Marine Biodiversity Hub

National Environmental Science Programme

Marine Biodiversity Survey of Elizabeth & Middleton Reefs: An overview

Dr Andrew Carroll

GA: *Scott Nichol, Justy Siwabessy, Nicholas Dando, Aero Leplastrier, Spinoccia Michele, Hannah Evans, Zhi Huang*
IMAS: *Neville Barrett, Jacquomo Monk, Justin Hulls, Kristy Brown, Taryn Swete (Crew AMC TV Bluefin)*
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Contractors: *Steve Dalton, Emre Turak*
CSIRO: *Scott Foster*

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Project D3: Implementing monitoring of Australian Marine Parks and the status of marine biodiversity assets on the continental shelf

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Elizabeth & Middleton Reefs

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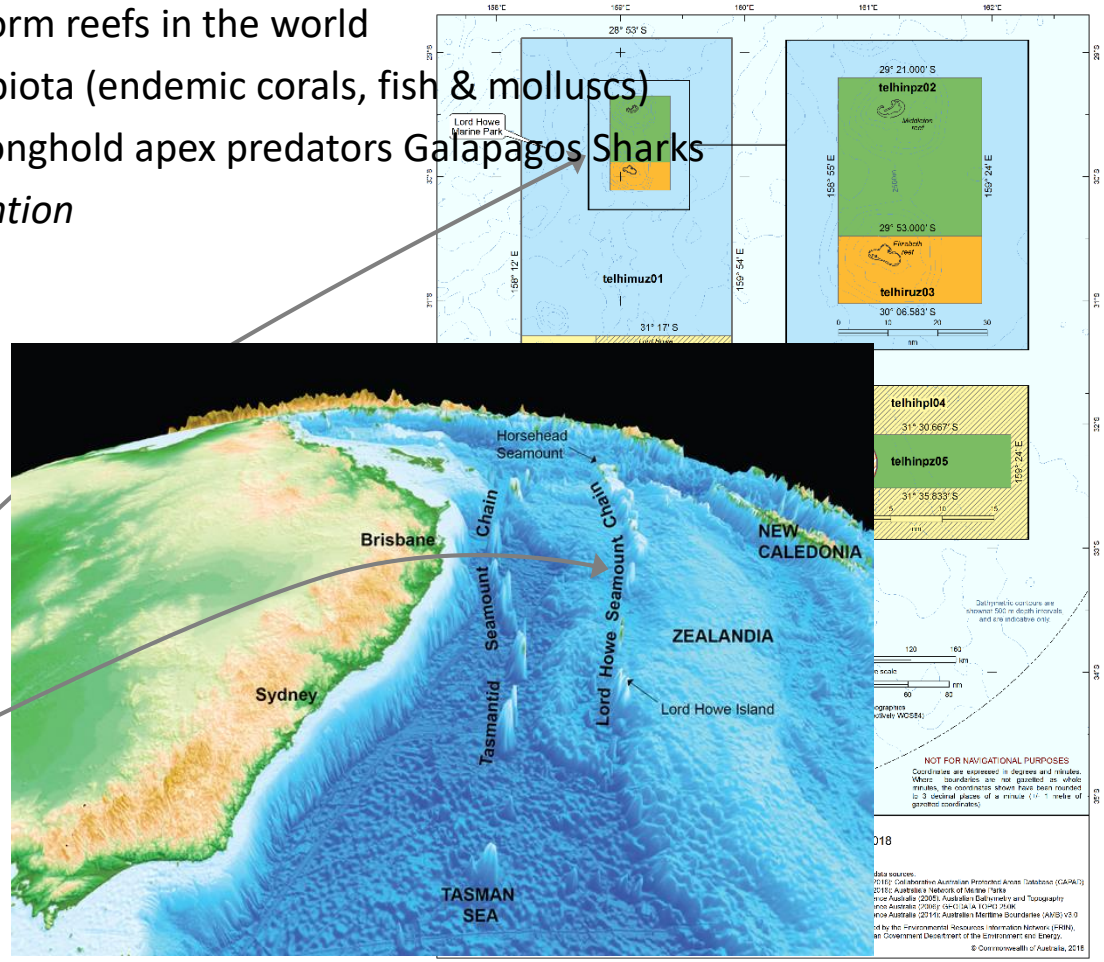
- Elizabeth & Middleton reefs are located within the Lord Howe Marine Park – ~ 600 km east of mainland Australia
- Atoll-like reef structures associated with the Lord Howe seamount chain (Key Ecological Feature)
- These remote reefs are unique – represent the two southern-most platform reefs in the world
- Support a unique & diverse assemblage of tropical & temperate marine biota (endemic corals, fish & molluscs)
- Host seabirds/shorebirds, provide refuge for threatened Black Cod & stronghold apex predators Galapagos Sharks
- Listed as wetlands of international significance under the *Ramsar Convention*



Elizabeth & Middleton Reefs

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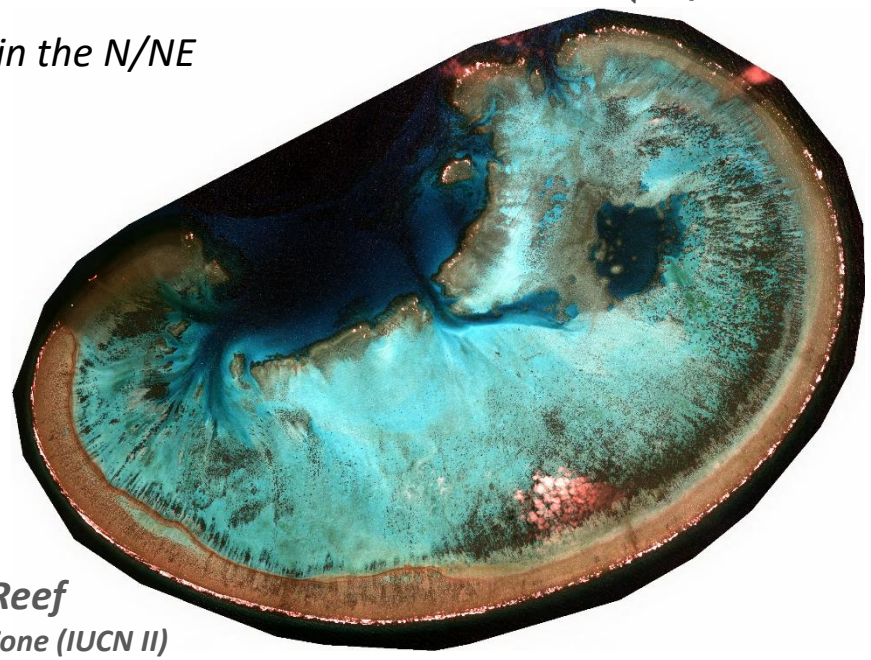
- *Both reefs – extensive lagoon with well defined reef crest, broken by channels in the N/NE*



Middleton Reef
National Park Zone (IUCN II)
No-take area

Elizabeth & Middleton Reefs

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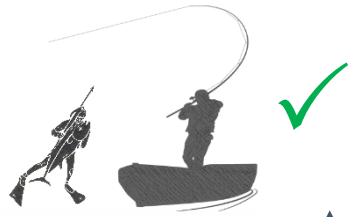

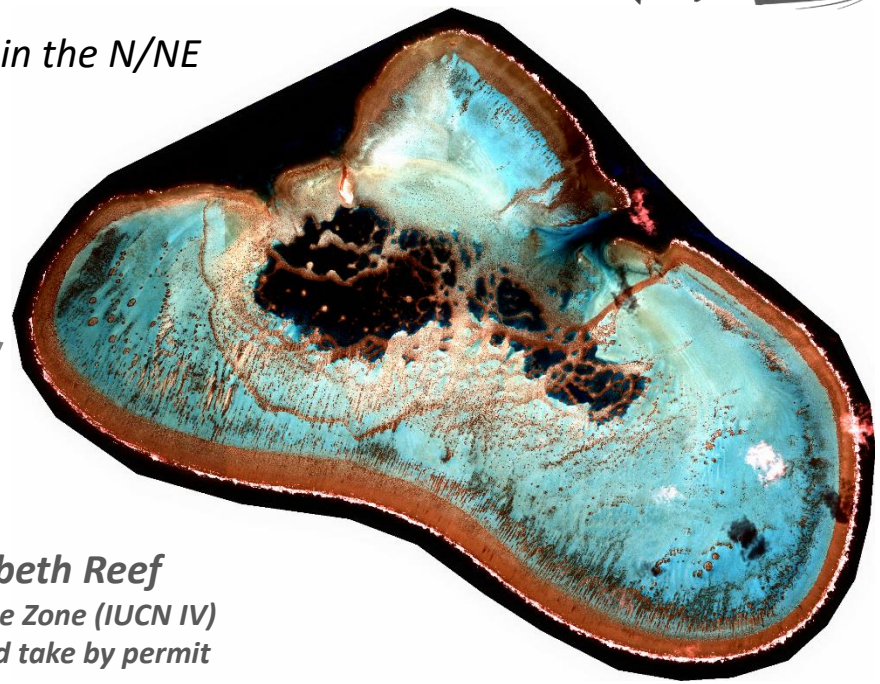

Elizabeth Reef
Rec Use Zone (IUCN IV)
Limited take by permit

Elizabeth & Middleton Reefs – potential threats

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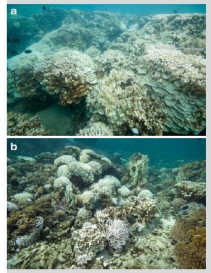
- Elizabeth & Middleton reefs are > exposed to marine heatwaves > potential coral bleaching
- Associated with increasing severity & duration of El Nino events & fast phase transitions from El Nino to La Nina
- Exposed to changes in ocean circulation (strengthening EAC) & ocean acidification associated with climate change
- Early research by the Australian Museum (1992) indicated that live coral cover has historically been higher at Elizabeth Reef
- However, continuing reports of low coral cover by more recent surveys (Australian Institute of Marine Science, James Cook University & Reef Life Survey) indicate that requent disturbance & slow recovery of shallow coral communities
  - *How extensive are the mesophotic coral communities?*
  - *Do they provide a potential refuge (supply of larvae) to shallow communities?*

Reef sites

Extensive coral bleaching on the world's southernmost coral reef at Lord Howe Island, Australia



The world's southernmost fringing coral reef and extensive high-latitude coral and reef assemblages occur at Lord Howe Island (LHI) (31°33'S, 159°05'E) (Harriott et al. 1995). More than 80 scleractinian species have been recorded from LHI reefs, and these corals dominate much of the reef benthos (Harriott et al. 1995; Harrison 2008).

The first widespread coral bleaching event recorded at LHI occurred during the 1998 austral summer season when sea temperatures increased above 27°C (P. Harrison pers. obs.), but the bleaching had limited detectable impact on coral cover. During the 2010 summer season, sea temperatures around LHI were abnormally high and exceeded 28°C (~2–3°C above normal summer maximum), with an accumulated thermal stress of more than 19 degree heating weeks (http://coralreefwatch.noaa.gov). This thermal stress coincided with calm seas and high light penetration, resulting in the most extensive and severe coral bleaching event recorded at LHI to date (Fig. 1).

Bleached and partially bleached coral cover exceeded 90% at Sylph's Hole and Comet's Hole in the lagoon during March 2010, with less extensive and patchy bleaching at other reef sites around LHI. Pocilloporid corals (*Stylophora*, *Pocillopora* and *Seriatopora*) and *Montipora* spp. bleached more extensively than other corals, with some *Porites*, *Isopora* and other acroporid and faviid colonies, and host sea anemones, observed with substantial or partial pigmentation loss at some sites. Some bleaching-related coral mortality was evident during March 2010, with up to 25% of corals at Comet's Hole having partial or complete bleaching-induced mortality.

Rising sea temperatures are predicted to induce more frequent coral bleaching events in future, leading to range shifts in reef corals to higher-latitude regions (Greenstein and Pandolfi 2008). However, this severe coral bleaching event at LHI demonstrates that even the highest latitude coral reef assemblages are also susceptible to bleaching stressors, which could limit future reef development and predicted range shifts to higher latitudes. Isolated reefs such as those at LHI, which lie more than 1,000 km south of the Great Barrier Reef, are likely to be slower to recover from severe disturbances due to their geographic and genetic isolation from other reefs that could potentially supply allochthonous coral larvae for recruitment (Harrison 2008).

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Harriott VJ, Harrison PL, Banks SA (1995) The coral communities of Lord Howe Island. Mar Freshw Res 46:457–465
Harrison PL (2008) Coral spawn sticks at Lord Howe Island, Tasman Sea, Australia: the world's most southerly coral reef. Coral Reefs 27:35

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Successive marine heatwaves cause disproportionate coral bleaching during a fast phase transition from El Niño to La Niña

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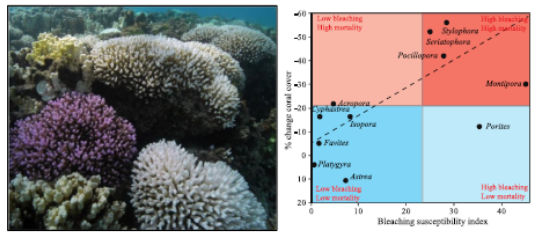
HIGHLIGHTS

- Marine heatwaves have intensified recently at high-latitude coral reefs.
- Lord Howe Island experienced unprecedented bleaching events in 2010 and 2011.
- Warm oceans were associated with a fast phase transition from El Niño to La Niña.
- Coral bleaching varied among taxa, with up to 99% affected at shallow sites.
- Despite immediate mortality coral cover returned to pre-bleaching levels in 3 years.

GRAPHICAL ABSTRACT



Elizabeth & Middleton Reefs – Aims

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- Understand what role these seamount reefs may play as refuges for benthic / pelagic communities in a warming ocean
- Need to fill knowledge gaps – distribution, extent & structure of seabed habitats & associated sessile / mobile biota
- Utilising the Marine Biodiversity Hub's national SOP:
  - Survey aimed to establish a robust quantitative baseline for future monitoring of shallow & mesophotic systems, & to compare marine life in different protection zones

frontiers in Marine Science

PERSPECTIVE
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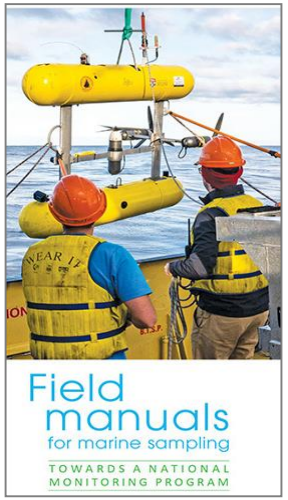
Check for updates

nespmarine.edu.au/field-manuals



A Suite of Field Manuals for Marine Sampling to Monitor Australian Waters

Rachel Przeslawski[1], Scott Foster[2], Jacquomo Monk[3], Neville Barrett[3], Phil Bouchet[4,5], Andrew Carroll[1], Tim Langlois[4], Vanessa Lucieer[3], Joel Williams[6] and Nicholas Bax[2,7]*

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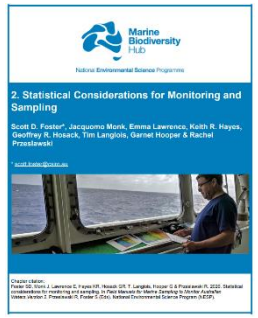

Elizabeth & Middleton Reefs – Execution

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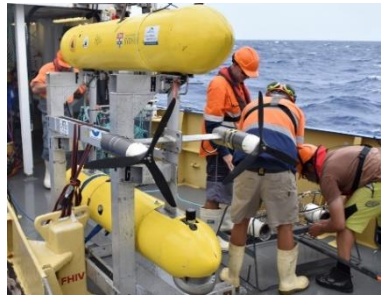
- Survey was undertaken on Australian Maritime Colleges *TV Bluefin (29 Jan to 5 Feb)*
- A hull-mounted multibeam echo-sounder (Kongsberg EM 2040C – single head) used to collect bathymetry data
- Autonomous underwater vehicles (AUV) used to gather imagery of biological communities across reef & sediment habitats
- Baited remote underwater stereo video systems (BRUVs) recorded mobile species in the lagoons and surrounding shelfs
- Snorkel surveys within the lagoons allowed measurements of black cod and other demersal fish
- Sediment samples were taken to characterise substrate types











Elizabeth & Middleton Reefs – Seabed Mapping

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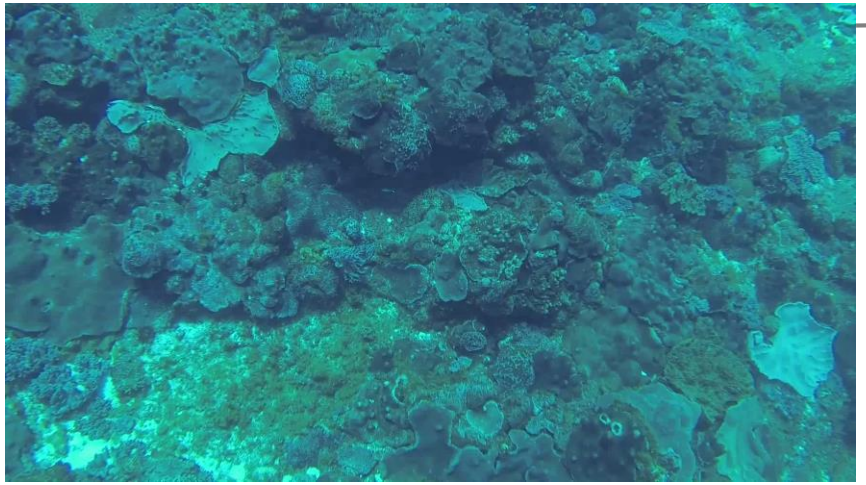
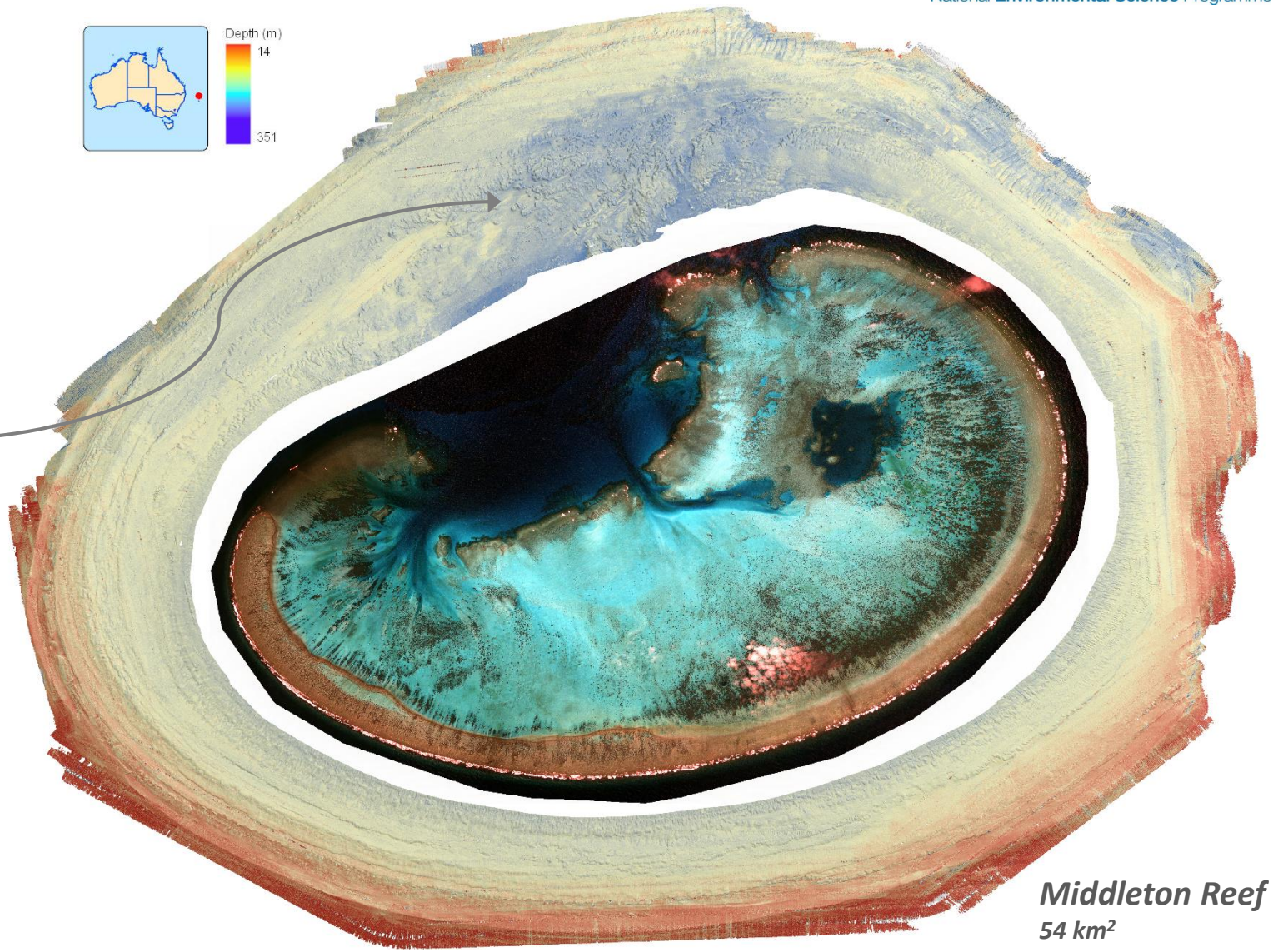
- Overall, we mapped 86 km^2 (2260 line km) of seafloor, revealing complex seabed features
- Include low profile mounds & ridges typically colonised by hard & soft corals
- Working with DPIE to classify key morphological features: ridges (high-relief reef), plains, scarps, depressions & channels





Middleton Reef
54 km²

Elizabeth & Middleton Reefs – Seabed Mapping

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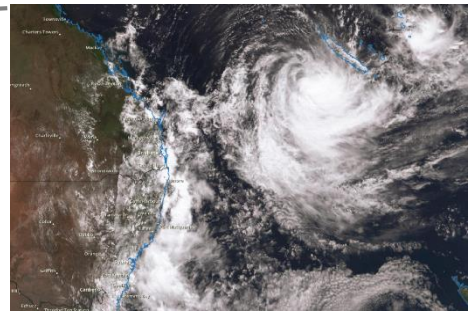
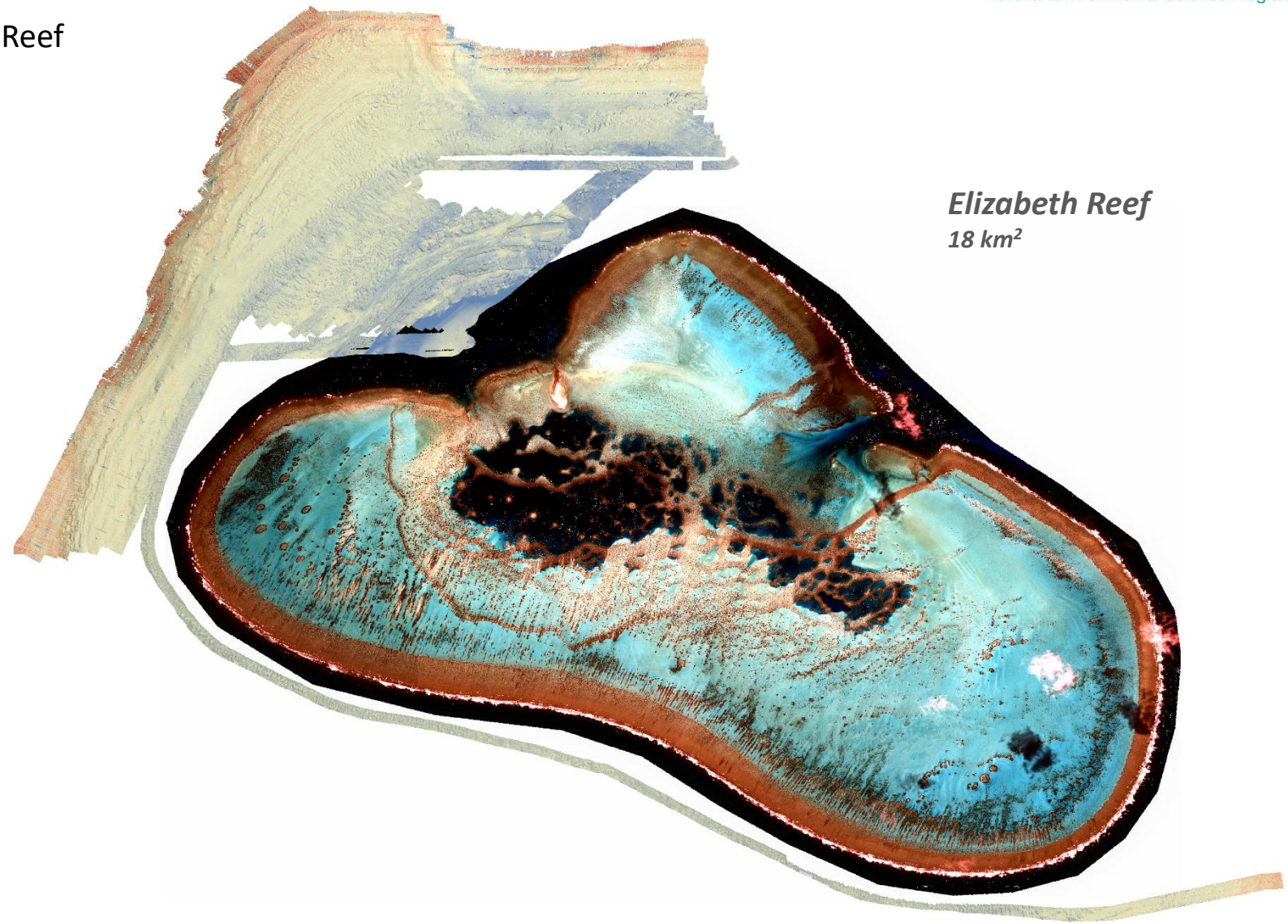
- Only part of the shelf surrounding Elizabeth Reef was mapped & sampled due to ex-tropical Cyclone Uesi resulting in an early end to the survey!





Elizabeth Reef
18 km²

Autonomous Underwater Vehicles (AUVs)

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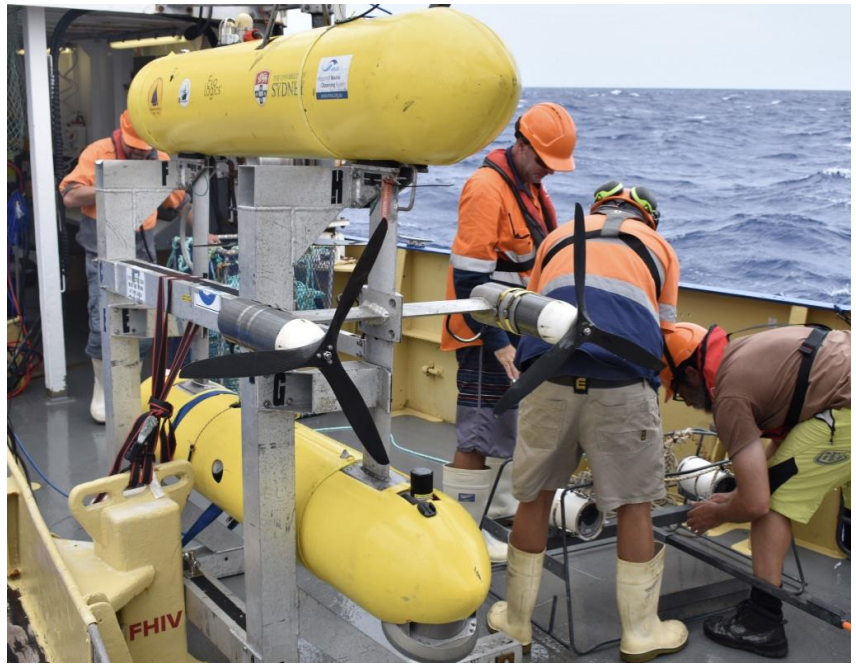
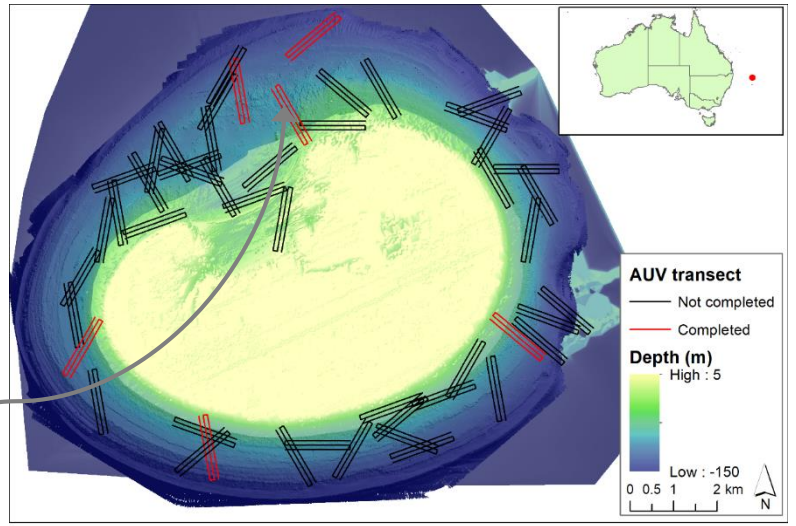
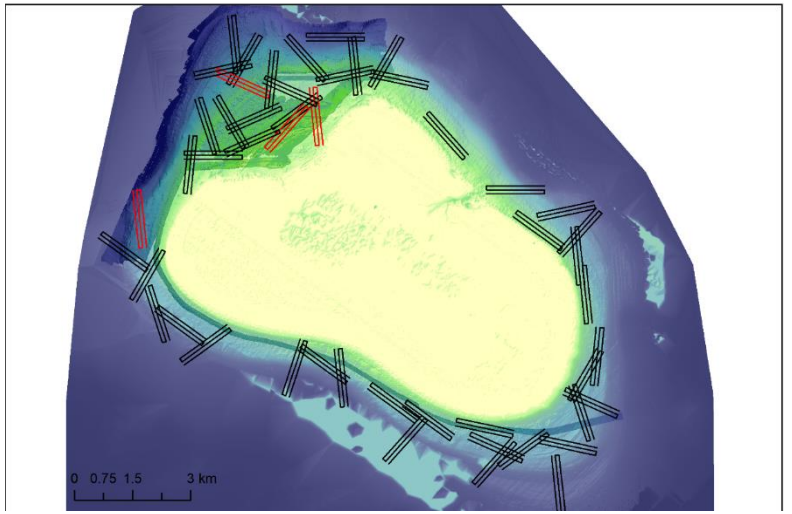
- High-resolution stereo images collected by two AUVs – *Sirius & Nimbus*
- Missions were spatially balanced applying MBHdesign (R package) – Scott Foster & Co.

IMOS Integrated Marine Observing System

THE UNIVERSITY OF SYDNEY — Australian Centre for Field Robotics







Autonomous Underwater Vehicles (AUVs)

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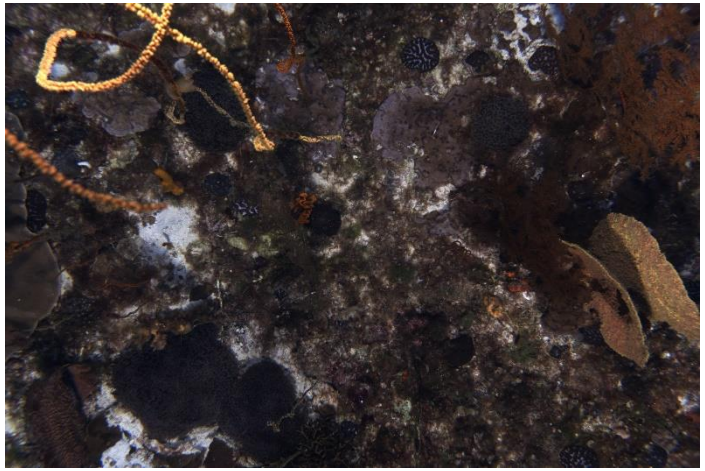
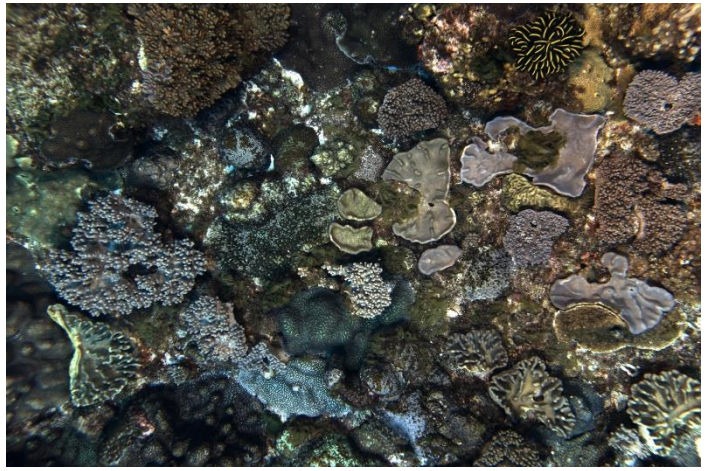
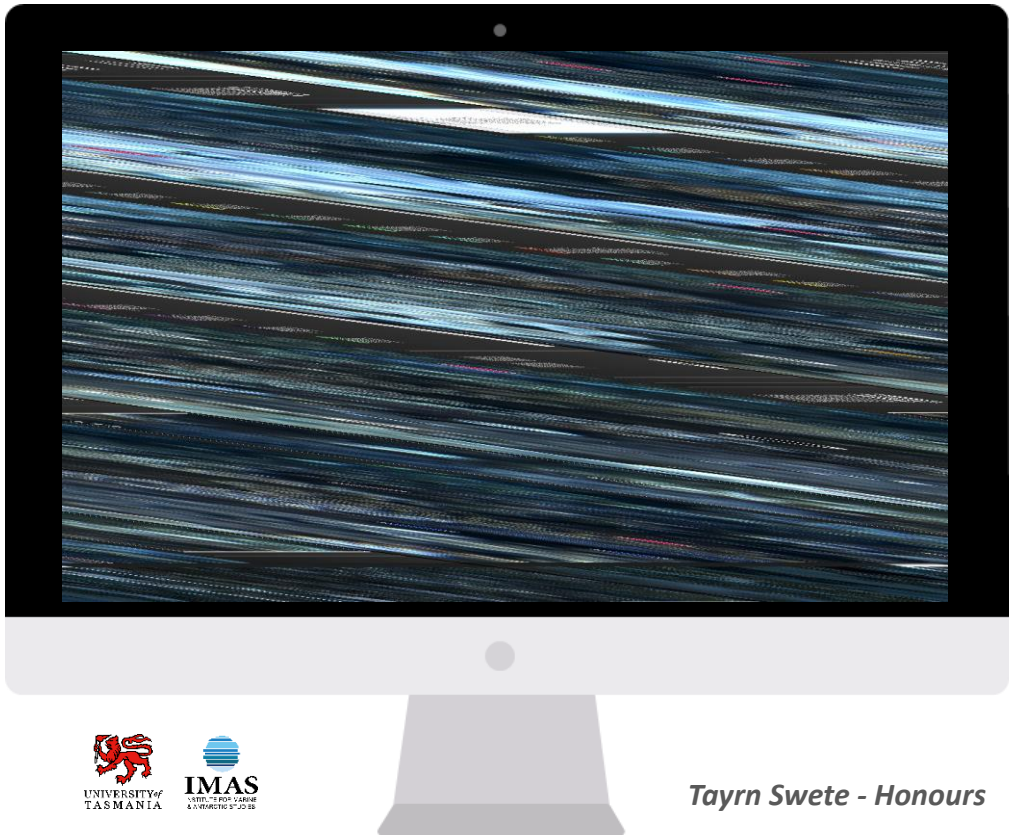
- 45 000 images! Revealing range of habitats across environ & depth gradients ~ 15 km of AUV data
- Squidle + to quantify benthic assemblage diversity, abundance, morphology (QA/QC functionality – 4 annotators)







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Tayrn Swete - Honours

Baited Underwater Video's (BRUVs)

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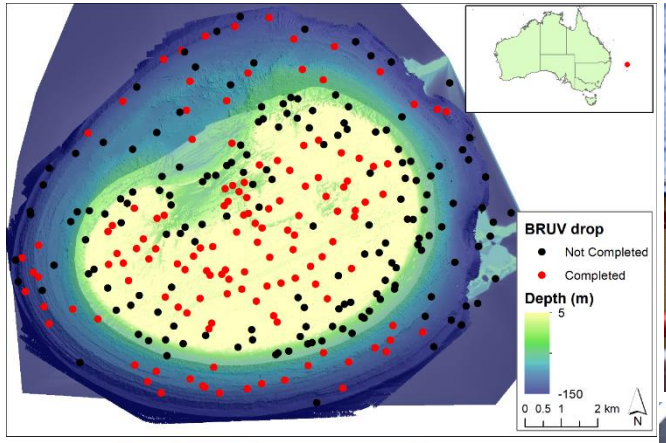
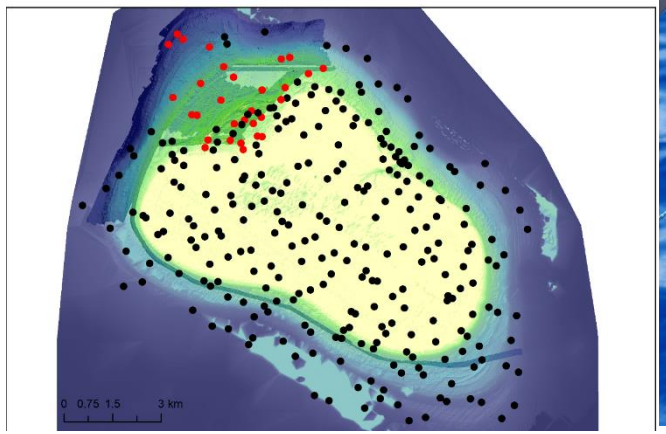
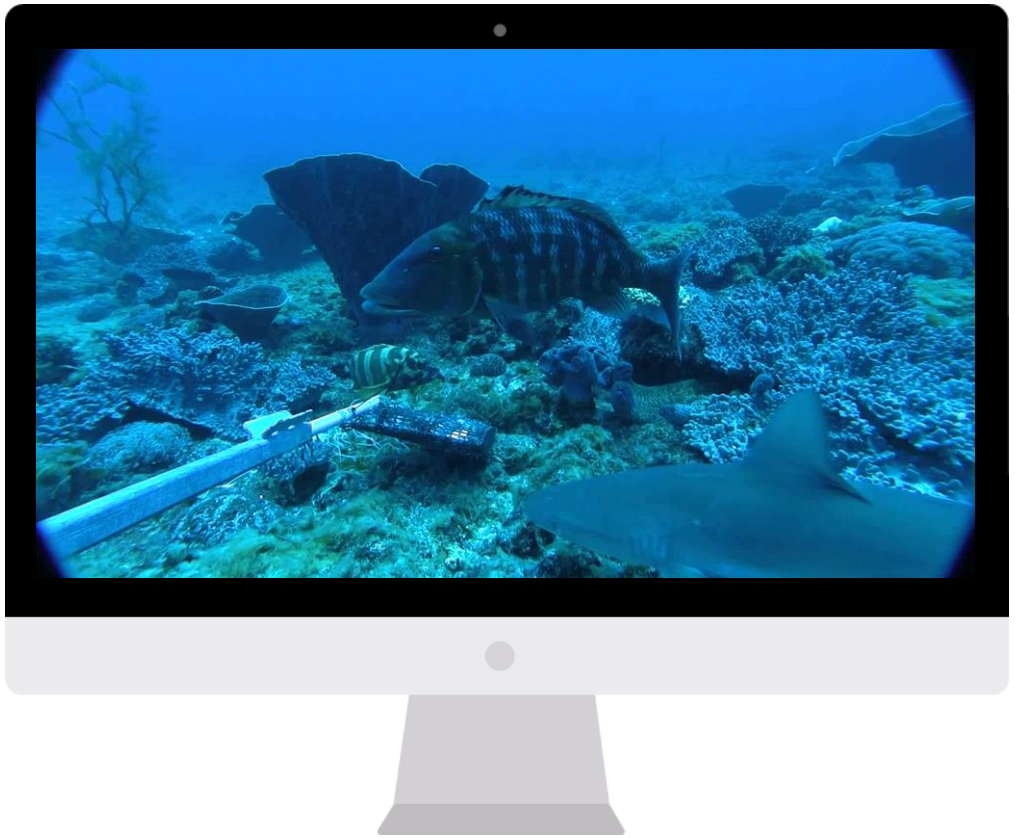
- Aim: Describe demersal fish biodiversity & assemblages across depth ranges 5 – 100m
- BRUV drops were spatially balanced using MBHdesign (R package) – Scott Foster & Co.
- High occurrence of Black Cod: *Kristy Brown – Masters*







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The University of Western Australia

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Museums Victoria

The NESP Marine Biodiversity Hub is funded by the Australian Government's National Environmental Science Programme. Our goal is to assist decision-makers to understand, manage and conserve Australia's environment by funding world-class biodiversity science.

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Questions?

Acknowledgements

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