

Norway-Japan Marine Seminar 2012

Modern aquaculture Technology, Norway

Marine aquaculture – challenges and opportunities

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SINTEF Fisheries and Aquaculture

Content

- Introduction and historical development in Norway
 - Industry growth
- Present technology and development
 - Farming equipment
 - Work vessels
- Some industrial challenges and solutions
 - Fish escaping and sea lice
 - Access to land
- Research
 - CREATE – centre for research-based innovation in aquaculture technology

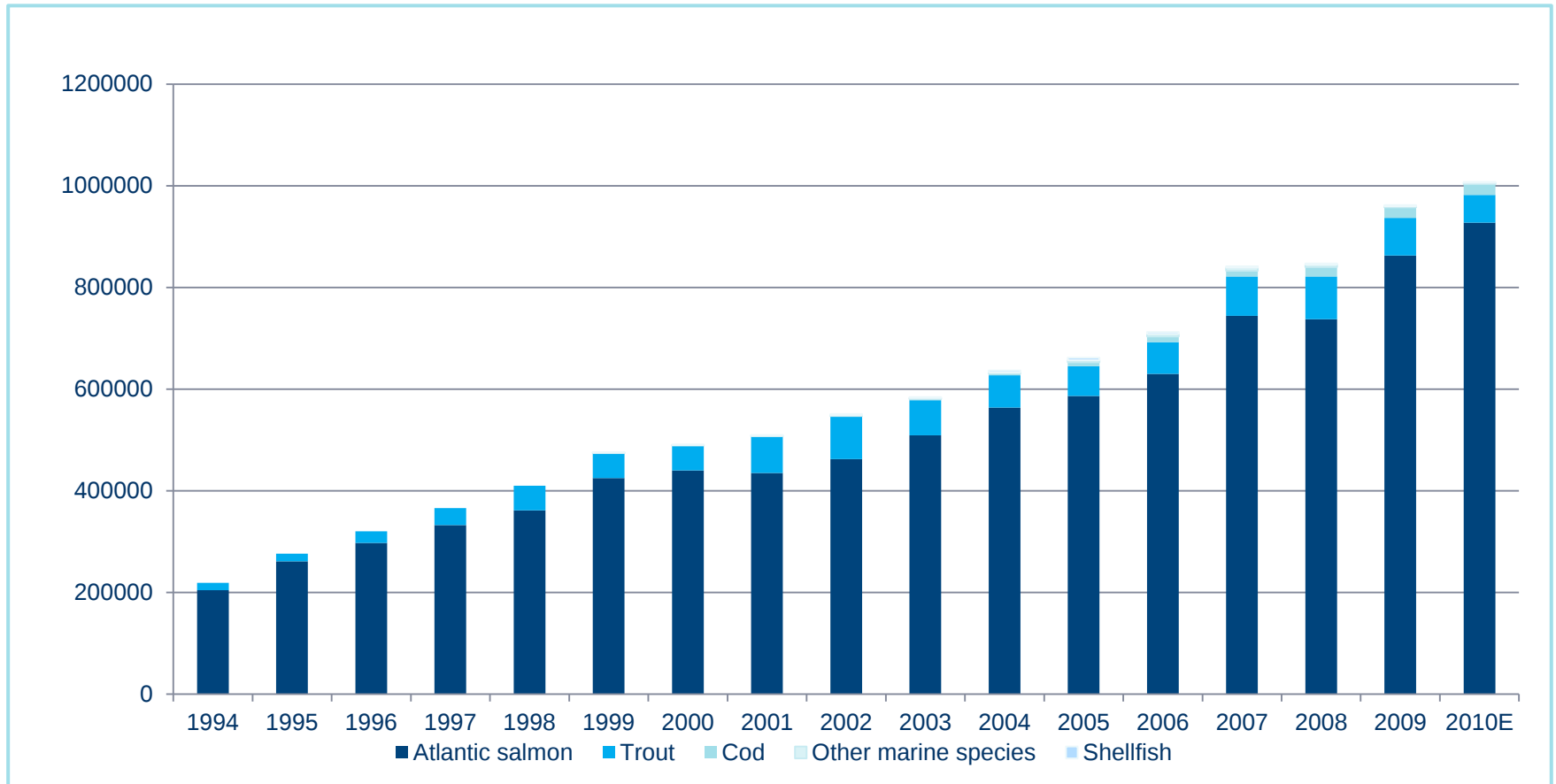
Introduction

The Norwegian Salmon Story

- Started up in the late 60s, small scale
- Since 1980 a pioneer in developing industrial salmon farming
 - Breeding
 - Management
 - Fish health
 - Technology, research and manufacturing
- Average of 8% annual growth
- Reached 1 million metric tonnes in biomass in 2010
- More than 95% exported
- Norwegian farming companies are now global enterprises with activity in Chile, Canada, Scotland and the Faroe Islands
- Leading global supplier of fish farming equipment

Introduction

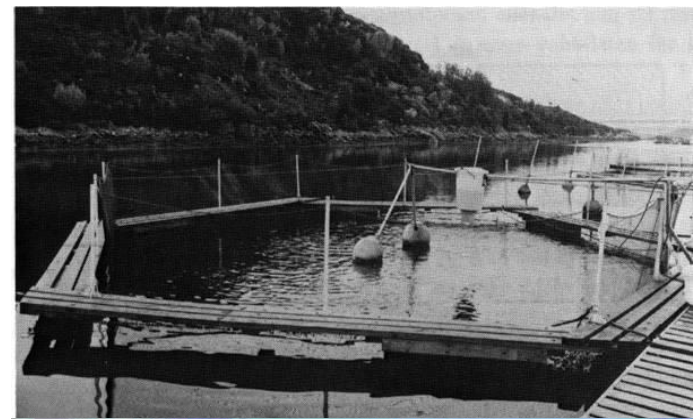
Production volumes



Introduction

Technological development

- Wooden cages in the sixties
- Polyethylene (PE) cages
 - "Industry standard"
- Hinged steel cages



Introduction

Farming operations – snap shots

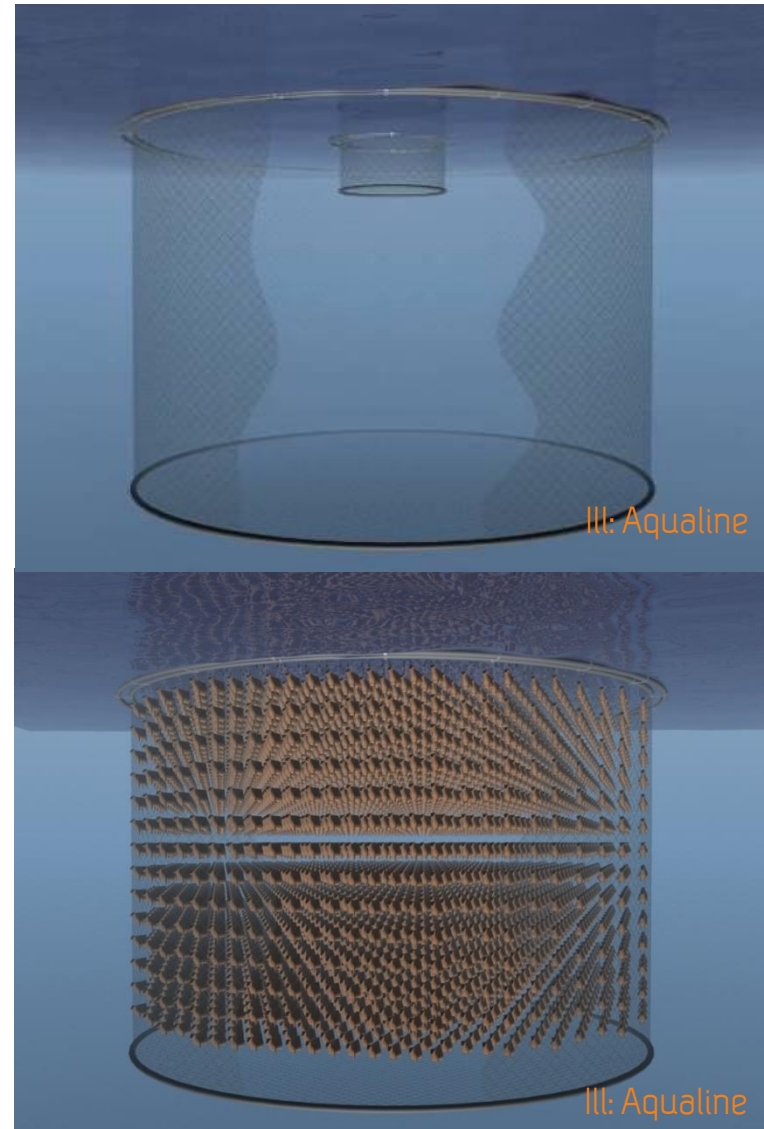
- Manual feeding, home made wet feed
- Harvesting salmon
- Site in sheltered fjords



Present technology and development

The size challenges

- Increasingly larger farms
 - Circumference 60 → 160m
 - Area and volume – factor of 10
- 300 million salmon standing in Norwegian cages
- New regulations
 - Max 200 000 individuals in each unit
- What is the optimum unit size?
 - oxygen
 - feed distribution
 - disease control and treatment



Present technology and development

Salmon – the most efficient food production in the world?

The largest/best sites:

- 10 000-15 000 tonnes per cycle
- 10 – 12 cages Ø 50 meter
- 200 000 – 1 million fish in each
- 1 000-1 500 tonnes per man-year
- Exposed but not offshore

Foto
aqualine

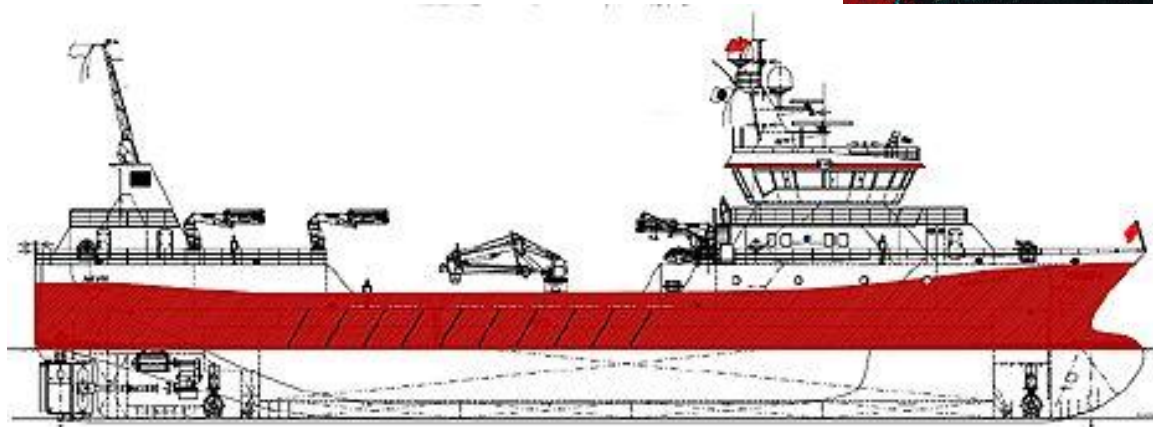
Present technology and development

Well boat and salmon loading

1989 Sigurd 180 m³



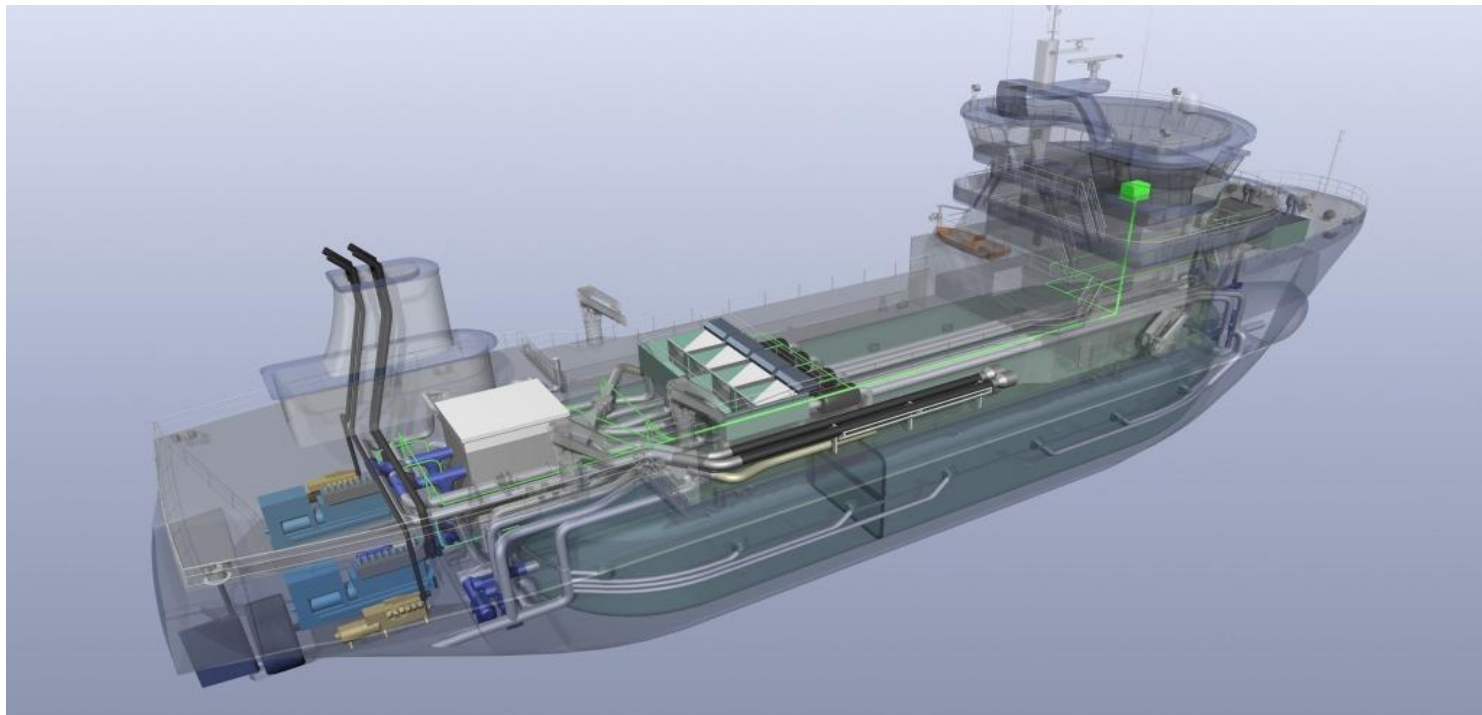
2010 Nordlaks Transport 2800 m³



Present technology and development

Next generation Well-boat Technology

- Large Well-boat innovation initiatives - large industry group and R&D
- Biosecurity, efficiency, fish welfare, gentle fish handling and the environment
- Improvement of the interaction with fish farms
- Possibly LNG-powered



Present technology and development

Service vessels



Present technology and development

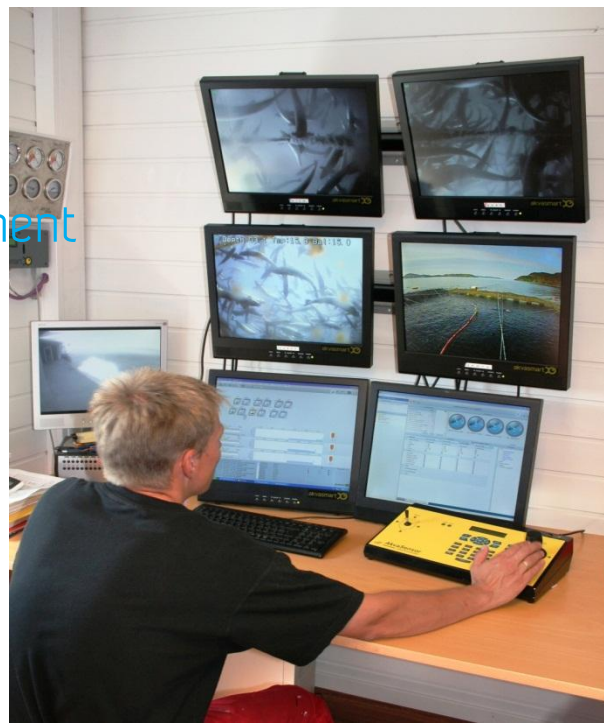
Next generation supply vessel Møre Maritime Macho40



Present technology and development

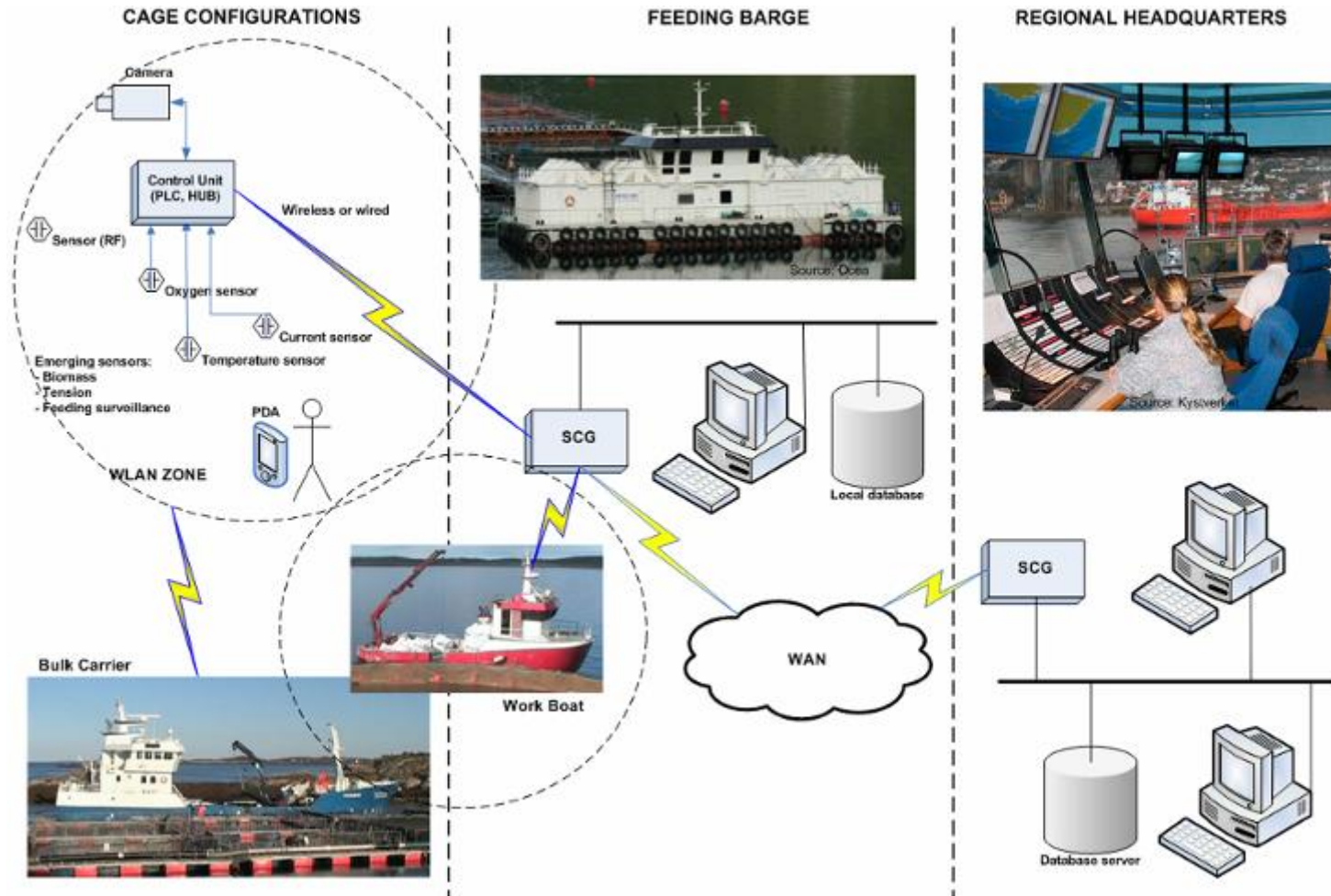
Feeding barge

- 500 – 600 ton storage
 - At peak loaded every 2-3 days
- Control rooms and monitoring
- Sensors
 - Current, temperature, oxygen, salinity
- Feed hoses up to 1200 m
- Living quarters
 - One week on/off



Present technology and development

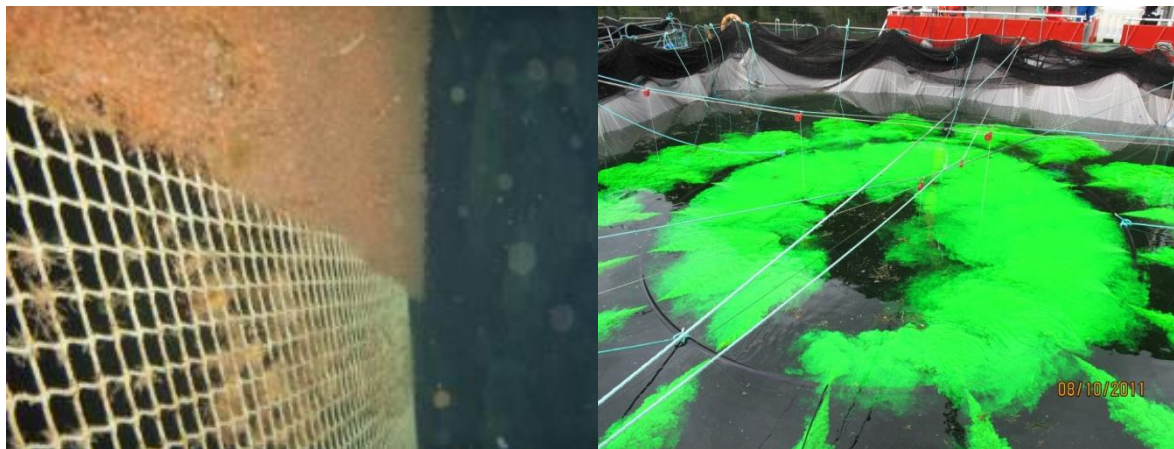
Remote operations and control



Some industrial challenges and solutions

Operational challenges

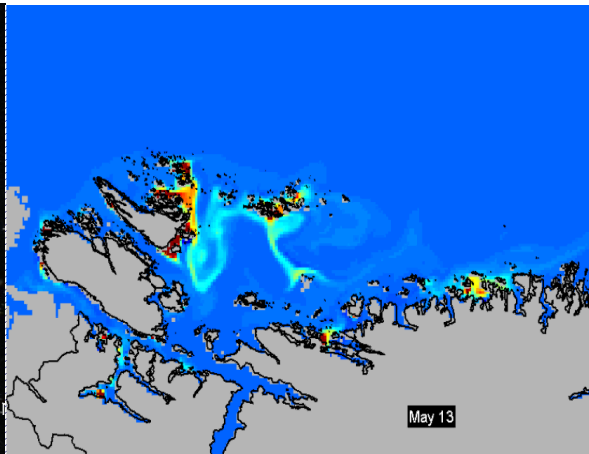
- Removing bio fouling
- Well boat access
- Feed and people logistics
- Bath treatment against parasites (salmon lice) and deceases



Some industrial challenges and solutions

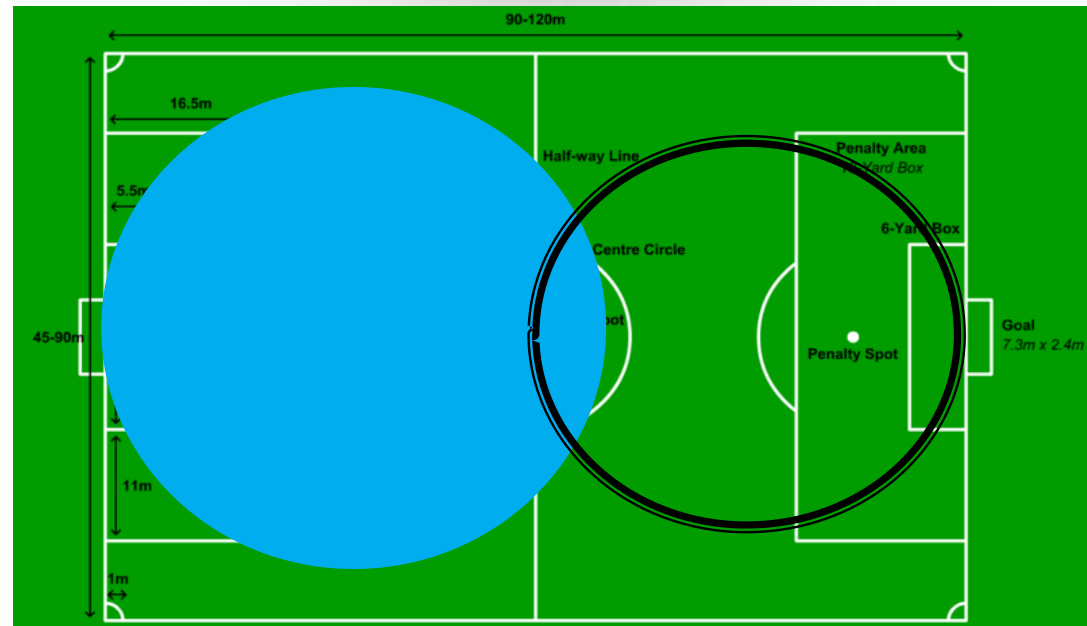
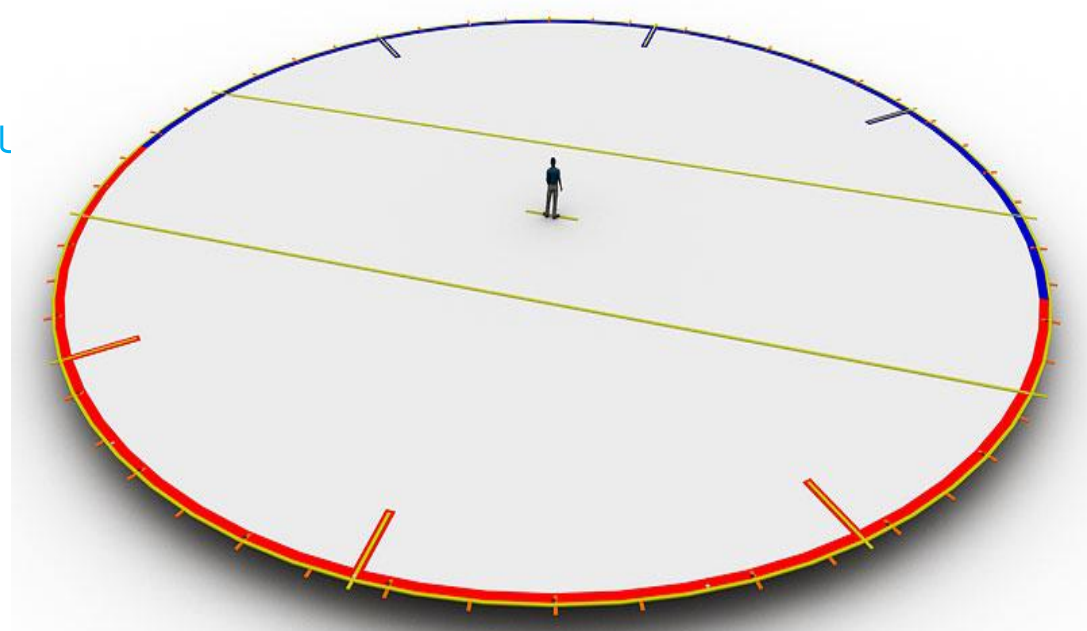
Remove/reduce parasites – sea lice

- Increasing problem over the last years
- Aim to avoid using chemicals
 - management, localisation of farms, cleaner fish
- Use of wrasse (cleaner fish)
 - Farming of wrasse
- Technical solutions
 - Water jet, laser, ..
- Dispersion modelling



Some industrial challenges and solutions Bath treatment

- Requirement to use closed cover by tarpaulin
- 160 m circumference cage:
 - Tarpaulin Ø 62 m og 6 m deep
- Oxygenation
- Challenging operations
 - Develop tarpaulin for improved, faster and more reliable delousing



Some industrial challenges and solutions

Bio fouling and cleaning

Fish farmers need clean nets:

- To reduce additional weight and ensure the stability of cages
- To ensure sufficient water exchange across the nets and maintain good water quality in cages
- To ensure cleaner wrasse predominantly feed on salmon lice

Development of novel cleaning methods:

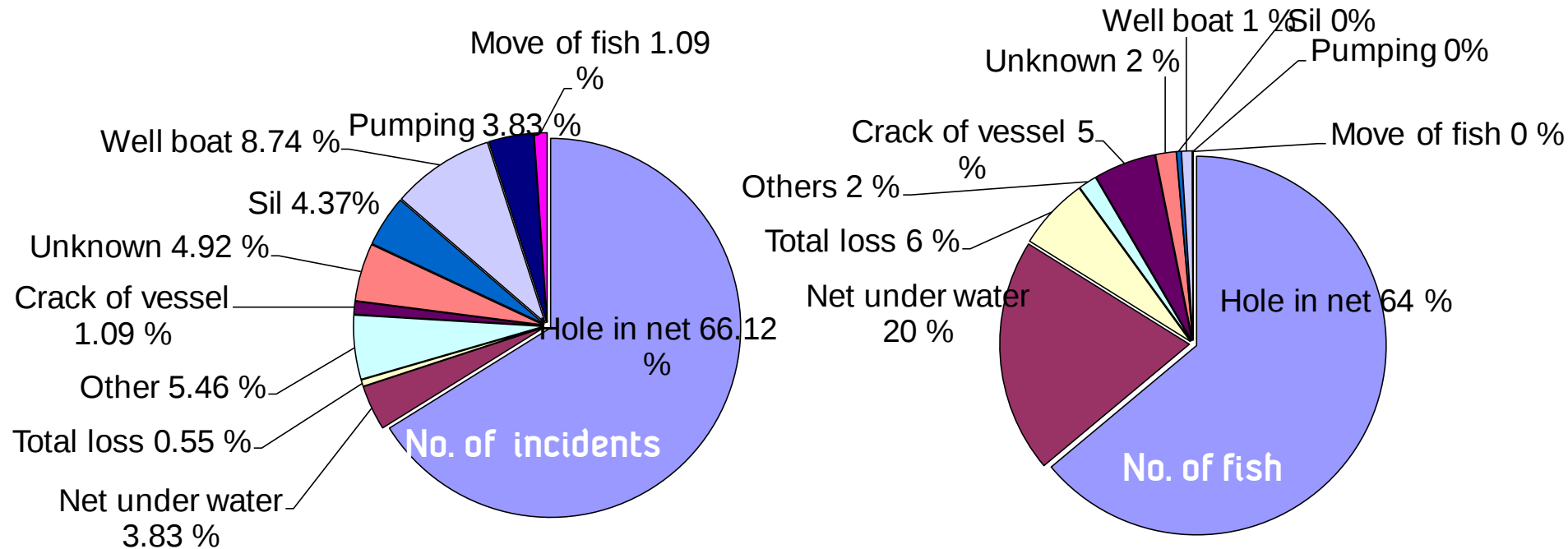
- To determine the effects of heat and acetic acid treatments on
 - the settlement of larvae
 - the survival of juvenile and adult
- Combine with industrial solutions



Some industrial challenges and solutions

Why does the fish escape (2006 – 2009)

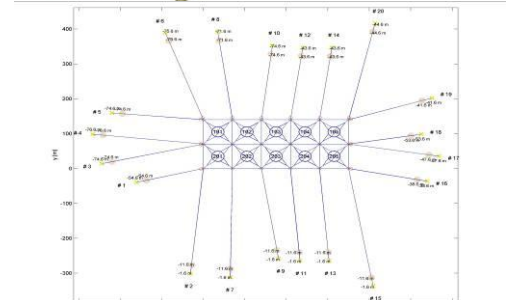
- Assessment of 95 incidents reports 2006 - 2009
- 19% large escapes incidents (> 10 000 fish) – 91% of total number of fish
- 44% of small escape incidents (< 200 fish) – 0.27% of total number of fish



Some industrial challenges and solutions

'NS 9415 "Marine fish farms Requirements for design, dimensioning, production and operation"

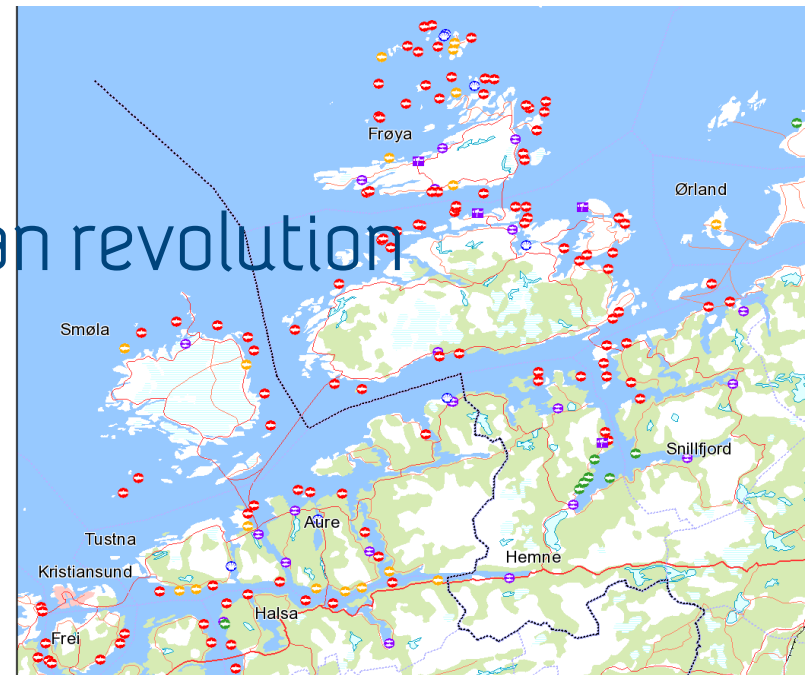
- Technical standards and requirements applicable to
 - Floater, Net cage, Mooring system and feed barge
- Requirement for site classification
 - With respect to wind, current and waves
 - Measurements of current, calculations (or measurement) of waves
 - Define methods for how to determine the values
- Requirements for life time, strength, and fatigue
 - No requirements for dimensions, only strength and material properties
- Requirements to which loads to include and how to calculate
 - Environmental (current, wave and wind), bio fouling, ice loads
 - Equipment
 - Accident loads
- Use and installation manuals
 - To ensure proper interaction between main components



Some industrial challenges and solutions

Offshore - evolution rather than revolution

- Look for more space and stable conditions
 - Temperate, oxygen, salinity
- Fewer and larger farms
- Expanding current systems towards the open ocean
- Existing "traditional" farming equipment for Hs above 3 m
 - Nets, floaters, barges
- It's not only wave height
 - Duration of weather
 - Adaption of equipment
 - Adaption of operations
- Combined with wind farms?





sfi

AKVA GROUP



Egersund
Feed

ERLING HIRSH

HAVFORSKNINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH

LERØY



Nofima

NTNU

SALMAR

SINTEF

CREATE – Centre for research-based innovation in aquaculture technology

Close collaboration industry and research

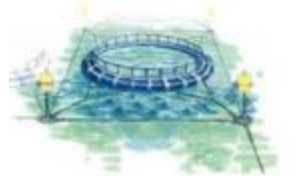
CREATE
Centre for research-based innovation in aquaculture technology

Research – biology, technology and industrial solutions



Three main research pillars - **integrate knowledge between**

- **Equipment and constructions** The physical equipment used to farm fish.
- **Operation and handling** The process of executing and carrying out operations necessary to farm fish.
- **Farming intelligence** Control of the total process of farming by understanding the integrated use of equipment and the process of operations.



Secondary objectives

1. Understand **fundamental biological preferences** and behaviour of fish to set criteria for technology development
2. Develop **improved management and operational protocols and systems** based on the needs of the fish.
3. Develop **equipment and systems to improve performance and safety** of fish farming operations
4. Develop a **framework for simulation, optimization and monitoring** of all aspects of fish farming



User partners

Close collaboration industry and research



AKVA GROUP - facts

The leading aquaculture technology supplier
Only supplier with global presence
Offices in 12 countries and staff of around 600
The largest supplier to the aquaculture industry
High growth company
Profitable
Industry consolidator



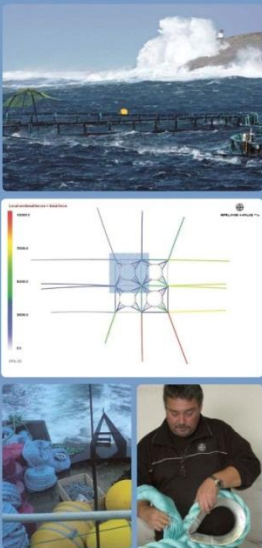
EGERSUND NET - facts

Leading supplier for the fish farming industry
Nets and bird nets
Antifouling
Service Equipment
Quality products and experienced staff
Profitable



ERLING HAUG - facts

Quality mooring components
Dynamic analysis of mooring systems
Flexible engineered mooring solutions
Provides lifting- and HSE products,
lice-skirts and LED marking buoys



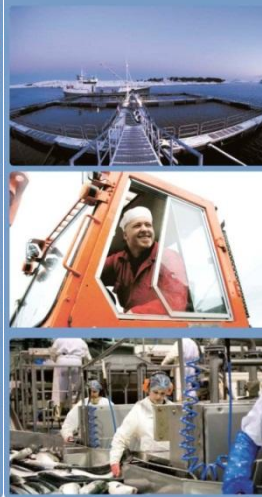
Lerøy - facts

Distribution, sale and marketing of seafood
Production of salmon, trout and other species
Product development



Marin Harvest - facts

Farmed salmon
Processed seafood
Operates in the whole value chain



Salmar - facts

Interactions between biology, environment
and technology
Focuses on a sustainable salmon industry
In-house processing



BioMar AS - facts

Novel feed solutions for global aquaculture
Healthy and sustainable growth
Research-based innovation
Interaction feed technology and biology
Strong focus on fish nutrition and health



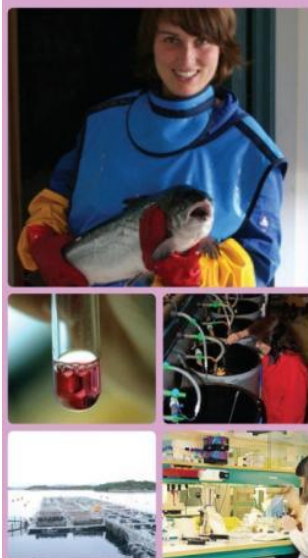
Research partners

Multi-disciplinary approach



NOFIMA MARIN - facts

R&D, innovation and knowledge transfer for fisheries and aquaculture
Breeding and genetics
Feed and nutrition
Fish health
Efficient and sustainable production
Seafood processing and product development
Marine bioprospecting



INSTITUTE OF MARINE RESEARCH - facts

Owner: Ministry of Fisheries and Coastal Affairs
Norway's largest marine research institute
Marine biology and population dynamics
Physical and biological oceanography
Experimental biology and population genetics
Welfare friendly and sustainable aquaculture
Research and advice for sustainable use of oceanic and coastal environments and resources



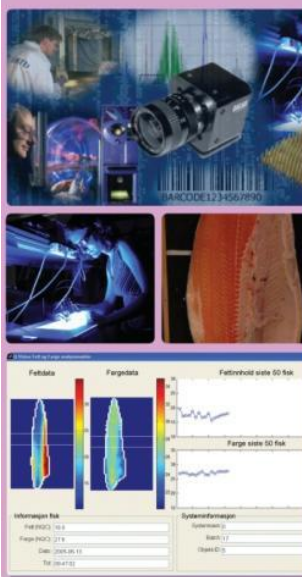
CeSOS - facts

Centre of Excellence initiated by RCN in 2003
Internationally recognised research on ships and ocean structures
Highly interdisciplinary approach
World-class testing facilities
About 80 affiliated PhD candidates and researchers
Above 100 scientific publications per year



SINTEF ICT - facts

Information and Communication Technology (ICT) provides research-based expertise, services and products ranging from microtechnology, communication and software technology, computational software, information systems and security and safety. Work ranges from simple technical analysis to complete systems



Department of Engineering Cybernetics - NTNU - facts

Engineering Cybernetics is the science of control and communications in dynamic systems. Vision to be one of Europe's most renowned research and education communities in the department's main areas.
27 permanent employees and about 40 PhD students and temporary academic staff.
Educate about 75 MSc and 10 PhD students per year (average last 3 years).
Cybernetics is a science with a very wide range of applications

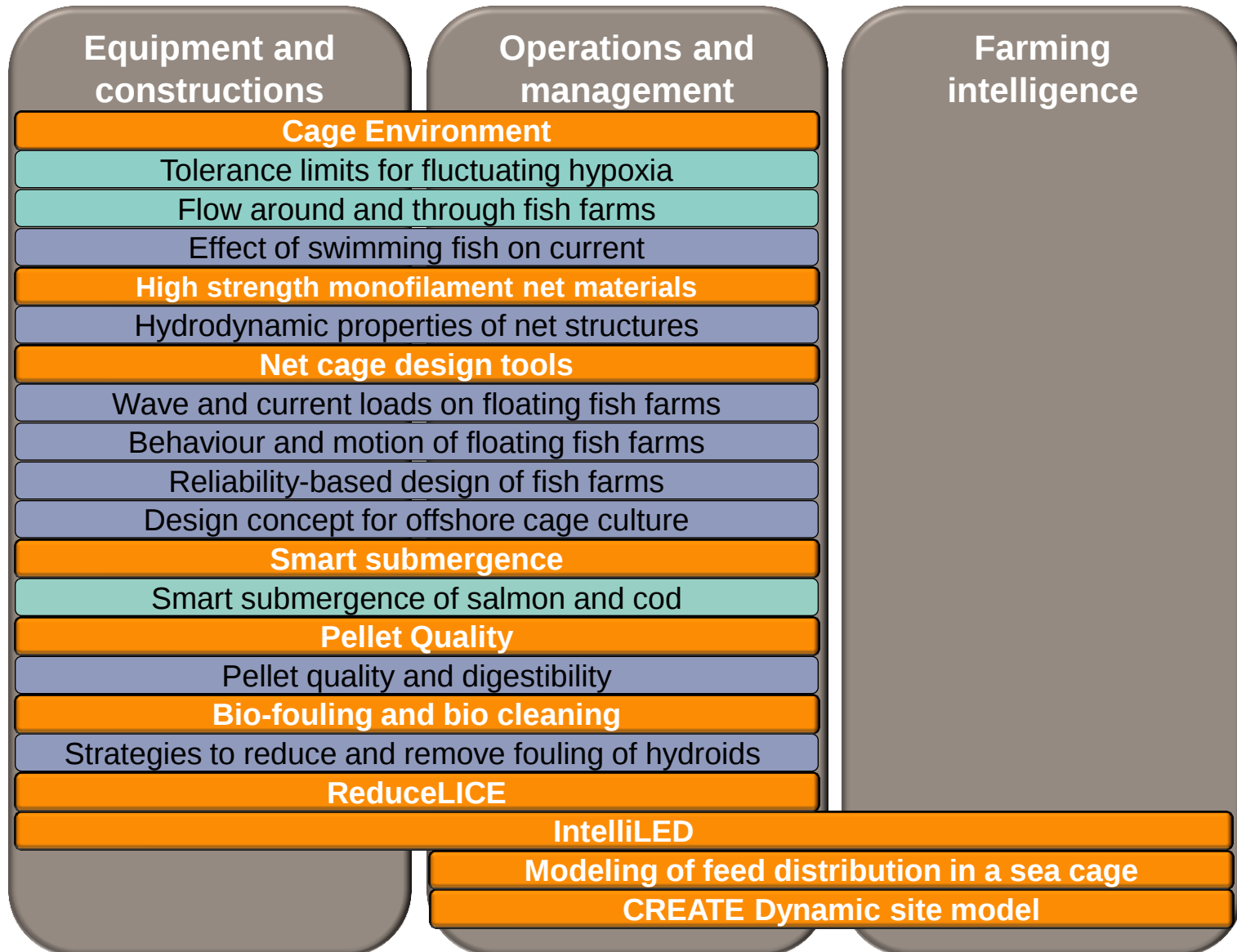


SINTEF Fisheries and Aquaculture - facts

Vision: Technology for a better society
Perform basic and applied research for commercial customers as well as governmental institutions and bodies
Contributes to solutions along the whole value chain



Research plan 2012 onwards



Thank you for the attention

- The future??
 - 20 000 tons at one location?
 - Operations run from central headquarters?
 - Wind farms, fish and kelp production combined?

