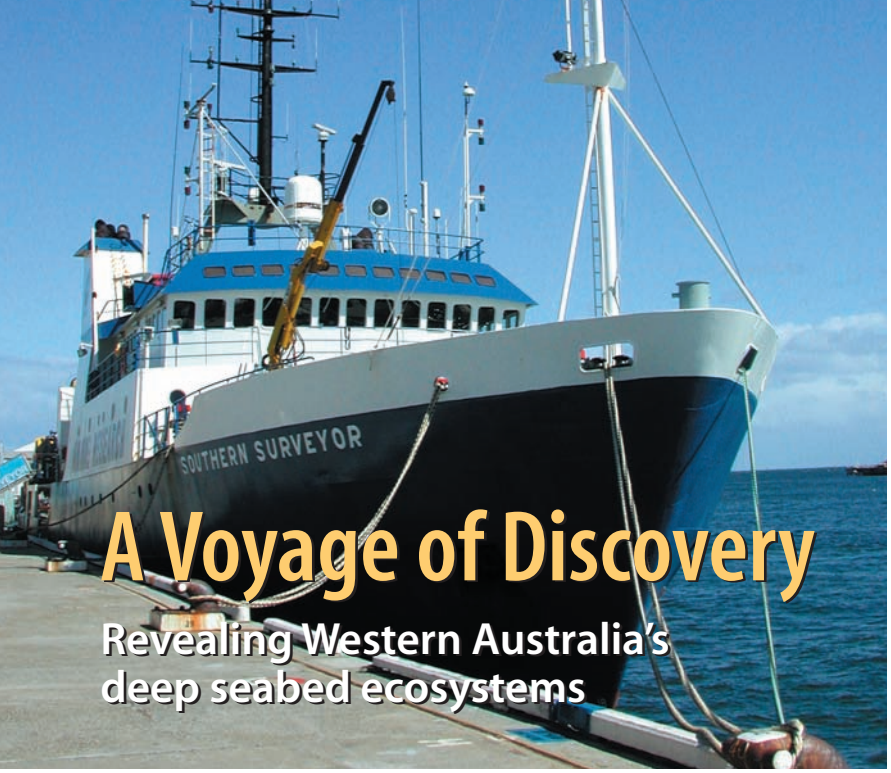


A Voyage of Discovery

Revealing Western Australia's deep seabed ecosystems

The *RV Southern Surveyor* berthed at Dampier before the start of the Voyage. CSIRO Marine and Atmospheric Research

Marine researchers recently spent four weeks on the Marine National Facility research vessel, *Southern Surveyor*, mapping the seabed and surveying biodiversity in previously unstudied areas along Australia's west coast. Their rewarding findings are increasing our understanding of the physical structure of the deep ocean seabed and the composition and evolution of its rich fauna. They also provide fundamental information for the development of national marine management plans that incorporate ecosystem-based principles.

The oceans are our last unexplored frontier. Although Australia is the world's largest island nation, its surrounding seas make up almost twice the size of the country's landmass. Most of what lies within and beneath them still awaits discovery.

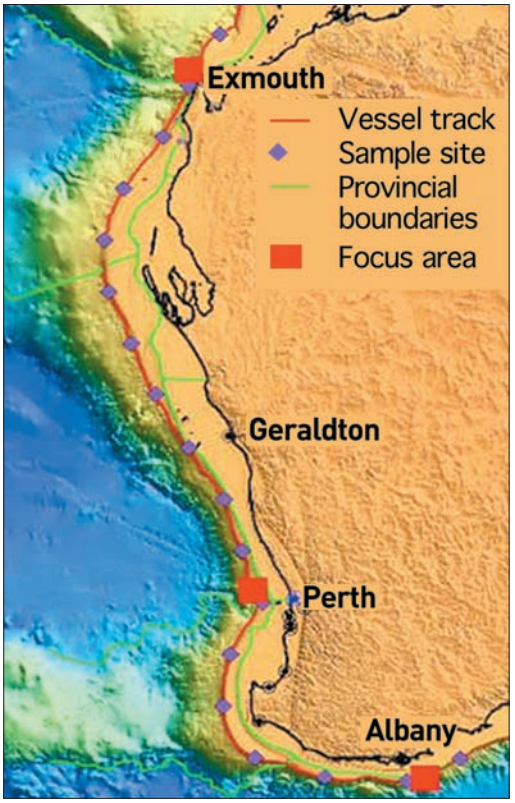
An ambitious sea-going project run by CSIRO Marine and Atmospheric Research, the marine survey – dubbed a modern 'Voyage of Discovery' – set out to take another step forward in revealing the deep secrets of our oceans. Its primary aim was to characterise the unknown seabed (benthic) ecosystems of the continental shelf and slope, over a wide range of water depths from 100 to 1500 metres, off Western Australia's spectacular coast.

The expedition was part of a major initiative by the CSIRO Wealth from Oceans Flagship, supported by the National Oceans Office. Outputs from the project will support the implementation of the Southwest Regional Marine Plan – which includes developing Commonwealth Marine Protected Areas – by providing a scientific backdrop of the deep seabed landscape in the form of detailed maps, and baseline information on its sea life.

Researching the ocean's potential

Understanding how to best manage the multiple uses of our marine environment is a key objective of CSIRO's Wealth from Ocean's Flagship programme. Flagship Director, Craig Roy, recognised the proposed project and its ocean-going voyages as a critical step in achieving this goal, and took a lead role in commissioning the project.

'To understand how ecosystems are going to respond to different uses and management strategies, we obviously have to know what's there in the first place,' said Roy. 'It's clear that the actions we take, as a nation, over the next decade, regarding the management of our marine environment, will shape our relationship with the oceans over the course of the next century.'



The Voyage of Discovery covered most of Australia's west coast. CSIRO Marine and Atmospheric Research

Bruce Barker checks the CSIRO camera before its deployment to the inky depths. CSIRO Marine and Atmospheric Research

'… we're breaking new ground every day, making maps and accumulating imagery that lets us visualise these previously unseen marine environments as we go.'

'To a large extent, our ability to manage the sustainable use of natural resources, at a national scale, relies on the sort of broad-scale marine ecosystem research being undertaken by these voyages. Over 70 per cent of the nation's potential wealth lies beneath its ocean territory, but we don't know much, yet, about where it is or how to make responsible use of it. Recording the characteristics of both the physical features and the animals of our deep ocean regions greatly helps us to recognise their value, and how best to manage their use.'

Already Australia's oceans drive 8 to 10 per cent of our Gross Domestic Product (GDP). That's more than our agriculture, more than our mining, and about 75 per cent of all our building and construction income. Yet we've only mapped about 10 per cent of our marine territory. It's easy to imagine how important that marine territory will be to Australia once we know what is there.

The *Southern Surveyor's* WA expedition was planned to widen that understanding by carefully targeting observations at special places on the seabed landscape that are either predicted to be high priorities for management, or where biodiversity hot-spots are believed to exist. CSIRO aims for the field programme to deliver new information that will have immediate uptake as scientific models and management strategies are developed. The focus on Western Australia is linked to the progressive rollout, region by region, of a national, integrated marine planning initiative, the Regional Marine Planning Process, directed by Australia's Department of Environment and Heritage.

A two-phase field campaign

The first of two scientific voyages planned for this year took a 15-person research team and 14 crew on a two-leg voyage from Dampier, on the north-west Pilbara coast, south past Ningaloo Reef, all the way to Albany. It then returned north to Fremantle.

Ropes were cast off for the first leg on 21 July, and finally re-secured at the end of Leg 2 on 17 August. For the 28 days in-between, the 13 researchers from CSIRO and two from Geoscience Australia, worked in two teams on opposite 12-hour shifts, seven-days-a-week, to complete a relentless sampling programme. Most of the work involved precise seabed mapping using an acoustic multi-beam sonar and photographic surveying with a towed camera platform, and this was interspersed with sediment and water column sampling.

Alan Williams, one of the project leaders and Chief Scientist on Leg 1, looked forward to the job ahead. 'This is an intensive exercise, and many of our team will be doing a month's straight work. But for most of the time it is exciting to be out here, and we're breaking new ground every day, making maps and accumulating imagery that lets us visualise these previously unseen marine environments as we go.'

There is a distinct separation of tasks and scientific expertise across the pair of voyages. Acoustic mapping and photography, and geology and water column characterisation has been completed on voyage one. On the second voyage, during a month between November and December, a largely different team of specialist biologists will fill the ship, collecting and identifying the seabed animals at target locations in the areas already surveyed. 'Biodiversity assessment requires us to identify our biological collections to individual species', Williams says. 'We have a heavy reliance on our colleagues from Australian and international museums who bring the expertise to do this.'

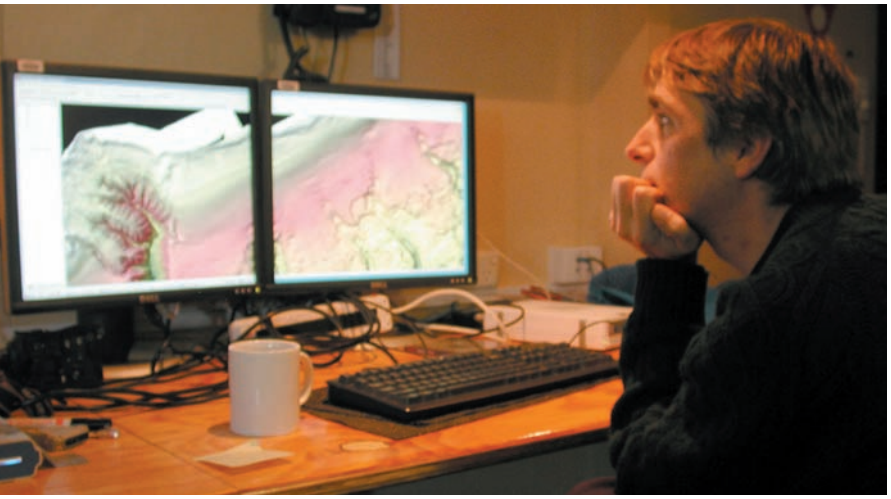
A large vase sponge attached securely to low reef outcrop at 106 m depth off Ningaloo, WA.
CSIRO Marine and Atmospheric Research

Technology at its best

The ocean has always been dangerous and difficult to explore, but a pivotal point has been reached. Affordable access to sophisticated 'remote access' tools and technology – such as the *Southern Surveyor*'s new swath mapper – are now opening exciting new opportunities for ocean discovery. It's akin to the early terrestrial explorers suddenly being given a helicopter.

Rudy Kloser, also one of the project leaders, and Chief Scientist on Leg 2, reflected on the technical capabilities of the equipment and science staff involved. 'We now have some of the most sophisticated technology for sampling the deep ocean on this vessel,' he said. 'We've been building toward this level of capacity over the last 10 to 15 years. Our acoustic mapping capability and our photographic tools are leading edge, and it is satisfying to be out here bringing them to bear on today's key research questions.'

Black coral, barnacles and fly-trap anemones on steep rocky reef at 490 m depth off the Abrolhos Islands, WA.
CSIRO Marine and Atmospheric Research



Cameron Buchanan watches the high definition output of the swath mapper as it paints a picture of the seabed.
CSIRO Marine and Atmospheric Research

Once winched over the side by Bruce Barker, Jeff Cordell and Mark Lewis, and towed behind the ship, CSIRO's submersible camera system was 'flown' a metre above the seabed. It uses a fibre-optic cable to send two streams of video footage up to the researchers in real-time – one from a camera recording high-resolution imagery of the seabed and its inhabitants, and the other from a camera that looks ahead, enabling the pilot to negotiate obstacles such as the steep rock walls frequently encountered along escarpments and in submarine canyons. Video is recorded in stereo to enable quantitative data – such as the area of seabed surveyed, and the numbers and sizes of animals observed – to be worked out using image analysis software. As well, at the push of a button, researchers took high-resolution photographs of particularly interesting features or animals illuminated by the system's lights.

No two camera deployments were the same. In the operations room, the video screen showed the seabed sliding by while coral gardens, sharks and drop-offs crossed the screen. Matt Sherlock, the team's Electrical Engineer, designed and built the camera system.

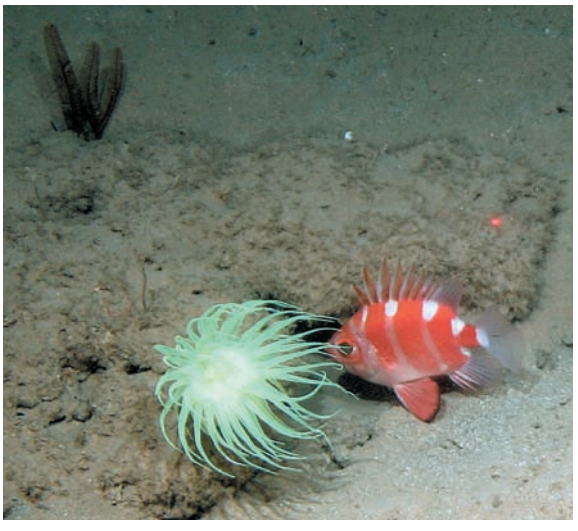
'It's pitch black until the passing landscape comes within range of our lights. We often see some big dark shapes disappear, but other animals, seals, small fish and plankton are attracted to the light like moths.'

Sometimes the head of an octopus or scampi is seen disappearing into a hole, while at other times languid fish seemed not to notice the apparatus, gliding overhead. Living in depths greater than 1000 metres, beyond the depth penetrated by sunlight, some species seemed baffled and skittered around until the cameras passed by.

Eventually, the camera was winched up and the screen showed a storm of krill against black sea as the camera made its long journey back to the surface.

During the roughest weather, when the swells rose and the ship's portholes looked like front-loading washing machines, the scientists aboard tended to gravitate to the operations room to watch its many screens. Located midship and central, the 'ops' room has the least forward pitch and sideways roll. It also bristles with electronics.

Some 20 monitors, and countless computers, line the room. Equipment includes an acoustic Doppler current profiler, bathymetry displays and video input controls. A winch display shows cable wire out, wire speed, wire tension and altimetry to gauge how far deployments are from the seabed. Meanwhile, navigational software charts the coastline revealing contours, hazards and soundings, some of which were first recorded by Captain Cook.



A small isolated boulder is home for a colourful 5-lined bigeye, a green anemone and a feather star at 155 m depth off Ningaloo, WA.
CSIRO Marine and Atmospheric Research

Living in depths greater than 1000 metres, beyond the depth penetrated by sunlight, some species seemed baffled and skittered around until the cameras passed by.

In the for'ard (front) section of the ops room, Cameron Buchanan and Gordon Keith were in charge of the vessel's EM300, the acoustic multi-beam swath mapper, which created topographical and backscatter maps. Their work revealed the complexity of seabed habitats and showed escarpments, plateaus, canyons, ripples and fissures. Buchanan and Keith also provided the bridge with navigational lines to follow for the precise back-and-forth transects used to form the swath maps – a steady process a bit like mowing a lawn.

Alix Post, of Geoscience Australia, operated the TOPAS sub-bottom profiler that collected data layers 60 to 100 metres below the sea floor. These data, and the mini-core samples Post collected, will enable Geoscience Australia to trace the environmental history of the area. The TOPAS system also showed changes in water channels, sediment drifts and outcrops of bedrock.

The DELP (display and event logging program) gave a combined display of every sensor aboard. It showed latitude, longitude, direction, speed, and the course over ground, which compensated for currents and wind. It also displayed meteorological conditions including temperature, humidity, light, barometric pressure, wind speed and wind direction. On this voyage, Bob Beattie and Pamela Brodie maintained a master list of all operations, with help from Piers Dunstan, Bruce Barker and Rudy Kloser.

Another piece of CSIRO's BYO equipment the Smith MacIntyre grab – is designed for soft sediment sampling on the seabed. Its jaws are like miniature earth movers and they clamp shut with spring-loaded force, scooping the sea floor.

Alix Post assisted with the 'Smith Mac's' sediment sampling and collected five mini-core samples per grab.

These identified the composition of sediments in terms of grain size, carbonate content and microfossils. The information helps to fine tune acoustic mapping techniques and helps further describe benthic (seabed) habitats.

Once the sampler was back on deck, and the jaws released, up to eight litres of sediment were delivered to Karen Gowlett-Holmes, Manager of CSIRO's Invertebrate Collection. Gowlett-Holmes worked in the aft section of the Fish Lab, wearing protective clothing, including gloves to protect her hands from sponge spicules – the remnants of sponge skeletons – that prickle like fibreglass. They are good indicators of past and present habitats.

Gowlett-Holmes also ran filtered seawater through the sediment to float and flush microscopic organisms into fine sieves. She then transferred the remaining seabed to a coarser sieve, and with a pair of forceps, picked out samples of scientific value. These included sponges and invertebrates such as worms, crabs, shrimps and brittlestars. After sorting the specimens, many of which are new to science, she preserved them. On shore, the samples were later despatched to relevant scientific experts around the world, who assist in the taxonomic and naming processes.

New findings

Initial results, in the form of maps, images and seabed profiles, have revealed a range of spectacular features, a great variety of animals, details of underlying geology, and immediate insights into their distributions and associations.

'A key to the success of our work is integrating this information and providing it at the relevant spatial scales for uptake into scientific modelling and management planning', says Alan Williams.

'We need to understand ecosystem structure and processes, and impacts, at the fine scales seen by the cameras, but then be able to confidently expand this knowledge to landscape scales for management purposes. At the end of the day, we need a basis for characterising and subdividing the marine environment into natural units in a broadly similar way to what we do on land, and that's where these results have an impact.' Australia has a rapidly increasing awareness of the values, but also the sensitivities, of deep ocean environments, and the need to find a balance between use and conservation (see *Ecos* 123, page 5).

Landscape features that may define biological distributions and the boundaries of local ecosystem processes are mappable using the techniques employed on the voyages. One such feature, the Perth Canyon, an expansive submarine gorge comparable in size to the well-known Grand Canyon in the United States, is just a stone's throw from one of our capital cities (see map). The canyon has been there for millions of years, carved out of the seabed by water draining from the land and shallow coast, but with almost nothing known about it.

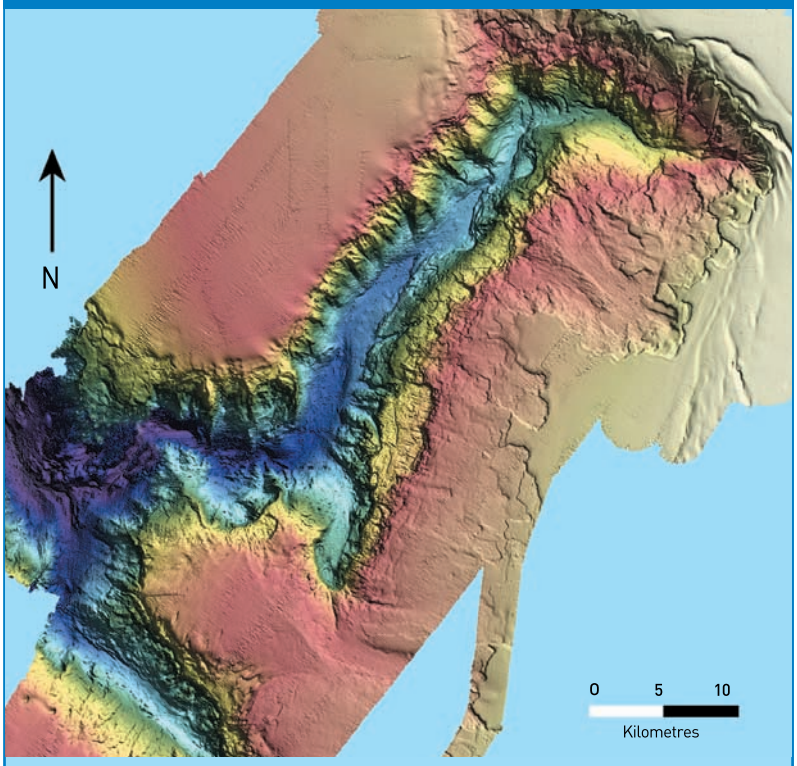
A growing role for the Marine National Facility

The *RV Southern Surveyor's* has an annual budget of $10 million, covering 180 days of operation. In addition, some researchers pay charter fees to bring her operational days up to 250 per year.

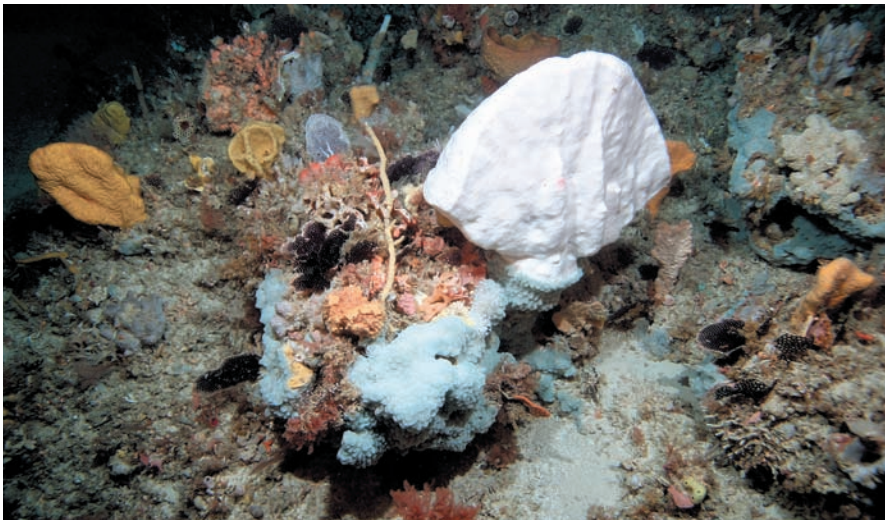
The ships steering committee, made up of representatives of various organisations that use the facility, watches the big picture of Australian marine research, to decide what science will be done aboard, when, and where.

The ship, however, is now in her thirties and, by today's standards, that's nearing retirement. 'We've just met as a committee and assessed proposals for 334 days of absolutely world-class science. It's difficult to decide which 250 days to approve. We don't yet have the experience to judge what full utilisation with a newer vessel would be,' said Captain Fred Stein, Director of the *RV Southern Surveyor*, 'but I'd estimate 320 to 340 actual days at sea.'

Australia's undersea Grand Canyon



A unique and extraordinary feature of Australia's seabed landscape is the Perth Canyon, 22 km seaward of Rottnest Island off Perth. As wide as the well-known Grand Canyon (USA), but deeper, mapping is the first step in determining its biodiversity values, and the ecosystem services it provides. Fish were collected in a previous survey; benthic invertebrates will be collected in November 2005. CSIRO Marine and Atmospheric Research/ Geoscience Australia



Sponge dominated seabed communities on rocky reef at 93 m depth off Jurien Bay, WA.
CSIRO Marine and Atmospheric Research

A holothurian sea slug and squat lobster at 1005 m depth off Ningaloo, WA.
CSIRO Marine and Atmospheric Research

There is little question about the return on the funding involved in the facility. With Australia's under-explored oceans already worth roughly $49.5 billion to the national economy annually, the *RV Southern Surveyor's* work around the country, to uncover the further potential of our marine resources is invaluable.

Because the impacts of natural events and human activities on marine ecosystems are often not well known, the development of marine industries can be risky business. But with resources such as the Marine National Facility, and the array of new research technology now available, Australia's marine scientists are working to help eliminate these unknowns, creating room for new investment and the responsible development of Australia's marine territories.

● **Lucy Potts**

The Voyage of Discovery SS0705 was sponsored by CSIRO's Wealth from Oceans Flagship, CSIRO Marine and Atmospheric Research, the National Oceans Office and the Marine National Facility itself. Geoscience Australia, the Western Australian Museum, the Australian Museum Sydney, Museum Victoria and the Museum and Art Gallery of the Northern Territory were essential collaborators and all parties now share the task of studying the data and samples collected during the voyage.

More information:
Marine National Facility, *RV Southern Explorer*: www.marine.csiro.au/nationalfacility

Wealth from Oceans Flagship: www.csiro.au/index.asp?type=blank&id=Oceans_Home

National Oceans Office: www.oceans.gov.au/home.jsp

Geoscience Australia: www.ga.gov.au

Marine National facility, *RV Southern Surveyor*: www.cmar.csiro.au

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