Experiences of compensatory measures

Workshop on environmental licenses for aquaculture

Stockholm, 12.-13.11.2019

Pia Kupka Hansen

Institute of Marine Research, Norway

EFFLUENTS FROM AQUACULTURE

The amounts and quality of effluents and the potential environmental impacts of aquaculture varies with:

- Species
- Production system
- Production intensity
- Management
- Location
- Environmental carrying capacity to absorb impacts

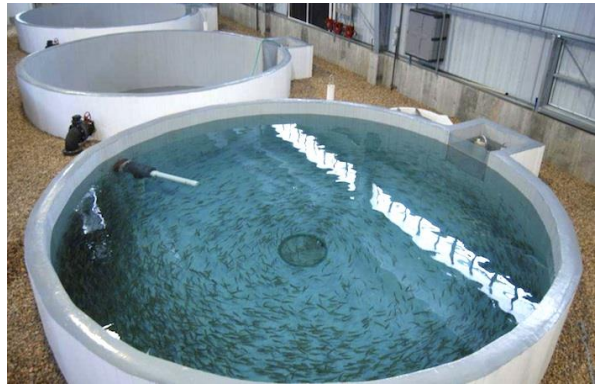
Nutrients and organic waste (feaces and excess feed)

In landbased and closed systems waste streams can be directed and waste collected.

In open net cage systems everything is lead into the surrounding environment.

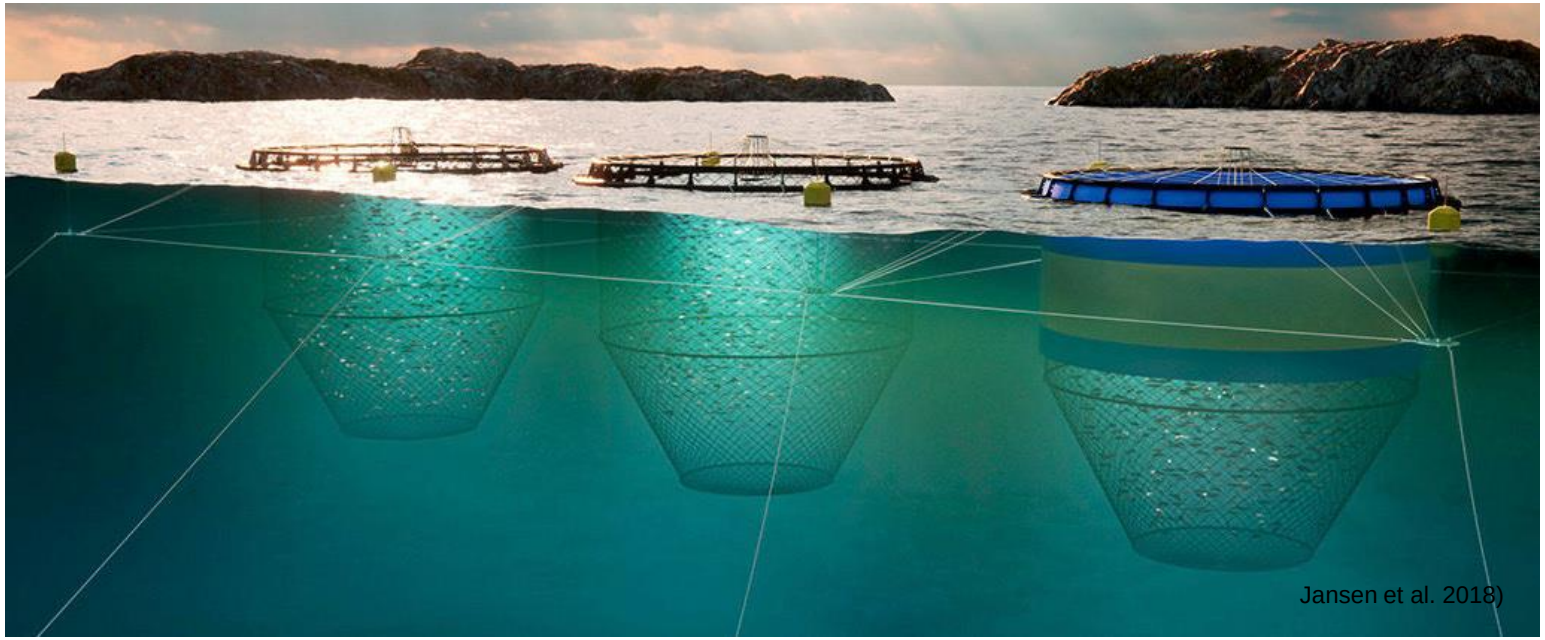
There are various types of closed systems where the effluents can be collected and used:

- As feed for other species – collection of the organic waste to be used to feed f.ex. polychaetes in tanks
- Production of fertilizers
- Biogas production

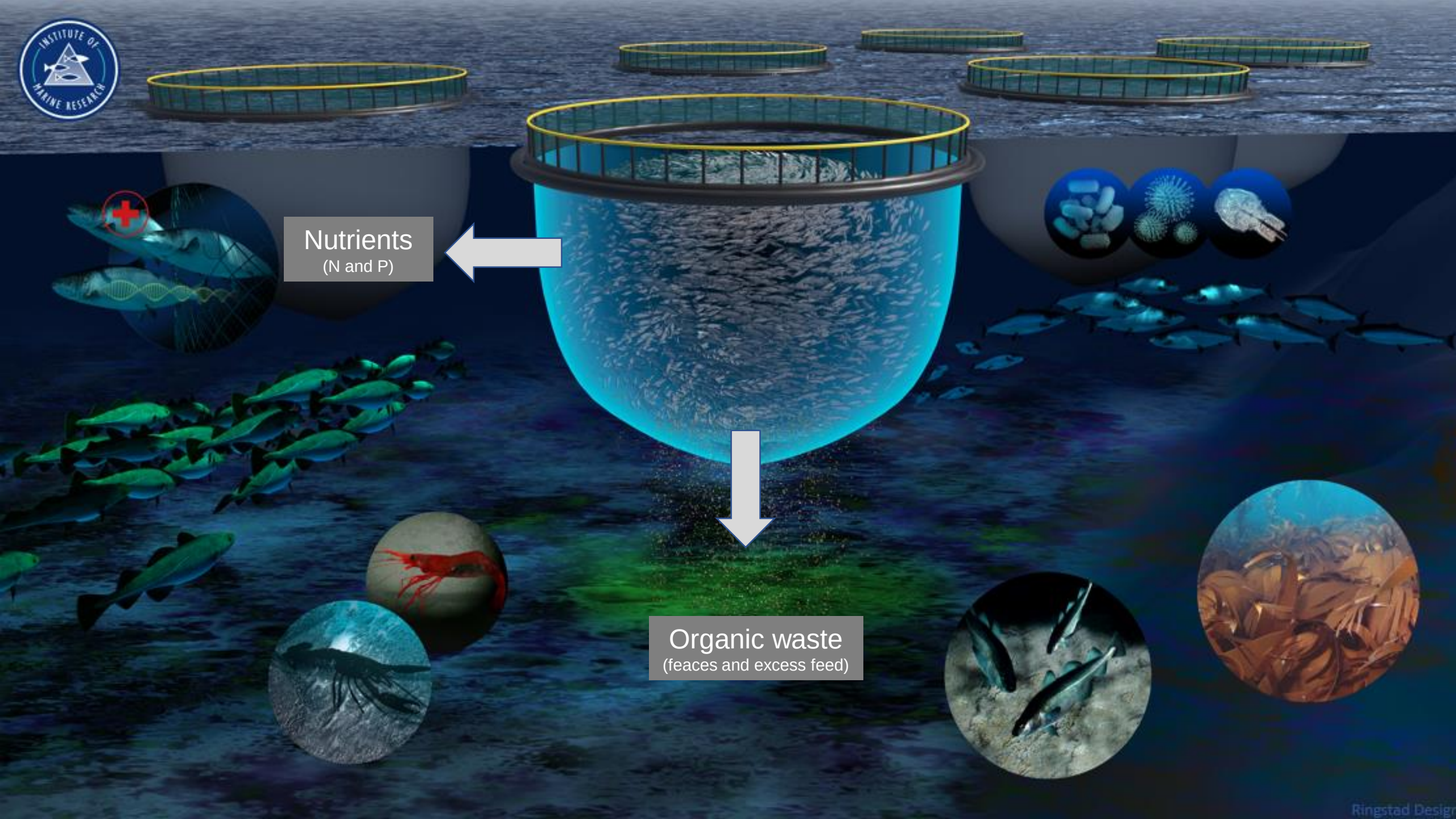


Compensatory measures for nutrients and organic waste from open net pen fish farming:

- IMTA - no collection of waste, it is used directly as it is released into the water. Very dependent on location and current system.
- Polyculture/production of other species
- Collection of waste (feaces and excess feed)



Jansen et al. 2018)


Nutrients
(N and P)
Organic waste
(feaces and excess feed)

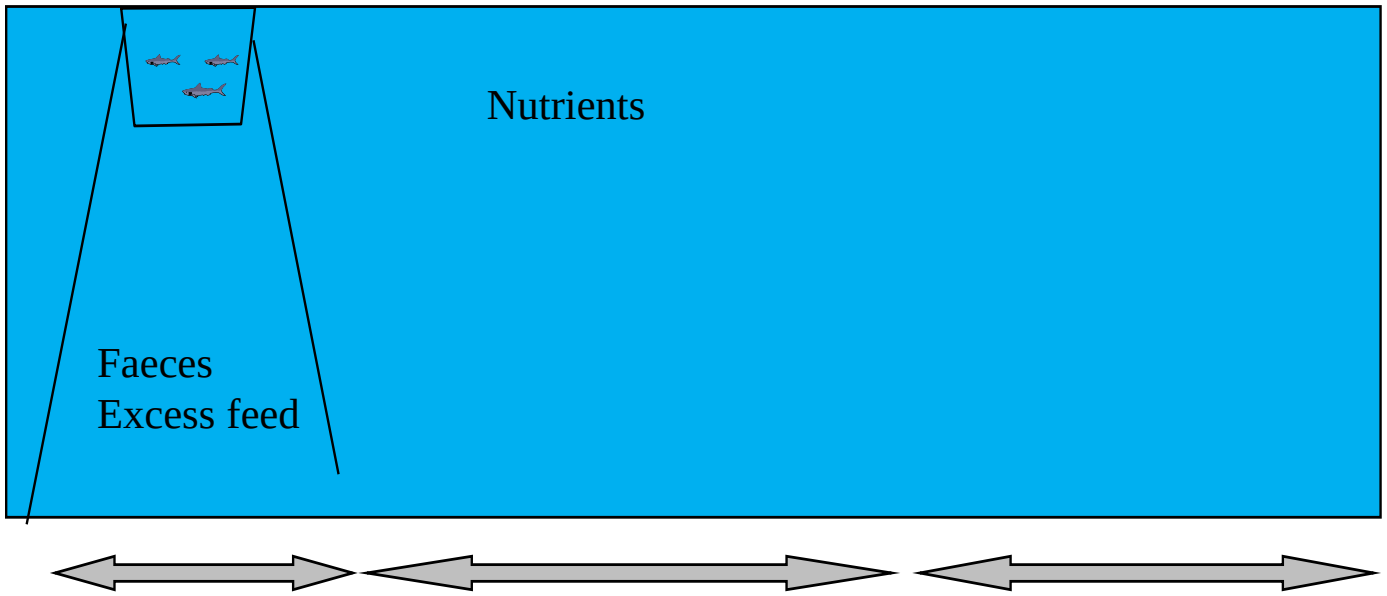
Current and impact zones from net pen fish farming

The importance of current at different depths:

Supply of oxygen and removal of soluble waste products

Dispersion of particles

Oxygen to the sediment



Local impact zone

Sedimentation of larger particles

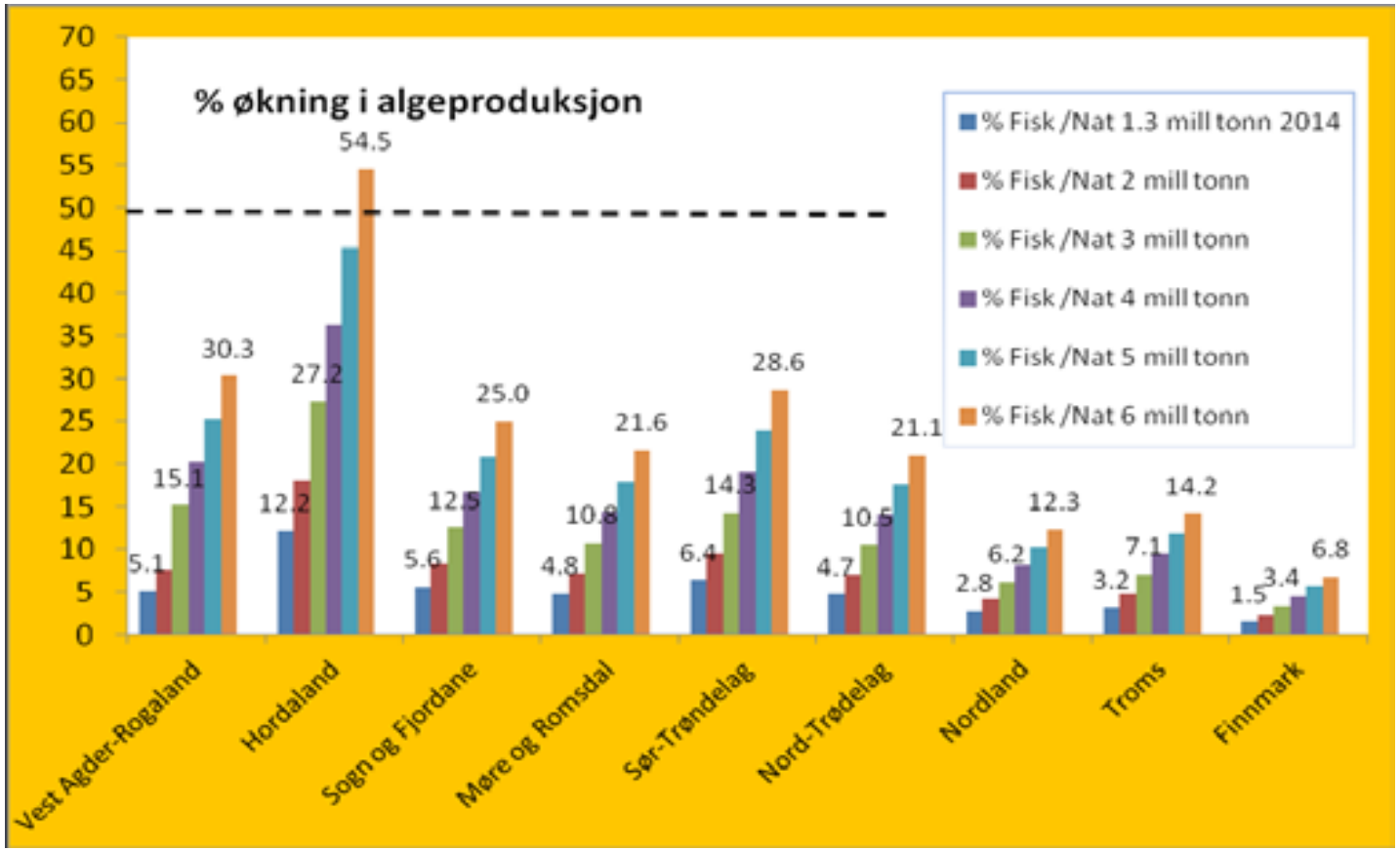
Intermediate impact zone

Sedimentation of smaller particles

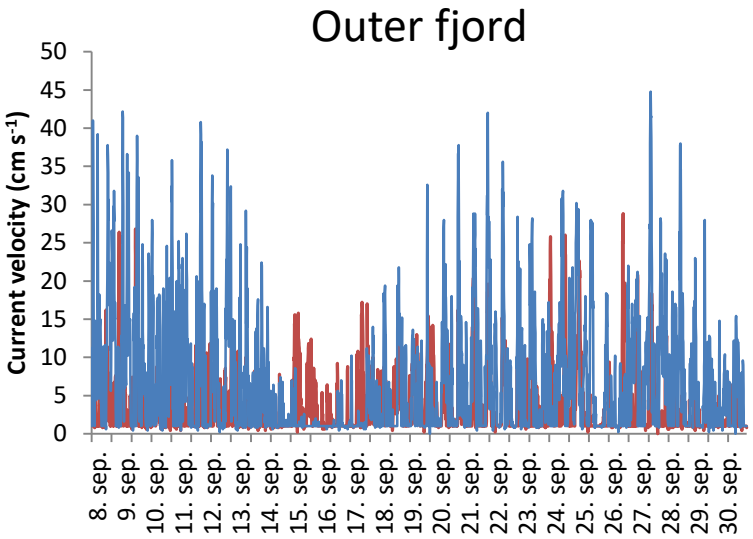
Regional impact zone

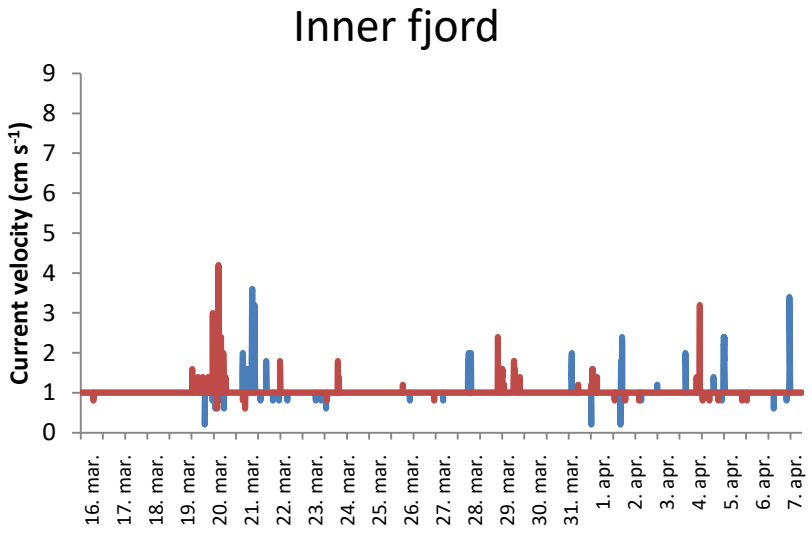
Dissolved substances

Percentage increase in plant plankton production with a fish production of 1,3 mill. tonnes/year, 2 mill. tonnes/year, 3 mill. tonnes/year, 4mill. tonnes/year, 5 mill. tonnes/year and 6 mill. tonnes/year.

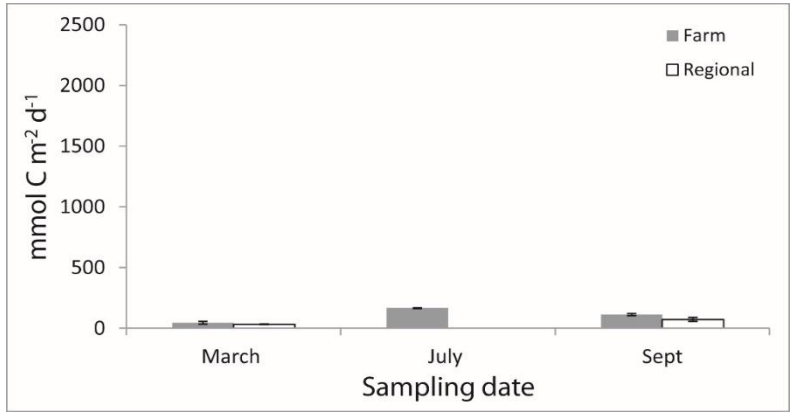


Dispersion current and sedimentation at two sites in a fjord

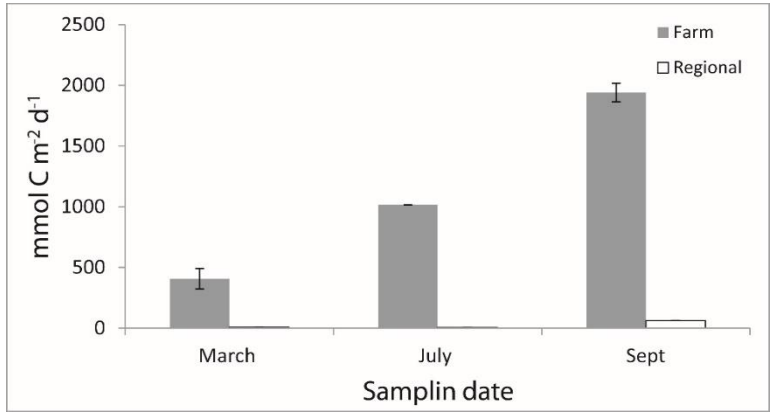




Greater dispersal:
Lower localised benthic impact



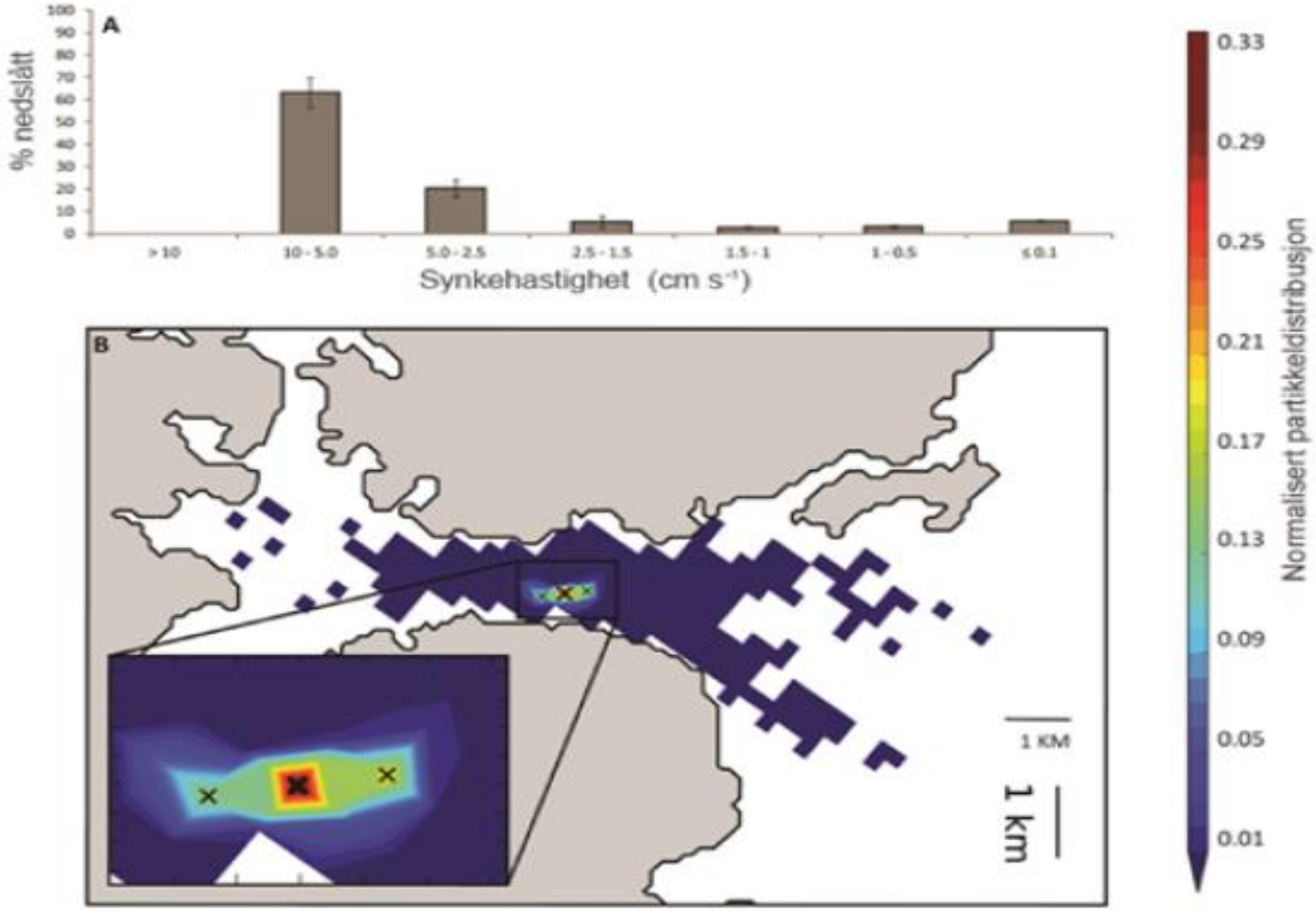
Lower dispersal:
Greater localised benthic impact



6 – 17 times higher deposition of organic carbon at inner-fjord location

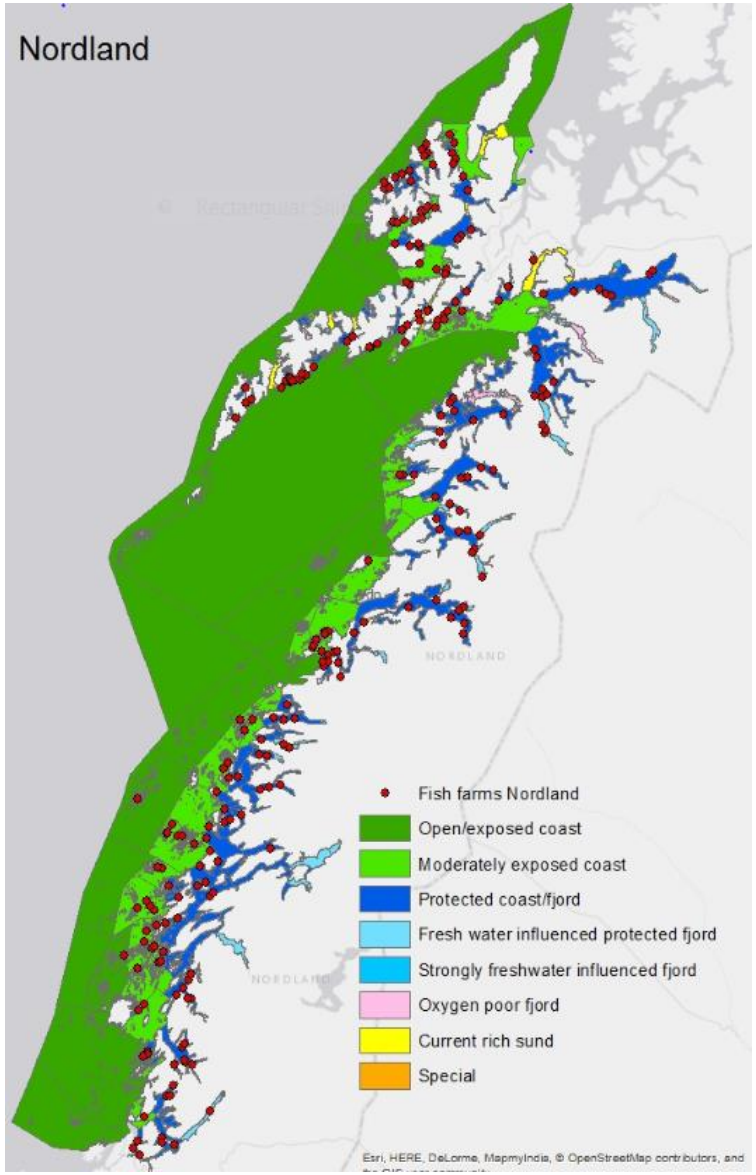
Bannister et al. 2012, Valdemarsen et al. 2014

A.Sinking velocity distribution of faeces from 1.5 kg salmon.
B. Dispersion of organic material from a fish farm

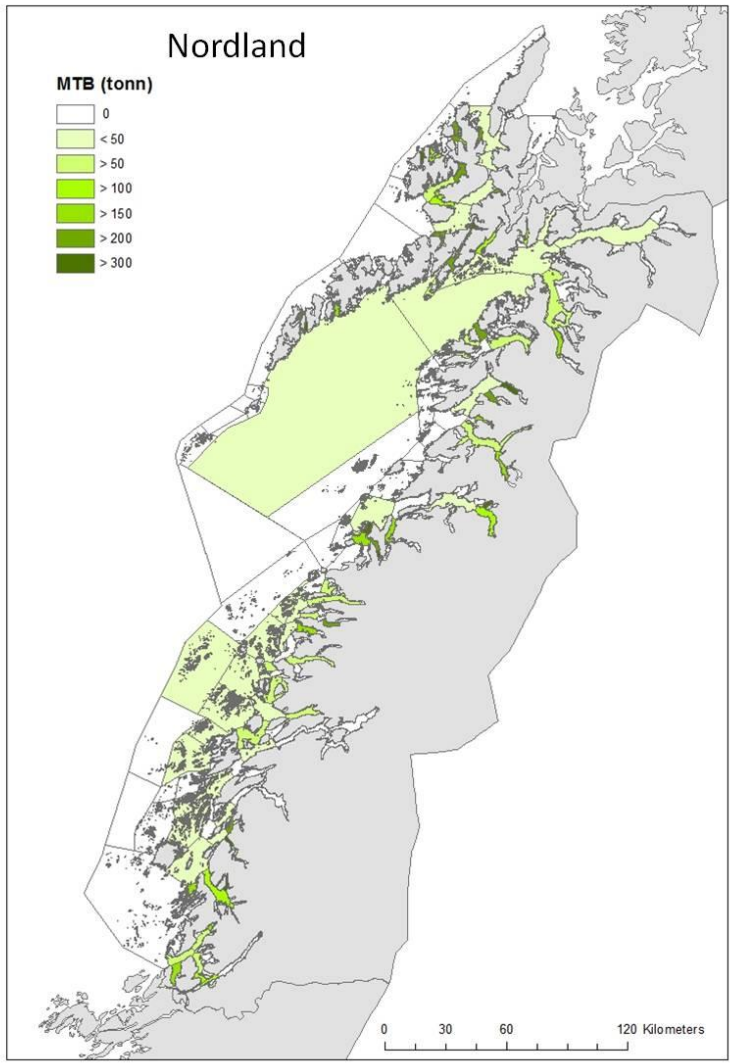


Bannister et al. 2016. RISK ASSESSMENT OF NORWEGIAN FISH FARMING 2016

Water body types (EU Water Framework Directive)

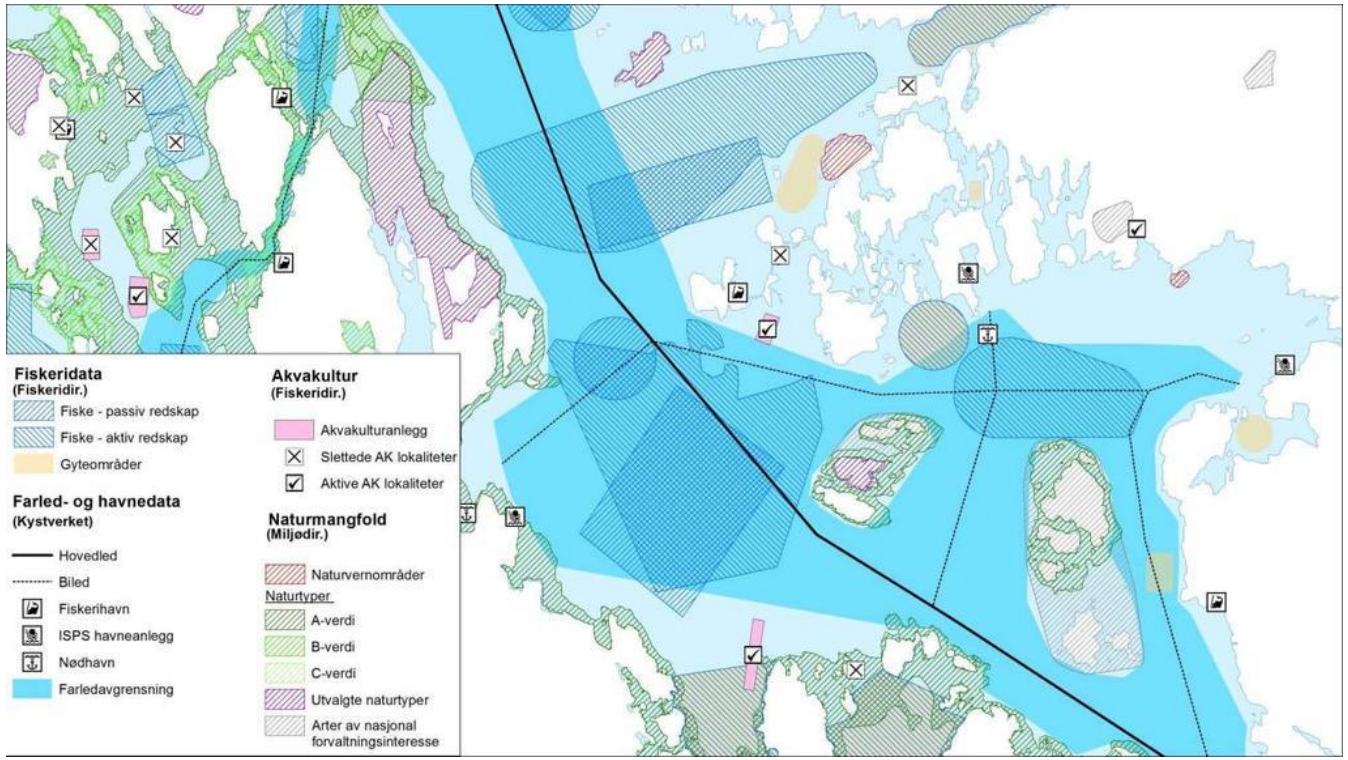


Farming pressure

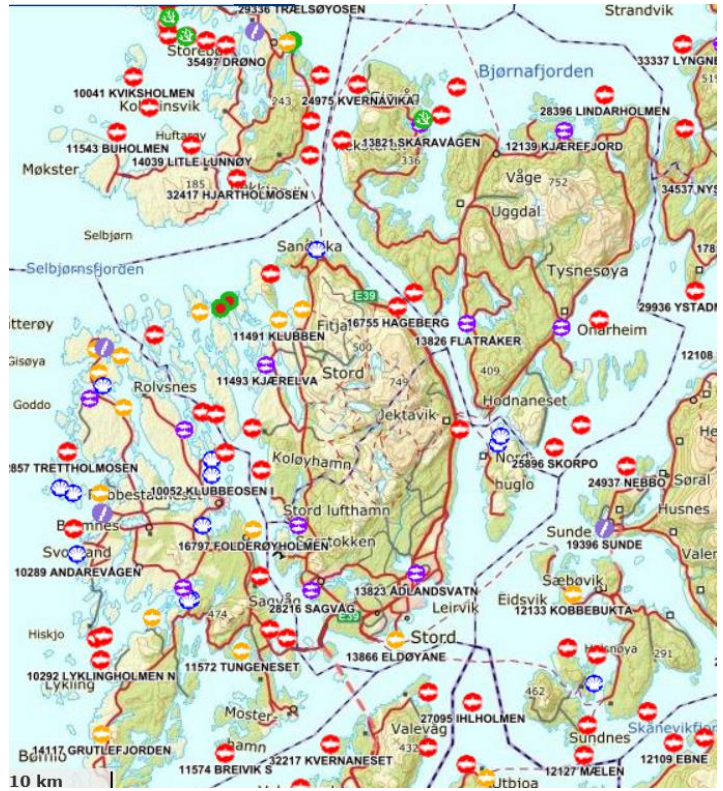


RISK ASSESSMENT OF NORWEGIAN FISH FARMING 2016

The municipalities makes spacial plans and allocates areas to various activties



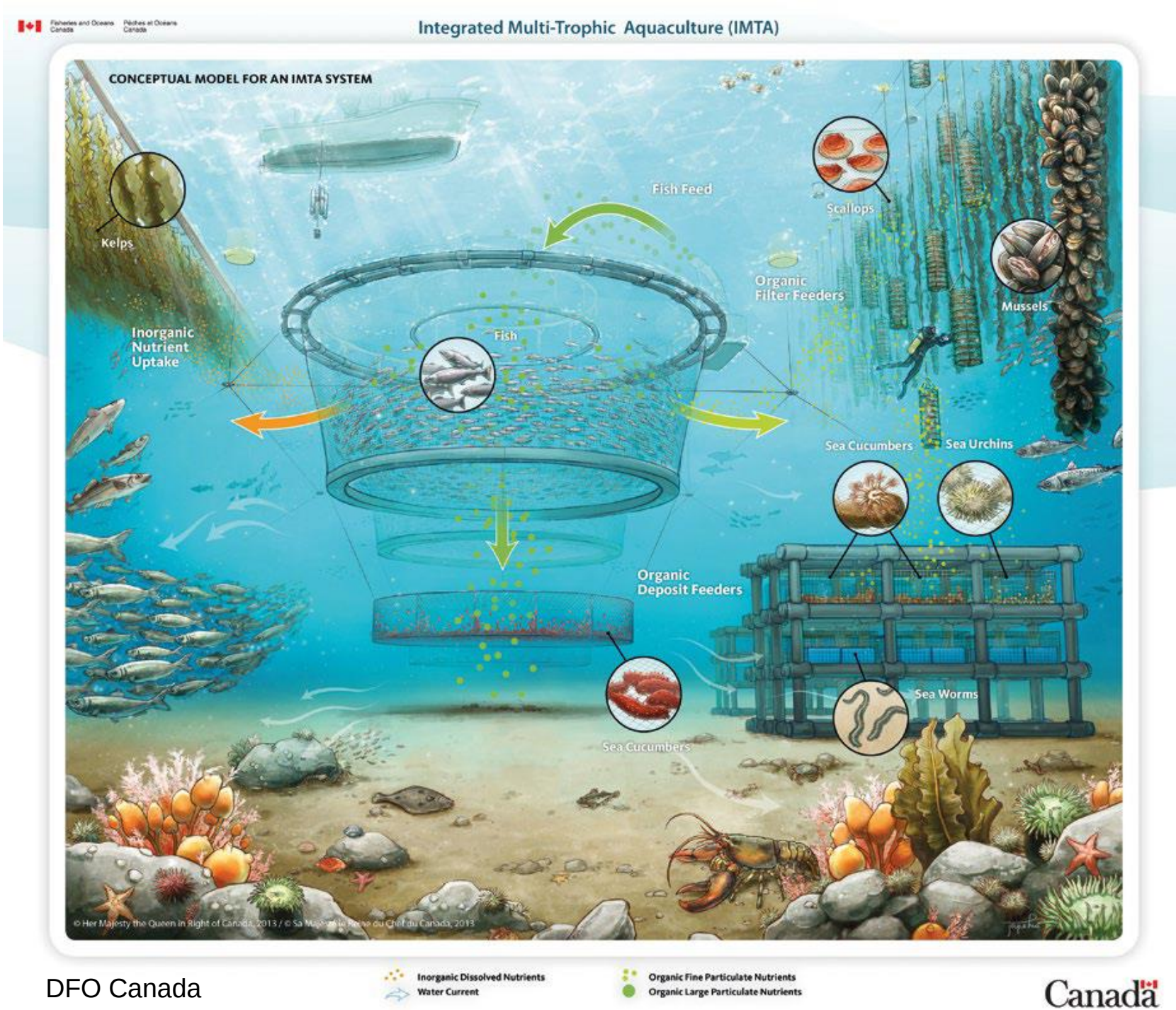
Kart og Plan i Blå sektor - Nordland 9. -11. januar 2018 28



IMTA

(Integrated Multi-Trophic Aquaculture)

A concept where different species are grown together in such a way that the invertebrates and/or plants can recycle the nutrients and organic material that are lost from the culture of the other species.

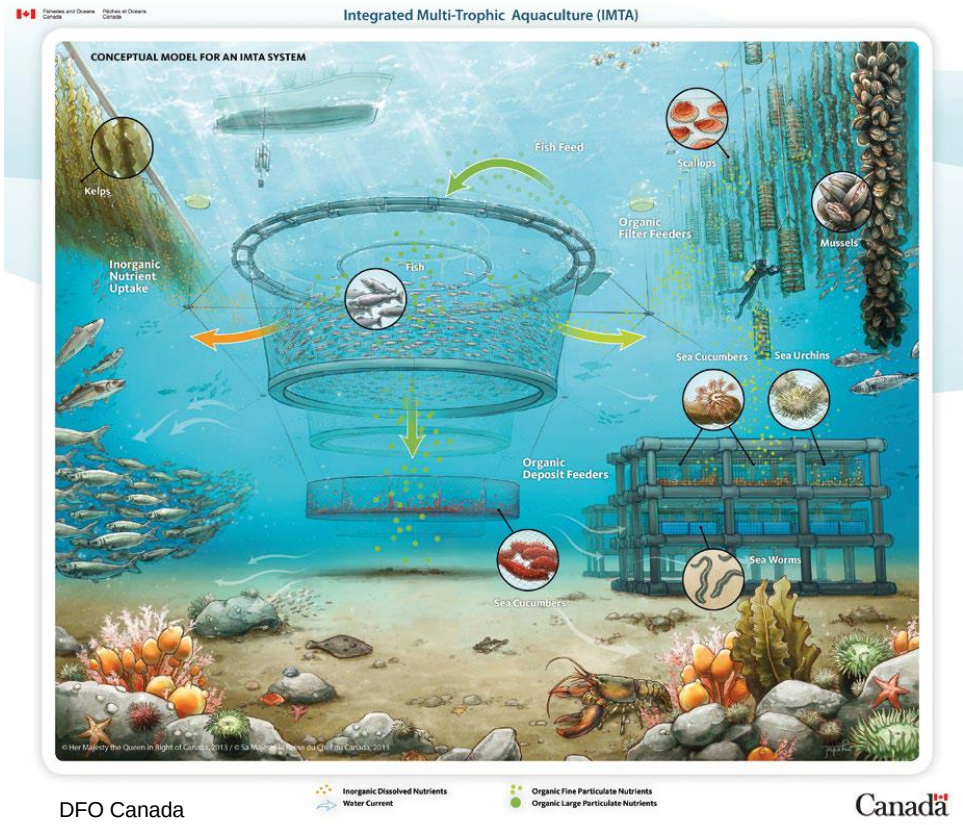


Experiences with IMTA:

- Macroalgae
- Blue mussels
- (Polychaetes)

Consensus that the main focus in IMTA should be on the larger particles that settle under the net pens (Strand et al, 2019)

Benthic organisms are most likely to benefit (e.g. sea cucumber, sea urchins, polychaetes)



“Salmonid farming in Norway releases considerable amounts of carbon, nitrogen and phosphorus. Maintaining a sustainable resource economy, reducing pollution and climate change are good reasons for efficient reuse of these emissions, preferably for food production, with the lowest possible negative impact. Integrated multi-trophic aquaculture (IMTA) is regarded as a possible solution, but it must be biologically, technically and commercially viable.”

Directorate of Fisheries, Norway, 2019.

Trial with polychaetes

We know from earlier studies that certain polychaetes (Ophryotroca spp) can be found in large numbers under and around fish farms overlaying hard bottom where there are low currents (densities up to 100.000 indiv /m2)

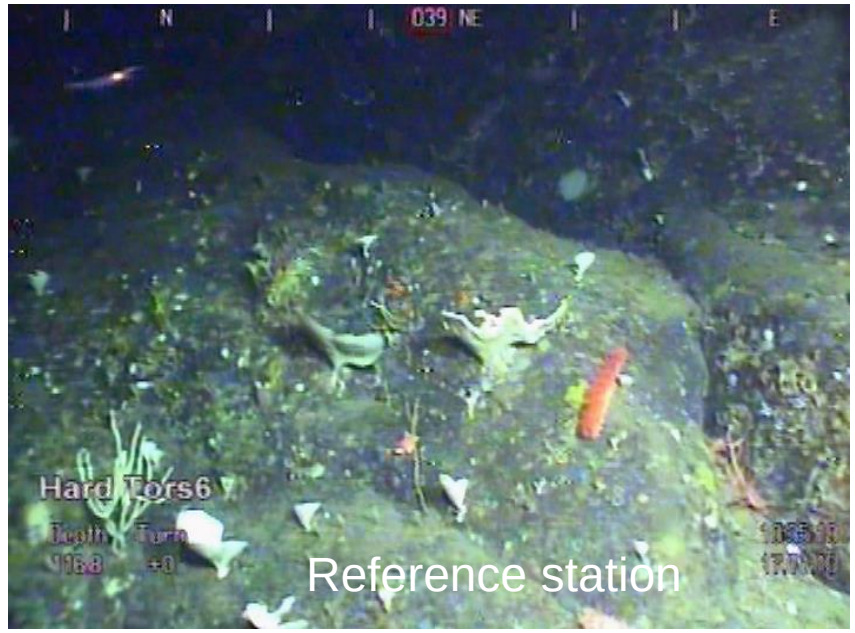
The polychaetes produce mucus which makes it possible for them to stay on the bedrock

The polychaetes consume large parts of the organic waste on the bottom

The polychaetes disappear when the organic waste is consumed (during fallowing)

The polychaetes come back when the fish production starts up again

(Hansen and Bannister 2011; Eike 2013 (Master thesis))



Results

Polychaetes (Ophryotroca spp) aggregates in large numbers within a week on trays placed under net cages where the organic waste accumulates

The polychaetes had a higher content (>30%) of PUFA than the fish feaces (5-9%)

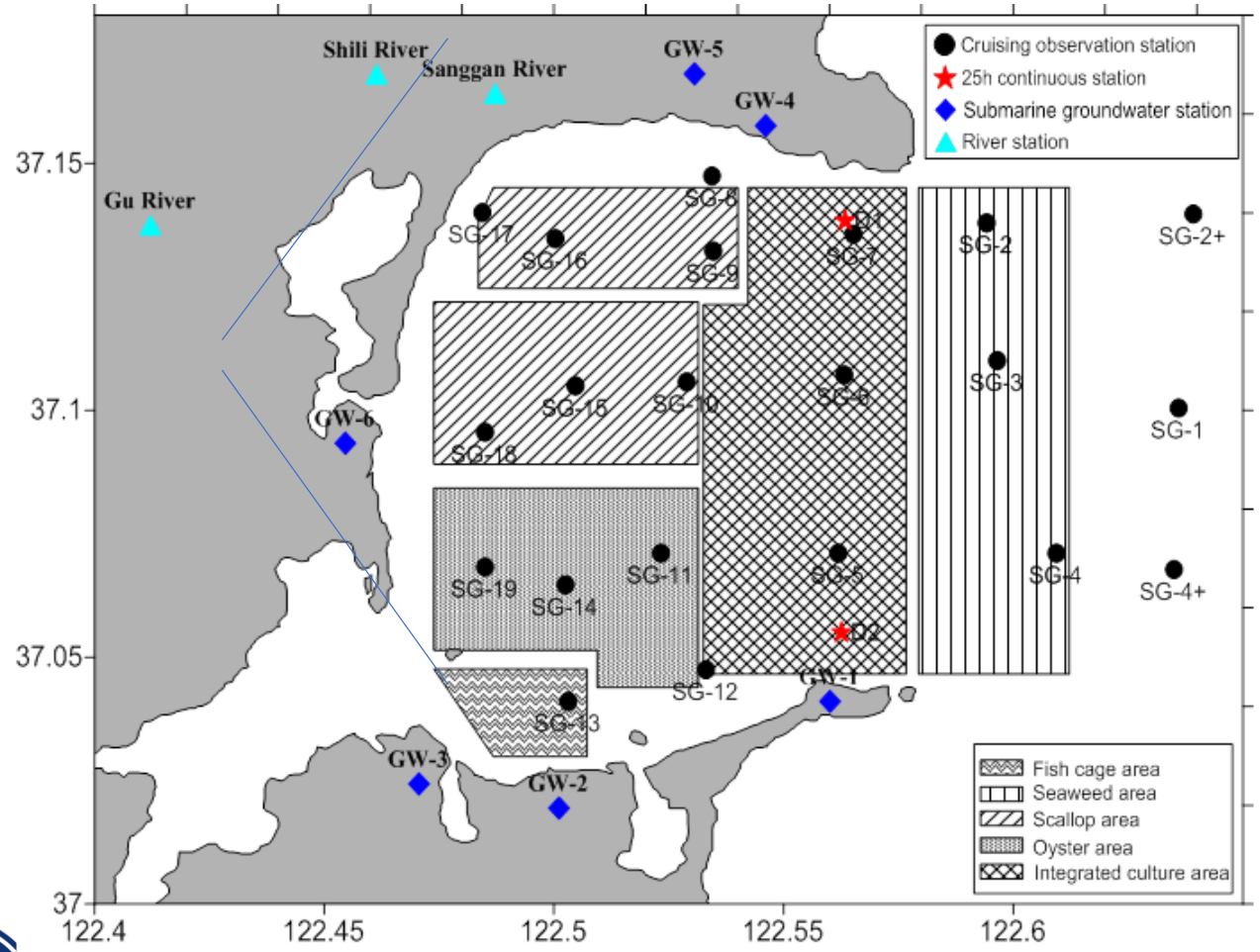
The polychaetes had an amino acid profile that meets requirements for fish feed

The polychaetes had a 77% uptake efficiency of organic waste

112 g polychaetes can decompose an input of 1gC/m2/day

Brennan 2018 (Master thesis); Jansen et al. 2019; Nederlof et al. 2019

Polyculture in Sanggou Bay (China)



- Area of SG Bay 133.3km^2, average depth 8m
- Seaweed culture long history, mainly kelp *Laminaria japonica*.
- 20+ aquaculture farms in bay, diverse culture type: longlines, lantern nets & net cages
- Annual mariculture production:
  - Kelp: 80,000 t dry weight
  - Abalone *Haliotis discus* 2,000 t fresh weight with shell
  - Oyster *Crassostrea gigas* 120,000 t fresh weight+shell
  - Scallop *Chlamys farreri* 10,000 t fresh weight + shell
  - Finfish: 100 t
  - Sea cucumber *Apostichopus japonicus* 100 t fresh weight

Thank you

Photo: Erik Røed