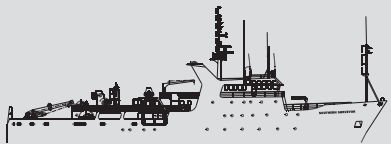


MARINE
NATIONAL FACILITY

2007 program

RV *Southern Surveyor*

CSIRO

voyage summary SS04/2007

SS04/2007

Pelagic ecosystem productivity and dynamics
off the west coast of Western Australia

Itinerary

- Mobilised in part, Hobart: Monday 30th April 2007.
- Transit 03/2007: Departed Hobart 1800hrs, Monday 30 April 2007
- Arrived Fremantle, AM Wednesday 9 May 2007, bunkered and took stores.

Leg 1: AM Thursday 10 May 2007, load WA-based scientific equipment.

Departed Fremantle 1600hrs, Thursday, 10 May 2007.

5 days of benthic survey off Perth

Arrived Fremantle 0800hrs, Tuesday, 15th May 2007.

Leg 2: Departed Fremantle 1600 hrs, Tuesday 15 May 2007

Completed 3 CTD transects and 2 seasoar transects at 34, 33, ~ 32° S.

Small boat transfer of 2 personnel to Fremantle on 21 May.

Leg 3: Departed Fremantle after small boat transfer, 21 May 2007.

Completed transects north of Perth and eddy mapping.

Arrived Dampier 1000 hrs, Wednesday 6 June 2007 and demobilised.

Principal Investigators

Dr. Peter Thompson (Chief Scientist) – CSIRO Marine & Atmospheric Research, GPO Box 1538, Hobart 7001 Tasmania
Phone: (03) 6232 5298 **Email:** peter.a.thompson@csiro.au

John Keesing – CSIRO Marine & Atmospheric Research, Floreat, WA.

Lynnath Beckley – Murdoch University, Perth, WA.

Ming Feng – CSIRO Marine & Atmospheric Research, Floreat, WA.

Martin Lourey – CSIRO Marine & Atmospheric Research, Floreat, WA.

Scientific Objectives

The Leeuwin Current, a unique poleward-flowing eastern boundary current, dominates the oceanography off the west coast of Western Australia. Factors regulating the seasonal plankton cycle and its interannual variability remain poorly understood in this region. One of its most interesting features is the ten-fold increase in chlorophyll, which coincides with the seasonal intensification of Leeuwin Current flow.

We propose here to examine: the regional extent of this bloom and its key drivers for primary production: stratification and depth of the mixed layer, the influence of Leeuwin eddy dynamics and local wind-driven upwelling, and alongshore and cross-shelf advection, plankton food web structure during the bloom: the relative importance of picoplankton and larger phytoplankton, micro- and meso-zooplankton, and links with larval and juvenile fish in relation to onshore-offshore and north-south oceanographic features.

Benthic productivity and recycling of nutrients on the shelf were to be intensively studied in leg 1 of the voyage. If a suitable eddy was present off the west coast between May 20th and May 25th we had proposed to spend 1-3 days mapping the features of the eddy and sampling it.

Voyage Objectives

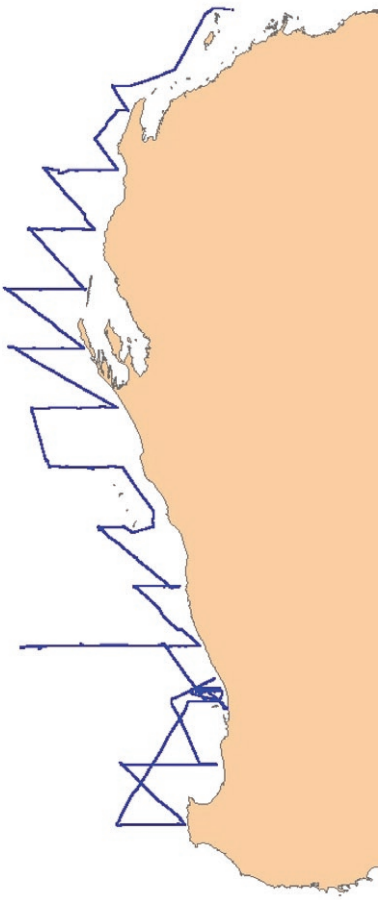
These objectives require a voyage to cover the west coast of Australia during the late autumn/early winter (May/June) period. Initially the voyage will survey the shallow habitats near Perth do assess benthic productivity. Swath mapping, video 'samples', dredges, grabs and box cores are to be collected. Rates of primary production and nutrient efflux will be measured from box cores. Animals and plants will be sorted and stored for analysis later.

The voyage will then be based on 13 CTD onshore-offshore transects undertaken every degree of latitude from Northwest Cape (22° S) to Capes Naturaliste and Leeuwin (34° S). Each transect will extend from as nearshore as is practicable (25 – 30 m depth) to 2000 m depth (Fig. 4). Stations will be set at 25 (inshore), 50, 75, 100 (mid-shelf), 200 (shelf-break), 300, ~500 (Leeuwin core), 750, 1000, and 2000 (offshore) m depth.

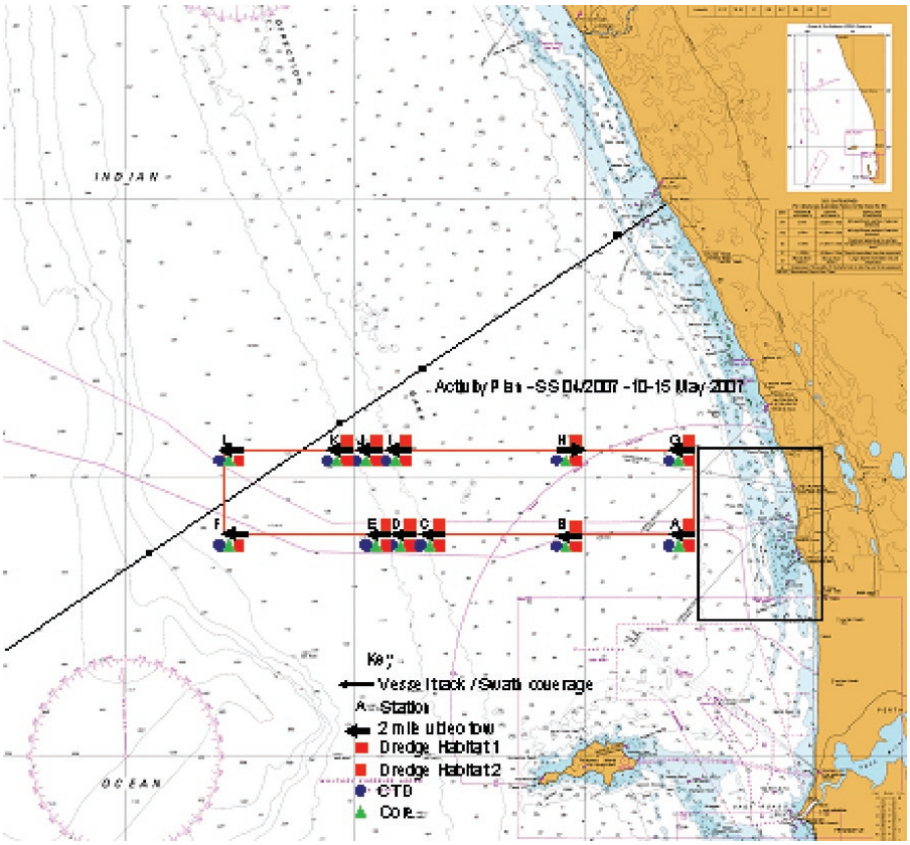
Each transect leg will be joined by a diagonal Seasoar leg to give high vertical and horizontal resolution of temperature, salinity and fluorescence. These will be used to locate a station in the middle of the Leeuwin Current on each CTD transect. The Seasoar mapping, combined with current satellite images, will enable us to place the 'Leeuwin' station within the core of the Leeuwin Current on each transect. CTD profiles will be carried out at all stations to measure temperature, salinity, dissolved oxygen, PAR, chlorophyll fluorescence, and zooplankton acoustic backscatter (using the 6-frequency Trachor Acoustic Profiling System, TAPS) through the water column to a maximum depth of 1000 m. Water samples will be taken at standard depths to measure salinity and nutrients (nitrate/nitrite, ammonia, dissolved organic nitrogen, particulate nitrogen, phosphate, silicate).

Full biological sampling will be carried out at the inshore (50 m), Leeuwin Current (200 – 500 m) stations, and offshore (2000 m). Replicate oblique bongo tows to 150 m maximum; the light profile to 50 m using a profiling reflective radiometer (PRR); water samples for phytoplankton pigment (HPLC) analysis and species composition from near-surface and chlorophyll maximum depths; measurement of size-fractionated primary productivity (C-14 incubation method and PAM measurements from standard sampling depths); nitrogen uptake from labelled nitrate, ammonia, and N2; sampling of lipids and/or stable C and N isotopes in the size-fractionated phytoplankton and in selected zooplankton and ichthyoplankton species to examine food web pathways; microzooplankton grazing based on the dilution method (Landry and Hassett, 1982); total alkalinity & DIC (to assess pH); and secondary production estimates based on egg production and a biochemical (aminoacyl-tRNA synthetase (Yebra and Hernandez-Leon, 2004)) assay. Zooplankton samples will be split, with part retained in ethyl alcohol to examine selected larval fish otoliths for growth to be related to oceanographic conditions. Neuston sampling will also be carried out.

Voyage Track



Map of region and alternating CTD lines and Seasoar lines.



Week 1 of benthic sampling including swath mapping (high resolution acoustic mapping of the bottom), video sampling and benthic sampling with several different sleds and dredges was in the area bound by the red box.

Actual voyage track Legs 1, 2 & 3: May 10th to June 6th 2007. Diagonal lines are Seasoar sections, those at 34, 33, ~32, 31, 29, 28, 27, 26, 25, 24, 23, 22°S are CTD lines and 29°S was a mix of CTD and Seasoar through a large eddy.

Results & Voyage Narrative

The voyage was hugely successful. We had an ambitious plan of activities and were kept very busy but were able to achieve them all. We were fortunate to have reasonable weather and did not miss a single operation due to weather problems. Much of the equipment had intermittent faults, sometime electronic, sometimes mechanical but due to the diligence of the ship's crew and CSIRO technical staff it was continuously repaired and redeployed. Special thanks to Steve Thomas (CSIRO) for his sterling efforts to keep all the electronic instrumentation operating. Many of the ship's crew were relatively new to the vessel and the senior crew were often required to show unusually high levels of leadership in regard to training. Special mention should be made of Tony Hearn, Les Morrow and Madeleine Habib in this regard.

Leg 1 consisted of mostly of swath (acoustic) mapping of the bottom in transects across the shelf from ~ 25 to 150 m depths. Once a region of likely reef was identified from the swath mapping the vessel returned and the deep water video camera was deployed in sections across the depth gradient from 25 to 150m. Areas of high biological diversity were identified and geo-referenced. Once the video transects were completed the vessel returned and the benthic sled and grabs were deployed to collect samples. 15 CTD profiles were also undertaken. This benthic sampling required a great deal of precision from the ship's officers in terms of accurately positioning the vessel. Retrieved samples were photographed, catalogued and preserved. Sediment samples were incubated to measure primary production, nutrient fluxes and benthic microalgal biomass. A high biomass of benthic macroalgae and benthic microalgae were found at depths not previously sampled off WA. These results will change everything from our conceptual to our mathematical models of the WA shelf ecology.

On Leg 2 and 3 we conducted a more traditional water column sampling regime. CTD transects at every degree from 34 to 22°S with diagonal inshore – offshore Seasoar legs in between. CTD transects had stations at ~ 25, 50, 100, 200, 300, 500, 1000 and 2000m water depth along most transects. At each station multiple depths were sampled by Niskin bottle for a range of parameters such as: dissolved oxygen, dissolved inorganic carbon, alkalinity, nutrients ($NO3^-$, NH4+, PO4, Si). At least three stations per transect (usually 50m, 300m and 2000m) had samples for chlorophyll a (6 depths), other pigments (2 depths) particulate organic N and C, δ15N and δ13C, primary production (by 14C and pulse amplitude modulated fluorescence), 15N uptake ($NO3^-$, NH4+, urea and N2), phytoplankton, picoplankton and microheterotroph species abundance. At these stations up to 5 bongo tows and 1 neuston net tow were completed. Zooplankton samples were collected for biomass, species composition, grazing rates, secondary and egg production. Larval fish samples were collected for later identification to assess biogeography and onshore – offshore transport. Samples were collect to examine the effects of UV upon phytoplankton cell viability and to assess microheterotroph grazing rates. Vertical profiles of zooplankton abundance were collected using zooplankton acoustic backscatter (6-frequency Trachor Acoustic Profiling System, TAPS), Hobilab's Hydroscat and the vessel's echo sounders. Vertical profiles of optical properties were obtained using Biospherical profiling reflectance radiometer (PRR) & samples from the surface and depth were collected on filters for subsequent scanning of absorbance at 400 – 700 nm wavelengths.

We expect to be able to quantify any onshore – offshore gradients in these properties as well as any north – south gradient.

On the mesoscale we observed a strong Leeuwin Current that produced 3 eddies along our voyage track. We took ~ 36 hours to sample all the way through one of

these eddies. The combination of onshore to offshore Seasoar transects with ADCP measurements of current velocities will be used to produce a map of the Leeuwin Current (see example below). We hope to turn this map into a full size poster.

We amassed a huge data set that will be enormously useful to parameterize physical, chemical and biological models of the WA coast. We anticipate it might take several years to extract the majority of the scientific value from these results.

Summary

The continental shelf inside of the Leeuwin Current was well mixed top to bottom and phytoplankton biomass was > 5 times greater than during late summer. We were very successful in observing this annual autumn-winter bloom that stretched out over nearly 700 km of the WA coastal zone. The Leeuwin Current was running strongly and 3 eddies were observed, one was mapped. All transects were completed. The voyage achieved all of its scientific goals.

Personnel

Leg 1: May 10th to May 15th

Peter Thompson	CSIRO	Chief Scientist
John Keesing	CSIRO	Benthic sampling
Martin Lourey	CSIRO	Primary production nutrient efflux
Bruce Barker	CSIRO	Camera
Jeff Cordell	CSIRO	Camera
Mark Lewis	CSIRO	Gear/camera
Karen Gowlett-Holmes	CSIRO	Inverts
Andrea Cortese	GA	Swath
Rick Smith	CSIRO	Swath support
Mark Salotti	WA Museum	Invertebrates
Julia Phillips	CSIRO	Benthic plants
Ron Plaschke	MNF	Voyage Manager
Pamela Brodie	MNF	Computing
Drew Mills	MNF	Electronics
Mark Rayner	MNF	Hydrochem

Leg 2. May 15th to small boat transfer May 21st

Peter Thompson	CSIRO	Chief Scientist
James McLaughlin	CSIRO	C14 uptake
Joanna Strzelecki	CSIRO	Zooplankton grazing
Pru Bonham	CSIRO	Pigments
Cecile Rousseaux	UWA	Microzooplankton grazing
Nugzar Margvelashvili	CSIRO	Zooplankton acoustics
Harriet Patterson	UWA	Flow cytometry
David Holliday	Murdoch Uni	Larval fish
Lynnath Beckley	Murdoch Uni	Larval fish
Martin Lourey	CSIRO	N15 uptake
Lindsay Pender	MNF	Seasoar
Pamela Brodie	MNF	Voyage Manager & Computing
Stephen Thomas	MNF	Electronics
Dave Terhell	MNF	Hydrochem
Mark Rayner	MNF	Hydrochem

Small boat transfer: Lindsay Pender off and Karen Wild Allen on.

Leg 3. May 21st to June 6th

Peter Thompson	CSIRO	Chief Scientist
James McLaughlin	CSIRO	C14 uptake
Joanna Strzelecki	CSIRO	Zooplankton grazing
Pru Bonham	CSIRO	Pigments
Cecile Rousseaux	UWA	Microzooplankton grazing
Nugzar Margvelashvili	CSIRO	Zooplankton acoustics
Harriet Patterson	UWA	Flow cytometry
David Holliday	Murdoch Uni	Larval fish
Lynnath Beckley	Murdoch Uni	Larval fish
Martin Lourey	CSIRO	N15 uptake
Karen Wild-Allen	CSIRO	ocean optics
Pamela Brodie	MNF	Voyage Manager & Computing
Stephen Thomas	MNF	Electronics
Dave Terhell	MNF	Hydrochem
Mark Rayner	MNF	Hydrochem

Marine Crew (same for all legs of the voyage)

Les Morrow	Master
Madeleine Habib	First Mate
Luke Brooks	Second Mate
John Morton	Chief Engineer
David Jonker	First Engineer
Seamus Elder	Second Engineer
Charmayne Aylett	Chief Steward
Kym Farmer	Chief Cook
Oliver Herlihy	Second Cook
Tony Hearn	Bosun
Michael Conway	IR
John Hall	IR
Paul Iddon	IR
John Allwood	TIR

Peter Thompson
Chief Scientist

Figures

One example of a x-section through an eddy formed from the Leeuwin Current. Visible are 2 warm (23°C +) and relatively fresh (~ 35.5 ppt) streams, one flowing south (~ 113.5 ° E) and the other north (114.2 °E) as vessel bisected the eddy.