Ningaloo Outlook

A BHP-CSIRO Research Partnership
Year 3 – Progress Report

Ningaloo Outlook is a five-year strategic marine research partnership between BHP and CSIRO which is now in its fourth year. Since 2015 the team has tagged an array of iconic marine wildlife to better understand their movement patterns, developed maps of seafloor habitat for deeper areas of Ningaloo reef, and applied innovative approaches to understand shallow reefs.

Ningaloo Reef is the largest fringing coral reef in the world, extending over 300 kilometres. The reef is home to many species, and the shallow lagoons and deeper offshore seabed provide a diverse array of habitats.

Project deliverables

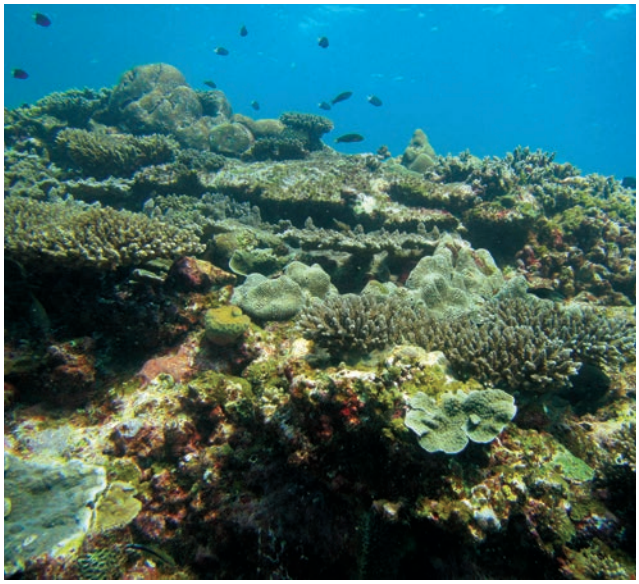
- Status assessments of the core ecological values of the reef.
- New knowledge and a better understanding of the ecology of Ningaloo Reef to inform conservation and management.
- Community engagement to build capacity and understanding within the local community.
- Training opportunities for the next generation of scientists to become world-class researchers.
- Creating knowledge transfer opportunities through an annual symposia and meeting with the people who are responsible for managing the Ningaloo Marine Park and World Heritage Area.

An update – progress made in Year 3 – what are we finding?

Research for the Ningaloo Outlook project is grouped into three distinct themes; deep reefs, shallow reefs, and understanding movement of turtles and sharks through tagging. Activities commenced in 2015 and will run until 2020.

We have embarked upon numerous field trips to Ningaloo, begun analysis and interpretation of data collected so far, and led community engagement activities in Exmouth and Perth.

We've also been ensuring our three Ningaloo Outlook PhD scholars have access to the best training available.



Shallow reef habitat at Ningaloo (CSIRO)

Deep reefs

Research on Ningaloo's deep reefs continues to shed new light on the complex range of habitats in waters deeper than those that divers can access. During 2017 data was collected using multi-beam, towed video and still images. Autonomous Underwater Vehicles (AUVs), CSIRO's Starbug-X and the IMOS-University of Sydney AUV Sirius were also deployed.

Mapping work on deep reef areas at Helby Bank, Tantabiddi, Mangrove, Mandu and Osprey is showing a complex arrangement of habitats within each of these areas, as well as substantial variation between areas. Twelve habitat assemblage types were identified, which fall into three broad categories; (1) coral-dominated, (2) coralline algae-dominated; and (3) macroalgae- and filter feeder-dominated.

Coral recruitment (i.e. arrival and survival of juvenile corals, termed 'recruits') was also measured during the 2017 surveys in deep and shallow reefs. The abundance and species composition of recruits varied with depth. The highest numbers of recruits were found at 25-m, with a secondary peak at 3-m and the lowest density in 40-m. The composition and abundance of recruits was postively correlated with the percentage cover of adult corals, implying that larval supply and settlement might determine adult distribution and deep-reef-dwelling corals are unlikely to provide a significant refugia that might re-populate any damaged shallow water reefs.

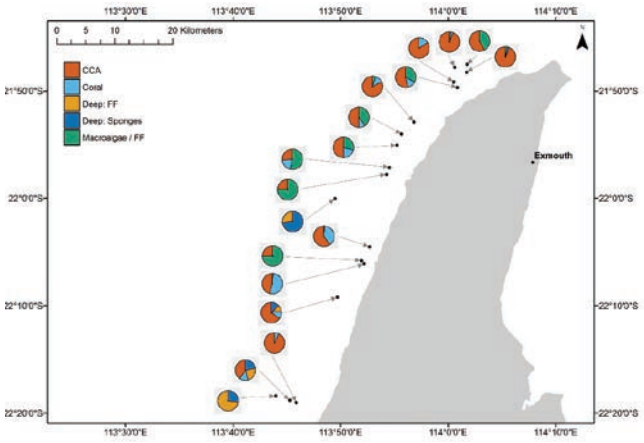
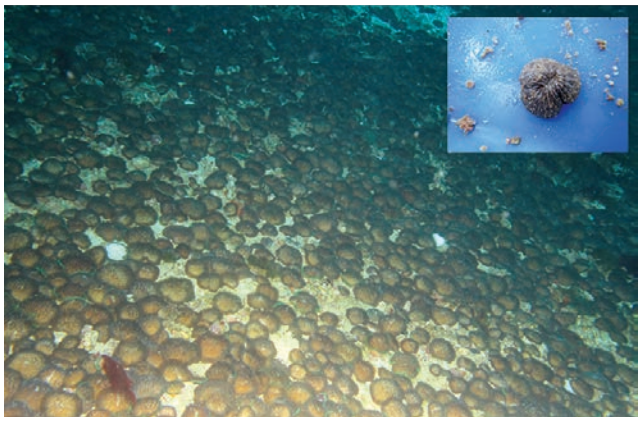


Figure 1. Proportion of the main habitat assemblage types found at each site surveyed at Ningaloo.

During a deployment of *Starbug-X* the team discovered a deepwater community of more than 12 million mushroom-shaped corals which were later identified to be *Cycloseris distorta.* The corals were found in depths of approximately 40-m and are so dense it would be similar to half of Australia's entire population standing should to shoulder on Bondi Beach. While such corals have been reported in other areas, this appears to be the largest aggregation yet described.



***Cycloseris distorta* at Ningaloo (Russ Babcock, CSIRO)**

Shallow reefs

The shallow reef team has applied innovative approaches to understand the patterns and functions of the shallow reefs of Ningaloo.

The team resurveyed 63 sites between Osprey and Jurabi during May 2017, measuring the abundance and composition of fish, sharks, corals, invertebrates and macroalgae (Figure 1). Surveys revealed that unlike many coral reefs globally, Ningaloo Reef did not experience coral bleaching in 2016. The team also collected data on the amount of marine debris found at the survey sites.

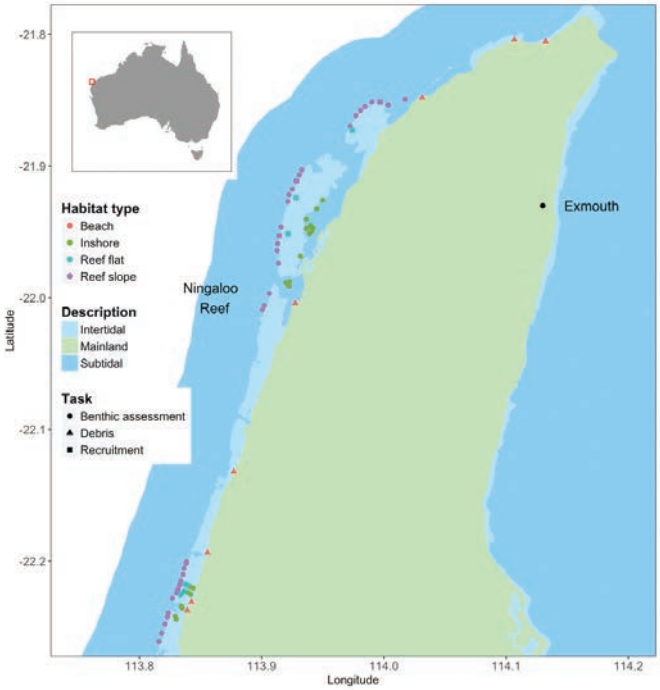


Figure 2. Shallow reef sampling locations in the northern region of the Ningaloo Marine Park for surveys completed in Year 3 (2017).

The team has now compiled one of the longest continuous datasets on abundance of fish and corals for northern Ningaloo (CSIRO dataset: Mandu 2006 – 2017) which in combination with reef slope surveys, is furthering our understanding of links between reef flat and deeper reef slope habitats.

Surveys of reef fish assemblages of northern Ningaloo revealed significant differences in assemblages within different habitats and regions. On the reef slope, the most abundant families were surgeonfish (Acanthuridae) and parrotfish (Scaridae), while on the reef flat the most abundant families were emperors (Lethrinidae) and wrasses (Labridae). These fish families typically perform very different functional roles so understanding their importance in maintaining ecosystem processes will be a research priority.

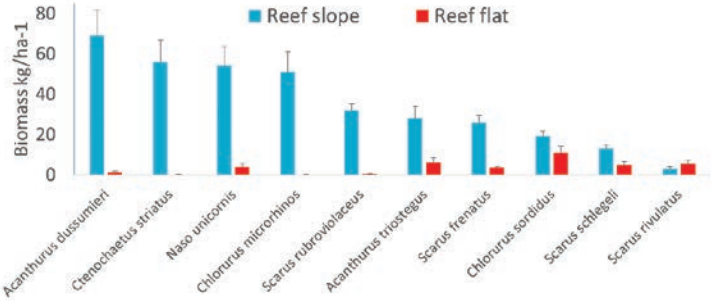


Figure 3. Mean biomass (kg ha^{-1}) (±1 SE) of –the 10 most abundant fish species recorded on the reef slope and reef flat in 2017 surveys.

Our long-term data indicates a significant decreasing trend in *Acropora* cover on the reef flat from 2007-2017. However surveys of benthic communities at northern Ningaloo between 2015 and 2017 suggest a recent trend of increasing *Acropora* cover from 2015 to 2017 on the reef flat and reef slope. These increasing trends in *Acropora* cover suggest that corals might be recovering, but more robust estimates of long-term trends in coral assemblages within the reef flat and reef slope habitats are needed. This will be a major focus of the shallow reefs project in subsequent years.

In addition to the underwater surveys, marine debris surveys were also undertaken at eight locations between Osprey Bay and Lighthouse Bay. Debris was observed, but at low levels, and its spatial distribution was highly variable. The apparent young age of most of the shore debris suggests it had been discarded recently (i.e. within 2 years), however, some in-water debris, such as monofilament fishing lines, may have been present for many years. Further work will be undertaken to document the age of the observed in-water debris.

Tagging turtles and sharks

Turtles, whale sharks and reef sharks are iconic species that capture the attention of the community, both locally and more broadly. These species are also listed as important ecological assets of Ningaloo Coast World Heritage Area.

Since the project commenced, 158 green turtles have been measured and flipper-tagged. These flipper tags last long periods, recording information that researchers can use for decades to come. The oldest tag that the team has found was deployed by government researchers in 1987.

Of the 158 turtles, 60 have had acoustic tags attached, and 26 have had satellite tags attached. Of the 26 turtles, fitted with satellite tags, 9 have been nesting turtles. Successful transmission of the tags has ranged between 72 and 416 days. Web-based platforms are an important outreach tool, where members of the public can view the tracks of animals captured in near real-time (www.seaturtle.org/tracking).

In September 2018 ultrasound was trialled to test whether vitellogenic (yolk-forming) follicles could be detected in a female turtle. This technique could then be used to develop predictions of whether individuals were likely to nest in the subsequent season – a novel outcome that has rarely been successfully applied to any species of sea turtle. The team successfully obtained images of vitellogenic follicles in a 103 cm (115 kg) individual, named 'Wanda'. Wanda subsequently moved ~800 km to the vicinity of LaGrange Bay, where she stayed in the vicinity of northern 80 Mile Beach for several months, likely laying several clutches.

"We thought it was really interesting how scientists research the reef with an AUV, collect the data, check the health of the system and discover new things."
- Chelsea Davies Yr12 (2018 School Captain)

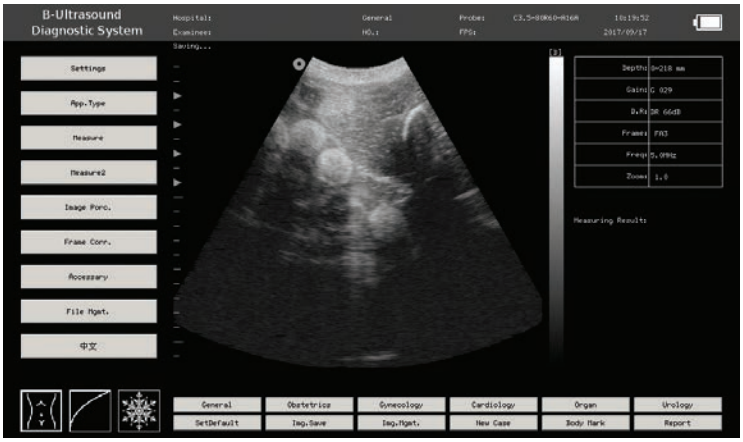


Image of vitellogenic follicles generated by ultrasound of female green turtle on 17 September 2017

In addition to the tagging of turtles, the Ningaloo Outlook Partnership has now tagged 38 whale sharks (with acoustic or satellite tags) and 42 reef sharks (acoustic tags) which includes 21 lemon sharks. There has been considerable variability in the distance and direction of movement of whale sharks tagged to date. Of the ten tags deployed in 2017, two animals were recorded as far south as Perth while another shark moved into the Gulf of Carpentaria (QLD), the first recorded movement of a whale shark tagged at Ningaloo moving into the Gulf of Carpentaria and the longest recorded movement away from Ningaloo by a tagged Whale Shark.

Researchers were also fortunate enough to recover two towed tags that were attached to a male and female whale shark for over ten and seven months, respectively. Data from these tags provide a detailed insight into the dive behavior of whale sharks with the tags recording depth and temperature every 10 seconds. Both animals dived deeper than 1000 m (including the deepest recorded dive by a whale shark) and frequently dived below the thermocline. Detailed analysis of these data demonstrated individual variability in dive behaviours and distinct dive patterns associated with feeding and travelling.

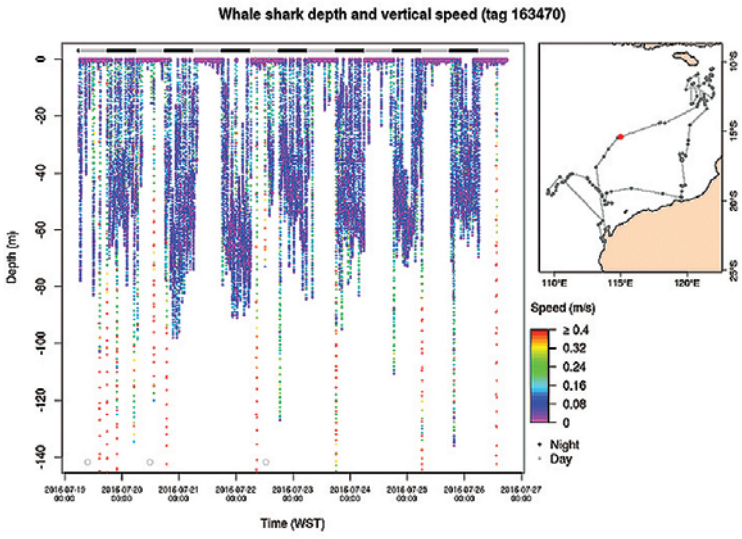


Figure 4. Plot of Whale Shark depth and vertical speed (m.s^{-1}) over a 7 day period in July 2017. Map shows location of the shark during on the 22 July 2017.

BHP staff participating in the September 2017 green turtle tagging field trip (Mat Vanderklift, CSIRO)

Community Engagement

Community participation is a key part of the Ningaloo Outlook Project and the team has continued to engage with Exmouth School and with volunteers from the Cape Conservation Group. BHP staff are now also active in participating in the annual green turtle tagging field trip to Ningaloo.

Training our future scientists

A core element of the Ningaloo Outlook partnership is training opportunities for future scientists. This is in part being achieved through co-supervision of three PhD scholars (Anna Cresswell, Joe Turner and Jessica Stubbs), all based at the University of Western Australia (UWA). All of our scholars have had the opportunity to participate in field activities at Ningaloo during 2017 and also presented their research at a relevant national conference, which has allowed contacts to be made and public speaking skills to be further developed. All of the scholars were active participants at community events including educational science outreach activities run for students at Exmouth School and attendance at the annual Exmouth Whale Shark Festival.

Did you know?

Science generated from the Ningaloo Outlook research partnership will inform future management of the Ningaloo reef area through the generation of knowledge, monitoring techniques and input into key environmental baselines.

Key users of this information include government departments responsible for managing and monitoring the Ningaloo reef area and industries (e.g. resource extraction activities, fisheries, tourism) operating in the vicinity of the Ningaloo reef.

Like to know more and keep-up-to-date?

Visit our webpages:

https://research.csiro.au/ningaloo/

Or email:

- CSIRO Team: Ningaloo.outlook@csiro.au
- BHP: bhppetexternalaffairs@bhpbilliton.com