What is the way forward for IMTA development in Norwegian aquaculture?

10 years of salmon-driven IMTA research

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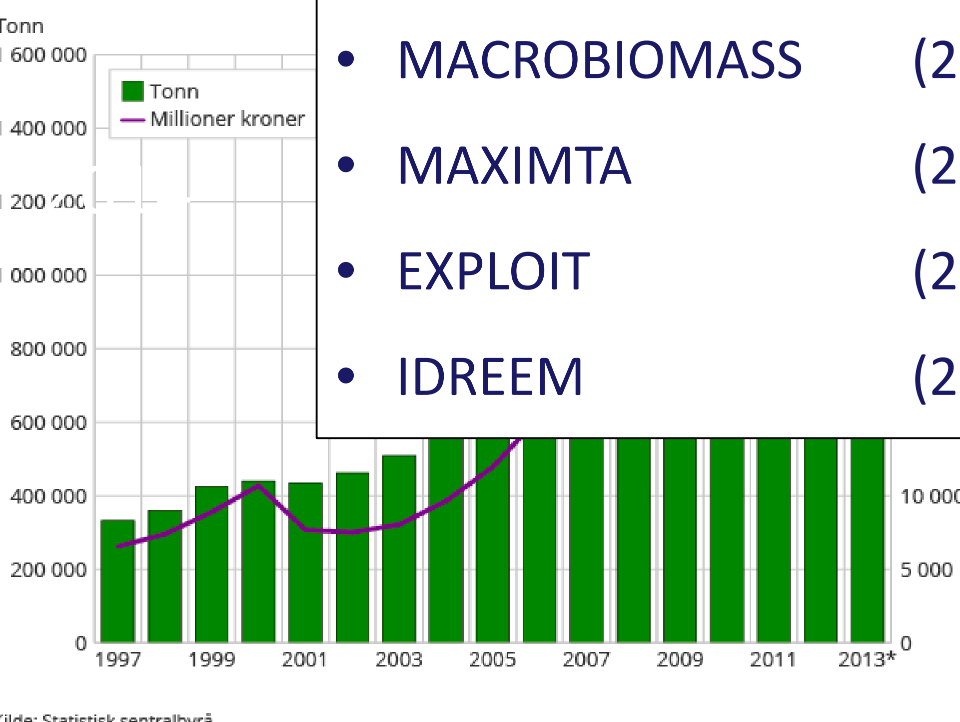
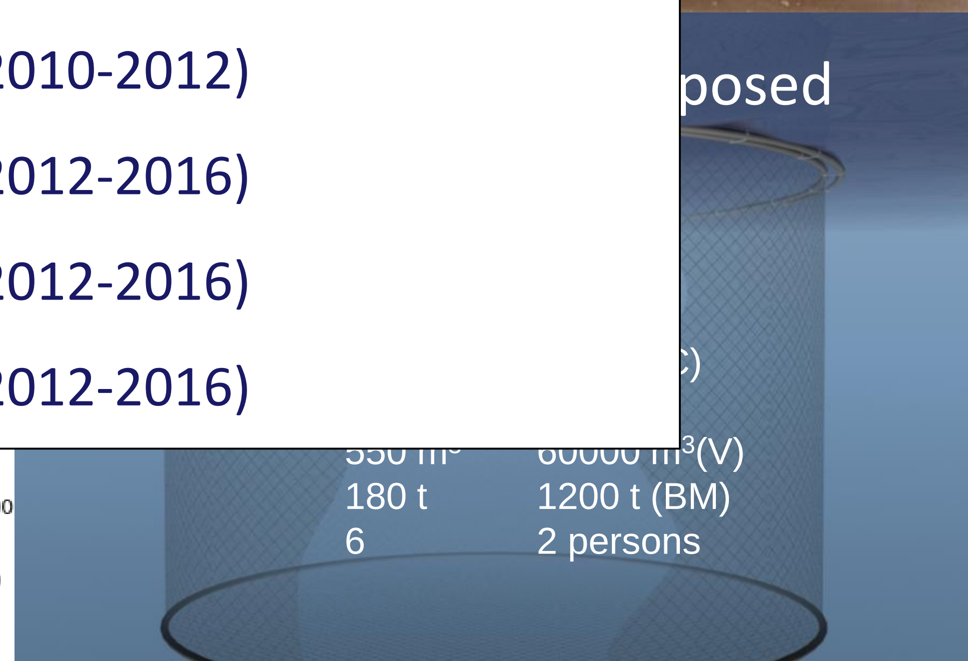
SINTEF

10 years of salmon-driven IMTA research in Norway

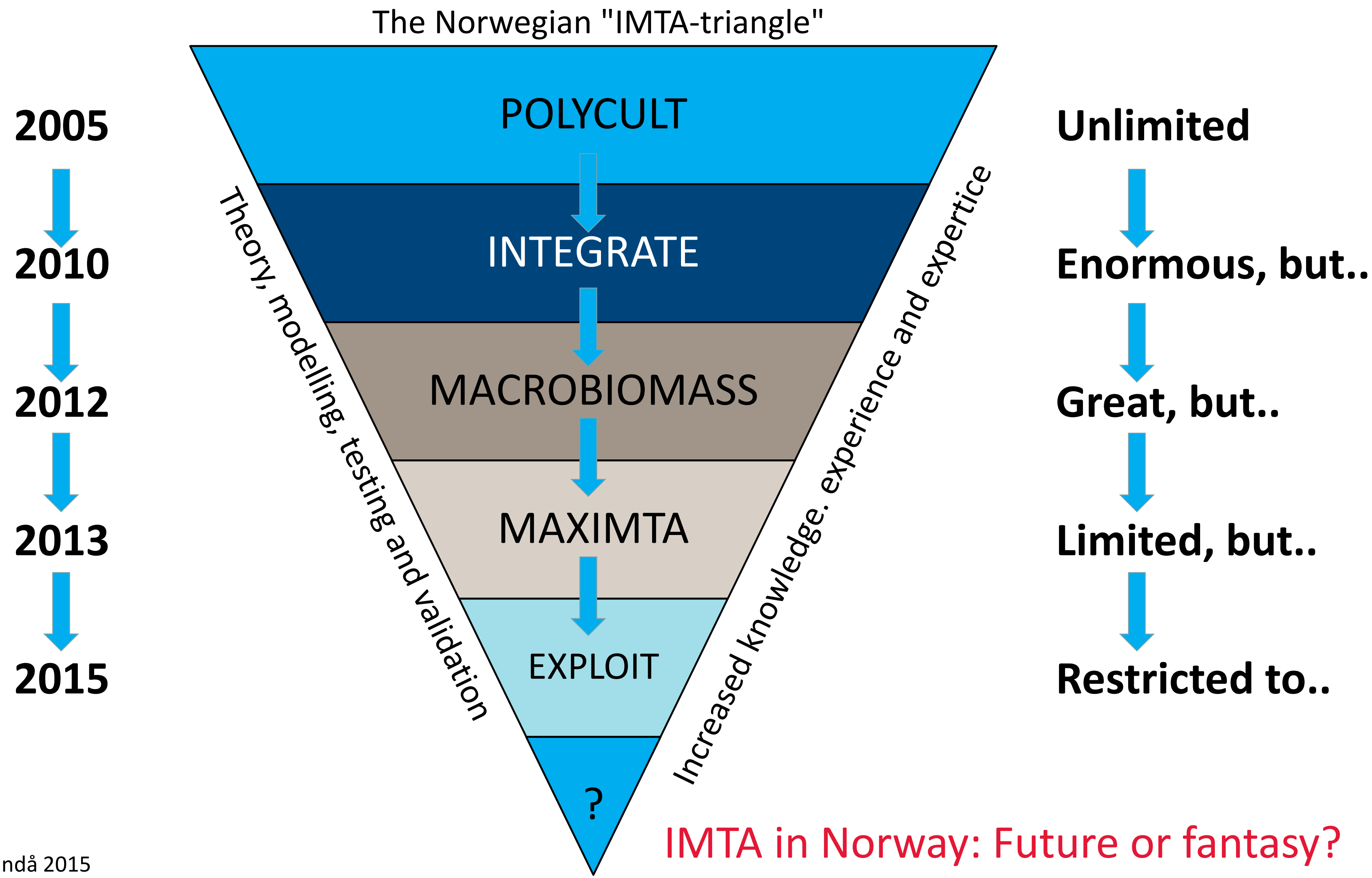
- POLYCULT (2004-2006)
- INTEGRATE (2006-2011)
- MACROBIOMASS (2010-2012)
- MAXIMTA (2012-2016)
- EXPLOIT (2012-2016)
- IDREEM (2012-2016)





FHL, 2012, Olafsen et al., 2012

Potential for IMTA



Handå 2015

What is the way forward for IMTA in Norway?

Skjerjehamn

<u>Outline:</u>

1. **Synthesis of results, challenges and opportunities**

   Seaweed Case, Bivalve Case, Benthic Case

2. **Stakeholder workshop**

   Environment and aquaculture governance – EAG project

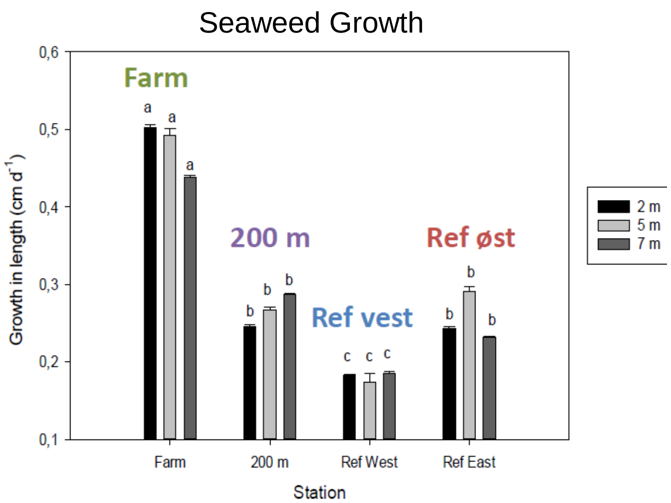
   "Possible application of IMTA and advance on the development of alternative and/or adapted approaches in Norwegian aquaculture"

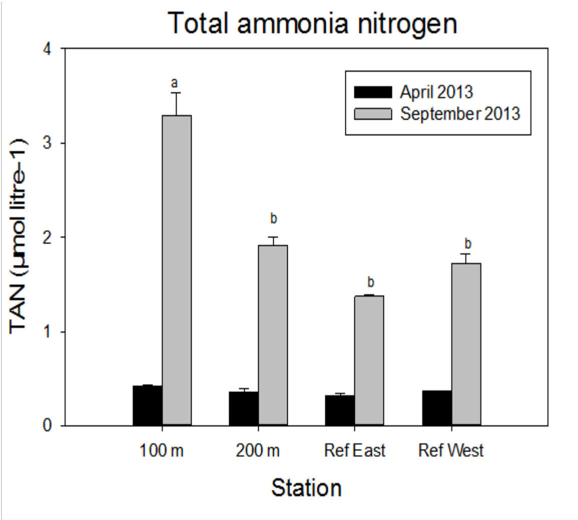
   - National stakeholders: Science, Industry, Government
   - International experts: China (YSFRI), Canada (DFO), UK (SAMS)

The Seaweed case

RESULTS

- Up to 1.5x to 3x better growth at salmon farm
  (Handå et al 2013, Fosberg et al in prep)
- SI suggest fish waste uptake (Fosberg et al in prep)
- Positive growth only close to farm (Fosberg et al in prep)
- Nutrient dispersion patterns indicate quick dilution
  (Jansen et al in prep)

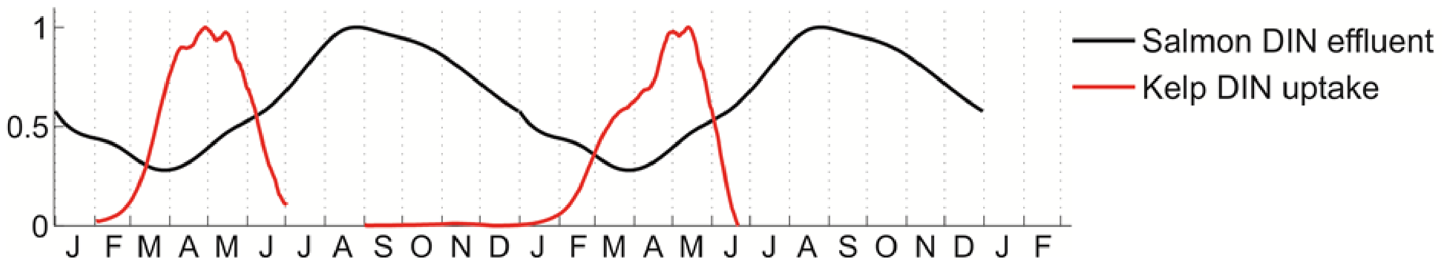




The Seaweed case

CHALLENGES

- Unbalanced production (ratio 1:10 fish to seaweed) (Reid et al 2013, Broch et al 2013)
- Large areas required for bioremediation
- Growth enhancement not relevant at commercial scale
- Seasonal mismatch (Broch et al 2013, in prep)



OPPORTUNITIES:

- Balance approach – regional scale
- Developing seaweed sector in Norway (although still immature)
- Market potential

The bivalve case

RESULTS

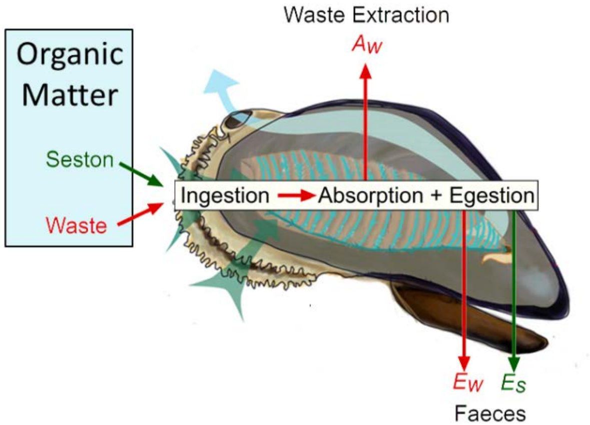
- Mussels and Scallops assimilate fish waste
  (Handå et al 2012a, Redmond et al 2010, Bergvik et al in prep)
- No increases in shell length at salmon farm, higher meat content autumn/winter (Handå et al 2012b)

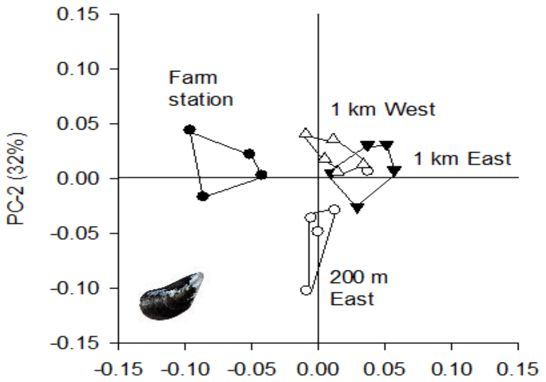
CHALLENGES:

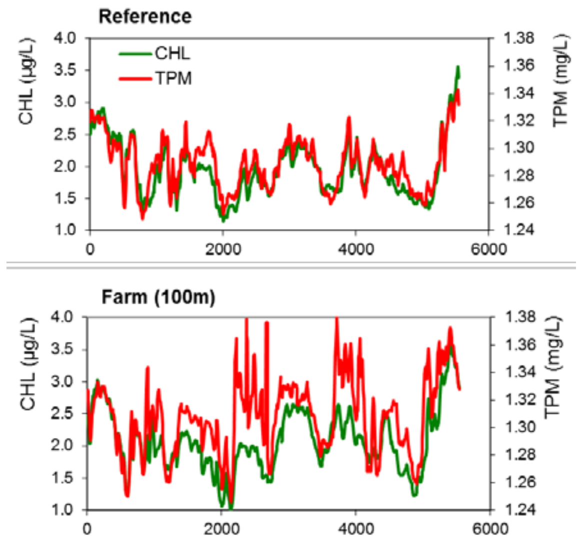
- Waste extraction efficiency is low (Cranford et al 2013)
- Large areas needed
- Loading small particulate fines is low (Cranford unpubl)
- Biodeposition: extraction> egestion (Cranford et al 2013)
- Low potential for bivalves in IMTA

OPPORTUNITIES:

- Balance approach
- Alternative function: Sealice removal?



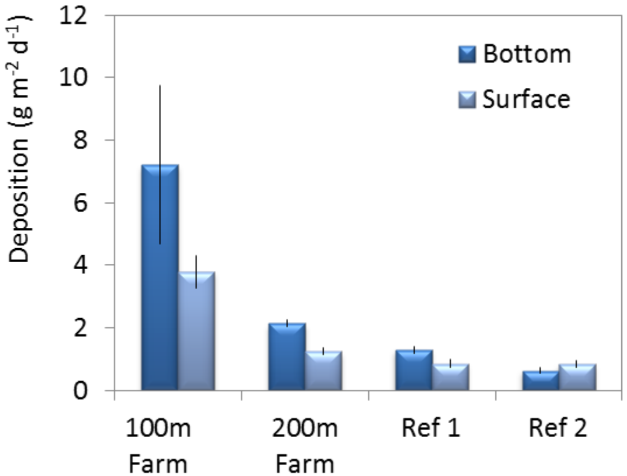




The benthic case

RESULTS

- No culture trials performed yet
- Most particulate waste settle quickly
- Footprint of farm 50-500m (Kutti et al 2007a)
- Biomass and diversity enhanced under fish cages (Kutti et al 2007b)



The benthic case

OPPORTUNITIES:

- Concentrated waste source > farm scale
- Industry interest: Need for feed ingredients

- International experience indicates high potential
- Candidates: Polychaetes, Sea urchins, cucumbers,...
- Scaling seems right (Robinson & Reid 2014)

- Alternative function : Reefs – nature conservation

CHALLENGES

- Technical feasibility (depth fjords)
- Complex production systems
- Containment options vs sea ranging
- Extraction efficiency is largely unknown

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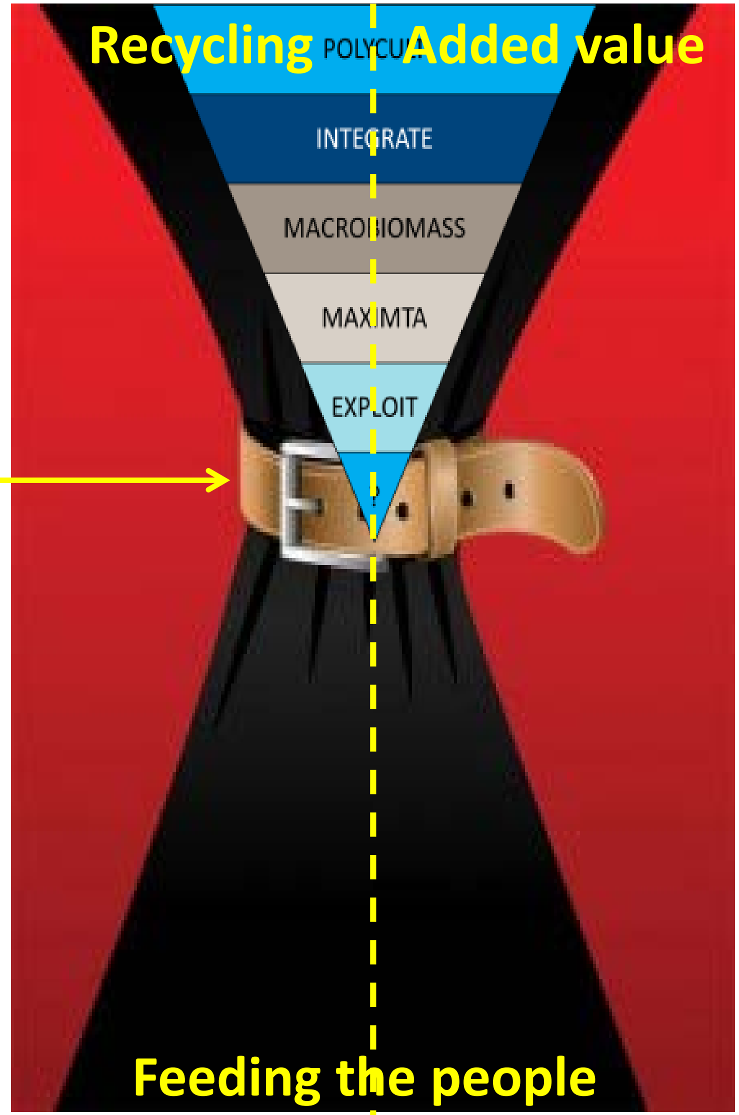
What is the way forward for IMTA in Norway?

Workshop:
What is needed to loosen the belt?

- Rethinking and defining IMTA, specific for Norwegian conditions
- SWOT
- Actions required



Past

Present

Near future

Future

The IMTA bottleneck (Cranford 2015)

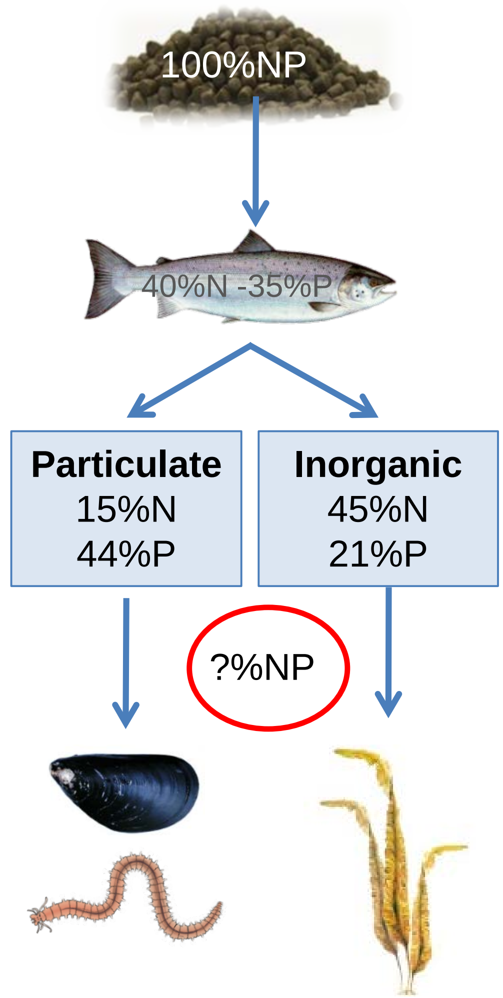
Rethinking and defining IMTA

How does IMTA assist sustainable development

- How 'green' are integrated cultures?
  Define % removal required
- Arrows need numbers
- (un)balanced production

Amount seaweed required for 100% removal (Wang et al 2012)

County	DIN (t)	Potential seaweed biomass based on DIN (t WW)	Area needed for potential seaweed cultivation (km^2)
RAG	350–1060	56 000–168 000	8–25
HOR	650–1940	102 000–307 000	15–44
SFJ	310–920	49 000–146 000	7–21
MRO	440–1310	69 000–208 000	10–30
STR	390–1160	61 000–184 000	9–26
NTR	310–930	49 000–148 000	7–21
NOR	630–1880	99 000–298 000	14–43
TRO	390–1160	61 000–184 000	9–26
FIN	180–540	29 000–86 000	4–12
Total		577 000–1 730 000	82–247



Rethinking and defining IMTA

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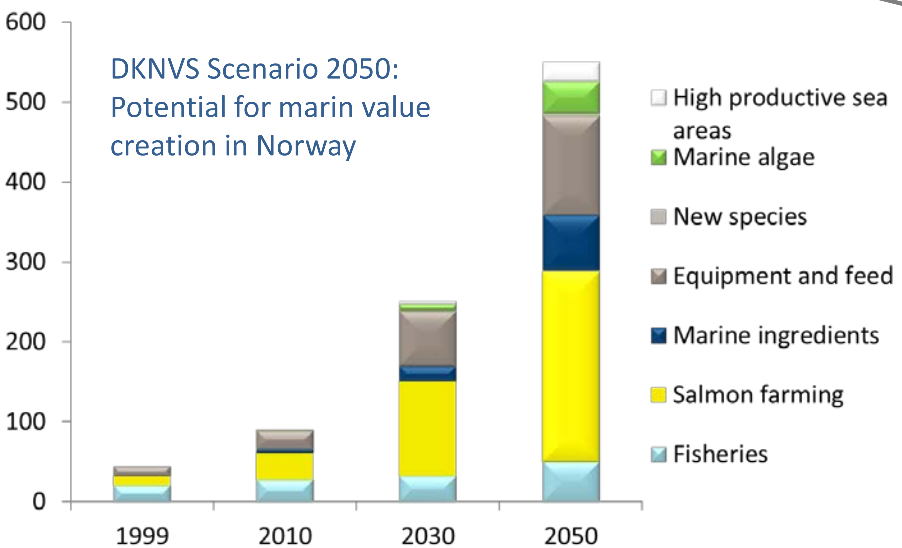
→ Salmon 2010: 40 km^2

(Gullestad et al 2011)



Biomass	Salmon (Mton)	Marine algae (Mton)
2012	1.3	*0.2*
2030	3	4
2050	6	20

Rethinking and defining IMTA

Scaling – Where are wastes recycled?

- Inorganic: Regional scale (Coastal Zone Management plans)
- Organic: Farm scale (Site management)
- Fjord versus Coastal zone production areas
- IMTA > IA > MTA

Value chain

- Growth salmon, matched with increase extractive species
- Low trophic production is currently limited in Norway
- Market development

SWOT Analysis

Strengths

- Strong & professional industry
- Strong marine engineering
- Leading role scientists
- Support Government and society
- International linkages

Weaknesses

- Lack of model / Trial & error
- Lack of clarity
- Commitment by government
- Lack of spokesperson
- Lack of education

Opportunities

- Acceptance of science
- Cosmopolitan tastes (restaurants)
- What other options for nutrient extraction do we have?
- International collaboration (Demonstration sites, transfer tech)

Threats

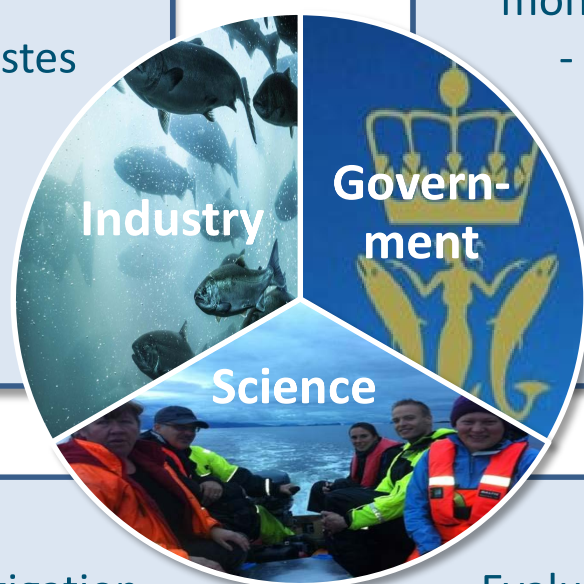
- Lack of diversification
- Imposed regulation
- Supply chain
- Sustainable food production: if we wait until we need to, we might be too late

SWOT IMTA development Norway - By S Robinson (2015)

Further actions required (to loosen the belt)

- Development low trophic aquaculture
- Develop benthic production
- Business plans IMTA
- Semi-containment of wastes
- Market (chain, feed)
- .....

- Licences & regulation
- Apply EAA to IMTA
- Develop environmental monitoring IMTA sites
    - Stimulate pilot sites/regions
        - Stimulate circular economy
        - .....



- Development benthic mitigation
- Technology development
- Ecosystem knowledge, impact
- Define appropriate scales, mitigation

- Evaluate alternative functions
- Disease issues
- Socio- Economics of IMTA
- ....

Transparent stakeholder exchange of concerns and solutions

Thank you.

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