

Using the NeCTAR research cloud to develop national on-line services to annotate and analyse underwater imagery: SQUIDLE+ and GlobalArchive



Roger Proctor (AODN),
Tim Langlois (UWA), Ariell Friedman (Greybits),
Brendan Davey (TPAC)

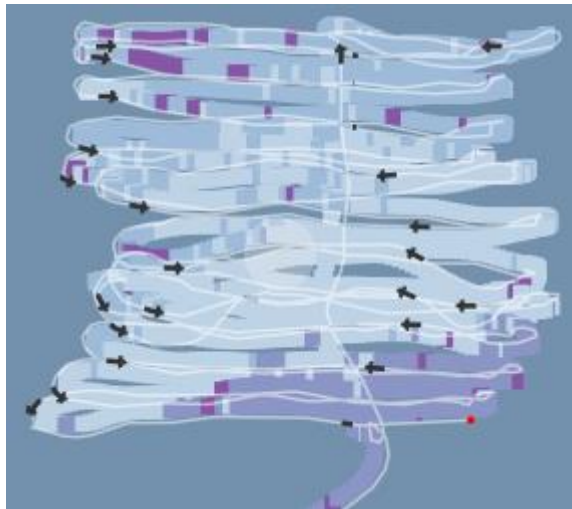
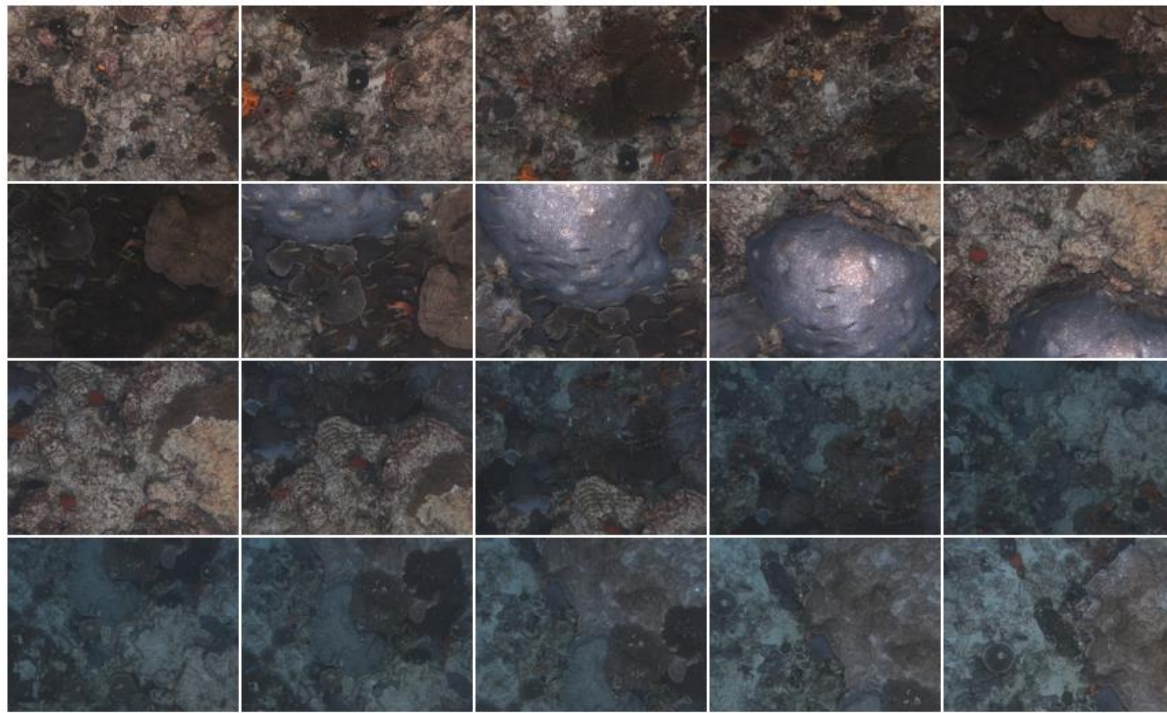
Why is imagery important?

- Imagery fast becoming a tool of choice of State of Environment Reporting
- Enables fast, 'cheap' repeat sampling to assess health of area
- 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

IMOS Autonomous Underwater Vehicle



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



Stereo BRUV data collection



Deploying the BRUV
Baited Remote Underwater Video

Deployments typically last an hour
Aim: identify local fish population



Australian Community Cloud funded by Nectar

Marine Sciences Cloud – IMOS, Ecosystems Science Cloud – TERN, Biosciences Cloud – Bioplatforms Australia



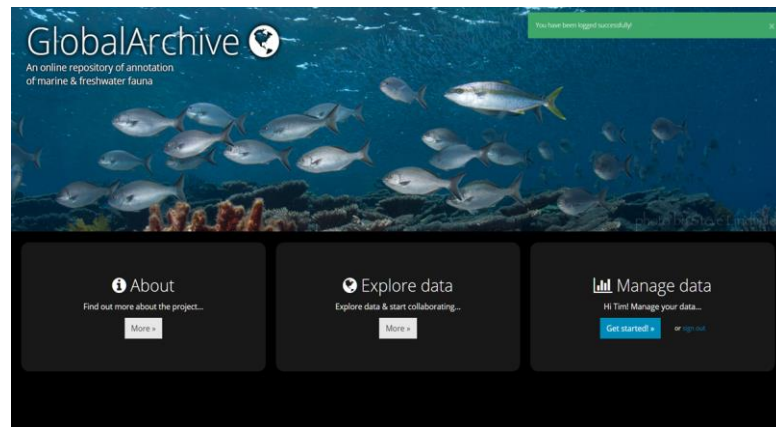
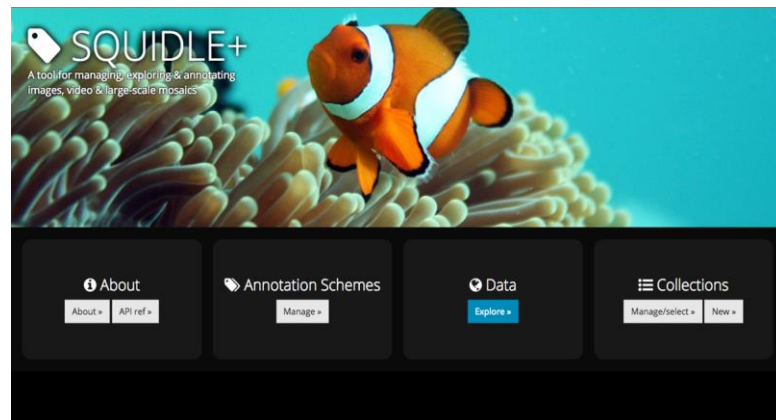
Marine Sciences Cloud has two components:

National services 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

Virtual desktop support for marine and climate scientists

- Researchers can run analyses using a suite of online graphical and scripting tools (eg: Jupyter notebook, QGIS Browser, Rstudio, Panoply)
- Links to data repositories





SQUIDLE+

A tool for managing, exploring & annotating
images, video & large-scale mosaics



About

[About »](#)[API ref »](#)

Annotation Schemes

[Manage »](#)

Data

[Explore »](#)

Collections

[Manage/select »](#)[New »](#)

Developed & maintained by Ariell Friedman (Greybits Engineering)
With support from SOI, IMOS and the Nectar Science 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:

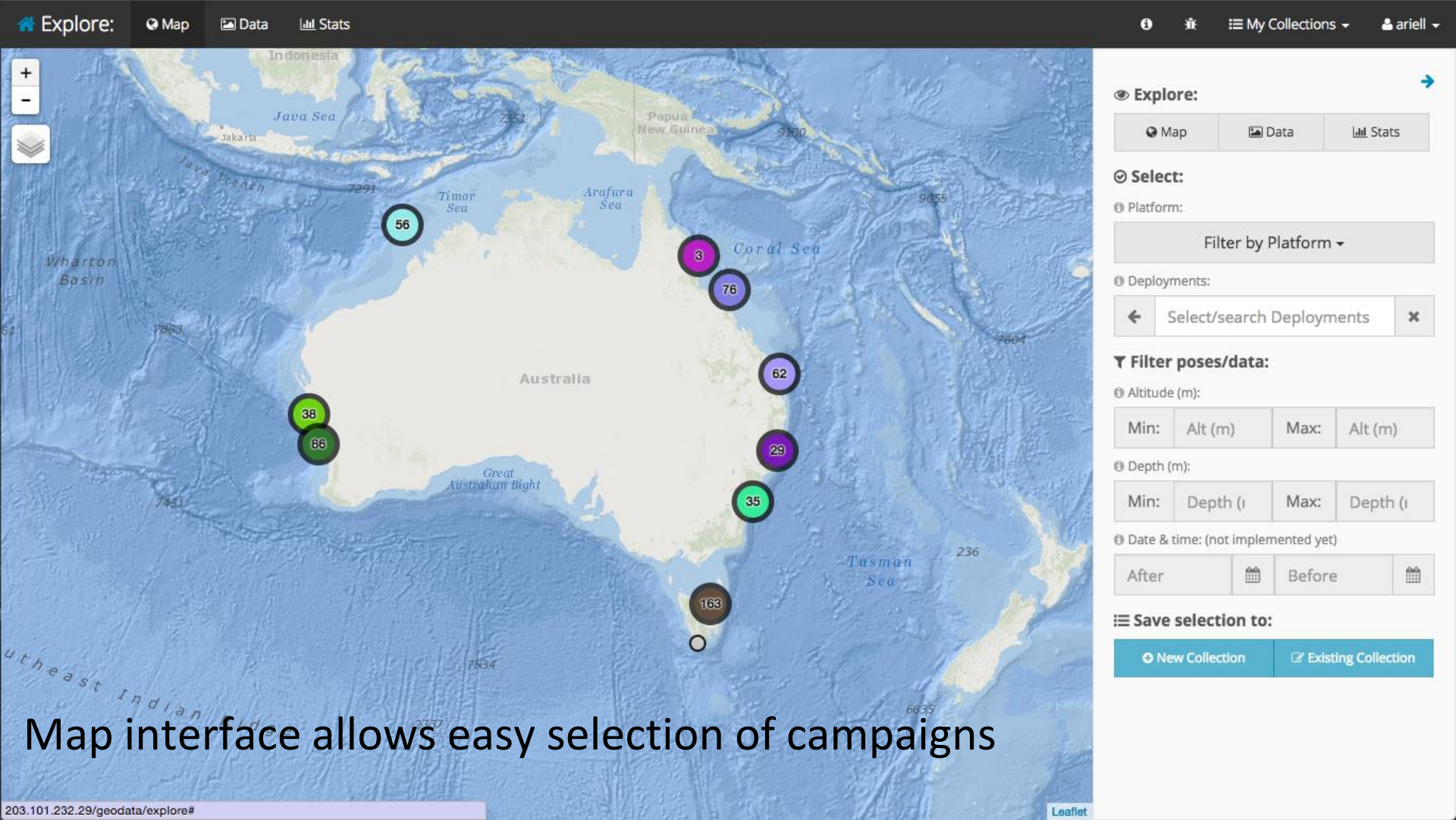
Users can define their own annotation schemes or select from existing ones, and can translate between them meaning all annotations can be viewed in a unified consistent framework

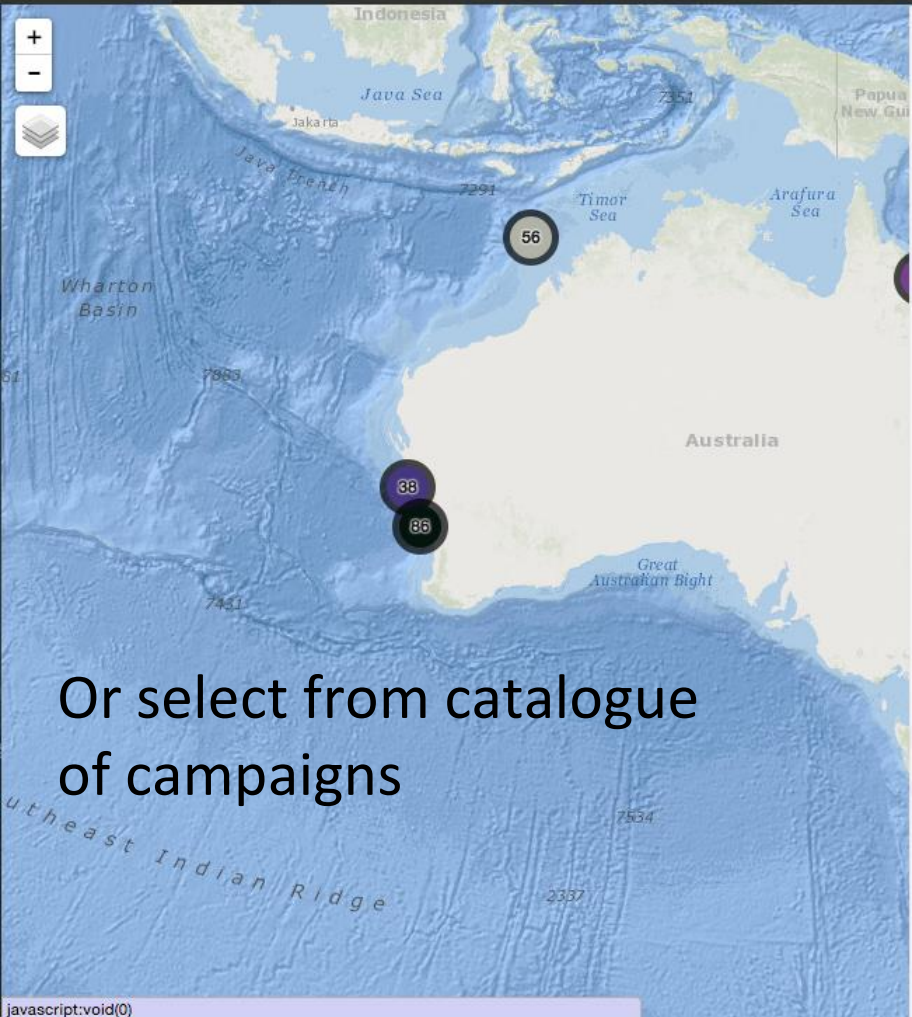
Collaborative / automated labeling

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.





Batemans201011

- batemans_03_site1sz
- batemans_06_site6guz
- site6guz_08_broadgrid
- site4sz_09_transect
- site6guz_10_densegrids
- site6guz_11_densegrid3
- site5sz_12_densegrids
- site3guz_13_densegrids
- site2guz_14_densegrids
- site1sz_15_densegrids
- site1sz_16_densegrids3
- site4sz_17_densegrids
- site4sz_18_broadgrid

Batemans201211

- Durras_site3guz_01_dense
- Durras_site3guz_02_broad
- Tollgates_site4sz_03_dense
- Tollgates_site4sz_04_broad
- Burrewarra_BU_DG3_05_dense
- Lilli_Pilli_LP_DG2_06_dense
- Lilli_Pilli_LP_DG2_07_broad

Batemans201411

- 01_Tollgates_site4sz_broad
- 02_Tollgates_site4sz_dense
- 03_Durras_site3guz_broad
- 04_Durras_site3guz_dense
- 05_Burrewarra_broad
- 06_Burrewarra_BU_DG3_dense
- 07_Burrewarra_BU_DG3_dense_continue
- 09_Burrewarra_BU_DG3_dense_continue_grid3
- 11_Lilli_Pilli_LP_DG2_dense

GBR200709

- gbr_06_viper_leg_grid
- gbr_07_viper_grids
- gbr_08_viper_grids_2
- gbr_02_ribbon_grid
- gbr_09_hydrographers_leg
- gbr_04_noggin_leg_grid
- gbr_05_noggin_grids
- gbr_10_hydrographers_grid_leg
- gbr_11_hydrographers_shoal_sandwaves

GBR201102

IMOS AUV Sirius

2010-11-17T00:19:12

2010-11-17T22:46:23

2010-11-18T01:03:26

2010-11-18T05:33:54

2010-11-19T20:44:43

2010-11-19T22:40:28

2010-11-20T00:23:02

2010-11-20T19:21:36

2010-11-20T22:26:27

2010-11-21T03:09:56

2010-11-21T06:24:24

2010-11-22T18:54:20

2010-11-22T21:41:34

IMOS AUV Sirius

2012-11-27T20:41:11

2012-11-27T23:15:20

2012-11-28T02:57:27

2012-11-28T05:15:32

2012-11-28T19:58:06

2012-11-28T22:52:41

2012-11-29T01:16:10

IMOS AUV Sirius

2014-11-11T22:09:36

2014-11-12T00:45:00

2014-11-16T20:27:33

2014-11-16T22:56:28

2014-11-17T03:02:54

2014-11-17T05:32:29

2014-11-17T07:02:59

2014-11-17T21:38:57

2014-11-18T01:27:15

IMOS AUV Sirius

2007-10-05T04:44:57

2007-10-06T00:11:40

2007-10-07T02:45:59

2007-09-28T01:30:04

2007-10-10T23:09:32

2007-10-03T23:09:51

2007-10-04T01:34:37

2007-10-11T04:37:24

2007-10-12T04:21:11

Explore:

Map Data Stats

Select:

Platform:

Filter by Platform

Deployments:

Select/search Deployments

Filter poses/data:

Altitude (m):

Min:	Alt (m)	Max:	Alt (m)
------	---------	------	---------

Depth (m):

Min:	Depth (m)	Max:	Depth (m)
------	-----------	------	-----------

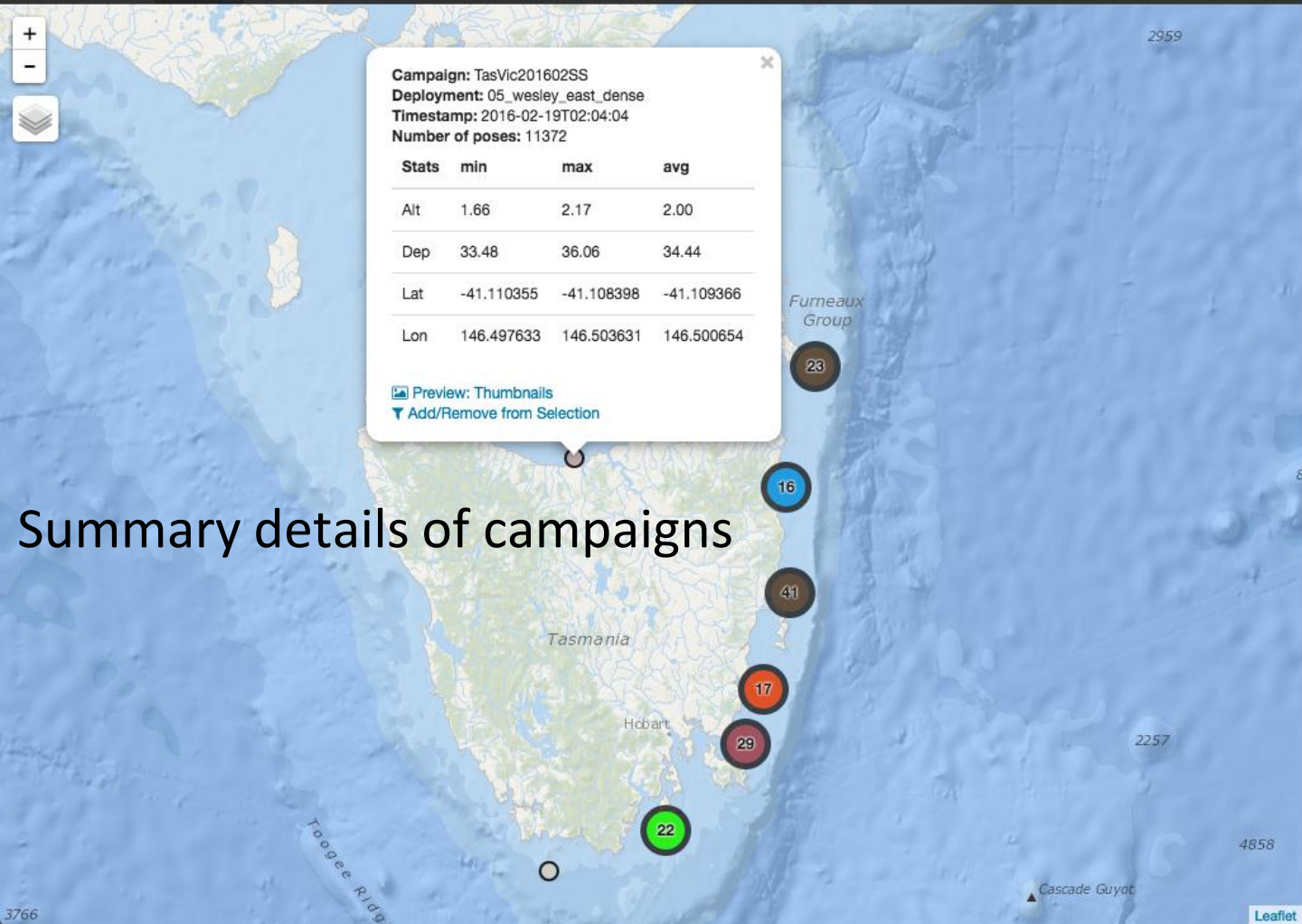
Date & time: (not implemented yet)

After		Before	
-------	--	--------	--

Save selection to:

New Collection

Existing Collection



Explore:

Map Data Stats

Select:

Platform:

Filter by Platform

Deployments:

Select/search Deployments

Filter poses/data:

Altitude (m):

Min:	Alt (m)	Max:	Alt (m)
------	---------	------	---------

Depth (m):

Min:	Depth (m)	Max:	Depth (m)
------	-----------	------	-----------

Date & time: (not implemented yet)

After		Before	
-------	--	--------	--

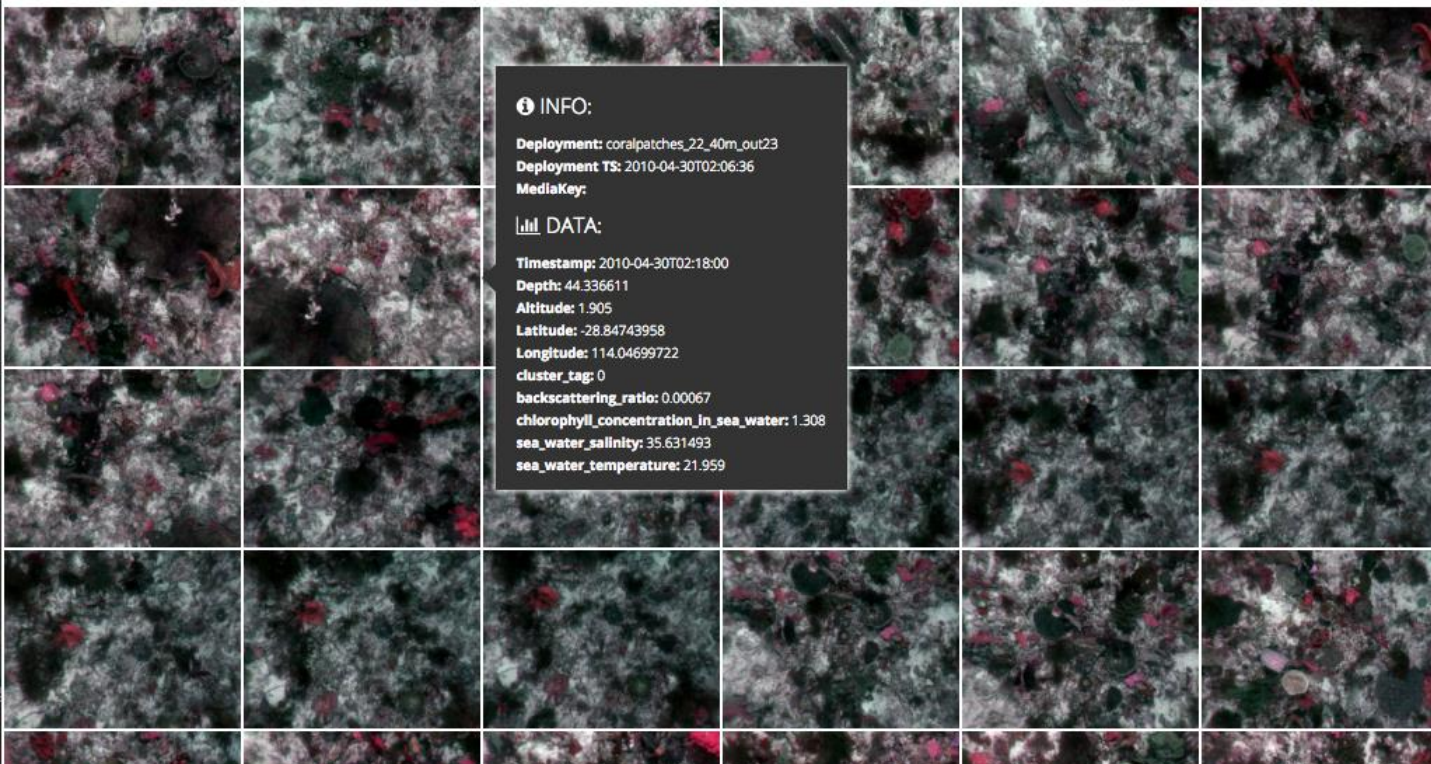
Save selection to:

New Collection Existing Collection

returned: 1698 results | page: 1/19

Next

QUERY



Immediate view of thumbnail images of a campaign

Explore:

Map

Data

Stats

Select:

Platform:

Filter by Platform

Deployments:



WA coral



coralpatches_22_40m_out23 coralpatches_23_40m coralpatches_01_15m_in

Filter poses/data:

Altitude (m):

Min:

1.9

Max:

2.1

alt > 1.9 alt < 2.1

Depth (m):

Min:

40

Max:

45

dep > 40 dep < 45

Date & time: (not implemented yet)

After



Before



Save selection to:

New Collection

Existing Collection

Substrate: Consolidated (hard)

TAGS: physical substrate consolidated (hard)

COMMENT: This is a free form comment

Macroalgae: Large canopy-forming: Brown

TAGS: macroalgae biota large canopy-forming brown

COMMENT: This is another comment

Magical suggestions (click to label):

Biota prob: 0.75 by: KELBOT V1.0

HINT: dbl-click for more options.

Macroalgae: Large canopy-forming: Brown (ID:1320)

TAGS: macroalgae biota large canopy-forming brown

INFO:

Schema: Catami 1.4 (ID: 4)

code_parent: 80300901

code_short: MALCB

code: 80300902

link: http://www.marine.csiro.au/caabsearch/caab_search.caab_rep?sprode=80300902

Filter/Search

- Macroalgae: Articulated calcareous: Green
- Macroalgae: Articulated calcareous: Red
- Macroalgae: Encrusting
- Macroalgae: Encrusting: Brown
- Macroalgae: Encrusting: Green
- Macroalgae: Encrusting: Red
- Macroalgae: Encrusting: Red: Calcareous
- Macroalgae: Encrusting: Red: Non-calcareous
- Macroalgae: Erect coarse branching
- Macroalgae: Erect coarse branching: Brown
- Macroalgae: Erect coarse branching: Green
- Macroalgae: Erect coarse branching: Red
- Macroalgae: Erect fine branching
- Macroalgae: Erect fine branching: Brown
- Macroalgae: Erect fine branching: Green
- Macroalgae: Erect fine branching: Red
- Macroalgae: Filamentous / filiform
- Macroalgae: Filamentous / filiform: Brown
- Macroalgae: Filamentous / filiform: Green
- Macroalgae: Filamentous / filiform: Red
- Macroalgae: Globose / saccate
- Macroalgae: Globose / saccate: Brown
- Macroalgae: Globose / saccate: Green
- Macroalgae: Globose / saccate: Red
- Macroalgae: Laminar
- Macroalgae: Laminar: Brown
- Macroalgae: Laminar: Green
- Macroalgae: Laminar: Red
- Macroalgae: Large canopy-forming
- Macroalgae: Large canopy-forming: Brown

Point and click annotation – choice of annotation schemes

Data & Export

Dataset info:

- **Media Collection:** Demo
- **Annotation Set:** Demo
- **Annotation Scheme:** Squidle 1.0
- **# Media items:** 100
- **# Points:** 1173
- **# UNLABELED points:** 1118

Export Annotations:

- ☐ POINTS+META ☒ AGGREGATED+META
Export points (x,y,t). Export counts per media item.
- ☐ AGGREGATED+META (ALL CLASSES)
Export counts per media item (including unused classes).

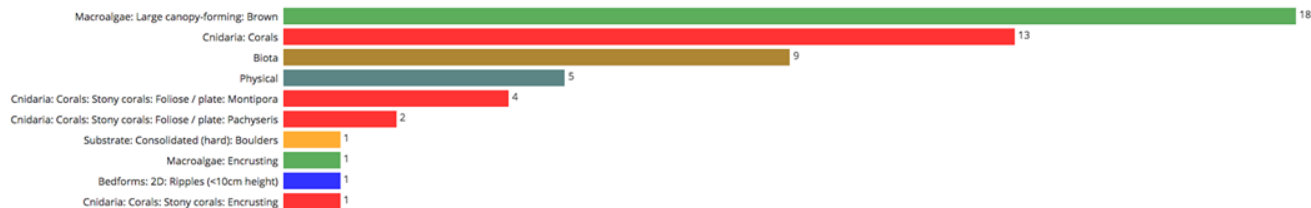
EXPORT ANNOTATIONS

Export Media Collection:

- ☒ MEDIA+ALLINFO
Export collection media and all meta data.
- ☐ MEDIA+SOMEINFO
Export collection media items.

EXPORT COLLECTION

Label distribution



Export summary annotation details of campaigns

GlobalArchive

An online repository of annotation
of marine & freshwater fauna

You have been logged successfully!



About

Find out more about the project...

[More »](#)

Explore data

Explore data & start collaborating...

[More »](#)

Manage data

Hi Tim! Manage your data...

[Get started! »](#)

[or sign out](#)

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
Nectar Science Cloud

[Campaigns](#)[Projects](#)[Collaborations](#)[Search by Method](#)

Method	Image	Reference
stereo-BRUVs		Watson, D. L., E. S. Harvey, M. J. Anderson, and G. A. K.
stereo-DOVs		Harvey, E., and M. Shortis. 1996. "A System for Stereo-
UVC		Connell, S. D., M. A. Samoilys, M. P. L. Smith, and J. Leq



Flexible import of
datasets from any
sampling method

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

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

GlobalArchive Home About Data + Explore Euan Harvey

Data was successfully written to the database

Campaigns

Search by Campaign

Campaign

2004_11_A...

2007_05_Ju...

2007_09_Re...

2007_11_A...

2007_11_P...

2007_11_Re...

2008_02_Br...

2008_10_P...

2009_05_Re...

2009_07_Re...

2009_08_Capes.sanctuaries_stereoBRUVs Nagari Capes Marine Park (timothy.langlois@uwa.edu.au)

2010_05_Abrohos.WAMSI_stereoBRUVs Western Australian Marine Science Institute (1) Node 4.2 Tim Langlois (timothy.langlois@uwa.edu.au)

2010_05_Capes.WAMSI_stereoBRUVs Western Australian Marine Science Institute (1) Node 4.2 Tim Langlois (timothy.langlois@uwa.edu.au)

2009_03_Capes.sanctuaries_stereoBRUVs Nagari Capes Marine Park Tim Langlois (timothy.langlois@uwa.edu.au)

2014_12_Philippines.Appo_stereoBRUVs Appo Island deepwater pilot stereo-BRUVs Tim Langlois (timothy.langlois@uwa.edu.au)

2015_01_Pilbara.Montes.transect_stereoBRUVs Western Australian Marine Science Institution (1) Node 3.2 Euan Harvey (euan.harvey@curtin.edu.au)

120

173

200

180

184

180

162

165

358

124

1

35

1

40

1

99

1

140

1

29


11

120

Campaign: 2015_01_Pilbara.Montes.transect_stereoBRUVs

Project: Western Australian Marine Science Institution (1) Node 3.2

Method: stereo-BRUVs



Campaign files:

1. 2015_01_Pilbara.Montes.transect_stereoBRUVs_EMObs.zip
2. 2015_01_Pilbara.Montes.transect_stereoBRUVs_Lengths.txt
3. 2015_01_Pilbara.Montes.transect_stereoBRUVs_MovieSeq.txt
4. 2015_01_Pilbara.Montes.transect_stereoBRUVs_Period.txt
5. 2015_01_Pilbara.Montes.transect_stereoBRUVs_Points.txt
6. 2015_01_Pilbara.Montes.transect_stereoBRUVs_Source.txt
7. 2015_01_Pilbara.Montes.transect_stereoBRUVs_3DPoints.txt
8. 2015_01_Pilbara.Montes.transect_stereoBRUVs_Camera.txt
9. 2015_01_Pilbara.Montes.transect_stereoBRUVs_ImagePtPair.txt
10. 2015_01_Pilbara.Montes.transect_stereoBRUVs_Info.txt
11. 2015_01_Pilbara.Montes.transect_stereoBRUVs_InfoGlobalArchive.txt

Uploaded: 2016-02-10T22:14:23.498020
By: Euan Harvey (euan.harvey@curtin.edu.au) [me]

Deployments: 120 deployments (already imported)

Run data query / execute task:

Download: all static files

Run

SHARE EDIT DELETE

GlobalArchive

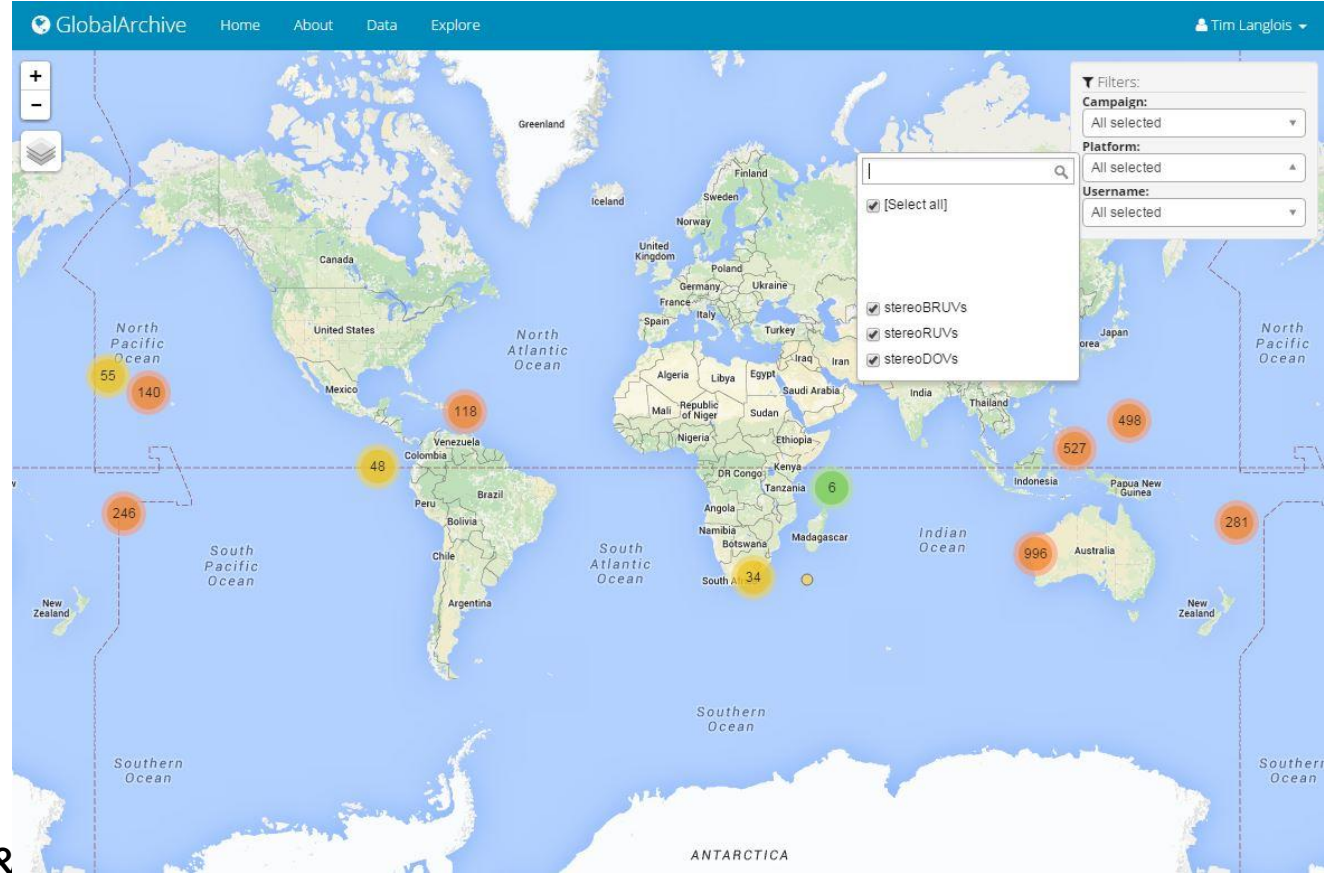
**Flexible import of
historical and modern
annotation data**

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

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



FinPrint



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

[Campaigns](#)[Projects](#)[Collaborations](#)

 Project	Custodian	Funding bodies
 Rottneest Sanctuaries LTM	Tim Langlois (timothy.langlois@uwa.edu.au)	UWA/RIA
 Houtman-Abrolhos Reef Observation Areas	Tim Langlois (timothy.langlois@uwa.edu.au)	UWA/CURTIN
 Nagari Capes Marine Park	Tim Langlois (timothy.langlois@uwa.edu.au)	UWA/SWCC
 Securing Western Australia's Marine Futures	Tim Langlois (timothy.langlois@uwa.edu.au)	South Coast Nat Government Nat
 Western Australian Marine Science Institute (1) Node 4.2	Tim Langlois (timothy.langlois@uwa.edu.au)	UWA/WAMSI
 Appo Island deepwater pilot stereo-BRUVs	Tim Langlois (timothy.langlois@uwa.edu.au)	SU/JCU/UWA
 Pan Pacific	Tim Langlois (timothy.langlois@uwa.edu.au)	NOAA
 Caribbean	Tim Langlois (timothy.langlois@uwa.edu.au)	
 Galapagos	Tim Langlois	

Organisation of multiple
Campaigns by Projects

With option to make data
sets **Open Access**

Projects and Collaborations to share Campaign data

Share the "Pilbara Marine Conservation Partnership" project

All of the Campaigns contained within the "Pilbara Marine Conservation Partnership" project will be shared with the Members listed below.

Add a User to Members list:

Euan Harvey (euan.harvey@curtin.edu....)

Share

Members list:

Tim Langlois (timothy.langlois@uwa.edu.au) ✕

Dianne McLean (dianne.mclean@uwa.edu.au) ✕

Kirk Larsen (kirk@vulcan.com) ✕

Ariell Friedman (ariell@greybits.com.au) ✕



Emily Darling (edarling@wcs.org) ✕

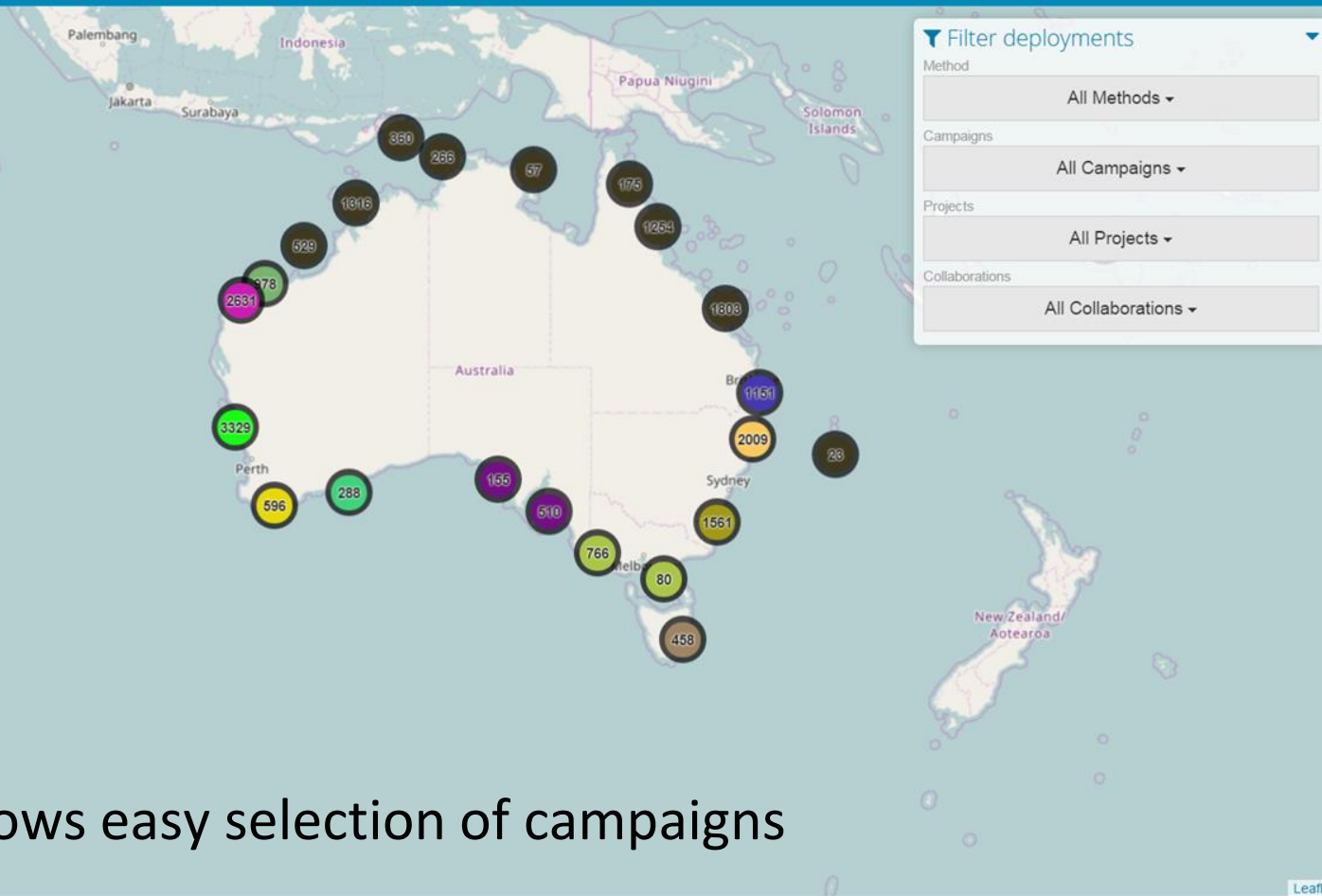
Tom Holmes (thomas.holmes@dpaw.wa.gov.au) ✕

Tim Langlois (timothy.langlois@gmail.com) ✕

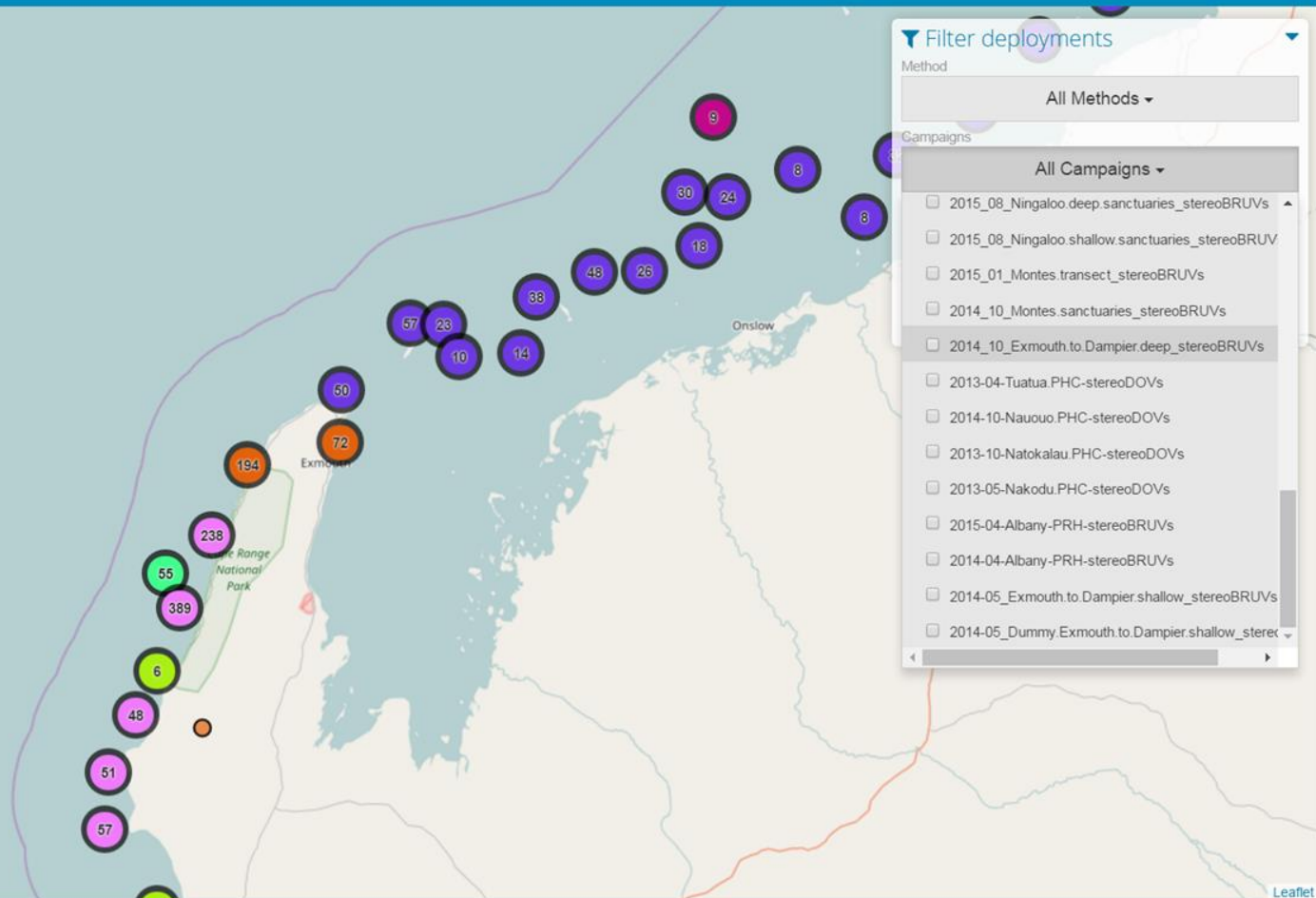
Message Members ▾

[Campaigns](#)[Projects](#)[Collaborations](#)[Methods](#)[Users](#)[+ CREATE NEW WORKGROUP](#)

 WorkGroup	Custodian	Funding bodies / institutions	Descripton	#Campaigns	#Users
 Shark Synthesis	Tim Langlois (timothy.langlois@uwa.edu.au)	Global		1	3



Map interface allows easy selection of campaigns



Filter deployments

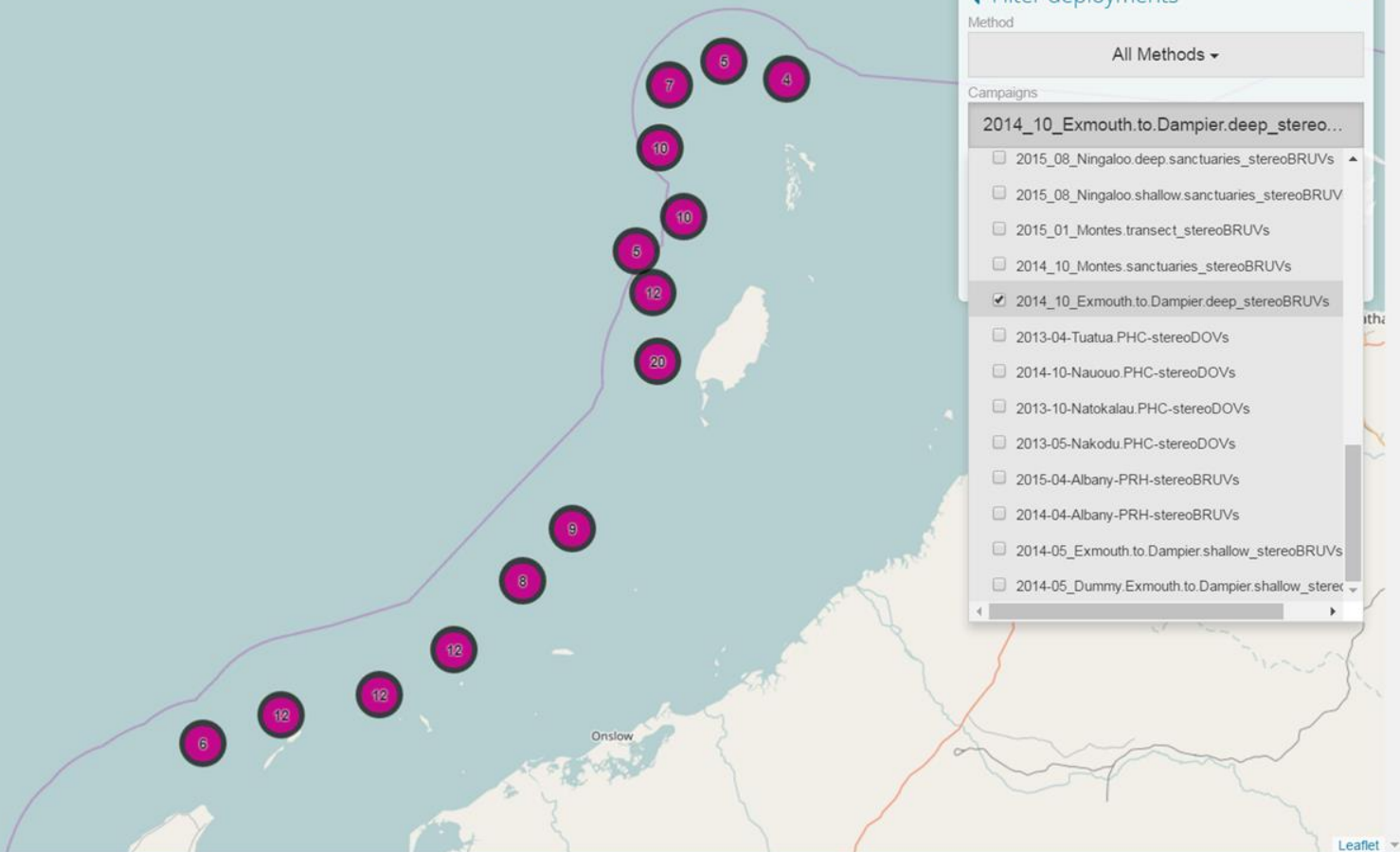
Method

All Methods

Campaigns

All Campaigns

- ☐ 2015_08_Ningaloo.deep.sanctuaries_stereoBRUVs
- ☐ 2015_08_Ningaloo.shallow.sanctuaries_stereoBRUVs
- ☐ 2015_01_Montes.transect_stereoBRUVs
- ☐ 2014_10_Montes.sanctuaries_stereoBRUVs
- ☐ 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs
- ☐ 2013-04-Tuatua.PHC-stereoDOVs
- ☐ 2014-10-Nauouo.PHC-stereoDOVs
- ☐ 2013-10-Natokalau.PHC-stereoDOVs
- ☐ 2013-05-Nakodu.PHC-stereoDOVs
- ☐ 2015-04-Albany-PRH-stereoBRUVs
- ☐ 2014-04-Albany-PRH-stereoBRUVs
- ☐ 2014-05_Exmouth.to.Dampier.shallow_stereoBRUVs
- ☐ 2014-05_Dummy Exmouth.to.Dampier.shallow_stere



2014_10_Exmouth.to.Dampier.deep_stereoBRUVs ✕

📍 Lat: -20.67596833, Lon: 115.2061767

📶 NCB472

📅 2014-10-27T09:18:00

📷 stereo-BRUVs

👤 Tim Langlois



🔑 You are the custodian of this campaign

Filter deployments ▾

Method

All Methods ▾

Campaigns

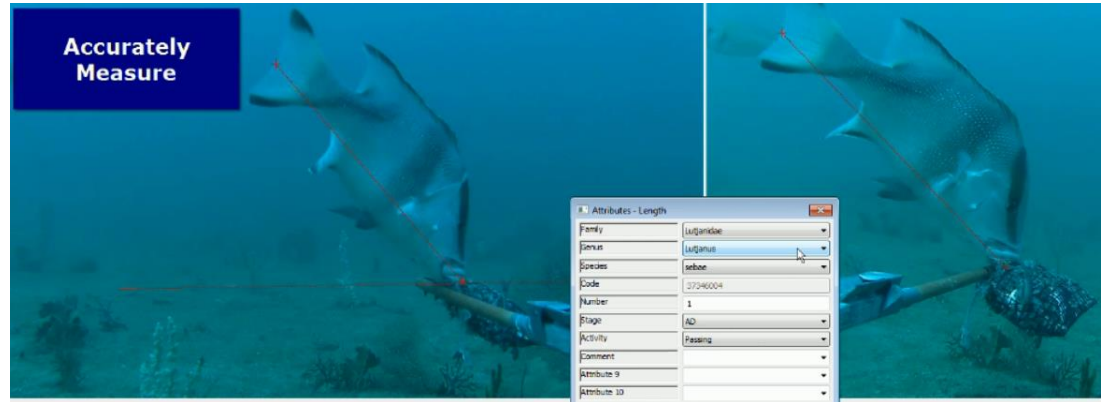
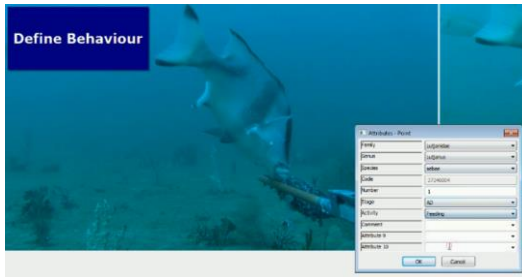
2014_10_Exmouth.to.Dampier.deep_stereo...

- ☐ 2015_08_Ningaloo.deep.sanctuaries_stereoBRUVs ▴
- ☐ 2015_08_Ningaloo.shallow.sanctuaries_stereoBRUV
- ☐ 2015_01_Montes.transect_stereoBRUVs
- ☐ 2014_10_Montes.sanctuaries_stereoBRUVs
- ☒ **2014_10_Exmouth.to.Dampier.deep_stereoBRUVs**
- ☐ 2013-04-Tuatua.PHC-stereoDOVs
- ☐ 2014-10-Nauouo.PHC-stereoDOVs
- ☐ 2013-10-Natokalau.PHC-stereoDOVs
- ☐ 2013-05-Nakodu.PHC-stereoDOVs
- ☐ 2015-04-Albany-PRH-stereoBRUVs
- ☐ 2014-04-Albany-PRH-stereoBRUVs
- ☐ 2014-05_Exmouth.to.Dampier.shallow_stereoBRUVs
- ☐ 2014-05_Dummy.Exmouth.to.Dampier.shallow_stere...

Summary details of campaigns

BRUV analysis...

What does EventMeasure enable you to do?



Campaigns

2014

Campaigns

2014_12_P

2014_10_M

2014_10_E

2014-10-N

2014-04-A

2014-05-E

2014-05-D

Conceived by Timothy Langlois at UWA

Campaign:

2014_10_Exmouth.to.Dampier.deep_stereoBRUVs

Project: Pilbara Marine Conservation Partnership

Method: stereo-BRUVs



Deployments: 132 deployments (already imported)

Campaign files:

1. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_InfoGlobalArchive.txt
2. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_Lengths.txt
3. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_MovieSeq.txt
4. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_Period.txt
5. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_Points.txt
6. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_Source.txt
7. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_3DPoints.txt
8. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_Camera.txt
9. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_ImagePtPair.txt
10. 2014_10_Exmouth.to.Dampier.deep_stereoBRUVs_Info.txt

Uploaded: 2016-04-04T05:38:41.092104

By: Tim Langlois (timothy.langlois@uwa.edu.au) [me!]

Run data query / execute task:

Download: generated MaxN f

Aggregates: sum(N), max(N) in *_Points.txt file, then merges with *_Metadata.txt

maxN

*_Points.txt

```
"validate",
'_Metadata.txt',

"ignore": {
  "required": true,
  "type": "string",
  "nullable": false
},
"Sample": /
```

Run

#Deployments

29

80

132

18

35

267

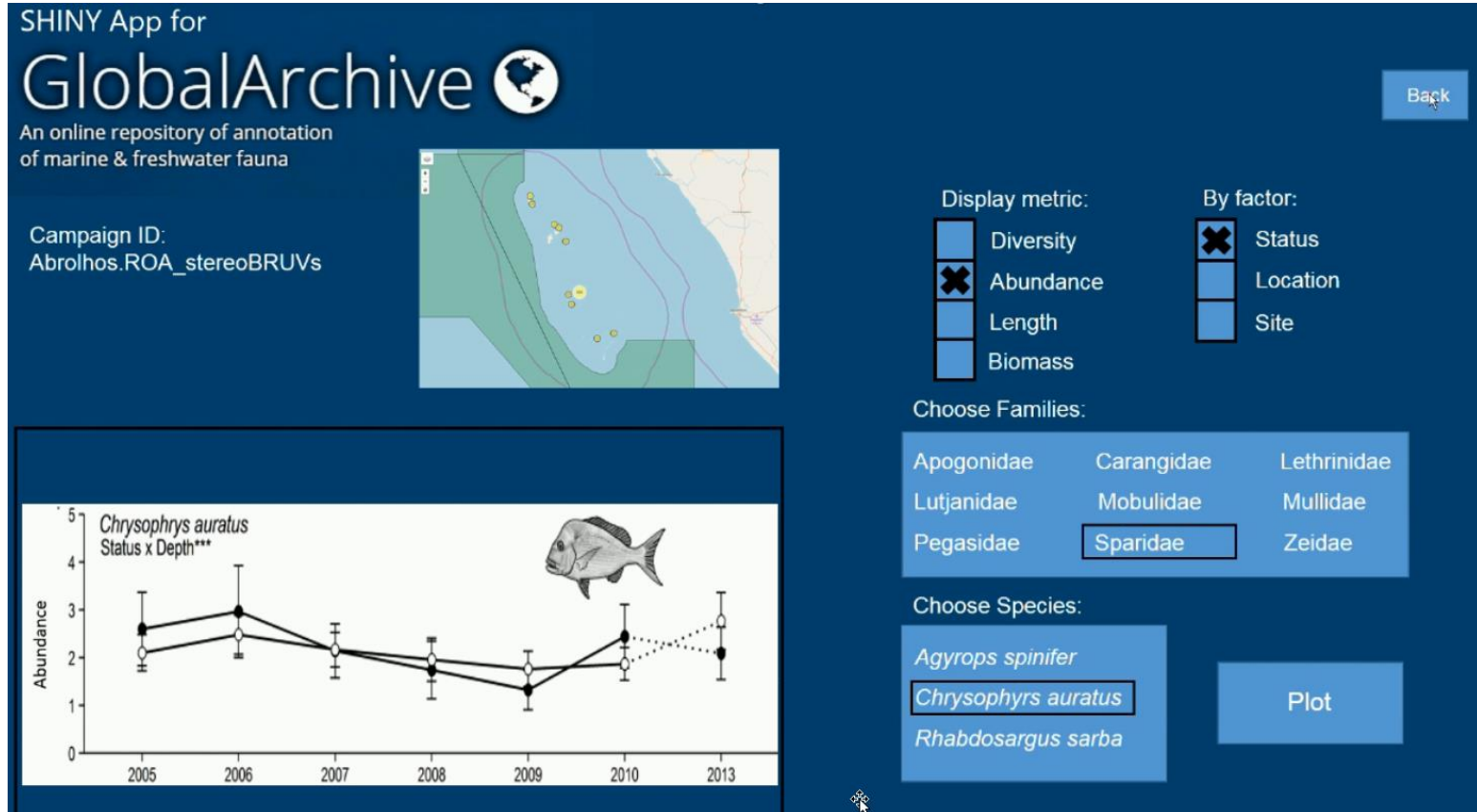
0 / Not imported

About Contact

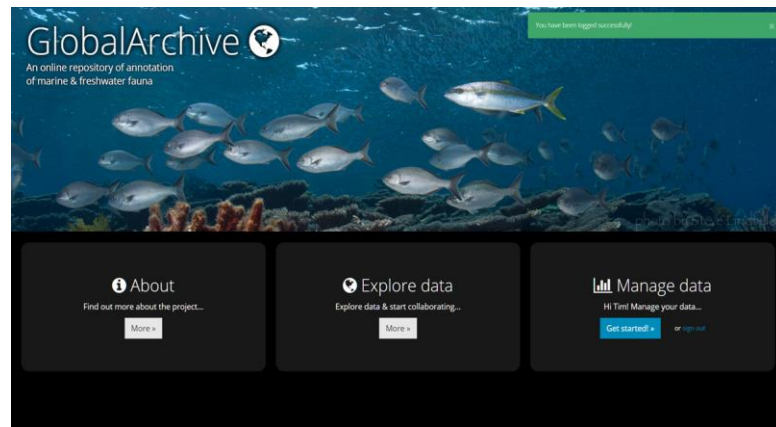
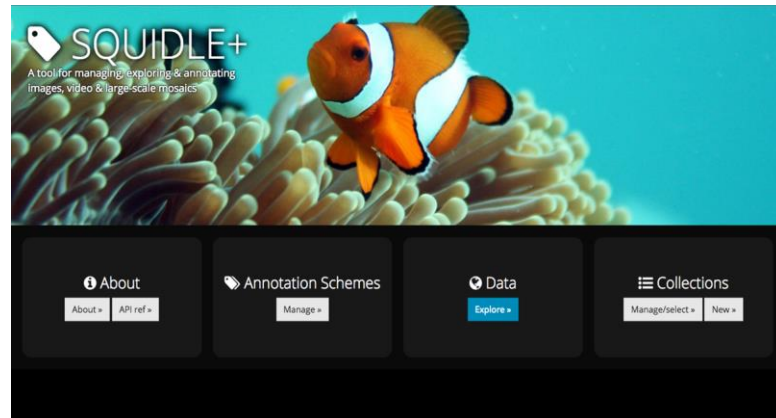
Easy import of a BRUV campaign

Showing EventMeasure outputs

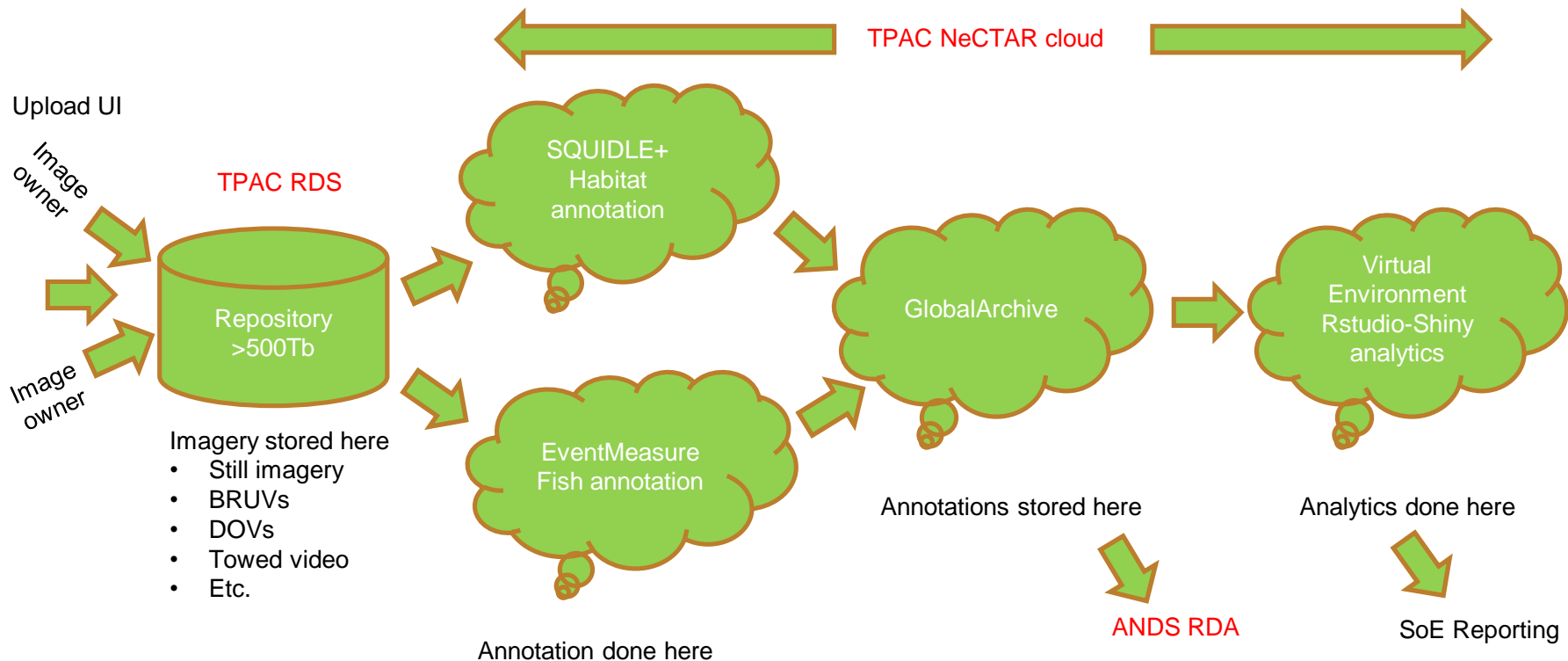
Example 'plug-in' tool for analysis of annotations



What next?



The National Service for Underwater Imagery



Marine Research Data Cloud (ANDS-NeCTAR-RDS)

The National Service for Underwater Imagery

ANDS – NeCTAR - RDS

