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Kunnskap for en bedre verden

Effects of seaweed farming on the on open water ecosystems

(WP3 KELPRO)

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Content

- Physical environment
- Nutrient concentrations

Growth and nutrient physiology

- Specific growth rate (day-1)
- Total intracellular N and P contents
- Inorganic nutrient storage
- Net N and P uptake

Interaction of large scale farming with phytoplankton community

- Comparative uptake kinetics of micro and macroalgae
- Effect on phytoplankton community state and carrying capacity
- Growth and nutrient flow, from experiment
- What if ….. Challenge of conclusion

Two groups of Saccharina latissima

Deployed:

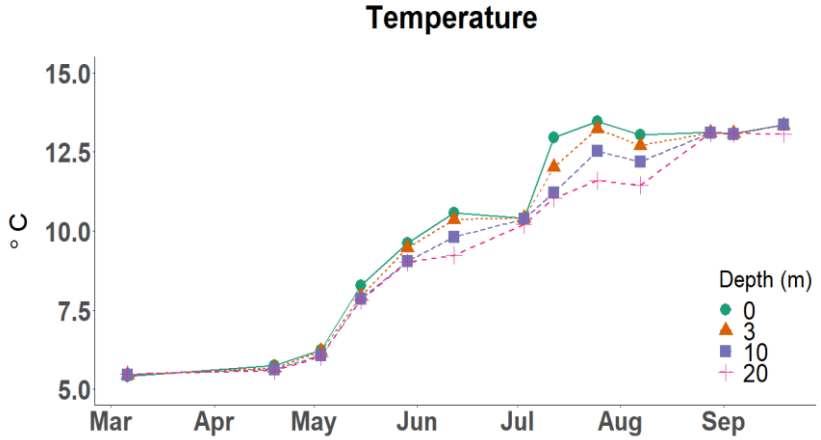
- ❑ August 2017
- ❑ January 2018

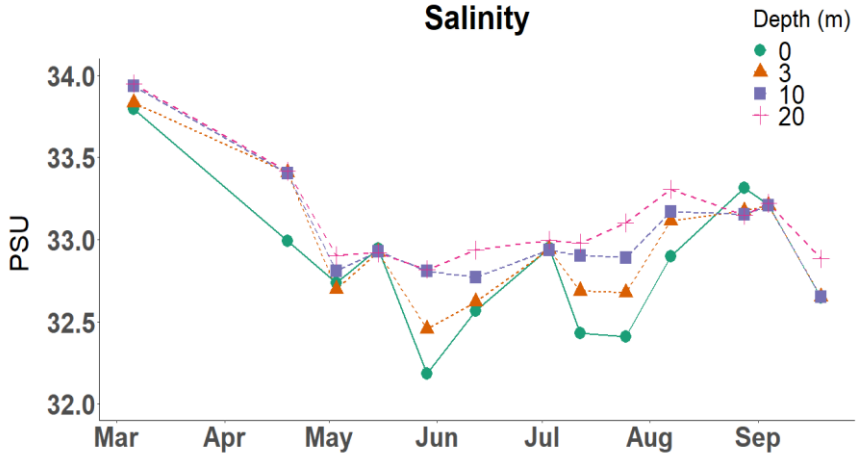
Sampling:

- ❑ February to June 2019
- ❑ Summer period May-June 2019

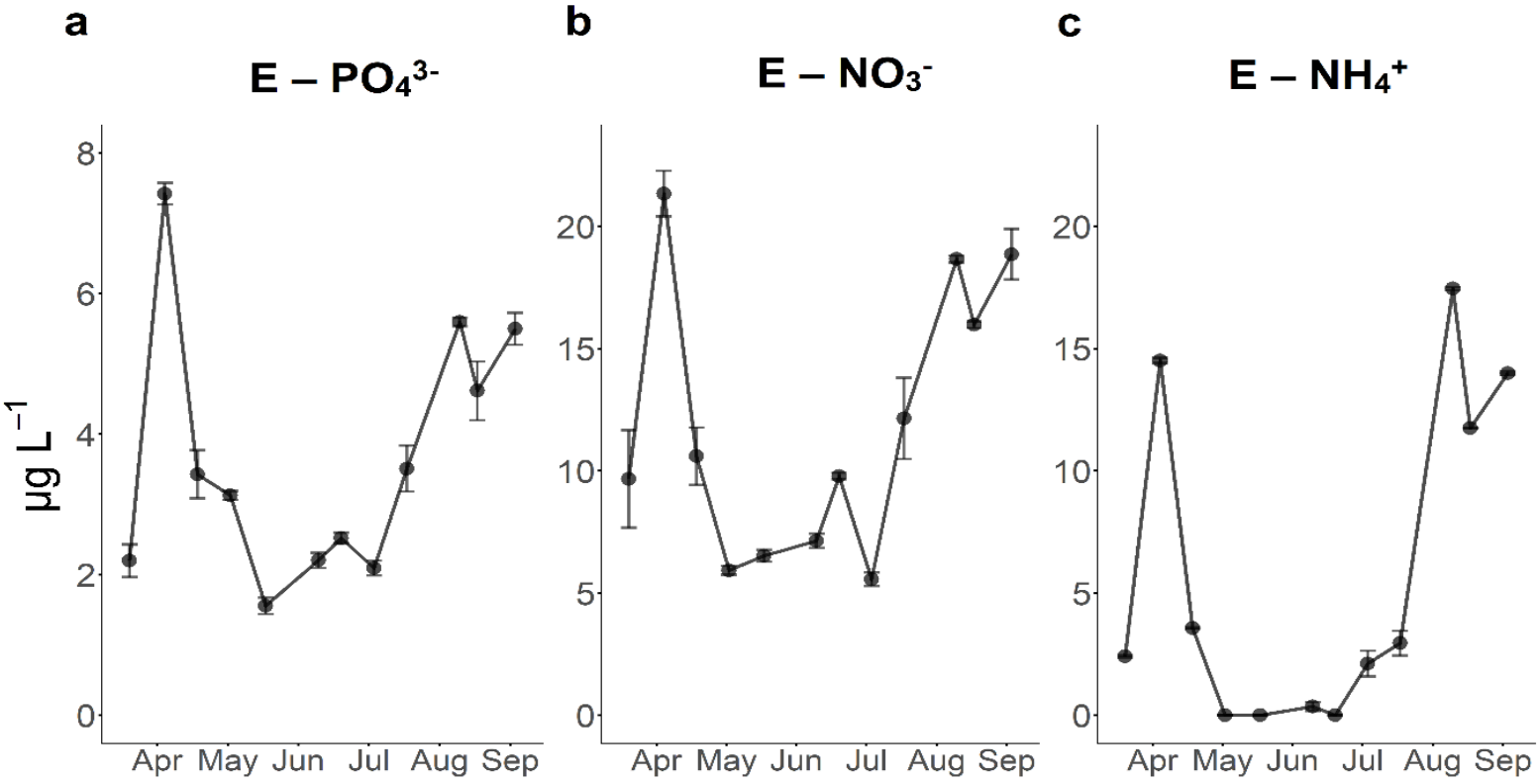
Measurements:

- ❑ Abiotic variables
- ❑ Growth of *S. latissima*
- ❑ Elemental composition
- ❑ Nutrient uptake

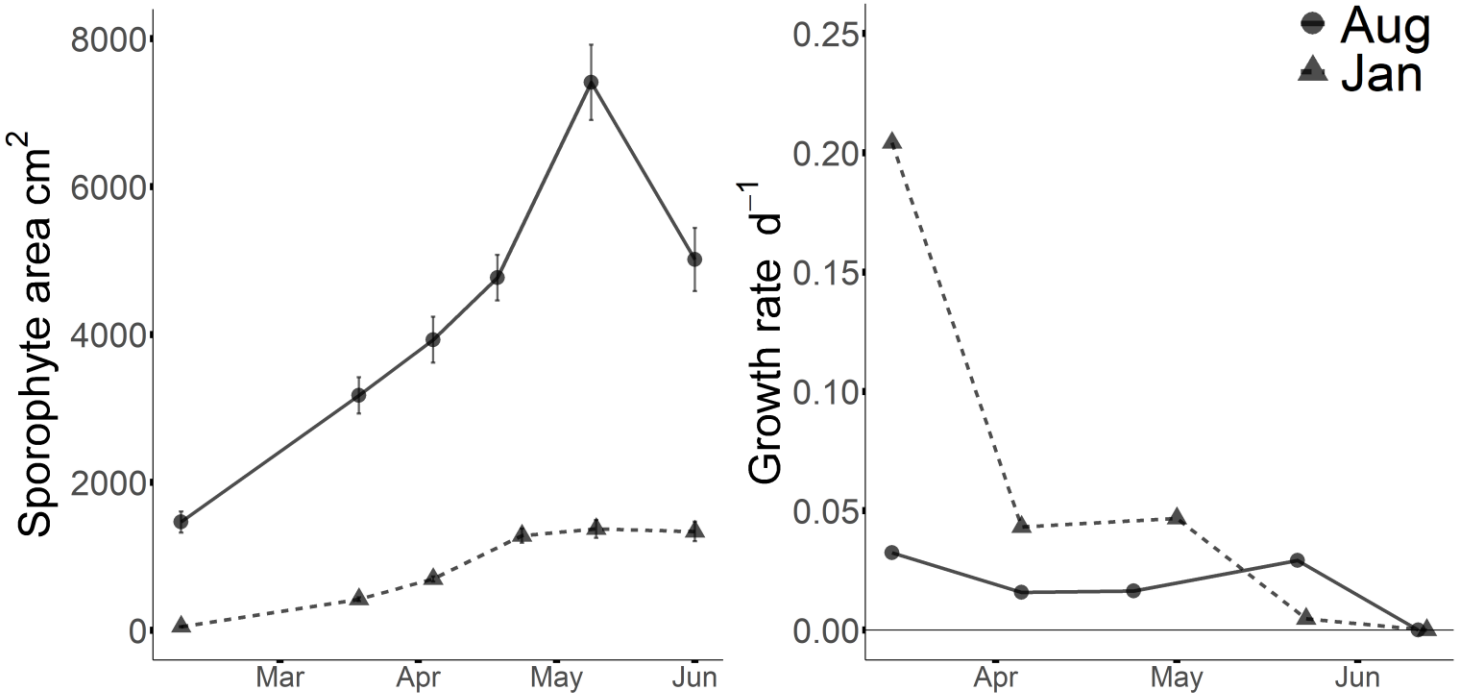




External nutrient concentrations, µg per litre

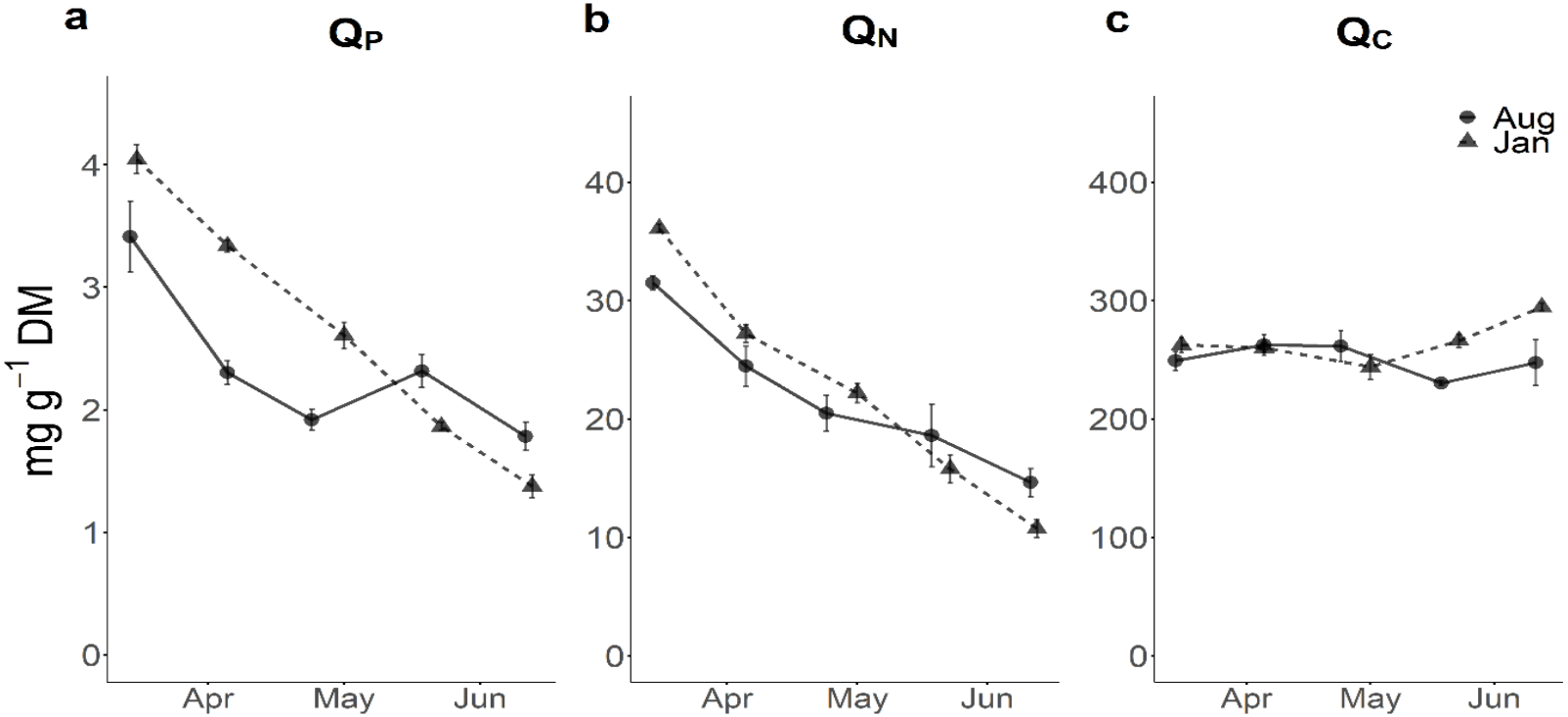


Growth of *Saccharina latissima*. a) area based growth, cm^2 b) specific growth rate, day^{-1}



Total intracellular nutrient contents

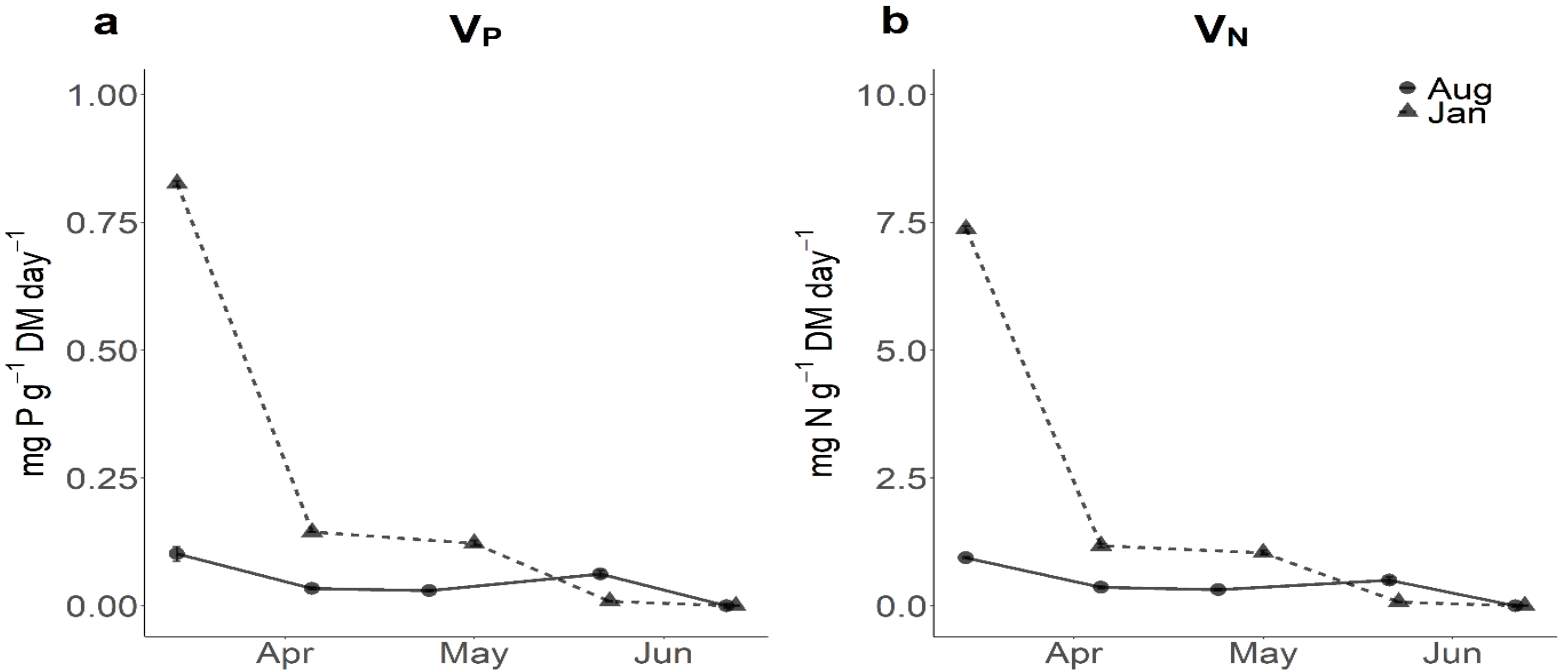
a: Q_P (µg P/mg DW, **b:** Q_N (µg N/mg DW), **c:** Q_C (µgC/mg DW)



Net steady state uptake of N and P ($V = Q \times \mu$)

a: Net P uptake (V_P, µg P/mg DW and day)

b: Net N uptake (V_N, µg N/mg DW and day)



Interaction of large scale farming with phytoplankton community

- Comparative uptake kinetics of micro and macroalgae
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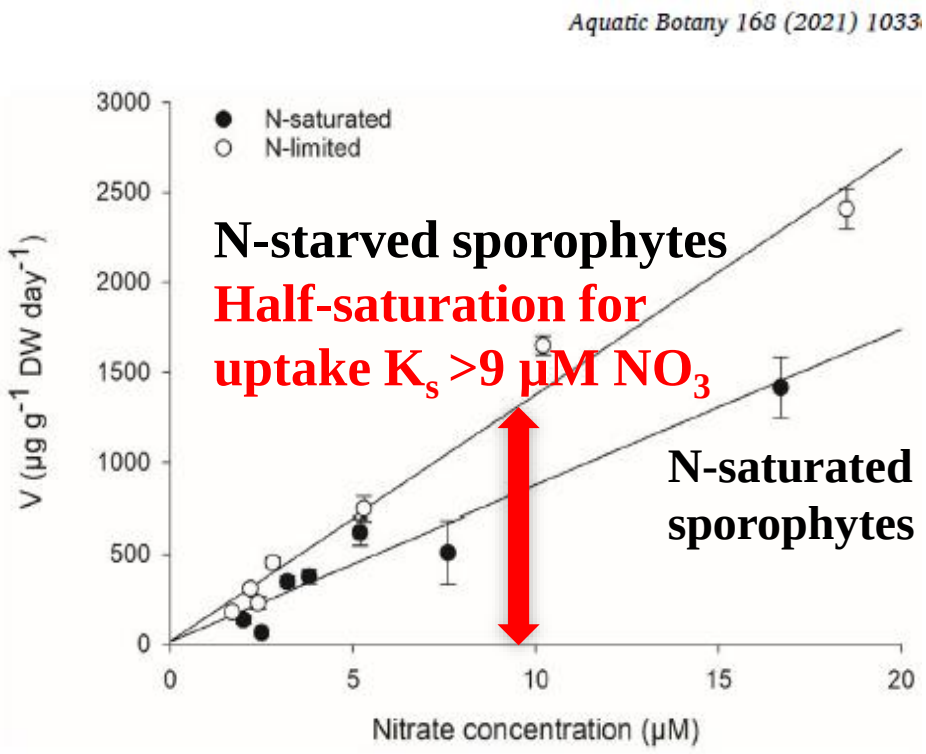
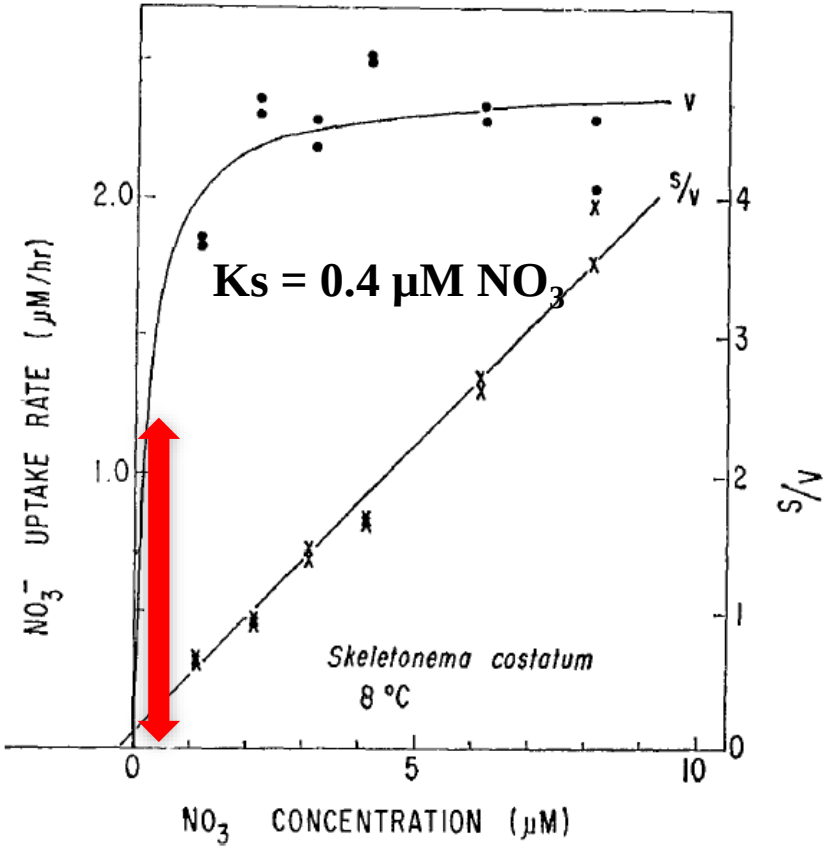
Comparative nutrient uptake kinetics

Saccharina latissima

Forbord et al 2020



Skeletonems costatum, diatom and cosmopolite



Saccharina latissima

Capabilities of nitrate uptake:

- Maximum uptake rate V_{max} at >20 µM
- Half saturation constant K_S at >9 µM

Marine phytoplankton

Skeletonems costatum, diatom and cosmopolite, K_S: 0.4 µM

Ks of other phytoplankton:

Oceanic species: 0.1 - 0.3 µM
Neritic species: 0.6 -3.5 µM
Neritic or littoral flagellates: 0.1- 8.6 µM
Natural communities: 0.2 - 1.0 µM

Eppley et al 1976

Saccharina experiment:
0.5 µM nitrate in the summer period

0.5 µM can support a growth rate of 0.004 day^{-1}, 1-2% of the maximum growth rate

THE PHYTOPLANKTON TAKES IT ALL

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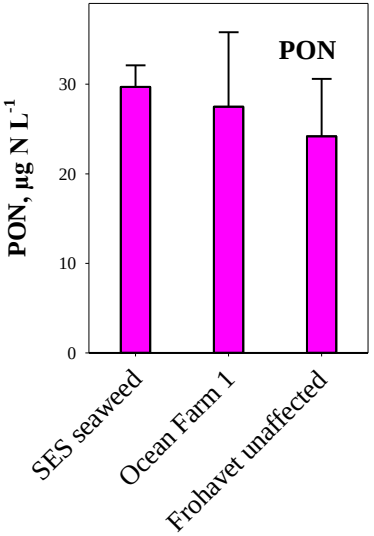

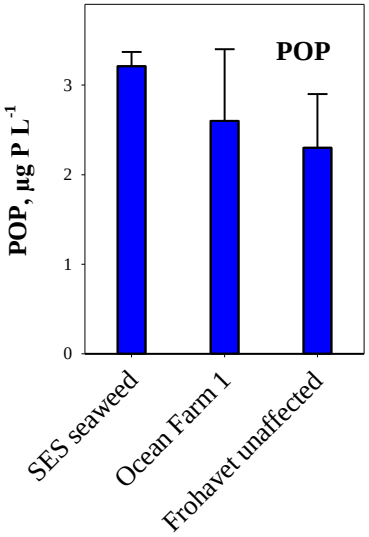

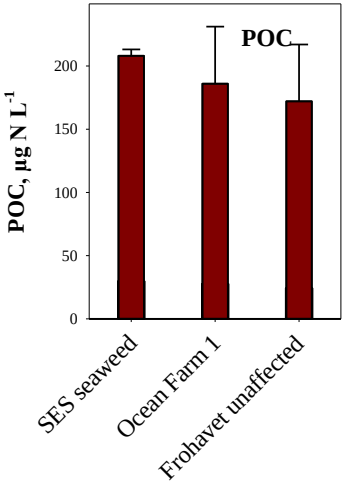

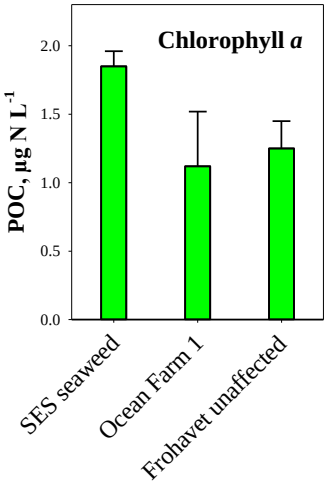

SES Seaweed location compared to two Froan locations

(and many other locations)

- Phytoplankton biomass and carrying capacity were not affected
- Elemental C:N:P composition of phytoplankton revealed potential P limitation ……
- …. **and undisturbed ecological and chemical states and food chain functionality**

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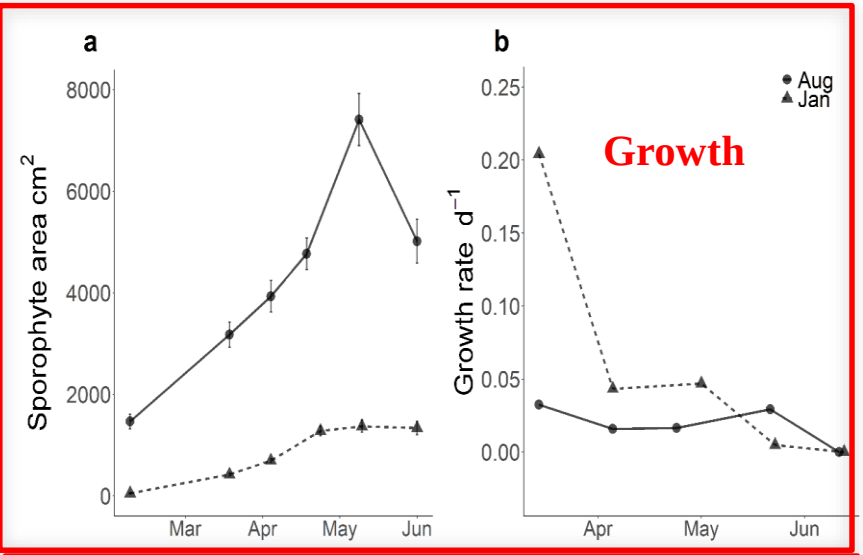

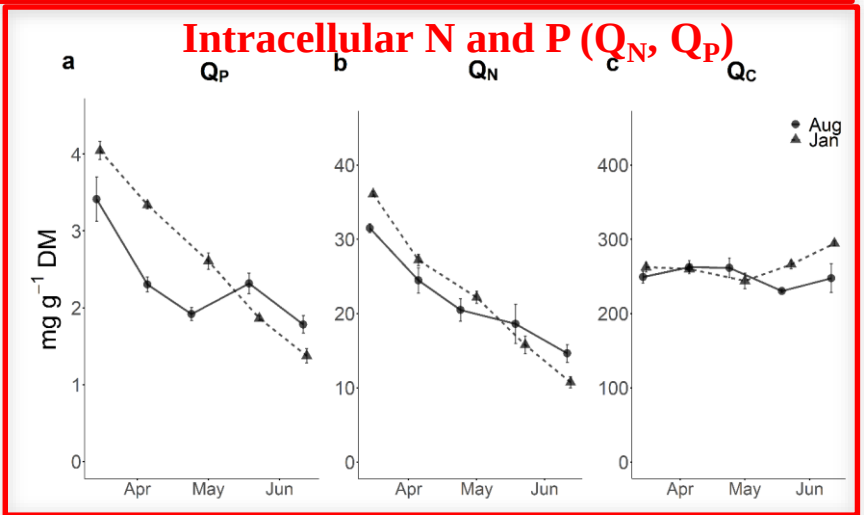

Evaluation of phytoplankton interactions based on growth/ stoichiometry data

For May-June, mean for groups:

Specific growth rate:

$\mu = 0.018 \pm 0.008$ day^{-1}

Reduction rate of N-contents (Q_N):

$DQ_N = - 0.018 \pm 0.008$ day^{-1}

Reduction rate of P-contents (Q_P):

$DQ_P = - 0.014 \pm 0.008$ day^{-1}

For Saccharina latissima in the summer season;

Growth is completely supported by intracellular sources of N and P

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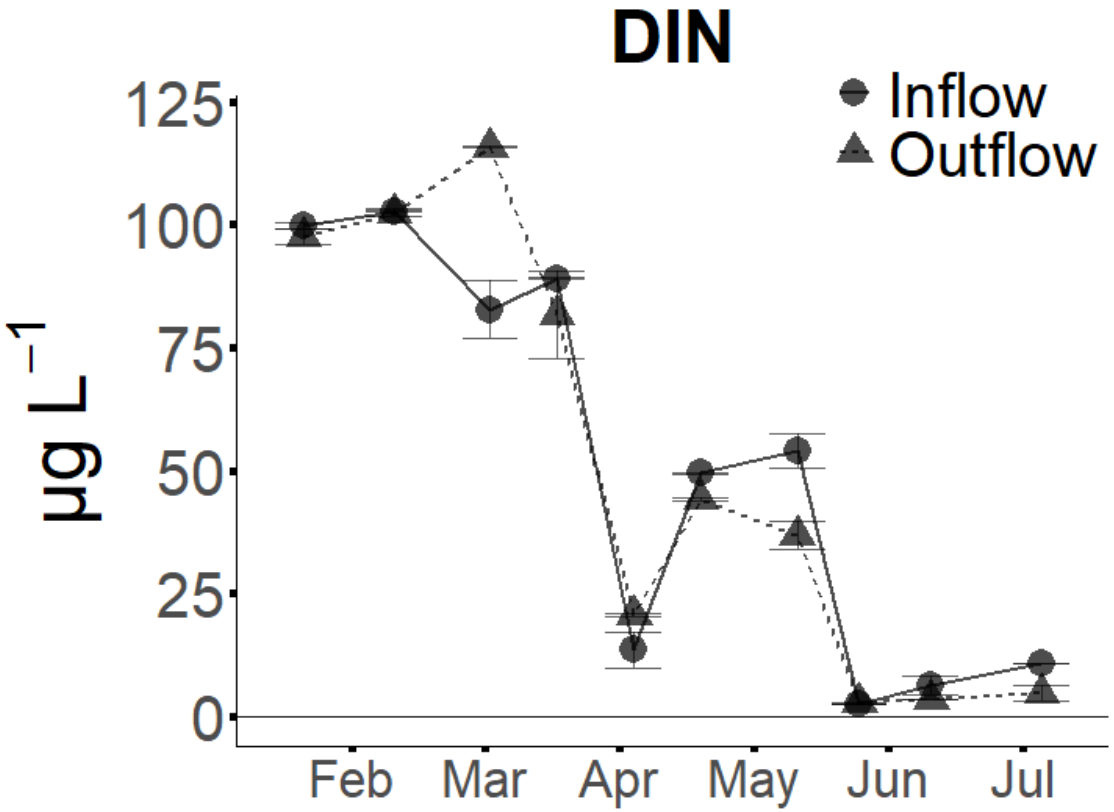
Nitrate concentration in water flowing into and out of SES seaweed farm (Elin tells more)



The phytoplankton takes it all!

Saccharina latissima

- **No differences in nutrient concentrations in water flowing into and out of the SES seaweed farm in May –June**
- ***S. latissima* survive based on internal nutrient resources**
- **Around 0.4 gN per ha and day is available for the phytoplankton (Olsen et al 2016)**

THE WINNER TAKES IT ALL!

There is no negative interaction between seaweed farming and the surface water phytoplankton community

- *S. latissima* accumulates their nutrients before the spring bloom
- Phytoplankton outcompetes macroalgae in May to September, in Central Norway