Industrial Marine Fish Farming
- Selected R&D results

Jostein Storøy, Research Director
Arne Fredheim, Senior research scientist
Department of Aquaculture Technology
SINTEF Fisheries and Aquaculture Ltd
Our focus

- Increase efficiency and reduce production cost
- Reduce environmental impact (feed, chemical, escape)
- Fish welfare
- Safety in working operations

Our areas

- Fish farming structures
- Operation of fish farms
- Land based fish farming
- Food traceability
Fish farming structures

- Challenges
  - Escapee
  - Exposed locations
  - Upscaling
Our contributions

- Standard for floating fish farms
- New cod net technology
- New fish farming concepts
- Groundbreaking biological research
Norwegian standard NS9415 - NYTEK

- Floating Fish Farming Technology; Requirements on design, dimensioning, installation and operation
New cod net technology

- Larger relative number of escapees by Cod
- Cod behavior a part of solution
  - Cod bit on net and make hole
  - Necessary to understand Cod behavior
- Operational solutions
  - Stimulating cage environment
  - Welfare and feeding?
- Constructional solutions
  - Increased bite resistance
  - Reduction of traditional ‘small damages’
  - Uninteresting or repulsive net wall
New Fish Farming concepts

- **Helgeland Plast/PolarCirkel**
  - Flexible polyethylene cage
  - Pump water in/out
  - Ordinary net and operations
  - Surface mode
  - Gravity cage

- **Nautilus by Fish Farm technology Inc.**
  - Steel construction
  - Winch for submerging - machinery
  - Ordinary net and operations
  - Surface mode
  - Rigid cage

- **Tension Leg Cage**
  - Integrated floater and net
  - Tilts due to wave force
  - No machinery
  - Special net
  - High current issues
Submergence of salmon

- Biological challenge
  - Salmon gulp air from the surface to regulate buoyancy

- Results from test
  - Salmon adapt to tolerate submergence
  - Swim faster when submerged

![Swimming speeds](image)

**Swimming speeds**

- Control 1
- Control 2
- Submerged 1
- Submerged 2

Day

Body lengths s⁻¹

0.2
0.4
0.6
0.8
1.0
1.2

Sub 1 submerged

Sub 1 re-surfaced
Operation of Fish Farms

Challenges

- Safe working conditions
- Minimum environmental impact
- Predictable biomass production
- Fish welfare
Our contributions

- Solutions for safe working conditions
- Solving the fouling problem
- Fish welfare oriented technology design
- Monitoring and control
Safe working conditions

- Mapped critical points
- Carried out risk analysis
- Designed new technical solutions
- New vessel concepts
- LAN technology and surveillance systems
Solving the fouling problem

- smarter operational procedures, new material technology
Fish welfare
New well boat concepts - movable bulkheads
Land based fish farming

- Challenges
  - Old technology
  - Water quality
  - Access to water
  - Mortality
Our contributions

- Upscaling
- New technology
- Recirculation
- Monitoring and control
- Hygenic design
Food Traceability

- Challenges
  - No common practice
  - Poor Data recording
  - No Unique identifiers
  - Few have traceability systems
Our contributions
Our future focus

- Offshore fish farming technology
- Intelligent structures
- Competence based operations

- CREATE – Centre for Research Based Innovations in Aquaculture Technology
The **INTELLIGENT** aquaculture structure

- One main focus area in Intellistruct

![Diagram of INTELLIGENT aquaculture structure]

- Hydrodynamics
- Structural mechanics
- Desired behaviour
- Structural limitations
- Fish welfare

Automatic control loop

- Physical model
- Sensors
- Actuators
A vision for the future:
- Autonomous offshore fish cages developed in Intellistruct

For further information:
www.intellistruct.no
www.sintef.no
leif.m.sunde@sintef.no
pal.lader@sintef.no
CREATE
- Centre for Research based Innovation in Aquaculture

- **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.