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

10 years of salmon-driven IMTA research

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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)
The Norwegian "IMTA-triangle"

- **2005**: Unlimited
- **2010**: Enormous, but...
- **2012**: Great, but...
- **2013**: Limited, but...
- **2015**: Restricted to...

**IMTA in Norway: Future or fantasy?**
What is the way forward for IMTA in Norway?

Outline:

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
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

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)

<table>
<thead>
<tr>
<th>County</th>
<th>DIN (t)</th>
<th>Potential seaweed biomass based on DIN (t WW)</th>
<th>Area needed for potential seaweed cultivation (km²)</th>
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<tbody>
<tr>
<td>RAG</td>
<td>350–1060</td>
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<tr>
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<td>4–12</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>577 000–1 730 000</td>
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Rethinking and defining IMTA

DKNVS Scenario 2050: Potential for marin value creation in Norway

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Salmon 2010: 40 km² (Gullestad et al 2011)

Biomass

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<th>Year</th>
<th>Salmon (Mton)</th>
<th>Marine algae (Mton)</th>
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<tr>
<td>2012</td>
<td>1.3</td>
<td>0.2</td>
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<tr>
<td>2030</td>
<td>3</td>
<td>4</td>
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<tr>
<td>2050</td>
<td>6</td>
<td>20</td>
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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
**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
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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