# AE-FISHBIT: A SMART DEVICE FOR MONITORING FISH HEALTH AND WELFARE


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## SUMMARY

**Researchers have designed a miniaturised tool called AE-FishBIT, to monitor individual farmed fish in a non-invasive manner. The device's simultaneous measurement of physical activity and respiratory frequency sets it apart from similar devices in the market. AE-FishBIT will be of interest to aquaculture farmers and other end users who can use it to monitor fish behaviour for selective breeding and for fine-tuned adjustment of environmental conditions.**


## KNOWLEDGE NEED

The assessment of overall production, health, welfare and stress is a major challenge for more efficient and ethical fish production. With the recent advent of MicroElectroMechanical System (MEMS) technology, biosensors are increasingly being used to non-invasively measure a wide range of variables. However, challenges with the technology so far include interference between transmitted signals which limits the use of a large number of sensors, and in the aquatic environment the use of low radiofrequency transmission is limited. AE-FishBIT overcomes current technological challenges with its small size, low power, and its capacity to measure physical activity and metabolic activity simultaneously.

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## POTENTIAL IMPACT

- Individual and non-invasive assessment of feeding behaviour, fish health and welfare status allowing farmers to select robust fish and make correct adjustments in the culture conditions, which ultimately contribute to improved productivity in the aquaculture sector.
- Better monitoring leads to more strict and reliable welfare standards, and a better perception of quality controls in aquaculture production, which could lead to improved consumer perception of aquaculture products.

**EATiP – Strategic Research and Innovation Agenda (SRIA)** Thematic Area 2 – Technology and Systems; Goal 4, Thematic Area 7 – Aquatic Animal Health and Welfare; Goal 4. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

## UNDERLYING SCIENCE

Weighing less than one gram, AE-FishBIT is a tiny programmable and reconfigurable tri-axial accelerometer for on-board processing of recorded data. The prototype is externally attached to the fish operculum to monitor physical activity by mapping accelerations in x- and y-axes, while operculum beats (z-axis) serve as a measurement of respiratory frequency. The device has been tested and validated in gilthead sea bream and European sea bass.

## RESULTS

- AE-FishBIT can register jerk accelerations and operculum beats (two in one) as a direct measure of physical activity and respiratory frequency.
- Testing in swim test chambers allows a close correlation between $O_2$ consumption and calculated respiratory frequency in exercised fish.
- The device allows for the discrimination of fish with different proactive/reactive stress responses when facing different aquaculture stressors, including diet composition, oxygen levels and tank size.
- Using the device, it was also found that age, photoperiod, feeding time or enteric parasitic infections alter basal metabolism and diurnal/nocturnal activity of farmed fish.
- Visual observations regarding tissue damage, feeding behaviour and circulating levels of stress markers did not suggest a negative impact from device tagging.

## END-USERS & POTENTIAL APPLICATIONS

**END-USER 1: Aquaculture farmers**
**APPLICATION:** Managing health and welfare by monitoring a number of "sentinel" fish, allowing farmers to make necessary adjustments in culture conditions with less trial-and-error than traditional methods.

**END-USER 2: Aquaculture breeders**
**APPLICATION:** Tool for selective breeding by monitoring changes in feeding behaviour and metabolic activity to identify fish with a more efficient energy use.

**END-USER 3: Fish processors and wholesalers**
**APPLICATION:** Good quality certification of aquaculture products through the monitoring of the welfare status of the fish, increasing its appeal to customers and potentially increased profitability.

**END-USER 4: Aquaculture researchers**
**APPLICATION:** Measuring reactions to variables such as a change in nutrition, rearing density or other environmental conditions by monitoring physical activity and respiratory frequency of fish in controlled experiments.

## STATUS

**Technology Readiness Level (TRL) 4 – the knowledge has been validated in a laboratory environment.**

- To the best of the researchers' knowledge there is currently no other tagging device that provides a simultaneous measurement of both physical activity and respiratory frequency in a non-invasive manner.
- Additional tests of the device are planned in other farmed fish (Atlantic salmon, trout, sole, turbot), correlating adjustments at cellular-tissue level with the monitored AE-FishBIT parameters.
- Further developments to the AE-FishBIT device are envisaged to increase the autonomy of the system, make it more compact and easier to attach.

## AT A GLANCE

**TITLE:** AE-FishBIT: A Smart Device for Monitoring Fish Health and Welfare

**KNOWLEDGE TYPE:** Prototype and Scientific Publication

**WHERE TO FIND IT:** vimeo.com/325943543; Martos-Sitcha et al. 2019. Ultra-Low Power Sensor Devices for Monitoring Physical Activity and Respiratory Frequency in Farmed Fish. Front Physiol 10, 667. DOI: 10.3389/fphys.2019.00667

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**TNA FACILITY USED:** Consejo Superior de Investigaciones Científicas (IATS-CSIC), Spain; Universidad de las Palmas de Gran Canaria (ULPGC), Spain

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**PATENTS OR OTHER IPR EXPLOITATIONS:** A patent for the device has been being registered (P201830305) with the goal of licensing it at international level before the end of the AQUAEXCEL2020 project.



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