Seaweed farming in Norway: Blue Carbon and Blue Economy perspectives

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Photograph: K Hancke/NIVA

the BLUE CARBON initiative

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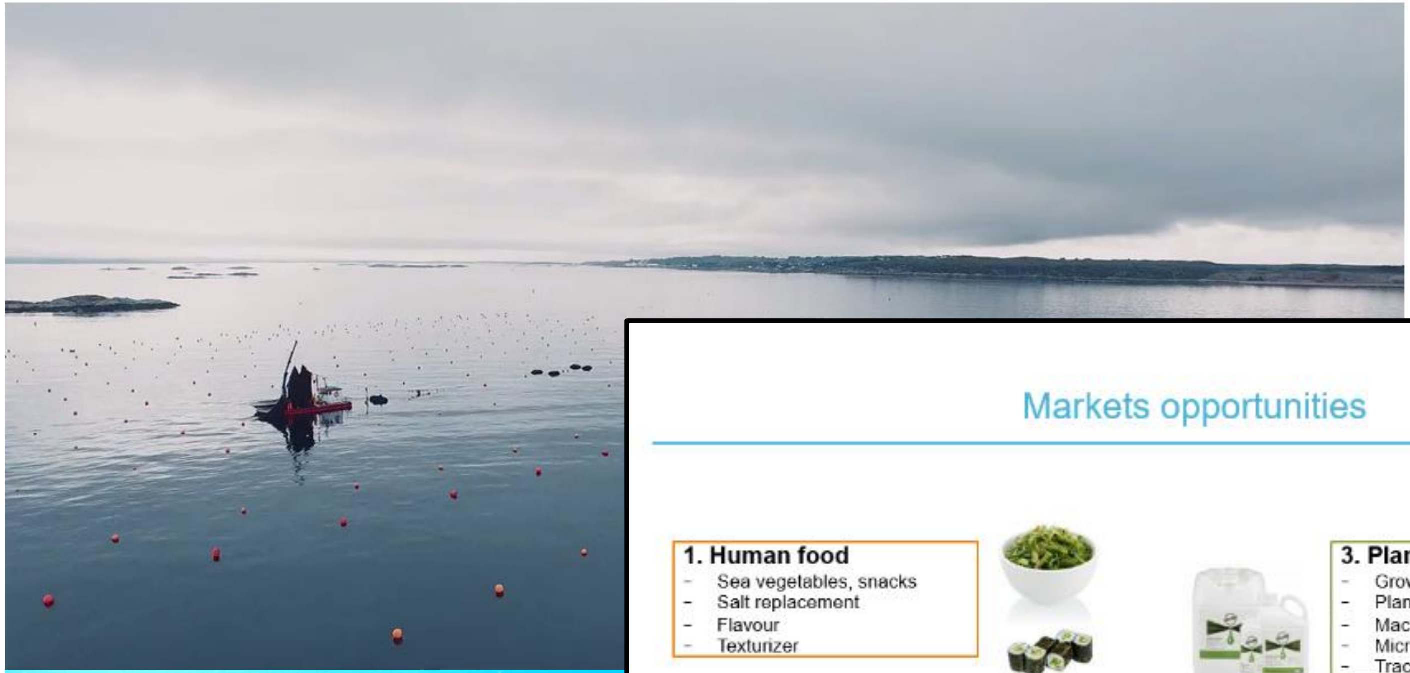
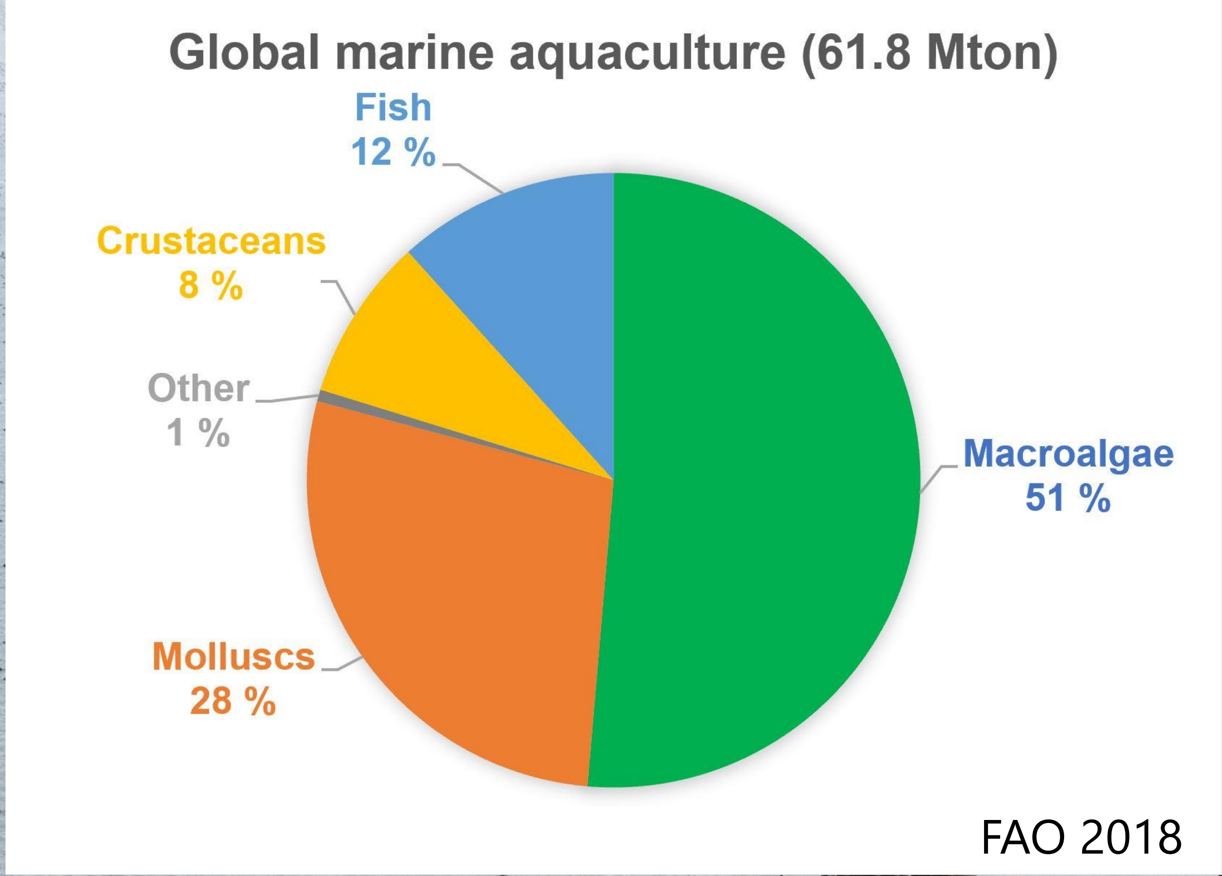
Seaweed farming and market opportunities



Photograph: Funderud/SES

A global perspective on seaweed farming



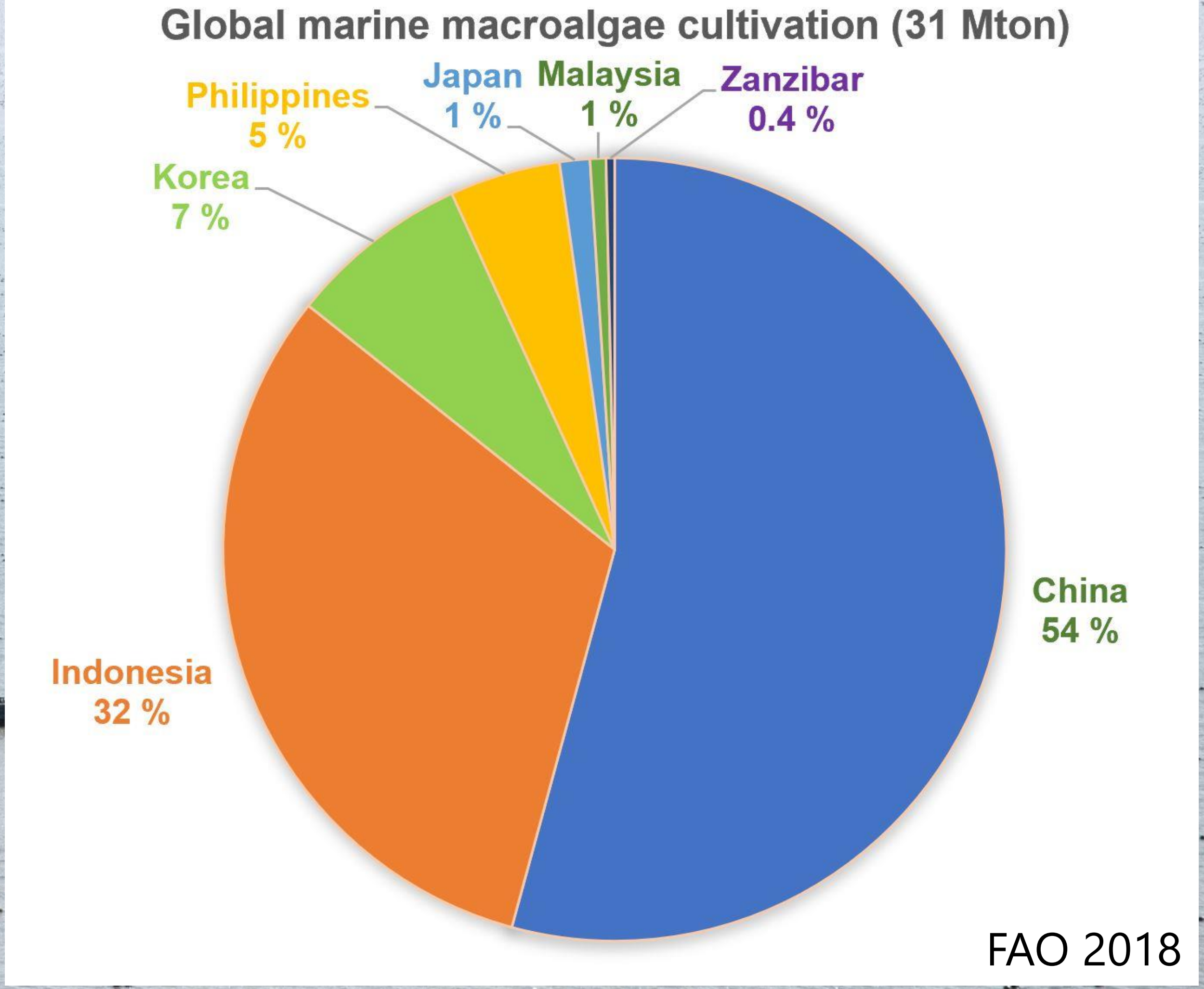
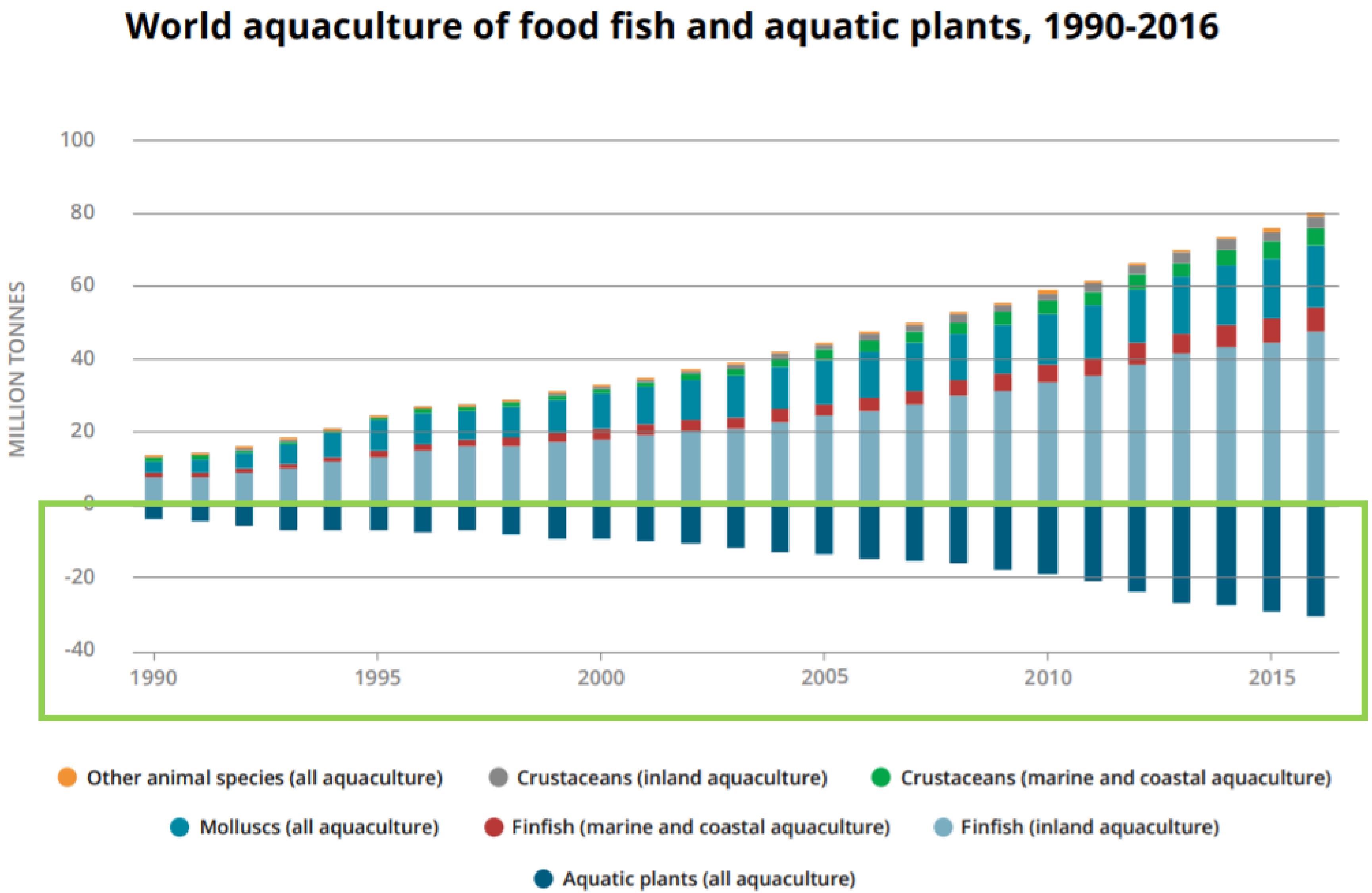


Image by J Funderud/SES



FAO 2017

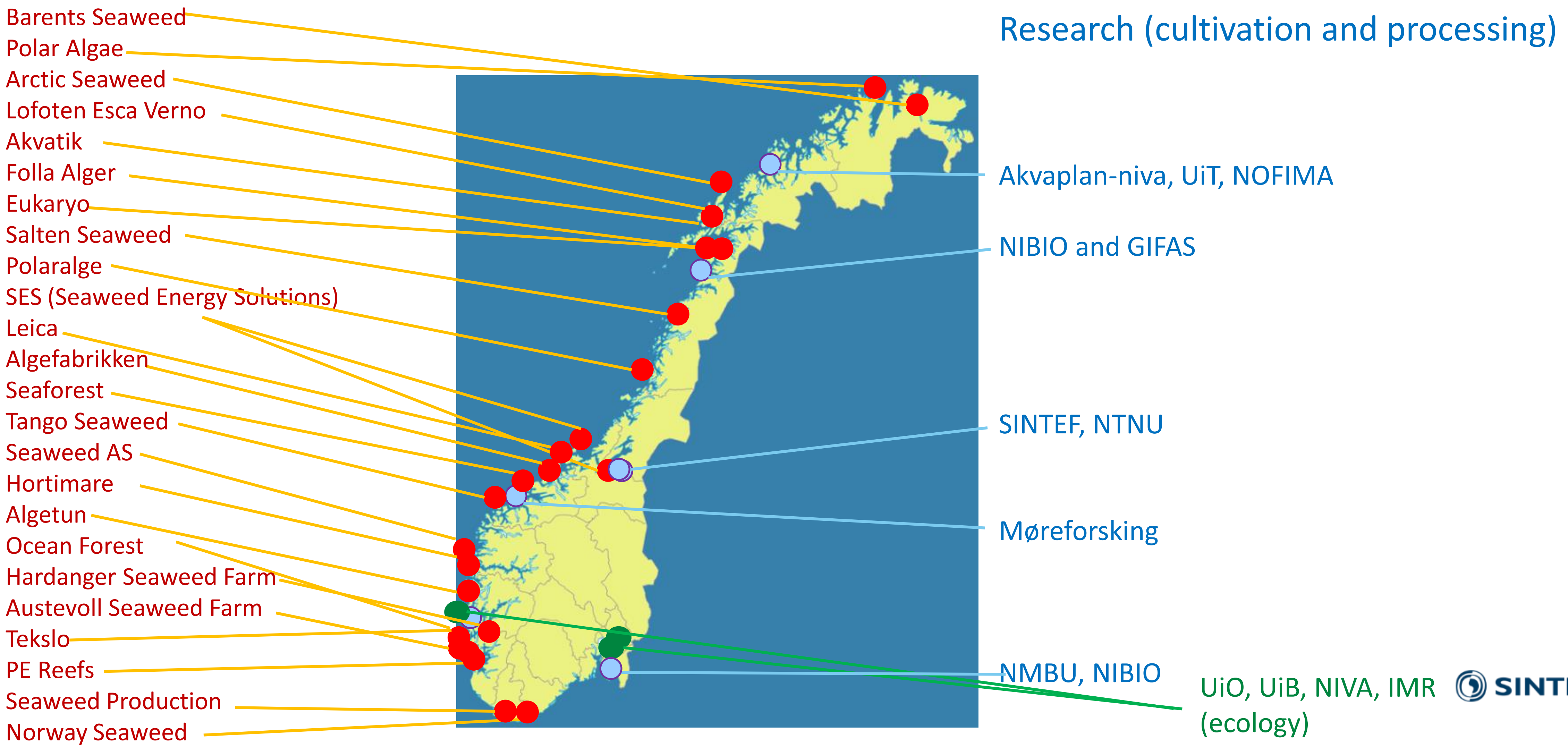
Globally (2018)

- 32 mill tons
- 14 bill USD
- 7-9% annual increase

http://www.fao.org/state-of-fisheries-aquaculture

Seaweed industry and R&D in Norway

- 29 companies, 264 licenses
- 15 companies with ongoing operations



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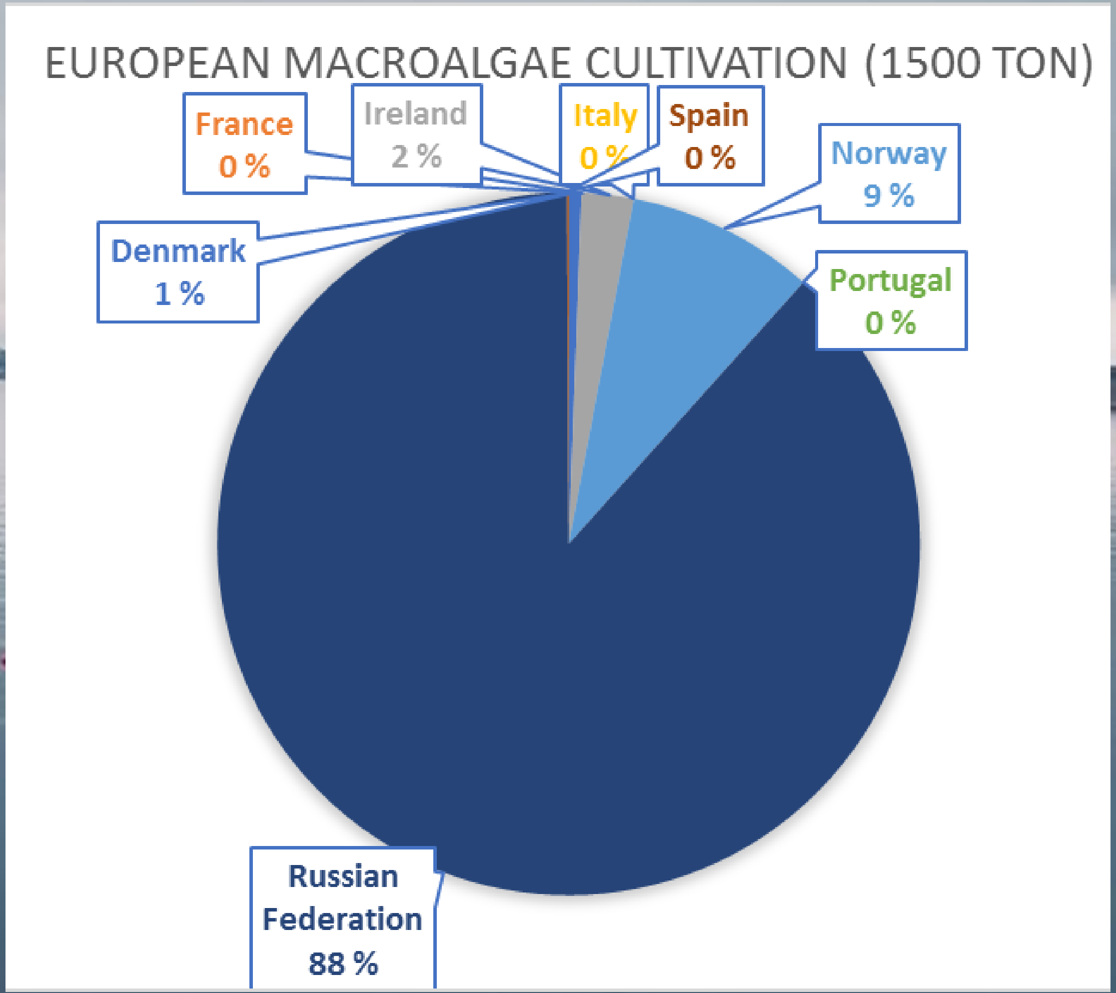
Norway

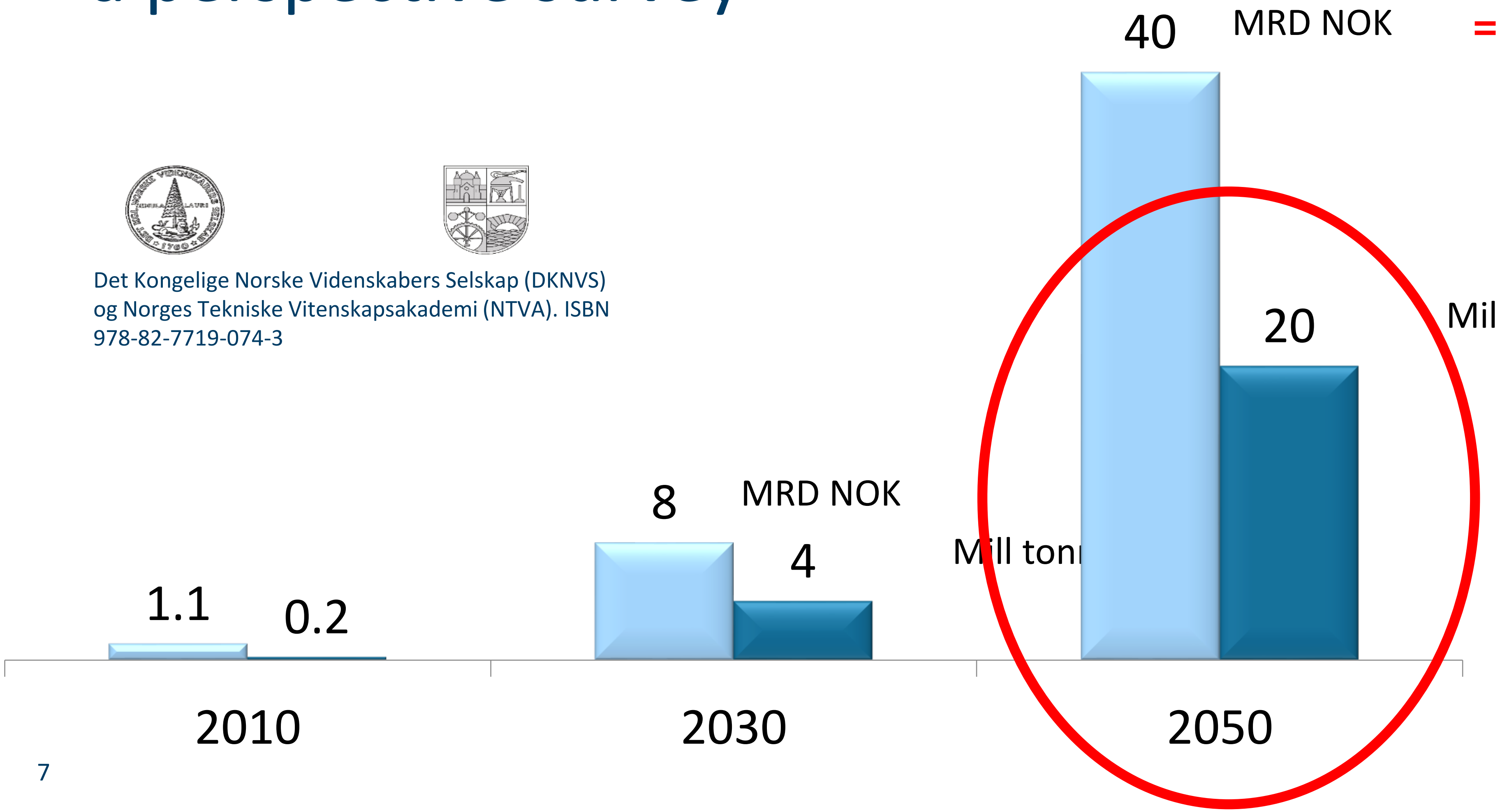
- Norway produced 148 tons (2017),
- Cultivation efficiency is 20 to 200 ton/ha



FAO 2018, SINTEF OCEANS

Photograph: Funderud/SES

Perceptive of the Norwegian seaweed industry towards 2050 – a perspective survey



= 4.8 bill USD

Det Kongelige Norske Videnskabers Selskap (DKNVS) og Norges Tekniske Vitenskapsakademi (NTVA). ISBN 978-82-7719-074-3

This requires an area of 2000-3000 km2, equivalent almost to

- **22 – 35 cities of Copenhagen, or**
- **33 – 50 times the size of Manhattan Island**

Olafsen et al. 2012

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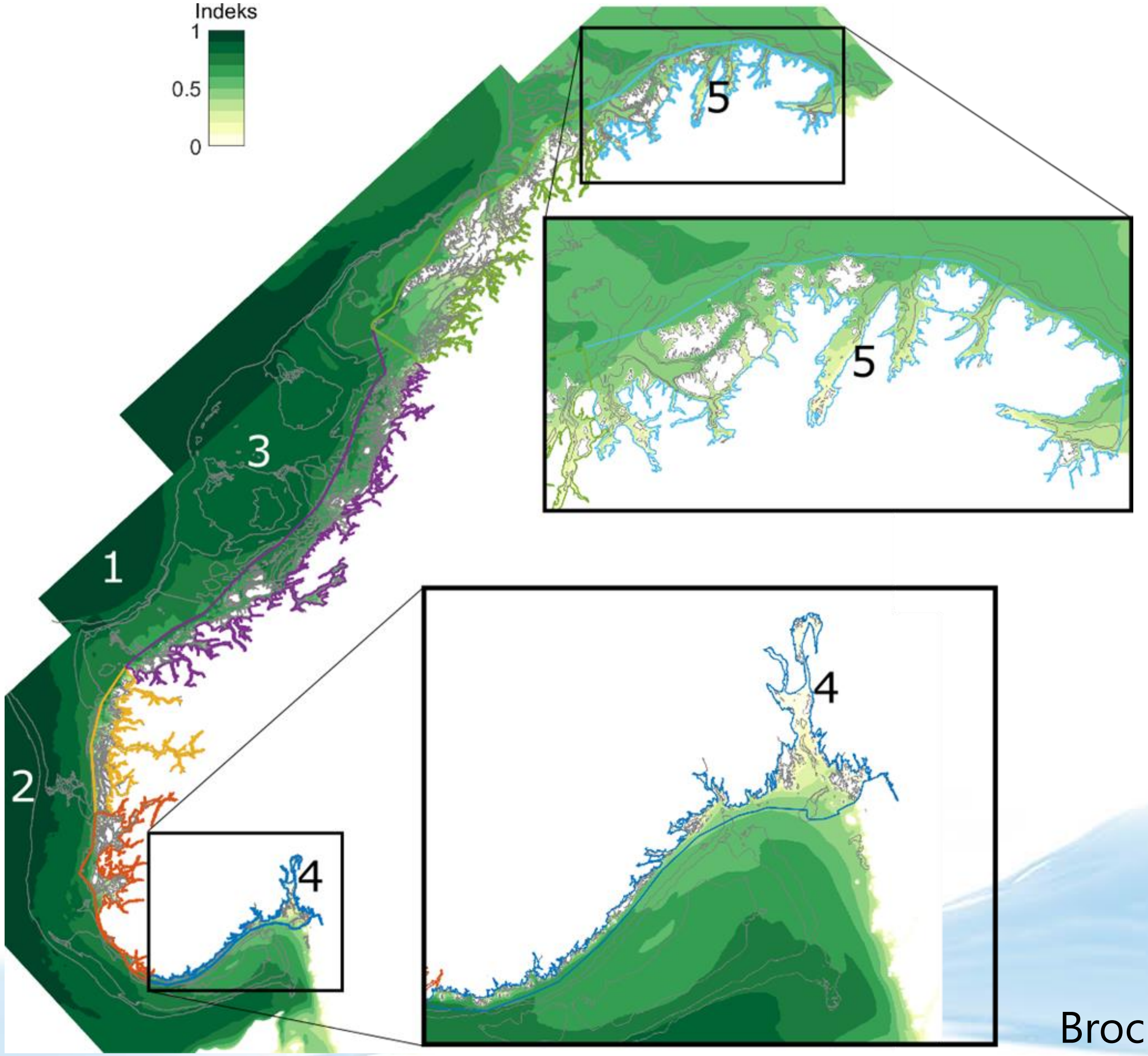
Cultivation potential in Norway

Cultivation potential is modelled for the Norwegain coast.

Conc: coastal is good, off-shore better, that is where large biomass can be cultivated (>>mill ton)

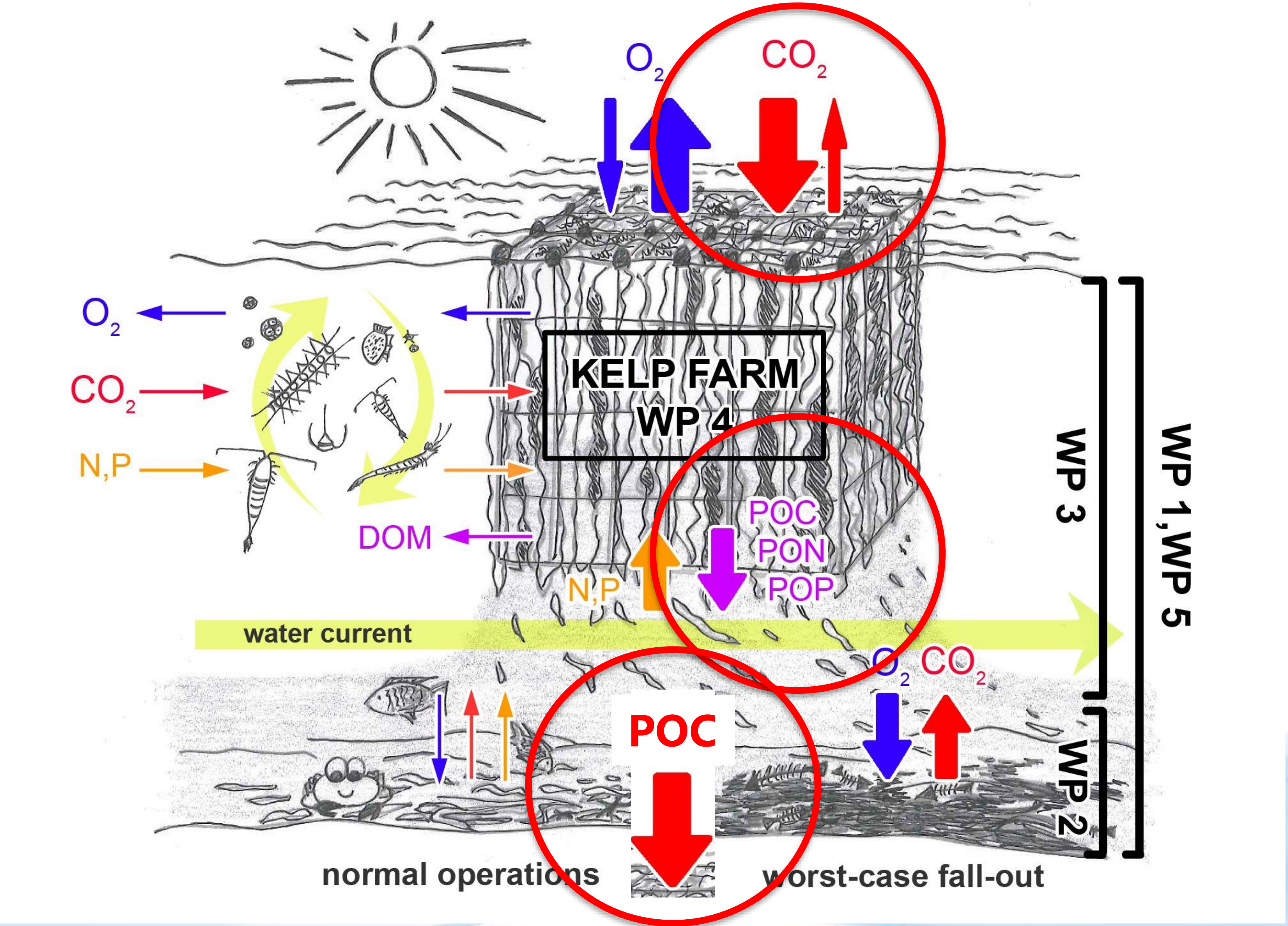


Broch et al. 2019

Mechanisms of C sequestration in seaweed cultivation

- CO_2 drawdown by seaweeds, building biomass (photosynthesis)
- Carbon export from cultivation sites by erosion of biomass (30-60% of harvested biomass)
- Exported C/biomass to the coastal region and deep sea

Fieler et al. in prep
Zhang et al 2018



Hancke et al. In prep.

SEAWEED FARMING AND CLIMATE CHANGE

MITIGATION VIA:

Ongoing processes:

C-sequestration
via export of "unseen" production

Food production
with reduced CO_2 foot print

Future potentials:

Bioenergy production
substituting fossil fuels

Reduction of methane emission
via seaweed feed additive to ruminants

Stimulation of land-based production
via seaweed biochar soil amelioration & seaweed prebiotic health benefits to livestock

Climate benefit of circular nutrient management
Via avoidance of CO_2 emissions for synthetic fertiliser production

ADAPTATION TO:

Increased storminess and sea level rise
Shoreline protection via dissipation of wave energy

Ocean Acidification
High daytime pH in seaweed to the benefit of calcifiers

Oxygen inputs to coastal waters
Avoiding ocean deoxygenation with warming

Duarte et al. 2017

CO2 sequestration from seaweed farming, perspectives

Assuming cultivation of 20 mill ton seaweed y^{-1} (Olafsen 2012)

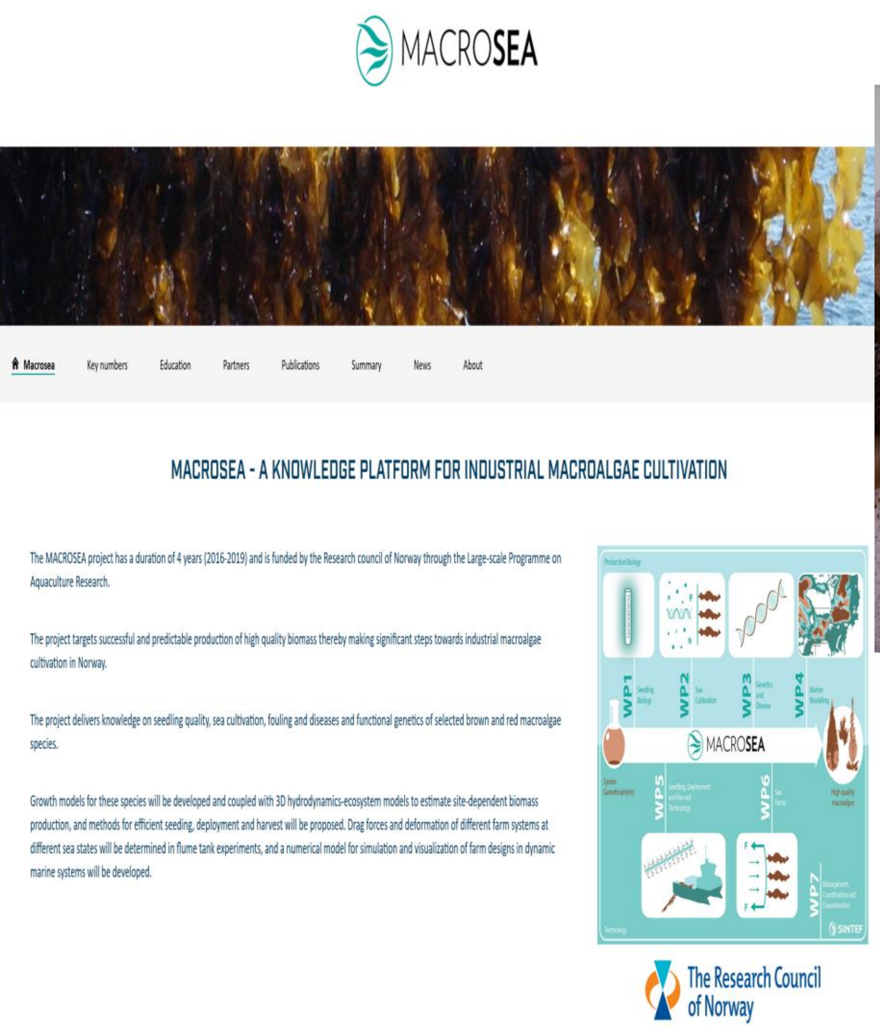
A sequestration potential of 1500 ton CO_2 km^{-2} y^{-1} (Duarte et al. 2017)

Norwegian C sequestration potential **~ 4.5 mill. ton CO_2 y^{-1}**

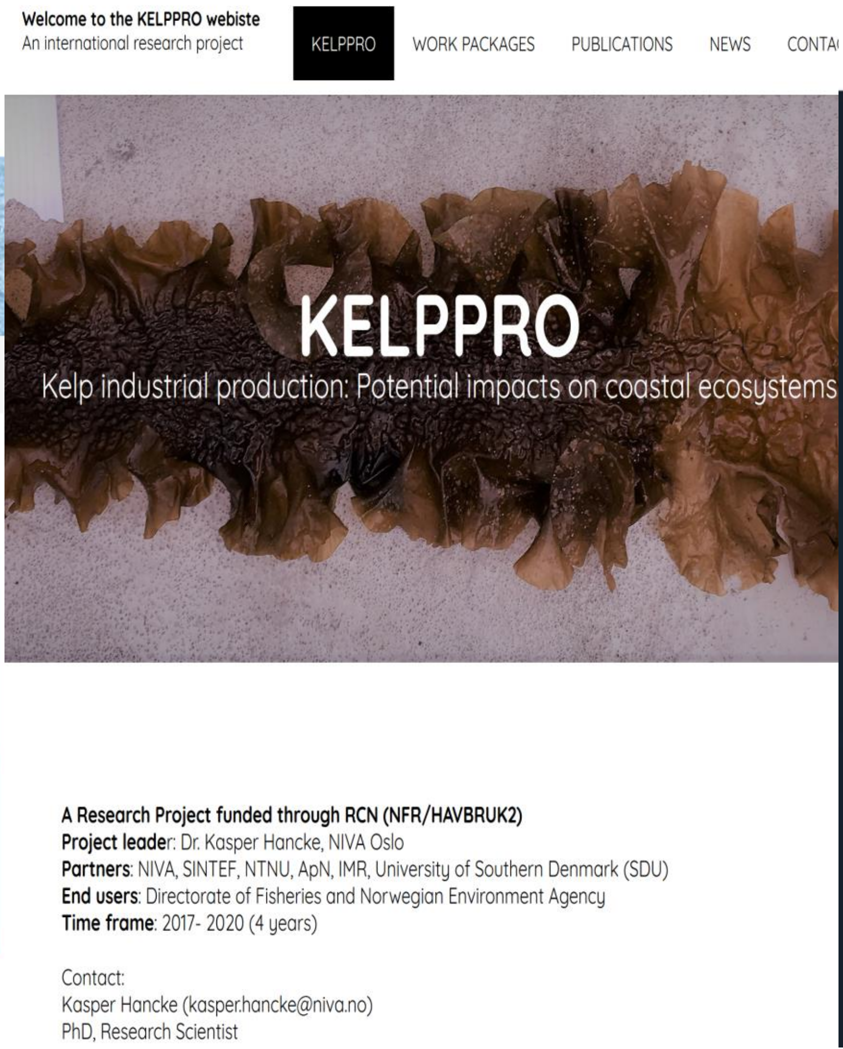
Norwegian CO_2 emissions
53 mill. ton y^{-1}
(10 ton y^{-1} $pers^{-1}$)

- **Equivalent to 8.5 %** of the Norwegian annual CO_2 emission

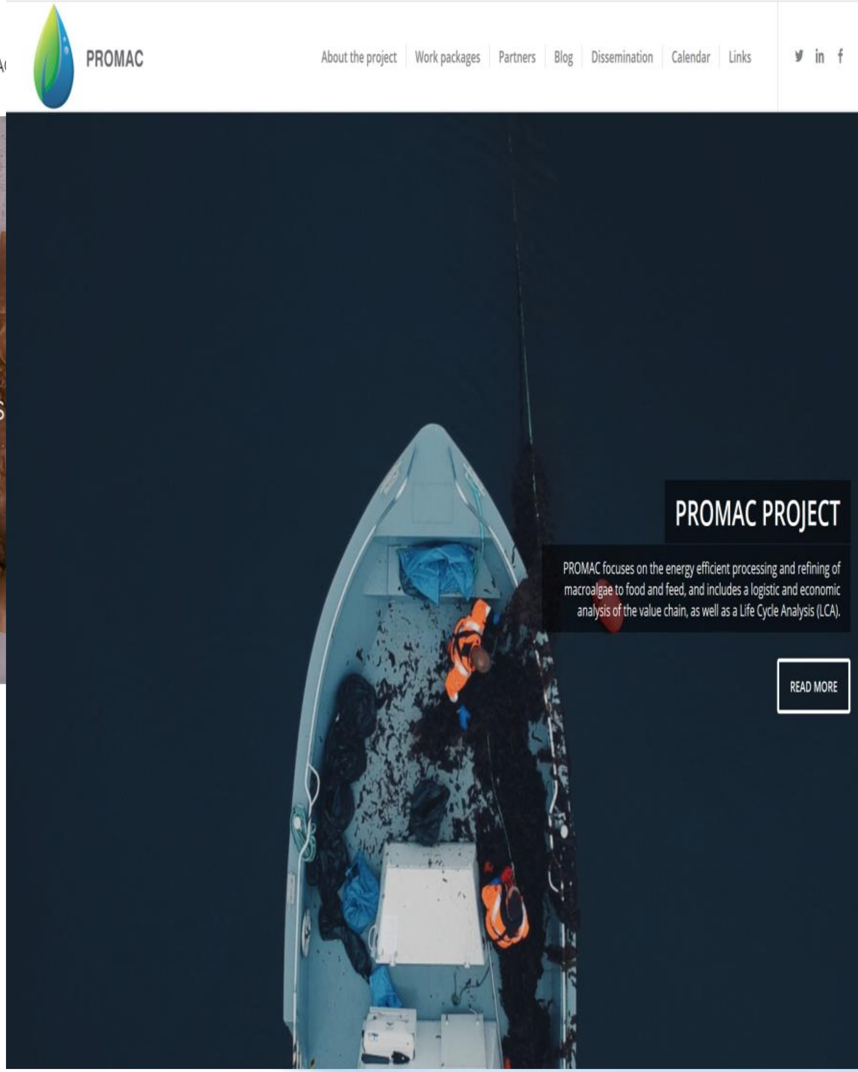
MACROSEA
Industrial cultivation



KELPPRO
Environmental impacts



PROMAC
Product development



Take-home message

- Global seaweed cultivation is 30 mill. ton yr^{-1} (14 bill USD), increasing 7%
- Norwegian seaweed predicted to cultivate 20 mill. ton in 2050
- C sequestration potential is 8.5% of annual Norwegian CO_2 emission (4.5 mill ton CO_2 yr^{-1})
- Pathway and fate of the C can be managed and regulated
- Macroalgae cultivation can be managed efficiently, and the produced biomass needs to be if CO_2 mitigation actions are indented

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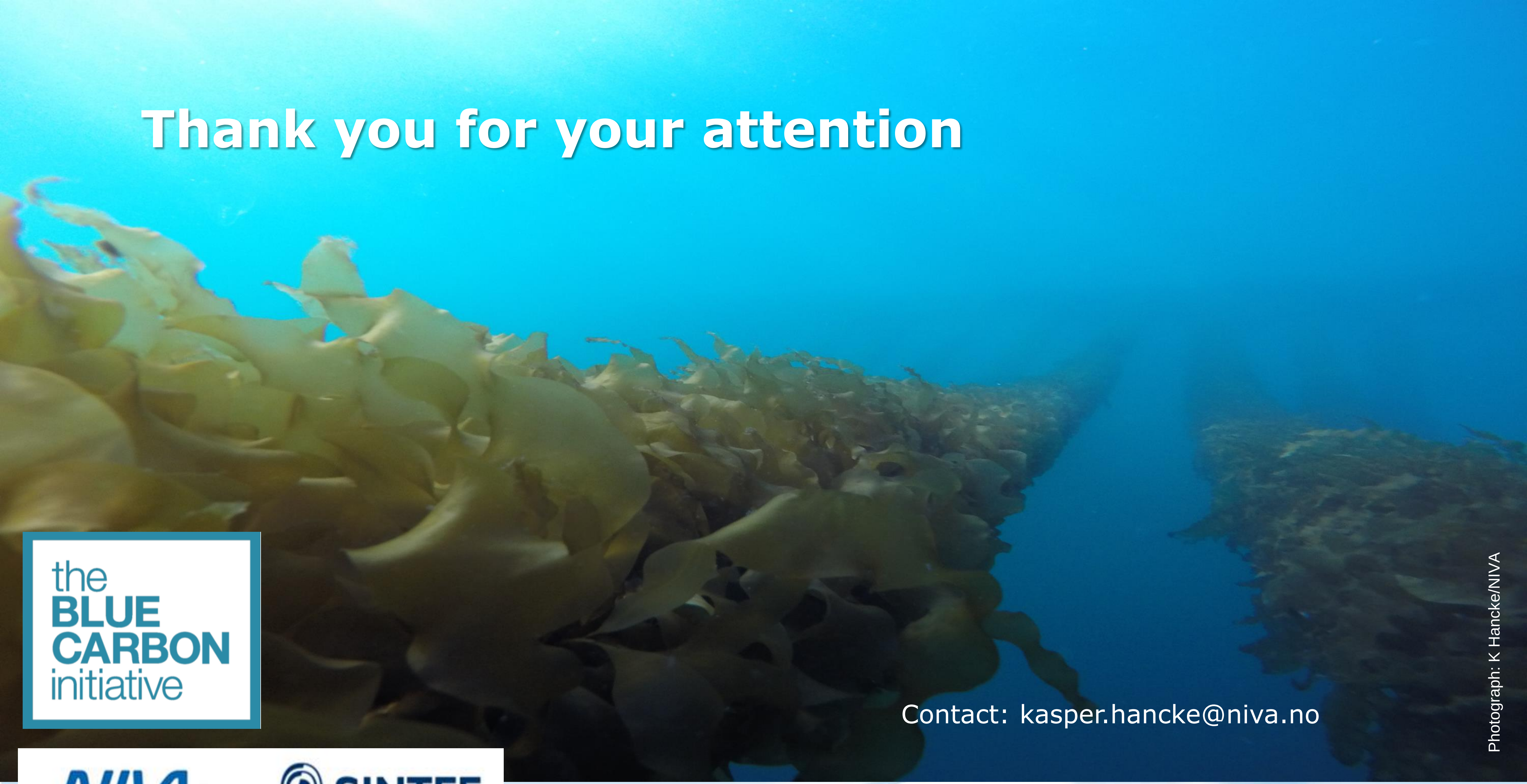
Thank you for your attention



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