The EXPLOIT Project

"Exploitation of nutrients from salmon aquaculture“

RCN: 216201/E40

Goal: To deliver fundamental knowledge regarding IMTA productivity and design under Norwegian coastal conditions as well as consider socio-economic aspects of such production

Aleksander Handå,

Henrice Jansen, Maria Bergvik, Silje Forbord, Ole Jacob Broch, Peter Cranford, John Ellis, Raymond Bannister, Vivian Husa, Julia Fossberg, Lene Stensås, Henny Førde, Jorunn Skjermo, Kjell Inge Reitan, Øyvind Strand and Yngvar Olsen

NTNU – Trondheim Norwegian University of Science and Technology

SINTEF

INSTITUTE OF MARINE RESEARCH
HAVFORSKNINGSINSTITUTTET

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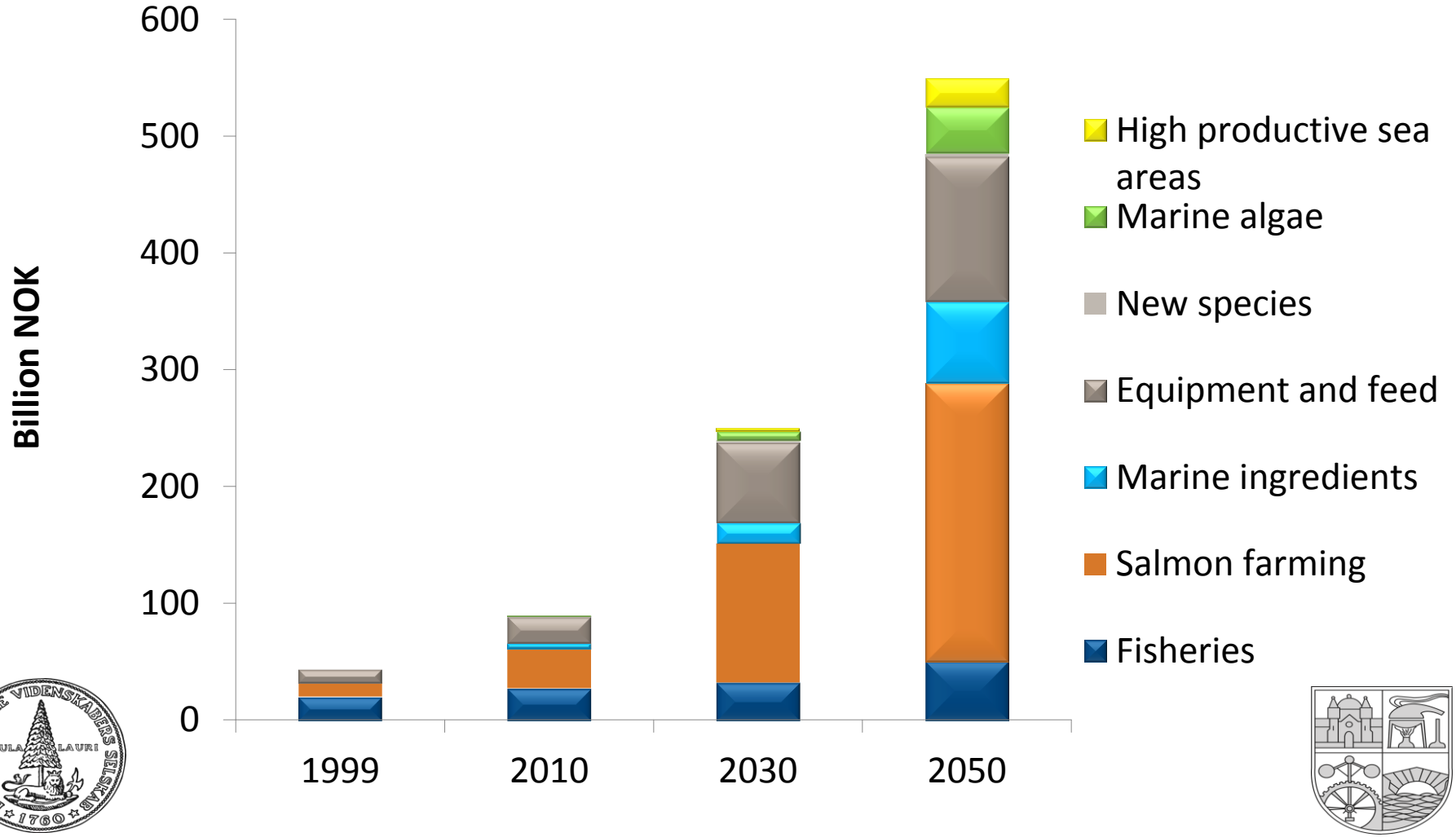
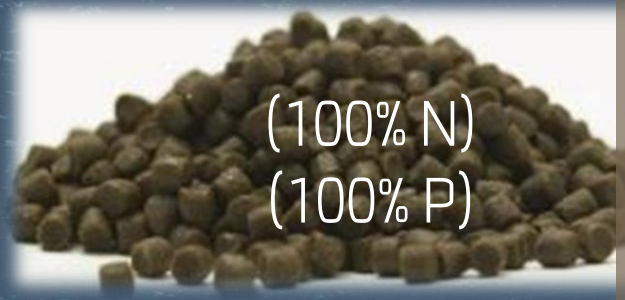
DKNVS Scenario 2050:
Potential for marin value creation in Norway



Wastes from salmon aquaculture



Feed (% of DW)
97-99 % dry weight

Carbon:	54%
Nitrogen:	5.8%
Phosphorous:	0.9%
Lipid:	39%
EPA:	1.9%
DHA:	1.7%

Particles
(~15% N)
(~44% P)

Dissolved
nutrietns
(~45% N)
(~21% P)

Fish (% of DW)
31-40 % dry weight

Carbon:	61%
Nitrogen:	7.4%
Phosphorous:	0.6%
Lipid:	49%
EPA:	1.7%
DHA:	2.6%

Faeces (% of DW)
11-25 % dry weight

Carbon:	37%
Nitrogen:	2.7
Phosphorous:	2.3%
Lipid:	7.4%
EPA:	0.1%
DHA:	0.2%

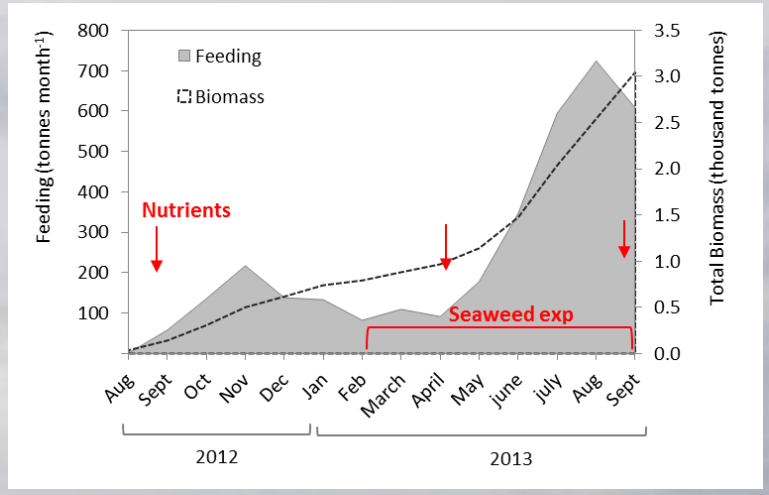
M Heide / SINTEF Fiskeri og havbruk AS - 2012

Wang et al. 2012. Aquaculture and Environment Interactions. *2:267-283*

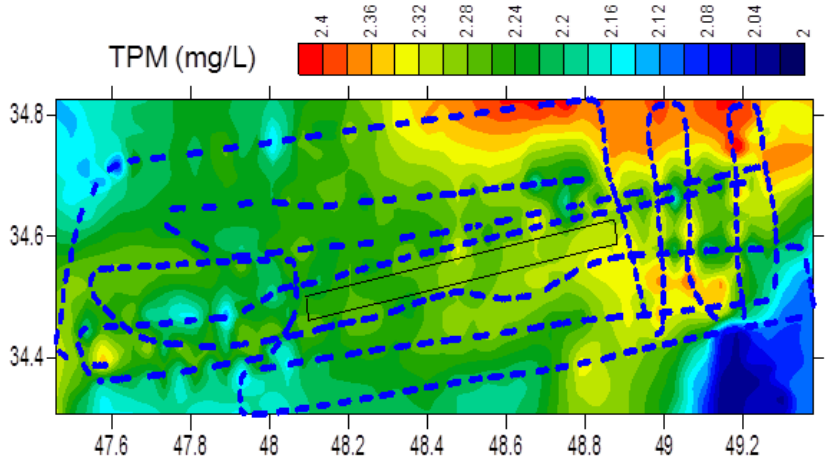
Aquaculture facilities:

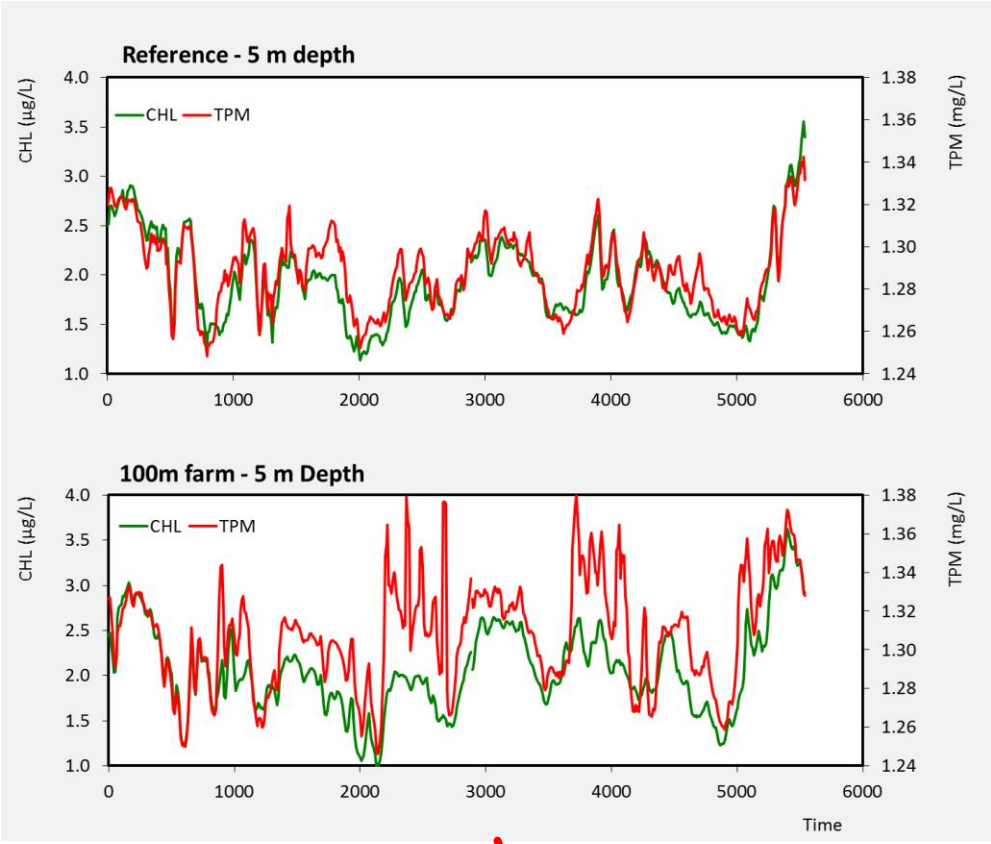
- Coastal area
- 6000 tons production
- Depth 75-200m
- Production cycle 18-20 months

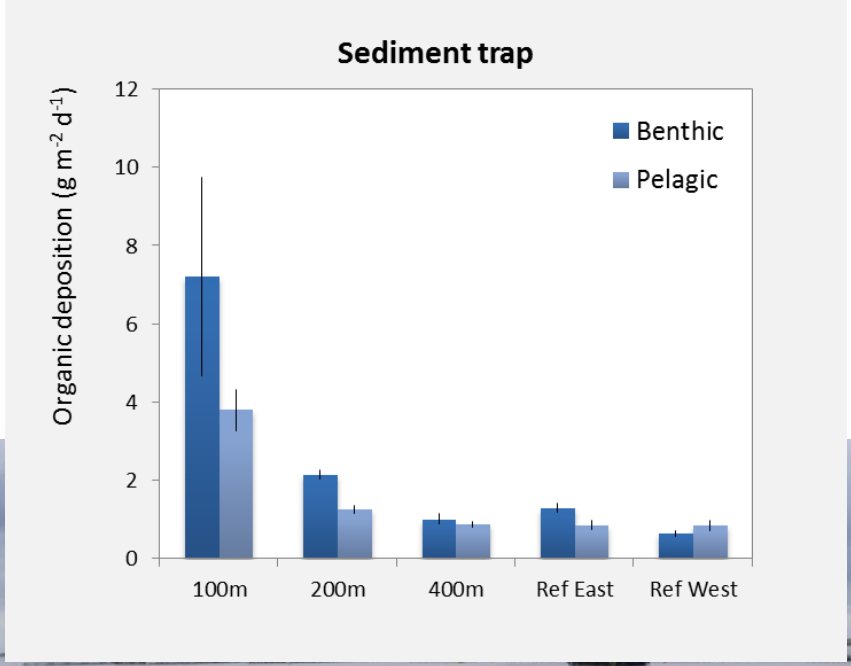
- Nutrient sampling (3x)
- Seaweed cultivation (feb-sept)
- Mussels (Feb-sept)
- Scallops (May-Sept)

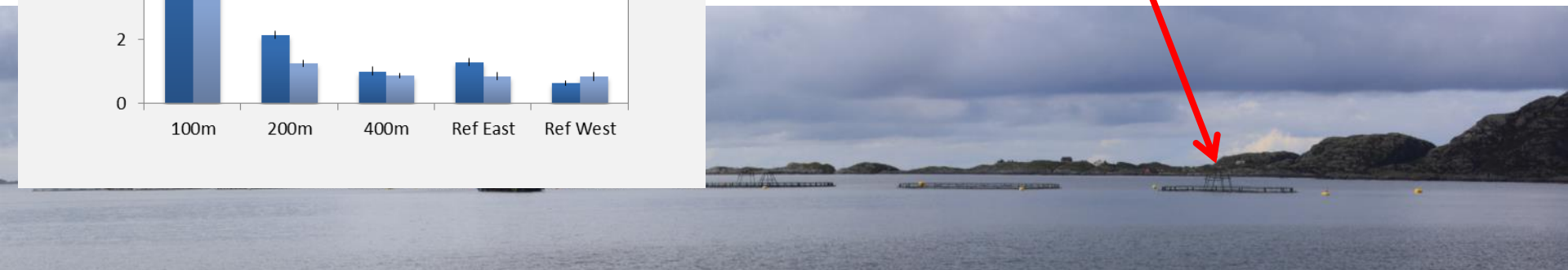


Particle dynamics May 2013 - High resolution 3D mapping

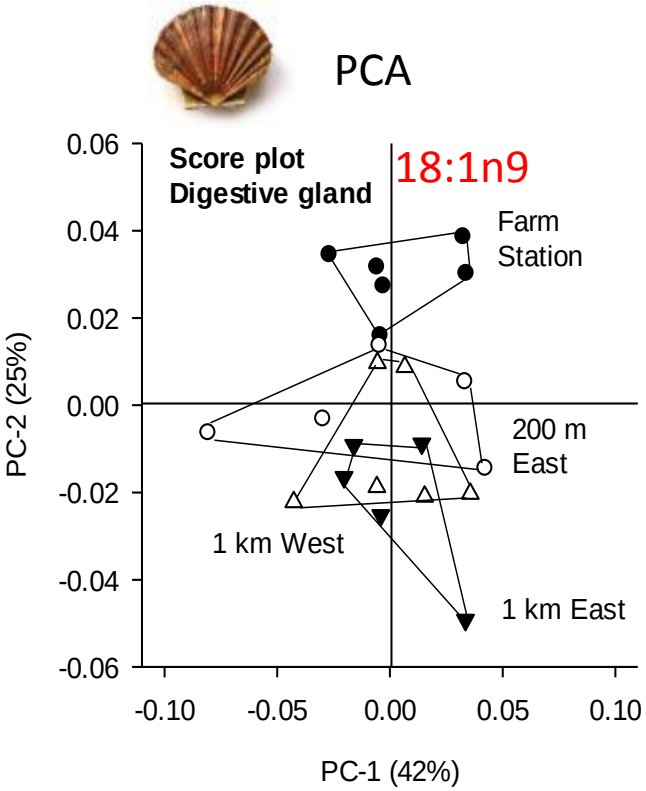




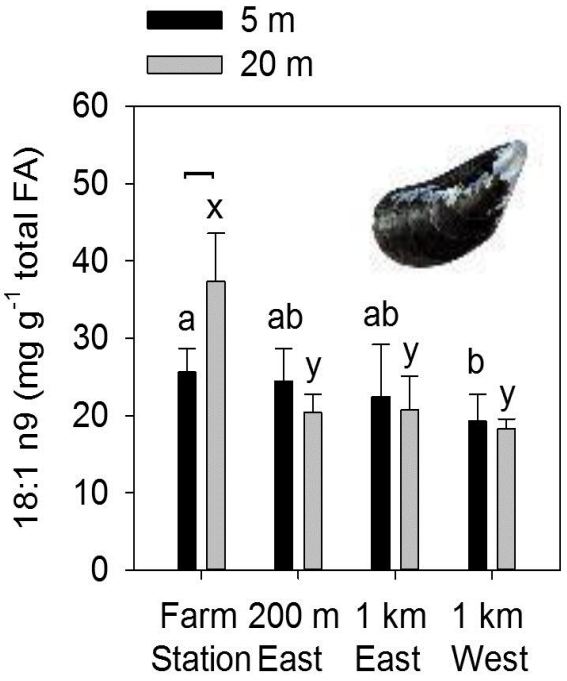




Main results scallops and mussels



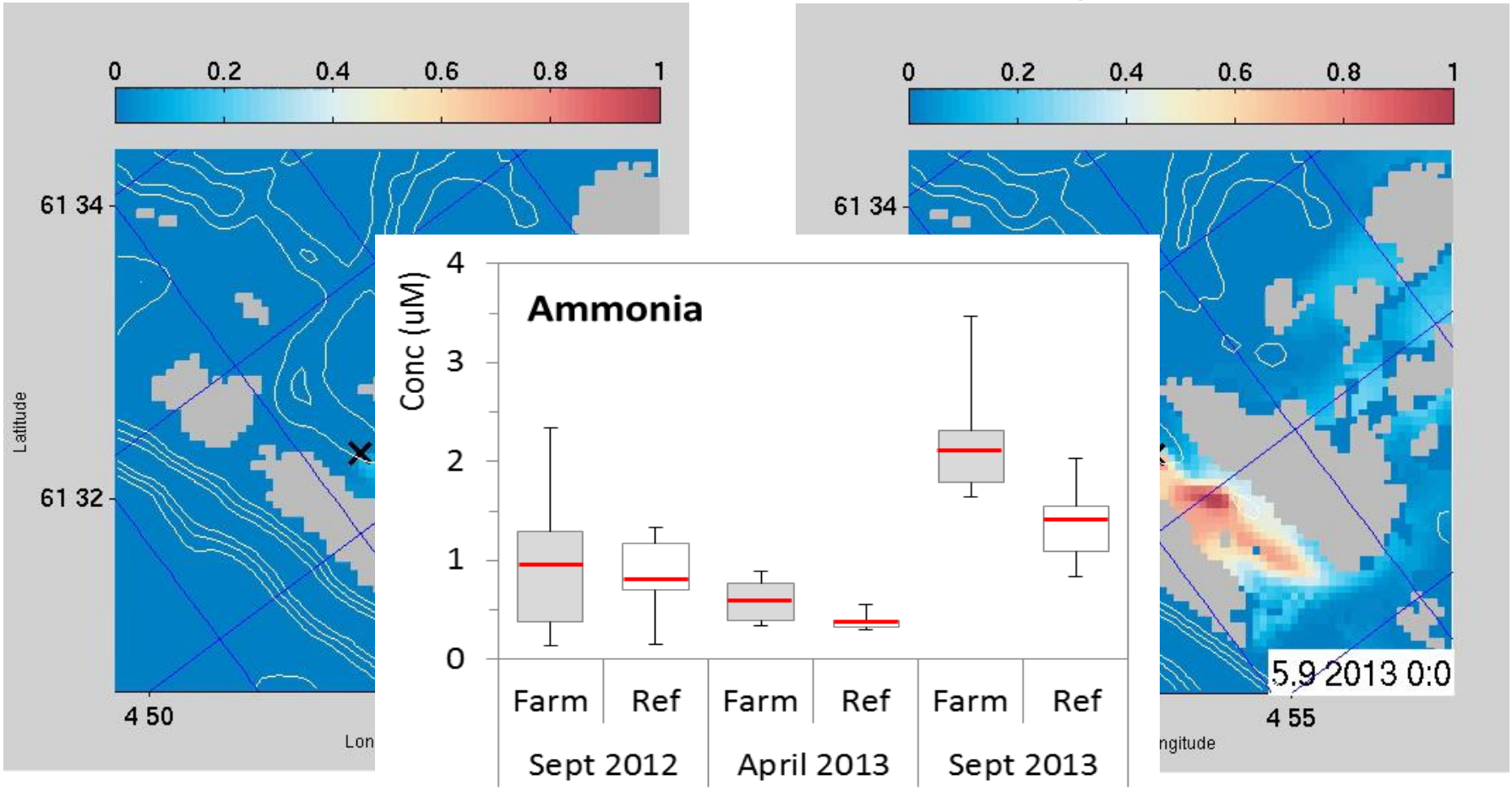
Blue mussels -
field experiment



Ammonium dispersal

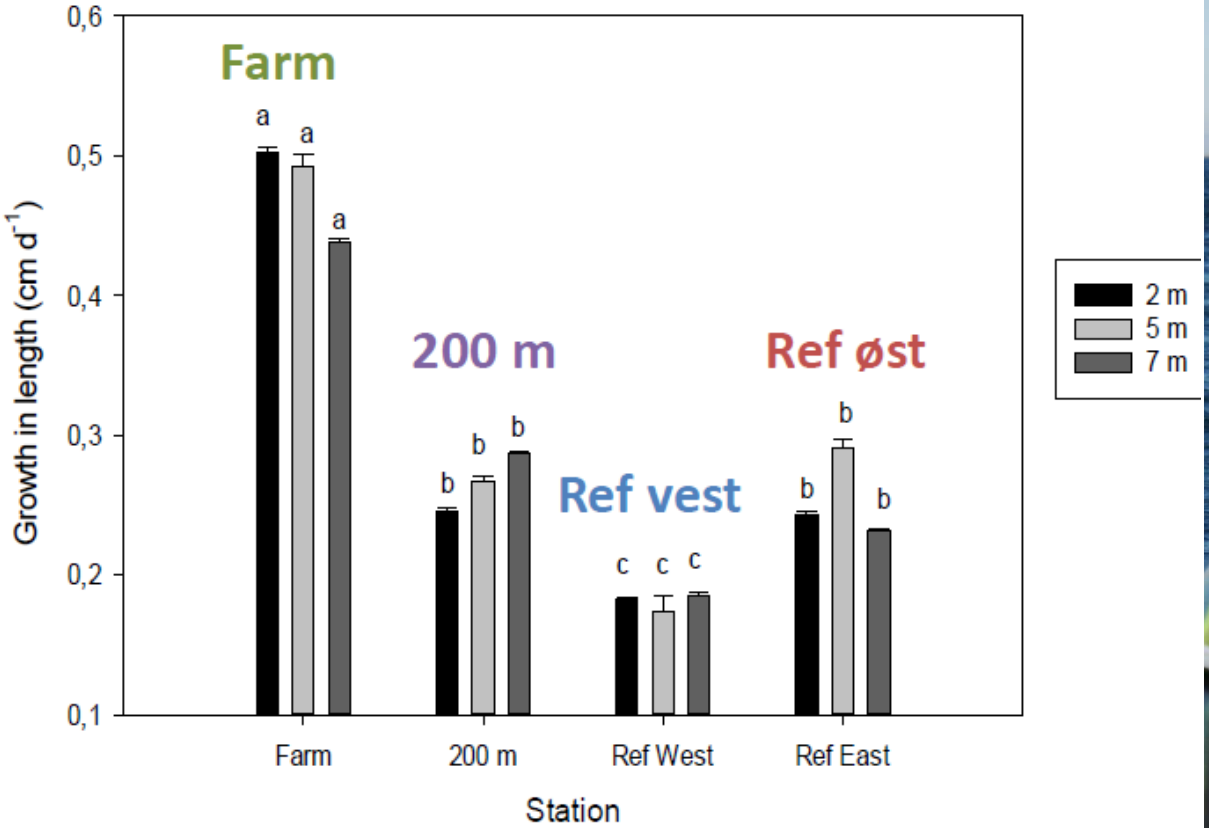
February

September



"background"

Average growth of sugar kelp (Feb-Jun)




1.2
APRIL


1.5

So, what can we conclude from the results in EXPLOIT?

IMTA in open coastal waters are indeed challenging!

Direct or indirect uptake of nutrients, does the source matter?

Particulate waste: **YES**

Because of the fast sedimentation rates and local environmental impact, in order to remove wastes, bentic organisms and sludge-removal systems are required.

Dissolved nutrients: **NO**

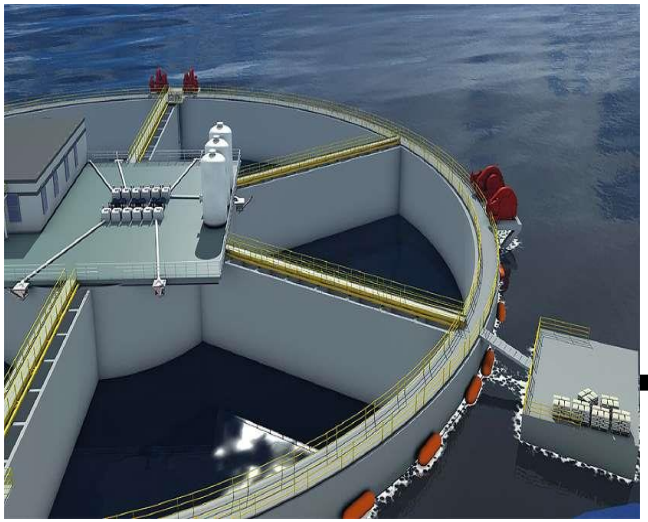
Fertilized phytoplankton blooms will feed bivalve aquaculture at distance, and seaweed cultures may balance N-input at regional and annual scale .

In order to realize *a doubling of the Norwegian salmon production*, we must develop new technologies for an ecosystem-based approach that e.g.

1. Mitigates benthic impacts on the marine environment
2. Secures access to sustainable feed-resources
3. Reduces salmon-lice pressure

What if…

Closed systems are designed with combined mechanical and biological waste treatment?



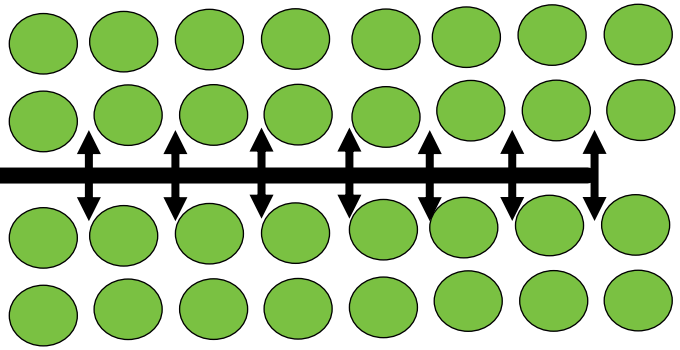
Dissolved wastes

Pipeline

Outflow - Dissolved nutrients

Seaweed biofilter

32 units*170 tonnes=5000 tonn per year



Salmon cage rings with seaweed cultivation

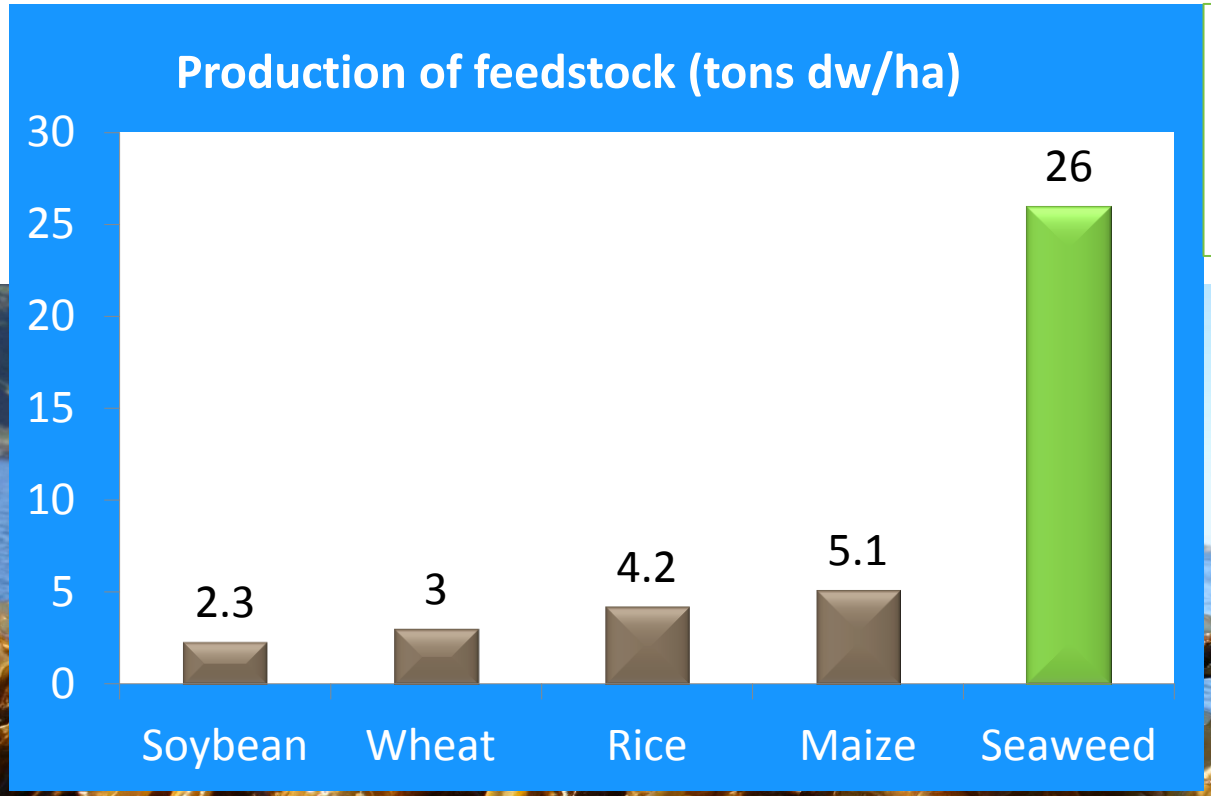
Particulate wastes

Polychaetes/bentic scavengers in shelf systems on the bottom of the closed system –also valid for open systems?

+ Collection of sludge:

- High value products from the sludge in biorefinery?
- Feed for polychaetes – converted to fish feed?
- Phosphorous?

Production pr hectare (100x100 m)



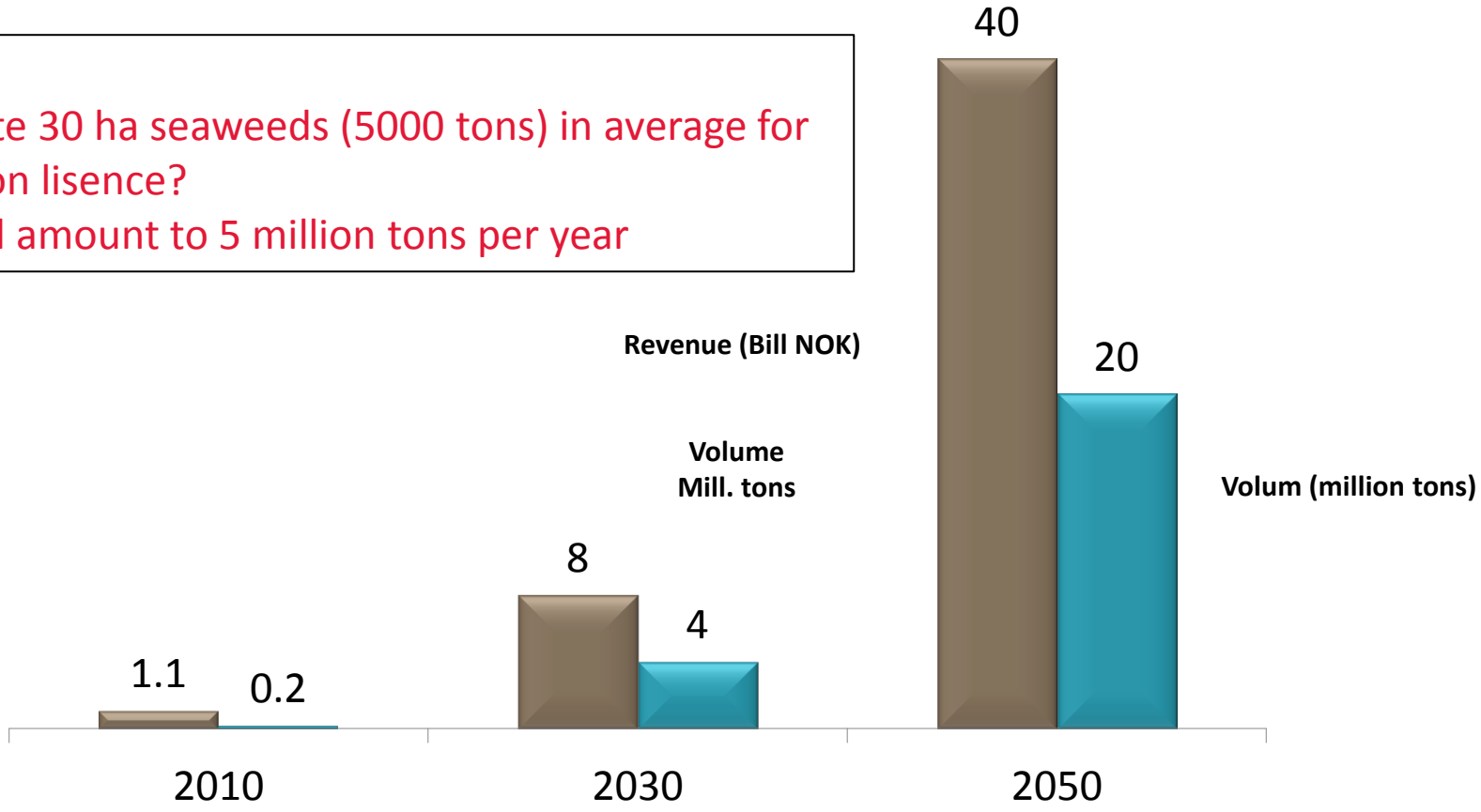
- 170 tons ww
- 26 tons dw
- 15 tons carbohydrates
- 3.8 tons protein

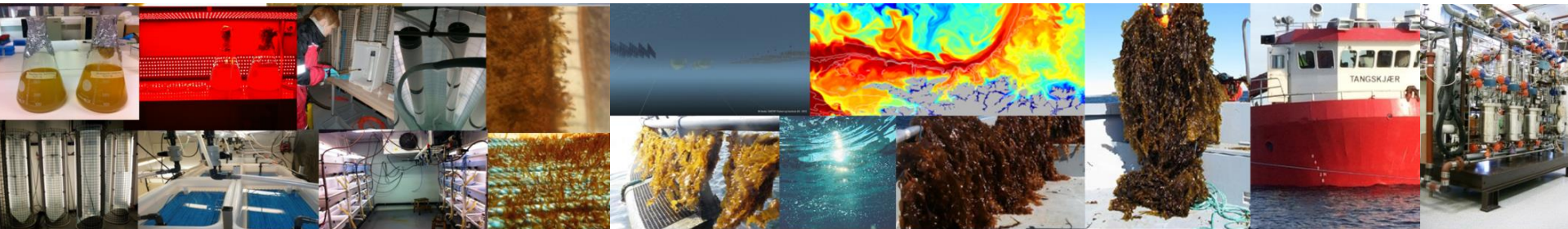
DKNVS Scenario 2050:
Potential for marin value creation from macroalgae

What if …

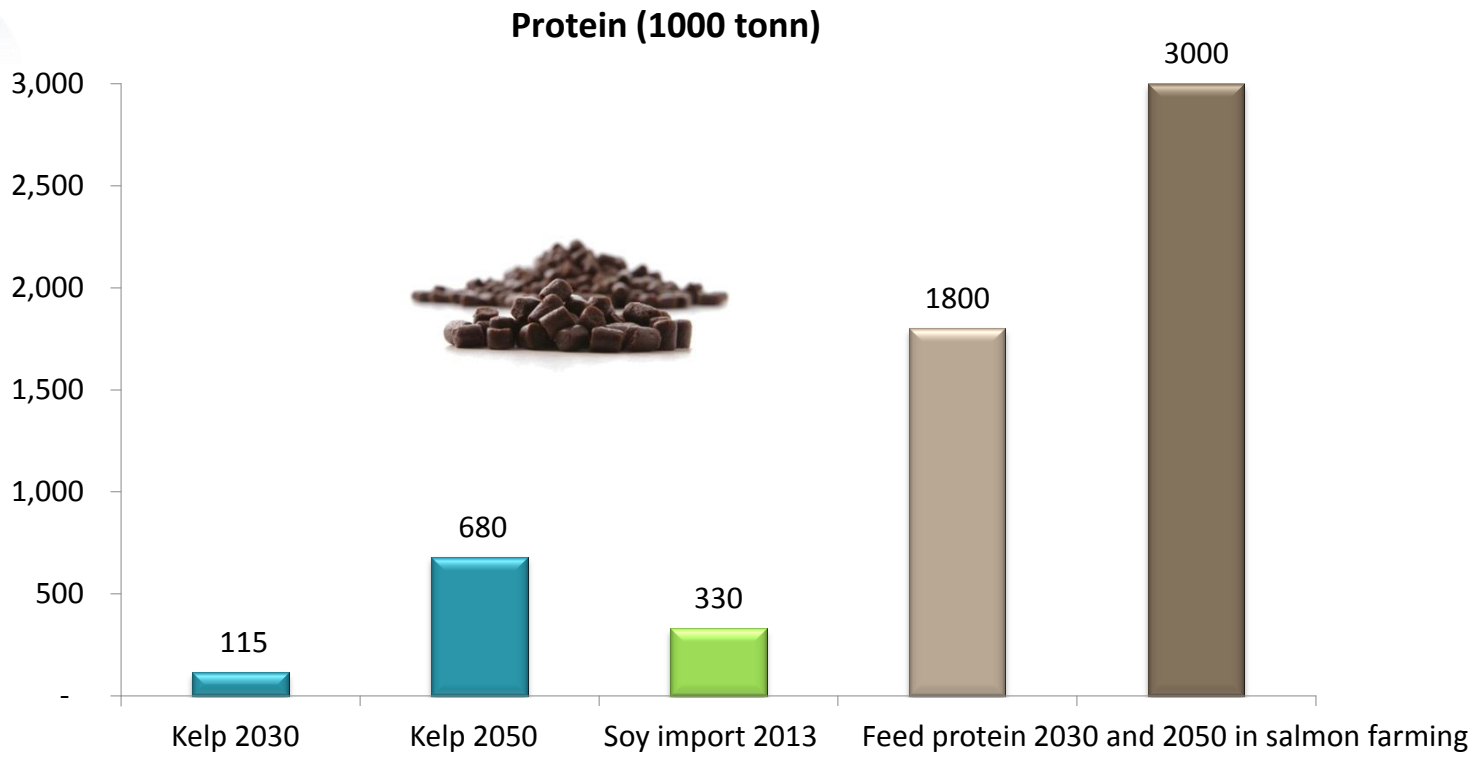
We cultivate 30 ha seaweeds (5000 tons) in average for each salmon lisence?

That would amount to 5 million tons per year





Feed protein from seaweed



What if…

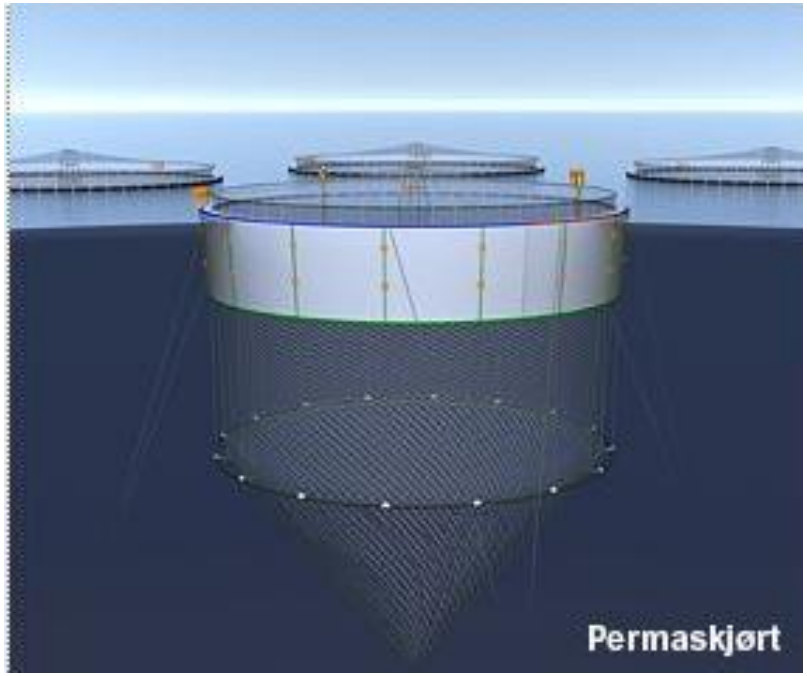
Surface water flow is already blocked by salmon-lice skirts, and deep-water is driven up inside the cages by pumps?

- Can we then cultivated seaweed and mussels at larger scale in the same area without altering the environmental conditions for the fish?

2 m

5 m

8 m



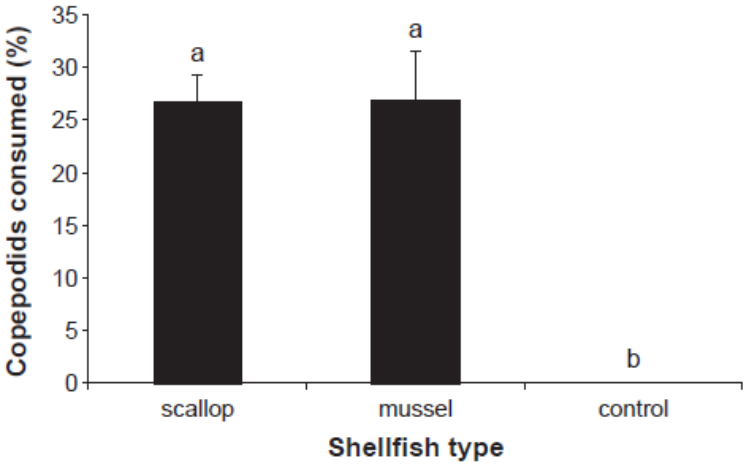
www.botngaard.no

PS: Seaweed farms acts as habitats for cleaner fish – what if they can reduce the lice preasure by 5%?

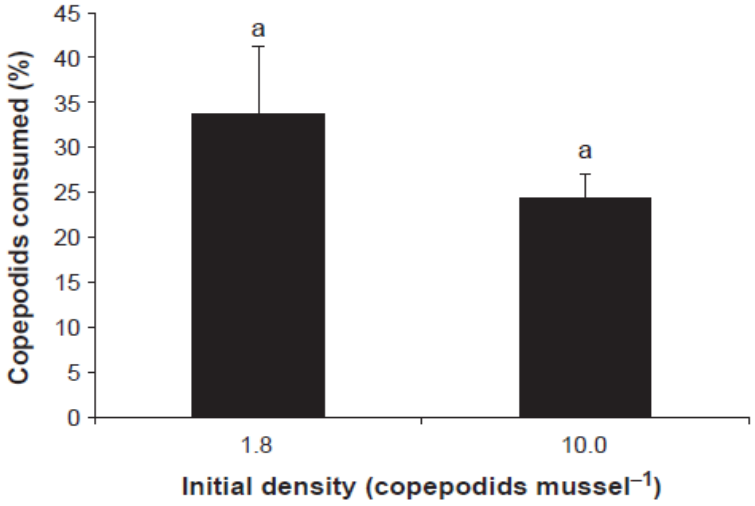
What if…

Blue mussels can eliminate salmon-lice copepodits in industrial scaled systems in salmon farming areas, in addition to beeing and exellent source of marine feed meal?

27% removal in stagnant water



25-33% removal with blue mussels in flowing water

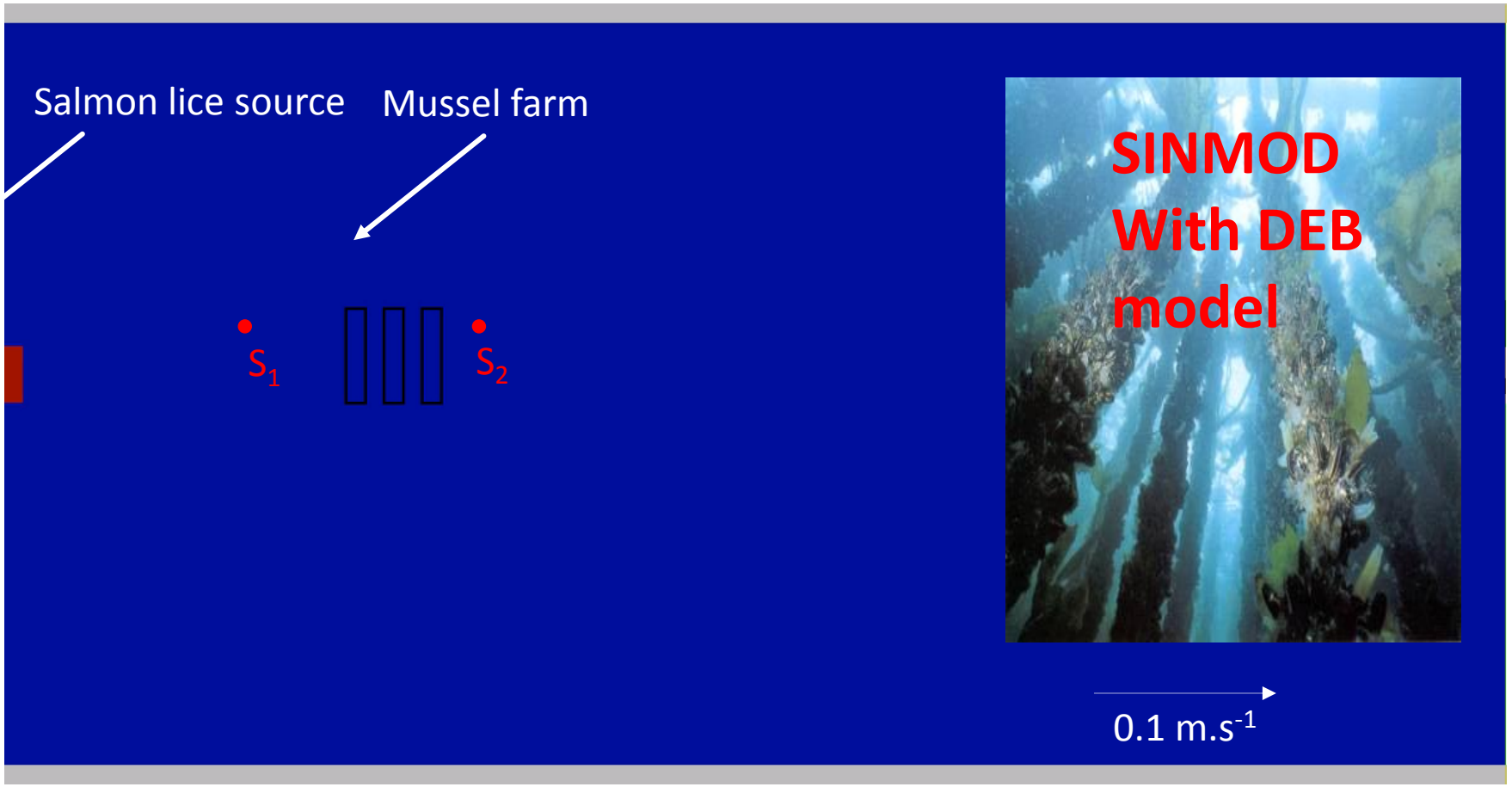


Malloy et al., 2011 Aquaculture

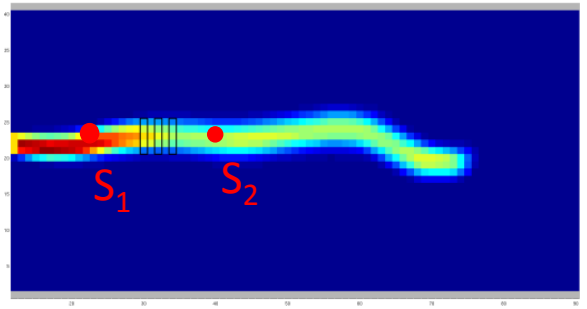
Bartsch et al., 2013 Journal of Fish Diseases

Challenge: who will run the first industrial scaled test?

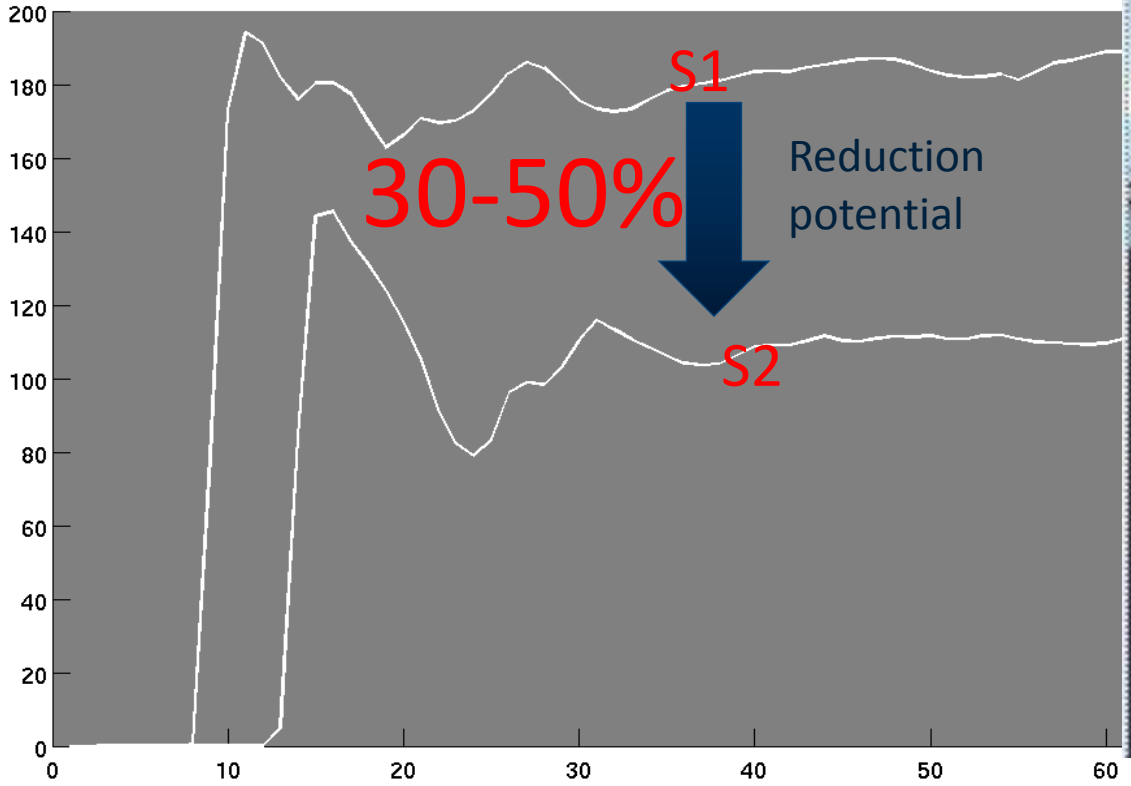
Scenario: 2400 t mussel farm (1 M€ investment)

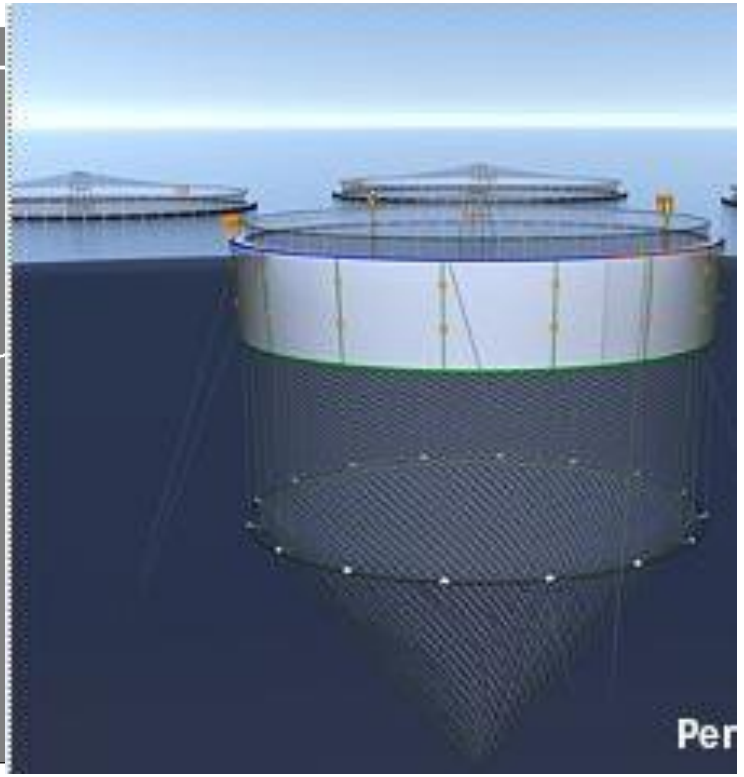


Case scenario :
2400 t mussel farm / 100t per hectar



L. Salmonis larval concentration (ind m^{-3})



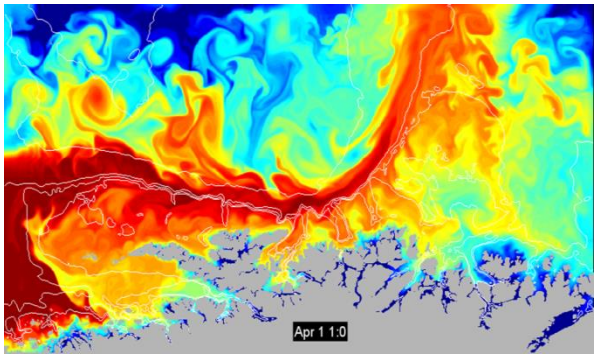


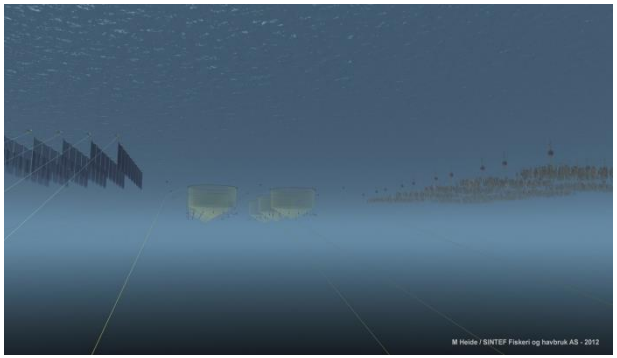
What if…

A doubling of the Norwegian salmon production is actively accompanied with production of low-trophic non-fed biomass meeting the global challenges for food and feed, and at the same time position a new Norwegian biomarine industry for growth in the global bioeconomy

How would public perception to salmon aquaculture respond to that?

Thanks for your attention!





Area use

Norwegian land area:	307,442 km^2
Norwegian coastline:	103,000 km
Norwegian territorial zone:	145,500 km^2

20 Mtons seaweed <1% of the territorial zone