



National Environmental Science Programme

# Bremer Canyon Progress Report

Emerging Priorities Project EP2 –  
Spatial distribution of marine wildlife in the Bremer Bay region

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*Milestone 4 Progress report*

June 2017



Photo courtesy: Bec Wellard



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**Acknowledgement**

This work was undertaken for the Marine Biodiversity Hub, a collaborative partnership supported through funding from the Australian Government's National Environmental Research Programme (NESP). NESP Marine Biodiversity Hub partners include the University of Tasmania; CSIRO, Geoscience Australia, Australian Institute of Marine Science, Museum Victoria, Charles Darwin University, the University of Western Australia, Integrated Marine Observing System, NSW Office of Environment and Heritage, NSW Department of Primary Industries.

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## SUMMARY OF RESEARCH ACTIVITY

The field period from February to April saw successful completion of all proposed field activities with:

1. Deployment of 100 mid-water stereo-baited remote underwater video systems (stereo-BRUVS) in February – March 2017, recording a total of 14 species, most notably orca *Orcinus orca*, blue shark *Prionace glauca*, bronze whaler shark *Carcharhinus brachyurus* and cock-eyed squid *Histioteuthis miranda*.
2. One week aerial survey of the Bremer Sub-basin region in March 2017, with a total of 25 hours of plane time and 62 sightings of 11 different species, including orca, long-finned pilot whales *Globicephala melas*, sperm whales *Physeter macrocephalus*, bottlenose dolphin *Tursiops* spp. and several unidentified dolphins and sharks. Out of the 62 sightings, there was a total of seven orca encounters with group sizes varying from one to upwards of 30 individuals.
3. A total of eight acoustics recordings of orca by means of either hand-held hydrophone or SoundTraps. Recording lengths varied from 3:44 to 20:00 minutes.
4. A twenty-six day orca biopsy and tagging expedition resulting in a total of five orca biopsy tissue samples were collected. No Low Impact Minimally Percutaneous External-electronics Transmitter (LIMPET) satellite tags were deployed due to challenging weather conditions. This expedition also resulted in two biopsy samples of sperm whale and one sample of giant squid, possibly *Architeuthis dux*. Sightings of long-finned pilot whales, false killer whales *Pseudorca crassidens* and several dolphin species including common *Delphinus delphis*, spinner *Stenella longirostris* and striped dolphins *Stenella coeruleoalba* were noted.
5. Deployment of a Seaglider in the offshore Bremer Bay region for a six week period, from 11<sup>th</sup> March to 13<sup>th</sup> April 2017. The Seaglider was equipped with a Seabird-CTD, WETLabs BBFL2VMT 3 parameter optical sensor and a Seabird Oxygen sensor (Pattiaratchi 2017). This equipment enabled the Seaglider to record an array of oceanographic data, such as sea temperature, salinity, oxygen content and chlorophyll-a fluorescence, across Knob, Henry, Hood and Bremer canyons.

## 1. INTRODUCTION

In October 2016, researchers, park managers and a tourist operator interested in the Bremer Bay region came together at the University of Western Australia with the aim of assessing the extent and likely drivers of a megafauna aggregation, including orca *Orcinus orca*, long-finned pilot whales *Globicephala melas*, sperm whales *Physeter microcephalus* and several shark species that are currently the focus of tourism activities in an area inside and adjacent to the western margin of the Bremer Commonwealth Marine Reserve (CMR) (Meeuwig et al. 2016).

The Minister for Environment and Energy, the Honourable Josh Frydenberg, committed \$100,000 to the National Environmental Science Programme's Marine Biodiversity Hub (MBH) to (1) convene a scientific workshop to design a research plan that may help answer these core questions and (2) conduct priority research in a short time frame. The October 2016, workshop participants identified two areas of priority over the short term as relevant to the needs of the Minister. These were:

1. What is the distribution of marine mammals beyond the recognised aggregation and in relation to the Bremer CMR?
2. What science communication tools do we need to assist in decision making?

As a way forward, the following high priority actions were identified:

1. Design a sampling strategy to estimate the distribution of orcas at the aggregation site and within the CMR.
2. Identify with Parks Australia, key communication tools stemming from this new research and in relation to existing research.

Parks Australia offered an additional \$50,000 to extend the survey options and communication possibilities. The NESP Marine Biodiversity Hub and Integrated Marine Observing System (IMOS) supported deployment of a Seaglider at the time of the aggregation.

Researchers from numerous institutions including but not exclusive to the University of Western Australia (UWA), Curtin University, Marine Information and Research Group (MIRG) Australia and IMOS, conducted an array of sampling methods from February 2017, with the aim of capturing the key actions identified at the workshop. This report summarises the current outcomes of these research programs.

## 2. RESEARCH

The following research activities have been completed since the Bremer Canyon Workshop in October 2016 and represent ongoing research occurring in the region. Data are currently being analysed.

### 2.1 Pelagic Assemblage Surveys

A team from the University of Western Australia completed ten days of non-invasive sampling using mid-water stereo-baited remote underwater video systems (stereo-BRUVS; Letessier et al. 2013, 2015a, 2015b) in and to the west of the Bremer CMR between 27<sup>th</sup> February and 8<sup>th</sup> March 2017. This expedition produced a total of 100 mid-water stereo-BRUVS deployments in 20 sets of five rigs (Figure 1). The survey was designed to characterise the shelf-break and canyon heads both inside the CMR and to the west in the recognised orca aggregation area (Figure 2).

Image analysis of the video footage has been completed, with species identified, relative abundance estimated as MaxN (the maximum number of individuals of a given species in a single frame), and fork lengths measured.

The video footage from a total of one hundred mid-water BRUVS deployments revealed a total of 14 species, most notably orca, blue shark *Prionace glauca*, bronze whaler shark *Carcharhinus brachyurus* and cock-eyed squid *Histioteuthis miranda* (Table 1; Figure 3).

Additionally, schooling scombrids and clupeids were observed and small juveniles of unidentifiable species. Additionally, fork length (FL) measures were reported when possible and additional observations were noted, including feeding and intraspecies interactions in cock-eyed squid and unique markings on female blue sharks, most probably from mating (due to shape and position of markings) (Figure 3).

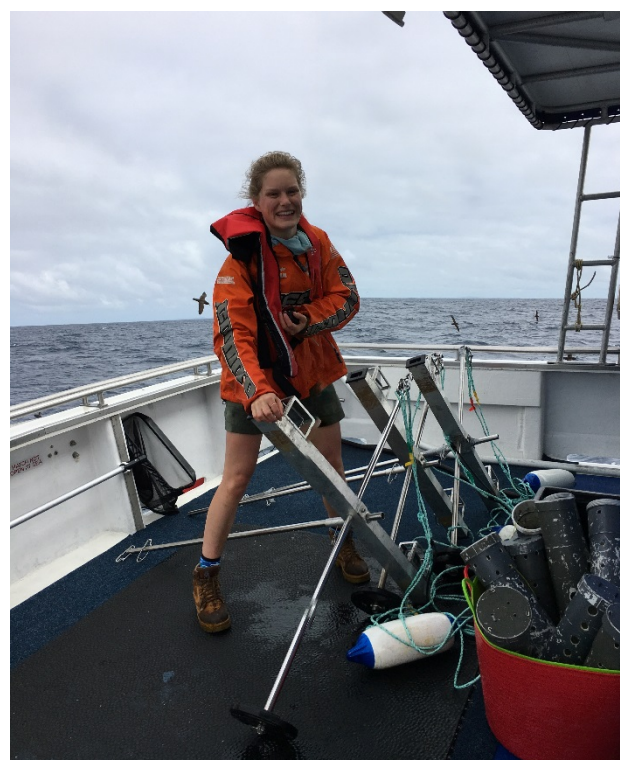


Figure1: Preparation of mid-water BRUVS at Bremer CMR



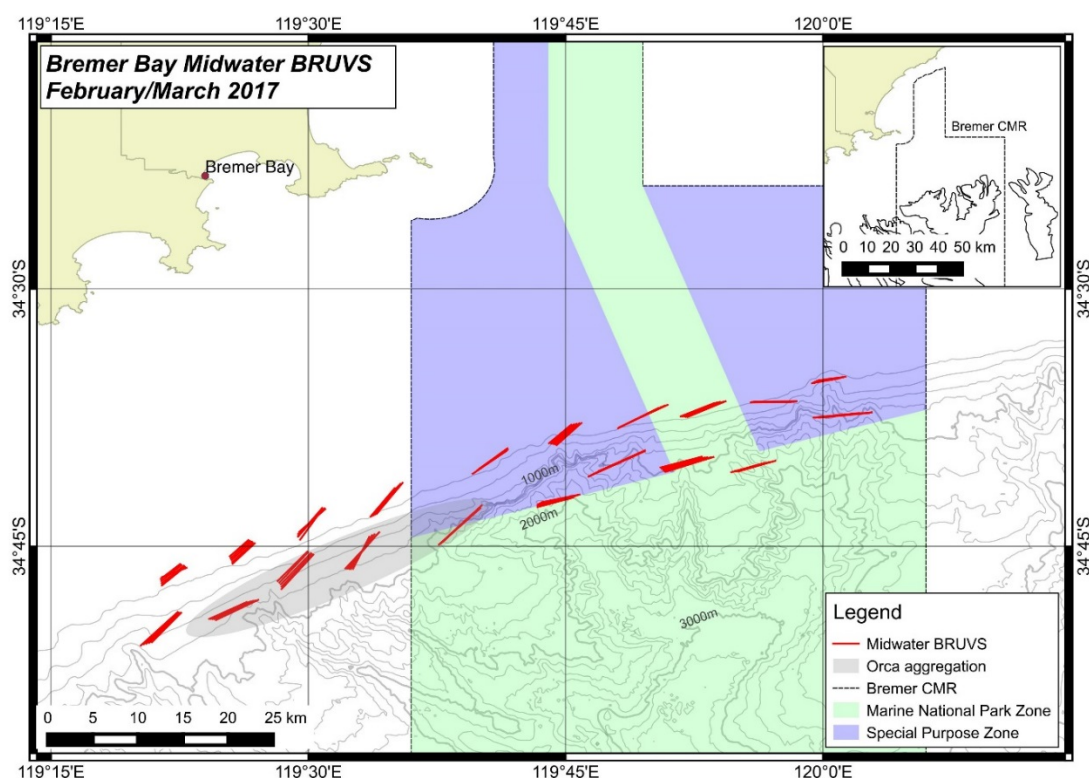


Figure 2: Sampling locations (depicted by red lines) for 20 mid-water stereo-BRUVS longlines deployed in and to the west of the Bremer Canyon CMR between 27th February and 8th March 2017.

Preliminary analysis of the data derived from the video imagery suggests no difference between mean species richness per deployment inside and adjacent to the CMR ( $SR_{CMR} = 1.62 \pm 0.58$  SD vs  $SR_{ADJ} = 1.85 \pm 0.53$  SD). There was also no statistically significant difference in mean total abundance per deployment inside the CMR and adjacent to it ( $TA_{CMR} = 6.77 \pm 4.81$  SD vs  $TA_{ADJ} = 9.68 \pm 12.0$  SD;  $p=0.62$ ; t-test on log10 values of TA). The slightly greater mean total abundance outside the CMR resulted from high numbers of small clupeids (herrings). Sharks were found both in the CMR and adjacent to it albeit in slightly higher numbers within the CMR than adjacent to the CMR (20 individuals of three species vs. 14 individuals of two species). Two orcas were observed on camera adjacent to the CMR.

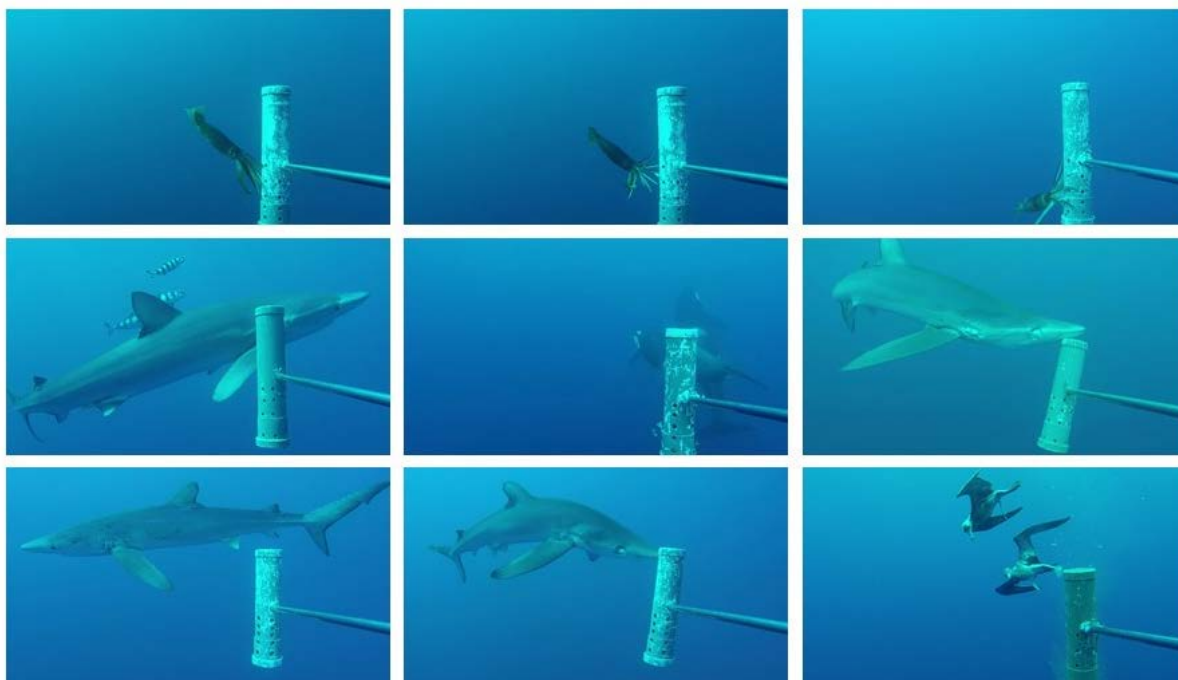


Figure 3: Stills from the mid-water stereo-BRUVS deployed in and adjacent to the Bremer CMR between 27th February and 8th March 2017. Top row – cock-eyed squid *Histioteuthis miranda*, Middle row left and right – blue shark *Prionace glauca*; Middle row centre orca *Orcinus orca*, bottom row left and centre – blue shark and Bottom row right – fleshy footed shearwater *Puffinus carneipes*.

In addition to the mid-water stereo-BRUVS research, this expedition also included opportunist orca sampling conducted by John Totterdell, with assistance from David Bond and Bruce King (Figure 4). One biopsy sample was successfully collected during this expedition. See 2.2 Marine Mammal Research – Biopsy and Tagging for more details.



Figure 4: Field team members on board 'Big Dreams'. From left – John Totterdell, Bruce King, David Bond, Louis Masarei, Adam Jolly and Jem Turner.



**Table 1** – MaxN\* and average, minimum (min) and maximum (max) fork length (FL) of the fifteen taxa observed on the mid-water stereo-BRUVS at Bremer Canyon Commonwealth Marine Reserve. \*MaxN refers to a conservative measure of abundance defined as the maximum number of one species recorded in a single camera frame at one point in time.

Species	Common Name	MaxN	Mean FL (mm)	Min FL (mm)	Max FL (mm)
<i>Carangidae</i> sp.	jacks, jack mackerels, scads	150	44.4	7.3	336.5
<i>Carcharhinidae</i> sp.	whaler sharks	1	NA**	NA	NA
<i>Carcharhinus brachyurus</i>	bronze whale	19	2136	1518	2817
<i>Clupeidae</i> sp.	herrings and sardines	198	157.7	19.7	824.7
<i>Histioteuthis miranda</i>	cock-eyed squid	9	393.5	243.4	867.7
Juvenile sp.	juvenile fishes	145	13.6	5.2	49.1
<i>Monacanthidae</i> sp.	leatherjackets	1	19.2	19.2	19.2
<i>Naucrates ductor</i>	pilotfish	14	478.0	304.0	753.9
<i>Orcinus orca</i>	orca	2	NA	NA	NA
<i>Prionace glauca</i>	blue shark	14	2526	1857	3443
<i>Remora remora</i>	remora	2	NA	NA	NA
<i>Scomber australasicus</i>	blue mackerel	202	318.4	112.6	892.5
<i>Thunnus maccoyii</i>	southern bluefin tuna	2	1001	1001	1001
<i>Trachurus novaezelandiae</i>	yellowtail horse mackerel	32	152.3	126.7	194.8

\*\*NA represents no accurate measurement was possible.

## 2.2 Marine Mammal Research

### *Aerial Surveys*

Between 16<sup>th</sup> March and 23<sup>rd</sup> March 2017, a team lead by researcher Rebecca Wellard from Curtin University conducted aerial transects of the western boundary of the Bremer Canyon CMR and throughout the previously identified orca aggregation region. The sampling consisted of two transects. Transect A is the originally planned set of diagonal transects that allow large scale coverage inside and adjacent to the CMR, while Transect B (yellow box) consisted of a series of denser vertical transects across the known aggregation area (Figure 5). This week long survey resulted in over 25 hours of plane time and 62 sightings of 11 different species, including orca, sperm whales and long-finned pilot whales, bottlenose dolphin *Tursiops* spp. and several unidentifiable dolphin and shark species. Most notably for the purposes of this report, orca were sighted seven times during the week, with group sizes varying from 1 to upwards of 30 individuals (Figure 6). Of these seven encounters, two were inside the CMR boundaries and the remaining five outside. The individuals were travelling in the majority of orca sightings ( $n=6$ , 85.7%). The remaining sighting, a group of more than 30 orca, including at least two calves, was seen feeding with long-finned pilot whales and bottlenose dolphins (Wellard 2017). It remains unclear whether the orca were feeding upon or with these species. The on-water positions of animals across the transects are currently being determined based on their position relative to the plane. Figure 7 provides a snapshot of the positions of animals in relation to the position of the plane at the point of observation.

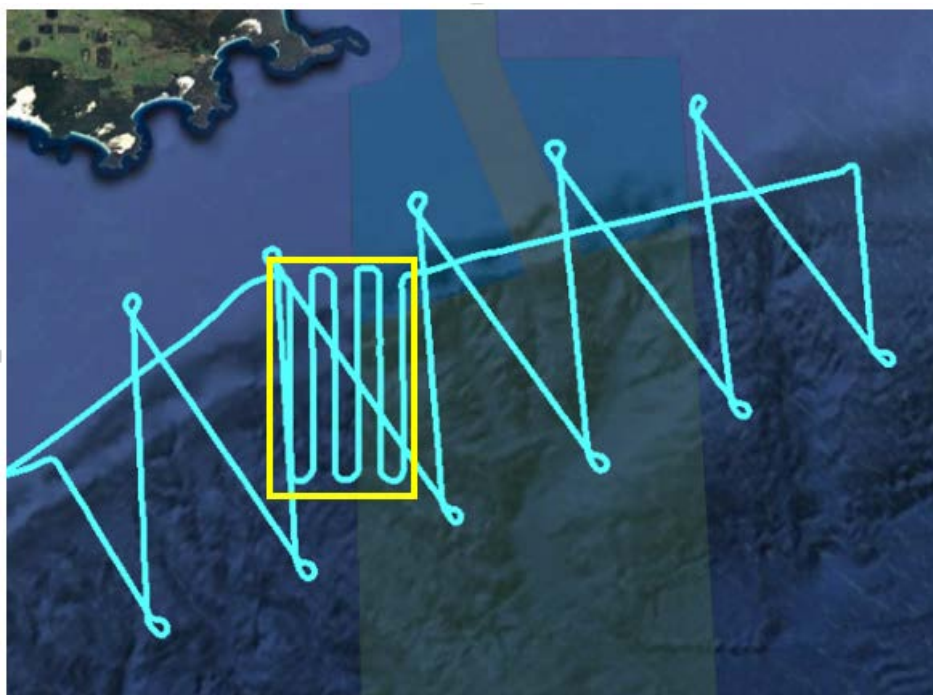


Figure 5: Transect as flown at the large scale (Transect A) and finer scale across the known aggregation area (Transect B; yellow box) with the Bremer CMR as per the shaded area.



Figure 6: Photos from aerial surveys conducted around the previously identified orca aggregation region on the western border of the Bremer CMR. Courtesy of Bec Wellard, Curtin University.

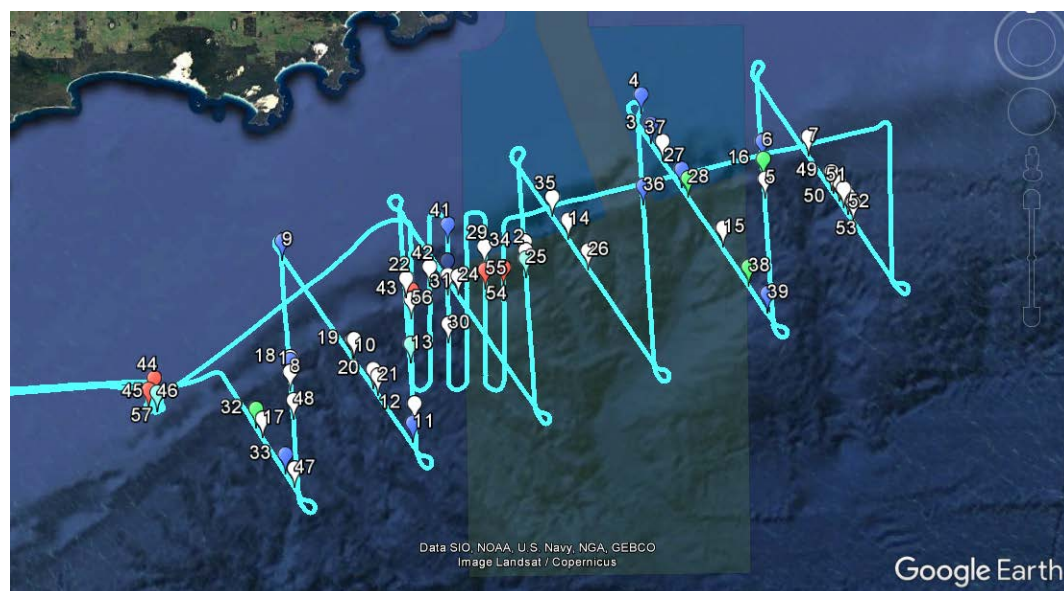


Figure 7: Observations of orcas (red), sperm whale (white), long-finned pilot whales (green) and unidentified animals (blue) as a function of the spotter plane's position along Transects A and B as well as off-transect observations (far left). The Bremer CMR outline is overlaid on the map.

## Acoustics

Multiple methods have been utilised to collect cetacean acoustics data, with a primary focus on orcas in the Bremer Canyon. For the purposes of this report, they will be separated into (1) hand-held hydrophone and SoundTrap data, and (2) autonomous underwater sound recorders, including one low-frequency (LF) sound recorder designed and built by the Centre for Marine Science and Technology (CMST; <http://cmst.curtin.edu.au/products/usr.cfm>) at Curtin University and one high-frequency (HF) SM2+ model from Wildlife Acoustics.

### Hand-held hydrophone and SoundTrap

A research team from Curtin University, led by PhD candidate Rebecca Wellard, has conducted surveys every austral summer since 2014, with the aim of studying orca population dynamics and acoustics through non-invasive observational methods (Wellard 2017). Thus far, 77 days have been spent at sea, totalling 621 hours and 265 cetacean sightings, 183 of which were orca. In addition to these sightings, by means of hand-held hydrophone or SoundTraps, 129 acoustic recordings of orca have been collected since 2014, eight of which were recorded in 2017 (Table 2). The acoustic recordings from 2017 are currently being analysed in the context of the previous recordings.

**Table 2** - Acoustic recordings progress for orca in the Bremer Sub-Basin in 2017. Courtesy of Rebecca Wellard.

Date	Duration of recording	Device
1/04/2017	20:00.2	SoundTrap
3/04/2017	12:05.9	Hand-held Hydrophone
3/04/2017	19:00.0	Hand-Held Hydrophone
3/04/2017	05:41.2	Hand-held Hydrophone
3/04/2017	03:44.6	Hand-Held Hydrophone
3/04/2017	04:53.3	Hand-held Hydrophone
3/04/2017	07:19.2	Hand-Held Hydrophone
3/04/2017	08:39.0	Hand-held Hydrophone

## Biopsy and tagging

From late February to early April the CETREC cetacean team spent a total of 26 days offshore in the Bremer sub-basin region off the south coast of WA. Orcas were encountered on a total of 14 of the 26 days (53.8%) and a small tender vessel was deployed for tagging activity on six days, when weather conditions permitted. The aim was to deploy Low Impact Minimally Percutaneous External-electronics Transmitter (LIMPET) satellite tags. These LIMPET tags are deployed onto the dorsal fin of the animal, and if successful, will track the individual's fine scale movements and residency patterns, providing insight into various activities such as foraging behaviour. These tagging data can also be coupled with surface observations of predatory behaviour and/or feeding. During tender deployment, approximately 20 hours were spent following orcas (Figure 8), mostly in challenging sea



conditions. Due to the weather conditions, no suitable tagging opportunities occurred. However, these LIMPET tags are still useable and John Totterdell and his team are planning to attempt deployment early in the next season. In the same time period, a total of five orca biopsy tissue samples were collected. These samples bring the total number of orcas sampled in this region to 33, from 2014 – 2017. This season produced several newly identified individuals, including calves; see **Killer Whales of the Bremer Sub-Basin: A Photo ID Catalogue** for an extensive list of identified individuals (<http://cmst.curtin.edu.au/wp-content/uploads/sites/4/2017/04/Killer-Whales-Bremer-Sub-Basin-Catalogue.1st-Edition.-Wellard-2017.-Project-ORCA.pdf>).

In addition to the orca work in late February to early April, the cetacean research team also reported sightings of other species. Out of the 26 sampling days, sperm whales were observed on 15 days (57.7%). The individuals recorded were mostly solitary adult males, however larger groups of around 10 individuals were recorded, and on one occasion up to 40 individuals were observed. Two biopsy tissue samples were taken (Figure 9).



*Figure 8: Top – Cetacean research team following a male orca in the small research tender, Middle – Successful biopsy tissue sample of an adult orca in Hood Canyon on 19th March 2017 and Bottom – Adult orca and a calf.*



Long-finned pilot whales were observed less frequently, on 9 out of 26 days (34.6%). The pods of long-finned pilot whales were regularly moving in an east or west traverse trajectory in pods ranging from 30 to 80 individuals. False killer whales *Pseudorca crassidens* and several dolphin species including common *Delphinus delphis*, spinner *Stenella longirostris* and striped dolphins *Stenella coeruleoalba* were also observed in the region. Pods of false killer whales were seen mixing with long-finned pilot whales and various dolphin species throughout the research in Bremer Canyon, however only one sighting was recorded during the late February/early April expedition. The three dolphin species aforementioned were seen moving through the deeper canyons in the Bremer sub-basin region.



Figure 9: Biopsy tissue sampling of an adult sperm whale *P. macrocephalus* in March 2017.

Several species of squid have been observed and sampled over the duration of research in Bremer Canyon. The most frequently sampled species is the small cock-eyed squid, as reported on mid-water stereo-BRUVS. Field team members have also encountered recently killed giant squid, possibly *Architeuthis dux* (Figure 10). The cause of death and identity of the predator (if predation was cause) of these large squid found in this offshore canyon area has not been confirmed and is subject to further research. Orca have however been documented surface feeding on giant squid.



Figure 10: Sampling of possible giant squid *Architeuthis dux*. Left – Giant squid beak and Right – Researcher John Totterdell holding squid mantle.

## 2.3 Oceanography

On 11 March 2017, the Integrated Marine Observing System (IMOS) deployed a Seaglider in the offshore Bremer Bay region for a six week period, retrieving the glider on 13<sup>th</sup> April 2017 (Figure 11; Figure 12). The Seaglider was equipped with a Seabird-CTD, WETLabs BBFL2VMT 3 parameter optical sensor and a Seabird Oxygen sensor (Pattiaratchi 2017). This equipment enabled the Seaglider to record an array of oceanographic data, such as sea temperature, salinity, oxygen content and chlorophyll-a fluorescence, across Knob, Henry, Hood and Bremer canyon (Pattiaratchi 2017).



Figure 11: Deployment of Seaglider on 11th March 2017.

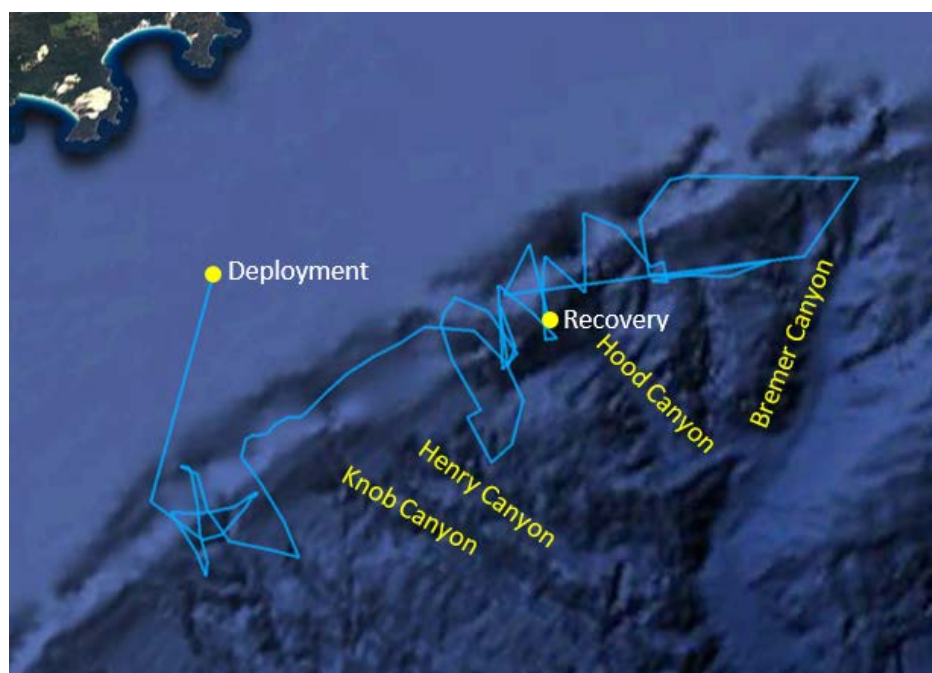


Figure 12: Path of Seaglider from deployment on the shelf edge on 11th March 2017, traversing eastward along the continental shelf covering the heads of the canyons, until retrieval on 13th April 2017.

One of the abilities of the Seaglider is to identify and differentiate different water masses within the canyon systems. The following TS diagram indicates substantial variation in salinity and temperature above 14° Celsius, which is in the top 100 – 200 m of water

(Pattiaratchi 2017). This variation represents the presence of different water masses, in addition to that of the Leeuwin Current (Pattiaratchi 2017; Figure 13). Below this layer of variation, the water characteristics remain relatively stable, and correspond to the characteristics present in the Flinders Current (Pattiaratchi 2017).

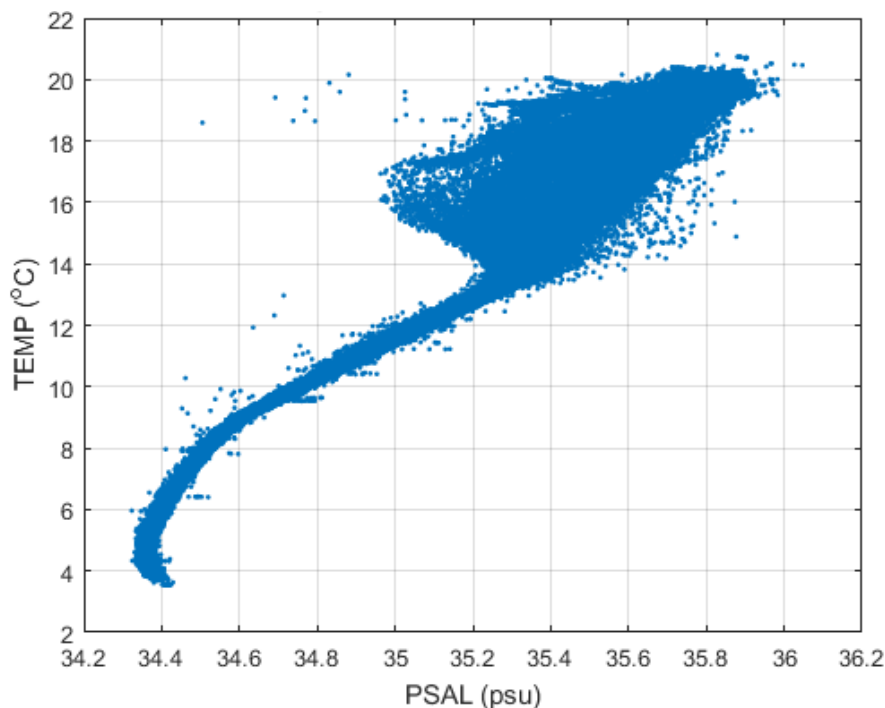


Figure 13: Temperature (°C)/Salinity (TS) diagram for the Bremer Sub-Basin canyon system from 11th March 2017 to 13th April 2017

During its six week deployment, the Seaglider collected time series data on temperature, salinity, dissolved oxygen, chlorophyll and chromophoric dissolved organic matter (CDOM) (Figure 14). The temperature and salinity time series plots support the TS diagram (Figure 13) findings, that the warmer and more saline Leeuwin Current is present in the top 100 – 200 metre surface waters. Additionally, the dissolved oxygen (DOXY) concentration time series further supports the TS diagram due to the higher DOXY concentration present between ~100m and 600m depth (Figure 13). It is important to note that typically the Leeuwin Current is characterised as a warm, low salinity and oligotrophic water mass (Pattiaratchi 2007). However, during the summer months (December – February), the higher salinity South Indian Centre Water (SICW) moves to the surface along Australia’s west coast and is transferred along the south coast (Pattiaratchi 2017). As for chlorophyll in the canyon system, the maximum was present sub-surface in some regions, however local weather conditions experienced at some locations caused instances of high chlorophyll mixed into the surface layer (Pattiaratchi 2017; Figure 14). Finally, Pattiaratchi (2017) reported that the chromophoric dissolved organic matter (CDOM) readings in the canyon system were “very low” (< 2 ppb) (Figure 14), which indicates minimal hydrocarbon concentrations at the time of sampling.



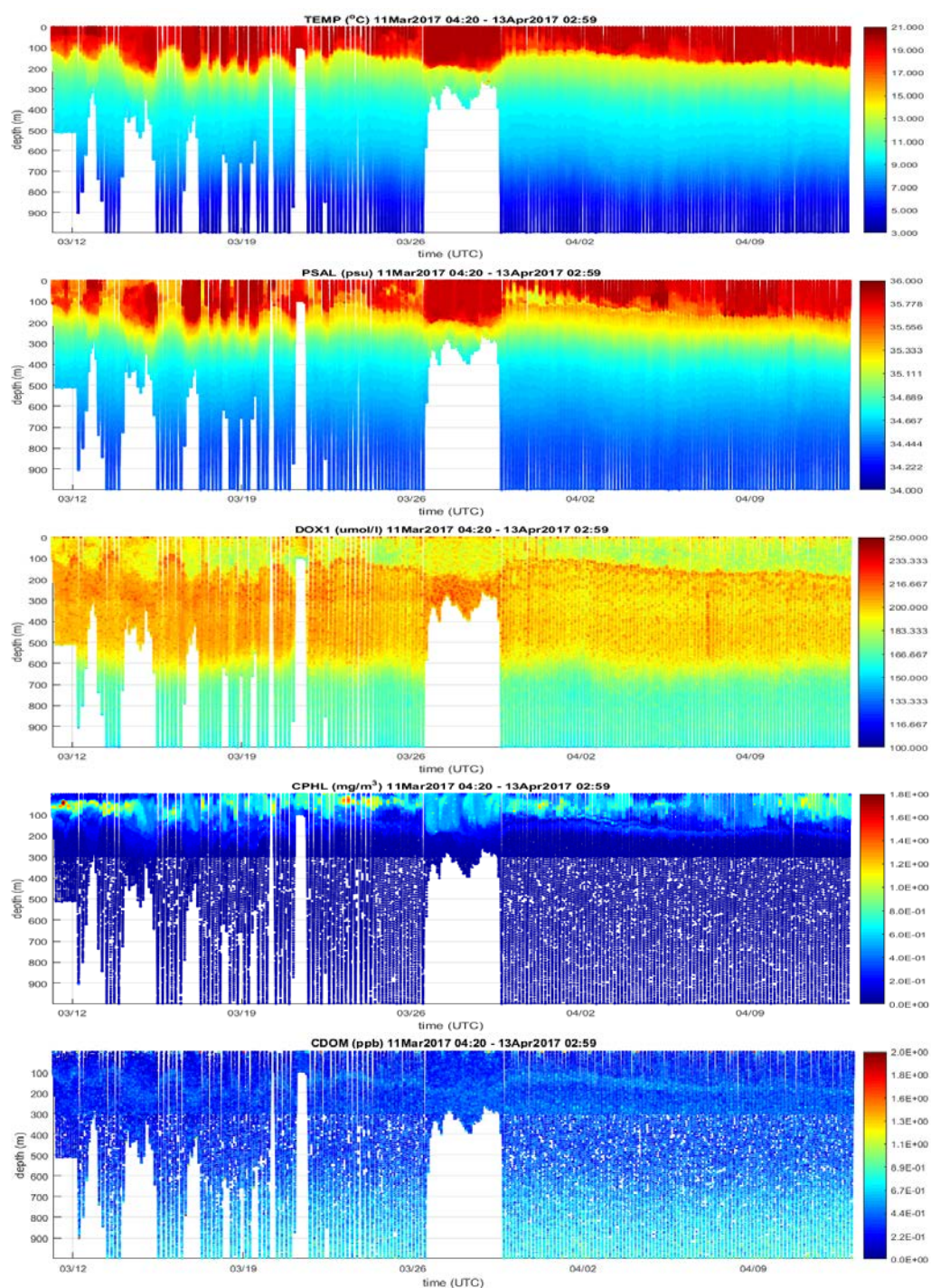


Figure 14: Time series plots of (top to bottom) temperature, salinity, dissolved oxygen (DOXY), chlorophyll and chromophoric dissolved organic matter (CDOM) for the Bremer Sub-Basin canyon system from 11th March 2017 to 13th April 2017

### 3. COMMUNICATIONS OUTCOMES

The second main outcome identified at the October workshop was increasing science communications around the Bremer Canyon region. To date,

1. A summary of the field outcomes was published on the Marine Biodiversity Hub - <https://www.nespmarine.edu.au/project/ep2-surveying-marine-life-canyons-bremer-bay>
2. A briefing on the field work was provided to the Member for O'Connor who highlighted the research in Parliament on 22<sup>nd</sup> March 2017
3. The Orca Photo ID Catalogue has been published, with new individuals from this programme included <http://cmst.curtin.edu.au/wp-content/uploads/sites/4/2017/04/Killer-Whales-Bremer-Sub-Basin-Catalogue.1st-Edition.-Wellard-2017.-Project-ORCA.pdf>
4. A video of highlights from the mid-water survey is being produced.
5. A video of highlights from the biopsy sampling is being produced.

### 4. PROJECT OUTCOMES

This interim report is the second output from this project, the first being the October 2016 workshop report (Meeuwig et al. 2016). Additional outputs include a final report due in late November 2017 that will contain the final results of the major components of this project and additional communication products to be identified jointly with Parks Australia.



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