*Final Conference*
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WP5
Internet of things for healthy fish and environment

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# Acknowledgments

- ## Institutes

- COISPA Tecnologia & Ricerca, Bari (Italy)

- Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe), Padova (Italy)

- DTU Aqua

- University of Thessaly, Vólos (Greece)

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- University of Bologna

- Aquaculture farms
  AVRAMAR, Kefalonia Fisheries SA, Vork, Hornbæk

# Internet of Things for healthy fish and environment
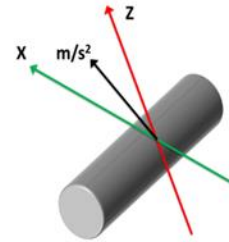
Network of physical objects or « things » embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.



Aquaculture

## Task 5.1.1 - State-of-the-art and future needs



Fish health & welfare

Accelerometer tags

Electromyogram - EMG
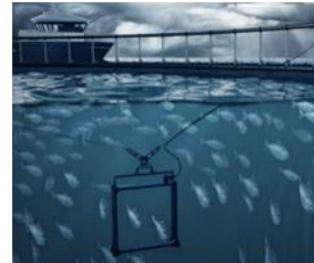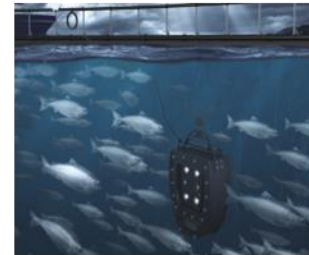
Heart beat rate logger

IP camera system

Biomass estimation

Acoustic transmissions
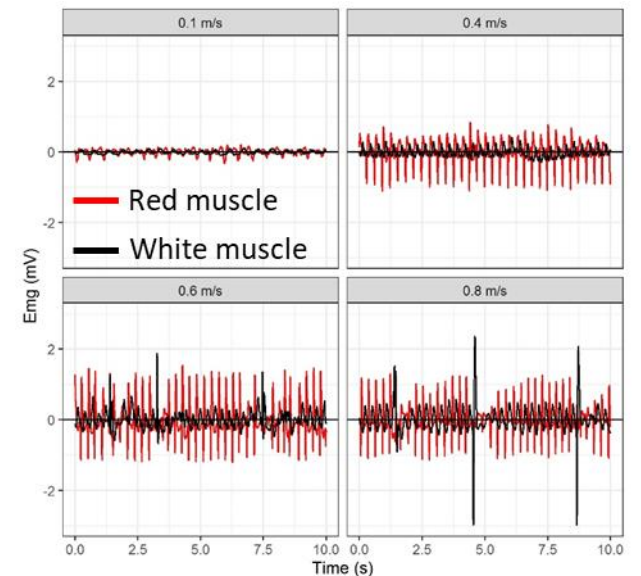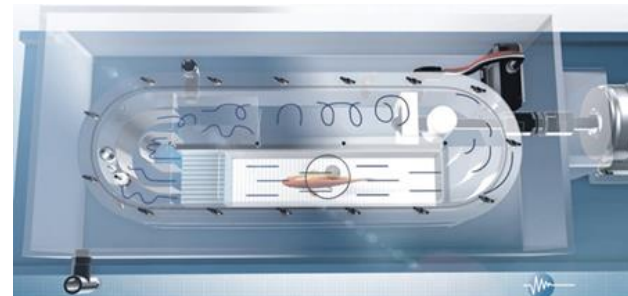
Infrared technologies

Video cameras

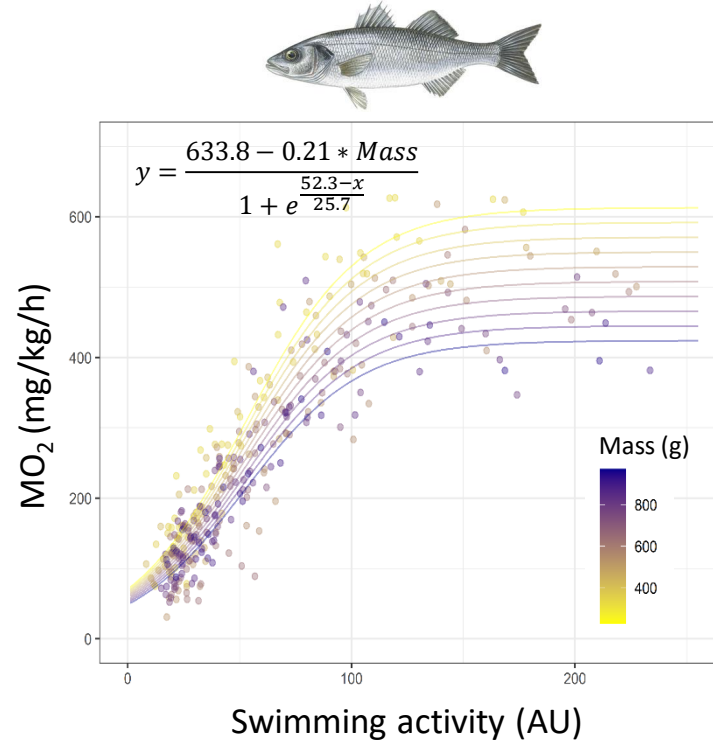See the **deliverable D5.1** for more details:
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/home

# Task 5.1 - Wireless sensor networks and technologies

## Task 5.1.2 - Calibration of physiological sensors technologies



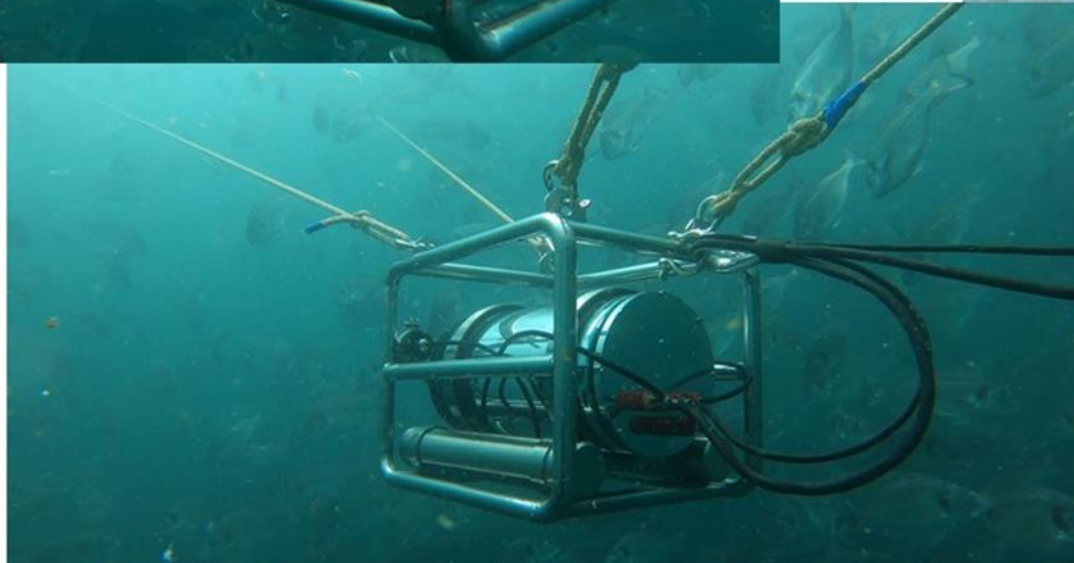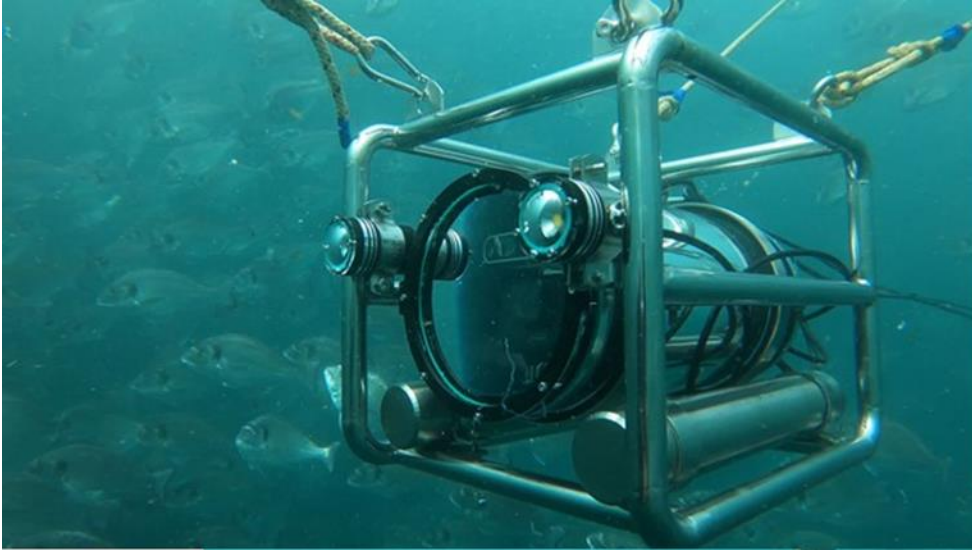$$y = \frac{696.8 - 0.34 * Mass}{1 + e^{\frac{34.4 - x}{19.3}}}$$

$$y = \frac{633.8 - 0.21 * Mass}{1 + e^{\frac{52.3 - x}{25.7}}}$$

$$y = \frac{466.7}{1 + e^{\frac{24,7 - x}{18.1}}}$$
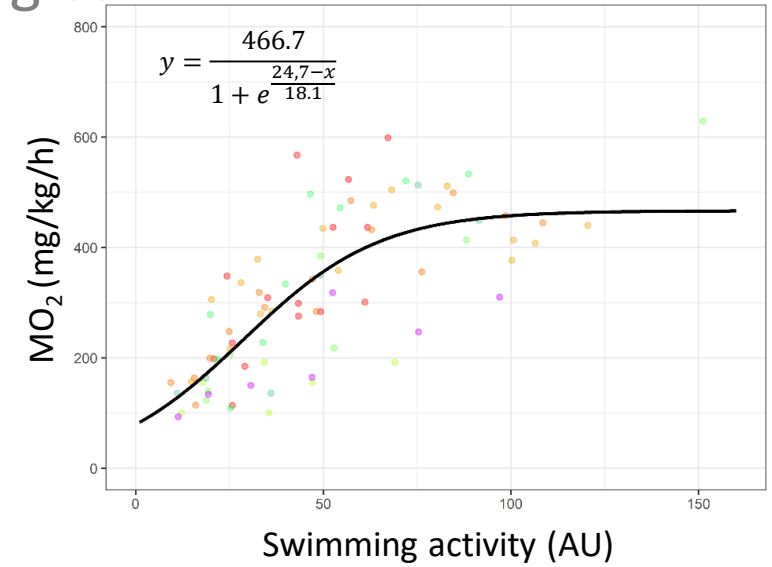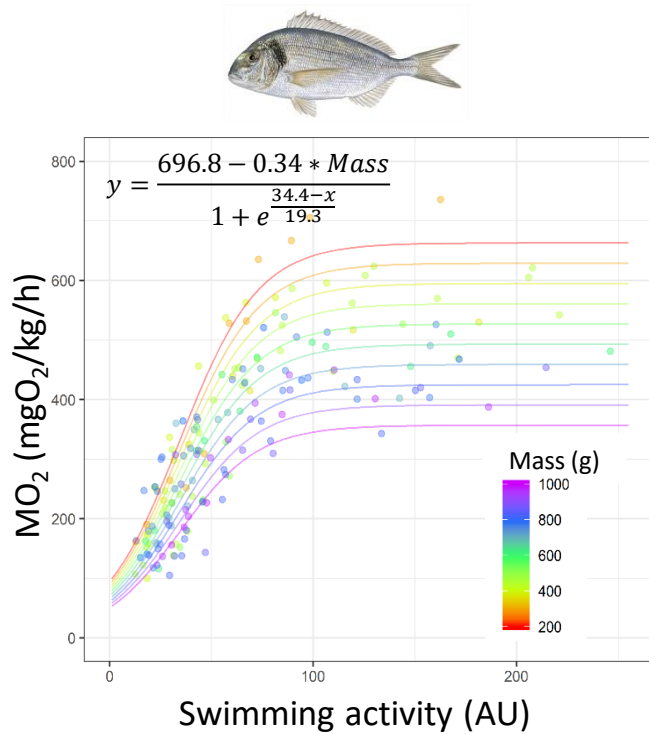
Calibration work published:
- **Rainbow trout:** Zupa et al., 2021 https://doi.org/10.3390/ani11061496
- **Sea bream:** Alfonso et al., 2021 https://doi.org/10.3390/biology10121357
- **Sea bass:** Alfonso et al., 2022 https://doi.org/10.3389/fanim.2022.885850

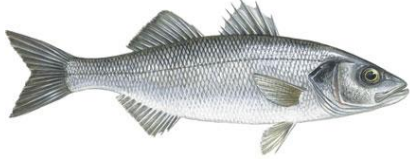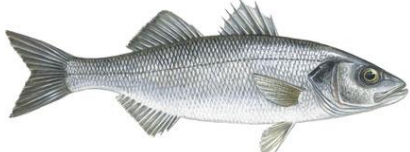**Task 5.1.3 -** Development of biomass estimation sensing system

# Task 5.1 - Wireless sensor networks and technologies

## Task 5.1.4 - Planning the fish health and welfare monitoring activities

| Large scale experiments: Innovative diets [Link with WP2, AUTH and DTU] *Task 5.2 & 5.3 - Enhancing fish health & welfare* | | | Wireless sensor network *Task 5.4 - Enhancing environmental sustainability* |
|---|---|---|---|
| European sea bass | Sea bream | Rainbow trout | European sea bass |
|  |  |  |  |
| **Conventional :** AVRAMAR, Palairos (GR) (2020-2021) | **Conventional :** COISPA, Bari (IT) (2022) | **Conventional :** Hornbæk, Løgstør (DK) (2022) | **Implementation of the system:** KEFISH Fisheries, Argostoli (GR) (2021-2022) |
| **Organic:** Galaxidi farm, Galaxidi (GR) (2020-2021) | **Organic:** COISPA, Bari (IT) (2022) | **Organic:** Vork, Egtved (DK) (2022) | |

Enhancing environmental/economic sustainability
Wireless communication system
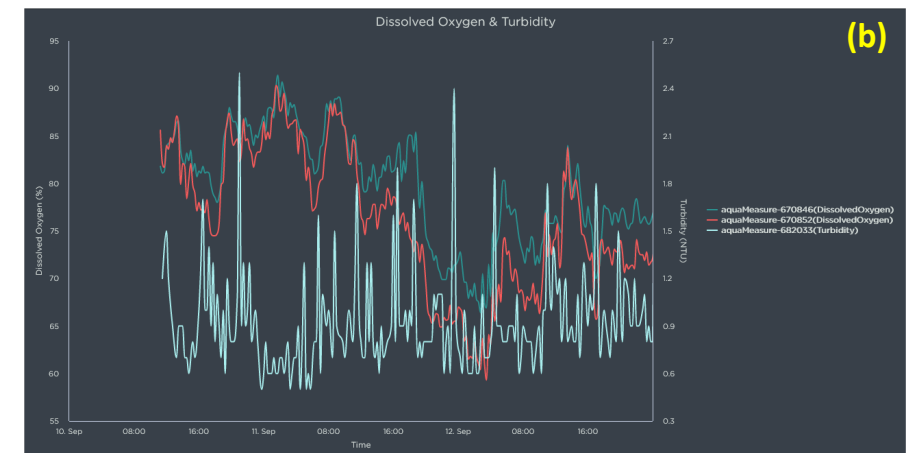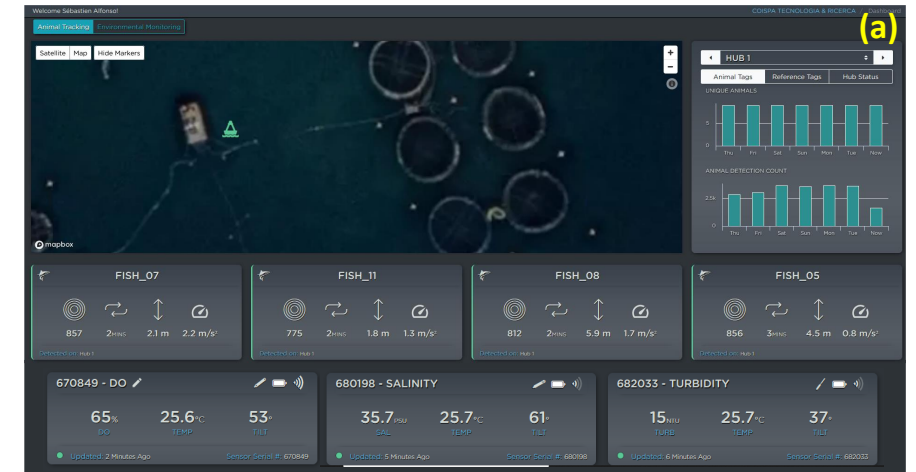Experiment with KEFALONIA farm - Argostoli

# Experimental protocol
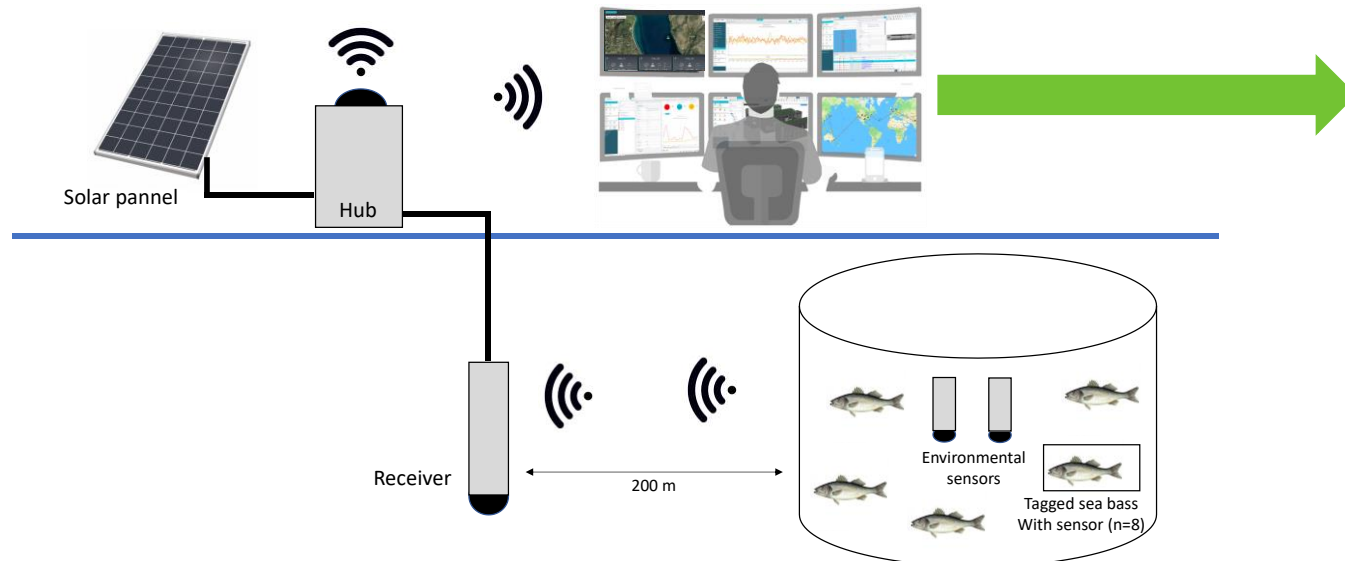
Live dashboard
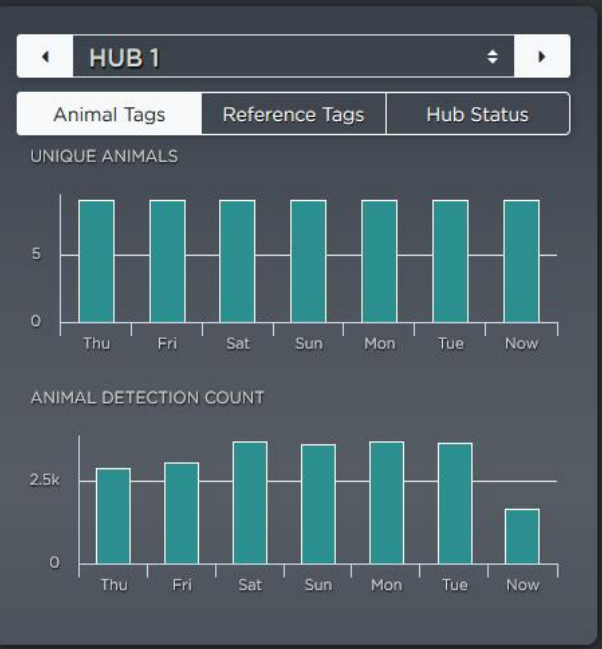


- **Material:**
- - DO sensors
- - Temperature sensors
- - Turbidity sensors
- - Salinity sensors
- - Accelerometer sensors

**Animal Tracking**    Environmental Monitoring

Satellite | Map | Hide Markers

mapbox

◄ | HUB 1 | ⬍ | ►

Animal Tags | Reference Tags | Hub Status

UNIQUE ANIMALS

5

0

Thu | Fri | Sat | Sun | Mon | Tue | Now

ANIMAL DETECTION COUNT

2.5k

0

Thu | Fri | Sat | Sun | Mon | Tue | Now

## FISH_07

857 | 2 MINS | 2.1 m | 2.2 m/s²

Detected on: Hub 1

## FISH_11

775 | 2 MINS | 1.8 m | 1.3 m/s²

Detected on: Hub 1

## FISH_08

812 | 2 MINS | 5.9 m | 1.7 m/s²

Detected on: Hub 1

## FISH_05

856 | 3 MINS | 4.5 m | 0.8 m/s²

Detected on: Hub 1

### 670849 - DO

**65**% DO | **25.6**°C TEMP | **53**° TILT

● Updated: 2 Minutes Ago      Sensor Serial #: 670849

### 680198 - SALINITY

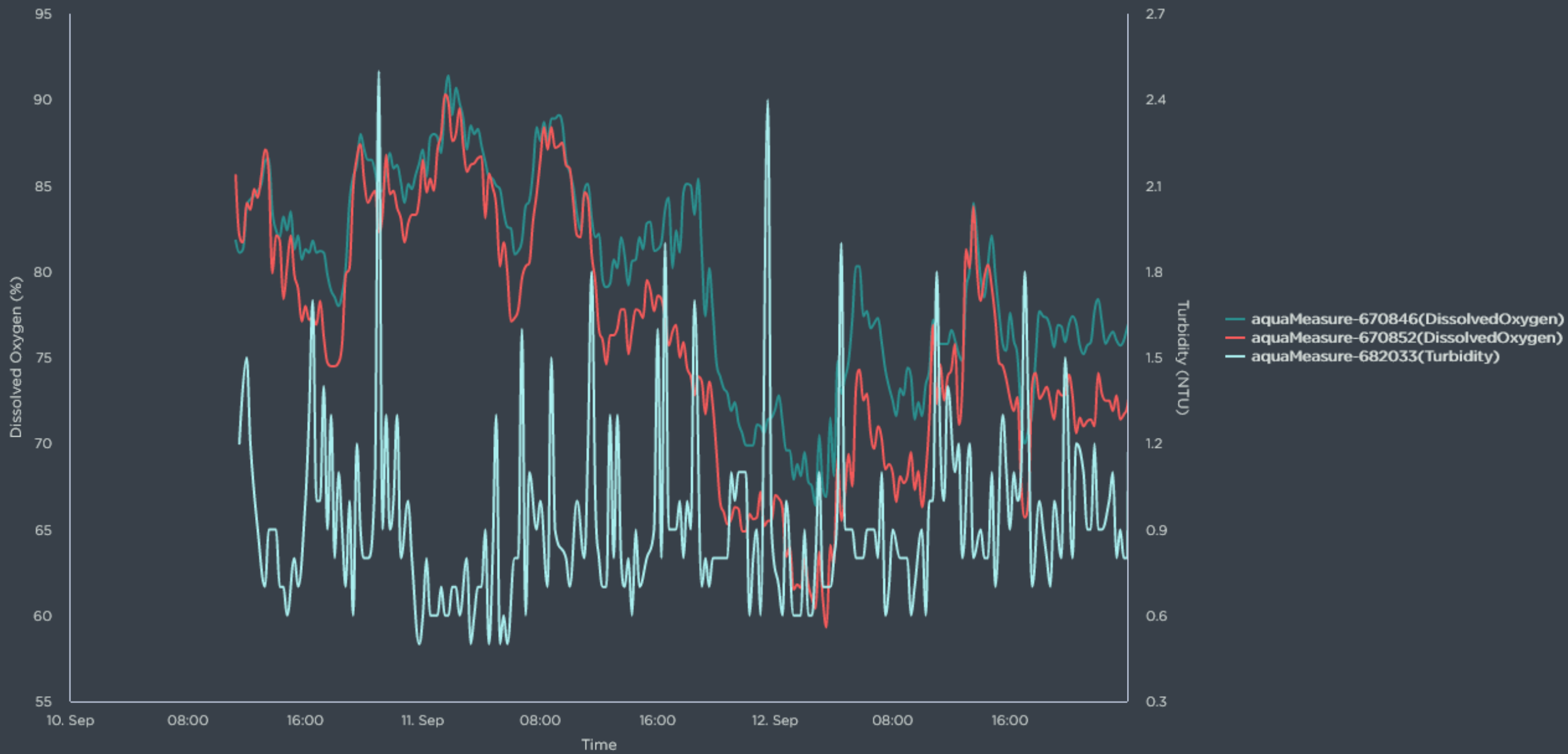**35.7** PSU SAL | **25.7**°C TEMP | **61**° TILT

● Updated: 5 Minutes Ago      Sensor Serial #: 680198

### 682033 - TURBIDITY

**15** NTU TURB | **25.7**°C TEMP | **37**° TILT

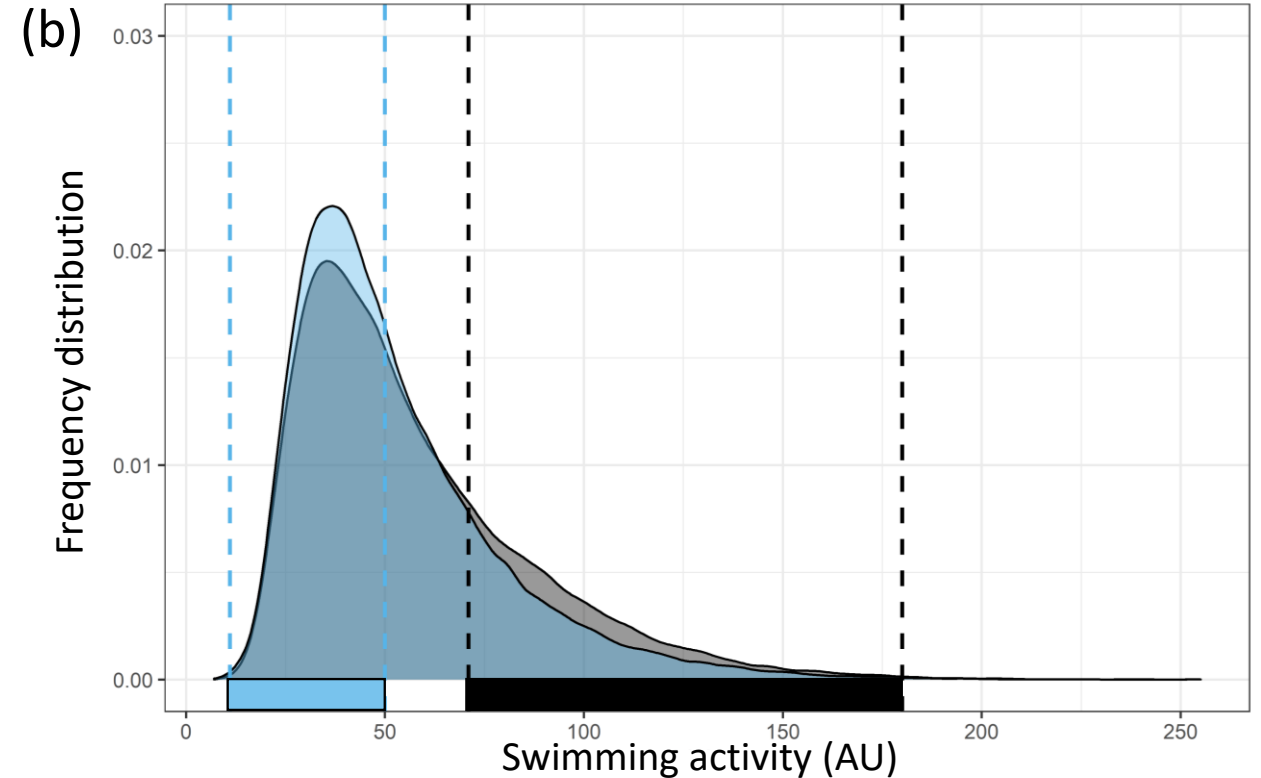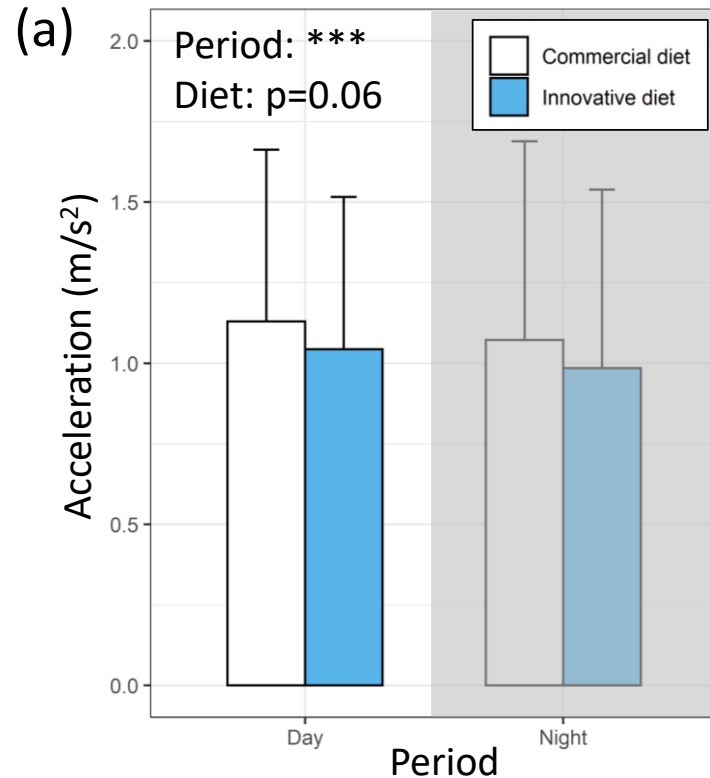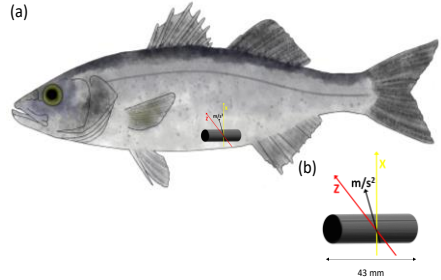● Updated: 6 Minutes Ago      Sensor Serial #: 682033

Dissolved Oxygen & Turbidity

Enhancing fish health and welfare
Commercial vs. innovative diet
Experiment with AVRAMAR - Palairos

**1 |** European sea bass | Conventional | AVRAMAR, Palairos (GR)



- **Conclusion:**
- Sea bass fed innovative diet tends to display lower acceleration over the experimental duration (p=0.06).
- Differences in frequency distribution of swimming activity values between the two diets
➔ **Greater use of anaerobic metabolism in fish fed control diet than fish fed innovative diet**

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# Task 5.2 & 5.3 - Enhancing fish health & welfare

## Assessing physiological effects of feeding an innovative diet

- **PCA analysis| Combination of tag data with other health/welfare markers**
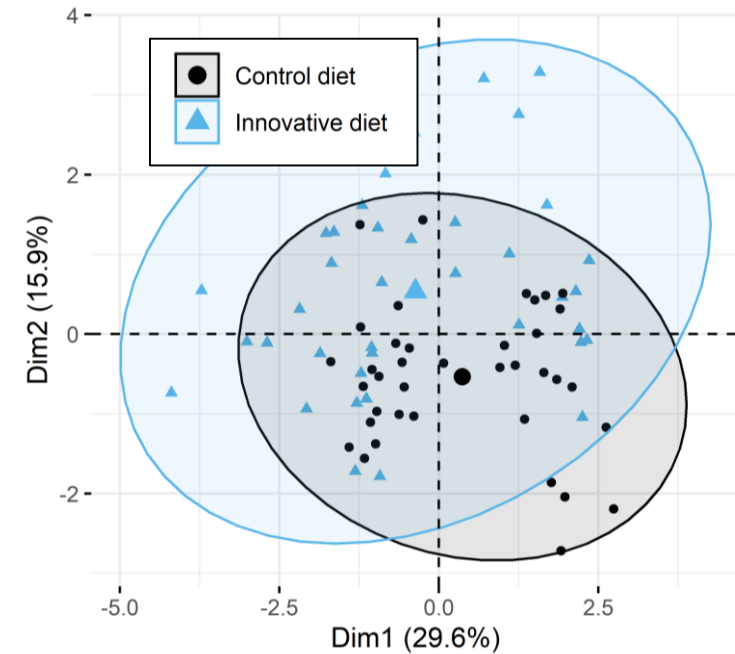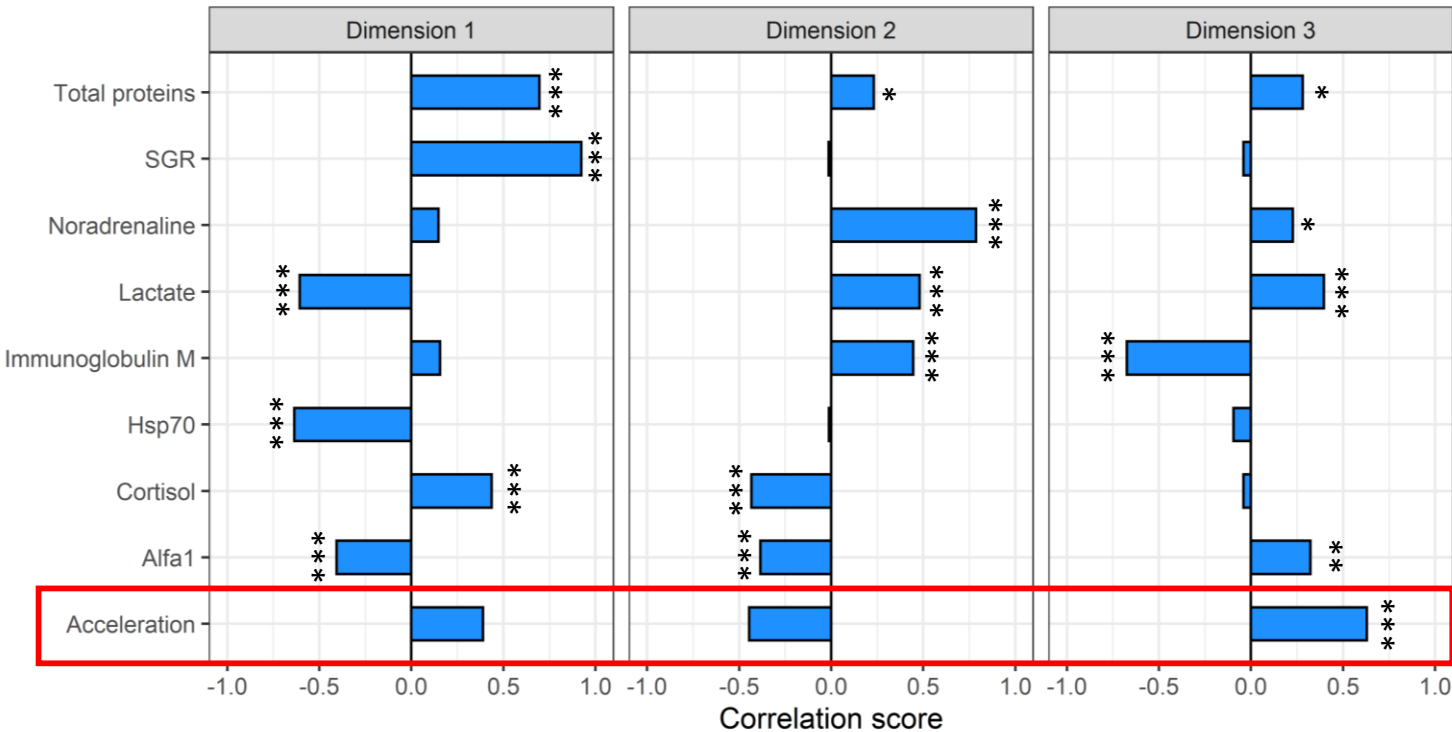


**Dim 2.** Innov > control diet

- **Conclusion:**

Acceleration recorded by tag could be linked to other health/welfare markers (e.g. cortisol, lactate, total proteins)
➔ Give a larger and more comprehensive overview of health/welfare state of fish because continuous welfare monitoring

IMPACT & INNOVATION

# Impact & Innovation

**Where we are**



O$_2$ concentration

Add of O$_2$



**Where we want to go**



O$_2$ concentration

Growth performances

Fish activity

Early identification to prevent health/welfare issue



**Algorithmes/ machine learning**

# Impact & Innovation

**Real-time interaction between farm and farmers**

Biomass

Water quality

Swimming acitivity

Physiological markers

Cloud Server

4G Base station

Gateway Device

Sensors

Camera System

**Feedback / Decisions**

**Wireless communication system and sensor network**

FUTURE EU AQUA
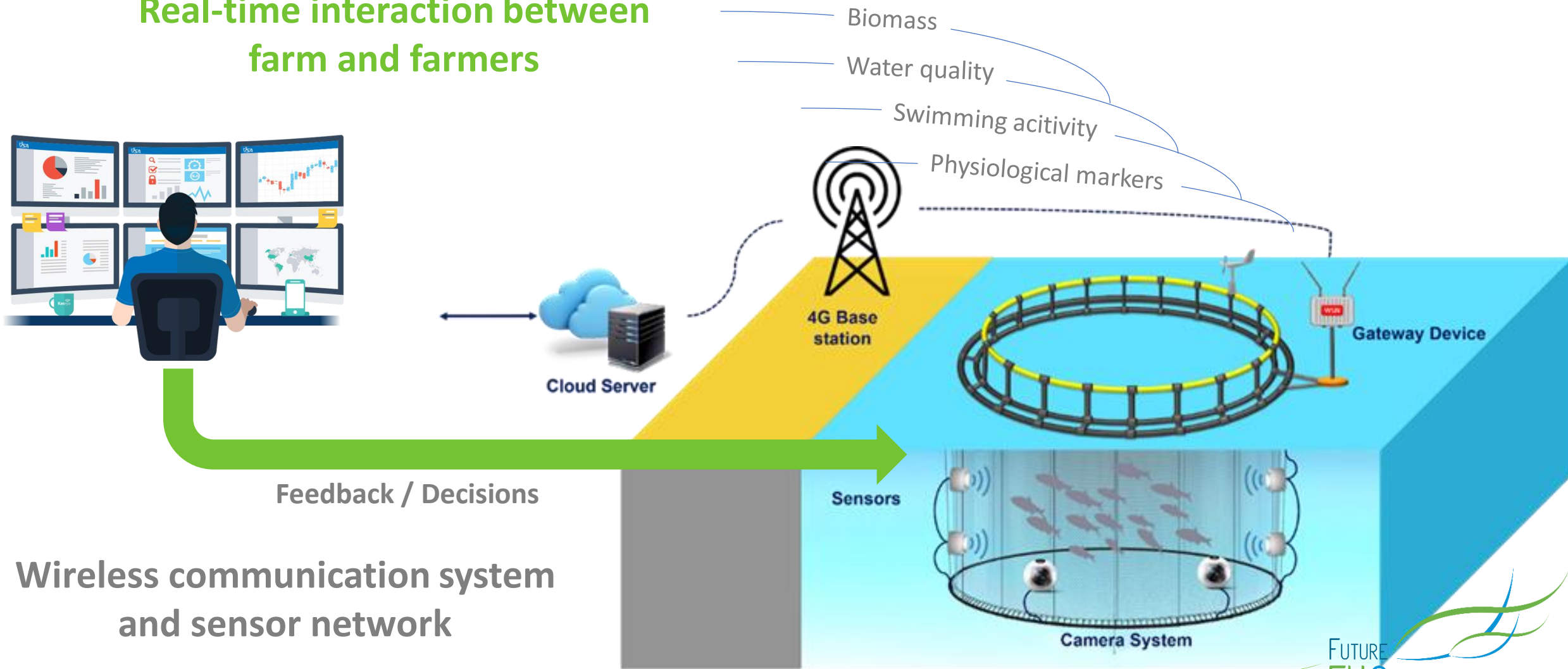
# Conclusions



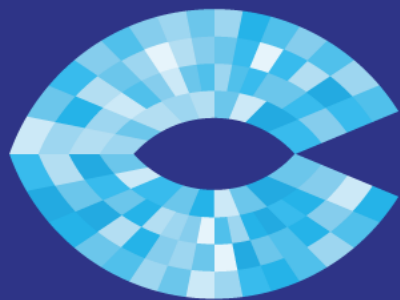**A real-time wireless communication system**

Water quality ✓

Fish health & welfare ✓

Growth performances ✓

**Environmental gains**

**Economic gains**

Fondazione COISPA ETS

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