Integrated salmon-seaweed farming

Results from an IMTA project in Norway

Henrice Jansen **(IMR/IMARES)**

R Bannister, V Husa, Ø Strand (IMR)

A Handå, S Forbord, J Skjermo, J Arff, KI Reitan (SINTEF)

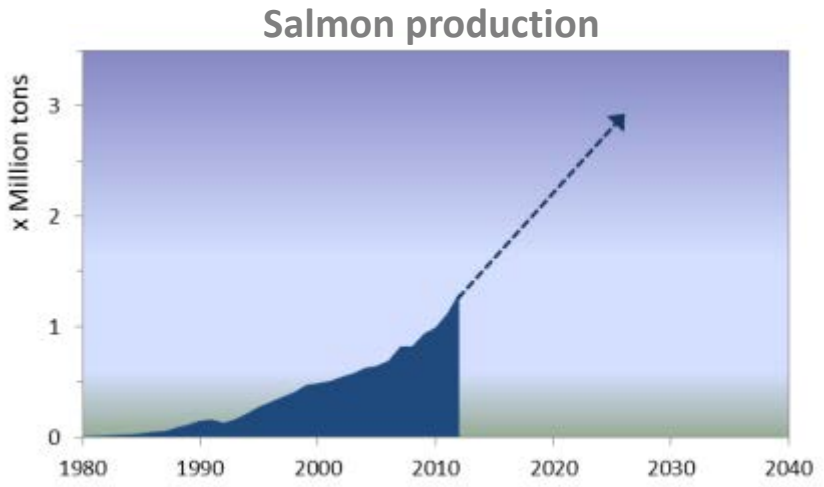
M Bergvik, J Fossberg, H Førde, Yngvar Olsen (NTNU)

Outline

- Why integrated salmon-seaweed farming in Norway
- The EXPLOIT project
- Perspective for integrated salmon-seaweed farming: scaling issues

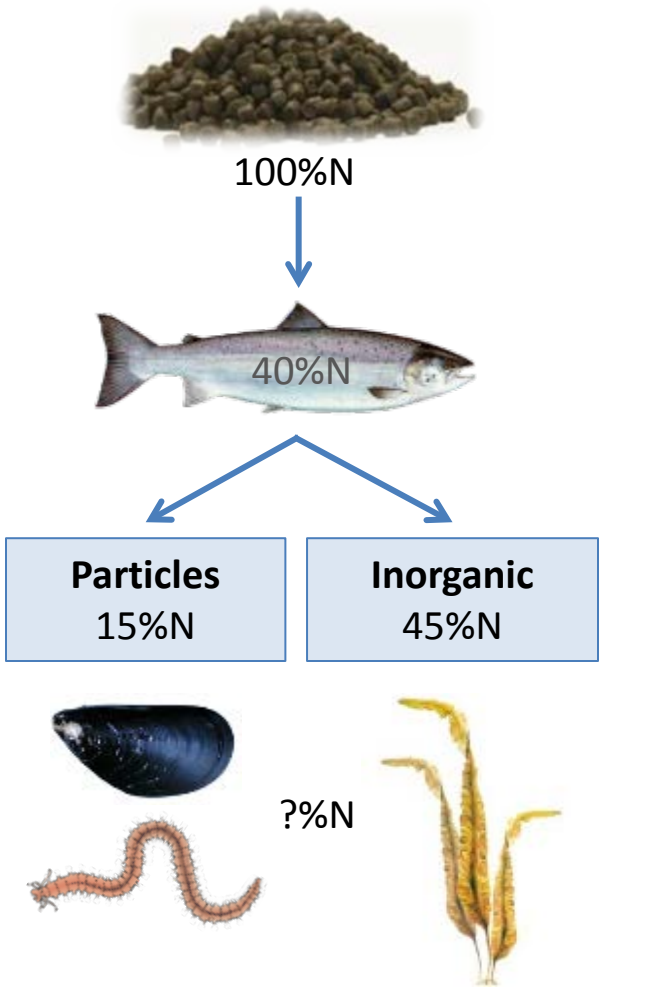
Introduction – Why IMTA in Norway

- Salmon sector:
  - fast growing sector
  - 3 million tons production,
    3.6 million tons feed per year in 2030



Introduction – Why IMTA in Norway

- Salmon sector:
  - fast growing sector
  - 3 million tons production,
    3.6 million tons feed per year in 2030
- Sustainability of salmon sector:
  - ~60% of feed is lost as excess nutrients
    (Olsen et al 2008, Wang et al 2012)
  - IMTA proposed as a biomitigation tool



Introduction – Why IMTA in Norway

- Seaweed sector
  - 30-fold increase of the annual turnover in the macro-algae industry by 2050 (value: from 150 million € in 2010 to 5 billion € in 2050)
  - The Norwegian harvest is strictly regulated, with annual landings of ~150 000 tons, which stresses the need for cultivation
  - Expected growth for both salmon and seaweed: Smart combinations possible?

NTNU – Trondheim Norwegian University of Science and Technology · SINTEF · Institute of Marine Research Havforskningsinstituttet

BELLONA · YSFRI · Universidade Federal de Santa Catarina · UNB University of New Brunswick · Wageningen UR For quality of life · Fisheries and Oceans Canada · Universidad De Los Lagos

The EXPLOIT Project

"Exploitation of nutrients from salmon aquaculture“

RCN: 216201/E40

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

What is the potential for IMTA in Norway?

M Heide / SINTEF Fisker

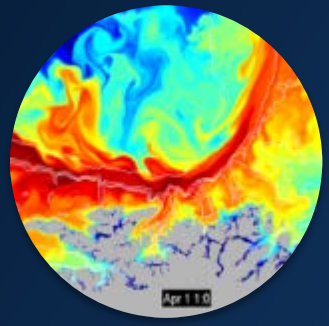
The EXPLOIT Project

WP 1 - Environment

- Hydrography
- Temperature and salinity
- Nutrients - Particles
- Chlorophyll a
- Biological tracers
- Sediment traps
- Acrobat

WP2 - Cultivation

- Atlantic salmon (*Salmo salar*)
- Suger kelp (*Saccharina latissima)*
- Blue mussel (*Mytilus edulis*)
- Great Scallop (*Pexten maximus*)



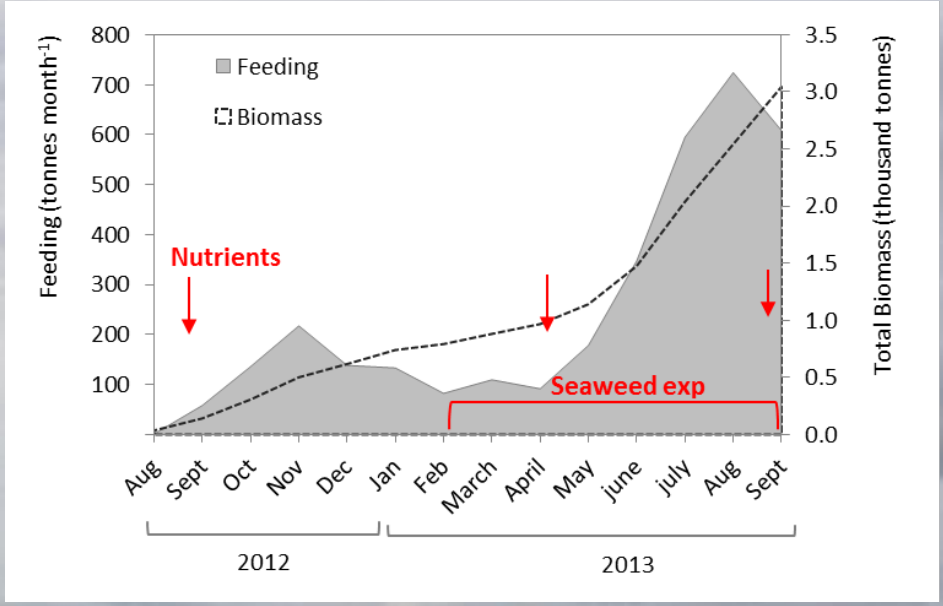
WP 3 - Modelling

- Hydrodynamic-biological model FLÅTEGRUNNEN
- Hydrodynamics (SINMOD)
- Ecosystem and nitrogen (SINMOD)
- Growth of sugar kelp (Broch)
- Growth of blue mussels (DEB)

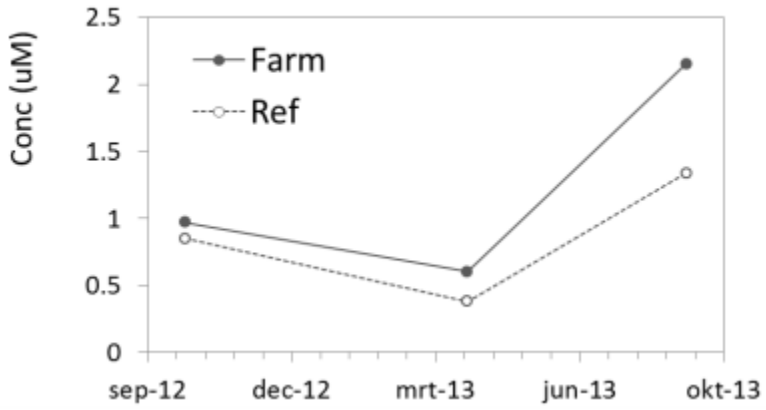
Aquaculture facilities:

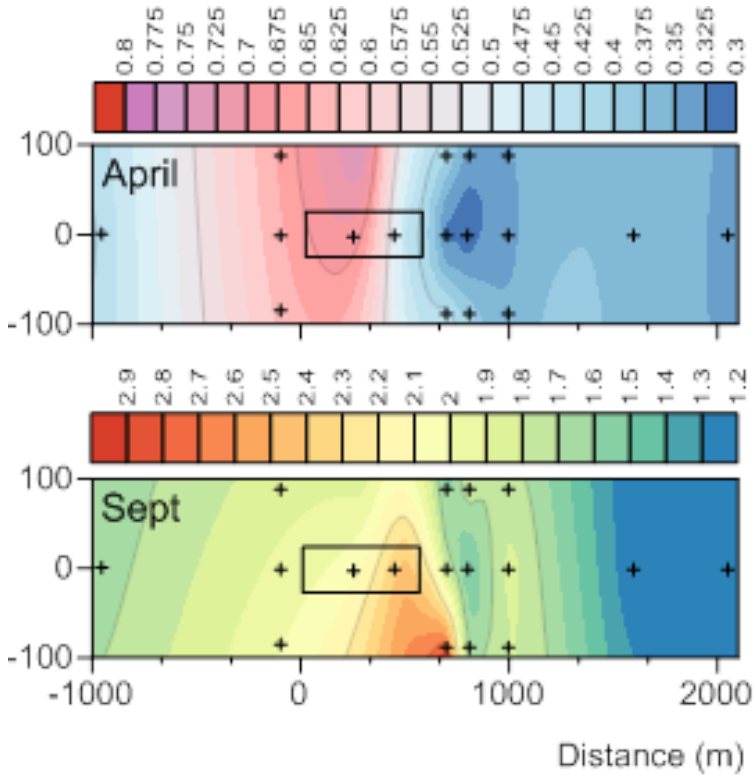
- Coastal area
- 6000 tons production (net pens)
- Depth 75-200m
- Production cycle 18-20 months

- Nutrient sampling (3x)
  Seaweed cultivation (feb-sept)



Results EXPLOIT– Waste plume dynamics



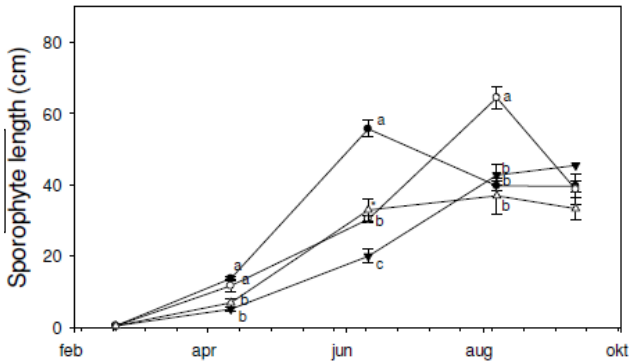


- Only Ammonia,
  no other nutrients
- 1.6-1.7 times higher at farm

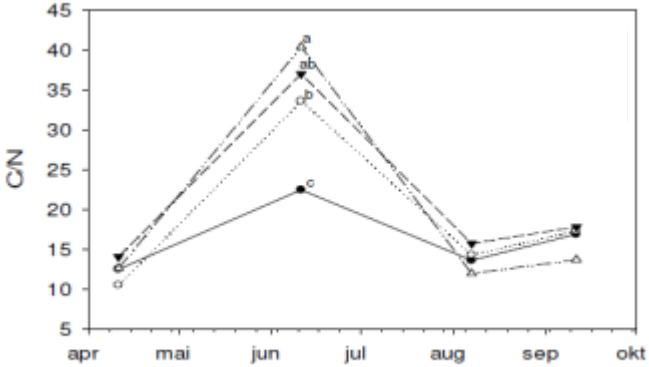
- Waste plume quickly diluted

Results EXPLOIT– Seaweed growth & composition

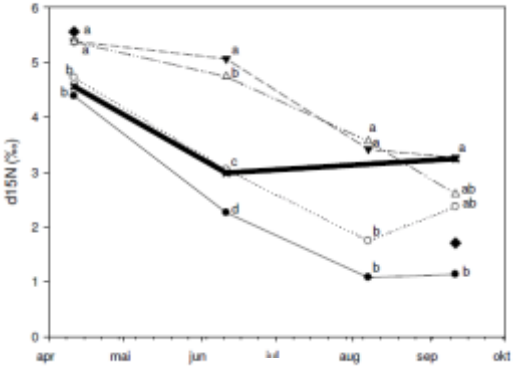
Sporophyte length



C/N ratio



Stable Isotopes (δN_{15})



Growth at Farm station higher in June

N content higher

- Farm & 200m station ≠ ref stations
- Can be related to δN_{15} values in salmon faeces
- δN_{15} better proxy for N dispersal than wet chemistry?

Conclusions EXPLOIT

- Ammonia enhancement observed, but concentrations quickly diluted
- Difficult to quantify a waste plume

- Seaweed growth initially faster in proximity of the farm, but overall no enhanced growth was observed
- Content analysis indicates that waste nutrients from salmon are assimilated

- What does this mean for the potential of IMTA?

Scaling issues for integrated Salmon-Seaweed farming

- Growth enhancement only in close proximity of salmon cages (<200m): large scale seaweed farms impossible at such spatial scale

- Much larger areas needed for seaweed growth:

Reid et al 2013:
Reporting ratio of x kg of kelp (fresh) required to remove the nutrients excreted from 1kg growth of salmon

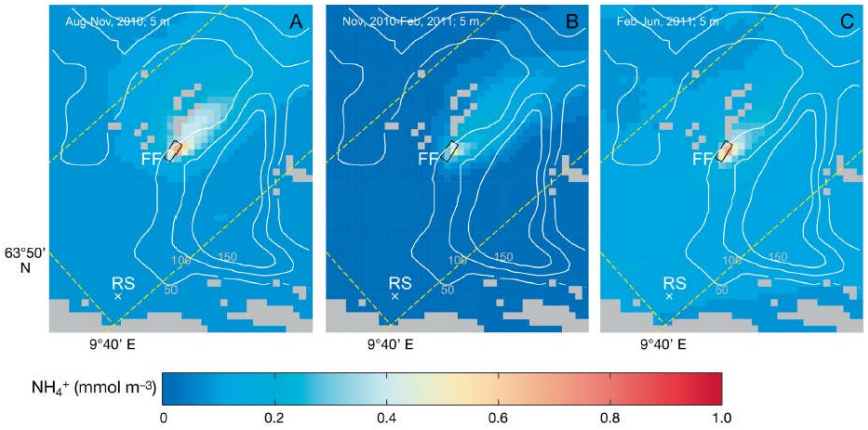
	Alaria	*Saccharina*
C	5.8(±1.4):1	10.2(±2.2):1
N	6.7(±1.5):1	**12.9(±2.7):1**
P	4.8(±3.0):1	10.5(±6.2):1
DO	4.1(±1.0):1	7.2(±1.5):1

Scaling issues for integrated Salmon-Seaweed farming

Modelling study by Broch et al (2013) for Norwegian conditions indicates:

- Similar areal assignment for salmon and seaweed (*S latissima*) installations (30 ha in this study):
  - yield comparable biomass
  - results in 10%N removal by seaweeds

- Seasonal mismatch between max salmon effluent and max uptake rates in *S. latissima*



Conclusions

- There is potential for Seaweed production in Norway
- Biomitigation potential for present salmon-seaweed farming is limited
- Considerations for future:
  - Alternative configurations for increased effectiveness of IMTA *or*
  - Alternative measures for waste disposal from salmon farms

Contact
Henrice.jansen@wur.nl
Aleksander.h.handa@sintef.no
Silje.forbord@sintef.no