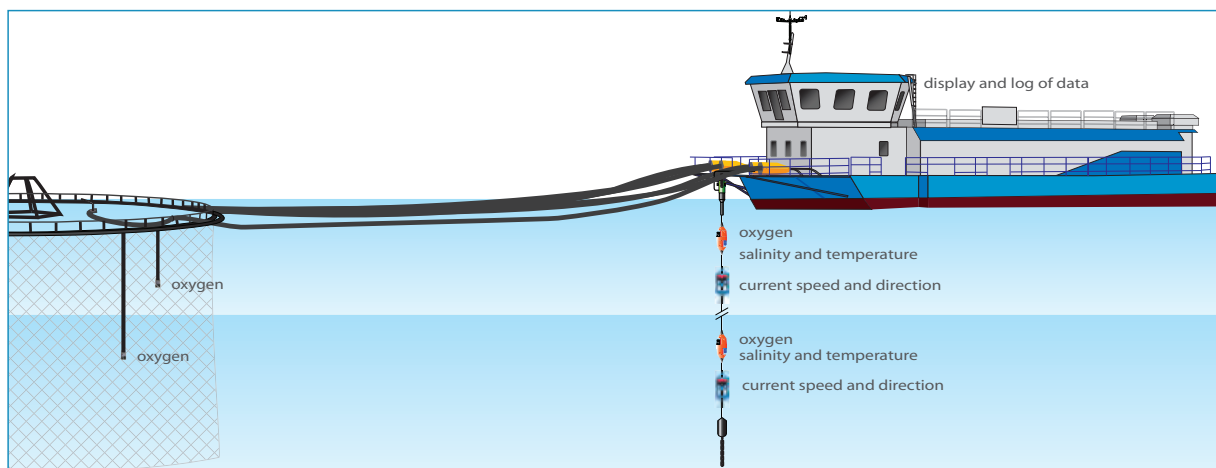


Get more out of your most important investments with Aanderaa's Environmental Monitoring Station



It is essential to use sensor technology to monitor actual conditions in and around marine fish farming, one of Norway's largest export industries. The monitored data, together with research into effective operation will provide productive management and also alleviate any negative environmental impacts.

Since 1966 Aanderaa has developed and manufactured instruments, sensors and systems for oceanographic research related to the mapping of oceans and fjords. Our customers include marine research institutes, cartography firms, oil companies and the military who set strict requirements for the design, quality and accuracy of our sensors and instruments.

Many of the measurement data used in oceanographic research are also applicable when monitoring the environment in fish farms. Aanderaa has recently developed separate systems intended for the fish farming industry based on its long experience gained from the development of instruments for research. Trustworthy intelligence about the environment the fish inhabit may prove the difference between poor or healthy fish farming economics.

Monitoring Station

Aanderaa Environmental Station is a complete system designed to monitor critical parameters, both in and outside the cage to ensure the best possible well-being and growth conditions for the fish. As a minimum oxygen, temperature, current direction and current strength are measured, while other parameters such as salinity can easily be added. All data are shown in real-time via a graphical display system, and historical data is stored for later use as a basis for trend analysis or comparison of farms to optimize production performance.

Oxygen

Oxygen is the most important parameter. Low oxygen levels stress fish and increase the possibilities of disease. During feeding, low oxygen levels can decrease the intake of feed and increase the feed factor (feed use/economy).

Current

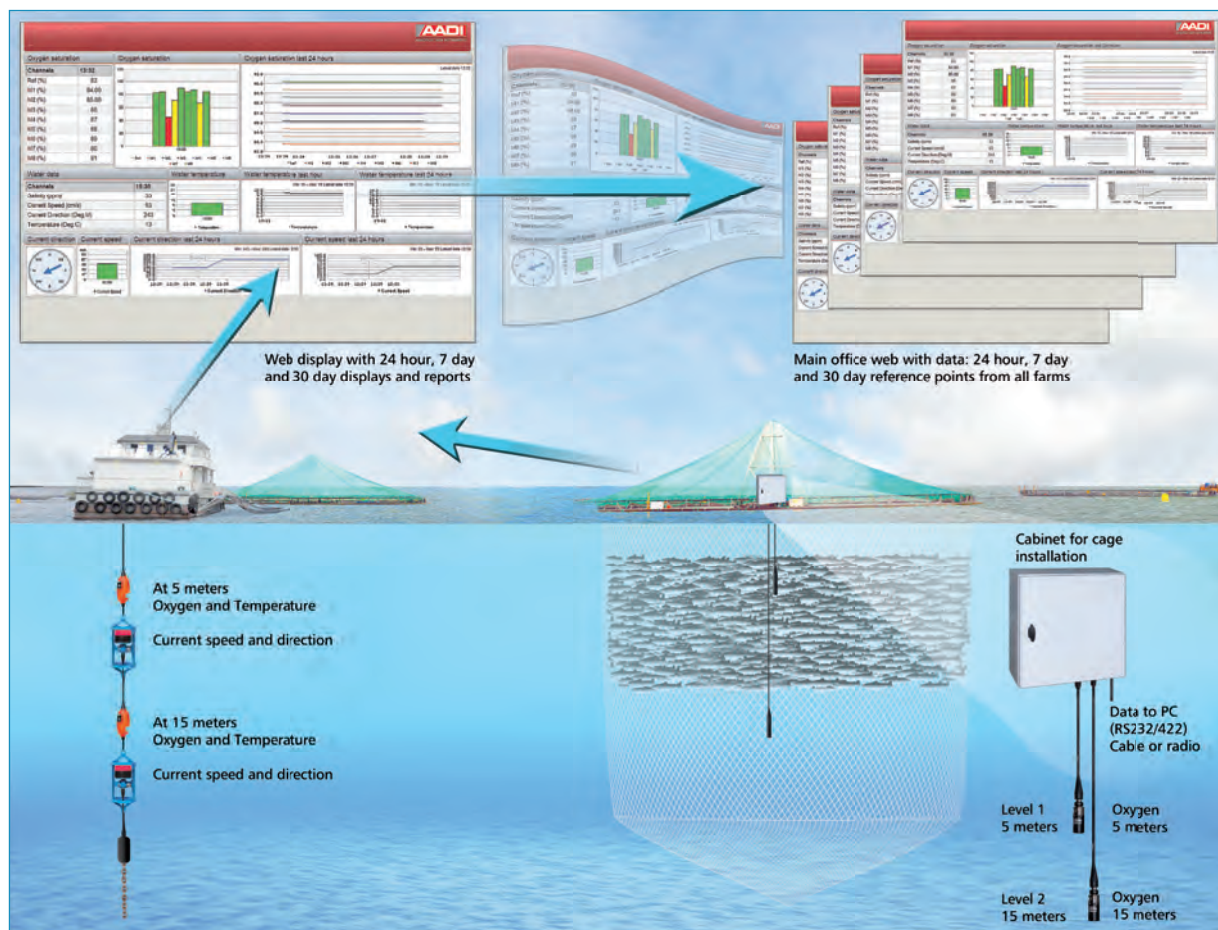
Good current conditions will ensure fresh oxygen rich seawater flowing through fish farms. Information about the current strength may also be used to limit the spread of feed outside cages.

Temperature

Temperature is also an important physiological parameter. Fish have greatest appetite under optimum temperature conditions.



Environmental Monitoring Station System Description



The Aanderaa Environmental Monitoring Station consists of a combination of sensors placed at a fish farm in order to monitor the quality of the environment in which the fish live. Collected data contributes to optimizing feed routines to achieve the most efficient production possible.

The system consists of three main systems:

- Reference system: sensors that are placed at the outer edge of the farm to measure the available water quality outside the cage.
- Sensor system in cage.
- Software system: to display data in real-time and store historical data.

All sensors are "Aanderaa Smart Sensor", i.e. each sensor stores its own calibration coefficients and other settings and provides data in engineering

units independently. In the event of sensor failure the other sensors will continue their measurements unaffected.

"Aanderaa Smart Sensor Technology" has the following feature set:

- Calibration data and sensor information/metadata are stored in the sensor.
- DSP technology, flash storage and real-time synchronization are used.
- High sensor accuracy and an almost unlimited resolution.
- Transfer speed of 125 kbit/s (with AiCaP interface).
- Real-time data output through AiCaP or RS-232 interface.
- Two-way communication.

Reference System

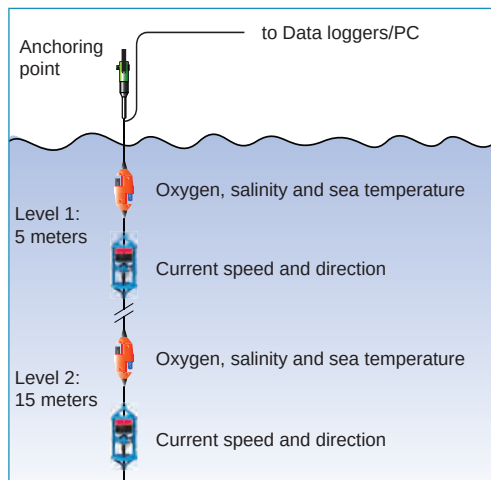


Figure 1 - Reference system

The reference system consists of a range of sensors placed in series in a sensor string (see Figure 1).

Sensors are placed in groups at preferred depths, usually in accordance with the prevailing NS9415 recommendation of 5 and 15 meters or other depths.

Each group consists of one freestanding current sensor as well as a sensor housing with space for two sensors. One of them is used for a combined oxygen and temperature sensor. The free sensor space can be used for O₂ or conductivity (salt). Up to seven groups of sensors can be connected on one sensor string.

The recommended position of the sensor string is where the dominant current direction arrives at the farm. This is to achieve a correct measurement of available water quality.

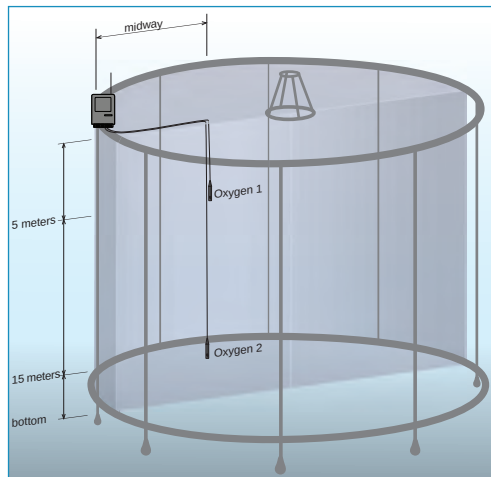


Figure 2a - Standardisation of measuring points

The sensor string's anchor point may be on the feed barge, a buoy system or other suitable attachment device. The current sensor uses acoustic Doppler technology requiring a two-meter obstruction free zone (rope, chains etc) around the sensor.

Sensor System in Cage

Oxygen and temperature are considered to be the most important parameters for the fish well being and growth conditions. The sensor system for measurements within the cage consists of a cabinet with a communication unit, Datalogger and the option to connect one or several combined current and temperature sensors at the desired depths within the cage (see Figure 2a).

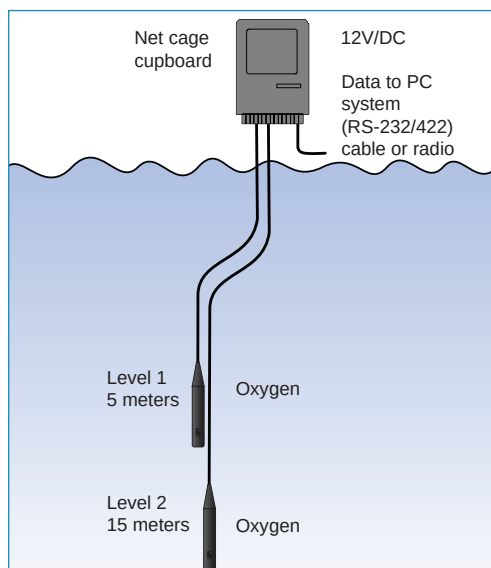


Figure 2b - Sensors in the net

It is also possible to connect other types of sensors to the Datalogger, e.g. wind, air temperature, precipitation sensors etc.

By comparing the oxygen level inside the cage with the value measured in reference systems outside, the following observations can be made:

- Oxygen consumption before, during and after feeding.
- The net's flow through capacity (optimising cleaning intervals).

Software Systems

The software kit accompanying the Environmental Monitoring Station enables the user to read the collected data in real-time.

The software consists of the following two parts:

1. Aanderaa Real-Time Collector
2. Aanderaa GeoView

Aanderaa Real-Time Collector is an open platform collecting data from multiple instruments and sensors. Data can be integrated and distributed to one or several databases or display programs through a well documented XML interface.

It is also used to remotely configure sensors and instruments. Measurement data from the

majority of RS-232/422 based third party sensors can also be read by the software.

Aanderaa GeoView is a web-based solution for real-time display of collected environmental data. It consists of an SQL database and SOAP web-services that are used for communication with standard web browsers (Firefox, Internet Explorer etc.) installed on PCs, laptops or more recently mobile telephones.

The programs can be installed on a Windows based server or PC.

Communication

Communication between server/PC, reference system and sensor system in the cage can use LAN, GPRS, radio etc.

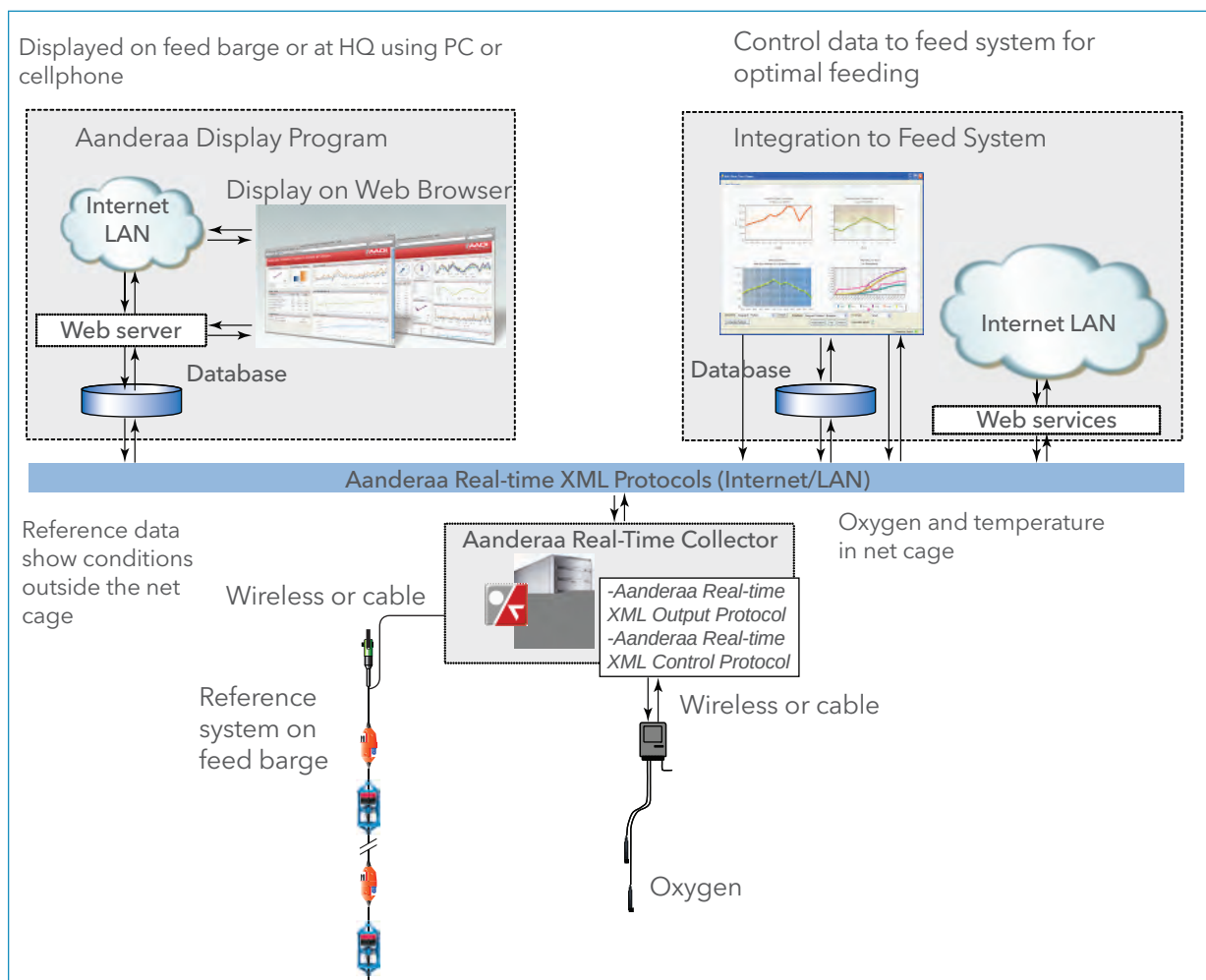


Figure 3 - Open interface and data display

Environmental Monitoring Station – User Interface



Figure 4 - Real time and report

User-friendliness is one of the main points of the Aanderaa Environmental Monitoring Station. The Geoview display program displays collected data either as numerical values, line graphs, bar charts, a compass rose or in table format.

The software can be configured to show data from the last hour, last 24 hours, last week or other preferred intervals. Historic data can be

displayed in the same diagram using the "from and to" date.

Collected data can be exported in e.g Excel format in order to create trend analyses over long periods, documentation in connection with examination by the authorities or to manage data for future use.



Figure 5 - Click on a fish farm

Central Monitoring

Large businesses with multiple farms in operation at various locations often need to observe conditions at individual farms from one or more central locations.

The GeoView display program is designed with a hierarchy of screen images, also called pages. The design of the pages can be individually adapted to different needs and customization is offered as an installation service, usually performed by Aanderaa (see Figure 4).

One page may contain diagrams for collected data from one system, while another page shows data from a different system. Additionally a page showing i.e. oxygen data from all systems can be created.

It is possible to import map sections in GeoView and to mark the location of various fish farms on the map together with the real-time display of selected data. This can also be used as a menu to navigate to the page that shows all data for the selected system (see Figures 5 and 6).

Collected data from the different farms are stored in a database where history search can be performed. Data can also be exported for further analyses, e.g. in cases where there is a deviation in production efficiency between the individual farms or to evaluate a farming cycle.

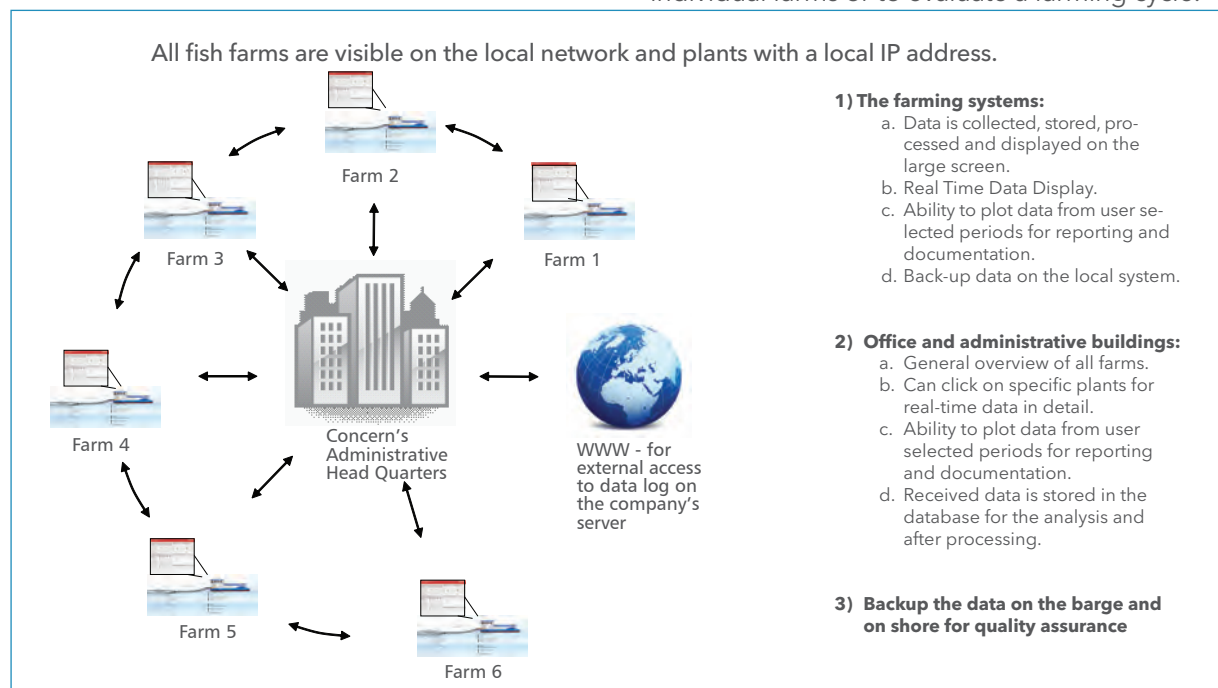


Figure 6 - Network

Operation and Maintenance of Aanderaa Sensors

Aanderaa sensors are designed to operate in demanding environments over long periods where inspection is not possible. Therefore strict requirements are set about mandatory calibration and servicing.

The Aanderaa sensors are very stable and in the majority of cases the sensors will maintain calibration for a period of three to five years. In areas with significant algae growth, it may be necessary to clean the oxygen and conductivity (salt) sensors at regular intervals

Minimal cleaning will normally be sufficient. Recommended cleaning intervals will usually coincide with the need to clean underwater cameras.

We recommend that Aanderaa perform a system check after a farming cycle to ensure functionality and quality of the equipment before the next generation of fish are released.

Information Concerning the Sensors

The current sensors use coustic Doppler technology and are therefore calibration-free.

The salt content of the water influences oxygen measurements if milligrams/liter are used as a

measurement unit, necessitating the installation of a conductivity sensor together with the oxygen sensor. This is not required if the measuring unit for oxygen is given as saturation in percent.



Technical Specifications of Sensors

Dissolved Oxygen Optode		
	% Saturation	Mg/liter
Accuracy	+/- 2,5%	+/- 2,5%
Operating temperature	-5 to 40°C	-5 to 40°C
Measuring range	0-150	0-16
Measurement principle	Optical lifetime based on luminescence quenching	Optical lifetime based on luminescence quenching
Salinity	0-42	0-42
Materials	Delrin (POM)	Delrin (POM)
Current consumption	20mA	20mA
Cable length	50m	50m
Plug	Waterproof	Waterproof
Max operating depth	100m	100m
Size - L x Dia.	120 x 40mm	120 x 40mm

Conductivity (salinity)		
	S/m	
Accuracy	+/- 0.005S/m	
Operating temperature	-5 to +40°C	
Measuring range	0 to 7.5 S/m	
Measurement Principle	Inductive	Inductive
Materials	Epoxy coated Titanium	Epoxy coated Titanium
Current consumption	0.16 +48 mA/S where S is recording interval in seconds	0.16 +48 mA/S where S is recording interval in seconds
Cable length	Max 50m	Max 50m
Plug	Option/waterproof	Option/waterproof
Max operating depth	300m	300m

Current speed and direction		
	Cm /sec	Knots
Accuracy speed	+/- 0.15 cm/s	+/- 0.3 knots
Measuring range speed	0 to 300 cm/s	0 to 6 knots
Accuracy direction	+/- 5° at 15° tilt	+/- 5° at 15° tilt
Resolution	0.35°	0.35°
Measuring range direction	0-365°	0-365°
Temperature range	-10 to +43°C	-10 to +43°C
Measurement Principle	Doppler	Doppler
Materials	Durotong, Titanium and stainless steel	Durotong, Titanium and stainless steel
Current consumption	Approx. 30 mA	Approx. 30 mA
Cable length	Max 50 meter	Max 50 meter
Plug	Optional / Waterproof	Optional / Waterproof
Max operating depth	300 meters	300 meters
Size - L x Dia.	261 x Ø120	261 x Ø120

Temperature		
Accuracy	0.05°C	
Resolution	0.01°C	
Temperature range	-5 to 40°C	
Calibrated measuring range	0 to 36 °C	
Measurement principle	Fenwall Termistor	
Materials	See oxygen sensor	
Current consumption	See oxygen sensor	
Cable length	See oxygen sensor	
Plug	See oxygen sensor	
Max operating depth	See oxygen sensor	
Size - L x Dia.	See oxygen sensor	
Weight	See oxygen sensor	



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