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# Offshore Aquaculture Trends and developments

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and Innovation Platform

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# Conventional salmon farming is already a large-scale industry and can be ... fairly exposed

## Cages

- Cages 160 to 200 meter in circumference
- 1000 tons of salmon in each cage (equal to 2200 cows)
- 16 cages in one fish farm (15 000 tons production)
- From manual to mechanical and automated operations

## Feeding

- Formulated dry feed pellets
- Feed air-blown through pipes to each cage
- Monitoring, control and remote operations from land

## Vessels

- Work boats (< 15 m in length)
- Specialized vessel for maritime aquaculture operations (24 – 40 m in length)
- Well boats with capacity of 4500 m<sup>3</sup> – can carry (700 tons of live salmon)





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# Technological concepts for sustainable utilisation of the coast

Closed (RAS)



Semi-closed



Open, flexible cage



Sheltered/submergible cage



More rigid, larger cage



Current exposed salmon sites in Norway

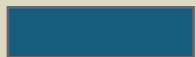


Ship

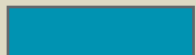


EXPOSED

AQUACULTURE OPERATIONS  
CENTRE FOR RESEARCH-BASED INNOVATION



Current production



In development



Future opportunities

# EXPOSED Aquaculture Operations

Knowledge and technology for robust, safe and efficient fish farming at exposed locations

Significant parts of the Norwegian coast is today unavailable to industrial fish farming due to remoteness and exposure to harsh wind, wave, current and ice conditions. Regular as well as infrequent operations are challenging.

The centre is funded by the Norwegian Research Council and the 22 centre partners, has a planned duration of 8 years, starting in 2015 and a total budget of 210 MNOK ( $\approx$  23 M USD) and 15-25 PhDs.

Host: SINTEF Ocean  
Fish farmers: Mowi, Cermaq Norway, SalMar Farming  
Service partners: AQS  
Research partners: SINTEF Digital, Institute of Marine Research,  
Norwegian University of Science and Technology  
Technology providers, engineering and certification providers: Kongsberg Maritime,  
Aqualine, Argus Remote Systems, Anteo, MacGregor Norway,  
Marine Design, Møre Maritime, DNV GL, Safetec

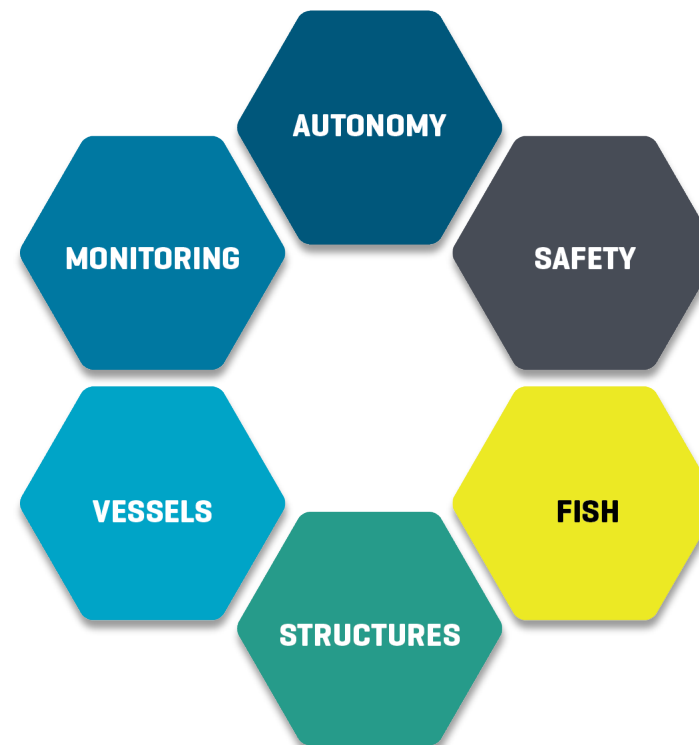






Illustration: Bolandet Miljøfisk

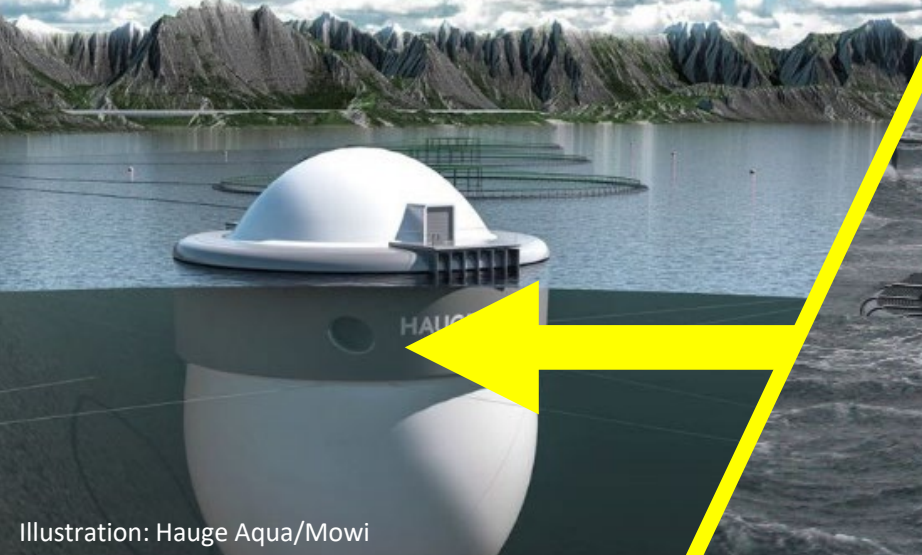


Illustration: Hauge Aqua/Mowi

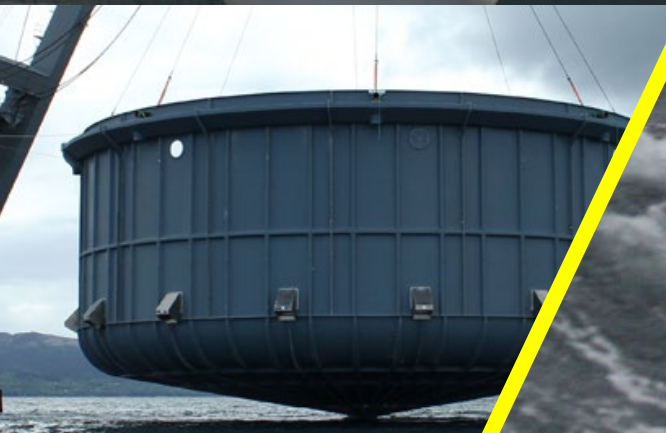


Photo: Aquafarm Equipments/MOWI

Photo by Marius Dahle Olsen

A very special period,  
with a rare rate of  
innovation in Norway

Significant international relevance

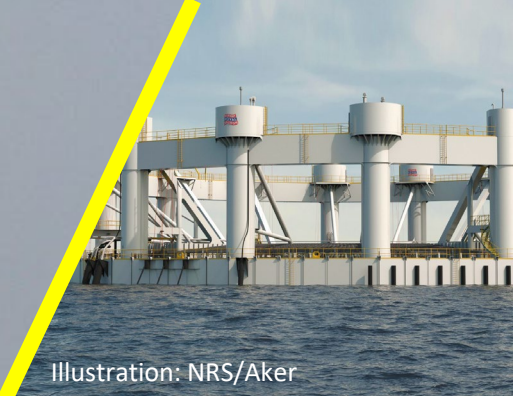


Illustration: NRS/Aker

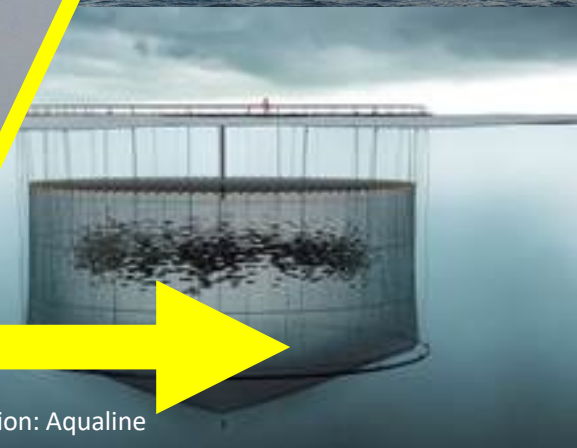


Illustration: Aqualine



Photo: Salmar



Illustration: Nordlaks





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# Even modest wave heights limits routine tasks



## Operational challenges

1. Increased risk of human work environment
2. Demanding management and daily operations
3. Vessel operations become more demanding
4. Fish welfare under rough conditions
5. Increased risk of escaped fish

Source: MOWI

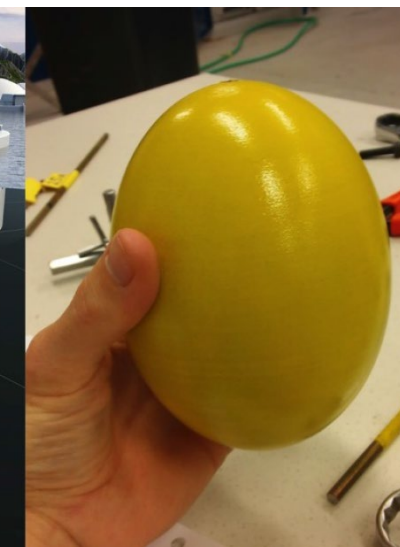
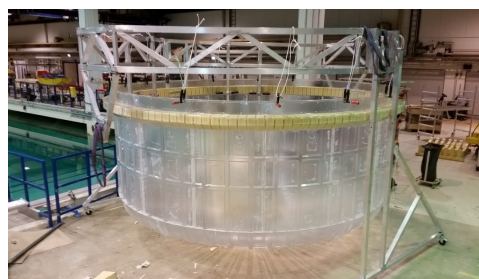
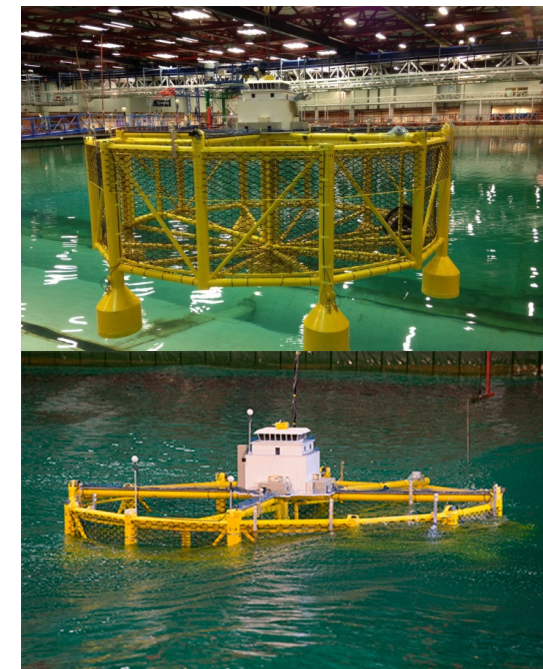


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# Model testing of novel designs

Research-based product development by Aqualine

- Exploring complex physics like turbulence, wave-current interaction and braking waves
- Verification and parametrization of numerical models
- Verification of designs



Technology for a better society





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# Looking ahead

- Current cage designs still prevalent, but experimentation with farm concepts and rapid development of auxiliary systems
- Significant synergies between the various production systems
- Governance and regulations has to keep up!
- Clear potential for international collaboration

Do we solve existing challenges?

Do we create new ones?

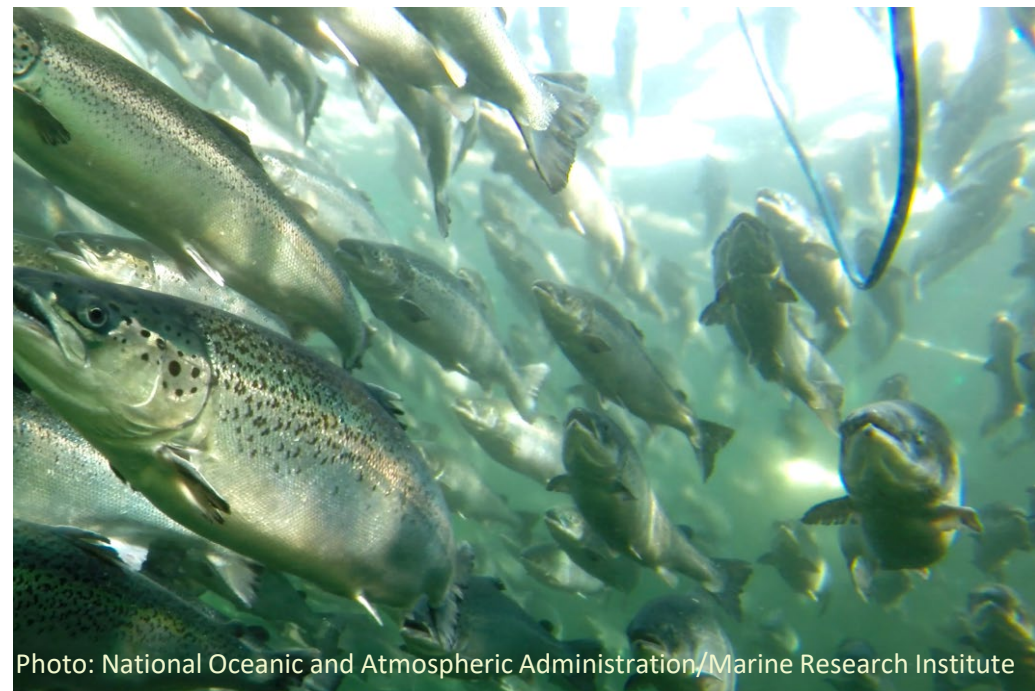
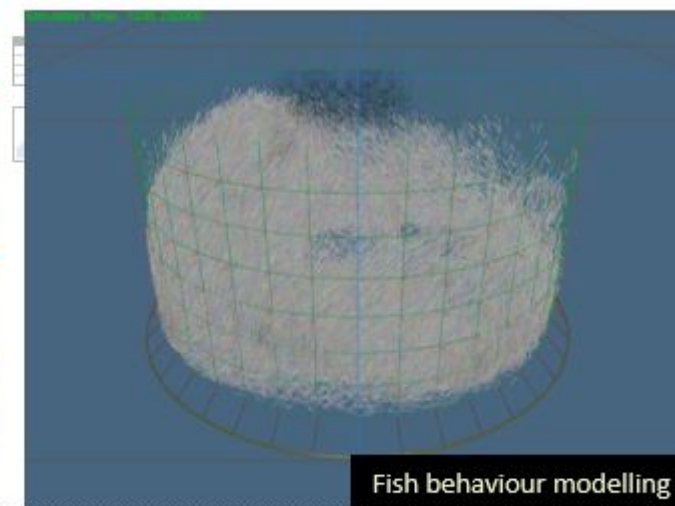
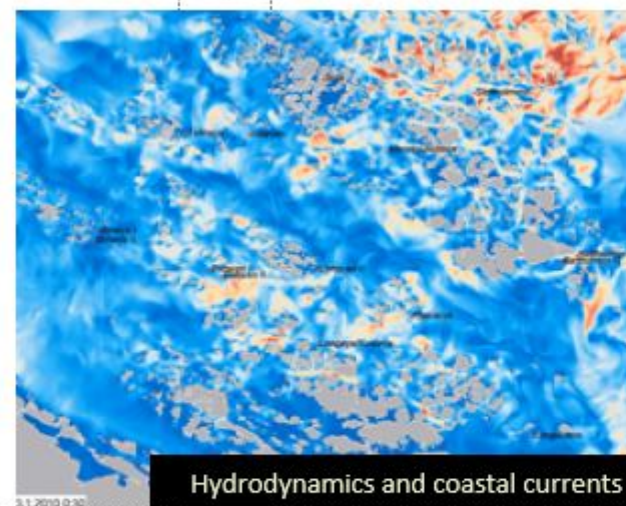
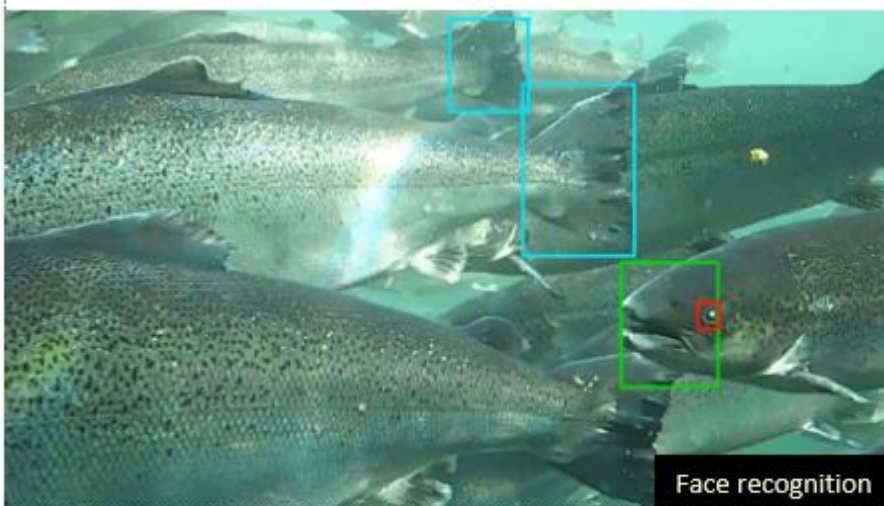
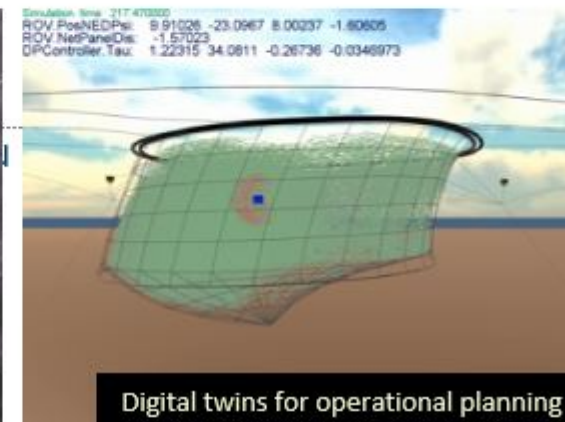
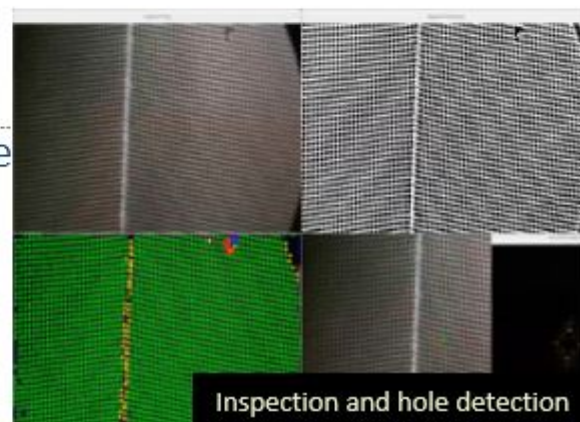


Photo: National Oceanic and Atmospheric Administration/Marine Research Institute



# Digitalisation and automation for increased control





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Technology for a  
better society