

Automated Coral Spawn Monitoring for Reef Restoration: The Coral Spawn and Larvae Imaging Camera System (CSLICS)

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Motivation

- Coral reefs support **25%** of marine biodiversity and provide critical ecological, economic, cultural and coastal protection value.
- Climate change is driving rapid reef decline through bleaching and ecosystem degradation; estimates project **loss of 70-90% of live coral by 2050** without action.

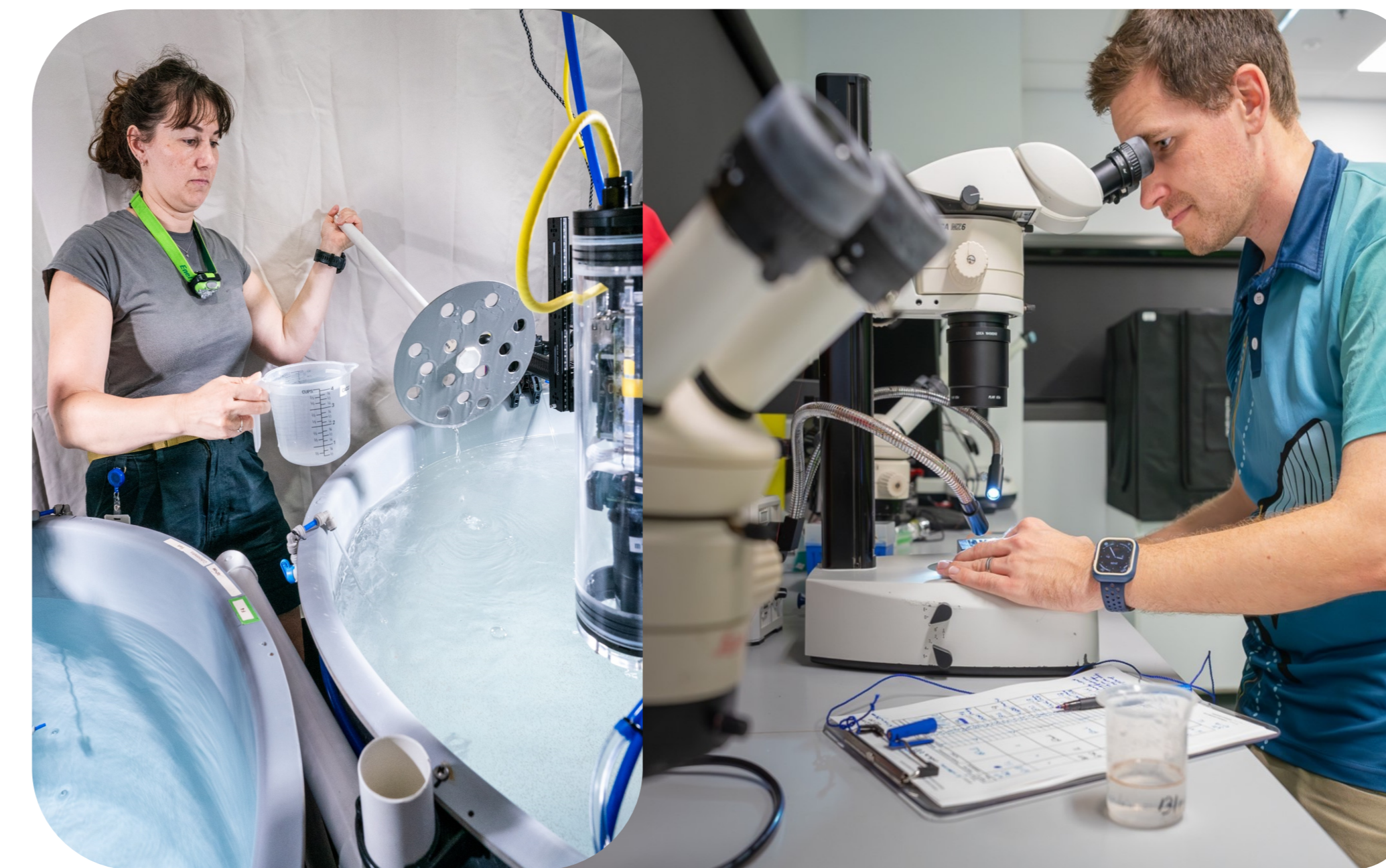
Reef Restoration

- Reef restoration aims to increase the resilience of corals: sexual reproduction of corals improves genetic diversity and adaptive capacity to environmental change.
- Land-based coral aquaculture enables **scalable production of corals** but requires monitoring at different stages of reproduction and growth.
- Current monitoring methods are time-consuming and intensely manual: viable reef restoration requires **automation to scale effectively**.

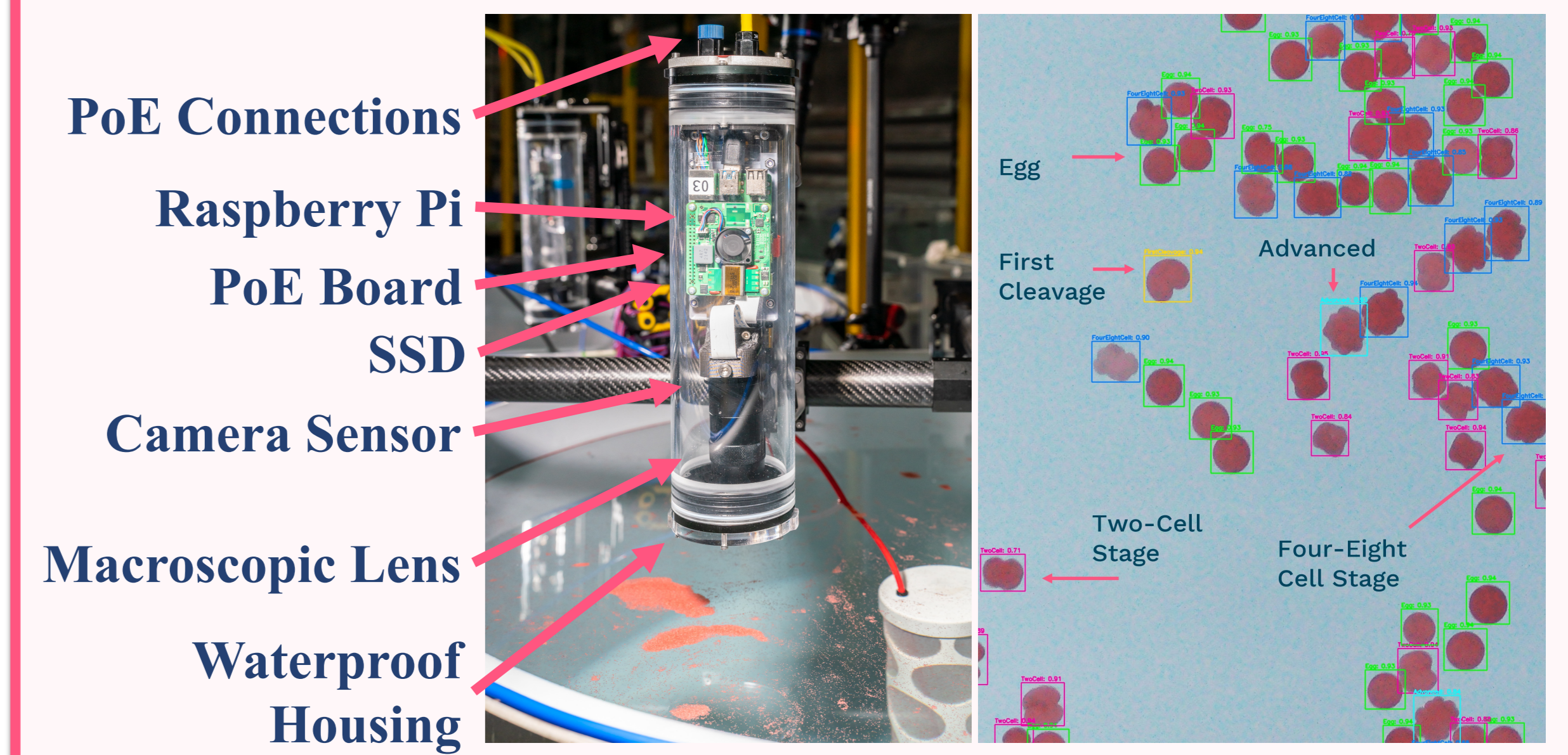
Coral Aquaculture with CSLICS

- Coral spawn are fragile and manual handling risks damaging the cultures; vision-based automation enables **continuous, non-invasive monitoring**, delivering **high-resolution data** at scale.
- World's first** tank-mounted vision system for real-time automated coral spawn monitoring.
- CSLICS is an image capture and analysis system comprising a network of cameras and controllers mounted to aquaculture tanks.
- Automated detection and counting for *A. kenti* and *A. loripes* corals to assess fertilization success performed by YOLOv8 object detectors (surface operation model detects fertilization and stage of embryo development, and sub-surface operation model counts in focus coral spawn).

Manual Methods of Counting Coral Spawn



The Coral Spawn and Larvae Imaging Camera System (CSLICS)

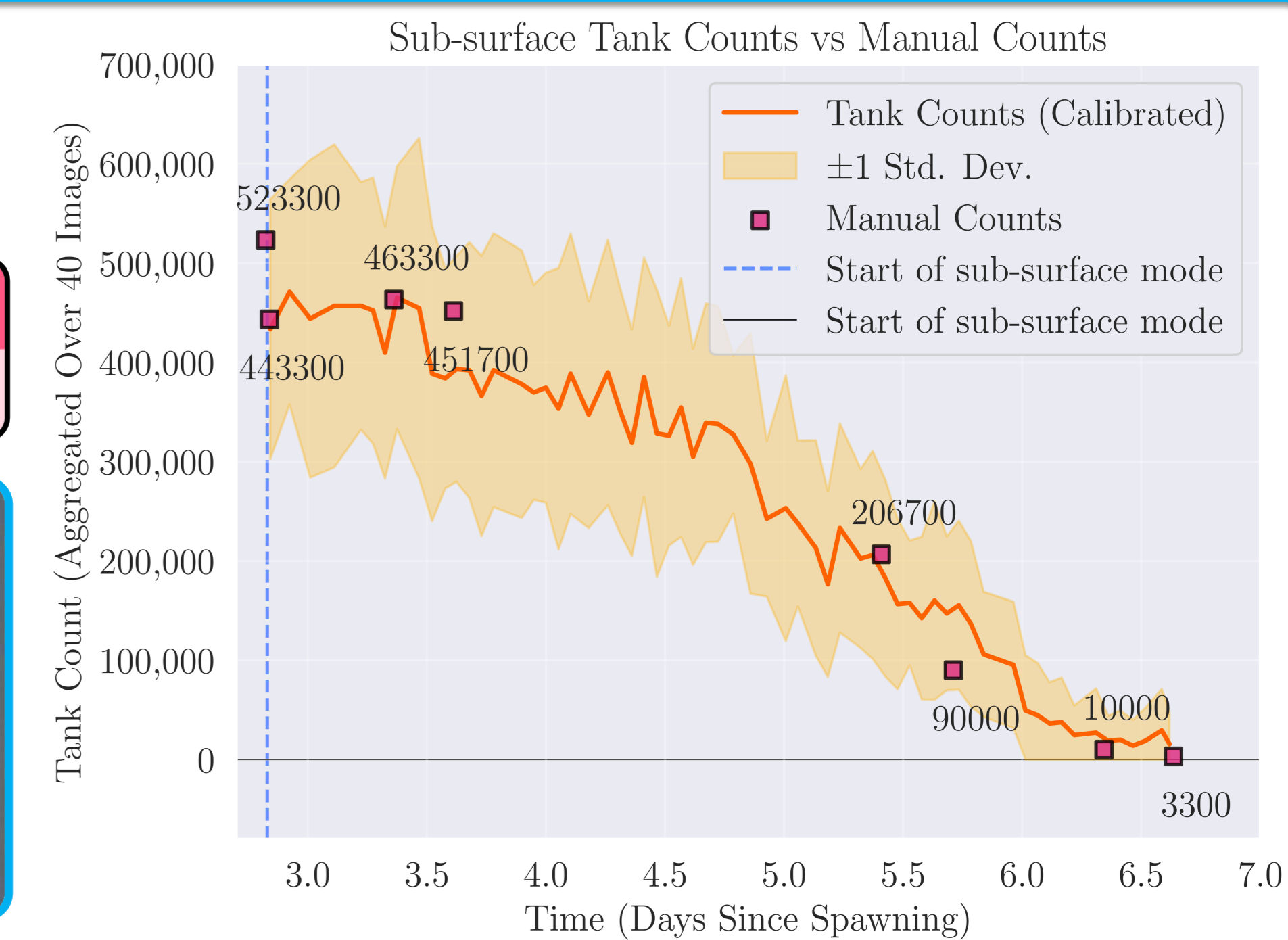


Results

- CSLICS was deployed to the Australian Institute of Marine Science SeaSim facility and validated during two mass coral spawning events in 2022 and 2023.
- 80x** reduction in operation time for the same volume sampled
- CSLICS enables a **saving of 5,720 hours of labour per spawning event** compared to manual sampling methods at the same frequency.

Sub-surface Operation

Overall F1 Score
83.0%



Surface Operation

Overall F1 Score
82.4%

