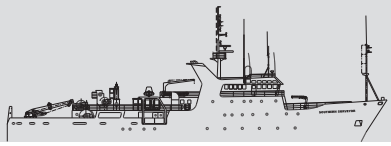

MARINE
NATIONAL FACILITY

2007 program

RV *Southern Surveyor*

CSIRO

voyage summary SS05/2007

SS05/2007

Exploring and characterising marine ecosystems of the NW Region

Characterising the benthic biogeography of the deep continental shelf and slope in Australia's "North Western Region", with emphasis on the processes maintaining (and threatening) biodiversity, and support for implementing the NW Regional Marine Plan and Commonwealth Marine Protected Areas.

Itinerary

Leg 1
Depart Dampier 1900 hrs Thursday 7th June 2007
Arrive Broome 0800 hrs Thursday 21st June 2007

Leg 2
Depart Broome 0730 hrs Monday 25th June 2007
Arrive Broome 0700 hrs Friday 29th June 2007

Leg 3
Depart Broome 1000 hrs Friday 29th June 2007
Arrive Darwin 0800 hrs Monday 9th July 2007

Principal Investigator(s)

Dr Alan Williams (Chief Scientist, Legs 1 &2)
Dr Rudy Kloser (Chief Scientist, Leg 3)
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Email: gpoore@museum.vic.gov.au

Scientific Objectives

Our overall aims are to provide data on the distribution of deep seabed habitats and fauna that are amenable to scientific hypothesis testing, can be immediately applied to marine resource management processes, and that enable strategic development of tools and techniques for understanding the processes that maintain deep sea biodiversity. This work will support the process of NWR Estate inventory and management performance assessment by providing interpreted benthic habitat maps, faunal inventories, distribution maps and conservation values. Data will be collected at scientific reference sites from potential MPA areas that can be re-visited for monitoring purposes in the future. Sampling along environmental gradients (geographic range and depth) in this section of Australia's coast will also provide the opportunity to evaluate biogeographic hypotheses. Further refinement of predictive methods for identifying seabed habitat types, initially developed in temperate and cool-temperate environments, will be enabled by data collection from this tropical location in Australia.

Sampling will be targeted at nested spatial scales of habitat – terrains of sediment and rocky substrata comprising features (e.g. canyons, seamounts and terraces of the continental slope), within depth zones, across latitude/ longitude – to determine how biodiversity is distributed at particular scales. At the highest level, samples are allocated to enable comparison of the provincial benthic bioregions off northwest coast of Western Australia. To the extent possible, sampling will target sites that may become candidate sites for MPAs, or are already conserved – e.g. deep waters around the Rowley Shoals, or suited to the establishment of scientific reference sites, and that will demonstrate the different outcomes from alternative conservations strategies.

The project will be planned, implemented and delivered by a team of scientists from CSIRO Marine and Atmospheric Research and a consortium of Australia's museums, with input from international taxonomic experts.

The overarching project will address five primary objectives:

1) Test hypotheses on the evolution and biogeography of Australia's biodiversity relating to species composition, distribution patterns and taxonomic surrogacy, and whether or not the NWR may be a biodiversity hotspot.

2) Test the use of fine and broad scale spatial patterns of biodiversity in determining the physical (and possibly biological) processes maintaining species boundaries.

3) Collect and identify biological specimens from major benthic invertebrate taxa (including Cnidaria, Echinodermata and Decapoda) and fishes for the BarCode of Life program.

4) Document the benthic biodiversity in areas of high topographic complexity that could form the focus of future MPA areas in the North West Region (NWR).

5) Validate, and permit refinement of, a marine bioregionalisation of the NWR during the development of the NW Regional Marine Plan by the Department of the Environment and Water Resources

Voyage Objectives

At depths of 100 m, 200 m, 400 m, 700 m and 1000 m on transects in focus areas, and at 'standard' 100 m and 400 m sites spaced at approximately 60 n.m. intervals, sampling will:

1. Generate swath acoustic maps of seabed terrains with the Simrad EM300 multibeam sonar in target areas on the deep continental shelf and continental slope seabed (~150-1500 m) to pre-stratify for biological sampling and provide greater context for physical and photographic samples.

2. Ground-truth representative slope terrains with photographic imagery using the CMAR deep towed camera platform to identify the types and distributions of habitats and provide a set of target sample sites in each target area.

3. Collect a standard set of biological and physical samples with a sediment grab and epibenthic sleds at each site to ground-truth data from remote methods.

4. Coarse-sort, photograph and preserve benthic fauna as the basis for providing a biological inventory for each site and area at increasing levels of resolution:

   - an 'at sea' composition of large fauna based on sorting to the finest taxonomic level possible

   - an 'immediate post-cruise' species-level identification of some taxonomic groups of large invertebrates selected on the basis of taxonomic tractability, available expertise, and information content

   - a mid-term (18 month) refinement of the species-level identifications of other large taxa; and

   - a 'longer term lab-based' extraction from sediment samples and determination of micro-invertebrates on a taxon by taxon basis, together with a 'longer term genetic-based' identification of up to major benthic phyla as part of the Barcode of Life program

5. Collect fishes with a commercial-sized fish trawl during Leg 2, in corresponding depths to invertebrate samples, at a small number of selected locations north of Broome.

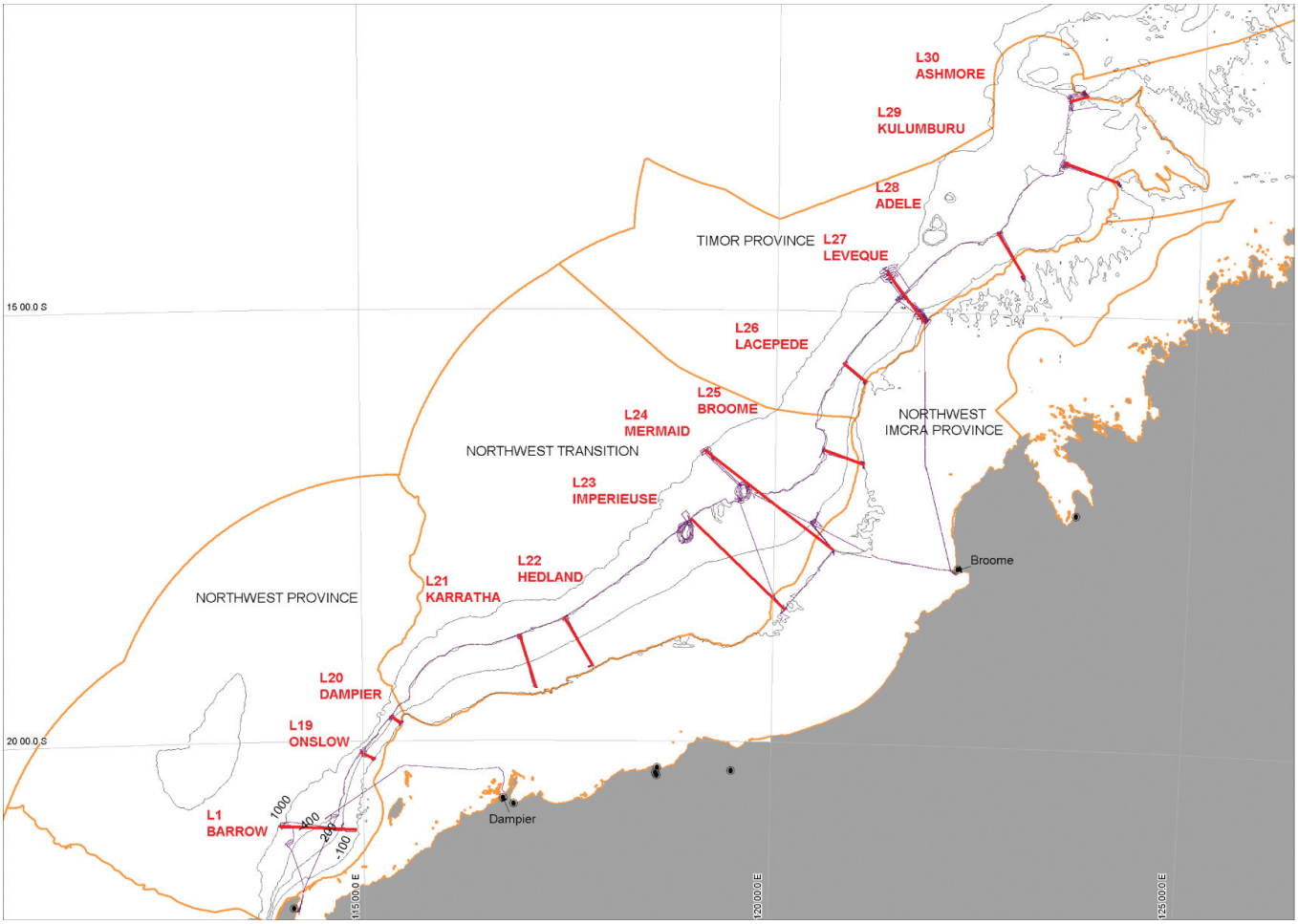

Figure 1: Map showing the survey vessel track (magenta line) following the 400 m bathymetric contour between 'latitude' sites sampled at 400 and 100 m (ends of red lines) with additional sampling (200, 700 and 1000 m) at L1 Barrow, L24 Mermaid and L27 Leveque.

Results

A total of 198 operations were completed (Table 1): these consisted of 55 beam trawls, 58 sediment grabs, 15 Sherman sled tows, 46 camera/video tows, 15 demersal fish trawls and 3 CTD's. All biological catches were sorted to the lowest practical taxonomic resolution on board, and large quantities of invertebrates and fishes were retained for museum identification and curation. Over 1,300 invertebrate species were photographed creating a unique record of the fauna for the area. Sediment and rock specimens were also retained for geological analysis by Geoscience Australia. Approximately 15,000 km^2 of swath mapped seabed data were collected with associated parametric 1.5 kHz sub-bottom and 38 kHz and 120 kHz water column data. The seabed data were processed and mapped in near real-time on board to provide bathymetric and seabed composition maps to target our sampling gears.

This voyage, in combination two voyages completed off the Western Australian west coast in 2005, provides the first systematic collection of deep water invertebrate fauna and associated habitat information for Australia's western and northwestern regions.

Voyage Narrative

Leg 1

Thursday June 7

Departed Dampier at 1800 and headed for the first sampling area towards the centre of the NW Province, north of Exmouth.

Friday June 8

At ~0800hrs we diverted towards Exmouth due to a medical emergency on board. After the Medivac was completed, we spent the remainder of the day steaming alongshore in Exmouth Gulf. There was no option to do any sampling, or to drop anchor, because there was a problem with the steering gear and the two remaining engineers were new to the ship and did not have enough local knowledge to deal with an emergency.

Saturday June 9

Spent most of the day steaming close to Exmouth while waiting for the replacement engineer. Finally steamed out from Exmouth around 1300hrs. We intended to start the sampling on a small conical 'seamount' shown on the bathymetry chart on the upper-slope. However, mapping revealed this was a spurious feature and so we continued on to the Barrow site: the first latitude site on the WA Voyage of Discovery survey is expanded on this survey to become a transect with the addition of sites at 200, 700 and 1000 m depths. This site was suitable for a transect being centrally located in the NW Province, and provided the opportunity to save time since the 100 and 400 m depths were mostly sampled on the previous survey.

Commenced the sampling program during late evening with a beam trawl sample from 700 m.

Sunday June 10

This was followed with another beam trawl in 1000 m. Both provided small but diverse catches. These sites were subsequently surveyed with cameras before we moved to the shallow end of this transect. A successful camera tow and beam trawl were completed at 200 m depth before moving into 100 m depth. Here, a large reef-like mound had provided the opportunity to take both hard and soft samples during the previous survey. We completed a camera transect, and then a repeat hard bottom sample with the Sherman sled. Little rocky bottom was seen in imagery, and the sled collected a large amount of coral cobbles. Sediment grab samples were taken at 100 m, and then a target Sherman sample taken from hard bottom at the shelf edge in 270 m depth to be sorted on the steam to the next site.

Monday June 11

Steamed up to standard site L19 (Onslow), arriving at 0600hrs. Completed mapping of a small area, followed by a camera tow in 400 m. The ground here is steep with many gullies. Had problems with video connector that caused the tow to be cut short. Moved in to the 100 m station and completed a camera tow that showed mostly bioturbated sediments, but with hard bottom and dense sponge communities in one area. Successfully repeated the 400 m camera tow across the shelf edge, and followed this with a beam trawl (op 15). An attempted sediment grab (op 16) was unsuccessful due to problems with the CTD winch. Following this, a beam trawl and a Sherman sled in 100 m, respectively, collected representative catches of fauna from soft sediment and hard rocky bottom. The hard bottom sample from the old coastline reef was large – with about 12 bins of demosponges. Two sediment grabs provided samples of sticky mud sediments from 100 m, while three grabs in 400 m were unsuccessful and that site was finally left unsampled.

Tuesday June 12

Arrived at L20 (Dampier) site at 0200hrs and mapped a small area before towing the camera (op 22) along the flank of a canyon at ~400 m. This showed fine sediments with a moderate amount of bioturbation. We then steamed into the 100 m contour and again mapped a small area with slightly increased backscatter showing in one area. A camera tow confirmed the higher backscatter being due to coarser sediments and a harder area with sparse attached fauna. Two sediment grabs were completed on the softer area in 100 m and later another two sediment grabs at the 400 m site. A beam trawl in 400 m followed along the same line as the camera tow and resulting in a moderate catch of fishes and crustaceans. A beam trawl at 100 m collected several large sponges, indicating it had run over harder bottom. A repeat was done away from the higher backscatter areas – but this also collected sponges. Swath shows distinct sand waves in the area – perhaps resulting from accelerated currents around the adjacent Rankin Bank. It appears the bottom here is scoured, with hard material amongst the soft sediments. Moved out to collect additional sediment samples at the 200 and 700 m sites, since these were missed earlier in the NW Province due to winch problems. Two sediment samples were taken at 200 m, but only 1 at 700 m, again due to winch problems. A repeat beam trawl was taken at 400 m as the last sample at the Dampier site. The vessel then steamed towards the next site, Karratha, some 110 n.m. to the NE.

Wednesday June 13

Arrived at the Karratha L21 site ~0930hrs and proceeded to map the 400 m region showing a gently sloping bottom with no features. A camera tow was completed at this depth and confirmed that the bottom was flat and muddy with bioturbation. A beam trawl completed at this depth provided large numbers of prawns. We then headed into the 100 m site where a camera tow showed just clear bioturbated sediments. A beam trawl and two grabs were completed successfully before heading back out to the 400 m depth to finish the site with a pair of sediment grabs. Steamed towards the Hedland L22 site at 0130hrs.

Thursday June 14

On arrival at the Hedland L22 400 m site we deployed the camera showing soft bioturbated muddy sediments with signs of gear marks for two thirds of the tow. Proceeded in to the 100 m site for another camera tow which was followed by a beam trawl and sediment grabs. A second beam trawl was done on slightly harder bottom. Both returned small catches. Steamed back out to the 400 m site to complete sampling with a beam trawl and two sediment grabs. Because we were slightly ahead of time, a second beam trawl was done. Catches from both were reasonably large, and very similar consisting – mostly of fishes and decapods. Commenced the steam up to the next transect at 2330hrs.

Friday June 15

Arrived at the Imperieuse site (L23) at 1100hrs. Ran enough swath to identify a camera tow in 400 m. Completed this, and followed with a beam trawl. Circumnavigated the Imperieuse Shoal in about the 100 m depth range. Completed two more beam trawls towards the northern end: one a repeat of the first, the second a tow to the north in the scampi fishing grounds. The first two tows were with the current, and caught relatively little. The third was into the current (at mid-tide) and was very difficult to get on the bottom (1300 m wire out, and slow tow speed).

Saturday June 16

Commenced swath lines on the western side followed by a camera tow from shallow to deep. Completed another camera tow north of the reef with strong currents settting the gear to the south. A high relief knoll was negotiated with a lot of exposed rock and boulders but little attached fauna. The next camera tow was on the eastern side of the reef starting in less that 50 m with corals followed by seafans and whips down slope to boulder fields with some large angular boulders. Continued to swath the perimeter of the reef and deployed the camera at the southern end of Imperieuse where strong currents set the camera off to the west. The tow commenced in ~40 m where there were many corals and the down a current scoured rubble slope with few attached fauna. The deeper part of the tow was on heavily rippled sediments. Attempted to get some hard bottom samples with the Sherman sled: the first shot in 100m was successful, and returned a large bag of rubble with many octocorals and other fauna. The second in 200 m was a bad pin up and took a lot of effort to free. The sled came back on the safety chains, but intact, and with a small catch. Subsequently a beam trawl was completed successfully in 400m. A burst pipe resulted in the loss of the hydraulic oil for the winches and the cessation of sampling at Imperieuse.

Sunday June 17

Steamed to Mermaid (L24) site along the 400 m contour and mapped to the north east of the reef where a camera tow in 400 m on low backscatter was completed. Continued to map around the reef and then proceeded out to the 700 m and 1000 m depth sites for camera tows. These were completed successfully, with little seen at 700 m, but many erect epifauna and fishes at 1000 m. This was reflected in the respective beam trawl samples, with relatively large catches in the two samples taken at 1000 m.

Monday June 18

Sediment grabs at 1000 and 700 m depth provided good samples of muddy substratum. Steamed back to Mermaid and completed inshore swath mapping. Did a camera tow from shallow (~60 to 410 m), perpendicular to the first at Mermaid. Followed this with two beam trawls: the first with the current produced only a small catch. The second into the current went well, but came fast. The beam trawl was recovered successfully with little damage, and a very good catch returned – including some hard bottom animals (glass sponges and stalked crinoids) from the rocky pin-up. Continued swathing around to the west until the beam trawl was repaired and then did another sample on the south side in 400 m. Good sample with numerous decapods and a substratum dominated by pterapod shells. Followed with a Sherman tow into hard, presumed rubble, bottom.

Tuesday June 19

Completed the swath mapping of the outer perimeter of Mermaid Reef and proceeded to the 100 contour of the Imperieuse transect. Ran a few swath lines and mapped a contrasting area of bottom with a rocky bank extending up to 80 m depth from the surrounding sediment flats in 100 m. Dense communities of sponges and soft corals were seen on the camera tow 81. Physical sampling consisted of a Sherman sled tow on the hard bottom of the bank in about 80 m, a pair of sediment grabs on the adjacent soft sediment in 100 m, and a beam trawl on soft sediment. We then steamed off to complete the final two sites on the inner end of the Mermaid transect.

Wednesday June 20

Ran a few swath lines that identified a large rocky mound adjacent to flat sediments in 100 m. Commenced sampling at Mermaid 100 with two camera transects: the first in 100 m showing coarse rippled sediments, the second running up the rocky mound showing accumulations of coral rubble and some rocky edges. Two sediment grabs were completed on the soft sediments before heading out to the 200 m site. Here only sediments were found, although some areas marked up as harder patches. A beam trawl completed on a harder patch showed it to be an accumulation of mollusc shells. This and a following tow on the soft sediments bottom produced good catches. Two sediment grabs were completed between the beam trawls – as well as a trial of the trawl fishing net in readiness for Leg 2. The vessel then steamed into the 100 m site where the sampling for Leg 1 was completed with a beam trawl sample and Sherman sample respectively from soft and hard bottom. The soft bottom sample was good; the Sherman sample included a large quantity of cobble-sized coral rubble. Sampling was concluded around 2300hrs before setting a course for Broome.

Thursday June 21
Came alongside in Broome at 0800hrs. Mechanical problems with a hydraulic pump on the steering gear prevented us from leaving at the scheduled time.

Friday June 22
Alongside in Broome.

Saturday June 23
Alongside in Broome.

Sunday June 24
Alongside in Broome.

LEG 2

Monday June 25
Departed Broome at 0730hrs and steamed towards the L27 Leveque transect in the Northern Province. Arrived late in the day and mapped at the 100 m site.

Tuesday June 26
Moved out to the 200 m site and after running a couple of short swath lines did the first trawl tow in 200 m. The trawl was on bottom for ~25 minutes and yielded a small mixed sample of fish and rays plus a selection of inverts including stalked crinoids. A second trawl at this site yielded another small but diverse catch and again included stalked crinoids. Steamed to the 100 m site for a trawl tow catching a small number of fish and inverts. Another trawl was completed at 100 m with the final part on slightly hard ground that resulted in a good catch (~4 boxes mixed fish) and an assortment of soft corals. Steamed to the 400 m depth contour where after mapping the area another trawl was completed to yield a small catch of fishes. After mapping at 700 m a trawl was deployed for a small catch. Mapped from 700 to 1500 m.

Wednesday June 27
A trawl tow was targeted at 1000 m in a canyon but was overshot and aborted. Another attempt also failed to get the gear on the bottom in 1000 m hampered by the net monitor signals dropping out due to the gear setting off to port. Moved to the 700 m site for a repeat trawl at this depth with only a small catch resulting. Trawls were completed at 400 and 300 m before mapping a reef edge and surrounding high backscatter area at 100 m.

Thursday June 28
Completed a camera tow at 100 m. A second short camera tow characterized the reef top and edge. A trawl was completed in 100 m and resulted in a small catch of fish and many stalked crinoids in the net. Another trawl targeted a gutter running around the edge of the reef and resulted in a large catch (20+ boxes) of fish and a large sponge. We then steamed towards Broome for the end of leg 2 and for a crew change.

LEG 3

Friday June 29

Docked at Broome at 0600 hrs with crew change and bunkering completed and departed at 1030 hrs. This was 12 hrs after our scheduled departure for leg 3 to accommodate gaining access to the wharf for bunkering. Steamed to the 400 m contour at the Mermaid site and then north along the 400 m towards the L25 Broome site.

Saturday June 30

Arrived at the Broome L25 site where a camera tow was completed after mapping the area around 400 meters. Steamed to the 100 m site and completed another camera tow across contrasting reflectivity and showing hard gravelly bottom grading to softer bioturbated sediments. A large sample of coral gravel was obtained from a sled tow on the hard bottom. A beam trawl along a corridor of softer bottom yielded a good mixed sample of fish and inverts. Sediment grabs obtained sandy samples from the same area. Moved to the 400 m site and completed a beam trawl that provided only a small sample but appeared to have been fishing well. Grab samples at this site were of muddy ooze.

Sunday July 1

Steamed along the 400 m contour north to the Lacepede L26 site where a camera tow was completed at this depth having mapped the area. A moderate number of invertebrates were observed on current rippled fine muddy sands. Moved to the 100 m site where another camera tow was completed following the mapping of the area. The camera tow showed fine sediments with seapens grading to rubble with seafans and other invertebrates down slope. At the 100 m site the Sherman sled retained a large amount of rubble on the hard ground whilst the medium backscatter coarse sand beam trawl site yielded a small catch of with the notable inclusion of drift seaweed and a sea snake. Due to the small catch the beam tow was repeated but the catch was similar in size < 10 kg and composition. At the 400 m fine sand site a beam tow retained a small < 10 kg catch dominated by fishes.

Monday July 2

The vessel operated on the Leveque L27 transect line with stations at 100, 200, 400, and 700 m. Video, benthic dredges and sediment grabs were targeted at each site based on the geo-referenced multibeam bathymetry and backscatter. The 200 m hard site was characterized with stalked crinoids whilst the soft site beam trawl retained a high number of urchins. The 400 m and 700 m beam trawls retained small < 10 kg catches dominated by fish. All sediment grabs were successful with coarse to fine sediments grading from shallow to deep. A high number of biological samples kept the scientific crew very busy.

Tuesday July 3

Completed the Leveque L27 deep 700 and 1000 m biological, sediment and video operations with very well targeted sampling. The video sampling at the 1000m hard site revealed complex topography with glass sponges and black coral. The 700 m video tow crossed over the fish trawl tracks done on the previous leg of the voyage.

Steamed north along the 400 m contour to the Adele L28 site.

Wednesday July 4

Completed a camera tow at 400 m and 100 m at the Adele L28 transect. A sled tow provided a good sample from the hard bottom and seafans and sponges predominated. The beam tow was targeted on heavily rippled sands surrounded by harder terrain with the catch dominated by crinoids and fish. The swath map of the 100 m region revealed a complex undulating terrain with many channels.

Thursday July 5

Mapping at the Kulumburu L29 site revealed high, medium and low reflectivity areas making it a good prospective site for sampling hard bottom communities at 400 m. A camera tow confirmed the presence of some areas of hardness with a moderate density of attached and erect faunas. Sampling at the 100 m site the now usual suite of sampling tools retained small and diverse samples. Further sampling was done at the 400 m site with a Sherman tow on high backscatter returning a sample including hard chert limestone rock fragments.

Friday July 6

A camera tow targeted at the higher backscatter at the L29 site revealed subcropping interspersed with current rippled fine sediments. Completed a beam trawl on medium backscatter at L29 for a diverse and largish sample (~20 kg) including crustaceans, corals, anemones, crustaceans and fishes. Steamed along the 400 m contour to the Ashmore L30 site where a camera tow revealed fine flat with some bioturbation and sessile epifauna. Moved to the nearby 100 m site skirting close to Cartier Is where swath mapping continued. Very complex 100 m site with a platform rising from 250 m to 90 m. Mapped the region and targeted sediment grabs on a small patch of soft in a depression that yielded coarse sand with shell hash. Targeted the beam trawl on the flat high backscatter with a good retention of sponges, urchins and coral rubble. Returned to the 400 m soft site and two beam trawls and sediment grabs retained good specimens. A hard section of seafloor was mapped south of the site as a prospective tow site.

Saturday July 7

Two short dedicated stereo camera calibration dips were completed at 100 m followed by a camera tow that began on the line of a beam trawl and down into the deeper bowl across craggy hard bottom and onto fine sediments. A Sherman tow was completed on the hard bottom and consisted of mostly rubble with only a small number of animals. Relocated to the 400 m site and towed the camera across some areas of higher backscatter showing mostly pavement with occasional slabs and rubble and a few attached inverts. The final operation for this site was a beam trawl in 400 m along the line of the previous camera tow that resulted in a good mixed sample with crustaceans, echinoderms and corals. Commenced steaming towards Darwin at 1035 hours. The light winds that we have experienced over the past 10 days ended and we punched our way into 20 to 25 knot south east trade winds.

Sunday July 8

Continued our steam to Darwin punching into a steady wind making good progress whilst packing, cleaning and backing up data.

Monday July 9

The vessel docked at 0800 hrs and all equipment and specimens were off loaded for freight to various museums and CMAR Hobart.

Summary

This was a highly successful voyage that succeeded in meeting its sampling schedule over the 3 legs – despite a number of unforseen delays due to illness and vessel gear failure. The volume, quality and distribution of the data collected will ensure that the overarching scientific objectives dependent on this voyage can be met.

Personnel

Scientific participants

Leg 1

Alan Williams	CMAR	Chief Scientist
Bruce Barker	CMAR	Watch Leader/ Camera systems
Matt Sherlock	CMAR	Camera systems
Mark Lewis	CMAR	Gear operations
Hiski Kippo	CMAR	MNF Computing support
Cameron Buchanan	GA	MNF Swath mapping
Peter Dunn	CMAR	MNF Electronics support
Karen Gowlett-Holmes	CMAR	Invertebrate taxonomy coordination
Gary Poore	MV	Invertebrate taxonomy
TBA	AM	Invertebrate taxonomy
Corey Wisson	WAM	Invertebrate taxonomy
Oliver Gomez	WAM	Invertebrate taxonomy
David Staples	MV	Invertebrate taxonomy/ Sediment processing
Martin Gomon	MV	Fish taxonomy

Leg 2

Alan Williams	CMAR	Chief Scientist
Bruce Barker	CMAR	Watch Leader/ Camera systems
Mark Lewis	CMAR	Gear operations
Hiski Kippo	CMAR	MNF Computing support
Cameron Buchanan	GA	MNF Swath mapping
Lindsay MacDonald	CMAR	MNF Electronics support
Karen Gowlett-Holmes	CMAR	Invertebrate taxonomy/ sediment processing
Alastair Graham	CMAR	Fish taxonomy
John Pogonoski	CMAR	Fish taxonomy
Melody Puckridge	CMAR	Fish taxonomy (genetics)
Martin Gomon	MV	Fish taxonomy
Dianne Bray	MV	Fish taxonomy

Leg 3

Rudy Kloser	CMAR	Chief Scientist
Bruce Barker	CMAR	Watch Leader/ Camera systems
Jeff Cordell	CMAR	Camera systems
Mark Lewis	CMAR	Gear operations
Hiski Kippo	CMAR	MNF Computing support
Cameron Buchanan	GA	MNF Swath mapping
Lindsay MacDonald	CMAR	MNF Electronics support
Karen Gowlett-Holmes	CMAR	Invertebrate taxonomy coordination
Peter Davie	QM	Invertebrate taxonomy
Anna McCullum	MV	Invertebrate taxonomy
Mark Salotti	WAM	Invertebrate taxonomy
Joanna Brown	MV	Invertebrate taxonomy
Robin Wilson	MV	Invertebrate taxonomy/ sediment processing
Dianne Bray	MV	Fish taxonomy

Note: CMAR, CSIRO Marine and Atmospheric Research; GA, Geoscience Australia; MV, Museum Victoria; WAM, Western Australian Museum; AM, Australian Museum; QM, Queensland Museum

Officers and crew

Ian Taylor	Master
John Boyes	First Mate
Gerry O'Doherty	Second Mate
Roger Thomas	Chief Engineer Leg 1
Evan Peters	Chief Engineer Leg 1
Fred Rostron	Chief Engineer Legs 2 and 3
Jarrod Taft	Engineer
Ross Beattie	Engineer Leg 1
Rob Cave	Engineer Legs 2 and 3
Ashleigh Pollock	Steward
Rebecca Lee	First cook
Andy Goss	Second cook
Graham McDougall	Bosun
Mal McDougall	IR Legs 1 and 2
Mark MacFarlane	IR
John Howard	IR
Matt Barret	IR
Tony Kennard	IR Legs 2 and 3
Stuart Crapper	IR Leg 2
Joel Wilkinson	IR Legs 2 and 3

This voyage summary is in accordance with the directions of the National Facility Steering Committee for the Research Vessel *Southern Surveyor*.

Acknowledgements

The success of this voyage can be attributed to the wide variety of expertise and hard work provided by the science team, the genuine collaboration by the many organisations involved, and to the high standard of support provided by the marine crew, the Bridge Officers and staff of the Marine National Facility. Many other people provided support, but we would especially like to acknowledge the efforts of staff at the CSIRO Marine and Atmospheric Research mechanical and electronic workshops, and administration section for their assistance in getting this survey mobilized and the overarching project organised. Additionally, staff from the Museum and Art Gallery of the Northern Territory provided invaluable assistance in demobilising the ship in Darwin, and in distributing the biological collections. The work has been principally co-funded by CSIRO Marine and Atmospheric Research, the Wealth from Oceans Flagship, the Department of the Environment and Water Resources, and the Marine National Facility. We also gratefully acknowledge the additional support provided by Geoscience Australia, Museum Victoria, the Western Australian Museum, the Australian Museum, and the Queensland Museum.

Signed Chief Scientists
Alan Williams and Rudy Kloser

Table 1: List of operations

Op #	Gear	Site	Depth (m)	Longitude Latitude Start position (decimal degrees)		Straight line tow length (km)
1	Beam trawl	Barrow L1	700	114.132	-20.990	1.01
2	Beam trawl	Barrow L1	1000	114.013	-20.952	0.97
3	Camera	Barrow L1	700	114.129	-20.992	2.04
4	Camera	Barrow L1	1000	114.009	-20.959	1.49
5	Camera	Barrow L1	200	114.732	-20.997	2.67
6	Beam trawl	Barrow L1	200	114.724	-20.981	1.16
7	Camera	Barrow L1	100	114.891	-21.039	1.45
8	Sherman sled	Barrow L1	100 H	114.888	-21.036	0.38
9	Sediment grab	Barrow L1	100	114.884	-21.030	-
10	Sediment grab	Barrow L1	100	114.882	-21.028	-
11	Sherman sled	Barrow L1	250 H	114.653	-21.014	0.44
12	Camera	Onslow L19	250	114.990	-20.147	0.71
13	Camera	Onslow L19	100	115.140	-20.212	1.76
14	Camera	Onslow L19	270-440	114.981	-20.141	1.51
15	Beam trawl	Onslow L19	400	114.979	-20.133	0.86
16	Sediment grab	Onslow L19	400	-	-	-
17	Beam trawl	Onslow L19	100	115.134	-20.205	1
18	Sherman sled	Onslow L19	100	115.139	-20.204	0.24
19	Sediment grab	Onslow L19	100	115.137	-20.202	-
20	Sediment grab	Onslow L19	100	115.137	-20.203	-
21	Sediment grab	Onslow L19	400	114.977	-20.131	-
22	Camera	Dampier L20	400	115.344	-19.725	1.11
23	Camera	Dampier L20	100	115.469	-19.793	2.28
24	Sediment grab	Dampier L20	100	115.476	-19.790	-
25	Sediment grab	Dampier L20	100	115.476	-19.790	-
26	Sediment grab	Dampier L20	400	115.350	-19.728	-
27	Sediment grab	Dampier L20	400	115.350	-19.728	-
28	Beam trawl	Dampier L20	400	115.343	-19.726	1.03
29	Beam trawl	Dampier L20	100 H	115.472	-19.789	1.23
30	Beam trawl	Dampier L20	100	115.476	-19.791	1.1
31	Sediment grab	Dampier L20	200	115.367	-19.751	-
32	Sediment grab	Dampier L20	200	115.367	-19.750	-
33	Sediment grab	Dampier L20	700	115.323	-19.717	-
34	Beam trawl	Dampier L20	400	115.354	-19.730	1.13
35	Camera	Karratha L21	400	116.909	-18.774	1.17
36	Beam trawl	Karratha L21	400	116.912	-18.774	1.27
37	Camera	Karratha L21	100	117.111	-19.387	2.23
38	Beam trawl	Karratha L21	100	117.112	-19.386	1.44
39	Sediment grab	Karratha L21	100	117.109	-19.386	-
40	Sediment grab	Karratha L21	100	117.109	-19.386	-
41	Sediment grab	Karratha L21	400	116.917	-18.775	-
42	Sediment grab	Karratha L21	400	116.917	-18.774	-
43	Camera	Hedland L22	400	117.457	-18.571	1.54
44	Camera	Hedland L22	100	117.774	-19.138	1.94
45	Beam trawl	Hedland L22	100	117.771	-19.138	1.09
46	Sediment grab	Hedland L22	100	117.770	-19.138	-
47	Sediment grab	Hedland L22	100	117.770	-19.138	-
48	Beam trawl	Hedland L22	100 H	117.784	-19.139	1.04

Op #	Gear	Site	Depth (m)	Longitude Latitude Start position (decimal degrees)		Straight line tow length (km)
49	Beam trawl	Hedland L22	400	117.457	-18.571	0.94
50	Sediment grab	Hedland L22	400	117.461	-18.571	-
51	Sediment grab	Hedland L22	400	117.461	-18.571	-
52	Beam trawl	Hedland L22	400	117.464	-18.570	1.33
53	Camera	Imperieuse L23	400	118.963	-17.460	1.62
54	Beam trawl	Imperieuse L23	400	118.969	-17.463	1.16
55	Beam trawl	Imperieuse L23	400	118.962	-17.460	1.22
56	Beam trawl	Imperieuse L23	430	118.955	-17.358	1.44
57	Beam trawl	Imperieuse L23	400	118.844	-17.529	1.51
58	Camera	Imperieuse L23 W	175-350	118.885	-17.583	1.53
59	Camera	Imperieuse L23 N	200-395	118.970	-17.502	1.71
60	Camera	Imperieuse L23 E	50-265	118.980	-17.598	1.37
61	Camera	Imperieuse L23 S	40-357	118.926	-17.664	2.06
62	Sherman sled	Imperieuse L23 E	100 H	118.982	-17.595	0.7
63	Sherman sled	Imperieuse L23 E	200 H	118.985	-17.600	-
64	Beam trawl	Imperieuse L23 W	400	118.853	-17.517	1.45
65	Camera	Mermaid L24 E	400	119.662	-17.050	1.43
66	Camera	Mermaid L24	700	119.256	-16.730	1.36
67	Camera	Mermaid L24	1000	119.142	-16.641	1.73
68	Beam trawl	Mermaid L24	1000	119.154	-16.634	2.48
69	Beam trawl	Mermaid L24	1000	119.136	-16.645	1.51
70	Beam trawl	Mermaid L24	700	119.251	-16.738	1.2
71	Sediment grab	Mermaid L24	1000	119.148	-16.635	-
72	Sediment grab	Mermaid L24	1000	119.152	-16.633	-
73	Sediment grab	Mermaid L24	700	119.257	-16.732	-
74	Sediment grab	Mermaid L24	700	119.256	-16.731	-
75	Camera	Mermaid L24 E	60 - 400	119.647	-17.055	1.95
76	Beam trawl	Mermaid L24 E	400	119.667	-17.057	1.25
77	Beam trawl	Mermaid L24 E	400	119.661	-17.047	3.37
78	Beam trawl	Mermaid L24 S	400	119.561	-17.198	1.66
79	Sherman sled	Mermaid L24 S	400 H	119.580	-17.197	1.14
80	Beam trawl	Mermaid L24 N	400	119.591	-17.018	1.56
81	Camera	Imperieuse L23	100	120.154	-18.445	3.68
82	Sherman sled	Imperieuse L23	100 H	120.145	-18.460	0.2
83	Sediment grab	Imperieuse L23	100	120.098	-18.429	-
84	Sediment grab	Imperieuse L23	100	120.099	-18.429	-
85	Beam trawl	Imperieuse L23	100	120.099	-18.425	1.62
86	Camera	Mermaid L24	100 S	120.709	-17.760	1.12
87	Camera	Mermaid L24	70-50 H	120.721	-17.770	0.63
88	Sediment grab	Mermaid L24	100	120.710	-17.761	-
89	Sediment grab	Mermaid L24	100	120.711	-17.761	-
90	Camera	Mermaid L24	200	120.455	-17.483	2.28
91	Beam trawl	Mermaid L24	200 (H)	120.461	-17.487	1.19
92	Trawl (test)	Transit	-	-	-	-
93	Sediment grab	Mermaid L24	200	120.440	-17.441	-
94	Sediment grab	Mermaid L24	200	120.439	-17.441	-
95	Beam trawl	Mermaid L24	200	120.435	-17.435	1.15
96	Beam trawl	Mermaid L24	100	120.708	-17.759	1.21
97	Sherman sled	Mermaid L24	100	120.719	-17.768	0.47

Op #	Gear	Site	Depth (m)	Longitude	Latitude	Straight line tow length (km)
				Start position (decimal degrees)		
98	Fish trawl	Leveque L27	200	121.653	-14.990	2.46
99	Fish trawl	Leveque L27	200	121.636	-15.014	3.77
100	Fish trawl	Leveque L27	100	121.758	-15.079	3.04
101	Fish trawl	Leveque L27	100	121.753	-15.085	3.15
102	Fish trawl	Leveque L27	400	121.441	-14.847	3.12
103	Fish trawl	Leveque L27	700	121.329	-14.609	2.92
104	Fish trawl	Leveque L27	1000	0.000	0.000	-
105	Fish trawl	Leveque L27	1000	121.289	-14.526	1.93
106	Fish trawl	Leveque L27	700	121.318	-14.612	3.44
107	Fish trawl	Leveque L27	400	121.459	-14.817	3.74
108	Fish trawl	Leveque L27	300	121.565	-14.892	3.95
109	Camera	Leveque L27	100	121.785	-15.090	3.08
110	Camera	Leveque L27	100	121.789	-15.094	0.68
111	Fish trawl	Leveque L27	100	121.741	-15.103	3.01
112	Fish trawl	Leveque L27	200	121.670	-14.978	3.31
113	Fish trawl	Leveque L27	100	121.770	-15.109	5.05
114	Camera	Broome L25	400	120.569	-16.621	2.12
115	Camera	Broome L25	100	121.047	-16.748	2.15
116	Sherman sled	Broome L25	100	121.047	-16.753	1.48
117	Beam trawl	Broome L25	100	121.032	-16.740	1.3
118	Sediment grab	Broome L25	100	121.032	-16.747	-
119	Sediment grab	Broome L25	100	121.033	-16.749	-
120	Beam trawl	Broome L25	400	120.575	-16.605	1.73
121	Sediment grab	Broome L25	400	120.567	-16.617	-
122	Sediment grab	Broome L25	400	120.564	-16.618	-
123	Camera	Lacepede L26	400	120.810	-15.605	1.92
124	Camera	Lacepede L26	100	121.063	-15.813	2.32
125	Sherman sled	Lacepede L26	100	121.062	-15.811	0.48
126	Beam trawl	Lacepede L26	100	121.054	-15.799	0.99
127	Sediment grab	Lacepede L26	100	121.060	-15.790	-
128	Sediment grab	Lacepede L26	100	121.060	-15.789	-
129	Beam trawl	Lacepede L26	100	121.058	-15.793	2.05
130	Beam trawl	Lacepede L26	400	120.808	-15.610	2.45
131	Sediment grab	Lacepede L26	400	120.829	-15.577	-
132	Sediment grab	Lacepede L26	400	120.829	-15.578	-
133	Sediment grab	Lacepede L26	400	120.819	-15.591	-
134	Camera	Leveque L27	400	121.433	-14.852	2
135	Camera	Leveque L27	200	121.666	-14.975	1.87
136	Sediment grab	Leveque L27	200	121.651	-14.972	-
137	Sediment grab	Leveque L27	200	121.649	-14.971	-
138	Sediment grab	Leveque L27	100	121.781	-15.078	-
139	Sediment grab	Leveque L27	100	121.779	-15.077	-
140	Sherman sled	Leveque L27	100	121.786	-15.095	0.54
141	Beam trawl	Leveque L27	100	121.780	-15.081	1.62
142	Beam trawl	Leveque L27	200	121.677	-14.968	2
143	Beam trawl	Leveque L27	200	121.643	-14.973	1.69
144	Beam trawl	Leveque L27	400	121.431	-14.853	2.22
145	Sediment grab	Leveque L27	400	121.438	-14.845	-
146	Sediment grab	Leveque L27	400	121.439	-14.845	-
147	Beam trawl	Leveque L27	700	121.328	-14.615	2.3

Op #	Gear	Site	Depth (m)	Longitude Latitude Start position (decimal degrees)		Straight line tow length (km)
148	Sediment grab	Leveque L27	700	121.361	-14.595	-
149	Sediment grab	Leveque L27	700	121.362	-14.597	-
150	Sediment grab	Leveque L27	1000	121.242	-14.574	-
151	Sediment grab	Leveque L27	1000	121.242	-14.574	-
152	Camera	Leveque L27	700	121.335	-14.617	1.55
153	Camera	Leveque L27	1000	121.348	-14.566	2.84
154	Camera	Leveque L27	1000	121.288	-14.565	1.92
155	Beam trawl	Leveque L27	1000	121.256	-14.551	2.36
156	Sherman sled	Leveque L27	1000	121.340	-14.557	1.81
157	Sediment grab	Adele L28	400	122.611	-14.062	-
158	Sediment grab	Adele L28	400	122.611	-14.062	-
159	Camera	Adele L28	400	122.601	-14.062	1.68
160	Camera	Adele L28	100	122.919	-14.562	1.9
161	Sherman sled	Adele L28	100	122.918	-14.562	0.35
162	Beam trawl	Adele L28	100	122.906	-14.562	1.36
163	Sediment grab	Adele L28	100	122.907	-14.559	-
164	Sediment grab	Adele L28	100	122.907	-14.559	-
165	CTD	Adele L28	100	122.909	-14.561	-
166	Beam trawl	Adele L28	400	122.617	-14.061	1.83
167	Beam trawl	Adele L28	400	122.604	-14.063	2.02
168	Camera	Kulumburu L29	400	123.361	-13.273	1.77
169	CTD	Kulumburu L29	400	123.373	-13.255	-
170	Camera	Kulumburu L29	100	124.021	-13.446	2.46
171	Beam trawl	Kulumburu L29	100	124.020	-13.461	1.41
172	Beam trawl	Kulumburu L29	100	124.011	-13.457	0.61
173	Sediment grab	Kulumburu L29	100	124.019	-13.470	-
174	Sediment grab	Kulumburu L29	100	124.019	-13.471	-
175	Beam trawl	Kulumburu L29	400	123.376	-13.259	1.77
176	Sherman sled	Kulumburu L29	400	123.396	-13.225	0.88
177	Sediment Grab	Kulumburu L29	400	123.373	-13.233	-
178	Sediment Grab	Kulumburu L29	400	123.371	-13.233	-
179	Camera	Kulumburu L29	400	123.402	-13.227	2.01
180	Beam trawl	Kulumburu L29	400	123.374	-13.265	2.06
181	Camera	Ashmore L30	400	123.417	-12.484	1.88
182	CTD	Ashmore L30	400	123.412	-12.520	-
183	Sediment Grab	Ashmore L30	100	123.601	-12.434	-
184	Sediment Grab	Ashmore L30	100	123.601	-12.434	-
185	Sediment Grab	Ashmore L30	100	123.601	-12.434	-
186	Sediment Grab	Ashmore L30	100	123.601	-12.434	-
187	Sediment Grab	Ashmore L30	100	123.601	-12.434	-
188	Beam trawl	Ashmore L30	100	123.601	-12.445	1.1
189	Beam trawl	Ashmore L30	400	123.418	-12.481	1.99
190	Sediment Grab	Ashmore L30	400	123.419	-12.515	-
191	Sediment Grab	Ashmore L30	400	123.419	-12.516	-
192	Beam trawl	Ashmore L30	400	123.427	-12.530	1.81
193	Camera	Ashmore L30	100	123.597	-12.436	0.36
194	Camera	Ashmore L30	100	123.599	-12.440	0.18
195	Camera	Ashmore L30	100	123.606	-12.448	1.91
196	Sherman sled	Ashmore L30	100	123.596	-12.432	0.27
197	Camera	Ashmore L30	400	123.438	-12.619	1.81
198	Beam trawl	Ashmore L30	400	123.426	-12.602	1.95