

2011-12 Annual Highlights document published

The IMOS office published the **2011-12 Annual Highlights** document in November 2012, distributing more than 200 copies by mail to individual stakeholders.

The document opens with an overview of the year and a brief description of how IMOS works, followed by summaries of the five major research themes addressed by IMOS and a small selection of annual highlights. Performance indicators and a financial summary are provided at the rear, along with acknowledgement of our operators and co-investors.

The activities and outcomes highlighted in the document reflect the collective

efforts of multiple operating institutions, dozens of co-investors, and many hundreds of scientists, technicians and administrators working across Australian marine and ocean-climate science. By all measures, 2011-12 has been another outstanding year for the IMOS national collaboration.

Importantly, the benefits of sustaining IMOS are now being seen not just within innovation, science and research, but across all areas where scientifically

robust ocean information can improve knowledge, understanding and decision making: climate variability and change, extreme weather, defence maritime activities, marine environment, marine industries, and international cooperation within the Australian region.

The Annual Highlights document is available from the IMOS website <http://imos.org.au/highlights.html> or if you would prefer a paper copy please contact the office at imos@imos.org.au



director's corner

Tim Moltmann



Welcome to the final edition of Marine Matters for 2012, the sixth full year of operation for Australia's Integrated Marine Observing System. It's pleasing to see such a strong emphasis on the many ways in which IMOS is being used by the marine and climate science community, and the impact it is having.

The second Report Card on Marine Climate Change in Australia highlights the growing importance of IMOS observations in understanding impacts, highlighting knowledge gaps, and informing adaptation responses. Our burgeoning partnership with the Marine Biodiversity Hub is a great example

of a high profile national research program being able to use the IMOS national research infrastructure.

On the international front, the Australia-New Zealand Arrangement on Marine Observation is progressing under the stewardship of a newly established steering committee. Interoperability of data systems and common instrumentation of research vessels are practical steps being taken to establish a collaborative, trans-Tasman effort.

Collaborations with coastal and ocean modellers and with the satellite remote sensing community are also featured in a few different stories. These are tremendously important connections for IMOS to be facilitating as a key component of the national innovation system.

A particular highlight is the 'ten millionth detection' recorded by the Australian Animal Tagging and Monitoring System. This is really just the tip of the iceberg, and the number of detections will continue to grow rapidly now that we have the national tagging database

working effectively. It's really exciting to see a large community of researchers from around the country coming together to participate in this national network, pooling their resources and benefiting from a scale of observational and data infrastructure that none of them could hope to create through their individual projects and teams. We can all now look forward to exploiting this new resource to undertake research projects that simply couldn't be contemplated in the past.

In closing, I want to acknowledge that everyone in the IMOS community is eagerly awaiting advice on funding from July 2013. Based on all of the feedback we have received, I remain confident that IMOS will have a life into the next financial year and beyond, and we expect the details to be announced very soon.

All the very best for the festive season, and for a bright and prosperous 2013.

Tim Moltmann

Report card shows Australia's oceans are changing

Launched in August, the 2012 Marine Climate Change in Australia Report Card demonstrates that climate change is having significant impacts on Australia's marine ecosystems.

The report card provides information about the current and predicted future state of Australia's marine climate and its impact on our marine biodiversity. The report card also outlines actions that are underway to help our marine ecosystems adapt to climate change.

CSIRO Project Leader Dr Elvira Poloczanska said that Australia has unique marine ecosystems that are of great social, economic and environmental value.

"They are enjoyed recreationally, generate considerable economic wealth through fisheries, aquaculture, and tourism, and provide irreplaceable services including coastal defence, oxygen production, nutrient recycling and climate regulation," she said.

"Although there are some concerning findings in the 2012 report card, the information we've compiled is helping to ensure that ocean managers and policy makers are best placed to respond to the challenge of managing the impact that climate change is having on these systems."

Key findings show:

- warming sea temperatures are influencing the distribution of marine plants and animals, with species currently found in tropical and temperate waters likely to move south

- new research suggests that winds over the Southern Ocean and current dynamics are strongly influencing foraging of seabirds that breed in south-east Australia and feed close to Antarctica each summer
- some tropical fish species have a greater ability to acclimatise to rising water temperatures than previously thought
- the Australian science community is widely engaged in research, monitoring and observing programs to increase our understanding of climate change impacts and inform management



Photo: Steve Rintoul

- adaptation planning is happening now, from seasonal forecast for fisheries and aquaculture, to climate-proofing of breeding sites for turtles and seabirds.

Led by CSIRO, more than 80 Australian marine scientists from 34 universities and research organisations contributed to the 2012 report card. The report card draws on peer-reviewed research results from hundreds of scientists, demonstrating a high level of scientific consensus.

"Our knowledge of observed and likely impacts of climate change has greatly advanced since the first card in 2009," Dr Poloczanska said.

Aspects of marine climate that have been analysed include changes in sea temperature, sea level, the East Australian Current, the Leeuwin Current, and El Niño-Southern Oscillation.

Marine biodiversity assessed for the report card includes:

- impacts on coral reefs
- tropical, temperate and pelagic fish
- marine mammals and reptiles
- seabirds
- mangroves, tidal wetlands and seagrass
- macroalgae
- marine microbes
- phytoplankton and zooplankton.

The two new sections included in the 2012 report card focus on the smallest and largest organisms in the oceans: microbes and whales.

The project has been funded by the Australian Government Department of Climate Change and Energy Efficiency, through the National Climate Change Adaptation Research Facility's Marine Biodiversity and Resources Marine Adaptation Network, Fisheries Research and Development Corporation, and CSIRO's Climate Adaptation National Research Flagship.

IMOS made a strong contribution through Katy Hill, Anthony Richardson and others in the community, and the important role of IMOS in observing change was well-represented in the report.

<http://www.csiro.au/portals/media/oceans-are-changing.aspx>

WAIMOS Science Meeting

The WAIMOS Annual Science Meeting held on 5 November 2012 attracted more than 80 attendees. The workshop provided an excellent opportunity for a wide range of users to realise the full potential of IMOS and the data streams already available for enhancing their research.

Ian Poiner, Chair of the IMOS Advisory Board, opened the full day workshop by speaking about the successful integration of the IMOS portfolio across Facilities, Partners and Nodes. He spoke of the importance of data stream delivery and a nationally integrated set of marine observations in contributing to research of ocean physics, chemistry and biology.

The recent critical contribution of funds from the WA state government was also highlighted. Infrastructure is now in place in the Indonesian Throughflow, in the Kimberley and the Pilbara, in addition to the previously established national reference stations, glider transects and coastal radars in southern Western Australia. This is a significant boost to the data on boundary currents for the WAIMOS node, which

extends from the South Australian border into the Northern Territory.

Speakers gave presentations contributing towards answering the major science questions in the WAIMOS Node Science and Implementation Plan. Multiplatform and interagency research is becoming more evident.

Node Science Leader, Chari Pattiaratchi, spoke to attendees about how the availability of data could allow any of them to present an IMOS seminar, using information from moorings, gliders, acoustic receivers, benthic habitats, argo floats and coastal radars as well as ocean current which gives realtime Sea Surface Temperature, chlorophyll and altimeter Sea Surface Height.

The program, abstracts and presentations will be made available on the IMOS website in the near future.



IMOS ocean gliders prove irresistible for sharks

The team at the ocean glider facility at the University of Western Australia (UWA) was surprised when one of its gliders surfaced unexpectedly on a regular deployment in the Perth Canyon. Once recovered, it was found that one of the wings was broken, with a tooth mark and part of a tooth embedded in the glider.

Following the 'attack', the glider began spiraling upwards. It then surfaced in emergency mode and was recovered successfully. An analysis of the dive data indicated that the incident occurred at 550m, evidenced by spikes in the pitch and roll, and 'spiralling' (glider spinning on its own axis) towards the surface. The glider team is awaiting identification of the shark species from UWA experts, but it is believed that it was most likely a Mako.

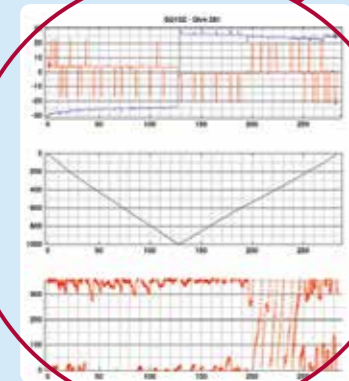
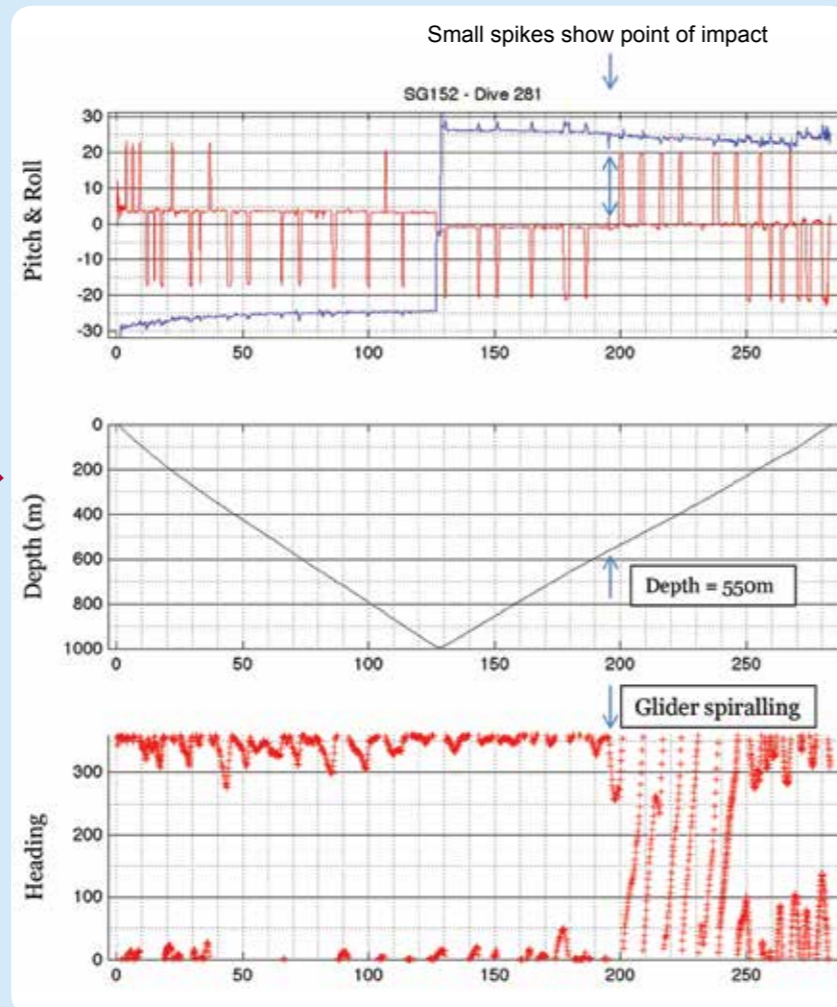
Glider returns with evidence of shark attack on previous deployments in water off the Kimberley, Pilbara, Perth Canyon and Gulf of St Vincent in the last few months.

In another recent instance in South Australia's Gulf of St Vincent, a glider was recovered and tooth marks were evident. Some tooth fragments were analysed and identified to be from a White Pointer. The hull section of the glider had been severely damaged, requiring repair.

Shark attacks on the ocean glider fleet demonstrate just one of the many challenges our technicians face in observing our oceans, even with robots.



Above: Damage to the glider caused by a shark. Below: Chart of dive and spiralling.



Satellite Altimeter news from Venice

The Ocean Surface Topography Science Team (OSTST) conference was held recently in Venice, based on the theme "20 years of progress in radar altimetry". The conference was strongly attended, and included a side meeting on the global Argo program.

The conference was also an important milestone for IMOS satellite altimetry calibration and validation work. Updated results were released from the Bass Strait and Storm Bay sites and from global tide validation work. The tide validation technique has generated increased attention from the international community, providing a timely opportunity for exposure of the work being undertaken and of IMOS as a globally significant ocean-observing program.

The work being done in Bass Strait featured across a number of sessions at the conference. The precision now available from this site has helped to identify

another treatment within the altimeter, improving the accuracy of results for use by the international community.

Dr Christopher Watson from UTAS School of Geography and

Environmental Studies was in attendance, along with Dr David Griffin, Dr Susan Wijffels and Mr Ken Ridgway from CSIRO.



Satellite calibration and validation moorings.

Marine Biodiversity in the frame

IMOS is working with a number of research projects that will influence development of the observing system into the future. In a project with the National Environmental Research Program (NERP) Marine Biodiversity Hub, IMOS is providing data for use in development of a set of National Marine Ecological Indicators to monitor and evaluate the state of Australia's marine environment.

Qualitative models of key ecological features have been developed, based on our understanding of how they work. From these models, the key drivers, threats, and indicators are identified. These models are being tested, with data from IMOS and Australian Ocean Data Network delivering to the identified drivers, threats and indicators. IMOS is also working with the hub to ensure that existing datasets they require, and

data and products being produced by the Hub, will be made available through the Australian Ocean Data Network.

The NERP Marine Biodiversity Hub provides scientific information and advice to support decision-making in the marine environment, specifically in implementing and monitoring marine bioregional plans, developing the National Representative System of Marine Protected Areas, and supporting the information needs of the Department of Sustainability, Environment, Water, Population and Communities in providing key baseline information.

IMOS Director Tim Moltmann said that the hub is an important engagement for IMOS.

"As an integrated system we're investing physical, chemical, and biological

observations and data management. So it's vital that we're relevant to major national research programs in marine biodiversity, and the Hub is a wonderful example," he said.

IMOS was well represented at the first annual meeting of the NERP Marine Biodiversity Hub, held in Sydney on 8 November 2012. The Marine Biodiversity Hub is one of only five national research hubs funded by the Federal Environment Department under the NERP to provide first-class science that is essential for sustainably managing Australia's environment.

For more information on the NERP Marine Biodiversity Hub visit <http://www.nerpmarine.edu.au/>

IMOS hosts the first Australian Coastal and Oceans Modelling and Observations (ACOMO) Workshop

Eighty marine and coastal scientists from across Australia and overseas descended on the Academy of Science, Canberra, on 4-5 October for the first Australian Coastal and Oceans Modelling and Observations (ACOMO) Workshop. Their goal was to explore ways to make better use of available observations and new research tools to unlock the secrets of Australia's vast marine and coastal systems.

IMOS Director Tim Moltmann said that it is surprising that we do not have better knowledge and information about marine and coastal systems in Australia.

"As an island nation these systems are vital to our livelihood and prosperity. But in the past we've been quite poor at sustaining observing and monitoring programs, and at managing marine and coastal data so that it can be discovered, accessed, used and reused," he said.

The situation has been changing for the better over the last five years through the IMOS program. Universities, research institutions, governments and industry partners around the country are now working together to undertake sustained observations of essential ocean variables, from physics to fish. Importantly, they are also making all of the data available to the entire research and user community. It is about to get even better as new tools enable the data collected in the field to inform and improve computer

modelling of marine and coastal systems – modelling that is essential for research, and for management.

"The focus of what we're doing this week is closing the loop between marine observations, data management, and numerical modeling," Mr Moltmann said.

"Marine and coastal systems are so vast and complex that we have to use computer models to understand them. The models have to be grounded in observations, and quality controlled data has to be available to do this. All three elements are necessary for success, and we're very fortunate in Australia to have a national research infrastructure program that's taken this 'big picture' approach."

Marine and coastal scientists are now able to access large data stores, fast networks and high performance computers to help with their studies. They will soon have brand new software tools to bring all these elements together, and go 'from the deep to the desktop'.

One new tool: Virtual marine laboratories

One of the new tools presented at the workshop, the Marine Virtual Laboratory (MARVL), helps researchers to accelerate modelling studies by simplifying the set-up of numerical models and the search for validating observations.

It involves university and government researchers in developing and demonstrating the utility of MARVL for a range of model types in different Australian geographical settings.

National eResearch Collaboration Tools and Resource program (NeCTAR) Director, Associate Professor Glenn Moloney, said that virtual laboratories provide a new place to access data libraries and computer tools.

"They will allow scientists to collaborate more easily, streamline research workflows and enable new opportunities for research innovation," he said.

A report from the ACOMO workshop can be found at <http://www.imos.org.au/acomo>

Animal tag detections hit 10 million and rising

One of the strengths of IMOS is its capacity to bring together researchers from different institutions and regions to create facilities that are much bigger than the sum of their parts. This is particularly true for the Australian Animal Tagging and Monitoring System (AATAMS), and the benefits are now being reaped through unprecedented levels of access to detection data.

Professor Rob Harcourt, leader of the AATAMS Facility, explains the scale of what's been achieved. "Through IMOS we have developed and are now running the world's largest marine acoustic receiver network, servicing 34 institutions and more than 110 researchers," he said.

"Having put in the hard work to get the receivers in the water and the data systems working, the Australian marine science community is now in a position to do all kinds of new and exciting research with the detection data that's being collected."

IMOS has deployed 300 acoustic receivers in coastal waters of Australia, with a further 700 receivers deployed by co-investors as part of the national network. Importantly, data from these 1,000 receivers is captured and managed through a state-of-the-art database.

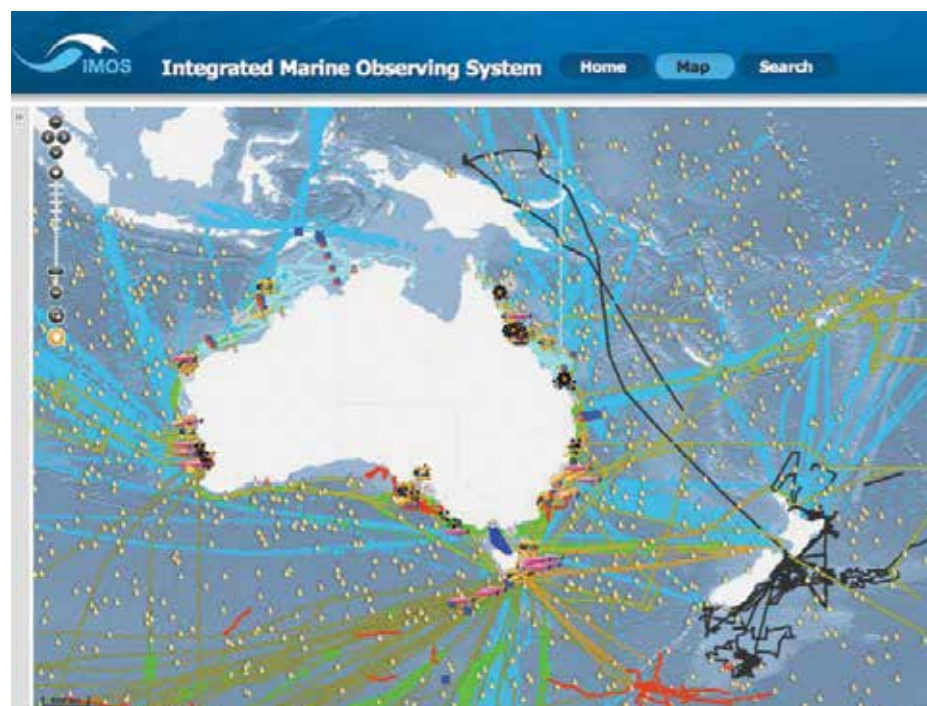
"Now that we've overcome some technical problems with getting the

database working, the number of detections is growing exponentially," IMOS Director Tim Moltmann said.

"We've gone from two, to three to six to ten million detections over the last four months, and we're confident this will double again by early 2013. This is a fantastic new resource for Australian researchers, as well as for

stakeholders involved in fisheries and marine environmental management."

All IMOS data can be discovered and accessed through the Ocean Portal – <http://imos.aodn.org.au/webportal/>. The AATAMS database can be directly accessed at <http://aatams.emii.org.au/aatams/>



AATAMS receiver.

International relations buoyed by marine recovery mission

A Japanese research vessel has gone out of its way to recover a \$1 million Australian marine research buoy that had been adrift in the Southern Ocean since becoming detached from its anchor three months ago.

The buoy is part of a deep-water mooring known as Southern Ocean Flux Station (SOFS), belonging to IMOS.

SOFS was deployed to measure real-time meteorological and oceanographic conditions at the sea surface in the wild and remote Southern Ocean. It provides observations of heat and moisture exchange between the ocean and atmosphere, which are essential for understanding climate variability. There are very few observations from this area of the global ocean, and SOFS is a site of growing international significance.

The *Mirai*, a research vessel owned by the Japan Agency for Marine-Earth Science and Technology and operated by Global Ocean Development Inc., was in the Southern Ocean performing hydrographic surveys and agreed to attempt the recovery of SOFS3 on the way to its planned stopover in Hobart.

Despite adverse conditions, the *Mirai* crew and four technicians

from Marine Works Japan Ltd under the leadership of the Chief Officer, successfully recovered SOFS with all sensors and instruments intact.

Dr Eric Schulz from the Bureau of Meteorology said that the *Mirai* is experienced in recovering large ocean moorings.

“The vessel has the required specialised equipment and personnel on board, making it suitable for the task,” he said.

“We were fortunate that the *Mirai* was able to assist us and we are very appreciative of its efforts in returning SOFS home. This is a great example of international coordination between Australia and Japan for the advancement of marine and climate research.”

SOFS had been moored at 47S, 142E approximately 350 nautical miles southwest of Tasmania in water more than 4.6 kilometres deep when the wire broke at a depth of around 1200 metres. Since September SOFS has

drifted slowly 200 miles to the east, where it was recovered on a longitude equal to the west coast of Tasmania.

While drifting, the meteorological instruments have continued to collect observations and transmit data to the Bureau and to the IMOS Ocean Portal.

IMOS Director Mr Tim Moltmann said he was very relieved to know the buoy would be back in Hobart by the weekend.

“Taking observations in the Southern Ocean is vitally important, but it’s also a difficult business that doesn’t always go according to plan. With this buoy successfully recovered and all of the data secure, we’ve been able to turn a potential setback into a real success story.

“The cooperation of our Japanese colleagues has been crucial and we are extremely grateful for their help.”

Tim Moltmann, Eric Schulz and Thomas Trull.
Photo: Craig Macaulay



IMOS Postgraduate Student Profile

Students using IMOS data for their postgraduate research

Thisara Welhena

**School of Environmental Systems
Engineering and Oceans Institute of
the University of Western Australia**

This study uses water column data collected by the Australian National Facility for Ocean Gliders (ANFOG) along the Two Rock transect in SW Australia.

Since 2009, ANFOG has obtained more than 60 individual physical and biological transect data sets along the Two Rocks, covering different seasons of the year corresponding to more than 25 glider deployments.

This study has focused on the dense water masses that occur throughout the year with varying degrees of intensity in the inner shelf region of the Rottenest Shelf (RCS), which lies approximately between 31.2°S - 32.2°S and 115.0°E - 115.7°E, from 0 to 50m depths and from the shelf break between inner and outer continental shelves (50m to 150m depths).

Mechanism of dense water formation in RCS can be explained as increased evaporation in summer and subsequent cooling in autumn and winter. This results in a density difference between shallow and deeper depths of the shelf, leading to a cross-shelf density gradient, which drives the bottom density flow with a thickness ~20m where the water depths are 40m. This flow accounts for transport of inner shelf waters to offshore with a speed of ~1-5 cms⁻¹ and a volumetric transport rate of ~40-60 m³/s /km of shelf edge. Estimated bottom transport rates in RCS are comparable with those measured in other similar regions globally.

This phenomenon, which has been documented as Dense Shelf Water Cascading (DSWC), provides an effective mechanism for transferring water, heat, salt, phytoplankton, nutrients and pollutants from coastal regions to the deep ocean.

Project: *Dense Shelf Water Cascade (DSWC) on the Rottneest Continental Shelf in South-western Australia*



National Research Investment Plan released

Minister for Science and Research, Senator Chris Evans, recently launched the 2012 The National Research Investment Plan (NRIP), which highlights the need for ongoing investment in national collaborative research infrastructure.

Tim Moltmann, IMOS Director notes that NRIP acknowledges the importance of the marine environment to Australia's future, and that it states:

"In recent years, Australia has put in place a range of world-class research facilities including the Integrated Marine Observing System."

The NRIP sets out a comprehensive national research investment planning process. It will enable a coordinated, whole-of-government approach to research investment that is structured to meet national needs and provide value for money.

The NRIP will support future decisions by the government in relation to the level and balance of research investment. In summary, the planning process comprises:

- the objective of guiding Australian Government research investment in a way that improves national wellbeing by increasing productivity and addressing Australia's key challenges
- a framework, in the form of a national research fabric, that enables the development of Australia's research capacity and capability to be responsive to the needs of all sectors including business
- a set of research investment principles that ensures government

investments address the overall investment objective and are delivered efficiently

- a statement of strategic-research priorities that enables investment to be focused on meeting the government's priorities.

The NRIP was developed by the Australian Research Committee (ARCom).

Senator Evans said the investment plan will support future funding decisions by the Government and sets a path to achieving national research goals.

"The Australian Research Committee will use the plan to develop a set of strategic research priorities and to guide future government funding to ensure it is delivered most efficiently," he said.

The NRIP stresses the need for ongoing investment in national collaborative research infrastructure, referring to the Strategic Roadmap for Research Infrastructure.

Australia's Chief Scientist Professor Ian Chubb said there is sector concern over the National Collaborative Research Infrastructure Strategy (through which IMOS was funded) coming to an end without a replacement.



"We are all aware substantial investment was made in infrastructure and now the program is terminating," he said. He noted the need for ongoing funding over a longer period of time to ensure that researchers can depend on national infrastructure capabilities, and that these capabilities will be able to operate efficiently.

The National Research Investment Plan is available on the Department of Innovation website for download.

<http://www.innovation.gov.au/Research/Pages/NationalResearchInvestmentPlan.aspx>

Port Hacking 50m Coastal Station turns 70 years old

One of a network of stations set up around the Australian coast in the 1940s to observe coastal conditions celebrated its 70th birthday in early December 2012.

The Port Hacking 50m Coastal Station, (PH50m) was first sampled on 5 December 1942 and is still sampled today by the NSW Office of Environment and Heritage for CMAR. PH50m has over 2000 sampling records in the hydrology dataset at CMAR Data Centre.

PH50m is now part of a transect of four sites including PH100m started in May

1953 and two additional sites called PH140m and PH25m both sampled since December 1998. David Rochford originally set PH50m up when CSIRO Division of Fisheries and Oceanography was based in Cronulla, NSW. The CSIRO coastal monitoring program established a network of sampling stations from the 1940s onwards, for the purpose of collecting long time-series of coastal temperature, salinity and nutrient data from south-eastern and south-western Australian coastal waters.

Most sites were closed down but Maria Island (started in October 1944) and Rottnest Island (started in April 1951), and the two Port Hacking sites – PH50m and PH100m – remained. All are still sampled monthly.

In 2009, as part of IMOS, the coastal station network was expanded and there are currently nine biogeochemical sites. Maria Island, Port Hacking 100m and Rottnest are included in this project.



Photo: Steve Rintoul

Latest AODN newsletter released

The Australian Ocean Data Network (AODN) operates a portal through which Australian marine data is made publicly available.

The last few months have seen the development of several activities which all contribute to the expansion of the AODN and improvements to the search, discovery and access to an increasingly wide range of marine data.

The AODN has published its [November 2012 newsletter](#), which features:

- the linkage to the NCRIS project Atlas of Living Australia, enabling the discovery of marine taxon through a set of web services
- the integration of the Australian Oceans Distributed Active Archive Center (AODAAC) enabling gridded data of all types (e.g. from satellites, models, coastal radar) to be accessible as layers alongside other data layers

- and the addition of ocean colour satellite data to the IMOS 'OceanCurrent' facility; and details of the CATAMI project which is developing a unified system for underwater imagery and video.

Archived AODN newsletters are also available on the [IMOS website](#).



IMOS has developed a 'circle diagram' to capture the complexity of engagement for IMOS as a broadly based research infrastructure program delivering to a national community, undertaking research of relevance across government portfolios (Federal and State), industries and communities.

The diagram has five layers:

1. IMOS at the core,
2. the ten operating institutions,
3. the broader research community,
4. various pathways for uptake and use of IMOS data and products, and
5. portfolios of relevance and impact.



Director

Mr Tim Moltmann
Tim.Moltmann@imos.org.au

Project Manager

Mrs Jo Neilson
Jo.Neilson@utas.edu.au

Communications Manager

Frances Hutchinson
Frances.Hutchinson@utas.edu.au

Project Officer

Dr Shavawn Donoghue
Shavawn.Donoghue@utas.edu.au

Personal Assistant

Miss Donna Chilcott
Donna.Chilcott@utas.edu.au

For more information about

IMOS please visit the website www.imos.org.au

General enquiries:

Integrated Marine Observing System (IMOS),
University of Tasmania, Private Bag 110, Hobart, TAS, 7001
• +61 (03) 6226 7549 T • +61 (03) 6226 2107 F



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