VOYAGE SUMMARY SS01/2004

Title
Seasonality in community structure, productivity and energy flows in the continental shelf and offshore pelagic environment off southwestern Western Australia.

Itinerary
Depart Fremantle 0800 hrs, Tuesday 20 January 2004
Arrive Fremantle 1000 hrs, Wednesday 28 January 2004

Principal Investigator
Dr. Tony Koslow (Chief Scientist)
CSIRO Marine and Atmospheric Research
Floreat Marine Laboratories
Underwood Ave, Floreat Park, WA 6014
Private Bag No 5
Wembley, WA 6913
Phone: (08) 9333 6520, Fax: (08) 9333 6555
E-mail: tony.koslow@csiro.au

Scientific Objectives
The scientific objectives were to:
- Investigate the physical, chemical, and biological (phytoplankton, zooplankton and micro-nekton) structure along a transect north of Perth extending from the nearshore (17 m depth) to offshore (1000 m depth);
- Measure processes associated with biological productivity inshore and offshore;

Voyage Objectives
The Voyage objective was to occupy stations along a transect north of Perth orthogonal to the coast, with its nearshore station outside Two Rocks. Stations were at the following depths:
- 17 m (coastal) (A);
- 40 m (inner shelf) (B);
- 100 m (outer shelf) (C);
- 300 m (shelf break)(D); and
- 1000 m (offshore-Leeuwin Current) (E)

Each station was to be repeated day and night
At each station the following sampling was to be undertaken:
- CTD profiles to measure temperature, salinity, light, chlorophyll, oxygen, and acoustic backscattering (TAPS). (CTD casts were also to be made midway between each full sampling station). Plankton pump samples obtained dya and night to ground-truth the acoustic profiles.
- Rosette casts to collect water for oxygen, nutrients (N, P, Si), salinity, chlorophyll a, photosynthetic pigments, micro-zooplankton and determinations of primary productivity at depths (as available) of: 0 (bucket or sub-surface Niskin), 10, 25, 50, 75, 100 and 150 m depth or

near bottom at shallow stations. A sample from the chlorophyll maximum should be substituted for one of the latter depths, depending upon its position.

- Replicated double-oblique Bongo net tows, plus one daytime and one night-time depth stratified tow from near surface to within 5-10 m of bottom or to a maximum of 150 m depth. The depth-stratified tows will cover the following strata: surface, mixed layer above chlorophyll maximum, chlorophyll maximum, and the layer below chlorophyll maximum. Fewer strata may be sampled at station B (40 m depth).
- Replicated day and night midwater trawl tows, vertically stratified at stations greater than 100 m depth.
- Measurements of upwelling and downwelling light irradiance and hyperspectral irradiance through the water column to 30 m depth.

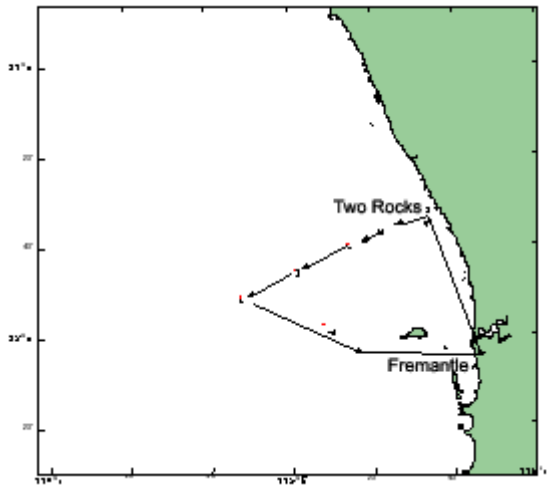
Other sampling included:

- Measurements of primary productivity based on 24-hr 14C incubations, microzooplankton and mesozooplankton grazing at stations A, C and E,

samples for an enzyme assay of secondary production from stations A,C and E.

- Microzooplankton dilution experiments will be carried out at the surface and chlorophyll maximum depths.
- Deploying and retrieving a drifting sediment trap, with satellite tracking buoy, at stations C and E and to carry out a 3 x 3 grid of stations around the trap, stations at 3 n mi intervals, sampled with CTD and 1 bongo tow, to assess fine-scale variability.
- Collecting three replicate box-core or grab samples of the bottom sediments at stations A – D to assess sources of organic matter deposited in the sediments.
- Collecting underway temperature, salinity, and chlorophyll fluorescence between each station. A sample will be obtained at each full station to calibrate the underway fluorescence.
- Deploying the high-frequency acoustic system (TAPS) at the shallow station (A) for 24 hr to examine diel vertical movements of the plankton. Plankton pump sampling was conducted for ground-truthing.

Voyage Track



Results

All stations were occupied and virtually all objectives were achieved. At each station, the CTD was deployed to obtain a water column profile of temperature, salinity, oxygen, and chlorophyll a fluorescence. Water samples were obtained at the selected depths to calibrate the salinity, oxygen and chlorophyll values and to obtain samples for nutrient analyses, as well as to analyse for phytoplankton and microzooplankton species composition from the surface (bucket sample and just below surface, respectively) and chlorophyll maximum. Water samples from near surface were size fractionated for analysis of stable isotopes to trace food web processes.

Leon Majewski (Curtin University) took an irradiance profile at each station. These measurements have been compared to near coincident remotely sensed data sets. The MODIS-Aqua based retrievals of the water leaving radiance at stations D and E are within 5% of the in situ measurements.

Replicate tows with a bongo net were carried out day and night at each station to sample macrozooplankton and ichthyoplankton. Fine (100 m m) and coarse mesh (355 m m) nets were used to adequately sample the smaller and larger copepods. A 1m square-framed net was towed at the surface day and night at each station to sample the neuston (near-surface macrozooplankton and micronekton). The neuston community is quite distinct and many interesting specimens were obtained of macro- and megazooplankton and of larval and juvenile fishes.

Stephane Pesant (Centre for Water Research, UWA) undertook measurements of primary production at stations A, C and E, based on 24-hr C-14 incubations and also nitrogen uptake experiments to measure the uptake by phytoplankton of nitrate, atmospheric nitrogen and ammonium. Harriet Paterson (UWA) measured the grazing of phytoplankton by microzooplankton at these stations based on the dilution method, and Joanna Strzelecki (CMR) measured the grazing by macrozooplankton using standard grazing experimental techniques. Ms Strzelecki also measured the feeding by zooplankton on phytoplankton at each station based on measurements of gut fluorescence and also copepod egg production based on 24-hr incubations of individual copepods, using the dominant species at each station. Copepod egg production is a standard means to estimate zooplankton secondary productivity. Small aliquots from the 100 µm mesh bongo tow samples were obtained for an enzyme assay for secondary production. The second of the replicate bongo tows was split with half frozen in liquid nitrogen for analysis of lipid biomarkers and stable isotopes as part of a PhD thesis project (K Danaher, JCU).

We obtained triplicate sediment samples with a Smith-McIntyre grab at stations A- D for Karen Crawley (Edith Cowan University) to examine sources of organic carbon (e.g. seagrass and macroalgae vs phytoplankton detritus) in the sediments.

Stephane Pesant deployed a sediment trap at the outer shelf (C: 100 m) and offshore (1000 m) stations, allowing it to drift for approximately 24 hr to measure the quantity of organic matter sinking below the euphotic zone. The trap was tethered to a freely drifting buoy equipped with Iridium satellite GPS positioning to enable the trap to be re-located. Eight cylindrical traps (60-80mm diameter) were mounted on an aluminium frame. Four replicate traps were used to determine carbon and nitrogen isotope fluxes as well as pigment fluxes and particle composition, i.e. intact plankton, fecal pellets and detritus. The other four traps contained gels that allow video analysis of sinking particles. A grid of stations around the trap was sampled over this time (3 x 3 n mi) with CTD and 1 bongo tow.

Depth-stratified EZ net plankton tows were carried out at stations B — E, day and night. MIDOC (midwater opening-closing) net tows were carried out with varying success at stations C — E.

Voyage Narrative

Voyage operations generally followed a routine, whereby sampling continued over 24 hours at each station, enabling the plankton to be sampled during daylight and night-time hours to assess diurnal variability. Dawn and dusk periods were used to obtain sediment grab samples and, where possible, to steam between stations. Steaming between stations was carried out at reduced speeds (6 — 8 nm/h) to enable the collection of high-quality acoustic data. Sampling grids carried out around drifting sediment traps at stations C & E enabled finer-scale sampling variability to be examined.

The vessel returned to port to allow the bosun to take leave on compassion grounds. Because of the generally excellent conditions that prevailed, the lost time did not critically affect the voyage.

A highlight of the voyage was the appearance of extensive Trichodesmium blooms at stations D & E during periods of calm conditions. Opportunistic sampling was carried out in the T. patches to examine the neuston for potential grazers.

Summary

The Southern Surveyor is a highly seaworthy vessel, providing a stable platform with ample laboratory space and sufficient deck (winch) facilities to collect a wide range of samples and data.

In a relatively brief voyage we were able to sample the physical, chemical and biological environments from the coastal lagoon, across the shelf and over the continental slope in the region of the Leeuwin Current. The voyage complements SS 07/2003 carried out during winter. Together they provide our most detailed assessment to date of the plankton communities off southwest Western Australia, their productivity and feeding interactions, and relationships with their physico-chemical environment. There is considerable interest in the role of nitrogen fixation in global carbon budgets. The opportunity to sample within an extensive Trichodesmium bloom should prove of considerable interest.

Personnel

Scientific Crew

- Tony Koslow, CMR Chief Scientist
- Nick Mortimer, CMR Acoustics
- Joanna Strzelecki, CMR Zooplankton
- Mark Lewis, CMR Biologist
- Stephane Pesant, UWA Phytoplankton
- Harriet Paterson, UWA Microzooplankton
- Chris van Etten, Curtin Uni Acoustics
- Leon Majewski, Curtin Uni Remote sensing
- Barbara Muhling, Murdoch Uni Ichthyoplankton
- Neale Johnston, CMR National Facility Hydrochemistry
- Jeff Cordell, CMR National Facility Electronics
- Pamela Brodie, CMR National Facility Voyage Manager, Computing

Marine Crew

- Ian Taylor, Master
- John Boyes, Chief Officer
- Drew Miencke, 2nd Officer
- John Moreton, Chief Engineer
- David Jonker, 1st Engineer
- John Hinchcliffe, Electrical Engineer
- Malcolm McDougall, Bosun
- Tony Hearne, IR
- Manfred German, IR
- Graham McDougall, IR
- Phil French, Greaser
- Peter Williams, Chief Steward
- Andy Goss, Chief Cook
- Angela Zutt, 2nd Cook
- Mark Spearritt, Extra IR
- Fiona Perry, Extra IR
- Les Kearns, Extra IR

Acknowledgements

The success of this voyage resulted from the hard work and dedication of all scientific and support staff. The hard work, skill and experience of the mates and crew all contributed to making the voyage a success, and are gratefully acknowledged.

Tony Koslow
Chief Scientist