MARINE
NATIONAL FACILITY

annual report

2010-2011

RV *Southern Surveyor*

CSIRO

Australia has the third largest marine estate of any nation, more than twice the size of the Australian continent. Recognising that blue water marine research is beyond the means of individual Australian research organisations, the Marine National Facility (MNF) was established by the Australian Government in 1980. The MNF operates Australia's only dedicated blue water research vessel that carries out research in the national interest from the tropics to the Southern Ocean.

The Marine National Facility provides researchers from organisations across Australia and their international collaborators with a world class blue water research platform. Through strategic long term investment the facility has developed a body of expertise and an equipment portfolio to support blue water research.

The facility is owned and operated by CSIRO on behalf of the Australian government. It is overseen by an independent Steering Committee that reports to the Minister for Innovation, Industry, Science and Research.

Proposals for research on the vessel are evaluated by an independent Science Advisory Committee and peer reviewed by Australian and international scientists for science quality, the ability of researchers to reach the stated objectives and how the work contributes to national benefit.

Our marine estate is extensive and largely unexplored. Australia's surrounding oceans and seas are a source of food, minerals, energy and a major driver of our climate. Ocean based industries contribute more than 10% of the nation's Gross Domestic Product – yet their potential has barely been tapped.

Marine geological events can result in tsunamis that can threaten our coastal communities and shipping.

Regions that have a high environmental value such as the Great Barrier Reef support communities through the generation of tourist income. Conservation plays a critical role in protecting biodiversity and fishing stocks.

Research improves our understanding of the marine environment and our ability to manage it more effectively.

Australia's investment in marine science is an investment in our future.

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Chairman's ADDRESS

The past year can be characterised by two broad areas of work – laying the foundations for our new research vessel, the *Investigator*, and maintaining an intensive program of scientific work on our existing vessel, the *Southern Surveyor.*

After the excitement of having a new research vessel funded the focus then shifted to translating the vision into reality. The selection of a prime contractor was a major focus for the first half of the financial year. Although this may not be particularly exciting for those watching the process from outside, the importance of having an experienced and skilled team to design and build the new vessel cannot be understated.

A rigorous procurement process concluded with the signing of a contract between Teekay Holdings Australia Pty Ltd, as prime contractor, and the Australian Government on the 17 January 2011.

The new vessel will be built at the Sembawang Shipyards in Singapore and design work carried out by RALion, a consortium of Robert Allan Ltd, Alion Canada of Konata and Alion Science & Technology.

The new vessel is scheduled for delivery in mid-2013. Thus we intend to conclude operations with the *Southern Surveyor* in 2013 in preparation for decommissioning and sale.

The first year of operation for the *Investigator* will start in the second half of 2013 and will be a commissioning year in which we will fully test the new vessel across its full range of operating environments. Some of the voyages will be sea trials with no or minimal science attempted. Many of the voyages in 2013-14 will be carrying out opportunistic science. This will enable us to maintain a science program over this period, test out the equipment and give the scientific participants an opportunity to familiarize themselves with the new vessel.

In 2014-15, once the commissioning period has finished, we will begin a normal year of scientific operations.

As we will be operating quite differently in 2013-15 due to commissioning activities there was a call for expressions of interest for

sea time in May 2011 for the 2013-14 and 2014-15 periods. This was to alert applicants that this was not a normal period of operation due to the commissioning of the new vessel and there was a need for greater flexibility from scientific participants.

Regardless of the challenges, it is expected there will considerable interest in the opportunity to carry out research on *Investigator* which will become Australia's principal science platform for ocean research.

Building a research vessel to meet the needs of so many stakeholders has not been easy. It has been greatly helped by the input from the broader marine community. The Technical Advisory Group is a committee that supports the CSIRO team involved in building the vessel and provides extensive input into the design of the vessel and the equipment that goes onboard. This committee has representatives from four science disciplines – geosciences, oceanography, biology and meteorology. These people draw input from their colleagues throughout the broader scientific community.

In addition to the formal input, there have also been extensive discussions with research vessel operators overseas. Add this to the knowledge of the collaborating science organisations and what has been built up in CSIRO over many years of operating the Marine National Facility, the experience of our Technical Director and contractors, and we have an excellent team with a considerable depth of experience.

To strengthen the coordination of the CSIRO team, Toni Moate has been appointed the Executive Director of the Future Research Vessel Project. The Project's Technical Director, Graham Stacey, will soon be moving to Singapore to coordinate activities there.

With the excitement of a new vessel on the horizon it is easy to be distracted from the world-class work being undertaken by our scientists on the *Southern Surveyor*.

Marine research scientists are working collaboratively with international and national partners to help answer regional and global questions involving climate, fisheries, geoscience and the ecological dynamics and status of our oceans. Our approaches to collecting and storing research results are increasingly becoming harmonized through involvement in international programs. This process facilitates the utilization of data collected across large regions and provides greater insight into how our planet works.

Voyages this year include maintenance of moorings in the Southern Ocean for the Integrated Marine Observing System, maintenance of the tsunami warning system, better understanding of the Eastern Australian and Leeuwin currents and their impact on biological communities and the study of benthic communities in the Benthic Protection Zone of the Great Australian Bight Marine Park.

There was also strong support by the Marine National Facility of the *Next Wave* student program with four transit voyages largely dedicated to student training. On these voyages students carry out marine research and see firsthand the operations of a marine research vessel. Some universities also maintain a student blog which enables students not on the voyage to stay engaged with what is happening and share some of the excitement.

The *Next Wave* program provides an important training opportunity for the next generation of marine scientists. A voyage can be a life changing experience.

This year we have also made significant progress in improving the discoverability and accessibility of data from voyages. Data is progressively being made available through the Australian Ocean Data Network (AODN) portal. The portal also provides access to data from other sources making it a rich source of information for the marine community, government and industry.

In summary, there is great cause for optimism and excitement about the current and planned operations of the Marine National Facility and the importance of this work to the national interest and its relevance to several of the 'big challenges' facing modern Australian society. Nonetheless ongoing funding of the MNF remains our most crucial issue, and the Steering Committee looks forward to helping move the MNF from the current situation of year-to-year funding support to longer term secure funding, as befits a critical and large scale component of national marine research infrastructure.

Professor Craig Johnson
Chairman, Steering Committee
Marine National Facility

Investigator – the contract is signed

The *Investigator* is a new research vessel to replace the Marine National Facility's ageing *Southern Surveyor* which is approaching 40 years old.

In August 2009 the Minister for Innovation, Industry, Science and Research, Senator the Hon. Kim Carr, joined CSIRO Chief Executive, Megan Clark and other staff and guests to launch the project to build Australia's new blue-water research vessel.

Following a rigorous procurement process undertaken by CSIRO a contract for the design and construction of *Investigator* was signed with Teekay Holdings Australia Pty Ltd (Teekay) on 17 January 2011.

Teekay has subcontracted Sembawang Shipyard Pty Ltd (SSPL) as the ship builder. SSPL is a subsidiary of Sembcorp Marine Ltd (Sembcorp), a leading global marine and offshore engineering group. The vessel is being designed by RALion (Robert Allan Ltd and Alion Science and Technology) from USA and Canada and is to be built by SSPL in Singapore.

Although the vessel is being built in Singapore, Teekay is working through the Industry Capability Network (ICN) seeking opportunities for Australian participation in the construction.

The delivery schedule is 28 months with the vessel expected to arrive in Hobart in the middle of 2013.

Since the signing of the contract, tank testing with an 8 metre model has been carried out in Austria and Germany to test the hull design. The tests were all completed successfully.

As the contract was based on a statement of functional requirements there is still a lot of work to do to finalise the design and equipment details for the vessel. This task is carried out by the CSIRO Future Research Vessel Project Team which is based in Singapore and Hobart.

On 17 January 2011 the contract for the design and construction of *Investigator* was signed with Teekay Australia.

Above: Mr Iain Hempstead, Sembawang Shipyard's Country Representative; Mr Sese Nathaniel, Proposal & Contracts Manager, Sembawang Shipyard; Mr P.K. Ong, Managing Director, Sembawang Shipyard; Dr Bruce Mapstone, Chief, CSIRO Marine and Atmospheric Research; Professor Craig Johnson, Chair, Marine National Facility Steering Committee; Ms Toni Moate, Deputy Chief Business and Executive Director Future Research Vessel Project, CSIRO Marine and Atmospheric Research; Mr Mark Baker, Senior Legal Counsel, Procurement and Property, CSIRO; Mr Graham Stacey, Future Research Vessel Project Director, CSIRO; Mr David Parmeter, Managing Director, Teekay Shipping (Australia) Pty Ltd and Mr Anthony Fielding, Manager, Teekay Shipping (Australia) Pty Ltd.

Contract signing in Hobart, Tasmania. From left: Mr David Parmeter, Managing Director, Teekay Shipping (Australia) Pty Ltd; Dr Bruce Mapstone, Chief CSIRO Marine and Atmospheric Research and Mr P.K. Ong, Managing Director, Sembawang Shipyard.

PROJECT TEAMS

CSIRO has a project team, an advisory group and various governance/ evaluation groups to support the construction of *Investigator*.

Future Research Vessel Project Team

This team and its associated governance committees oversee the contract and the construction of the vessel, including the management of technical, legal, financial and change issues.

Future Research Vessel Technical Advisory Group

This group reports to the Future Research Vessel project Team and advises on a wide range of technical issues relating to the design and selection of scientific equipment for *Investigator*. Members consist of research scientists with expertise representing biology, geosciences, oceanography and atmospherics with experience extending from the tropics to the polar regions.

Group members are from the Australian National University, Australian Institute of Marine Science, Bureau of Meteorology, CSIRO, Department of Defence, Geoscience Australia and the University of New South Wales. The members work with their colleagues in each scientific discipline and across disciplines to provide advice as required.

Governance and management

Steering Committee

Chairman
Professor Craig Johnson

Members
Professor Richard Arculus
Mr Greg Paten
Mr Graham Peachey
Mr Tim Moltmann
Ms Toni Moate (ex- officio)

Scientific Advisory Committee

Chairman
Professor Roger Bradbury

Members
Professor Craig Johnson (ex-officio)
Dr Kathryn Burns
Professor Iain Suthers
Dr Diana Greenslade
Dr David Griffin
Dr Peter Harris

Ship Management Team

Acting Director
Mr Ron Plaschke

Ship Manager
Mr Stephen McCullum

Ship Operations Manager
Mr Don McKenzie

Ship Operations Officer
Ms Lisa Woodward

Personal Assistant
Ms Martina Miksch (- October 2010)
Ms Linda Gaskell (December 2010 -)

Executive Officer
Mr Leigh Walters (April 2011 -)

Meeting Australia's National Research Priorities

Australia's marine research needs are defined by the National Research Priorities. The Australian Government sets these priorities to address the challenges facing the nation.

The four National Research Priorities are:

- An environmentally sustainable Australia
- Promoting and maintaining good health
- Frontier technologies for building and transforming Australian industries
- Safeguarding Australia

Each priority area has a suite of associated goals. Seven goals across the priority areas, appropriate to the Marine National Facility, have been selected and are considered when assessing the national benefit of applications to use the Facility.

An environmentally sustainable Australia

Transforming the way we utilise our land, water, mineral and energy resources through a better understanding of human and environmental systems and the use of new technologies

Goal 2
Transforming existing industries

New technologies for resource-based industries to deliver substantial increases in national wealth while minimising environmental impacts on land and sea.

Goal 5
Sustainable use of Australia's biodiversity

Managing and protecting Australia's terrestrial and marine biodiversity both for its own value and to develop long term use of ecosystem goods and services ranging from fisheries to ecotourism.

Goal 6
Developing deep earth resources

Smart high-technology exploration methodologies, including imaging and mapping the deep earth and ocean floors, and novel efficient ways of commodity extraction and processing (examples include minerals, oil and gas) while minimising negative ecological and social impacts.

Goal 7
Responding to climate change and variability

Increasing our understanding of the impact of climate change and variability at the regional level across Australia and addressing the consequences of these factors on the environment and on communities.

Frontier technologies for building and transforming Australian industries

Stimulating the growth of world-class Australian industries using innovative technologies developed from cutting-edge research

Goal 4
Smart information use

Improved data management for existing and new business applications and creative applications for digital technologies (examples include e-finance, interactive systems, multi-platform media, creative industries, digital media creative design, content generation and imaging).

Safeguarding Australia

Safeguarding Australia from terrorism, crime, invasive diseases and pests, strengthening our understanding of Australia's place in the region and the world, and securing our infrastructure, particularly with respect to our digital systems

Goal 1
Critical infrastructure

Protecting Australia's critical infrastructure including our financial, energy, communications, and transport systems.

Goal 5
Transformational defence technologies

Transform military operations for the defence of Australia by providing superior technologies, better information and improved ways of operation.

Summary of voyages and national priorities 2010 – 2011

The Marine National Facility carried out three types of voyages in this period.

Research voyages

A research voyage is a program of scientific work approved by the Marine National Facility through an independent international peer reviewed process. A call for applications for sea time is made annually and Australian scientists can apply with their international collaborators. Research voyages are funded by the Marine National Facility.

Transit voyages

A transit voyage is a connecting voyage between two Research Voyages or a Research Voyage and a Research Charter Voyage. To make best use of the facility these voyages are used for opportunistic science, and for training of students and young scientists through the *Next Wave* program. The call for transit voyage applications is made annually after announcing the research voyage schedule which details any transits that are required.

Research charter voyages

A research charter voyage is funded by an Australian research organisation for the purposes of carrying out national priority research for that organisation. The vessel is available for research charter when not being used for Marine National Facility research voyages.

Research voyages

			NATIONAL RESEARCH PRIORITIES						
			Environmentally Sustainable Australia				Frontier Technologies	Safeguarding Australia	
Voyage	Voyage title	Lead Organisation	2	5	6	7	4	1	5
ss2010_v05	Biological oceanography of Western Rock Lobster larvae	University of Western Australia		■					
ss2010_v06	Continental slope and shelf processes along the south-west region of Western Australia during winter	University of Western Australia		■		■			
ss2010_v07	Southern Ocean Time Series moorings	Antarctic Climate and Ecosystems Cooperative Research Centre				■	■		
ss2010_v08	Krill in 3D – Vertical stratification and spatial distribution of krill communities in the East Australian Current	University of New South Wales		■		■			
ss2010_v09	Impact of the East Australian Current on water chemistry, bio-optical properties and coastal primary productivity in the New South Wales region	University of Technology, Sydney		■		■			
ss2011_v01	Southern Ocean Time Series moorings	Antarctic Climate and Ecosystems Cooperative Research Centre				■	■		
ss2011_v02	GEOTRACES: A collaborative international study of the marine biogeochemical cycles of trace elements and their isotopes along a zonal section of the Pacific Ocean east of Australia	Antarctic Climate and Ecosystems Cooperative Research Centre				■			

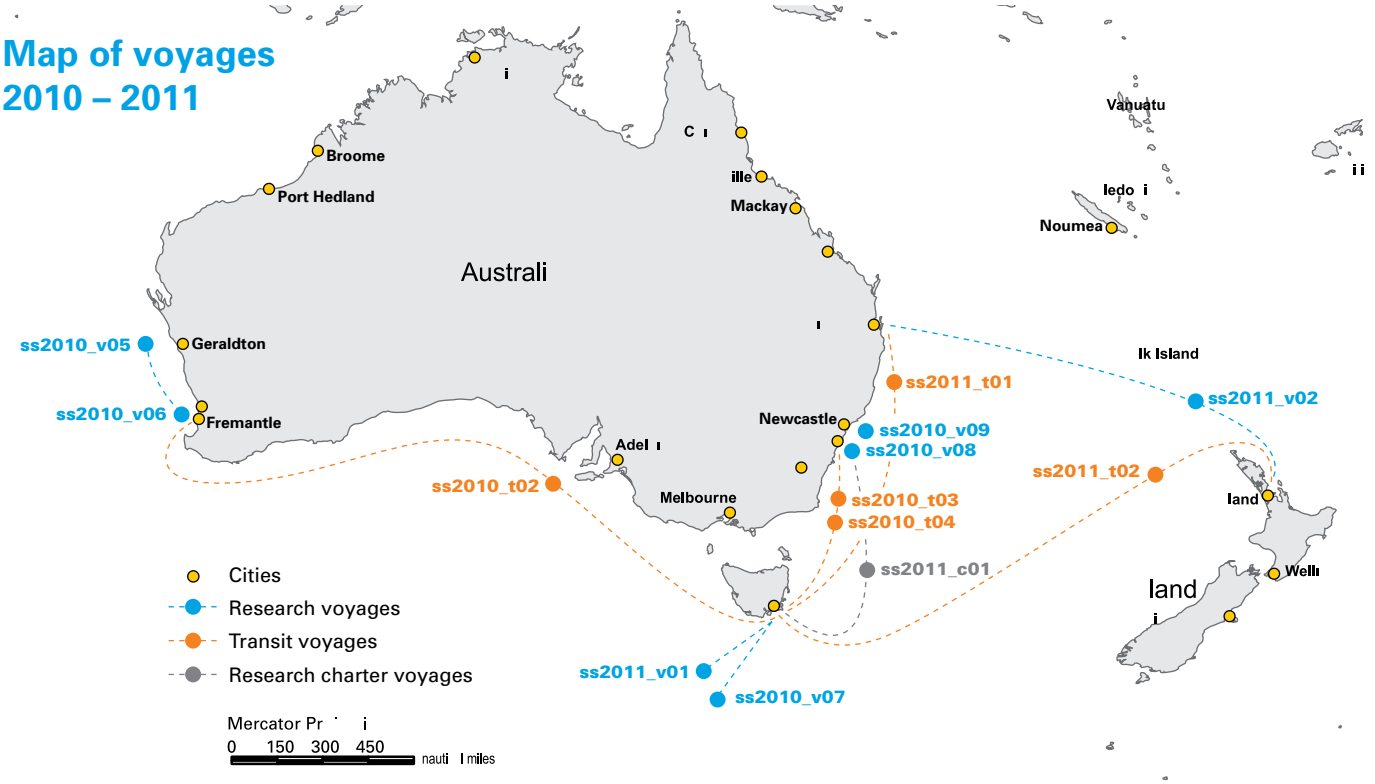
Transit voyages

Voyage	Voyage title	Lead Organisation	NATIONAL RESEARCH PRIORITIES						
			Environmentally Sustainable Australia				Frontier Technologies	Safeguarding Australia	
			2	5	6	7	4	1	5
ss2010_t03 *Next Wave*	*Next Wave* Transit, Hobart to Sydney	University of New South Wales		■		■			
ss2010_t04 *Next Wave*	An examination of the temperate reef and deep sea benthic fauna of the South-Eastern Australian shelf and the trophic relationships between euphausids and larval fish	University of Sydney		■		■			
ss2011_t01 *Next Wave*	Pre-industrial sea-surface temperature reconstructions in the Australian region – Eastern Australia	Australian National University				■			
ss2011_t02 *Next Wave*	Towards an understanding of mid-trophic biomass, distribution, variability and energetics in ocean ecosystems	CSIRO Marine and Atmospheric Research		■		■			

Research charter voyage

ss2011_rc01	Tsunami detection buoy maintenance for Australian Tsunami Warning System	Bureau of Meteorology						■	

Map of voyages 2010 – 2011



Research voyages

Research voyage ss2010_v05

The biological oceanography of Western Rock Lobster larvae

Prof Anya Waite, University of Western Australia (Chief Scientist)

The Western Rock Lobster is the most valuable single-species fishery in Australia worth $200-300 million a year and representing about 20% of the total value of Australia's fisheries. Variability in settlement of larvae and catch of adults has persisted and been shown to be highly correlated with the strength of Western Australia's Leeuwin Current and westerly wind conditions.

In 2009 the Department of Fisheries, Western Australia fishing industry representatives and oceanographers assessed the failure of rock lobster recruitment in two consecutive years. An industry workshop confirmed that lack of understanding of the biological oceanographic mechanisms affecting nutrition, growth and survival of the rock lobster larvae ("phyllosoma") at sea posed a serious risk to a sustainable rock lobster industry.

On this voyage scientists determined the key prey targeted by the phyllosoma at sea, identified a major oceanographic feature (the Abrolhos Front) that may impact regional recruitment off Western Australia and assessed the nutrition of wild larvae as well as the nutritional potential of the planktonic food web. Estimates were also made of phyllosoma abundance to compare with the previous estimates in the 1970s.

Preparing the EZ Net for deployment. The EZ Net contains up to ten nets that can be opened at different depths and provides real-time telemetry to the vessel whilst deployed. Credit: Megan Saunders

As a result of this voyage:

1. We have a much better understanding of the feeding ecology of rock lobster phyllosoma. By identifying the key prey of the larvae, we have opened up new research potential in both fisheries and aquaculture. Further biochemical analyses of both predator and prey should yield a clearer picture of how the key prey support progress to metamorphosis.
2. We have assessed the productivity of the Leeuwin Current water mass at a critical time for phyllosoma feeding and have evaluated the capacity of the planktonic food web to deliver high quality prey to feeding larvae. Much of this work is still in progress.
3. We have identified a major oceanographic feature (Abrolhos Front) which apparently brings two very contrasting but productive water masses in proximity to each other, while providing a shoreward regional flow pattern favourable for successful recruitment. This novel finding should support better understanding of oceanographic mechanisms governing recruitment as well as supporting stronger modelling outcomes.

Addressing National Research Priorities

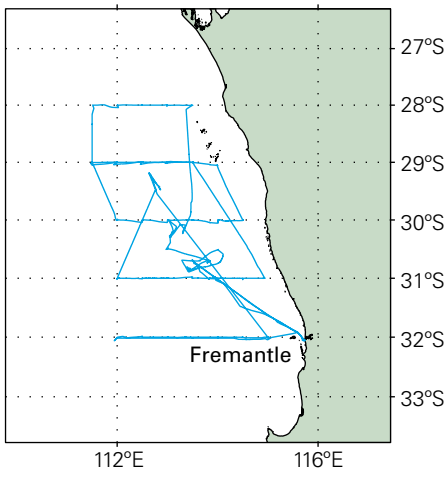
An environmentally sustainable Australia

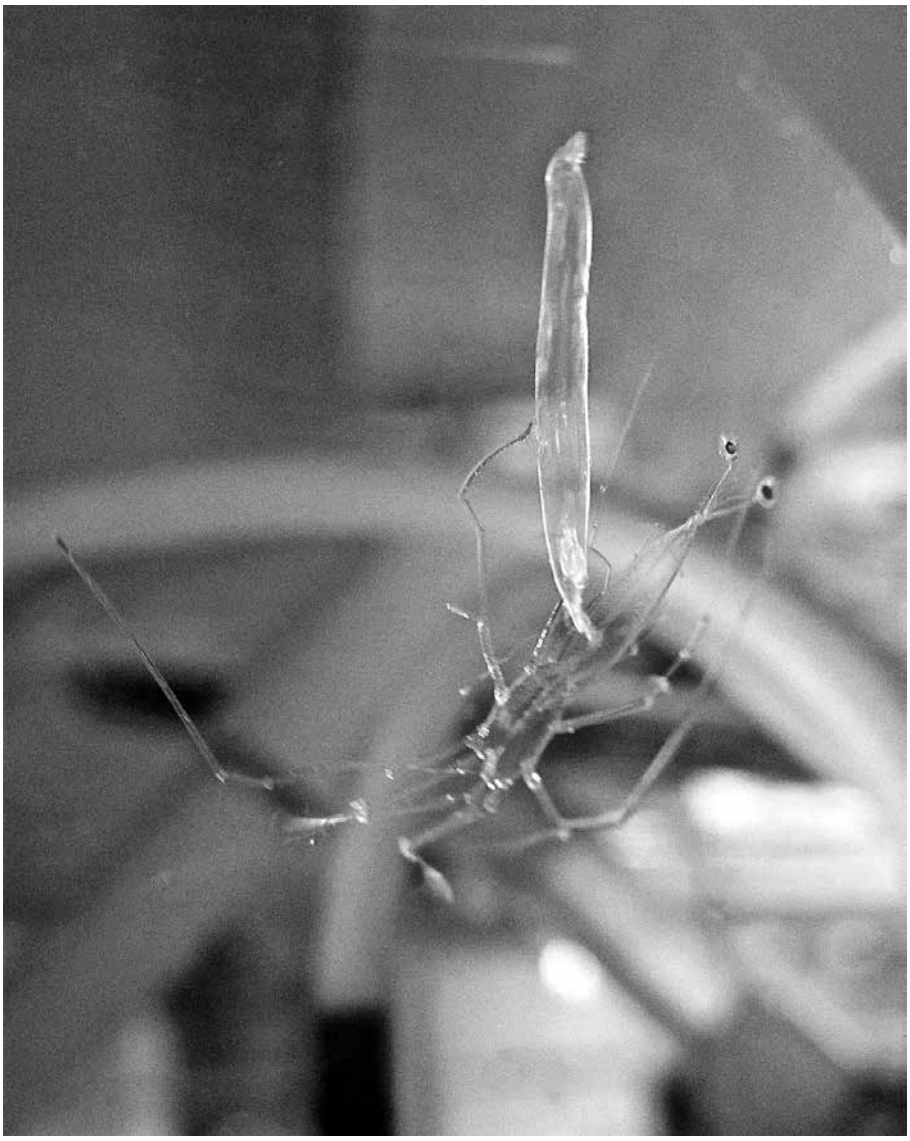
- Goal 5: Sustainable use of Australia's biodiversity

Itinerary

Departed Fremantle 6 July 2010
Arrived Fremantle 27 July 2010

> Voyage track





The phyllosoma is the larval stage of the Western Rock Lobster. Credit: Megan Saunders

Research voyage ss2010_v06

Continental slope and shelf processes along the south west region of Western Australia during winter

Prof Charitha Pattiaratchi, University of Western Australia (Chief Scientist)

This was one of the first research voyages to examine the winter oceanography off south-western Australia. The Leeuwin Current is strongest in winter and only a few studies have been undertaken on the structure and volume of water transported by the current during this time of year.

The voyage was planned to compliment information collected from the West Australian node of the Integrated Marine Observation System (IMOS). Use of the recently acquired Acoustic Doppler Current Profiler (ADCP) on the *Southern Surveyor* allowed for the first time direct measurements of the Leeuwin Undercurrent and its interaction with the Leeuwin Current.

The information gained on the voyage will help to answer questions about the mechanisms important to the formation of the winter phytoplankton bloom in this region.

Chief Scientist Prof Chari Pattiaratchi preparing surface drifters for deployment. Credit: Yasha Hetzel

Contribution to Australia's national benefit

The project will contribute to the understanding of the dynamics of ocean currents, primary productivity and phytoplankton taxonomy of a region which has one of the highest marine biodiversity in the world. Understanding of the physical oceanography and its interaction with primary production is an essential element of regional marine plans.

The results of this project will improve our understanding of winter dynamics which has been limited to date due to the availability of data.

The data collected will also contribute to the understanding of the dynamics of the Perth Canyon which has been proposed as a Marine Protected Area. The Perth Canyon is a standout Australian submarine canyon because of its size, location on the shelf and slope, and its ecological importance. Deep ocean currents upwelling in the canyon create a nutrient-rich coldwater oasis under the warm waters of the Leeuwin Current attracting deep diving mammals, such as pygmy blue whales and beaked whales and large predatory fish that feed on aggregations of small fish, krill and squid.

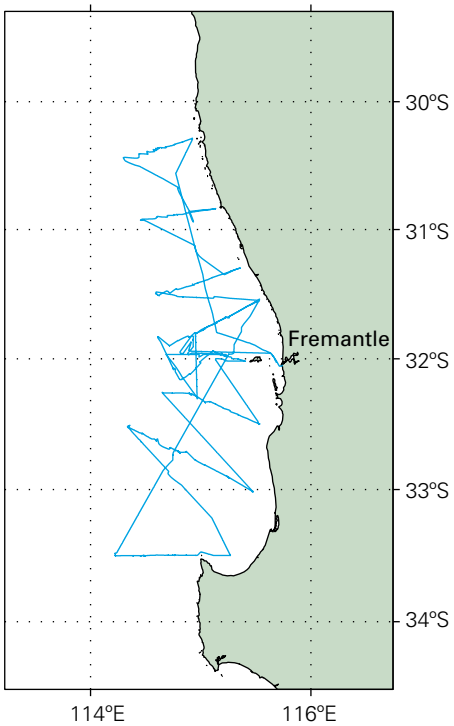
Acoustic Doppler Current Profiler

The Acoustic Doppler Current Profiler (ADCP) is lowered into the water to record water current velocities at a range of depths.

As a result of this voyage:

1. We have a better understanding of the wintertime circulation and biological oceanography off south-western Australia. In particular, the data collected during the voyage will contribute to the understanding of the dynamics of the Leeuwin Current and the Leeuwin Undercurrent and associated phytoplankton dynamics.
2. We have found that the Leeuwin Current flows strongly southward with speeds to 2m/s. There was an eddy located above the Perth Canyon and to the north of Cape Naturaliste. A well defined sub-surface chlorophyll maximum present during the summer months was absent during winter.

> Voyage track



3. We have mapped the temperature, salinity and fluorescence in south-western Australia during the winter. The ship based measurements were complimented by Integrated Marine Observing System (IMOS) infrastructure which included an ocean glider, HF radar systems for surface currents and moorings.

4. We have commenced a program of monitoring through the IMOS infrastructure which will monitor the ocean currents (Leeuwin and Leeuwin Undercurrent) until at least 2013. The data from this voyage will complement this program as well as contributing to the training of honours and postgraduate students.

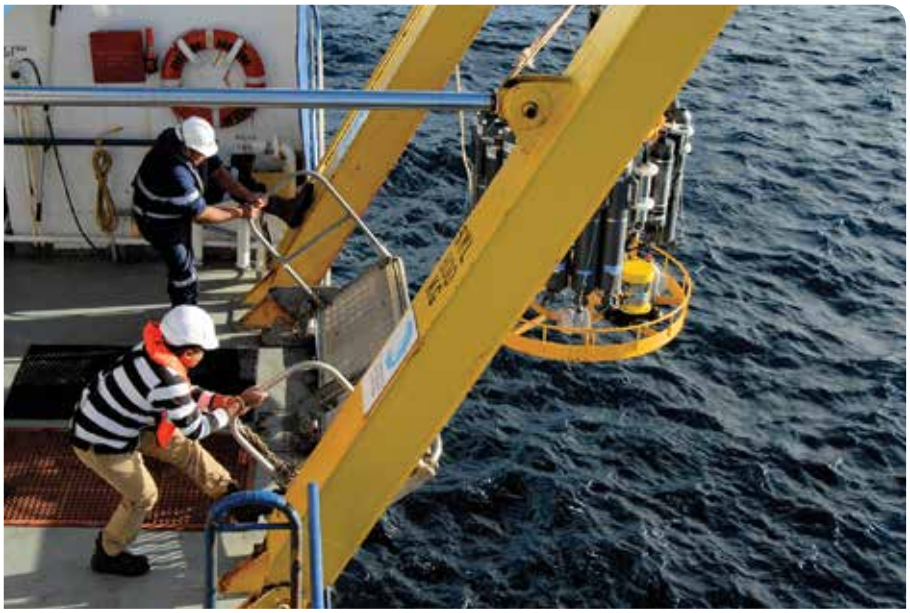
Addressing National Research Priorities

An environmentally sustainable Australia

- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Fremantle 29 July 2010
Arrived Fremantle 9 August 2010



Deploying the CTD rosette from *Southern Surveyor.* Credit: Yasha Hetzel

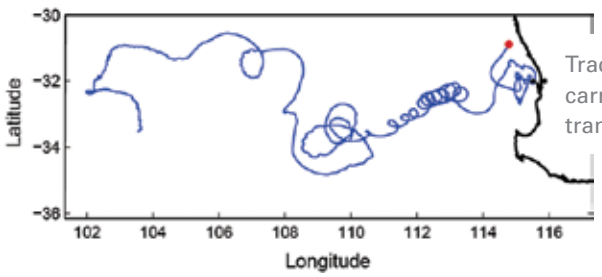
Dr Shari Gallop (UWA) helping to bring the CTD rosette inboard. Credit: Yasha Hetzel

Leeuwin Current

The Leeuwin Current is a warm ocean current which flows southwards near the western coast of Australia. It rounds Cape Leeuwin to enter the Great Australian Bight.

Its strength varies throughout the year with the greatest flow in the winter period. The current has an important influence on weather and marine production in the south-west region of Western Australia.

The Leeuwin Current is relatively shallow and lies on top of a northwards counter current called the Leeuwin Undercurrent.



Track of a drifter carried in an eddy and transported west.

Research voyage ss2010_v07

ss2010_v07 •

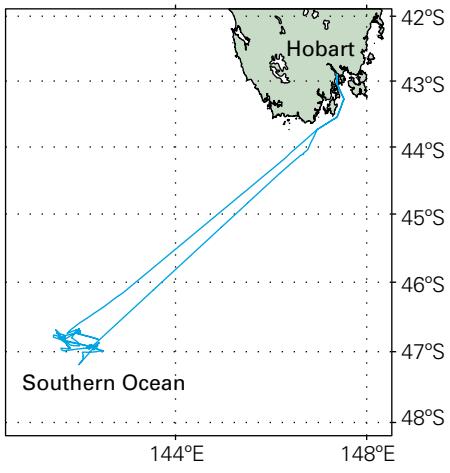
Southern Ocean Time Series moorings

Prof Tom Trull, Antarctic Climate and Ecosystems Cooperative Research Centre (Chief Scientist)

The objective of the Southern Ocean Time Series is to obtain frequent measurements of surface and deep ocean properties that control the transfer of carbon dioxide (CO_2) from the atmosphere to the upper ocean, and then onwards to the ocean interior in the form of sinking particles. This "biological pump" drives carbon sequestration from the atmosphere, and writes the sedimentary record.

The processes involved are complex and vary on daily, weekly, seasonal, and inter-annual timescales. Obtaining observations with the necessary frequency is not possible from ships. For this reason the Integrated Marine Observing System (IMOS) Southern Ocean Time Series Facility seeks to obtain this information using automated sensor measurements and sample collections.

> Voyage track



Contribution to Australia's national benefit

The Southern Ocean is important to global and regional climate and carbon cycling, because of its highly energetic interactions with the atmosphere, its deep mixing, and its role in connecting all the basins in the global ocean.

The development and deployment of instrumentation to observe air-sea exchanges in these waters is essential to enable informed assessment of possible changes in climate and climate variability, and in uptake of atmospheric CO_2 by the Southern Ocean.

The physical and meteorological observations will allow testing of the parameters that specify the air-sea interactions in climate models. This assists in the development of climate projections and the assessment of their accuracy, and thus their usefulness in efficient adaptation to changing climate.

The carbon, oxygen, and biogeochemical observations will assist in determining the factors that control the amount of CO_2 produced by human activities that is absorbed by the Southern Ocean.

The Southern Ocean provides an important role in regulating CO_2 in the atmosphere and a better understanding of this role informs debate about the urgency of efforts to mitigate emissions.

As a result of this voyage

The voyage has achieved a significant milestone in the overall development of the sustained observing system. It marks the start of the second six months of operational deployments of three moorings, accompanied by profiling floats and an ocean glider.

Data from these systems are provided via the Integrated Marine Observing System (IMOS) internet portal to Australian and international researchers.

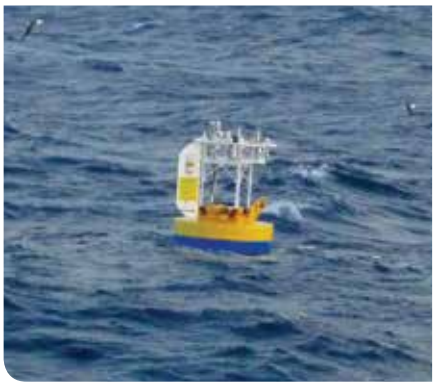
Addressing National Research Priorities

An environmentally sustainable Australia

- Goal 7: Responding to climate change and variability

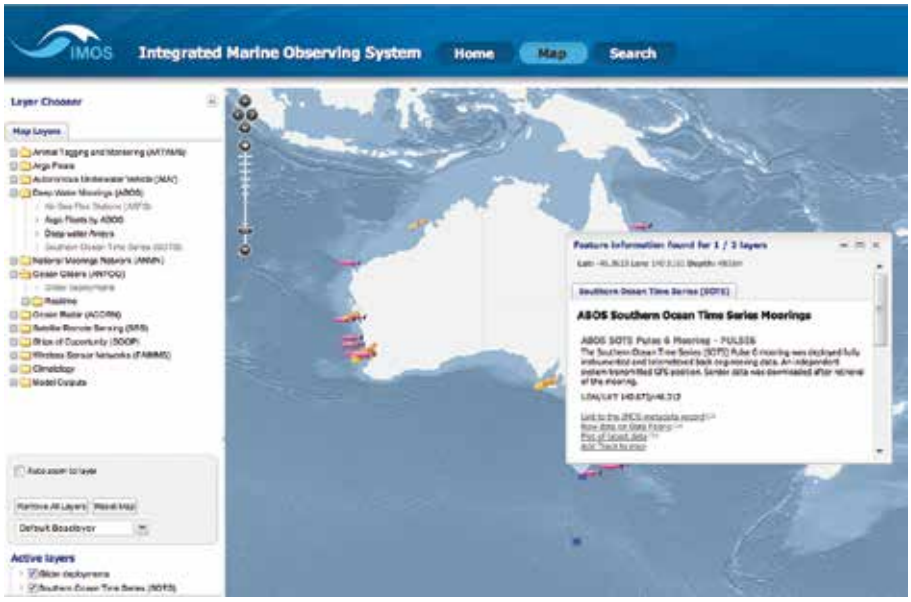
Itinerary

Departed Hobart 7 September 2010
Arrived Hobart 15 September 2010

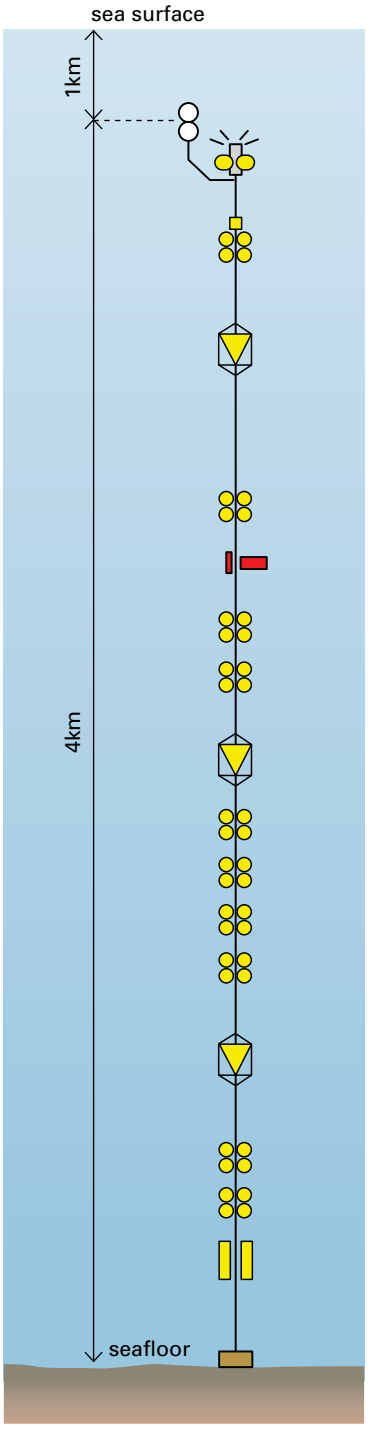


Recovery of the Southern Ocean Flux Station mooring deployed in April 2010. Credit: Eric Schultz, CAWCR-BOM

Behind the deployment team are three large sediment traps that must be lifted overboard as the mooring is deployed from the *Southern Surveyor*. Deployments in rough weather require careful coordination between the officers controlling the ship, the crew operating the winches and A-frame, and the science party assembling the mooring. Watching out for waves and each other is important for all the team. Credit: Tom Trull, CAWCR-CSIRO, ACE CRC, UTAS



The IMOS portal provides information and data from observing equipment in the oceans around Australia.



SAZ47-13 Sediment trap mooring

Research voyage ss2010_v08

Krill in 3D – Vertical stratification and spatial distribution of krill communities in the East Australian Current

Dr Matt Taylor, University of New South Wales (Chief Scientist)

Greater than 90% of the organic matter that moves from the surface to mid depth ocean zones is transformed from organic molecules to inorganic forms (i.e. nutrients, microelements and carbon dioxide) and returned to the surface. Understanding this process is important as it reduces the downward movement of organic matter to the deep ocean and acts as a positive feedback to global warming.

The movement of water horizontally and vertically in the ocean through currents affects biodiversity, species distribution and the outcomes of competitive interactions in pelagic zooplankton (e.g. between krill and salps). The nature of these interactions is important in determining the fate of carbon but little is known about the dynamics in the unique Eastern Australian Current (EAC) community.

Changes in the inputs of nutrients into coastal waters resulting from climate change will have substantial effects on the abundance, distribution and interactions of these species.

Significance of the work

Gaining a better understanding of these processes will enable findings to be integrated with established ocean models to provide estimates of changes in zooplankton community structure with a changing climate.

Climate impacts at the bottom of the food chain cascade to the higher trophic levels that offer ecosystem services of social, cultural and economic significance. These services include recreational and commercial fishing.

These predictions will be relevant to the region of our east coast that provides much of the primary and secondary productivity to support juvenile fish which eventually progress to the important South East Trawl Fishery.

As a result of this voyage:

1. We have a better understanding of the way in which different layers of the ocean interact with each other, and how the movement of animals such as krill can shunt energy between food webs in a nutrient limited environment such as the EAC.
2. We have found that krill and salps appear to have a negative interaction off eastern Australia. Krill are far more abundant this year than on previous voyages (2008 and 2009), when salps dominated the plankton assemblage.
3. We have mapped the diversity of krill and copepods in relation to hydrography, across areas of differing primary productivity and different circulation patterns. A diverse krill assemblage forms an important part of the zooplankton off NSW, providing food for fish, seabirds and whales.
4. We have commenced a program investigating the movement of organisms between the ocean depths of the most rapidly changing water mass in the world. We will study the nature and variability of organism movement across latitudes and depths over coming years and develop models that simulate changes in energy flow in response to climate variation.

Addressing National Research Priorities

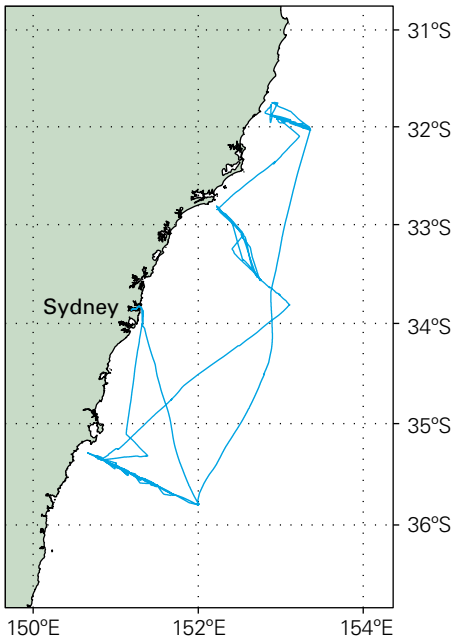
An environmentally sustainable Australia

- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Sydney 22 September 2010
Arrived Sydney 5 October 2010

> Voyage track



Epipelagic (surface) zone

This is the illuminated zone where there is adequate sunlight for photosynthesis. Most of the primary production in the ocean occurs in this zone.

Mesopelagic (mid depth) zone

Although there is some sunlight in this zone it is inadequate for photosynthesis. In this zone water becomes depleted of oxygen so usually only animals suited to this environment such as swordfish and squid are found.

Bathypelagic (deep) zone

This zone is pitch black with no living plant life. Animals living here usually survive on detritus or the remains of plants and animals falling from the above zones.

Science team at work in the fish laboratory onboard *Southern Surveyor* sorting samples for stable isotope analysis.
Credit: Matt Taylor, UNSW

Research voyage ss2010_v09

Impact of the East Australian Current on water chemistry, bio-optical properties and coastal primary productivity in the New South Wales region

Dr Martina Doblin, University of Technology, Sydney (Chief Scientist)

The East Australian Current (EAC) is the single-most important factor affecting regional productivity along the eastern seaboard of Australia.

The aim of the voyage was to better understand the interaction of the EAC with the continental shelf in the area north and south of the EAC separation zone off New South Wales, an important region supporting almost 50% of Australians living near the coast.

Work carried out

High resolution data was collected to characterise the relationship between physical oceanography, water chemistry (e.g. nutrient distribution and light availability) and the productivity and diversity of bacteria and phytoplankton in the EAC and across a partially flooded cold core eddy. In addition, bio-optical biogeochemical and aerosol properties were measured within and outside four river plumes (Macleay, Clarence, Richmond, Shoalhaven) and will provide much needed data for the wider New South Wales scientific community to improve remotely-sensed estimates of ocean colour.

Productivity and grazing losses were assessed. Samples were taken to assess shifts in the composition and function of bacterial communities and will be related to specific oceanographic features and phytoplankton community characteristics.

Nutrient and organic source enrichment experiments were carried out in the EAC and at the edge of a cold core eddy, and will provide insights about the role of nutrients and coastal inputs in controlling plankton biomass, diversity and activity. These experiments will gather knowledge not only on phytoplankton but also bacteria, and processes affecting coloured dissolved organic matter composition and its bio-optical signature.

As a result of this voyage:

1. We have a better understanding of the impact of river runoff on regional productivity and the nutrients driving primary production on the New South Wales continental shelf. We also have more comprehensive estimates of the variability in bio-optical parameters in the New South Wales coastal region.
2. We have found strong differences in primary productivity across the shelf, elevated from background levels by river runoff and upwelling. As expected, large phytoplankton (>10 µm) are responsible for most of the productivity in the near shore, but small phytoplankton (< 2 µm) are responsible for most productivity offshore.
3. We have mapped the variability of bio-optical parameters along the New South Wales coast using underway and discrete sample collections in waters ranging from turbid river discharges to clear blue EAC waters. We have also mapped changes in primary productivity across the shelf in waters influenced by upwelling, river runoff and eddy activity.
4. We have commenced a program of sample analysis to improve satellite based estimates of ocean colour and productivity, are compiling data to input parameter values to a regional biogeochemical model and will test its prediction of carbon dioxide drawdown under perturbed conditions (e.g. nutrient enrichment).

Addressing National Research Priorities

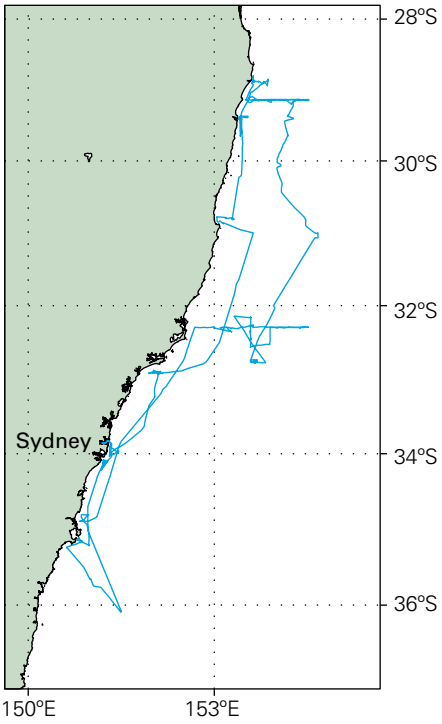
An environmentally sustainable Australia

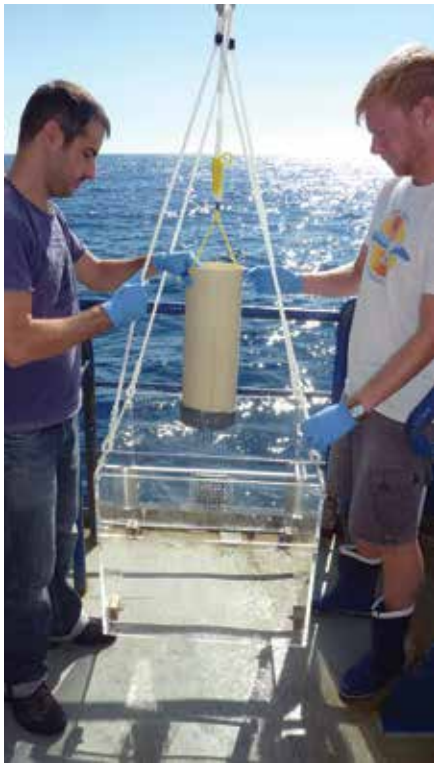
- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Sydney 15 October 2010
Arrived Sydney 31 October 2010

> Voyage track





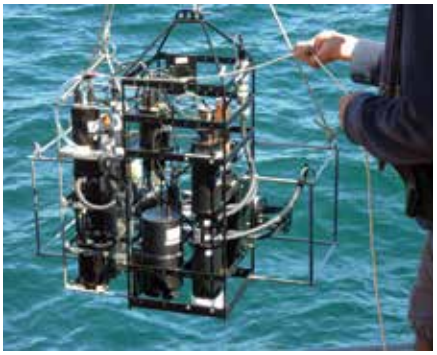
Devices to assess bacterial behaviour (chemotaxis) in the ocean. Mr Massimo Pernice (left) and Dr Justin Seymour (right).

East Australian Current separation zone

The East Australian Current separates from the coast, 100–200 nautical miles north of Sydney, to form the eastward flowing Tasman Front and a southward flowing eddy field. This region is referred to as the East Australian Current separation zone.

The science team just prior to departing. Credit: Vinod Kumar

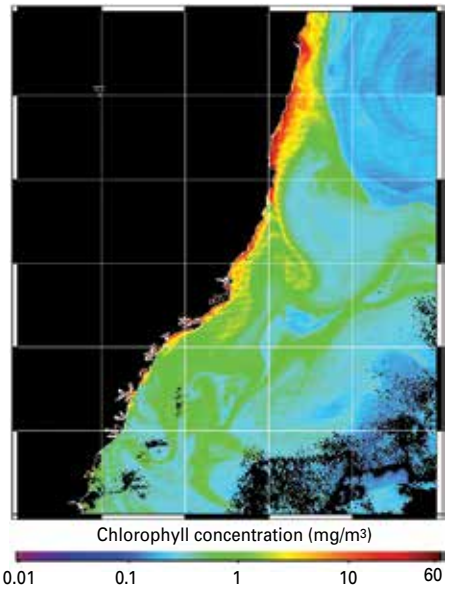
Assessing primary productivity using a photosynthetron. Credit: Martina Doblin



Deploying the optics frame. Credit: Martina Doblin

Ocean colour

Colour is an indicator of phytoplankton biomass in the surface layers of the ocean.



Ocean colour (surface chlorophyll-a) image of New South Wales coast on 29 October 2010

Research voyage ss2011_v01

Southern Ocean Time Series moorings

Dr Eric Schulz, Bureau of Meteorology (Chief Scientist)

The aim of the voyage was to take measurements of surface and deep ocean properties that control the transfer of carbon dioxide (CO_2) from the atmosphere to the upper ocean, and then onwards to the ocean interior in the form of sinking particles. This "biological pump" drives carbon sequestration from the atmosphere, and writes the sedimentary record.

The controls on the intensity of the process are complex and involve processes that vary on daily, weekly, seasonal, and interannual timescales. Obtaining observations with the necessary frequency is not possible from ships. For this reason the Integrated Marine Observing System (IMOS) Southern Ocean Time Series Facility seeks to obtain this information using automated sensor measurements and sample collections.

Work carried out

This voyage recovered the Southern Ocean Flux Station (SOFS-1) mooring to obtain in-air and in-sea measurements to better understand the exchange of heat, moisture, and gases between the ocean and atmosphere. It will also recovered the Pulse-7 mooring that has been making measurements of temperature, salinity, mixed layer depth, photosynthetically available radiation, oxygen, total dissolved gases, and phytoplankton fluorescence and backscatter. The Pulse-7 mooring also collected 24 paired water samples, approximately weekly, for later measurement of dissolved nitrate, silicate, inorganic carbon and total alkalinity.

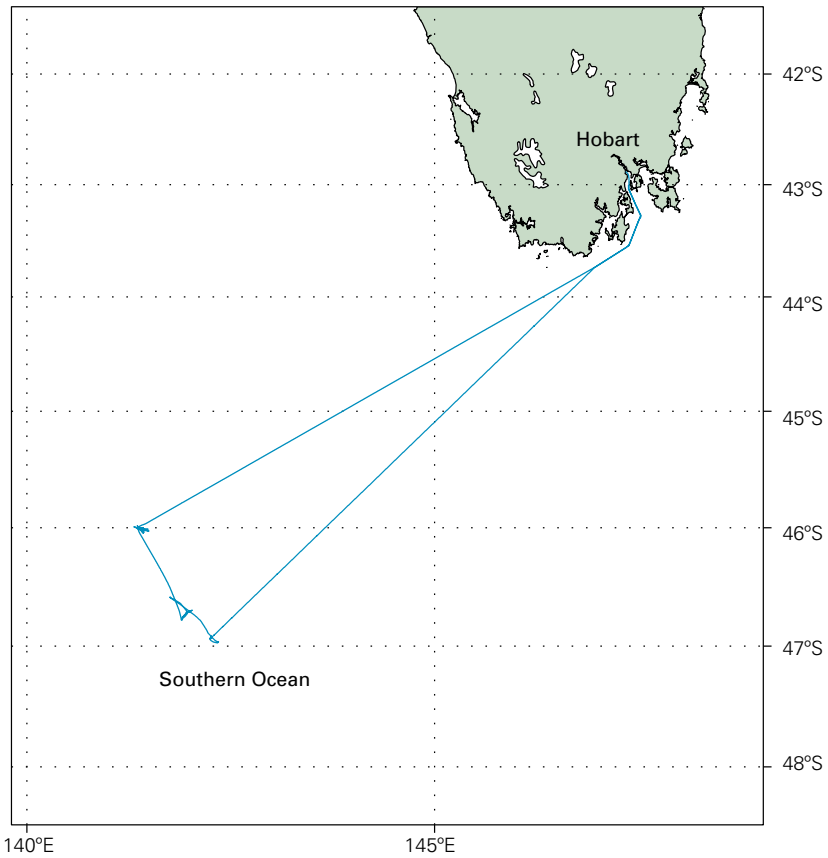
Contribution to Australia's national benefit

The Southern Ocean is important to global and regional climate and carbon cycling, because of its highly energetic interactions with the atmosphere, its deep mixing, and its role in connecting all the basins in the global ocean.

The development and deployment of instrumentation to observe air-sea exchanges in these waters is essential to enable informed assessment of possible changes in climate and climate variability, and in uptake of atmospheric CO_2 by the Southern Ocean. The physical and meteorological observations will allow testing of the parameterization of air-sea interactions in climate models. This informs development of climate projections and assessment of their fidelity, and thus their utility in efficient adaptation to changing climate.

The carbon, oxygen, and biogeochemical observations will contribute to determining the factors that control, and thus the propensity for change in the ecosystem service the Southern Ocean provides of absorbing significant amounts of anthropogenic CO_2. This informs debate about the urgency of efforts to mitigate emissions.

> Voyage track



As a result of this voyage:

1. The first recovery of a full year of air-sea flux observations from SOFS-1.
2. Recovery of the second full season of carbon system observations from the Southern Ocean from the Pulse-7 mooring.
3. Continued the effort to map the spatial context of Southern Ocean Time Series via the ongoing deployment of gliders and autonomous profiling floats.

Data from these systems will be provided via the Integrated Marine Observing System to Australian and international researchers.

Addressing National Research Priorities

An environmentally sustainable Australia

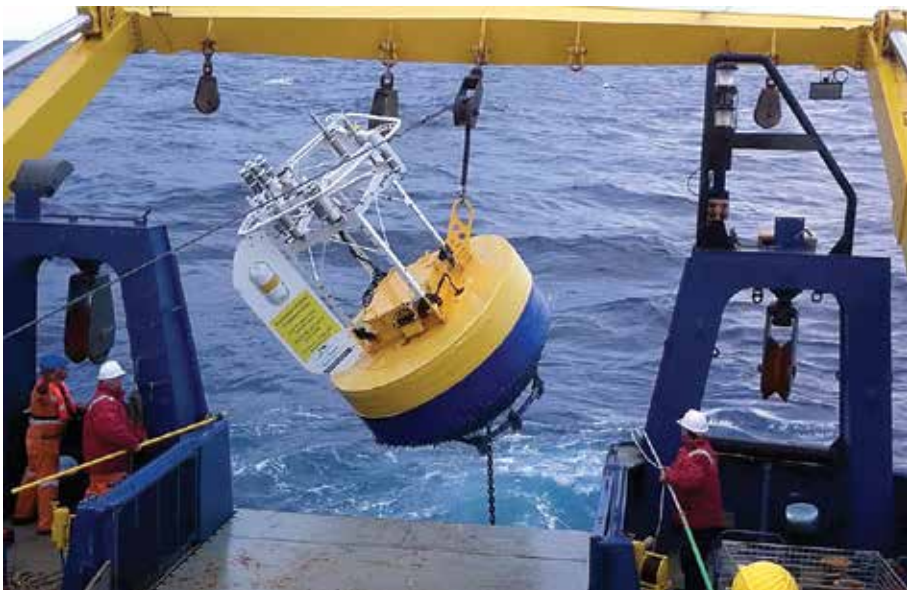
- Goal 7: Responding to climate change and variability

Frontier technologies

- Goal 4: Smart information use

Itinerary

Departed Hobart 16 April 2011
Arrived Hobart 22 April 2011



The Southern Ocean Flux Station mooring was deployed 350 nautical miles southwest of Tasmania to record meteorological and oceanographic observations to help scientists better understand climate variability. Credit: Jason Wall

Research voyage ss2011_v02

GEOTRACES: A collaborative international study of the marine biogeochemical cycles of trace elements and their isotopes along a zonal section of the Pacific Ocean east of Australia

Dr Andrew Bowie, Antarctic Climate and Ecosystems Cooperative Research Centre (Chief Scientist)

The ocean plays a vital role in Earth's climate through control of atmospheric carbon dioxide concentrations.

One important component of this system is the iron cycle, in which iron-rich soil dust is transported from land through the atmosphere to the ocean. Iron is a key micronutrient for marine plankton productivity, the scarcity of which limits essential biogeochemical processes and thus ocean fertility.

The project examined an east-west transect approximately 30ºS (i.e. just north of Coffs Harbour) for iron, other trace elements, and their isotopes (TEIs).

Deployment of the CTD from *Southern Surveyor* in the Pacific Ocean. Credit: Louiza Norman

Contribution to Australia's national benefit

This research was part of Australia's contribution to the new international GEOTRACES program (www.geotraces.org). The international program involves the study of a wide range of chemical, physical and biological processes involved in the cycling and supply of trace elements and TEIs in the ocean, and their sensitivity to changing environmental and climatic conditions.

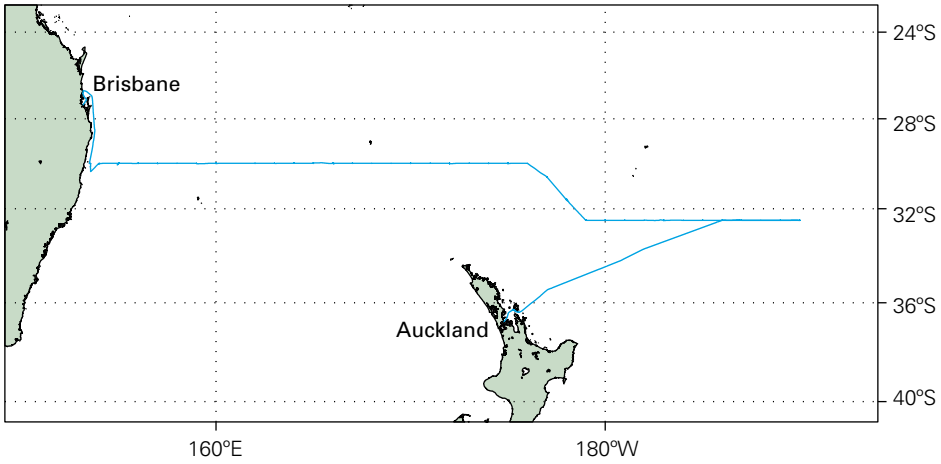
Our studies have provided vital information on the prevalence and flux of key TEIs for ocean-atmosphere biogeochemical and climate models. This work will help us understand the role of ocean biology in past (glacial) and future regulation of atmospheric CO_2, and inform policy on ocean fertilisation.

The collaborative international effort has resulted in the development of innovative technologies and expertise for the broader advantage of research partners, fostered Australian research competitiveness, and improved its oceanographic science and technology capabilities.

As a result of this voyage:

1. We have a better understanding of the marine biogeochemistry of key TEIs in the ocean, thus facilitating their explicit inclusion in numerical models of ocean marine ecosystems, and allowing a prediction of the role of biology in regulation of carbon transfer to the deep sea.
2. Preliminary results from shipboard analysis indicate that the western end of the transect had extremely low dissolved iron concentrations (an element vital for marine biological growth), despite proximity to continental sources. Post-voyage laboratory analysis will indentify the degree of iron and nitrogen co-limitation in these waters.

> Voyage track



3. We have mapped, for the first time, the three-dimensional distribution of TEIs in the southwest Pacific Ocean, and conducted experiments to understand their sources, sinks and internal cycling.

Addressing National Research Priorities

An environmentally sustainable Australia

- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

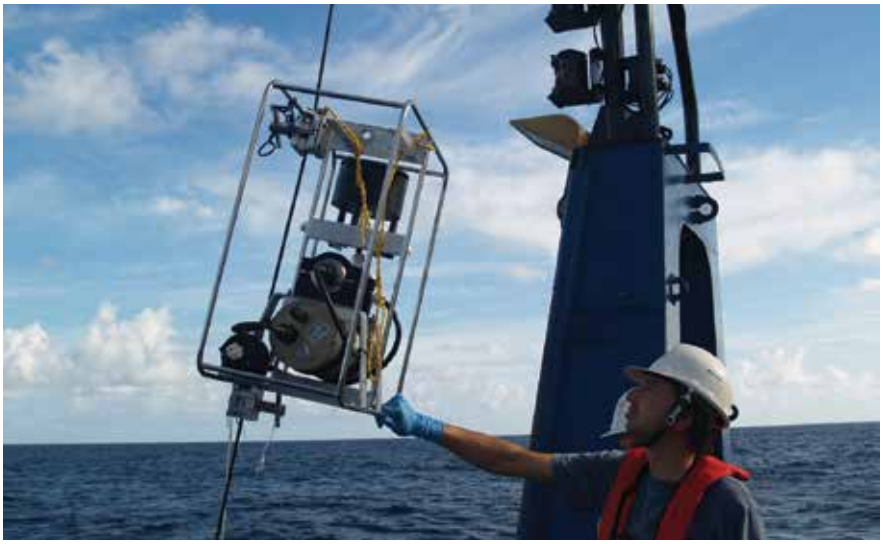
Frontier technologies

- Goal 4: Smart information use

Itinerary

Departed Brisbane 13 May 2011
Arrived Auckland, New Zealand 5 June 2011

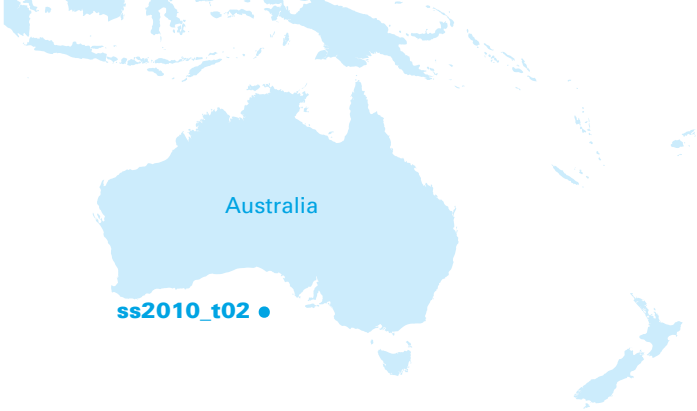
Filtration for micronutrients from the trace metal rosette in a clean air container laboratory. Credit: Andrew Bowie



Deployment of the McLane in situ pumps from the stern of *Southern Surveyor* in the Pacific Ocean. Credit: Taryn Noble

Installation of filter for collection of marine aerosol particles above the bridge. Credit: Laurie Burns

Transit voyages



Transit voyage ss2010_t02

Deep water benthic biodiversity of the Great Australian Bight Marine Park

Dr David Currie, South Australian Research and Development Institute (Chief Scientist)

This voyage aims to develop a better understanding of the benthic communities in the Benthic Protection Zone (BPZ) of the Great Australian Bight Marine Park.

The Australian Government have established a series of Marine Protected Areas (MPAs) to protect and maintain marine biological diversity. These areas provide important reference areas for scientific studies and long-term environmental monitoring.

A comprehensive audit of the composition, distribution and ecological significance of the benthic fauna and habitats in the protected area will enable government authorities and scientists to better understand the biological diversity and more effectively determine the impact of commercial activities in adjacent regions.

The Benthic Protection Zone is located in waters between 200 and 5,000 metres creating a significant challenge for sampling. The *Southern Surveyor* is one of few vessels in the country equipped to carry out such research work. The availability of this vessel on a transit voyage from Hobart to Fremantle provided the opportunity to gain a better understanding of this poorly surveyed region.

Benthic Protection Zone

The Benthic Protection Zone (BPZ) of the Great Australian Bight Marine Park was proclaimed in 1998 and consists of a 20 nautical mile wide strip of seabed orientated north to south and extending from three nautical miles from the coast to the edge of Australia's Exclusive Economic Zone, 200 nautical miles offshore. Within this zone, the benthic assemblages are protected from demersal trawling and other potentially destructive human activities.

The Benthic Protection Zone is presently one of fourteen temperate Commonwealth Marine Protected Areas (MPAs) in Australia. The MPAs form part of an integrated strategy for marine conservation and management through the National Representative System of Marine Protected Areas. Conservation of marine biological diversity is the overarching goal of the strategy, but it remains to be determined what biological diversity is being conserved offshore on the slope seafloor of the Benthic Protection Zone.

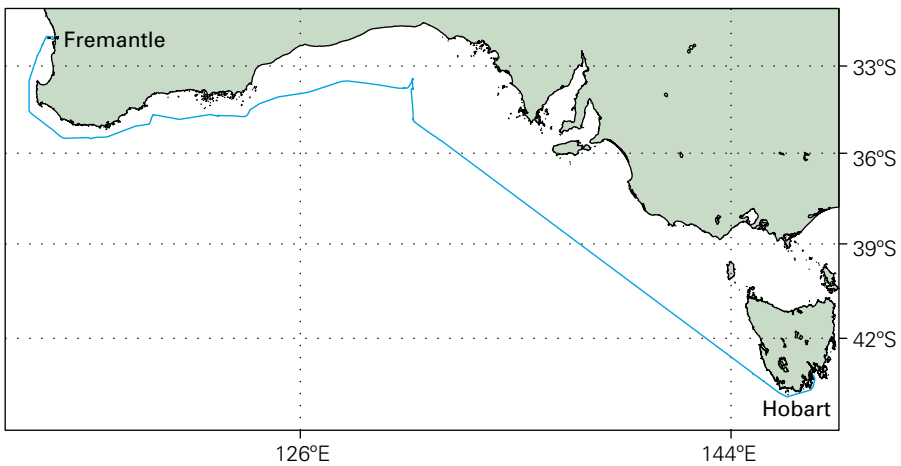
This research voyage addresses this knowledge gap and provides for the first time, quantitative information on the regional significance and diversity of the deep water faunal communities of the Benthic Protection Zone.

Sampling program

Sampling was carried out at three depths (500, 1,000 and 2,000 metres) on the continental slope of the Benthic Protection zone using a 0.1 metre² Smith-McIntyre grab and a 4 metre wide beam trawl.

A total of 141 species were collected during this sampling, many of which appear to be undescribed in the literature.

> Voyage track



Dr David Currie with deep-sea corals and anemones collected on the voyage.

Anna's Pimple

An exciting find on the voyage was the discovery of a volcanic pinnacle, Anna's Pimple. This cone-shaped structure was located at a depth of 2,000 metres and rose almost 200 metres. Due to its extreme age and geographical isolation in the Benthic Protection Zone it may support benthic organisms and communities that have evolved on and are unique to the rocky structure.

As a result of this voyage:

1. We have a better understanding of the composition and distribution of the seafloor fauna inhabiting the deep offshore areas of the Great Australian Bight Marine Park.
2. We have found that the upper continental slope is characterised by a diverse suite of soft sedimentary facies that support rich and varied benthic communities.

Addressing National Research Priorities

An environmentally sustainable Australia

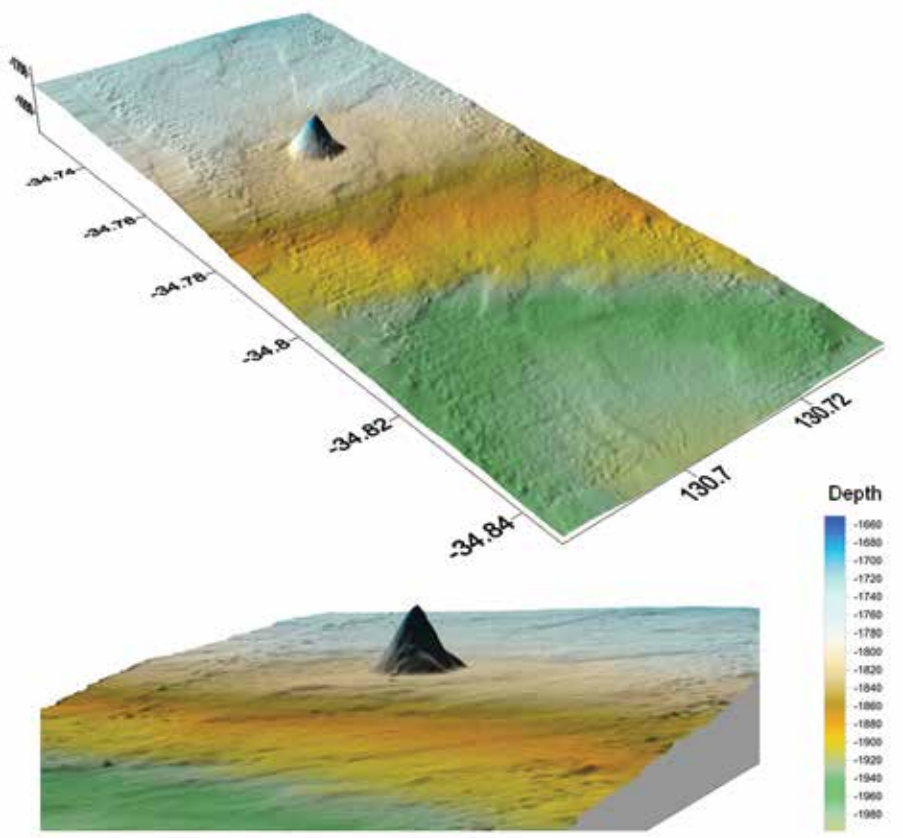
- Goal 5: Sustainable use of Australia's biodiversity

Itinerary

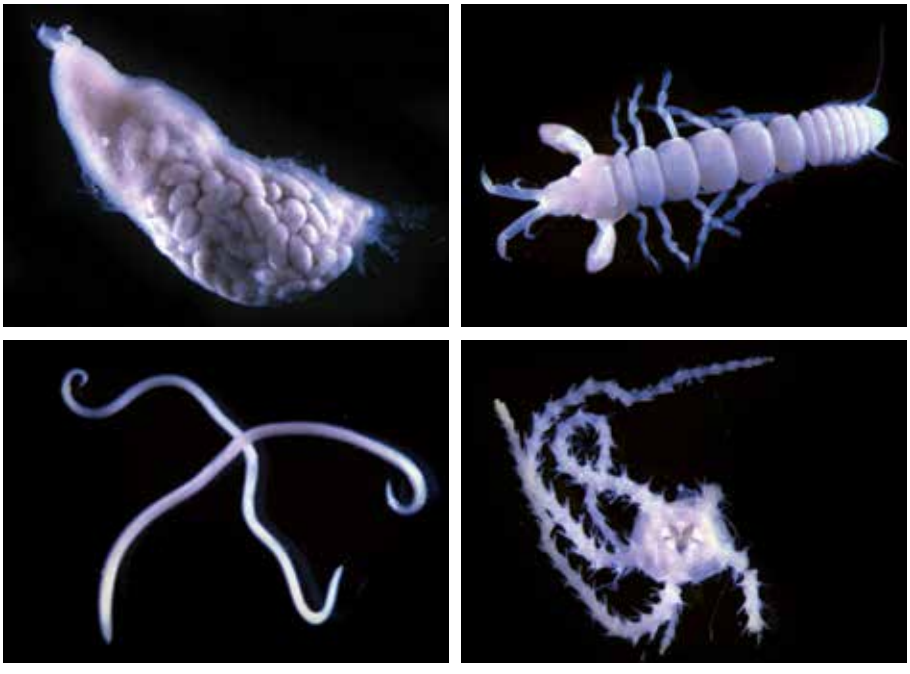
Departed Fremantle 10 August 2010
Arrived Hobart 20 August 2010

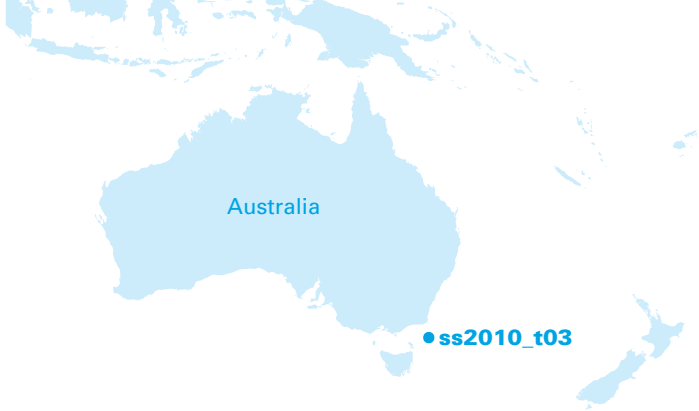
Reference area

A reference area is one that has been largely unaffected by human activities and provides a comparison to areas where commercial activities are being undertaken.



Anna's Pimple





Transit voyage ss2010_t03

Next Wave transit Hobart-Sydney

Dr Jock Young, CSIRO Marine and Atmospheric Research (Chief Scientist)

This voyage was part of the *Next Wave* program which was developed to allow young and aspiring scientists the opportunity to experience marine science at sea.

Training ground for students

On this voyage there were eleven students from four different institutions – University of New South Wales, University of Sydney, University of Tasmania and Deakin University. There were five undergraduates, a prospective honours student, two Masters' students and three PhD students. Nine of the students had not been to sea before.

Apart from introducing young scientists to life at sea, the program provided the opportunity for a young PhD student to be a Watch Leader, resulting in them seeing the process of organising and running a research voyage.

Throughout the voyage we also managed to support the World Climate Research Program through the deployment of Argo Floats and add valuable data to the benthic mapping network through running the ship's swath system.

As a result of this voyage:

1. We have a better understanding of the biological processes of warm core and cold core eddies. We had the opportunity to sample two adjacent eddies and through analysis will be able to see how this affected the zooplankton community for four PhD students at two universities, and inspired six undergraduates of the possibilities in biological oceanography.
2. We have mapped a vast region of the eastern Australian coast with the use of the ship board swath system with a large section of this being across the slope of the sea floor along the south coast of New South Wales and across Bass Strait.
3. We have commenced a program of long-term sampling of a warm core eddy on the New South Wales south coast, from spring and likely into late summer (2011). It was sampled on this voyage, the subsequent voyage and will be sampled again a month later on the return transit, and possibly in 2011.
4. We have contributed to the long term ocean observing by Integrated Marine Observing System (IMOS) with the use of the continuous plankton recorder off eastern Australia, which would otherwise have suffered a significant gap in the sampling record.

Addressing National Research Priorities

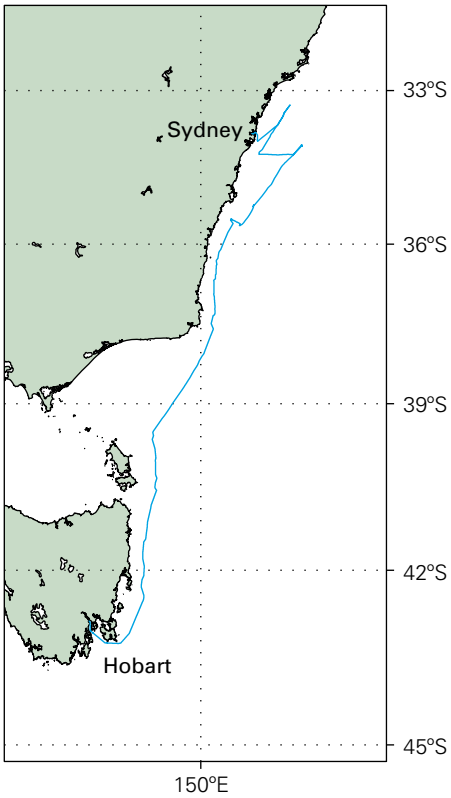
An environmentally sustainable Australia

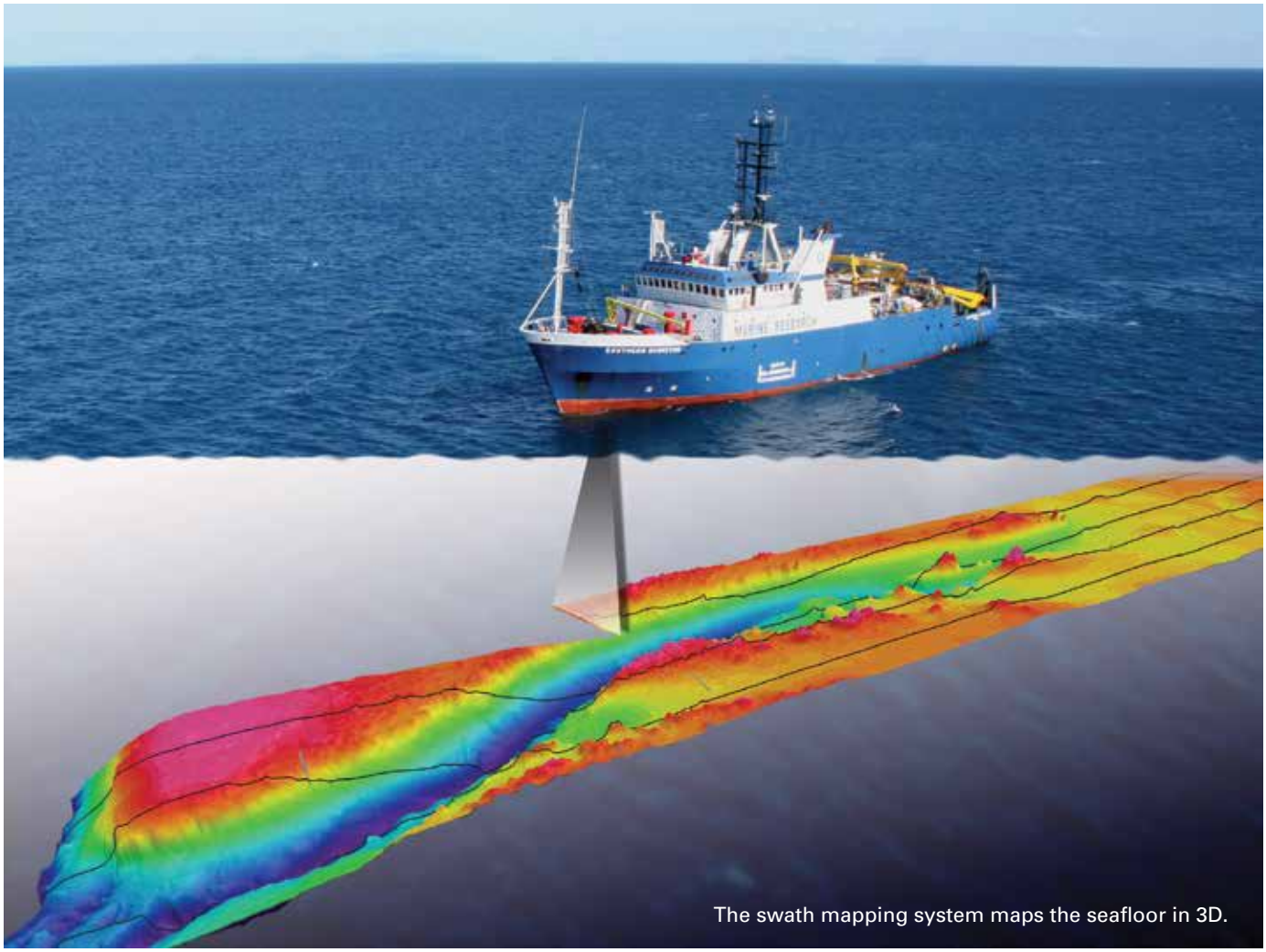
- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Hobart 17 September 2010
Arrived Sydney 21 September 2010

> Voyage track





The swath mapping system maps the seafloor in 3D.

Participants of the *next wave* voyage at the completion of the trip in Sydney (Back row: Luke McPhan, Ben Roennfeldt, Matt Ward; Middle row: Ben Harris, Jock Young, Lauren Ooi, Natasha Henschke, Natalie Rivero, Sarah Payne, Alicia Navidad; Front row: Emma Hall, Louisa Attard, Paloma Matis. Credit: Poloma Matis

Transit voyage ss2010_t04

An examination of the temperate reef and deep sea benthic fauna of the South-Eastern Australian shelf and the trophic relationships between euphausids and larval fish

Dr Sebastian Holmes, University of Sydney (Chief Scientist)

Next Wave tomorrow's ma i

The focus of the voyage was to give students a taste of what it is like to live and work on an ocean going research vessel and to expose them to some of the different sampling methods and equipment that are used in biological research programs.

The students had three (quasi) scientific aims which contributed to our knowledge about Australian waters. The aims were:

1. Characterise the macro-fauna inhabiting a unique geological feature (reef) off the coast of Wollongong.
2. Examine the effect of depth on species composition in Bass Canyon.
3. Examine the trophic relationships between euphausids and larval fish, extending the work carried out on ss2010_v08.

To a large extent aims 1 and 2 aligned with those of Dr Rudy Kloser (CMAR) and complement the piggyback project of Dr Ronald Thresher, which will provide the students with a window into another benthic habitat.

Credit: Daniel Harrison

Work carried out

For Dr Rudy Kloser the voyage provided the opportunity to use vessel transit time to continue the national mapping of the upper-mid slope seabed with multi-beam mapping and associated ecological interpretation.

The upper-slope and mid-slope seabed 100 m to 1500 m depth range, are regions important for regional marine planning, biodiversity and conservation assessments and fisheries habitat mapping.

On this voyage the Benthic Optical Acoustic and Grab Sampler (BOAGS) was used to video and acoustically survey, and selectively sample (i.e. using a surface fired Smith-Macintyre grab mounted on the BOAGS) the benthos.

The benthic sampling carried out by the students using the Sherman Sled supplemented the information and samples collected by the BOAGS.

An inventory of benthic macro fauna was obtained and combined with the ongoing analysis of their stable isotope signatures will provide a baseline for future research into the rarely studied deep sea fauna.

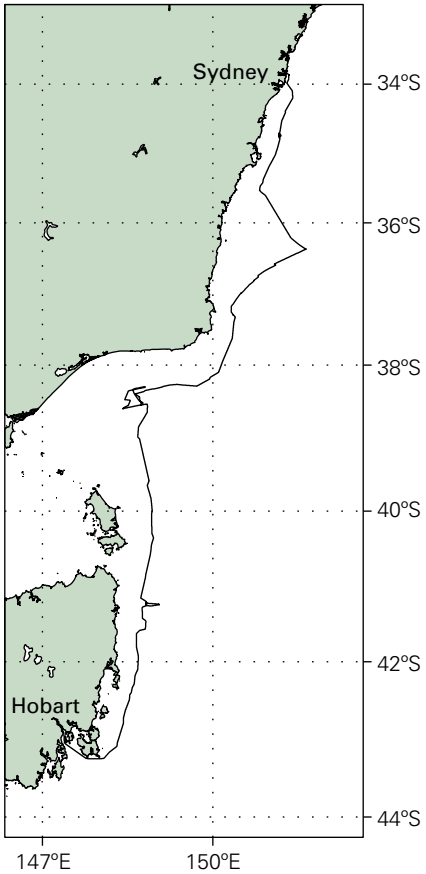
Contribution to Australia's national benefit

The deployment of BOAGS coupled with the swath mapping undertaken, is key to the ongoing and generally serendipitous mapping of the Australian marine habitat. On this voyage in particular, we discovered a new uncharted seamount (Amelia's mount) off St Helens Hill.

The successful collection of the reef forming coral, Solenosmilia variabilis, for work on ocean chemistry and coral distribution was an important contribution to our understanding of the future effects of climate change on marine communities.

The collection of specimens for natural chemistry research increased our knowledge about Australia's natural marine resources, whilst the deployment of the Continuous Plankton Recorder improved our understanding of how populations/ regions maybe connected.

> Voyage track



As a result of this voyage:

1. We have a better understanding of a unique geological feature off Wollongong and the benthic macro fauna of Bass Canyon.
2. We have found a new seamount (Amelia's mount) off St Helens Hill.
3. We have mapped a section of the mid-upper slope of the continental shelf along a transect from Sydney to Hobart, including filling in some of the shallower gaps of Bass Canyon and the canyon heads associated with it.
4. We have commenced a program of examining the stable isotopes of the benthic fauna collected to better understand the trophic ecology of deep sea communities and measuring the physiological response and performance of Solenosmilia variabilis with a view towards determining how climate change may have impacted their distribution.

Addressing National Research Priorities

An environmentally sustainable Australia

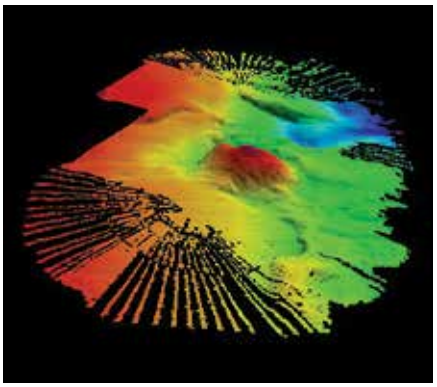
- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Sydney 3 November 2010
Arrived Hobart 8 November 2010

Credit: Daniel Harrison

Dr Rudy Kloser working in the Operations Room.
Credit: Matt Sherlock



A 3D map of Amelia's mount.

The Benthic Optical, Acoustic and Grab Sampler (BOAGS) takes underwater samples and pictures which are transmitted back to the vessel. Credit: Rudy Kloser

Left: Pictures from the BOAGS being viewed in the Operations Room on the vessel. Credit: Daniel Harrison

Transit voyage ss2011_t01

Pre-industrial sea-surface temperature reconstructions in the Australian region – Eastern Australia

Prof Patrick De Deckker, Australian National University (Chief Scientist)

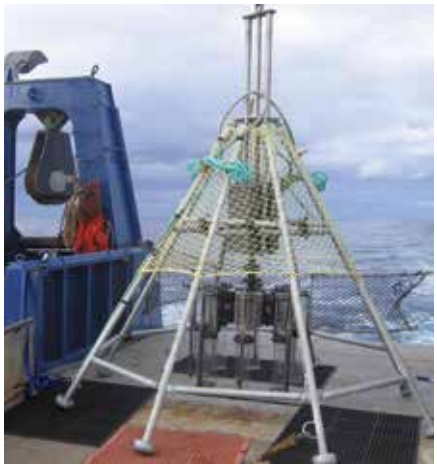
Next Wave
tomorrow's ma i

This project aims to generate high-resolution records of sea-surface temperature changes that have occurred in the oceans surrounding Australia.

This voyage provides data for the first part of the project. Using an innovative organic biomarker, past sea-surface temperatures will be reconstructed.

Additional small projects conducted during the voyage included:

1. Collecting material from some of the cores for a study of magnetic minerals in marine sediments.
2. Filtering air at the front of the vessel during the entire voyage to enable DNA analysis to be carried out back on land to determine the microbial composition of aerosols.
3. Examining the nature of the sea floor to determine if the microbiota are concentrated in the sediment-water interface or below.



The Multicorer consists of a tripod which is about 800 kilograms that is lowered to the sea floor to sample the sediment/water interface. On average, about 300 years of sediment from the sea floor was collected at selected sites in the Tasman Sea. Credit: Lyndsay Dean

4. Obtaining samples from the cores for dating purposes using radionuclides. (This work supplements the research into calibrating past environmental records).
5. Collecting plankton to study calcareous nanoplankton and filtered water samples for chemical analysis [e.g. trace elements, stable isotopes of oxygen and carbon, and radiocarbon].

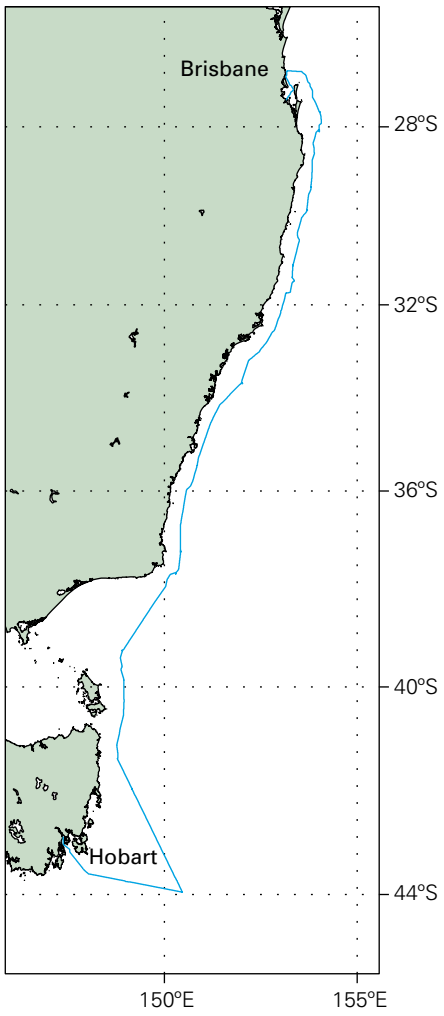
Contribution to Australia's national benefit

We have obtained a series of short sedimentary archives that predate the instrumental record that will help us reconstruct past sea-surface temperature records form the Tasman Sea across a broad temperature gradient. This is the first time that sediment/water interface samples have been obtained from the Tasman Sea. Once we have made our measurements on those sedimentary archives, we will be able to contribute to a global network of past temperature records for comparison with instrumental archives and help better predict future variability.

Our project relied on international collaboration with colleagues from France [University of Bordeaux] and the USA [Indiana State University] who brought expertise to the project and also will work on some of our samples in their respective laboratories.

In addition, one of our students will go to Holland [Royal Netherlands Institute for Sea Research - NIOZ] to process some of our samples as part of an international collaboration funded though a Discovery Project awarded by the Australian Research Council.

> Voyage track



As a result of this voyage:

1. We have a better understanding of the nature of the sea floor at the sediment-water interface in the Tasman Sea. We collected short sediment cores which will now be analysed with the aim of reconstructing past sea-surface temperature changes. We also gathered numerous water samples for radiocarbon dating and chemical analysis to better understand processes that exist in the water column.
2. We have found evidence of substantial water currents at the bottom of the Tasman Sea down to depths over 1,000 metres. Once our laboratory analyses are completed, we will be able to estimate rates of sediment accumulation on the sea floor.
3. We have collected samples of calcareous nanoplankton and zooplankton from the western side of the Tasman Sea and will relate their distribution to chemical parameters to be measured in the laboratory, including stable isotopes of water.
4. We have collected numerous samples of benthic microbiota in order to define their ecological requirements that may be related to processes in the water column at their site of collection.

Addressing National Research Priorities

An environmentally sustainable Australia

- Goal 7: Responding to climate change and variability

Itinerary

Departed Hobart 5 May 2011
Arrived Brisbane 12 May 2011

Multicorer being returned to the deck with some tubes containing sediment and water. Credit: Lyndsay Dean

The 8 multitubes containing sediment and water [at the interface] are fixed to a frame in the ship's laboratory for examination and extrusion. Credit: Lyndsay Dean

Transit voyage ss2011_t02

Towards an understanding of mid-trophic biomass, distribution, variability and energetics in ocean ecosystems

Dr Rudy Kloser, CSIRO Marine and Atmospheric Research (Chief Scientist)

Next Wave tomorrow's ma i

This transit voyage developed and applied new methods to understand the zooplankton and micronekton of the Tasman Sea.

This work adds value to ongoing data collections from bio-acoustic and continuous plankton recorder facilities within the Integrated Marine Observing System (IMOS).

Contribution to Australia's national benefit

The Tasman Sea is a climate change 'hot spot' with temperature predicted to rise due to the strengthening of the East Australian Current.

A baseline and monitoring of the ecosystem responses and its potential flow on effects to the goods and services that the ecosystem provides in this region has high priority.

Monitoring the zooplankton and micronekton communities ~2 to 20 cm length (including small fish, crustaceans, squids and gelatinous zooplankton) at basin scales should provide valuable inputs to ecosystem-based fisheries management, marine planning and monitoring impacts of climate change for the region.

Despite the enormous pelagic realm these organisms occupy and their pivotal role in the functioning of ecosystems linking biogeochemistry to the distribution and abundance of predators, they remain one of the least known components of the ecosystem.

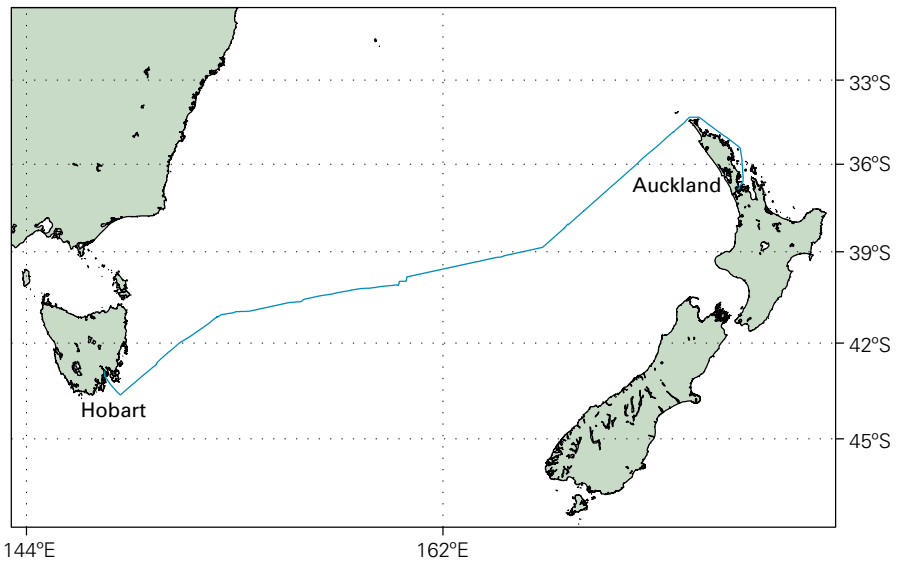
Student participation

Two undergraduate students (University of Sydney) and four post-graduate students (University of Queensland, University of Western Sydney, University of Tasmania and University of Western Australia) participated in the voyage. All students were actively involved in the collection and processing of samples from plankton and MIDOC nets.

As a result of this voyage:

1. We have a better understanding of the community structure and biomass of zooplankton and fish species across the Tasman Sea.
2. We have found fish diversity and biomass is low in the East Tasman and high in the West Tasman along the 41o S latitude. This appears to be in direct contrast to ecosystem model predictions of biomass for the region.
3. We have mapped the distribution of micronekton using acoustic methods from New Zealand to Tasmania across the Tasman Sea to a depth of 1200 m and physically sampled this distribution with depth stratified nets. Data collected will form the basis of several student PhD, Masters and Honours works.

> Voyage track



4. We have commenced a program to understand mid-trophic biomass, distribution, variability and energetics in ocean ecosystems that should enable better modelling of the ecosystems and input into ecosystem-based fisheries management, marine planning and monitoring impacts of climate change for the region.

Addressing National Research Priorities

An environmentally sustainable Australia

- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Auckland, New Zealand
7 June 2011

Arrived Hobart 15 June 2011

The diversity of the deep pelagic micronekton in the Tasman Sea retained in the MIDOC net fished from 600 m to 400 m.

Scientists and students busy sampling the net catch.

Research charter voyage

Research charter voyage ss2011_c01

ss2011_c01 •

Tsunami detection buoy maintenance for the Australian Tsunami Warning System

Alan Thomas, Bureau of Meteorology (Chief Scientist)

The Australian Tsunami Warning System (ATWS) is a national effort involving the Australian Bureau of Meteorology, Geoscience Australia and Emergency Management Australia to provide a comprehensive tsunami warning system capable of delivering timely and effective tsunami warnings to the Australian population.

The project also supports international efforts to establish an Indian Ocean tsunami warning system, and contributes to the facilitation of tsunami warnings for the South West Pacific.

Network of monitoring buoys

The current, and proposed, network of six tsunameters has been developed to support the enhancement of Australia's Tsunami early warning system. Deployment sites have been selected from areas around Australia that experience significant tectonic instability.

Due to the complexity and uncertainty as to whether an undersea earthquake has the potential to generate a tsunami, the observation of sea levels is a critical factor in verifying whether a tsunami has actually been generated. The use of actual sea level observations, as compared with reliance on seismic observations alone, therefore helps to significantly reduce the risk of false tsunami warnings being issued.

All Australian-owned buoys, as well as deep-ocean buoys operated by other countries in the Australian region, provide critical data to Australia's tsunami warning system.

As a result of this voyage:

One of the key components of the Australian Tsunami Warning System project is the deployment and the continued support of the Tsunameter Network that is under the direct management of the Australian Bureau of Meteorology, and this voyage included:

1. The successful deployment of the Easy to Deploy (ETD) tsunameter. This deployment was the result of a collaborative arrangement between NOAA/PMEL (National Oceanic and Atmospheric Administration/ Pacific Marine Environmental Laboratory) and the Australian Bureau of Meteorology to further develop Tsunami Warning Systems.
2. The deployment of the new Deep Ocean Assessment and Reporting of Tsunamis system (DART) II tsunameter comprising separate bottom pressure recorder and moored surface buoy.
3. Recovery of the SAIC Tsunami Buoy tsunameter, which comprised a separate bottom pressure recorder and moored buoy.
4. Changeover of the existing ETD buoy to allow the continued operation of the station.

Addressing National Research Priorities

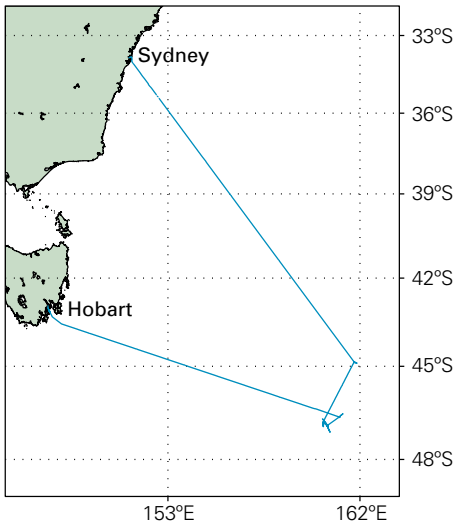
Safeguarding Australia

- Goal 1: Critical infrastructure

Itinerary

Departed Sydney 1 April 2011
Arrived Hobart 8 April 2011

> Voyage track



Students gain insight at sea and at home

The *Southern Surveyor* through its *Next Wave* program provides students the opportunity of experiencing life at sea. This can be a life changing experience that strengthens a student's commitment to being part of the marine science community.

Comments from voyage ss2010_t04

Students took turn in station activities, operating and processing the swath (a device that maps the ocean floor), and in marine mammal watching. For them the voyage was very enjoyable and a resounding success, as captured in their own words:

"My time at sea was a truly incredible and eye-opening experience. Witnessing how crew members from various fields integrated into a cohesive unit was fantastic, and it was great to feel that I was a part of it all. What excited me the most was seeing deep-sea creatures that I'd never even imagined existed! For me, the Southern Surveyor was unforgettable, and I hope that many more students are given the same opportunity in the future."

"It was an amazing experience to get a chance to work with equipment and software that I had never seen, or only ever read about. Learning how to apply my love for all things marine was one of the most rewarding parts of the voyage."

Blogs keep students up to date back home

Not all marine science students who would like to go to sea have the opportunity to do so. There are only a small number of berths available on the *Southern Surveyor* so many contenders miss out. For this reason the University of Sydney came up with the idea of a blog so that those back on land can share the excitement of the voyage.


Students Work Like Marine Biologists

The thrilling conclusion

(Edited extract from the student voyage report by Matt Ward – ss2010_t03)

Today would be another day of sampling, this time though we were looking at the cold core eddy. Once again we sampled at the edge, partially in and the core of the eddy. By this stage all three teams knew what they were doing and we functioned as an efficient unit.

That night we listened to talks from several of the MNF support staff, Dr Jock Young, the chief scientist and PhD students hearing of community dynamics of the salp (*Thalia democratic*) and krill, behaviour of top predators in the East Australian Current and a virus that is currently affecting copepods. Tomorrow we will be arriving in Sydney which would be the end of our adventure.

It was a great experience where I learnt a lot and managed to develop myself as a scientist. I would like to sincerely thank Prof Iain Suthers and the Marine National Facility for making this possible.


Students gain practical experience with a wide range of marine research equipment. Credit: Daniel Harrison


Rugged up for work in the lab. Credit: Rudy Kloser

New technology

The Marine National Facility adds new functionality and upgrades technologies on the vessel to ensure that it can meet the needs of the marine research community.

Further upgrades to scientific echo sounder

Last year the 12kHz EA500 echo sounder was replaced as the first stage of implementing a multi-frequency echo sounder system.

This year a Simrad 38 and 120 kHz transducer and associated computing hardware and software was purchased to implement a full EK60 multi-frequency echo sounder system. This superseded the legacy EK500 scientific echo sounder on-board.

Upgrade of EZ Net

The EZ Net is a multi-depth plankton sampling net system which provides real-time telemetry to the vessel whilst it is deployed. The old system had been troubled by reliability issues dating back many years.

The electronics system was re-designed and mechanical improvements carried out.

The EZ Net will now provide more reliable sampling with enhanced capability in terms of sensor payload, data visualisation and control.

EZ Net being retreived

Electronic manual and issue tracking system

A new documentation and issue tracking system called Polarion was launched in March 2011.

The introduction of Polarion was driven by the need for a searchable, web-enabled system which allows the MNF support team's documentation and software repository to be synchronised between the ship and the onshore support facility in the absence of a network connection. The issue tracking component of the system also helps in troubleshooting problems as it allows support staff to look back and see what was done, when and by whom.

Replaced backup satellite system

The old Mini-M backup satellite communication system became unserviceable and was replaced by a new Iridium Openport system.

Scanmar depth sensor

The vessel is equipped with Scanmar trawl telemetry system which tracks the depth and controls trawl nets and other sub-surface sampling tools. A crucial component of the system is a depth transponder. A replacement was required as the past units have become unserviceable.

The current-generation Scanmar ScanSense SS4VTL-D depth transponder features modern battery technology allowing greater deployment times and shorter charging cycles.

Spare CTD and auxiliary sensors

The Conductivity Temperature and Depth (CTD) unit is a critical piece of equipment on the vessel. A spare was needed to provide redundancy in case of loss or failure of the main unit.

A complete Seabird 9-plus CTD was purchased with additional sensors for measuring oxygen, transmission, PAR, fluorescence and altimetry.

CTD package being lowered into the water.

Better access to data from voyages

Access to marine data from the *Southern Surveyor* has been greatly simplified through the introduction of the Australian Ocean Data Network (AODN) web portal.

AODN provides user friendly access to marine data from a range of organisations including Australian Antarctic Division, Australian Institute of Marine Science, Bureau of Meteorology, CSIRO, Geoscience Australia, Royal Australian Navy and Integrated Marine Observing System (IMOS) - University of Tasmania.

The portal is an important step forward in providing a one stop shop for marine data.

The vision of the AODN was articulated in 2005 by the Australian Ocean Data Centre Joint Facility (AODCJF), a joint venture between the six Commonwealth Agencies with primary responsibilities for marine data. The vision was:

"to put in place, by June 2011, an interoperable, online network of marine and coastal data resources, including data from the six AODCJF partner agencies, supported by standards-based metadata, which will serve data to support Australia's science, education, environmental management and policy needs: Australia's ocean commons."

Since the opening of the AODN office on the 1 July 2010 development of the portal has accelerated. Work in the agencies has been underway to make as much marine data as possible accessible and freely available over the internet.

The Marine National Facility has been at the forefront of providing data through AODN.

The *Southern Surveyor* collects data continuously (underway data) while at sea. The vessel also maps the sea floor and collects data from a wide range of deployed instruments.

An enormous amount of information or data is collected and made available through the CSIRO Marine and Atmospheric Research data library which is the primary custodian of data collected by Marine National Facility equipment on the *Southern Surveyor*.

The AODN now provides access to much of the underway, CTD and hydrology data through its user friendly portal. However, not all data is in a compatible format for use through the AODN and work continues to address these issues.

The AODN has provided an important new outlet to facilitate improved use of marine data. Over time, more organisations will use the AODN to disseminate data to users, further increasing the utility of this important web portal.

The portal allows voyage tracks to be displayed. By clicking on a voyage track the information available at that point is outlined in a dialog box. The data can be downloaded to the user in three different file types – CSV (e.g. Spreadsheet), KML (e.g. Google Earth) and NetCDF (open access file format particularly suited for data from scientific and engineering instrumentation).

Equipment such as the Remote Underwater Vehicle (ROV) collects a lot of data which goes back to the vessel. This is stored and then processed either on the vessel or back on land.

Maintaining operational efficiency

Maintaining the operational efficiency of *Southern Surveyor* until *Investigator* arrives has been a priority for the Marine National Facility. This has been achieved through an enhanced maintenance program funded by the Australian Government.

This program is funded until mid 2012 to ensure that marine research can continue with minimal interruption until the decommissioning of *Southern Surveyor* in 2013.

The following is a breakup of enhanced maintenance projects by category carried out during the 2010-11 financial year at a total cost of nearly $1.8 million.

Category of works	Number of projects
Hull and superstructure	4
Propulsion	2
Auxiliary machinery and services	10
Air conditioning and refrigeration	7
Electrical	4
Safety systems	5
Navigation and bridge	3
Deck machinery and research equipment	6
Accommodation	1

During a routine underwater inspection of the vessel, the kort nozzle (steerable casing around the propeller) was found to contain cracks. The nozzle could not be repaired while the vessel was in the water, so *Southern Surveyor* was dry docked in March 2011 to facilitate the repair.

The propeller being removed from the vessel.

As noted in the underwater inspection the kort nozzle was cracked and in some places metal plating was missing.

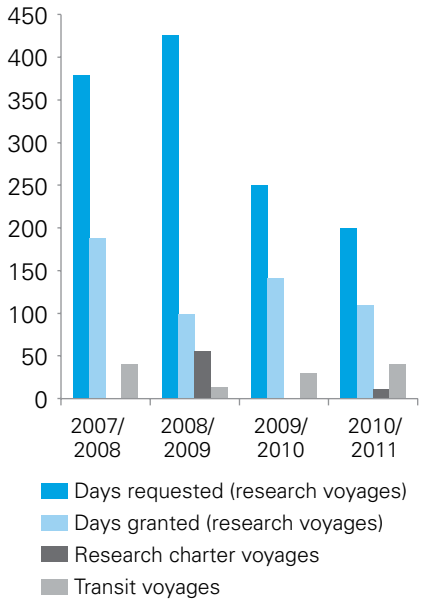
The reconditioned propeller and repaired kort nozzle fitted back on the vessel.

Statistics

The following statistics are for the 2010 – 2011 financial year.

Application for use of the Marine National Facility

The Marine National Facility provided 110 days of ship time grants for research voyages.



Ports Visited

The Marine National Facility's research vessel, *Southern Surveyor*, visited the following ports (home port Hobart not included).

Port	Number of visits
Auckland	1
Brisbane	1
Fremantle	3
Sydney	3

Availability of Platform

At sea	Days
Research Voyages	102
Research charter voyages	11
Transit Voyages	41
Sea Trials	2
Days at sea	**156**

In port	
Research Voyages Mob/Demob	8
Unallocated port days	169
Dry dock	32
Days in port	**209**

Note – Ship time grants for research voyages include days at sea and the days in port to load (Mob – mobilisation) and unload (Demob – demobilisation) the vessel.

Voyage participation

The Marine National Facility brings scientists together from a wide variety of research organisations to address Australia's marine research issues.

Investment in the Marine National Facility enables universities, Australian government and State agencies to conduct research that supports the sustainable development of Australia's marine resources.

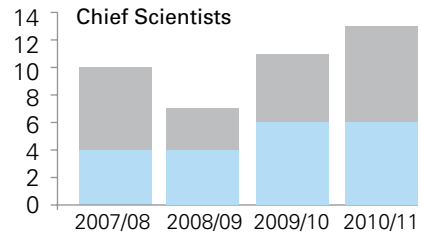
Scientific personnel from 26 organisations from Australia, Canada, France, Germany, South Africa and United States America sailed on the *Southern Surveyor*.

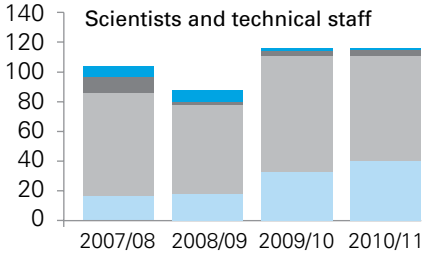
Australian Universities	13
Australian Agencies*	8
International Universities	4
International Agencies	1

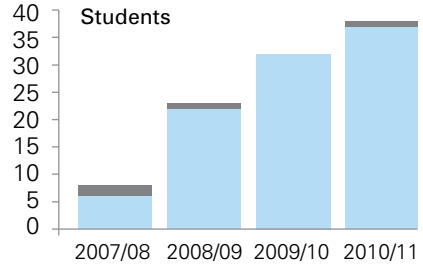
* CSIRO divisions are listed on the next page but only counted once in the total number of Australian agencies.

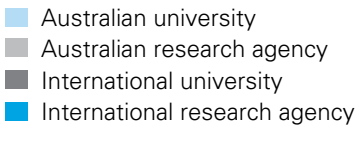
On a research voyage, the Chief Scientist is responsible for the scientific program. Other scientists (including international collaborators) and technical staff provide support for the scientific program and research equipment, while students assist and gain valuable experience in research vessel operations. Together, these groups make up the scientific participants on a research voyage. The following charts illustrate the number of scientific participants on research voyages by their affiliation.

The number of students who can participate on Marine National Facility voyages has grown considerably as a result of the *Next Wave* student program. Transit voyages, or voyages that connect two research voyages or a research and charter voyage, are now being used for opportunistic science and providing students with experience in working at sea.









The following is a list of the organisations represented on the voyages.

National

Antarctic Climate Ecosystems Cooperative Research Centre

Australian National University

Bureau of Meteorology

CSIRO Land and Water

CSIRO Marine and Atmospheric Research

Curtin University

Department of Environment and Natural Resources, South Australia

Department of Environment, Climate Change and Water, New South Wales

Department of Fisheries, Western Australia

Department of Primary Industries, Queensland

Murdoch University

South Australian Research and Development Institute

University of New England

University of New South Wales

University of Sydney

University of Tasmania

University of Technology, Sydney

University of Western Australia

International

CSIR, South Africa

Indiana University, United States America

University of Bordeaux, France

University of British Columbia, Canada

University of Kiel, Germany

Students

Australian National University

Deakin University

University of New South Wales

University of Queensland

University of the Sea

University of Sydney

University of Tasmania

University of Wollongong

Key performance indicators

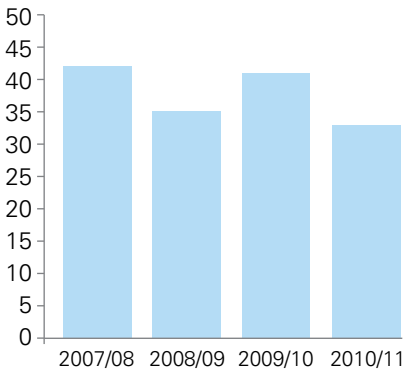
Incidents are an important indicator of performance but more importantly provide continuous feedback which assists in the management of the vessel.

An incident is any event, which has the potential to impact on our people, neighbours, the environment or to our business.

By looking at the cause of incidents, many of which are minor, managers have the opportunity to make continual improvements.

Incidents reported on *Southern Surveyor* decreased from 41 in 2009/10 to 33 in 2010/11.

Total vessel incident reports over the past four years



Occupational Health & Safety

In 2010/11 there were no lost time injuries (LTI) and no medical treatment injuries (MTI).

A LTI is a work related injury which results in a person being unfit for work on any shift, watch or work day after the occurrence of the injury or illness, as reported in a medical certificate.

A MTI is an incident that is not severe enough to result in lost work days (i.e. LTI) but severe enough to require medical treatment rather than requiring just simple first aid treatment.

Environmental impact

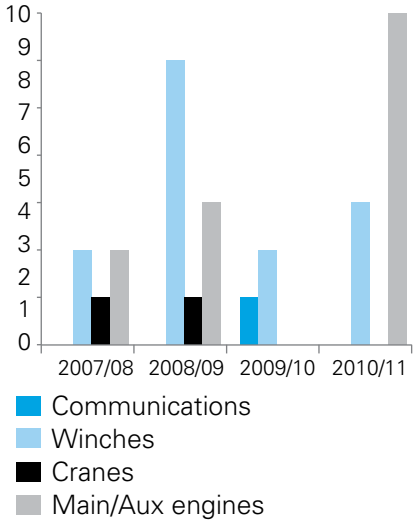
No incidents resulted in hydrocarbons entering the environment.

No incidents resulted in releases of ozone depleting gas emissions.

Repairs and maintenance

Most incidents were relatively minor and did not affect the vessel's operation apart from cracks in the Kort nozzle which were repaired in dry dock.

Total incidents per year for each equipment category



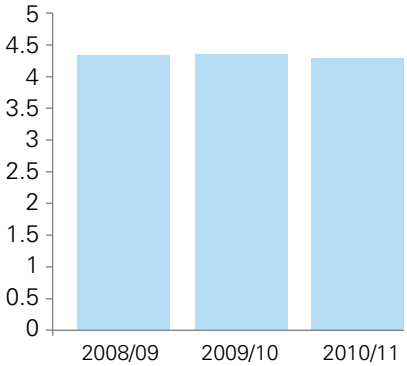
User feedback

Continuous improvement is an important part of ship management. The Chief Scientist, Voyage Manager and the Ship's Master each have different perspectives of a voyage due to their job roles. To help identify changes that need to be made after a voyage each of the managers are asked to rate their degree of satisfaction of a range of issues, using the following scale:

5 Excellent
4 Very Good
3 Good
2 Moderate
1 Poor

The following graph provides an overall satisfaction rating by taking an average across all voyages and the responses from the Chief Scientist, Voyage Manager and the Ship's Master.

Overall satisfaction



Financial statement

Financial report for the period ending 30 June 2011

Balance Sheet	2011 $	2010 $
REVENUE		
Research and Services Revenue	-	653,700
Other External Revenue	508,212	63,600
Appropriation Revenue	12,532,475	13,771,052
TOTAL REVENUE	**13,040,687**	**14,488,352**
EXPENSES		
Salaries	2,223,130	1,641,687
Travel	229,241	265,272
Other Operating	8,951,825	9,203,194
Business Unit/Enterprise Costs	1,862,876	2,642,052
TOTAL EXPENSES	**13,267,072**	**13,752,204**
OPERATING RESULT	**(226,385)**	**736,148**
CAPITAL		
Capital Purchases	466,379	150,534

Please note: With the exception of capital purchases, all other Balance Sheet accounts are maintained at the Organisational level only.

Glossary

ATWS
Australian Tsunami Warning System

BOAGS
Benthic Optical, Acoustic and Grab sampler

BPZ
Benthic Protection Zone

Chief Scientist
The person with the responsibility for the science program on the voyage

CMAR
CSIRO Marine and Atmospheric Research

CO_2
Carbon dioxide

CPR
Continuous Plankton Recorder

CTD
Usually refers to an instrument that measures Conductivity (used to measure the salinity of sea water), Temperature and Depth

FRV
Future Research Vessel

GEOTRACES
An international study of marine biogeochemical cycles of trace elements and their isotopes.

IMOS
Integrated Marine Observing System

IPCC
Intergovernmental Panel on Climate Change

MNF
Marine National Facility – Includes the *Southern Surveyor*, data generated from voyages and the people and equipment to support the vessel

MPA
Marine Protected Area

Next Wave
A program that provides the opportunity for early career researchers and students of marine science to experience the working environment on a blue water research vessel.

NCRIS
National Collaborative Research Infrastructure Strategy

SOFS
Southern Ocean Flux Station

SOTS
Southern Ocean Time Series

Voyage Manager
The Voyage Manager represents CSIRO's interests as owner of the vessel.

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