MARINE
NATIONAL FACILITY

annual report 2009-2010

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 was established by the Australian Government in 1980. It is Australia's only blue water vessel that carries out research of 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

It is an extremely exciting period to be involved with the Marine National Facility (MNF). In the May 2009 budget, $120 million was allocated to build a new research vessel to replace the RV *Southern Surveyor* and another $29.6 million provided for the operation and maintenance of our current vessel and first year of operation of the new vessel. In January 2010, after an open competition, Senator the Honourable Kim Carr announced that the new vessel would be named RV *Investigator* (more below).To get to this point has involved a lot of work by the Steering Committee, CSIRO, our colleagues in the Australian Government and, most importantly, Senator the Honourable Kim Carr.

Our focus now is to maintain a scientific program of excellence for the remaining voyages on the RV *Southern Surveyor* while at the same time supporting the designing, building and commissioning of the new vessel. There will be many significant challenges ahead but the enthusiasm generated in embracing the opportunity to design a state-of-art purpose built research vessel, representing a once in a lifetime opportunity for most involved, will prevail.

Compared to our present vessel, RV *Investigator* will be notably larger, carry more people, be better equipped, cover a much broadened science capability, be able to stay at sea longer and will be able to navigate the full breadth of Australian waters down to the ice edge. With a science compliment of around 40 people and the potential to operate 300 days a year at sea, RV *Investigator* represents an increase in person-days at sea, and therefore scientific output, greater than five times that of RV *Southern Surveyor*. By any measure, the new vessel represents an extraordinary opportunity for Australian bluewater marine science.

The MNF office, and MNF Steering and Science Advisory committees, have already commenced work to transition existing systems to meet the needs of a new vessel with much greater capacity and capability and to accommodate the additional complexities inherent in its operation, to ensure it delivers optimal return to the nation. The Future Research Vessel project has now been established and the Project Technical Director, Graham Stacey appointed. The project is run by a project team in CSIRO separate to the Marine National Facility (MNF). The challenge now rests with the scientific community to leverage the full potential of the new national facility. I have full confidence that this challenge will be met in full given the current level of interest and engagement by the broad bluewater research community in the Future Research Vessel project.

The name for our new vessel arose from a national Float-a-Name competition, and I congratulate Kirrily Moore of Tasmania and Clare Cameron of Queensland for coming up with the winning name. *Investigator* is absolutely appropriate for a specialist built vessel devoted to scientific enquiry, and of course is named after Matthew Flinders' ship which completed the first circumnavigation of Australia. The competition generated a lot of interest with 1458 entries!

The year's activity hasn't all been about the new vessel. Significant effort has also been directed towards maintaining momentum in the work program enabled by RV *Southern Surveyor*, including a unique opportunity to promote the MNF. Prince William's interest in the environment resulted in him visiting RV *Southern Surveyor* at Garden Island in Sydney in January 2010. This was an exciting time for the staff involved and a great opportunity to showcase marine science. Prince William's interest in what we do also had the added benefit of raising the awareness, through media coverage of the RV *Southern Surveyor* and the important role of marine science in Australia.

Careful attention has been given to ensuring that RV *Southern Surveyor*, which by any standard is an old vessel and in need of ongoing work, is maintained at maximum operational efficiency. In the past 12 months the enhanced maintenance program for RV *Southern Surveyor* has proceeded apace, enabling the three transit voyages dedicated to the *Next Wave* program and eight research voyages to proceed smoothly.

Attracting bright and enthusiastic students is critical to producing the marine scientists of tomorrow, and if the enthusiasm of students on the MNF *Next Wave* program is any measure, then the future of bluewater marine science is assured. This is an important initiative to give students a taste of what marine science at sea is all about. In 2009-10 students studied tuna prey resources off Eastern Australia, the deep sea benthos in the Bass Canyon off the Victorian Gippsland coast, and the Leeuwin Current off the Western Australian coast, and took on the challenges with great enthusiasm. The MNF is strongly committed to continuing the success of the *Next Wave* Program.

The increased number of research voyages in 2009-10 reflects improved funding on the previous 12 month period and, as always, most voyages collected important data, samples or other information. The focus of one voyage was to better map and more extensively sample the seafloor between Fiji and Vanuatu to provide a clearer picture of the processes of magmatism (the formation of igneous rocks from magma) in the region. This work facilitates better knowledge of the formation of ore deposits as a potentially important deep sea resource.

The transfer of carbon dioxide from the atmosphere to the upper ocean and then onwards to the ocean interior through sinking particles is an important part of the carbon sequestration process, and detailed measurements of this process are vital in quantifying key elements of the carbon cycle. Because the process varies through time, continuous automated moorings are needed which can be deployed to take measurements and samples over a long period. In the first of two Integrated Marine Observing System (IMOS) voyages in the Southern Ocean, a sediment trap mooring that collects sinking particles was recovered and redeployed and a second mooring deployed to collect a wide range of measurements and water samples. In the second voyage for IMOS work, the first deployment of a surface air-sea interaction mooring in the Southern Ocean was carried out, followed by the first recovery of another mooring that had recorded a full season of carbon observations. On the same voyage there was also the first Australian deployment of an autonomous glider to map open ocean properties off the continental shelf in the deep Southern Ocean south of Tasmania. This was a pioneering – and exciting – voyage for all involved. The IMOS program was initiated in 2007 under the National Collaborative Research Infrastructure Strategy (NCRIS) to establish a diversity of observing equipment in the oceans around Australia.

A voyage off south eastern Australia in the Stockton Bight observed a highly productive region influenced by eddies. The data collected are helping to resolve why this region is so productive and to determine its importance to production on the New South Wales coast.

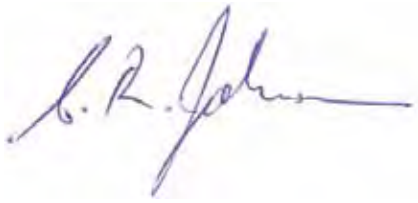
The impact of seamounts or underwater mountains on the flow of stratified water can have profound implications for nutrient movement and biological productivity, and these kinds of features can be critical to capture in developing models of water movement and ecosystem dynamics at regional and large scales. A voyage in the Tasman Sea provided valuable information to understand water flow and the mechanism driving production around reefs and islands of the Lord Howe Rise.

The Intergovernmental Panel on Climate Change has predicted that the Tasman Sea will be one of the marine areas most impacted by ocean warming, and so a clear understanding of ecosystem processes in the area is vital to predicting response to climate change. On another voyage scientists measured the impact of nitrogen and iron on marine algae in this region. These algae form the base of the food web and are also responsible for 30-50% of the biological uptake of carbon dioxide from the atmosphere.

Voyages on the west coast focused strongly on gathering information to inform management of the impact of development on marine ecosystems in the region. A voyage on the Kimberly Shelf looked at processes affecting marine productivity so that costs and benefits of management action could be better evaluated at a whole-of-system level. This is important given the scale of development occurring and proposed in the area.

Another voyage in the west looked at how offshore industrial developments impinge on Ningaloo Reef. This information provides a basis to assess the 'oceanographic reach' of industrial developments on reef ecology, i.e. to assess the distance from marine industry over which reef ecological processes may be affected.

Decision makers need knowledge – a solid scientific basis – if human responses to risk are to be robust and effective. This year, as previously, MNF voyages help provide the understanding and knowledge to unpin the policy process. Given the vastness of Australia's ocean territories, the challenges are many and Australia's marine science community has an enormous and absorbing task ahead of it. The MNF continues to be a lynch pin in this enquiry.



Professor Craig Johnson
Chairman, Steering Committee
The Marine National Facility

New research vessel – RV *Investigator*

The Australian Government's investment in a new deep water research vessel passed three important milestones this year with the launch of the Future Research Vessel project, naming of the new vessel and the appointment of a Project Technical Director.

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. Senator Carr also took the opportunity to launch a national competition to give all Australians a chance to suggest a name for the new vessel.

The Float-a-name competition closed in December 2009 and the winners were announced by Senator Carr in January 2010.

Kirrily Moore of Mount Stewart in Tasmania and Queensland primary school student Clare Cameron were announced joint winners of the competition.

The name for the new vessel, *Investigator*, was chosen from 1,458 entries and paid tribute to Australia's prestigious maritime heritage. It reflected the remarkable achievement over 200 years ago when Matthew Flinders circumnavigated Australia onboard the original *Investigator*.

New Project Technical Director

After naming the winners for the national Float a name competition for the new vessel Senator Carr also took the opportunity to welcome the appointment of experienced marine engineer Graham Stacey as Project Technical Director for the Marine National Facility Future Research Vessel.

Graham Stacey is a Marine Engineer with recognised marine expertise and extensive project management experience in offshore vessels.

He is the Sole Principal Consultant of Graham Stacey Associates Pty Ltd, a successful project management company specialising in ship construction and conversion. Mr Stacey has extensive experience ranging from contract management, procurement and scheduling, through to construction, client relations and safety.

Graham is an important addition to the team and we welcome him onboard.

RV *Southern Surveyor*

The *Southern Surveyor* will be replaced by a larger more capable vessel that can stay at sea longer, carry more scientific staff and travel to the ice edge. This will be a purpose built, state-of-the-art research vessel that will double Australia's research capabilities when it joins the national fleet.

Prince William visits the *Southern Surveyor*

During a tour in Sydney of the Marine National Facility's research vessel, *Southern Surveyor*, CSIRO scientists briefed His Royal Highness Prince William of Wales KG on CSIRO's contribution to international research into climate change, marine biodiversity and fisheries. Prince William also viewed robotic marine instruments that have revolutionised ocean observations and climate science, and viewed some of Australia's unique marine biodiversity.

CSIRO was approached to participate in Prince William's three day visit to Australia in January 2010, specifically in relation to his interest in climate change and sustainable development. He was welcomed by Chief Executive, Megan Clark on the Garden Island Navy Wharf, and received an overview of the Marine National Facility from Toni Moate, Deputy Chief Business, CSIRO Marine and Atmospheric Research.

CSIRO scientists Alan Williams, Steve Rintoul, Ian Cresswell and Tom Hatton were on hand to brief the Prince and respond to questions from the large international and local media contingent following Prince William.

Prince William and staff of CSIRO (Meg Rive, Simon Torok, Megan Clark, Ian Cresswell, Prince William, Steve Rintoul, Toni Moate, Tom Hatton, Alan Williams).

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

Director
Captain Frederick R. Stein

Acting Director/Ship Manager
Mr Ron Plaschke

Ship Manager
Mr Stephen McCullum

Ship Operations Manager
Mr Don McKenzie

Ship Operations Officer
Ms Lisa Woodward

Administrative Assistant (Casual)
Ms Roslyn Barnett

Personal Assistant
Ms Martina Miksch

Staff changes

Director resigns

Captain Frederick Stein resigned as Director of the MNF office in June 2010. Mr Ron Plaschke assumed the role as Acting Director.

The Steering Committee would like to thank Captain Frederick Stein for his valuable contribution to the Marine National Facility.

New Ship Manager

The Steering Committee welcomes Stephen McCullum as the new Ship Manager.

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

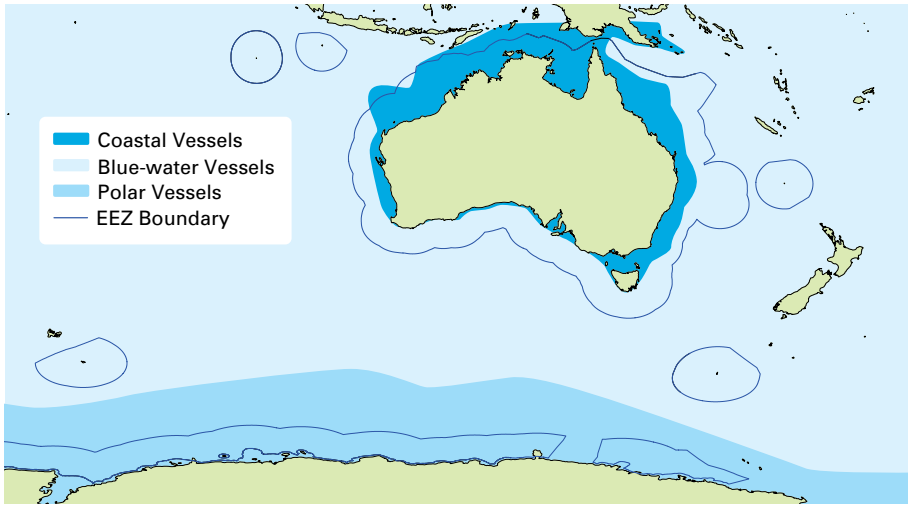
Transforming the way we utilise our land, water, mineral and energy resources through a better understanding of human and environmental systems and the use of new technologies

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.



Research vessel areas of operation.

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 2009-2010

The Marine National Facility carried out two types of voyages.

Research voyages

A research voyage is a program of scientific work approved by the Marine National Facility through an independent international peer review process. A call for applications for sea time is made annually and organisations can apply with their international collaborators.

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 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 voyages

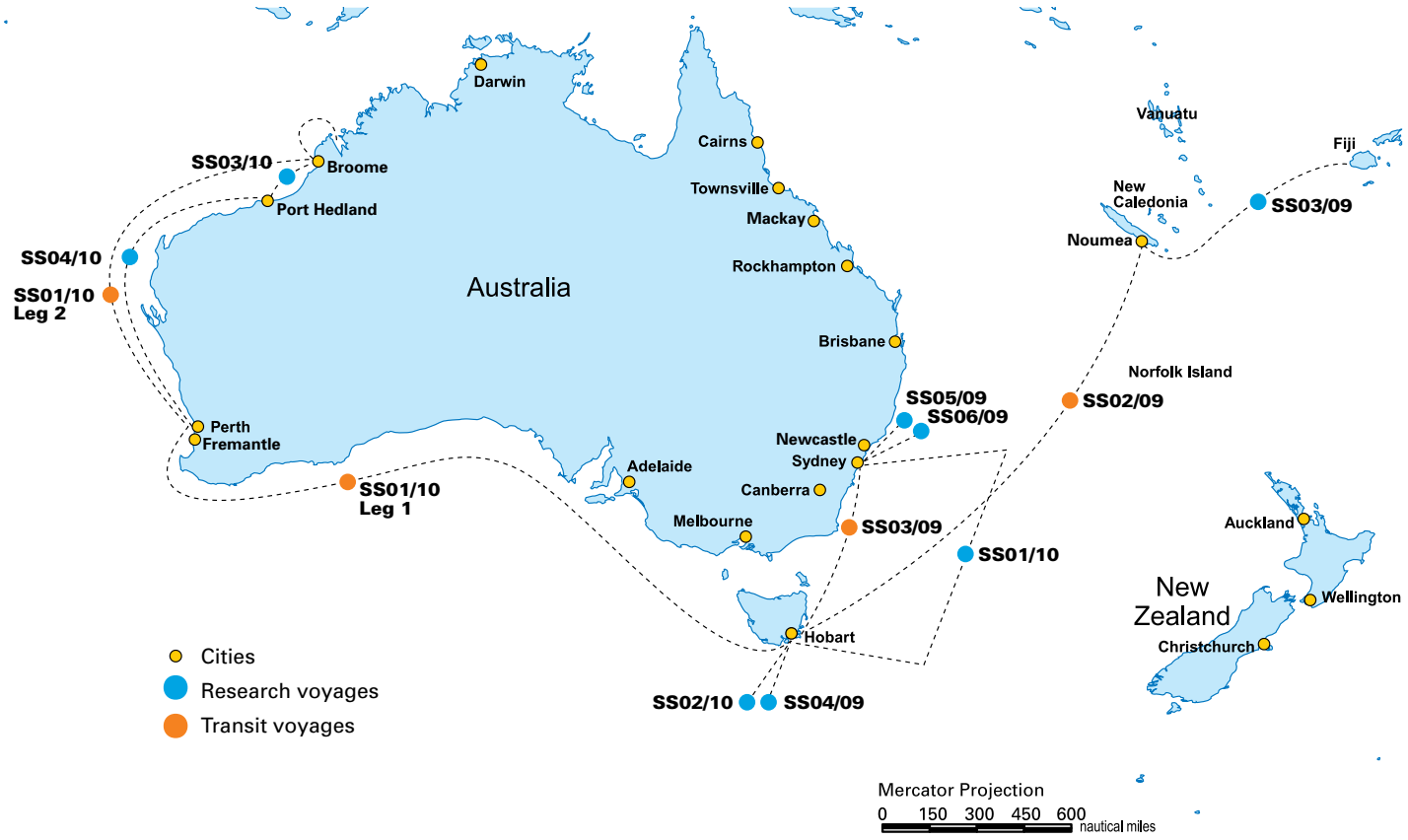
			NATIONAL RESEARCH PRIORITIES						
			Environmentally Sustainable Australia				Frontier Technologies	Safeguarding Australia	
Voyage	Voyage title	Lead Organisation	2	5	6	7	4	1	5
SS03/09	Hot subduction – recycling of oceanic crust in a dynamic West Pacific setting	University of Tasmania			■			■	
SS04/09	IMOS – Southern Ocean Time Series (SOTS) moorings for climate and carbon cycle studies southwest of Tasmania	Antarctic Climate and Ecosystems Cooperative Research Centre				■			
SS05/09	Salps, eddies and entrainment in the Stockton Bight	University of New South Wales		■		■			
SS06/09	Perturbation flow processes over seamounts in the East Australia Current Outflow in the Tasman Sea	University of New South Wales		■					
SS01/10	Primary productivity induced by nitrogen and iron in the Tasman Sea	University of Technology, Sydney		■		■			
SS02/10	IMOS – Southern Ocean Time Series Facility	Antarctic Climate and Ecosystems Cooperative Research Centre				■			
SS03/10	Physical forcing of productivity on the Kimberley Shelf	CSIRO Marine and Atmospheric Research		■		■			
SS04/10	Assessing oceanographic delivery of nutrients to Ningaloo Reef	University of Western Australia		■		■			

Next Wave Transit voyages

SS02/09 Transit	Quantifying tuna prey resources off eastern Australia in relation to the regional oceanography	CSIRO Marine and Atmospheric Research		■					
SS03/09 Transit	The composition of shelf and deep sea benthos in the Bass Canyon and the distribution of larval fish off the eastern Tasmanian coast	University of Sydney		■					
SS01/10 Transit	ANNiMS Student Training Voyage	University of Western Australia		■		■			

ANNiMS – Australian National Network in Marine Science

Map of voyages 2009-2010



Research voyage SS03/09

Hot subduction – recycling of oceanic crust in a dynamic West Pacific setting

Prof Leonid Danyushevsky, University of Tasmania (Chief Scientist)

Contribution to Australia's national benefit

This project maintains Australian scientific leadership in an area of international interest and addresses the following priority objectives of Australia's Marine Science and Technology plan (1999):

1. To characterise and better understand the geological framework of Australia's continental margin and adjacent ocean basins; and
2. To improve the marine science and technology skills base.

With respect to the latter point, and as identified in the Australian Research Council Discipline Research Strategies Review for Earth Sciences, this research contributes to 'strengthening of marine geoscience research potential in Australian universities'.

Much of Australia's mineral rich Phanerozoic geology is developed in complex subduction related plate boundaries, thus an improved understanding of magmatism in a modern active subduction setting will have direct relevance to the interpretation of Australia's geological history. A better understanding of the tectonics and magmatism associated with these environments will lead to a better understanding of the formation of new deep earth resources.

As a result of this voyage:

1. We have a better understanding of the tectonic structure of the Hunter Ridge and the extent of active magmatism along the southern margin of the North Fiji Basin.
2. We found numerous active submarine volcanic centres along the entire southern margin of the North Fiji Backarc Basin and also sites of active hydrothermal systems along the southernmost propagating spreading centre of the Basin.
3. We mapped 11,600 km^2 of the seafloor at the southern margin of the North Fiji Backarc basin.
4. We commenced a program of detailed investigations of the chemical composition of the samples collected in order to constrain magma generation and evolution processes in the region and the connection between magmatic and hydrothermal systems which ultimately produce ore deposits on the seafloor.

Addressing National Research Priorities

An Environmentally Sustainable Australia

- Goal 6: Developing deep earth resources

Safeguarding Australia

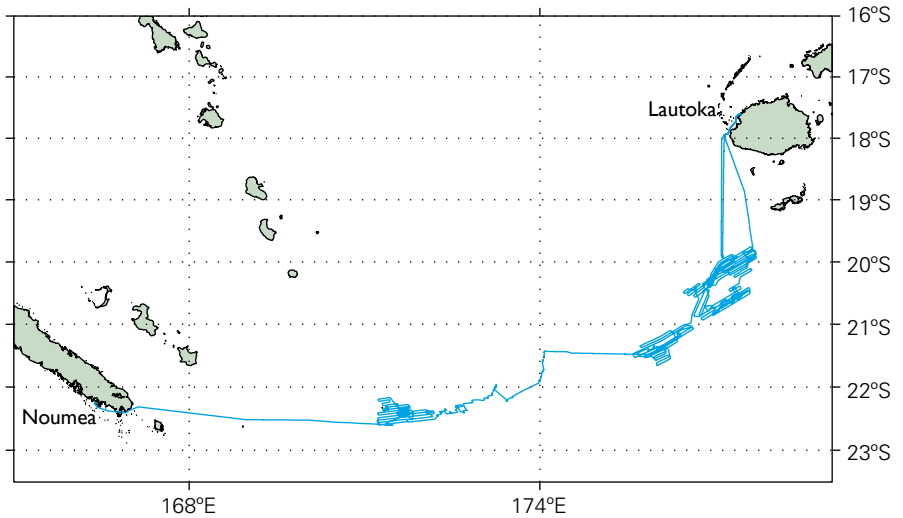
- Goal 1: Critical infrastructure

Itinerary

Departed Latouka, Fiji 3 July 2009

Arrived Noumea, New Caledonia 27 July 2009

> Voyage track SS03/09



Research voyage SS04/09

IMOS – Southern Ocean Time Series (SOTS) moorings for climate and carbon cycle studies southwest of Tasmania

Prof Tom Trull, ACE-CRC/University of Tasmania/CSIRO Marine and Atmospheric Research (Chief Scientist)

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 overall scientific objective of this project is to obtain frequent measurements of surface and deep ocean properties that control the transfer of 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 its intensity 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 National Collaborative Research Infrastructure Strategy Integrated Marine Observing System (IMOS) Southern Ocean Time Series Facility seeks to obtain this information using automated sensor measurements and sample collections.

The objectives of the voyage were to recover and redeploy a sediment trap mooring that collects sinking particles at approximately fortnightly intervals at three depths (near 1000m, 2000m and 3800m), and deploy a second mooring that will take measurements of temperature, salinity, mixed layer depth, photosynthetically available radiation, oxygen, total dissolved gases and phytoplankton fluorescence and backscatter. The second mooring will also collect 48 water samples for later measurement of dissolved nitrate, silicate, inorganic carbon and total alkalinity.

This voyage was largely successful in achieving its objectives, despite very difficult weather conditions. The moorings were successfully recovered and redeployed (albeit with some loss of equipment – 12 glass floats and an acoustic transponder). 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

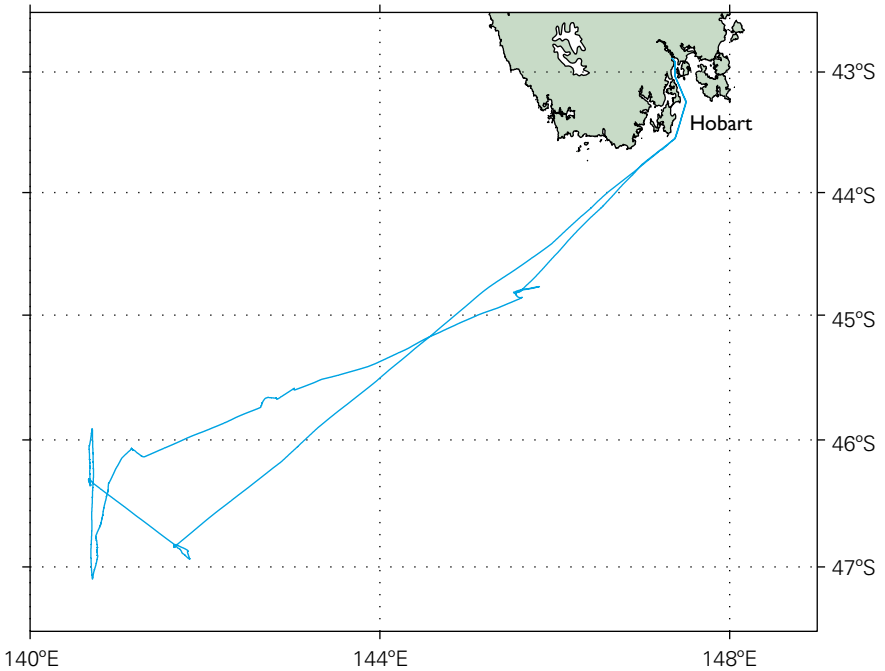
- Goal 7: Responding to climate change and variability

Itinerary

Departed Hobart 22 September 2009

Arrived Hobart 30 September 2009

> Voyage track SS04/09



Research voyage SS05/09

Salps, eddies and entrainment in the Stockton Bight

Prof Iain Suthers, Sydney Institute of Marine Science/University of New South Wales (Chief Scientist)

Contribution to Australia's national benefit

The separation of the East Australian Current from the coast creates an unappreciated zone of production for South Eastern Australia, which has major implications in anticipating climate change effects.

The region is especially productive in the spring, generating vast concentrations of gelatinous zooplankton ("jelly balls" or salps). Surprisingly, these filter feeders may actually be nutritious and could enhance carbon uptake into the coastal ocean.

Off Port Stephens, the separation injects new nutrients into the waters of the Continental Shelf, and also forms clockwise and anticlockwise eddies. These specific processes were observed on this voyage, in conjunction with two autonomous ocean gliders, extending our 3D view over four months from birth to death of an eddy.

We have begun to analyse the 160 plankton samples, looking for larval sardine growth and production and to estimate the fantastic production rates of these enigmatic salps (described as growing at 10% of their length per hour).

As a result of this voyage:

1. We have observed the formation and the effects of a cold core eddy off the productive Stockton Bight region. The eddy entrained water laden with larval fish and plankton into what we believe to be a nursery or "incubator" – the first test of this novel hypothesis.

2. We found a concentration of gelatinous salps and larval sardines in part driven by a cold core eddy, which complements the Bakun (1997) paradigm for successful fisheries production: entrainment; enrichment; and retention.

3. The Stockton Bight region is renowned for its biodiversity and production, as well as an aggregation/feeding zone for juvenile white shark. This voyage provided the benchmark data to establish why the region is so productive and just how important the region is for the NSW coast.

4. We discovered remarkable concentrations of krill in the Tasman Sea, which contribute to the daily 500 m vertical migration of the deep scattering layer. We targeted these layers acoustically and with a net. These temperate krill (5 species) are not just the purview of the Southern Ocean and may be an unappreciated cog in the fisheries production of our coastal ocean.

Addressing National Research Priorities

An Environmentally Sustainable Australia

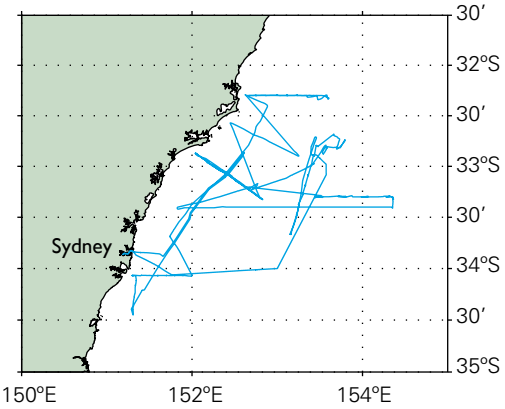
- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

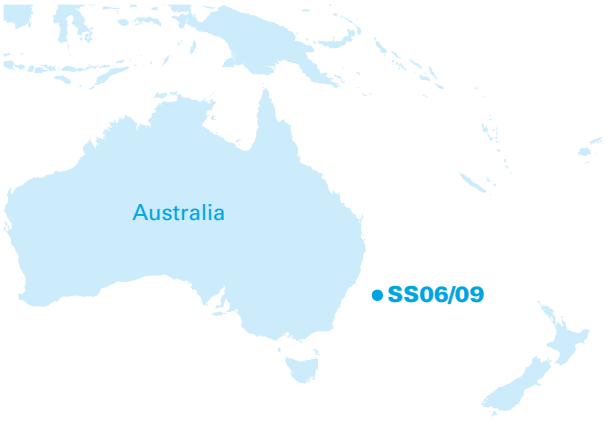
Itinerary

Departed Sydney 16 October 2009

Arrived Sydney 27 October 2009

> Voyage track SS05/09





Research voyage SS06/09

Perturbation flow processes over seamounts in the East Australian Current Outflow in the Tasman Sea

Prof Jason Middleton, University of New South Wales (Chief Scientist)

Contribution to Australia's national benefit

The aim of the project was to investigate flow perturbations over and around seamounts in stratified waters.

The moderate currents of the East Australia current outflow impinging on seamounts in the Tasman Sea provide a unique laboratory for the study of oceanic stratified flows over and around topographic features. This study is significant as a study in fundamental physical oceanography in its own right because of the complexity of stratified rotating flows over topography, the need to accurately encapsulate such effects in regional and larger scale models and because of the implications of nutrient uplift to biological productivity.

This work will build substantially on that undertaken during Voyage SS09/2006 where we studied flow perturbations around reefs and islands of the Lord Howe Rise. In this project we utilised both modelling and field work approaches.

As a result of this voyage:

1. We thoroughly documented observations of the flow properties incident to, over, around and in the wake of a large seamount embedded in a strong baroclinic oceanic flow.

2. While we have not yet had time to digest all of the implications of the salient features it is clear that the presence of the large seamount in the strong current induces processes including:

- Upwelling in the incident flow upstream of the seamount.
- A depression of isotherms in the flow over the seamount top.
- A further raising of isotherms downstream of the seamount top.
- Recirculating wake flows downstream of the seamount at depth.
- Strong vertical shear in horizontal velocity just below the level of the seamount top.
- Constant temperature layers in the wake probably due to vertical and horizontal mixing due to shear instabilities.
- Internal waves and internal tides emanating from the Seamount sides.

Addressing National Research Priorities

An Environmentally Sustainable Australia

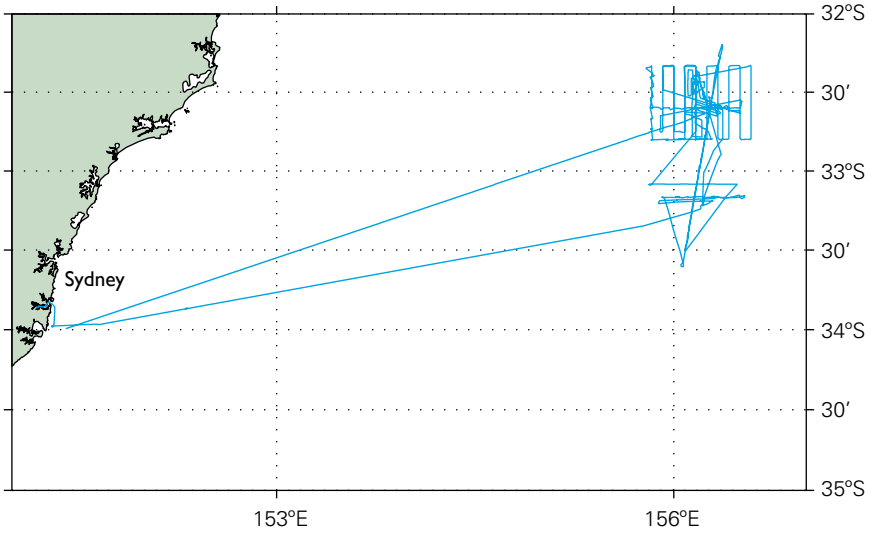
- Goal 5: Sustainable use of Australia's biodiversity

Itinerary

Departed Sydney 29 October 2009

Arrived Sydney 9 November 2009

> Voyage track SS06/09



Research voyage SS01/10

Primary productivity induced by nitrogen and iron in the Tasman Sea

Dr Christel Hassler, University of Technology, Sydney (Chief Scientist)

Contribution to Australia's national benefit

This research took place in the Tasman Sea, an area representing an important economical value both in terms of fisheries and recreational use. In addition, the Tasman Sea is predicted to be one of the most sensitive marine areas to temperature increases under Intergovernmental Panel on Climate Change (IPCC) climate change scenario. It is therefore urgent to understand the functioning of the Tasman Sea, a first step towards predicting its response to climate change.

The major outcome of this research is a better understanding of the dynamics of the Tasman Sea undercurrent and future conditions, focused on the link between nutrient sources, availability and their impact on marine algae.

Marine algae are pivotal for the functioning of marine systems; they are the base of the food web and thus support fish stocks. In addition, marine algae can influence the Earth's climate. These small organisms are responsible for 30%-50% of the biological uptake of atmospheric CO_2, an important greenhouse gas.

Nitrogen and iron are present at low level in the Tasman Sea and are amongst the main factors controlling marine algal biodiversity and biological CO_2 uptake in the world oceans. This research promoted cross-disciplinary scientific collaborations at national and international levels to understand the role of these pivotal nutrients on oceanic algal biodiversity and biological CO_2 uptake, a research area that is still in its infancy.

Scenarios relevant to possible climate evolution were also studied on marine algae and aquatic chemistry. Both current and increased levels of atmospheric CO_2 and atmospheric dust deposition were studied. Dust enrichment of the Tasman Sea mimicked the scenario of a dryer central Australia, promoting dust storm events such as the one recently experienced in Sydney, Canberra and Brisbane.

Since marine algae are intimately associated with CO_2 drawdown from the atmosphere to the ocean, the outcomes from our work enables better representation and validation of biogeochemistry (e.g. carbon cycle and its feedbacks), facilitating discovery and modelling of key oceanic processes that drive Australian climate for improved climate predictions.

By improving the knowledge and management of sensitive Australian resources (Tasman Sea), as well as investigating new insights on how nitrogen and iron in the ocean can mitigate our climate, this project also benefits human society in a broader sense.

Finally, the research on the RV *Southern Surveyor* is a GEOTRACES process study. GEOTRACES is an international scientific program (www.geotraces.org), promoting a decade long study of trace elements to identify and quantify fluxes that control their distributions in the ocean and establish the sensitivity of these distributions to changing environments. This project thus contributes to a larger global effort to advance oceanic biogeochemistry.

Addressing National Research Priorities

An Environmentally Sustainable Australia

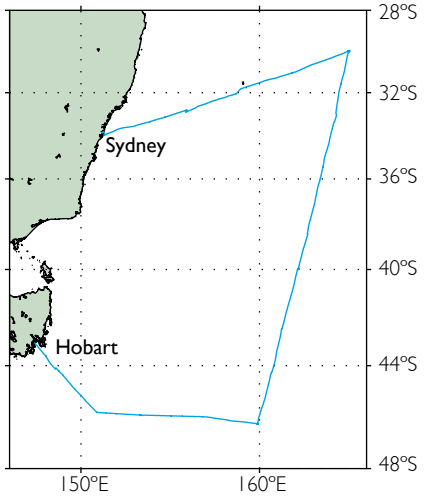
- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Sydney 23 January 2010

Arrived Hobart 15 February 2010

> Voyage track SS01/10



Research voyage SS02/10

IMOS – Southern Ocean Time Series Facility

Prof Tom Trull, ACE-CRC/University of Tasmania/CSIRO Marine and Atmospheric Research (Chief Scientist)

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.

As a result of this voyage:

This voyage achieved significant milestones in the overall effort:

1. The first deployment of a surface air-sea interaction mooring in the Southern Ocean (SOFS-1 mooring).
2. The first recovery of a full season of carbon system observations from the Southern Ocean (Pulse-6 mooring).
3. The first Australian deployment of an autonomous glider to map open Southern Ocean properties. 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

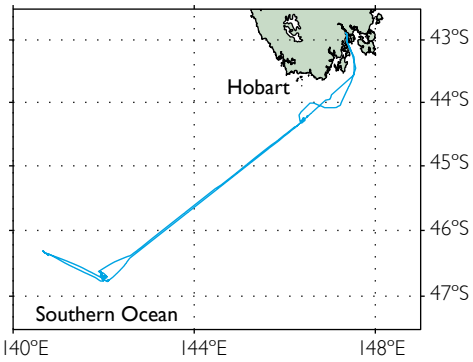
- Goal 7: Responding to climate change and variability

Itinerary

Departed Hobart 16 March 2010

Arrived Hobart 22 March 2010

> Voyage track ss02/10



Research voyage SS03/10

Physical forcing of productivity on the Kimberley Shelf

Dr Peter Thompson, CSIRO Marine and Atmospheric Research (Chief Scientist)

Contribution to Australia's national benefit

Given exponential population growth, it is not surprising that we have exploded into an age where humans profoundly impact the ecology of the planet. This project is designed to provide scientific support for management regarding the environment. This science team has a track record of characterising aquatic ecosystems with the goal of understanding how these ecosystems function so that the costs and benefits of any management decisions can be estimated.

Our voyage to the Kimberley quantified the key fluxes of carbon and nitrogen through a combination of measurements and experiments. More insights into these fluxes were gained from the application of sophisticated flow cytometry and genetic techniques. We quantified the flux of carbon and nitrogen from the air and water into the animals and plants. Sophisticated modelling allows us to extrapolate our measurements while rigorously tracking the uncertainties to produce a verifiable accounting of these fluxes. This approach can tell us how much carbon is naturally sequestered around Australia. It can be used to predict effects impacted on endangered biota or to make scientifically-sound, local decisions regarding development.

Addressing National Research Priorities

An Environmentally Sustainable Australia

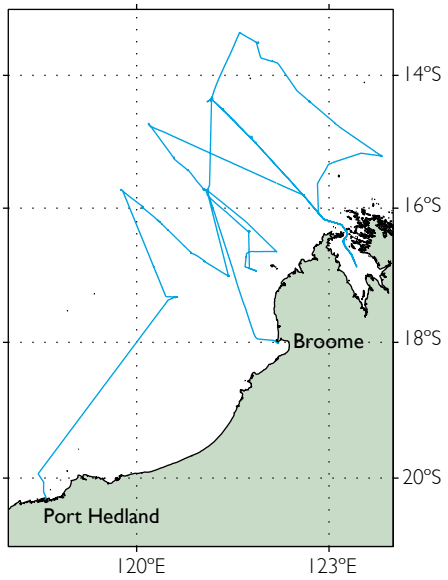
- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Broome 14 April 2010

Arrived Port Hedland 5 May 2010

> Voyage track SS03/10



Research voyage SS04/10

Assessing oceanographic delivery of nutrients to Ningaloo Reef (Part I: Autumn Dynamics)

Prof Anya M. Waite, UWA Oceans Institute (Chief Scientist)

Contribution to Australia's national benefit

Ningaloo Reef is Australia's largest fringing coral reef and the basis of a major tourist industry. Our work has shown that currents flowing through offshore industrial developments in Australia's northwest can impinge directly on the reef, via mechanisms yet to be elucidated. Our work will helps to provide a scientific basis for determining the oceanographic distance beyond which industrial developments will not damage a reef's ecological processes. This analysis is essential for maintaining guiding sustainable development in the region.

We have documented complex mixing processes occurring at the consolidation point of the Leeuwin Current off the North West (NW) Cape and analysed the biogeochemical signatures and processes therein. We observed potentially novel sources of nitrate, layers of low and high salinity and oxygen and strong northerly water flow apparently against the regional geostrophic forcing. Our work clarifies the core biogeochemical processes driving regional ecology, especially including reef dynamics.

As a result of this voyage:

1. We have a better understanding of the major uncertainties in circulation in Australia's NW region. We now understand the complexities in water mass distribution and movement, biogeochemical signatures and production rates. We have the first set of comprehensive data on regional ocean acidity.

2. We found a series of interleaving water masses entering the Leeuwin Current, originating from the NW (Gyral Current) and the north east (NW Australian Shelf). These create repeating layers of low/high oxygen and high/low nitrate, whose microbial dynamics we have assessed (nitrogen uptake; genetic analysis).

3. We mapped the forming Leeuwin Current from 21 S using SVP drifters, showing high degree of unexplained complexity. Our understanding of the regional circulation is, surprisingly, still rudimentary. Coastal currents flowing through oil and gas installations move directly onto the shores of Ningaloo Reef.

4. We have commenced a program of detailed assessment of water mass biogeochemistry to elucidate precisely how the low-salinity waters of the NW contribute to the as yet unexplained nitrate maxima associated with these layers in the forming Leeuwin Current.

Addressing National Research Priorities

An Environmentally Sustainable Australia

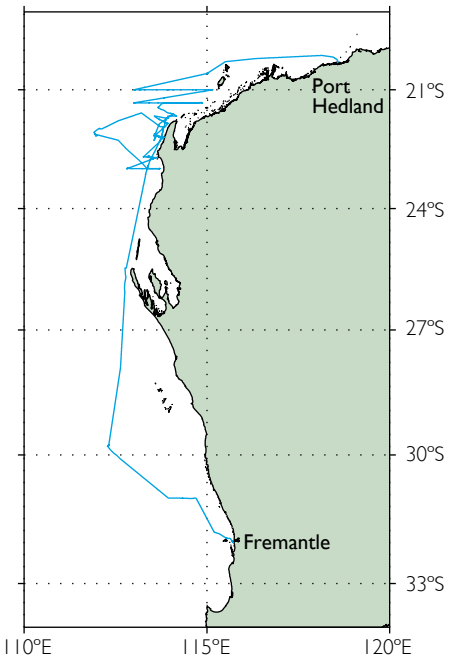
- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Port Hedland 8 May 2010

Arrived Fremantle 27 May 2010

> Voyage track SS04/10



Next Wave
tomorrow's marine scientists

Transit voyage SS02/09

Quantifying tuna prey resources off Eastern Australia in relation to the regional oceanography

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

As a result of this voyage:

1. We have a better understanding of winter acoustic backscatter of the Tasman and Coral Seas. This backscatter gives an indication of the concentration and biomass of the prey of tuna and billfish which form the basis of an important Commonwealth fishery. The acoustic signal of these animals was recorded to a depth of 1000 m along the transect.
2. We found acoustic backscatter in the Coral Sea similar to the relatively more productive waters of the Tasman Sea.
3. On route to Hobart, the bathymetry of the Taupo Seamount was mapped and the continent slope off eastern Tasmania using the on-board swath mapper.

Addressing National Research Priorities

An Environmentally Sustainable Australia

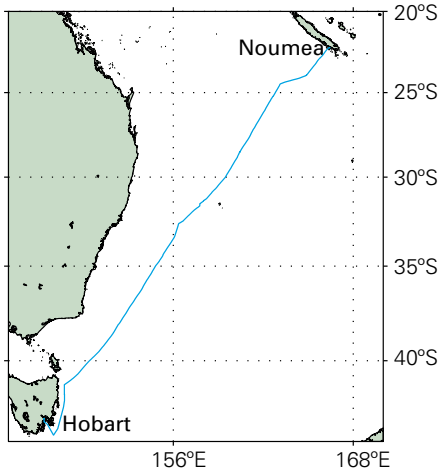
- Goal 5: Sustainable use of Australia's biodiversity

Itinerary

Departed Noumea 30 July 2009

Arrived Hobart 7 August 2009

> Voyage track SS02/09



Next Wave
tomorrow's marine scientists

Transit Voyage SS03/09

The composition of shelf and deep sea benthos in the Bass Canyon and the distribution of larval fish off the Eastern Tasmanian coast

Dr Sebastian Holmes, The University of Sydney (Chief Scientist)

Contribution to Australia's national benefit

The inventory of the benthic macro fauna obtained provides a baseline for future investigations/research. Correspondingly, the development and deployment of BOAGS helps to map Australian marine habitat and forms part of CSIRO Marine and Atmospheric Research's ongoing mapping program.

As a result of this voyage:

1. We have a better understanding of the benthic macro fauna of Bass Canyon.
2. We found a unique and diverse geological feature off Wollongong (Kloser) and that salp carcasses may play an important role in bentho-pelagic coupling.
3. We mapped a middle depth portion of Bass Canyon and the unique geomorphic feature off Wollongong (Kloser).

Addressing National Research Priorities

An Environmentally Sustainable Australia

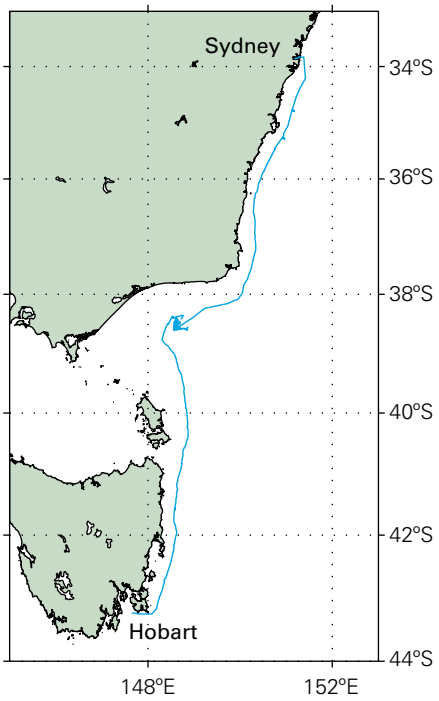
- Goal 5: Sustainable use of Australia's biodiversity

Itinerary

Departed: Hobart 10 September 2009

Arrived: Sydney 15 October 2009

> Voyage track SS03/09



Next Wave
tomorrow's marine scientists

Transit voyage SS01/10

ANNiMS Student training voyage

Prof Anya M. Waite, UWA Oceans Institute and Prof Tom Trull, ACE-CRC/University of Tasmania/CSIRO Marine and Atmospheric Research (Chief Scientists)

Contribution to Australia's national benefit

Our aim on this voyage was to train postgraduate and undergraduate students in operational oceanography. We see this as critical to the long-term support of oceanography as a field-based, ocean-going discipline in Australia. The maintenance of an ocean-going research community is critical to our ability to understand and adapt to climate change, as well as maintaining leadership in regional scientific dialogue.

As a result of this voyage:

1. We have a better understanding of the extent and reach of the Leeuwin Current at this time of year, the regional distribution of oxygen minima below the Leeuwin Current and the vertical distribution of nutrients within it.
2. We have found a new unmapped canyon off the Montebello Islands with the Swath Mapper. We named it the Tryal Canyon after the 1622 shipwreck.
3. We have mapped the full length of the Leeuwin Current from Hobart to Broome.
4. We have commenced a program of student training through the ANNiMS programme which we hope will help build oceanographic teaching in Australia over 3-5 years.

Addressing National Research Priorities

An Environmentally Sustainable Australia

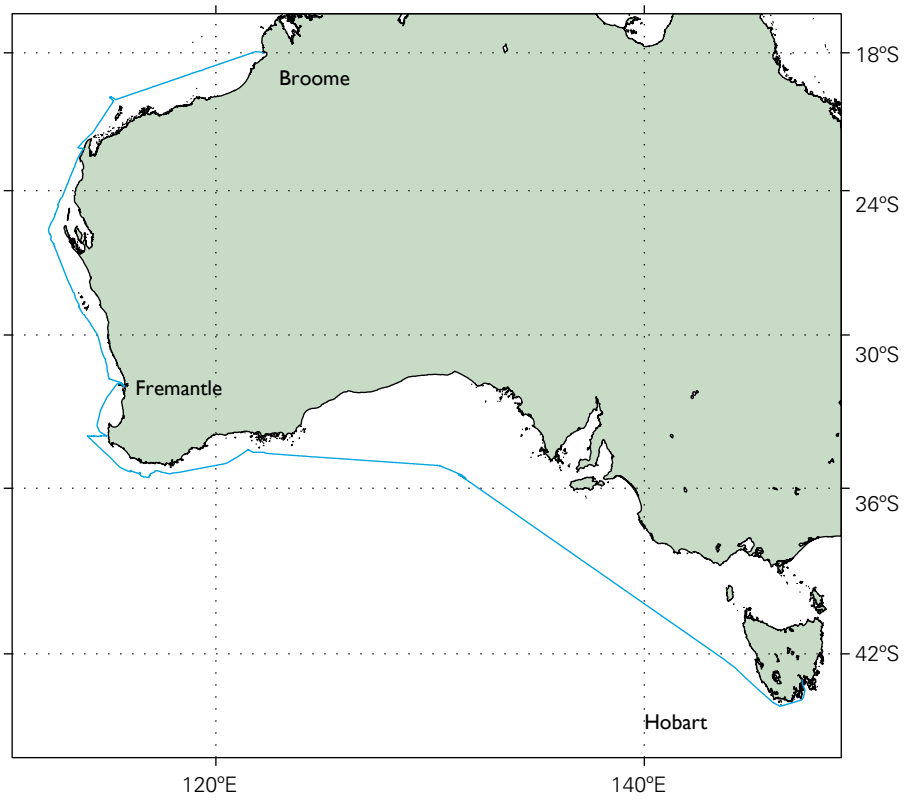
- Goal 5: Sustainable use of Australia's biodiversity
- Goal 7: Responding to climate change and variability

Itinerary

Departed Hobart 31 March 2010
Arrived Fremantle 7 April 2010

Departed Fremantle 7 April 2010
Arrived Broome 13 April 2010

> Voyage track SS01/10



Students experience the thrill of science at sea

Comments from students on the transit voyage SS03/2009

The following are a sample of comments from students who participated on the transit voyage from Hobart to Sydney.

"The voyage gave me a unique feeling for real life marine biology research that I couldn't have received from any other trip. It also made identifying species much more practical and useful for my interests. It was also an amazing experience for its value as a feel of sea life, the opportunities to watch amazing sunsets, etc."

"For me the voyage has reaffirmed my decision to go back to University next year. The time at sea gave me a good reminder of why I chose to study marine biology in the first place – it wasn't to sit in an office in Canberra, wearing a suit."

"I found the voyage an extremely enjoyable and educational experience. I would highly recommend to anyone that is ever given the opportunity to go on such a cruise to take it; you will certainly not regret it. I think the idea of giving students the opportunity to experience how research vessels like CSIRO's *Southern Surveyor* operate is a great and eye opening experience."

"I had an excellent time aboard the RV *Southern Surveyor*. I learnt a lot about the ocean I had never even considered before. I saw marine life with my own eyes that would have made David Attenborough jump for joy. Observing the BOAGS system in action made me feel like I was on the forefront of marine exploration. It was definitely an experience I will remember for the rest of my life."

Even on a ship you cannot get away from the paperwork!

Salp sorting.

Whale watching.

Repairing a net on the deck.

Other news

Arctic Blast – *Southern Surveyor* in the movies

Hobart CSIRO staff had a brief brush with fame when a film crew arrived on site to film scenes for a new Sci-Fi feature film, "Arctic Blast", on board the Marine National Facility's Research Vessel *Southern Surveyor*. The film is set in Hobart, and will be released in 2010. It features Canadian actor Michael Shanks (star of the hit US Sci-Fi series "Stargate – SG1"). According to the press release, it "tells the story of a mega ice fog caused by a rift in the Ozone layer, that creates deadly flash freezing. Shanks plays Jack, a maverick US meteorologist, who along with his small team of researchers are the only people that can save the world from destruction."

Fog machines were used extensively over the two days, so staff were pre-warned not to be alarmed when they saw smoke emanating from the vessel!

The video.

Southern Surveyor interactive tour

An interactive tour of the RV *Southern Surveyor* was released in July 2009 to make visiting the ship possible without worrying about seasickness.

The interactive format allows users to explore the ship and view panoramas of some of the cabins and decks. The virtual tour will be a key tool to assist marine scientists in the preparation and planning of their research voyages.

The virtual tour is available from the Marine National Facility website.

www.marine.csiro.au/nationalfacility/virtualtour/

Deep-Sea Canyon Discovered

A deep-sea canyon new to science was discovered on the continental shelf near the Monte Bello Islands by students from The University of Western Australia, James Cook University and the University of Tasmania, whilst on a training voyage on board the Marine National Facility's Research Vessel *Southern Surveyor*.

The exciting and unexpected discovery was made on a voyage from Hobart to Broome via Fremantle to determine the biological and physical signature of the ocean.

The deep cleft in the continental shelf was discovered using the vessel's swath mapper that uses sonar to map the sea floor.

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.

DAP upgrade

The last phase of the Data Acquisition Processing (DAP) upgrade was completed in this period. This included a centralised storage system, communal display, enterprise class multi-function printer and a wireless network link to the shore facility. The wireless network link enables the *Southern Surveyor* to be linked into the CSIRO network when in home port rather than using more costly commercial services.

The aim of the upgrades was to develop a modern data acquisition, processing and visualisation system. This has provided the following benefits:

- Real time data from the vessel's sensors can be viewed and used easily.
- Live data can be transmitted ashore for use by other organisations.
- It has a higher level of automation for quality control resulting in better datasets and reduced processing time.
- The time required to administer and maintain the system has been greatly reduced.

TECHSAS

The TECHSAS underway data acquisition system which collects meteorological, navigation and oceanographic data from various instruments was installed last year and run in parallel with the existing FDCS system in a trial period. Given the success of the trial the TECHSAS software has been updated and the old FDCS removed from the vessel in the November port period.

Upgraded satellite communication

The ship's old Fleet 77 satellite communication system was upgraded in June 2010 to an Inmarsat Fleet Broadband system. The new system has significant advantages over the old system including simultaneous voice and data connections, greatly increased bandwidth for data transmission and cheaper call rates.

Scientific echo sounder

After 10 years of providing reliable, single-beam bathymetric observations, the vessel's Simrad EA500, 12kHz echo sounder was deemed obsolete and replaced.

Its successor, a Simrad 12kHz General Purpose Transceiver (GPT) now provides the following benefits:

- Backwards compatibility with the vessel's 12kHz hull-mounted transducer
- Improved data resolution, modern file formats and descriptive metadata
- Improved control over operating parameters
- Improved user interface and real-time display

The new system is being operated as a stand-alone instrument initially but it is planned to become part of an integrated multi-frequency echo sounder system in the near future.

Development of the Nacelle towed body instrument

Following the loss of the Seasoar towed Conductivity, Temperature and Depth (CTD) instrument in 2009, the Nacelle towed body was developed by CSIRO as a short term replacement. The Nacelle consists of a heavy, cylindrical section of steel, machined to accommodate a CTD.

The Nacelle is deployed from behind the vessel and towed at 3-5 knots, continuously raised and lowered using the winch. Real-time telemetry to the surface provides a continuous CTD profile, allowing sea water to be sampled relatively quickly over large distances. Whilst performance is inferior to the Seasoar, it fills an important short term need.

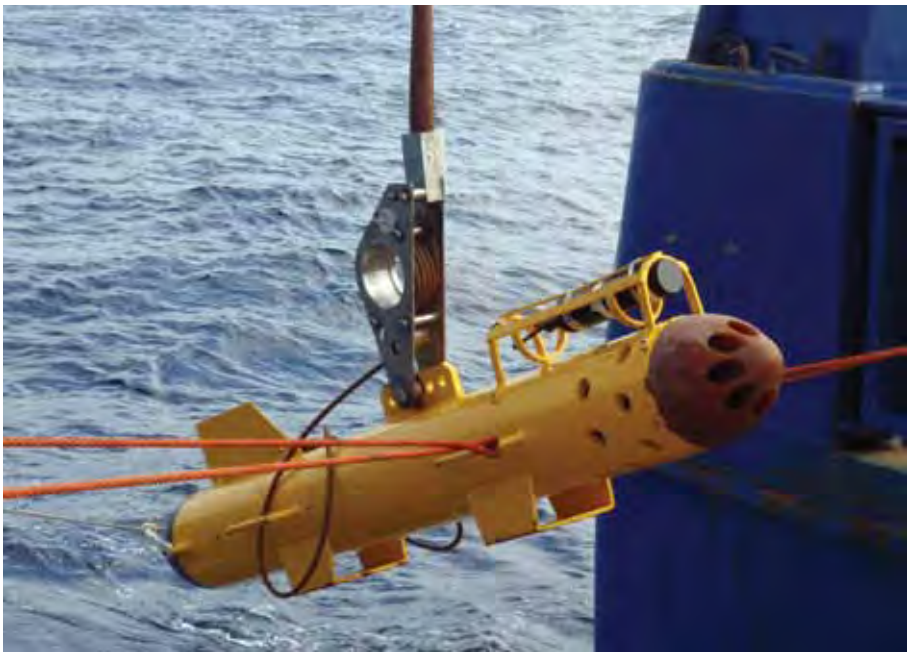
Eco Triplet

A self-contained battery-powered Wetlabs Eco Triplet optical instrument was purchased to measure chlorophyll and CDOM fluorescence, 660 nm backscatter and pressure. Traditionally for these measurements to be taken it would have required three separate instruments.

The Eco Triplet is small and light, allowing it to be deployed on a variety of platforms, including Conductivity, Temperature and Depth (CTD) instruments, towed bodies and plankton nets.

Improving the resolution of the dissolved oxygen sensor

One of the parameters frequently measured during Conductivity, Temperature and Depth (CTD) profiling is dissolved oxygen. Unlike temperature and conductivity measurements, which utilise a dual sensor configuration to enhance data quality, only a single dissolved oxygen cell had been used. An additional oxygen cell was purchased which provided the ability to record and compare dissolved oxygen measurements thereby enhancing data quality.



The Nacelle towed body.

Enhanced maintenance program

The *Southern Surveyor* is nearly 40 years old and needs additional maintenance to maintain its operational efficiency until the new vessel arrives.

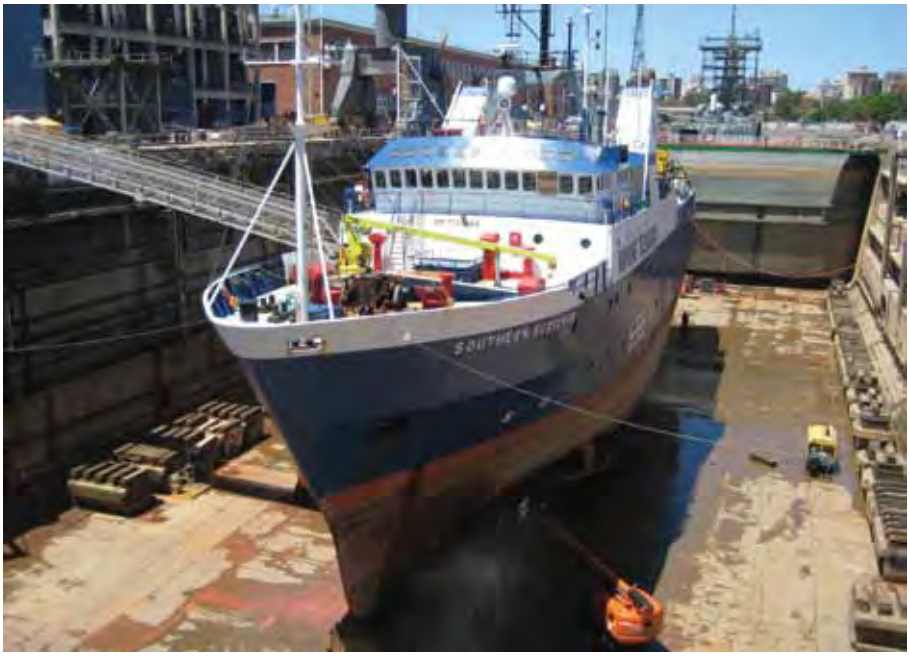
The Australian Government recognised the need for a new vessel but also saw the importance of ensuring the *Southern Surveyor* could continue to perform its important work in the interim while a new vessel was being designed and built.

To ensure the *Southern Surveyor* could continue operating at a high efficiency the Australian Government invested $5.97 million over three years in an enhanced maintenance program.

The dry docking from November to January 2009 allowed for a wide range of repairs and maintenance to be carried out including painting the vessel and repairing the propeller.

Other significant works were carried out in Hobart and Fremantle.

The benefits of the enhanced maintenance program can be seen not only in improved reliability but also in improved moral for those who work on the vessel.



Southern Surveyor in dry dock in Sydney.

The vessel needed to be painted and the propeller was in need of maintenance.

The vessel after painting.

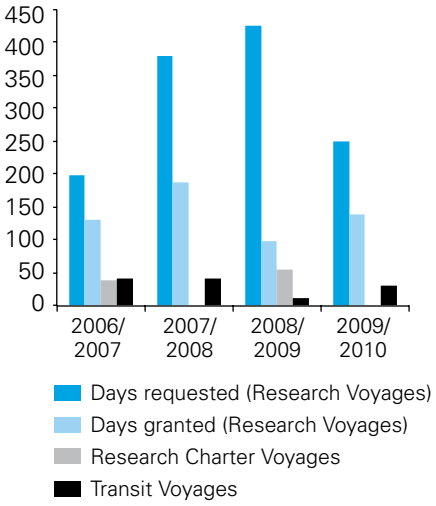
The propeller was removed, repaired in the workshop and fitted back on the vessel.

Statistics

The following statistics are for the 2009 – 2010 financial year.

Application for use of the Marine National Facility

The Marine National Facility provided 141 days of ship time grants for research voyages. New funds announced by the government to operate the research vessel will increase the facility's availability over the next few years.



Ports visited

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

Port	Number of visits
Broome	1
Fremantle	1
Lautoka	1
Noumea	1
Port Hedland	1
Sydney	3

Availability of Platform

At Sea	Days
Research Voyages	131
Transit Voyages	30
Sea Trials	2
Days at sea	**163**

In Port	
Research Voyages Mob/Demob	10
Unallocated port days	136
Dry dock	56
Days in port	**202**

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.

Benthic Optical, Acoustic and Grab Sampler (BOAGS).

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 24 organisations from Australia, Fiji, Germany, New Zealand, Russia and Vanuatu sailed on the *Southern Surveyor*.

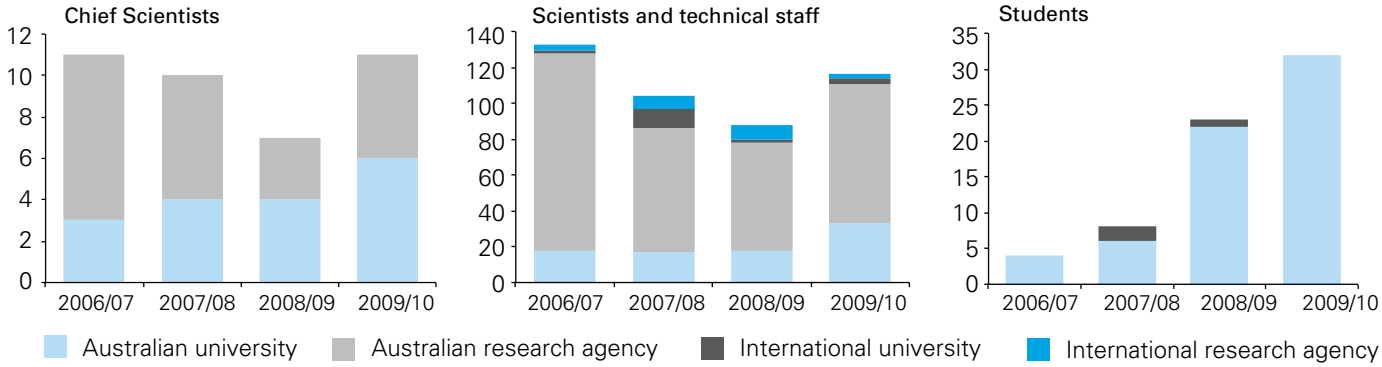
Australian Universities	13
Australian Agencies*	5
International Universities	3
International Agencies	3

* CSIRO divisions are listed (see page 29) 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.

When interpreting these charts, some voyages may be split into two or three legs. In these instances the vessel returns to a port and some scientific participants may leave the voyage and others join for the next leg. In these cases, any new scientific participants that join the voyage will be included in the total number of scientific participants. For a voyage with more than one leg, the total number of scientific participants may therefore be greater than the number of berths available due to people changing over in port during the voyage.

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.



Organisations represented on the voyages

National

Antarctic Climate Ecosystems Cooperative Research Centre

Australian National University

Bureau of Meteorology

CSIRO Exploration and Mining

CSIRO Land and Water

CSIRO Marine and Atmospheric Research

Griffith University

Murdoch University

Sydney Institute of Marine Science

University of New South Wales

University of Sydney

University of Tasmania

University of Technology, Sydney

University of Western Australia

International

Fiji Department of Mines

Moscow State University, Russia

National Institute of Water and Atmospheric Research, New Zealand

University of Kiel, Germany

University of Otago, New Zealand

Vanuatu Geological Survey

Students

ADFA (UNSW)

Australian National University

James Cook University

Macquarie University

University of New South Wales

University of Queensland

University of Sydney

University of Tasmania

University of Technology, Sydney

University of Western Australia

University of Western Sydney

Key Performance Indicators

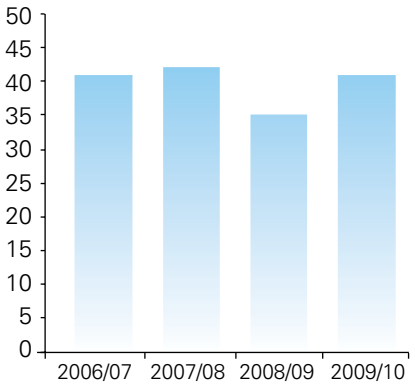
Incidents are an important indicator of performance but more importantly provide continuous feedback which assists in the management of the vessel.

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

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

Incidents reported on the *Southern Surveyor* increased from 35 in 2008/09 to 41 in 2009/10.

Total vessel incident reports over the past four years



Occupational Health & Safety

In 2009/10 there were no lost time injuries (LTI) and four 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

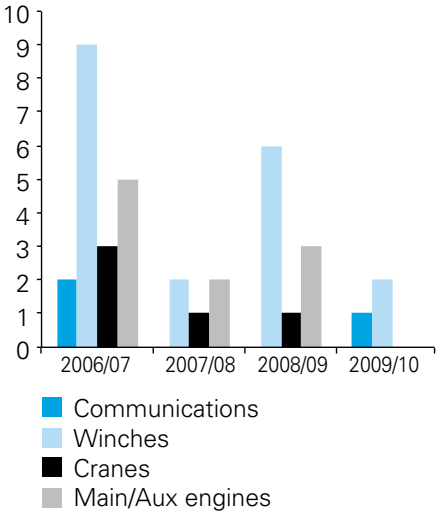
No incidents resulted in hydrocarbons entering the environment.

One incident occurred resulting in the loss of refrigerant gas due to a refrigerant pipe splitting.

Repairs and maintenance

The benefits of the enhanced maintenance program continue to be reflected in reduced incidents highlighting the importance of preventative maintenance.

Total incidents per year for each equipment category



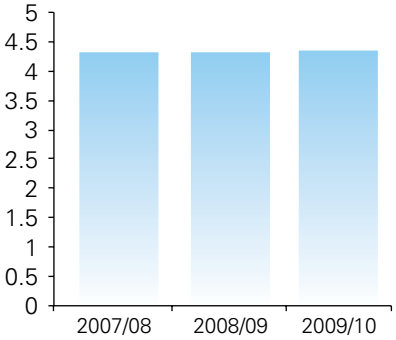
User feedback

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 Statements

Financial report for the period ending 30 June 2010

Operating Statement

	2010 $	2009 $
REVENUE		
Research and Services Revenue	653,700	3,284,528
Other External Revenue	63,600	16,480
Appropriation Revenue	13,771,052	7,977,400
TOTAL REVENUE	**14,488,352**	**11,278,408**
EXPENSES		
Salaries	1,641,687	1,700,823
Travel	265,272	299,650
Other Operating	9,203,194	7,150,884
Business Unit/Enterprise Costs	2,642,052	2,188,416
TOTAL EXPENSES	**13,752,204**	**11,339,773**
OPERATING RESULT	**736,148**	**(61,365)**
CAPITAL		
Capital Purchases	150,534	313,818

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

Glossary

ANNiMS
Australian National Network in Marine Science

BOAGS
Benthic Optical, Acoustic and Grab sampler

CART
Coastal Acoustic Release Transponder

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

CMAR
CSIRO Marine and Atmospheric Research

CO_2
Carbon dioxide

CMAN
Capital maintenance program for the *Southern Surveyor*

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

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

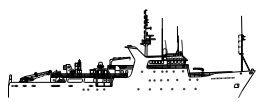
Next Wave
A program that provides the opportunity for early career researchers and students of marine science to experience the working environment on a blue water research vessel.

NCRIS
National Collaborative Research Infrastructure Strategy

SOFS
Southern Ocean Flux Station

SVP
Surface Velocity Program

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



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