

# Aquaculture monitoring solutions

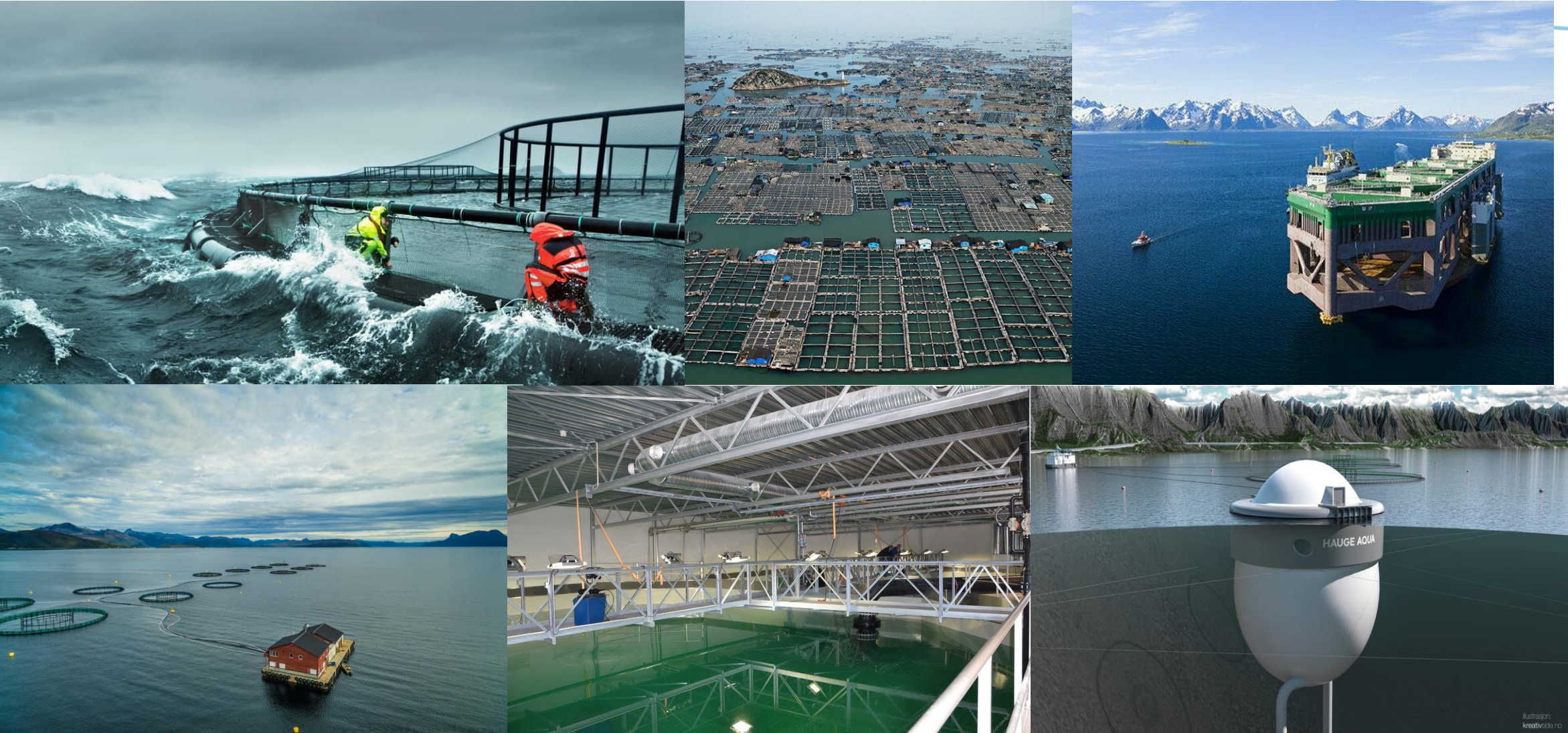


**STIG OEN & LAHOUCINE BENGARA**  
4<sup>TH</sup> OF OCTOBER, 2022

**Environmental  
Monitoring  
Workshop '22**



# What is aquaculture



# Aquaculture in Norway Background

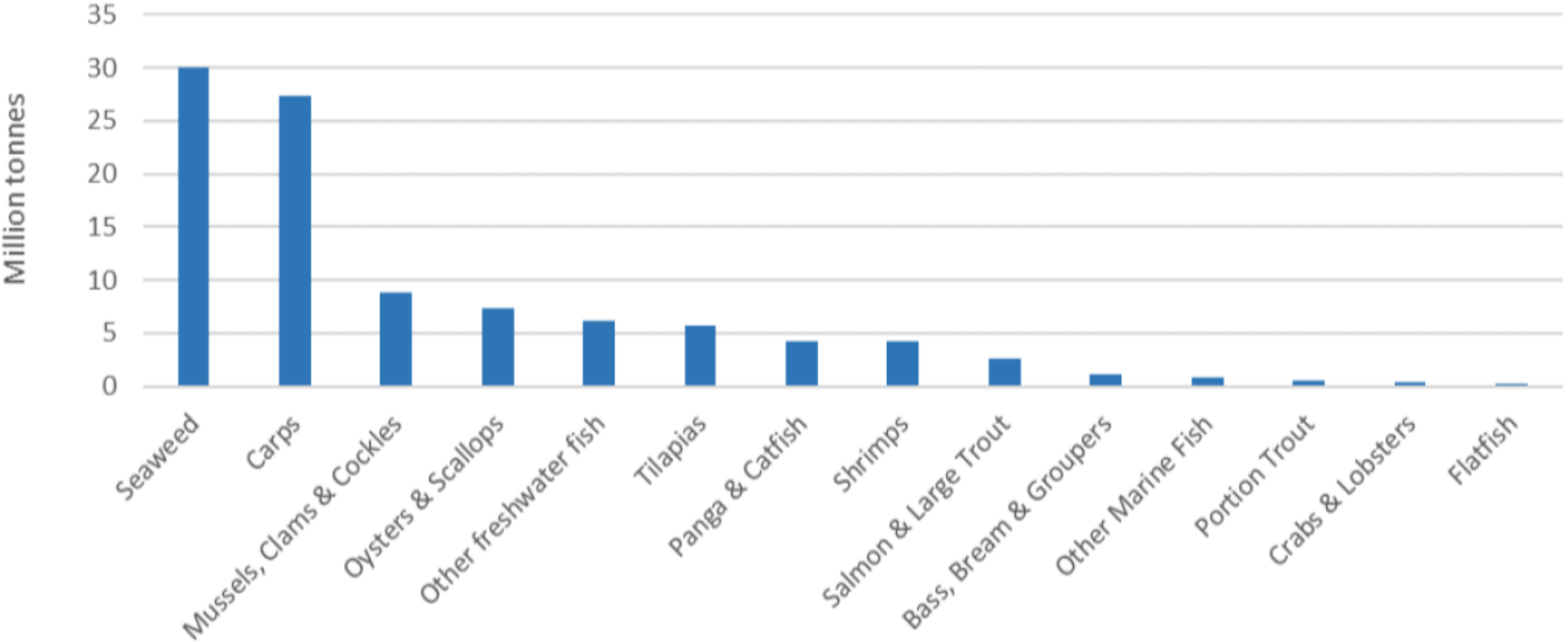
- **A growing market**
  - Started on an experimental level in the 1960s
  - Became an industry in Norway in the 1980s, and in Chile in the 1990s
  - Grown substantially in the past 40 years and today approximately 60% of the world's salmon production is farmed.
  - In 2015 2,200,000 tons of farmed salmon and 880,000 tons of wild salmon were caught.
  - UN predicts that the world's population will reach 9.7 billion by 2050, with the need for protein expected to grow by 40% worldwide and 50% increase in farmed fish.
- **National regulations vary**
  - Main production in: Norway, Chile, Canada, Scotland, Australia, Faroe Islands, Iceland, Ireland, and New Zealand.
  - Different challenges: Lice, Seal, Algae and diseases.
- **Important factors**
  - The salmon farming production cycle lasts about 3 years.
  - Efficient and optimal feeding
  - Reduce stress on the fish
  - Fish Welfare

# Global Aquaculture Where & What ?

In million Tonnes	Salmonids		Other Marine Fish			Other Freshwater Fish			Carps and Carp-like	Crustaceans		Molluscs				Aquatic Plants	Grand Total
	Salmon & Large Trout	Portion Trout	Bass, Bream & Groupers	Flatfish	Other	Tilapia	Panga & Catfish	Other		Shrimps	Crabs & Lobsters	Clams & Cockles	Oysters	Scallops	Mussels	Seaweed	
EUROPE	1,6	0,3	0,3	0,0	0,0	-	-	-	0,2	-	-	-	0,1	-	0,5	-	3,0
AMERICAS	0,9	0,1	-	-	0,0	0,6	0,2	0,1	-	0,8	-	0,1	0,1	-	0,3	-	3,2
ASIA	0,0	0,2	0,9	0,2	0,8	4,2	3,9	5,8	27,0	3,4	0,4	5,4	5,1	2,0	2,4	29,5	91,2
AFRICA	-	-	-	-	-	0,9	0,2	0,2	0,2	0,0	-	-	-	-	-	0,3	1,8
OCEANIA	0,1	-	0,0	-	0,0	-	-	0,0	-	0,0	-	-	-	-	0,1	-	0,2
	2,6	0,6	1,2	0,2	0,8	5,7	4,3	6,1	27,4	4,2	0,4	5,5	5,3	2,0	3,3	29,8	99,5
TOTAL	3,2		2,3			16,1			27,4	4,6		16,1				29,8	99,5

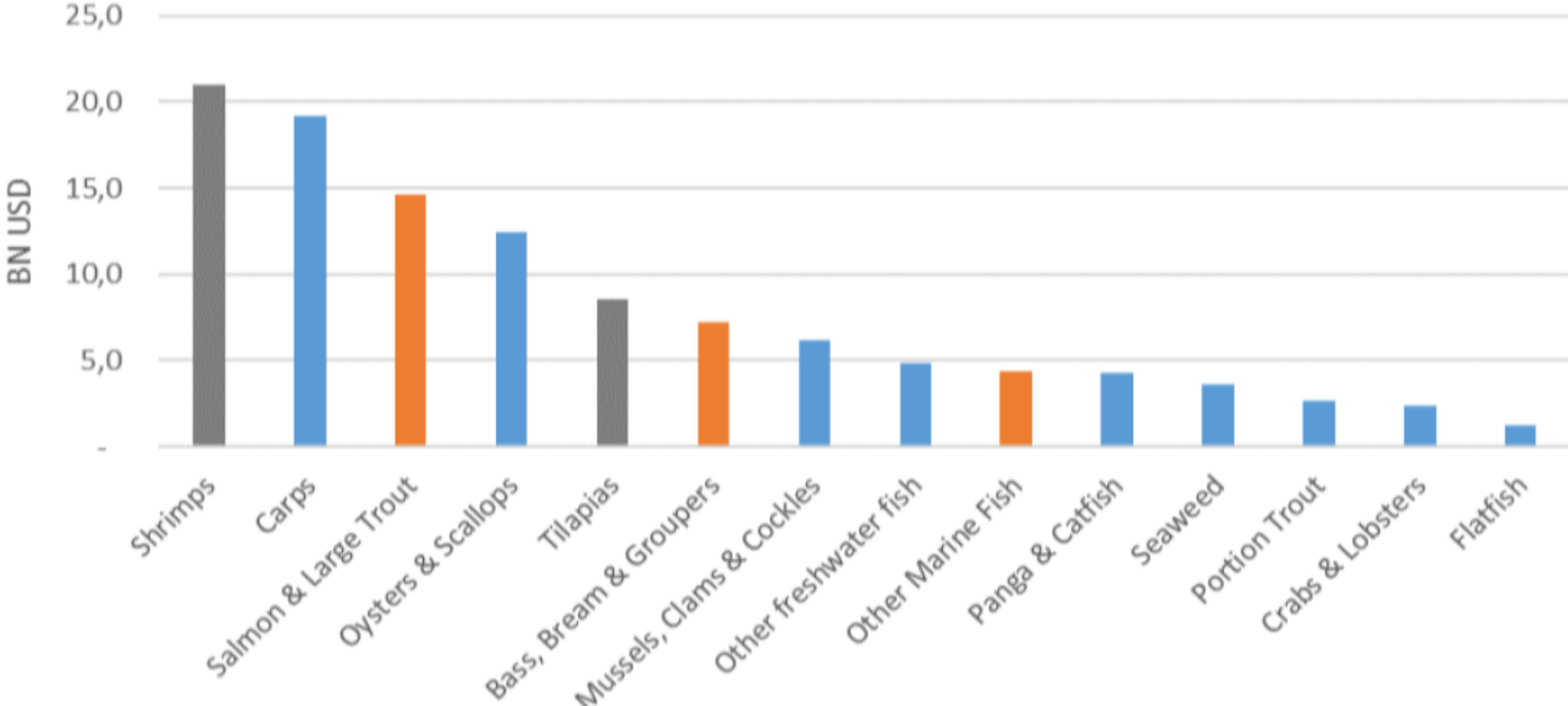
It all depends on the perspective....

# Aquaculture - Ranked by Volume



It all depends on the perspective....

# Ranked by Value...



# Marked value for seafood companies by region



# Site Survey

1. Document the environmental conditions that exist at the site in question, measurement or prediction of wind, water flow, waves, icing, bottom topography (depth map) and bottom sediments
2. Carried out in advance of placing the fish farm on the site. The site report further forms the basis for the strength calculation of the floating aquaculture facility and its moorings
3. Can only be performed by accredited companies. A total of 7 companies in Norway and Åkerblå are by far the largest with almost 300 RCM Blue in operation.
4. Measurement period has been extended from 1 to 3 months in the new Standard.



# Xylem Analytics Aquaculture

## Site Survey



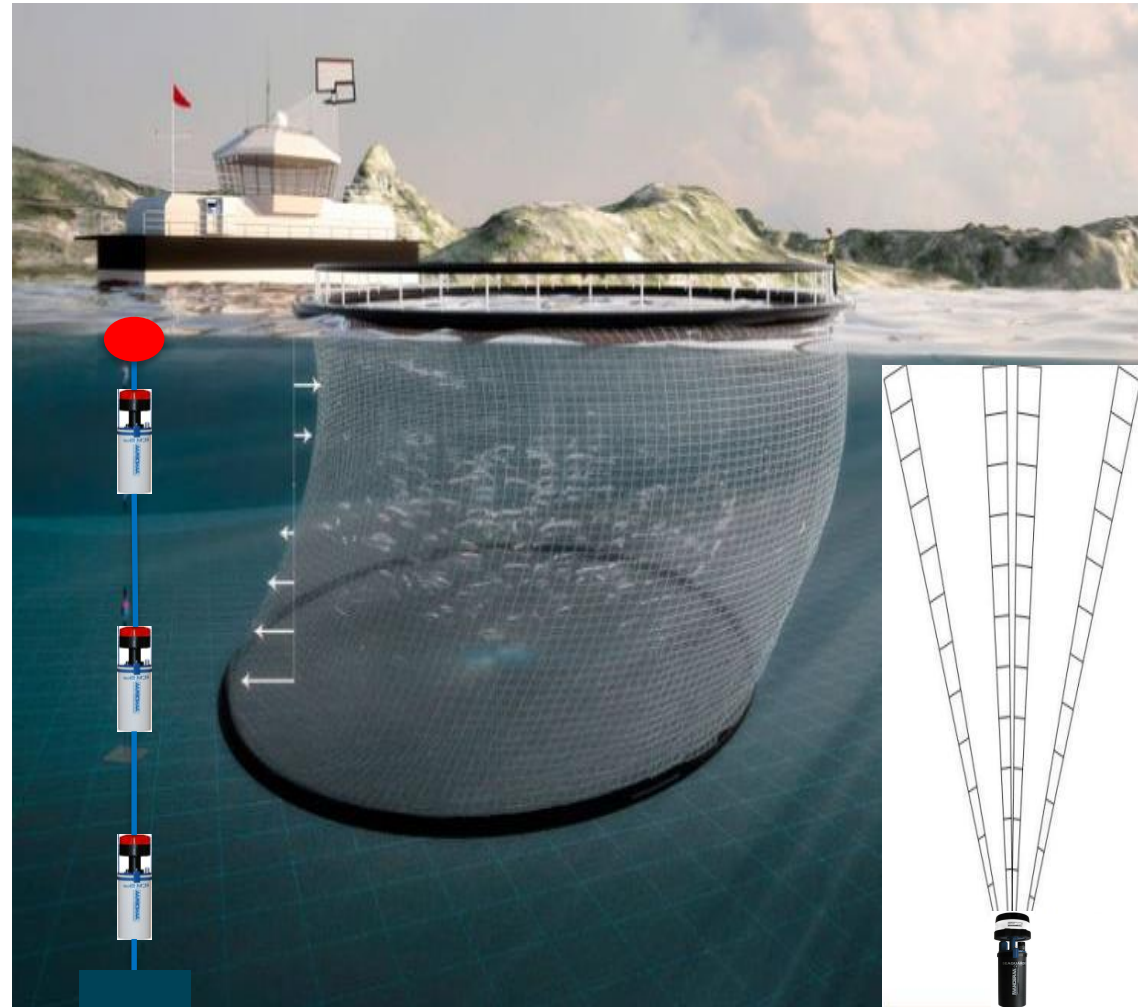
### RCM Blue

- Current Speed
- Current Direction
- Temperature
- Pressure (depth)



### SeaGuard RCM

- Current Speed
- Current Direction
- Temperature
- Pressure (depth)
- Salinity
- O2
- Turbidity
- Wave height

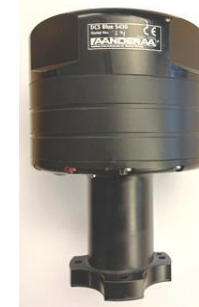


### SeaGuardII DCP

- Current Speed
- Current Direction (multiple levels)
- Temperature
- Pressure (depth)
- Salinity
- O2
- Turbidity
- Wave height



# Different options for stand-alone current measurement



Name	In-line DCS	DCS	DCS Blue	DCPS
Profiling				X
Single point(horizontal)	X	X	X	
Z-Pulse	X	X	X	
Broadband/Narrowband				X
AiCaP	X	X		X
RS-232	X	X	X	X
RS-422	X	X		X
Depth rated	Max 4500m	Max 8000m	Max 300m	Max 6000m

# Current Measurement Solutions

- Simple one point solution to measure current at one level and send data to PC
- Two or three point solutions to measure at for instance 5m, 15m and 35meter.
- Current Profilers to measure from the bottom to the surface or surface to bottom



5m

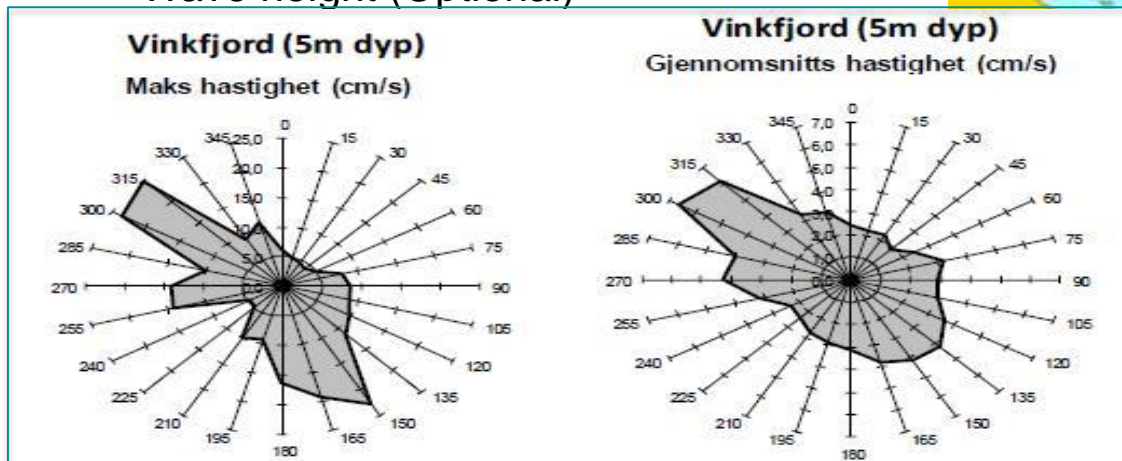
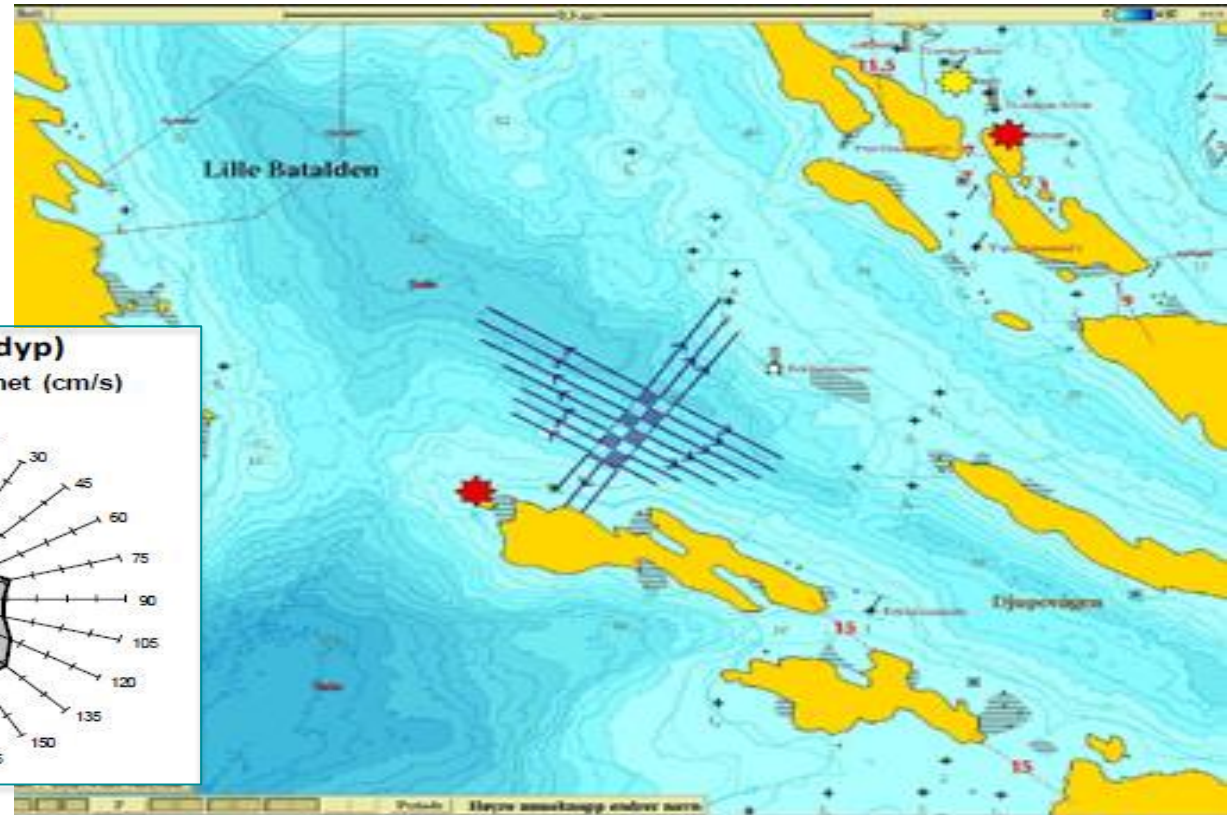
15m

# Xylem Analytics – Fish Welfare

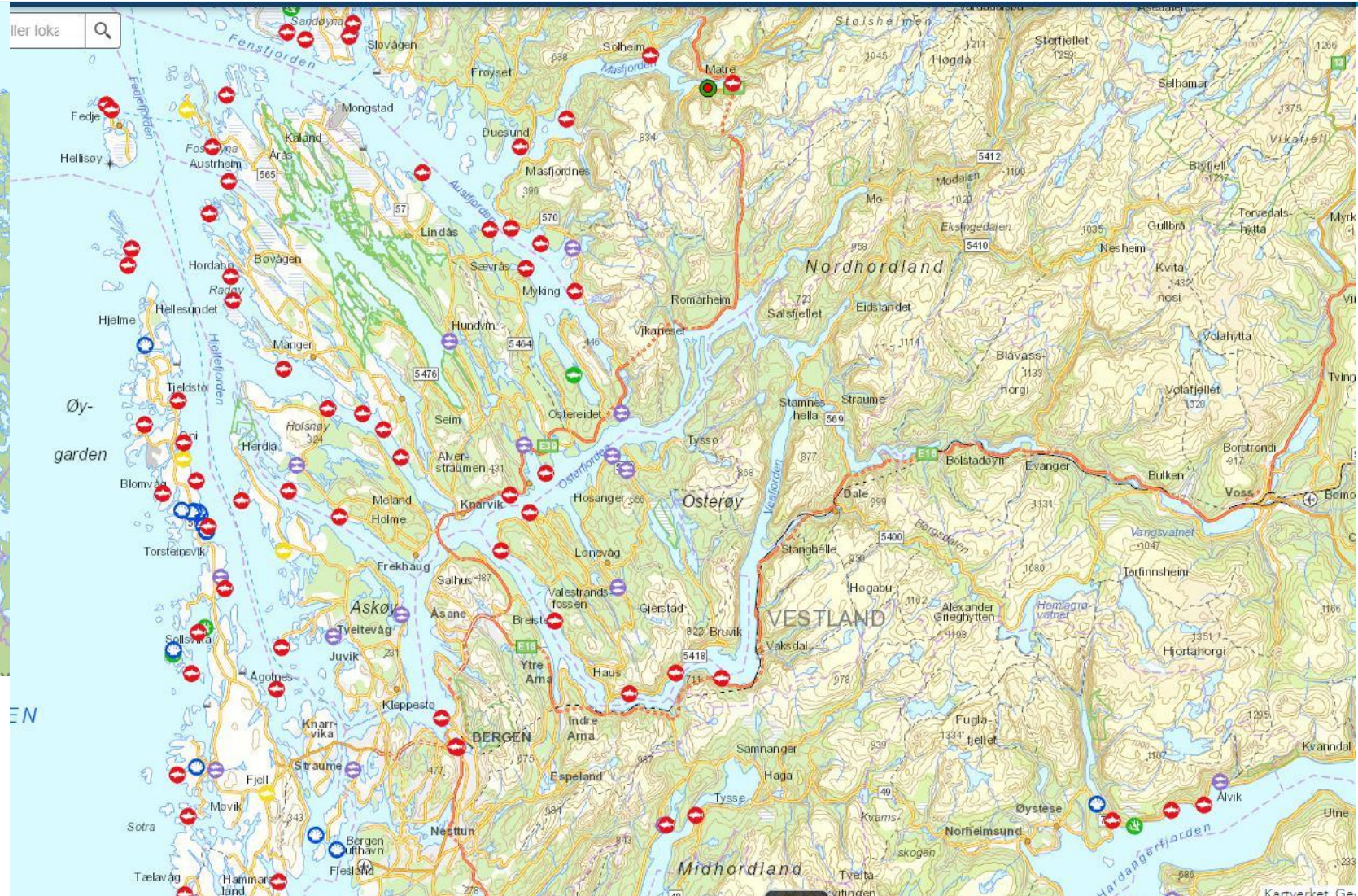
## Site Survey

Required water distribution, quality and wave parameters with the 30-day to 365-days Site Survey:

- water current speed
- water current direction
- water temperature
- Tide (Optional)
- Salinity (Optional)
- O<sup>2</sup> (Optional)
- Wave height (Optional)

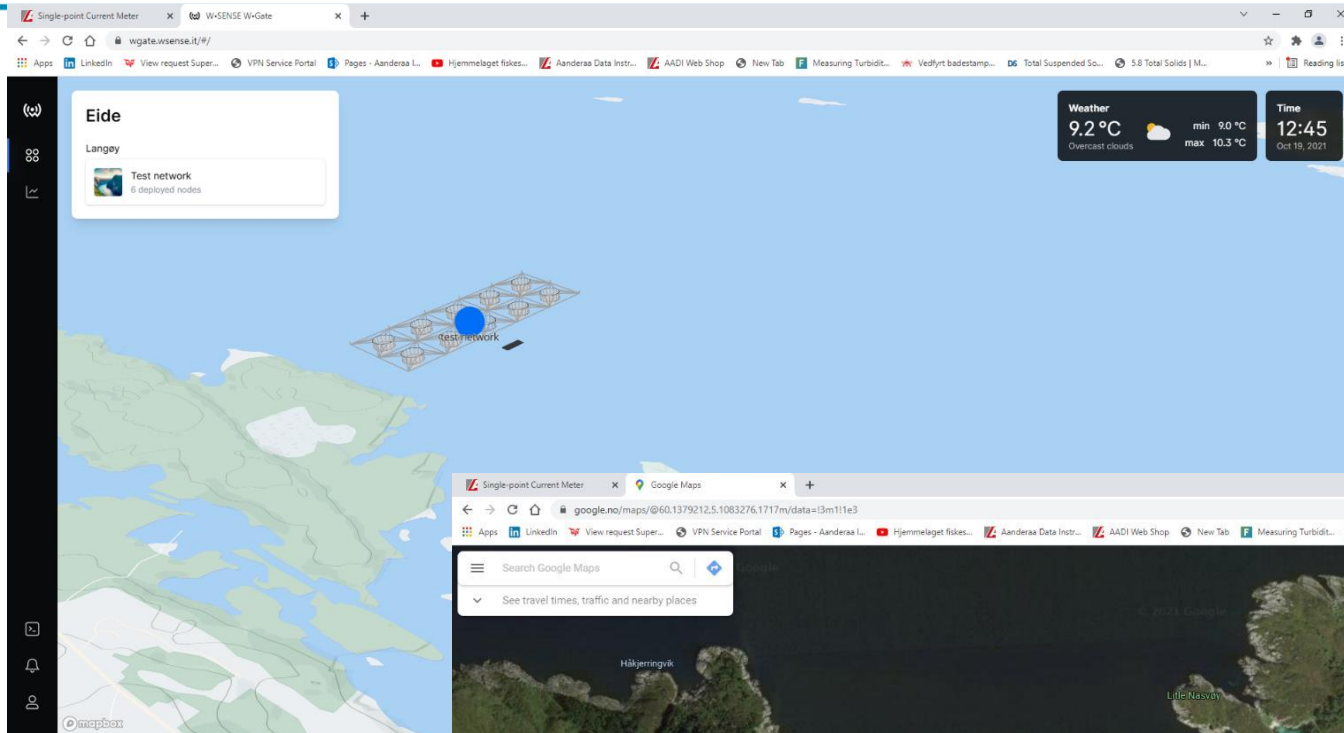


# Official sites in Norway

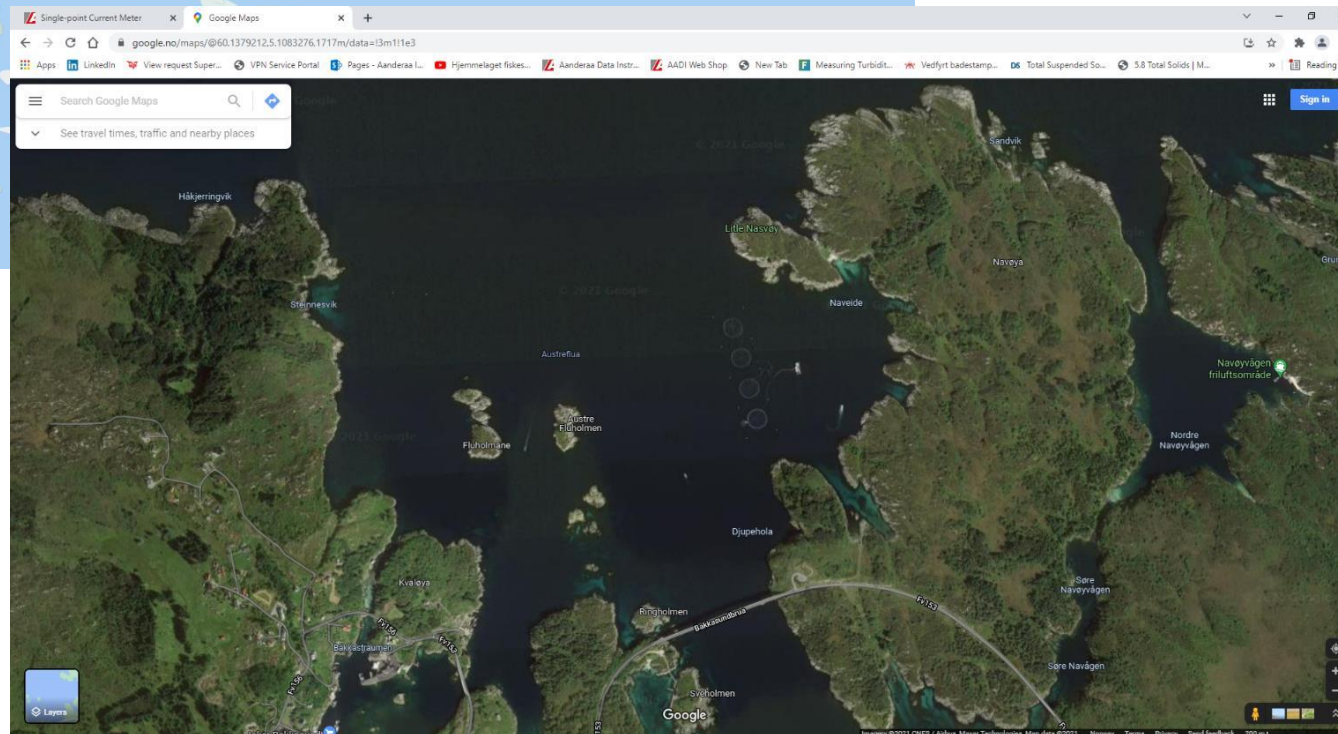


- 1270 sites in Norway
- 691 traditional sites

# Biomass limitations

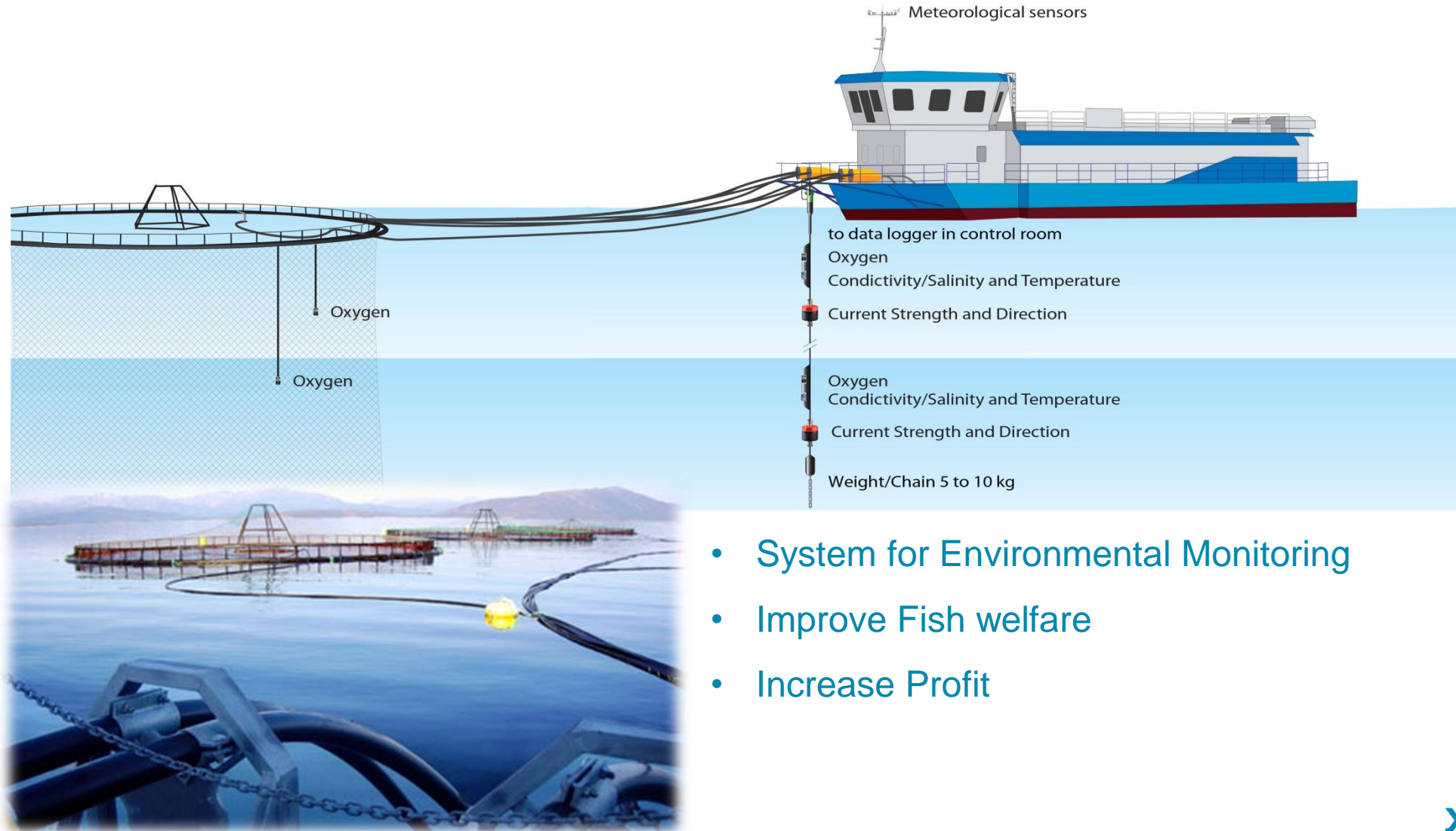


- Site survey result gives the position and orientation



- Adequate access to Oxygen 24/7 in all cages is necessary

# Environmental monitoring



- System for Environmental Monitoring
- Improve Fish welfare
- Increase Profit

# Xylem Analytics Aquaculture

Online cage monitoring  
Reference measurements

## YSI Sonde

- Salt
- Temp
- O2
- pH
- Algae detection
- Turbidity
- Chlorophyll



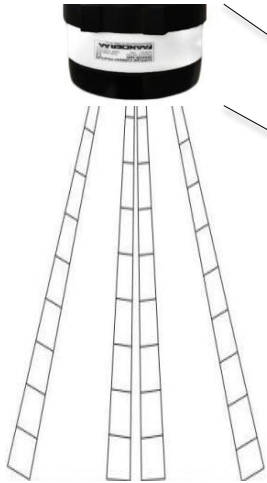
## Aanderaa/YSI Buoy

- Water Currents (all levels)
- Waves
- Water Quality (all parameters)
- Atmospheric data



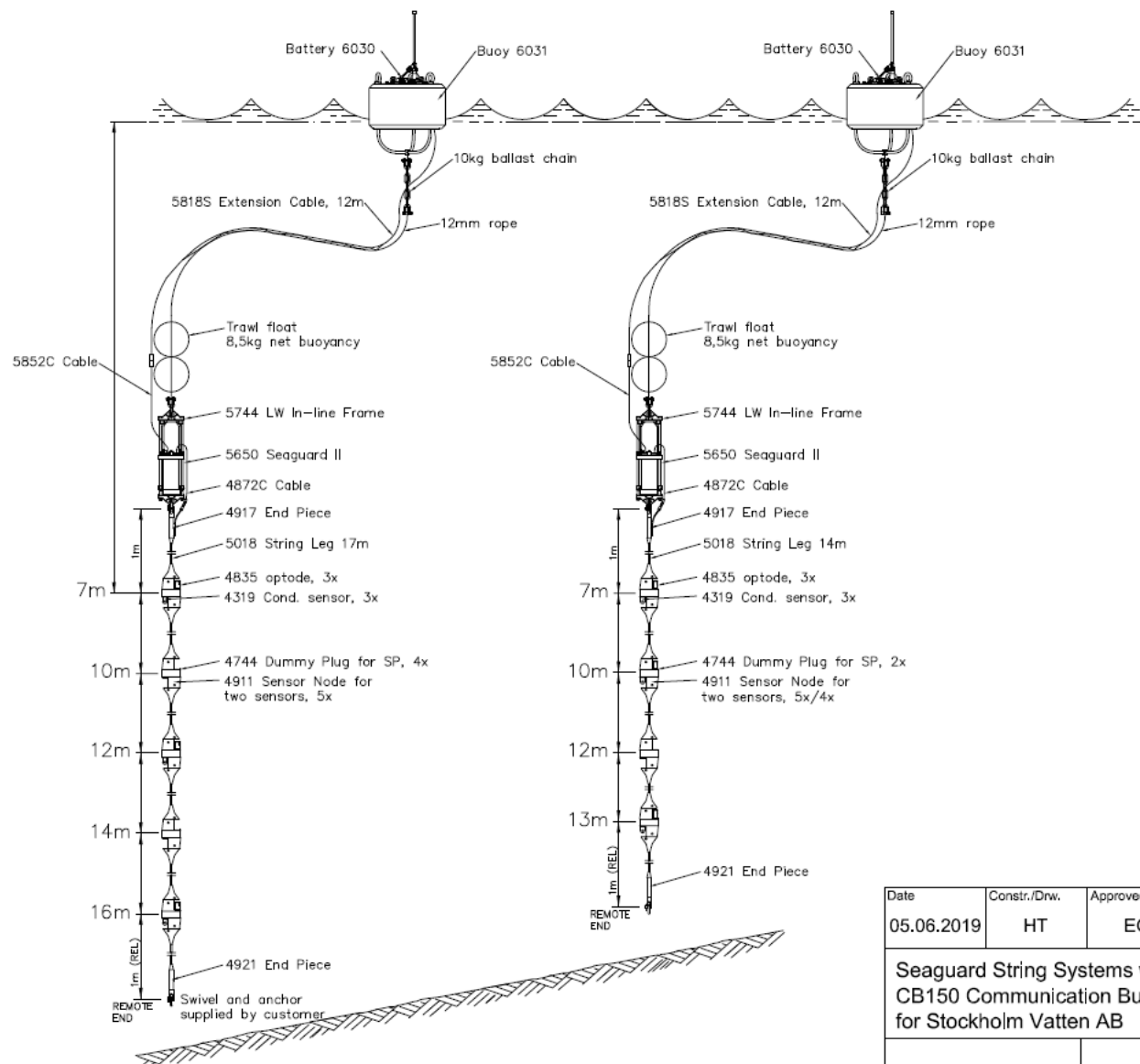
## Aanderaa DCPS

- Current Speed
- Current Direction (multiple levels)





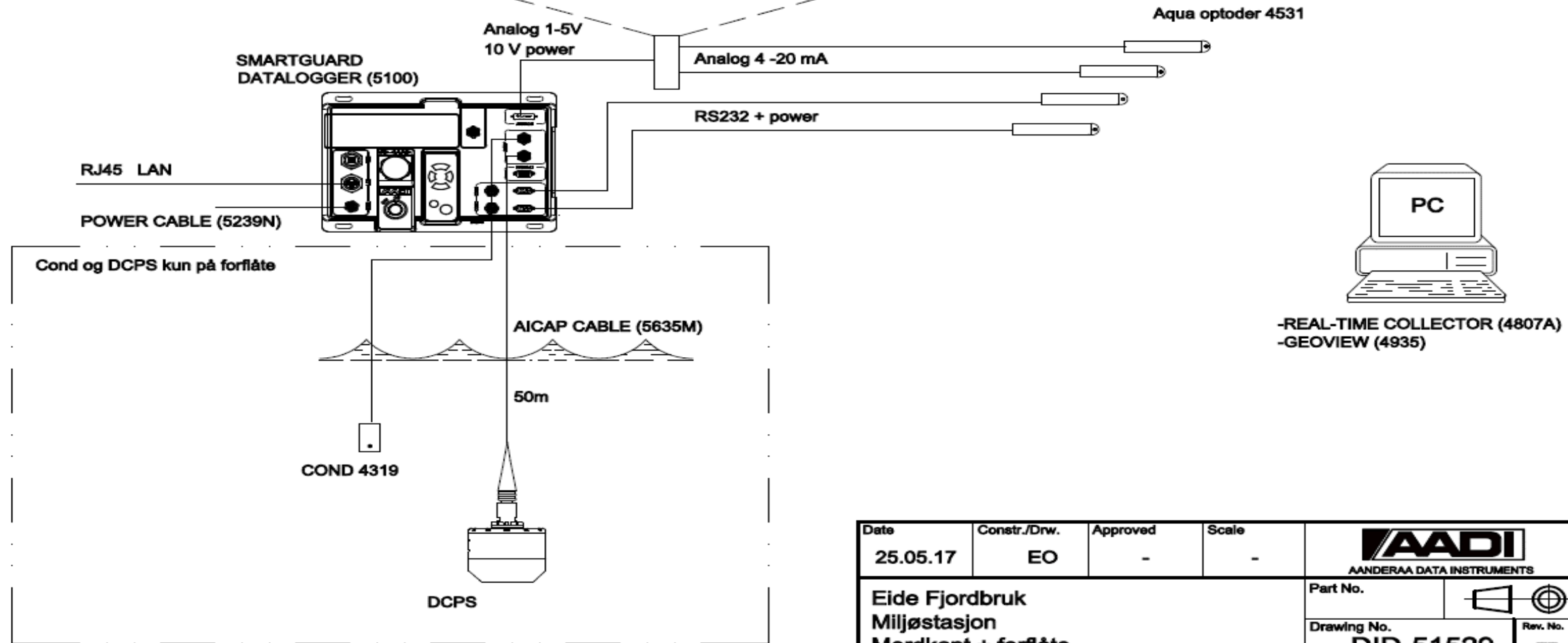
# Reference buoy



Date	Constr./Drw.	Approved	Scale	AANDERAA	
05.06.2019	HT	EO	N.A.	www.aanderaa.com	a xylem brand
Seaguard String Systems with CB150 Communication Buoys for Stockholm Vatten AB				Reference N1911019	
				Drawing No./Revision <b>DID-060473 00</b>	
				Last correction: 00.07.06.2019.KPS	

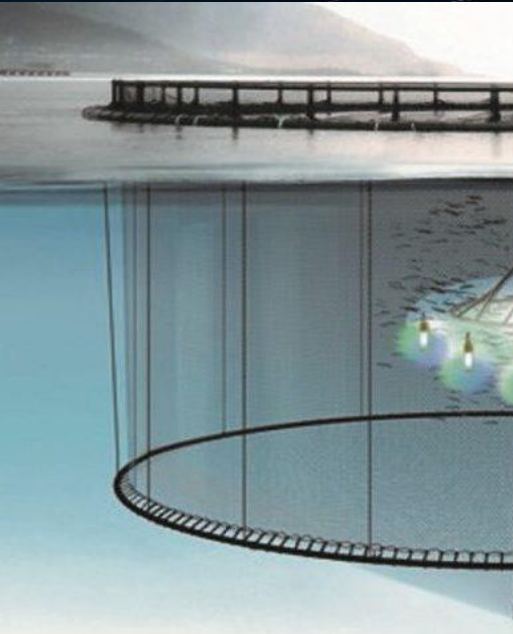
SMARTGUARD	16 PIN	Jumper 290ohm	REKKEKLEMMER NUMMER	SENSOR 1	Sensor 2
ANALOG 1 +	1		1 (2 stk)	ANALOG 1 +	ANALOG 3+
ANALOG 2 +	2		2 (2 stk)	ANALOG 2+	
ANALOG 3 +	3		3 (2 stk)		
ANALOG 1 -	9		4 (3 stk)	ANALOG 1 & 2 -	ANALOG 3-
ANALOG 2 -	10		5 (3 stk)		
ANALOG 3 -	11		6 (2 stk)		
GND 1	12		7	GND	
POWER 3	5		8	10V	
GND 3	15		9		GND
POWER 3	8		10		10 V

REKKEKLEMMER



Date	25.05.17	Constr./Drw.	EO	Approved	-	Scale	-	 AANDERAA DATA INSTRUMENTS	
Eide Fjordbruk Miljøstasjon Merdkant + forflåte							Part No.		
							Drawing No.	<b>DID-51529</b>	
Original Size							A3	Sheet	1 of 1
							Edition		

# Feeding-innovation important to reduce overfeeding



# Xylem Analytics – Operational Aquaculture

## Spot sampling

### YSI ProSolo

- O2
- Temp or Cond/Temp



### YSI ProDSS

- Salt
- Temp
- O2
- pH
- Algae detection
- Turbidity
- Chlorophyll



## Online cage monitoring

### Steinsvik Aqua profiling camera with Aanderaa

- O2
- Temp



- Aanderaa Aquaoptode
- O2
- Temp
- at 5m+15m

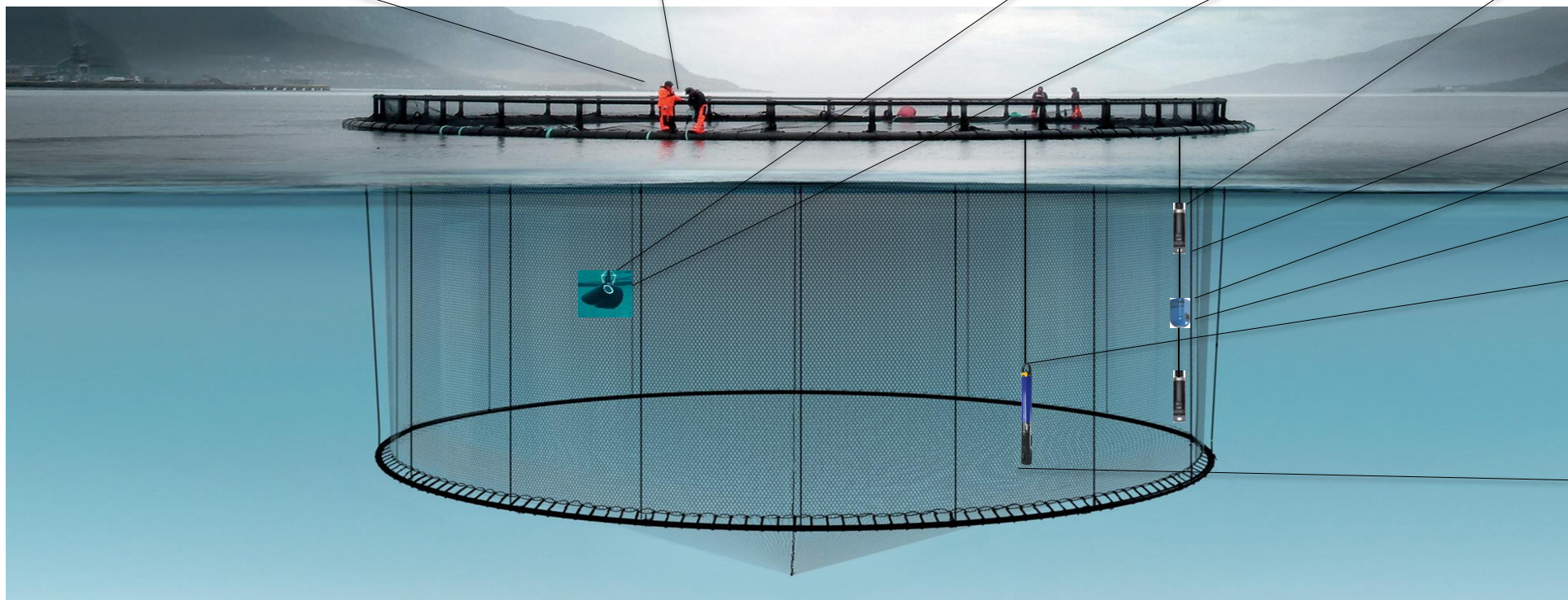


- Aanderaa
- Salt
- Temp



- YSI Sonde EXO
- Salt
- Temp
- O2
- pH
- Algae
- Turbidity
- Chlorophyll
- Anti-fouling

Water current measurements inside the cage - not possible



# Floating open or semi-closed cages



## Feeding Barge or Feeding Central

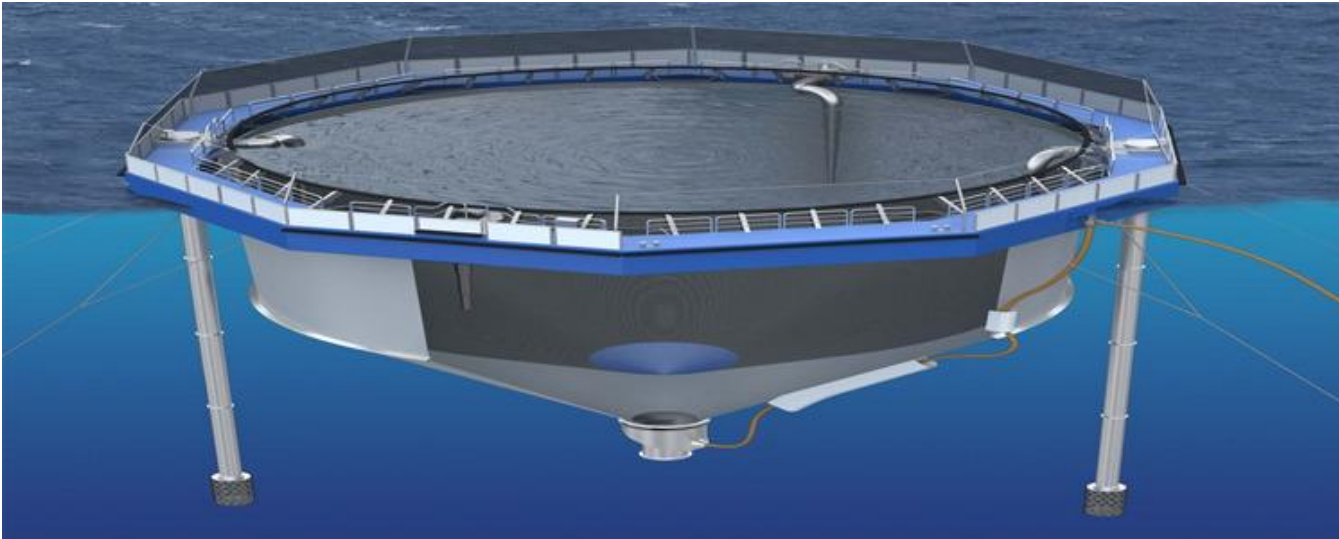
- Mainly used in fjords

## Open Cages

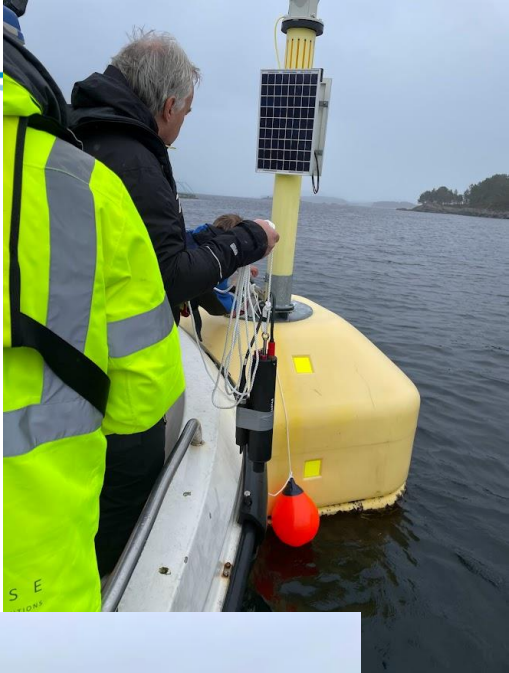
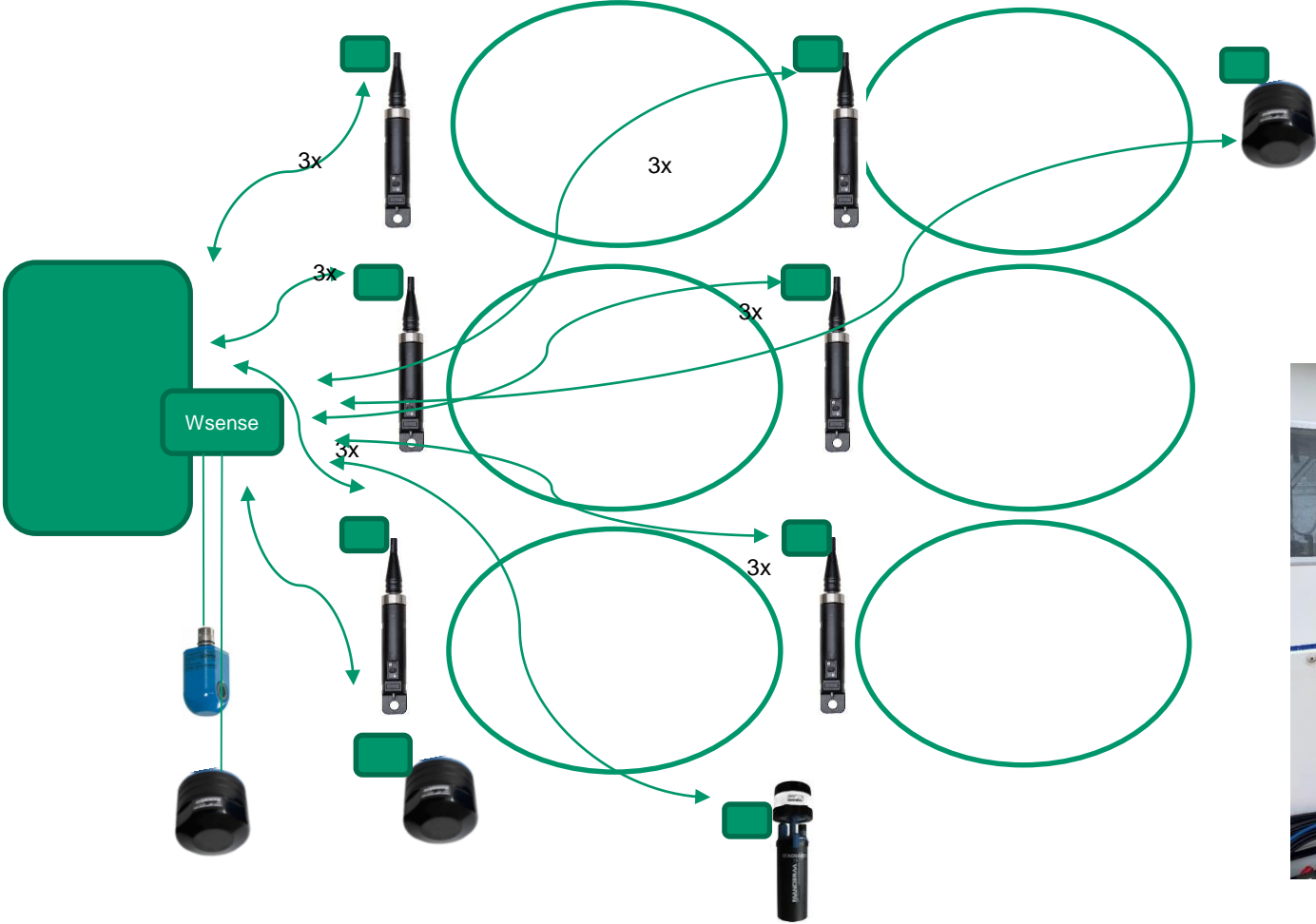
- Exposed to infection from neighboring location
- Access to water without pumping

## Semi-closed cages

- Pumping clean water from depth below lice belt
- Vulnerable to movements



# Wireless Solution



# 14 days test at location

←

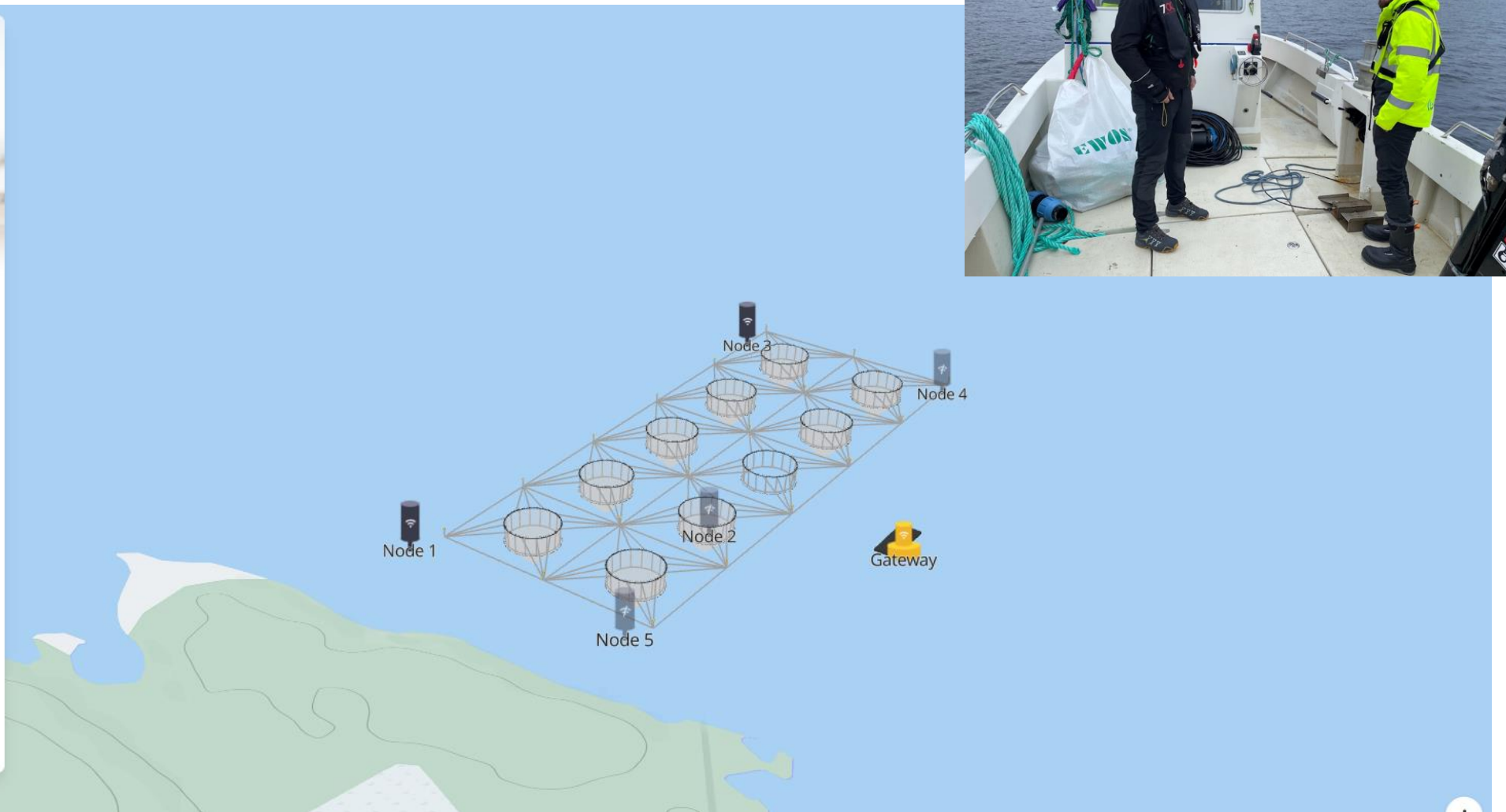
**Node 1**

● active

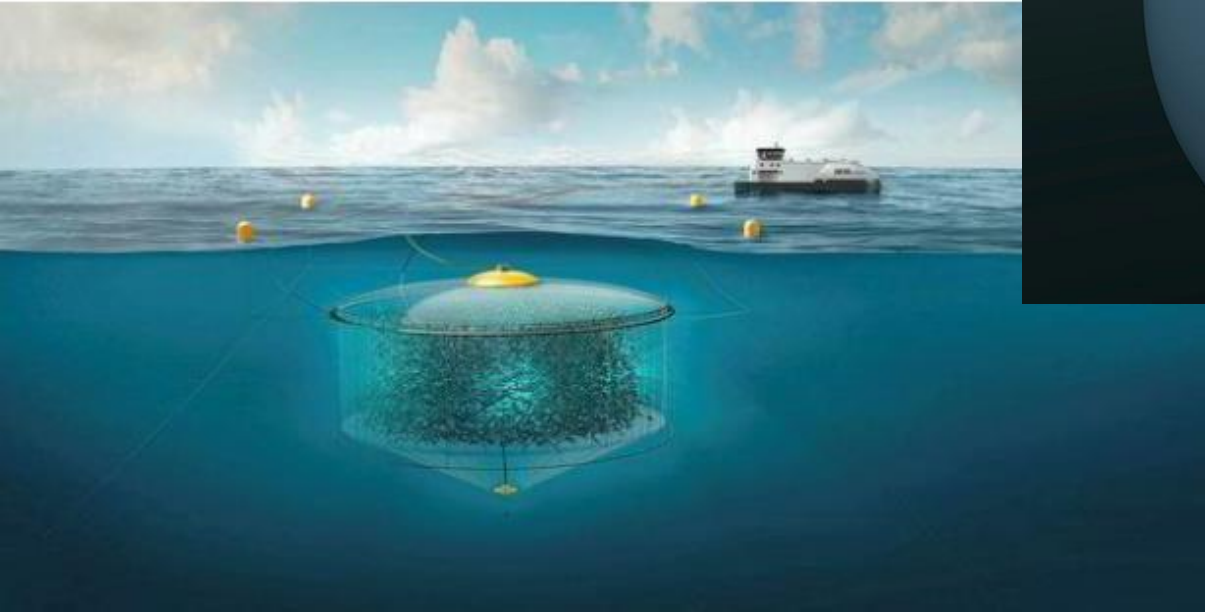
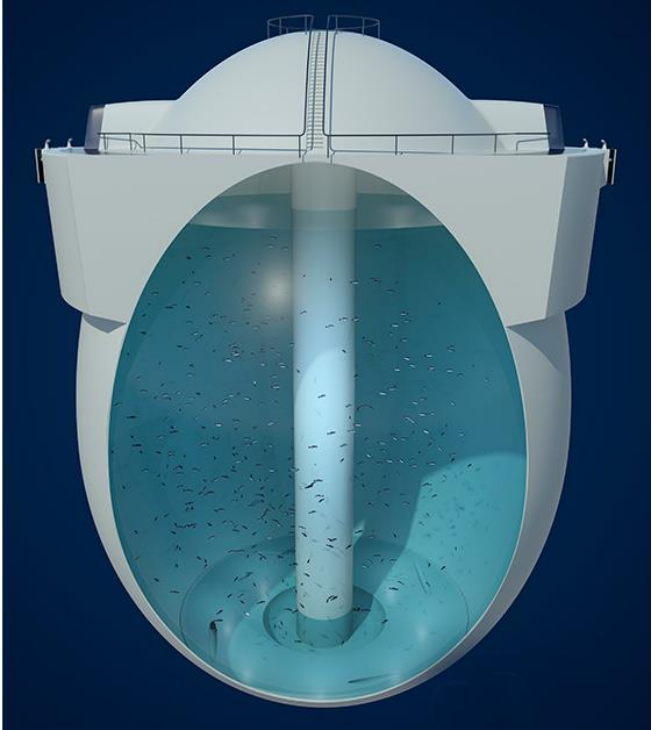
Telemetries Modules

	Temperature	13.30 °C
	O2	237.33 μM
	Air saturation	90.24 %
	Depth	6.41 m
	Battery level	3847.00 mV

Analyze telemetries



# Submersal cages and closed systems





# Instrument

## Water quality sensors Oxygen

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### Oxygen Probe

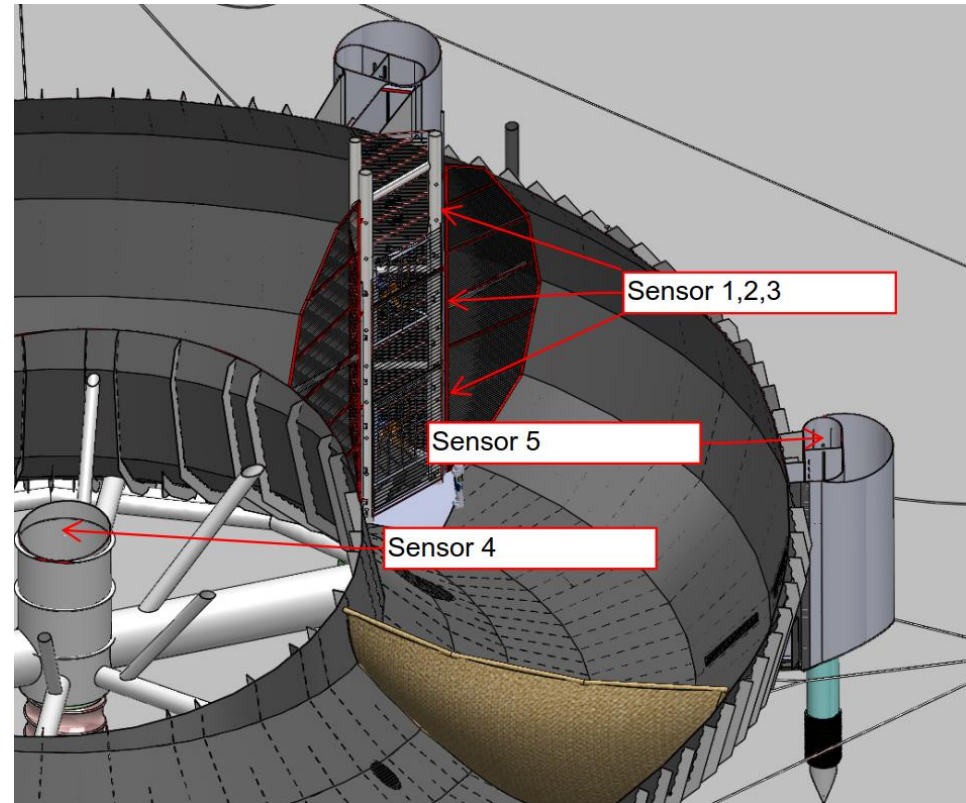
1 year between recalibration

Stand alone sensor

Measures absolute oxygen concentration without repeated calibrations.

Location:

3 different depths at flow motor structure + at intake and outlet.



# Instrument

Water quality Salinity / Conductivity and og temperature

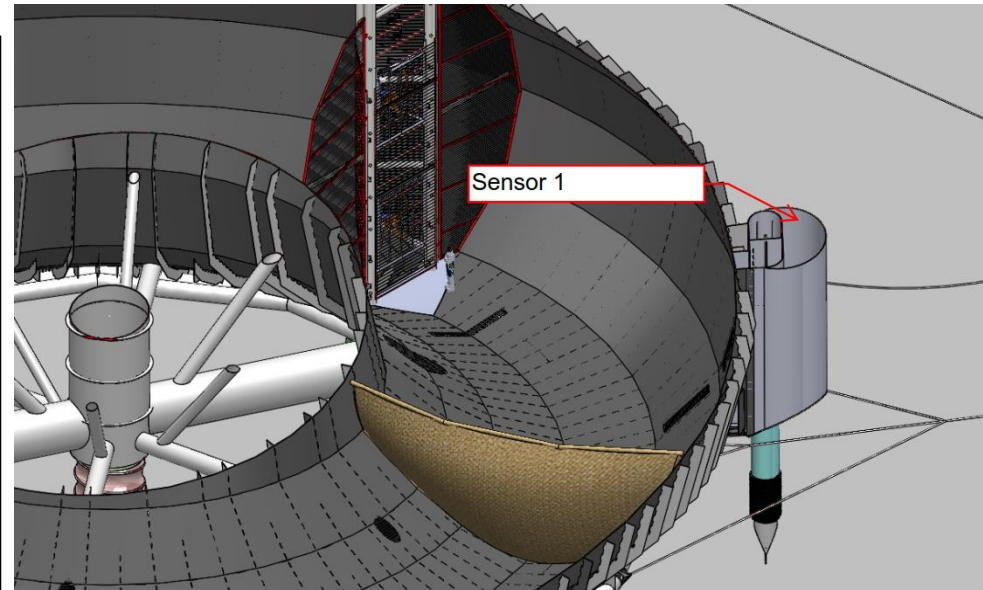
Conductivity sensor

Accuracy - +/- 0,005 S/m, RS-232

Rugged and robust with low maintenance needs

Temperature Range -5 to 40 C

Location: Water inlet and outlet



# Instrument

Water quality sensors CO<sub>2</sub>/ PH sensor used

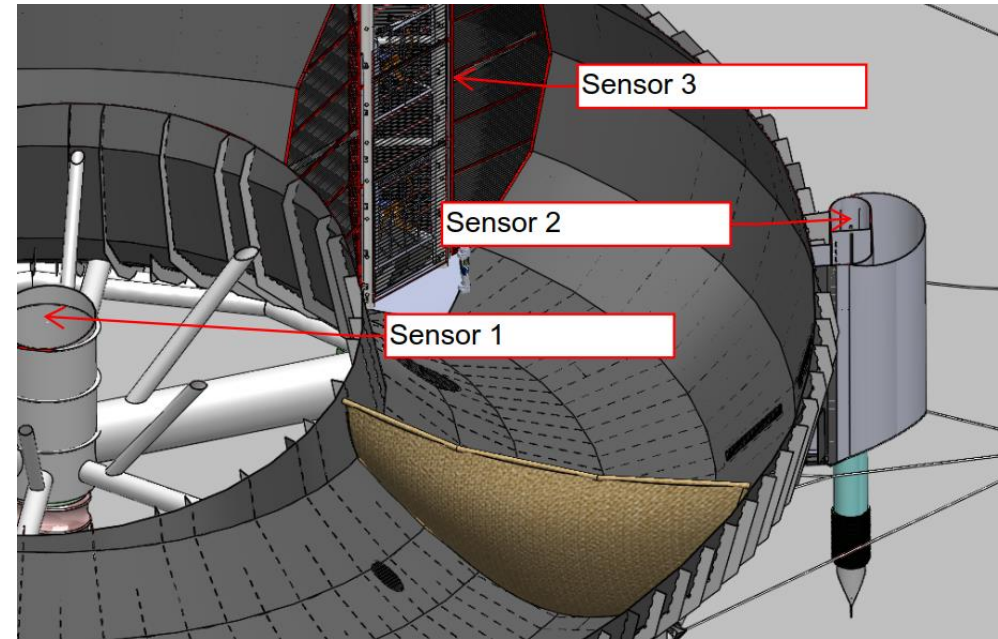
Co<sub>2</sub> sensor required frequent calibration and maintenance.

PH sensor proposed used for calculating CO<sub>2</sub>.

This reduces the need for calibration and maintenance of the sensor

Electrical 4-20 mA signal

Location: Inlet, outlet and flow motor structure



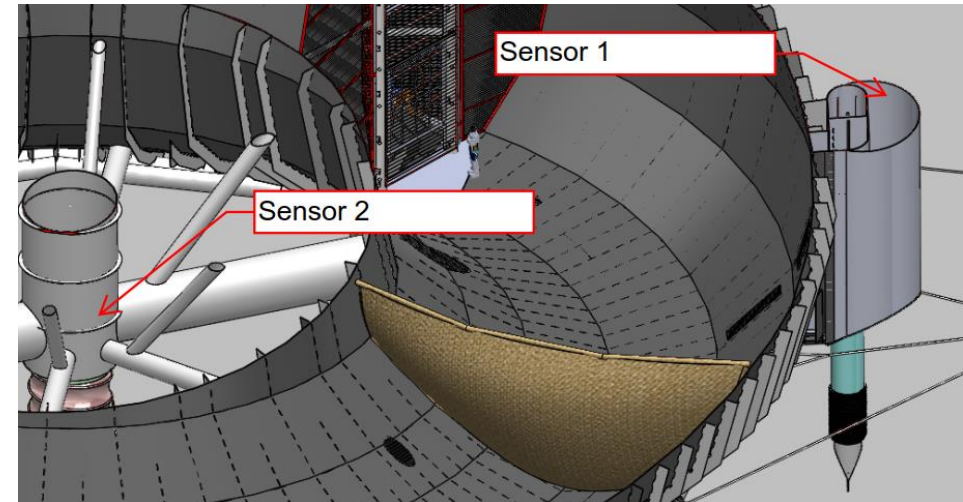
# Instrument

## Water quality sensors Turbidity

The turbidity sensor proposed is a new Aanderaa sensor

Electrical RS-232, and a converter to 4-20mA will be installed in the local junction box.

Location: Inlet and water outlet



# Instrument

## Water quality sensors flow

Doppler with built in software for close water flow measuring

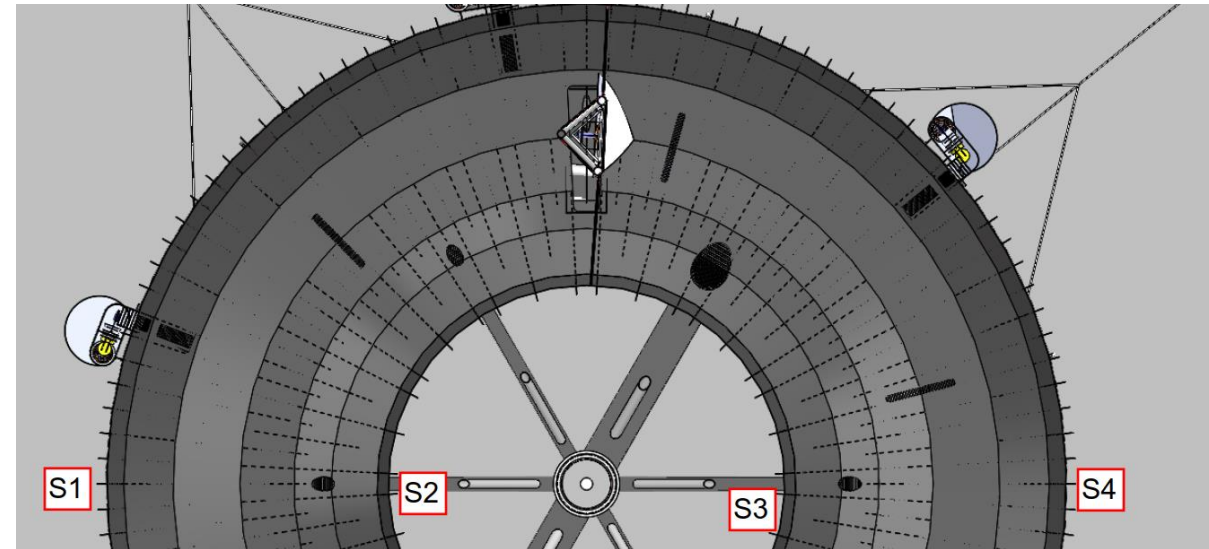
Sensor data correlated with flow motors

No calibration required if not damage

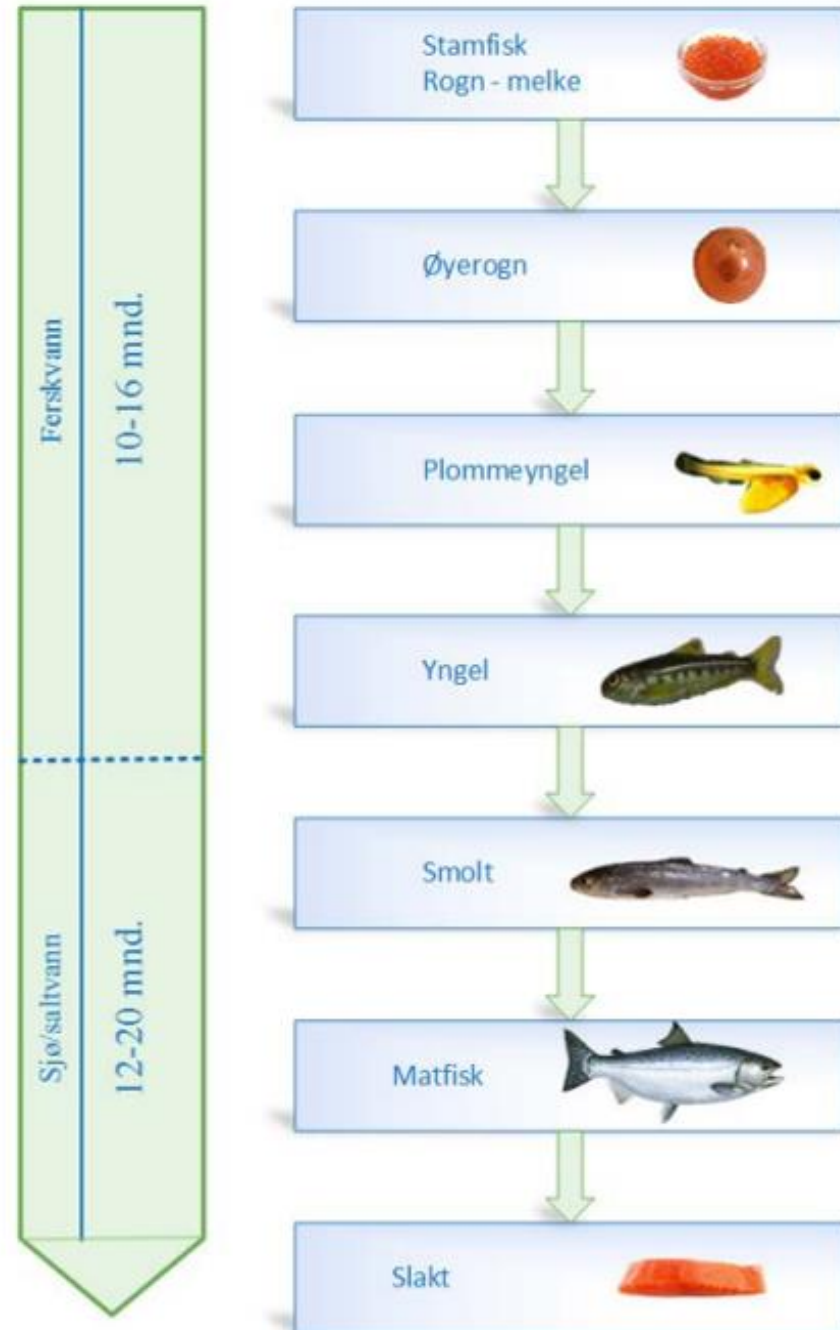
Can be located outside the area to be controlled.

max measuring area 5 meter

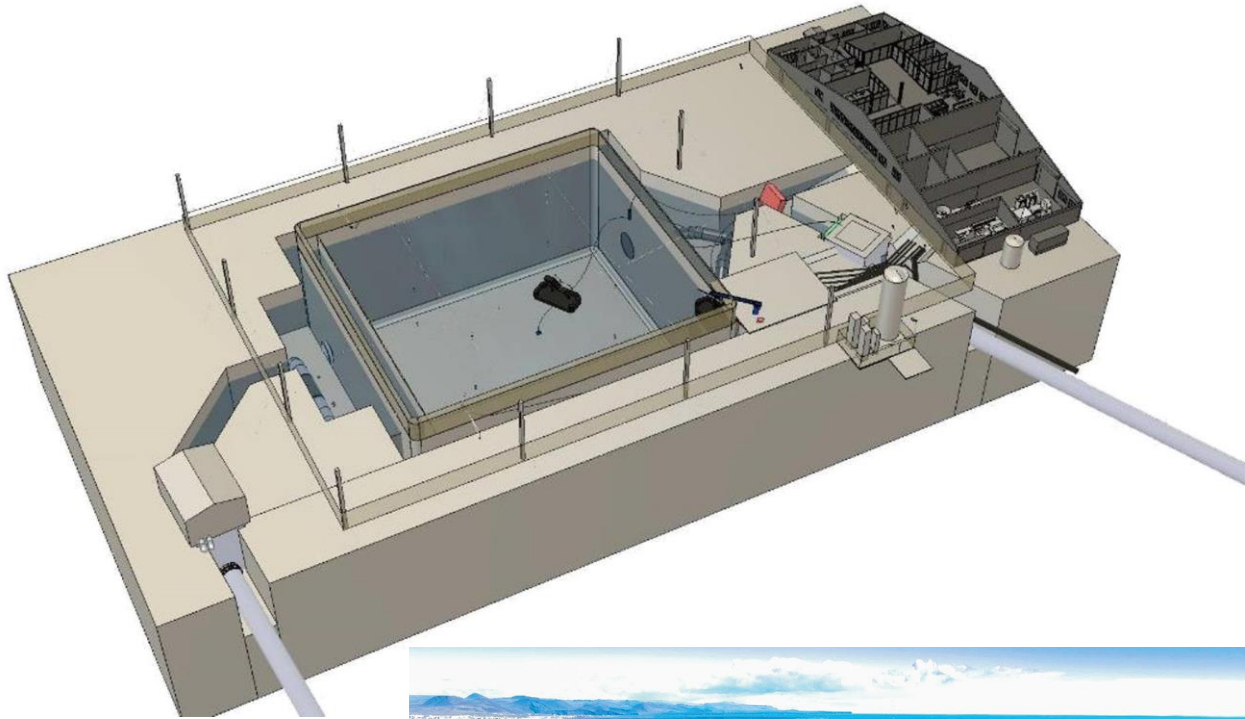
Location outside feeding areas. One on the inside and one on the outside of the donut tube



# Freshwater to Seawater



# Landbased sites



## Increasing size

- Pumps water from ocean if possible, or recircles water
- Needs to create movements in water
- Possible to produce closer to consumer
- Not vulnerable to climate
- Vulnerable to technical failure

# Remote operation

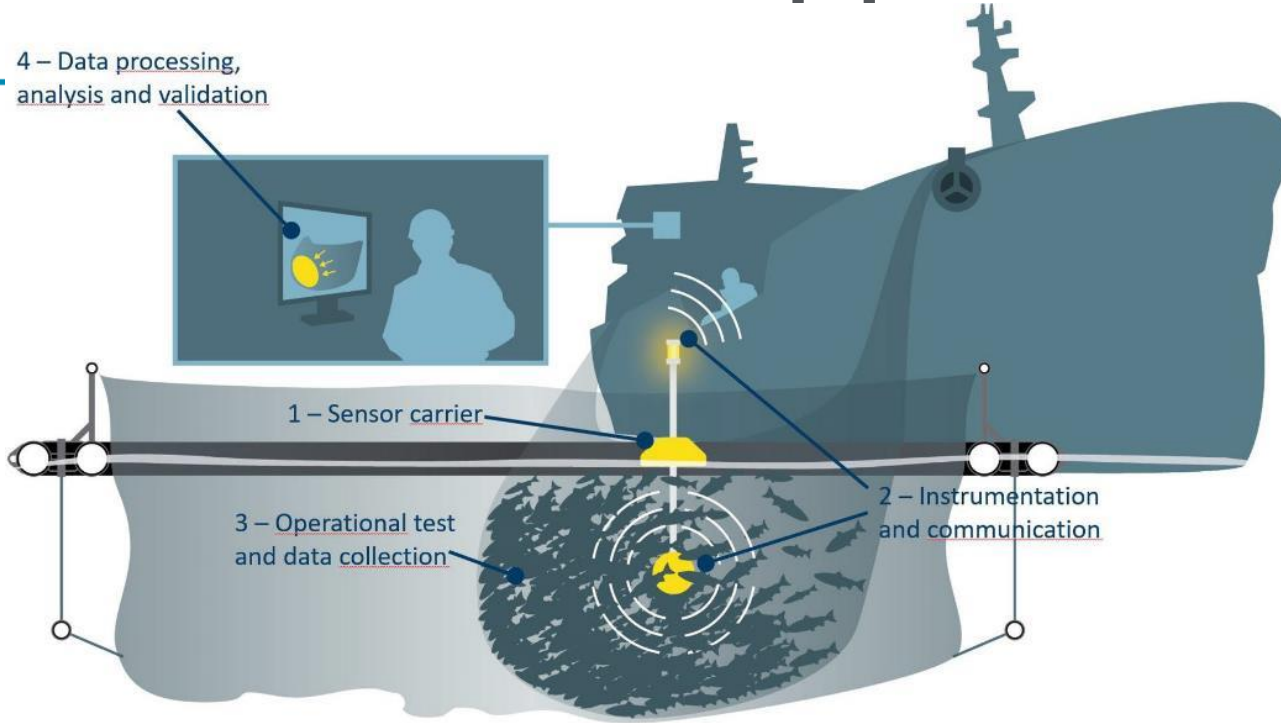
- Can operate more sites with less personal
- Needs reliable real-time data
- Easy to compare sites to optimize growth





# Treatment support

4 – Data processing,  
analysis and validation

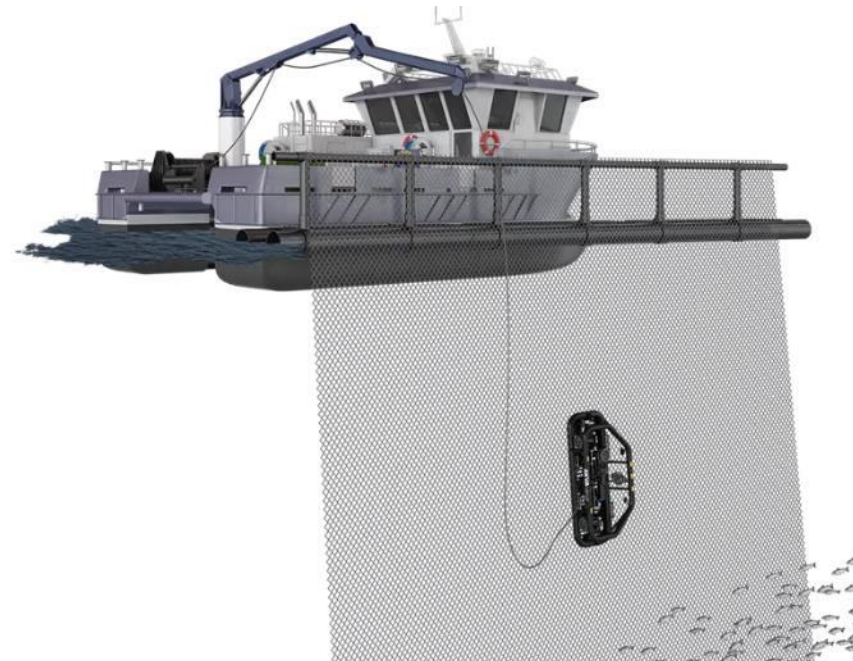


## Crowding

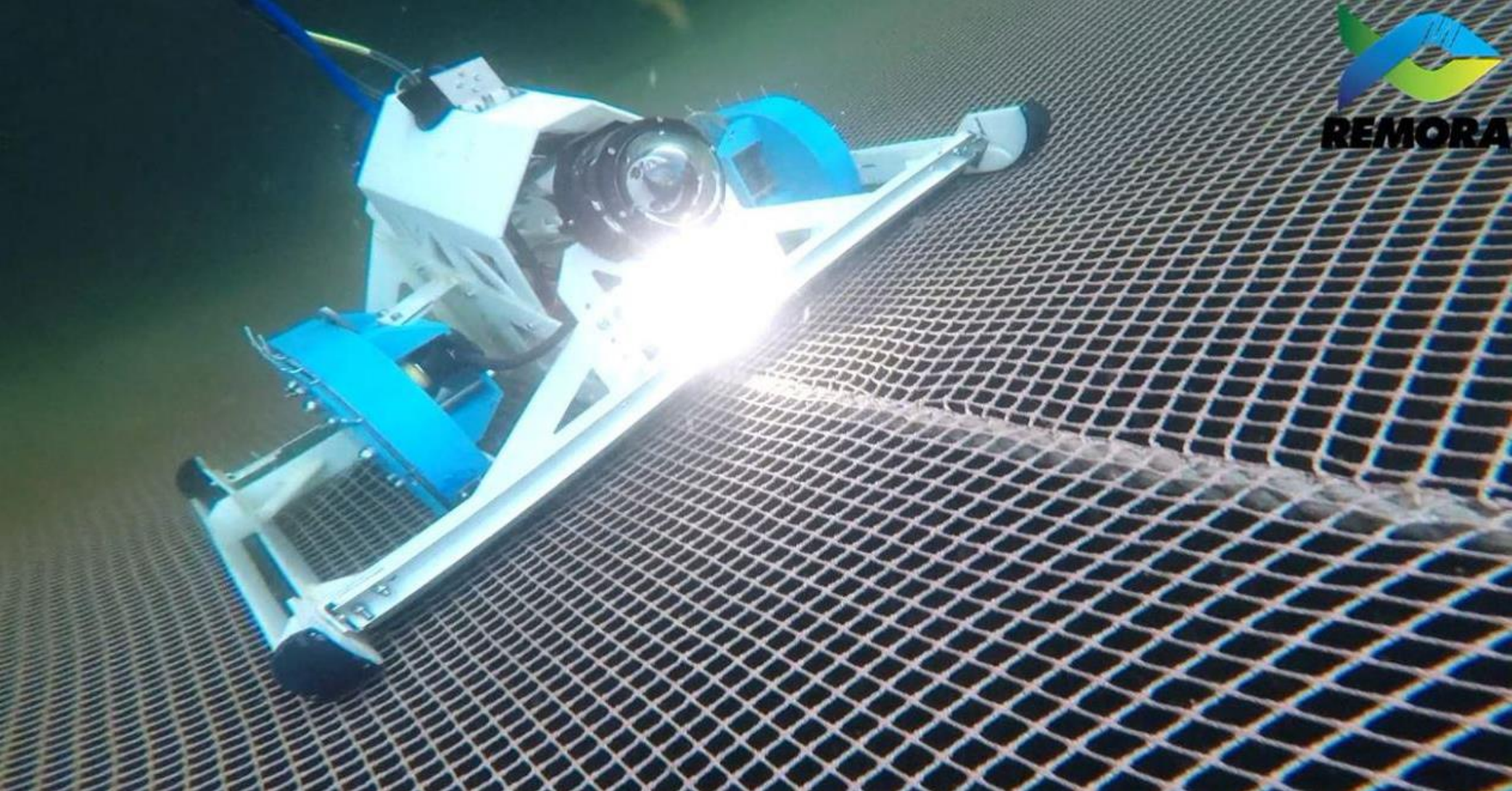
- De-licing
- Transport of fish

## Cleaning and inspection of net

- Using high pressure washer or brushing



# NetClean 24/7



# Ongoing project

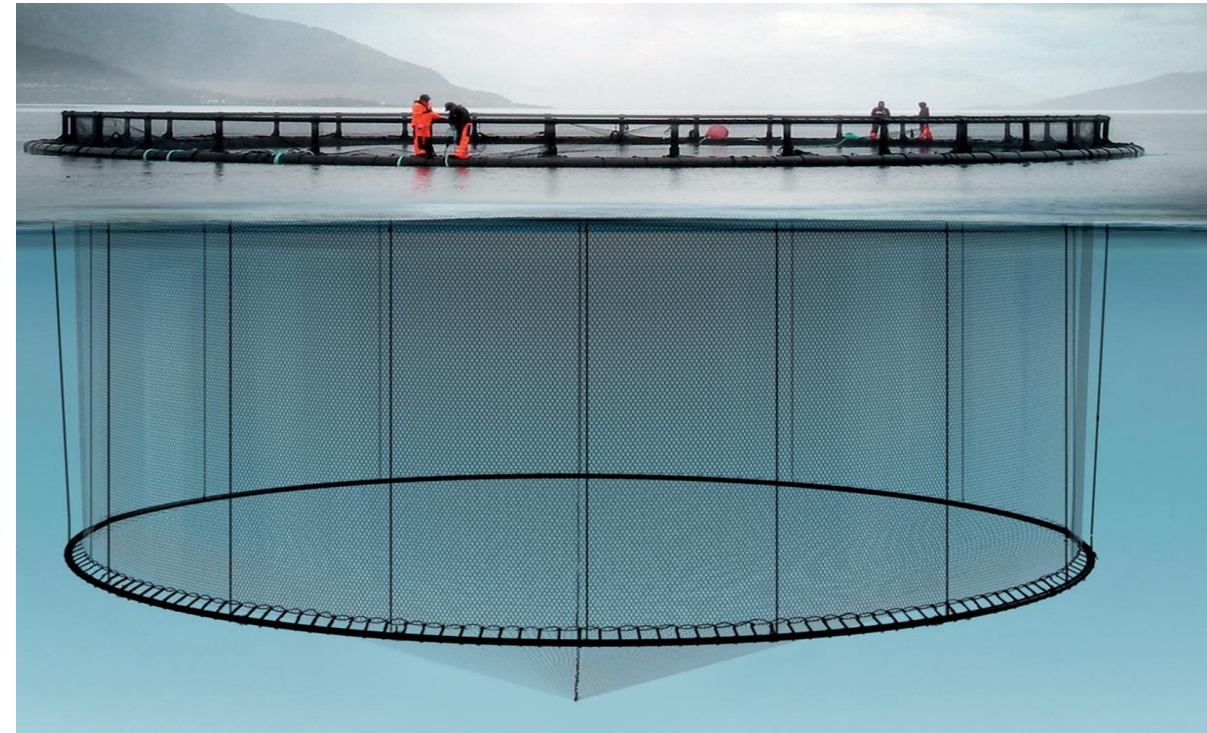
## Using DCS to measure current in cage

- Collect data at 25Hz
- Separate reflection from fish and water
- Measure biomass

## Measuring pressure in fenders

- Pressure sensor integrated in fenders

## Wireless measurement in cage



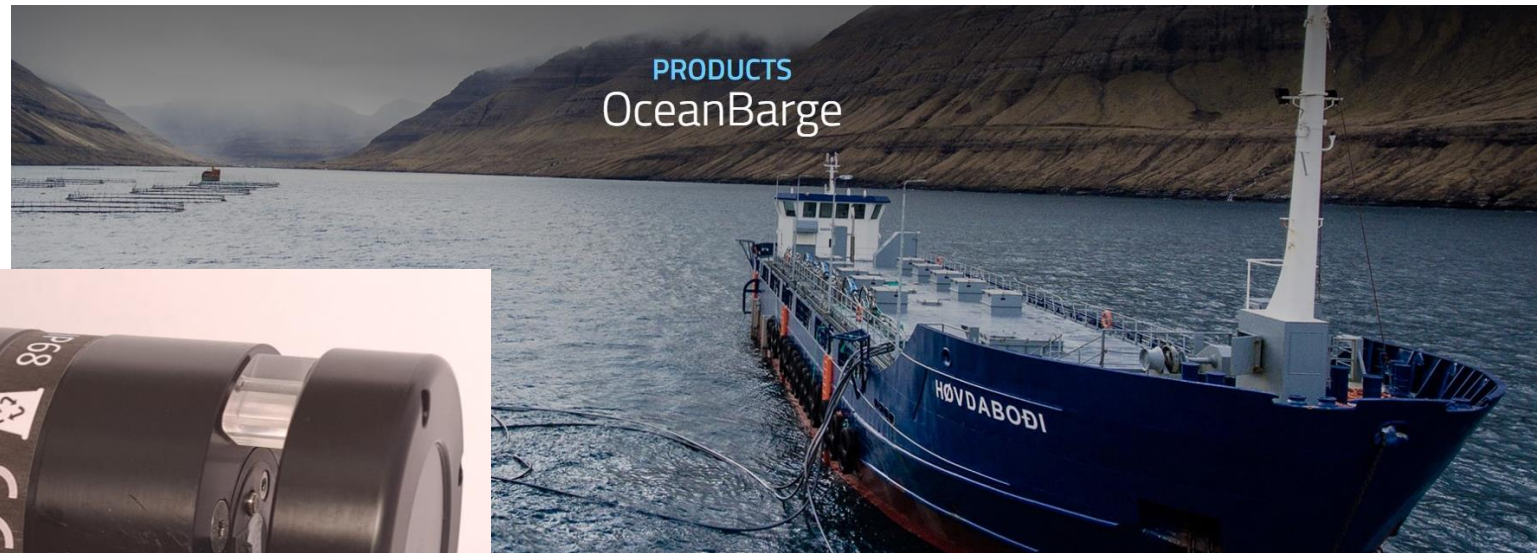
# Oxygen Sensor 5730

- Developed with customer(Steinvik/ScaleAQ) for integration to camera
  - More than 2000 units sold
    - Used in HD camera
    - Used as stands-alone sensor
    - Used as part of sensor package
- Now open for free sales



# Oxygen Sensor 5730

- Developed sensor with UV-light together with JT Electric
  - 40 units delivered in 2021
  - 65 units delivered in 2022
  - New order for 200 units received in February 2022



# Monitoring & Control for onshore application

## YSI 5200A Multiparameter



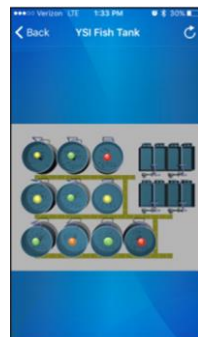
DO, pH, Cond, Salinity, ORP (Redox), Temp.



## YSI 5500D Multi-DO Optical

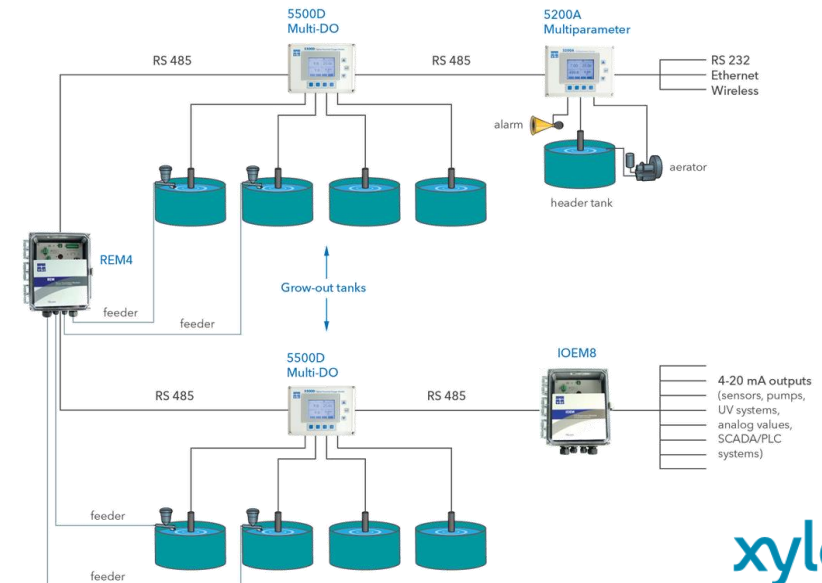


Multichannel (1 to 4) optical DO



## Features

- Ethernet TCP/IP or wireless communications – optional
- Conditional feed timer with Feed Smart software included
- Networking capability up to 32 instruments per communications port or integration with 5200As and 5400s
- Graphic interface function for quick, reliable system status with the use of AquaManager software
- Plug-and-play...easy to install, setup and maintain;
- Flexible control software
- E-mail and SMS alarming
- AquaViewerII app available for easy access to data at any time



# Questions?

## CONTACT US

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