Deliverable No. 4.1

Project acronym:

AquaVitae

Project title:

New species, processes and products contributing to increased production and improved sustainability in emerging low trophic, and existing low and high trophic aquaculture value chains in the Atlantic

Grant agreement No: **818173**
Project co-funded by the European Commission within the
Horizon 2020 Programme
Start date of project: **1st June 2019**
Duration: **48 months**

Due date of deliverable:	31/10/2019
Submission date:	31/10/2019
File Name:	AquaVitae D4.1
Revision number:	01
Document status:	Final[1]
Dissemination Level:	PU [2]
Re submission date after review:	6/3/2021

Revision Control

Role	Name	Organisation	Date	File suffix[3]
Task leader, author	Celine Boechat	Nofima	23.06.2019	CB
WP leader	Petter Olsen	Nofima	23.06.2019	PO
Scientific Advisor	Valur Gunnlaugsson	MATIS	24.10.2019	VG
Coordinator	Philip James	NOFIMA	26.10.2019	PJ
Revision after review meeting				
Task leader, author	Celine Boechat	Nofima	2/3/2021	CB
WP leader	Petter Olsen	Nofima	2/3/2021	PO
Scientific Advisor	Valur Gunnlaugsson	MATIS	5/3/2021	VG
Coordinator	Philip James	NOFIMA	6/3/2021	PJ

[1] Document will be a draft until it is approved by the coordinator
[2] PU: Public, PP: Restricted to other programme participants (including the Commission Services), RE: Restricted to a group specified by the consortium (including the Commission Services), CO: Confidential, only for members of the consortium (including the Commission Services)
[3] The initials of the revising individual in capital letters

Deliverable D4.1

Scope, plans and initial stakeholder feedback

31/10/2019

Contents

Executive Summary

In WP4 "Sensors, data integration and Internet of Things", three different sensors will be developed by DTU, Biolan and Norce. The sensors are already created, but in this WP the purpose is to develop them further in order to reach the practical needs and requirements of future buyers. To accomplish this task, stakeholders have been interviewed to evaluate their needs regarding the use of the sensors developed in the project. Based on this feedback, the scope and a plan of development for each sensor has been created.

The first sensor's prototype will be delivered by month 12, and tested and evaluated by the same, and eventually additional, stakeholders. A second prototype will be created by month 36. During the lifetime of the project, other deliverables will be written to follow the work in process of the sensor development:

- D4.3: Report on first development phase, M12
- D4.4: Report on second development phase, M30
- D4.5: Report on final development phase, M46

From the interviews, the stakeholder's main purposes regarding use the sensors are: better process control, better yield, and lower costs. The main requirements for the sensors are: accuracy, affordability, and robustness.
This deliverable gives a detailed overview of the different answers obtained, and contains the development plan for each of the different sensor prototypes for the next 12 and 18 months.

1. Introduction

i. Scope of AquaVitae

AquaVitae is a research and innovation project funded by the EU's Horizon 2020 programme, BD-08-2018. The project consortium consists of 36 partners, from 16 different countries, spread across four continents. In addition to Europe, partners are situated in countries bordering the Atlantic Ocean, including Brazil, South Africa, Namibia, as well as in North America. Its broad objective is to introduce new low trophic species, products and processes in marine aquaculture value chains (VCs) across the Atlantic.

ii. Scope of WP4 "Sensors, data integration and Internet of Things"

The objective of WP4 is to develop or improve and test new or existing sensors for use in the aquaculture industry using an Internet of Things (IoT) approach; this includes biochemical sensors, biomass sensors, and the integration and visualisation of data from environmental sensors (SO5). Specific objectives are:

- To develop new methods for biomass monitoring in offshore aquaculture sites by combining underwater laser cameras with computer vision and machine learning algorithms
- To design and develop a smart sulphite biosensing device for use in aquaculture production
- To develop an IoT platform for integration and analysis of sensor data related to aquaculture production
- To develop a Data Management Plan (DMP) for the data generated in AquaVitae, and to update the DMP at the end of every reporting period

iii. T4.1 Scoping, planning, and eliciting stakeholder feedback for sensor development

In WP9 the AquaVitae multi-actor platform will be created and put into operation, and this involves numerous stakeholder meetings on CS level. AV will employ a multi-actor approach to ensure that project outcomes are co-created with extensive involvement of users and other stakeholders, to ensure relevance and acceptability. In this task, the scope and a detailed multi-actor plan for the sensor development work that is linked to WP4 will be defined, based on the overall AV / WP project description, the priorities of the industry participants and the scientists, and the feedback from the stakeholders. The plan for the sensor development will contain descriptions of who will do what when and where, and it will need to be synchronised with the plans made for the CSs in WP1-3.

2. Company case examples

i. DTU – 3D camera for mussels

Develop new methods for biomass monitoring in offshore aquaculture sites (DTU, Norut)
This task will use and adapt next generation range-gated camera technology based on state-of-the art "time of flight" image sensors and innovative pulsed laser illumination (LiDAR). This is referred to as an Underwater Time Of Flight Image Acquisition (UTOFIA) camera, and it was an output from the H2020 UTOFIA project which ended in 2018. DTU will develop optimised range gating for mussel production, and specific software for volumetric reconstruction of the mussels lines with machine learning functionality. We will develop and test the system in CS8 and CS9, but it is also applicable in other CSs where biomass monitoring is relevant, e.g IMTA production and finfish production. The monitoring device will be integrated with the IoT platform to enable data storage, visualisation, and

analysis (machine learning). The encoding and exchange format for all data to be transferred to the IoT platform will be defined. APIs will be developed to enable the collection of data from the biosensor.

ii. Biolan – sulphite sensor for shrimps

Design and develop a smart sulphite biosensing device for use in aquaculture production (Biolan, Norut)

This task will deliver a prototype of a high-performance, battery-operated, portable and connected biosensor for sulphite monitoring, aimed to be used in shrimp production. The electronics will be designed to achieve technical specifications by first running simulations, and then testing different circuit architectures. The layout of the printed circuit board will be defined and created for mounting the prototypes. For software development, the tool-chain will be selected and configured, and signal processing and calibration processes will be coded. The mechanical structure design will consist of the design of the mechanical frame of the portable device based on 3D printing and/or other technologies for first prototypes and design of the final casts. The biosensing device will be integrated with the IoT platform to enable data storage, visualization, and analysis (machine learning). The encoding and exchange format for all data to be transferred to the IoT platform will be defined. APIs will be developed to enable the collection of data from the biosensor.

iii. Norce – integrated sensor data platform

IoT platform for integration and analysis of sensor data (Norut, Nofima)

Data gathering will be based on local infrastructure for power efficient and resilient communication between low power IoT devices without fixed infrastructure and will enable integration with existing IoT devices and platforms at the test sites. Machine learning functionality will be developed for sensor fusion, sensor calibration, sensor monitoring and prognosis. A flexible and simple visual tool (dashboard) to create AI training sets with automated training, validation and deployment of AI based monitors / virtual sensors will be developed. Edge computing support for sensors and AI trained monitors/virtual sensors will be provided for sites with no or unstable Internet access. The IoT platform will be tested in IMTA, shellfish, and finfish production cases.

3. Method – spiral model of technology innovation

AquaVitae consists of 5 VCs with Research and Innovation activities undertaken in 11 CSs (in addition to 2 cross cutting case studies) which will generate new knowledge and commercially exploitable project outputs of various types. The actual CS work takes place in WP1-3 and a three-step prototyping approach will be utilised in all of them. Prototype I and II of the exploitable project outputs will be delivered during the project (M13, M36) and the final version will be delivered at the end (M48). The multidisciplinary and cross-cutting WPs 4-8 will each deal with a number of CSs and will focus on issues particularly relevant for the CS in question. WPs 4-8, complemented by the IRG, the EAG and by other stakeholders engaged through the multi-actor approach, will deliver extensive evaluation of prototypes I and II from each CS to ensure a relevant and usable final version of the project output that industry partners can exploit.

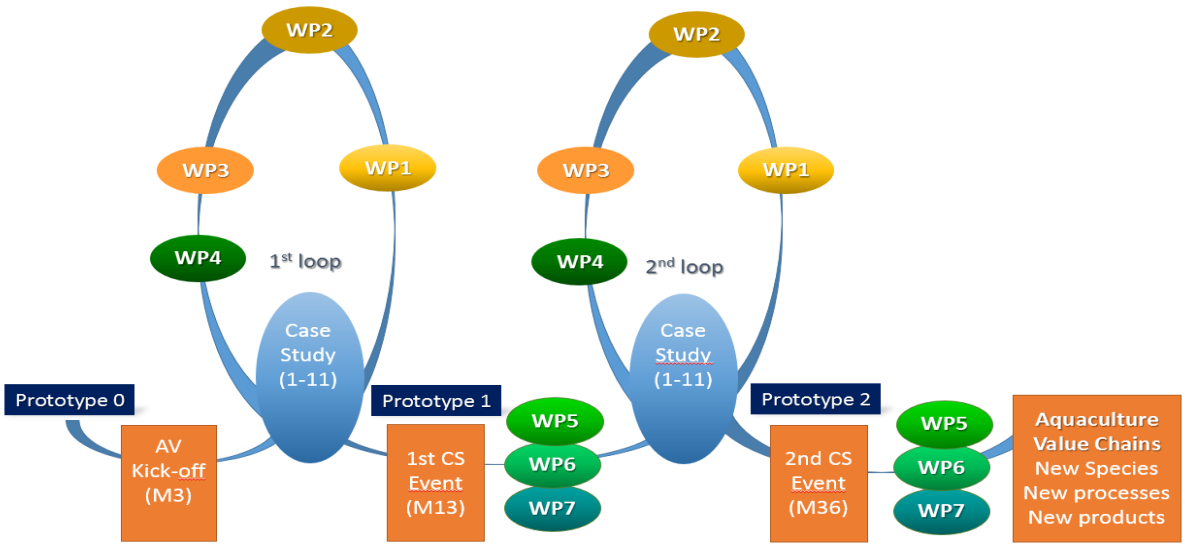

Figure 1 Development process for AV outputs, based on 2 prototyping loops

The following tasks have been attributed to the three partners of WP4 developing sensors:

1. Contact stakeholder companies

For Biolan and DTU: approach and interview 3 to 4 stakeholder companies who might be interested in their sensor technology.

For Norce, who are working on an integrated data collection platform, there is a wider application for their platform. The aim is to find 8 to 10 companies that could see an application/use for this integrated data platform.

2. Use the interview guide

An interview guide that acts as a standard questionnaire to ensure consistency has been created by Nofima. It contains questions on detailed sensor-specific requirements from the stakeholders, including the desired purpose of the sensors and what attributes is primary for them.

3. Create a development process

Based on the feedback from the stakeholders, write a more detailed development process for the next years, breaking down the main goal into subtasks in order to fit the spiral development model based on the overall prototyping / stakeholder consultation plan:

- M1-M12 – initial development phase culminating in a prototype available for user testing
- M13-M18 – extensive stakeholder consultation and prototype testing
- M19-M30 – main development phase culminating in a close to finished version
- M31-M36 – extensive stakeholder consultation and testing of fully functional version
- M37-M46 – final touches

4. Discussion and conclusion

In total the 3 partners have interviewed 23 stakeholders. 9 for DTU, 3 for Biolan and 11 for Norce.

The profile of these organizations is broken down in table 1.

Table 1. Organization's profile

Industry	Policy maker	NGO	Others
13	1	3	7*

* DTU as a stakeholder for NORCE has been classified in Industry and Others for research & development

Biolan and DTU have interviewed external stakeholders. Norce have interviewed 3 external stakeholders, 2 AquaVitae project partners and 6 CSs (CS 4-6; CS 8-10).

Seven of the stakeholder interviews where transcribed in the template form, and the results are attached in the appendix, along with the development process for the 3 partners. For confidentiality, sensitive content like personal information about the interviewees and localization of the companies have been removed from the forms.

Based on these 7 interviews the purposes of the stakeholders for using these sensors are mainly to have a better control on the process, a better yield and lower costs (see Fig. 2).

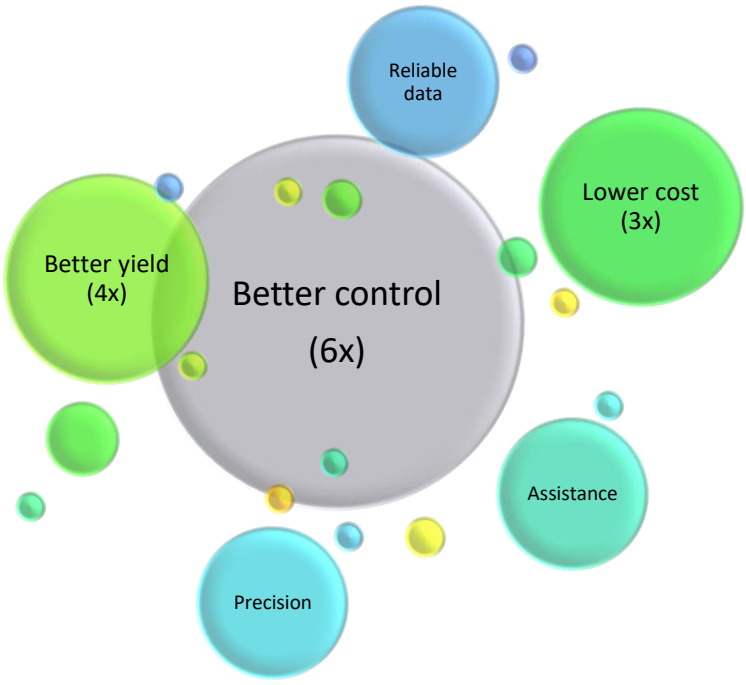

Figure 2: Stakeholder' purposes by using these sensors

The different stakeholders have also been asked to mention what attribute were important for the sensors. The different characteristics and their rank are shown in Fig.3.

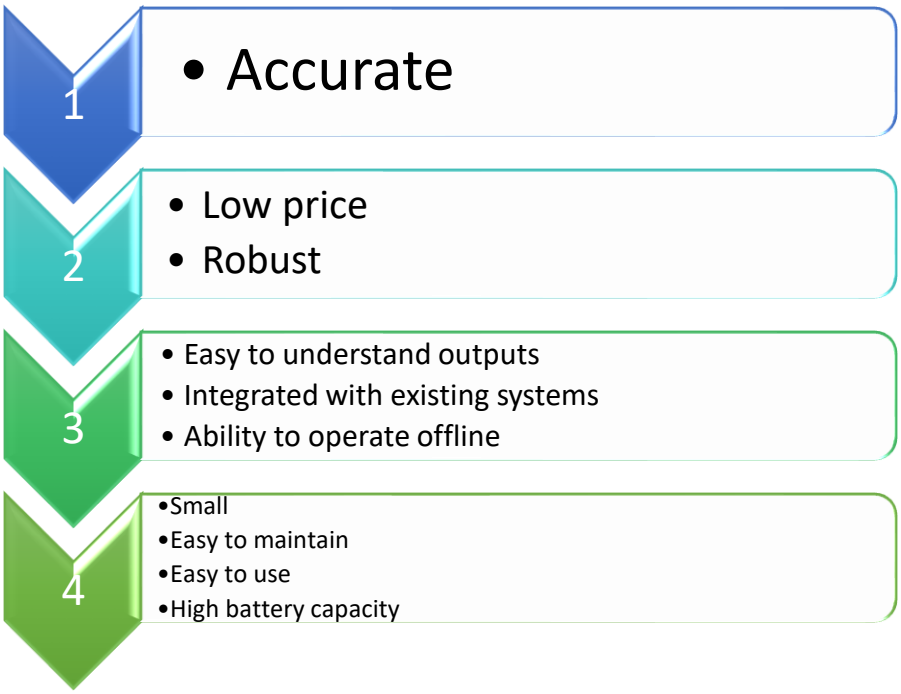

Figure 3: Sensor's attributes rank by importance

The development process of the 3 partners, based on the stakeholder survey, is the following:

First prototype delivered by M12 attributes:

DTU:

- Ability to **collect 3D images** of object of interests (e.g. mussels)

Biolan:

- **Bluetooth** enabled biosensing device
- First prototype of an **App** on a mobile device as connection to BIOLAN cloud

Norce:

- A **preliminary** prototype version of the IoT platform, with support for **automatic** transfer and storage of data and **simple** visualization.
- Sensors of interest for the use-cases **identified** and **integrated** with the IoT platform.
- **Machine learning** functionality for sensor fusion, sensor calibration, sensor monitoring and prognosis.
- **Integration** with sensors and platforms at the selected test sites, were possible, for data import and export.
- **Preliminary** integration of the UTOFIA camera into the AquaVitae IoT platform, enabling automatic transfer and storage of data, and **simple** visualization. (with DTU)
- **Preliminary** integration of the BIOFISH biosensor into the AquaVitae IoT platform, enabling automatic transfer and storage of data, and **simple** visualization. (with Biolan)

Second prototype delivered by M36 attributes:

DTU:

- **Autonomous** edge detection and volume estimates for object of interest
- IoT **interface**

Biolan:

- **Improvement** of biosensing device by implementation of System on **Chip** electronics
- **Improvement** of the developed **App**

Norce:

- **Final** version of the IoT sensor platform, integrated with **all appropriate** IoT sensors.
- A visual tool (**dashboard**) to create AI training sets with automated training, validation and deployment of AI based monitors / virtual sensors.
- **Edge computing** support for sensors and AI based **analysis**.
- **Final** integration of the UTOFIA camera into the AquaVitae IoT platform, enabling automatic transfer and storage of data, **visualization** and **analysis**. (with DTU)
- **Final** integration of the **new** BIOFISH biosensor into the AquaVitae IoT platform, enabling automatic transfer and storage of data, visualization and **analysis**. (with Biolan)

In terms of interaction between the partners, as described in the description of action, DTU and Biolan may collaborate with Norce and their IoT platform at a later stage of development.

First, all three partners are developing their sensors separately. Biolan is focusing on the improvement of the device and the app and DTU is working on the detection of the object of interest by their camera as well as the IoT interface. Once both the camera and the sulphite sensor is operational they will decide if a collaboration with Norce and their sensor integrating platform makes sense and if it would be an add-on to their respective sensor.

Appendix

i. Stakeholder feedback

DTU

Interview details

Interview date:	13.09.2019
Interviewer:	Patrizio Mariani
Interview form (telephone, mail, face to face, survey, etc.):	Telephone
Respondent name:	
Respondent e-mail:	
Respondent company/organization:	
Company/organization address:	
Company/organization website:	

Questions relating to the respondent

What is your role in the company/organization (title)?	
Number of years in the company?	
What is your experience within the industry?	

Questions relating to the company/organization the respondent represents

What are your main business areas?	Software Development for image analyses
What is the size of your company (number of people, SME?, profitability, harvest units, etc.)?	2 people in the software development unit
Where are you located? Does location matter for your products?	
Who are your competitors? What are your main strengths / weaknesses? What is the market position for your product?	Flexibility strength, LABTRACK main product for over 20 years now

Questions relating to the production process where the sensor is to be applied

In what production process do you intend to use the sensor?	Fish monitoring and growth
How many sensors would you need?	
Where in the process do you intend to use the sensor? Geographically, where is this process located?	Using the unit to develop new software
How important is this process for your company?	central
In general, what are the challenges related to this process?	Image quality
What are the customer / consumer requirements relating to the outputs of this process?	
What sensors do you currently use to monitor this process?	Regular HD cameras
In what way would the sensor proposed here be of use to you?	Augmented data on 3D
What would you hope to achieve by using this sensor (lower cost, better yield, better control, higher product price, customer preference, …)?	Better control and higher price
Please indicate importance of the following sensor attributes - Low price - Small - Fast - Accurate - Robust - High battery capacity - Ability to operate offline - Easy to use - Easy to understand outputs - Integrated with existing systems - (add as needed)	Small, fast, accurate

Additional questions or comments

BIOLAN

Interview details

Interview date:	3th October 2019
Interviewer:	Arrate Jaureguibeitia
Interview form (telephone, mail, face to face, survey, etc.):	email, telephone
Respondent name:	
Respondent e-mail:	
Respondent company/organization:	
Company/organization address:	
Company/organization website:	

Questions relating to the respondent

What is your role in the company/organization (title)?	
Number of years in the company?	
What is your experience within the industry?	

Questions relating to the company/organization the respondent represents

What are your main business areas?	Fishery, aquaculture (turbot, vannamei shrimp, tilapia), manufacturing and selling of fishery and aquaculture products
What is the size of your company (number of people, SME?, profitability, harvest units, etc.)?	More than 10,000 employers in Europe, America, Africa and Asia. We farm in an area of 7,000 Ha, producing 60,000 MT. We process 177,000 MT of seafood products in 17 processing plants. We sell in 80 countries € 1.008 billion
Where are you located? Does location matter for your products?	
Who are your competitors? What are your main strengths / weaknesses? What is the market position for your product?	We market in 80 countries and leaders in Spain and Portugal. is a brand at consumers' top of mind Ranked 8 among the most chosen brands by Spanish consumers

Questions relating to the production process where the sensor is to be applied

In what production process do you intend to use the sensor?	Sulphite treatment
How many sensors would you need?	8 sensors could be fine

Where in the process do you intend to use the sensor? Geographically, where is this process located?	
How important is this process for your company?	Controlling sulfite levels in water treatment is very important, because of regulation compliance, and also because of process efficiency.
In general, what are the challenges related to this process?	Have the whole control of sulphite levels during the treatment processing.
What are the customer / consumer requirements relating to the outputs of this process?	immediate and reliable results
What sensors do you currently use to monitor this process?	BIOLAN in crustaceans
In what way would the sensor proposed here be of use to you?	Measurement of sulphite levels in treatment water in our ponds
What would you hope to achieve by using this sensor (lower cost, better yield, better control, higher product price, customer preference, …)?	Lower cost, better yield, better control.
Please indicate importance of the following sensor attributes - Low price - Small - Fast - Accurate - Robust - High battery capacity - Ability to operate offline - Easy to use - Easy to understand outputs - Integrated with existing systems - (add as needed)	From 1 to 5: - Low price: 5 - Small: 4 - Fast: 5 - Accurate: 5 - Robust: 5 - High battery capacity: 2 - Ability to operate offline: 4 - Easy to use: 4 - Easy to understand outputs: 5 - Integrated with existing systems: 3

Additional questions or comments

Do you have your own Data Management Software or LIMS? If yes, would you like to integrate the data retrieved by the sensors in this software?	Yes, but crustaceans data LIMS (Oralims). We would like to integrate the data
Do you find of interest a tool to visualize and share data retrieve by the sensors?	Yes, very interesting
Do you find of interest the possibility of obtaining statistics and alerts from data retrieved by the sensors?	Yes, huge of interest
Would you share your data	Yes to achieve project results Would not share with competitors

NORCE

Interview details

Interview date:	07.10.2019
Interviewer:	Lars Vognild
Interview form (telephone, mail, face to face, survey, etc.):	Skype, and then email
Respondent name:	
Respondent e-mail:	
Respondent company/organization:	
Company/organization address:	
Company/organization website:	

Questions relating to the respondent

What is your role in the company/organization (title)?	
Number of years in the company?	
What is your experience within the industry?	

Questions relating to the company/organization the respondent represents

What are your main business areas?	IMTA development, here industrializing seaweed cultivation
What is the size of your company (number of people, SME?, profitability, harvest units, etc.)?	SME
Where are you located? Does location matter for your products?	
Who are your competitors? What are your main strengths / weaknesses? What is the market position for your product?	Seaweed cultivators, specifically sugar kelp

Questions relating to the production process where the sensor is to be applied

In what production process could you envision the use of a sensor?	Macroalgae cultivation in ocean rigs
How many sensors would you ideally want to use? and are there any reasons why you would deploy fewer sensors than the ideal?	Outgrowing in ocean phase: Salinity, light, temperature, phosphorus Video monitor of: Growth and epiphyte colonization
Where in the process do you intend to use the sensor? Geographically, where is this process located?	Outgrowing in ocean phase, Norwegian coast
How important is this process for your company?	Central

In general, what are the challenges related to this process?	Maximizing growth, optimizing growth conditions, minimizing epiphyte colonization prior to harvest
What are the customer / consumer requirements relating to the outputs of this process?	Macroalgae for food ideally free of epiphytes
What sensors do you currently use to monitor this process?	Unable to ascertain info at point of interview. Monitoring of ocean conditions in use, source of info or technology used unclear
What would you hope to achieve by using a sensor (lower cost, better yield, better control, higher product price, customer preference, …)?	Optimization of localities, better control of parameters relevant for growth possibly enabling better yield, better control of appearance and biomass increase
Please indicate importance of the following sensor attributes - Low price - Small - Fast - Accurate - Robust - High battery capacity - Ability to operate offline - Easy to use - Easy to understand outputs - Integrated with existing systems (add as needed)	Likely all

Additional questions or comments

Do you have issues with existing sensors you are using?	Unable to ascertain
What information gap have you identified?	Unable to ascertain
How would a flexible sensor platform allowing you to place sensors temporarily in other locations be useful to you?	Likely most use for fixed monitoring at outgrowing site over growing period

Interview details

Interview date:	03/10/2019
Interviewer:	Lars Vognild
Interview form (telephone, mail, face to face, survey, etc.):	Skype
Respondent name:	
Respondent e-mail:	
Respondent company/organization:	
Company/organization address:	
Company/organization website:	

Questions relating to the respondent

What is your role in the company/organization (title)?	
Number of years in the company?	
What is your experience within the industry?	

Questions relating to the company/organization the respondent represents

What are your main business areas?	Seaweed aquaculture and processing for food, cosmetics and feed additives. Fish farming as part of the IMTA system.
What is the size of your company (number of people, SME, profitability, harvest units, etc.)?	SME, 18 people, first positive year in 2017. Sales from production close to 500 000€. Land-based integrated aquaculture unit with 14ha available. Currently 15,000m2 with fish and 700m2 with seaweed. Next year same for fish, increase of seaweed to 1400m2.
Where are you located? Does location matter for your products?	Yes: natura2000 site, water quality, existence of fish farms with available space for farming, strong processing capacities in the region, proximity to University of Aveiro.
Who are your competitors? What are your main strengths / weaknesses? What is the market position for your product?	Competitors: Seaweed suppliers across Europe, Microalgae suppliers; Vegetable ingredients Market: Premium (quality, origin, sustainability, technical support) but with democratization objectives. Organic certified. Seaweed sold as ingredient/additive; Seaweed-based finished products for specialized retail and Horeca channels.

Questions relating to the production process where the sensor is to be applied

In what production process could you envision the use of a sensor?	In different phases of our production and processing. Production: Fish (Daily): salinity, DO, temperature Seaweed (Daily) hatchery and outdoor tanks: pH, temperature, salinity, irradiance (PAR), DIN (ammonia, nitrate, phosphate) – sporadically Seaweed Processing: Moisture content of the biomass during drying (to avoid several sampling moments during that process)
How many sensors would you ideally want to use? are there any reasons why you would deploy fewer sensors than the ideal?	No pre-defined number. More important is to get the data in a reliable, fast way. That allow us to process and use integrated data to manage the processes.
Where in the process do you intend to use the sensor? Geographically, where is this process located?	On-shore system. Easy access by road, access to all sorts of telecommunications.
How important is this process for your company?	Mandatory
In general, what are the challenges related to this process?	Currently the data are collected manually with multiparametric sensors. Data are not integrated with the daily decisions and/or interpretation of events since data processing/treatment is a time-consuming activity…
What is the customer / consumer requirements relating to the outputs of this process?	Customer looks for traceability, quality and sustainability measures.
What sensors do you currently use to monitor this process?	pH, Salinity, DO, Temperature – Hach Lange rough multiparametric Irradiance|PAR – Apogee sensor or Li-Cor (spherical, better) DIN – sporadic measurements done by university lab (SKALAR water analyser) Moisture in biomass – Moisture scale
What would you hope to achieve by using a sensor (**lower cost, better yield**, **better control**, higher product price, customer preference, …)?	Assistance to production management allowing processes to be more accurate and efficient = optimized production protocols, automation, lower costs, higher yields, better traceability)
Please indicate importance of the following sensor attributes - Low price - Small - Fast - Accurate - Robust - High battery capacity - Ability to operate offline - Easy to use - Easy to understand outputs - Integrated with existing systems	- Accurate - Low price - Robust - Integrated with existing systems - Ability to operate offline -

Additional questions or comments

Do you have issues with existing sensors you are using?	They always need an assigned operator. Data is good, a lot but not integrated with production management platform.
What information gap have you identified?	
How would a flexible sensor platform allowing you to place sensors temporarily in other locations be useful to you?	Sent you an image. Very important as it would be important that the sensors can be moved between production units.

Interview details

Interview date:	2019-09-30
Interviewer:	Lars Vognild
Interview form (telephone, mail, face to face, survey, etc.):	Skype
Respondent name:	
Respondent e-mail:	
Respondent company/organization:	
Company/organization address:	
Company/organization website:	

Questions relating to the respondent

What is your role in the company/organization (title)?	
Number of years in the company?	
What is your experience within the industry?	

Questions relating to the company/organization the respondent represents

What are your main business areas?	Å: R&D K: Mussel farming
What is the size of your company (number of people, SME?, profitability, harvest units, etc.)?	Å: 300 pers K: 7-8
Where are you located? Does location matter for your products?	
Who are your competitors? What are your main strengths / weaknesses? What is the market position for your product?	K: Scanfjord, Danish mussel producers (even scallops), mussel farmers in Northern Europe Strengths: processes efficency improvement, innovation, durability/"keeping quality" aspects Weaknesses: needs to establish/build brand, increase production Market position: Producer

Questions relating to the production process where the sensor is to be applied

In what production process could you envision the use of a sensor?	Larvae/spawn settling, growth phase (growth, fouling, HABs)
How many sensors would you ideally want to use? and are there any reasons why you would deploy fewer sensors than the ideal?	3-5 per cultivation Costs + maintenance
Where in the process do you intend to use the sensor? Geographically, where is this process located?	Larvae/spawn settling, growth phase (growth, fouling, HABs)

How important is this process for your company?	Very (Larvae/spawn settling), desirable (growth phase)
In general, what are the challenges related to this process?	Timing of larvae/spawn settling + concurrence with fouling organisms Reduced product quality due to fouling Suboptimal farming conditions (food scarcity) Production stop due to toxic algae
What are the customer / consumer requirements relating to the outputs of this process?	Clean, toxin-free mussels
What sensors do you currently use to monitor this process?	None (manual sampling for HABs)
What would you hope to achieve by using a sensor (lower cost, better yield, better control, higher product price, customer preference, …)?	Better process control Increase number of settled mussles Better product quality –> better price Predictive instead of reactive/production planning/harvest planning
Please indicate importance of the following sensor attributes - Low price - Small - Fast - Accurate - Robust - High battery capacity - Ability to operate offline - Easy to use - Easy to understand outputs - Integrated with existing systems (add as needed)	- Low price - Accurate - Robust - High battery capacity - Easy to maintain

Additional questions or comments

Do you have issues with existing sensors you are using?	No – the issue is that they do not exist
What information gap have you identified?	See earlier answer
How would a flexible sensor platform allowing you to place sensors temporarily in other locations be useful to you?	Valueable: Assess new localities, locality-specific differences in settling, assess food availability, food safety

Interview details

Interview date:	23/092019
Interviewer:	Lars K. Vognild
Interview form (telephone, mail, face to face, survey, etc.):	Email
Respondent name:	
Respondent e-mail:	
Respondent company/organization:	
Company/organization address:	
Company/organization website:	

Questions relating to the respondent

What is your role in the company/organization (title)?	
Number of years in the company?	
What is your experience within the industry?	

Questions relating to the company/organization the respondent represents

What are your main business areas?	Research and education
What is the size of your company (number of people, SME?, profitability, harvest units, etc.)?	Marine Shrimp Laboratory is a research lab. We have working 6 professors, 4 technicians and around 40 students.
Where are you located? Does location matter for your products?	
Who are your competitors? What are your main strengths / weaknesses? What is the market position for your product?	We have no competitors. We are a university. We do not consider the other universities or research labs competitors.

Questions relating to the production process where the sensor is to be applied

In what production process could you envision the use of a sensor?	On biofloc system (shrimp production system)
How many sensors would you ideally want to use? and are there any reasons why you would deploy fewer sensors than the ideal?	1 per tank to measure oxygen and temperature.
Where in the process do you intend to use the sensor? Geographically, where is this process located?	
How important is this process for your company?	It is important to control mainly the oxygen on the water, but we can survive without then.
In general, what are the challenges related to this process?	The main challenge is to maintain the water quality parameters adequate for the shrimp.
What are the customer / consumer requirements relating to the outputs of this process?	Our consumer are companies that contract us to do experiments. So, they expect good and confinable data.
What sensors do you currently use to monitor this process?	We have portable oximeters, pHmeters and thermometers.
What would you hope to achieve by using a sensor (lower cost, better yield, better control, higher product price, customer preference, …)?	Better control of water quality and a sensor with low cost and durability.
Please indicate importance of the following sensor attributes - Low price - Small - Fast - Accurate - Robust - High battery capacity - Ability to operate offline - Easy to use - Easy to understand outputs - Integrated with existing systems (add as needed)	- Low price – very important - Small – not very important - Fast – important - Accurate – very important - Robust - important - High battery capacity – not very important - Ability to operate offline – important - Easy to use – important - Easy to understand outputs – important - Integrated with existing systems – important

Additional questions or comments

Do you have issues with existing sensors you are using?	They are expensive and the maintenance is also expensive.
What information gap have you identified?	None
How would a flexible sensor platform allowing you to place sensors temporarily in other locations be useful to you?	It would be very interesting. Depending of the experiment, I could use different sensors.

Interview details

Interview date:	20 September 2019
Interviewer:	Lars Vognild, NORCE
Interview form (telephone, mail, face to face, survey, etc.):	Skype
Respondent name:	
Respondent e-mail:	
Respondent company/organization:	
Company/organization address:	
Company/organization website:	

Questions relating to the respondent

What is your role in the company/organization (title)?	
Number of years in the company?	
What is your experience within the industry?	

Questions relating to the company/organization the respondent represents

What are your main business areas?	Research on fish reproduction
What is the size of your company (number of people, SME?, profitability, harvest units, etc.)?	Embrapa is a public, non-profit research institute owned by the Brazilian government, has 9545 employees in 47 research units spread around Brazil. Its social profit of 9.77 billion EUR (2018; 165 technologies and 220 cultivars)
Where are you located? Does location matter for your products?	Yes, our location is important given the species farmed in the region are climate/ecosystem specific.
Who are your competitors? What are your main strengths / weaknesses? What is the market position for your product?	Do not apply. We are a public research company.

Questions relating to the production process where the sensor is to be applied

In what production process could you envision the use of a sensor?	In researches willing to understand the influence of water quality parameters on the reproduction or a finfish species.
How many sensors would you ideally want to use? and are there any reasons why you would deploy fewer sensors than the ideal?	Ideally, I want to monitor water quality parameters (Temperature, water depth, dissolved O_2) in 12 earth ponds where couples of *Arapaima gigas* breeders will be stocked. No.
Where in the process do you intend to use the sensor? Geographically, where is this process located?	Earth ponds are located at Embrapa Fisheries and Aquaculture,

How important is this process for your company?	It is important for research since environmental parameters highly influence reproduction of finfish species, and these parameters need to be monitored in such experiments.
In general, what are the challenges related to this process?	Acquire cheap sensors; acquire know-how on automation (Arduino etc.)
What are the customer / consumer requirements relating to the outputs of this process?	Do not apply.
What sensors do you currently use to monitor this process?	At the moment, none.
What would you hope to achieve by using a sensor (lower cost, better yield, better control, higher product price, customer preference, …)?	Precision, reliable data for use in experiments on fish reproduction.
Please indicate importance of the following sensor attributes - Low price - Small - Fast - Accurate - Robust - High battery capacity - Ability to operate offline - Easy to use - Easy to understand outputs - Integrated with existing systems (add as needed)	All important !

Additional questions or comments

Do you have issues with existing sensors you are using?	Do not apply
What information gap have you identified?	Do not apply
How would a flexible sensor platform allowing you to place sensors temporarily in other locations be useful to you?	For the reproduction system we plan to have, this is not important at the moment.

ii. Subtask Specification

DTU

The overall T4.2 is broken up into sub-tasks as follows:

Subtask	Subtask description	Start month	End month	Participants in development process	Industry / user participants
T4.2.1	**Data collection in tanks.** The UTOFIA system will be used in the tank available at DTU to collect images from known targets at different level of complexity (from a simple box to mussels). Data will be stored in binary format for further analyses and software development.	8	12	DTU Aqua	none
T4.2.2	**Software development**. Analyses of the images and data collected in Task 4.2.1 are conducted here. The software will include computer vision and machine learning algorithms for object detection, edge identification, 3D estimates of object of interest, volume calculation. The software should be able to estimate volumes of object of interests.	13	18	DTU Aqua	Musholm, BIORAS
T4.2.3	**Data collection in real conditions**. UTOFIA system will be deployed in CS8 and images collected in real conditions. Operation at sea will be conducted in this task and samples taken for software validation.	19	30	DTU Aqua Norut	Musholm
T4.2.4	**Refining software, integration of IoT technologies and end user test**. (1MM). Images collected in T4.2.3 will be processed to refine the software and estimate uncertainties to finalize a first end-user interface. Integration with IoT systems will be provided in this task. Norut will be responsible to define the encoding and exchange format for all data to be transferred to the IoT platform and develop the APIs to enable the collection of data from the biosensor.	31	42	DTU Aqua Norut	Musholm, BIORAS

The first sensor prototype, developed end delivered by M12, will have the following attributes:

- Ability to collect 3D images of object of interests (e.g. mussels)

The focus of the second prototyping loop, from M18 (when user feedback is available) to M36, is to add the following attributes to the sensor:

- Autonomous edge detection and volume estimates for object of interest
- IoT interface

Collaboration between DTU and NORCE:

Subtask	Subtask description	Start month	End month	Participants in development process	Industry / user participants
T4.2.5	Integration of the UTOFIA camera in the AquaVitae IoT platform, enabling automatic transfer and storage of data, and visualization and analysis.	6	18, 36	NORCE, DTU	Appropriate use-cases

The first sensor platform prototype, developed end delivered by M12, will have the following attributes:

- **Preliminary** integration of the UTOFIA camera into the AquaVitae IoT platform, enabling automatic transfer and storage of data, and **simple** visualization.

The focus of the second prototyping loop, from M18 (when user feedback is available) to M36, is to add the following attributes to the sensor platform:

- **Final** integration of the UTOFIA camera into the AquaVitae IoT platform, enabling automatic transfer and storage of data, **visualization** and **analysis**.

BIOLAN

The overall T4.3 is broken up into sub-tasks as follows:

Subtask	Subtask description	Start month	End month	Participants in development process	Industry / user participants
T4.3.1	Improvement of BIOFISH 700 by implementation of Bluetooth module; integration of the Bluetooth communication solution	1	12	BIOLAN	GRUPO NUEVO PESCANOVA
T4.3.2	Development of an App that will be implemented on a mobile device acting as a data gateway and user interface.	6	48	BIOLAN	GRUPO NUEVO PESCANOVA
T4.3.3	Development of an improved biosensing device based on System on Chip electrconics (BIOFISH7000); this task will provide a fully functional hardware system; integration of the Bluetooth communication solution	12	48	BIOLAN	GRUPO NUEVO PESCANOVA
T4.3.4	Integration of the biosensor into the AquaVitae IoT platform, enabling automatic transfer and storage of data, visualization and analysis.	6	18, 36	NORCE, BIOLAN	GRUPO NUEVO PESCANOVA

The first sensor prototype, developed end delivered by M12, will have the following attributes:

- Bluetooth enabled biosensing device
- First prototype of an App on a mobile device as connection to BIOLAN cloud
- **Preliminary** integration of the BIOFISH biosensor into the AquaVitae IoT platform, enabling automatic transfer and storage of data, and **simple** visualization.

The focus of the second prototyping loop, from M18 (when user feedback is available) to M36, is to add the following attributes to the sensor:

- Improvement of biosensing device by implementation of System on Chip electronics
- Improvement of the developed App
- **Final** integration of the **new** BIOFISH biosensor into the AquaVitae IoT platform, enabling automatic transfer and storage of data, visualization and **analysis**

NORCE

The overall T4.4 is broken up into sub-tasks as follows:

Subtask	Subtask description	Start month	End month	Participants in development process	Industry / user participants
T4.4.1	Design and develop the IoT sensor platform.	6	12, 36	NORCE	
T4.4.2	Identify and integrate the needed sensors, IoT devices and platforms at the selected test sites.	6	12, 30	NORCE	The selected use-cases
T4.4.3	Develop machine learning functionality for sensor fusion, sensor calibration, sensor monitoring and prognosis.	6	12, 36	NORCE	
T4.4.4	Test and evaluate the IoT platform in selected IMTA, shellfish, finfish, or other production cases.	13	18, 36	NORCE	The selected use-cases
T4.4.5	Develop a flexible and simple visual tool (dashboard) to create AI training sets with automated training, validation and deployment of AI based monitors / virtual sensors.	19	36	NORCE	The selected use-cases
T4.4.6	Develop edge computing support for sensors and AI based **analysis**.	19	36	NORCE	

The first sensor platform prototype, developed end delivered by M12, will have the following attributes:

- A **preliminary** prototype version of the IoT platform, with support for **automatic** transfer and storage of data and **simple** visualization.
- Sensors of interest for the use-cases **identified** and **integrated** with the IoT platform.
- **Machine learning** functionality for sensor fusion, sensor calibration, sensor monitoring and prognosis.
- **Integration** with sensors and platforms at the selected test sites, were possible, for data import and export.

The focus of the second prototyping loop, from M18 (when user feedback is available) to M36, is to add the following attributes to the sensor platform:

- **Final** version of the IoT sensor platform, integrated with **all appropriate** IoT sensors.
- A visual tool (**dashboard**) to create AI training sets with automated training, validation and deployment of AI based monitors / virtual sensors.
- **Edge computing** support for sensors and AI based **analysis**