

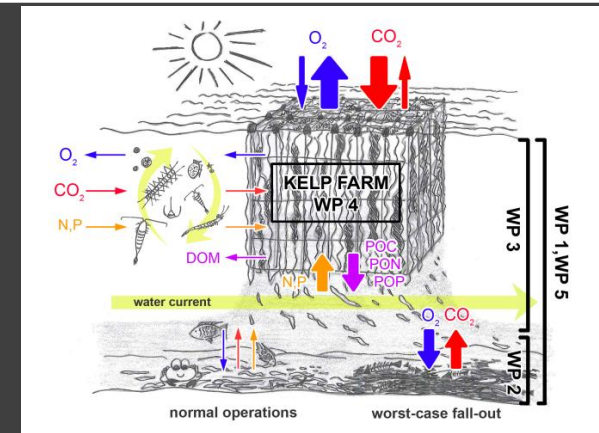
Impact of kelp cultivation on the ecosystem - results of the KELPPRO project

KELPPRO

Kelp industrial production: Potential impacts on coastal ecosystems
2017-2020

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SIG Seaweed 6 conference – 26 November 2021



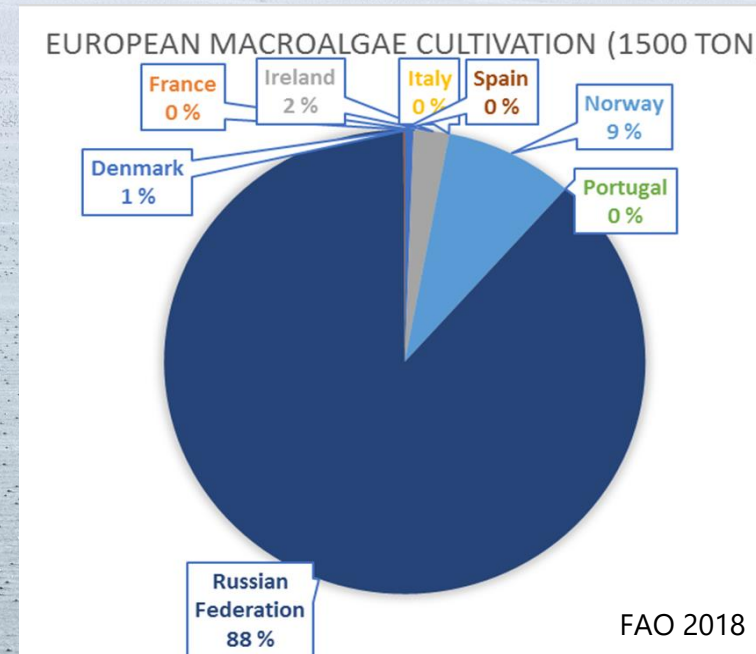
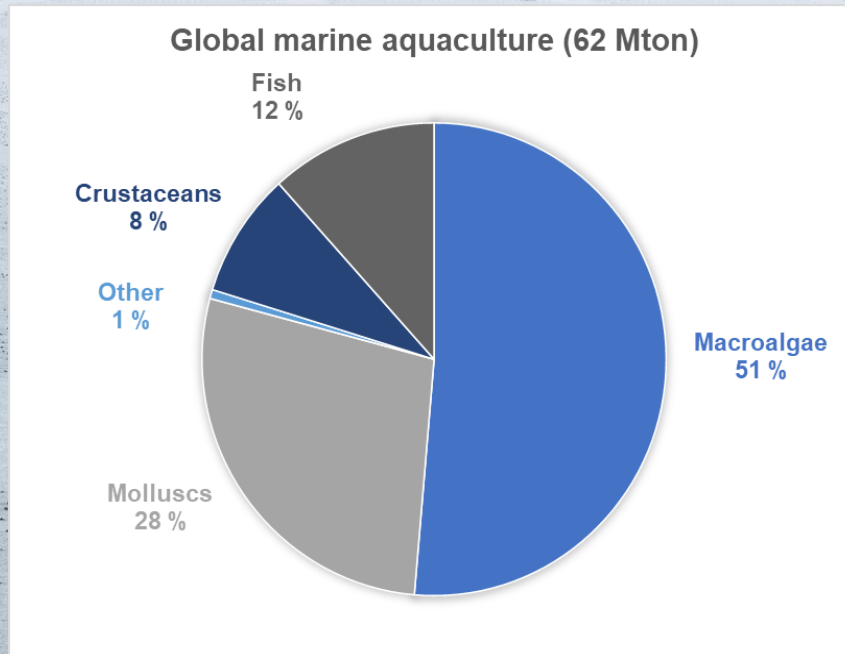
Why spend time on environmental impacts?



Sangou Bay, Kina
26 November 2021

Hancke - Environmental impacts of kelp cultivation

Why spend time on environmental impacts?



- Global seaweed production **>31 mill. tonnes** (FAO 2018)
- Norway produce >300 tonnes in 2021
- Future prospect is **20 mill. tonnes** by 2050 (Olafsen 2012)
- This requires an area of 2000-3000 km², equivalent to an area of the Hardangervidda national park

Why spend time on environmental impacts

What's why!



www.visitnorway.com

Sangou Bay, Kina
26 November 2021

Kelp industrial production: Potential impacts on coastal ecosystems

Aim:

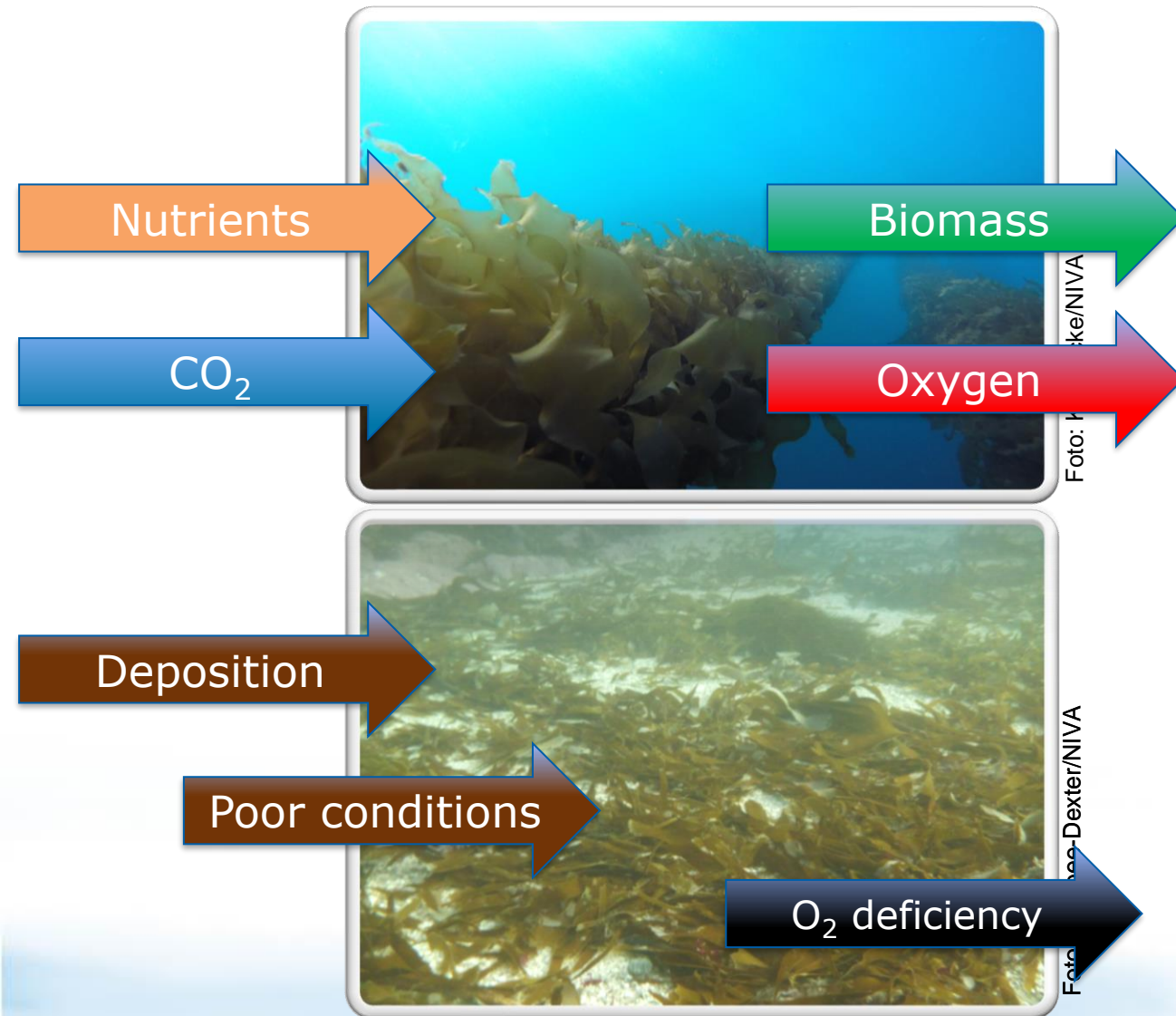
Provide an **integrated assessment of positive and negative impacts** of industrial-scaled kelp farming on the marine ecosystem

Three main questions:

- 1) Will large scale kelp farming **impact the coastal ecosystems** – open water and sea floor habitats and functioning?
- 2) Will farmed kelp detritus provide **valuable bio-resources or pose a threat** to natural coastal ecosystems?
- 3) Will kelp farming facilities provide ecosystem functioning as **'artificial' forest habitats**?



Potential environmental impacts of extensive seaweed cultivation



Positive impacts are

- **Nutrient uptake**, reducing eutrophication
- **CO₂ uptake**, reducing ocean acidification
- **Oxygen production**
- **Increased primary production**
- Stimulate **biodiversity**

Negative impacts are

- **Reduced light** availability
- **Depletion** of limited nutrients
- **Depositing** of organic matter on the seafloor, leading to
- **poor environmental conditions**,
- **oxygen deficiency**,
- change in natural **biodiversity**
- Spreading of **unwanted species, genetic material and diseases**

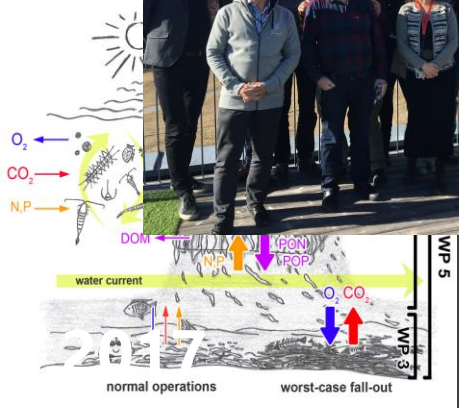
KELPPRO

Seaweed farming – good or bad news to the coast and society?

KELPPRO, an NFR funded research project (2017–2020) investigates if novel large-scale kelp farming can be accompanied by a sustainable marine management, and asking the following key questions:

- 1) Will future large-scale seaweed farming impact our coastal environment, the water masses or life at the sea floor?
- 2) Will kelp farming provide valuable bio-resources or pose a threat to natural coastal ecosystems?
- 3) Will seaweed farms work as artificial kelp forests and work against climate change?

KELPPRO applies both field investigations, laboratory experiments and numerical modelling to provide a holistic and comprehensive assessment. Involved are both research institutes, universities, seaweed farmers and industry.

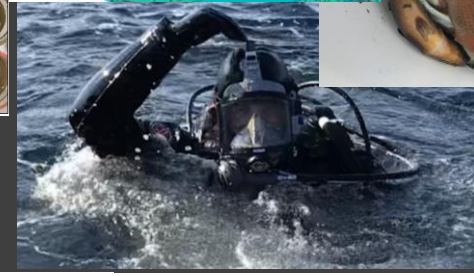
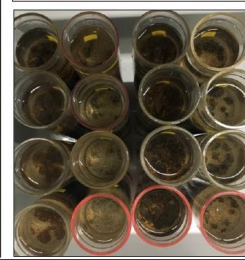
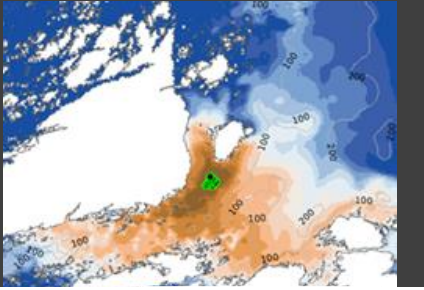
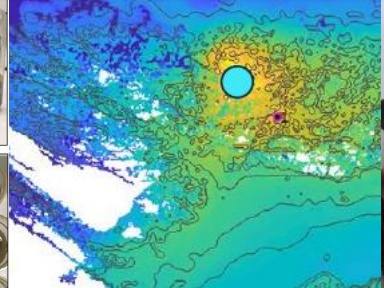
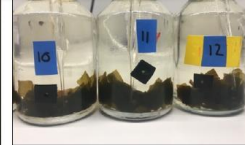
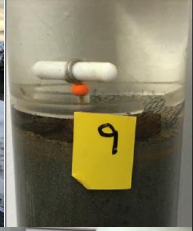
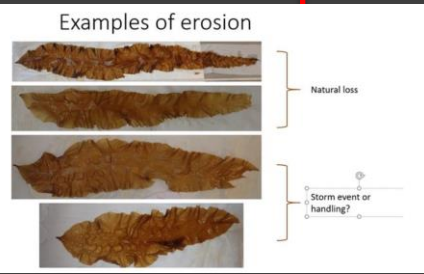
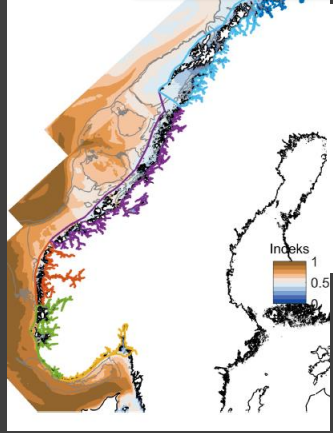


2018

2019

2020

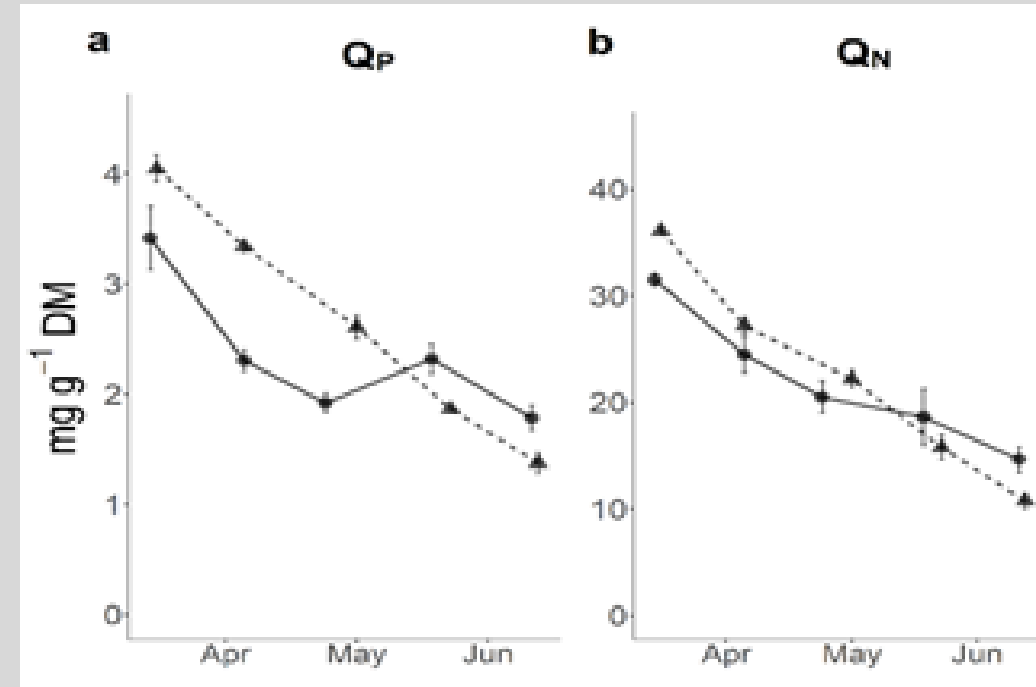
2021



Effects on life in the water column

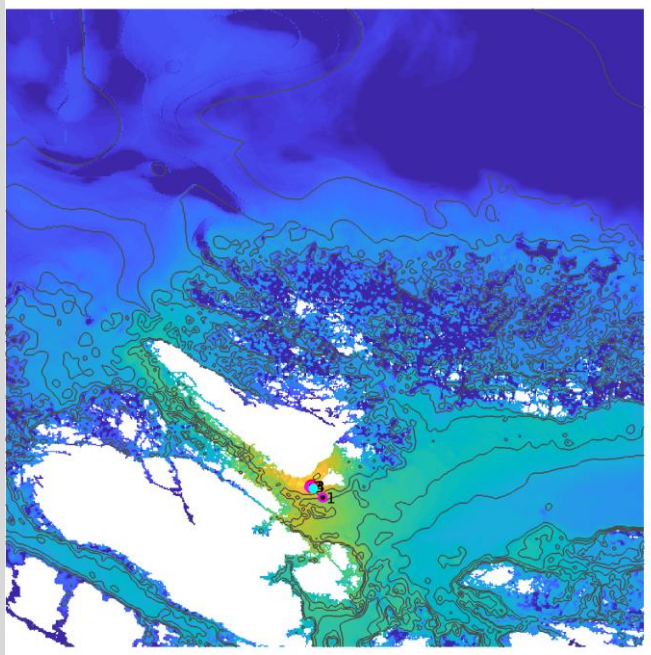
Competition on nutrients between microalgae and kelp?

- Kelp take up nutrients in early spring and growth largely on that throughout the season
- Phytoplankton has a much faster and more efficient nutrient uptake and kelp (>10 times)
- **No significant negative influence found of kelp cultivation on natural phytoplankton and the pelagic foodweb**

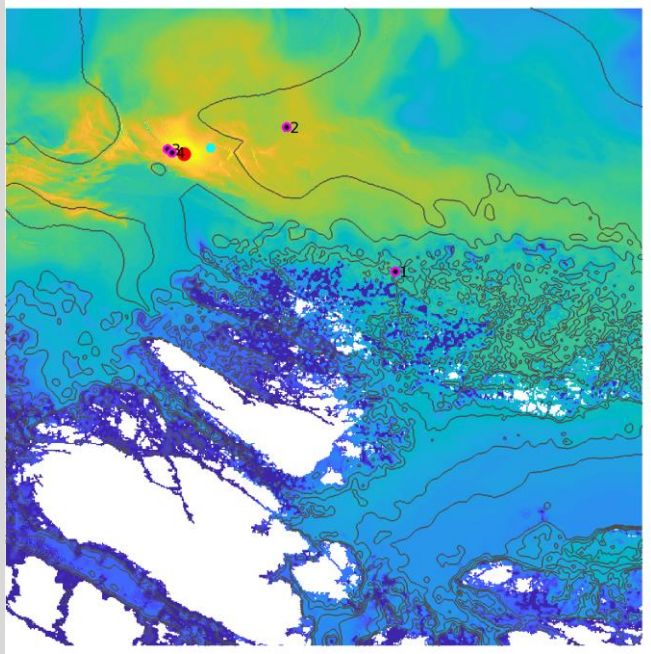


Content of phosphorus (a) and nitrogen (b) in cultivated kelp (*Saccharina latissima*), through season 2018.

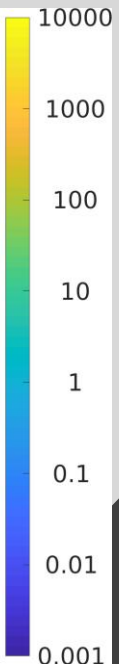
Hancke et al 2021; Njåstad, Olsen et al. in prep.



Sheltered
30m deep



mg C m⁻²



Offshore
255m deep

Cultivated kelp settling on the seafloor –results from modelling

- Farm export 8-15% of harvested biomass under normal production scenarios. And >50% after the summer (*Fieler et al. 2021*)
- Exported kelp only deposition in thin amounts under the farm but **spread from 1 to 10 to 100's of kilometers**
- **Kelp typically spread over large areas in thin layers depending on physical surroundings and geography of the region. *Sometimes in thick layers.***

Seafloor biodiversity

Kelp can provide a food source to seafloor fauna or pose a threat to life at the seafloor

- At normal farming conditions effects on seafloor fauna is minimal
- By 'massive' accumulations of kelp on the seafloor ($>8 \text{ kg m}^{-2}$) biodiversity decreased and a few species increased in numbers
- **The documented effect was short: $>90\%$ was gone in three months and conditions normalized**



Borgersen et al. in prep.

Hancke et al. in prep.



Foto: Hartvig Christie (NIVA) og SES



«Large quantities of *Caprella mutica* was found late in the fall

Hancke et al 2021;
Bekkby et al. in prep.

Kelp farms as artificial reef

- Kelp farms provide an ‘artificial’ ecosystem
- Length of the grow season impact the fauna community
- **Kelp farms can be a vector for alien species and spreading of genetic material**
- **Scientific documentation is sparse**



Short summery

- **No larger negative impact of kelp cultivation** on phytoplankton or functioning on life in the open water column
- Kelp biomass from farms **spread over large areas** and settle on the seafloor
- **No significant impacts** of present-day kelp cultivation were documented **on seafloor fauna** (business as usual)
- **Large scale cultivation** and deposition of kelp on the seafloor **might negatively impact seafloor biodiversity**
- **Kelp farms may act as a vector for alien species and genetic transportation**, but data foundation is spare still

KELPPRO WORK PACKAGES PUBLICATIONS NEWS CONTACT

KELPPRO

Kelp industrial production: Potential impacts on coastal ecosystems

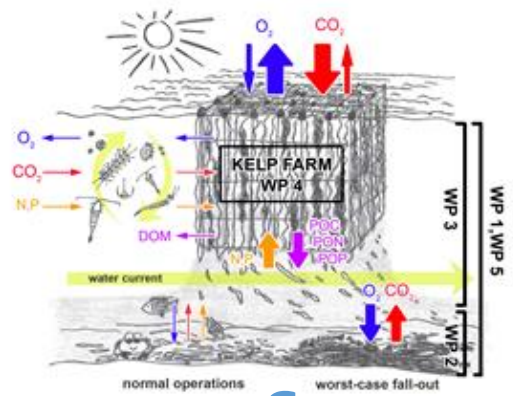
The research project **KELPPRO** aims to provide an integrated assessment of positive and negative impacts of industrial-scaled kelp farming on coastal environments, and is funded by The Research Council of Norway (HAVBRUK2).

The diagram illustrates a kelp farm (WP 4) and its interactions with the surrounding environment. It shows a cross-section of the water column and seafloor. Key components include:

- WP 1, WP 5:** The water column above and below the farm.
- WP 2:** The seafloor area directly beneath the farm.
- WP 3:** The area of the water column immediately surrounding the farm.
- WP 4:** The kelp farm itself.

Normal operations: Shows a kelp farm with a water current flowing through it. Arrows indicate the exchange of O_2 (blue), CO_2 (red), and N, P (orange) between the water column and the seafloor. The farm releases POC , PON , and POP (purple) into the water column. The seafloor shows a fish and a crab, with arrows indicating the exchange of O_2 (blue) and CO_2 (red).

Worst-case fall-out: Shows the same kelp farm, but with a large amount of POC , PON , and POP (purple) falling out of the water column and settling on the seafloor. This leads to a significant increase in CO_2 (red) and a decrease in O_2 (blue) in the water column and seafloor.



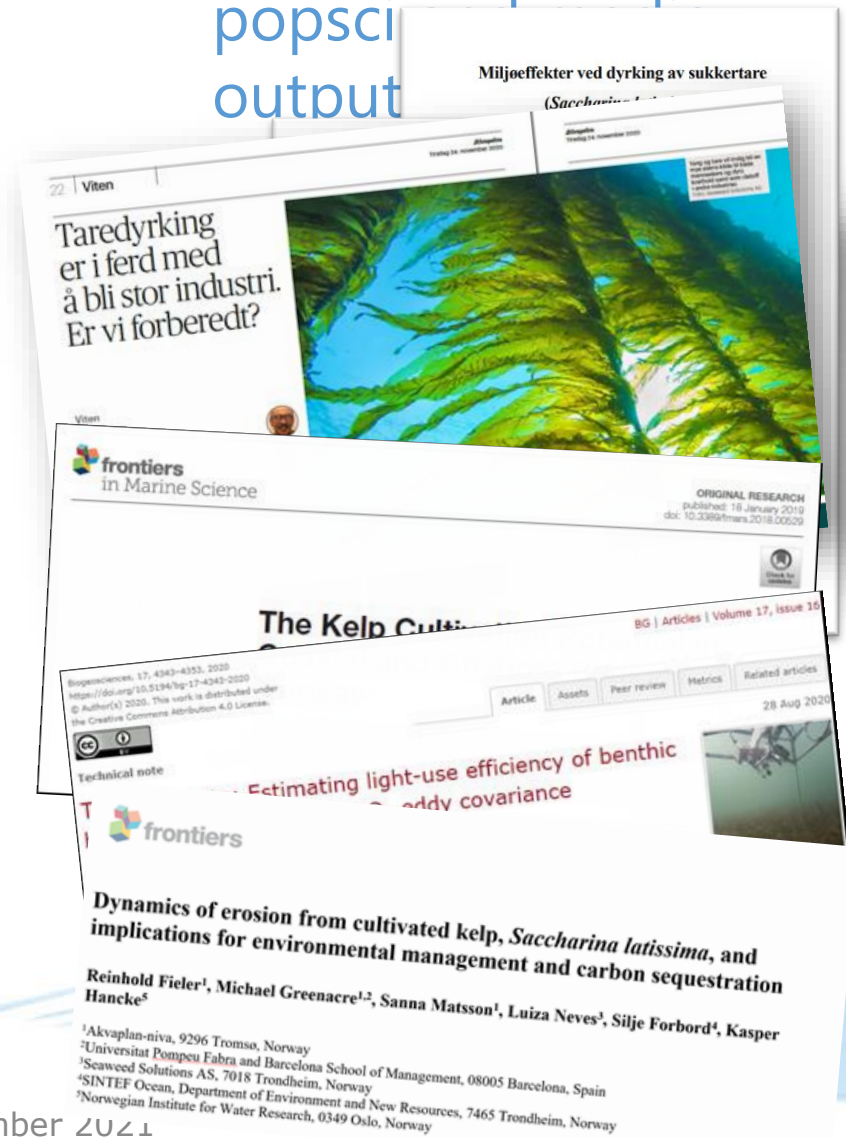
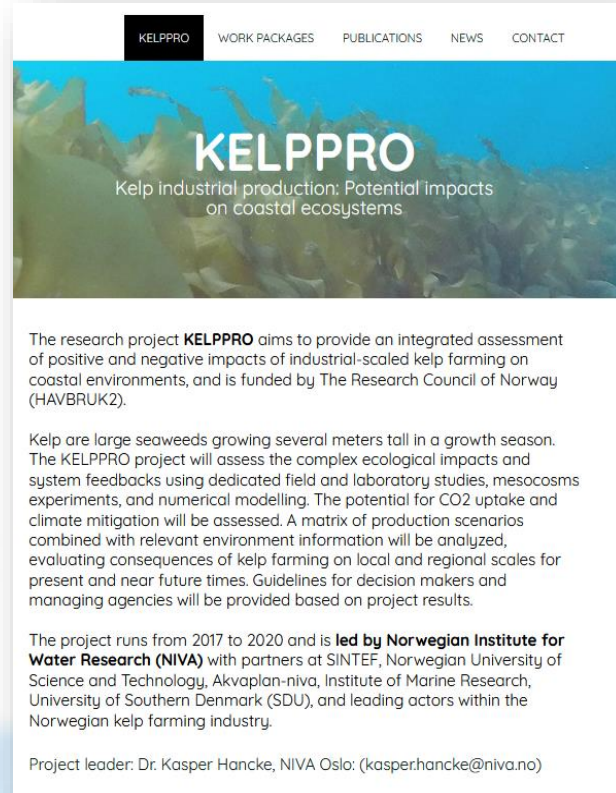
Main outputs

Papers, MSc thesis, popsci output

Summery report
(In Norwegian, abstract in English)



Website



Thank you for your attention!

More information on
www.kelppro.net

Acknowledgments to the:

- Researchers
- Technicians
- Students
- Industry members
- Advisory board
- Stakeholders
- and og course - **The Research Council of Norway** for funding!



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