Cloud-based national on-line services to annotate and analyse underwater imagery

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THE UNIVERSITY OF WESTERN AUSTRALIA

GREY BITS ENGINEERING

TPAC TASMANIAN PARTNERSHIP FOR ADVANCED COMPUTING

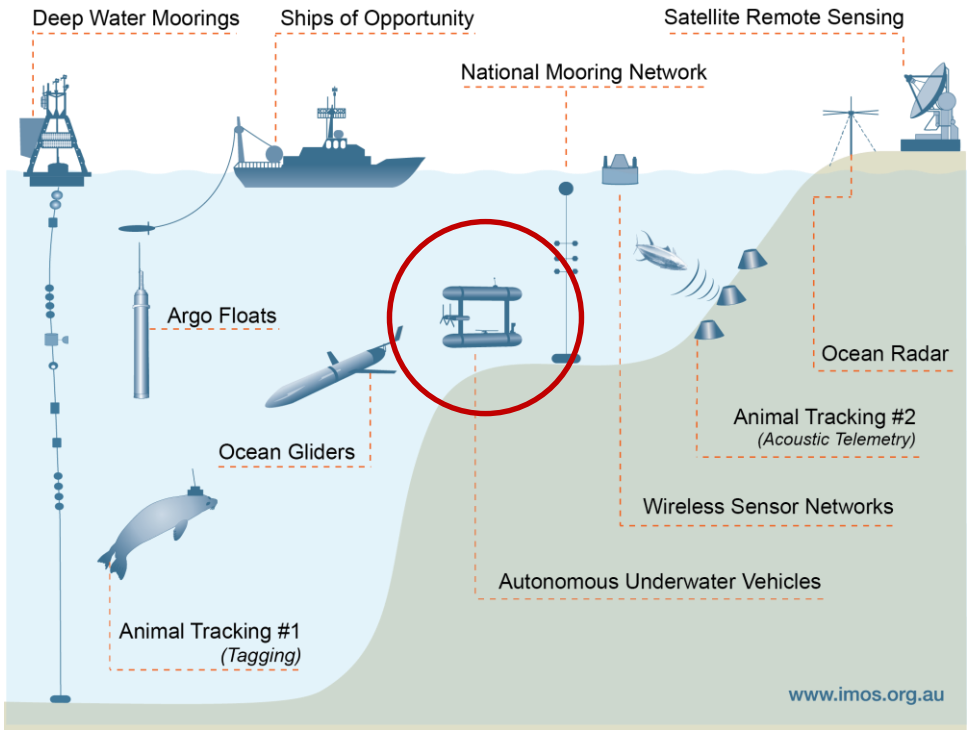
UTAS

IMOS Integrated Marine Observing System

IMDIS 2018, Barcelona

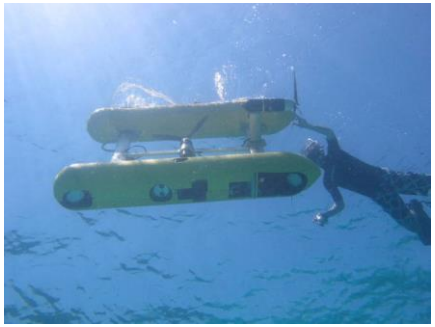
What is IMOS?

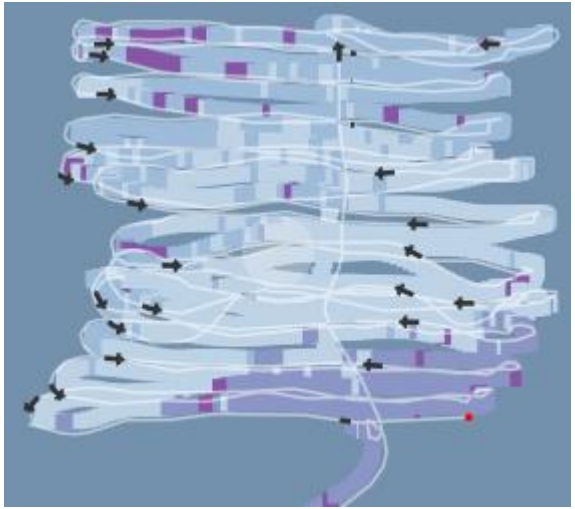
- IMOS is Australia's Integrated Marine Observing System
- Australia has the third largest marine jurisdiction of any nation on Earth —13.86 million km^2
- Maritime activity is predicted to generate € 63 billion/year by 2020
- IMOS undertakes systematic and sustained multi-disciplinary observations across this jurisdiction
- It turns these observations into data, products and analyses that can be freely used and reused (abiding by FAIR principles)
- IMOS is now seen as delivering 'operational' information
- It does this through the Australian Ocean Data Network (AODN)



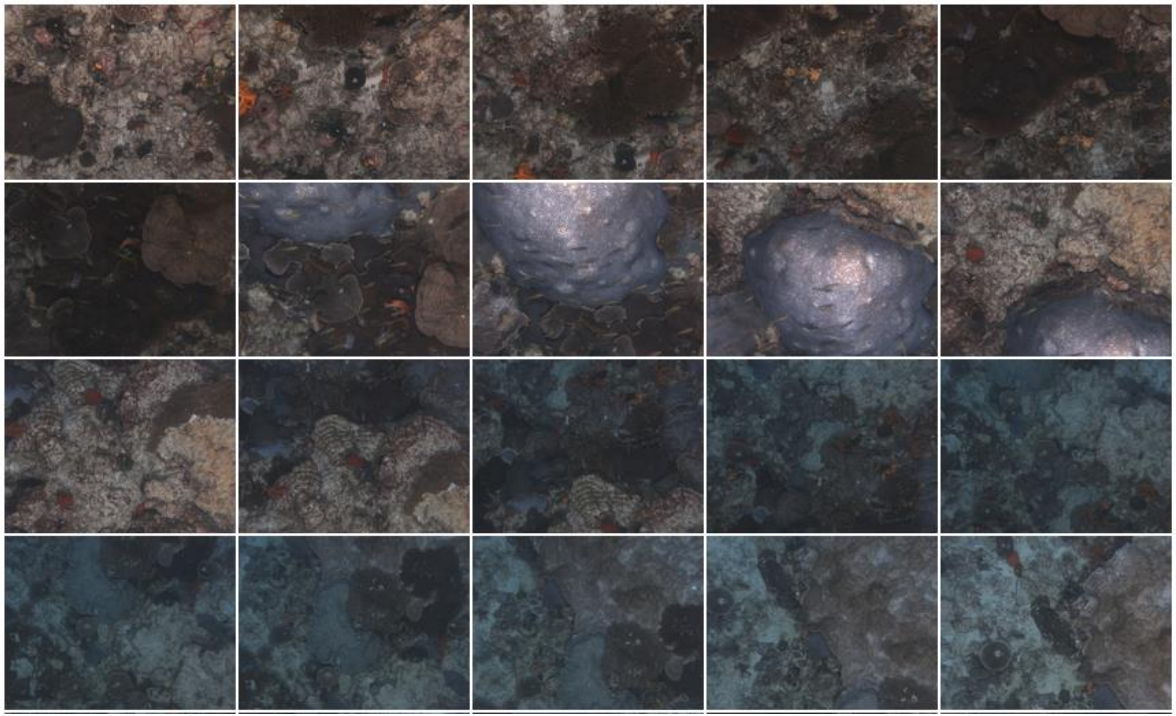
Sebastien Mancini talk earlier today … and Tuesday 1145!

IMOS Autonomous Underwater Vehicle

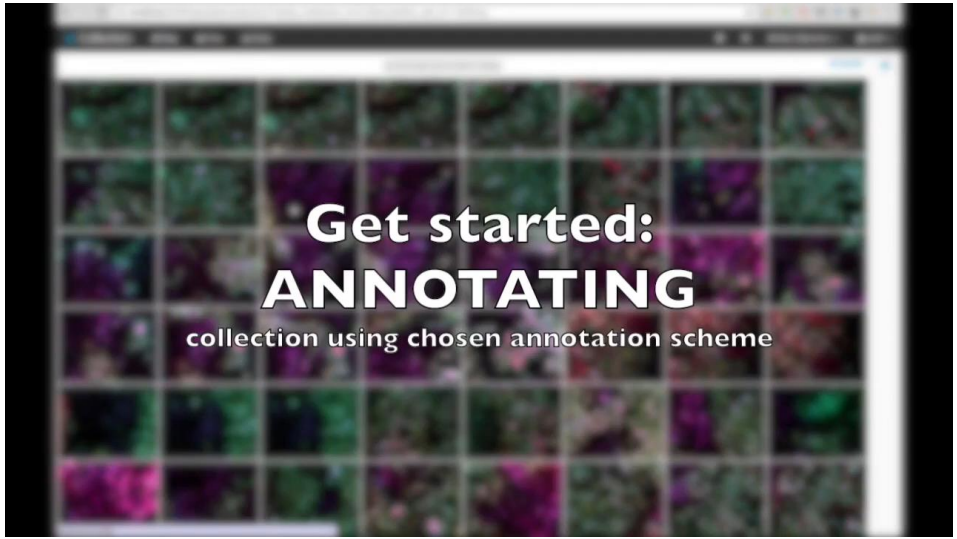


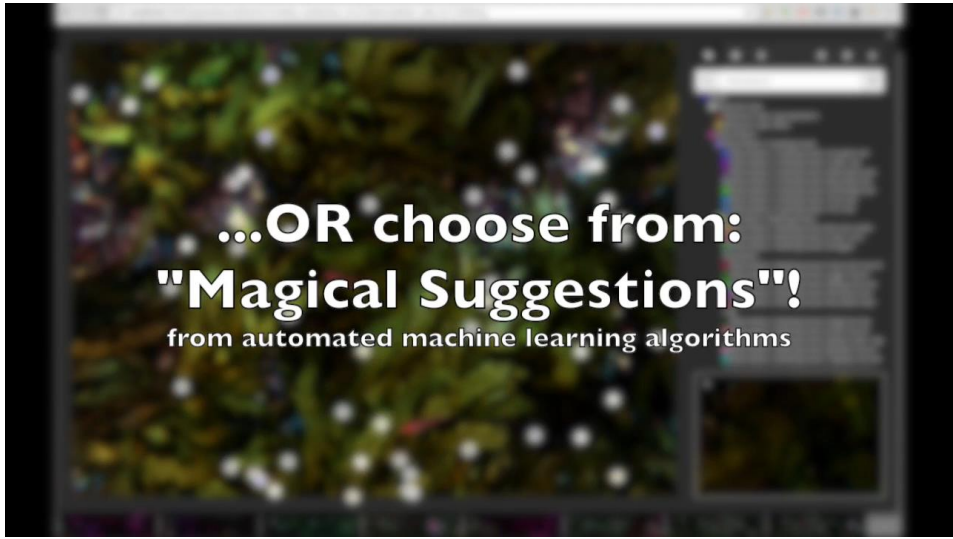


30,000 Stereo images of benthos in typically 50m x 50m square



AUV image annotation carried out with Squidle on desktop





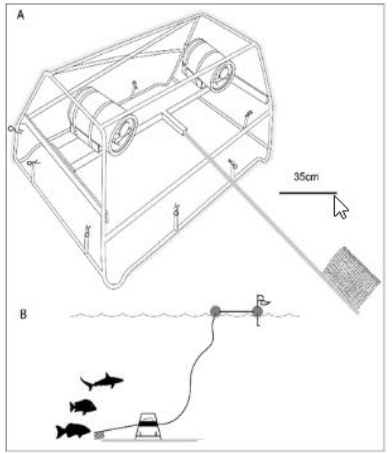
3 annotation schemes to choose from

Or machine learning algorithms

Another kind of imagery is video …

one particular instrument is a

BRUV – Baited Remote Underwater Video



Australia is currently the world leader in remote underwater and diver stereo-video sampling.
(e.g. stereo-BRUVs, stereo-DOVs, stereo-TV)

IMOS is looking to support this data collection platform

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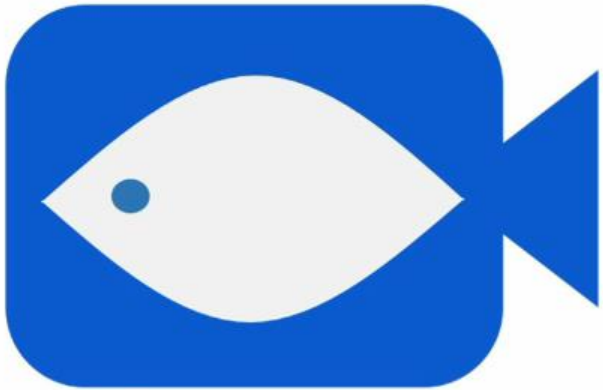


MARINE ECOLOGY GROUP
Fisheries Research

Why do this?

Body-size information is essential for:

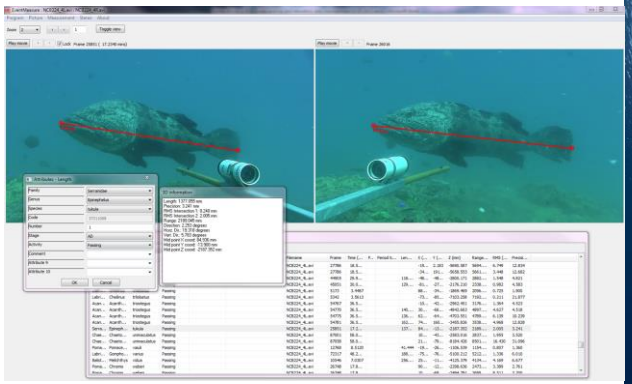
- many fish/ecological metrics
- standardise sample unit area

Most stereo-image annotation (in Oz) is done with:

- EventMeasure (.EMObs)

Mono annotation

- FinPrint Annotator
- FISH_ROCK
- VMS



Analysis … also currently a desktop, process

Courtesy:Jordan Goetze

Here's Waisea from Wildlife Conservation Society Fiji about to get started

Each video records about one hour of footage, and typically takes many, many hours to analyse and extract the annotations

Why is imagery important?

- Imagery fast becoming a tool of choice of State of Environment Reporting
- Enables fast, ‘cheap’ repeat sampling to assess health of area ($5-10k/BRUV)
- World-wide interest in its use
- Video == BIG DATA, laborious workflow, mostly desktop
- Because mostly desktop, sharing is difficult
- Cloud can address this and improve efficiency and uptake

Australian Research Data Cloud

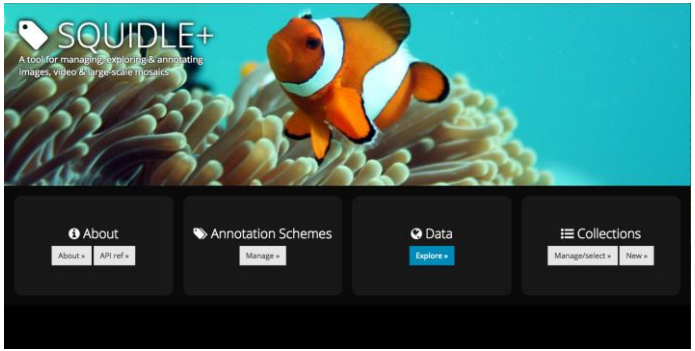
National Research Infrastructure Roadmap

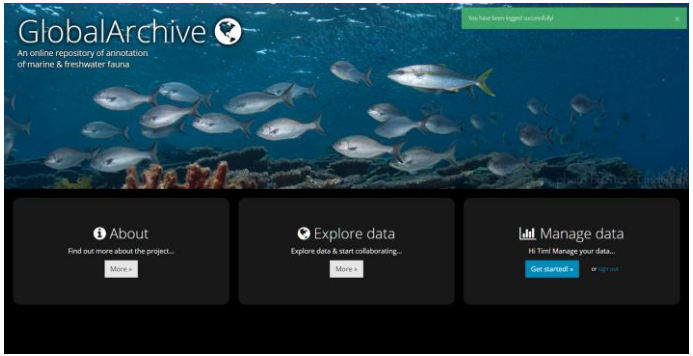
http://www.ands.org.au/news-and-events/share-newsletter/share-29/towards-the-australian-research-data-cloud

Marine Research Data Cloud

National service to annotate and analyse underwater imagery by leveraging existing software initiatives:

- **Squidle+**: exploration, management and annotation of georeferenced images & video
- **GlobalArchive**: exploration, sharing and querying of annotation data
- And establishing cloud online imagery repository





Developed & maintained by Ariell Friedman (Greybits Engineering)
With support from SOI, IMOS and the ARDC Research Data Cloud

Key features of SQUIDLE+

Flexible data storage:

Sync with existing data storage infrastructure (i.e.: data linked from AODN). Avoids needing to copy and duplicate data. Takes minutes instead of days to import data into the system.

Flexible, translatable annotation schemes:

Users can define their own annotation schemes or select from existing ones, and can translate between them meaning all annotations can be viewed in a unified consistent framework

Collaborative / automated labeling

Data can be annotated by different users with different skill levels and automated algorithms can be called upon to speed up the annotation process.

"Media object" annotation

Images, videos, mosaics, etc can all be annotated using the same consistent framework.

Developed & maintained by Tim Langlois (UWA) and Ariell Friedman (Greybits Engineering)

Support from UWA Emerging Leaders Fund, Gorgon Barrow Island Net Conservation Benefits Fund and the ARDC Research Data Cloud

GlobalArchive

For **synthesis and interpretation of annotation datasets** there is a need for:

- Centralised agnostic data archive
- Standardised formats
  - Platform/Sampling information
- Future ready
- Quality control
- Ease of use and access

GlobalArchive offers

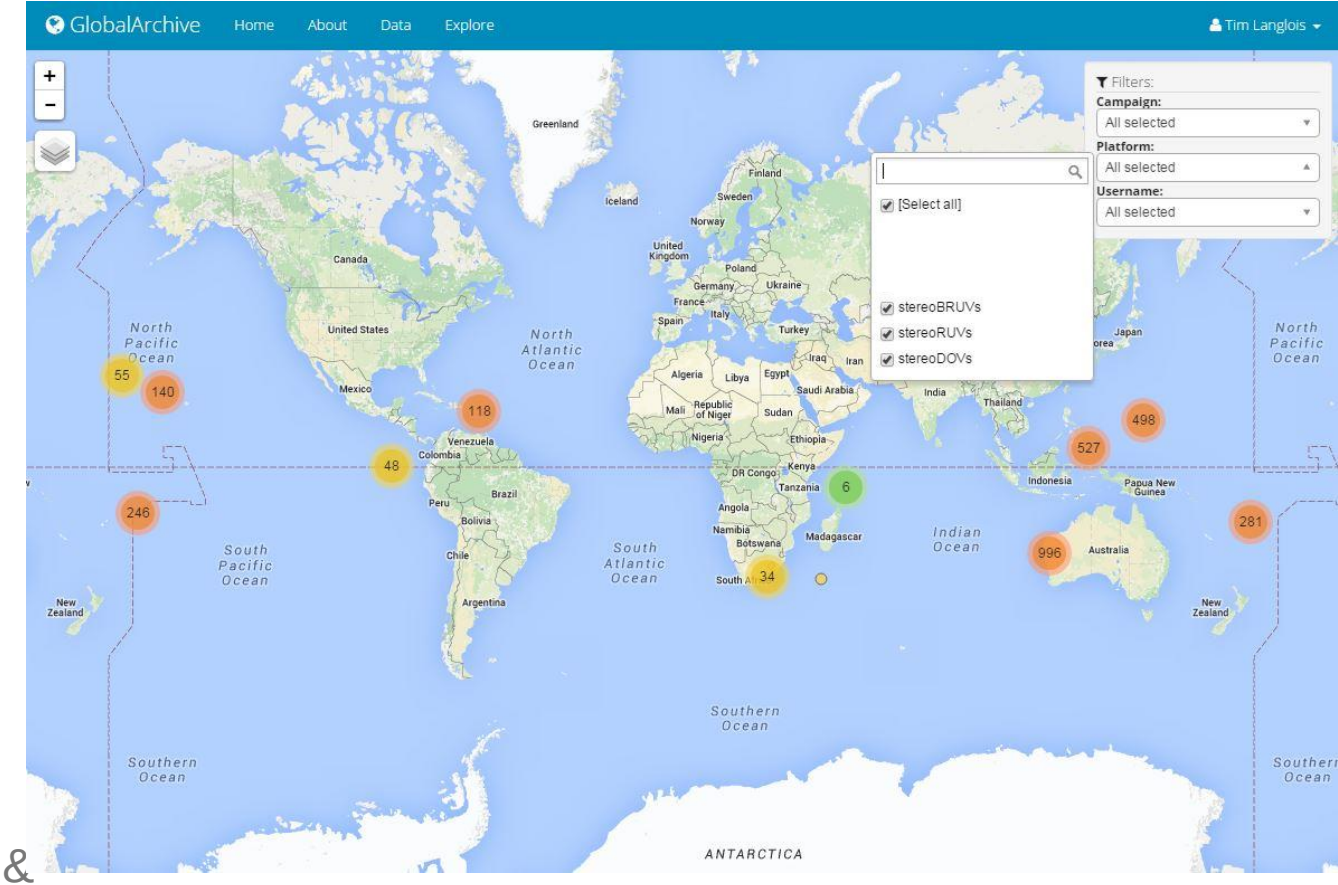
- Project sharing or open data
- Solving problems of data storage
- Added value through synthesis
- Ensuring time series data will be available

GlobalArchive

Flexible import of **historical** and **modern** annotation data

Direct import from leading stereo annotation software (SeaGIS - EventMeasure)

Working with other annotation initiatives to ensure data transferability & interoperability (GlobalFinPrint)



22,000 BRUVs worldwide, https://globalfinprint.org/

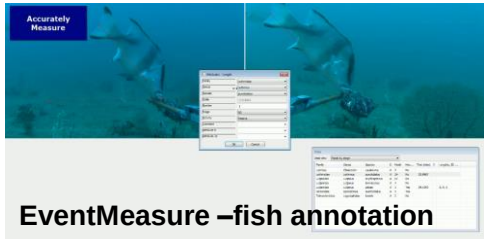
A National Service for Underwater Imagery

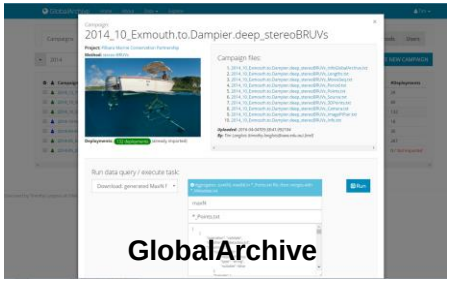
User Upload

Repository >500Tb

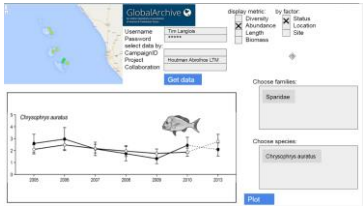
Imagery stored here
- Still imagery
- BRUVs
- DOVs
- Towed video
- Etc.

Annotation done here





Annotations stored here

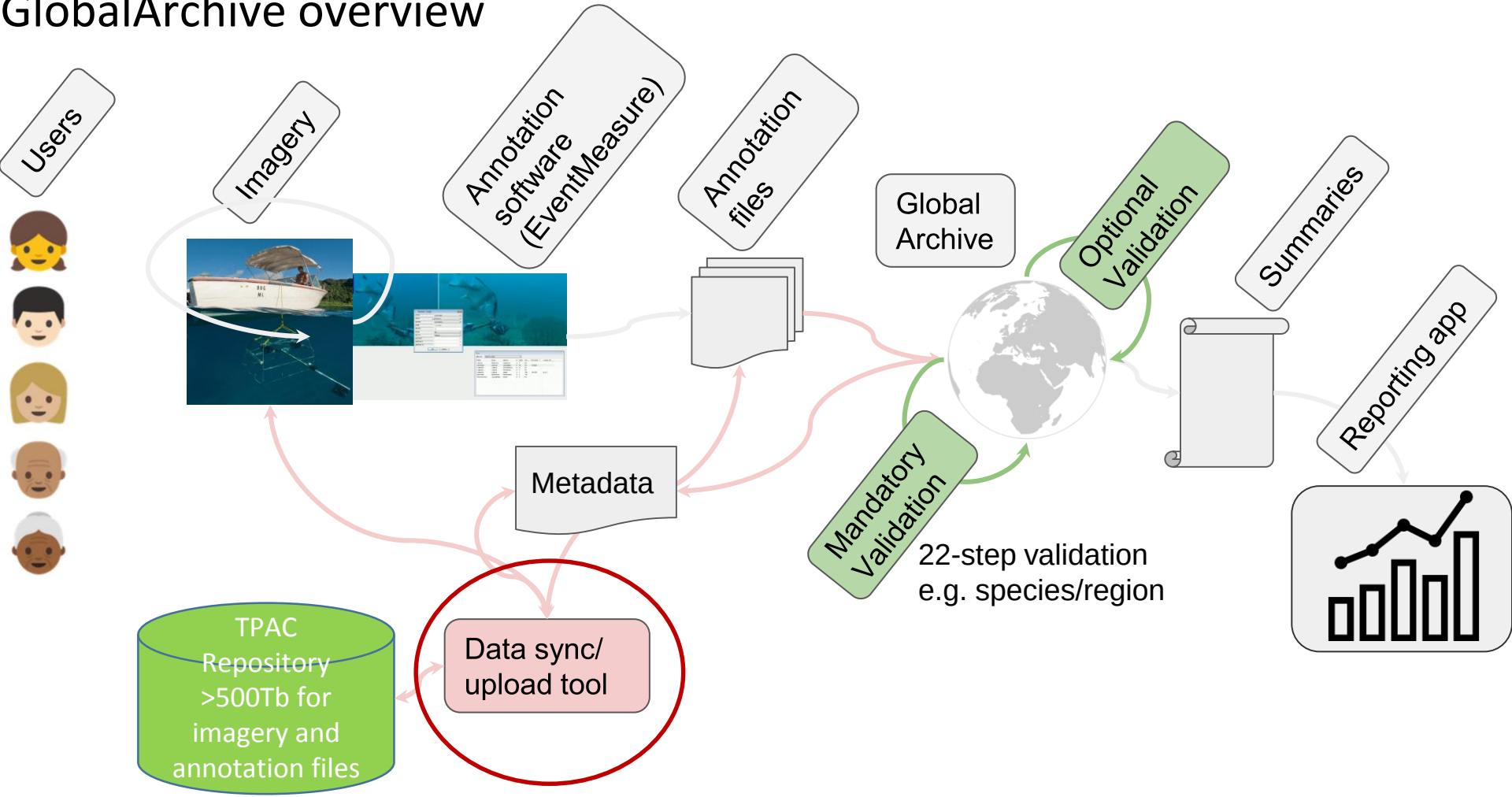


Analytics done here

SoE Reporting

Marine Research Data Cloud 2018

GlobalArchive overview



Datasync Tool – important

- Data wrangling
  - Cleaning the data and ironing out inconsistencies is often laborious and manual
- Data upload
  - Handles all the syncing and upload of annotation & imagery data
- Access to original imagery
  - No standardised methods for upload and retrieval
  - Links to annotations are often not easily maintained
  - Often ends up archived on drives in boxes under someone's desk
- Standardisation of annotation data
  - Usually difficult to reuse / validate between organisations
  - With links to original imagery
  - Future hooks to Squidle+

Datasync Tool

Organise data
select files on local computer / drive

Create metadata
using included tools to ensure consistency

Validate
cross check data files and imagery

Sync annotations
upload metadata and files to GlobalArchive

Upload imagery
to cloud storage repository

An example of the value of GlobalArchive

GlobalArchive

The Australian National BRUV synthesis
Started at a week-long workshop in early Feb 2018

- 32 BRUV researchers
- 6 Government institutions and 6 Universities

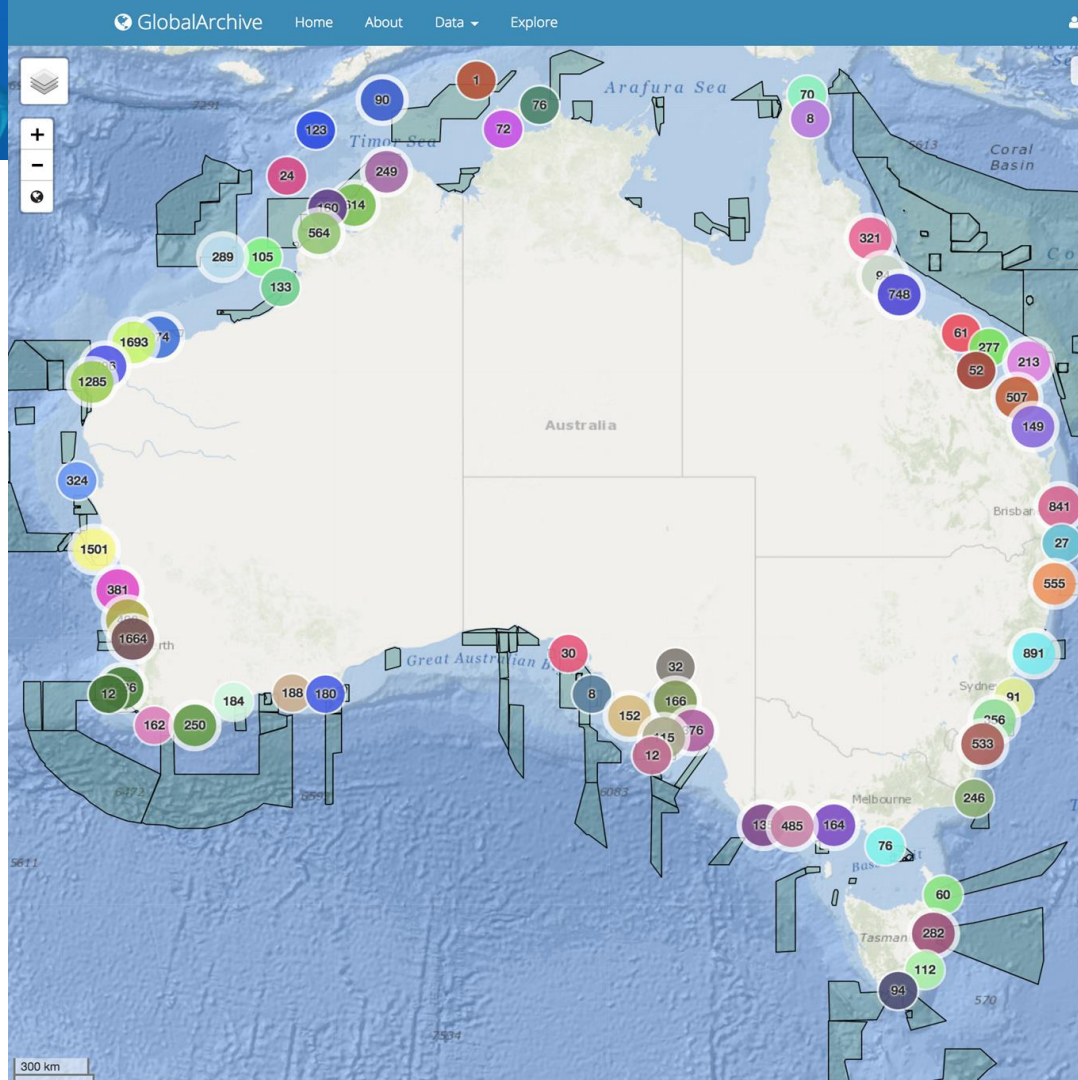
- 80% of available annotation analyses loaded into the cloud
- Represents an investment of ~$10M

Curtin, Deakin, Flinders, JCU, Utas, UWA, AIMS, CSIRO, NSW-DPI_F, SA-DEWNR, WA-DBCA, WA-DPIRD_F

GlobalArchive

The Australian National BRUV synthesis

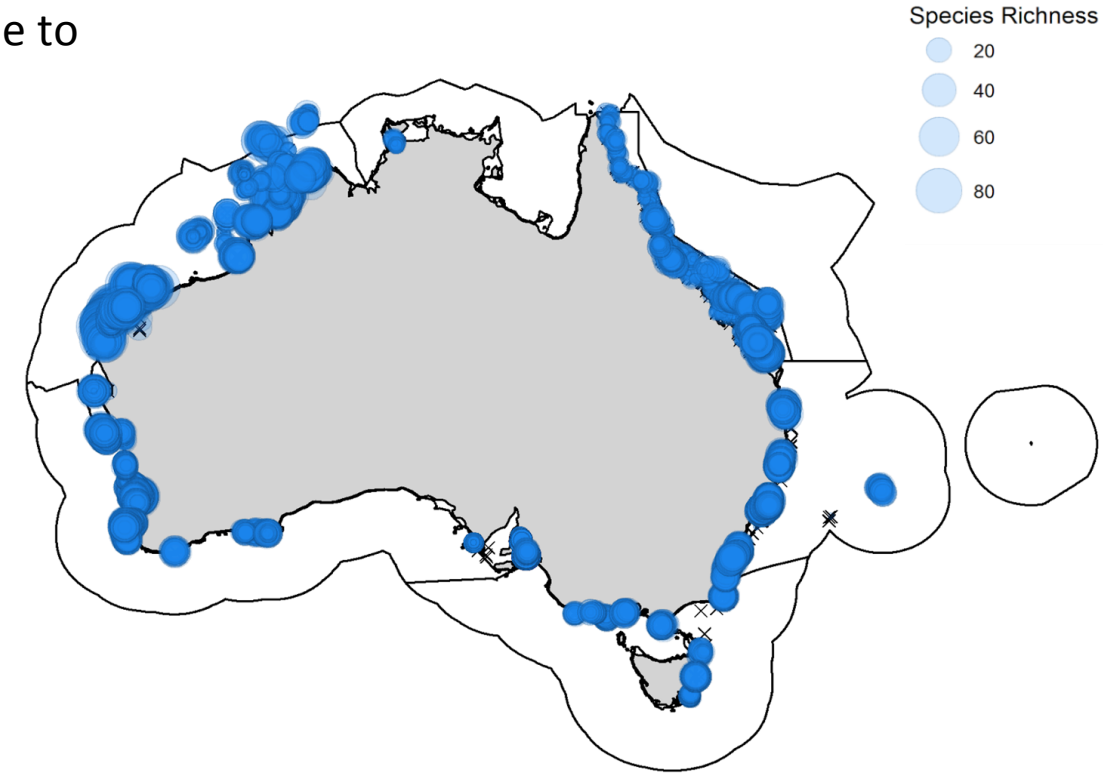
- 20,022 BRUV deployments
- 1,888 species
- 2,693,906 individual fish
- 660,481 length measurements



GlobalArchive

Initial synthesis: information of value to

- State of Environment reporting
- Potential for improved fisheries management
- Conservation from broad scale assessments



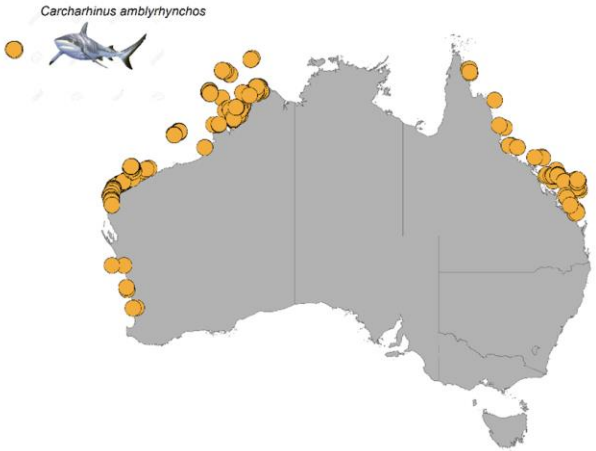
GlobalArchive

Tiger shark

Galeocerdo cuvier

Grey reef shark

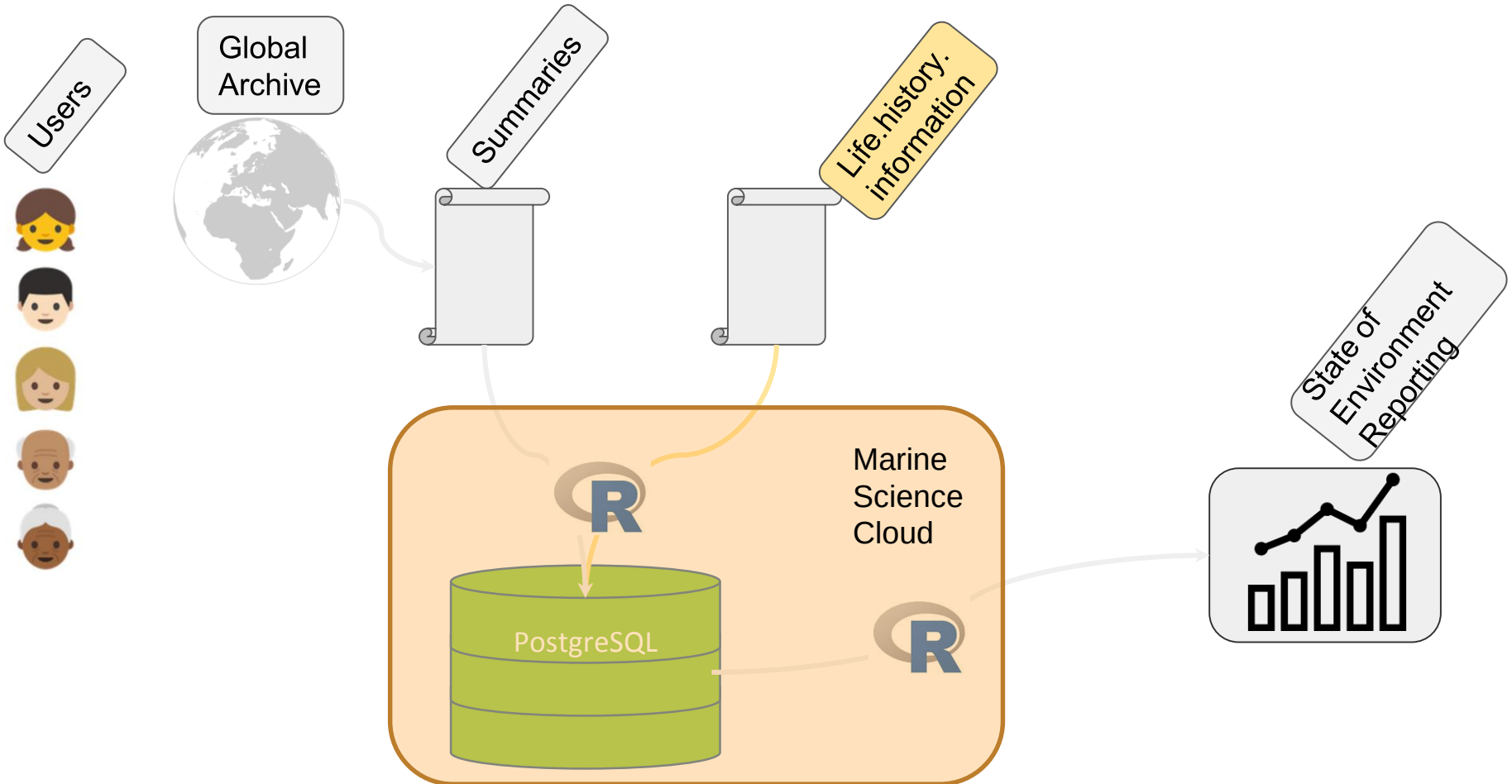
Carcharhinus amblyrhynchos



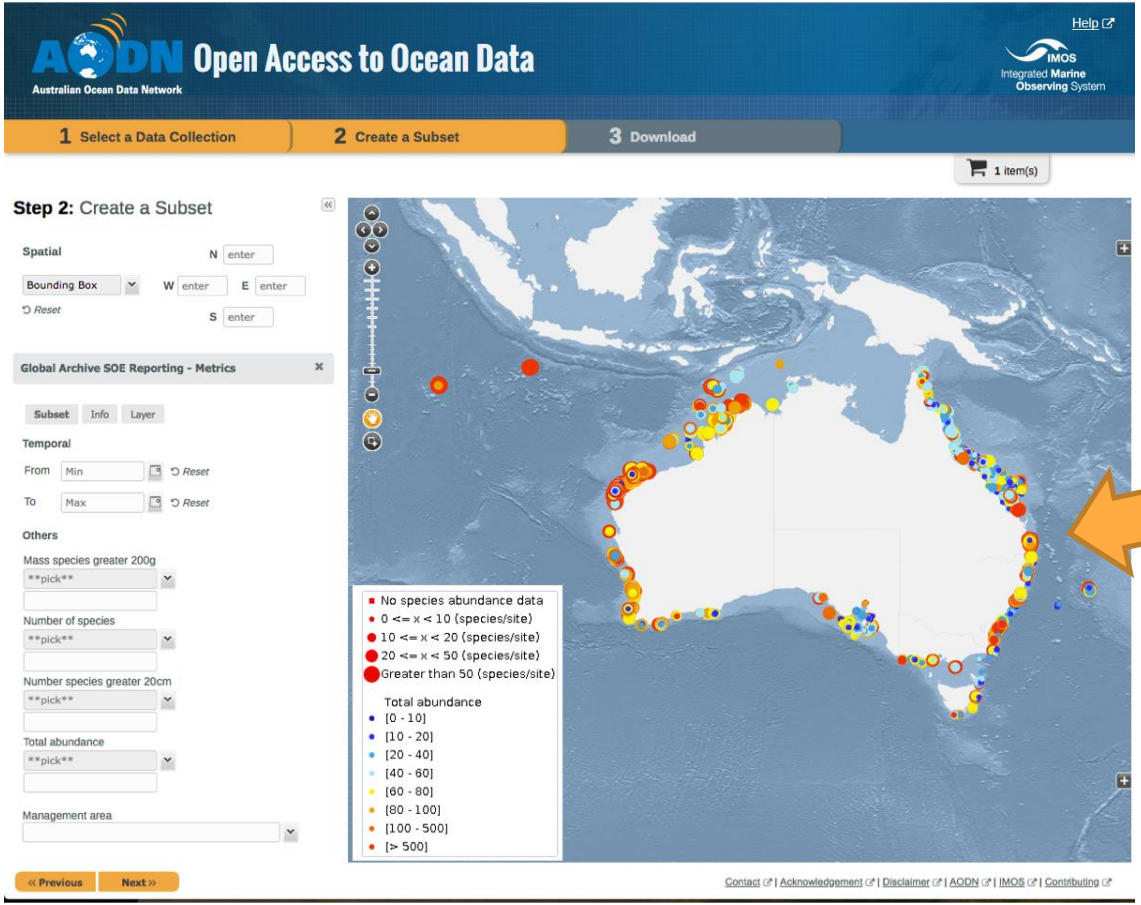
Port Jackson shark

Heterodontus portusjacksoni

Workflow for State of Environment reporting app

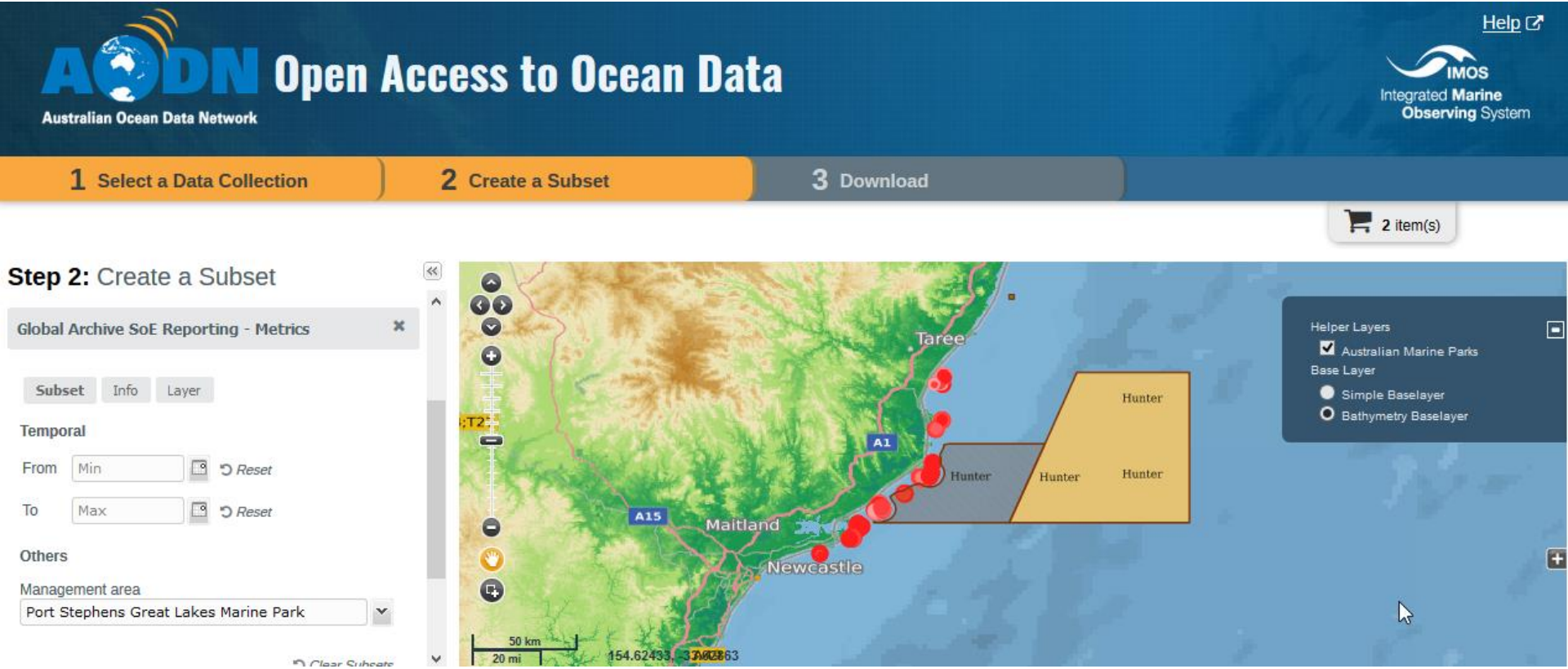


Using the AODN portal for State of Environment reporting

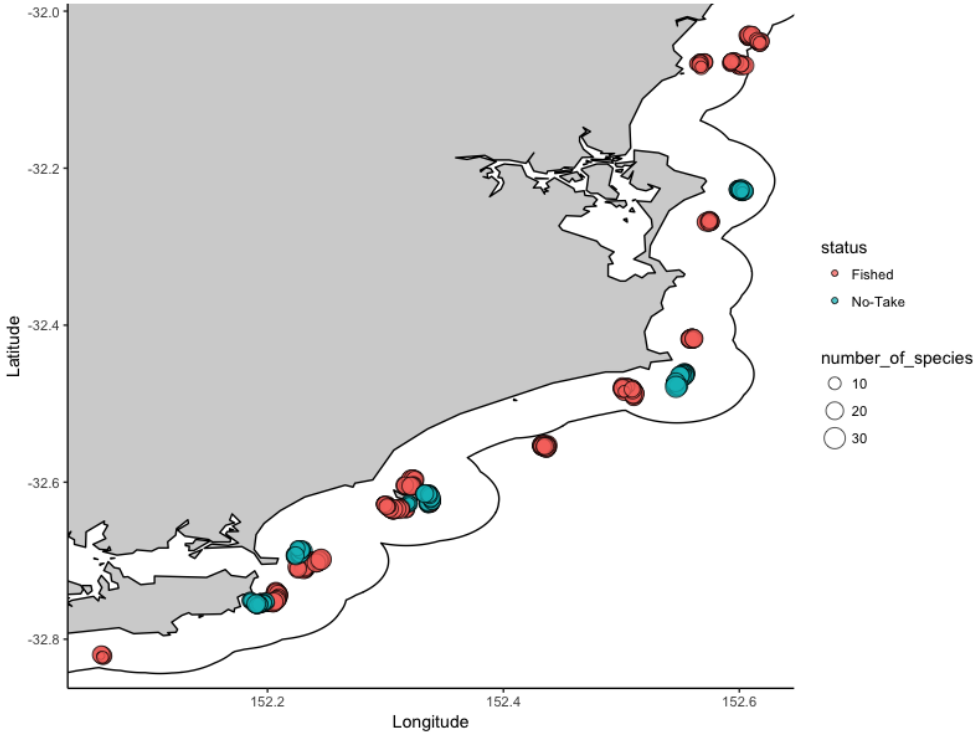


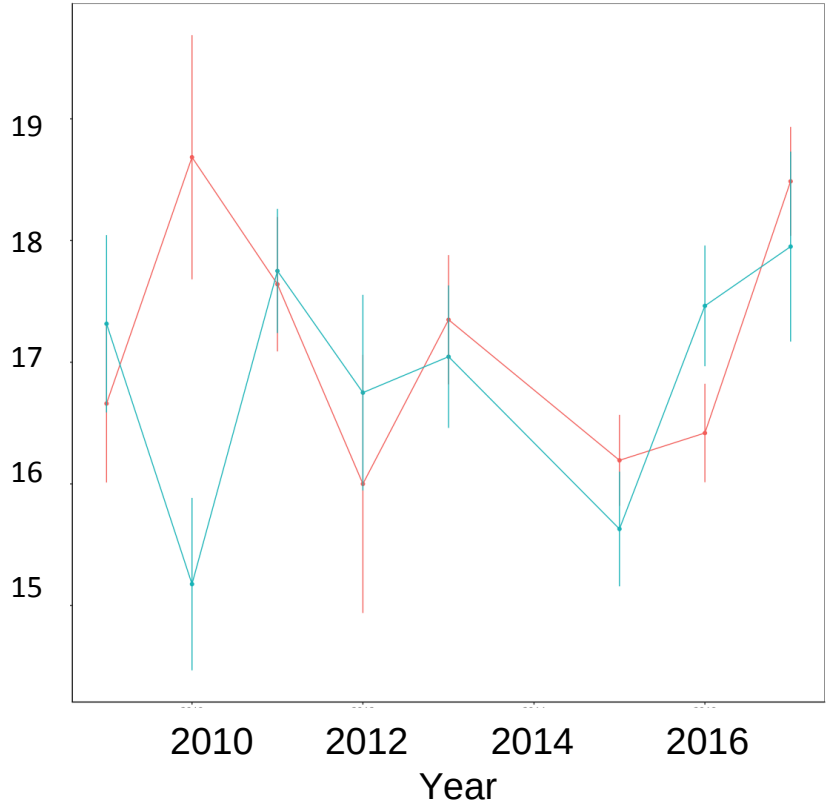
Click on a ‘blob’

Using the AODN portal for State of the Art reporting

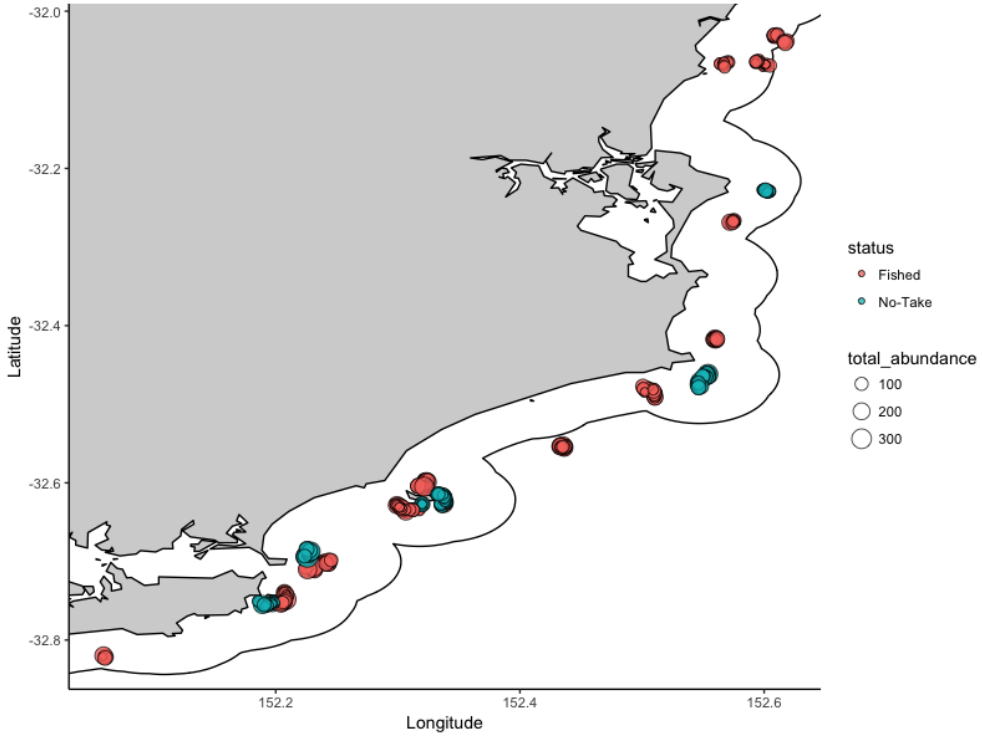


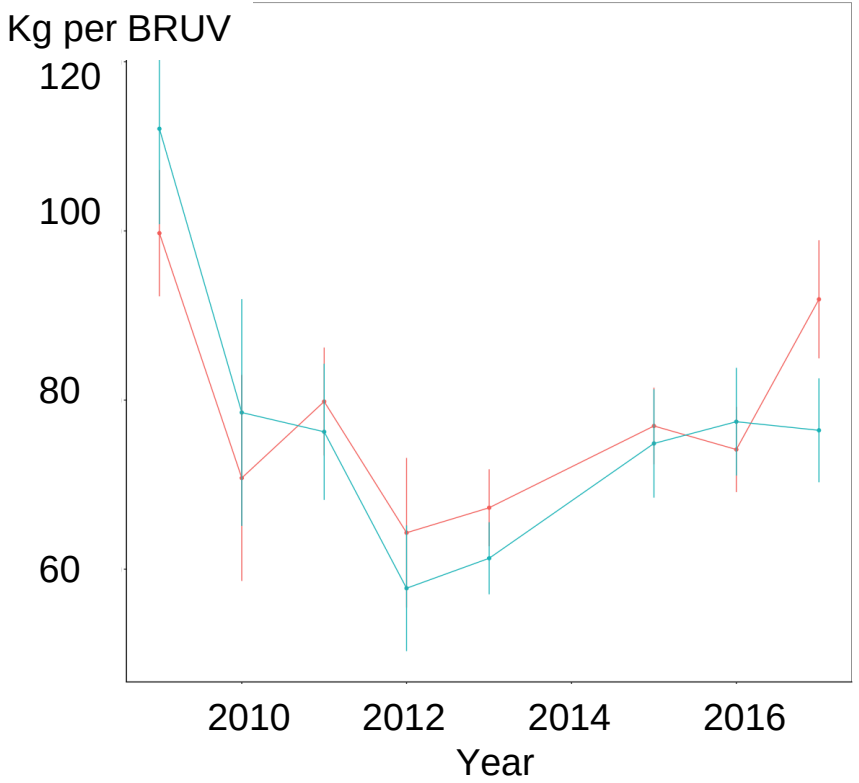
Port Stephens Great Lakes Marine Park
Number of Species - Fished (red); No Take (green)





Port Stephens Great Lakes Marine Park
Total abundance - Fished (red); No Take (green)





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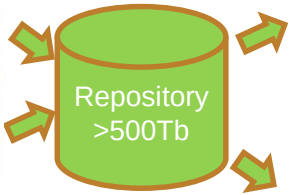
User Upload Interface



Imagery stored here
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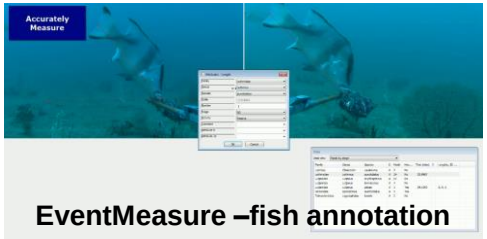
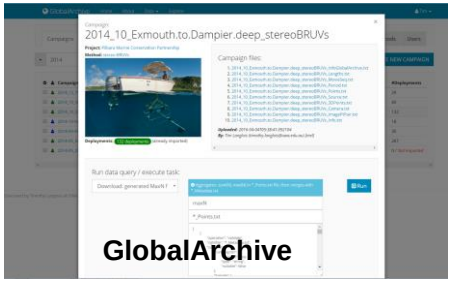
Annotation done here





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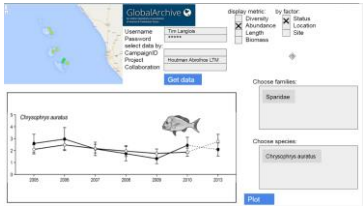
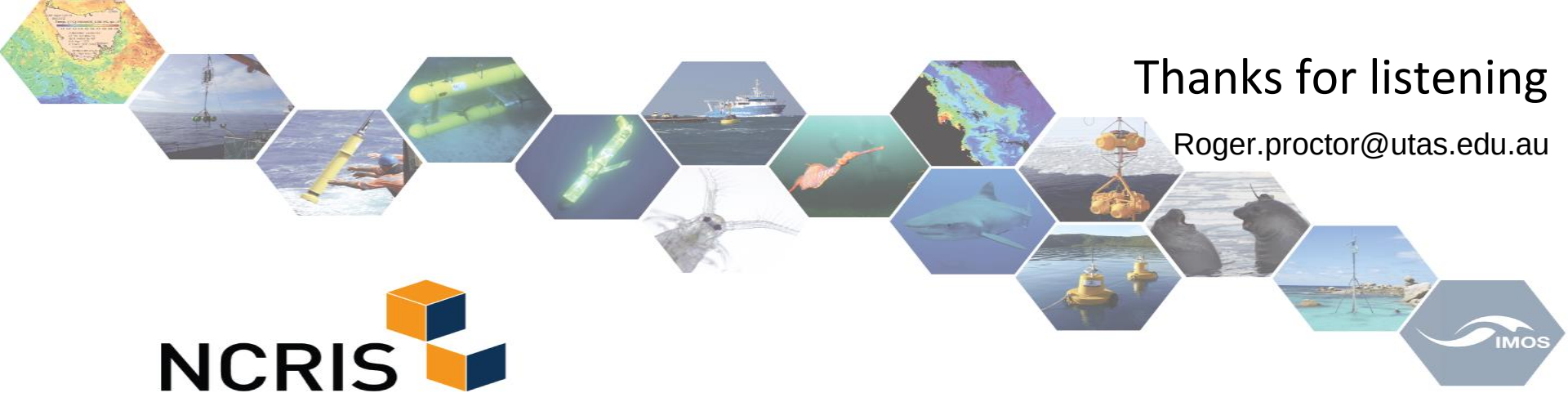


Analytics done here

SoE Reporting

Marine Research Data Cloud 2018



Thanks for listening

Roger.proctor@utas.edu.au

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

IMOS is a national collaborative research infrastructure, supported by Australian Government. It is operated by a consortium of institutions as an unincorporated joint venture, with the University of Tasmania as Lead Agent. **www.imos.org.au**

PRINCIPAL PARTICIPANTS

University of Tasmania (Lead Agent)

Australian Government

Australian Institute of Marine Science

Australian Government Bureau of Meteorology

CSIRO

Government of South Australia

SARDI South Australian Research and Development Institute

The University of Western Australia

sims sydney institute of marine science

UTS

The University of Sydney

Macquarie University

UNSW Sydney

SIMS is a partnership involving four Universities.

ASSOCIATE PARTICIPANTS

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