

# FRANKLIN

National Facility  
Oceanographic Research Vessel

## RESEARCH SUMMARY

FR 11/94

Sailed Port Lincoln	0800	6 December 1994
Called Albany	1400 - 1800	11 December 1994
Arrive Fremantle	1300	19 December 1994

## CIRCULATION OFF SOUTH WESTERN AUSTRALIA AND IN THE GREAT AUSTRALIAN BIGHT

Principal Investigator

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## SEABIRD DISTRIBUTIONS AND DENSITIES

Dr R Wooler

Murdoch University

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### Itinerary

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The ocean south of Western Australia is influenced by: a branch of the West Australian Current in summer; the Leeuwin Current in autumn and winter; and long intrusions of cold sub-Antarctic water that flow north and west from 37° to 38°S towards the continental shelf. This cruise examined the cold intrusions and their interaction with the "summer" Leeuwin Current. In addition, current and water property data were collected in the data-sparse waters of the Great Australian Bight.

### Objectives

- A To examine the intrusions of cold sub-Antarctic water (estimated temperature for December ~14°C) that reach north and west from 37°-38°S towards the southern WA shelf edge and interact with the summer Leeuwin Current
- B To measure currents and water properties in the Great Australian Bight.
- C To gather information on unusual associations of seabirds away from their breeding colonies with respect to the effect of the Leeuwin Current

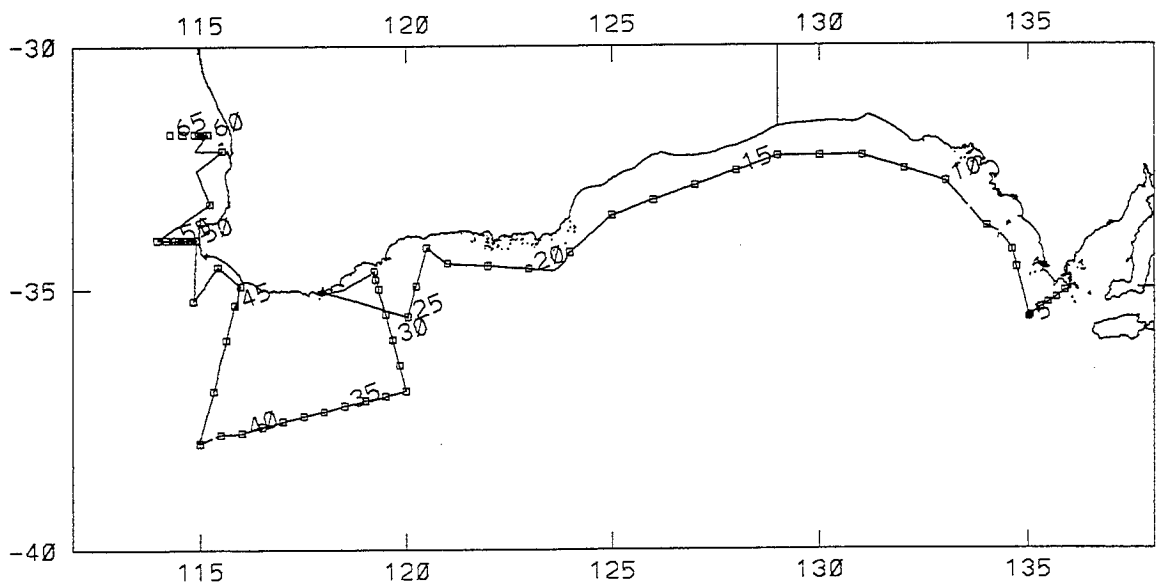


Figure 1 The ship's track

## THE COMPONENTS OF THE VOYAGE

These include:

- A transect of the currents and water properties across the shelf and upper slope off Eyre Peninsula.
- A transect along the middle of the continental shelf of the Great Australian Bight (GAB).
- Coincident, or near-coincident, transects along Synthetic Aperture Radar (SAR) swaths of the ERS-1 satellite.
- A transect across intrusions of subantarctic water and an offshoot of the Leeuwin Current.
- Transects across the summer Leeuwin Current from near the southern WA coast to well offshore.
- A transect across the Leeuwin and Capes Currents along 34°S (out from Cape Mentelle).
- Oblique transects of the shelf north from Cape Naturaliste to Rottnest.
- An XBT transect of the Perth Canyon.
- A transect from 60 miles offshore to the beach at Hilliarys (33°50'S), with the waters inshore of the 20 m isobath being surveyed by boats from CSIRO Fisheries and the WA Department of Conservation and Land Management (CALM).

70 CTD stations were occupied; 72 XBTs were dropped; and two satellite-tracked drifters were released. The usual underway instruments measured weather conditions, depth, current profiles (ADCP) and surface temperature, salinity and fluorescence.

Cmdr Martin Rutherford RAN used much of the data with his PC-based ocean analysis scheme.

The oceanographic surveys were complemented by:

- Zooplankton hauls made by Simon Bryars of Flinders University for blue crab larvae and by Ken White and Dan Gaughan of the WA Fisheries Research Institute for pilchard larvae, and
- Seabird observations by Chris Surman of Murdoch University.

## SCIENTIFIC PARTY

George Cresswell	CSIRO-Oceanography	
Susan Wijffels	CSIRO-Oceanography	(Albany-Fremantle)
Bernadette Heaney	CSIRO-ORV	
Phil Adams	CSIRO-ORV	
Val Latham	CSIRO-ORV	
CMDR Martin Rutherford	RAN	
Chris Surman	Murdoch University (Supervisor	Prof R Wooller)
Simon Bryars	Flinders University (Supervisor	Dr G Matsumoto)
Ken White	WA Fisheries Research Institute	
Dan Gaughan	WA Fisheries Research Institute	
Chris Viney	Photo-journalist	(Pt. Lincoln-Albany)

## SHIP'S OFFICERS AND CREW

Neil Cheshire	Master
Dick Dougal	First Mate
Ian Menzies	Second Mate
Mike Culpepper	Chief Engineer
Lindsay Cale	Second Engineer
Don Roberts	Electrical Engineer
Jannek Hansen	Bosun
Ronnie Carr	Able Seaman
Ron Kellerher	Able Seaman
Jack McCabe	Able Seaman
Tony Bernardin	Greaser
Gary Hall	Chief Cook
Nat Dall	Second Cook
Frank Braden	Steward

(I thank the ship's officers and crew for their competence, willing assistance, and patience with this Chief Scientist. The food produced in the galley was of an incredibly high standard.)

## NARRATIVE

Local times are used in the narrative.

The ship sailed from Pt Lincoln in pleasant weather at 0800 on Tuesday 6 December and commenced a line of stations (#1-#6) southwestward across the continental shelf and upper slope.

On Wednesday 7 December the ship crossed back onto the shelf and commenced a series of 17 stations that were 1° of longitude apart. The weather continued to be favourable, with winds following us for several days.

On Saturday 10 December at 121°E we occupied the final station in the 1° of longitude series and then went nearer the coast at 120°30'E for a station to start a CTD transect on course 195° along the SAR swath that would occur at 1000 local time Sunday. Late in the evening we were treated to a rough ride because of taking a 20 knot wind on our bow while we were with a 1 knot favourable current. In order to meet a rendezvous on Sunday afternoon in Albany we broke off the line of stations at 35°S and set a course for Albany. Along this course we dropped XBTs #12-#20.

We reached the Albany anchorage at 1400 on Sunday 11 December. Chris Viney was taken ashore by boat and then Susan Wijffels and Dan Gaughan joined the ship. We left the anchorage at 1800 and headed eastward along the shelf to reach the middle of the next SAR track and then along this on a course of about 170° to 37°S; CTDs #26 to #32 were occupied. The sea and swell made for a bumpy ride.

At this juncture we were aided greatly by a satellite image (Figure 3) that had been hand-carried to Albany from Paul Tildesley in Hobart. It enabled us to lay out a course across two subantarctic intrusions and a warm offshoot and have station spacing appropriate to the structures — the spacing was 0.5° of longitude along a course from 35°S, 120°E to 38°S, 115°E. This took from 2200 on Monday 12 December until 1500 on Wednesday 14 December. Drifter 1835 was released into the cold intrusion of subantarctic water at the western end of the transect. Along this transect Chris Surman observed many more birds in the cold subantarctic

intrusions than in the warm offshoot. The birds included more than twenty Gould's petrels, whose range had previously been thought to be east of the Australian continent.

The ship was then taken back to the coast at Pt D'Entrecasteaux, arriving at 1400 on Thursday 15 December. Profiles were collected en route at CTDs #42 to #47 and XBTs #26 to #34. Three whales were sighted about 5 miles from Pt D'Entrecasteaux. The Leeuwin Current was not very strong (<1knot) and there was a countercurrent on the inner shelf that ran to the northwest. Drifter 6152 was released into the countercurrent at the 50 m isobath midway between D'Entrecasteaux and Black Point. There was a fresh southeasterly breeze.

An extra transect was run from Black Point along ~215° to further examine the countercurrent and its relationship, if any, with the Leeuwin Current. This took from 2000 on 15 December to 0400 on 16 December and comprised ADCP and underway measurements, CTDs #48 and #49 and XBTs #35 to #43. The wind was still a strong southeasterly and the ADCP and temperature profiles showed evidence for upwelling, with warm surface waters moving offshore and cold deep waters moving onshore across the shelf.

The ship was taken to Cape Mentelle (34°S) and then a transect was run to the west taking from 1100 to 2300 on Friday 16 December with CTDs #50 to #57 and XBT #44. On the inner shelf there was a northward current (the Capes Current) of about 1/2 knot. On the outer shelf the southward Leeuwin Current had reached 1 knot just below the surface mixed layer. The mixed layer may have been influenced by the strong southerly wind.

From 2300 on Friday 16 December to 1100 on Saturday 17 December the ship ran a transect from the offshore end of the Cape Mentelle transect in across the slope and shelf finishing on the inner shelf north of Bunbury. The transect comprised XBTs #45 to #54 and CTDs #57 and #58. Three humpbacks joined the ship for CTD #58; one was very small.

The ship then steamed roughly NNW between 1100 and 1600 on Saturday 17 December to the outer shelf off Mandurah measuring currents with the ADCP and taking the underway measurements. The wind had

freshened to around 25 knots. XBT #55 was dropped at the outer shelf (depth 120 m). Another was dropped at the 160 m isobath and showed top and bottom mixed layers separated by a thermocline. The southerly wind got up to 30 knots. A course was set to the NNE to the vicinity of Garden Island with the passage taking from 1600-2030 on the same day. CTD #59 was done near Garden Island.

Four XBTs, #57 to #60 were dropped between the Garden Island CTD station and the Perth Canyon. The Canyon runs roughly SW-NE and has particularly steep walls that drop roughly 1000m. Along its axis the depths are as much as 1900 m. All this is well known, of course, but it still filled this author with some awe. A transect, XBTs #60 to #72, was run along the axis of the canyon from 0100 to 0430 on Sunday 18 December.

The ship then moved onto the continental shelf and occupied CTD #60. This was a station on the Hilliarys transect. The ship was taken westward out to sea and CTD stations were occupied. The wind and sea were from the south with wind speeds of 35 knots. Some problems were encountered for a while with the bow thruster, but were solved. Having done the continental slope stations the ship moved back to occupy CTD stations on the continental shelf, thereby completing the transect into the 30 m isobath. Boats from the CSIRO Division of Fisheries and the WA Department for Conservation and Land Management continued the transect from the 30 m isobath into the beach.

An hour and half of the mid-morning of Monday 19 December was spent manoeuvring the ship for a stills cameraman aboard a helicopter. All aboard the ship marvelled at the skill of the helicopter pilot.

The ship docked at Fremantle at 1300.

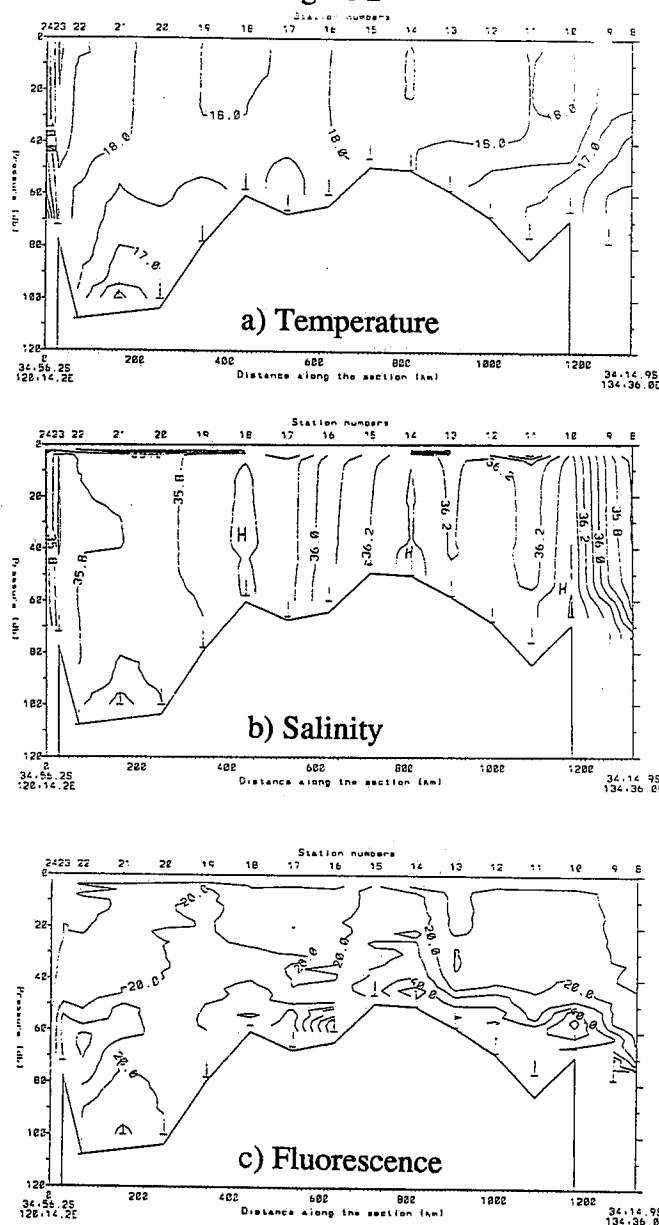
## A SELECTION OF THE RESULTS

This selection aims at giving a flavour of the preliminary findings from the voyage.

The transect along the middle of the continental shelf of the Great Australian Bight

The salinity section was much more effective than the temperature section in showing discrete tongues of water against a slowly varying backdrop (Figure 2 a, b). Salinities in excess of 36.3 occurred at stations #10 and #14. These tongues were most noticeable near the bottom and were probably due to evaporation in the shallows of the Bight producing dense water that then flowed offshore. The temperature picture was probably confused by the shallows producing cold water in winter and hot water in summer, with December being an intermediate stage. Near-bottom fluorescence (Figure 2 c) peaked at the two high-salinity stations (#10 & #14). The reason for this is not yet obvious to this author.

Figure 2



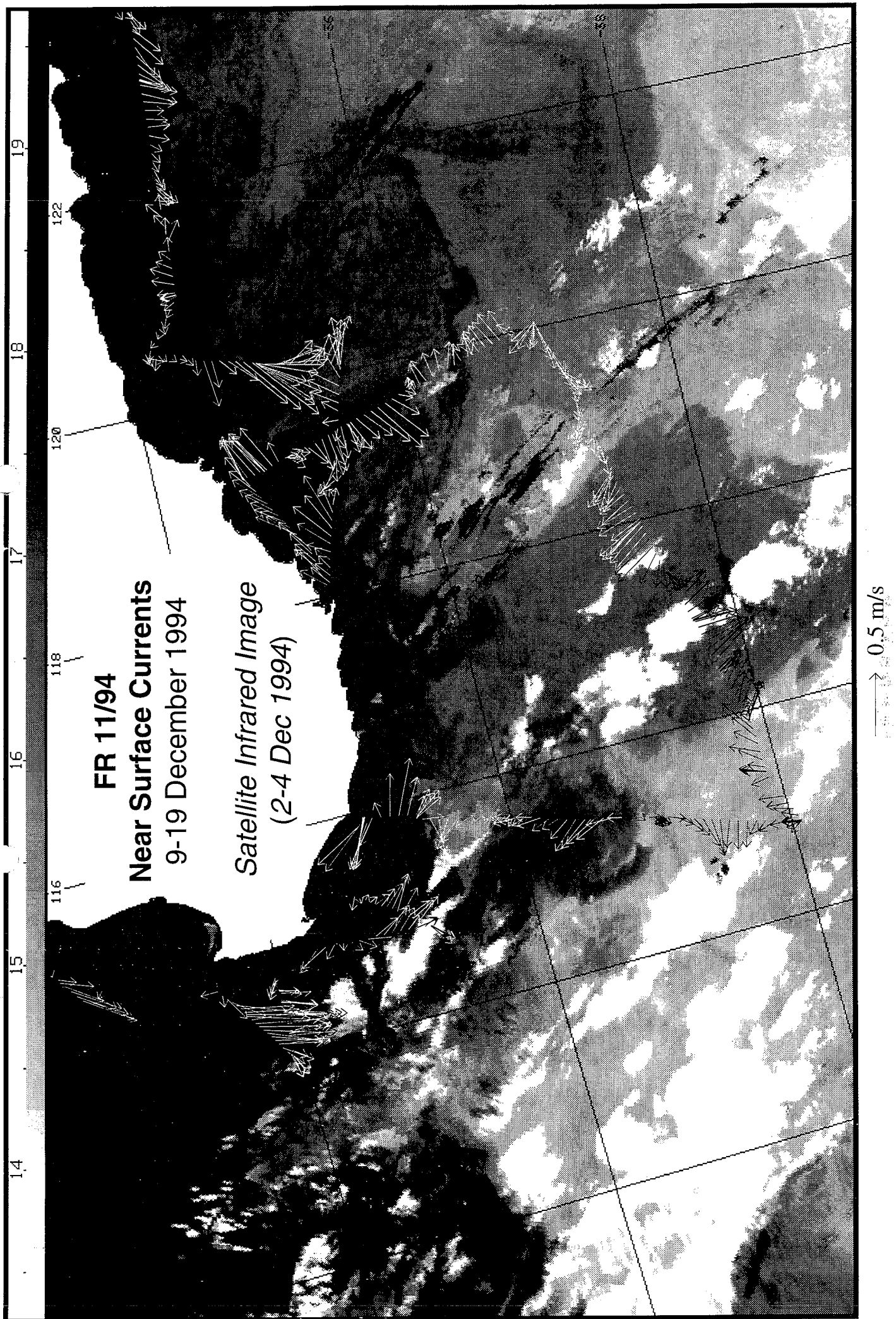
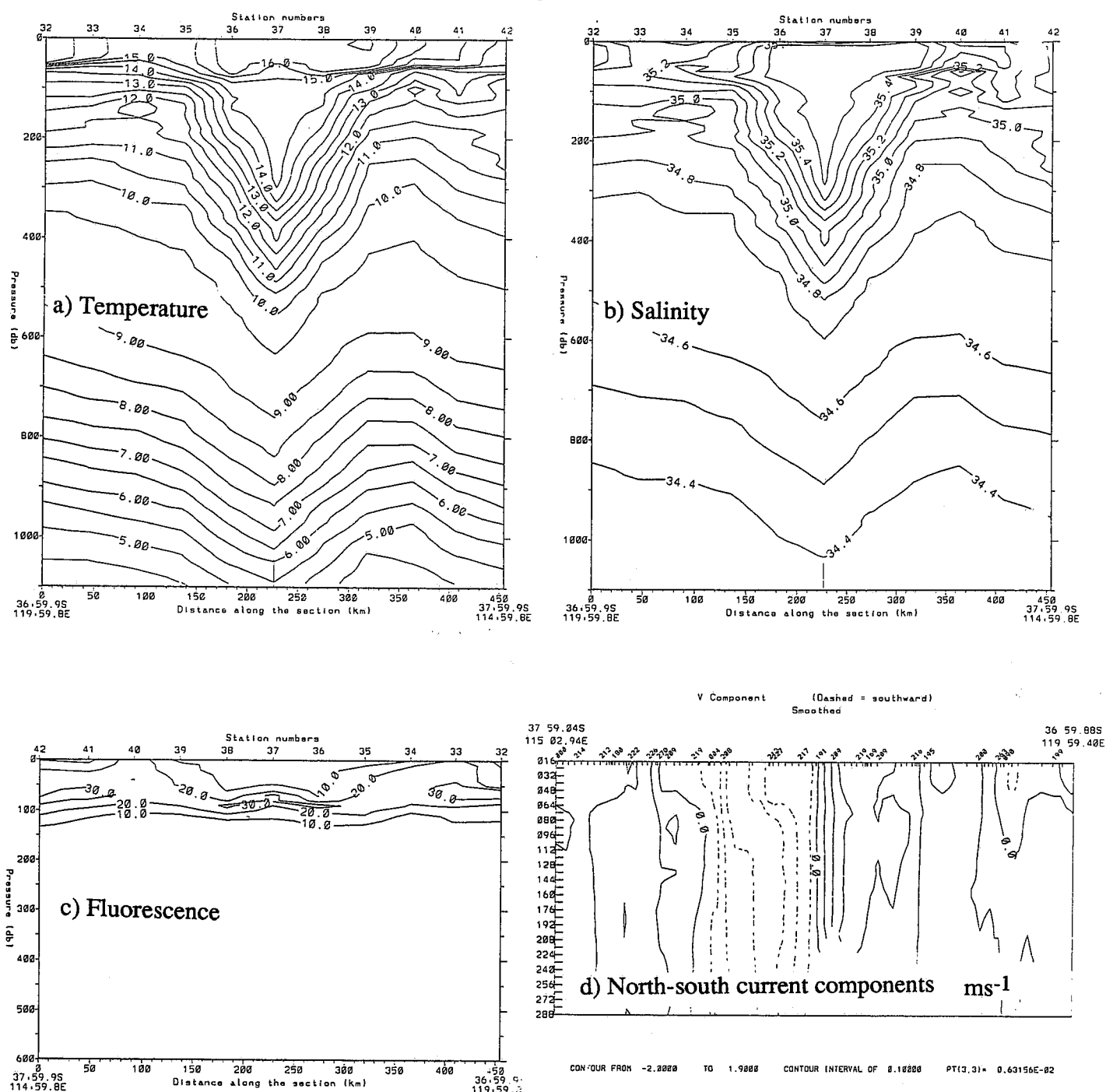


Figure 3

## The transect across the subantarctic intrusions and the warm offshoot

The ship occupied eleven stations (#32-#42) to 1100 m at 0.5° longitude intervals along this transect. The satellite image (Figure 3) used to plan the ship's track, shows a warm offshoot/eddy with cold intrusions of subantarctic water on its eastern and western sides; near-surface current vectors from the ADCP are superimposed on the image. The temperature and salinity sections (Figures 4 a, b) show the influence of the 200 km diameter eddy reached down to at least 1100 m. At its centre the eddy had a subsurface mixed layer of "winter" water (due to cooling and deep convection) between 100 and 300 m depth with temperature ~14.7°C. The layer was capped with new, warmer, water from the Leeuwin Current. In salinity the layer appeared to extend very near to the surface, but this was because the capping layer, coincidentally, had the same salinity, ~35.5, as the mixed layer. One can comment that this salinity seems quite low for the Leeuwin Current south of WA. Fluorescence values (Figure 4 c) exceeded 10% of full scale only in the upper 130 m. In the upper 50 m fluorescence was low in the eddy and high in the intrusions, e.g. <10% of full scale at stations #36-#38 and >20% at #33 and #40. The north-south current components (Figure 4 d) show that the surface current structure extended down to the ~300 m depth reached by the ADCP, in agreement with the deep influence of the eddy on the temperature and salinity structures. The contrast of temperature, salinity and fluorescence in and out of the eddy was reflected in the bird observations made by Chris Surman and reported in an attachment to this report. In brief, the Leeuwin Current waters in the eddy held little to no attraction for the birds.

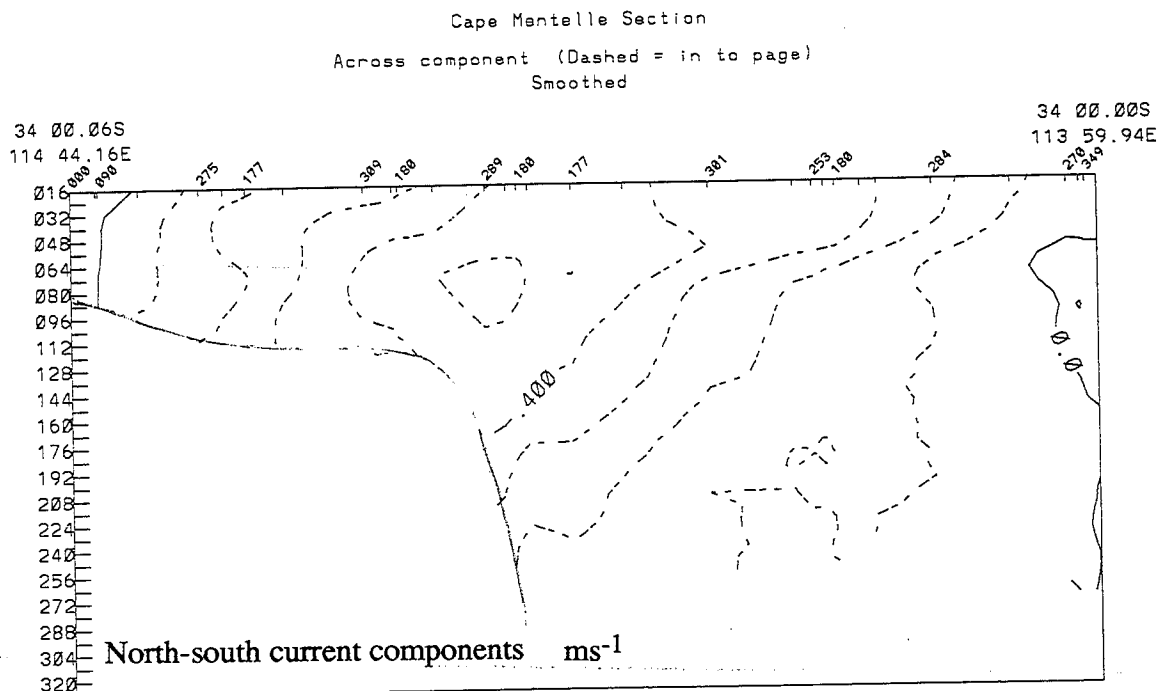
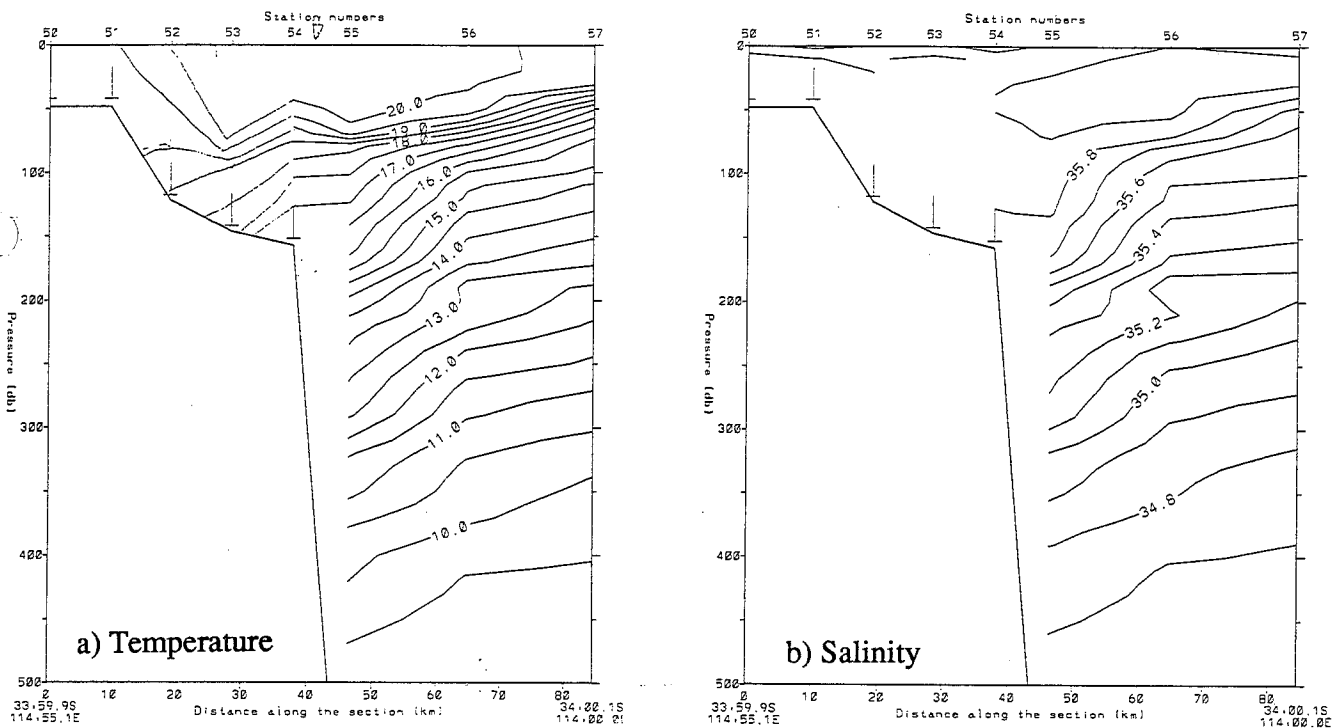
Figure 4



## The Cape Mentelle (34°S) transect

The temperature and salinity structure driving the Leeuwin Current sloped down from west to east into the continental slope (Figure 5 a, b). The surface core of the LC had temperature exceeding 20°C and salinity exceeding 36.0. Its speed peaked at 0.5 ms<sup>-1</sup> between 60 and 90 m depth just above the continental shelf edge (Figure 5 c). One can speculate that the subsurface maximum may have been the result of the strong southerly winds retarding the near-surface waters. The currents at the nearshore end of the transect were northward — the Capes Current.

Figure 5





## Density and Distribution of Southern Ocean Seabirds: Cruise summary.

Seabirds are limited in their distribution during breeding by the availability of suitable nesting sites that are still within range of reliable foraging grounds. Previous studies have found a strong relationship between seabird distribution and water types during non-breeding periods. This study aims to broaden our knowledge of seabirds and their association with the Leeuwin Current, and other bodies of water.

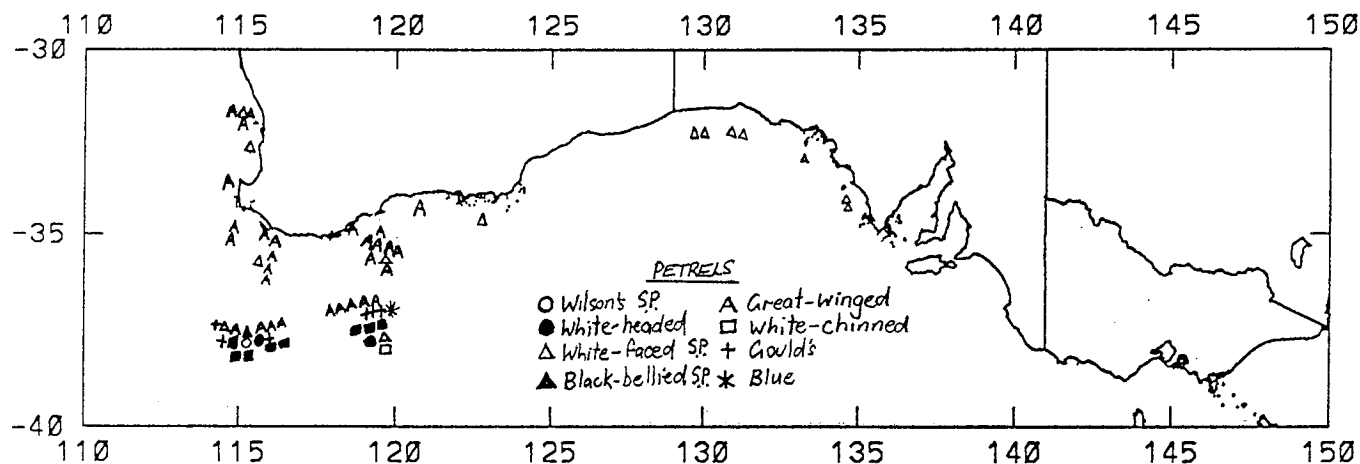
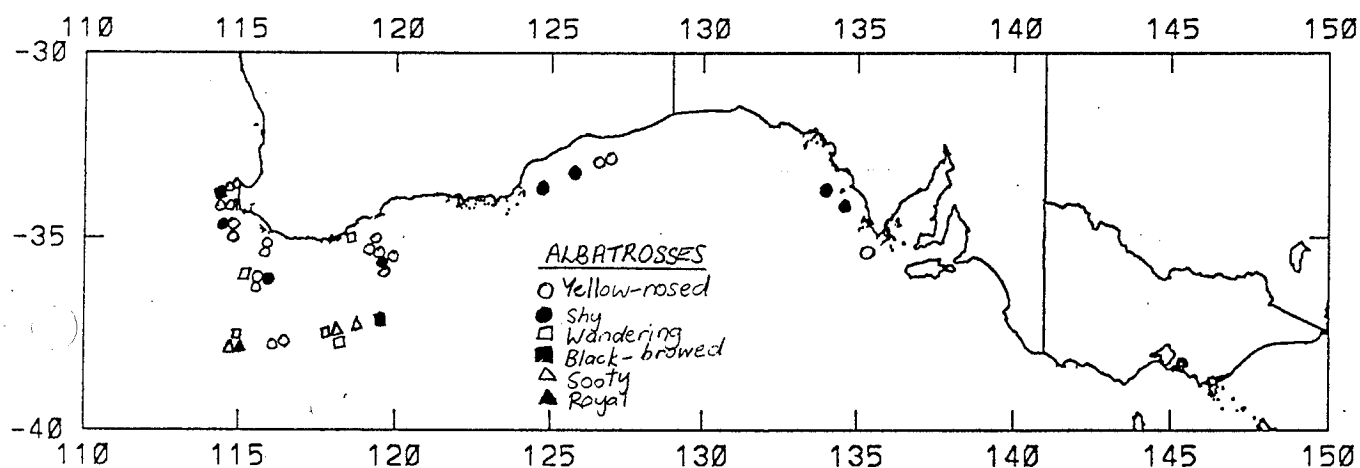
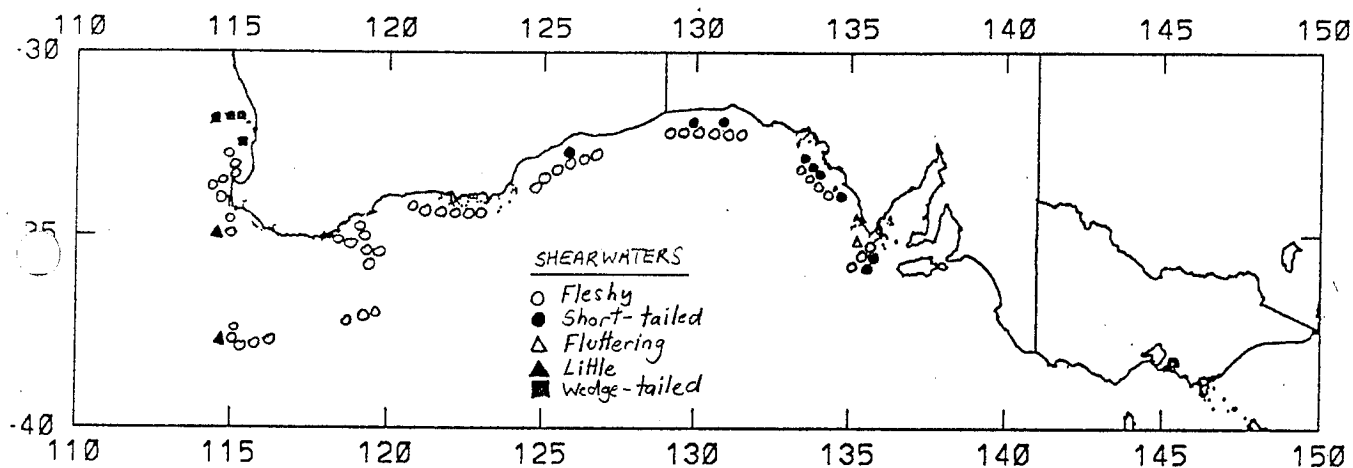
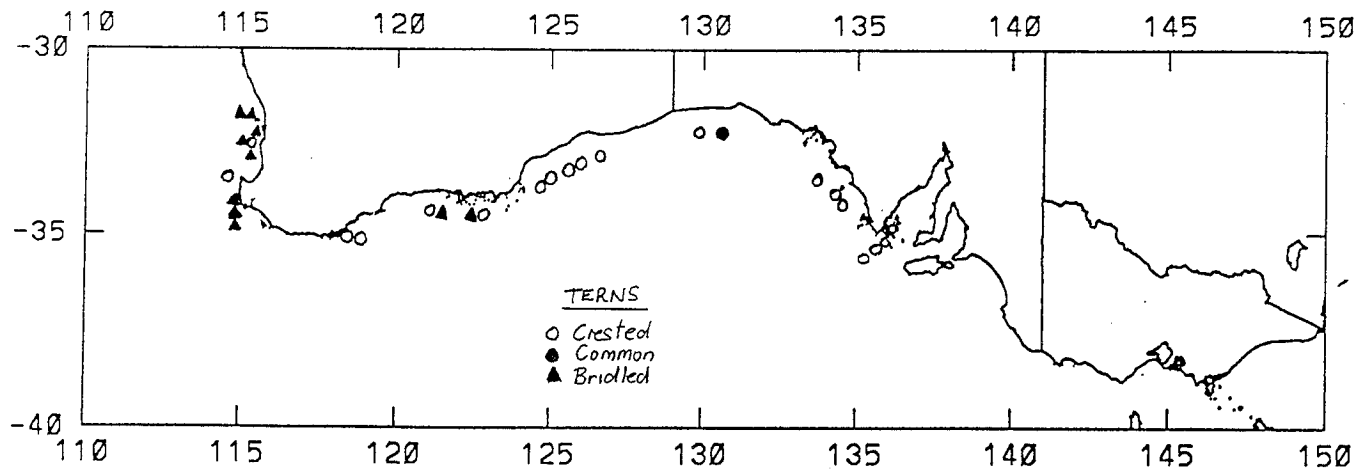
The results from observations taken during this cruise reveal a number of interesting patterns. The accompanying figure shows the distributions of the four major groups of seabirds identified during this voyage; terns, shearwaters, petrels and albatrosses. Terns appear to be largely restricted to shelf waters. Bridled Terns were found to near known breeding sites at Cape Leeuwin and Penguin Island, however several individuals were recorded well east of their normal range. These birds are obviously associated with the Leeuwin Current (LC) and may have colonised a new breeding location in the vicinity of the Recherche Archipelago, towards the eastward limits of the LC's reach.

Shearwater distribution changed markedly at two points. Short-tailed Shearwaters were lost after leaving the eastern parts of the bight, and Wedge-tailed Shearwaters replaced the almost ever present Fleshy-footed Shearwater just north of Cape Naturaliste. Shearwater distribution in this region demonstrates the utilisation of different water types (and hence prey types) and colonisation of different geographical locations thereby avoiding excessive competition between these three very similar species.

Perhaps the most interesting findings were the seabirds found associated with cold water intrusions, including the siting of a number of Gould's Petrels nearly 3700km from their nearest known breeding station. Seabird diversity certainly increased as the *Franklin* steamed south, and was particularly noticeable where the water temperatures hovered around 15°C, and the salinity 35‰. In fact the majority of petrels and albatrosses were encountered in this region.

The associations of seabirds with particular water types enhances the overall oceanographic picture of any region. The discovery of the sub-tropical Gould's Petrel and the tropical Bridled Tern south of 34° has put a whole new perspective on the range extension of seabirds that has been evident in W.A. over the last 20 years. Without further "bird-persons" on such journeys, who knows what avian wonders will pass unnoticed?

Chris Surman, Murdoch University.

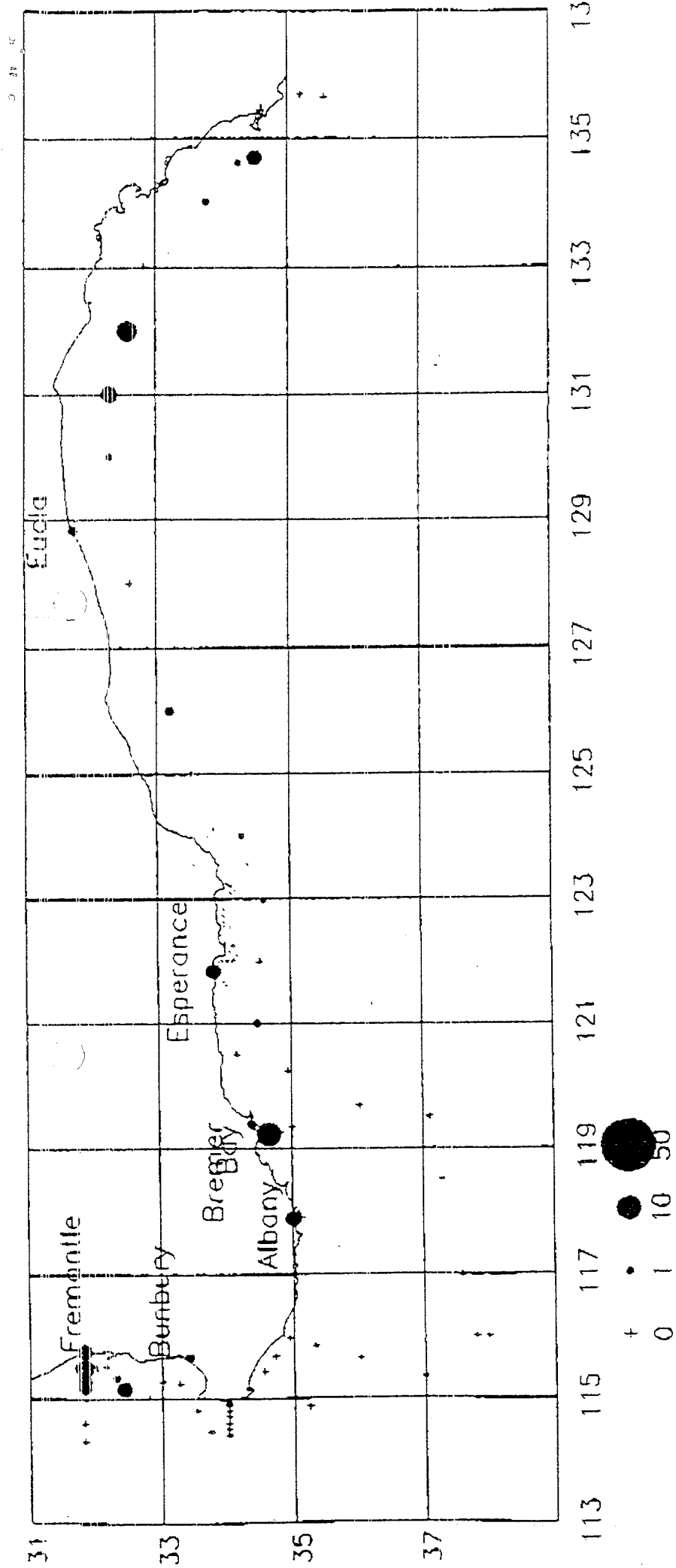


## LARVAL FISH DISTRIBUTIONS

**Dr Rick Fletcher - WA Marine Research Labs, North Beach WA**

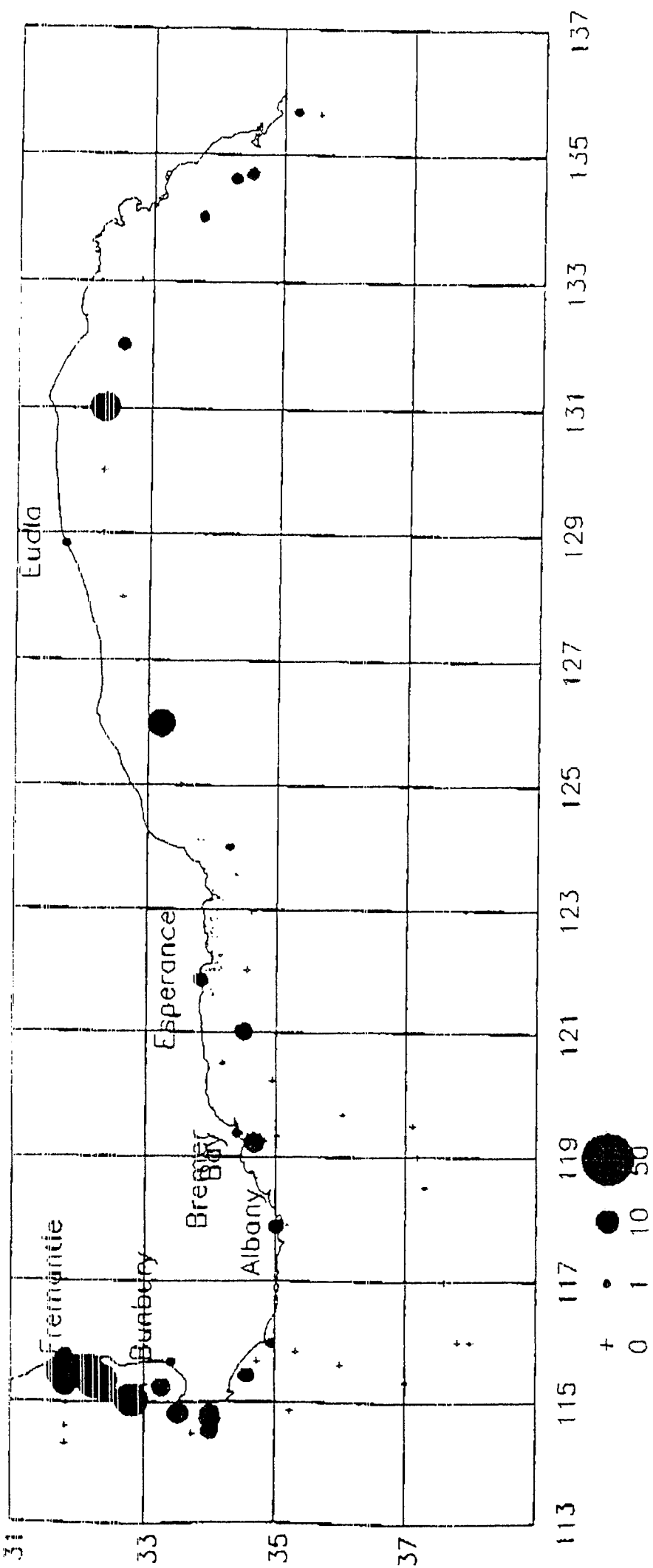
During December 1994, two members of the Pelagic Fisheries research group of the Western Australian Fisheries Department participated on a cruise by RV Franklin from Port Lincoln to Fremantle. Ichthyoplankton samples were taken to further our knowledge of the distribution of the pilchard *Sardinops sagax neopilchardus* in southern Australian waters.

Samples were taken on the continental shelf from Port Lincoln to Bremer Bay (119°30'E), offshore (south to 37°30'S) between Bremer Bay and D'Entrecasteaux Point (116°E) and both on and off the shelf from Cape Leeuwin (34°30'S) to Fremantle (32°S). Pilchard eggs were distributed along much of the continental shelf across the Great Australian Bight and west to Bremer Bay (Fig. 1). On the west coast, eggs were again found predominantly at stations on the shelf, and were most common at 32°S. Pilchard larvae were similarly distributed across the Great Australian Bight but were more common off the west coast than eggs, being widely distributed from Cape Leeuwin to Fremantle (Fig. 2). At all regions covered by the cruise, pilchard larvae were typically more abundant than eggs. No pilchard eggs or larvae were found in the oceanic regions to the south of Western Australia. The patterns of egg and larvae distribution, confirm that populations of *Sardinops sagax neopilchardus* occur across southern Australia and in this region are largely confined to the continental shelf.



Franklin Dec. 94 Vert. 500: Pilchard Egg  
Nos./200m³

FIG 1



Franklin Dec. 94 Vert. 500: Pilch. Larva  
Nos./200m3

Fig 2