RV *Investigator* Voyage Summary

Voyage #:	**IN2017_V03**		
Voyage title:	Sampling the Abyss		
Mobilisation:	Hobart, Wednesday, 4 May 2017		
Depart:	Bell Bay, 21:05 Monday, 15 May 2017		
Return:	Brisbane, 10:00 Friday, 16 June 2017		
Demobilisation:	Brisbane, Saturday, 17 June 2017		
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Objectives and brief narrative of voyage

Scientific objectives

1. Describe latitudinal and bathymetric patterns of biodiversity of Australia's eastern lower bathyal (2500 m) and abyssal (4000 m) fauna from 24 to 42°S. Test whether patterns of latitudinal turnover described for the shelf and upper bathyal are replicated at deeper depths.
2. Survey and photograph the lower-bathyal and abyssal ecosystem of seven Commonwealth marine reserves for the first time.
3. Correlate biodiversity patterns against measured and modelled oceanographic and geological environmental factors.
4. Describe the faunal communities present in broad terms and compare with similar depths and environments known from other regions.
5. Sequence DNA from selected species to examine latitudinal and bathymetric connectivity. Specifically test for latitudinal and bathymetric source-sink dynamics, i.e. whether gene-flow occurs predominantly in direction of bottom currents or down-slope.
6. Sequence RNA and DNA of selected species to examine species-boundaries and determine the evolutionary history of the fauna.
7. Measure isotopes of carbon, nitrogen and sulphur in selected species to detect the contributions of land-derived organic matter as a food supply to seafloor consumers (i.e. 'land-ocean coupling').
8. Photograph live animals in chilled aquaria, and examine the bioluminescent capabilities and life history strategies of selected species.
9. Convey the excitement of deep-sea marine science to the general public by having specialised science communicators on the voyage.

Voyage objectives

The primary objective of this voyage is to sample the biodiversity of lower bathyal (2500 m) and abyssal (4000 m) seafloor habitats from 13 sites off eastern Australia, and in particular deep-water ecosystems of seven Commonwealth marine reserves (CMR) using the following gear:

1. Beam trawl – for larger invertebrates, rocks and fishes. This was to be replaced by the Sherman heavy sled for sites with rocky seafloor.
2. Brenke Sled – for smaller invertebrates and foraminifera.
3. Box Core – for infaunal invertebrates and foraminifera, environmental DNA, sediment samples and micro-plastic analyses.
4. Demersal trawl – for fish and larger invertebrates.

Secondary objectives included:

1. Multi-beam mapping of sample sites and transits, particularly CMRs.
2. Echo-soundings of transits – using IMOS default settings.
3. CTD soundings – mounted on the Brenke Sled and Towed Video system.
4. Towed video transects – for visualisation of CMR reserves (1500-2500 m).
5. Manta plankton nets – to sample surface plastic debris.

6. Meso-zooplankton nets – for pelagic invertebrates and larval fish.
7. Beam trawl at 1000 m for comparative biological specimens.
8. Survey of bioluminescence/florescence in collected animals.
9. Assessment of trophic relationships using isotope analyses.
10. Ship-board communication of scientific results through media interviews, video, images, blogs, and live streams.

Results

The voyage successfully obtained faunal samples from a south-north latitudinal transect of 18 degrees along eastern Australia, from 42° to 24°S, at (approximately) both 2500 and 4000 m. This was principally achieved using two gear types, beam trawl and Brenke Sled. In all, the voyage conducted 136 operations, collecting 42,747 specimens from 5241 samples (taxon/site). The outcome will be a substantial increase in our understanding of the Australian deep-sea fauna, both in terms of taxonomy and spatial diversity patterns. New discoveries will continue to be made from collected samples for decades. The catch was preserved to facilitate future DNA research and will be permanently stored in five Australian collections (Museums Victoria, Australian Museum, Queensland Museum, Tasmanian Museum & Art Gallery and CSIRO National Fish collection).

The deployment of the demersal trawl and the box core were not so successful. Rugged terrain precluded their use for most of the trip. In addition, time was lost to bad weather (3-4 days), winch spooling issues and the need for additional multi-beam data to locate suitable sampling sites. Consequently, the deployment of the beam trawl and Brenke sled was prioritised.

The voyage greatly improved our knowledge of seven Commonwealth Marine Reserves and their fauna. We (almost) completely mapped two CMRs, mapped the continental slope of another two, and mapped new areas in a further three. We obtained the first video and imagery of deep-water (1500-2800 m) sections of six CMRs. Plus we obtained faunal samples from (approximately) 1000, 2500 and 4000 m.

In addition, we quantified human debris on the seafloor and sea surface, and collected a large variety of environmental data. The debris was dominated by unburnt coal and clinker ejected in the past from steamships, but more recent bottles, paint cans, fishing debris and wood chips were also common. We incidentally caught a manta ray carcass in one beam trawl and a whale skull in another, which allowed us to collect a scavenging and bone-consuming fauna. We assessed numerous seafloor species for light producing or reflective characteristics, greatly improving our knowledge of bioluminescence of the abyssal fauna.

These results were communicated in real time through a daily on-line blog and through approximately 50 media interviews, for TV, radio, print and online audiences. We conducted a live stream to the Annual Marine Science Forum in Merimbula on June 4th (hosted by Merrick Ekins) and again to ~120 schools on June 8th (hosted by Tim O'Hara and Di Bray). Having two full time communicators on-board, as well as focused onshore media teams, facilitated the barrage of media interest.

The voyage objectives were met as follows:

1. Beam trawls. We successfully obtained samples at all 13 sites at approximately 2500 m and 4000 m. In reality, bottom depths varied between 2300-2800 m and 3800 and 4800 m depending on terrain. We repeated two 4000 m shots at Bermagui and Central Eastern due to poor catches. Large catches full of mud were sorted in their entirety. For the 2500 m sites, 1,636 provisionally identified lots (species/site) were made from 13,741 specimens. For the 4000 m sites, 847 lots were identified from 4,685 specimens. The Sherman sled was not deployed on the voyage due to safety concerns about remounting the heavy trawl doors off the stern winches. The beam trawl was the workhorse of the expedition, collecting samples under all conditions, including invertebrates and fish, and easily repaired. An added benefit is that the beam trawl data can be directly compared with similar catches collected recently from the Great Australian Bight. The large number of on-board scientists who could process samples resulted in a largely sorted, well preserved and provisionally identified catch that will facilitate rapid analysis of the results.

2. Brenke sleds. We successfully obtained samples from 12x 4000 m sites (not Coral Sea) and 11x 2500 m sites (not Flinders or Moreton). A repaired Brenke Sled was deployed four times at the 2500 m Coral Sea site before a successful sample was obtained. In total we separated the catches into a) 2500 m, 600 lots with 6578 specimens, and b) 4000 m, 704 lots with 8097 specimens. This is almost certainly an underestimate of diversity as the catch was only sorted to higher taxonomic units (usually family-level) and some samples were partially preserved in bulk and require further sorting and identification. The Brenke sled worked really well at collecting fragile epifauna, such as pericarid crustaceans and polychaete worms, in excellent condition.

3. Box corer. This gear was deployed only five times at Freycinet (2500 & 4000 m), Bass Strait (2500 & 4000 m) and Bermagui (2500 m). Of these only the Freycinet 2500 m resulted in a full sample. The other four deployments resulted in partial samples or no samples at all, with the spade not firing at all or firing too early). Consequently, once bad weather started to delay operations, the box core was downgraded in operational priority and not used at all after the fifth site. In total, we obtained microplastics/Sediment, eDNA samples and 93 sorted faunal lots from four box cores.

4. Demersal trawl. This gear was deployed on only four occasions. The first two at Freycinet were mid-water shots designed to calibrate the Evologic beacon. The first attempt to deploy the net on the bottom was aborted near the end of the shot as the net became snagged on a rock. The net was torn, some floats and the beacon were lost. Although we had a spare net we ceased deployment until we could ensure we had sufficient flat muddy ground. This did not occur until we arrived in southern Queensland. The net was deployed off Fraser Island in 4000 m of water. However, problems with the trawl winches again restricted the use of the net to a mid-water tow. In all, only 81 specimens were collected with the demersal trawl, mostly mid-water pelagic fish.

5. Multi-beam. The MNF EM122 multi-beam system was used to map sample sites before deployment, all transits between sites, and to map CMRs when the weather precluded deployment of other gear. We successfully mapped two CMRs to near completion (East Gippsland, Jervis), and mapped large new sections of the Freycinet, Flinders, Hunter, Central Eastern, and Coral Sea CMRs focusing on the continental slope. Deployment of the multi-beam

prior to sampling was very important to the subsequent success of the sampling. It proved to be very difficult to locate suitable transects at 2500 m due to the rugosity of the terrain. Even at 4000 m many sites off New South Wales had terraces of rock, and the depth of the flat abyssal plain was lower than 4400 m. The EM122 was turned off during the deployment of the USBL as it interfered with the USBL signal.

6. Simrad EK60 Echo-sounder was run using IMOS protocols on all transits. The EK60 was turned off during the deployment of the USBL as it interfered with the USBL signal. It was used however, to successfully track the deployment of the box corer under the vessel.

7. CTD devices were successfully deployed on the Brenke Sled (CSIRO Seabird) for temperature, salinity and pressure, and on the towed camera (MNF), which also included oxygen concentrations.

8. Towed video. The towed video was deployed in all CMRs, although the deployment in Flinders had to be abandoned due to a capacitor failure in one of the vessel engines. Generally our camera tows ran downslope from around 1500 to 2600 m deep and successfully captured mega-faunal and landscape images/video of the seafloor.

9. Three manta tows were successfully performed for all sites except Freycinet and Newcastle. All the samples were processed on board and plastics and larval fish collected and removed.

10. Meso-zooplankton net was deployed 14 times at 10 sites (the exceptions being Freycinet, Flinders and Newcastle). These samples were sorted under microscopes and pelagic gastropods and larval fish preserved.

11. Beam trawl (1000 m). We obtained 7x 1000 samples from Flinders, Hunter, Bryon Bay, Moreton and the Coral Sea. In addition we also deployed a beam trawl at 1700 m at the Coral Sea as a comparison to what was observed on the camera tow.

12. Bioluminescence. A range of animals were tested for bioluminescence from most beam and demersal trawls. Notable highlights include the fluorescent lizard fish, the bioluminescent sea-spiders and sea-cucumbers.

13. A number of samples were collected for isotope analysis, principally from large beam trawl catches. However, the failure of, and then inability to deploy, the demersal trawl has resulted in far fewer samples being collected for isotope analysis than anticipated.

14. Communication. The media interest in the voyage and its immediate findings were intense. Although there was some notable media even before the voyage departed, the real interest started with an ABC TV news segment on 30th May, which was picked up by Australian and foreign news agencies. The “faceless fish” appeared on news sites throughout the world from Russia to Chile, generating more on-board interviews. Near the end of the voyage the “peanut worm” became another social media sensation, reaching a global audience of tens of millions on Twitter and Facebook. In all we did approximately 50 domestic and international interviews, many live from the boat. The Australian media audience was estimated to have exceeded 5.5M. In addition, we maintained a daily blog (https://www.nespmarine.edu.au/abyss-landing-page).

Voyage Narrative

Monday 15/5/17

The advance science party boarded the Investigator at Bell Bay wharf at 8am and began to set up the vessel laboratories. The majority of the science party arrived around 14:00 on a bus from Hobart via Launceston airport and downtown. The vessel departed at 21:05, a little late due to accommodate the pilot window.

Tuesday 16/5/17

The demersal trawl was unpacked, but was twisted, so this took some time. The trawl was deployed (18:11) in mid-water (001) to a depth of several hundred meters to test the Evologic beacon. The cod end was open but still caught a few pelagic fish and other animals.

Wednesday 17/5/17

At 7:56am, the demersal trawl was again trialled (002) to 1500m water depth with the aim of corroborating the Evologic and Wakeford's beacons. Again the trawl caught a few pelagic animals. We designed the first demersal trawl to avoid both rough ground and deployment in CMR. Consequently, we headed SE along park boundary until the trawl reached 2000m then turned the vessel 90° to deploy at bottom. The Evologic depth gauge gave uncertain results but the altimeter recorded the correct net height. We trawled at 2862m. Unfortunately, we hooked up at end of run and it took several hours of manoeuvring to free the net. The headline broke and we lost 9 floats and the Evologic beacon. We recovered the damaged net at 22:30. We then proceeded south into CMR, and deployed the beam trawl at 2500 m (stn 004).

Thursday 18/5/17

The beam trawl (004) was on bottom at 1:03am, off at 2:59am, at 2771 m. Great catch. Followed by 2500m Brenke Sled (005), on bottom at 7:15 am, off at 8:06 am. Moderate catch. We then transited to 4000 m site, proceeded with a beam trawl (stn 006) at 14:14, off at 16:38, using a maximum of 5800 m of wire. The catch was good, although trawl appeared to have been dragged upside down for at least part of the transect. The first box core was deployed at 4030 m (stn 007), lowered at 60 m/min until 50 m off bottom (echo sounder at 18kHz) then finally at 10 m/min. On bottom at 22:05. Retrieved empty, appeared to have fired early.

Friday 19/5/17

We repeated the box core (stn 008) at 4012 m which was on bottom at 2:51. It was retrieved with a small sample of mud from which we took eDNA samples. The Brenke sled at 4000 m was next. It was on bottom at 7:39 am at 4255 m (USBL) and produced a nice sample, much more diverse than the previous one. We then went back to 2500 m site for a camera tow. The first deployment (stn 10) failed due to a faulty cable. Consequently we proceeded to deploy the box corer at 2,793 m at 17:52 (stn 011). This was the first good deployment, with sponge/bryozoan colonies, a carnivorous sponge, and obvious ophiuroids (*Ophiactis amator*) and polychaetes. This was followed by a successful deployment of the towed camera at 21:12 (stn 012) at 1600 to 1858 m, which produced nice images of a rocky environment, with large boulders, with some fish, sea-cucumber herds etc.

We decided that we had run out of time for this site and did not proceed with the 1000 m site or plankton tows, and deferred deployment of demersal trawl until East Gippsland CMR. We then headed north to Flinders CMR.

Saturday 20/5/17

First deployment at Flinders was a beam trawl at 1309 m at 11:51 (stn 013). The beam (with weak mid-point) broke, so the catch was small. The beam was replaced by a solid tube. We then moved to the 2500 m site. After a few false starts, where the net turned upside down, it eventually hit bottom at 16:02 (stn 014) at 2505 m with 3480 m of wire out. It was off bottom at 17:16 at 2492 m and retrieved with a good catch. We then transited to the 4000 m site and deployed the beam trawl again (stn 015), on bottom at 4138 m at 23.39 am, off bottom 4175 m, 65 minutes later. Good catch.

Sunday 21/5/17

A Brenke sled (stn 016) was on bottom at 7:38 am in 4114 m, and lifted at 9:28 in 4100 m. Good sample. We then transited back to the 2500 m site and deployed the box corer at 2331 m at 15:16 (stn 017). Unfortunately, it fired early and returned empty. Consequently Brett Muir and Mark Lewis decided to design a float system that would surface when the corer fired. We deployed the manta plankton net for the first time, three times in a row (stns 018-020) for 15 minutes, to look for plastic-debris on the sea surface, starting at 16:19. We then deployed the deep towed camera at 20:33 (021) but had to abort at 1480 m of wire out due to an engine switch board issue. Decided to transit to Bass Strait site was it was estimated that we would need 6 hours required to fix the engine (although it only took 3 hours to change all the engine capacitors in the faulty bank).

Monday 22/5/17

Arrived at the Bass Strait 2500 m site. The beam trawl was on bottom at 8:05 at 2512 m (stn 022), off bottom 63 minutes later at 2517 m. Good catch. This was followed by a Brenke Sled (stn 023) at 11:47 on bottom at 2780m. Another good catch. Three more 15 minute manta tows (024-026) starting from 13:24. The box corer (stn 027) was on bottom at 18:23 in 2741 m, but was recovered with only half a bucket of mud, although the upper layer looked like intact (discoloured) seafloor. But not much in the sample. Transited to 4000 m site with box core still on the block. Stn 028 was in 4270 m at 23:53. The box core was damaged leading to flow of sediment from bottom rim and slumping of sample. The seafloor layer was still evident but resulted in a small catch of animals.

Tuesday 23/5/17

We deployed a meso-zooplankton net at 1:55 (stn 029) which caught larval fish but no pelagic gastropods. A beam trawl (030), on bottom at 4:30, resulted in a small but successful catch in 4177 m. This was followed by a Brenke sled (031) in 4172 m at 11:09. We then transited to the East Gippsland CMR. The weather was good and there was a beautiful sunset. However, the forecast was for upcoming bad weather including strong winds from SW. Consequently, we decided to head to a 4000 m site at the southern end of the East Gippsland CMR to ensure we started sampling before the weather hit.

Two operational issues arose. The deployment of the Sherman sled using a stern winch could only occur if a trawl door was moved to the deck. While, this operation could occur in light seas, re-mounting the heavy 2-tonne trawl door was considered unsafe at any offshore location. Effectively, if we choose to deploy the Sherman we could no longer deploy the demersal trawl. Also we needed to schedule future "night" plankton tows in the early evening, if they were to be deployed at the same time as the general purpose winch.

Wednesday 24/5/17

We deployed the beam trawl (stn 032) in 4000 m soon after arrival at the East Gippsland site. A strong east Australian eddy current complicated deployment but the net eventually reached the bottom and resulted in a small but successful catch. This was followed by a Brenke Sled (stn 033) in 4000m, which resulted in a limited supranet catch but good epinet catch including a juvenile stalked crinoid. The weather deteriorated, the wind picking up to 40 kn in a squall. We then moved up the CMR to a 2500 m site for short a camera tow (stn 034) from 2300 to 2500. The video showed a muddy plain with a few fish, cnidarians, and lots of plankton in the water. The winds picked up considerably. By this stage, the winds were very strong (35-40 kn from the SW), and the current 1.5 kn from north. Consequently we called a halt to sampling operations. Instead we proceeded to multi-beam the park in a SW to NE direction at a speed of 7-8 kn, which was followed by a turn south and then SW to multi-beam a second line to the east. We deferred deployment of the demersal trawl and plankton tows until Bermagui because of the weather.

Thursday 25/5/17

Strong 35kn winds prevented operations until the morning. This time was used to almost complete the multi-beam mapping of the East Gippsland CMR. After the winds dropped to 25kn, we headed to the north of the park to a suitable 2500 m site. Here we deployed a beam trawl (stn 035) at 12:25 which landed on bottom at 2350 m. The EAC made deployment difficult, pushing the trawl back towards the vessel, which was managed by slowing and then increasing the winch speed through the upper water column. It came off bottom at 2588 m after 1 hour and 20 minutes. The catch was diverse, with many pycnogonids, sea-stars, a finned-octopus and a large red spiny Lithodes crab. This was followed by three 15 minute manta tows (stns 036-038) and a meso-zooplankton tow (stn 039) which was completed by 14:58. The Brenke sled operation (stn 040) was very similar to the beam trawl at a slightly more westerly heading. Again the current complicated deployment and the sled hit bottom almost a kilometre beyond the designated start point at 19:22 at 3497 m. After 40 minutes it left bottom at 2510 m. The catch was satisfactory. We then began out transect to the Bermagui site.

Friday 26/5/17

We arrived at the Bermagui site about 7am. The beam trawl (stn 041) was deployed at 4000 m. However, a strong bottom current shifted the beam trawl 500 m to the north of the line, consequently the trawl landed in a rocky area and was caught on rocks several times before a major hook-up. The net took 3 hours to free. The trawl was retrieved with a bent beam and slightly torn net, but with the sonardyne still operational. The catch consisted mainly of small to medium sized boulders. Due to the nature of the seabed at 4000 m, we shifted to deeper water. The Brenke Sled was deployed first, to allow time for the beam trawl to be fixed and re-sown. It was deployed from the north in 4700-4800 m water. The strong current caused a large wire to depth ratio of 1.5 and it landed on the seafloor at 17:02 at 4675 m with 7120 m of wire.

We subsequently let out 7865 m to ensure it hit bottom and remove the deep-spooling issue that has been challenging previous operations. It was lifted an hour later and arrived on deck at 21:10. The next operation was the beam trawl (stn 042), set a little to the NE of the Brenke transect to avoid a tuna longliner.

Saturday 27/5/17

A beam trawl (042) in 4800 m, which required 7800 m wire, came up with a good catch, but included a paint tin and other debris. The encrusting organisms included goose barnacles and the rubbish appeared recent. This was followed by another beam trawl (stn 044) at 9:16 in 2861 m to the north. This was hauled in at 13:00 with a huge catch of mud and stones. The stones were largely clinker and coal discarded in the past from steam vessels. The catch took both shifts 4 hours to wash (on deck on a sunny afternoon) and the sorting was not completed until 22:00. Lots of interesting animals. While the vessel transited back to the start point of the run, we deployed 3 15 minute manta (047-049) and 3 meso-zooplankton (050-052) tows. After the mud was washed from the deck we deployed the Brenke sled (stn 045) over a similar transect. The catch was substantial. Finally at this site we deployed the box corer (stn 046) in 2643 m.

Sunday 28/5/17

After transiting to Jervis Bay, we began sampling as usual with a beam trawl (stn 053) at 4000 m that resulted in a manageable catch. The catch included a Faceless Cusk fish that starred in later media reports. The beam trawl was followed by a Brenke sled (stn 054) near the same location. We then shifted back upslope to 2500 m and deployed the Brenke Sled again (stn 055) which was on bottom by 23:36.

Monday 29/5/17

Early in the morning we deployed a 2500 m beam trawl (stn 056) followed by a box corer (stn 057). Unfortunately the box corer returned unfired and empty. This was the last time the box corer was used. A camera tow (stn 058), revealed mostly muddy ground, with some boulders near the end. Visible animals included sea pens, brittle-stars, sea-stars, and sea spiders. During the camera operation we also deployed 3 manta tows (stns 059-061) and 3 meso-zooplankton tows (stns 062-064) before transiting to Newcastle at 18:27.

Tuesday 30/5/17

We arrived at Newcastle at 08:50 and deployed a beam trawl in 4400 m (stn 065) of water, as the ground at 4000 m had rock terraces and appeared unsuitable for trawling. This was followed by a Brenke sled also at 4400 m (stn 066) which resulted in a distinct and perhaps slightly impoverished fauna.

Wednesday 31/5/17

After swathing for some hours, we deployed a beam trawl (stn 067) which was on bottom at 2700 m at 6:04 am and towed for almost 5 km. The Brenke sled (Stn 068) at 2700 to 2963 m resulted in a very small catch, possibly lost in the turbulent conditions off the stern when the sled was recovered. Winds started to pick up, reaching gale force, over 30 kn. We made an operational decision to not deploy any other gear at this site, but to endure the rough weather while transiting to the Hunter CMR.

Thursday 1/6/17 and Friday 2/6/17

A gale continued for over 48 hours, which prevented sampling, with seas building to a 4-5 m swell. We used this opportunity to use the multi-beam to map much of the continental slope section of the Hunter CMR.

Saturday 3/6/17

We finally recommenced sampling in Hunter CMR at 11:20, starting with a 1000 m, beam trawl (stn 069). This resulted in a good catch, with bamboo corals, sponge rods, lots of crinoids, ophiuroids and sea-stars, and a juice bottle. This was followed by another beam trawl in 2500 m (stn 070), which resulted in another fine catch, with glass sponges, large pieces of pumice, can of (empty) fosters beer. During the beam trawl deployment we deployed 3 manta tows (071-073) and 2 meso-zooplankton samples (074-075) during retrieval. The 2500 m Brenke sled (stn 076) resulted in a small catch, with plenty of sediment in the supranet as well as epinet. There were relatively few crustaceans but lots of polychaetes.

Sunday 4/6/17

We transited to the north end of the Hunter CMR to sample a relatively flat site at 4000 m. Nearby we deployed a towed camera (stn 077) from 1741 to 2115 m seafloor depth. This revealed a muddy plain with a few boulders. The demersal trawl was again postponed due to lack of suitable bottom & weather/current conditions. Consequently, we deployed a beam trawl (stn 078) and Brenke sled at 4000 m (stn 079). The beam trawl resulted in a good catch with pumice, clinker, wood chips and a plastic bag. The Brenke sled resulted in lots of mud in both nets, but a good diversity of crustaceans and polychaetes. At 21:05 hours, we then began the 120 nm transit to the Central Eastern CMR. Merrick Ekins hosted a live cross to the Annual Marine Science Forum in Merimbula, New South Wales.

Monday 5/6/17

At the NW of the Central Eastern CMR we deployed a beam trawl at 1000 m (stn 080) which was recovered at 13:00. This surprisingly caught a 4m wide manta ray carcass, with lots of scavenging amphipods and brittle-stars (*Ophiura flagellata*). There were also lots of fish, although apparently not scavengers. The next camera tow (stn 081) followed a transect down a southwards facing ridge from 1600 to 2100 m. This revealed another muddy plain with rat-tails, eels, glass sponges, and sea-whips. While the camera was going down, we deployed three manta tows (stns 082-084) and one zooplankton tow (stn 085). More multi-beam was necessary before selecting the 2500 and 4000 m sites. We finished the day with a challenging 2500 beam trawl (stn 086) across a hill in the north of the CMR. It landed at 2am and the ensuing sample contained many stones and rocks.

Tuesday 6/6/17

A Brenke sled (stn 087) across the same hill in Central Eastern CMR pinned up at one point. The catch was relatively small but the sled had come into contact with dark sticky mud. The search for a suitable 4000 m involved more multi-beam swaths. A site to the south of the park was selected in 4450 m. The resulting beam trawl (088) included a cookie-cutter shark, large prawns, and many brittle-stars of six species. There were some whale bones, which were not infested with *Osedax* worms.

The Brenke sled tow (089) was orientated more to the south (206°) to suit squall conditions but at similar depth. It was brought up at 2am. The route to the site off Byron Bay was selected to maximise new multi-beam coverage.

Wednesday 7/6/17

After further swathing, we arrived at the 2500 m Byron bay site around midday. The beam trawl (stn 090) contained lots of stones and a little mud, with some tropical fauna evident. While we lowered the trawl, we deployed 3 manta tows (stn 091-093) and two zooplankton tows (stn 094-095) off the side winch. The 2500 m Brenke sled (stn 096) was full to overflowing, with distinct polychaetes and lots of crustaceans.

Thursday 8/6/17

World Ocean day. Our multi-beam mapping of the Byron Bay site again failed to locate a suitable demersal trawl location. Some pre-recorded footage went live to schools at 2-2:45 pm. The 4000 m beam trawl (stn 097) briefly pinned up shortly after hitting bottom. The operation was continued but upon retrieval the beam was bent and the net torn. The catch was unrepresentative, consisting of soft boulders and gravel, with few animals. However, there was an abundance of serpulid worms which had not been previously collected successfully. The 4000 m Brenke Sled (stn 098) was deployed in a more SW direction and was completed without interruption. There was a lot of foraminiferan sand with few crustaceans. We then repeated the 4000 m beam trawl (stn 099).

Friday 9/6/17

Final shot for Byron was the 1000 m beam trawl. The haul included a whale skull and vertebrae with necrophagous polychaetes (*Osedax*) and bivalves. The catch was also rich in fishes and sea-stars. We then transited to the Moreton site. The collected multi-beam data identified several candidate 2500 transects. The best faced in a SE direction that met wind requirements. Unfortunately, the net was pinned up several times during the deployment resulting in another bent pole and torn apron. We abandoned the tow early and hauled up a load of mud with brittle stars, black coral and scaphopods. We decided against using the Brenke Sled at this site. We then transited to a candidate 4000 m site. The multi-beam looked OK and we deployed the beam trawl (stn 102) at 23:45.

Saturday 10/6/17

The Moreton 400 m beam trawl was successful, collecting another faceless cusk fish and some invertebrates. This was followed by a successful Brenke Sled (stn 103) in 4300 m. We then transited to the 1000 m site. The swath maps looked fine, however, we hooked up again about a third of the way down the transect with wire tension reaching 7 tonnes. The beam was bent again and there was lots of thick discarded fishing wire around the net. However, damage to the net was minimal and the USBL beacon was OK. The catch was small but diverse. We then transited to the Fraser site.

Sunday 11/6/17

At Fraser, the multi-beam indicated a flat featureless plane at 4000 m that appeared suitable for trawling. The beam trawl (stn 109) was deployed successfully and resulted in a small representative catch. Another faceless fish. The 4000 m Brenke Sled (stn 110) was also uneventful. The supra catch was small but the epi catch was overflowing with lots of polychaetes and crustaceans. During this trawl, we deployed 3 manta tows (stns 111-113) and one meso-zooplankton (stn 114) tow.

The multi-beam backscatter indicated a 2500 m site on a small plateau due west was suitable for operations. The beam trawl was deployed first (stn 115). During deployment, we also took 2 more meso-plankton samples (stn 116-117) early in the night (8pm) that were full of sea-angels (planktonic gastropods). The beam trawl catch was small but full of animals, particularly ophiuroids. A Brenke sled (stn 118) over the same track had to be aborted due to the presence of a pelagic shark longline (40 nm long) that drifted across our path.

Monday 12/6/17

The 2500 m Brenke sled (stn 119) was repeated the next morning at a more northern site. After 10:00 we deployed the demersal trawl at last in a flat plain at 4000 m. However, due to problems with the trawl winches, the hope of lowering the trawl net to abyssal depths was abandoned and it was slowly hauled in through mid-water. The catch was tiny, with wire wrapping around one of the doors, preventing the proper set of the net. We then transited to 1000 m at the last, most northerly, site in the Coral Sea CMR. We deployed a beam trawl almost immediately (stn 121), which resulted in a clean but diverse catch.

Tuesday 13/6/17

The selected 2500 m site proved to be unsuitably rugged on the multi-beam data, so we transited SE to the 2500 m contour and headed east to the Cato Trough. The beam trawl (stn 122) was successful but brought up a heap of mud that took 1.5 hours to process. The Brenke sled (stn 123) on the other hand was retrieved with a broken bottom lever and the catch was lost. While this was being deployed we towed the manta net three times (stns 124-126) and the zooplankton net once (stn 127) during the day. While the Brenke sled was being repaired, we decided to deploy the beam trawl (stn 128) once more in 1700 m along the line of the projected video tow to observe the catch difference. Two more meso-zooplankton nets were deployed (stns 129-130) during this operation in the dark evening, one shallow with the side lights on and one deep without lights.

Wednesday 14/6/17

The patched Brenke sled was deployed twice more at 2500 m (stns 131-132) both without success, as the doors did not open. Following that, we deployed the towed video camera (stn 133) along a plateau at 1700-2000 m.

Thursday 15/6/17

The Brenke sled was repaired again and this time successfully deployed at 2500 m (stn 134) resulting in a good catch. A route south was determined to a projected 4000 m site, which lay on an apparently flat muddy plain. However, the beam trawl (stn 135) bent again, resulting in a very small catch in a large amount of mud. Our final operation was to deploy the Brenke sled (stn 136) to 4000 m. This was to get a final CTD cast as we did not have time to sample. At 14:00 we began the long transit to Brisbane. The database was completed, the laboratories were disassembled and packed, and the catch placed into sealed drums for transport.

Friday 16/6/17

There was the group photo at 9am. Arrival in Brisbane Grain Wharf at 10:00 am.

Summary

The voyage was the first dedicated expedition to survey the seafloor at abyssal depths in Australian waters. The voyage collected samples and environmental data from 13 sites at 4000 and 2500 m across 18 degrees of latitude off the coast of eastern Australia. The result is tens of thousands of animal specimens that are now available in Australian museums for full taxonomic description and DNA analysis. There is enough data to facilitate a full description and analysis of the patterns of diversity for the east coast abyssal fauna.

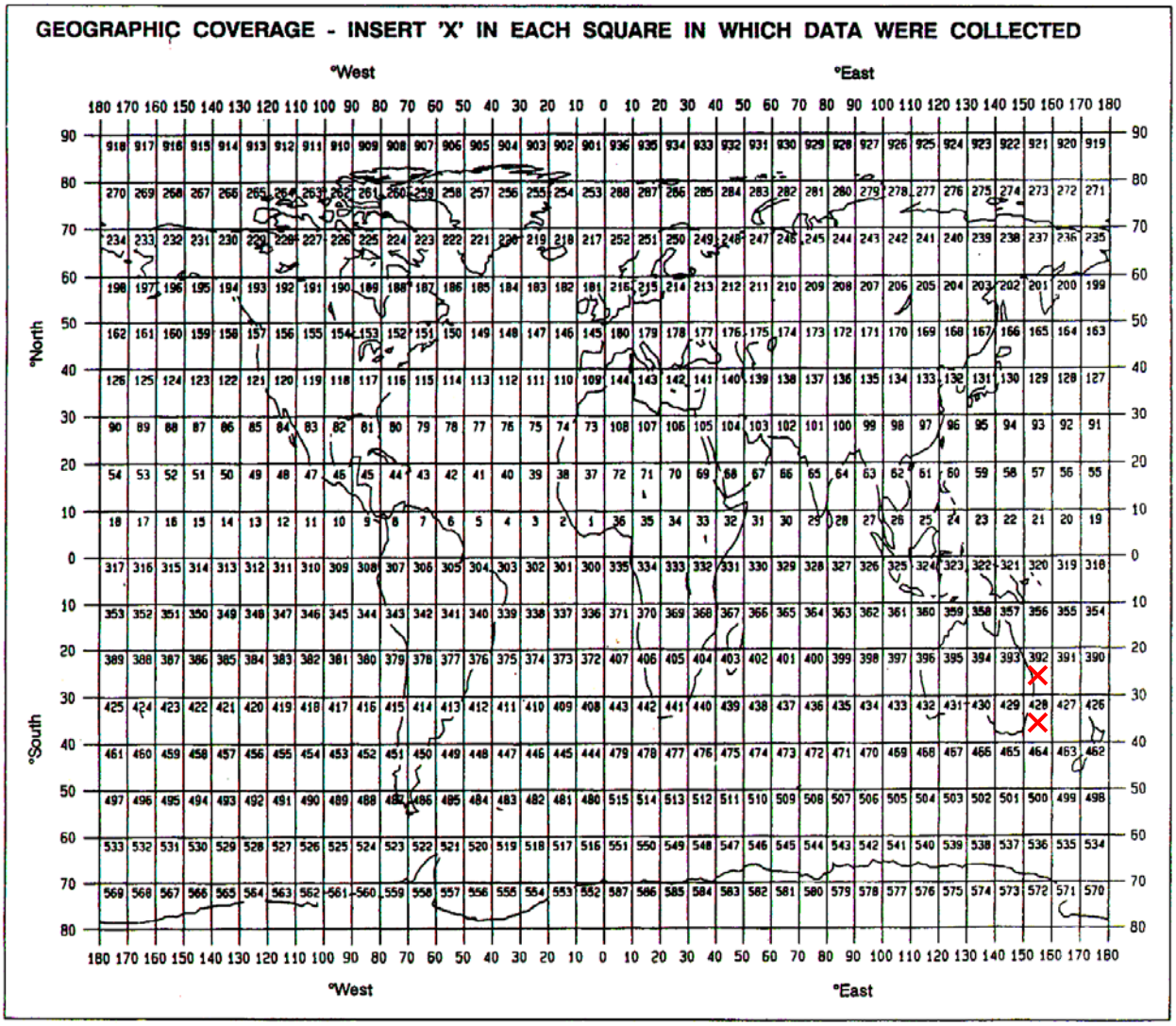
The voyage was the first deep-water survey of seven newly proclaimed CMRs off eastern Australia. In addition, large areas of seafloor was mapped across these reserves and video imagery produced of the seafloor at mid-bathyal depths (1500-2800 m).

Finally, the voyage, and deep-sea science generally, was successfully (if not spectacularly) communicated to the general public through daily blogs, numerous media interviews, social media and live streams from the vessel.

The voyage will be remembered as one of the great Australian deep-sea explorations, thanks to the enthusiastic and talented voyagers, including the science party, MNF staff and ASP crew, The NESP Marine Biodiversity Hub, and the magnificent vessel ‘Investigator’.

Marsden Squares

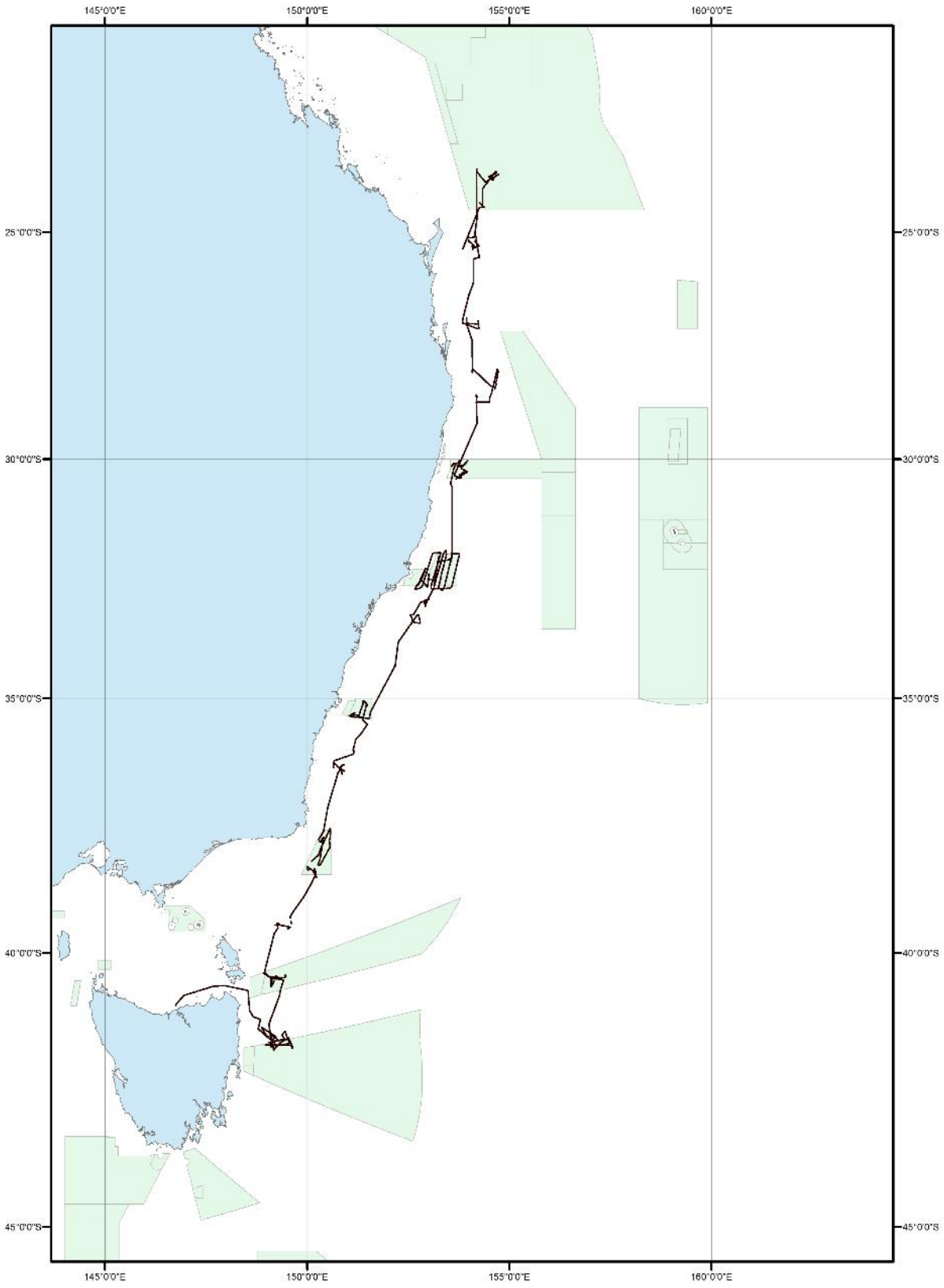
× × × ×



Summary of Measurements and samples taken

Item No.	PI see page above	NO see above	UNITS see above	DATA TYPE Enter code(s) from list at Appendix A	DESCRIPTION
1	TOH/AW	3573	lots	B18	Beam trawl biological samples. Archived into museum collections, including Museums Victoria, Australian Museum, Queensland Museum, Tasmanian Museum & Art Gallery, CSIRO National Fish collection.
2	TOH	1034	lots	B18	Brenke sled biological samples. Archived into museum collections as above.
3	TOH	67	lots	B08	Assorted zooplankton from meso-zooplankton and Manta nets. Archived into museum collections as above.
4	TOH	152	lots	B18	Assorted biological material from box cores and McKenna demersal trawls. Archived into museum collections as above.
5	TOH	16	cores	G04	Box corer sediment samples to be analysed by Geoscience Australia
6	TOH	84	lots	G03	Rock samples, to be archived at Geoscience Australia/Museums Victoria
7	Chris Wilcox CSIRO	13	cores	P90	Box core microplastics sub-cores
8	Denise Hardesty CSIRO	33	samples	P90	Plastic collected by the Manta tows.
9	TOH			P90	Rubbish & detritus, deposited at Museums Victoria and CSIRO National Fish collection
10	MNF	6	videos	G08	Towed video and still photographs
11	MNF	31	days	G74	Multi-beam
11	MNF	31	days	B28	Echo sounder
11	MNF	34	transects	H10	CTD data

Track Chart



Sample locations

Science personnel, from left:: (top) Di Bray, Tim O'Hara, (2nd row) Ian McRobert, Frank Koehler, Anoosh Sarraf, Merrick Ekins, Lauren Hughes , Martin Gomon, Mark Lewis,
(3rd row) John Wakeford, Caroline Farrelly, Lupita Bribiesca-Contreras, Marc Eléaume, Maggie Georgieva, Anne Enge, Izwandy Idris, Peter Shanks, Mel Mackenzie, Kirrily Moore, Maylene Loo, Tina Molodstova, Amy Nau,
(front) Bernie Heaney, John Pogonoski, Jasmine Bursic, Phoebe Lewis, Lena Kupriyanova, Alan Williams, Brett Muir, Jérôme Mallefet, David Staples, Al Graham, Will Ponsonby. Photographers: Rob Zugaro, Asher Flatt.

Personnel List

	Name	Organisation	Role
1.	Muir, Brett	CSIRO/MNF	Voyage Manager
2.	Lewis, Mark	CSIRO/MNF	Mech Tech
3.	Shanks, Peter	CSIRO/MNF	DAP support
4.	Sarraf, Anoosh	CSIRO/MNF	DAP support
5.	Ponsonby, Will	CSIRO/MNF	SIT Support
6.	McRobert, Ian	CSIRO/MNF	SIT Support
7.	Nau, Amy	CSIRO/MNF	GSM support
8.	Heaney, Bernadette	CSIRO/MNF	GSM support
9.	O'Hara, Tim	Museums Victoria	Chief Scientist
10.	Mackenzie, Melanie	Museums Victoria	Invertebrate processing
11.	Gomon, Martin	Museums Victoria	Fish processing
12.	Bray, Diane	Museums Victoria	Fish processing
13.	Zugaro, Robert	Museums Victoria	Videographer
14.	Lewis, Phoebe	Museums Victoria	Micro-plastics
15.	Farrelly, Caroline	Museums Victoria	Invertebrate processing
16.	Bursic, Jasmine	Museums Victoria	Invertebrate processing
17.	Bribiesca-Contreras, Lupita	Museums Victoria	Invertebrate processing
18.	Flatt, Asher	Museums Victoria	Communicator
19.	Staples, David	Museums Victoria	Invertebrate processing
20.	Williams, Alan	CSIRO/O&A	Alt Chief Scientist
21.	Gowlett-Holmes, Karen	CSIRO/O&A	Invertebrate photography
22.	Loo, Maylene	CSIRO/O&A	Invertebrate processing
23.	Pogonoski, John	CSIRO, NRCA	Fish processing
24.	Graham, Alistair	CSIRO, NRCA	Fish processing
25.	Hughes, Lauren	Australian Museum	Invertebrate processing
26.	Koehler, Frank	Australian Museum	Invertebrate processing
27.	Kupriyanova, Elena	Australian Museum	Invertebrate processing
28.	Ekins, Merrick	Queensland Museum	Invertebrate processing
29.	Moore, Kirrily	Tasmanian Museum Art Gallery	Invertebrate processing
30.	Molodstova, Tina	P.P.Shirshov Institute of Oceanology, Russia	Invertebrate processing
31.	Eléaume, Marc	Muséum national d'Histoire naturelle, France	Invertebrate processing
32.	Mallefet, Jérôme	University of Louvain, Belgium	Bioluminescence
33.	Georgieva, Magdalena	Natural History Museum UK	Invertebrate processing
34.	Enge, Annekatrin	University of Vienna, Austria	Invertebrate processing
35.	Idris, Izwandy	Universiti Malaysia Terengganu	Invertebrate processing

Marine Crew

	Name	Role
1.	Watson, Michael	Master
2.	Quinn, Roderick	Chief Mate
3.	Koolhof, Adrian	Second Mate
4.	Watson, Thomas	Third Mate
5.	Gervasiev, Gennadiy	Chief Engineer
6.	Benson, Sam	First Engineer
7.	McDonald, Ian	Second Engineer
8.	Agnew, Ryan	Third Engineer
9.	Kromcamp, Shane	Electrical Engineer
10.	Martin, Alan	Chief Steward
11.	Lade, Emma	Steward
12.	Hughes, Adrian	Chief Cook
13.	Stanley, Paul	Cook
14.	Lumb, Jonathan	Chief Integrated Rating
15.	Hingston, Dean	Integrated Rating
16.	Dorling, Christopher	Integrated Rating
17.	Lord, Murray	Integrated Rating
18.	Freeman, Timothy	Integrated Rating
19.	Lewis, Kel	Integrated Rating
20.	Capon, Darren	Integrated Rating
21.	Watson, Gregory	Integrated Rating
22.	Nicholson, Daniel	Integrated Rating
23.	Wakeford, John	Fishing master

Acknowledgements

My primary thanks is to those on board the voyage (listed above) who made it such a great success, including the science party, the MNF staff, and the ASP crew. Everyone was fantastic. I would like to thank the many people who helped put this voyage together behind the scenes. At Museums Victoria this includes Anna Quinn (media), Genefor Walker-Smith and Chris Rowley (collection managers), Elke Barczak (Education), Robin Wilson (Science) and many, many others. At the Marine Biodiversity Hub, to Director Nic Bax and deputy Paul Hedge for all their support, and Bryony Bennet who facilitated communications from Lightbox 42. At the Marine National Facility, a special thanks to Lisa Woodward, who taught me how to conduct a voyage, and Don McKenzie, Matt Marrison and Ben Rae. To David Watts for producing the vessel sample database. To scientists at CSIRO, including Mathew Sherlock, Denise Hardesty, Ryan Downie, and Rudy Kloser, who provided vital pieces of equipment. And finally to Maria Baker and Tammy Horton at INDEEP, University of Southampton, who facilitated several of the international collaborations.

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Signature

Your name	Tim O'Hara
Title	Chief Scientist
Signature	
Date:	10 July 2017

List of additional figures and documents

Appendix A CSR/ROSCOP Parameter CodeS

Appendix B List of operations

Appendix C Photographs of the voyage

Appendix D Maps of Commonwealth Marine Reserves

Appendix A - CSR/ROSCOP Parameter CodeS

	METEOROLOGY
M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

	PHYSICAL OCEANOGRAPHY
H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys

	MARINE BIOLOGY/FISHERIES
B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans

D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

	CHEMICAL OCEANOGRAPHY
H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

	MARINE GEOLOGY/GEOPHYSICS
G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements

	MARINE CONTAMINANTS/POLLUTION
P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

Appendix B List of operations

Op	Station name	Equipment	Start date	start time	start lat	start lon	start depth	End date	End time	End lat	End lon	End depth	Lots	Spec count
1	Freycinet (outside)	McKenna demersal fish trawl net	16-May-17	18:11:00	-41.4915	148.9407		16-May-17	18:11:00	-41.5522	148.997		21	34
2	Freycinet (outside)	McKenna demersal fish trawl net	17-May-17	8:56:00	-41.6268	149.1493	0	17-May-17	11:34:00	-41.5127	149.0753	1500	26	28
3	Freycinet (outside)	McKenna demersal fish trawl net	17-May-17	16:27:00	-41.651	149.298	2948	17-May-17	21:09:00	-41.6742	149.054	2787	2	2
4	Frey_2500_BT	CSIRO Four Metre Beam Trawl	18-May-17	1:03:00	-41.7305	149.1197	2820	18-May-17	2:59:00	-41.7913	149.1558	2751	251	2027
5	Frey_2500_BS	Brenke Epibenthic Sledge	18-May-17	7:15:00	-41.7303	149.135	2789	18-May-17	8:06:00	-41.753	149.147	2779	24	241
6	Frey_4000_BT	CSIRO Four Metre Beam Trawl	18-May-17	14:14:00	-41.6255	149.5515	4022	18-May-17	16:38:00	-41.6892	149.5843	4052	81	238
7	Frey_4000_BC	Biological Box Corer	18-May-17	22:05:00	-41.6472	149.5695	4030						0	
8	Frey_4000_BC	Biological Box Corer	19-May-17	2:51:00	-41.6472	149.5693	4012						4	
9	Frey_4000_BS	Brenke Epibenthic Sledge	19-May-17	7:39:00	-41.626	149.56	4021	19-May-17	9:06:00	-41.662	149.574	4035	53	765
10	Frey_2500_TC	Deep Towed Camera System	19-May-17	3:22:00									0	
11	Frey_2500_BC	Biological Box Corer	19-May-17	17:58:00	-41.7207	149.1252	2793						71	107
12	Frey_2500_TC	Deep Towed Camera System	19-May-17	21:12:00	-41.7242	148.9845	1671	19-May-17	23:25:00	-41.7267	149.0489	2516	0	
13	Flin_1000_BT	CSIRO Four Metre Beam Trawl	20-May-17	11:51:00	-40.386	148.928	932	20-May-17	12:32:00	-40.383	148.951	1151	52	108
14	Flin_2500_BT	CSIRO Four Metre Beam Trawl	20-May-17	16:02:00	-40.464	149.1015	2298	20-May-17	17:16:00	-40.4613	149.1467	2486	66	189
15	Flin_4000_BT	CSIRO Four Metre Beam Trawl	20-May-17	23:39:00	-40.4732	149.3967	4114	21-May-17	0:44:00	-40.464	149.4255	4139	77	647
16	Flin_4000_BS	Brenke Epibenthic Sledge	21-May-17	7:38:00	-40.463	149.415	4129	21-May-17	9:28:00	-40.4612	149.364	4131	71	1449
17	Flin_2500_BC	Biological Box Corer	21-May-17	15:16:00	-40.4598	149.1085	2331						0	
18	Flin_2500_Manta_1	Manta plankton net	21-May-17	16:28:00	-40.4563	149.1013	0	21-May-17	16:43:00	-40.4537	149.0958	0	2	
19	Flin_2500_Manta_2	Manta plankton net	21-May-17	16:50:00	-40.4527	149.0938	0	21-May-17	17:04:00	-40.4507	149.09	0	2	
20	Flin_2500_Manta_3	Manta plankton net	21-May-17	17:06:00	-40.4503	149.0893	0	21-May-17	17:21:00	-40.4475	149.0842	0	2	
21	Flin_2500_TC	Deep Towed Camera System	21-May-17	20:00:00									0	
22	Bass_2500_BT	CSIRO Four Metre Beam Trawl	22-May-17	8:05:00	-39.462	149.276	2760	22-May-17	9:08:00	-39.465	149.242	2692	151	2478
23	Bass_2500_BS	Brenke Epibenthic Sledge	22-May-17	13:00:00	-39.462	149.277	2774	22-May-17	10:00:00	-39.465	149.246	2694	67	1313
24	Bass_2500_Manta_1	Manta plankton net	22-May-17	15:32:00	-39.469	149.2155	0	22-May-17	15:47:00	-39.4672	149.2307	0	3	1
25	Bass_2500_Manta_2	Manta plankton net	22-May-17	15:49:00	-39.467	149.2333	0	22-May-17	16:04:00	-39.4655	149.248	0	2	
26	Bass_2500_Manta_3	Manta plankton net	22-May-17	16:06:00	-39.4652	149.2505	0	22-May-17	16:21:00	-39.4632	149.2655	0	2	
27	Bass_2500_BC	Biological Box Corer	22-May-17	18:33:00	-39.4623	149.2712	2741						28	26
28	Bass_4000_BC	Biological Box Corer	22-May-17	23:53:00	-39.4995	149.5348	4147						18	
29	Bass_4000_MesoZoo	Meso zooplankton net	23-May-17	1:55:00	-39.5068	149.5313	1	23-May-17	2:14:00	-39.5173	149.5268	1	18	76

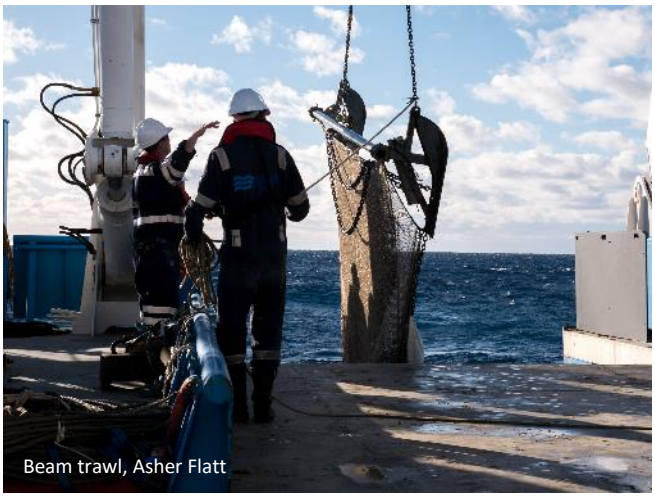
Op	Station name	Equipment	Start date	start time	start lat	start lon	start depth	End date	End time	End lat	End lon	End depth	Lots	Spec count
30	Bass_4000_BT	CSIRO Four Metre Beam Trawl	23-May-17	4:30:00	-39.552	149.553	4197	23-May-17	5:57:00	-39.496	149.598	4133	91	452
31	Bass_4000_BS	Brenke Epibenthic Sledge	23-May-17	11:09:00	-39.422	149.604	4150	23-May-17	12:30:00	-39.391	149.597	4170	98	2000
32	East_Gipps_4000_BT	CSIRO Four Metre Beam Trawl	24-May-17	1:03:00	-38.479	150.1845	3850	24-May-17	2:02:00	-38.453	150.186	3853	89	475
33	East_Gipps_4000_BS	Brenke Epibenthic Sledge	24-May-17	9:00:00	-38.521	150.213	4107	24-May-17	10:00:00	-38.498	150.207	4064	75	818
34	East_Gipps_2500_TC	Deep Towed Camera System	24-May-17	15:39:00	-38.3653	150.0627	2357	24-May-17	16:02:00	-38.3565	150.0652	2594	0	
35	East Gipps_2500_BT	CSIRO Four Metre Beam Trawl	25-May-17	13:16:00	-37.792	150.382	2338	25-May-17	14:33:00	-37.8178	150.353	2581	123	698
36	East_Gipps_2500_Manta_1	Manta plankton net	25-May-17	15:46:00	-37.8687	150.3098	0	25-May-17	16:03:00	-37.8668	150.3122	0	2	
37	East_Gipps_2500_Manta_2	Manta plankton net	25-May-17	16:06:00	-37.8665	150.3125	0	25-May-17	16:21:00	-37.8642	150.3145	0	2	
38	East_Gipps_2500_Manta_3	Manta plankton net	25-May-17	16:23:00	-37.864	150.3148	0	25-May-17	16:38:00	-37.8617	150.3167	0	2	
39	East_Gipps_2500_MesoZoo	Meso zooplankton net	25-May-17	16:43:00	-37.861	150.3173	0	25-May-17	16:58:00	-37.8593	150.319	1	1	1
40	East_Gipps_2500_BS	Brenke Epibenthic Sledge	25-May-17	19:22:00	-37.815	150.3733	2746	25-May-17	20:05:00	-37.8177	150.3558	2600	61	321
41	Berm_4000_BT	CSIRO Four Metre Beam Trawl	26-May-17	8:33:00	-36.418	150.8	3980	26-May-17	8:43:00				16	41
42	Berm_4000_BS	Brenke Epibenthic Sledge	26-May-17	17:02:00	-36.3853	150.863	4744	26-May-17	18:30:00	-36.4335	150.8632	4716	57	526
43	Berm_4800_BT	CSIRO Four Metre Beam Trawl	27-May-17	1:19:00	-36.3507	150.9143	4800	27-May-17	2:38:00	-36.384	150.913	4800	75	333
44	Berm_2500_BT	CSIRO Four Metre Beam Trawl	27-May-17	10:39:00	-36.355	150.644	2821	27-May-17	12:14:00	-36.315	150.651	2687	143	1213
45	Berm_2500_BS	Brenke Epibenthic Sledge	27-May-17	19:05:00	-36.3603	150.6435	2835	27-May-17	20:28:00	-36.3232	150.6502	2739	51	758
46	Berm_2500_BC	Biological Box Corer	27-May-17	23:44:00	-36.2838	150.6578	2643						36	139
47	Berm_2500_Manta_1	Manta plankton net	27-May-17	14:01:00	-36.2913	150.6555	0	27-May-17	14:16:00	-36.3017	150.6548	0	4	3
48	Berm_2500_Manta_2	Manta plankton net	27-May-17	14:18:00	-36.3053	150.6538	0	27-May-17	14:33:00	-36.3132	150.653	0	2	1
49	Berm_2500_Manta_3	Manta plankton net	27-May-17	14:36:00	-36.3147	150.6528	0	27-May-17	14:51:00	-36.3252	150.6522	0	2	1
50	Berm_2500_MesoZoo_1	Meso zooplankton net	27-May-17	14:56:00	-36.3288	150.6518	1	27-May-17	15:11:00	-36.3395	150.6512	1	5	18
51	Berm_2500_MesoZoo_2	Meso zooplankton net	27-May-17	15:14:00	-36.342	150.6508	1	27-May-17	15:29:00	-36.3515	150.6495	1	0	
52	Berm_2500_MesoZoo_3	Meso zooplankton net	27-May-17	15:31:00	-36.3528	150.6492	1	27-May-17	15:46:00	-36.3617	150.6478	1	0	
53	Jervis_4000_BT	CSIRO Four Metre Beam Trawl	28-May-17	11:42:00	-35.114	151.469	3952	28-May-17	13:13:00	-35.084	151.441	4011	45	140
54	Jervis_4000_BS	Brenke Epibenthic Sledge	28-May-17	17:11:00	-35.1168	151.473	4026	28-May-17	18:29:00	-35.0992	151.4547	3881	46	212
55	Jervis_2500_BS	Brenke Epibenthic Sledge	28-May-17	23:36:00	-35.3352	151.2593	2667	29-May-17	0:45:00	-35.334	151.2185	2665	44	68
56	Jervis_2500_BT	CSIRO Four Metre Beam Trawl	29-May-17	5:13:00	-35.333	151.258	2650	29-May-17	6:29:00	-35.332	151.214	2636	215	3525
57	Jervis_2500_BC	Biological Box Corer											0	
58	Jervis_2500_TC	Deep Towed Camera System	29-May-17	15:50:00	-35.2958	151.1545	2126	29-May-17	16:42:00	-35.3038	151.1353	2355	0	
59	Jervis_2500_Manta_1	Manta plankton net	29-May-17	15:10:00	-35.2977	151.1518	0	29-May-17	15:25:00	-35.3017	151.1433	0	2	
60	Jervis_2500_Manta_2	Manta plankton net	29-May-17	15:27:00	-35.302	151.1423	0	29-May-17	15:42:00	-35.306	151.1332	0	2	
61	Jervis_2500_Manta_3	Manta plankton net	29-May-17	15:44:00	-35.3065	151.1322	0	29-May-17	15:59:00			0	2	
62	Jervis_2500_MesoZoo_1	Meso zooplankton net	29-May-17	16:05:00	-35.3123	151.119	0	29-May-17	16:20:00	-35.3162	151.1095	1	5	107

Op	Station name	Equipment	Start date	start time	start lat	start lon	start depth	End date	End time	End lat	End lon	End depth	Lots	Spec count
63	Jervis_2500_MesoZoo_2	Meso zooplankton net	29-May-17	16:22:00	-35.317	151.1078	0	29-May-17	16:37:00	-35.3213	151.098	1	1	4
64	Jervis_2500_MesoZoo_3	Meso zooplankton net	29-May-17	16:39:00			0	29-May-17	16:54:00	-35.3265	151.0877	1	0	
65	Newc_4000_BT	CSIRO Four Metre Beam Trawl	30-May-17	13:16:00	-33.441	152.702	4280	30-May-17	14:22:00	-33.435	152.665	4173	78	464
66	Newc_4000_BS	Brenke Epibenthic Sledge	30-May-17	19:27:00	-33.4482	152.7328	4378	30-May-17	21:13:00	-33.4368	152.6737	4195	33	133
67	Newc_2500_BT	CSIRO Four Metre Beam Trawl	31-May-17	6:04:00	-32.985	152.952	2704	31-May-17	7:33:00	-33.015	152.913	2902	85	290
68	Newc_2500_BS	Brenke Epibenthic Sledge	31-May-17	10:52:00	-32.993	152.957	2745	31-May-17	12:20:00	-33.023	152.943	2963	13	13
69	Hunter_1000_BT	CSIRO Four Metre Beam Trawl	03-Jun-17	11:59:00	-32.479	152.994	1006	03-Jun-17	12:51:00	-32.507	152.991	1036	209	1900
70	Hunter_2500_BT	CSIRO Four Metre Beam Trawl	03-Jun-17	16:22:00	-32.575	153.1617	2595	03-Jun-17	17:34:00	-32.631645	153.142	2474	130	715
71	Hunter_2500_Manta_1	Manta plankton net	03-Jun-17	15:19:00	-32.5798	153.1612	0	03-Jun-17	15:34:00	-32.5905	153.1578	0	2	
72	Hunter_2500_Manta_2	Manta plankton net	03-Jun-17	15:36:00	-32.592	153.1575	0	03-Jun-17	15:51:00	-32.6035	153.1542	0	2	
73	Hunter_2500_Manta_3	Manta plankton net	03-Jun-17	15:53:00	-32.6047	153.1538	0	03-Jun-17	16:08:00	-32.6145	153.1497	0	2	
74	Hunter_2500_MesoZoo_1	Meso zooplankton net	03-Jun-17	17:45:00	-32.6515	153.1368	1	03-Jun-17	18:00:00	-32.6628	153.1335	1	7	42
75	Hunter_2500_MesoZoo_2	Meso zooplankton net	03-Jun-17	18:02:00	-32.6648	153.133	1	03-Jun-17	18:17:00	-32.6768	153.1288	1	5	32
76	Hunter_2500_BS	Brenke Epibenthic Sledge	03-Jun-17	21:22:00	-32.5772	153.1607	2534	03-Jun-17	22:38:00	-32.613	153.1488	2480	64	316
77	Hunter_1700_TC	Deep Towed Camera System	04-Jun-17	4:20:00	-32.094	153.253	1741	04-Jun-17	5:33:00	-32.115	153.251	2115	0	
78	Hunter_4000_BT	CSIRO Four Metre Beam Trawl	04-Jun-17	11:01:00	-32.138	153.527	3980	04-Jun-17	12:48:00	-32.182	153.524	4029	48	79
79	Hunter_4000_BS	Brenke Epibenthic Sledge	04-Jun-17	17:48:00	-32.1308	153.5273		04-Jun-17	19:09:00	-32.1626	153.5236	4031	76	1145
80	Cent_East_1000_BT	CSIRO Four Metre Beam Trawl	05-Jun-17	11:07:00	-30.099	153.596	1257	05-Jun-17	12:24:00	-30.128	153.571	1194	153	1236
81	Cent_East_1500_TC	Deep Towed Camera System	05-Jun-17	16:29:00	-30.0444	153.7513	1511	05-Jun-17	18:26:00	-30.09635	153.7296	2246	0	
82	Cent_East_1500_Manta_1	Manta plankton net	05-Jun-17	15:58:00	-30.0392	153.7543	0	05-Jun-17	16:13:00	-30.0483	153.7505	0	2	
83	Cent_East_1500_Manta_2	Manta plankton net	05-Jun-17	16:16:00	-30.05	153.7497	0	05-Jun-17	16:31:00	-30.061	153.745	0	2	
84	Cent_East_1500_Manta_3	Manta plankton net	05-Jun-17	16:33:00	-30.0618	153.7445	0	05-Jun-17	16:48:00	-30.0695	153.741	0	2	
85	Cent_East_1500_MesoZoo_1	Meso zooplankton net	05-Jun-17	16:54:00	-30.0725	153.7395	0	05-Jun-17	17:09:00	-30.0802	153.7367	1	3	6
86	Cent_East_2500_BT	CSIRO Four Metre Beam Trawl	05-Jun-17	23:48:00	-30.0977	153.8987	2429	06-Jun-17	0:52:00	-30.1193	153.8745	2518	122	374
87	Cent_East_2500_BS	Brenke Epibenthic Sledge	06-Jun-17	3:56:00	-30.113	153.898	2634	06-Jun-17	5:18:00	-30.116	153.867	2324	71	138
88	Cent_East_4000_BT	CSIRO Four Metre Beam Trawl	06-Jun-17	14:17:00	-30.264	153.87	4481	06-Jun-17	16:26:00	-30.2867	153.8302	4401	69	498
89	Cent_East_4000_BS	Brenke Epibenthic Sledge	06-Jun-17	22:48:00	-30.2633	153.8587	4436	07-Jun-17	0:03:00	-30.2893	153.8438	4414	51	443
90	Byron_2500_BT	CSIRO Four Metre Beam Trawl	07-Jun-17	16:28:00	-28.6765	154.2033	2587	07-Jun-17	17:56:00	-28.709	154.1897	2562	116	412
91	Byron_2500_Manta_1	Manta plankton net	07-Jun-17	15:18:00	-28.6695	154.2073	0	07-Jun-17	15:33:00	-28.6747	154.2052	0	3	1
92	Byron_2500_Manta_2	Manta plankton net	07-Jun-17	15:35:00	-28.6757	154.2048	0	07-Jun-17	15:50:00	-28.6817	154.2027	0	2	
93	Byron_2500_Manta_3	Manta plankton net	07-Jun-17	15:53:00	-28.6827	154.2022	0	07-Jun-17	16:08:00	-28.6887	154.1998	0	2	
94	Byron_2500_MesoZoo_1	Meso zooplankton net	07-Jun-17	16:13:00	-28.6903	154.1992	0	07-Jun-17	16:28:00	-28.6962	154.1968	1	4	40
95	Byron_2500_MesoZoo_2	Meso zooplankton net	07-Jun-17	16:31:00	-28.697	154.1965	0	07-Jun-17	16:49:00	-28.704	154.1937	1	0	

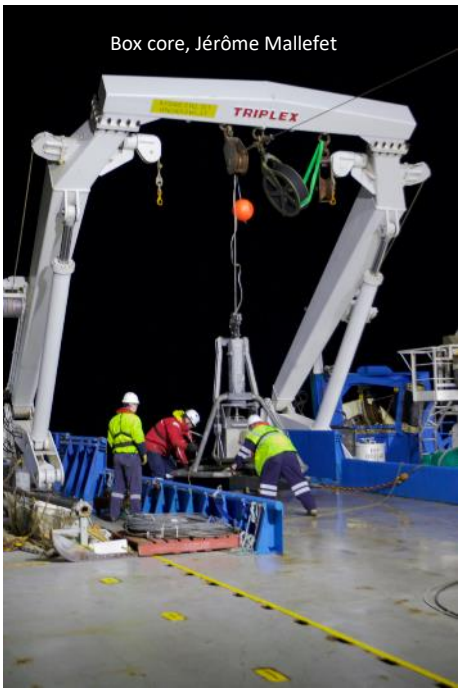
Op	Station name	Equipment	Start date	start time	start lat	start lon	start depth	End date	End time	End lat	End lon	End depth	Lots	Spec count
96	Byron_2500_BS	Brenke Epibenthic Sledge	07-Jun-17	21:13:00	-28.6778	154.2037	2591	07-Jun-17	22:43:00	-28.7158	154.189	2566	70	2620
97	Byron_4000_BT	CSIRO Four Metre Beam Trawl	08-Jun-17	10:54:00	-28.355	154.636	3762	08-Jun-17	12:38:00	-28.414	154.615	3803	33	279
98	Byron_4000_BS	Brenke Epibenthic Sledge	08-Jun-17	18:31:00	-28.3713	154.6472	3811	08-Jun-17	19:53:00	-28.3888	154.6123	3754	42	251
99	Byron_4000_BT_2	CSIRO Four Metre Beam Trawl	09-Jun-17	0:14:00	-28.371	154.6487	3825	09-Jun-17	1:33:00	-28.3875	154.617	3754	45	647
100	Byron_1000_BT	CSIRO Four Metre Beam Trawl	09-Jun-17	7:27:00	-28.0544	154.083	999	09-Jun-17	8:47:00	-28.097	154.081	1013	266	1548
101	Moreton_2500_BT	CSIRO Four Metre Beam Trawl	09-Jun-17	17:43:00	-26.9458	153.945	2520	09-Jun-17	18:48:00	-26.9712	153.9512	2576	66	216
102	Moreton_4000_BT	CSIRO Four Metre Beam Trawl	10-Jun-17	1:32:00	-27.0078	154.2232	4274	10-Jun-17	3:07:00	-27.049	154.224	4264	41	300
103	Moreton_4000_BS	Brenke Epibenthic Sledge	10-Jun-17	8:52:00	-27.0003	154.223	4260	10-Jun-17	10:30:00	-27.061	154.223	4280	33	147
104	Moreton_1000_BT	CSIRO Four Metre Beam Trawl	10-Jun-17	16:00:00	-26.9613	153.8475	1071	10-Jun-17	17:01:00	-26.9913	153.8468	1138	128	604
105	Moreton_1000_Manta_1	Manta plankton net	10-Jun-17	15:45:00	-26.9622	153.8477	0						2	
106	Moreton_1000_Manta_2	Manta plankton net	10-Jun-17	16:03:00	-26.9713	153.848	0	10-Jun-17	16:18:00			0	2	
107	Moreton_1000_Manta_3	Manta plankton net	10-Jun-17	16:19:00	-26.98	153.848	0	10-Jun-17	16:34:00	-26.9882	153.8478	0	2	
108	Moreton_1000_MesoZoo_1	Meso zooplankton net	10-Jun-17	16:37:00	-26.9895	153.8478	1	10-Jun-17	17:00:00	-27.0013	153.8475	1	1	
109	Fraser_4000_BT	CSIRO Four Metre Beam Trawl	11-Jun-17	7:46:00	-25.221	154.164	4006	11-Jun-17	9:22:00	-25.253	154.192	4005	57	105
110	Fraser_4000_BS	Brenke Epibenthic Sledge	11-Jun-17	14:09:00	-25.2198	154.1602	4005	11-Jun-17	15:53:00	-25.2605	154.2	4010	69	1033
111	Fraser_4000_Manta_1	Manta plankton net	11-Jun-17	14:32:00	-25.2562	154.1945	0	11-Jun-17	14:47:00	-25.2628	154.2008	0	2	
112	Fraser_4000_Manta_2	Manta plankton net	11-Jun-17	14:49:00	-25.2637	154.2018	0	11-Jun-17	15:04:00	-25.2697	154.2078	0	2	
113	Fraser_4000_Manta_3	Manta plankton net	11-Jun-17	15:06:00	-25.2703	154.2085	0	11-Jun-17	15:21:00	-25.2768	154.2147	0	2	
114	Fraser_4000_MesoZoo_1	Meso zooplankton net	11-Jun-17	15:20:00	-25.2768	154.2147	0	11-Jun-17	15:44:00	-25.2818	154.2192	1	0	
115	Fraser_2500_BT	CSIRO Four Metre Beam Trawl	11-Jun-17	20:56:00	-25.3253	154.0683	2350	11-Jun-17	21:56:00	-25.3513	154.076	2342	83	1274
116	Fraser_2500_MesoZoo_2	Meso zooplankton net	11-Jun-17	20:08:00	-25.3193	154.0665	1	11-Jun-17	20:24:00	-25.3278	154.0695	1	5	6
117	Fraser_2500_MesoZoo_3	Meso zooplankton net	11-Jun-17	20:27:00	-25.3295	154.0702	3	11-Jun-17	20:47:00	-25.3398	154.0733	3	1	1
118	Fraser_2500_BS	Brenke Epibenthic Sledge											0	
119	Fraser_2500_BS	Brenke Epibenthic Sledge	12-Jun-17	4:48:00	-25.206	153.991	2247	12-Jun-17	6:10:00	-25.178	153.979	2369	53	456
120	Fraser_4000_FT	McKenna demersal fish trawl net	12-Jun-17	11:00:00	-25.1478	154.1557	3993	12-Jun-17	17:45:00	-25.0577	154.1463		19	17
121	Coral_Sea_1000_BT	CSIRO Four Metre Beam Trawl	13-Jun-17	2:31:00	-23.587	154.194	1013	13-Jun-17	3:31:00	-23.617	154.1947	1093	168	764
122	Coral_Sea_2500_BT	CSIRO Four Metre Beam Trawl	13-Jun-17	10:41:00	-23.751	154.639	2369	13-Jun-17	11:56:00	-23.773	154.616	2329	69	289
123	Coral_Sea_2500_BS	Brenke Epibenthic Sledge	13-Jun-17	14:46:00	-23.7485	154.6413	2271	13-Jun-17	15:56:00	-23.774	154.6172	2339	9	27
124	Coral_Sea_2500_Manta_1	Manta plankton net	13-Jun-17	13:58:00	-23.746	154.6435	0	13-Jun-17	14:13:00	-23.7497	154.6407	0	2	
125	Coral_Sea_2500_Manta_2	Manta plankton net	13-Jun-17	14:15:00	-23.7502	154.6402	0	13-Jun-17	14:30:00	-23.7568	154.634	0	2	
126	Coral_Sea_2500_Manta_3	Manta plankton net	13-Jun-17	14:32:00	-23.7578	154.6278	0	13-Jun-17	14:49:00	-23.7653	154.6278	0	2	
127	Coral_Sea_2500_MesoZoo_1	Meso zooplankton net	13-Jun-17	14:54:00	-23.7673	154.6257	1	13-Jun-17	15:15:00	-23.7757	154.6177	1	4	3

Op	Station name	Equipment	Start date	start time	start lat	start lon	start depth	End date	End time	End lat	End lon	End depth	Lots	Spec count
128	Coral_Sea_2000_BT	CSIRO Four Metre Beam Trawl	13-Jun-17	21:05:00	-23.6312	154.6597	1770	13-Jun-17	22:17:00	-23.659	154.6438	1761	114	1937
129	Coral_Sea_2000_MesoZoo_2	Meso zooplankton net	13-Jun-17	20:33:00	-23.6297	154.661	3	13-Jun-17	20:53:00	-23.6378	154.6568	3	6	16
130	Coral_Sea_2000_MesoZoo_3	Meso zooplankton net	13-Jun-17	20:56:00	-23.639	154.6562	1	13-Jun-17	21:16:00	-23.6467	154.6518	1	3	12
131	Coral_Sea_2500_BS_2	Brenke Epibenthic Sledge	14-Jun-17	3:21:00	-23.748	154.643	2297	14-Jun-17	4:43:00	-23.778	154.613	2358	2	3
132	Coral_Sea_2500_BS_3	Brenke Epibenthic Sledge	14-Jun-17	7:53:00	-23.756	154.568	2181	14-Jun-17	9:13:00	-23.78	154.54	2132	6	9
133	Coral_Sea_1700_TC	Deep Towed Camera System	14-Jun-17	12:10:00	-23.6312	154.6597	1753	14-Jun-17	16:35:00	-23.659	154.6438		0	
134	Coral_Sea_2500_BS_4	Brenke Epibenthic Sledge	14-Jun-17	18:32:00	-23.7503	154.5718	2093	14-Jun-17	19:46:00	-23.7739	154.5464	2156	65	295
135	Coral_Sea_4000_BT	CSIRO Four Metre Beam Trawl	15-Jun-17	4:36:00	-24.352	154.291	3968	15-Jun-17	6:18:00	-24.384	154.325	4034	18	28
136	Coral_Sea_4000_CTD	Brenke Epibenthic Sledge											0	

Appendix C: Photos of the voyage: Gear


Beam trawl, Asher Flatt

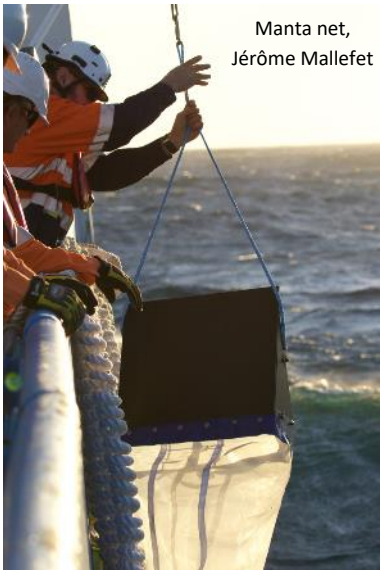

Brenke sled, Jérôme Mallefet



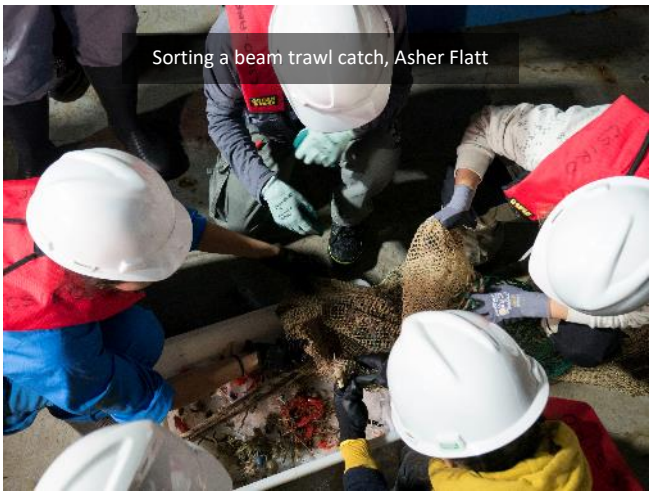
Box core, Jérôme Mallefet


Towed video, Jérôme Mallefet


Meso-zooplankton net, Jérôme Mallefet


Manta net,
Jérôme Mallefet

Photos of the voyage: Life

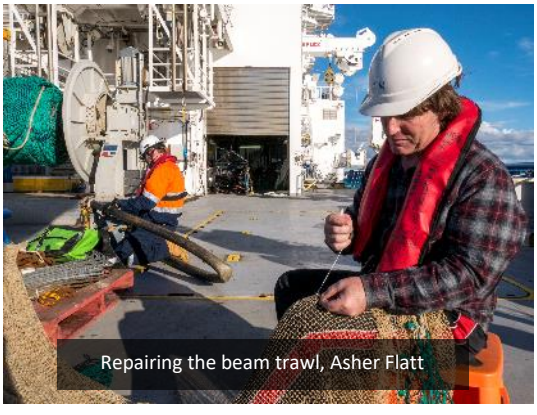

Sorting a beam trawl catch, Asher Flatt


Sorting mud, Jérôme Mallefet


Chief scientist and voyage manager, Rob Zugaro/MV


Sorting in the wet dirty lab, Asher Flatt


Picking through a manta ray carcass, Asher Flatt


Repairing the beam trawl, Asher Flatt


Selecting the next operational site, Rob Zugaro/MV

Photos of the voyage: Animals

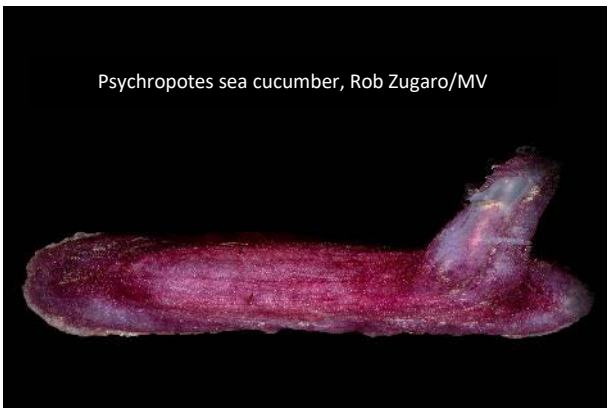
Fin octopus, Rob Zugaro/MV

Flesh-eating amphipod, Rob Zugaro/MV

Whale skull, Asher Flatt

Zoroaster seastar, Jerome Mallefet

Blobfish, Rob Zugaro/MV



Psychropotes sea cucumber, Rob Zugaro/MV

Faceless Cusk, Asher Flatt

Coffin fish, Rob Zugaro/MV

Appendix D – Maps of Commonwealth Marine Reserves