



National Environmental  
Research Program

**MARINE BIODIVERSITY** *hub*



## Research Portfolio 2013

*A national research collaboration delivering  
marine biodiversity knowledge to  
the Australian Government*



## Director's overview

This brochure summarises the core funded projects of the NERP Marine Biodiversity Hub. It demonstrates the national scope of Hub research, the depth of expertise our partners can bring to providing solutions of national significance, and the capabilities that have been enhanced through collaboration.

The impacts extend well beyond the specific project outcomes; Hub researchers also support the uptake of science into national decision making through:

- enhanced collaboration with the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) throughout project design and delivery;
- enhanced collaboration with the research and infrastructure sectors, States and Northern Territory to develop complementary approaches that will support national relevance; and
- increased participation in and access to international research teams, including the support of multilateral environmental agreements.

Each project has been designed jointly by researchers and managers from DSEWPaC in a mostly straightforward process. Where the research has been designed to inform pressing decisions, we have worked iteratively with DSEWPaC managers to refine questions, timelines and outputs, ensuring a clear path to impact. This has been educational and no doubt frustrating

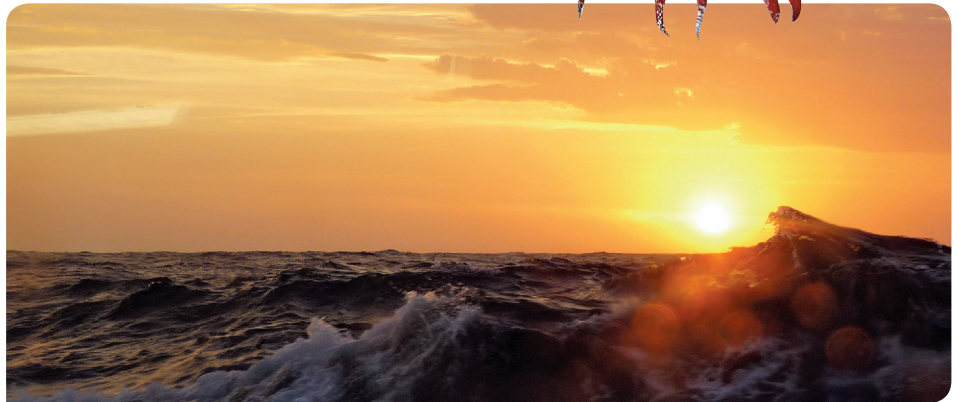
at times for both groups, and ultimately has improved our joint understanding of how research can be used to support evidence-based decision-making.

Our work with external collaborators is enhancing our research and its uptake. Collaboration with the Integrated Marine Observing System is essential to developing a blueprint for marine monitoring of Australian Commonwealth waters, and the Australian Ocean Data Network (AODN) has become integral to data delivery. The AODN has provided additional resources to deliver information in a form that will support DSEWPaC managers in their work. The collaboration has also identified where Hub partners and other data providers need to improve their data infrastructure and processes to support a national system.

We have worked with the States to develop complementary monitoring frameworks and supported several workshops to bring those groups together. Additional research initiatives, through the Australian National

Data Service and the National eResearch Collaboration Tools and Resources in particular, support the development of the framework for Collaborative and Automated Tools for Analysis of Marine Imagery and Video. And in New South Wales, we have paired resources to conduct complementary surveys in adjacent State and Commonwealth waters around the Solitary Islands.

Finally, the research and approaches we have developed to support national needs have been recognised as world-leading and are being extended to better understand the formation and distribution of life in the global oceans, including the identification of ecologically and biologically significant areas. We are collaborating with international research agencies such as the Woods Hole Oceanographic Institute to bring world-leading expertise to Australia. This research, to discover and describe natural and cultural assets in the deep Coral Sea, will support the management of Australia's newest and largest Commonwealth Marine Reserve.



CSIRO/Alicia Navidad



## Providing a marine context for offsets and social values

Offsets are defined as measures that compensate for the residual impacts of an action on the environment. The Environmental Offsets Policy outlines when and how offsets may be used under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC). Experience with offsets in the marine environment is relatively undeveloped and their design and implementation in this context poses particular challenges.

This NERP Marine Biodiversity Hub project addresses the practical issue of how the offsets policy can be used in the marine environment.

A key component of the project involves researchers and DSEWPaC personnel working together to determine the potential for designing and implementing practical, feasible and effective marine offsets. This project will include an evaluation of the extent to which alternative forms of offset and institutional arrangements for their management have 'social licence'.

The working groups will focus on two case studies: seagrass and migratory shorebirds, and will deliver outputs of direct operational and policy relevance. The collaborative case study approach will enable effective and speedy uptake of findings and foster two-way learning between researchers and managers.



Seagrass and migratory shorebirds will be the focus of working groups set up by the NERP Marine Biodiversity Hub to trial marine offsetting (Image: CSIRO).



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# A blueprint for monitoring management outcomes and environmental health of Australian Commonwealth waters

The Australian Government has been working with CSIRO and the NERP Marine Biodiversity Hub to develop a sustained, cost-effective, environmental monitoring system to assess the Commonwealth marine reserves (CMR) networks and the environmental health of Commonwealth waters.

The system aims to document the management outcomes of the CMR networks, and report on a select suite of ecosystem health indicators for Key Ecological Features (KEFs), identified by the Australian Government for their high biodiversity and productivity value.

CSIRO and NERP scientists have canvassed Australian specialists to develop conceptual models that predict how

KEF indicators will respond to various anthropogenic pressures. These models, together with the ecosystem's response to CMR management, will provide the basis for testing scientific predictions, assessing ecosystem health, State of the Environment reporting and management planning.

Technical aspects of the monitoring strategy are being tested in pilot studies designed to investigate logistical and statistical challenges. Pilot studies have been completed at the Flinders CMR (SE Marine Region), and the shelf KEF in the vicinity of the Solitary Islands CMR (Temperate East Marine Region). Additional studies are planned at the Houtman-Abrolhos KEF (SW Marine Region) in 2013. The first exploratory survey of the Oceanic Shoals KEF (North Marine Region) was completed in August 2012.

**The RV *Challenger* prepares to leave Hobart on a Marine Biodiversity Hub voyage to trial environmental monitoring techniques in the Flinders Commonwealth Marine Reserve. (Image: CSIRO)**



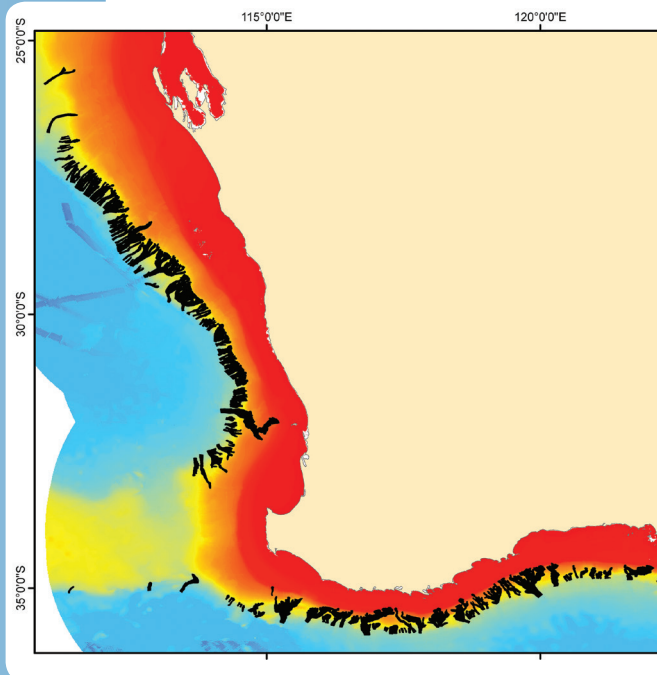
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# Classifying Australia's submarine canyons

Submarine canyons have been identified in marine bioregional plans as areas of high productivity and marine life aggregation, ranging from deep water corals to iconic species such as blue whales. But information is lacking on the number of canyons around Australia, how they vary, and their connection to ocean currents.



To address this, the NERP Marine Biodiversity Hub is developing a national classification of canyons that will form the framework for understanding the physical and biological variation among canyons of various types. Importantly, for managers this work will show how unique a particular canyon is – in a local, regional and national context – and how likely it is to support a higher level of biodiversity than surrounding areas.

The classification will draw on the national bathymetry grid compiled by Geoscience Australia (GA) at a spatial resolution of 250 metres and will incorporate finer resolution data collected by CSIRO and GA for many years from the Marine National Facility Research Vessel *Southern Surveyor*.

It will derive a range of metrics that describe canyon form (location and exposure to large-scale ocean currents), and which may influence biodiversity through processes such as upwelling. These physical parameters will be tested against available biodiversity data that describe communities on the seafloor through to large charismatic megafauna.

Results from this work will be available as digital maps showing the location of canyon types for the entire continental EEZ and associated biodiversity values.



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# Assessing the impact of multiple, cumulative, pressures

Australia's marine territory is affected by many different pressures. Their collective impacts are complex to understand and predict, yet central to the management of marine activities and biodiversity conservation.

Assessing the impact of multiple, cumulative, pressures on the marine environment traditionally has involved canvassing expert opinion that can be variable and contradictory. In contrast, this three-year project is taking a quantitative approach to let the data speak for themselves. Statistical tools are being used to analyse existing datasets (fishery, shipping, oil and gas, and conservation databases) for their effects on environmental assets nominated by DSEWPaC.

The analysis will generate multi-layered 'pressure maps' for selected regions that identify high pressure areas, such as where multiple activities interact. The pressures include fishing, oil and gas exploration, undersea pipelines, recreational and military activities, shipping and temperature variation. The analyses and maps will be publically available on the Australian Ocean Data Network.

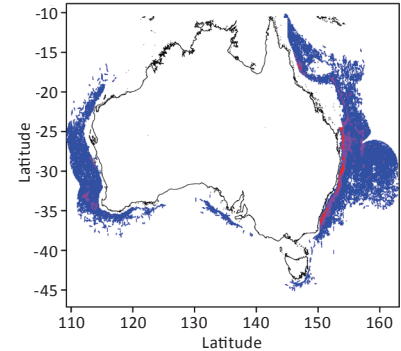
**Intensity of activity for longline commercial fishing, shipping and oil and gas wells. The activities overlap in some locations, but are distinct in others.**



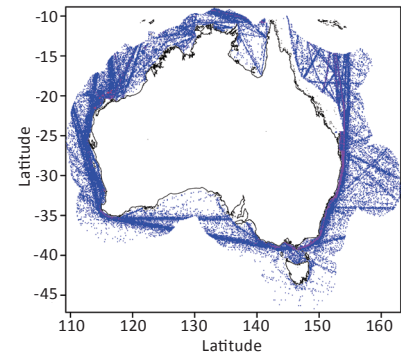
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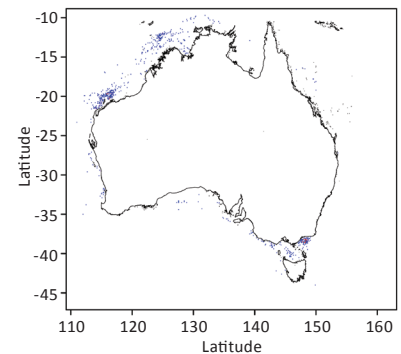
### Longline fishing



### Shipping routes



### Oil wells





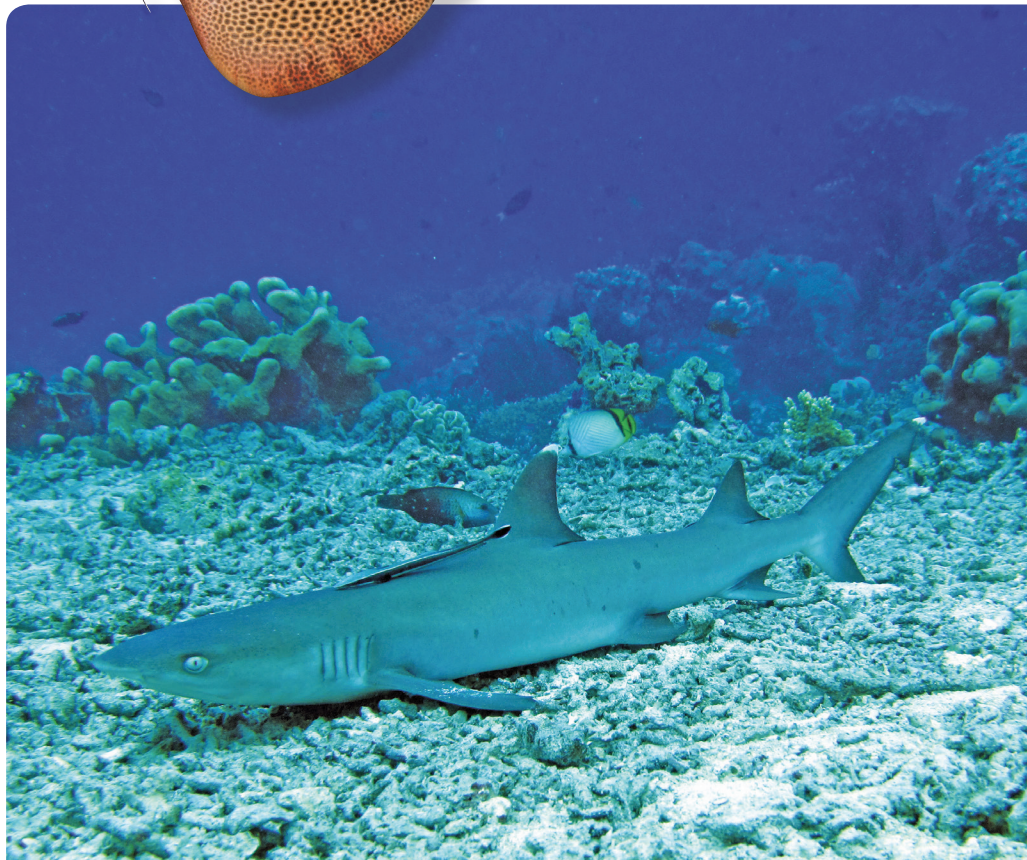
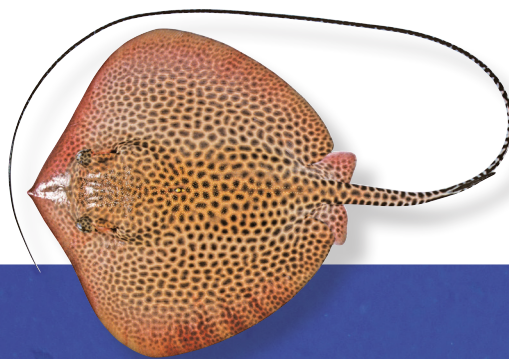
## Managing ecosystems to manage species

Marine conservation and biodiversity management in Australia includes two frequently competing goals: protecting threatened and endangered species, and providing for the sustainable use of resources.

Protecting species one by one has been identified by government as inefficient and ultimately impractical, so alternative approaches are being considered. One of these is a 'landscape' (seascape!) approach to management. Marine reserves are one example of this approach.

The NERP Marine Biodiversity Hub is investigating two applications of this approach. The first focuses on communities of at-risk species, with a particular focus on sharks and rays. Areas of ecological importance are being identified for a range of these species. The second focus is on protecting benthic biodiversity, again focusing on identifying 'hot spots' for special management consideration.

The results will be delivered to both DSEWPaC and the Australian Fisheries Management Authority, as management responses both on and off reserve are likely to be required.



**Whitetip Reef Shark, *Triaenodon obesus*. The NERP Marine Biodiversity Hub is investigating management focussed on at-risk species and biodiversity 'hot-spots'. (Images: CSIRO)**



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## New options for assessing rare and threatened marine species

Reliable, cost-effective assessment tools are vital for managing rare and threatened species. Northern Australia has some of the last remaining populations of sawfish, sharks and rays that live in both freshwater and seawater environments. The population status of these species and the effectiveness of conservation management – a key requirement of recovery plans – are unknown.

The NERP Marine Biodiversity Hub will provide the first estimate of population status for these species using electronic tagging (acoustic telemetry) and advanced genetic techniques (close-kin genetics) designed for this project.

Acoustic telemetry will establish how many juveniles survive through time. Close-kin genetics will establish how often animals give birth, whether females return to the same river to give birth, how many of their offspring survive, and which adults are the parents of juveniles sampled in a river.

Field surveys of juvenile sawfish and spartooth shark (species listed under the EPBC Act) are being conducted in Northern Territory rivers. Many surveys are being undertaken in close collaboration with traditional owners in the Daly River region and Kakadu National Park.

The project will lead to estimates of population trend and size for focal species, enabling management strategies to be evaluated and improved.



**A freshwater sawfish on the Daly River being released after tissue sampling for genetic analysis. The NERP Marine Biodiversity Hub will provide the first estimate of population status for this and other shark and ray species. (Image: Miguel Clavero)**



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# New tools to assess the recovery of white sharks

A monitoring strategy to estimate the size of white shark populations is being developed for Australian waters. This is essential to developing and assessing recovery plans for the species, which is listed as vulnerable under the EPBC Act. Australian waters include an eastern and a western population of white sharks divided by Bass Strait.

The NERP Marine Biodiversity Hub project integrates and builds on years of research supported by various funding agencies, and provides the first clear opportunity to estimate the population size and other vital rates for the eastern Australian white shark population.

Up to 60 juvenile white sharks will be fitted with internal acoustic tags at two known nursery areas – Corner Inlet/Ninety Mile Beach in Victoria and the Port Stephens region of New South Wales – and their survival monitored by acoustic receivers moored along eastern Australia.

Aerial surveys will provide estimates of abundance for juveniles in the Port Stephens area, and mark-and-recapture techniques will be used to estimate adult abundance.

Genetic sampling of juveniles will help to establish estimates of adult survival and frequency of reproduction. These demographic parameters are essential for determining population trends.

The new estimates of survival, abundance and breeding intervals, will be integrated with existing knowledge on the species

biology and ecology. The new tagging research will complement data being generated from 40 juvenile white sharks already tagged in eastern Australia.

The project will add new information on juvenile aggregation sites as well as migratory routes and look for evidence of pupping areas. This understanding is important to recovery planning, marine bioregional planning and environmental assessments.

While the initial focus will be on the eastern Australian population, the techniques will be transferable to white sharks west of Bass Strait, as the movement patterns, spatial footprint and key habitats of the western population are identified.

Tools developed will provide a framework for similarly assessing the population status of other marine species listed under the EPBC Act such as the grey nurse shark.



Image: David Harasti



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# National maps of marine biodiversity and connectivity

Australia has an ongoing need to understand spatial patterns of biodiversity across its vast marine domains. The knowledge is needed for managing marine reserves (particularly where field surveys have not been possible), and for heritage and environmental assessments.

Direct field surveys are expensive. In the interim, a NERP Marine Biodiversity Hub project is collating data stored in museum collections (some overseas) and interpolating various biometrics across the seascape to create large scale maps of the marine domain. This research has become possible thanks to the digitisation

of museum collections and the development of data analysis and mapping software.

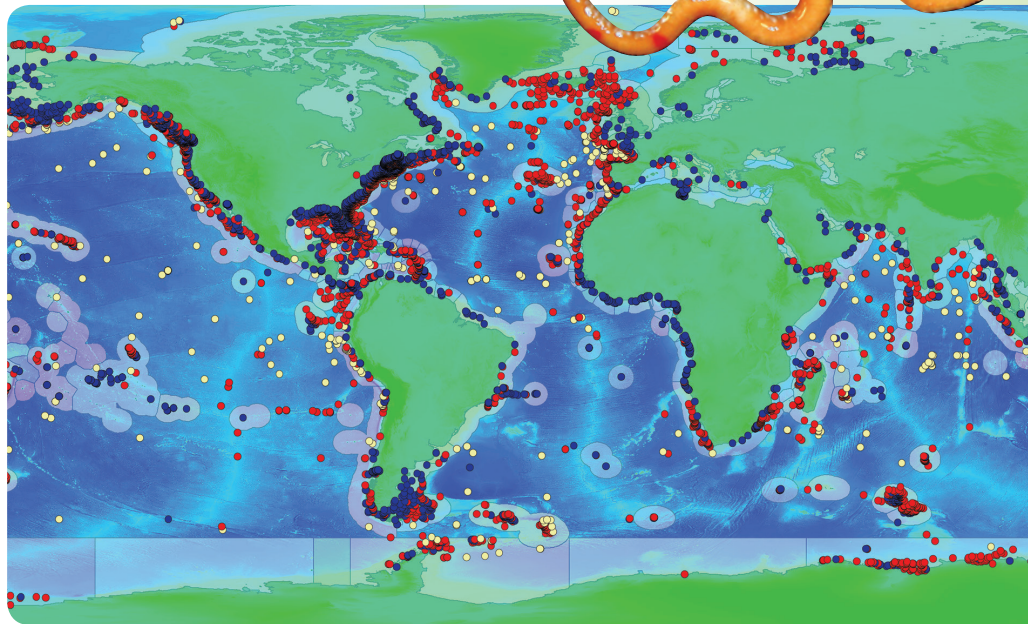
The metrics being mapped include species assemblages, species richness, species turnover, local endemism, and phylogenetic endemism. This last metric involves mapping where ancient lineages ('living fossils') are located. Animal groups being mapped include brittle-stars, squat lobsters, and sharks and rays. Although some of these groups are not of economic importance, they are well known and can be used as surrogates for other seafloor fauna.

The work has international significance. Few nations have assembled similar datasets at such scales. It will further

our understanding of the formation and distribution of life in the oceans, and provide guidance for marine management. International science agencies have provided co-funding to extend the work globally. This will particularly benefit less-developed nations with large marine domains.



Locations of brittle star samples destined to contribute to the global mapping project. Blue dots: continental shelves; red dots: bathyl; yellow dots: abyssal.



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## Describing the evolutionary history of Australia's marine fauna

An understanding of the ecological processes and historical biogeography of Australia's marine fauna is a key factor in Australia's marine bioregionalisation.

It has been widely thought that many Australian marine species originated in the tropics and expanded southwards. Work by the Marine Biodiversity Hub, however, suggested some Australian fish groups actually were ancestral to their tropical relatives.

These groups are more likely to have originated in southern Australia and radiated towards the tropics. These findings highlight the fact that Australia's fish fauna may be far more ancient than previously thought.

This project is examining phylogenetic relationships within several informative fish groups, such as groups recognised as important biogeographic indicator. The aim is to determine the timing and pathways of evolution within these groups, and to test for generalised patterns.

The work will foster a better understanding of marine areas that may have acted as refugia during earlier extinctions, and could offer clues to the response of species to future change.



**The NERP Marine Biodiversity Hub is investigating the evolution of fish groups that include sea robins (top) and flounders (above). (Images: CSIRO)**



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# Investigating Oceanic Shoals: a Commonwealth Marine Reserve

In September 2012, a three-week survey of the Oceanic Shoals Commonwealth Marine Reserve off northern Australia was conducted from the Australian Institute of Marine Science (AIMS) research vessel *RV Solander*.

Oceanographic, biological and acoustic sampling was conducted using techniques including towed and baited remote cameras, ocean drifters, benthic sleds, multibeam sonar, a box corer, and sediment and water collection. The result is an unprecedented, integrated description of biological communities and their relationship with the shallow seabed and open water

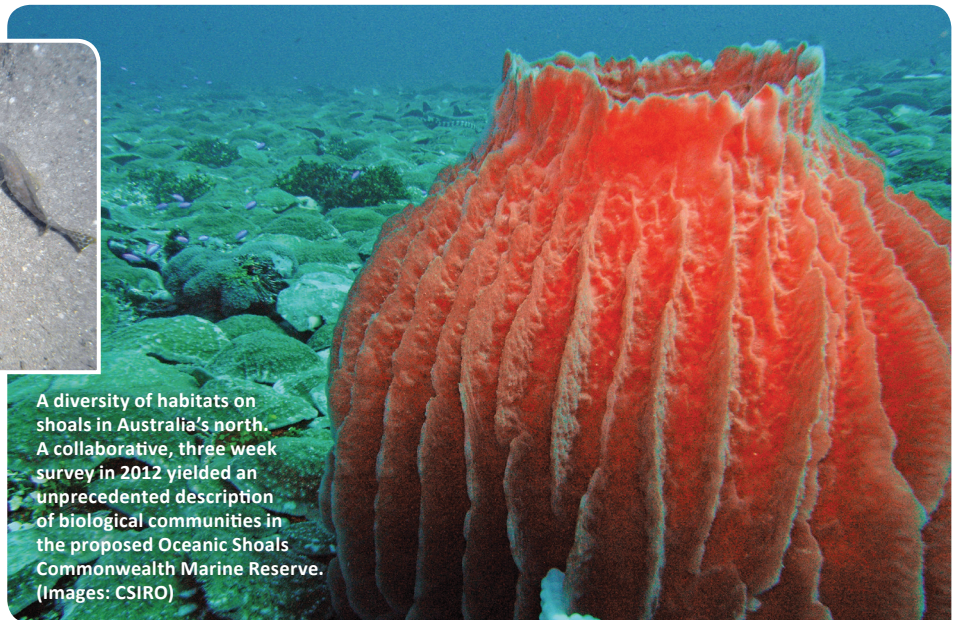
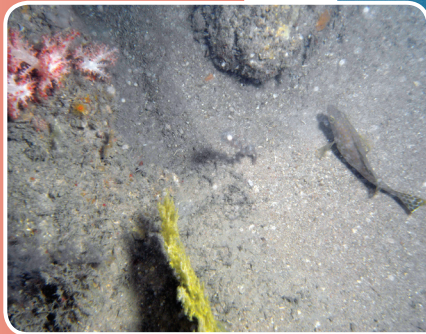
environments of a poorly known region of Australian's marine jurisdiction.

This new knowledge will support NERP Marine Biodiversity Hub projects, designed in consultation with DSEWPac staff, to address ongoing information needs and support management outcomes. The breadth of data collected could not have been achieved without the collaboration of research staff from many organisations including AIMS, Geoscience Australia, University of Western Australia, and the Museum and Art Gallery of the Northern Territory.



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A diversity of habitats on shoals in Australia's north. A collaborative, three week survey in 2012 yielded an unprecedented description of biological communities in the proposed Oceanic Shoals Commonwealth Marine Reserve. (Images: CSIRO)



# Linking Great Barrier Reef monitoring to management needs

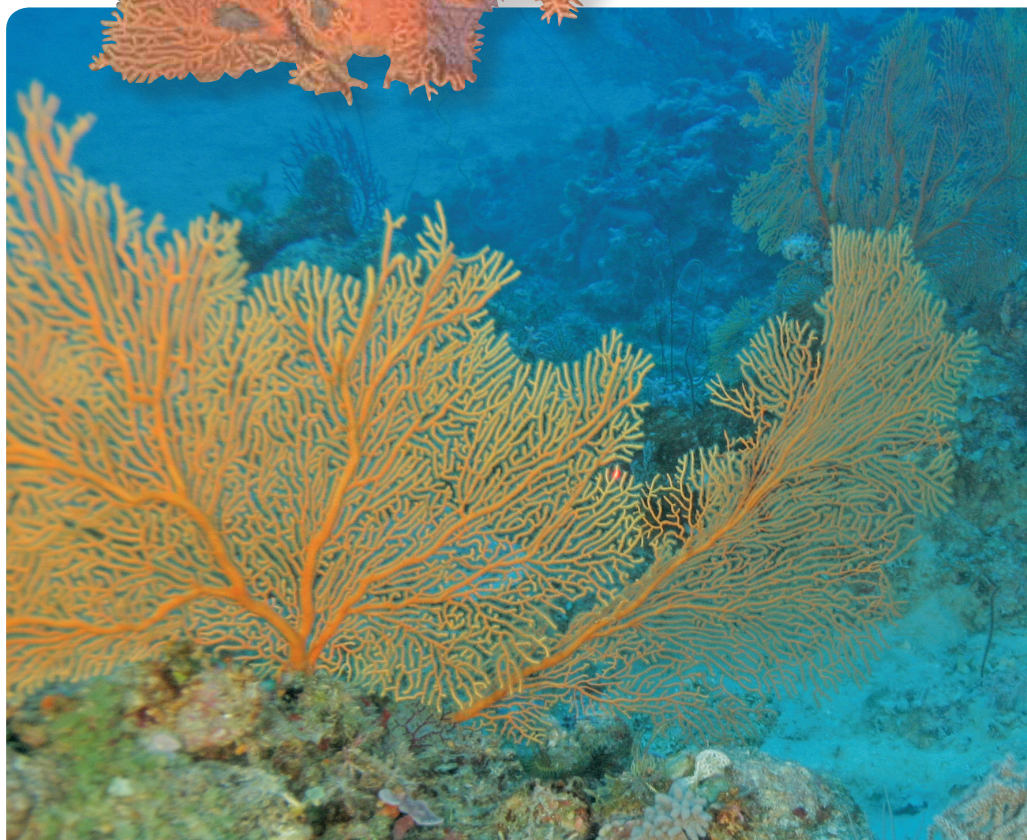
A monitoring framework is being developed to assist the Australian Government in its commitment to adapt and improve management of the Great Barrier Reef World Heritage Area (GBRWHA) to meet future challenges. The framework will standardise and integrate the collection of priority ecological, social and economic information, building on existing work relating to marine and coastal monitoring.

The project involves the NERP Marine Biodiversity Hub, Tropical Ecosystems Hub and Environmental Decisions Hub, the Great Barrier Reef Marine Park Authority (GBRMPA), the Australian Institute of Marine Science, and other stakeholders. The team is working with the GBRMPA's Strategic Assessment Team to ensure the research supports the strategic assessment of the GBRWHA. A draft project report was provided to DSEWPaC in April 2013, with a final report in June 2013.

The NERP Marine Biodiversity Hub is working with DSEWPaC to develop a blueprint for national-scale monitoring that will support marine bioregional plans and Commonwealth Marine Reserve networks.



The new monitoring framework for the Great Barrier Reef World Heritage Area will build on existing work relating to marine and coastal monitoring (Images: CSIRO)



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# Supporting biodiversity management on the high seas

NERP Marine Biodiversity Hub scientists have been helping Southern Hemisphere nations to identify priority marine areas for conservation and management.

The program to identify Ecologically and Biologically Significant Areas (EBSAs) was requested by the Conference of the Parties to the Convention on Biodiversity (CBD) in 2010. Since then, six regional workshops have been held: three in the Northern Hemisphere and three in the Southern Hemisphere.

NERP Marine Biodiversity Hub scientists led all the Southern Hemisphere workshops, and more than 50 physical data layers were made available to participating countries through the Australian Ocean Data Network.

Hub Director, Nic Bax, presented workshop results to the 193 parties to the CBD in Montreal and Hyderabad in 2012.

Although the initial focus of the work was to identify areas of high ecological value on the high seas, almost all the emerging economies involved in the workshops have been equally interested in applying the CBD approaches to their own waters.

The Cook Islands has declared a marine protected

area based on the defined EBSAs and further marine spatial planning efforts are under way in the Southwest Pacific.

## Developing management options

Identifying areas meeting the EBSA criteria is only the start of a long process towards developing management options for these areas. A key question is whether new international agreements will be needed to facilitate their implementation.

The Hub team is working with the United Nations Food and Agriculture Organisation to determine how EBSAs overlap with conservation instruments being developed by regional fisheries management bodies.

Outcomes of the workshops have been used to guide UN members considering whether to develop a new multilateral agreement to manage Biodiversity Beyond National

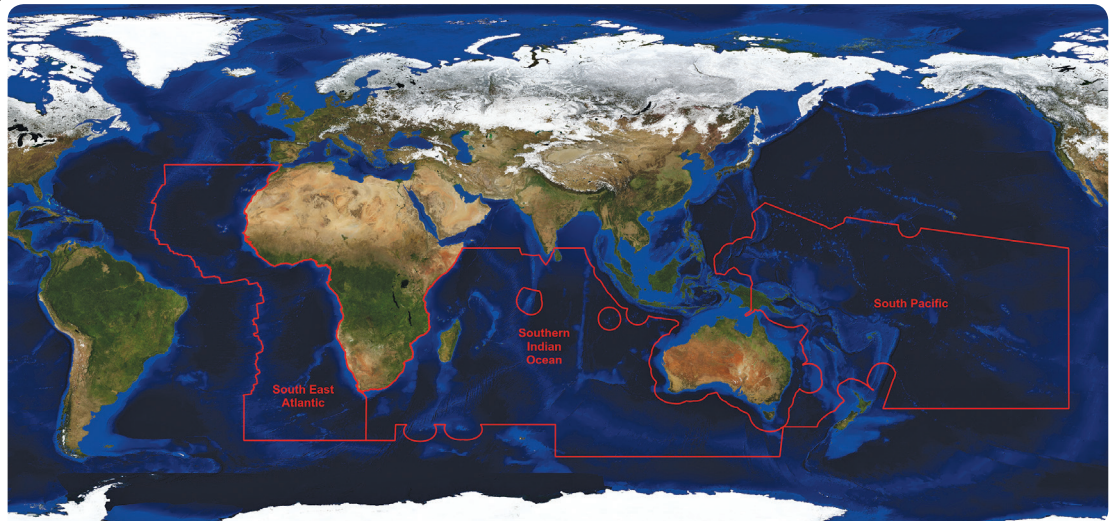


Jurisdiction (a development supported by Prime Minister Julia Gillard in June 2012).

A group of international experts brought together by the Hub team and James Cook University has assessed existing management instruments against a Systematic Conservation Planning framework.

The group found that while many existing agreements lacked essential attributes for applied conservation, they could provide interim management while more complete arrangements were developed by the UN.

Ban, NC, NJ Bax, KM Gjerde, R Devillers, DC Dunn, PK Dunstan, AJ Hobday, SM Maxwell, DM Kaplan, RL Pressey, JA Ardron, ET Game, PN Halpin (2013) Systematic conservation planning: A better recipe for managing the high seas for biodiversity conservation and sustainable use. *Conservation Letters*.



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# Managing natural and cultural assets deep in the Coral Sea

The NERP Marine Biodiversity Hub is partnering with the team that discovered the *Titanic* to survey three United States warships sunk during the World War II 'Battle of the Coral Sea': *USS Lexington*, *Sims* and *Neosho*). The team will also survey the surrounding biodiversity at 1000–3000 metres depth.

The survey, scheduled for 2014 on Australia's new RV *Investigator*, will involve scientists from the National Oceanic and Atmospheric Administration, DSEWPaC, Woods Hole Oceanographic Institution, the US National Park Service Submerged Resources Center, CSIRO and other Hub partners.

This will be the first standardised evaluation of deepwater natural and cultural assets in the proposed Coral Sea Commonwealth Marine Reserve. It will set a standard for evaluating deepwater marine reserves, contributing to the national blueprint for monitoring marine ecosystem health and the impact of marine reserves being developed by the Hub and DSEWPaC.



Ecological questions relevant to managing the proposed Coral Sea Commonwealth Marine Reserve include:

- Is Australia's deep eastern Coral Sea biogeographically distinct?
- If diverse epifaunal assemblages including coldwater corals occur on seamounts, can they act as climate refugia, or are they especially vulnerable due to isolation?
- Do deep shipwreck habitats demonstrate model biodiversity patterns such as community structure, connectivity, growth and colonisation, and responses to environmental conditions?
- Do deep shipwrecks pose environmental threats as sources of pollution?



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# NERP MARINE BIODIVERSITY hub

THEME 1 National Monitoring, Evaluation and Reporting Keith Hayes (CSIRO)		THEME 2 Supporting Management of Marine Biodiversity Tony Smith (CSIRO)				THEME 3 National Ecosystems Knowledge Scott Nichol (GA)		THEME 4 Regional Biodiversity Discovery to Support Marine Bioregional Plans Julian Caley (AIMS)	THEME 5 Science and Policy Initiatives
<b>1.1</b> Collation and analysis of existing data sets  Keith Hayes, CSIRO	<b>1.2</b> Analysis of approaches for monitoring biodiversity in Cwth MPAs  Keith Hayes, CSIRO	<b>2.1</b> Integrating social, economic and environmental values  Sarah Jennings, UTAS	<b>2.2</b> Integrating threats, values and assets for management  Piers Dunstan, CSIRO	<b>2.3</b> Landscape approaches to managing high priority conservation values  <i>Task 1</i> – High Conservation priority species  Tony Smith, CSIRO  <i>Task 2</i> – Marine benthic priority  Roland Pitcher, CSIRO	<b>2.4</b> Supporting management of listed and rare species  Peter Kyne, CDU  <b>2.5</b> White shark population & abundance trends  Barry Bruce, CSIRO	<b>3.1</b> Shelf and canyon ecosystems – functions and processes  Scott Nichol, GA  <i>Task 1</i> – Data discovery <i>Task 2</i> – Data analysis and synthesis	<b>3.2</b> National maps of connectivity and biodiversity  Tim O’Hara, MV  <i>Task 1</i> – Maps <i>Task 2</i> – Datasets for sharks, rays, teleosts	<b>4.1</b> Twenty-one day RV <i>Solander</i> Survey  Andrew Heyward, AIMS	<b>5.1</b> Great Barrier Reef World Heritage Area integrated monitoring  Paul Hedge, UTAS  <i>Collaboration between:</i> GBR Marine Park Authority; NERP Environ. Decisions Hub; NERP Marine Biodiversity Hub; NERP Tropical Ecosystems Hub
CSIRO, UTAS, UWA, AIMS, GA	CSIRO, UTAS, UWA, GA	CSIRO, UTAS, UWA	CSIRO	CSIRO, UWA	CDU/NT Fish, CSIRO	GA, UWA, AIMS, CSIRO	MV, AIMS, CSIRO	AIMS, GA, MV, UWA	



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The NERP Marine Biodiversity Hub is supported through funding from the Australian Government's National Environmental Research Program, administered by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). Our goal is to support marine stakeholders in evidence-based decision making for marine biodiversity management. Stakeholders include DSEWPaC, the Australian Fisheries Management Authority (AFMA), the Australian Petroleum Production and Exploration Association (APPEA) and the Integrated Marine Observing System (IMOS).