All-Atlantic Ocean Sustainable Profitable and Resilient Aquaculture

ASTRAL POOL OF TECHNOLOGIES: A TECHNOLOGY VALIDATION PERSPECTIVE WITHIN THE ATLANTIC AREA

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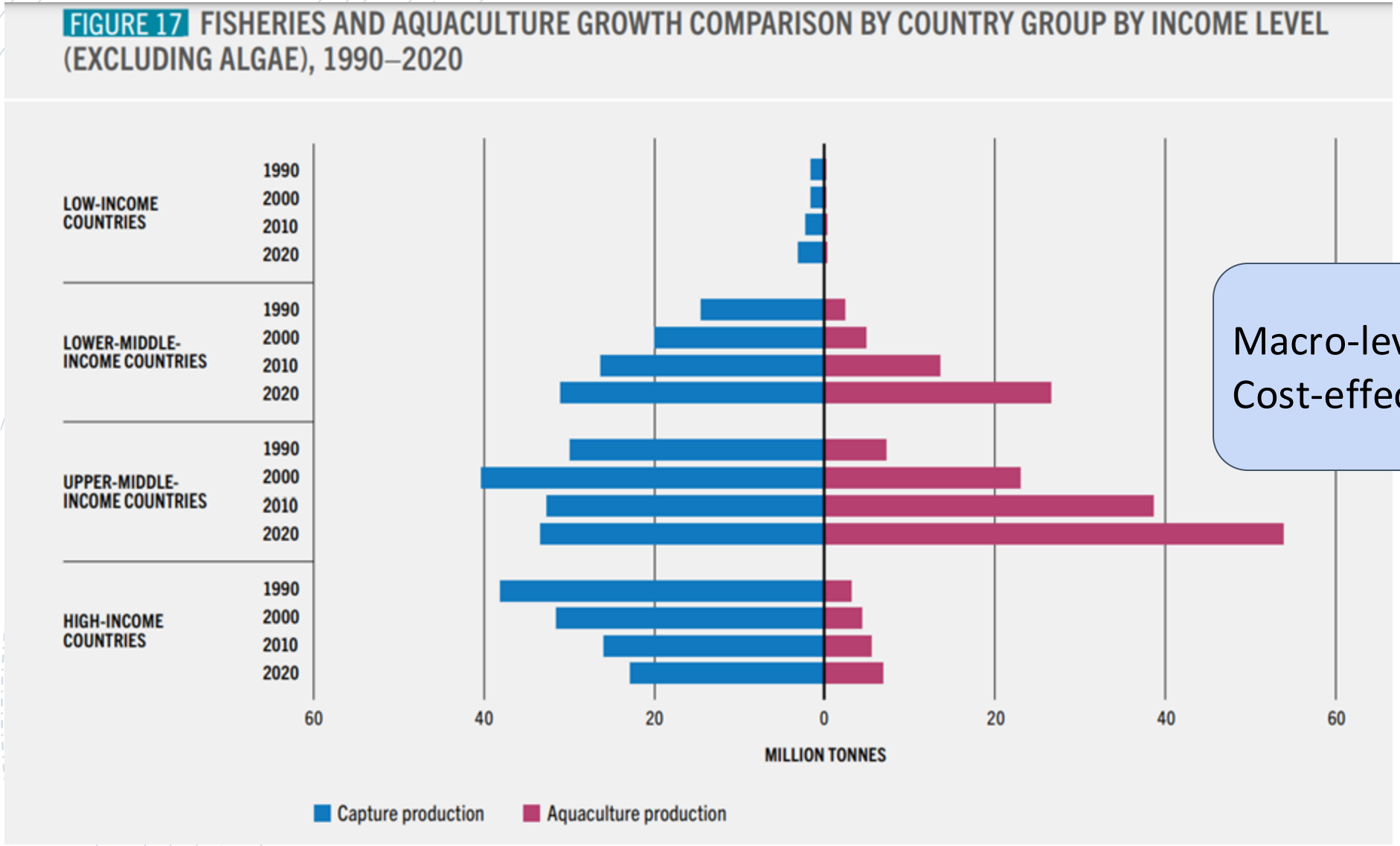
Summary

- Aquaculture sector needs and opportunities in a nutshell
- Integrated Multi-Trophic Aquaculture (IMTA)
- ASTRAL Pool of Technology Innovations
- Take-away message



Macro-level opportunity
Cost-effective technology

Source: FAO. 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO.

The Need

Interviews with end-users (from December 2021 to September 2022)
10 countries, 38 interviews done (14 IMTA, 6 co-culture, 18 monoculture)

"Monitoring is very important for us. We control the salinity and temperature of the water, to ensure good production processes" – **Brazilian producer** 

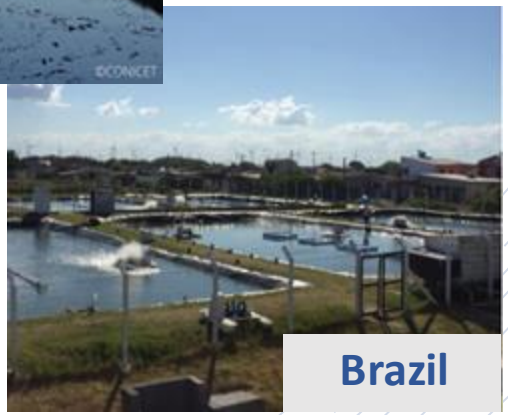
"We would like to use monitoring devices for monitoring water quality but they are very expensive especially for small producers" – **Portuguese prod** 

"We are using open water pen culture system with automatic feeders, water quality is key. It is monitored by taking manual samples routinely" – **Irish producer** 

"We do daily monitoring for pH and determine CO2 based on the pH and alkalinity. This is difficult and expensive to measure with a probe" – **South African producer** 

Integrated Multi-Trophic Aquaculture (IMTA)

- Technologies that support sustainable aquaculture production
- Integrated multi-trophic aquaculture (IMTA)
- Exposure to many threats and risks
  - Climate change
  - Harmful Algae Blooms (HAB)
  - Microplastics
  - Critical physicochemical parameters
- Technological suite to best address end-user needs

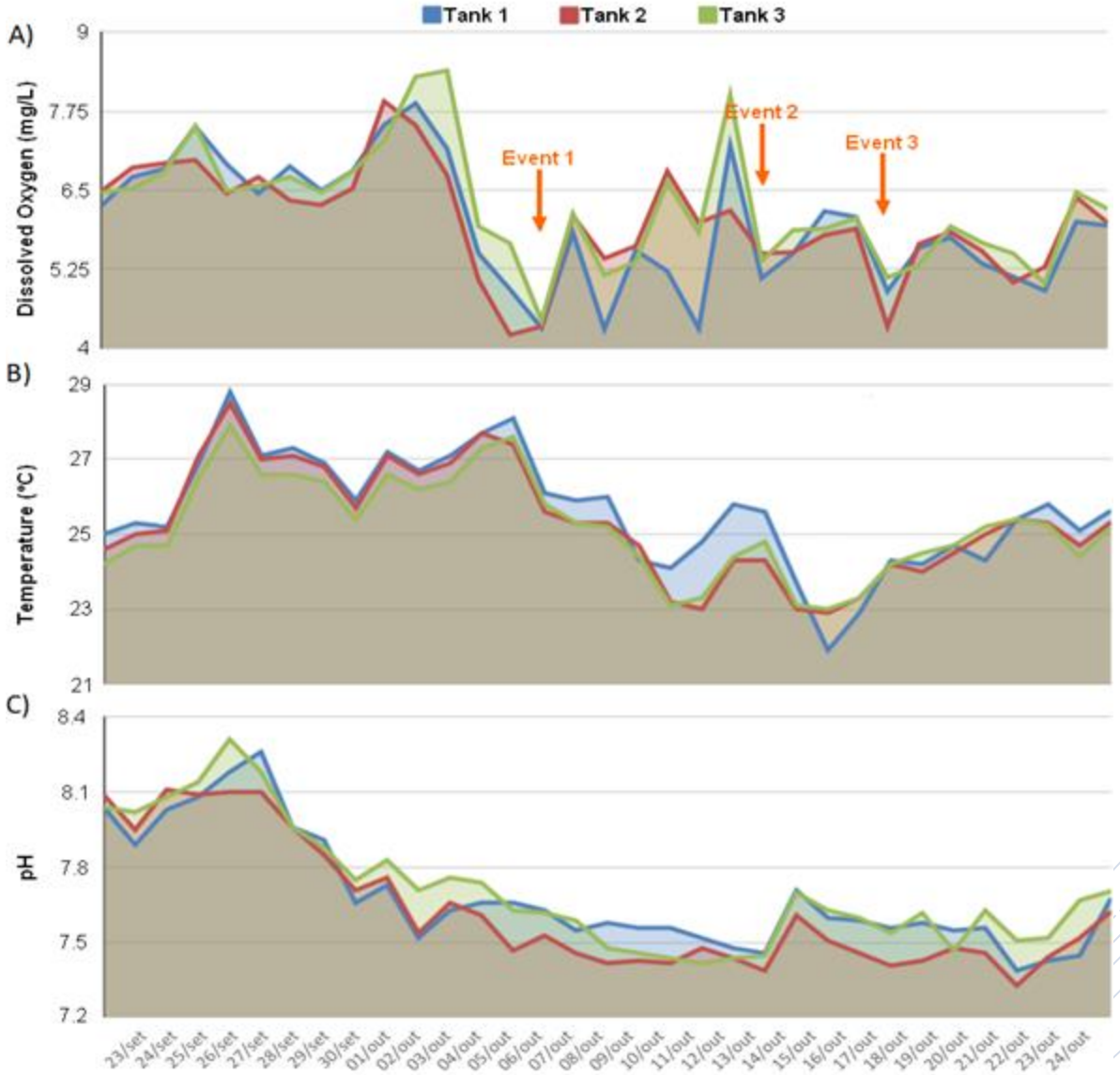


https://www.astral-project.eu

One of the many problems in IMTA (marine land-based)

- **Event 1**
  - Event 1: Power outage of aeration; water temperature above average. Backup power generator *must* be started soon. Otherwise hydrogen peroxide to be used (30 min reaction time)
- **Event 2**
  - Power outage situation; lower water temperature (slow animal metabolism). Backup power generator started in a few minutes causing a less sharp oxygen drop.
- **Event 3**
  - Use of hydrogen peroxide to control the dissolved oxygen level.

30-minute for mitigation



Integrated Multi-Trophic Aquaculture (IMTA)

Is it possible to design and deploy a digital twin to enable closed-loop feedback and operational autonomy in aquaculture farms?

- **Digital Twins** explore closed-loop feedback and control as key features to build a a virtual replica of farming physical assets.

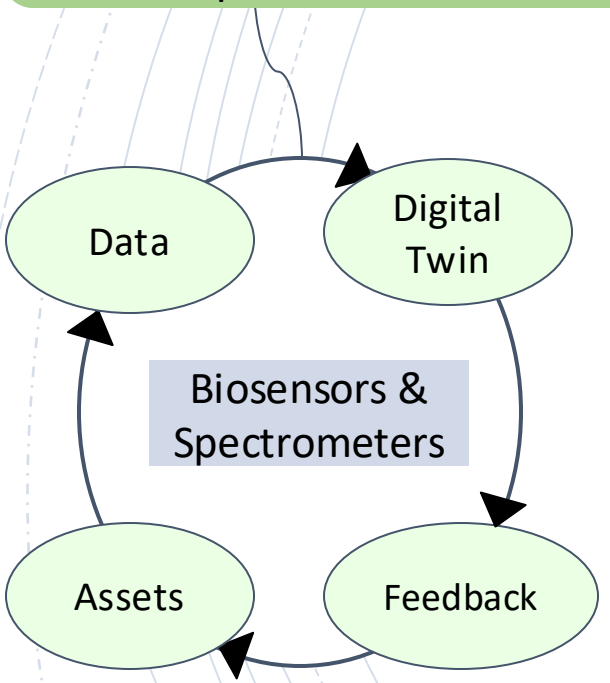
ASTRAL Pool of Technology Innovations

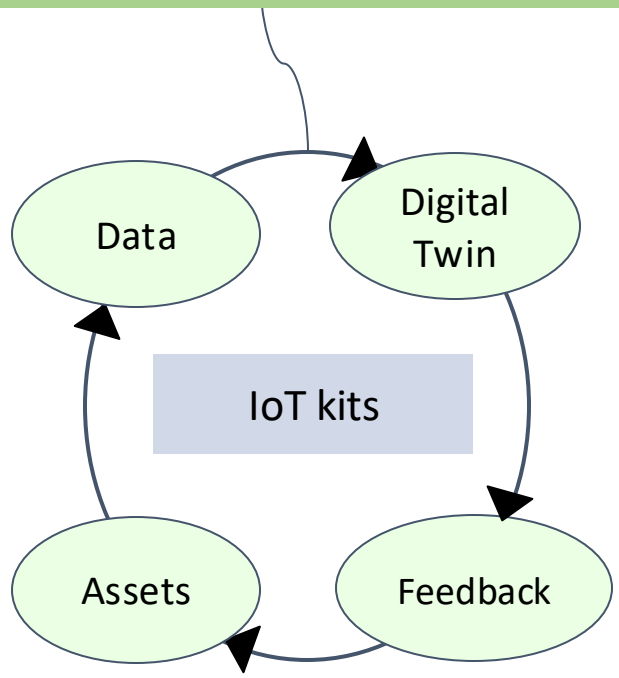
ASTRAL AIDAP
Artificial Intelligence Data Analytics Platform

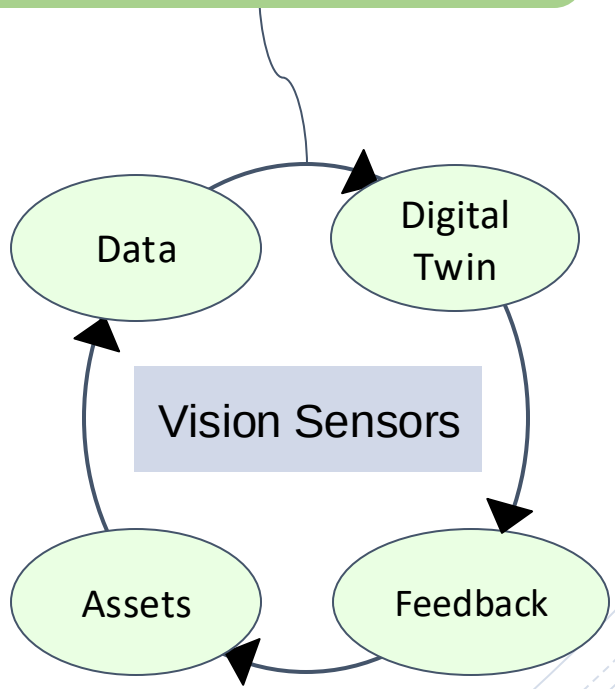
+ Environmental proxy
+ Animal welfare
+ Microplastic

+ Physico-chemical variables
+ Essential water quality variables

+ Biomass estimation
+ HAB monitoring



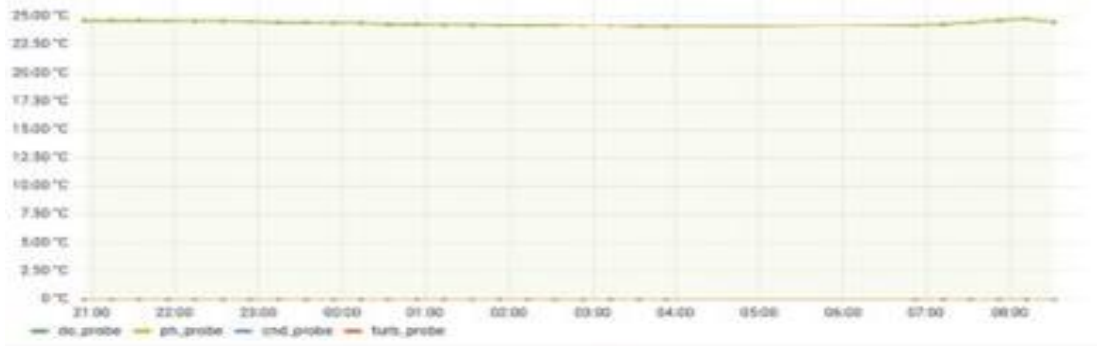




The Royal Society, Digital technology and the planet: Harnessing computing to achieve net zero Issued: December 2020 DES7035 ISBN: 978-1-78252-501-1

Cost Effective IoT kits (Internet of Things)

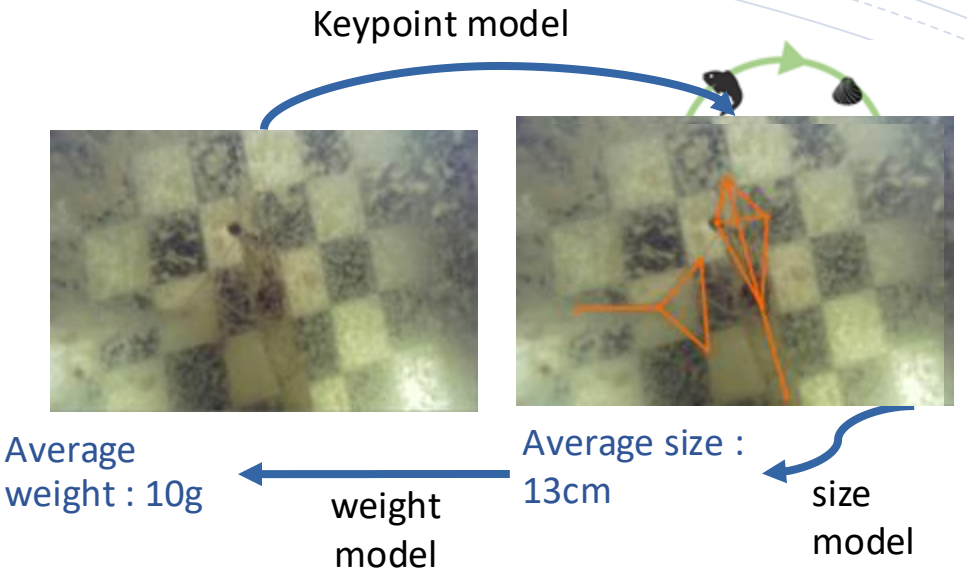
- Adaptable device
  - Various IMTA requirements and constraints
- No need for technology migration
  - Off-the-shelf sensors and probes for aquaculture monitoring
- Solution based on trade-offs
  - Compromise between cost, aquaculture needs, constraints and expectations

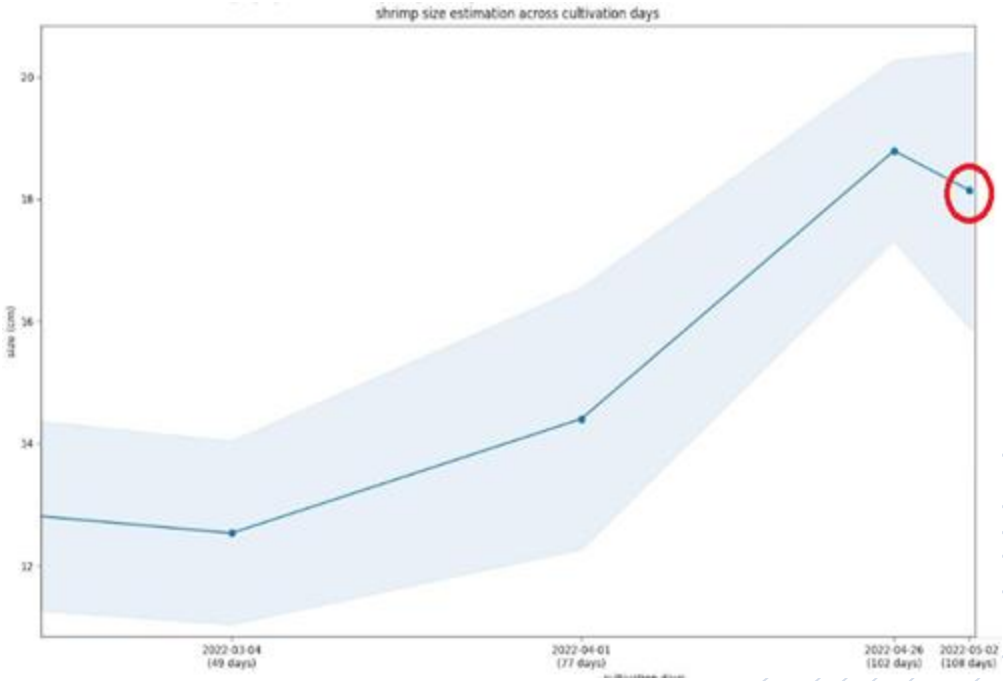


Vision sensors

Biomass estimation

- Biomass estimation
  - Daily feeding optimization, control stocking densities and determining ideal time for harvesting
- Biometric approaches are recommended practice
  - Labour intensive, time consuming…
- AI vision-based solutions for non-invasive automatic biomass estimation
  - Off-the-shelf camera systems coupled with advanced deep neural networks
  - Continuous end-user feedback and prototype deployment
- Shrimp biomass estimation (validated in Brazil)
  - Key-point detection model calibrated
  - Mean relative error: 15%

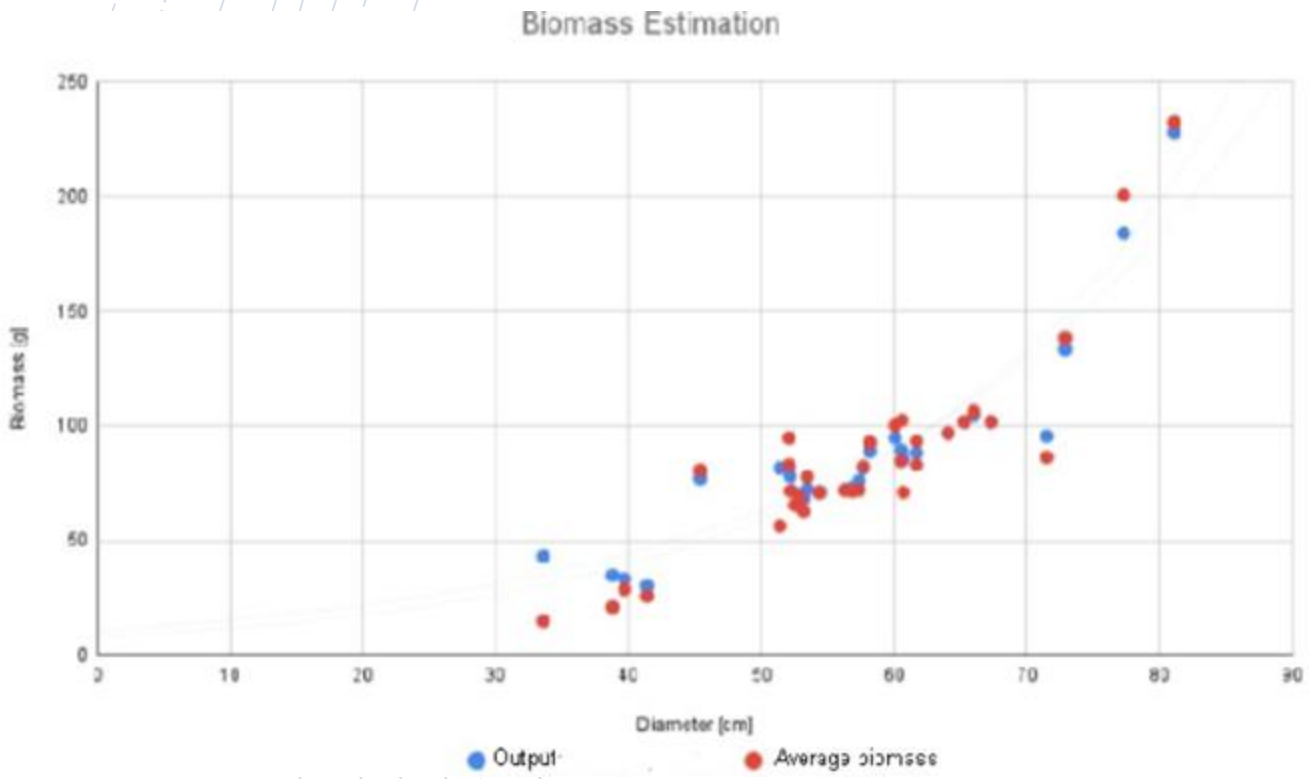




Vision sensors

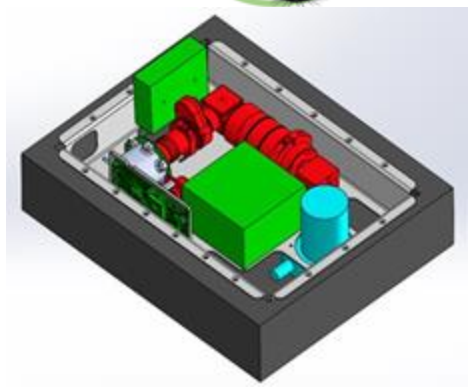
Biomass estimation

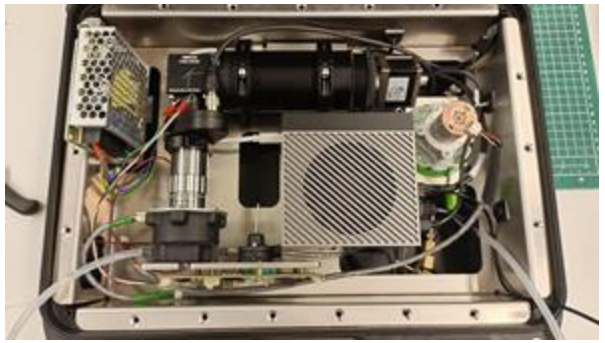
- Urchin biomass estimation
  - South African IMTA lab
  - Mean relative error: 9%

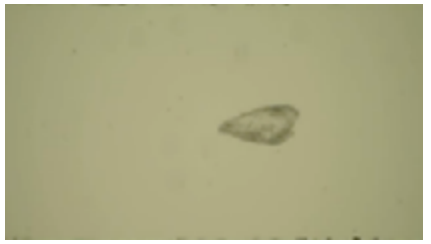


Microplastic Monitoring Sensor

- **Technology** developed and validated a microplastic sensor
- **Compact Design:** 41 x 32 x 18 cm standalone device.
- **Advanced AI:** Convolutional Neural Network for accurate image segmentation and classification.
- **Continuous Learning:** AI improves accuracy over time.
- **High Detection:** Detection accuracy over 80%
- **Enhanced Detection:** Includes UV and visible light for fluorescence-based detection.
- **Wide range of Detection:** Capable of detecting particles from µm to mm
- **High sensitivity:** Detects particles as small as 250µm
- **Custom Training**: Tailor-made microplastic dataset.
- **Superior Imaging:** State-of-the-art microscope objective.
- **Precise Fluid Handling:** Integrated peristaltic pump
- **High throughput:** processing up to 170mL/min

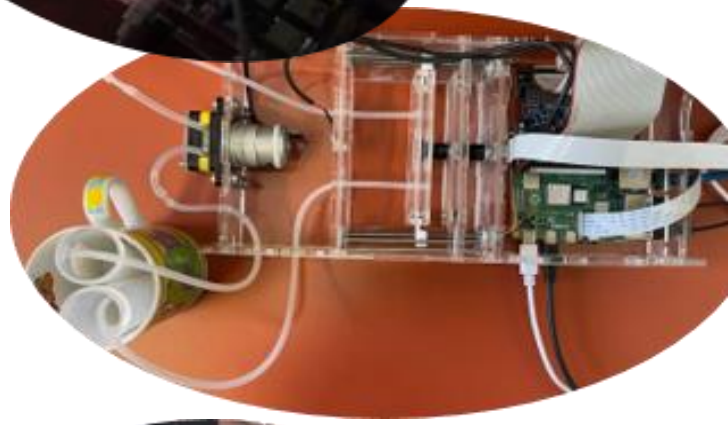


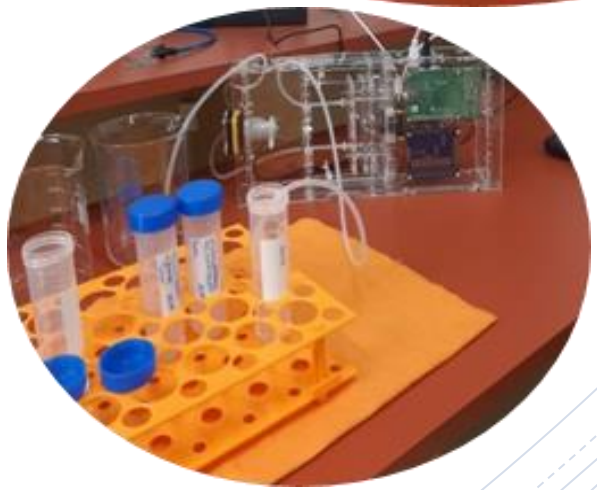




Phytoplankton/HAB monitoring device

- Technology based on open-hardware
  - Cosf-effective solution (~1.200 EUR)
  - Optimized list of target species, commoly found in the Atlantic Area
- Technology validation at IMTA facilities
- Several AI vision-based models assessed and optimized to run on resource-constrained platforms (cost-effective)
- Mili, micro and now nano-particle detection capability

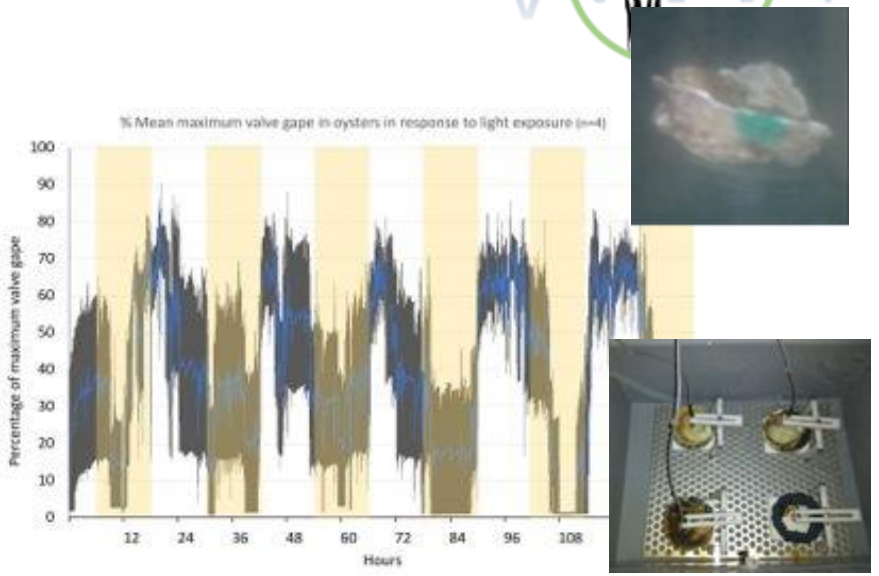




Biosensors and MEMS-based Spectrometer

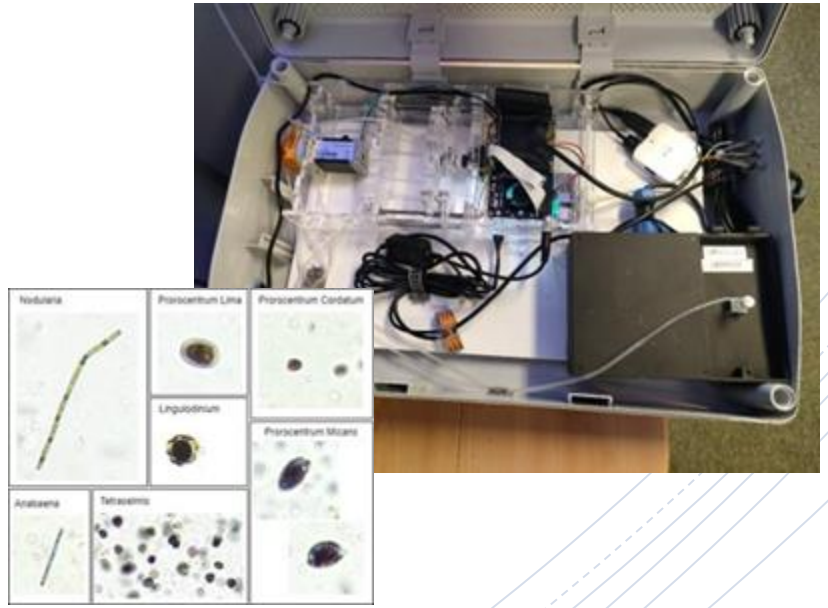
Biosensor

- Vision-based and MEMS-based valvometry techniques
  - Easy deploy and animal welfare
- Proxy information for overall water quality monitoring



MEMS-based spectrometer and fluorometer

- MEMS spectrometer coupled with AI models
- Quantification of key aquaculture nutrients
- Integration with PlanktoScope system to support HAB monitoring
- Goal: Broad spectrum physico-chemical parameters (e.g. ammonium, nitrate and dissolved oxygen)



Take-away Message

- ASTRAL technology offer cost-effective and flexible solutions
  - Digital Twins
- Cost-effective Internet of Things (IoT) sensors
- AI tailored vision and MEMS-based sensor:
  - Early HAB detection
  - Microplastic
  - Water quality: biosensors, nutrients monitoring, physicochemical parameters
- AIDAP platform for predictive modelling of physico-chemical parameters and biological water-quality indicators

Thank you!

Welcome to visit **ASTRAL booth** for further information on ASTRAL and the Pool of Technological Innovations

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