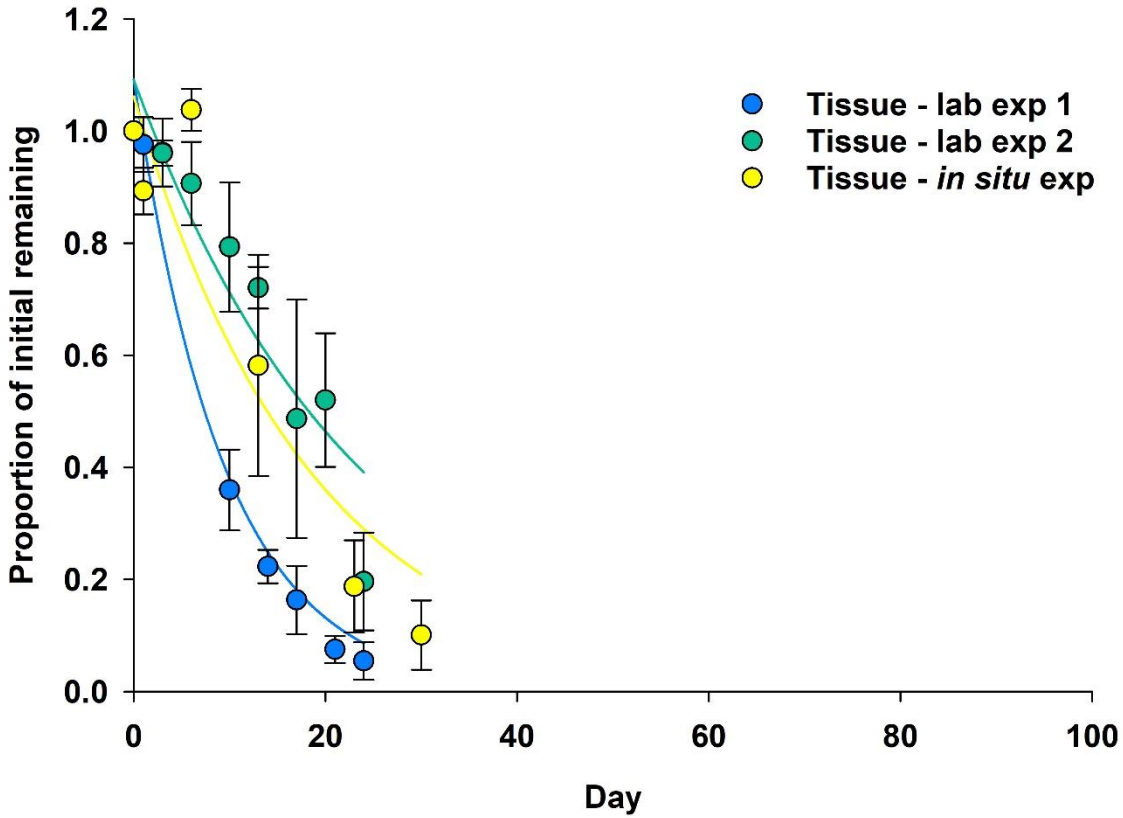
Kelp DOC degradation



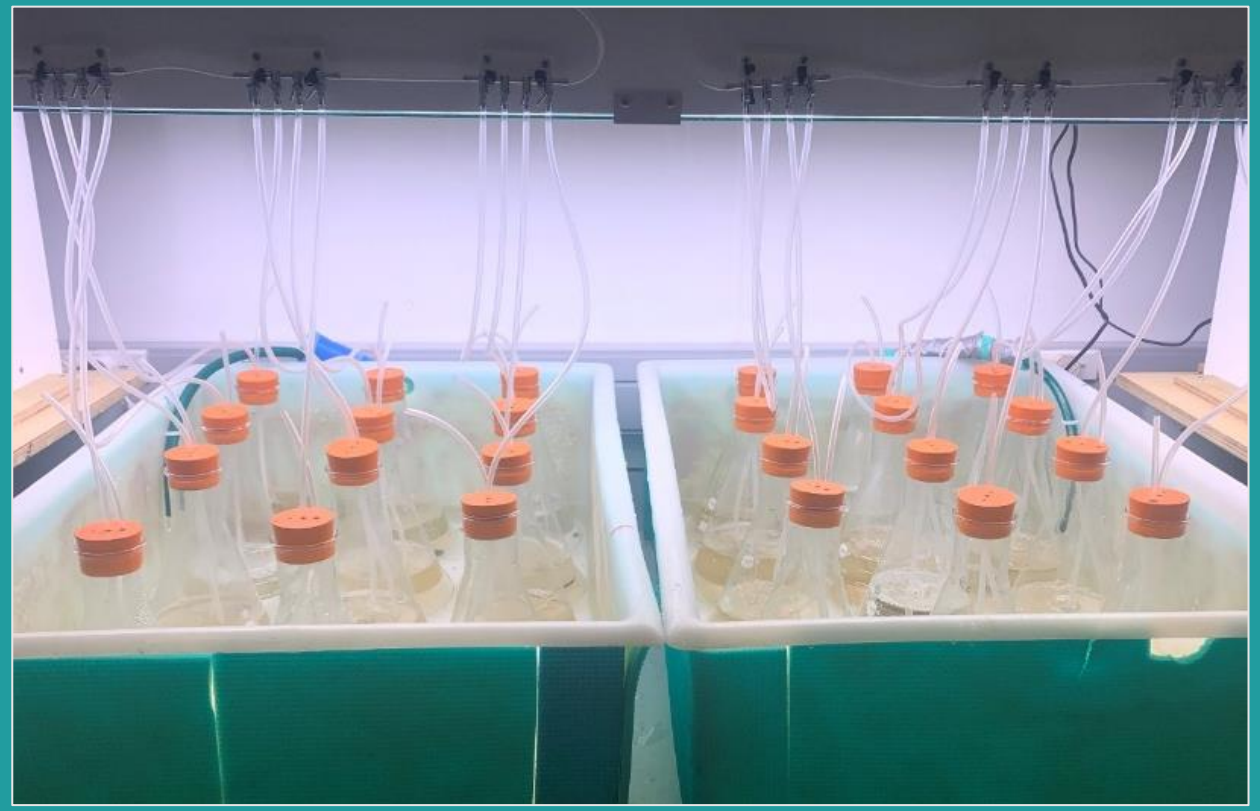


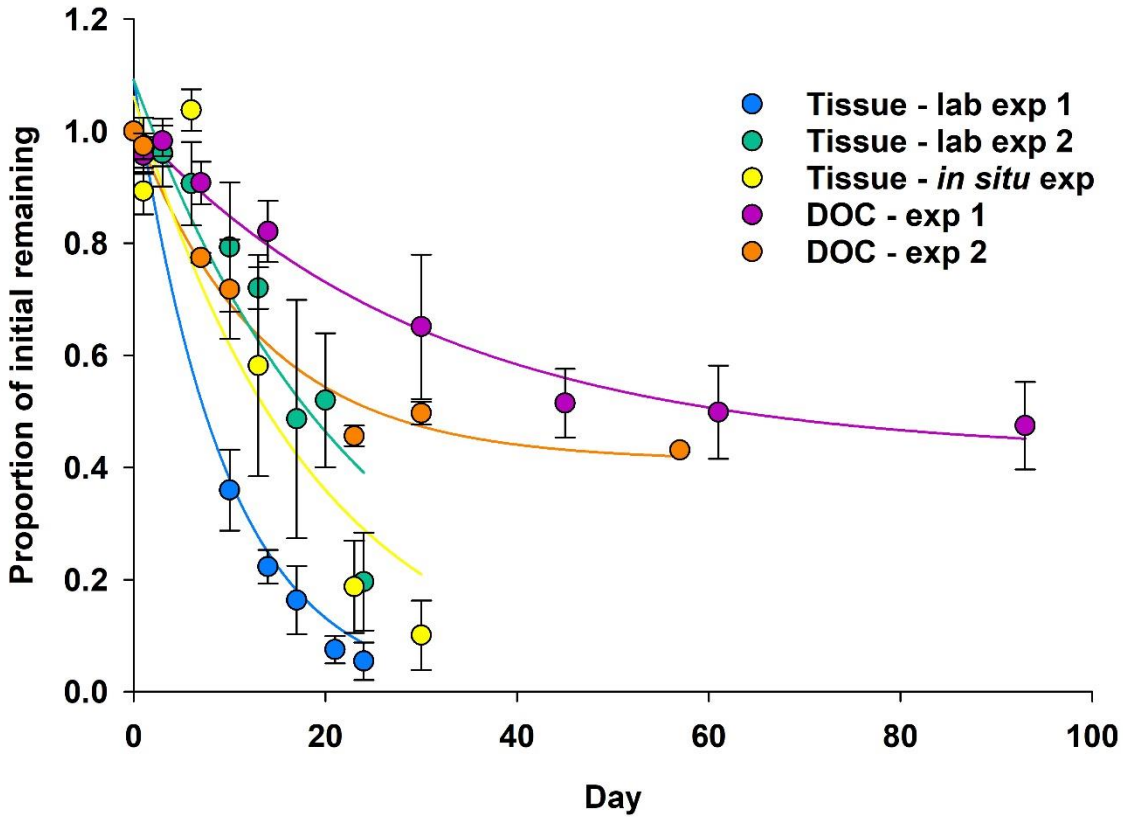
Kelp carbon degradation



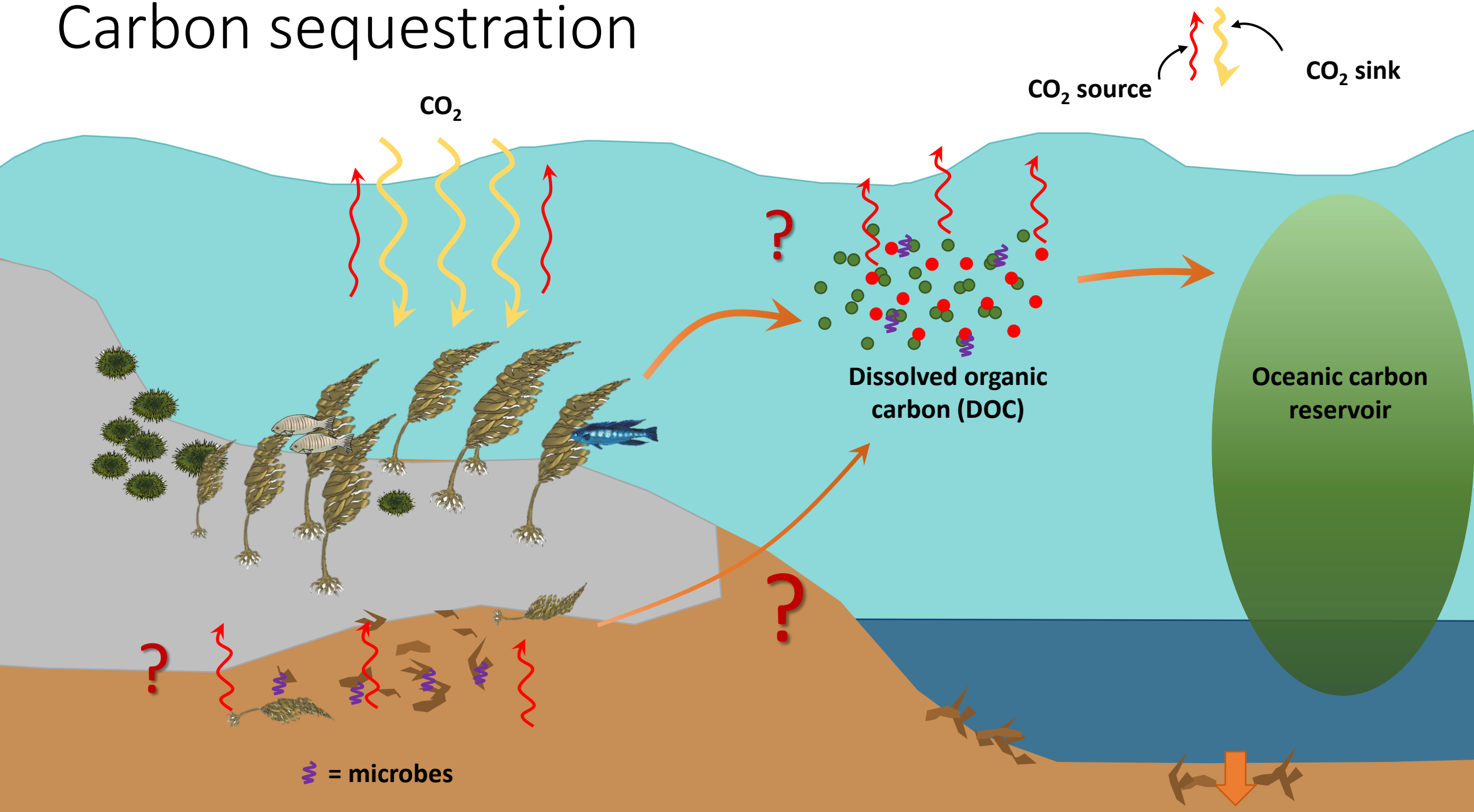


Kelp carbon degradation





Carbon sequestration

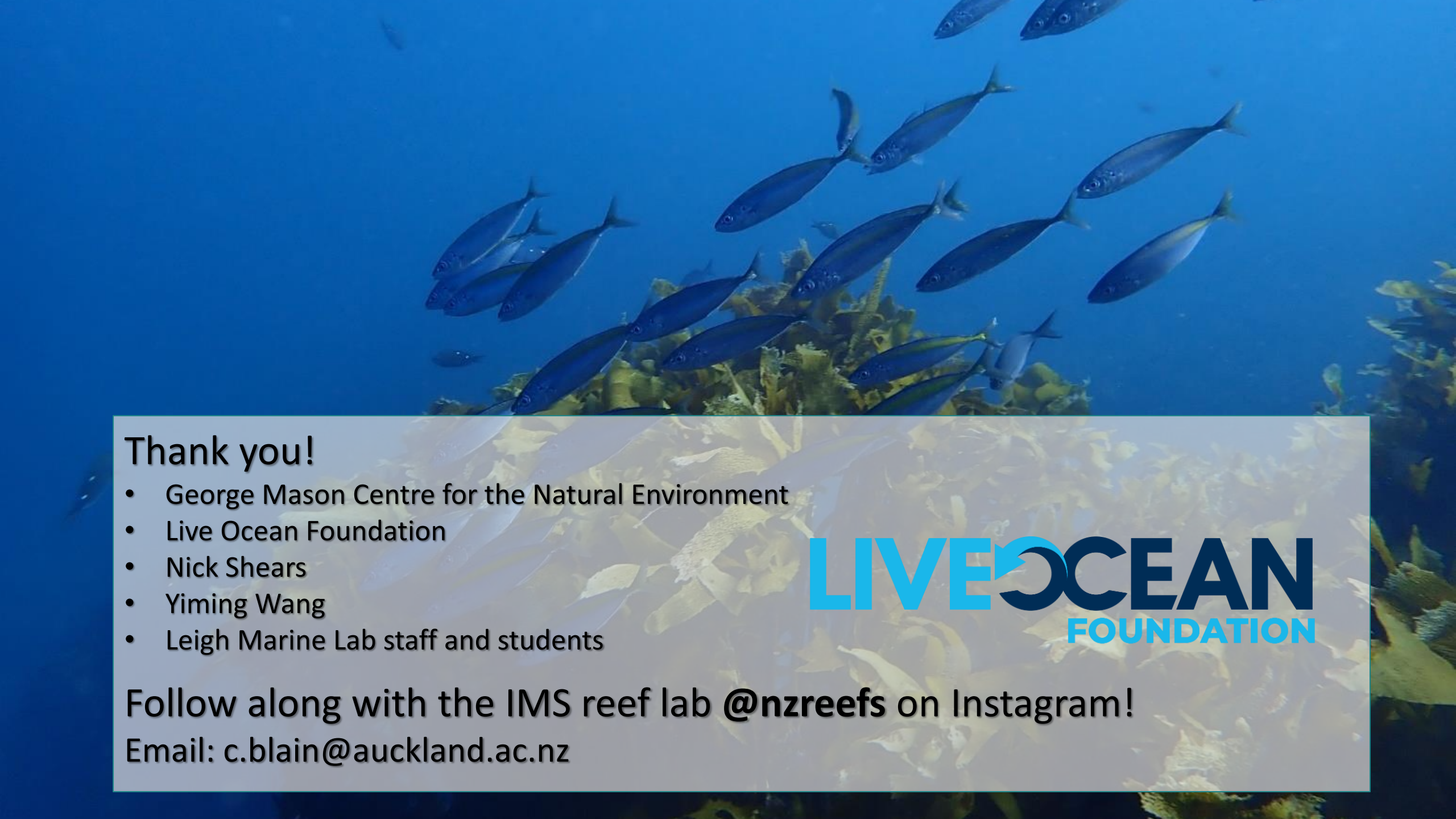


Can kelp forests mitigate CO_2 emissions?

Photo: Paul Caiger

Conclusions

- The quantity and form of organic carbon released by kelp is dependent on a suite of variables
- Turbidity substantially reduces NPP and DOC release
- The fate of kelp-carbon is significantly under studied
- DOC may be an important, yet overlooked, source of organic carbon to coastal carbon cycles



Thank you!

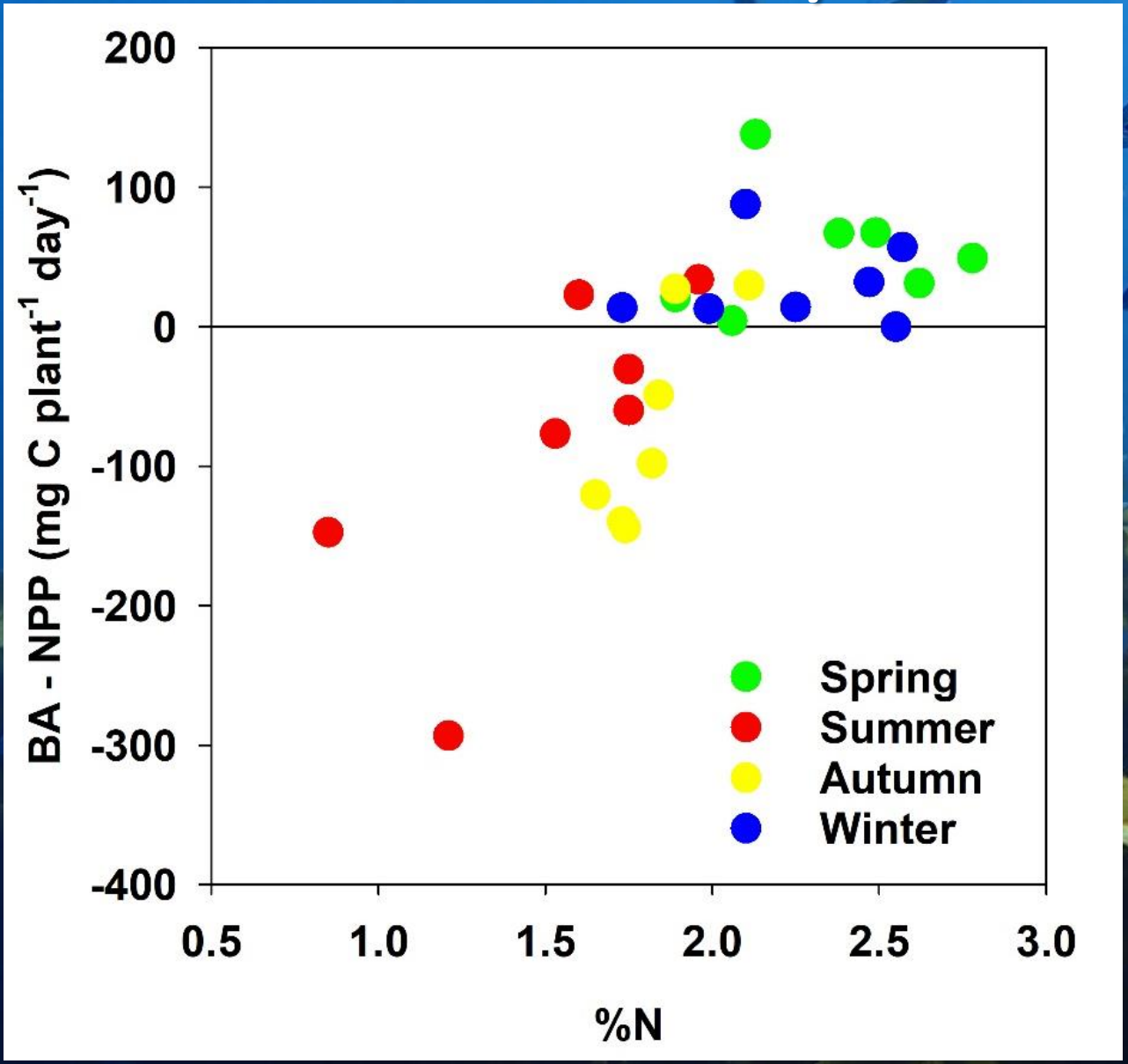
- George Mason Centre for the Natural Environment
- Live Ocean Foundation
- Nick Shears
- Yiming Wang
- Leigh Marine Lab staff and students

LIVE OCEAN FOUNDATION

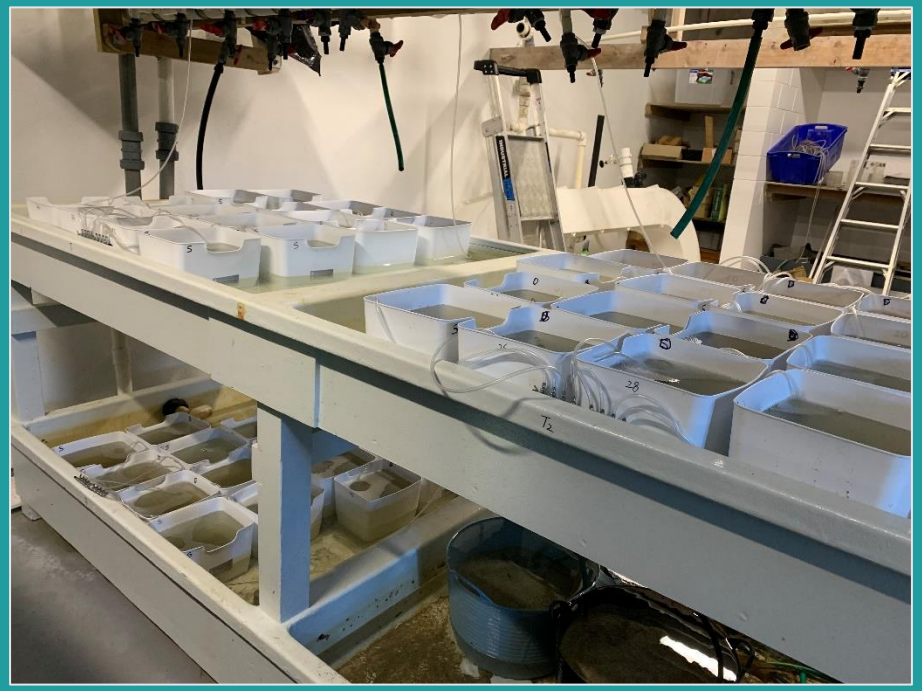
Follow along with the IMS reef lab **@nzreefs** on Instagram!

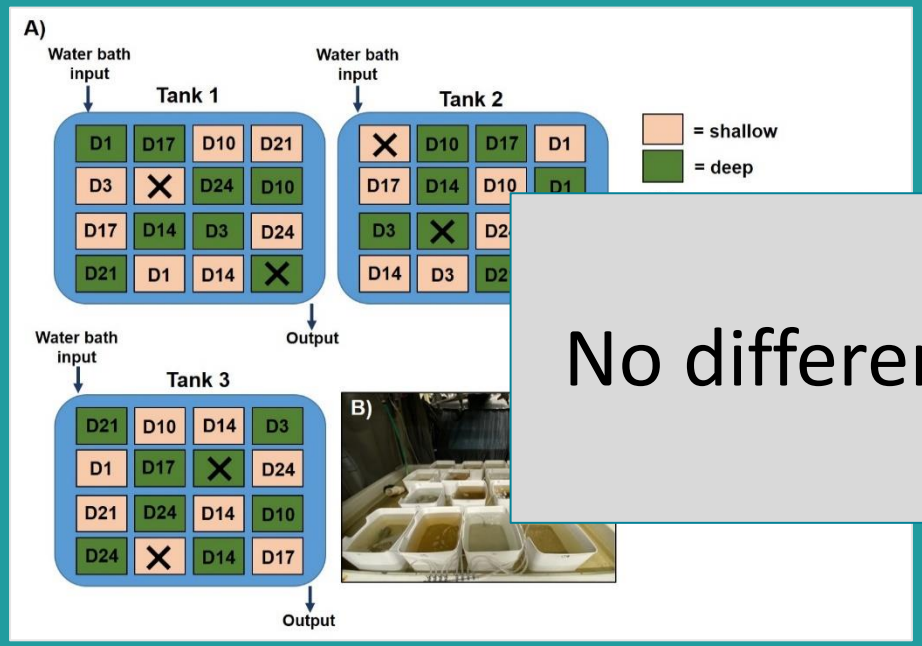
Email: c.blain@auckland.ac.nz

Nutrients availability:

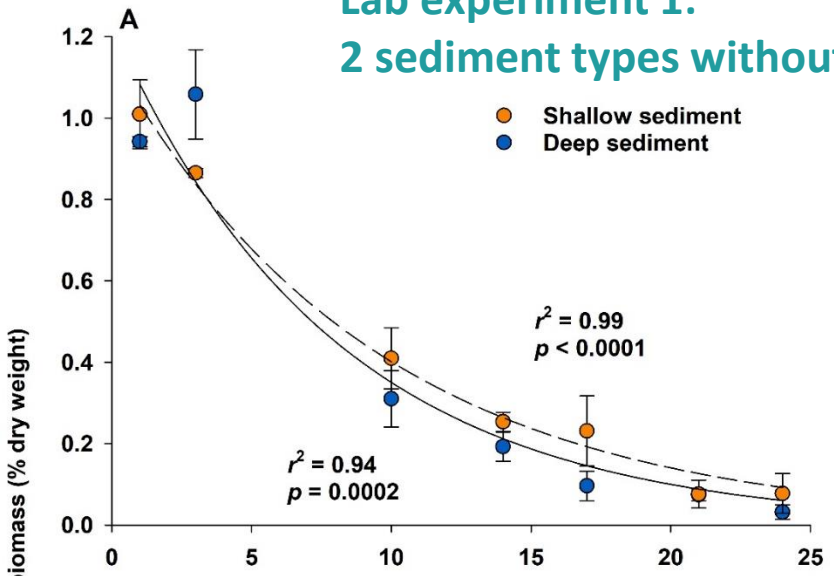


Kelp carbon degradation

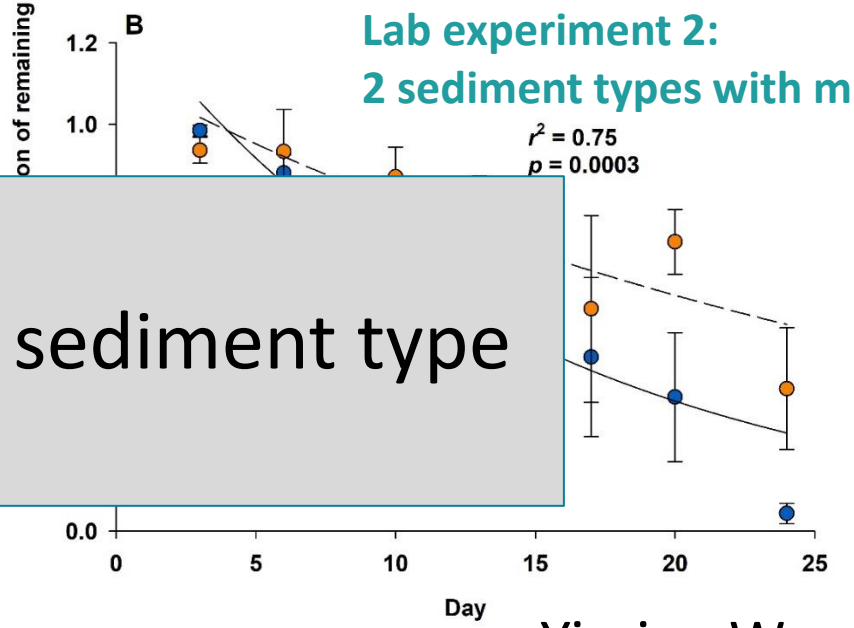




Lab experiment 1:
2 sediment types without microbes



Lab experiment 2:
2 sediment types with microbes



No differences due to sediment type

Yiming Wang MMS