National Facility Research Vessel

RV FRANKLIN

VOYAGE DOCUMENTS

RV SOUTHERN SURVEYOR

CSIRO AUSTRALIA

CSIRO MARINE AND ATMOSPHERIC RESEARCH

Voyage Plans and Summaries

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Franklin Voyage Summary No. FR10/2000

Title

Continental shelf processes between Shark Bay and North West Cape.

Itinerary

Departed:Fremantle 1800 hrs, Monday 13 November, 2000
Arrived:Fremantle 1530 hrs, Monday 27 November, 2000

Principal Investigator

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Scientific Objectives

To use RV Franklin together with satellite data and other instrumentation to investigate:

1. Several key physical features of the WA coast:

- summer circulation pattern along the continental shelf between Shark Bay and North-West Cape,
- interaction between the northward coastal current and the southward Leeuwin Current at the coastal promontory at Point Cloates and
- processes controlling the exchange of water between Shark Bay and the continental shelf including the fate of high salinity outflow from Shark

Bay.

2. Biological productivity related to the physical features above:

- examine the biological response of the shelf system to summer upwelling events via vertical profiles of primary productivity,
- Subsurface Chlorophyll Maximum (SCM) - determine if there is a consistent SCM on the shelf and under the Leeuwin Current, and the spatial extent of this feature between Shark Bay and North-West Cape and
- Southwest region vs. NW Shelf - investigate differences between these two regions in terms of productivity, nutrient profiles, species composition and physical dynamics.

Cruise Objectives

After departing Fremantle, Franklin will conduct 10 standard lines along the continental shelf (Figure 1). For each transect, 10-15 CTD stations will be occupied depending on the shelf width. The transects will extend from the coast (20 m isobath) to the 1000 m contour. In addition to the standard CTD and fluorescence, nutrient data will also be collected. The measurement of currents (from the shipborne ADCP) and water properties (temperature, salinity, fluorescence) will enable the mapping of the structure of the continental current systems and the Leeuwin Current.

Process studies (using ADCP measurements and high resolution CTD stations) will be undertaken at three sites: (a) off Point Cloates to examine the eddy structure; (b) at Geographe Channel to examine the Shark Bay outflow; and (c) at Naturaliste Channel to examine the frontal feature.

Cruise Track

The cruise track is shown in Figure 1. Franklin departed Fremantle and then deployed a current meter mooring to the north of Rottnest Island for George Cresswell (CSIRO). After the mooring had been deployed, Franklin sailed north to Shark Bay. The first cross-shelf transect, Transect G was completed and then sailed north to North West Cape. Here, Transects A to D were completed. Based on the data collected from transects C and D and satellite imagery, an additional ADCP run was completed to capture the eddy structure at Point Cloates. We then completed transects E, F and sailed into Shark Bay through Geographe Channel and completed transect SB (within Shark Bay). Franklin exited Shark Bay and completed transect H. An additional transect (DH) was added to examine the high salinity water outflow from Shark Bay. Subsequently, transect I (extended further offshore to capture a cold water eddy) was completed. After transect J was completed the ship set sail toward Fremantle. During this leg we completed an XBT transect across a high chlorophyll eddy identified from

SeaWIFS imagery. Prior to docking two ADCP transects along Hillarys boat harbour to the north of Rottnest Island were completed.

Results

This cruise is one of the first to undertake detailed physical and biological measurements on the continental shelf/slope between the Abrolhos Islands and North West Cape during the summer months. Preliminary analysis of the data indicate that we will be able to address all of the scientific objectives as detailed below:

Summer circulation pattern along the continental shelf between Shark Bay and North-West Cape.

The data collected during the cruise indicated that in general there are two major current systems: (a) the strong southerly Leeuwin Current located along the shelf edge and further offshore; and (2) a weaker northward current on the shelf. The latter northward current was found to be very inconsistent depending on the location.

Interaction between the northward coastal current and the southward Leeuwin Current at the coastal promontory at Point Cloates.

The ADCP transect between end of transect G and beginning of transect A showed some evidence of the presence of this eddy which appears to extend to a depth of 200m. However, the additional ADCP transects undertaken after the completion of transect D and about 2-3 days after the initial transect did not appear to show this feature clearly. It is possible that this is a transient feature. SeaWiFS imagery obtained during September/October 2000 indicate that the feature may have a timescale (from initiation to dissipation) of about 4-5 days.

Processes controlling the exchange of water between Shark Bay and the continental shelf including the fate of high salinity outflow from Shark Bay.

Interestingly, highest salinity on the continental shelf was found offshore Shark Bay. However, this water was higher in salinity to that within Shark Bay. There are two possibilities: (1) the higher salinity is upwelled from the Leeuwin undercurrent; or (2) discharged from Shark Bay prior to our survey.

Examine the biological response of the shelf system to summer upwelling events via vertical profiles of primary productivity

Vertical profiles of primary productivity were obtained from at least two stations (on the continental shelf and at the shelf edge) at most transects. All of the vertical CTD transects indicated a strong relationship between the water column structure (density), dissolved oxygen concentration and fluorescence. These relationships will be examined in detail together with the nutrient data when the calibrated data is available.

Subsurface chlorophyll maximum - determine if there is a consistent SCM on the shelf and under the Leeuwin Current, and the spatial extent of this feature between Shark Bay and North-West Cape.

One of the major findings of this cruise is that we will be able to demonstrate that there is a consistent subsurface chlorophyll maximum (at depths of 70-100 m) on the shelf and beneath the Leeuwin Current. A typical example of the SCM is shown on Figure 2 for transect A. Every transect (A to J) shows the existence of this feature. In general, the fluorescence within the SCM was a factor of 3-4 higher than at the surface.

Southwest region vs. NW Shelf - Investigate differences between these two regions in terms of productivity, nutrient profiles, species composition and physical dynamics

Pattiaratchi has been awarded a University of Western Australia research grant to collect data off south-western Australia (between Cape Leeuwin and Rottnest Island) during the summer of 2001 to examine the differences between the two regions. Here, CTD (including fluorescence), nutrient and primary productivity data (similar to that collected during this cruise) but limited to < 100 m water depth. will be collected.

Cruise Narrative

General and Physical Oceanography

The cruise was delayed by 6 days due to a medical emergency during the previous cruise (FR09/2000). Thus the cruise dates were changed to 13-27 November 2000. The ship departed on schedule at 1800 hrs on 13th November. There were problems with the shipboard ADCP during the previous cruise and this was fixed during the first few hours of our cruise. The current meter mooring for George Cresswell was deployed without any problems.

All underway measurements: standard meteorological, thermosalinograph (including fluorometer), shipboard ADCP and echo-sounder were enabled when the ship departed and worked without any problems throughout the voyage.

On route to the first station (on transect G), completed a test CTD station to check the system. For the duration of the cruise, the Seabird CTD was used, which also included sensors for dissolved oxygen, fluorescence and PAR. A 24*5L bottle rosette was used.

After completing transect G (10 stations) set sail to start of transect A and completed 11 stations. At the deepest station (1000m) the rosette failed to fire due to a faulty connection. Then completed transect B (9 stations) and then onto transect C. The wind began to freshen and during transect C, we had to

suspend operations for 5 hours due to strong winds. Completed transects C (8 stations) and D (12 stations) without any problems. Undertook additional ADCP runs to define the eddy off Point Cloates.

After completing of transects E (10 stations) and F (12 stations) we sailed into Shark Bay and completed 13 stations before beginning transect H (12 stations). Subsequently, we completed transects DH (5 stations), I (13 stations) and J (12 stations) before the return leg to Fremantle.

There were no major equipment or weather problems for the duration of the cruise.

Primary Productivity

Anya Waite, Christine Hanson and Peter A Thompson aimed to characterize the biological community on and off the WA continental shelf, focusing particularly on the productivity of the deep chlorophyll maximum, which was ubiquitous, and as deep as 120 m. We sampled for particulate carbon and nitrogen, chlorophylls a,b, and c, HPLC pigments and phytoplankton species composition. Process measurements included nitrogen uptake rate experiments, primary productivity and microzooplankton grazing rates (the latter once only). Primary productivity measurements were undertaken on board Franklin within the biological container using equipment provided by Brian Griffiths (CSIRO Marine Research).

Chlorophylls were measured at every sampling depth on at least 3 stations per transect. Where full chlorophylls were not taken, samples were taken at the surface and at the deep chlorophyll maximum. Phytoplankton cell count samples were taken at the surface and at the chlorophyll maximum for each station.

Christine Hanson measured primary productivity twice per transect, where possible on the shelf and at a deep station for each transect. HPLC and POC/PON samples were taken at every productivity station. At each productivity station where possible, Peter Thompson measured nitrate and ammonium uptake using trace and saturating additions of 15N-ammonium and 15N-nitrate. Halfway through the cruise, a microzooplankton grazing experiment was conducted at the chlorophyll maximum only.

Zooplankton

Zooplankton were sampled by Tony Koslow with a 60 cm diameter ring net (330 mm mesh with 200 mm mesh codend) deployed as a vertical drop net, and a 1 m square net (1 mm mesh with 500 mm mesh codend) deployed at the sea surface to sample the neuston. The drop net was deployed to ~5 m of bottom or to a maximum of 170 m depth at the 50, 100, 200, 500 and 1000 m depth stations on transects A, D, E, G, I, and J. In all, 37 drop net samples were obtained both at these stations and in conjunction with the neuston tows. Surface tows were intended primarily to obtain phyllosoma larvae, so they were carried out only at night at stations beyond the continental shelf (200 m). In all,

10 neuston samples were obtained on transects F - J. Phyllosoma were only obtained during the latter half of the cruise, when there was no moon present and in the southerly portion of the cruise track.

Summary

This cruise was one of the first to examine in detail the physical and biological oceanography along the west coast of Western Australia. The cruise was very successful in meeting its scientific objectives. During the cruise we had no problems with instrumentation (except when the CTD rosette failed to fire at two stations). The weather was reasonable - we only lost 5 hours when the winds were too strong for deck operations. All of these factors and the excellent support and cooperation of the ship's crew and CSIRO personnel (both on board and in Hobart) combined to produce a very successful and 'happy' cruise.

Personnel

Scientific

Charitha Pattiaratchi,CWR/UWA, Chief Scientist, Physical Oceanography
Anya Waite, CWR/UWA, Phytoplankton, nutrients
Mun Woo, CWR/UWA, Physical Oceanography
Betsy Nahas, CWR/UWA, Physical Oceanography
Christine Hanson, CWR/UWA, Phytoplankton, nutrients
Will Schroeder, Uni of Alabama, Physical Oceanography
Peter Thompson, Uni of Tasmania, Phytoplankton, nutrients
Tony Koslow, CMR, Zooplankton
Lindsay Pender, CMR, Cruise Manager, Computing
Phil Adams, CMR, Electronics
Neale Johnston, CMR, Hydrochemistry
Gary Critchley, CMR, Hydrochemistry

ORV Franklin crew

Neil Cheshire, Master
Bob Hardinge, 1st Officer
John Boyes, 2nd Officer
John Morton, Chief Engineer
Greg Pearce, 1st Engineer
Hugh McCormick, Electrical Engineer
Dan Davies, Greaser
Mal McDougall, Bosun
Tony Hearne, AB
Manfred Germann, AB
Jim Lindop, AB
Jim McGarvey, Chief Steward
Charlie Vigh, Chief Cook
Wayne Hattom, 2nd Cook

The scientific party would like to acknowledge the professional expertise of Captain Neil Cheshire, all officers and crew of ORV Franklin, and thank them for their friendly help at all times. The CSIRO personnel (Lindsay Pender, Phil Adams, Neale Johnston and Gary Critchley) were thoroughly competent and co-operative. Their continuous cheerfulness and skill in all situations enabled non-stop data-gathering and a very high data return.

Compliments are also due to the Chefs, Charlie and Wayne, for their excellent and varied menus throughout the voyage.

Charitha Pattiaratchi
Chief Scientist.

Figures

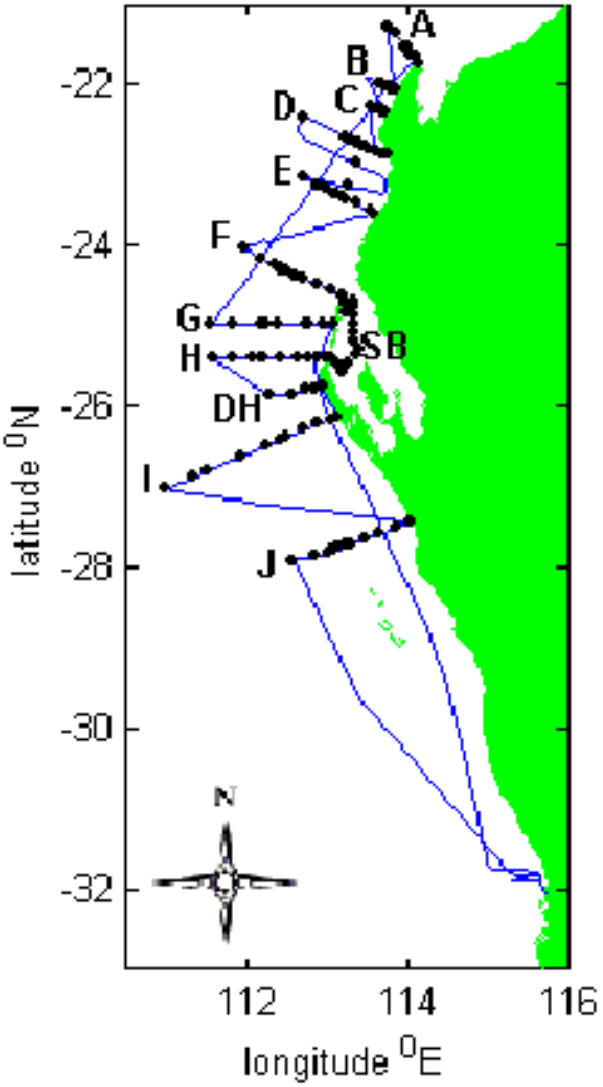

Figure 1 Cruise track of FR10/2000 and locations of CTD stations.

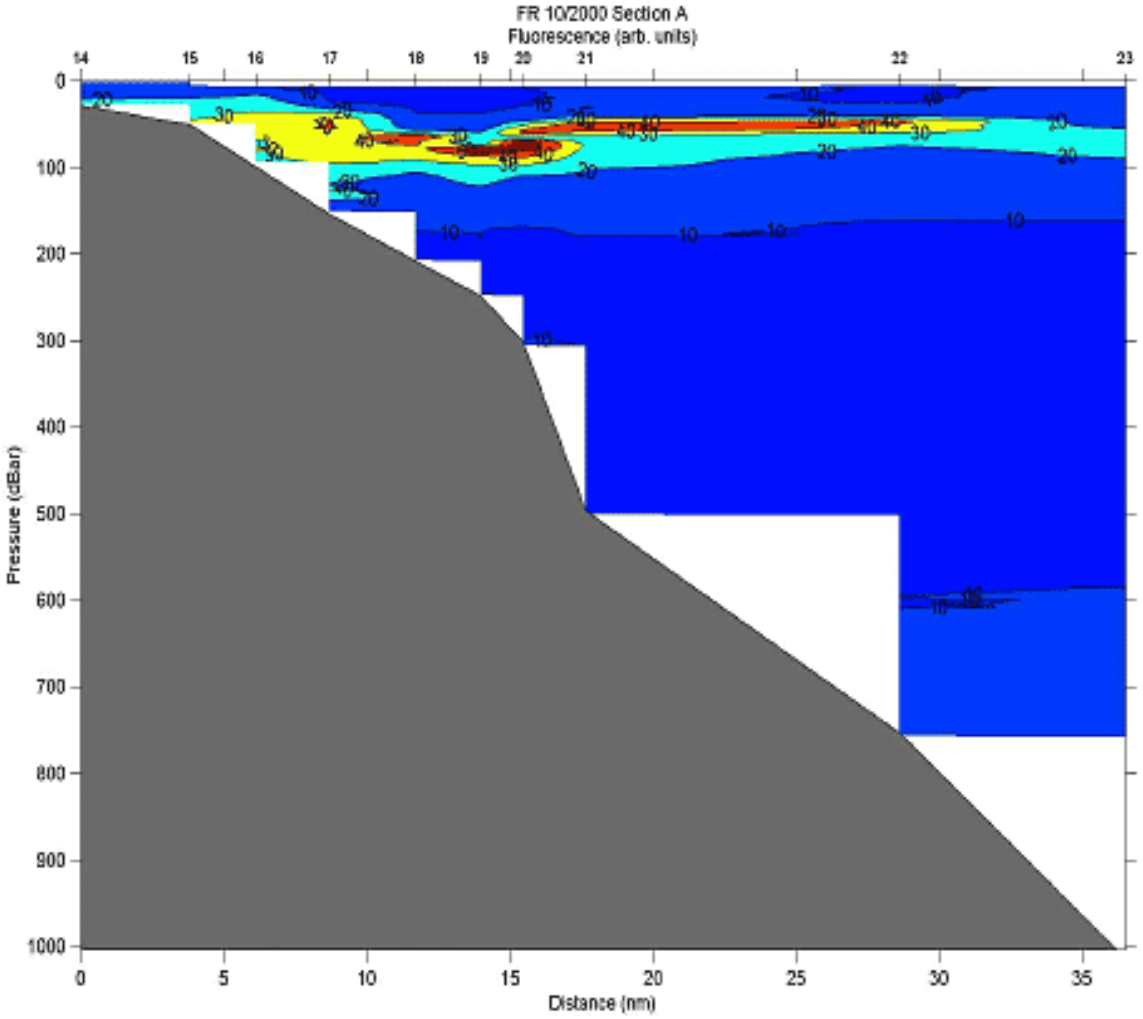

Figure 2 Cross-section transect of fluorescence at Transect A showing the consistent deep chlorophyll maximum.

Updated: 31/01/03