

Marine Biodiversity Hub **Impact Report**

SYNOPSIS OF RESEARCH IMPACTS: **2007-2020**

DECEMBER 2020



National Environmental Science Programme

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Marine Biodiversity Hub funding programs and research partners

Commonwealth Environmental Research Facilities 2007–2010

Australian Institute of Marine Science
CSIRO

Geoscience Australia

Museums Victoria

University of Tasmania

Director: Prof. Nic Bax

National Environmental Research Program 2011–2014

Australian Institute of Marine Science
Charles Darwin University
CSIRO

Geoscience Australia

Museums Victoria

University of Tasmania

The University of Western Australia

Director: Prof. Nic Bax

National Environmental Science Program 2015–2021

Australian Institute of Marine Science
Charles Darwin University
CSIRO

Geoscience Australia

Integrated Marine Observing System

Museums Victoria

New South Wales Government

University of Tasmania

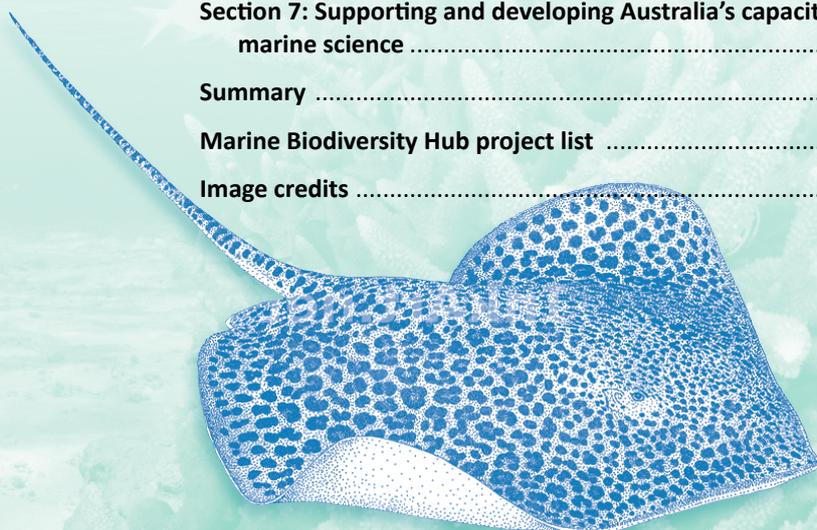
The University of Western Australia

Director: Prof. Nic Bax

(Jan 2015–Mar 2020)

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The Marine Biodiversity Hub commenced in 2007 as an Australian Government initiative to help decision-makers understand and conserve Australia's unique marine biodiversity and manage sustainable use of the marine environment.

Research conducted within Marine Biodiversity Hub programs has provided foundational scientific evidence for biodiversity conservation and sustainable use in Australia's marine environment. The Hub has established enduring partnerships to deliver fit-for-purpose scientific advice and tailored outputs to meet priority needs. It has become an indispensable part of Australia's national approach for advancing its blue economy.

The current Hub, extending from 2015 to 2021, is funded under the Australian Government's National Environmental Science Program (NESP) and has nine research partners (see copyright page). The NESP was preceded by two earlier programs: the 2011–2014 National Environmental Research Program (NERP), and the 2007–2010 Commonwealth Environment Research Facilities (CERF) program. Collectively, these programs provided scientific information and advice to support decision making by the Australian Government and have had an important influence on the sustainable management of Australia's marine environment. The major theme areas of the programs include:

- Marine bioregional planning for Australia's ocean territory;
- Australian Marine Park planning and management;
- Protecting conservation values in World Heritage Areas;
- Recovery of threatened and migratory species; and
- Restoration of coastal habitats.

The specific priorities and policy and management drivers have continued to evolve over the 14 years of the Marine Biodiversity Hub programs, and the Hub has remained adaptable to meet the needs of the end-users of the science. For example, the Hub has provided ongoing advice through the development of the Marine Bioregional Plans, management of Australian Marine Parks, and the development of its monitoring, evaluation, reporting and improvement system. The Hub also addressed emerging issues including species and habitat recovery, and increased their success by building strong enduring partnerships and developing innovative approaches.

Hub data has increased the quality and quantity of environmental data being used within the Australian State of the Environment Report which continues to build confidence in the reporting process and product, and increase its influence and value to end-users, stakeholders and the broader community. The Hub has continued to adopt new tools and build partnerships to ensure data is managed and delivered to suit the needs of both the science and management community. There are also numerous instances where the Hub's work and expertise has supported international negotiations and initiatives.

This report showcases the Hub's impact across its three funding programs on the knowledge base and management activities of the Australian, state and territory governments, non-government organisations, marine researchers and industries.

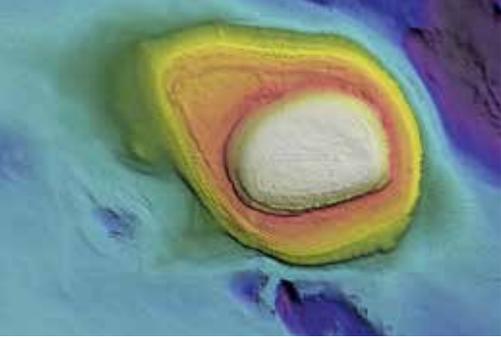
CONNECTING ON SEA COUNTRY

Across its research activities, the Hub has progressively increased Indigenous engagement and partnerships in regionally focused projects to identify and advance Indigenous research interests and priorities.

The kinship connection between land, sea and people is at the heart of Indigenous culture and an important part of the past, present and future of their lands and waters.

Empowering Indigenous people in land and sea research and management helps keep culture strong and ensure a future that is guided by people who understand and promote its unique biodiversity and environmental characteristics.

The Hub has attempted to be both strategic and pragmatic, guided by science while embedded with Indigenous knowledge and customary practices and sufficiently ambitious yet flexible enough to inspire and unite all stakeholders.



SECTION 1: SCIENCE TO SUPPORT MARINE BIOREGIONAL PLANNING FOR AUSTRALIA'S OCEAN TERRITORY

Australia's ocean territory is one of the largest and most diverse in the world, extending out to 200 nautical miles from the coast and covering some 9.2 million km². The Hub has worked closely with the Australian Government since 2007 to ensure that marine bioregional planning for this territory is based on the best available science.

Marine bioregional plans aim to improve the way decisions are made under Australia's *Environment Protection and Biodiversity Conservation Act 1999*, particularly in relation to biodiversity protection and sustainable use by marine-based industries. The plans identify the need to better understand marine conservation values (protected species, protected places and key ecological features), the risks posed by human activities, and the need to monitor and report on ecosystem health. This section features Hub research that was essential to developing and implementing marine bioregional plans.

► UNDERSTANDING AND MAPPING BIODIVERSITY TO DEVELOP AND IMPLEMENT MARINE BIOREGIONAL PLANS

Hub research was used by the Australian Government to develop bioregional profiles for four marine regions (South-west, North-west, North and Temperate East). Bioregional profiles synthesised the biophysical characteristics of each region, assessed the pressures on conservation values, and identified key ecological features (KEFs) and biologically important areas for protected marine species. They are a central and essential component of the bioregional planning process. Hub researchers coordinated collaborative efforts across the Australian marine science community to improve understanding of KEFs (conservation values that are important for either the region's biodiversity or ecosystem function and integrity).

National maps of seafloor features (such as submarine canyons and seamounts) and predicted patterns of biodiversity were used to describe marine bioregions and identify the location and extent of many KEFs. Regional maps were also developed to define boundaries for KEFs identified as important areas of enhanced pelagic productivity and biodiversity. This research has involved important national collaborations in data discovery and interpretation and implementing national taxonomic standards.

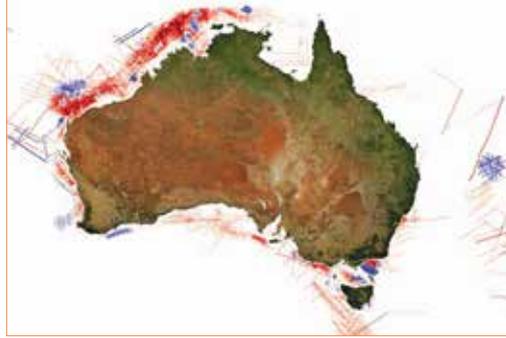


DID YOU KNOW?

- *Australia is surrounded by more than 750 submarine canyons, 60 of which extend onto the continental shelf. Many contain a rich diversity of marine life.*
- *Different marine ecosystems contain distinct species and assemblages across such features as pelagic hotspots; seamounts; shelf and slope reefs and soft-sediments.*

MAKING AN IMPACT

The Australian Government's marine bioregional plans were founded on the best available biophysical evidence base, and utilised world-leading research on national and regional scale patterns of marine biodiversity. Hub research has provided an improved and shared understanding of priority conservation values, including key ecological features, to benefit the Australian Government, and state and territory governments. The plans are also an important contribution to prioritising ongoing biodiversity surveys and enhancing collaborations across the research community.



SECTION 1: SCIENCE TO SUPPORT MARINE BIOREGIONAL PLANNING FOR AUSTRALIA'S OCEAN TERRITORY

► PREDICTING BIODIVERSITY PATTERNS ACROSS THE AUSTRALIAN MARINE ESTATE

Much of the Hub's early research focused on developing new methods and models to predict biodiversity structure and composition across more than two million km² of the seafloor. Biological and physical datasets (including previously inaccessible data) were used with new statistical methods to predict biodiversity nationally at a scale of one km² in four major marine biomes: the continental shelf, continental slope, tropical coral reefs, and temperate rocky reefs.

For selected areas, high resolution bathymetry and habitat types were mapped from multibeam sonar surveys, revealing the influence of habitats and fine-scale seabed features on biodiversity patterns. National-scale maps were developed representing continental shelf demersal fish assemblages and large-scale seafloor features, with a focus on canyons, seamounts, continental shelf reefs, and more recently, the abyssal plain to depths of ~4000 m. This allowed the physical factors of water depth and seafloor features to be used as 'surrogates' for the distribution of biodiversity where biological information gaps existed.



DID YOU KNOW?

- Variables such water temperature, light, depth, and seafloor topography influence patterns of marine biodiversity.
- Seafloor communities on the continental shelf and slope have evolved independently and even today provide evidence of Australia's evolution.
- Species at bathyal depths (200–2000 m) can occur across extensive longitudinal ranges. For example, the faunas of Tasmanian and southern New Zealand seamounts and the southern Australian continental slope are closely related.
- On the shelf and upper slope, species richness peaks at tropical and sub-tropical latitudes for brittlestars and squat lobsters, then declines in richness towards the poles.

MAKING AN IMPACT

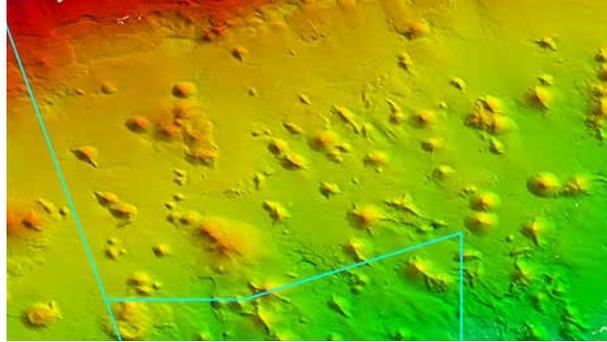
The Hub developed national scale maps of predicted biodiversity across Australian state and Commonwealth waters which were used by the Australian Government to inform marine park design. Hub research has led to Australia being a global leader in predicting large-scale patterns of marine biodiversity, and an important contributor to improved collation and analysis of bathymetry to describe seafloor features.

► UNDERSTANDING PRESSURES ON CONSERVATION VALUES

As pressures on the marine environment increase, understanding their extent and their impact on conservation values is essential to developing and prioritising management actions. Working with government and industry, Hub researchers have produced comprehensive national maps of current and historical pressures. The resulting pressure assessments contribute to State of the Environment reporting and marine bioregional planning. They also support decision making under the *Environment Protection and Biodiversity Conservation Act 1999* relating to development conditions, species recovery plans and marine park zoning and management. Several initiatives examined specific pressures to better understand their extent and impacts.

- The identification and mapping of ship-strike risk, with a focus on whales, Dugongs, turtles and dolphins for an evidenced-based review of Australia's *National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna*.
- Surveys of pollutants on shallow reefs to identify pressures including sewage, heavy metals, fishing, rising sea temperature and introduced species.
- An Australia-wide analysis of the extent of bottom trawl fishing using high-resolution trawl effort data.





SECTION 1: SCIENCE TO SUPPORT MARINE BIOREGIONAL PLANNING FOR AUSTRALIA'S OCEAN TERRITORY

- A National Outfalls Database developed with the Clean Ocean Foundation to track wastewater discharged to Australia's ocean and estuaries.
- Mapping of cumulative shipping noise as a step towards focused mitigation measures and risk management.
- Research on plastic waste management policies to provide a national survey framework and assess risk to conservation values.

Pressures data are curated to international standards to ensure their long-term availability and made available via portals such as the Australian Ocean Data Network, SeaMap Australia and the North-West Atlas. This allows governments and industry to make decisions about resource use and protecting conservation values.

Practical approaches developed for assessing cumulative impacts have been applied in priority settings where cumulative impacts threatened conservation values. Technical guidance for assessing cumulative risks and impacts in the Great Barrier Reef (GBR) is being collaboratively developed to assist regional managers and development proponents. In addition, a rapid assessment of the cumulative effects of pressures on the values of Australian Marine Parks (AMPs) underpins the identification of management and monitoring priorities.

DID YOU KNOW?

- *In general, pressures associated with fisheries have decreased throughout Australian waters, while oil and gas and shipping activities have increased.*
- *The effect of climate change is evident in all marine regions and cumulative pressures have increased.*
- *Humpback Whales have a higher relative risk of strike from large vessels in the GBR region on the eastern seaboard and from Dampier to Port Hedland in the west.*

MAKING AN IMPACT

Hub research on anthropogenic pressures has increased the capacity of governments and industry to understand the distribution of pressures on marine and coastal values, and consider the effect of cumulative pressures when planning and prioritising investments. For example, new and shared understanding of wastewater inputs, plastic waste, ship strike and shipping noise provides an evidence-base for effective reporting and management. This includes improved State of the Environment reporting, decision-making under the *Environment Protection and Biodiversity Conservation Act 1999*, marine bioregional planning and management, AMP management, Australian Fisheries Management Authority harvest strategies and threat abatement planning.

► IMPROVING MONITORING, EVALUATION AND REPORTING ON ECOSYSTEM HEALTH

Hub researchers have worked closely with the Australian Government to build capacity to monitor, evaluate and report on ecosystem health in the marine environment. For example, the establishment of baselines and monitoring of key attributes in many locations required auditing and exploring existing data, and developing national standards for collecting new seafloor and biodiversity data (see case study on page 6). Reefs on the continental shelf, submarine canyons and seamounts in marine parks were a key focus for expanding baseline data. Partnerships with other national programs and facilities, such as the National Marine Facility and the Integrated Marine Observing System were important for advancing these baselines. The report, *Monitoring Australia's oceans: towards a blueprint*, distils the findings of more than eight years of research in this area.





SECTION 1: SCIENCE TO SUPPORT MARINE BIOREGIONAL PLANNING FOR AUSTRALIA'S OCEAN TERRITORY

The Hub significantly improved monitoring, assessment and reporting on the health of shallow reefs by supporting a national citizen science initiative started under the first Hub funding program (see case study on page 7). Reef Life Survey data combined with other biological and environmental datasets offer an unprecedented view of spatial and temporal trends and status of fish and invertebrates, and impacts such as fishing, pollution and climate change.

Similarly, Hub research is central to developing the Monitoring, Evaluation, Reporting and Improvement system which integrates knowledge of values and pressures and supports adaptive management of AMPs. The new capacity for sustained, coordinated monitoring to produce comprehensive, long-term datasets in turn enables objective, national biodiversity assessments for State of the Environment (SoE) reporting.

DID YOU KNOW?

- *About half of the species sampled in the deep sea are new to science.*
- *The Hub's shallow water reef biodiversity assessment will summarise population trends for more than 500 reef species.*
- *Australia is now a world leader in the development and implementation of marine surveys and monitoring standards, and the coordination of key data such as high-resolution bathymetry.*

MAKING AN IMPACT

Australian, state and territory governments have a stronger evidence-base and capacity to understand and communicate the status and trends of natural values in Australia's Exclusive Economic Zone, including those protected by marine parks. This includes protecting biodiversity and promoting sustainable use of shallow water reefs. Australia also has an improved capacity to understand regional and national biodiversity status and trends, for national marine monitoring and evidence-based decision-making. This supports implementation of marine bioregional plans and AMPs, assessments under the *Environment Protection and Biodiversity Conservation Act 1999*, and SoE reporting.



CASE STUDY: NATIONAL STANDARD OPERATING PROCEDURES

Marine scientists use a diverse array of sampling platforms to collect baseline environmental data, identify important habitats or taxa, and detect change. In order to meet national and regional assessment and reporting requirements, especially when resources are limited, the chosen methods must be appropriate, efficient and nationally comparable. A comprehensive assessment and comparison of sampling platforms led by the Hub provides guidance for this selection process. For example, acoustic sampling provides a baseline for appropriate survey design, but may not be required on subsequent surveys to detect ecological change: a task that requires detailed species inventories acquired through direct sampling. Repeat observations with non-extractive methods such as underwater imagery enable change and trend detection and the quantification of seafloor impacts.

The Hub's field manuals are endorsed by experienced researchers, managers and technicians from multiple agencies, and are being championed as the way forward to further build nationally coordinated marine research and monitoring. They outline survey design, planning and reporting, quality control, data management, discoverability and accessibility, and standardised methods to acquire data. Individual chapters cover multibeam echosounder; autonomous underwater vehicles; benthic and pelagic baited remote underwater video; towed imagery; remotely operated vehicles; grabs and box corers; and sleds and trawls. They are now recommended by Parks Australia as part of approving scientific sampling in marine parks.

The move towards standardisation facilitated by the field manuals is happening alongside the development of national and international facilities for storing, accessing and sharing marine data. Together, these standardised tools and approaches will give unprecedented capability to aggregate and analyse marine data and deliver marine biodiversity information of value to marine managers and scientists. This will be fundamental to support effective monitoring of Australia's marine conservation values and environmental assets and will contribute to progressing the United Nations Sustainable Development Goal 14a.



► STATE OF THE ENVIRONMENT REPORTING

Every five years the Australian Government conducts a comprehensive review of the Australian environment, with national State of the Environment (SoE) reports providing information about environmental and heritage conditions, trends and pressures for the Australian continent, surrounding seas and external territories. The Hub has made a substantial contribution to national reporting data quality and standards; providing datasets, case studies, analyses and better use of existing quantitative data. To ensure data used for the 2016 report was discoverable and accessible for future reports, the Hub published metadata records for the marine assessments on the Australian Ocean Data Network. The Hub also contributed an unprecedented level of scientific evidence to *SoE 2016*, informing governments, industries and the public about status, trends and outlook for Australia's marine environment.

National-scale pressure data analyses and maps support assessments of cumulative and relative impact and risk, and the status and trends of threatened shark species. They also enabled the first national map of continental shelf reefs. One of the most informative biological marine datasets available to *SoE 2016* was the Hub's shallow reef biodiversity assessment, which included national rocky and coral reef data collected by volunteer divers as part of Reef Life Survey (see case study below).



DID YOU KNOW?

- *Reef Life Survey has conducted more than 13,000 surveys ranging from cold-temperate to tropical waters.*
- *The Hub contributed a co-author for the marine chapter of the SoE 2016 report.*
- *One of the most important health indicators for shallow reefs is the biomass of fish greater than 20 cm.*

MAKING AN IMPACT

Hub contributions to SoE reporting strengthened the structure and focus of marine environmental status and trend information, with almost half of all case studies based on Hub research outputs. The 2016 SoE report broke new ground on the scope and depth of reporting, and for setting a baseline for future comparisons over time. Reef Life Survey provided an outstanding example of how support for funding environmental research can grow to become a high-valued, cost-effective citizen science program providing benefits for Australian Governments and the broader community.

CASE STUDY: REEF LIFE SURVEY

The Hub has a long-standing partnership with Reef Life Survey (RLS), a program in which volunteer divers conduct scientifically rigorous long-term monitoring of shallow-water reefs. RLS provides Australia's most comprehensive, quantitative marine biodiversity baseline data, with standardised surveys covering more than 3000 species and 1500 sites in Australia, and more than 2400 sites worldwide. This provides an important foundation for analysing the health of shallow reefs and the influence of marine protected areas on species recovery. This analysis has often benefitted from the inclusion of data from other relevant long-term monitoring programs led by the University of Tasmania (UTAS) and the Australian Institute of Marine Science.

A UTAS team used RLS data covering fish, invertebrates and algae in the first continental-scale analysis of biogeographic patterns, ecosystem function, and ecological impacts generated by human pressures. RLS has provided data to evaluate key indicators for Australian State of the Environment reporting. Two ecological indicators for ocean warming and fishing pressure based on RLS data are being used to independently track progress towards United Nations Sustainable Development and Convention on Biological Diversity goals. RLS data have also allowed a global assessment of the direct and indirect benefits of marine protected areas (MPAs) for coral reef conservation. MPAs were found to promote the persistence of some functional groups of corals, supporting the use of MPAs as a management tool globally.



SECTION 2: INDIGENOUS ENGAGEMENT, PARTICIPATION AND PARTNERSHIPS

Traditional Owners, Indigenous organisations and their ranger groups are increasingly interested in driving the marine and coastal research agenda, leading research, and establishing partnership arrangements to provide benefits for Indigenous people. Since 2010 the Marine Biodiversity Hub has progressively developed and enhanced its focus on Indigenous engagement to establish partnerships with Indigenous organisations and communities.

The Hub has provided national leadership to promote respectful partnerships for research and monitoring on Sea Country. This has involved innovative collaborations with many Indigenous organisations, and with Australia's largest marine science society: the Australian Marine Sciences Association (AMSA). A broad range of regionally focused projects instigated by the Hub have identified and advanced Indigenous research interests and priorities, providing benefits to Indigenous communities through training and employment.

► PROMOTING INDIGENOUS PARTNERSHIPS AT A NATIONAL LEVEL

The Hub has championed partnerships with Indigenous organisations and AMSA to convene four annual Indigenous engagement workshops designed to promote Indigenous partnerships in marine science. Successive regional workshops took place at Wellington, New Zealand (2016), Darwin (2017), Adelaide (2018) and Fremantle (2019). The workshops were designed to raise the profile of Indigenous engagement in marine research by showcasing collaborative projects and sharing information and perspectives on a range of topics. These included Indigenous Sea Country rights and aspirations, successful research partnerships, lessons learned from partnerships, and the importance of culturally appropriate engagement based on accepted standards. The workshops have become a fixture at annual AMSA conferences, and a fifth workshop is planned for Sydney in 2021.



DID YOU KNOW?

- *The annual AMSA workshops convened by the Hub have showcased numerous examples of Indigenous partnerships in marine science, across both temperate and tropical Australia.*
- *The Fremantle workshop laid the groundwork for advancing regional approaches to Sea Country research and management in Western Australia.*
- *The workshops instigated and informed several new partnership approaches including between the Western Australian Marine Science Institution and the Malgana Aboriginal Corporation.*

MAKING AN IMPACT

The rolling annual AMSA workshops have significantly improved understanding and capacity in Australia's marine science community about the importance of Indigenous engagement and how to do this in a culturally appropriate and respectful way. The workshops have also been instrumental in advancing AMSA's approach to embracing Indigenous rights and perspectives. This has included the establishment of an Indigenous sub-committee in AMSA's governance arrangements and development of a Sea Country web page.



SECTION 2: INDIGENOUS ENGAGEMENT, PARTICIPATION AND PARTNERSHIPS

► IDENTIFYING AND ADVANCING INDIGENOUS RESEARCH INTERESTS AND PRIORITIES

The Hub worked with the North Australian Indigenous Land and Sea Management Alliance to understand Indigenous priorities for threatened and migratory marine species in the Northern Australia. The research interests identified by Indigenous people reflect the powerful obligations as custodians of country and the lifeforms and ancestors that depend on their management of country.

For almost a decade, the Hub has worked with Malak Malak Traditional Owners and rangers on the recovery of Critically Endangered Largetooth Sawfish in northern Australian rivers. The rangers decided to carry out an annual on-country patrol to find sawfish that might need rescuing from drying waterholes. This is part of the Malak Malak community's contribution to protecting the sawfish for future generations, and is the only known place in the world where this patrol and rescue occurs.

Indigenous communities have demonstrated strong interests in research partnerships to restore coastal habitats. The Malgana Aboriginal Corporation at Shark Bay, Western Australia, has developed co-led research with the Hub to restore seagrasses destroyed by marine heatwaves. The Weetapoonna Aboriginal Corporation is working with the Hub to shape research to restore giant kelp forests off Tasmania. In both cases Indigenous people are identifying their interests, contributing to research design, and advising on culturally respectful access to sites. In 2016 the Hub convened Traditional Owners from Australia and New Zealand to identify Indigenous aspirations and collaborative opportunities for restoring shellfish reefs.



DID YOU KNOW?

- *Between 2015 and 2020 the Hub research portfolio included nine projects focused on Indigenous research interests. This represents a nine-fold increase compared with the period 2011–14.*
- *While interests vary between Indigenous groups in northern Australia, priority interests in threatened and migratory marine species include marine turtles, dugong, shorebirds and seabirds, and sawfishes.*
- *The 'seven pearls of wisdom' approach was developed as a guide for restoration researchers and practitioners to initiate and advance Indigenous engagement in marine and terrestrial habitat restoration.*

MAKING AN IMPACT

Indigenous engagement and participation in Hub research has significantly increased the level of understanding and respect for Indigenous rights, interests, responsibilities and cultural values among Hub researchers and their stakeholders and collaborators.

► PROVIDING BENEFITS THROUGH TRAINING AND EMPLOYMENT

Indigenous Australians are increasingly seeking opportunities to establish marine research partnerships that can provide training and employment opportunities. Hub research partnerships have provided employment and training to a range of Indigenous communities, particularly for recovery of threatened species and restoration of coastal habitats.

Malak Malak Rangers have been employed on a part-time basis and trained to capture, handle, tag and relocate Daly River Largetooth Sawfish to promote species recovery. In northern Queensland, Yuku Baja Muliku Rangers have been employed on a part-time basis and trained to capture, handle, tag and release hammerhead sharks as part of wide-ranging research seeking to understand species distribution and improve conservation outcomes.





At Shark Bay, Malgana Rangers have been employed on a part-time basis and trained to collect seagrass seeds, seedlings and samples and apply nature-based restoration techniques to counteract the effect of heatwaves. Training of Weetapoonna Indigenous people in giant kelp restoration techniques will promote recovery and explore commercial aquaculture opportunities off southern Tasmania. Wadandi Traditional Owners were contracted to map their Sea Country to inform biodiversity surveys in Australian Marine Parks in waters off South-western Australia.

Additionally, the Hub has also commissioned numerous Indigenous people to organise Indigenous workshops and prepare research communication products including artwork, interpretive signs, educational videos and reports.

DID YOU KNOW?

- *Between 2017 and 2019, Hub researchers trained 28 Indigenous people in the use of tools and techniques for environmental management.*
- *Cross-cultural communication products (artwork, videos, signage, handling protocols and reports) were commissioned to communicate the findings of research on threatened species and habitat restoration.*

MAKING AN IMPACT

The Hub has provided benefits to many Indigenous people across several communities by offering employment and training opportunities. This provision of training has raised the capacity of Indigenous communities to provide leadership for managing Sea Country and to work in partnership with research and management institutions.

► A NATIONAL BASELINE FOR INDIGENOUS ENGAGEMENT IN MARINE SCIENCE

Engagement between Indigenous people and marine scientists appears to have grown in Australia in the past decade, but these observations are based on anecdotal evidence. Additionally, there is a need for scientific evidence to inform discussions about performance and opportunities for improvement. The Hub surveyed 128 marine scientists across Australia in a study that sought to gauge their understanding about motivations, perceptions and practices.

The survey found that while 63% of respondents had engaged with Indigenous people to progress research, most marine research projects had not included engagement. When engagement had occurred, it was often shorter than three years in duration and typically confined to specific project stages. The study identified a positive aspirational response by Australia's researchers. The biggest challenge lies in converting this goodwill into respectful, effective engagement that delivers mutually beneficial outcomes for researchers and Indigenous Australians.



DID YOU KNOW?

- *More than a third of surveyed researchers were unsure when asked: "Does all marine research require Indigenous engagement?"*
- *The most common practices among researchers for improving understanding about Indigenous engagement are discussions with experienced research colleagues and Indigenous communities.*
- *The least common practices among researchers for improving understanding about Indigenous engagement are use of Indigenous engagement documentation and academic literature.*
- *Almost two thirds of surveyed researchers indicated that engaging, partnering and involving Indigenous communities will become more important in the future.*

MAKING AN IMPACT

The Hub survey provides marine researchers, research institutions and Indigenous organisations with new national-scale insights about the status of Indigenous engagement in marine science in Australia and the challenges and opportunities for targeting investment to improve performance. The study also established an empirical baseline for monitoring changes through time.



SECTION 3: AUSTRALIAN MARINE PARK PLANNING AND MANAGEMENT

In 1996, three years after Australia ratified the UN Convention on Biological Diversity, the National Strategy for the Conservation of Australia's Biological Diversity called for a network of parks to encompass representative examples of marine environments in Australia's Commonwealth waters.

The Hub has worked closely with the Australian Government for more than a decade to ensure the design and management of the world's largest representative network of marine parks is based on the best available science. Starting with scant knowledge of many of these areas, Hub researchers developed tools and approaches that have vastly improved our understanding of the natural values protected by Australian Marine Parks (AMPs), and the benefits they bring to the Australian community.

The process began with collating, synthesising and presenting existing knowledge to predict biodiversity patterns across Commonwealth waters. Field surveys were then conducted in selected areas to map the seafloor, sample biodiversity, and establish monitoring baselines. The societal values of AMPs have also been assessed, and pressures data mapped on a national scale to understand risks to park values. Throughout this work, there has been a strong focus on building the national capacity required to support the needs of managers. Hallmarks of this approach include collaboration with governments, industry and other researchers; coordinated use of national research infrastructure; and the development and use of national standards for marine data collection.

▶ ESTABLISHING BASELINE UNDERSTANDING OF NATURAL VALUES IN AUSTRALIAN MARINE PARKS

To protect natural values and promote sustainable use, AMP managers need to understand these values and track changes to their status through time. Hub studies have collated and analysed existing data for all AMPs, established inventories and monitoring baselines, and collated targeted reef habitat and biodiversity data for continental shelf AMPs across all planning regions.

New surveys in 15 marine parks have produced detailed maps of seafloor bathymetry from high-resolution multibeam sonar, vastly extending the inventory and baselines at these locations. Sampling of seafloor assemblages and fish communities using new stereo camera systems on autonomous and remotely operated vehicles, towed systems and baited platforms has provided significant insights into patterns of marine biodiversity around the country, across an extensive range of depths (see case study on page 9).

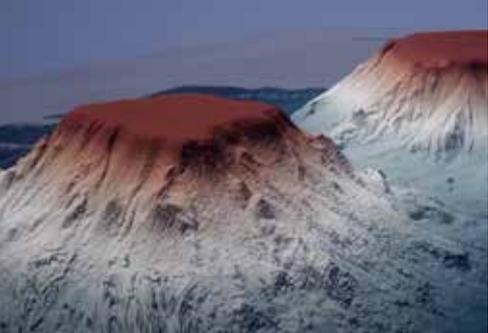


DID YOU KNOW?

- *Seamounts off Tasmania host coral reef communities that are deep-water biodiversity hotspots.*
- *First surveys in the deeper waters of Geographe Bay revealed some of the largest continuous seagrass meadows in Australia.*
- *Australia's Marine National Facility has been used to systematically map and sample the deep-water habitats of many AMPs, including seven AMPs on Australia's eastern seaboard in one voyage.*

MAKING AN IMPACT

Detailed analysis of existing data combined with targeted field surveys has provided Parks Australia with information about AMP natural values at an operational level to support promotion of park values, assessment of risks and identification of management and monitoring priorities. The program has also advanced national collaborations in marine data sharing, and visualisation tools to improve user accessibility.



CASE STUDY: MAPPING AUSTRALIA'S MARINE BIODIVERSITY

Mapping the distribution, extent and structure of biodiversity is fundamental to understanding and managing natural values in Australia's marine environment. The Hub has supported biodiversity surveys from the coast to the abyssal plain across tropical and cold temperate regions, while advancing the use of technologies such as swath acoustics, remotely operated vehicles and stereo underwater cameras. High-resolution maps and imagery generated by the surveys support evidence-based marine planning, establishment of baselines to support monitoring, and improved knowledge of the biodiversity features in Australian Marine Parks (AMPs). Communication products that showcase the new knowledge help communities understand the values that need to be managed to achieve conservation goals and sustainable use.

Detailed mapping has revealed the diversity of Australia's seafloor topography. For example, Perth Canyon Marine Park unfolds the plains, valleys, gorges, landslides and towering cliffs of Perth Canyon; Gifford Marine Park east of Brisbane features flat-topped volcanic seamounts or 'guyots' that rise 300 m from the abyssal plain; and Oceanic Shoals Marine Park off northern Australia harbours hundreds of thousands of seabed craters or 'pockmarks' where gas and liquids push up through the sediments.

Further mapping and sampling supported by the Hub has unveiled abyssal habitats in seven eastern Australian AMPs, and collected some 60,000 stereo images, 300 hours of video and more than 100 unnamed species, and identified new areas of deep-sea coral reef at seamounts in AMPs south of Tasmania. North of Tasmania, where an ancient land bridge once joined the island to Victoria, hundreds of Port Jackson sharks were found assembling among the sponge gardens of Beagle Marine Park. The Hub also inventoried 170 sponge species and conducted targeted mapping and fish surveys at Ningaloo Marine Park, and recorded the throngs of predators and prey that aggregate at Bremer Marine Park off southern Western Australia.

► SOCIAL AND ECONOMIC BASELINES FOR UNDERSTANDING THE BENEFITS OF AUSTRALIAN MARINE PARKS

Understanding the social and economic costs and benefits of marine parks – particularly no-take national park zones – is important to ensuring effective monitoring and management. Marine park agencies have been limited in their capacity to develop and establish the rigorous systems needed to quantify and monitor these factors.

Hub researchers worked closely with Parks Australia and other marine park agencies to develop a set of robust and easily understood key measures. These capture changes in the way people experience and value the marine environment, in response to the establishment and management of AMPs. Benchmark surveys were designed and implemented to commence monitoring. The measures are designed to be incorporated into the adaptive management of AMPs through the Monitoring, Evaluation, Reporting, and Improvement system. Standard operating procedures have been developed to ensure future surveys are cost-effective and consistent. Allied research investigated public knowledge and perceptions of AMPs in the south-east region.

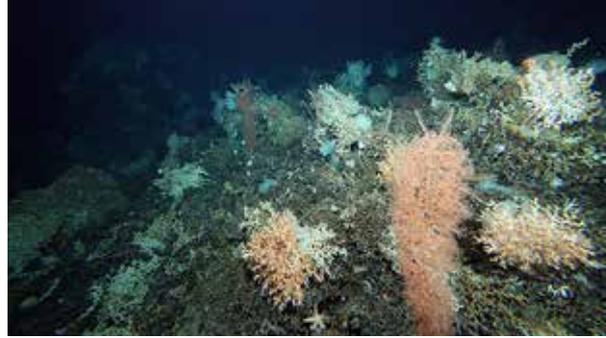


DID YOU KNOW?

- *Hub projects have enhanced national coordination among managers and researchers for monitoring the social and economic aspects of marine parks.*
- *Key measures draw on existing data sources including oil and gas infrastructure databases, vessel registration data, and fisheries catch and effort records.*

MAKING AN IMPACT

The Hub has designed and trialled a benchmark social and economic monitoring program for the world's largest representative marine park network. This will help to ensure that common approaches are used to evaluate social and economic values associated with AMPs, including how these values may change through time.



▶ ASSESSING RISKS TO THE VALUES AND BENEFITS OF AUSTRALIAN MARINE PARKS

Parks Australia managers need to understand pressures on the marine environment in order to protect the values and maximise the benefits of Australian Marine Parks (AMPs). In the past, however, pressure data have not been routinely collated, nor provided in formats that articulated their combined effects, or allowed the assessment of risks.

Pressure datasets were collated to help assess risks to natural values and benefits provided by AMPs. They include oil and gas extraction and infrastructure, seismic surveys, shipping movements, aquaculture leases, pollution events, and changes in ocean temperature. A study of recreational fishing patterns at the Ningaloo and Hunter marine parks built the capacity of Parks Australia to conduct surveys and work with state agencies to assess trends and potential impacts. Pressure analysis frameworks that identify the risks that pressures pose to natural values, including the effect of cumulative pressures, are helping to guide Parks Australia decision-making about management and monitoring priorities.



DID YOU KNOW?

- *Key values and pressures datasets are now accessible via many data portals for re-use by Australian governments, industry and non-government organisations.*
- *Deep seamounts off southern Tasmania that were revisited after two decades of protection from fishing showed no evidence of recovering coral communities. Some individual species of corals, featherstars and urchins, however, have regained a foothold.*

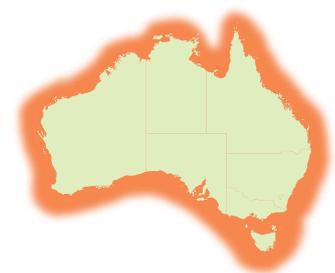
MAKING AN IMPACT

Hub research has allowed decision-making for AMP management to draw on the best available information and methodologies for assessing pressures and risks to park values. Parks Australia is better placed to work with the states and territory to assess recreational fishing inside and outside AMPs, and how this pressure may change through time.

▶ DEVELOPING A MERI SYSTEM FOR AUSTRALIAN MARINE PARKS

Regular Monitoring, Evaluation, Reporting and Improvement (MERI) is essential to achieving the Australian Government's vision for AMPs and the objectives of network management plans. Hub researchers have worked closely with Parks Australia for more than a decade to help the government develop a MERI system. They have collated and organised key environmental and pressure datasets to build an underlying evidence base, and applied new risk-based methods to identify management and monitoring priorities and performance indicators. These have already been applied in several surveys to assess how AMPs have contributed to the protection of natural values. For example, deep-sea corals have been surveyed on several occasions in and near the Huon and Tasman Fracture AMPs to monitor the effects of protection from fishing, and Southern Rock Lobsters have been measured in areas zoned as 'no-take' and in adjacent habitats open to fishing.

Hub researchers continue to work with Parks Australia to assist in establishing an operational MERI system for the world's largest representative marine park network. This standardised, data-driven process will provide a systematic way to understand how pressures are affecting the natural values of AMPs. The system builds on and complements earlier work to develop an integrated monitoring framework for the Great Barrier Reef Marine Park. The new capacity for sustained, coordinated monitoring to produce comprehensive, long-term datasets in turn contributes objective, national biodiversity assessments relevant to State of the Environment reporting.





DID YOU KNOW?

- *Hub research has assembled a scientific evidence base for marine park operational decisions and for 10-yearly reviews required under the Environment Protection and Biodiversity Conservation Act 1999.*
- *Outputs and accessible datasets provided by the Hub have made an important contribution to marine monitoring programs developed by Australian and state government agencies.*

MAKING AN IMPACT

The Hub and Parks Australia have worked together to establish the policy and science building blocks of a Monitoring, Evaluation, Reporting and Improvement system for adaptive management of the world’s largest representative marine park network. The system will ensure consistency across these essential components of best-practice management.

▶ **BUILDING AUSTRALIA’S CAPACITY TO BRIDGE THE SCIENCE/POLICY DIVIDE**

Effective collaboration between researchers and marine park managers is fundamental to understanding, managing and communicating the value of Australian Marine Parks (AMPs). The Hub has built and maintained this collaboration with Australian and state government marine scientists and managers through a structured process of regular meetings and workshops. The National Marine Protected Area Science and Management Network founded and supported by the Hub promotes coordination and information sharing among marine park managers, science providers and research infrastructure managers. The forum has convened three annual meetings and promoted the uptake of standard approaches to data collection and coordinated monitoring of AMPs, as envisaged under the *National Marine Science Plan 2015–2025*.

Parks Australia managers have participated in marine park surveys to map and sample deep-sea coral communities south of Tasmania, platform coral reefs at Elizabeth and Middleton reefs in the Temperate East region, and shoal habitat in the Gulf of Carpentaria. They worked alongside researchers during onboard sampling and analysis, engaged in voyage and communication planning, and contributed to blogs and documentaries. The approach was a step change in the science/policy partnership approach to complex biodiversity surveys.



DID YOU KNOW?

- *All Australian governments with responsibilities for managing marine parks participate in the National Marine Protected Area Science and Management Network, founded by the Hub.*
- *Parks Australia managers have worked closely with Hub researchers to plan AMP surveys and joined surveys to the Huon, Tasman Fracture, Lord Howe and Wessel AMPs.*

MAKING AN IMPACT

Capacity building by the Hub has helped to foster an unprecedented level of coordination, information sharing and understanding among Australia’s researchers, marine park managers and operational staff, scientists and infrastructure managers. This extends across monitoring and evaluation, understanding and communicating natural values and pressures, and Indigenous engagement.





SECTION 4: PROTECTING CONSERVATION VALUES IN WORLD HERITAGE AREAS

The Australian Government has a duty to protect and conserve the superlative values of its natural World Heritage Areas (WHAs). In the marine realm, the Australian and state governments manage many of these areas cooperatively. This task is becoming more challenging due to the combined effects of increasing human pressures, including climate change.

Hub research has focused on five of Australia's marine WHAs, and the Kakadu WHA which borders the Northern Territory coast. Our work has provided the understanding required to improve integrated planning, monitoring and reporting, and risk-assessment of proposed activities. It has also helped to strengthen appreciation and respect for World Heritage values and built capability for on-ground management.

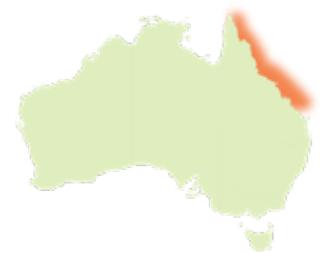
In addition to the Lord Howe Island and Ningaloo surveys outlined in this section, Hub studies identified Kakadu WHA as a site of global significance for the Northern River Shark (see page 20) and partnered with Malgana Indigenous rangers to restore habitat values (seagrasses) at Shark Bay WHA (see page 26).

► INTEGRATED MONITORING AND MANAGING CUMULATIVE IMPACTS FOR THE GREAT BARRIER REEF

Australia's large and spectacular Great Barrier Reef (GBR) WHA is one of the most complex natural systems on Earth, but a poor long-term outlook puts it at risk of being listed as 'in danger' by UNESCO. Furthermore, past approaches to adaptive management were not supported by robust monitoring driven by reef-wide management priorities.

At the request of the Australian Government, the Hub led collaborative research to establish a monitoring framework for evidence-based adaptive management of the GBRWHA and GBR Marine Park. The framework showed how to integrate ecological, social and economic monitoring to meet management needs, including consideration of cumulative impacts and emerging issues. It contributed to a strategic assessment of the WHA, and links to the *Reef 2050 Long-Term Sustainability Plan*. The framework marked an important pivot point for securing long-term funding and ultimately establishing a reef-wide integrated monitoring program.

Subsequent research is developing practical guidance for assessing and managing cumulative impacts and risks to environmental, social and economic values. This has been developed with reef managers and industry representatives to meet the needs of broad-scale planners, GBR Marine Park Authority reporting requirements, and development proponents. It provides a tool for practitioners needing to implement the reef's Cumulative Impact Management Policy.



DID YOU KNOW?

- *Research to integrate monitoring in the GBR started a collaborative process to define monitoring priorities.*
- *The process for developing the integrated monitoring framework highlighted practical, cultural and governance needs required to support an operational GBR monitoring program.*
- *Fifty-two different values, processes, pressures and drivers were identified for monitoring.*

MAKING AN IMPACT

The integrated monitoring framework was a key element of the Australian Government's strategic assessment and Reef 2050 plan that demonstrated to the UNESCO World Heritage Committee the adequacy of plans for protecting the reef's outstanding universal values. It has provided collaborative and structured pathways to review current arrangements and take constructive steps to address complex challenges for reef-wide adaptive management.



► BASELINE AND MONITORING SURVEYS FOR LORD HOWE AND NINGALOO WORLD HERITAGE AREAS

Hub surveys in marine areas of the Lord Howe Island Group WHA and Ningaloo Coast WHA produced detailed seafloor maps and estimates of the distribution of seafloor flora and fauna. High resolution bathymetric and video surveys across the Lord Howe Island shelf revealed a relict barrier reef and a complex shelf structure that influences the sediment habitats and biodiversity.

The first Hub Ningaloo survey revealed high numbers of unusual sponges and echinoderms, adding to the significance of the area. With support from the Hub, taxonomists inventoried 499 sponge specimens, comprising 170 species. Sixteen species were identified as new to science. Subsequent baited camera surveys have focused on demersal fish communities identifying numerous species of bony fishes, sharks and rays. The biodiversity data are available on the *Atlas of Living Australia*.



DID YOU KNOW?

- *Bathymetric surveys at Lord Howe Island identified a relict barrier reef on the mid-shelf that is ~20 times larger than the modern shallow coral reef adjacent to the island.*
- *Surveys of seafloor communities at Lord Howe Island revealed that abundant hard corals grow on the mid-shelf mesophotic reefs.*
- *Deep water habitats of Ningaloo Reef contain gardens of sponges and gorgonian sea fans populated by a diversity of fish species.*

MAKING AN IMPACT

Habitat maps generated by Lord Howe Island shelf surveys led to a more robust survey design and cost-effective approaches for environmental monitoring across both Commonwealth and state-managed areas. The maps were a key component of the Lord Howe Island Marine Park zoning plan review. New understanding of natural and biodiversity values generated by Ningaloo survey were included in the 2010 *Ningaloo Coast World Heritage Nomination – IUCN Technical Evaluation* that led to the area's inscription in 2011.





SECTION 5: RECOVERY OF THREATENED AND MIGRATORY SPECIES

Marine Biodiversity Hub research supports the recovery and conservation of threatened and migratory sharks, fishes, sea snakes and marine mammals. Our projects strengthen Australia's capacity to effectively implement regional, national, and international conservation policies: from research prioritisation and strategic planning and reporting to on-ground action.

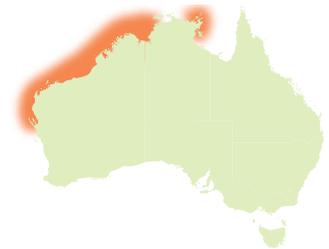
▼ Mapping species distribution and habitat

Obtaining species distribution and demographic data is critical to recovery planning, monitoring and threat identification. It involves surveys from boats and planes, research in biology and genetics labs, and desktop analysis and modelling.

► SEA SNAKES

Western Australia has a diverse assemblage of sea snake species, and the greatest number of threatened sea snakes in the world. Inexplicable population declines at Ashmore Reef Marine Park, and the presumed local extinction of three species, means sea snakes are a conservation priority. Accurate information on the spatial and temporal distribution of protected sea snake species is critical to understanding and managing risks. The Hub is assessing the status of sea snakes across tropical Australia, with a primary focus on the west coast. Existing data are being combined with targeted surveys to predict and visualise fine-scale distributions and habitat association patterns inside and outside marine parks and fishing grounds. Surveys have discovered new populations of two threatened sea snake species.

Anindilyakwa Land and Sea Rangers partnered with researchers to survey sea snakes within the waters of the Indigenous Protected Area centered on Groote Eylandt. These surveys will shed light on whether protected areas adjacent to heavily fished grounds provide refuge for sea snake species regularly caught as bycatch in the nearby fishery. Sea Rangers are sharing knowledge and building their capacity to collect data about the status of sea snakes and other marine species.



DID YOU KNOW?

- *Seventeen species of sea snakes have been recorded at Ashmore, nine as breeding residents and eight as visitors.*
- *The high degree of habitat specialisation of these species needs to be considered when assessing potential impacts from extractive activities and exposure to extreme weather events.*

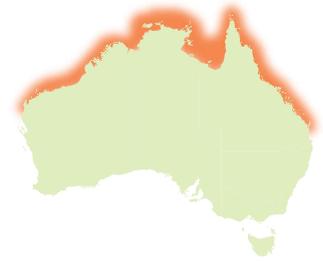
MAKING AN IMPACT

A new understanding of species distributions and threatening processes is reducing uncertainty about the conservation status of sea snake species. This knowledge is guiding state and territory fisheries bycatch strategies and assessments, and recovery actions and research prioritisation managed by the Australian Government. It is also adding to the inventory of natural values and baselines available for monitoring in Australian Marine Parks and will contribute to State of the Environment reporting and species listings under the *Environment Protection and Biodiversity Conservation Act 1999*.



▶ HAMMERHEAD SHARKS

Australian and state governments need to better understand the status of hammerhead sharks in Australian waters to meet international obligations for trade in endangered species and national requirements under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, including managing incidental capture in fisheries. This project fostered national collaboration to access and aggregate existing data, including commercial catch records. These were combined with new tagging, genetics and shark parasite data, and Indigenous knowledge, to determine how Australian populations are structured, distributed and connected with stocks in other countries such as Indonesia and Papua New Guinea.



DID YOU KNOW?

- *Australian hammerhead populations are connected to those in Indonesia and Papua New Guinea, but tracking and parasite data suggest limited movement between countries.*
- *The Western Australian Scalloped Hammerhead population is distinct from other parts of Australia, Indonesia and Papua New Guinea.*
- *Rangers from the Giringun Aboriginal Corporation, Yuku Baja Muliku, and Yirrganydji Traditional Owners participated in Queensland tagging expeditions.*

MAKING AN IMPACT

The research findings informed the listing of Scalloped Hammerhead Sharks as Conservation Dependent under the *EPBC Act*, and the modelling of Australia's western, northern and eastern stocks by the Northern Scalloped Hammerhead Stock Assessment Team. Hub data contributed to Australian Government export permit assessments for fisheries that harvest hammerhead species listed by the Convention on International Trade in Endangered Species, and to state-based management of sustainable harvests. The apparent isolation of the Western Australian Scalloped Hammerhead population is important information for fisheries stock assessments.

▶ SOUTHERN RIGHT WHALE

The Australian Government's Southern Right Whale Conservation Management Plan (CMP) serves as a recovery plan for this species which is listed as Endangered under the *EPBC Act*. It also supports collaboration between countries and other stakeholders to protect and rebuild populations, as required by the International Whaling Commission (IWC). Understanding how populations are structured is critical to implementing the CMP, including monitoring recovery and identifying threats.

Annual aerial surveys between Cape Leeuwin, WA, and Ceduna, SA, are tracking the recovery of the 'western' population. National and international specialists helped to expand the capability and usability of the online Australasian Right Whale Photo-Identification Catalogue by unifying and correcting data streams from across Australia. This is providing a more comprehensive understanding of how Southern Right Whale populations mix around Australia, and their overall population abundance.

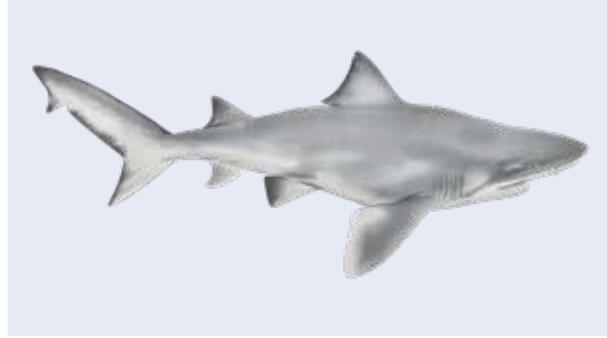


DID YOU KNOW?

- *The 2019 population size estimate for the 'western' Australian Southern Right Whale sub-population is 3164 individuals.*
- *Estimates from 2018 and 2019 are the largest since 1993 and indicate an increasing population trend of approximately 6% per year.*

MAKING AN IMPACT

This Hub research provides the Australian Government with the scientific evidence required to understand and report on the status and recovery of Southern Right Whales in Australian waters. This includes implementing the Southern Right Whale CMP, and supporting Australia's IWC delegation. It is also contributing to providing the Australian Government and the IWC in 2020 with the first population estimate of Southern Right Whale populations in Australian waters.



▼ Using modern genetics to count elusive shark species

Close-kin mark-recapture is providing reliable size estimates for threatened shark populations and a cost-effective approach to ongoing monitoring.

► NORTHERN RIVER SHARK

Actions required to recover the Endangered Northern River Shark are outlined in the national *Sawfish and River Sharks Multispecies Recovery Plan*. Distribution, population status and trend, and connectivity information is critical to the plan's implementation. A decade of Hub surveys discovered several new populations in northern rivers and identified nursery grounds in the Kakadu National Park and World Heritage Area. Close-kin mark-recapture analyses enabled the first population size estimates and five distinct populations were identified: four in Australia and one in Papua New Guinea.



DID YOU KNOW?

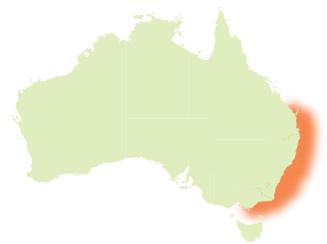
- In 2010, the species was known from only 32 records in six rivers/estuaries; now, more than 600 sharks have been recorded in 12 rivers/estuaries.
- Adult population size is very small (approximately 600–1100 adults in the Northern Territory's Van Diemen Gulf).
- Kakadu National Park and World Heritage Area is a site of global significance for the Northern River Shark.

MAKING AN IMPACT

This research established effective approaches to monitoring and population assessment, providing knowledge and capability directly relevant to understanding the status and trends of Northern River Shark populations. New evidence of population size and structure supports 'down-listing' of the Northern River Shark from Endangered to Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* and highlights the need for localised management. The new knowledge also underpins environmental assessments conducted under the *EPBC Act* in the context of northern Australia's development.

► GREY NURSE SHARK

Australia's east coast Grey Nurse Shark population is Critically Endangered and reliable estimates of population and trend are needed by Australian and state government agencies to address uncertainty and evaluate species recovery. Previous population estimates relied on photo identification, but this technique can have challenges relating to covering the full geographic range of the population, and the accuracy of matching the sharks' spot markings. Close-kin mark-recapture applied in Hub research provided the most rigorous population size and trend estimate to date for the east coast population.



DID YOU KNOW?

- The eastern adult Grey Nurse Shark population size estimate is 686–2167, with a 3.4–4.5% annual rate of increase.
- Based on modelled estimates of a positive annual rate of increase, the eastern population is believed to have made some overall recovery since protection measures were implemented.

MAKING AN IMPACT

The east coast Grey Nurse Shark population estimate reduced uncertainty regarding population status and trends, and has contributed to community support for the shark's continued conservation under the *EPBC Act* and the *New South Wales Fisheries Management Act 1994*. The Australian and New South Wales governments are using the results in policy development and conservation management. The modest population increase offers some evidence to the conservation community that this species will continue to exist in the wild.



▶ WHITE SHARK

White Sharks have been protected in Australia since the 1990s and scientific evidence is needed to support Australian and state government recovery and risk mitigation actions and policies. Close-kin mark-recapture provided the first robust estimates of Australasian White Shark abundance and demographic rates (survival and trend). Satellite tracking revealed diverse movement strategies and habitat use between shelf, slope and oceanic areas off south-western Australia, including differences between male and female dispersal.



DID YOU KNOW?

- *The 2017 eastern adult White Shark population size estimate was 750 (range: 470–1030) and the south-western adult population size estimate was 1460 (range: 760–2250).*
- *Females occupy a narrower temperature range and venture further offshore than males.*

MAKING AN IMPACT

This research demonstrated the effectiveness of close-kin mark-recapture for estimating status and trends of White Shark populations in Australia. The robust population estimates reduce uncertainty about conservation listings and provide a means of measuring the effectiveness of recovery actions under the *Environment Protection and Biodiversity Conservation Act 1999*, and state legislation. New mapping of movement and habitat use supports ecological risk assessments, monitoring and management of marine parks, and collaboration between institutions and jurisdictions.

▼ Strategies for seascapes and multiple species

Seeing the ‘forest for trees’ is an important part of strategic marine biodiversity conservation. Our research includes a range of strategic seascape approaches that focus nationally and across northern Australia.

▶ ACTION PLAN FOR CONSERVING AUSTRALIA’S SHARKS AND RAYS

The conservation of shark, rays, and chimaeras is an increasing priority globally as the overexploitation of species becomes increasingly apparent. Australia’s first *Shark Action Plan* provides a comprehensive review of extinction risk for Australia’s 329 sharks, rays, and chimaeras: from the south-eastern Australia’s Frill Shark to the Pacific Spookfish.

The *Shark Action Plan* maps distribution and summarises habitat preferences, management arrangements, conservation objectives, and threats and knowledge gaps for each species. Standardised assessments allow the prioritisation of research and conservation needs and actions, and provide a benchmark for measuring changes in populations and risk.



DID YOU KNOW?

- *Relative to other countries, Australia’s sharks have a low level of extinction risk (12% are threatened) and a high level of secure species (70% are listed as Least Concern).*
- *Of the 329 species assessed, information is inadequate for more than 30 of Australia’s species to assess extinction risk based on distribution and population status.*

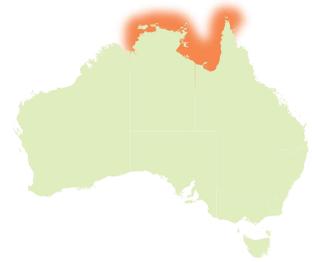
MAKING AN IMPACT

The *Shark Action Plan* gives managers and stakeholders a shared understanding of the status of Australia’s shark populations. The Australian Government is using the plan to identify at-risk species, species that may need future protection, and species of no immediate conservation concern. It is fundamental to ensuring the evidence underpinning the *Environment Protection and Biodiversity Conservation Act 1999* is as up to date as possible in protecting threatened sharks, rays and chimaeras.



► PRIORITISING SPECIES CONSERVATION INVESTMENTS IN NORTHERN AUSTRALIA

Northern Australia is the focus of substantial economic development and a place of rich marine biodiversity, sustaining critical habitat for marine species listed under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*. The Australian Government needs information about species distribution, abundance and movements in order to assess the impact of development proposals. This project engaged with research users across northern Australia to characterise knowledge gaps, historical and ongoing pressures, and Indigenous priorities and interests. Species distribution models are being developed for turtles, Dugong, dolphins, shorebirds, sharks and sawfishes.



DID YOU KNOW?

- Some 80 EPBC Act-listed marine species occur in the North Marine Bioregion. Sixteen priority species were identified, including sawfishes, river sharks, inshore dolphins, shorebirds, marine turtles and dugong.
- At Garig Gunak Barlu National Park on the Northern Territory's Cobourg Peninsula, drone surveys estimated Green Sawfish (*Pristis zijsron*) densities of up to 30 individuals per hectare. These are the highest sawfish densities recorded anywhere in the world.

MAKING AN IMPACT

A vast improvement in the breadth of data available for threatened and migratory species in northern Australia has enhanced the capacity of the Australian government to assess development proposals. The identification of pressures, knowledge gaps and Indigenous priorities provides a basis for linking future research with Indigenous interests and capabilities.

► QUANTIFYING SHIPPING RISK TO LARGE MARINE ANIMALS

Collisions between vessels and large marine animals are of increasing concern, particularly where high volumes of vessel traffic overlap critical resting, breeding and feeding areas. Underwater radiated noise from shipping can also have adverse impacts on marine life, especially marine mammals.

Hub researchers reviewed historical vessel collisions and created vessel, species and risk maps for Humpback Whales, Southern Right Whales, Dugong and turtles. The mapping can be used to assess mitigation measures such as potential changes to shipping routes; evaluate the vessel types that present a risk to particular whale groups (such as mothers and calves); and determine how risk changes over time at certain locations. The Hub's ocean noise research demonstrated techniques for fine-scale national ocean noise mapping and produced the first national map of cumulative shipping noise from large commercial vessels. The work provides a pathway for assessing and managing risks to large marine animals.



DID YOU KNOW?

- Vessel traffic near Exmouth, Port Hedland, Dampier and Broome poses a relatively high risk of collision with Humpback Whales
- Shipping noise levels are highest near Melbourne, from Sydney to Brisbane and the Great Barrier Reef and off the north-western coast of Western Australia.

MAKING AN IMPACT

This project provided new evidence to inform the review of Australia's *National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna* and its subsequent implementation. The mapping of shipping noise in Australia provides a way for government, industry and researchers to better understand the potential impacts of noise to marine animals and progress future research, focused mitigation measures and broader marine risk management.



▼ Active intervention for species recovery

► RED AND SPOTTED HANDFISHES

Tasmania's Red Handfish and Spotted Handfish are Critically Endangered and possibly the rarest marine fishes in the world. Handfish conservation activities facilitated by the Hub are backed by government, industry and the community as part of the Handfish Conservation Project. They include surveys and genetic studies, artificial spawning habitats, eco-friendly moorings, captive breeding and replenishment of wild populations. Holding facilities were adapted to meet the different preferences of Red Handfish and Spotted Handfish hatchlings, including water chemistry, diet and habitat features.



DID YOU KNOW?

- *Sixty Spotted Handfish have been raised in captivity and returned to the wild.*
- *Seventeen Red Handfish are being raised at Seahorse World in northern Tasmania.*
- *While Spotted Handfish like open sandy areas, Red Handfish are reef species and prefer to be wedged in place, with one 'foot' resting on a protective structure.*

MAKING AN IMPACT

This work has established new knowledge and methods for recovering wild populations, and fostered ongoing community support and collaboration. It has had a direct impact on species recovery by increasing handfish numbers and providing evidence to support management measures under Tasmania's Derwent Estuary Program and nationally under the *Environment Protection and Biodiversity Conservation Act 1999*.

► LARGETOOTH SAWFISH

The Largetooth Sawfish is Critically Endangered globally, with northern Australia representing the last remaining stronghold for a species previously distributed throughout the world's tropical waters. Conserving the sawfish species here may be its only hope for survival, so people who use the area need to know how they can help. In an enduring, on-ground partnership, Hub researchers and Indigenous rangers share knowledge and experience, perform field research and rescues, and raise awareness about Largetooth Sawfish conservation. Videos, artwork, protocols and educational signage produced together with ranger groups promote the conservation message and safe handling practices.

The Malak Malak Ranger Group initiated an annual 'search and rescue' for sawfish that could be saved and relocated from the drying floodplains of the Daly River as a locally driven conservation measure. Core equipment was provided by the Hub, including a custom-built sawfish transportation tank capable of withstanding the harsh four-wheel driving conditions of the floodplain.



DID YOU KNOW?

- *More than sixty Largetooth Sawfish have been relocated by rangers and scientists.*
- *Tyemirerriny is the Malak Malak name for Largetooth Sawfish.*
- *Ngukurr and Numbulwar rangers requested educational signage which they felt would empower them to speak to people about doing the wrong thing regarding take of sawfish.*

MAKING AN IMPACT

Malak Malak Rangers now have the capability to undertake annual on-country sawfish patrols, backed by protocols on safe handling practices, sampling and data collection. The sawfish patrol and rescue protocol is transferable to other locations and ranger groups across northern Australia. Sawfish that otherwise would have perished on the drying floodplain now have a chance of survival.



SECTION 6: INTERVENING TO RESTORE COASTAL HABITAT

In Australia, interest and investment is growing in coastal habitat restoration which offers the prospect of effective conservation in the face of chronic degradation and climate change. Best practice restoration requires scientific understanding of historical disturbances and the causes of habitat decline, and innovative methods for reinstating the structure and function of coastal habitats.

Hub research is generating an evidence base and fostering the participation needed to accelerate coastal habitat restoration around Australia. Our work with stakeholders and research users is forging nationally coordinated approaches to the repair of shellfish reefs and saltmarshes, and testing methods for enhancing recovery and survival of temperate seagrasses and giant kelp forests. This includes evaluating restoration practices and economics, working with Traditional Owners, and supporting platforms for knowledge-sharing among policy makers, practitioners and communities.

▶ RESTORING SHELLFISH REEF AND SALTMARSH HABITAT

Australia's saltmarsh wetlands are listed as Vulnerable Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* and native flat oyster reefs and Sydney rock oyster reefs have been nominated for *EPBC Act* listing. Restoring these ecosystems is vital to the health of Australia's bays and estuaries, and relies on support from governments, businesses and the community. Together with The Nature Conservancy and Shellfish Reef Restoration Network, Hub researchers have enriched the knowledge base available for shellfish reef and saltmarsh repair, established national networks, and shown how ecosystem restoration aligns with national policies for conservation.

An extensive study confirmed that shellfish reefs are one of Australia's most threatened ocean ecosystems, with 90–99% of this once widespread habitat having disappeared. For saltmarshes, a national synopsis covered habitat distribution, ecology and function, conservation status, and environmental, social and economic benefits. Saltmarsh repair strategies such as reconnecting tidal flows to boost habitat for prawns and fish were studied at Queensland's Burdekin floodplain, the New South Wales Clarence River estuary, and Circular Head in Tasmania. For shellfish reefs and saltmarshes, repair is feasible and recovery can be rapid, with significant ecological and economic benefits. These findings have raised community awareness and provided impetus and direction for policy and planning, conservation management, investment and on-ground action.

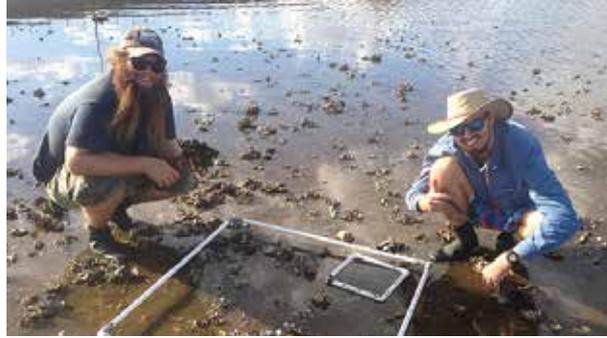


DID YOU KNOW?

- Fifteen shellfish repair projects are in progress involving The Nature Conservancy, Ozfish Unlimited and the Western Australian, New South Wales, South Australian and Victorian governments.
- More than \$20 million has been raised since 2015 to support coastal repair projects, including from the Australian and state governments, recreational fishing trusts, private foundations, corporations, individuals and community groups.
- Saltmarshes are being repaired in several New South Wales estuaries, including the Wooloweyah wetland in the lower Clarence River estuary.

MAKING AN IMPACT

Hub research has developed the knowledge and fostered the participation required to accelerate coastal habitat restoration actions by Australian governments, industries and communities. Evidence of national shellfish reef status underpins the nomination for native flat oysters and Sydney rock oysters to be listed as a Critically Endangered Ecological Community under the *EPBC Act*. Shellfish reefs are now part of Victoria's *Biodiversity 2037* strategy and *Port Phillip Environmental Management Plan* and the New South Wales *Marine Estate Management Strategy*. Traditional Owners from Australia and New Zealand have engaged in partnership-building for shellfish restoration.



SECTION 6: INTERVENING TO RESTORE COASTAL HABITAT

► A FRAMEWORK FOR ESTIMATING THE COSTS AND BENEFITS OF RESTORATION

Worldwide interest is growing in the restoration of coastal habitats, from saltmarshes to mangrove forests. The ability to evaluate the risks, and the full range of tangible (market) and intangible (non-market) costs and benefits across a range of restoration contexts, including alternative management approaches, spatial scales and habitat types, is pivotal to the advancement of successful, cost-effective restoration projects.

This research used an economic benefit-cost analysis approach to construct a framework for estimating the viability of shellfish reef repair projects. The framework integrates the environmental, social and economic outcomes of a restoration project and provides quantitative decision metrics for use in evidence-based decision making and the justification of funding support.



DID YOU KNOW?

- *Integrated economic frameworks allow us to understand which restoration configurations deliver the largest environmental, social and economic benefits relative to costs.*
- *Habitat restoration can provide 'co-benefits' additional to environmental objectives, including opportunities for economically profitable outcomes.*

MAKING AN IMPACT

The Australian Government, state and territory governments, marine industries and non-government organisations are better equipped to make decisions about how to invest in regional coastal habitat restoration and planning, monitoring and review. This is fundamental to Ramsar site management, and to recovery planning and activities for threatened shellfish reef ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999*.

► ESTABLISHING THE AUSTRALIAN COASTAL RESTORATION NETWORK

As momentum grew for coastal restoration in Australia, a national platform was needed for researchers, practitioners and managers to connect, collaborate, share knowledge and ideas, and seek assistance. The Australian Coastal Restoration Network was born in 2017 at the Inaugural Australian Coastal Restoration Symposium facilitated by the Hub and research partners, and has since hosted several national meetings and two international shellfish restoration conferences. With Hub support, the network is developing a consolidated database of information on all marine and coastal restoration projects in Australia.

The Hub also supports the operation of three independent groups that have a focus on particular habitat types: the Shellfish Reef Restoration Network, the Seagrass Restoration Network, and the Mangrove and Saltmarsh Network.



DID YOU KNOW?

- *The Marine and Coastal Habitat Restoration Database includes more than 150 restoration case studies focused on shellfish and coral reefs, seagrass meadows, kelp and mangrove forests, coastal wetlands and saltmarsh.*
- *The Australian Coastal Restoration Network has more than 280 members.*
- *Tidal wetlands have a poor chance of survival in areas where direct human pressures seriously reduce their resilience and adaptive capacity.*

MAKING AN IMPACT

Australia has a national capacity to connect and enable people who have an interest in coastal restoration. This capacity provides leadership and supports efforts by the Australian Government, state and territory governments, non-government organisations, marine industries and communities to conserve, restore and manage the ecosystem services these habitats provide to society.



▶ TESTING THE FEASIBILITY OF RESTORING GIANT KELP AND SEAGRASS HABITAT

South-eastern Australia's giant kelp marine forests are listed as a threatened ecological community under the *Environment Protection and Biodiversity Conservation Act 1999* due to progressive losses largely associated with climate change. These communities are an important part of the temperate rocky reef systems that support our unique marine biodiversity and high-value commercial, recreational and Indigenous fisheries. In a Hub project to improve the resilience of these communities, researchers collected thermally tolerant family lines to establish a 'seed-bank' for use in future restoration efforts and trialled out-planting methods off southern Tasmania. These activities are critical to making decisions about scaling up the restoration.

Shark Bay's seagrass meadows are among the largest recorded in the world, but the temperate seagrasses were severely degraded by a marine heatwave in 2011 and their natural recovery has been poor. The seagrasses support the important biodiversity of Shark Bay, including high value commercial, recreational and Indigenous harvests and World Heritage values. Hub research designed to maintain these benefits involves working with Malgana Indigenous rangers to scale-up seed and shoot-based replanting and restoration. A bay-wide approach to plant and site selection is based on a spatial analysis of the genetic structure of the targeted seagrass species, and methods are being trialled for seed capture and shoot transplantation.

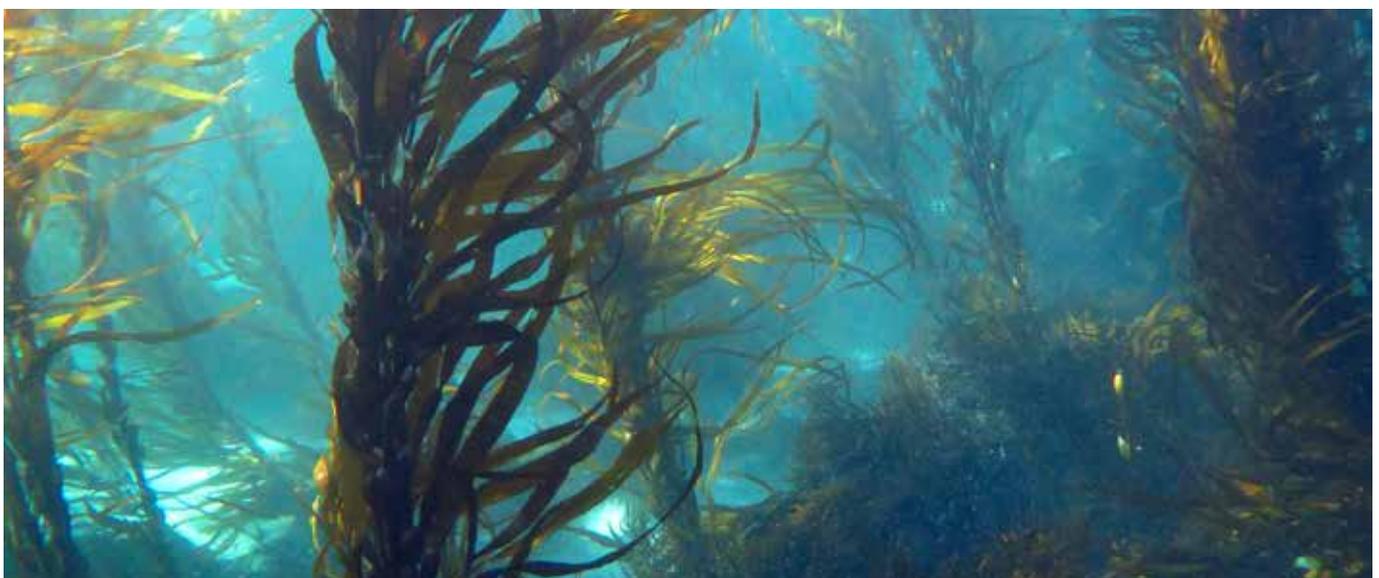


DID YOU KNOW?

- *Some family lines of giant kelp appear to tolerate water temperatures up to 20°C.*
- *Thermally tolerant family lines of giant kelp can be stored for extended periods.*
- *Hessian sandbags have an 80% success rate for capturing naturally released seagrass seedlings over an eight-month period.*
- *Transplanting of seagrass shoots has been successful at multiple sites in Shark Bay.*

MAKING AN IMPACT

A seed-bank of thermally tolerant giant kelp strains has been created for use in future restoration efforts and the results of out-planting trials will be reported in late 2020. A strategy for nature-based restoration presents a solution to the effects of climate change on seagrasses in the Shark Bay World Heritage Area. Malgana Rangers are developing the capacity to partner in the on-ground activities.





SECTION 7: SUPPORTING AND DEVELOPING AUSTRALIA'S CAPACITY FOR WORLD-LEADING MARINE SCIENCE

The Australian Government must meet a range of obligations under international conventions that champion effective, complementary approaches to marine biodiversity conservation and sustainable use. The Hub has effectively supported the government by providing the best available information tailored to decision-making, negotiations and reporting in this arena. Hub investments have also developed Australia's capacity for world-leading operational marine science that has influenced several global forums.

Hub projects have improved the capacity of Australia's marine community for effective international engagement. This externally funded participation extends the Hub's influence and showcases Australian research and the National Environmental Science Program to the world. The opportunity to exchange ideas and perspectives also facilitates an understanding of global research priorities and improves the quality of support the Hub provides to Australian researchers and managers.

For example, Hub researchers helped the Australian Government to access regional contributions to the Convention on Biological Diversity (CBD) post-2020 framework that will develop the global biodiversity goals and metrics for the next decade. They also participated in CBD discussions on the post-2020 marine theme, including facilitating a workshop on marine restoration and its role in climate mitigation and adaptation: an increasingly active area of research for the Hub.

Hub projects provide information for several biodiversity-related regional and international forums, and researchers from partner agencies attend relevant meetings in some instances, including as members of Australian Government delegations.

A project that is tracking Southern Right Whale populations provides the Australian Government with evidence to monitor and report on the status and recovery of this Endangered species in Australian waters. This supports the implementation of the Southern Right Whale Conservation Management Plan and Australia's delegation to the International Whaling Commission (IWC). Additionally it is contributing to providing the Australian Government and the IWC in 2020 with the first population estimate of Southern Right Whale populations in Australian waters.

Research on hammerhead shark populations helps to guide Australia's reporting to the Convention on International Trade in Endangered Species of Wild Flora and Fauna, and the Convention on Migratory Species.

EQUIPPED FOR THE WORLD STAGE

National capacity developed by the Hub has enabled Australian scientists to engage more effectively in these major international programs and negotiations.

- Convention on International Trade of Endangered Species of wild Flora and Fauna
- Convention on Migratory Species
- Global Climate Observing System
- Global Coral Reef Monitoring Network
- Global Ocean Observing System
- International Whaling Commission
- Memorandum of Understanding on the Conservation of Migratory Sharks
- United Nations Convention on Biological Diversity
- United Nations Decade of Ocean Science for Sustainable Development
- United Nations Educational, Scientific and Cultural Organization Intergovernmental Oceanographic Commission Ocean Best Practices Repository
- United Nations negotiations on Biodiversity Beyond National Jurisdiction



SECTION 6: SUPPORTING AND DEVELOPING AUSTRALIA'S CAPACITY FOR WORLD-LEADING MARINE SCIENCE

Australian expertise, global reach

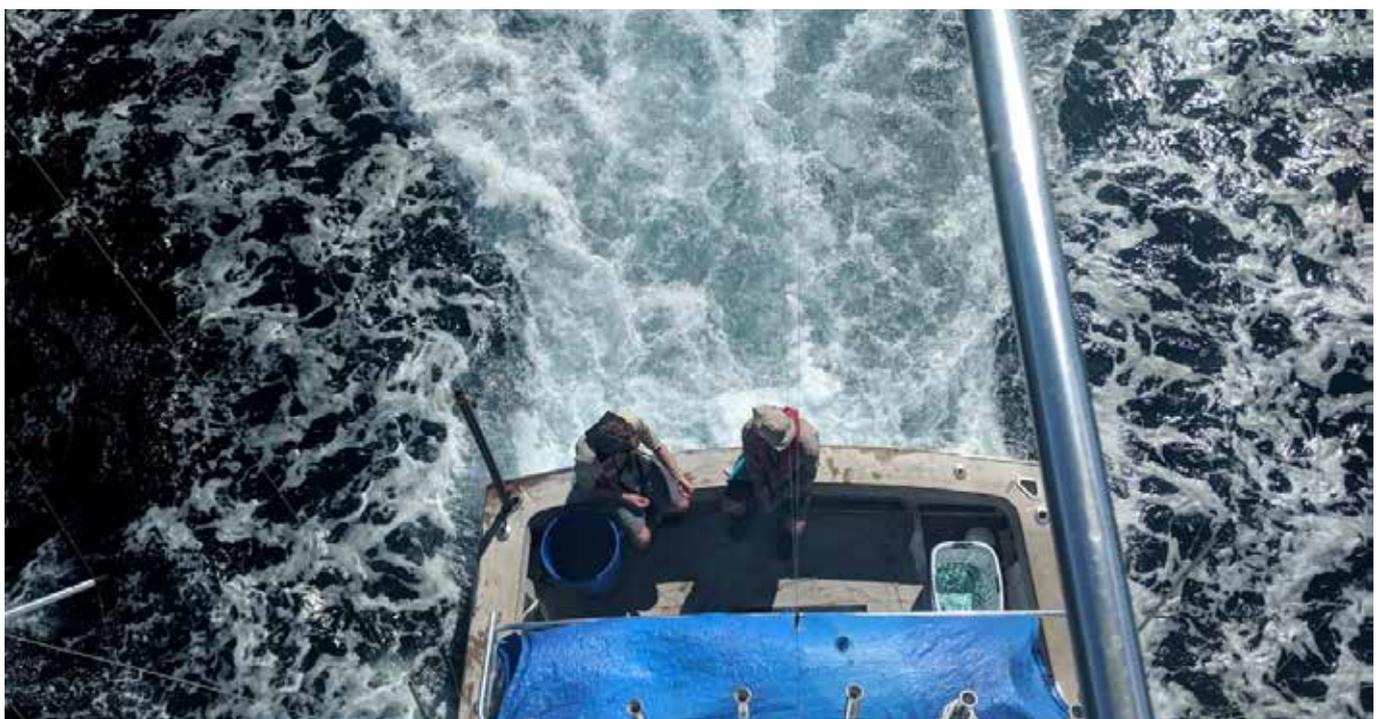
International uptake of Australia's world-leading marine research enhances our standing and encourages broader adoption among national stakeholders. Several Hub projects have served to strengthen Australia's contribution in the international realm.

Hub methods and findings have been applied to help the Global Ocean Observing System (GOOS) Biology Panel define essential ocean variables, and the International Coral Reef Initiative to plan global coral-reef monitoring. A working group supported by the Hub, the GOOS, and the Partnership for Observation of the Global Ocean met in Hobart to champion a global implementation plan and funding strategy for monitoring seaweed ecosystems.

The Hub's *Field Manuals for Marine Sampling to Monitor Australian Waters* (see case study on page 6) have become part of a growing international initiative linked to global ocean observing and the United Nations Decade of Ocean Science for Sustainable Development. The manuals are included on the Ocean Best Practices Repository, a project of the International Oceanographic Data and Information Exchange (a program of the Intergovernmental Oceanographic Commission) and the GOOS.

An international conference convened by Australia's Shellfish Reef Restoration Network (a group supported by the Hub) fostered partnerships, initiatives and information sharing necessary to further the science and practice of shellfish restoration worldwide.

Australia's commitment to knowledge and skill-sharing and cooperation with neighboring nations is important to raising regional capacity for ecological sustainability and conservation. The Hub supports this agenda by sharing experience gained during Australia's marine bioregional planning process. Opportunities have included the Enhancing Pacific Ocean Governance project, the Coral Triangle Initiative, and the Convention on Biological Diversity Sustainable Ocean Initiative Workshop for the Pacific Islands.





Since 2007 Marine Biodiversity Hub programs have delivered nationally consistent scientific information to support evidence-based decision making about the marine environment. This capability is increasingly important as pressures intensify on Australian marine and coastal ecosystems and the resources and services they provide.

Hub analysis of patterns and dynamics of marine biodiversity helped to determine the appropriate units and models for predictions of marine biogeography and diversity (provincial structure, depth structure and geomorphology) across Australia's Exclusive Economic Zone (EEZ). Subsequent Hub studies validated these predictions (and marine park design) and provided information to further improve spatial management of the EEZ. Mapping national patterns of marine species and key ecological features informed marine bioregional plans and allowed surveys to target priority areas such as Australian Marine Parks (AMPs) to inform their design and management. Detailed surveys at several World Heritage Areas, including the Ningaloo Coast and Lord Howe Island Group, helped to expand understanding of their natural values.

Working with government and industry, Hub researchers developed comprehensive national maps of current and historical pressures, enabling assessment of the risks posed to natural values, including the effect of cumulative pressures. Hub research has continued to support the recovery and conservation of threatened and migratory sharks, fishes, sea snakes and marine mammals. Our projects strengthen Australia's capacity to effectively implement regional, national, and international conservation policies: from research prioritisation and strategic planning and reporting to on-ground action.

Much of the recent Hub research has been central to developing the Monitoring, Evaluation, Reporting and Improvement system to support adaptive management of AMPs. Overall, the research provides the understanding required for improving integrated planning; monitoring and reporting; risk-assessment; and on-ground management. The data from Hub research projects are managed to national standards and made publicly available via portals such as the Australian Ocean Data Network, SeaMap Australia and the North-west Atlas for governments, industry and researchers to access and make decisions about resource use and protecting conservation values.

The Hub has had an increasing focus on marine restoration, initially by developing and supporting a national audit of coastal restoration, estimating the costs and benefits, and examining its role under the *Environment Protection and Biodiversity Conservation Act 1999*. The focus is now on developing restoration options with direct benefits to marine biodiversity and communities, including Traditional Owners.

The Hub has also supported the Australian Government in meeting a number of international obligations, and developed Australia's capacity for world-leading marine science that has been adopted by and influenced several global forums, such as the Global Ocean Observing System and International Coral Reef Initiative.

Research across all Marine Biodiversity Hub programs has had an important influence on conservation of biodiversity and the sustainable use of Australia's marine environment. Partnerships and processes established by the Hub will continue to serve the needs of end-users engaged in emerging initiatives and protecting conservation priorities.

BUILDING BRIDGES ON SEA COUNTRY

From 2010 the Hub has progressively developed and enhanced its focus on Indigenous engagement to establish partnerships with Indigenous organisations and communities, and Australia's largest marine science society, the Australian Marine Sciences Association. The Hub has provided national leadership to promote respectful partnerships for Sea Country research and monitoring by championing innovative collaborations and training through regionally focused projects with many Indigenous organisations.



MARINE BIODIVERSITY HUB PROJECTS

National Environmental Science Program (Jul 2015 to Jun 2021)

Theme A – Threatened and migratory species

- Project A1: Northern Australian hotspots for the recovery of threatened euryhaline species
- Project A3: A national assessment of the status of white sharks
- Project A5: Defining the connectivity of Australia's hammerhead sharks
- Project A6: Prioritisation of research and management needs for Australian elasmobranch species
- Project A7: Monitoring population dynamics of 'western' right whales off southern Australia
- Project A8: Exploring the status of Western Australian sea snakes
- Project A9: Grey Nurse Shark population estimate: east coast
- Project A10: Conservation of handfish and their habitat
- Project A11: Shark Action Plan
- Project A12: Australia's Northern Seascape: assessing status of threatened and migratory marine species
- Project A13: Estimation of population abundance and mixing of southern right whales in the Australian and New Zealand regions
- Project A14: Identification of near-shore habitats of juvenile white sharks in south-western Australia
- Project A15: Conservation status of tropical inshore dolphins

Theme B – Supporting management decision making (2015-2017)

- Project B1: Road testing decision support tools via case study applications
- Project B2: Analysis and elicitation to support State of the Environment reporting for the full spectrum of data availability
- Project B3: A pilot service for searching, aggregating and filtering collections of linked open marine data
- Project B4: Underpinning repair and conservation of Australia's threatened coastal-marine habitats

Theme C – Understanding pressures on the marine environment (2015-2017)

- Project C1: Improving our understanding of pressures on the marine environment
- Project C2: Continental-scale tracking of threats to shallow Australian reef ecosystems
- Project C3: Change detection and monitoring key marine and coastal environments: applying the Australian Geoscience Data Cube
- Project C4: National Outfall Database
- Project C5: Quantification of risk from shipping to large marine fauna across Australia

Theme D – Biophysical, economic and social assessments

- Project D1: National data collation, synthesis and visualisation to support sustainable use, management and monitoring of marine assets
- Project D2: Standard operating procedures for survey design, condition assessment and trend detection
- Project D3: Implementing monitoring of AMPs and the status of marine biodiversity assets on the continental shelf
- Project D4: Expanding our spatial knowledge of marine biodiversity to support future best-practice reviews
- Project D5: A standardised national assessment of the state of coral and rocky reef biodiversity
- Project D6: Socioeconomic benchmarks
- Project D7: Supporting the Monitoring, Evaluation, Reporting and Improvement System for Australian Marine Parks
- Project D8: Canyon mapping and biodiversity in Gascoyne Marine Park

Theme E – Science for a sustainable Australia

- Project E1: Guidelines for analysis of cumulative impacts and risks to the Great Barrier Reef
- Project E2: Characterising anthropogenic underwater noise to better understand and manage impacts to marine life
- Project E3: Microplastics in the Australian marine environment
- Project E4: Recreational fishing in Commonwealth waters
- Project E5: The role of restoration in conserving matters of national environmental significance
- Project E6: Assisting the restoration of seagrasses at Shark Bay

Project E7: Assessing the feasibility of restoring giant kelp beds in eastern Tasmania

Theme EP – Responding to emerging priorities

- EP1 - Assessing the effectiveness of waste management in reducing the levels of plastics entering Australia's marine environment
- EP2 - Surveying marine life in the canyons off Bremer Bay

Theme SS – Synthesis studies

- Project SS2: Interpreting pressure profiles
- Project SS3: National trends in coral species following heatwaves

National Environmental Research Program (Jul 2011 to Dec 2014)

Theme 1 – National monitoring, evaluation and reporting

- Project 1: Collation and analysis of existing data sets
- Project 2: Analysis of approaches for monitoring biodiversity in Commonwealth waters
- Project 3: Blueprint for monitoring marine ecosystems of the EEZ

Theme 2 – Supporting management of marine biodiversity

- Project 1: Integrating social, economic and environmental values
- Project 2: Integrating threats, values and assets for management
- Project 3: Landscape approaches to managing high priority conservation values
- Project 4: Supporting management of listed and rare species
- Project 5: White shark population and abundance trends

Theme 3 – National ecosystems knowledge

- Project 1: Shelf and Canyon Ecosystems - functions and processes
- Project 2: National Maps of Biodiversity and Connectivity

Theme 4 – Regional biodiversity discovery to support marine bioregional plans

Theme 5 – Science and policy initiatives

- Project 1: Great Barrier Reef World Heritage Area Integrated Monitoring Program

Commonwealth Environment Research Facilities Program (Jul 2007 to Jun 2010)

Theme 1 – Discovering and understanding biodiversity patterns

- Connectivity of Seamount Fauna
- Diversity, Distribution and History of Macrobenthos, especially Decapods off the WA continental margin
- Historical Biogeography – Derivation and Origin of Australia's Marine Biota
- Timing of Evolutionary Processes in Australia's Marine Biota
- Update Shelf Bioregionalisation

Theme 2 – Managing biodiversity - off-reserve management and biodiversity offsets

- Biodiversity Offsets
- Spatial Management of Marine Impacts Using Incentives

Theme 3 – Predicting patterns of biodiversity

- Biological Data Audit and Acquisition
- Predict Patterns of Continental Shelf Seabed Biodiversity from Physical Surrogates
- Predict Patterns of Continental Slope Biodiversity from Physical Surrogates
- Predict Patterns of Marine Biodiversity from Biological Surrogates
- Predict Patterns of Temperate Shallow Reefs from Physical Surrogates
- Predict Patterns of Tropical Coral Reefs from Physical Surrogates

Theme 4 – Surrogates for biodiversity

- Improvement of existing and development of new surrogacy relationships between physical variables and biodiversity patterns
- Influence of benthic disturbance on patterns of marine biodiversity
- Surrogacy review, data quality assessment and data compilation



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