TD106 Data and Services Discovery projects - Transformative Data Collections

Machine learning dataset creation for Australian fish species from Baited Remote Underwater Videos (BRUV)

Approach

The goal of this project was to untap the potential in BRUV video archives domestically and internationally, linked to annotations held in GlobalArchive (Fig 1). Enabling the labelled data held in these archives to be used in training state of the art machine learning algorithms, and create a dataset that could further research into automating the detection of fish from videos.

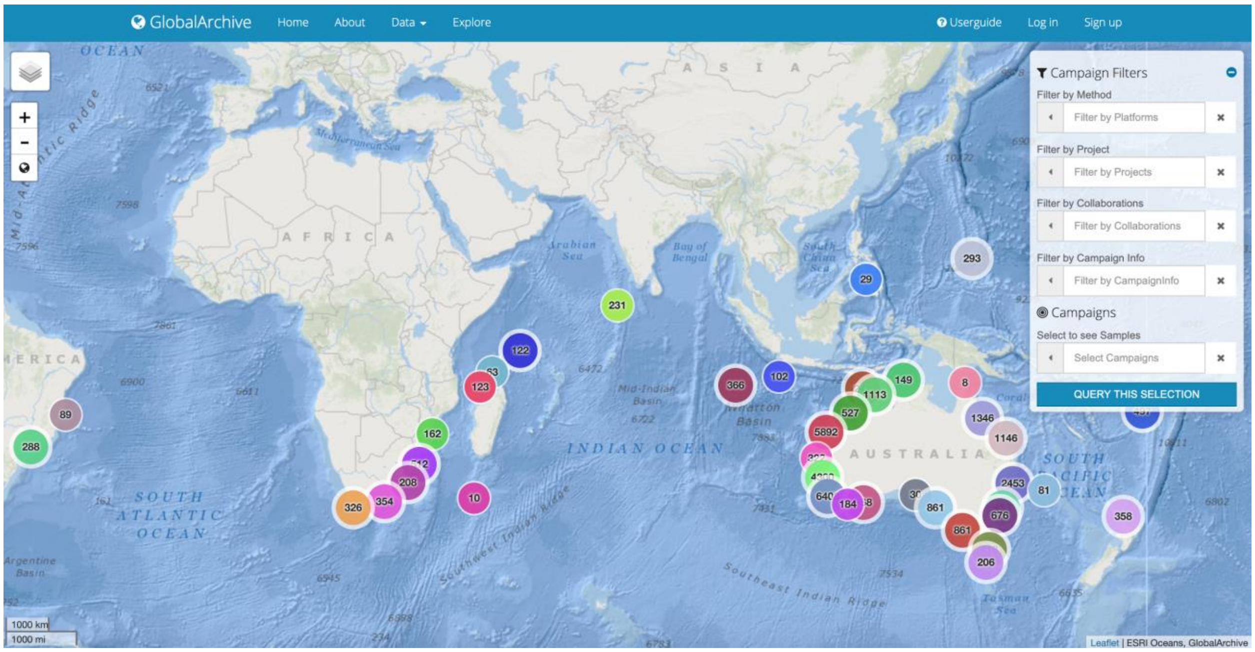

Fig 1. Spatial extent of BRUV/DOV data contributed to Global Archive

In order to achieve this goal, the project undertook the following actions:

1. (Completed) *Identified and aggregated over 3000 BRUV videos from AIMS, UWA and Curtin University to contribute to a public dataset.* The videos were spatially distributed along the WA coastline, spanning 17 field campaigns. Data selected was video that had

been analysed using the Event Measure (https://www.seagis.com.au/event.html) platform, with associated measurement files.

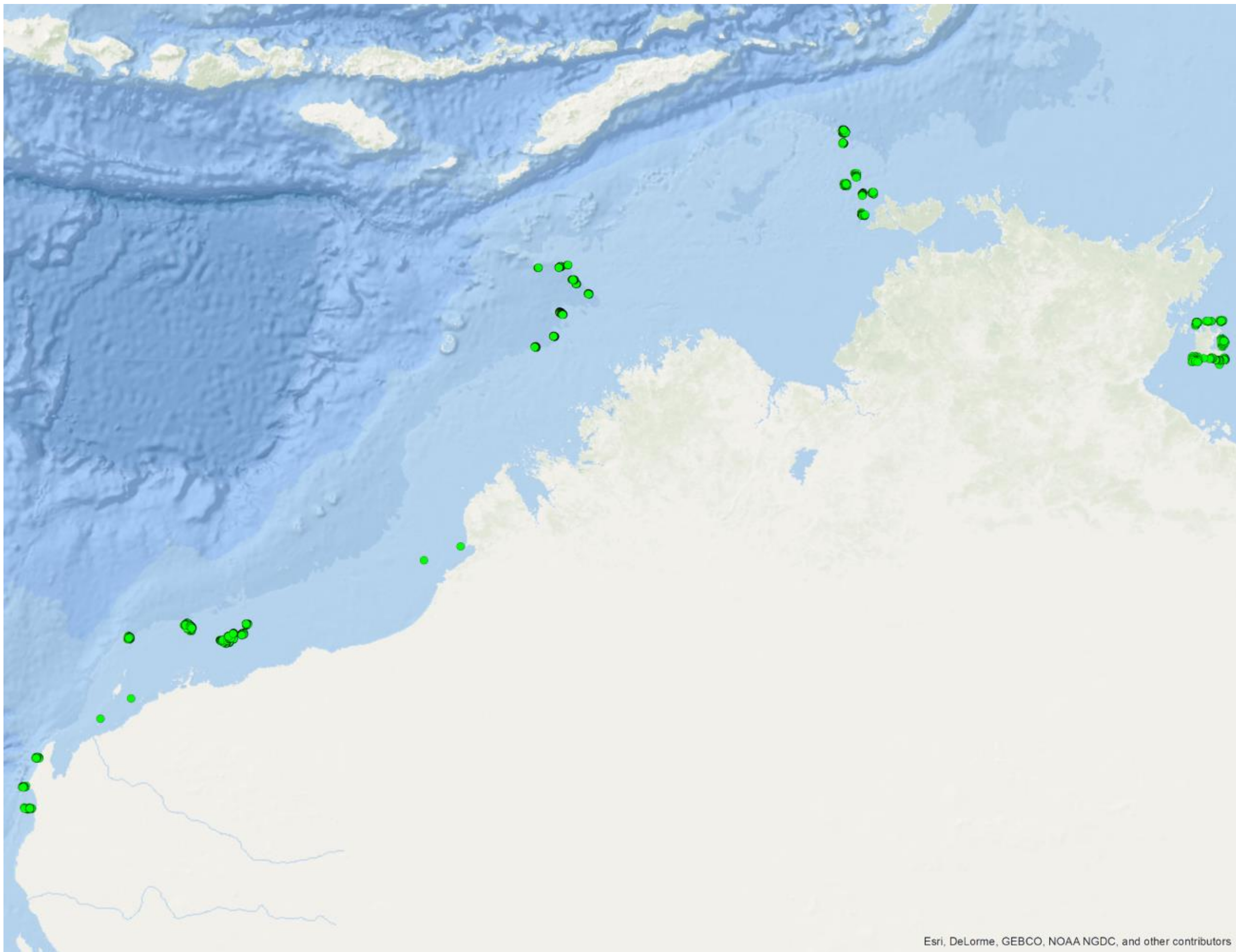

Fig 1. Spatial extent of BRUV data contributed to this collection

2. *(Completed) Developed a process and data extraction codebase for constructing a dataset suitable for a machine learning workflow.* The code available on github (https://github.com/marrabld/open_fish_classifier) has been developed to do three things: 1) Extract bounding boxes of fish from videos with point annotations annotated with event measure; 2) Extract bounding boxes of fish from videos with measurements annotated with event measures; 3) Extract bounding boxes of fish from any BRUV video that has not been annotated - acting as a region proposal detection.

3. *(Completed) Constructed a public dataset composed of ~3000 videos, ~60000 image frames, ~70000 fish crops labelled with 70 families, 200 genus and 507 species.* Using the code developed, ~3000 videos were processed along with their associated event measure annotation files, with fish crops being created and associated metadata generated for each crop.

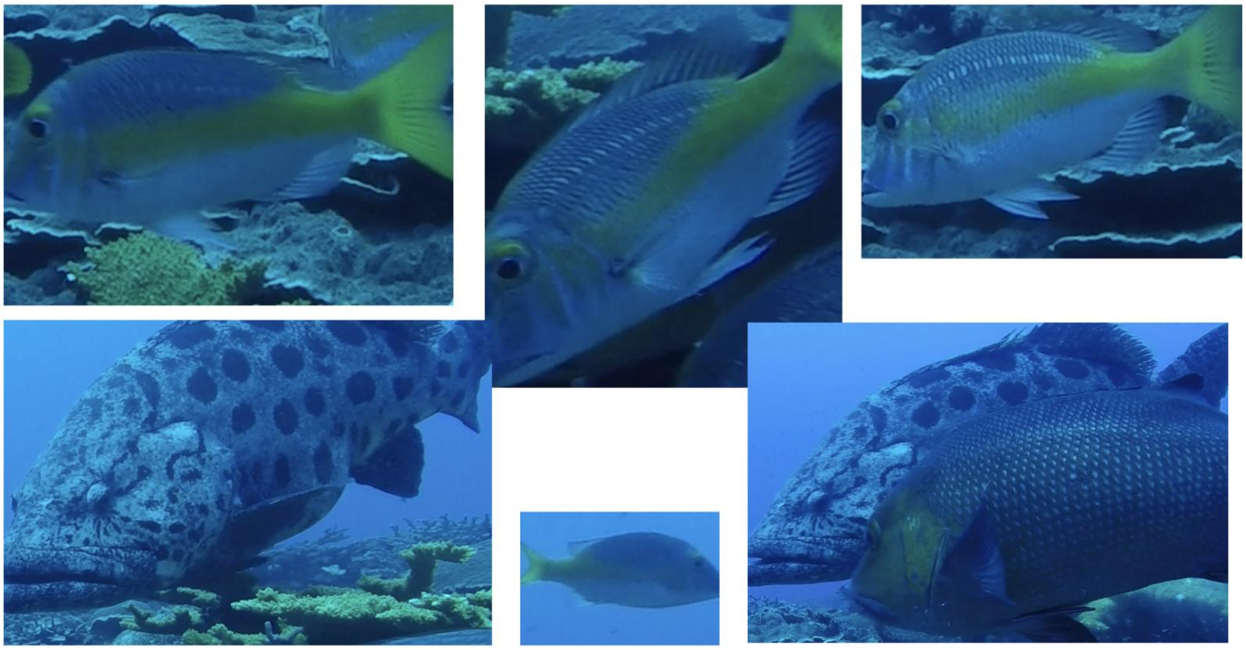

Fig 3. Example of fish crops from videos

Fig 4. Example of a frame where a fish measurement was taken

4. (In progress) *Fish/NoFish object detection dataset developed*. Using the Amazon Sagemaker Ground Truth platform we generated a dataset for object detection of fish. Generating bounding boxes for ~60000 fish across ~1500 frames.

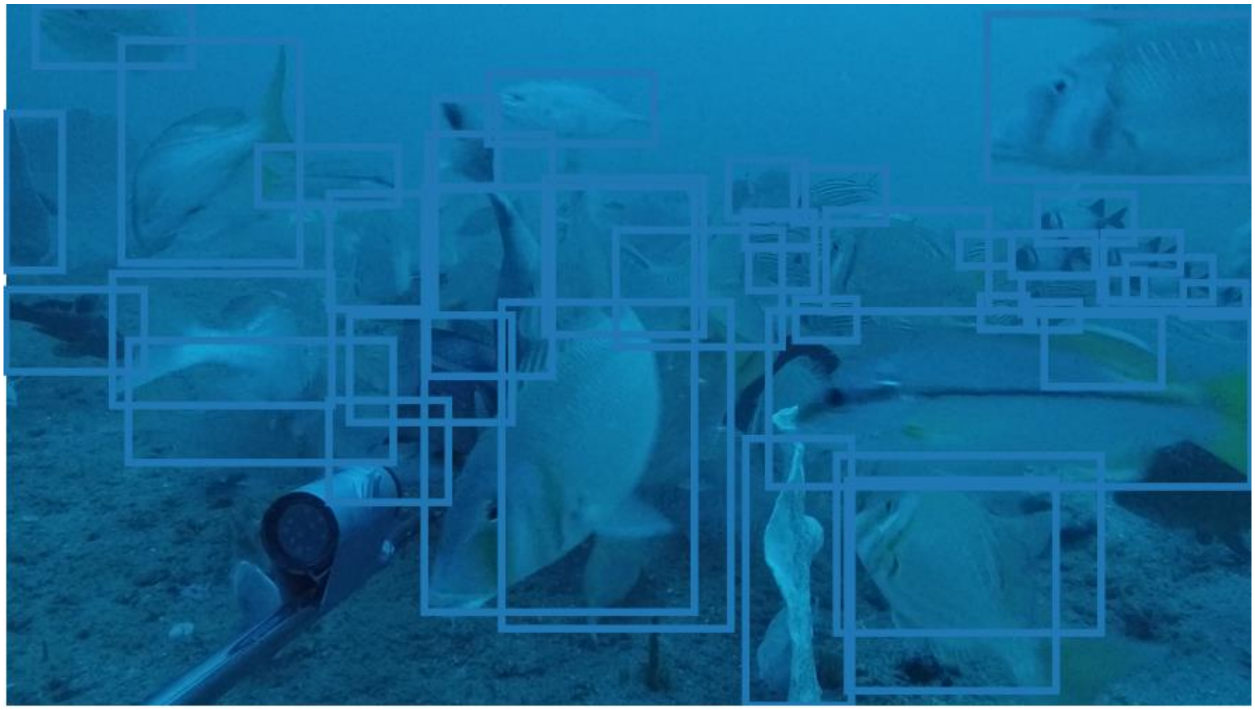

Fig 5. Example of a busy scene labelled for training a deep learning object detection algorithm

5. (Yet to be completed) Dataset reviewed before publication

6. (Yet to be completed) Dataset uploaded to S3 storage on Amazon Web Services, and a dataset publication created with a DOI

FAIR

See FAIR assessment spreadsheet.

Collaboration and coverage

This project has been a spearhead for a national approach to constructing a machine learning dataset for fish from Australian waters. Basing the dataset generation approach on data formats held in a national platform like GlobalArchive and analysed by the Event Measure software, allows for expansion to data from across Australia and internationally, spanning alternative data capture platforms to BRUVS, such as diver operated videos (DOV) and autonomous underwater vehicles (AUV).

The process and code from this project has been specifically designed to operate on any of the video data linked to GlobalArchive - which holds data from 12 government and academic organisations organisations across the world, with 20000 BRUV deployments and 1800 species of fish. Continuing on from this project we aim to extend the dataset by making the code easier to use, and the process easier to run for data owners, so that we can continually add to the dataset over time with new data continually being analysed.

This project has been a partnership between AIMS, UWA and Curtin University, with knowledge from all partners that the road to automating fish detection will require collaboration and is less likely to happen in isolation. The project has relied on the good will and cooperation from ecologists across organisations to contributed data, time, ideas and approach.

Sustainability

As part of AIMS' strategy 2025, the organisation is committed to increasing efficiency and expanding capability through the application of machine learning and artificial intelligence. Under the banner of 'Tech Transformation', AIMS is committed to sustainability of this project through investing further in automated fish detection from video - leveraging off of the work done as part of this ARDC project. As part of the additional investment in this area, AIMS and collaborators are seeking coinvestment from industry and university partners, with a collaborative project to be initiated in 2020. As part of this AIMS is also establishing a user community of fish ecologists across multiple organisations to drive the directions of future work and investment in this area.

Learnings

Good Will
The success of this project has been made on the back of good-will from collaborators at both UWA and Curtin University, who have given time from their ecologists and technicians to supply data to this project and offer suggestions on future work.

Outsourcing
Outsourcing of mundane tasks to online services is both cost efficient and has a rapid turn around. This has implications on how an organisation like AIMS optimises future work across all areas of data analysis, with a need to investigate to what extent outsourcing services can be utilised to alleviate mundane and repetitive tasks, and allow focus of efforts on high impact science.

Timelines
In the case of this tranche of funding, the timelines for project initiation and delivery were very tight, taking into account delays in contracting between organisations and various approvals for hiring staff.

Growing collections
The seed funding approach to the funding of this project was a great initiative, as it allows the catalyzation of ideas into opportunities to leverage further investment. For ARDC this seed funding idea could be extended to use a "silicon valley" style approach to startup funding, having further rounds of greater funding amounts based on delivery of smaller batches. Using

such an approach may make it easier to pick winners for further funding based on delivery of previous smaller projects.

Impact

Local impacts
Although this project is in the early stages of finalisation, it has already had a number of measurable impacts.

The project has underpinned further investment from AIMS for automating fish detection from video, which will contribute to a multi organisational project with investment from both industry and university partners.

Work has begun on a collaborative publication between Curtin University and AIMS - “Solving the bootstrap problem” - which will outline the outcomes of the ARDC project, the approach to dataset creation and techniques for applying machine learning to fish detection.

The project has stimulated discussion and a number of ideas which will investigation further and added to the collection in future. It is anticipated that once the collection is made public it will stimulate further innovation and research into the public dataset.

Broader impacts
This ARDC project and data collection has been mainly focussed on a dataset collection from BRUVS, though globally BRUV is just one method for detection of fish and counting fish abundance. Further work for AIMS will involve transferring the techniques and data from this project to other methods of data collection, and expanding the data collection for applicability in an international context. One example of building on this work relevant to industry would be detection and assessment of fish from Autonomous Underwater Vehicles (AUV) in assessments of underwater infrastructure such as pipelines and artificial structures.

In addition to further project development and alternative uses of the projects data collection, there is also the opportunity to have significant environmental impact. Current limitations of the use of video for fish analysis is the time it takes an ecologists to analyse a video. Automation, even semi-automation, will allow that scaling of this technology allowing for greater spatial and temporal sampling of the environment.

Report prepared by: Mathew Wyatt (Australian Institute of Marine Science)
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