RV *Investigator* Voyage Summary Draft

Voyage #:	IN2015_C02		
Voyage title:	GAB deep-water pelagic and benthic ecosystem study		
Mobilisation:	Port Lincoln, 12:00, Sunday 29th November 2015		
Depart:	Port Lincoln, 10:00, Monday, 30th November 2015		
Return:	Fremantle, 10:00, Tuesday, 22nd December 2015		
Demobilisation:	Fremantle, 17:00, Tuesday, 22nd December 2015		
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Objectives and brief narrative of voyage

The voyage was designed to characterise deep-water pelagic and benthic community structure and identify key ecological processes in the central and eastern GAB, and forms part of the GAB Research Program that aims to describe the key elements of the GAB marine ecosystem. This understanding of the structure and function of the ecosystem will be used to inform future integrated and sustainable ocean management and assessment/mitigation of potential future impacts. An overarching objective of the voyage is to contribute to developing models of ecosystem-level structure and function for the GAB

Scientific objectives

The pelagic ecosystem structure in the eastern GAB, which is characterised by seasonal upwelling and a narrower continental slope, will be compared with the poorly sampled central GAB, where year-round downwelling is predicted and the shelf and slope are wider with the following GAB Research Program objectives;

1. Compare the eastern and central GAB continental margin zooplankton and micronekton communities in terms of their species composition, size range, biomass, nutrient source/trophic pathways and habitat.

2. Testing the hypothesis that the “microbial food web” is the dominant planktonic food web over the deep GAB continental margin, particularly in the central GAB where year-round downwelling is thought to be the prevailing cross-margin flow, and that the more efficient “classic food web” only dominates in the eastern GAB during periods of nutrient-rich upwelling.

3. Describing the community structure, dynamics, biodiversity and endemism of microbes (i.e., viruses and bacteria), plankton (i.e., phytoplankton, zooplankton, ichthyoplankton) and micronekton (including squids, small pelagic and mesopelagic fish and gelatinous organisms).

Benthic characterisation is important because there are virtually no existing benthic biological data beyond continental shelf depths (<200 m); because conservation values attributed to Commonwealth Marine Reserves (CMR) spanning wide depth ranges are untested on the mid- and lower continental slope; and because oil and gas lease areas extend across the GAB Marine Park (GAB MP).

Within the GAB Research Program, the Benthic Biodiversity project has the following objectives:

1. Quantify spatial patterns in the physical environment, and composition and abundance of benthic fauna in BP leases and adjacent continental slope areas of the Great Australian Bight (GAB) to provide baseline metrics relevant to monitoring the potential future impacts of oil and gas exploration on benthic communities.

2. Determine requirements (including identifying indicators and metrics), and identify suitable control sites, for future ecological monitoring in the GAB – especially to detect and quantify ecological impacts from oil and gas exploration on benthic communities of the GAB Marine Park.

Voyage objectives

The pelagic sampling objectives were:

1. Collect and process a full set of water samples to characterize and quantify primary production, microbial communities (virus/bacteria/ picophytoplankton) and determine a variety of water column environmental and chemical parameters.
2. Collect and process phytoplankton, zooplankton and micronekton samples from vertical tow, side, EZnet (LOPC) and IYGPT MIDOC tows during day and night. Opportunistically collect nekton (e.g. squids and tuna) for food web studies.
3. Conduct experiments investigating microbial and planktonic physiology and productivity
4. Collect and process profiling lagrangian acoustic, optical (PLAOS) measurements day and night.
5. Collect and process underway pelagic acoustic measurements and target unique layers with TRIAXUS, net and PLAOS samplers.
6. Collect underway acoustic and water chemistry to investigate effects of eddies.

The benthic voyage objectives were:

7. Collect and process a full set of beam trawl samples (1 sample per site = 30 individual tow samples) to assess megafaunal biodiversity (composition and abundance).
8. Collect and process a set of sediment cores from the five 3000 m depth sites (unsampled in 2013) and 3 sites that were inadequately sampled in 2013 (1 multicore sample per site = 8 individual ICP samples) to assess macrofaunal biodiversity, characterize and quantify the structure and function of sediment microbial communities (including hydrocarbon degrading bacteria), and determine a variety of sediment environmental and chemical parameters.
9. If time permits, an additional 3-5 2013 sites will be resampled using the ICP to assess temporal changes in assemblages, so as to distinguish if differences between the 2015 sites and 2013 sites are spatial or temporal. One of these sites may be sampled multiple times to build a species accumulation curve, to provide information on how complete a representation of the fauna is sampled by a single ICP deployment.

Results

Objective 1 (Physical and water sampling)

A full set of samples to characterise and quantify primary production, microbial and phytoplankton communities, and water column physical and chemical parameters was successfully collected during this voyage. Water samples were collected with the rosette sampler at 16 locations during 21 sampling events. On the two main pelagic transects (T2, T6), samples were collected at stations on the 100m, 400m, 800m, and 3000m depth contours. There were five stations that were sampled twice over 24 hours (T2: 400m, 800m, 3000m; T6: 400m, 3000m). Samples were also collected at stations on the 400m and 3000m depth contours on the benthic transects. Samples from at least three depths (including 10m, the depth of the deep chlorophyll maximum (DCM), and 120m) were sub-sampled for DNA, RNA and DMSP analysis, virus/bacteria, picoplankton, and phytoplankton abundance and community composition, size fractionated pigments (>/< 5 µm) to be analysed via HPLC, and POC and PON for stable isotope food web studies. Sub-samples were collected from the three depths mentioned above (10m, DCM, 120m) for assessments of microbial and planktonic productivity; these will be elaborated on below. Hydrochemistry samples (macronutrients, dissolved oxygen, salinity) were collected at a number of depths at all stations mentioned above, and an additional 4 stations on each of the pelagic transects (T2, T6). Together with the physical measurements from the CTD and accessory sensors this information will provide a physical and chemical context for the biological data. The TurboMAP microstructure profiler was deployed successfully two times 'back-to-back' at 10 stations during the voyage, providing 20 high-resolution profiles of physical and biological microstructure to depths up to 200 m. TurboMAP deployments at each station followed CTD profiling and associated water sampling for nutrients and biomass. Information from TurboMAP facilitates the identification and quantification of the important mixing processes and rates that drive changes in microbial and planktonic abundance, community composition and productivity adding further physical and chemical context to biological data at micro-scales. From the perspective of objective 1 this has been a highly successful voyage.

Objective 2. (Pelagic net sampling)

On the two main pelagic sampling transects T2 and T6 five 24 hour sampling stations were done collecting vertical, side, EZ and MIDOC net samples at sampling depths of 400 m and offshore nominally 3000 m water depth successfully completing the objective. Along T2 a fifth 24 hour station was added at the 800 m depth strata based on the higher than expected biological activity and the available time. Along T6 a day time sampling of all nets was completed at the 1500 m depth contour. The vertical, side and EZ net samples were completed successfully for all stations. The twin door IYGPT net with MIDOC codend sampling improved throughout the voyage and was limited to operations due to weather and crew availability. Trawling operations could only be done between 13:00 hrs and 01:00 hours. At the start of the voyage the poor weather and uncertainty of how to deploy, operate and recover the gear reduced the number of samples and increased the sampling time. Fortunately after a lot of hard dedicated work from the ship's crew and science staff all operations along T2 were successful with reduced vessel time. A full set of samples were obtained from the vertical, side, EZ net and MIDOC to address objective 2.

Objective 3 (Production experiments)

Investigations of microbial and planktonic physiology and productivity were conducted at stations on the 100m, 400m, and 3000m depth contours on transects 2 and 6, with additional studies at the 800m contour on transect 2. Water samples were collected pre-dawn with the rosette sampler, as outlined above. Microbial production (via Thymidine and Leucine uptake), and primary productivity (via ^{14}C uptake) were examined using water from 10m, the DCM, and 120m. Microbial production incubations took place on the incubation platform with flow-through seawater keeping temperatures at near in-situ. Primary productivity studies took place in a photosynthetron in the Radvan. These were short (2 hour) incubations with samples exposed to 7 light treatments ranging in irradiance from 10 – 1000 µmol m^{-2} sec^{-1}. Grazing experiments to assess secondary productivity were conducted on the incubation platform using water from the DCM. All experimental studies were completed successfully, though some post-voyage processing is required before the quality of results can be fully ascertained.

Phytoplankton productivity was also assessed via the measurement of photophysiological parameters and rates of photosynthesis with a profiling Fast Repetition Rate Fluorometer (FRRf). Following the Rosette sampling, the FRRf was deployed at the stations outlined above, to 150m depth at a rate of 3m per minute. A second FRRf was used to produce steady state light curves for samples collected at the stations indicated above from 10m, the DCM, and 120m. A full set of profiles and steady state light curves was successfully acquired during the voyage.

Objective 4. (PLAOS sampling)

The profiling acoustic optical system (PLAOS) was deployed 14 times (without any failures) during the voyage to depths of 400 m to 1000 m both day and night mainly on transects T2 and T6 recording 500 GBytes of optical and acoustic sensor data. An interesting observation was the apparent larger avoidance reaction observed on the 18 kHz vessel acoustics (400 m to 800 m depths) when compared to the vessels 38 kHz acoustics. This may be due to resonance scattering of a fish species being detected by the 18 kHz at depth. Based on the oblique optical sampling the most striking biota were the large number and size of the siphonophores observed in their feeding mode. Based on the data collected it will be possible to compare the biomass and day and night habitat distribution of large zooplankton and fish within and between regions. Most importantly it will enable the first census of large gelatinous material in the open ocean to 1000 m in Australian waters with optical sensors.

Objective 5 (Targeted nekton sampling)

During the voyage we collected 7 frequency water column acoustic data six Simrad EK60 bio-acoustic calibrated single beam echosounders recording continuously throughout the voyage at 18, 38, 70, 120, 200 and 333 kHz and a 12 kHz uncalibrated sounder in waters less than 600 m depth. The vessel's acoustics was of the highest quality due to use of the lowered keel at full extension to eliminate bubble layer attenuation and the sustained calm weather. In total ~1217 nautical miles of water column acoustics to 1500 m depth were recorded, a combination of dedicated bioacoustic transect sections and continuous recording throughout all operations to give a comprehensive mapping of the pelagic eco-structure of the eastern and central GAB. This is the first time that this region has been surveyed with a full suite of acoustic frequencies consisting of 7 echosounders ranging from 12 to 333 kHz. In particular the observed difference in backscatter

across the frequencies will enable inferences of the size of gas inclusion in biota where the 18 kHz in particular provided new insights into the distribution of resonant scattering organisims.

These acoustic data were routinely processed on board and provided background to the net hauls and targeting of scattering layers. Unfortunately the TRIAXUS was not available for this voyage due to its loss on a previous voyage and inadequate time to instigate a replacement system. Opportunity to target unique scattering layers was limited by both weather and the available crew time window to deploy net gear during the voyage. Despite these limitation three target trawls were done on scattering layers at 200 m to 400 m water depths. An unusual observation was the avoidance of fishes (assume cardinal fish) to the passage of the vessel in 200 m water depth in the central GAB. Given the noise quietening of the vessel the fishes may be reacting to other stimuli including light and or ultrasound. Based on our trawl hauls we provisionally observed no significant difference in catch size between the eastern and central regions.

Objective 6 (Underway sampling)

Macronutrient samples were collected from the underway water supply, 2 hourly, for the voyage duration (216 samples). Between transects 2 and 6, biomass samples were collected from the underway water supply, at 0830, 1230, 1630 each day, coinciding with macronutrient sampling. Samples collected included DNA, RNA and DMSP, virus/bacteria, picoplankton and phytoplankton abundance and community composition, and size fractionated pigments (>/< 5 µm) to be analysed via HPLC. Phytoplankton physiology and productivity was also studied at these times, with the two Fastocean FRRfs; one making continuous measures of photophysiological parameters in the underway seawater supply, and the other producing steady state light curves from underway samples collected at the times indicated above. Underway bioacoustics data at 6 frequencies were collected along the 6 main transects to create an eco-acoustic profile to 1500 m depth as outlined in Objective 5 above. These acoustic curtains were merged with a temperature profile cross section to investigate any eddy effects that may be influencing the distribution and abundance of biota. During Transect 6 there was evidence that colder water in the central part of this transect was associated with lower backscatter and consistent with an eddy. Insufficient time was available to fully explore this observation. Post processing of the data will enable all 6 acoustic transects to be processed and compared with the co-variate physical and biological data.

Objective 7 (Benthic Beam trawl sampling)

This objective was met in full. The full set of 30 planned beam trawl samples was collected successfully (1 sample per site at 200, 400, 1000, 1500, 2000, 3000 m depths on each of 5 longitudinally-based transects), and all samples were fully processed on board. Sample sizes were adequate to ensure that representative numbers of invertebrates and fishes were collected in all depths. Over 100 taxa were present in some individual catches. This result will enable the benthic megafaunal biodiversity (composition and abundance) to be characterised across the central-eastern GAB in continental slope depths. Large collections of well-conditioned specimens were retained and preserved for long-term curation in museum collections. Selected biological tissue sampling was undertaken for archival purposes, and to contribute to the barcoding objective in Project 3.2. Sponge tissue samples were also retained for microbiomic and secondary metabolite analysis as part of a side-project.

Objective 8 (Multi-core sampling at 3000 m sites)

The five 3000m sites were successfully sampled with the ICP, with 5-6 cores obtained at each site, with the exception of transect 5 (the easternmost benthic transect), where only a single sample was obtained by merging several partial cores. This poorly sampled site was the first site sampled with the ICP, and we were still figuring out how to deploy it without dynamic positioning (DP), which was not available due to failure of the bow thruster. The site was not resampled, as time was required to develop an alternative strategy, and time constraints meant that we could neither remain on site while this was done, nor return at a later time. Time constraints and the lack of DP also meant that the 3 inadequately sampled sites from 2013 were not resampled. At each sampled site, 1 core was subsampled for sediment physical characteristics, 3 cores were subsampled for hydrocarbon degrading bacteria, molecular characterization of faunal assemblages and meiofrauna, with the remainder of each core elutriated for macrofauna, and the remaining 1-2 cores were elutriated whole for macrofauna.

Objective 9 (Repeat multi-core samples)

Four sites sampled in 2013 were successfully resampled, with a further site having only a single core retrieved. These cores were treated as per the 3000m sites, with the exception that meiofauna were not retained. At one of these sites (transect 1, 1000m), an additional 2 deployments were made to obtain samples to develop a species accumulation curve. The 11 cores retrieved from these 2 deployments were elutriated without subsampling.

Voyage Narrative

Overview of sampling strategy

The overall design of the survey was based on the combined needs of the GABRP Pelagic and Benthic projects along six transects T1 to T6 (Figure 1). The Pelagic sampling reflected the need for information over two gradients, T2 and T6, along which ecosystem characteristics are expected to vary: east-west (longitude) and depth. Longitudinal ecosystem differences (between the eastern and central GAB) are expected based on patterns in oceanographic processes, especially upwelling that influences the supply of nutrients and hence production processes. The benthic collections were designed to repeat samples obtained in 2013 on the RV Southern Surveyor along the five continental slope transects (T1 to T5). Depth-related ecosystem differences are poorly documented in the deep (>1000 m) GAB, but it can be confidently predicted from observations in other deep water ecosystems that there will be marked changes in both benthic and pelagic biological community composition and productivity between the shelf edge (200 m depth) and the deep slope (3000 m). Thus, an underlying systematic depth verses longitude stratified design was suited to the survey parameters: our hypothesis of ecosystem change over east-west and depth gradients, a general absence of data in the deep GAB region relevant to the project objectives, a large survey area, and limited time available on station.

The 18 days of sampling time were allocated roughly equally to pelagic and benthic sampling, and a mix of pelagic and benthic sampling was undertaken at most individual stations. Sampling

involved the use of many gear types, and these were interwoven to maximise the efficiency of the survey, and to meet the time-of-day dependence of much of the pelagic sampling.

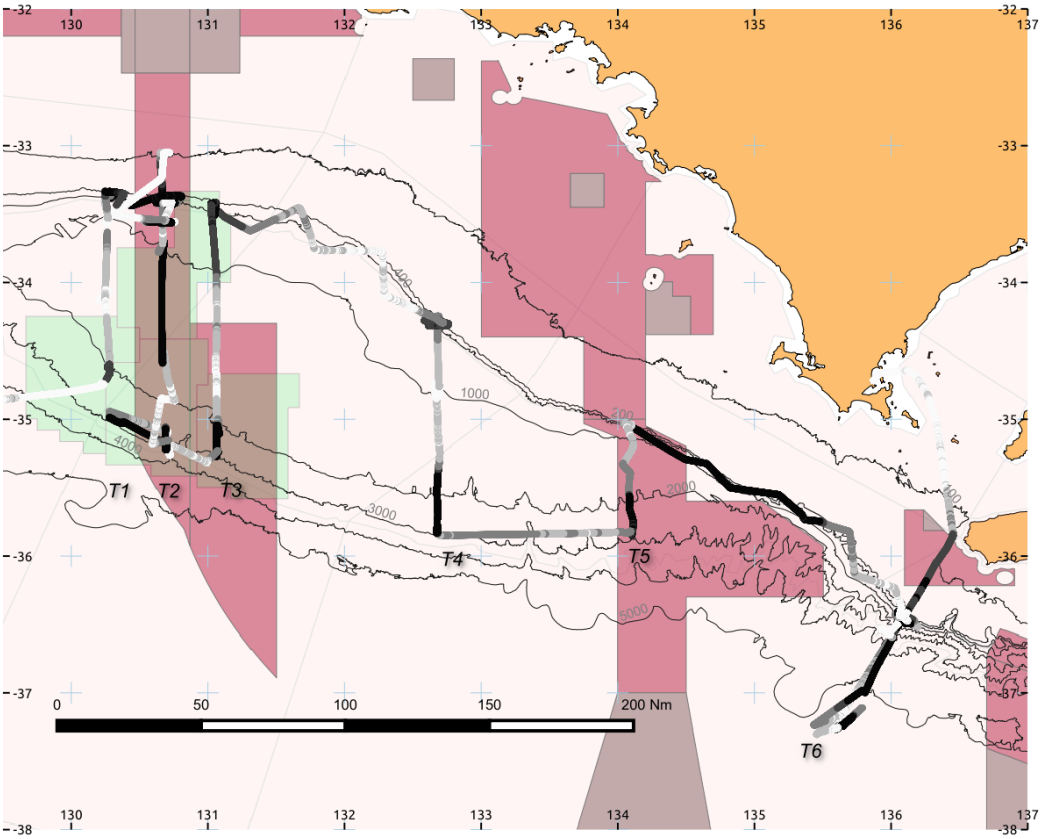


Figure 1 Voyage track highlighting the Transects T1 to T6.

The voyage started at Transect T6 involving predominately pelagic sampling for the first 4 days. The vessel then moved westward completing the predominately benthic stations of T5 and T4. The rest of the time was then allocated to sampling the Transects, (mainly benthic) T3, (benthic and pelagic) T2 and (mainly benthic) T1 (Figure 1)

Pelagic sampling to meet the objectives was emphasised on Transects 2 and 6, with stations at 100, 400, 800 and greater than 3000 m with 24 hour sampling at 400 m depth and greater than 3000 m. At these stations the water column physical properties, nutrients, microbial, planktonic, zooplankton and micronekton were sampled. Details of sampling methods are given below. Underway data including acoustic, ADCP and surface physical properties were complimented with regular (every 2 hours) surface nutrient sampling and triplicate surface net zooplankton samples at each pelagic and benthic site on T1 to T6. These samples are to provide a measure of the gradients between longitude and shelf break to offshore as well as to investigate the effects of eddies.

Benthic sampling used a beam trawl to collect benthic megafauna (seafloor invertebrates and fishes greater than approximately 1 cm is size) at 30 stations – 6 depth horizons (200, 400, 1000,

1500, 2000 and 3000 m) on each of transects T1 to T5 (5 meridians of longitude) were sampled (Figure 1). Transect locations were selected to achieve relatively high sampling density in the region of the GAB Marine Park (GAB MP) and active oil and gas leases: Transect 2 was located in the centre of the GAB Marine Park, and Transects 1 and 3 were located at 10 n.m. either side of the GAB MP. The two other transects were located to cross other active oil and gas lease blocks in the eastern GAB at 80 and 150 n.m. distance from the centre of the GAB MP (Transects 4 and 5 respectively).

The materials and methods of sampling are given below segmented by the objectives of the voyage.

Objective 1

A CTD mounted on a 36 bottle rosette sampler was deployed at each pelagic site, and at 400m and 3000m stations on benthic transects. The CTD provided a full profile of temperature, conductivity, fluorescence, irradiance (PAR) and dissolved oxygen. Water samples were collected with the rosette sampler at 16 locations during 21 sampling events. On the two main pelagic transects (T2, T6), samples were collected at stations on the 100m, 400m, 800m, and 3000m depth contours. There were five stations that were sampled twice over 24 hours (T2: 400m, 800m, 3000m; T6: 400m, 3000m). Samples were also collected at stations on the 400m and 3000m depth contours on the benthic transects. Samples from at least three depths (including 10m, the depth of the deep chlorophyll maximum (DCM), and 120m) were sub-sampled for DNA, RNA and DMSP analysis, virus/bacteria, picoplankton, and phytoplankton abundance and community composition, size fractionated pigments (>/< 5 µm) to be analysed via HPLC, and POC and PON for stable isotope food web studies. Hydrochemistry samples (macronutrients (ammonia, nitrite, nitrate, phosphate and silica), dissolved oxygen, salinity) were collected at a number of depths at all stations mentioned above, and an additional 4 stations on each of the pelagic transects (T2, T6), and analysed in the onboard hydrochemistry laboratory.

The turbulence microstructure acquisition profiler (TurboMAP; Figure 2, Wolk et al. 2002, Doubell et al. 2009) was deployed successfully two times ‘back-to-back’ at 10 stations during the voyage. This provided a total of 20 high-resolution profiles of physical and biological microstructure to depths up to 200 m (Figure 2). The majority of sampling events occurred on Transects 2 and 6, with four stations (inshore, offshore and two shelf break stations) sampled along each of these transects. Two opportunistic sampling events were made along Transect 1 in response to interesting biological (acoustic derived) and physical (CTD derived) observations. Dr Mark Doubell (SARDI) who has extensive experience using TurboMAP was assisted by, and provided training to,

David Spencer a Ph.D student of Prof. Charles Lemckert (Griffith University, Gold Coast) who kindly provided the TurboMAP profiler as part of an ongoing collaboration with Dr Doubell.

Figure 2 TurboMAP profiler provides for the measurement of conductivity, temperature, depth, chlorophyll a fluorescence, vertical shear and temperature gradient microstructure. Variables are sampled at rates ranging between 64 and 512 Hz and a nominal free-fall profiling velocity of ~0.6 m/s.

TurboMAP deployments at each station followed CTD profiling and associated water sampling for nutrients and planktonic biomass. Information from TurboMAP directly supports Objectives 1, 3 and 6. TurboMAP allows for the identification and quantification of mixing processes and rates. Specifically, in combination with the physical, biological and chemical curtains obtained from CTD profiling and macronutrient sampling, information from TurboMAP allows for the direct quantification of vertical heat, salt, buoyancy and nutrient fluxes. Further, this information will provide valuable information for the validation of oceanographic models currently being developed under GABRP Research Theme 1 (Oceanography the Science that Underpins).

Wolk, F., H. Yamazaki, L. Seuront, and R. G. Lueck, (2002), A new free-fall profiler for 395 measuring biophysical microstructure. *J. Atmos. Oceanic Technol.*, 19, 780–793.

Doubell, M.J., Yamazaki, H., Hua, L., Kokubu, Y., 2009. An advanced laser-based fluorescence microstructure profiler (TurboMAP-L) for measuring bio-physical coupling in aquatic systems. J. Plankton Res. 31 (12), 1441–1452.

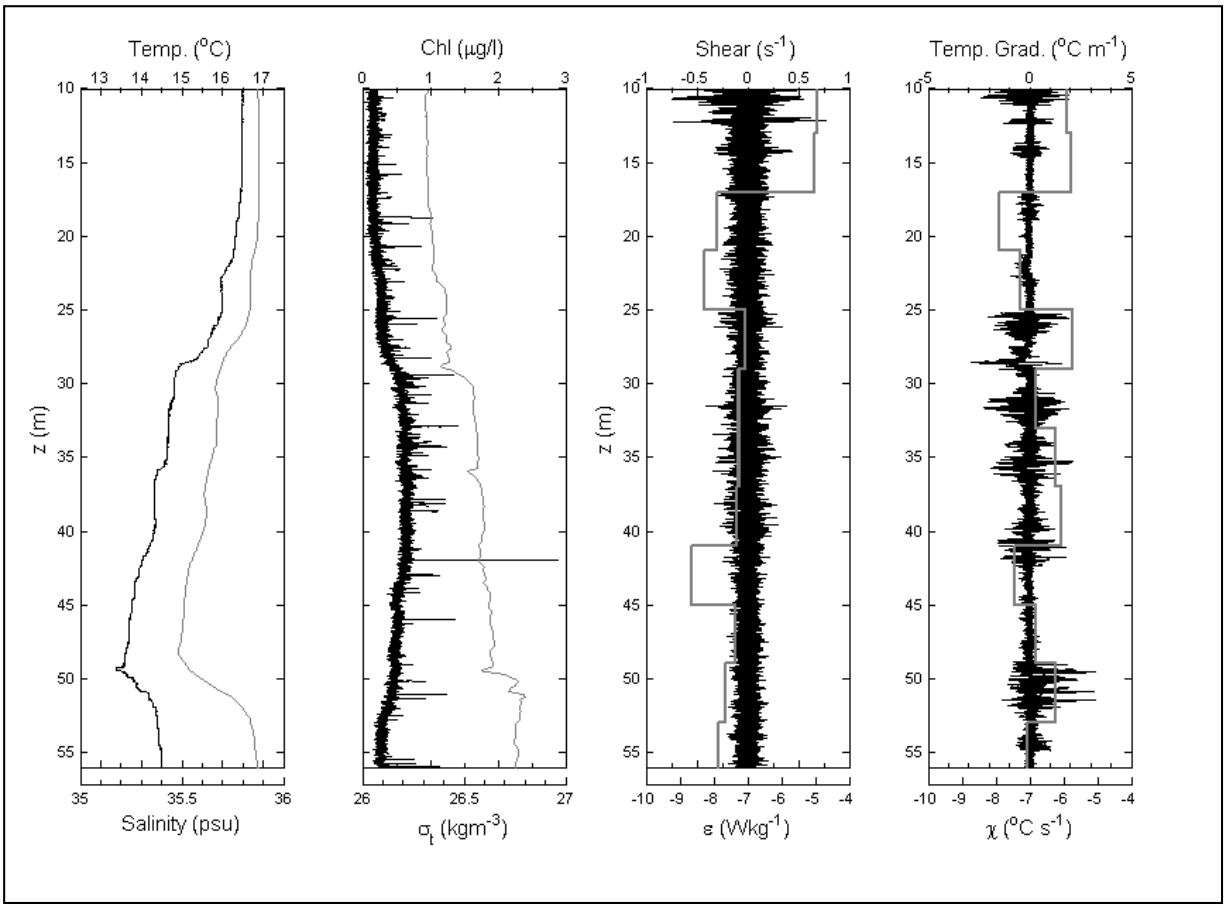


Figure 3 An example of vertical profiles obtained from TurboMAP profiling at the inshore station on Transect 6 - Station 1. Temperature and salinity signals (far left plot) indicate a cooler and fresher, possibly upwelled water mass, sitting between relatively warmer and saltier well mixed surface and bottom layers. The high salinity of bottom layer indicates water outflowing from Spencer Gulf. Chlorophyll fluorescence (second plot from left) is higher in the cooler, fresher water mass and fluorescence spikes indicate considerable centimetre scale patchiness throughout the water column. Vertical shear (second plot from right) is high in the surface layer, indicative of active turbulence, due to wind and waves down to approximately 17 m depth before decreasing with depth. In contrast to the reduced shear found below 17 m depth, high temperature gradient data (far right plot) located at temperature steps between 27 and 53 m depth indicate double diffusive mixing processes.

Objective 2 (Net capture vertical, side net, EZ-LOPC, MIDOC and IYGPT)

Side Surface Net

We successfully completed triplicate surface net samples for mezozooplankton at each pelagic and benthic station by towing a 1.2 m diameter 350 micron mesh net for a 10 minute duration (Figure 4). This net was normally deployed during beam trawl, MIDOC or EZ net operations, collecting a range of crustaceans, siphonophores, jellyfish and larval fish. A total of 117 surface net casts were completed.

At 24 hour production stations on T2 and T6 (400 m and 3000 m) surface net samples were fractioned into material retained on a 4000 µm, 1000 µm and 300 µm sieves. Each fraction was then split for ZooScan and stable isotope analysis. ZooScan splits were frozen in individual plastic bags. Isotope samples were frozen in glass jars. Samples collected at beam trawl stations were only split into material retained on a 4000 µm, 1000 µm and 300 µm sieves for ZooScan analysis. At 400m and 1000 m beam trawl stations on T5, T4, T3 and T2 samples were split for Zooscan and stable isotope analysis (except on T5).

On transect 4, 200 m station we experienced strong wind (25 knts) and high seas, which combined to cause challenging conditions for deploying and retrieval of the surface net. While retrieving the first replicate the surface net ripped in three places and was un-repairable. A spare net was lashed onto the 1.2 m ring and fortunately we managed to collect all three samples from this station.

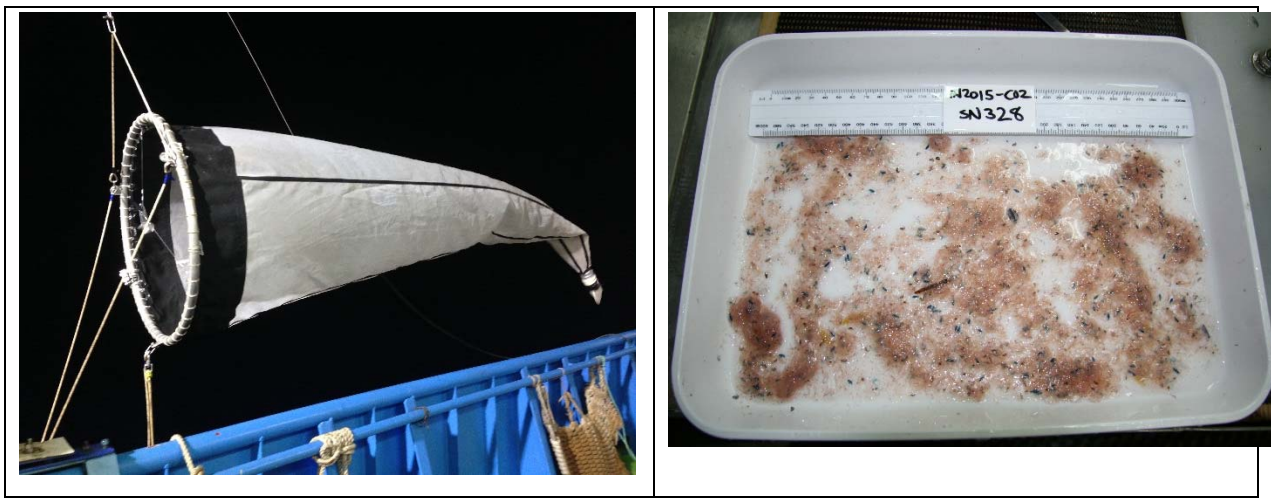


Figure 4. Surface net towed from starboard side of vessel, and typical catch of mesozooplankton.

Zooplankton were also sampled via vertical tows of nets of three different mesh sizes. A 335 µm mesh bongo net (30 cm net mouth diameter) and a bongo with one 64 µm mesh net and one 150 µm mesh net (both 30 cm net mouth diameter) were deployed to 200 m depth and hauled vertically to the surface at 30 m per minute at each of the pelagic stations, with day and night deployments on the 24 hour stations. A large range of crustaceans and larval fish were collected. For each deployment, the contents of cod-ends were split for assessments of abundance and community composition (fixed with 4% Formalin), and biomass (via ash free dry weight, filtered onto pre-weighed 20 µm mesh filters). Selected specimens were retained in cryovials and frozen for stable isotope analysis. Night samples were processed for abundance and biomass only.

EZ – LOPC

The MNF EZ net was configured as a 5-net opening and-closing system designed to sample meso-zooplankton at user defined depth intervals. The system is controlled via an optic fibre cable connection to the operation room. It hosts a CTDO, laser optical plankton counter, 2 x flowmeters, lights, video and is fitted with 5 x 335 micron mesh nests that are dropped on demand. Nets typically sampled five discrete depth intervals during the upcast of a deployment, in waters greater than 800m depth the nets sampled 600-400 m, 400-300 m, 300-200 m, 200-100 m, 100-0 m, in a 50 min period (Figure 5).

Day and Night samples were collected a part of the four 24 hour sampling stations on T2 and T6. In addition to these eight deployments the EZ was deployed at 100 m and 1000 m stations during daylight hours on both T2 and T6. This will allow for a depth integrated comparison of meso-zooplankton communities between the eastern and central GAB, two regions that are believed to be under different productivity regimes at this time of the year. Regional comparisons will be conducted by comparing community composition, abundance and size of meso-zooplankton communities. In addition to regional analyses we will explore which communities undergo diel migration, possible by the day/night sampling strategy. The EZ net is fitted with a laser optical

plankton counter (LOPC), which logs the size and abundance of plankton and particulate organic matter between 100 um and 35000 um in size. The LOPC was calibrated twice during the voyage once beginning of the voyage on the 2015-11-29 and once sampling had completed on the 2015-12-19. LOPC data will provide a complementary method for assessing depth integrated detrital and micro/meso-zooplankton communities.

The EZ and LOPC system performed well for the duration of the voyage, and all biological samples were processed according to pre-defined sample handling protocols. Biological samples were fractioned into material retained on a 4000 µm, 1000 µm and 300 µm sieves. Each fraction was then split for ZooScan and stable isotope analysis. ZooScan splits were frozen in individual plastic bags. Isotope samples were frozen in glass jars.

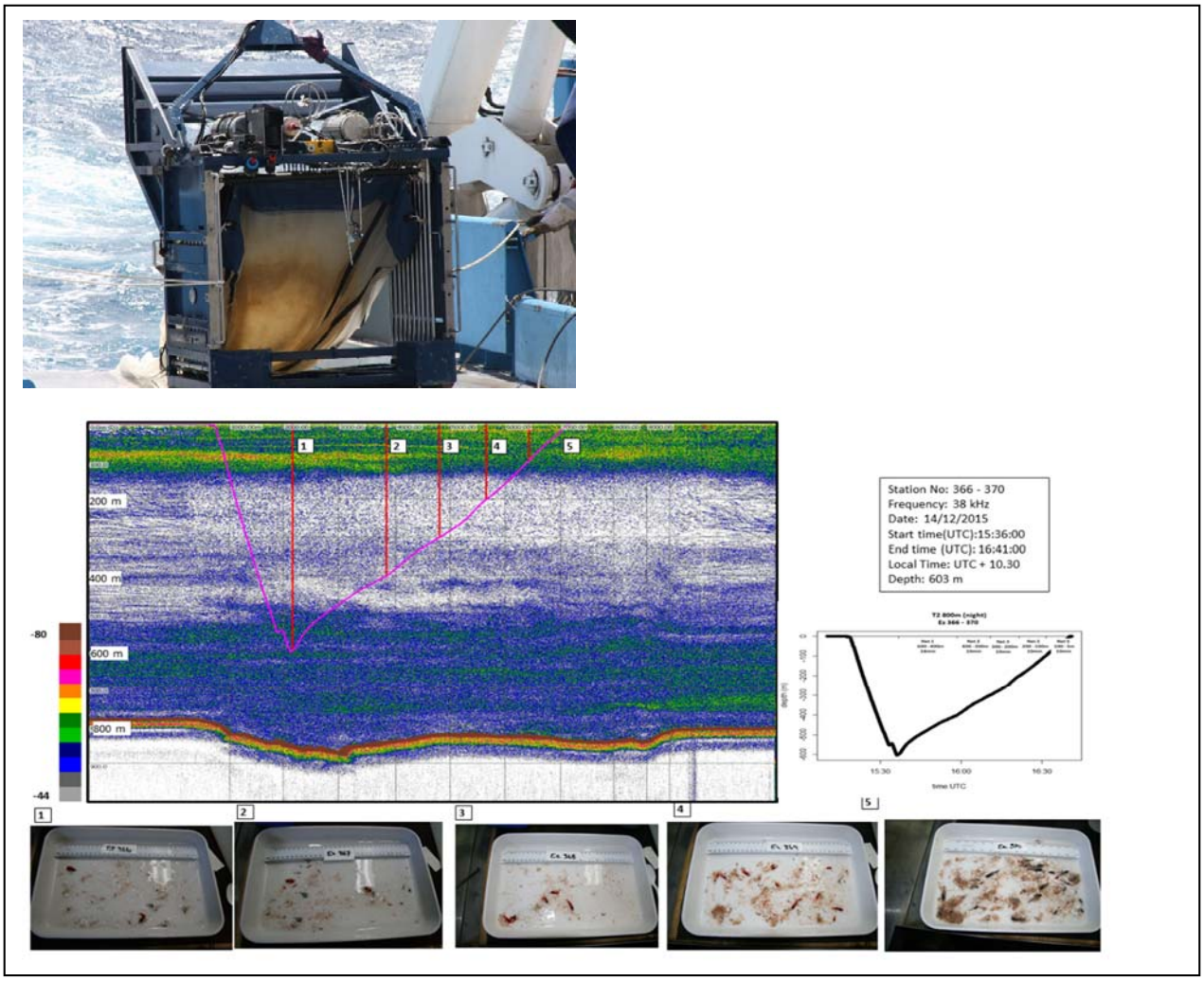


Figure 5. EZ net configured as a five net sampler b. showing a typical deployment with the associated catch for the five nets

IYGPT with MIDOC and IKMT

The primary method of micronekton sampling was trawling of the International Young Gadoid Pelagic Trawl (IYGPT) with the MIDOC multiple opening-closing codend device attached. The IYGPT was trawled with trawl doors attached to the net wings that were deployed using the dual winches. Net mesh size of the IYGPT ranged from 200 mm (knot-to-knot stretched mesh) in the wings and fore sections of the net, decreasing to 10 mm at the rear of the net where it attaches to the MIDOC codend. The MIDOC codend device comprised 6 nets made from knotless 6mm mesh and the final detachable collecting bag had a mesh size of 335 µm. The MIDOC is fitted with a CTD and light meter that records depth, temperature, conductivity and irradiance throughout the trawl.

The MIDOC was pre-programmed to open and close the codends on a timer that was activated upon deployment. The first net (net 1) is an integrative sample that collects throughout the descent of the net from the surface to the first target depth. Subsequent depth strata (nets 2 to 6) are fished during the ascent of the trawl. Planned trawl schedules are shown in Table 1. These schedules were modified in response to local bathymetry or where backscatter conditions identified alternative targets.

Table 1. ***Planned micronketon trawl schedules***

MIDOC depth x time program	**>1000 m site**	**800 m site**	**400 m site**	**200 m site**
Net 1	0 – 800 (80 mins)	0 – 600 (70 mins)	0 – 400 (50 mins)	0 – 200 (40 mins)
Net 2	800 – 600 (20 mins)	600 – 400 (20 mins)	400 – 300 (10 mins)	200 – 200 (10 mins)
Net 3	600 – 400 (20 mins)	400 – 300 (10 mins)	300 – 200 (10 mins)	200 – 150 (10 mins)
Net 4	400 – 200 m (20 mins)	300 – 200 m (20 mins)	200 – 100 m (20 mins)	150 – 100 m (20 mins)
Net 5	200 – 100 m (10 mins)	200 – 100 m (10 mins)	100 – 50 m (10 mins)	100 – 50 m (10 mins)
Net 6	100 – 0 (10 mins)	100 – 0 (10 mins)	50 – 0 (10 mins)	50 – 0 (10 mins)

During trawling, the depth of the net, door spread and headline height were monitored using the onboard Simrad ITI system. Wire out length and descent rate were also monitoring, along with vessel speed to target the desired depth strata within the time windows programmed into the MIDOC. Depth strata targets were met on most occasions with a reasonable degree of accuracy, although sea state, currents and operational factors on some trawls modified the sampling plan. Upon recovery of the trawl, the MIDOC computer was downloaded to recover the actual (rather than the planned) codend sampling depth and time achieved for the trawl (

Figure 6). These data were generally in good agreement with the data monitored from the Simrad ITI and the ITI system was considered suitable for real-time trawl monitoring to achieve planned depth targets.

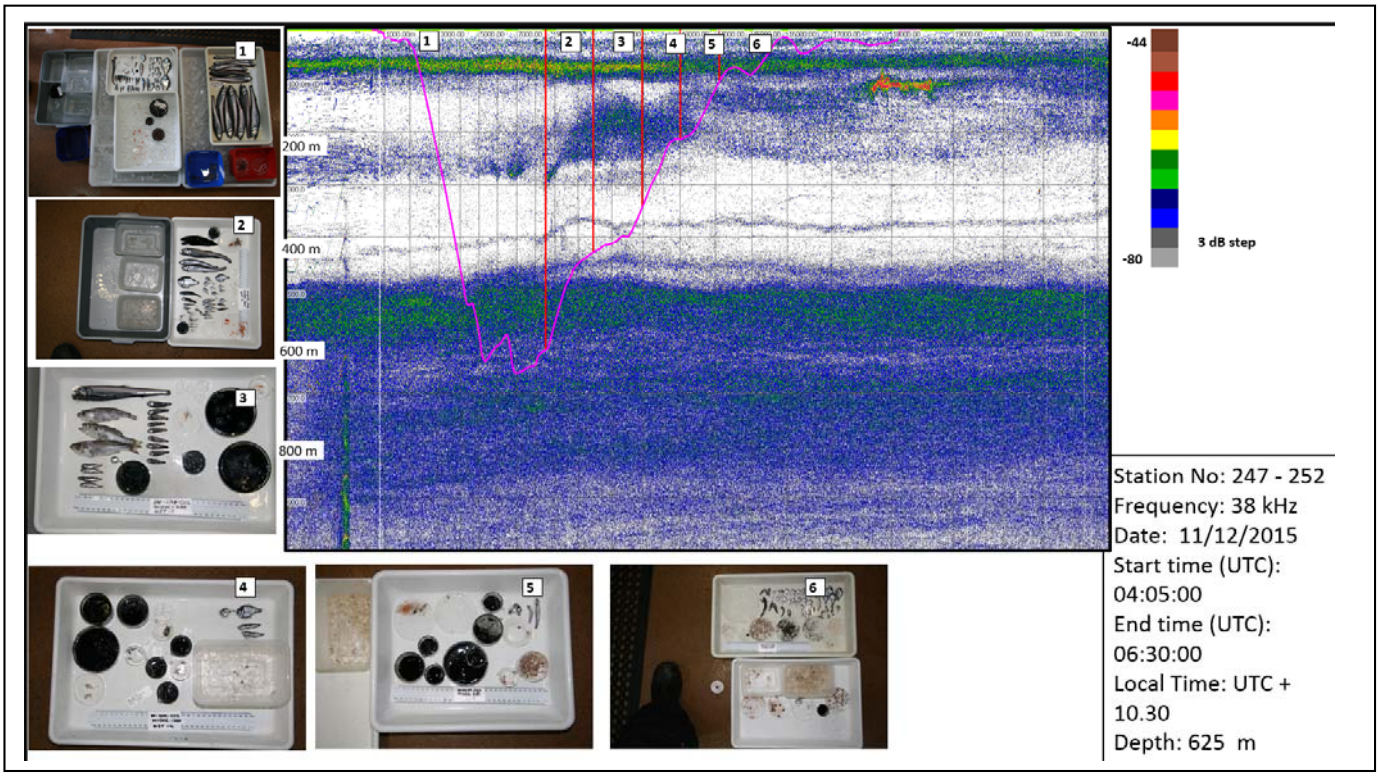


Figure 6 Profile of an IYGPT with MIDOC net tow over the acoustic backscatter at 38 kHz and the 56 nets and associated biological tray shots.

Previous experience with this net indicates that effective mouth area is approximately 188 m^2 (21 m wing spread x 8.9 m headline height). The data analysis phase of this project will aim to estimate mouth area for each trawl to normalise biomass estimates by volume filtered, using the real-time data recorded from the Simrad ITI.

An Isaacs-Kidd Midwater Trawl (IKMT) was also used on this voyage. This is a small midwater trawl that was not connected to the MIDOC system, but rather was a non-closing net with a single mesh codend that integrated catches over the full range of depth sampled during a trawl. This net was used to trial the effectiveness of a light-weight, easily deployable system for calibrating bioacoustics. The Simrad ITI net depth and headline height beacons were fixed to the IKMT. The mouth area is approximately 4 m^2. Three deployments were made with this net and catches were very small compared to those achieved with the IYGPT in all cases. IKMT sampling was discontinued in preference for the IYGPT.

Objective 3

Bacterial production was assessed through dark incubations investigating the uptake of H^3 as Thymidine and Leucine. Incubations took place on the incubation platform with flow-through seawater keeping temperatures at near in-situ.

Primary productivity was examined via uptake of radioactive carbonate in short (2 hour) incubations using the methods of Mackey et al. (1995) and Hanson et al. (2007). Briefly, water samples from 10 m depth, the DCM, and 120 m depth were collected pre-dawn at stations on the 400 m and 3000 m depth contours on transect 6, and the 100 m, 400 m, 800 m, and 3000 m depth contours on transect 2. Water from each depth was inoculated with a known concentration of ^{14}C stock solution then incubated in triplicate in a photosynthetron in the Radvan for 2 hours at 7 different irradiances ranging from 10 to 1000 µmol m^{-2} sec^{-1}. Incubations were terminated via acidification, and samples were vented for >24 hours. Sample activity was measured using the onboard liquid scintillation counter in the Radvan. Post-voyage processing will provide values for maximum photosynthetic rates (P_{max}), the light saturation parameter (E_k) and the photosynthetic efficiencies (α), which will be used to model daily integral primary productivity for the different regions of the GAB.

Primary productivity and phytoplankton physiology was also examined using Fast Repetition Rate fluorometry (Figure 7, Kolber *et al*., 1998). This technique is a specific type of active chlorophyll-*a* fluorometry and so-called because it delivers a series of closely-spaced excitation flashes to close all PSII reaction centres, stimulating a fluorescence yield transient; this closure occurs within a time frame of <200 µs, which is fast enough to reduce the first acceptor molecule within the photosynthetic electron transport chain (QA). A number of photophysiological parameters associated with PSII can be subsequently derived from this fluorescence transient by fitting a biophysical model describing photochemistry. In turn, these parameters can then be used to estimate the rate at which electrons flow from PSII through to NADPH during photosynthesis, i.e. the linear photosynthetic electron transport rate (ETR). Since the generation of electrons at PSII results from splitting of water to produce O_2, FRRf-based photochemistry rates (ETR) are considered to be indicative of gross O2 evolution.

In-situ profiling to assess phytoplankton physiology

A FastOCEAN MKIII FRRf (Serial number: 12-8679-007, Chelsea Technologies Group, London, UK) was programmed to deliver single turnover (ST) saturation of PSII by the application of 100 flashlets (1µs pulse with a 2µs interval between flashes), followed by a relaxation phase of 40 flashlets (1µs pulse with a 50 µs interval between flashes). A total of 100 sequences were performed per acquisition. The FRRf was mounted to a custom-designed frame housing (with associated battery pack) for deployment *in-situ*. The FRRf was programmed to measure continuously (automatic gain correction was enabled to compensate for increased fluorescence encountered within the sub-surface chlorophyll maximum). The FRRf was deployed via cable winch to a depth of 120m at a rate of descent of 3 metres per minute to ensure high-resolution sampling of the water column (the fluorometer was then recovered at a rate of 60 metres per minute). Data was corrected for baseline fluorescence (from filtered surface water) and downloaded using Fastpro v.1.55.2 software.

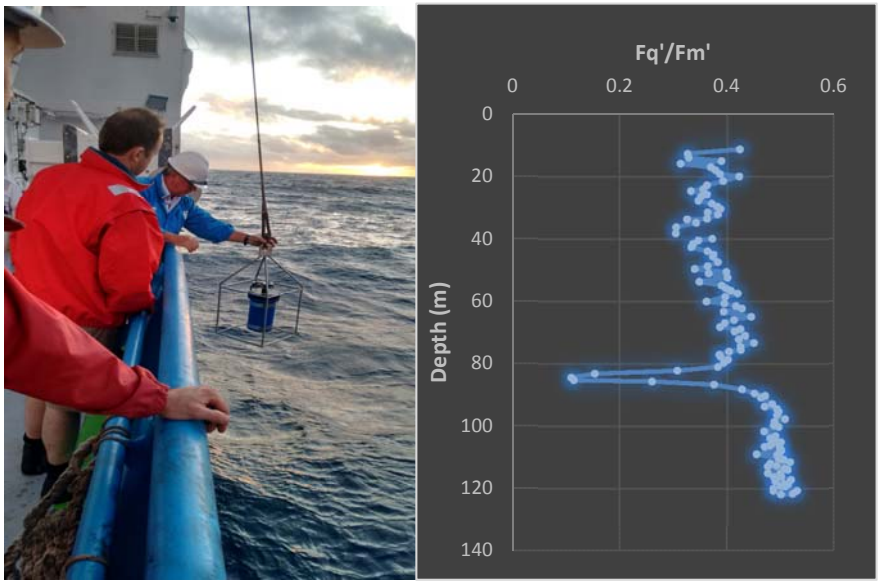


Figure 7. Dr Paul Van Ruth of SARDI overseeing the in-situ deployment of the Fast Repetition Rate Fluorometer (FRRf), and an example of depth profile data showing phytoplankton effective photochemical efficiency (Fq'/Fm' – dimensionless). A visible decline in photochemical efficiency can be observed for the DCM (~85m).

Photosynthetic Light-Response (PE) Curves (FRRf)

Actinic light (from the white LED array in the FRRf optical head) was applied in 15 steps of sequentially-increasing intensities (0, 10, 28, 47, 66, 85, 123, 160, 251, 330, 402, 550, 756, 905 and 1208µmol photons m^{-2} s^{-1}). Light intensity at each step was delivered for 4 minute periods to ensure fluorescence steady-state conditions were achieved. Photosynthesis-Irradiance (PE) curves were fitted to the hyperbolic tangent function described by Platt *et al*. (1980). Regression analysis of the model fit will yield maximum photosynthesis (ETR_{max}), the light saturation parameter (E_k) and the light utilisation efficiency (α), which will be used to model daily integral primary productivity for the different regions of the GAB.

Secondary productivity was examined via grazing experiments conducted on the incubation platform using water from the DCM.

Objective 4

The Profiling Lagrangian Acoustic Optical System (PLAOS) was designed and built at CSIRO and was deployed 14 times during the voyage between depths of 400 m to 1000 m. The PLAOS was lightly tethered to the vessel and descended to depth at a set rate of ~0.4 m s^{-1} recording 38 kHz, 120 kHz and 333 kHz acoustics at 10 Hz, vertical video, vertical still photography (at 0.5 Hz) and oblique photos at 0.5 Hz (Figure 8). The system also recorded CTD data with all acoustic, optical, motion and CTD data recorded internally. The acoustic data provides an estimate of the number and composition of biota through the water column. Vertical imagery data is used to record the biota and to assist in cross checking the acoustic data. Oblique imagery data provides a uniform lighted scene of predominantly gelatinous material that can be used to provide a census and depth

distribution of biota. Of note was the marked avoidance of biota to the system observed with the 18 kHz echosounder at depth whilst minimal avoidance was observed on the 38 kHz system.

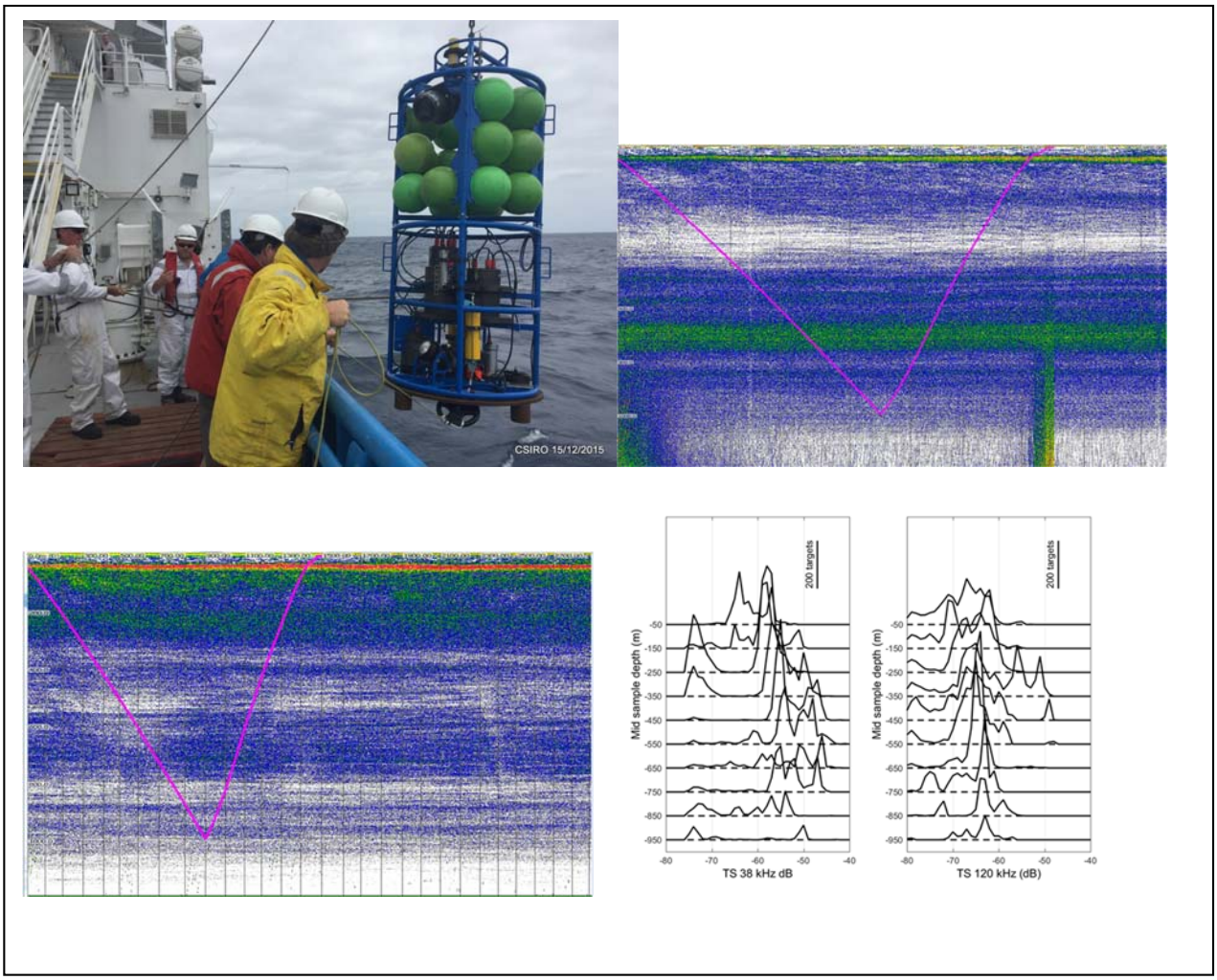


Figure 8 a. An image of the PLAOS being deployed and b. a 38 kHz and c. 18 kHz echogram with the PLAOS profile overlaid, d. the number of single targets of strength in dB recorded per 100 m depth bin at 38 kHz and 120 kHz.

The oblique cameras were used to image biota and in particular the gelatinous community at 0.5 Hz with approximately 2000 images collected during a 1000 m cast. Images of siphonophores were obtained throughout the water column with some very spectacular feeding displays (Figure 9).

Figure 9. Images of siphonophores from the oblique camera.

Objective 5 and 6 (Underway acoustics)

The Investigator had six Simrad EK60 bio-acoustic single beam echosounders recording continuously throughout the voyage at 18, 38, 70, 120, 200 and 333 kHz. These were calibrated for standard IMOS settings prior to IN2015_C02 during the October 2015 sea trials. The EK60 transducers are mounted on the port side keel which was lowered throughout the sampling, which, combined with sustained good weather ensured that the acoustic data was of the highest quality. Additionally water column acoustics from a 12 kHz uncalibrated Simrad ES600 hydrographic echosounder with gondola mounted transducer was recorded as part of the bio-acoustic suite of data. The bio-acoustic echosounders used standard IMOS open-ocean settings except for brief periods (~10 minutes) where a short logging range and pulse durations were set to obtain high resolution data in the top 250 metres of the water column (Table 2).

Table 2. Settings for Simrad EK60 bioacoustic data acquisition

Standard IMOS open-ocean settings							
Logging range: 0-1500 m default, adjusted to shorter range when in shallower water.							
Frequency (kHz)	12	18	38	70	120	200	333
Power (W)	1000	2000	2000	750	250	105	40
Pulse duration (ms)	1.024	2.048	2.048	2.048	1.024	1.024	1.024
High resolution fast pinging							
Logging range: 0-250 m							
Frequency (kHz)	12	18	38	70	120	200	333
Power (W)	1000	2000	2000	750	250	105	40
Pulse duration (ms)	1.024	0.512	0.256	0.256	0.256	1.024	1.024

The bioacoustic system provided continuous echogram data along each of the six sampling transects T1-T6 (Figure 10). The transect data were processed using IMOS protocols. This included removal of seafloor signal, transmit pulse and artefacts in the data including occasions of interference from other acoustic systems (hydrographic multibeam, adcp) or second echo interference at the lower frequencies. The multifrequency information can infer morphology of the dominant biological scatter, Figure 10 shows a simple multifrequency data product where 18 kHz data has been subtracted from 38 kHz data to map the difference in these two frequencies along transect 6.

Bioacoustics information provided continuous observation of the water column echo-structure which will provide context to the various deployed systems including MIDOC (Figure 6), EZ net and pLAOS operations. Additionally acoustic data will be mapped to co-variate environmental measurements including temperature, salinity and chlorophyll.

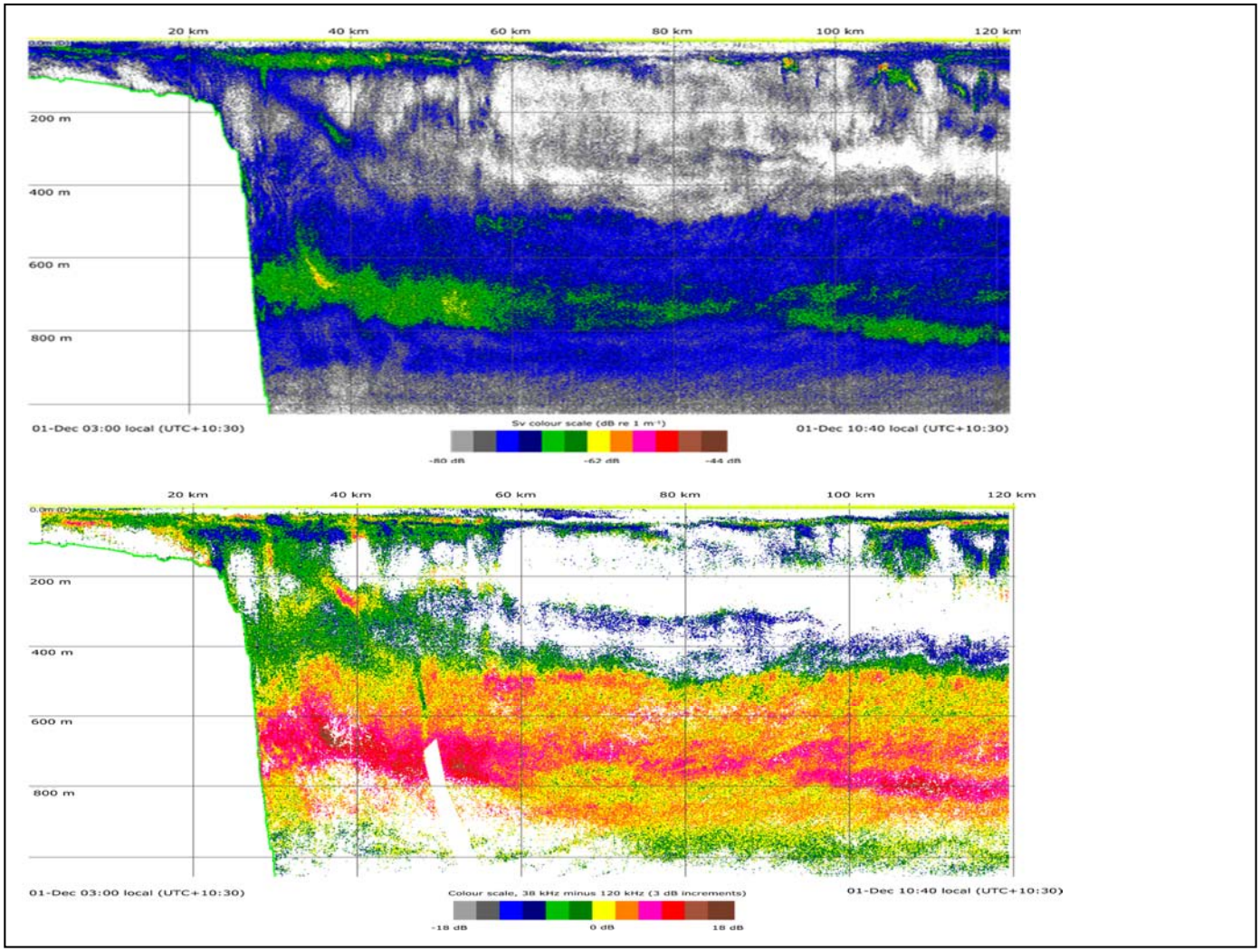


Figure 10 Acoustic volume backscatter (dB) for transect 6 and dB difference between the 38 kHz and 18 kHz frequencies highlighting different biota.

Objective 7. Beam trawl collections of benthic megafauna

Thirty beam trawls were successfully completed. Collectively, the collections produced a rich and diverse catch, and provide the first systematic characterisation of the GAB deep benthic fauna. All catches were sorted to the lowest taxonomic level on board, and all species-level taxa were photographed individually (e.g.Figure 11). The very great majority of the total collection was retained and suitably preserved (mostly in ethanol) for museum curation.

Figure 11 Example images of epifaunal decapods: top – Glyphocrangonidae sp1 (armoured-shrimp); bottom – Metanephrops velutinus (scampi)

Knowledge of the benthic invertebrate epifauna of the GAB area is poor. While there has been considerable work done in the inshore areas, intertidal and diving depths, virtually no sampling has been done in deeper water. Our new information indicates that the GAB is an area of very high biodiversity; there appears to be both a strong subtropical influence from the west from the Leeuwin Current, and a cooler temperate influence from the east.

Objective 8 and 9 Multicore sampling

The instrumented coring platform (the ICP profiler), designed and built by CSIRO for the GABRP surveys (Figure 12) was used to collect 6 sediment cores, environmental sensor data, and a water sample from single deployments. Fibre-optic telemetry enabled real-time manipulation of the corer on the seabed using imagery from platform-mounted cameras. Following the 2013 survey, modifications were made to prevent premature release of the gates closing the bottom the coring tubes on retrieval, and to allow re-arming of the corer without retrieval if required. These modifications reduced the frequency of failed deployments. Despite sediment coring being difficult at most stations due to the composition of sub-surface sediments (typically very dense clays), good samples were taken at all but one site (Figure 13). A Smith-MacIntyre grab was also used at 4 stations to obtain additional sediment samples to support an associated PhD project on phylogeography of deep-sea ampipods and isopods (Figure 14).

Cores of sediment were collected to provide samples to measure macrofaunal and meiofaunal composition and abundance, presence and composition of microbial communities including hydrocarbon degrading microbes, carbonate isotopes, grain size, and total carbon/ total organic carbon/ total inorganic carbon/ total solids. Standard CSIRO and SARDI protocols were applied to the sampling process. Sediment coring was difficult at most stations due to the composition of sub-surface sediments. These were typically very dense clays.

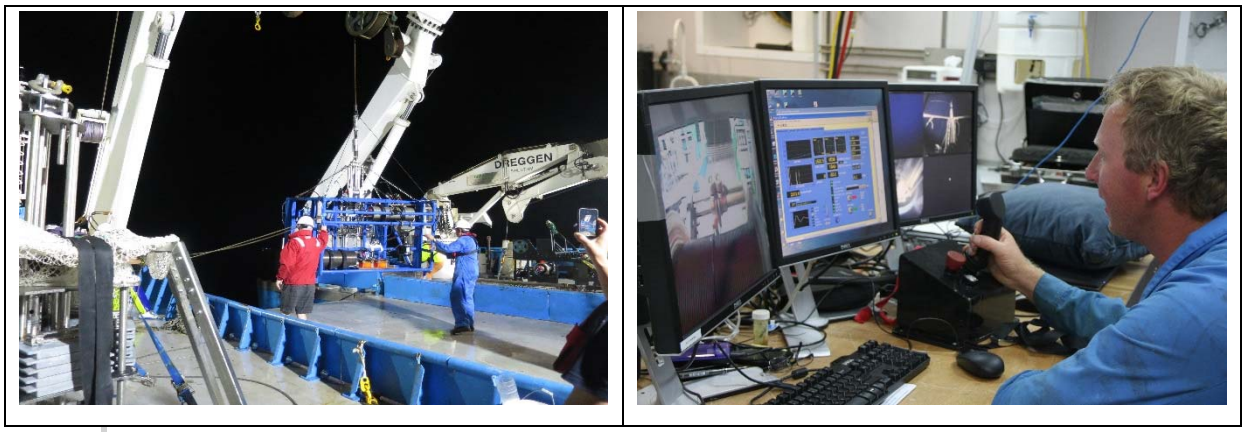


Figure 12: The instrumented coring platform (ICP); winch control and operations station.

Figure 13: Sediment cores being removed from the ICP, and as recorded photographically in the core extruder.

Figure 14: Deploying the Smith-McIntyre grab; sediment sample being elutriated.

Summary

This was a chartered voyage for the Great Australian Bight Research Program (GABRP) servicing the needs of two Theme areas (Pelagic and Benthic Ecology) within a research program that aims to characterise key elements of marine ecosystems across the GAB, including in the deep central GAB area where oil and gas exploration is planned in the next few years.

Unreservedly the voyage was an outstanding success in terms of the diversity of the science undertaken, sampling ocean physics and nutrients, pelagic microbes to nekton, and producing a benthic inventory of species to 3000 m. The extensive array of MNF and user supplied equipment that was used performed well, from the microstructure probes and fast repetition rate

fluorometers to the complex profiling lagrangian acoustic optical system and integrated coring platform sampling to 3000 m. A particular area of uncertainty prior to the voyage was the ability of the vessel to carry out twin door trawling. Thanks to the sustained efforts of the crew, MNF and science party this was achieved and is to be commended, with some excellent samples retained in good condition. Initial science results have been enlightening with higher production and biomass observed offshore and in the central GAB than previously reported. Our detailed sampling of the nutrients and biota will enable us to elucidate the mechanisms responsible for this production and biomass. Benthic assemblages were clearly depth stratified shallower than 1000 m, although 1500-3000 m assemblages are more homogeneous.

It is expected that uptake of data collected on this voyage will accrue over the long term through a better understanding of benthic species diversity, pelagic production and biomass. This data and derived knowledge will be used for input into ecosystem models and to identify needs of future monitoring programs for ecosystem effects of potential oil and gas exploitation.

As a result of this voyage:

1. We will be able to quantify and characterise differences in the biomass and physiological mechanisms driving pelagic production between the eastern and previously unsampled central offshore waters of the GAB (200 – 3000 m).
2. We will be able to characterize and quantify community structure of deep ocean (200-3000 m depth) benthic fauna (invertebrates and fishes) in the previously unsampled central GAB.

We the PI's thank the ships' crew, MNF and shipboard science teams on this new vessel for ensuring that the sustained deployment and retrieval of diverse deep-water benthic and pelagic sampling equipment was a success.

Voyage Track

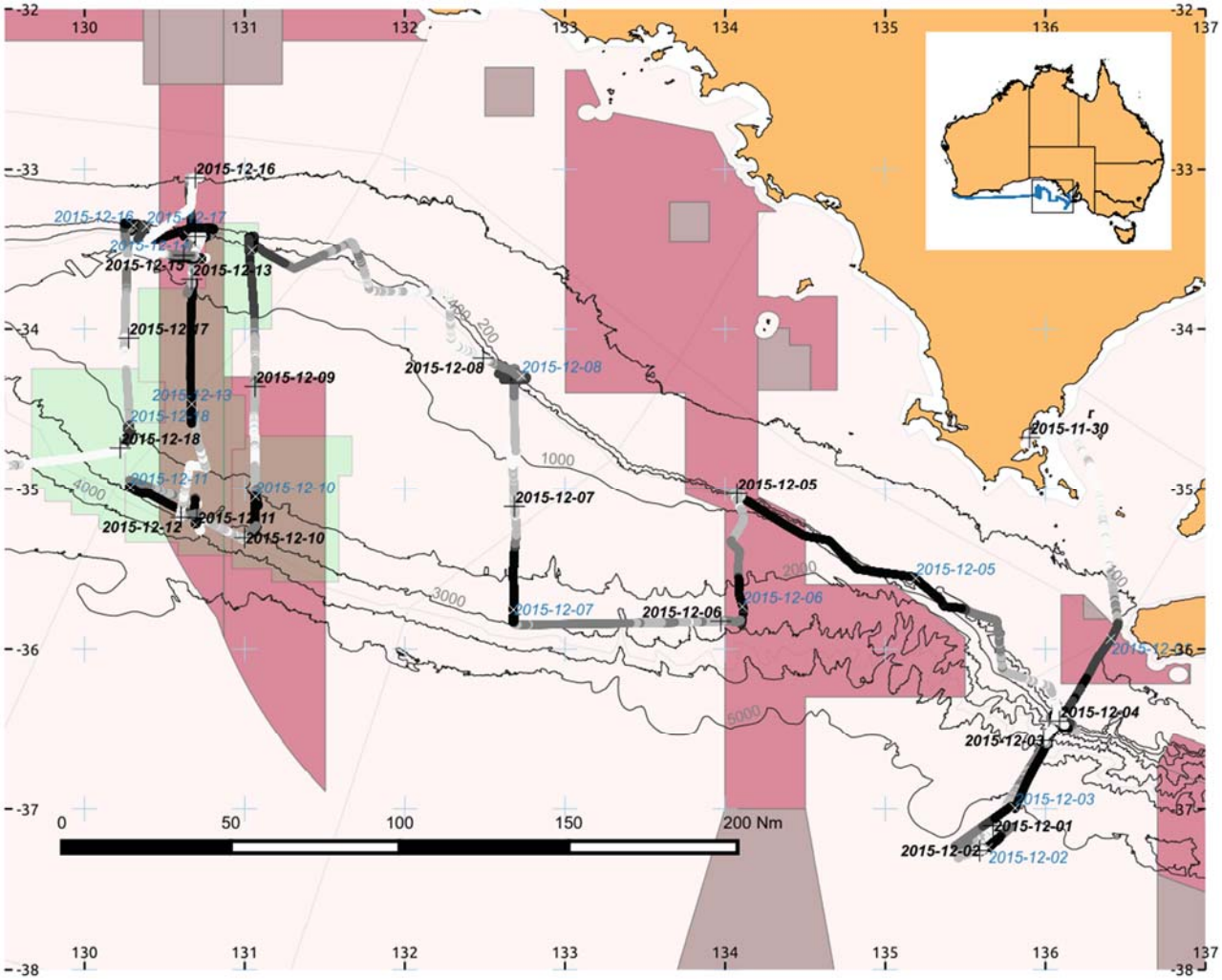
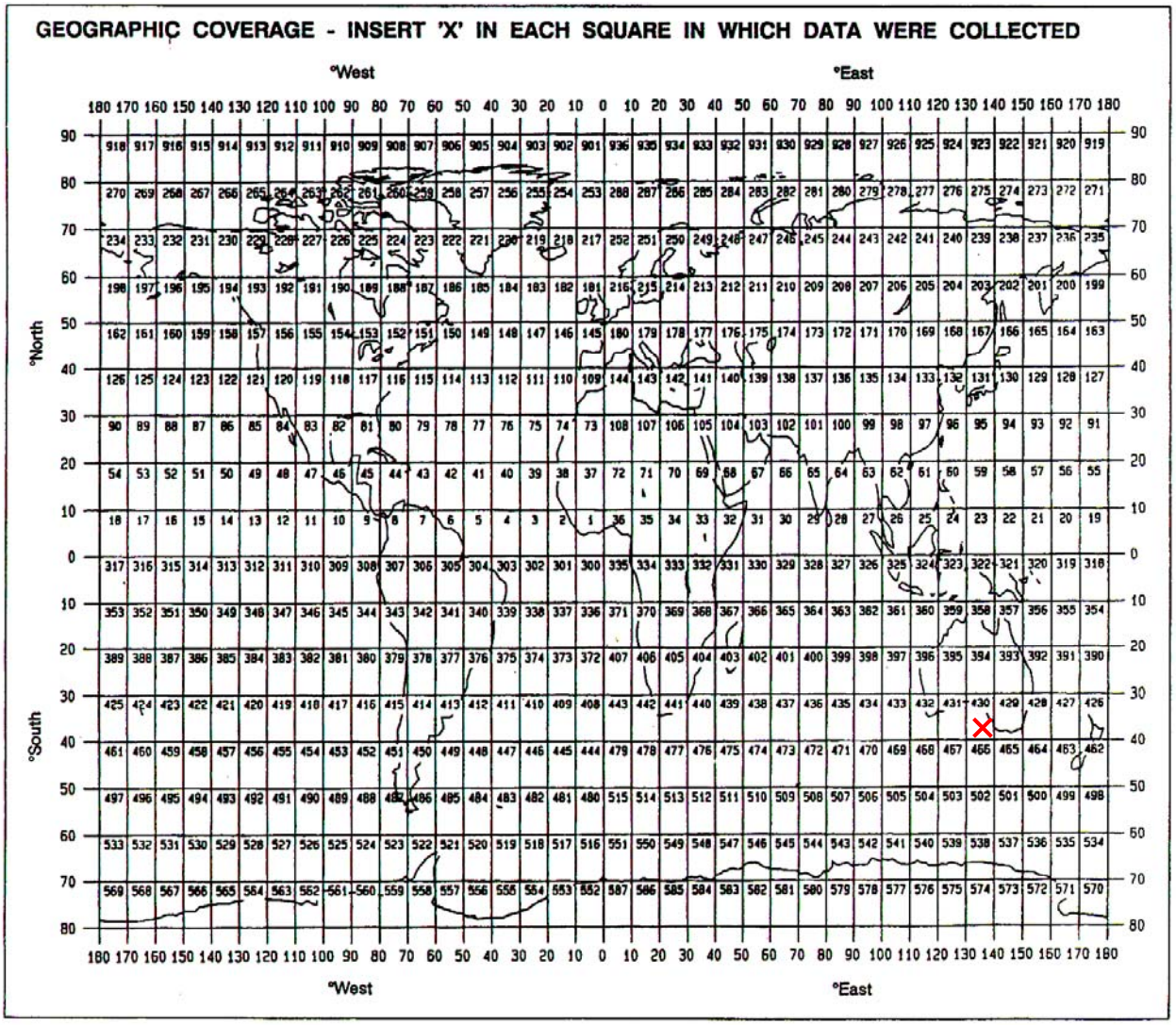


Figure 15. Voyage track with the underway par sensor added showing night (black) and day (white to grey). Date at midnight for UTC (black) and local SA time (blue UTC +9.5 hours)

Marsden Squares



Moorings, bottom mounted gear and drifting systems

Item No	PI See page above	APPROXIMATE POSITION						DATA TYPE enter code(s) from list on last page	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
									Please continue on separate sheet if necessary

Summary of Measurements and samples taken

Item No.	PI	NO	UNITS	DATA TYPE	DESCRIPTION
BEAMT	Williams	32	Stations	B18,B19, B20, B21	30 beam trawl samples was collected successfully (1 sample per site at 200, 400, 1000, 1500, 2000, 3000 m depths on each of 5 longitudinally-based transects), and all samples were fully processed on board. Large collections of well-conditioned specimens were retained and preserved for long-term curation in museum collections. Selected biological tissue sampling was undertaken for archival purposes, and to contribute to the barcoding objective in Project 3.2. Sponge tissue samples were also retained for microbiomic and secondary metabolite analysis as part of a side-project.
CFISH	Kloser	9	Events	B11, B14	Rod and line fishing was oportunistically done to catch squid and tuna for isotope measurements.
CPR	Kloser	3	Tows	B09	The continuous plankton recorder (CPR) was towed on 4 major transects to collect zooplankton for the IMOS SOOP CPR program.
CTD	Van Ruth	33	Stations	H10 H17	The CTD was deployed at each station on pelagic transects, twice on 24 hour stations. It was also deployed at stations on the 400m and 3000m depth contours on the benthic transects. Deployments were to ~20 m from bottom depth on stations <800 m depth and to 800 m on all other stations. Data collected included temperature, conductivity, fluorescence, irradiance (PAR), ADCP, and dissolved oxygen.
NISKIN	Van Ruth	21	Stations	H09, B01, BO2, B07, B08, B09, B71, H21, H22, H24, H25, H26, H32, H76, H90	Niskin bottle samples were collected with the rosette sampler at 16 locations during 21 sampling events. On the two main pelagic transects (T2, T6), samples were collected at stations on the 100m, 400m, 800m, and 3000m depth contours. There were five stations that were sampled twice over 24 hours (T2: 400m, 800m, 3000m; T6: 400m, 3000m). Samples were also collected at stations on the 400m and 3000m depth contours on the benthic transects. Samples from at least three depths (including 10m, the depth of the deep chlorophyll maximum (DCM), and 120m. Max depth = 800 m) were sub-sampled for DNA, RNA and DMSP analysis, virus/bacteria, picoplankton, and phytoplankton abundance and community composition, size fractionated pigments (>/< 5 µm) to be analysed via HPLC, and POC and PON for stable isotope food web studies. Sub-samples were collected from the three depths mentioned above (10m, DCM, 120m) for

					assessments of microbial and planktonic productivity. Hydrochemistry samples (macronutrients, dissolved oxygen, salinity) were collected at a number of depths at all stations mentioned above, and an additional 4 stations on each of the pelagic transects (T2, T6).
EZ	Kloser	13	Stations	B09 H10	The MNF EZ net is a 5-net opening and-closing system that is designed to sample meso-zooplankton at user defined depth intervals. The system is controlled via an optic fibre cable connection to the operation room. It hosts a CTDO, laser optical plankton counter, 2 x flowmeters, lights, and video and is fitted with 5 x 335 micron mesh nests that are dropped on demand. Nets typically sampled five discrete depth intervals during the upcast of the deployment, in waters greater than 800m depth the nets sampled 600-400m, 400-300m, 300-200m, 200m-100m, 100m-0m, in a 50min period. Biological samples were fractioned into material retained on a 4000µm, 1000µm and 300µm sieves. Each fraction was then split for Zooscan and stable isotope analysis. Zooscan splits were frozen in individual plastic bags labelled and aggregated into operation bags. Isotope samples were frozen in glass jars and labeled.
FRRF	Van Ruth	8	Stations	B01 B02	A Chelsea MKIII Fastocean Fast Repetition Rate Fluorometer (FRRf) was used to collect vertical profiles of phytoplankton photophysiological parameters to get an understanding of in-situ changes, with depth in the water column, in the efficiency of the conversion of light energy to carbon. The fluorometer was deployed to 150m at 3m per minute, collecting information on fluorescence, and the rate and efficiency of photosynthesis. Data will be examined in the context of variations in phytoplankton size and community composition, as well as physical (T, S, irradiance) and chemical (macronutrients) parameters, to provide insight into the dynamics of, and drivers of variation in, fine scale rates of primary productivity in the water column.
ICP	Tanner	16	Stations	B16, B18, B20, B21, G04, G08	An instrumented coring platform (ICP – previously known as the BOAGS profiler) designed and built by CSIRO was used to sample sediments; it incorporates a KC6 corer provided by KC of Denmark. The platform was used to collect 6 sediment cores and environmental data. Fibre-optic telemetry enabled real-time manipulation of the corer on the seabed using imagery from platform-mounted cameras.
ISK	Kloser	3	Tows	B09, B21, B14	An Isaacs-Kidd Midwater Trawl (IKMT) is a small midwater non-closing trawl with a single mesh codend that integrated catches over the full range of depth sampled during a trawl. This net was used to trial the

					effectiveness of a light-weight, easily deployable system for calibrating bioacoustics. The Simrad ITI net depth and headline height beacons were fixed to the IKMT. Three deployments were made with this net and catches were very small compared to those achieved with the IYGPT in all cases. IKMT sampling was discontinued in preference for the IYGPT
MIDOC	Kloser	12	Stations	B09, B21, B14 H10	The primary method of micronekton sampling was trawling of the International Young Gadoid Pelagic Trawl (IYGPT) with the MIDOC multiple opening-closing codend device attached. The IYGPT was trawled with trawl doors attached to the net wings that were deployed using the dual winches. Net mesh size of the IYGPT ranged from 200 mm (knot-to-knot stretched mesh) in the wings and fore sections of the net, decreasing to 10 mm at the rear of the net where it attaches to the MIDOC codend. The MIDOC codend device comprised 6 nets made from knotless 6mm mesh and the final detachable collecting bag had a mesh size of 335 µm. The MIDOC is fitted with a CTD and light meter that records depth, temperature, conductivity and irradiance throughout the trawl.
pLAOS	Kloser	14	Stations	B28 B90 H10	The Profiling Lagrangian Acoustic Optical System (PLAOS) was designed and built at CSIRO and was deployed 14 times during the voyage between depths of 400 m to 1000 m. The PLAOS was lightly tethered to the vessel and descended to depth at a set rate of ~0.3 m s^{-1} recording 38 kHz, 120 kHz and 333 kHz acoustics at 10 Hz, vertical video (at xx Hz), vertical still photography (at 0.5 Hz) and oblique photos at 0.5 Hz. The system also recorded CTD data with all acoustic, optical, motion and CTD data recorded internally. The acoustic data provides an estimate of the number and composition of biota through the water column. Vertical imagery data is used to record the biota and to assist in cross checking the acoustic data. Oblique imagery data provides a uniform lighted scene of predominantly gelatinous material that can be used to provide a census and depth distribution of biota.
PODPD	Tanner	9	Nets	B18, B21	A small 1mm cod-end mesh sampler was added to some of the beam trawls to collect amphipods and isopods for a PhD project on phylogeography.
SMG	Tanner	5	Grabs	B18, B21	A Smith-MacIntyre grab was used at 4 stations to obtain additional sediment samples to support an associated PhD project on phylogeography of deep-sea amphipods and isopods.
SNET	Kloser	117	Tows	B09	Triplicate 1.2m diameter surface net mesozooplankton samples were collected at each pelagic and benthic station by towing a 350 micron mesh net for a 10

					minute duration. This net was normally deployed during beam trawl, MIDOC or EZ net operations, collecting a range of crustaceans, siphonophores, jellyfish and larval fish. At 24 hour production stations on T2 and T6 (400m and 3000m) surface net samples were fractioned into material retained on a 4000µm, 1000µm and 300µm sieves. Each fraction was then split for Zooscan and stable isotope analysis. Zooscan splits were frozen in individual plastic bags and aggregated into operation bags. Isotope samples were frozen in glass jars.
TB	Van Ruth	18	Drops	B02, H90	The Turbulence Microstructure Acquisition Profiler (TurboMAP) is a high-resolution, free-fall microstructure profiler. The instrument measures hydrographic properties of conductivity-temperature-depth, biological properties of chlorophyll a fluorescence and turbulence vertical shear and temperature gradient and provides milli- to centimetre scale resolution of measured properties. TurboMAP was deployed at each pelagic station, with 2 profiles per station. Data will be examined in the context of variations in phytoplankton size and community composition, as well as physical (T, S, irradiance) and chemical (macronutrients) parameters, to provide insight into the dynamics of turbulence, nutrient fluxes and primary productivity in the water column.
VN335	Van Ruth	14	Hauls	B09	The 335 µm mesh bongo net (30 cm net mouth diameter) was deployed to 200 m depth and hauled vertically to the surface at 30 m per minute at each of the pelagic stations, with day and night deployments on the 24 hour stations. A large range of crustaceans and larval fish were collected. For each deployment, the contents of one cod-end were split for assessments of abundance and community composition (fixed with 4% Formalin), and biomass (via ash free dry weight, filtered onto pre-weighed 20 µm mesh filters). Selected specimens from the second cod-end were retained in cryovials and frozen for stable isotope analysis. Night samples were processed for abundance and biomass only.
VNDUA	Van Ruth	22	Hauls	B09	The dual bongo net (30 cm net mouth diameter) comprised a 64 µm mesh net alongside a 150 µm mesh net. The net was deployed twice at each sampling event on pelagic stations, with day and night samples collected at 24 hour stations. For each net, one sample was split for assessments of abundance and community composition (fixed with 4% Formalin), and biomass (via ash free dry weight, filtered onto pre-weighed 20 µm mesh filters). Selected specimens from the second sample were retained in cryovials and frozen for stable

					isotope analysis. Night samples were processed for abundance and biomass only.
Acoustics	Kloser			B28	The Investigator had six Simrad EK60 bio-acoustic single beam echosounders recording continuously throughout the voyage at 18, 38, 70, 120, 200 and 333 kHz. These were calibrated for standard IMOS settings prior to IN2015_C02 during the October 2015 sea trials. The EK60 transducers are mounted on the port side keel which was lowered throughout the sampling, which, combined with sustained good weather ensured that the acoustic data was of the highest quality. Additionally water column acoustics from a 12 kHz uncalibrated Simrad ES600 hydrographic echosounder with gondola mounted transducer was recorded as part of the bio-acoustic suite of data. The bio-acoustic echosounders used standard IMOS open-ocean settings except for brief periods (~10 minutes) where a short logging range and pulse durations were set to obtain high resolution data in the top 250 metres of the water column. The multi-frequency information was used to infer density and composition of the dominant biological scatter.
XBT	Kloser	12	Drops	H13	The expendable bathy thermographs were used at 12 sites along the transects to characterise the temperature in the upper 800 m.

Curation Report

Item No.	DESCRIPTION
1. 1	Macrofauna : registered in South Australian Museum and Museum Victoria collections
2.	Meiofauna : SARDI Aquatic Sciences, South Australia
3.	Megafauna (invertebrates) : registered in South Australian Museum and Museum Victoria collections
4.	Megafauna (fishes) : registered in Australian Fish collection, CSIRO Hobart
5.	Micronekton (MIDOC) : CSIRO Hobart
6.	Zooplankton (vertical nets) : SARDI Aquatic Sciences, South Australia
7.	Zooplankton (surface nets) : CSIRO Hobart
8.	Zooplankton (CPR) : CSIRO Brisbane
9.	Zooplankton (EZ nets) CSIRO Hobart

10.	Virus/Bacteria (Niskin): SARDI Aquatic Sciences, South Australia
11.	Picoplankton (Niskin): SARDI Aquatic Sciences, South Australia
12.	Phytoplankton (Niskin): SARDI Aquatic Sciences, South Australia
13.	DNA (Niskin) : CSIRO rHobart
14.	RNA (Niskin) : University of Technology, Sydney
15.	DMSP (Niskin) : University of Technology, Sydney
16.	Pigments (Niskin) : SARDI Aquatic Sciences, South Australia

Track Chart

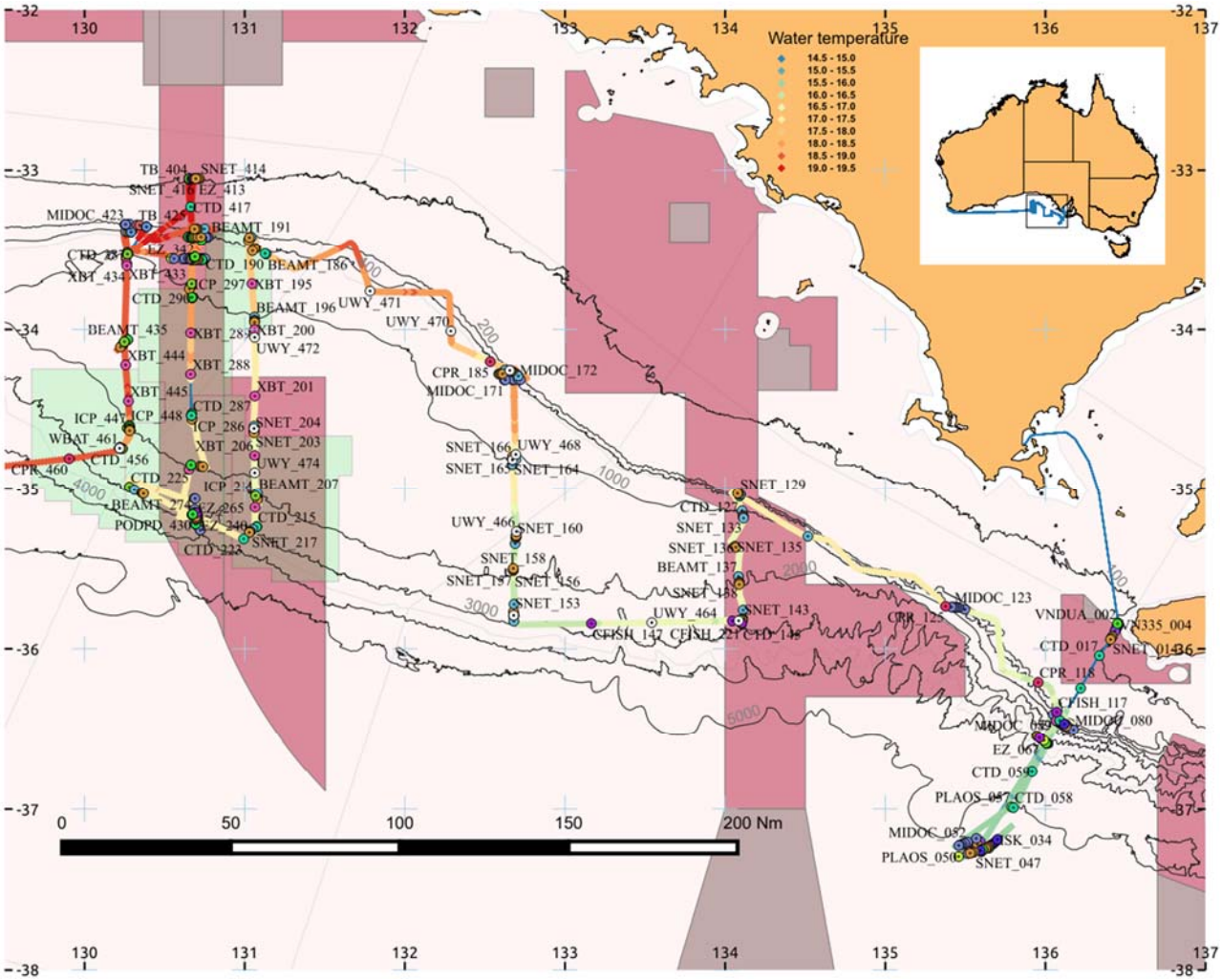


Figure 16 Voyage track showing locations that were sampled during the voyage detailed in Appendix A.

Personnel List

	Name	Organisation	Role
1.	Don McKenzie	CSIRO MNF	Voyage Manager
2.	Phil De Boer	CSIRO MNF	SIT Support (gear technician)
3.	Ian McRobert	CSIRO MNF	SIT Support
4.	Will Ponsonby	CSIRO MNF	SIT Support
5.	Stuart Edwards	CSIRO MNF	GSM Support
6.	Amy Nau	CSIRO MNF	GSM Support
7.	Christine Rees	CSIRO MNF	Hydrochemist
8.	Anoosh Sarraf	CSIRO MNF	DAP Support
9.	Steve Van Graas	CSIRO MNF	DAP Support
10.	Rudy Kloser	CSIRO, O&A	Chief Scientist
11.	Tim Ryan	CSIRO, O&A	Acoustics/optics sampling
12.	Matt Sherlock	CSIRO, O&A	Instrumentation/PLAOS
13.	Ryan Downie	CSIRO, O&A	Biological sampling/Acoustics
14.	Caroline Sutton	CSIRO, O&A	Biological sampling/Data base
15.	Adrian Flynn	Fathom Pacific	Biological sampling
16.	Gordon Keith	CSIRO, O&A	Voyage data integration
17.	Arti Verma	CURTIN UNI	PhD student acoustics PLAOS
18.	Kelly Merrin	Museum Vic	Invertebrates - imagery
19.	Paul van Ruth	SARDI	Production leader/ co PI
20.	Mark Doubell	SARDI	Oceanographer
21.	Nicole Patten	SARDI	Microbial ecologist
22.	Ian Moody	SARDI	Plankton technical
23.	David Hughes	UTS	PhD student plankton
24.	Bonnie Laverock	UTS	Microbial physiology
25.	David Spencer	Griffith	PhD student microstructure
26.	Alan Williams	CSIRO, O&A	Shift leader co-PI

27.	Jason Tanner	SARDI	Benthic ecologist co-PI
28.	Lisa Gouldie	M Vic.	Biological Processing
29.	Mark Green	CSIRO, O&A	Benthic gear and sampling
30.	Karen Gowlett-Holmes	CSIRO, O&A	Biological sampling - imagery
31.	Shirley Sorokin	SARDI	Biological processing (inverts)
32.	Maylene Loo	SARDI	Biological processing (inverts)
33.	Alastair Hirst	Museum Vic	Biological processing (inverts)
34.	Mandy Reid	Aus. Museum	Biological processing (inverts)
35.	Deb Osterhage	CSIRO	Biological sampling imagery
36.	Amelia Lewis	U of Adelaide	PhD student – Crustacea
37.	Jon Pogonoski	CSIRO	Biological processing (fishes)
38.	Al Graham	CSIRO	Biological processing (fishes)
39.	Martin Gomon	Museum Vic	Biological processing (fishes)
40.	Dianne Bray	Museum Vic	Biological processing (fishes)

Marine Crew

Name	Role
John Highton	Master
Gurmukh Nagra	Chief Mate
Adrian Koolhof	Second Mate
Andrew Roebuck	Third Mate
Ian Mortimer	Chief Engineer
Christopher Minness	First Engineer
Michael Sinclair	Second Engineer
Ryan Agnew	Third Engineer
John Curran	Electrical Engineer
Alan Martin	Chief Caterer
Rebecca Lee	Caterer
Alin Muresan	Chief Cook
Kyra Lade	Cook
Graham McDougall	Chief Integrated Rating
Christopher Dorling	Integrated Rating
Jarod Ellis	Integrated Rating
Paul Langford	Integrated Rating
Peter Taylor	Integrated Rating
Dennis Bassi	Integrated Rating
Roderick Langham	Integrated Rating

Acknowledgements

We are grateful to the dedicated staff of the MNF and ASP for ship access prior to the mobilization day, and for excellent support prior to and at sea. The efforts to undertake pelagic trawling were greatly appreciated and thanks go especially to Graham McDougall, Don McKenzie, Phil De Boer and Adrian Flynn for making this happen. Thanks go to the dedicated staff of the CSIRO O&A Science Equipment and Technology program that the Profiling Lagrangian Acoustic Optical System (PLAOS) and the Integrated Corer Platform (ICP). We thank the Great Australian Bight Research Program management committee for their support of this voyage and funding support from BP, CSIRO Wealth from Oceans, and Marine Innovation South Australia (MISA) through the South Australian Research and Development Institute. Finally we thank Steve Lapidge and Jane Ham for their administrative support.

Signature

Your name	Rudy Kloser
Title	Chief Scientist
Signature	
Date:	20/01/16

List of additional figures and documents

Appendix 1	Station positions
Appendix 2	Scientific Highlight
Appendix 3	Science personnel photo
Appendix 4	(title)

Appendix 1 Station positions

Cast Location	Station Num.	Cast_ID	UTC Date	UTC Time	Lng. X_DD	Lat. Y_DD
Transect6-100m	1	CTD_001	2015-11-30	09:02:00	136.4529	-35.8398
Transect6-100m	1	FRRF_016	2015-11-30	09:46:00	136.4491	-35.8433
Transect6-100m	1	VNDUA_002	2015-11-30	10:08:00	136.4497	-35.8450
Transect6-100m	1	VNDUA_003	2015-11-30	10:28:00	136.4510	-35.8465
Transect6-100m	1	VN335_004	2015-11-30	10:41:00	136.4516	-35.8478
Transect6-100m	1	TB_005	2015-11-30	11:14:00	136.4519	-35.8512
Transect6-100m	1	TB_006	2015-11-30	11:21:00	136.4515	-35.8521
Transect6-100m	1	EZ_007	2015-11-30	11:43:00	136.4502	-35.8584
Transect6-100m	1	EZ_008	2015-11-30	11:54:00	136.4456	-35.8666
Transect6-100m	1	EZ_009	2015-11-30	12:03:00	136.4418	-35.8733
Transect6-100m	1	EZ_010	2015-11-30	12:16:00	136.4371	-35.8829
Transect6-100m	1	EZ_011	2015-11-30	12:26:00	136.4337	-35.8905
Transect6-100m	1	SNET_013	2015-11-30	13:09:00	136.4166	-35.9221
Transect6-100m	1	SNET_014	2015-11-30	13:24:00	136.4105	-35.9333
Transect6-100m	1	SNET_015	2015-11-30	13:37:00	136.4053	-35.9424
Transect6-107m	2	CTD_017	2015-11-30	14:57:25	136.3360	-36.0427
Transect6-120m	3	CTD_018	2015-11-30	16:46:39	136.2188	-36.2463
Transect6-5000m	8	EZ_019	2015-12-01	01:21:00	135.5918	-37.2038
Transect6-5000m	8	SNET_024	2015-12-01	01:52:50	135.5738	-37.2212
Transect6-5000m	8	EZ_020	2015-12-01	02:18:00	135.5610	-37.2334
Transect6-5000m	8	EZ_021	2015-12-01	02:41:00	135.5473	-37.2444
Transect6-5000m	8	EZ_022	2015-12-01	03:07:00	135.5339	-37.2553
Transect6-5000m	8	EZ_023	2015-12-01	03:26:00	135.5234	-37.2641
Transect6-5000m	8	MIDOC_025	2015-12-01	04:58:02	135.5138	-37.2789
Transect6-5000m	8	EZ_026	2015-12-01	11:54:03	135.6882	-37.2046
Transect6-5000m	8	EZ_027	2015-12-01	12:14:00	135.6749	-37.2150
Transect6-5000m	8	EZ_028	2015-12-01	12:28:14	135.6648	-37.2219
Transect6-5000m	8	EZ_029	2015-12-01	12:37:00	135.6586	-37.2261
Transect6-5000m	8	EZ_030	2015-12-01	12:47:03	135.6515	-37.2310
Transect6-5000m	8	CTD_031	2015-12-01	13:25:39	135.6405	-37.2412
Transect6-5000m	8	VNDUA_032	2015-12-01	14:31:32	135.6437	-37.2431
Transect6-5000m	8	VN335_033	2015-12-01	14:53:00	135.6465	-37.2437
Transect6-5000m	8	ISK_034	2015-12-01	16:04:00	135.6992	-37.1905
Transect6-5000m	8	SNET_035	2015-12-01	17:45:00	135.6409	-37.2361
Transect6-5000m	8	SNET_036	2015-12-01	17:57:00	135.6335	-37.2416
Transect6-5000m	8	SNET_037	2015-12-01	18:10:00	135.6254	-37.2476
Transect6-5000m	8	CTD_038	2015-12-01	19:01:00	135.5979	-37.2667
Transect6-5000m	8	TB_039	2015-12-01	20:23:45	135.5988	-37.2632
Transect6-5000m	8	TB_040	2015-12-01	20:36:00	135.6051	-37.2570
Transect6-5000m	8	VNDUA_041	2015-12-01	20:53:34	135.6060	-37.2566
Transect6-5000m	8	VNDUA_042	2015-12-01	21:36:00	135.6034	-37.2527
Transect6-5000m	8	VN335_043	2015-12-01	22:00:00	135.6052	-37.2527
Transect6-5000m	8	VNDUA_044	2015-12-01	22:20:39	135.6064	-37.2529
Transect6-5000m	8	FRRF_045	2015-12-01	22:57:08	135.6082	-37.2539
Transect6-5000m	8	ISK_046	2015-12-01	23:55:00	135.5935	-37.2596
Transect6-5000m	8	SNET_047	2015-12-02	00:34:00	135.5540	-37.2692
Transect6-5000m	8	SNET_048	2015-12-02	00:48:00	135.5408	-37.2724

Transect6-5000m	8	SNET_049	2015-12-02	01:00:00	135.5289	-37.2755
Transect6-5000m	8	PLAOS_050	2015-12-02	03:05:00	135.4570	-37.2970
Transect6-5000m	8	MIDOC_051	2015-12-02	05:55:19	135.5670	-37.1840
Transect6-5000m	8	MIDOC_052	2015-12-02	06:55:00	135.5125	-37.2066
Transect6-5000m	8	MIDOC_053	2015-12-02	07:15:00	135.4944	-37.2139
Transect6-5000m	8	MIDOC_054	2015-12-02	07:35:00	135.4770	-37.2206
Transect6-5000m	8	MIDOC_055	2015-12-02	07:55:00	135.4646	-37.2255
Transect6-5000m	8	MIDOC_056	2015-12-02	08:05:00	135.4582	-37.2283
Transect6-5000m	7	PLAOS_057	2015-12-02	11:06:35	135.7877	-36.9881
Transect6-5000m	7	CTD_058	2015-12-02	12:40:30	135.7992	-36.9920
Transect6-5000m	6	CTD_059	2015-12-02	15:20:56	135.9155	-36.7704
Transect6-3000m	5	CTD_060	2015-12-02	17:54:00	136.0150	-36.5960
Transect6-3000m	5	TB_061	2015-12-02	19:00:00	136.0091	-36.5944
Transect6-3000m	5	TB_062	2015-12-02	19:20:00	136.0079	-36.5945
Transect6-3000m	5	VNDUA_063	2015-12-02	19:47:00	136.0049	-36.5941
Transect6-3000m	5	VN335_064	2015-12-02	20:04:43	136.0043	-36.5940
Transect6-3000m	5	FRRF_065	2015-12-02	20:32:00	136.0032	-36.5936
Transect6-3000m	5	EZ_066	2015-12-02	22:10:00	135.9785	-36.5712
Transect6-3000m	5	EZ_067	2015-12-02	22:22:00	135.9705	-36.5652
Transect6-3000m	5	SNET_071	2015-12-02	22:23:00	135.9698	-36.5647
Transit	0	CFISH_220	2015-12-02	22:35:00	135.9618	-36.5586
Transect6-3000m	5	EZ_068	2015-12-02	22:37:00	135.9605	-36.5577
Transect6-3000m	5	SNET_072	2015-12-02	22:40:00	135.9586	-36.5562
Transect6-3000m	5	EZ_069	2015-12-02	22:49:00	135.9526	-36.5516
Transect6-3000m	5	SNET_073	2015-12-02	22:55:00	135.9485	-36.5485
Transect6-3000m	5	EZ_070	2015-12-02	23:00:00	135.9450	-36.5458
Transect6-3000m	5	PLAOS_074	2015-12-03	00:14:00	135.9901	-36.5754
Transect6-400m	4	MIDOC_075	2015-12-03	03:45:00	136.0717	-36.4477
Transect6-400m	4	MIDOC_076	2015-12-03	04:45:00	136.1178	-36.4888
Transect6-400m	4	MIDOC_077	2015-12-03	05:05:00	136.1380	-36.4942
Transect6-400m	4	MIDOC_078	2015-12-03	05:15:00	136.1474	-36.4970
Transect6-400m	4	MIDOC_079	2015-12-03	05:25:00	136.1569	-36.5000
Transect6-400m	4	MIDOC_080	2015-12-03	05:45:00	136.1744	-36.5067
Transect6-400m	4	EZ_081	2015-12-03	07:22:00	136.1286	-36.4726
Transect6-400m	4	SNET_086	2015-12-03	07:40:00	136.1149	-36.4702
Transect6-400m	4	EZ_082	2015-12-03	07:42:00	136.1134	-36.4699
Transect6-400m	4	EZ_083	2015-12-03	07:52:00	136.1057	-36.4685
Transect6-400m	4	SNET_087	2015-12-03	07:54:22	136.1036	-36.4678
Transect6-400m	4	EZ_084	2015-12-03	08:03:00	136.0964	-36.4655
Transect6-400m	4	SNET_088	2015-12-03	08:06:47	136.0933	-36.4645
Transect6-400m	4	EZ_085	2015-12-03	08:14:00	136.0871	-36.4625
Transect6-400m	4	MIDOC_089	2015-12-03	10:40:00	136.0473	-36.4107
Transect6-400m	4	MIDOC_090	2015-12-03	11:40:00	136.0692	-36.4461
Transect6-400m	4	MIDOC_091	2015-12-03	12:00:00	136.0818	-36.4574
Transect6-400m	4	MIDOC_092	2015-12-03	12:10:00	136.0890	-36.4628
Transect6-400m	4	MIDOC_093	2015-12-03	12:20:00	136.0967	-36.4682
Transect6-400m	4	MIDOC_094	2015-12-03	12:30:00	136.1041	-36.4733
Transect6-400m	4	PLAOS_095	2015-12-03	14:03:30	136.0893	-36.4515
Transect6-400m	4	CTD_096	2015-12-03	15:08:34	136.0860	-36.4489
Transect6-400m	4	VNDUA_097	2015-12-03	16:14:34	136.0840	-36.4494
Transect6-400m	4	VN335_098	2015-12-03	16:25:15	136.0834	-36.4492
Transect6-400m	4	EZ_099	2015-12-03	17:03:27	136.0956	-36.4583

Transect6-400m	4	EZ_100	2015-12-03	17:11:05	136.1002	-36.4622
Transect6-400m	4	SNET_104	2015-12-03	17:18:00	136.1044	-36.4652
Transect6-400m	4	EZ_101	2015-12-03	17:21:20	136.1064	-36.4669
Transect6-400m	4	SNET_105	2015-12-03	17:31:00	136.1125	-36.4715
Transect6-400m	4	EZ_102	2015-12-03	17:31:28	136.1128	-36.4717
Transect6-400m	4	EZ_103	2015-12-03	17:41:48	136.1196	-36.4768
Transect6-400m	4	SNET_106	2015-12-03	17:55:00	136.1290	-36.4836
Transect6-400m	4	CTD_107	2015-12-03	18:54:35	136.0835	-36.4484
Transect6-400m	4	TB_108	2015-12-03	19:18:57	136.0824	-36.4469
Transect6-400m	4	TB_109	2015-12-03	19:38:44	136.0733	-36.4486
Transect6-400m	4	VNDUA_110	2015-12-03	19:52:26	136.0675	-36.4491
Transect6-400m	4	VN335_111	2015-12-03	20:13:14	136.0653	-36.4484
Transect6-400m	4	VNDUA_112	2015-12-03	20:19:00	136.0652	-36.4484
Transect6-400m	4	FRRF_113	2015-12-03	21:49:26	136.0949	-36.4545
Transect6-400m	4	PLAOS_114	2015-12-03	23:11:21	136.0904	-36.4517
Transect6-400m	4	CTD_115	2015-12-04	02:08:35	136.0882	-36.4471
Transect6-400m	4	ISK_116	2015-12-04	03:16:00	136.1174	-36.4703
Transit	0	CFISH_117	2015-12-04	05:00:00	136.0701	-36.3954
Transit	1	CPR_118	2015-12-04	06:11:47	135.9538	-36.2093
Transit	0	MIDOC_119	2015-12-04	09:52:00	135.4962	-35.7547
Transit	0	MIDOC_120	2015-12-04	10:27:00	135.4585	-35.7429
Transit	0	MIDOC_121	2015-12-04	10:37:00	135.4463	-35.7427
Transit	0	MIDOC_122	2015-12-04	10:48:00	135.4344	-35.7420
Transit	0	MIDOC_123	2015-12-04	10:58:00	135.4229	-35.7410
Transit	0	MIDOC_124	2015-12-04	11:08:00	135.4116	-35.7399
Transit	0	CPR_125	2015-12-04	11:45:00	135.3754	-35.7353
Transect5-400m	12	BEAMT_126	2015-12-04	16:57:34	134.5160	-35.2987
Transect5-400m	12	CTD_127	2015-12-04	22:08:47	134.0892	-35.0483
Transect5-200m	11	BEAMT_128	2015-12-04	23:18:51	134.0951	-35.0381
Transect5-200m	11	SNET_129	2015-12-04	23:34:00	134.0847	-35.0335
Transect5-200m	11	SNET_130	2015-12-04	23:48:00	134.0767	-35.0299
Transect5-1000m	13	BEAMT_131	2015-12-05	02:22:55	134.1048	-35.1396
Transect5-1000m	13	SNET_132	2015-12-05	03:17:00	134.1110	-35.1701
Transect5-1000m	13	SNET_133	2015-12-05	03:30:00	134.1122	-35.1769
Transect5-1500m	14	BEAMT_134	2015-12-05	04:00:49	134.1137	-35.1859
Transect5-1500m	14	SNET_135	2015-12-05	07:38:00	134.0598	-35.3613
Transect5-1500m	14	SNET_136	2015-12-05	07:54:00	134.0658	-35.3676
Transect5-2000m	15	BEAMT_137	2015-12-05	09:53:00	134.0816	-35.5500
Transect5-2000m	15	SNET_138	2015-12-05	10:53:00	134.0873	-35.5837
Transect5-2000m	15	SNET_139	2015-12-05	11:06:00	134.0869	-35.5905
Transect5-2000m	15	SNET_140	2015-12-05	11:20:00	134.0867	-35.5990
Transect5-3000m	16	BEAMT_141	2015-12-05	13:49:00	134.1113	-35.7592
Transect5-3000m	16	SNET_142	2015-12-05	15:29:00	134.1080	-35.8119
Transect5-3000m	16	SNET_143	2015-12-05	15:41:00	134.1078	-35.8168
Transect5-3000m	16	SNET_144	2015-12-05	15:54:00	134.1073	-35.8217
Transit	0	CFISH_221	2015-12-05	17:15:00	134.1024	-35.8395
Transect5-3000m	16	CTD_145	2015-12-05	18:10:00	134.1022	-35.8443
Transect5-3000m	16	ICP_146	2015-12-05	20:20:00	134.0921	-35.8196
Transit	0	CFISH_222	2015-12-05	23:15:00	134.0434	-35.8265
Transect4-3000m	26	CFISH_147	2015-12-06	03:36:40	133.1632	-35.8428
Transect5-3000m	26	ICP_148	2015-12-06	06:25:33	132.6790	-35.7947
Transect4-3000m	26	CFISH_149	2015-12-06	07:52:24	132.6781	-35.7967

Transect4-3000m	26	CTD_150	2015-12-06	09:27:00	132.6780	-35.7958
Transect4-3000m	26	BEAMT_151	2015-12-06	11:00:00	132.6794	-35.8279
Transect4-3000m	26	SNET_152	2015-12-06	12:27:00	132.6781	-35.7809
Transect4-3000m	26	SNET_153	2015-12-06	12:39:30	132.6779	-35.7753
Transect4-3000m	26	SNET_154	2015-12-06	12:52:30	132.6774	-35.7693
Transect4-2000m	25	BEAMT_155	2015-12-06	14:42:00	132.6805	-35.7217
Transect4-2000m	25	SNET_156	2015-12-06	16:51:00	132.6758	-35.5134
Transect4-2000m	25	SNET_157	2015-12-06	17:04:00	132.6758	-35.5064
Transect4-2000m	25	SNET_158	2015-12-06	17:18:00	132.6757	-35.4992
Transect4-1500m	24	BEAMT_159	2015-12-06	19:54:40	132.6875	-35.3446
Transect4-1500m	24	SNET_160	2015-12-06	21:02:00	132.6920	-35.3081
Transect4-1500m	24	SNET_161	2015-12-06	21:15:00	132.6929	-35.3009
Transect4-1500m	24	SNET_162	2015-12-06	21:28:00	132.6937	-35.2937
Transect4-1000m	23	BEAMT_163	2015-12-07	01:30:00	132.6716	-34.8467
Transect4-1000m	23	SNET_164	2015-12-07	02:16:00	132.6711	-34.8075
Transect4-1000m	23	SNET_165	2015-12-07	02:27:00	132.6710	-34.8016
Transect4-1000m	23	SNET_166	2015-12-07	02:38:00	132.6711	-34.7958
Transect4-1000m	23	BEAMT_167	2015-12-07	05:02:47	132.6918	-34.8147
Transect4-400m	22	MIDOC_168	2015-12-07	10:47:00	132.6189	-34.3157
Transect4-400m	22	MIDOC_169	2015-12-07	11:37:00	132.6703	-34.3155
Transect4-400m	22	MIDOC_170	2015-12-07	11:47:00	132.6825	-34.3151
Transect4-400m	22	MIDOC_171	2015-12-07	11:57:00	132.6265	-34.3161
Transect4-400m	22	MIDOC_172	2015-12-07	12:07:00	132.7078	-34.3145
Transect4-400m	22	MIDOC_173	2015-12-07	12:17:00	132.7205	-34.3142
Transect4-400m	22	BEAMT_174	2015-12-07	14:25:00	132.6230	-34.2550
Transect4-400m	22	CTD_175	2015-12-07	15:53:05	132.5848	-34.2777
Transect4-400m	22	SNET_176	2015-12-07	16:41:00	132.5896	-34.2799
Transect4-400m	22	SNET_177	2015-12-07	16:54:00	132.5996	-34.2790
Transect4-400m	22	SNET_178	2015-12-07	17:07:00	132.6095	-34.2780
Transect4-200m	21	BEAMT_179	2015-12-07	18:00:21	132.6914	-34.2758
Transect4-200m	21	SNET_180	2015-12-07	18:11:56	132.6966	-34.2821
Transect4-200m	21	BEAMT_181	2015-12-07	20:11:26	132.7067	-34.2916
Transect4-200m	21	SNET_182	2015-12-07	21:36:00	132.6688	-34.2623
Transect4-200m	21	SNET_183	2015-12-07	21:49:00	132.6609	-34.2592
Transect4-200m	21	SNET_184	2015-12-07	22:01:00	132.6536	-34.2561
Transit	30	CPR_185	2015-12-08	00:07:00	132.5323	-34.2014
Transect3-400m	32	BEAMT_186	2015-12-08	10:56:10	131.1323	-33.5277
Transect3-400m	32	CTD_190	2015-12-08	10:58:21	131.1259	-33.5240
Transect3-400m	32	SNET_187	2015-12-08	11:44:00	131.0671	-33.4909
Transect3-400m	32	SNET_188	2015-12-08	11:56:00	131.0601	-33.4936
Transect3-400m	32	SNET_189	2015-12-08	13:33:00	131.0478	-33.5065
Transect3-200m	31	BEAMT_191	2015-12-08	14:44:29	131.0407	-33.4179
Transect3-200m	31	SNET_192	2015-12-08	15:26:00	131.0234	-33.4327
Transect3-200m	31	SNET_193	2015-12-08	15:39:00	131.0238	-33.4423
Transect3-200m	31	SNET_194	2015-12-08	15:52:00	131.0279	-33.4203
Transect3-1000m	33	XBT_195	2015-12-08	17:32:00	131.0440	-33.7136
Transect3-1000m	33	BEAMT_196	2015-12-08	18:55:33	131.0601	-33.9228
Transect3-1000m	33	SNET_197	2015-12-08	19:32:00	131.0601	-33.9425
Transect3-1000m	33	SNET_198	2015-12-08	19:44:00	131.0602	-33.9489
Transect3-1000m	33	SNET_199	2015-12-08	19:58:00	131.0600	-33.9554
Transit	30	XBT_200	2015-12-08	21:17:48	131.0601	-34.0008
Transit	30	XBT_201	2015-12-09	00:19:48	131.0622	-34.4172

Transect3-1500m	34	BEAMT_202	2015-12-09	01:32:56	131.0570	-34.6050
Transect3-1500m	34	SNET_203	2015-12-09	02:28:00	131.0569	-34.6349
Transect3-1500m	34	SNET_204	2015-12-09	02:40:00	131.0568	-34.6414
Transect3-1500m	34	SNET_205	2015-12-09	02:50:00	131.0569	-34.6469
Transit	0	XBT_206	2015-12-09	05:03:00	131.0611	-34.7891
Transect3-2000m	35	BEAMT_207	2015-12-09	07:49:57	131.0773	-35.0295
Transect3-2000m	35	SNET_208	2015-12-09	08:48:00	131.0773	-35.0596
Transect3-2000m	35	SNET_209	2015-12-09	09:01:00	131.0774	-35.0650
Transect2-2000m	35	SNET_210	2015-12-09	09:13:00	131.0772	-35.0704
Transect3-2000m	35	ICP_211	2015-12-09	11:33:53	131.0667	-35.0454
Transit	0	XBT_212	2015-12-09	13:56:00	131.0633	-35.1173
Transect3-3000m	36	ICP_213	2015-12-09	15:32:10	131.0743	-35.2397
Transect3-3000m	36	CFISH_214	2015-12-09	18:01:01	131.0721	-35.2404
Transect3-3000m	36	CTD_215	2015-12-09	18:01:54	131.0721	-35.2403
Transect3-3000m	36	BEAMT_216	2015-12-09	20:27:26	131.0486	-35.2551
Transect3-3000m	36	SNET_217	2015-12-09	21:08:00	131.0349	-35.2682
Transect3-3000m	36	SNET_218	2015-12-09	21:20:00	131.0314	-35.2715
Transect3-3000m	36	SNET_219	2015-12-09	21:32:00	131.0275	-35.2752
Transect2-3000m	46	CTD_223	2015-12-10	00:39:37	130.9919	-35.3155
Transect2-3000m	46	ICP_224	2015-12-10	04:10:32	130.6693	-35.1656
Transect1-3000m	56	CTD_225	2015-12-10	10:11:32	130.2783	-34.9887
Transect1-3000m	56	ICP_226	2015-12-10	11:17:50	130.2788	-34.9890
Transect1-3000m	56	BEAMT_227	2015-12-10	14:11:32	130.3098	-35.0055
Transect1-3000m	56	SNET_228	2015-12-10	15:52:00	130.3551	-35.0255
Transect1-3000m	56	SNET_229	2015-12-10	16:05:00	130.3612	-35.0283
Transect1-3000m	56	SNET_230	2015-12-10	16:17:00	130.3668	-35.0304
Transect2-3000m	46	CTD_231	2015-12-10	20:20:57	130.6698	-35.1638
Transect2-3000m	46	TB_232	2015-12-10	21:25:00	130.6737	-35.1627
Transect2-3000m	46	TB_233	2015-12-10	21:37:03	130.6740	-35.1627
Transect2-3000m	46	VNDUA_234	2015-12-10	22:00:00	130.6809	-35.1629
Transect2-3000m	46	VNDUA_235	2015-12-10	22:10:00	130.6810	-35.1629
Transect2-3000m	46	VN335_236	2015-12-10	22:15:56	130.6811	-35.1629
Transect2-3000m	46	FRRF_237	2015-12-10	22:30:00	130.6848	-35.1640
Transect2-3000m	46	EZ_238	2015-12-11	00:20:00	130.7037	-35.1978
Transect2-3000m	46	SNET_243	2015-12-11	00:25:00	130.7045	-35.2018
Transect2-3000m	46	SNET_244	2015-12-11	00:36:00	130.7065	-35.2105
Transect2-3000m	46	EZ_239	2015-12-11	00:47:00	130.7084	-35.2194
Transect2-3000m	46	EZ_240	2015-12-11	00:58:00	130.7104	-35.2287
Transect2-3000m	46	SNET_245	2015-12-11	01:05:00	130.7117	-35.2346
Transect2-3000m	46	EZ_241	2015-12-11	01:10:00	130.7127	-35.2386
Transect2-3000m	46	EZ_242	2015-12-11	01:20:00	130.7147	-35.2469
Transect2-3000m	46	PLAOS_246	2015-12-11	02:30:00	130.7201	-35.2614
Transect2-3000m	46	MIDOC_247	2015-12-11	04:05:00	130.7217	-35.2600
Transect2-3000m	46	MIDOC_248	2015-12-11	05:25:00	130.7074	-35.1865
Transect2-3000m	46	MIDOC_249	2015-12-11	05:45:00	130.7028	-35.1664
Transect2-200m	46	MIDOC_250	2015-12-11	05:55:00	130.7007	-35.1570
Transect2-3000m	46	MIDOC_251	2015-12-11	06:05:00	130.6987	-35.1474
Transect2-3000m	46	MIDOC_252	2015-12-11	06:15:00	130.6966	-35.1380
Transect2-3000m	46	PLAOS_253	2015-12-11	08:19:00	130.6824	-35.0628
Transect2-3000m	46	MIDOC_254	2015-12-11	10:28:00	130.6891	-35.0637
Transect2-3000m	46	MIDOC_255	2015-12-11	11:38:00	130.6862	-35.1306
Transect2-3000m	46	MIDOC_256	2015-12-11	11:58:00	130.6861	-35.1509

Transect2-3000m	46	MIDOC_257	2015-12-11	12:08:00	130.6864	-35.1608
Transect2-3000m	46	MIDOC_258	2015-12-11	12:18:00	130.6870	-35.1708
Transect2-3000m	46	MIDOC_259	2015-12-11	12:28:00	130.6876	-35.1812
Transect2-3000m	46	VNDUA_261	2015-12-11	14:09:00	130.6911	-35.2223
Transect2-3000m	46	CTD_260	2015-12-11	14:21:41	130.6915	-35.2227
Transect2-3000m	46	VNDUA_262	2015-12-11	14:50:00	130.6916	-35.2224
Transect2-3000m	46	VN335_263	2015-12-11	15:20:00	130.6928	-35.2224
Transect2-3000m	46	EZ_264	2015-12-11	16:21:00	130.6950	-35.1950
Transect2-3000m	46	SNET_269	2015-12-11	16:23:00	130.6950	-35.1937
Transect2-3000m	46	SNET_270	2015-12-11	16:34:00	130.6947	-35.1867
Transect2-3000m	46	EZ_265	2015-12-11	16:41:00	130.6944	-35.1821
Transect2-3000m	46	SNET_271	2015-12-11	16:50:00	130.6941	-35.1766
Transect2-3000m	46	EZ_266	2015-12-11	16:51:00	130.6941	-35.1759
Transect2-3000m	46	EZ_267	2015-12-11	17:01:00	130.6938	-35.1695
Transect2-3000m	46	EZ_268	2015-12-11	17:11:00	130.6934	-35.1633
Transect2-3000m	46	PLAOS_272	2015-12-11	18:02:00	130.6930	-35.1530
Transect2-3000m	46	CFISH_273	2015-12-11	18:53:00	130.6989	-35.1533
Transect2-3000m	46	BEAMT_274	2015-12-11	20:28:47	130.6739	-35.1618
Transect2-3000m	46	PODPD_430	2015-12-11	20:28:47	130.6739	-35.1618
Transit	0	XBT_275	2015-12-12	02:22:00	130.6509	-34.8754
Transect2-2000m	45	PODPD_280	2015-12-12	02:41:00	130.6630	-34.8483
Transect2-2000m	45	BEAMT_276	2015-12-12	02:41:09	130.6632	-34.8484
Transect2-2000m	45	SNET_277	2015-12-12	03:52:00	130.7167	-34.8561
Transect2-1000m	45	SNET_278	2015-12-12	04:06:00	130.7277	-34.8577
Transect2-2000m	45	SNET_279	2015-12-12	04:19:00	130.7379	-34.8591
Transect2-1500m	44	BEAMT_281	2015-12-12	08:22:34	130.6686	-34.5268
Transect2-1500m	44	PODPD_282	2015-12-12	08:23:05	130.6686	-34.5271
Transect2-1500m	44	SNET_283	2015-12-12	09:12:00	130.6690	-34.5508
Transect2-1500m	44	SNET_284	2015-12-12	09:25:00	130.6693	-34.5568
Transect2-1500m	44	SNET_285	2015-12-12	09:38:00	130.6695	-34.5635
Transect2-1500m	44	ICP_286	2015-12-12	12:02:43	130.6660	-34.5390
Transect2-1500m	44	CTD_287	2015-12-12	12:03:31	130.6660	-34.5389
Transit	1	XBT_288	2015-12-12	14:30:53	130.6610	-34.2807
Transit	0	XBT_289	2015-12-12	15:56:00	130.6613	-34.0218
Transect2-1000m	43	CTD_290	2015-12-12	17:25:00	130.6711	-33.8030
Transect2-1000m	43	CFISH_291	2015-12-12	17:46:00	130.6702	-33.7976
Transect2-1000m	43	BEAMT_292	2015-12-12	18:14:49	130.6679	-33.7995
Transect2-1000m	43	PODPD_296	2015-12-12	18:15:00	130.6679	-33.7996
Transect2-1000m	43	SNET_293	2015-12-12	20:00:00	130.6596	-33.7330
Transect2-1000m	43	SNET_294	2015-12-12	20:12:00	130.6565	-33.7393
Transect2-1000m	43	SNET_295	2015-12-12	20:25:00	130.6530	-33.7461
Transect2-1000m	43	ICP_297	2015-12-12	22:21:03	130.6677	-33.7140
Transect2-800m	48	CTD_298	2015-12-13	01:08:00	130.6683	-33.5667
Transect2-400m	42	MIDOC_299	2015-12-13	03:51:00	130.7706	-33.4180
Transect2-400m	42	MIDOC_300	2015-12-13	04:41:00	130.7213	-33.4184
Transect2-400m	42	MIDOC_301	2015-12-13	04:51:00	130.7105	-33.4185
Transect2-400m	42	MIDOC_302	2015-12-13	05:01:00	130.6997	-33.4185
Transect2-400m	42	MIDOC_303	2015-12-13	05:11:00	130.6887	-33.4186
Transect2-400m	42	MIDOC_304	2015-12-13	05:21:00	130.6776	-33.4186
Transect2-400m	42	EZ_305	2015-12-13	07:08:00	130.6645	-33.4180
Transect2-400m	42	EZ_306	2015-12-13	07:18:10	130.6721	-33.4177
Transect2-400m	42	EZ_307	2015-12-13	07:28:28	130.6801	-33.4174

Transect2-400m	42	EZ_308	2015-12-13	07:38:00	130.6881	-33.4173
Transect2-400m	42	EZ_309	2015-12-13	07:50:00	130.6989	-33.4173
Transect2-400m	42	PLAOS_310	2015-12-13	08:14:53	130.7033	-33.4167
Transect2-400m	42	SMG_311	2015-12-13	09:47:12	130.7589	-33.4180
Transect2-400m	42	MIDOC_312	2015-12-13	10:40:00	130.7563	-33.4187
Transect2-400m	42	MIDOC_313	2015-12-13	11:30:00	130.7024	-33.4194
Transect2-400m	42	MIDOC_314	2015-12-13	11:40:00	130.6908	-33.4190
Transect2-400m	42	MIDOC_315	2015-12-13	11:50:00	130.6789	-33.4187
Transect2-400m	42	MIDOC_316	2015-12-13	12:00:00	130.6672	-33.4184
Transect2-400m	42	MIDOC_317	2015-12-13	12:10:00	130.6560	-33.4181
Transect2-400m	42	CTD_318	2015-12-13	13:34:55	130.6474	-33.4168
Transect2-400m	42	VNDUA_319	2015-12-13	14:26:00	130.6477	-33.4156
Transect2-400m	42	VN335_320	2015-12-13	14:37:35	130.6476	-33.4156
Transect2-400m	42	EZ_321	2015-12-13	15:08:00	130.6610	-33.4168
Transect2-400m	42	SNET_326	2015-12-13	15:16:00	130.6678	-33.4171
Transect2-400m	42	SNET_327	2015-12-13	15:30:00	130.6793	-33.4174
Transect2-400m	42	EZ_322	2015-12-13	15:36:00	130.6845	-33.4177
Transect2-400m	42	SNET_328	2015-12-13	15:41:00	130.6889	-33.4179
Transect2-400m	42	EZ_323	2015-12-13	15:46:00	130.6933	-33.4182
Transect2-400m	42	EZ_324	2015-12-13	15:59:00	130.7047	-33.4185
Transect2-400m	42	EZ_325	2015-12-13	16:04:00	130.7093	-33.4184
Transect2-400m	42	PLAOS_329	2015-12-13	16:49:00	130.7281	-33.4359
Transect2-400m	42	BEAMT_330	2015-12-13	17:40:00	130.7274	-33.4378
Transect2-400m	42	PODPD_331	2015-12-13	17:40:00	130.7274	-33.4378
Transect2-400m	42	CTD_332	2015-12-13	19:44:40	130.6708	-33.4200
Transect2-400m	42	TB_333	2015-12-13	21:04:40	130.6709	-33.4229
Transect2-400m	42	TB_334	2015-12-13	21:46:00	130.6713	-33.4227
Transect2-400m	42	VNDUA_335	2015-12-13	22:02:21	130.6738	-33.4212
Transect2-400m	42	VNDUA_336	2015-12-13	22:02:45	130.6739	-33.4211
Transect2-400m	42	VN335_337	2015-12-13	22:03:18	130.6740	-33.4211
Transect2-400m	42	FRRF_338	2015-12-13	23:00:00	130.6826	-33.4175
Transect2-400m	42	SNET_339	2015-12-14	00:04:00	130.6951	-33.4176
Transect2-400m	42	SNET_340	2015-12-14	00:16:00	130.7075	-33.4173
Transect2-400m	42	SNET_341	2015-12-14	00:39:00	130.7249	-33.4162
Transect2-800m	48	EZ_342	2015-12-14	02:53:00	130.6914	-33.5566
Transect2-800m	48	SNET_347	2015-12-14	02:55:00	130.6931	-33.5566
Transect2-800m	48	SNET_348	2015-12-14	03:09:00	130.7049	-33.5566
Transect2-800m	48	EZ_343	2015-12-14	03:11:00	130.7066	-33.5566
Transect2-800m	48	SNET_349	2015-12-14	03:21:00	130.7154	-33.5567
Transect2-800m	48	EZ_344	2015-12-14	03:25:00	130.7191	-33.5566
Transect2-800m	48	EZ_345	2015-12-14	03:37:00	130.7298	-33.5565
Transect2-800m	48	EZ_346	2015-12-14	03:47:00	130.7387	-33.5564
Transect2-800m	48	MIDOC_350	2015-12-14	04:25:00	130.7520	-33.5573
Transect2-800m	48	MIDOC_351	2015-12-14	05:35:00	130.6688	-33.5577
Transect2-800m	48	MIDOC_352	2015-12-14	05:55:00	130.6437	-33.5578
Transect2-800m	48	MIDOC_353	2015-12-14	06:05:00	130.6311	-33.5579
Transect2-800m	48	MIDOC_354	2015-12-14	06:15:00	130.6190	-33.5580
Transect2-800m	48	MIDOC_355	2015-12-14	06:25:00	130.6073	-33.5582
Transect2-800m	48	PLAOS_356	2015-12-14	08:20:11	130.5400	-33.5554
Transect2-800m	48	MIDOC_357	2015-12-14	10:28:00	130.5570	-33.5575
Transect2-800m	48	MIDOC_358	2015-12-14	11:28:00	130.6237	-33.5557
Transect2-800m	48	MIDOC_359	2015-12-14	11:48:00	130.6476	-33.5562

Transect2-800m	48	MIDOC_360	2015-12-14	11:58:00	130.6596	-33.5561
Transect2-800m	48	MIDOC_361	2015-12-14	12:08:00	130.6717	-33.5556
Transect2-800m	48	MIDOC_362	2015-12-14	12:18:00	130.6837	-33.5555
Transect2-800m	48	CTD_363	2015-12-14	13:29:57	130.7296	-33.5651
Transect2-800m	48	VNDUA_364	2015-12-14	14:32:39	130.7313	-33.5643
Transect2-800m	48	VN335_365	2015-12-14	14:51:05	130.7322	-33.5639
Transect2-800m	48	EZ_366	2015-12-14	15:36:00	130.7076	-33.5636
Transect2-800m	48	SNET_371	2015-12-14	15:36:00	130.7076	-33.5636
Transect2-800m	48	SNET_372	2015-12-14	15:50:00	130.6963	-33.5633
Transect2-800m	48	EZ_367	2015-12-14	15:58:00	130.6898	-33.5633
Transect2-800m	48	SNET_373	2015-12-14	16:03:00	130.6855	-33.5634
Transect2-800m	48	EZ_368	2015-12-14	16:10:00	130.6795	-33.5634
Transect2-800m	48	EZ_369	2015-12-14	16:21:00	130.6702	-33.5635
Transect2-800m	48	EZ_370	2015-12-14	16:31:00	130.6618	-33.5635
Transect2-800m	48	PLAOS_374	2015-12-14	17:15:00	130.6698	-33.5555
Transect2-800m	48	CTD_375	2015-12-14	19:17:00	130.6798	-33.5512
Transect2-800m	48	TB_376	2015-12-14	20:50:00	130.6864	-33.5475
Transect2-800m	48	TB_377	2015-12-14	21:10:22	130.6866	-33.5473
Transect2-800m	48	VNDUA_378	2015-12-14	21:45:00	130.6871	-33.5458
Transect2-800m	48	VNDUA_379	2015-12-14	22:10:00	130.6873	-33.5456
Transect2-800m	48	VN335_380	2015-12-14	22:30:00	130.6874	-33.5455
Transect2-800m	48	FRRF_381	2015-12-14	22:45:00	130.6876	-33.5445
Transect1-1000m	53	BEAMT_382	2015-12-15	02:05:00	130.2647	-33.5206
Transect1-1000m	53	PODPD_386	2015-12-15	02:05:00	130.2654	-33.5179
Transect1-1000m	53	SNET_383	2015-12-15	02:32:00	130.2614	-33.5325
Transect1-1000m	53	SNET_384	2015-12-15	02:50:00	130.2586	-33.5422
Transect1-1000m	53	SNET_385	2015-12-15	03:02:00	130.2571	-33.5487
Transect1-1000m	53	CTD_387	2015-12-15	04:32:50	130.2667	-33.5286
Transect1-1000m	53	ICP_388	2015-12-15	06:34:23	130.2701	-33.5278
Transect1-400m	52	BEAMT_389	2015-12-15	08:04:39	130.2563	-33.3813
Transect1-400m	52	SNET_390	2015-12-15	08:32:00	130.2726	-33.3839
Transect1-400m	52	CTD_393	2015-12-15	09:04:37	130.2871	-33.3857
Transect1-400m	52	SMG_394	2015-12-15	10:01:32	130.2894	-33.3851
Transect1-400m	52	SNET_391	2015-12-15	10:39:00	130.2893	-33.3820
Transect1-400m	52	SNET_392	2015-12-15	10:52:00	130.2932	-33.3741
Transect1-200m	51	BEAMT_395	2015-12-15	12:10:15	130.2575	-33.3369
Transect1-200m	51	PODPD_396	2015-12-15	12:10:55	130.2580	-33.3368
Transect1-200m	51	SMG_397	2015-12-15	12:57:52	130.2791	-33.3357
Transect2-200m	41	BEAMT_398	2015-12-15	16:45:00	130.7477	-33.3657
Transect2-200m	41	SNET_399	2015-12-15	17:49:00	130.7036	-33.3672
Transect2-200m	41	SNET_400	2015-12-15	18:01:00	130.6947	-33.3670
Transect2-200m	41	SNET_401	2015-12-15	18:14:00	130.6848	-33.3668
Transect2-100m	40	CTD_402	2015-12-15	20:15:06	130.6535	-33.0572
Transect2-100m	40	TB_403	2015-12-15	21:15:00	130.6501	-33.0554
Transect2-100m	40	TB_404	2015-12-15	21:35:00	130.6503	-33.0548
Transect2-100m	40	VNDUA_405	2015-12-15	21:55:00	130.6504	-33.0537
Transect2-100m	40	VNDUA_406	2015-12-15	22:11:00	130.6505	-33.0528
Transect2-100m	40	VN335_407	2015-12-15	22:22:00	130.6507	-33.0523
Transect2-100m	40	FRRF_408	2015-12-15	22:36:00	130.6516	-33.0518
Transect2-100m	40	EZ_409	2015-12-15	23:34:00	130.6681	-33.0531
Transect2-100m	40	EZ_410	2015-12-15	23:44:00	130.6765	-33.0531
Transect2-100m	40	EZ_411	2015-12-15	23:51:00	130.6824	-33.0530

Transect2-100m	40	EZ_412	2015-12-16	00:02:00	130.6919	-33.0529
Transect2-100m	40	EZ_413	2015-12-16	00:14:00	130.7023	-33.0528
Transect2-100m	40	SNET_414	2015-12-16	00:41:00	130.7151	-33.0516
Transect2-100m	40	SNET_415	2015-12-16	00:55:00	130.7042	-33.0520
Transect2-100m	40	SNET_416	2015-12-16	01:09:00	130.6927	-33.0524
Transect2-150m	49	CTD_417	2015-12-16	02:50:00	130.6613	-33.2282
Transect1-1000m	53	ICP_418	2015-12-16	06:45:37	130.2664	-33.5273
Transect1-200m	51	MIDOC_419	2015-12-16	10:54:27	130.2503	-33.3378
Transect1-200m	51	MIDOC_420	2015-12-16	10:56:29	130.2523	-33.3377
Transect1-200m	51	MIDOC_421	2015-12-16	10:56:49	130.2526	-33.3377
Transect1-200m	51	MIDOC_422	2015-12-16	10:57:29	130.2534	-33.3377
Transect1-200m	51	MIDOC_423	2015-12-16	10:57:50	130.2538	-33.3377
Transect1-200m	51	MIDOC_424	2015-12-16	10:58:17	130.2545	-33.3378
Transect1-200m	51	TB_425	2015-12-16	12:04:00	130.3262	-33.3412
Transect1-200m	51	TB_426	2015-12-16	12:19:00	130.3429	-33.3428
Transect1-200m	51	CTD_427	2015-12-16	14:14:07	130.3847	-33.3518
Transect1-200m	51	SMG_428	2015-12-16	14:52:32	130.3851	-33.3530
Transect1-200m	51	SMG_429	2015-12-16	15:15:55	130.3855	-33.3528
Transect1-1000m	53	ICP_431	2015-12-16	17:05:00	130.2664	-33.5280
Transect1-1000m	53	ICP_432	2015-12-16	18:42:09	130.2662	-33.5282
Transit	0	XBT_433	2015-12-16	21:01:00	130.2616	-33.5864
Transit	0	XBT_434	2015-12-16	21:13:00	130.2624	-33.6017
Transect1-1500m	54	BEAMT_435	2015-12-17	00:10:17	130.2677	-34.0647
Transect1-1500m	54	PODPD_436	2015-12-17	00:10:17	130.2677	-34.0647
Transect1-1500m	54	SNET_437	2015-12-17	01:12:00	130.2407	-34.0915
Transect1-1500m	54	SNET_438	2015-12-17	01:25:00	130.2350	-34.0974
Transect1-1500m	54	SNET_439	2015-12-17	01:38:00	130.2290	-34.1036
Transect1-1500m	54	SNET_440	2015-12-17	01:50:00	130.2224	-34.1101
Transect1-1500m	54	CTD_441	2015-12-17	03:40:00	130.2477	-34.0768
Transect1-1500m	53	WBAT_442	2015-12-17	03:40:46	130.2476	-34.0768
Transect1-1500m	54	ICP_443	2015-12-17	04:11:06	130.2474	-34.0770
Transit	0	XBT_444	2015-12-17	06:32:00	130.2550	-34.2224
Transit	0	XBT_445	2015-12-17	07:51:00	130.2725	-34.4487
Transect1-2000m	55	ICP_446	2015-12-17	09:10:19	130.2655	-34.6176
Transect1-2000m	55	ICP_447	2015-12-17	11:11:26	130.2654	-34.6165
Transect1-2000m	55	ICP_448	2015-12-17	13:43:43	130.2780	-34.5996
Transect1-2000m	55	BEAMT_449	2015-12-17	15:44:07	130.2796	-34.6082
Transect1-2000m	55	PODPD_450	2015-12-17	15:44:43	130.2797	-34.6086
Transect1-2000m	55	SNET_451	2015-12-17	16:05:00	130.2800	-34.6197
Transect1-2000m	55	SNET_452	2015-12-17	16:17:00	130.2801	-34.6263
Transect1-2000m	55	SNET_453	2015-12-17	16:30:00	130.2800	-34.6337
Transect1-2000m	55	PLAOS_454	2015-12-17	20:08:00	130.2359	-34.7465
Transect1-2000m	55	PLAOS_455	2015-12-17	22:31:49	130.2293	-34.7428
Transect1-2000m	55	CTD_456	2015-12-18	01:22:32	130.2175	-34.7435
Transect1-2000m	55	WBAT_461	2015-12-18	01:22:32	130.2175	-34.7435
Transect1-2000m	55	FRRF_457	2015-12-18	02:00:00	130.2156	-34.7420
Transect1-2000m	55	TB_458	2015-12-18	02:55:00	130.2187	-34.7384
Transect1-2000m	55	TB_459	2015-12-18	03:05:00	130.2181	-34.7399
Transit	0	CPR_460	2015-12-18	05:14:23	129.9020	-34.8096
Transit	0	CPR_462	2015-12-19	00:04:28	125.2436	-35.1329

Appendix 2 RV *Investigator* Scientific Highlight

Voyage:	IN2015_C02
Chief Scientist:	Rudy Kloser
Voyage title:	GAB deep-water pelagic and benthic ecosystem study
Mobilisation:	Port Lincoln, 12:00, Sunday 29th November 2015
Depart:	Port Lincoln, 10:00, Monday, 30th November 2015
Return:	Fremantle, 10:00, Tuesday, 22nd December 2015
Demobilisation:	Fremantle, 17:00, Tuesday, 22nd December 2015

Title: Great Australian Bight deep-water pelagic and benthic ecosystem study

Introduction

This was a chartered voyage for the Great Australian Bight Research Program (GABRP www.bpgabproject.com.au) servicing the needs of two Theme areas (Pelagic and Benthic Ecology) within a research program that aims to characterise key elements of marine ecosystems across the GAB, including in the deep central GAB area where oil and gas exploration is planned in the next few years.

Unreservedly the voyage was an outstanding success in terms of the diversity of the science undertaken, sampling ocean physics and nutrients, pelagic microbes to nekton, and producing a benthic inventory of species from 200 to 3000 m. Initial science results have been enlightening with higher production and biomass observed offshore and in the central GAB than previously reported. Our detailed sampling of the nutrients and biota will enable us to elucidate the dominant mechanisms responsible for this production and biomass. This improved knowledge of the structure and function of the central GAB ecosystem will be used to help inform ecosystem models and design long term monitoring programs of the region.

Contribution to the nation

It is expected that uptake of data collected on this voyage will accrue over the long term through a better understanding of benthic species diversity, pelagic production and biomass in the previously unsampled offshore waters of the central Great Australian Bight. The data and derived knowledge will be used for input into ecosystem models and to help formulate future monitoring programs for the sustainable management of the region if subject to oil and gas exploitation.

The voyage also provides national benefit by helping the Australian government (e.g. Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)) understand pelagic production and benthic conservation values attributed to Commonwealth Marine Reserves (CMR) spanning wide depth ranges. These values remain untested on the mid- and lower continental slope - which is particularly relevant in the GAB where oil and gas lease areas extend across the deep reaches of the GAB Marine Park.

As a result of this voyage

1. We will be able to quantify and characterise differences in the biomass and physiological mechanisms driving pelagic production between the eastern and previously unsampled central offshore waters of the GAB (200 – 3000 m).

2. We will be able to characterize community structure of deep ocean (200-3000 m depth) benthic fauna (invertebrates and fishes) in the previously unsampled central GAB.
3. We have found that there is elevated production in the central Great Australian Bight offshore waters 200- 1000 m compared to what has been previously reported.
4. We have established a benthic and pelagic baseline in a previously unsampled region to incorporate into future ecosystem models and help design monitoring programs.
5. We have commenced a program to characterise the central GAB benthic and pelagic ecosystem that can be used for the sustainable management of the region in future years.

Appendix 3 Science team on board