? no cruise report as at 01/95.

DIVISION OF **MARINE RESEARCH**

# 1996/7 RESEARCH VESSEL PROGRAM

# CRUISE PLAN

## FRV *SOUTHERN SURVEYOR*
## CRUISE SS–6/97

## 2 — 29 MAY 1997

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## ITINERARY

**DEPART:** CAIRNS 06:00 HRS FRIDAY, 2 MAY 1997

**RETURN:** CAIRNS 18:00 HRS FRIDAY, 29 MAY 1997

## AREA OF OPERATION

North-western Coral Sea, between 9°S - 17°S and 144°E - 154°E

## RESEARCH BACKGROUND

The overall aim of the cruise is to document the distribution and abundance of lobster phyllosoma larvae in the north-western Coral Sea. The need to determine the distribution and abundance of the phyllosoma larvae of *Panulirus ornatus* in the north-western Coral Sea was identified by the Torres Strait Fisheries Scientific Advisory Committee in 1986 when a proposal to undertake such a study was supported. This need arises because of the unusual life history of *P. ornatus* in Torres Strait (see below) and relates to determining potential larval trajectories and sources of recruitment to the Torres Strait stock in addition to scientific understanding of the ecology of the larval stages.

The Torres Strait lobster undergoes what is probably the longest migration known for lobsters, some 500-600 km from Torres Strait into the Gulf of Papua (GoP), to breed on coastal reefs west of Port Moresby. Although this migration has been well documented, it is not clear why lobsters migrate so far to breed. Some breeding has been recorded on reefs off the far north-eastern Queensland coast, but to date the observed larval production in this area is small relative to the GoP. A lucrative trawl fishery on the lobsters migrating into and across the GoP existed until 1984, when it was banned in order to protect what was believed to be a vital but vulnerable source of recruitment to Torres Strait.

Recent studies have hinted that the north-eastern Queensland coast breeding population may be more significant than previously thought, but questions remain regarding larval trajectories and which, if any, of the known breeding populations may be a source of recruitment to Torres Strait. Studies of current patterns by CSIRO and AIMS indicate the presence of a clockwise gyre in the far north-western Coral Sea that has the potential to mix larvae from both the far north-eastern Queensland coast and GoP breeding grounds and retain them adjacent to Torres Strait until the SE trade winds could potentially return them to Torres Strait between June and September each year. The westward South-Equatorial Current strips the southern edge of the gyre and becomes the southward East-Australia Current when it impinges on the Australian coastline near Cooktown — this current is likely to be a major sink for the phyllosoma larval pool of the gyre. At present, these explanations are merely hypotheses because there is no information on the distribution and abundance of the phyllosoma larvae relative to these major current patterns of the area or relative to major physico-chemical phenomena. For these reasons we propose to sample the distribution and

abundance of the phyllosoma larvae of *Panulirus ornatus* with respect to these major current patterns of the north-western Coral Sea between Cairns and Papua New Guinea and gain some understanding of the response of larvae to factors such as depth, lunar phase, diurnal cycle, and physical chemistry of the water column.

This research would enhance our understanding of the larval phase (about which we know almost nothing) in terms of distribution in the ocean, behaviour, larval retention areas, sinks, growth, recruitment mechanisms etc. This knowledge would have an impact on perceptions of the stock (resilience etc) and our ability to model and assess the impact of fishing, management actions, and environmental impacts.

*Background to DSTO research*

A knowledge of the behaviour of microwave signals in a marine environment has many military as well as civilian applications. Some of these include: Ship radar operations, Communication links across water, Satellite to ship microwave links, Effectiveness of GPS at sea and along coastal regions.

Data on the evaporation duct is necessary in order to understand the formation, maintenance and destruction mechanisms at work, which in turn affect the propagation of radiowaves at microwave and millimetre wave frequencies.

In order to validate the theory, we plan to install a multi-antenna receiver on board the *Southern Surveyor* before the cruise. Once into the cruise we plan to deploy a 9.4 GHz transmitter. Nearby the transmitter we plan to deploy the spar buoy carrying temperature, pressure and humidity sensors used to measure the local vertical refractive index profile. If deployed early in the cruise, the on board multi-antenna receiver will be able to measure the incoming signals while the Southern Surveyor is sampling phyllosoma larvae. Data from the spar buoy will be downloaded by radio modem once the vessel is within 5 - 10 miles of the buoy. Later in the cruise, signal strengths from the transmitter will be measured. Data from the spar buoy will be used to calculate the expected amplitude profiles and these will be compared to the results of the multi-antenna system.

## CRUISE OBJECTIVES

The overall objective is to determine the distribution and abundance of the phyllosoma larvae of *Panulirus ornatus* in the north-western Coral Sea with respect to the major current patterns, depth, lunar phase, diurnal cycle, and physical chemistry of the water column. The specific objectives are:

1. to determine the spatial distribution of phyllosomas relative to a clockwise current gyre in the north-western Coral Sea by sampling phyllosoma abundance at 90 plankton-trawl-stations, in groups of 6 stations, distributed across the region.
2. to determine the depth distribution of phyllosomas relative to the physical chemistry of the water column, diurnal cycle, and lunar phase by stratifying mid-water-trawl plankton-sampling at 6 depths at each station.
3. to determine the zoo-plankton biomass in the ocean surface waters by deploying vertical-haul plankton nets at each station.
4. to determine the spatial structure of the water surface across the north-western Coral Sea by continuously recording surface temperature, salinity, and chlorophyll with ship-borne instruments.
5. to determine the day-time and night-time structure of the water column, at each group of 6 stations, by profiling temperature, salinity, light and chlorophyll with a CTD.
6. to observe and document the behaviour of captured phyllosomas and puerulus; eg. swimming speed, orientation, photo-responses, feeding responses, settlement responses if any.
7. to preserve specimens of captured phyllosomas and pueruli for subsequent analysis to determine their gut-contents and for mitochondrial DNA analysis to identify the species mix of early stage Palinurids, and to examine possible sources of *P. Ornatus* phyllosomas.
8. to preserve all other plankton specimens (sub-sampled if necessary) for subsequent sorting and analysis.

*DSTO Objectives:*

1. To gather refractivity data in the Coral Sea by deploying buoy(s) carrying temperature, pressure and humidity sensors. The data will assist in the prediction of microwave propagation effects over tropical waters.
2. To investigate the effects of the evaporation duct on low grazing angle, over-the-horizon propagation at 9.4 GHz. Signal amplitude measurements will be carried out by a new multi-antenna receiving system.

## CRUISE PLAN

The timing of the cruise was chosen to maximise the chances of sampling lobster phyllosoma larvae in the Coral Sea and was restricted to a very narrow time window because breeding finishes at the end of March and settlement into Torres Strait begins in June/July. Thus, in late May, the greatest number of large phyllosoma are likely to be in the Coral Sea and they are likely to be distributed adjacent to areas to which they may be carried by surface currents driven by the SE trade-winds. To document the response of phyllosoma larvae to the lunar cycle, both the new and full moon cycles in May 1997 will be sampled.

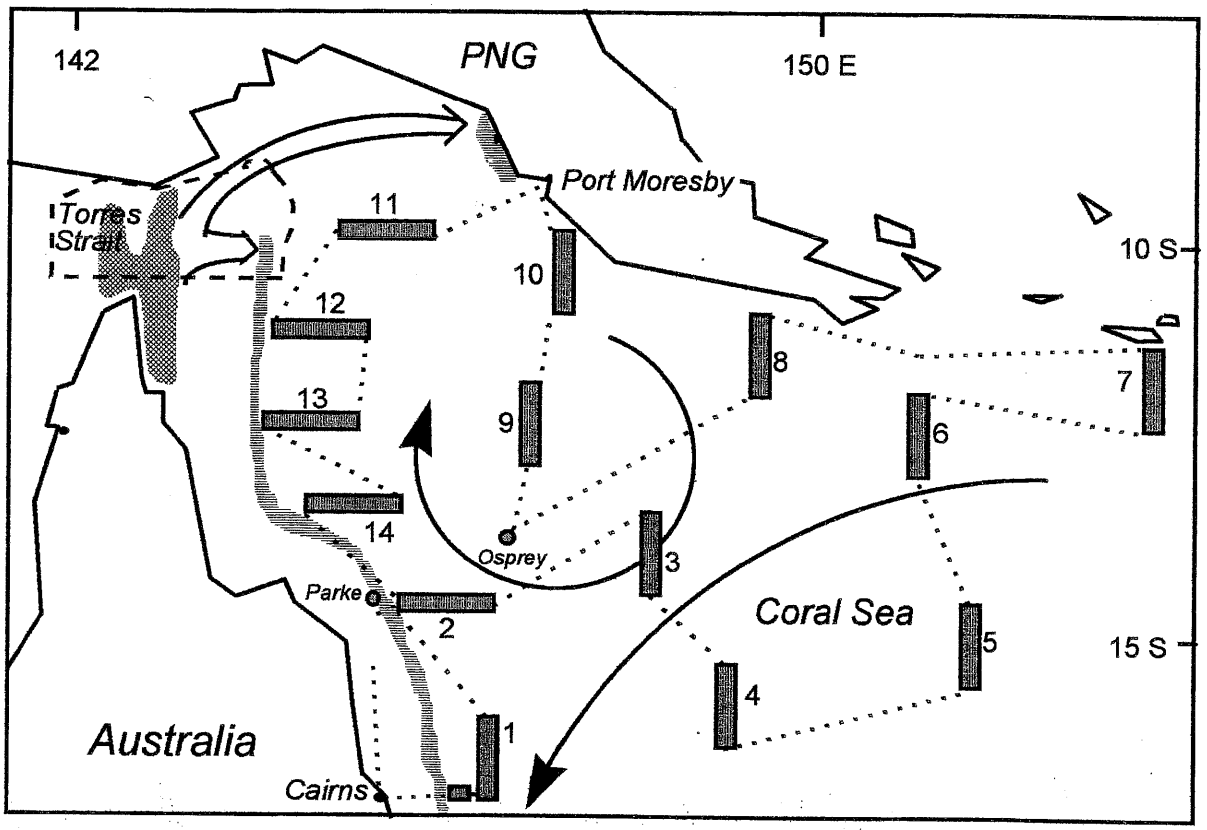


**Fig. 1.** Map of Torres Strait and Gulf of Papua showing the main lobster fishing grounds around the central and western reefs and islands (▬), the migration pathways (=>), breeding grounds (🍆), current patterns (—>) in the Coral Sea, the boundary of the Protected Zone (—), and proposed track and numbered sampling locations of SS-6/97.

*FRV Southern Surveyor* will depart Cairns for deep water just outside the Great Barrier to conduct gear shakedown trials. If all gear and equipment are functioning, the *Southern Surveyor* will conduct the first group of sampling stations in location#1 before transiting to Parke Rf (Fig. 1) to set up a micro-wave transmitter for DSTO. Then location#2 would be sampled before transiting back to the vicinity of Parke Rf to measure micro-wave transmisions. When sufficient measurements have been taken, the *Southern Surveyor* will transit to and sample locations #3-8 across to the far eastern end of Papua New Guinea (Louisiade Archipelago) (see Fig.1 & Table 1). The ship will then head south-west from the southern coast of PNG to OspreyRf in the centre of the Coral Sea to setup a meteorological station and collect data for DSTO. After DSTO, the ship will resume sampling at location#9, then #10 off the PNG coast, then refuel in Port Moresby. Locations #11—#14, off the far northern Great Barrier Reef, would then be sampled and location#2 re-sampled as a

temporal replicate, before collecting DSTO equipment at Parke Rf. The ship will return to port in Cairns.

*Sampling methods*

Sampling locations (groups of 6 sampling stations, indicated by shaded boxes in Fig.1) will be positioned relative to the major current patterns in the north-western Coral Sea. The East-Australia current will be sampled in the area directly east of Cairns; phyllosoma in this current will have been lost to the main gyre and could not return to Torres Strait – this will indicate the attrition of the larval pool in the gyre. The boundary between the South-Equatorial Current and the Coral Sea gyre will be sampled to examine the distribution of larvae with respect to this convergence. The remaining main sampling areas will provide representative sampling around and across the gyre so that larval distribution relative to the gyre can be documented. The areas in the centre of the gyre will also be sampled. The area directly east of Torres Strait may be a larval accumulation area due to the SE trade winds.

Details of methods will be similar to Rimmer & Phillips (1979 *Marine Biology* 54:109-124). Sampling will be conducted both day and night and over two lunar phases and at a range of depths at each station to determine the depth distribution of the larvae with respect to the diurnal and lunar cycles.

The sampling net will comprise a large (45 $m^2$) pelagic trawl (IYGPT) lined with 10 mm mesh and 0.5 mm plankton net cod-ends. The larger pelagic net serves to enhance the catch rates of phyllosoma by the plankton net cod end. Each tow will be depth stratified by using a multiple opening/closing net system (MIDOC) in the cod-end. Each station will be stratified at 5 depths, each for 25 mins, with a shoot-away time of 35 mins, giving a tow-time of 160 minutes. A surface/neuston net (~2 $m^2$, 2.5/1 mm mesh) will be deployed alongside the vessel for the duration of the depth-stratified tow. Each tow station in a group will be separated by ~45 minutes during which 1-2 vertical-plankton-hauls will be conducted, using 0.5 m diam x 100 um mesh net. Each group of 6 stations will be distribution over a 24 hr period, to cover the full diurnal cycle. The location#2 group of 6 stations will be repeat sampled, as a temporal replicate.

Physico-chemical parameters of the water column will also be measured, at midday and midnight within each 24 hr grouping of stations, by depth-profiling temperature, salinity, light and chlorophyll with CTD casts. This will allow the depth stratified sampling to be targeted to provide the best description of the distribution of larvae relative to water column structure.

Physico-chemical parameters of the surface waters, including temperature, salinity, and chlorophyll, will be measured and recorded continuously by ship-borne instruments to determine the spatial structure of the water surface across the north-western Coral Sea.

Any live captured phyllosoma larvae (and post-larvae = puerulus, if any) will be observed and videoed in ship-board aquaria and their behaviour documented; eg. swimming speed,

orientation, photo-responses, feeding responses and settlement responses if any. Further, the gut-contents (if any) of captured phyllosomas (and puerulus) will be documented, and specimens will be preserved for subsequent analysis, including specimens for subsequent mitochondrial DNA analysis to identify species mix of early stage Palinurids, and to examine possible sources of *P. ornatus* phyllosomas.

Plankton sample sorting, phyllosoma identification, and analysis of distribution patterns will be undertaken as far as possible during the cruise. All other plankton specimens (sub-sampled if necessary) will be preserved for subsequent sorting and analysis.

*DSTO methods*

The transmitter will be mounted on top of a 4.5 metre high scaffolding on Boulder Is. on Parke Reef, Great Barrier Reef, located at 14 26 S, 145 21 E. The transmitter will be powered by a series of deep cycle batteries which will be re-charged by solar cells. The total weight of the transmitter and power supply units is about 120 kg. Anticipated assembly time for the transmitter is 4 hours once all equipment is on the island. Southern Surveyor will position itself as close as possible to Parke Reef – depth of 30m exists right up to the reef – to ensure rapid transits with the zodiacs, to and from Boulder Is. Assistance is required to ferry personnel and equipment onto the island in order to assemble the transmitter.

The spar buoy is to be deployed near Parke Reef and it will carry sensors to measure the vertical humidity and temperature profiles and the sea surface temperature. The spar buoy is 12.5 metres long and weighs 430 kg. The spar buoy takes 3.5 hours to assemble, (including contingency). Assembly can take place on the ship while at sea. Assistance is required to deploy the spar buoy by towing the buoy into position using the zodiac.

A raft buoy is to be deployed inside Osprey Reef to measure local vertical refractive index profiles. It has a 6 metre spar on which the humidity and temperature sensors are mounted. The spar is fixed onto a metal frame which hold 4x200 l drums at each corner for floatation. The raft is stabilised by lead weights which hang below the metal frame. The weight of the whole raft is approximately 250kg. The buoy takes 3 hours to assemble, (including contingency). Assembly can take place at sea. A zodiac is required to tow the raft buoy into position at Osprey Reef.

A Multi-Antenna Receiver system will be mounted on the ship, comprising 6 antenna units and a power supply/ data logging unit. Three antenna units will be mounted on the port side of the ship between heights of 5 and 22 metres above sea level and also three antenna units will be mounted on the starboard side at similar heights. The power supply unit will be stored in an equipment rack on the bridge of the ship nearby the lap-top computer which is dedicated solely for controlling data aquisition and the storage of data. Assembly takes 48 hours, most of which has to be done in port before the cruise, although cabling can be done at sea.

**Table 1:** The proposed steaming and location time-allocations, timings and positions for the SS 6-97 cruise track. Note that there will be 6 sampling stations within each location.

| | | durat. hours | cumul. hours | days | Start | Finish | Stt.Lat | Stt.Long | End Lat. | End Lon |
|---|---|---|---|---|---|---|---|---|---|---|
| trans | Cns | 5 | 5 | 0.21 | Fri 2/5/97 6:00 — | Fri 2/5/97 21:00 | | | | |
| Gear shakedown | | 10 | 15 | 0.63 | Fri 2/5/97 11:00 — | Fri 2/5/97 21:00 | 16 40 | 146 07 | | |
| loc# | 1 | 24 | 39 | 1.63 | Fri 2/5/97 21:00 — | Sat 3/5/97 21:00 | 16 35 | 146 20 | 15 55 | 145 10 |
| trans | | 11 | 50 | 2.08 | Sat 3/5/97 21:00 — | Sun 4/5/97 8:00 | | | | |
| DSTO | Parke Rf | 9 | 59 | 2.46 | Sun 4/5/97 8:00 — | Sun 4/5/97 17:00 | 14 30 | 145 35 | 14 30 | 145 35 |
| trans | | 2 | 61 | 2.54 | Sun 4/5/97 17:00 — | Sun 4/5/97 19:00 | | | | |
| loc# | 2 | 24 | 85 | 3.54 | Sun 4/5/97 19:00 — | Mon 5/5/97 19:00 | 14 25 | 145 40 | 13 50 | 146 10 |
| trans | | 3 | 88 | 3.67 | Mon 5/5/97 19:00 — | Mon 5/5/97 22:00 | | | | |
| DSTO | Parke Rf | 6 | 94 | 3.92 | Mon 5/5/97 22:00 — | Tue 6/5/97 4:00 | 14 30 | 145 35 | 14 30 | 145 35 |
| trans | | 19 | 113 | 4.71 | Tue 6/5/97 4:00 — | Tue 6/5/97 23:00 | | | | |
| loc# | 3 | 24 | 137 | 5.71 | Tue 6/5/97 23:00 — | Wed 7/5/97 23:00 | 13 05 | 148 30 | 15 50 | 148 40 |
| trans | | 9 | 146 | 6.08 | Wed 7/5/97 23:00 — | Thu 8/5/97 8:00 | | | | |
| loc# | 4 | 24 | 170 | 7.08 | Thu 8/5/97 8:00 — | Fri 9/5/97 8:00 | 15 15 | 149 05 | 15 55 | 149 20 |
| trans | | 16 | 186 | 7.75 | Fri 9/5/97 8:00 — | Sat 10/5/97 0:00 | | | | |
| loc# | 5 | 24 | 210 | 8.75 | Sat 10/5/97 0:00 — | Sun 11/5/97 0:00 | 15 20 | 151 55 | 14 35 | 151 45 |
| trans | | 9 | 219 | 9.13 | Sun 11/5/97 0:00 — | Sun 11/5/97 9:00 | | | | |
| loc# | 6 | 24 | 243 | 10.13 | Sun 11/5/97 9:00 — | Mon 12/5/97 9:00 | 13 10 | 151 15 | 12 25 | 151 05 |
| trans | | 16 | 259 | 10.79 | Mon 12/5/97 9:00 — | Tue 13/5/97 1:00 | | | | |
| loc# | 7 | 24 | 283 | 11.79 | Tue 13/5/97 1:00 — | Wed 14/5/97 1:00 | 12 30 | 153 50 | 11 45 | 153 45 |
| trans | | 23 | 306 | 12.75 | Wed 14/5/97 1:00 — | Thu 15/5/97 0:00 | | | | |
| loc# | 8 | 24 | 330 | 13.75 | Thu 15/5/97 0:00 — | Fri 16/5/97 0:00 | 10 50 | 150 10 | 11 30 | 149 45 |
| trans | | 23 | 353 | 14.71 | Fri 16/5/97 0:00 — | Fri 16/5/97 23:00 | | | | |
| DSTO | Osprey | 36 | 389 | 16.21 | Fri 16/5/97 23:00 — | Sun 18/5/97 11:00 | 12 45 | 146 55 | 12 45 | 146 55 |
| trans | | 7 | 396 | 16.50 | Sun 18/5/97 11:00 — | Sun 18/5/97 18:00 | | | | |
| loc# | 9 | 24 | 420 | 17.50 | Sun 18/5/97 18:00 — | Mon 19/5/97 18:00 | 12 45 | 146 35 | 12 05 | 146 50 |
| trans | | 8 | 428 | 17.83 | Mon 19/5/97 18:00 — | Tue 20/5/97 2:00 | | | | |
| loc# | 10 | 24 | 452 | 18.83 | Tue 20/5/97 2:00 — | Wed 21/5/97 2:00 | 10 45 | 147 10 | 10 10 | 147 35 |
| trans | | 5 | 457 | 19.04 | Wed 21/5/97 2:00 — | Wed 21/5/97 7:00 | | | | |
| Pt.Moresby | | 4 | 461 | 19.21 | Wed 21/5/97 7:00 — | Wed 21/5/97 11:00 | 9 25 | 147 15 | 9 25 | 147 15 |
| trans | | 9 | 470 | 19.58 | Wed 21/5/97 11:00 — | Wed 21/5/97 20:00 | | | | |
| loc# | 11 | 24 | 494 | 20.58 | Wed 21/5/97 20:00 — | Thu 22/5/97 20:00 | 09 35 | 145 45 | 09 20 | 145 05 |
| trans | | 9 | 503 | 20.96 | Thu 22/5/97 20:00 — | Fri 23/5/97 5:00 | | | | |
| loc# | 12 | 24 | 527 | 21.96 | Fri 23/5/97 5:00 — | Sat 24/5/97 5:00 | 10 25 | 144 05 | 10 40 | 144 45 |
| trans | | 8 | 535 | 22.29 | Sat 24/5/97 5:00 — | Sat 24/5/97 13:00 | | | | |
| loc# | 13 | 24 | 559 | 23.29 | Sat 24/5/97 13:00 — | Sun 25/5/97 13:00 | 11 55 | 144 50 | 12 10 | 144 05 |
| trans | | 8 | 567 | 23.63 | Sun 25/5/97 13:00 — | Sun 25/5/97 21:00 | | | | |
| loc# | 14 | 24 | 591 | 24.63 | Sun 25/5/97 21:00 — | Mon 26/5/97 21:00 | 13 10 | 144 50 | 13 40 | 144 15 |
| trans | | 9 | 600 | 25.00 | Mon 26/5/97 21:00 — | Tue 27/5/97 6:00 | | | | |
| loc# | 2 | 24 | 624 | 26.00 | Tue 27/5/97 6:00 — | Wed 28/5/97 6:00 | 14 25 | 145 40 | 14 05 | 146 20 |
| trans | | 6 | 630 | 26.25 | Wed 28/5/97 6:00 — | Wed 28/5/97 12:00 | | | | |
| DSTO | Parke Rf | 12 | 642 | 26.75 | Wed 28/5/97 12:00 — | Thu 29/5/97 0:00 | 14 30 | 145 35 | 14 30 | 145 35 |
| trans | | 18 | 660 | 27.50 | Thu 29/5/97 0:00 — | Thu 29/5/97 18:00 | | | | |
| Cairns | | 0 | 600 | 25.00 | Thu 29/5/97 18:00 — | Disembark | 12 35 | 141 55 | 12 35 | 141 55 |

In summary, the total cruise time for the Coral Sea phyllosoma sampling will be 28 days, or 660 hrs of which, ~250 hrs will be towing plankton nets at 2 kn, ~161 hrs will be hove-to for CTD casts (30 hrs), for vertical plankton hauls (68 hrs) and for DSTO work (63 hrs), ~225 hrs will be steaming at 10-12 kn and 24 hrs will be for contingency and refuelling in Port Moresby.

## SCIENTIFIC PERSONNEL

| | |
|---|---|
| Dr Roland Pitcher, | Project/cruise leader (CSIRO Marine Research) |
| Mr Darren Dennis, | Biologist (CSIRO Marine Research) |
| Mr Doug Jacobs, | Biologist (CSIRO Marine Research) |
| Mr Clive Liron | Vessel Manager (CSIRO Marine Research) |
| Mr Lindsay MacDonald/Mr Jeff Cordell | Electronics, (CSIRO Marine Research) |
| Mr Mark Rayner | CTD & chemistry (CSIRO Marine Research) |
| Dr Barry Bruce/Dr Jock Young | Biologists (CSIRO Marine Research) |
| Mr Philip Polon | Biologist (PNG NFA) |
| Mr Barre Kare | Biologist (PNG NFA) |
| Dr Andrew Kulessa | Engineer (DSTO) |
| DSTO staff | Engineer (DSTO) |
| DSTO staff | Engineer (DSTO) |

## CONTACTS

For further information about this cruise, contact:

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**Dr C. Fandry**
Chief, CSIRO Division of Marine Research March 1997