

National Marine Science Plan 2015-2025:
The Midway Point





NATIONAL
MARINE
SCIENCE
— COMMITTEE —

Prepared by the National Marine Science Committee,
with Toni Moate as Chair and Kim Picard as
Deputy Chair.

You can access this report via the internet at:
www.marinescience.net.au

ISBN 978-1-922446-48-0 (online)

ISBN 978-1-922446-49-7 (print)

Cataloguing-in-Publication entry is available
from the National Library of Australia:
<http://catalogue.nla.gov.au/>

COPYRIGHT

With the exception of material that has been quoted from other sources
and is identified by the use of quotation marks, or other material explicitly
identified as being exempt, material presented in this report is provided
under a Creative Commons Attribution 3.0 Australia licence.

The details of the relevant licence conditions are available on the
Creative Commons website at:
<http://creativecommons.org/licenses/by/3.0/au/deed.en>

CITATION

This document should be attributed as
National Marine Science Plan 2015–2025: The Midway Point



CONTENTS

Foreword	2
Executive summary	3
Introduction	4
Report card: successes and next steps	5
Recommendation 1	6
Recommendation 2	7
Recommendation 3	8
Recommendation 4	9
Recommendation 5	10
Recommendation 6	11
Recommendation 7	12
Recommendation 8	13
Major events since 2015	14
2025 outlook: increasing and emerging challenges	16
Building resilience and preparedness: additional recommendations	18
Recommendation 9	18
Recommendation 10	18
Recommendation 11	19
Australia's marine science sovereign capability	20
Call to action	22
Acknowledgements and endnotes	24

Front cover: IMOS infrastructure collects data in Davies Reef, Queensland; ship building, services and infrastructure are an important blue economy sector in Australia; and soft corals are some of the eye-catching marine life that draws residents and visitors alike (Credits: Australian Institute of Marine Science, Avigator Fortuner/Shutterstock)

Inside cover: Fish swarm around the historic SS *Yongala* wreck, which sank in 1911 off the coast of Queensland and has become home to a vast array of marine life (Credit: Tom Bridge)

Acknowledgement of country |

The NMSC acknowledges the Traditional Custodians and Elders of the land and sea on which we work and observe, and recognise their unique connection to land and sea. We pay our respects to Aboriginal and Torres Strait Islander peoples past, present and future.

Foreword |

Australia's *National Marine Science Plan 2015–2025* was published in 2015 as a decadal plan to focus investment on the biggest development and sustainability challenges facing Australia's marine estate.

The Plan was the product of extensive consultation with Australia's marine science community, federal and state government departments, and marine industries. It was intended to complement Australia's national research priorities and support investment in Australia's blue economy, which is estimated to be worth \$100 billion per annum by 2025¹.

Five years later, increasing pressures on our marine environment and emerging priorities have driven the need to review the Plan's successes and next steps. Since 2015, global threats to ocean health – from climate change, illegal fishing, pollution, coastal development and biosecurity outbreaks – have continued unabated.

Meanwhile, the impact of COVID-19 is being felt on sea as well as on land. Economic recovery and resilience-building have become paramount in Australia and globally.

In response, the National Marine Science Committee (NMSC) has produced the *National Marine Science Plan 2015–2025: The Midway Point*. This report reflects the discipline and ambition of Australia's marine science community. It tracks progress against the eight key recommendations detailed in the 2015 decadal plan, and articulates priorities that were not apparent five years ago.

These priorities align with and complement other important national strategies and decadal research plans, such as *Climate Science for Australia's Future, A decadal plan for Australian Geoscience 2018–27*, the *National Research Infrastructure Roadmap*, the *Australian Antarctic Science Strategic Plan* and the *Reef 2050 Plan*. They also align with bottom-up, multi-stakeholder initiatives, such as the Future Earth Australia's *Sustainable Oceans and Coasts National Strategy 2021–2030*.

Australia is not alone in its efforts to maintain the long-term health of our oceans and coasts, and deliver the environmental, economic, social and cultural benefits of a blue economy.

The United Nations Decade of Ocean Science for Sustainable Development (2021–2030) is mobilising the global scientific community, policy-makers, industry and civil society around joint research and technological innovation to halt the decline in ocean health and support sustainable development. This initiative supports the broader UN Sustainable Development Goals.

In 2018, government heads from 14 countries, including Australia, joined forces on a High-Level Panel for a Sustainable Ocean Economy. Australia and these other governments have now committed to having an Ocean Action Plan to sustainably manage 100 per cent of their national estates by 2025.

In 2018, the first-ever global conference on the blue economy also finished with 62 commitments from country leaders. To achieve these blue economies, the World Bank has highlighted the importance of collaboration across nation-states and public-private sectors on a scale that has not been previously seen.

The Australian marine science community is a vital contributor and leader at this global level. We're also the lynchpin to the collaboration and scale that is required to tackle Australia's own marine challenges and fulfil our blue economy's promise.

To understand, predict and respond to ocean threats, the research community needs to collaborate and coordinate across natural and social sciences, all sectors and jurisdictional boundaries, especially coastal regions. We need to integrate the full participation of Traditional Owners, whose sustainable management of oceans stretches back millennia, and encourage greater engagement by the public.

Our marine science community is committed to working with all levels of government and industry to protect and grow the 338,974 jobs² in blue economy sectors. Sectors such as food and energy production, trade, tourism, transportation and technology development offer genuine opportunities to build our national economy over the next five years, particularly as we begin the economic recovery from COVID-19.

Australia is a marine nation and, together, we can build a blue economy that ensures a healthy environment, strong economy and vibrant society for many generations to come.

Toni Moate
Chair

Kim Picard
Deputy Chair

Executive summary |

The *National Marine Science Plan 2015–2025: The Midway Point* is a chance to double down on an essential roadmap for developing the blue economy and fulfilling its prosperity potential. And it comes at a time when the recovery, resilience and long-term health of Australia's marine environment, economy and community have never been more important.

What is the blue economy? It's an economy that sustainably manages Australia's most valuable resources – our oceans and coasts – to deliver a healthy marine environment, strong economy and vibrant society.

Its industries include marine tourism, energy and food production, transport, as well as emerging industries such as renewable energy, aquaculture and technology development. Science drives the blue economy's development by providing the data, knowledge and tools to support the sustainable operation of these industries.

As Australia seeks to rebuild our national post-COVID economy over the next five years, the blue economy offers genuine opportunities for growth, with an estimated value of \$100 billion per annum by 2025.

In 2015, the NMSC released the *National Marine Science Plan 2015–2025*, a decadal strategy for driving the blue economy's development. It made eight recommendations involving initiatives, investment and priorities to address seven grand challenges facing our marine estate. These include marine sovereignty and security, energy security, food security, biodiversity conservation, sustainable urban coastal development, climate change adaptation, and equitable, balanced resource allocation.

But since the Plan's implementation, the threats to ocean and coastal health – and the blue economy's foundation – have increased as our coastal population and reliance on marine resources have risen. These threats include accelerating climate change, pollution, demographic change, loss of biodiversity and habitat, aging or outdated marine and coastal infrastructure, and biosecurity threats. The COVID-19 pandemic has also driven a broader need for economic and social recovery, resilience-building and preparedness against future shocks.

Meanwhile, the Australian Government has joined 13 other countries in committing to an Ocean Action Plan to sustainably manage 100 per cent of their countries' national estates by 2025.

Against this backdrop, *The Midway Point* has brought our attention back to the blue economy's potential for meeting Australia's current needs and long-term prosperity. It reiterates the need for a strong, interdisciplinary approach across natural and social sciences to drive the blue economy's development and enable future economic, environmental and social resilience for Australia.

The report tracks the *National Marine Science Plan's* eight recommendations from 2015–2020, highlighting that two are at an early stage, four are underway and two are at maturity. It celebrates achievements, such as the establishment of the Blue Economy Cooperative Research Centre, funding of national research vessels and the expansion of the Integrated Marine Observing System (IMOS). It also identifies further steps to ensure all recommendations are fulfilled, and builds on the original Plan by identifying three new recommendations:

- Develop a nationally coordinated approach to integrate the knowledge, rights, capabilities and aspirations of Traditional Owners into conventional marine science.
- Establish national policy guidelines for open access to government-funded or regulatory data, provide historical-dataset access, and expand the Australian Ocean Data Network (AODN).
- Develop a coastal resilience-building approach firmly based in the proactive use of our natural environment.

Lastly, *The Midway Point* calls on all sectors of society to play their part in the development of Australia's blue economy through a series of actions. It calls on:

- the research community to build on and amplify existing resources to establish truly national research programs that incorporate all stakeholder needs
- industry to work with marine scientists and governments to ensure science underpins their operational decision-making, risk assessments and future planning, and to create efficient, sustainable businesses
- government to focus on and invest in the blue economy as an important plank in post-COVID economic recovery and a way to create long-term social, cultural and environmental benefits
- community to recognise the responsibility we all share as a marine nation, and to play an active role in ensuring the long-term health of our oceans and coasts for all Australians.

Together, we can ensure the health, resilience and future preparedness of our economy and communities by ensuring the same for our oceans and coasts. And with this strong blue-economy foundation, we can chart a course through the uncertainties of the future and create long-term prosperity for all Australians.

Introduction |

This report is both a review of the *National Marine Science Plan 2015–2025* and a renewed clarion call for the marine science community, industry and government to help drive the development of the blue economy and embed it in Australia's future.

The report assesses how far we've come, what is still required and how we can build on the *National Marine Science Plan's* roadmap for the long-term health and wealth of Australia's marine environment, economy and people.

To do this, the report tracks the progress of the Plan's eight recommendations from 2015–2020 via a report card, and highlights next steps. It then examines the outlook for 2025, and identifies emerging priorities that will address gaps in knowledge, infrastructure and capabilities, and re-prioritise the initial recommendations.

It has never been more vital to strengthen commitment to and build on the Plan's roadmap to a thriving blue economy. Launched in 2015, it identified seven grand challenges that Australia would have to tackle to fulfil the potential of its oceans and coasts:

- Maintain marine sovereignty and security by better understanding, monitoring and predicting sea state and extreme events.
- Achieve energy security by understanding the origin and accessibility of energy resources and the environmental impacts associated with their discovery and recovery.
- Ensure food security by developing better tools for managers, better decision-making systems and new technologies.
- Conserve our biodiversity and ecosystem health by filling in knowledge gaps, understanding ecological processes and informing evidence-based management with mapping, monitoring, experimental research and modelling tools.
- Create sustainable urban coastal development by using applied and basic strategic coastal research to underpin the repair and ongoing management of these high-value ecosystems.
- Understand and adapt to climate variability and change by observing and modelling heat, freshwater and carbon processes at global, regional and local scales, as well as the vulnerability and adaptability of marine ecosystems, communities and industries.
- Develop equitable and balanced resource allocation by integrating economic, environmental, social and Indigenous activities into data collection and problem formulation, and developing simplified tools and better modelling.

Five years later, the scale and speed of these challenges have only grown as cumulative impacts and extreme events have increased pressure on our oceans and coasts. The disruption wrought by COVID-19 has also highlighted the need to build the resilience of our ecosystems, marine industries and communities for future generations.

There is much at stake, but there are even greater opportunities too.

By 2025, the blue economy is projected to be worth \$100 billion per annum. It has already contributed \$69.2 billion to Australia's economy in 2018, which represented 3.7 per cent of national gross domestic product (GDP)³. The ocean's ecosystem services, such as climate regulation, carbon dioxide absorption, coastal protection and more, are estimated to be worth billions more. Meanwhile, the cultural value of our oceans and coasts is priceless.

Australia is responsible for a marine estate that covers an area greater than its land mass and is home to some of the world's most biodiverse and iconic ecosystems. These oceans and coasts are the bedrock of marine industries such as tourism, food and energy production, trade, tourism and transportation. Growth opportunities exist in sectors such as offshore aquaculture and marine renewable energy. Autonomous technologies, new sensor development and machine-learning applications support innovation and productivity gains across all sectors.

Oceans are also the very support system of human life, producing the oxygen we breath and dictating climate and weather. For a coastal-hugging nation, the oceans and coasts are an integral part of our cultural psyche, play and wellbeing. And they are the cultural lifeblood of Traditional Owners who have sustainably used marine resources and built their knowledge of and connection to Sea Country over millennia.

The blue economy focuses on achieving a healthy marine environment, a strong economy and a vibrant society by sustainably managing one of Australia's greatest resources: our oceans and coasts. In this economy, the long-term health, resilience and prosperity of oceans, coasts, economy and society are inextricably intertwined.

And science is the key driver for developing the blue economy. It creates the essential data, knowledge and tools to help governments, industries and communities make informed decisions, plan, invest, build resilience, mitigate risk and be future ready. The UN Decade of Ocean Science and the High Level Panel for Sustainable Ocean Economy have also highlighted the importance of science for the future of our oceans and humanity.

The responsibility to ensure we fulfil the blue economy's potential, and maintain Australia's position as a global leader in ocean sustainability, is a shared one. In this spirit, the report ends with a series of calls to action for all sectors of our society: research community, industry, government and community.

Report card: successes and next steps |

The report card provides a snapshot of how Australia has delivered against the *National Marine Science Plan's* eight recommendations, celebrating the achievements so far and identifying next steps for developing the blue economy.

The Plan designed the recommendations to tackle Australia's seven grand challenges for the decade and realise the blue economy's projected value of \$100 billion per annum by 2025.

The recommendations prioritise the marine science collaborations, investment and initiatives that will help establish essential knowledge of ocean systems and resources, and provide an evidence base for industry and government to plan, invest and mitigate risk.

The marine science community has advanced a number of these recommendations. Thanks to their efforts and government support, Australia is better prepared to apply its science, technology, engineering, mathematics and Traditional-knowledge capabilities to tackle the threats to our ocean and coasts, and to realise the prosperity they promise.

Clockwise from left: Waveswell's innovative Uni Wave200 converts wave energy into electrical energy near King Island, Tasmania; tourists enjoy the spectacular Great Barrier Reef World Heritage Area, Queensland; AIMS' RV *Solander* travels towards Woodside Energy's oil and gas rig on the North West Shelf, Western Australia; barramundi farming occurs in all states except Tasmania and Northern Territory (Credits: Waveswell, Richard Brickman ©Woodside Energy Limited, M. Carmody ©Commonwealth of Australia, GBRMPA, J. Jones ©Commonwealth of Australia, GBRMPA)

The report card also identifies the additional work required to drive the completion of the recommendations and deliver the best possible long-term outcomes for Australia. Of the original recommendations, two are at an early stage, four are underway and two are at maturity.

Throughout the report card, *Stories from the blue economy* highlight examples of the nexus between science, healthy oceans, industry, society and culture.

Report card key |

● **Mature** ● **Underway** ● **Early stage**

Mature stage:

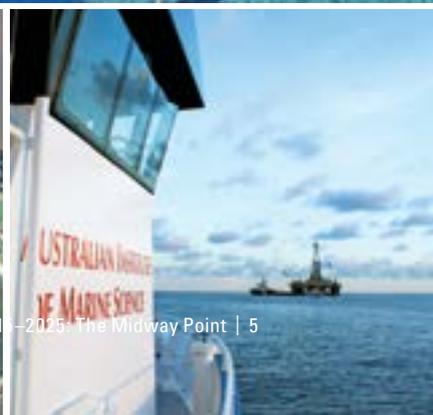
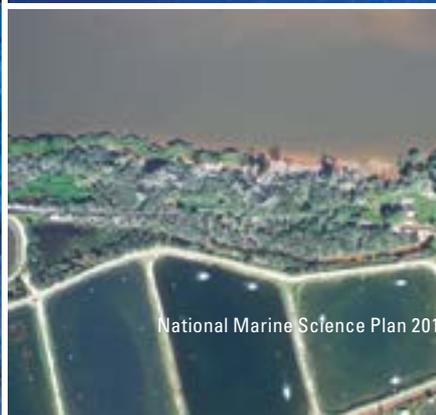
the recommendation has a clear-use case, user base and role supporting marine science and the blue economy

Underway:

the recommendation has a clear forward trajectory

Early stage:

the recommendation is still immature and a clear forward plan has yet to be established



Recommendation 1 |

Create an explicit focus on the blue economy throughout the marine science system

Indicator value | ● **Underway**

Rationale |

Australia's diverse portfolio of existing and emerging marine industries is expected to be worth \$100 billion per annum by 2025. Ecosystems services have been valued at tens of billions more.

For this contribution to be realised, fundamental shifts in marine science research are needed. These shifts will help fill the gaps of our marine estate knowledge and create essential data, knowledge, tools and innovations. This will enable more sustainable and economically resilient decision-making, regulation, management, planning and investment by governments and industry sectors.

Progress update |

The blue economy is now an integral element in the organisational strategy of most Australian marine science agencies, and many universities engaged in marine science and research.

By 2018, the blue economy was contributing 338,974 jobs and \$69.2 billion to the Australian economy, which represented 3.7 per cent of GDP. That same year, the output of the blue economy's industries was valued at \$81.2 billion, a substantial increase from \$63.6 billion in 2016⁴. In recognition of its value to Australia, the Australian Government funded the Blue Economy Cooperative Research Centre in 2019.

Key next steps |

- Use science to underpin future food and offshore energy production, transport, marine security and urban coastal development.
- Develop integrated systems where the blue economy focus is broadened to include community wellbeing through the use of sociocultural data.
- Recognise the blue economy as an important plank of post-COVID economic recovery and resilience-building.
- Remain committed to the delivery of The Paris Agreement and use the UN Decade of Ocean Science for Sustainable Development to guide and drive Australia's own sustainability efforts.

Above right: The Blue Growth Farm aero-hydro prototype in Reggio Calabria, Italy, which received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement n.774426 (Credit: Professor Felice Arena)



BLUE ECONOMY CRC EXPLORES INNOVATIVE ENERGY AND FOOD PRODUCTION

The Blue Economy Cooperative Research Centre (CRC) is addressing the challenges of offshore seafood and energy production by investigating multi-use offshore platforms for Australian aquaculture and renewable energy operations such as offshore wind. The platforms, which have been piloted successfully overseas, would enable each operation to benefit from using the same infrastructure, sharing the same space or occurring at the same time. This could increase the efficiency and economic performance of operations while decreasing their carbon footprint and impact on the environment. Offshore wind energy is growing rapidly globally and its costs are falling fast, but the sector is lagging in Australia. Meanwhile, Australian aquaculture faces a lack of suitable inshore sites and the knowledge to operate effectively in offshore environments.

Read more in [Stories from the blue economy, marinescience.net.au](https://marinescience.net.au)



Recommendation 2 |

Establish and support a national marine baseline and long-term monitoring program to develop a comprehensive assessment of our estate and help inform management of Commonwealth and State Marine Parks

Indicator value | ● **Underway**

Rationale |

Greater understanding of our marine estate and key assets will support marine park managers, tourism operators, commercial and recreational fishers, Indigenous communities, government agencies, port authorities and defence operators. It will help them better manage, use, allocate resources and maintain security in our oceans and coastal waters.

To achieve this, we need to collect geological, biophysical, ecosystem, biocultural, social and economic data. These will provide the baseline and basis for systematic mapping and characterisation of our marine estate, including waters adjacent to our Antarctic Territory and our Indian Ocean Territories.

They will also support the monitoring of key assets, such as the Great Barrier Reef, Australian Marine Parks, State Marine Protected Areas, Indigenous Protected Areas, major ports and urban embayments. However, key geographical data gaps still remain due to the logistical and resource challenges of operating in remote areas.

Progress update |

Baseline progress includes high-resolution mapping of another 15 per cent of the seabed of the mainland Exclusive Economic Zone (EEZ) and 10 per cent of the Australian Antarctic Territory, as well as the launch of the AusSeabed initiative to assist coordination of future efforts.

Through the *State and Trends of Australia's Oceans Report*, IMOS made available 27 time-series datasets for key ocean variables measured over 10 years. The Australia-NZ IODP Consortium (ANZIC) facilitated eight International Ocean Discovery Program expeditions in our region, enabling world-class research into natural hazards, past climate and resource evolution in key Australian regions.

National guidelines, released through the National Environmental Science Program (NESP), AusSeabed and IMOS, are now facilitating the consistent collection and publication of data for national comparisons and syntheses.

Right: A hyperspectral remote sensing image of Yardie Creek and Ningaloo Marine Park, WA, one of 60 marine parks around Australia (Credit: HyVista and Murdoch University/Dr Halina Kobryn)

The launch of the Western Australian Index of Marine Surveys for Assessment program will see more industry data openly available and provide a case study for national-scale implementation. A summary of the latest data on Australian marine systems was released through the *Australian State of the Environment 2016* (SoE) report.

The NMSC also completed a national audit of marine baseline and monitoring programs. A draft report outlining the results, critical gaps and the scope to establish a national program is being finalised.

Key next steps |

- Identify investment and coordination priorities for baseline and monitoring programs, including opportunities for participation by Aboriginal and Torres Strait Island Traditional Owners and citizen scientists.
- Establish a governance framework that includes relevant state and territory government agencies, universities, Indigenous organisations and industry to advance a national approach to marine baselines and monitoring, including the development and implementation of national guidelines for data collection, management, sharing and delivery.
- Establish a national mandate with appropriate oversight and coordination mechanisms to build on established regional, national and international monitoring programs, and ensure links with existing research and infrastructure programs.



Recommendation 3 |

Facilitate coordinated national studies on marine system processes and resilience to enable understanding of the impacts of development and climate change on our marine estate

Indicator value | ● Underway

Rationale |

To prepare and build resilient ecosystems, economies and communities for the future, we need science-based decision-making about sustainable development and adaptation to climate change. This decision-making must consider all the components of the marine system: geological, biological, physical, social and economic.

Research that improves our knowledge of the key processes underpinning system function is urgently required. This will help us to understand the limits to resilience and adaptation in our diverse range of marine ecosystems, and enable predictive modelling.

We also need to understand and quantify the compounding impacts of stressors such as population growth; industrial, urban and agricultural development; and fisheries.

Below: Scientists lower a PLAOS system over the side of RV *Investigator* during a GABRP voyage involving BP, CSIRO, SARDI, Flinders University and the University of Adelaide (Credit: CSIRO)

Progress update |

The NMSC completed the guidelines and investment rationale for the development of a national framework for experimental and process studies of marine systems. These are crucial to our understanding of system-wide processes and impacts.

This approach was implemented for the first time at a regional level via the Reef Restoration and Adaptation Program (RRAP). However, challenges remain in resourcing and delivery of national, integrated studies at appropriate scales.

Likewise, as identified in the *SoE 2016* report, a key gap remains in understanding and quantifying cumulative impacts. Several research projects have focused on this topic, including the Great Australian Bight Research Program (GABRP). See case study below.

Key next steps |

- Implement coordinated experimental programs, and build on the success of RRAP and GABRP, for other threatened coastal systems (e.g. kelp forests and oyster reefs) and key offshore ecosystems (e.g. Perth Canyon, Gulf of Carpentaria, Tasmanid Seamount Chain and the Coral Sea).
- For coastal systems, resolve political and jurisdictional issues constraining implementation of programs to ensure that key multi-jurisdictional ecosystems are understood and managed coherently at local, regional and national scales.
- Establish national and international frameworks that enable formal assessment of cumulative impacts on the resilience and dynamics of marine ecosystems (e.g. as part of the UN Decade of Ocean Science).



BIGHT RESEARCH SUPPORTS SUSTAINABLE INDUSTRY

The \$20 million, interdisciplinary Great Australian Bight Research Program (GABRP) has produced essential data, information and models to support the sustainable development of fishing, aquaculture, ecotourism and oil and gas exploration in the Bight. The four-year GABRP was the first large-scale integrated study of the Bight. It aimed to generate a whole-of-system understanding of the region's environmental, economic and social values, and has generated a much greater understanding of this region's deep-water marine systems. The Bight is one of Australia's most valuable marine ecosystems and, until recently, relatively under-explored and poorly understood.





Recommendation 4 |

Create a national oceanographic modelling system to provide the accurate, detailed data and predictions of ocean state that are required by defence, industry and government

Indicator value | ● **Early stage**

Rationale |

A comprehensive oceanographic modelling system that provides accurate data and predictions of ocean state (such as currents, waves, temperature, salinity, pH and productivity) would serve a broad range of Australian Government regulators and operational agencies, marine industry sectors (e.g. offshore oil and gas, shipping, fisheries, aquaculture, tourism) and public users.

The system would gather and assimilate data from a number of sources, including a sustained and expanded IMOS, our national research vessel fleet, and the significant observational data collected by industry and state agencies as part of their core business.

Progress update |

The Australian Coastal and Oceans Modelling and Observations Working Group has been established to tackle various impediments to a comprehensive modelling system. The group has set up a forum for sharing ideas and building collaboration.

Australia has strong ocean modelling capabilities across multiple institutions, including in the tertiary sector. The Blueink modelling system delivers freely available, daily ocean forecasts; however, there is still no national capability for coastal regions, which remains an important priority.

Several coastal system models are routinely run to provide information to industry and government decision-makers (e.g. eReefs for the Great Barrier Reef). However, most of these do not yet assimilate ocean observations and have no biogeochemical component. Moreover, data from these models are not freely available.

Key next steps |

- Identify investment to deliver a national coastal modelling capability.
- Improve coordination across multiple stakeholders and engage with them to co-design a business case for a national coastal modelling system focused on end-user requirements.
- Identify ways to address the lack of adequate coastal observations.

Below: Mangroves are an important blue carbon ecosystem that also protects coastlines (Credit: M. Johnson ©Commonwealth of Australia, GBRMPA)



FIGHTING CLIMATE CHANGE WITH BLUE CARBON

Queensland Blue, a collaboration between universities, industry and government, has revealed that mangrove forests and seagrass meadows within the Great Barrier Reef catchments hold over 111 million tonnes of carbon. This is equivalent to the annual emissions of around 87 million cars. These ecosystems would sequester around 251 million tonnes of CO₂ equivalent by 2100, helping to mitigate Australia's CO₂ emissions and fight climate change. Mangroves, tidal marshes and seagrasses are known as blue carbon ecosystems. They capture carbon 30–50 times faster than forests. Despite these benefits, blue carbon ecosystems are some of the most threatened ecosystems on Earth.

Read more in [Stories from the blue economy, marinescience.net.au](https://www.marinescience.net.au)



Recommendation 5 |

Develop a dedicated and coordinated science program to support decision-making by policy-makers and industry

Indicator value | ● Early stage

Rationale |

Over the past two decades, marine and coastal assets have increasingly been subject to conflicts relating to their development and governance. This is due to the differing values and aspirations of industry, government and communities.

In addition, the lack of appropriate decision-making tools available to date suggests that politicians and regulators are often required to make inherently difficult choices without conclusive information on the risks and benefits associated with their decisions.

The marine science community needs to work with decision-makers from all sectors, as well as the community, to develop and refine the tools that can translate knowledge and data into useful information for effective decision-making.

Progress update |

The NMSC is currently evaluating the use of an Integrated Ecosystem Assessment (IEA) approach in Australia, which is considered world's best practice for resource allocation and would support better decision-making processes.

This system-wide framework encompasses the natural parts of ecosystems, as well as social, cultural and economic considerations. The report will be available by late 2021.

Key next steps |

- Develop a national pilot project to apply an IEA approach at four trial sites: NSW Marine Estate, Victorian outer coast, Spencer Gulf SA, and Northern Seascapes, NT.
- Develop new and effective mechanisms to communicate the latest marine science for meaningful use by Australia's policy-makers and decision-makers.
- Establish mechanisms to assess this program's impact on decision-making by policy-makers and industry.

Above right: The Kimberley Indigenous Saltwater Science Project brought together scientists from WAMSI's partner organisations and Traditional Owners from seven Kimberley saltwater communities (Credit: Kimberley Land Council)



TRADITIONAL KNOWLEDGE STRENGTHENS KIMBERLEY RESEARCH AND MONITORING

The Western Australian Marine Science Institution worked with seven Indigenous Kimberley saltwater communities to ensure Traditional Owners are included in research and monitoring in the Western Australian region. This involvement includes Indigenous rangers taking part in data collection and research partnerships. The project also developed tools, protocols and training for monitoring and managing healthy Sea Country and jointly managing state marine parks. The five-year Kimberley Indigenous Saltwater Science Project (KISSP) included workshops that drew input from over 100 Traditional Owners.

Read more in [Stories from the blue economy, marinescience.net.au](https://marinescience.net.au)



Recommendation 6 |

Sustain and expand IMOS to support critical climate change and coastal systems research that includes coverage of key estuarine systems

Indicator value | ● **Mature**

Rationale |

National estuarine and coastal observations are critical to many established blue economy industries, such as aquaculture and tourism, as well as to emerging industries such as blue carbon and seaweed farming.

The *National Marine Science Plan* identified key research needs that rely on observations of estuarine, coastal and marine systems, including continental shelf and open ocean. While IMOS provides national marine observations, it does not provide national estuarine and coastal observations.

Long-term collection of these observations is critical to understanding and managing our marine estate, and at present IMOS is not sustained.

Below: Bob the Bluebottle is powered by solar, wave and wind energy, includes diverse data sensors, and can spend months at sea (Credit: Ocius)

Progress update |

The IMOS program, funded through the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS) fund, is now supported until 2023. This funding enables marine infrastructure investment decisions to be made on appropriate time scales and with a level of certainty that ensures a good return on investment.

IMOS has extended its focus into marine ecological monitoring, and expanded its links to industry and government. Maturity of the program is enabling a sharper focus on delivering information on impacts to stakeholders, including through the Fisheries Research and Development Corporation (FRDC) and establishment of the Forum for Operational Oceanography (FOO).

These relationships are driving closer collaboration between industries, government and the research community.

Key next steps |

- Expand IMOS into coastal and estuarine systems.
- Continue to expand ecological monitoring and exploration of new sensor technologies that lower the cost-per-observation.
- Ensure ongoing support for IMOS beyond 2023.



AUTONOMOUS TECHNOLOGY TAKES TO THE SEAS

Autonomous vessel technology is set to transform the way marine industries and organisations collect ocean and coastal data, making their operations more efficient, safe and sustainable. The Department of Defence has partnered with Australian company Ocius Technology to build and trial five 'Bluebottle' uncrewed surface vessels (USV) for advanced maritime surveillance. CSIRO has partnered with US start-up Saildrone to trial their USVs for measuring and monitoring Australian waters and the Southern Ocean. Meanwhile, Australian Maritime College Search, Trusted Autonomous Systems Defence Cooperative Research Centre, Queensland AI Hub and Australian Institute of Marine Science combined forces to upskill marine surveyors by running an autonomous systems training.

Read more in *Stories from the blue economy*, marinescience.net.au

Recommendation 7 |

Develop marine science research training that is more quantitative, cross-disciplinary and congruent with the needs of industry and government

Indicator value | ● **Underway**

Rationale |

Marine science research training is weighted towards specific disciplines that often don't match the future needs of industry or government employers. There is a need to ensure that training produces graduates with highly developed numeracy and communication skills.

In Australia, training of PhD students focuses on the research topic of the candidate's thesis, which often limits opportunities for cross-disciplinary training or networking. It also provides little formal structure for training in basic science technology, engineering and mathematics or interdisciplinary communication.

Progress update |

The NMSC completed an extensive national and cross-sector assessment of Australian university postgraduate training programs and the requirements and needs of employers in marine industries. The results of this assessment are provided in a report, available on the NMSC website, which includes a series of outcomes and recommendations.

These include enabling aspiring marine scientists to gain deep expertise in at least two disciplines prioritised by employers, and offering Masters coursework programs that are cross-disciplinary and problem-focused. The outcomes and recommendations of the report are actively being discussed with Australian tertiary institutions.

Key next steps |

- Engage with key peak bodies in academia and industry regarding outcomes of the report.
- Implement recommendations, including identification of the constraints to serving the needs of industry.
- Establish communication and extension activities through the Australian Marine Sciences Association and other bodies to ensure changes based on the recommendations occur by 2025.



SCIENCE-BASED STRATEGIES HELP FISHERIES GROW

Fishery harvest strategies have helped Australian fisheries and aquaculture meet the increasing consumer demands for seafood while ensuring they are economically and ecologically sustainable for the future. In order to grow, fisheries and aquaculture need to increase their market value through sustainable harvest practices and scientific advice on the benefits/risks of seafood products. Well-designed, formal harvest strategies provide a framework for predetermined management actions. They help ensure that catches are set and adjusted fairly using the best available science to meet agreed ecological, economic and/or social management objectives.

Read more in *Stories from the blue economy*, marinescience.net.au



Recommendation 8 |

Fund national research vessels for full use

Indicator value | ● **Mature**

Rationale |

To achieve the goals of the *National Marine Science Plan*, Australia's world-class research ship *RV Investigator* requires funding to operate for 300 days per year and with ocean-going research capability. It also requires the replacement of our ageing coastal research fleet, operated by government agencies and universities, within the next decade.

These vessels provide increased opportunities for collaborative use across the Australian marine science community, particularly for high-priority areas identified in the Plan.

Progress update |

Australia's research vessel capacity has increased due to investment from the Australian Government and the coordinated efforts of NMSC members.

Key successes include the replacement of the *Aurora Australis* with a new national icebreaker *RSV Nuyina*, scheduled to commence service in 2021; the operation of *RV Investigator* for a full 300 days per year from 2018–2022 (excluding a 2020 hiatus); the operation of coastal research vessels such as the *RV Cape Ferguson* and *RV Solander*; a scoping study for a national coastal research fleet supported through NCRIS; and an increased focus on coordination across research vessel operators.

Key next steps |

- Continue to prosecute the case for:
 - securing funding to maintain ongoing operations of *RV Investigator* for 300 days per year beyond 2022, and to ensure it is a state-of-the-art research platform
 - establishing a national coastal research fleet
 - establishing a coordinating committee for national research vessels to maximise investments.

Left: States and territories have drawn heavily on the harvest strategy guidelines to drive the adoption of a more consistent, national approach (Credit: Ideal Stock Photography/Shutterstock)

Above right: CAPSTAN students study sediment samples on board the *RV Investigator* (Credit: April Abbott)



MARINE SCIENCE TRAINING MEETS INDUSTRY, GOVERNMENT AND CULTURAL NEEDS

In 2015, Australian university and government partners developed a post-graduate program that would help develop a multidisciplinary marine science workforce ready to enable the blue economy. The Collaborative Australian Postgraduate Sea Training Alliance Network (CAPSTAN) provides training to students on board *RV Investigator*, which prepares them to collaborate with industry, government, universities and other marine science organisations. The program not only welcomes students from the 'hard sciences' but also those from related disciplinary areas, such as resource management, government, policy and communication studies. CSIRO's Marine National Facility has also implemented the Indigenous Time at Sea Scholarship initiative, which offers Aboriginal and Torres Strait Islander university students the opportunity to join voyages on *RV Investigator*.

Read more in [Stories from the blue economy, marinescience.net.au](https://marinescience.net.au)

Major events since 2015 |

Since the *National Marine Science Plan's* 2015 release, major environmental, health and social changes have positively and negatively affected the health of Australia's ocean and coasts, marine industries and communities, which all make up the blue economy.

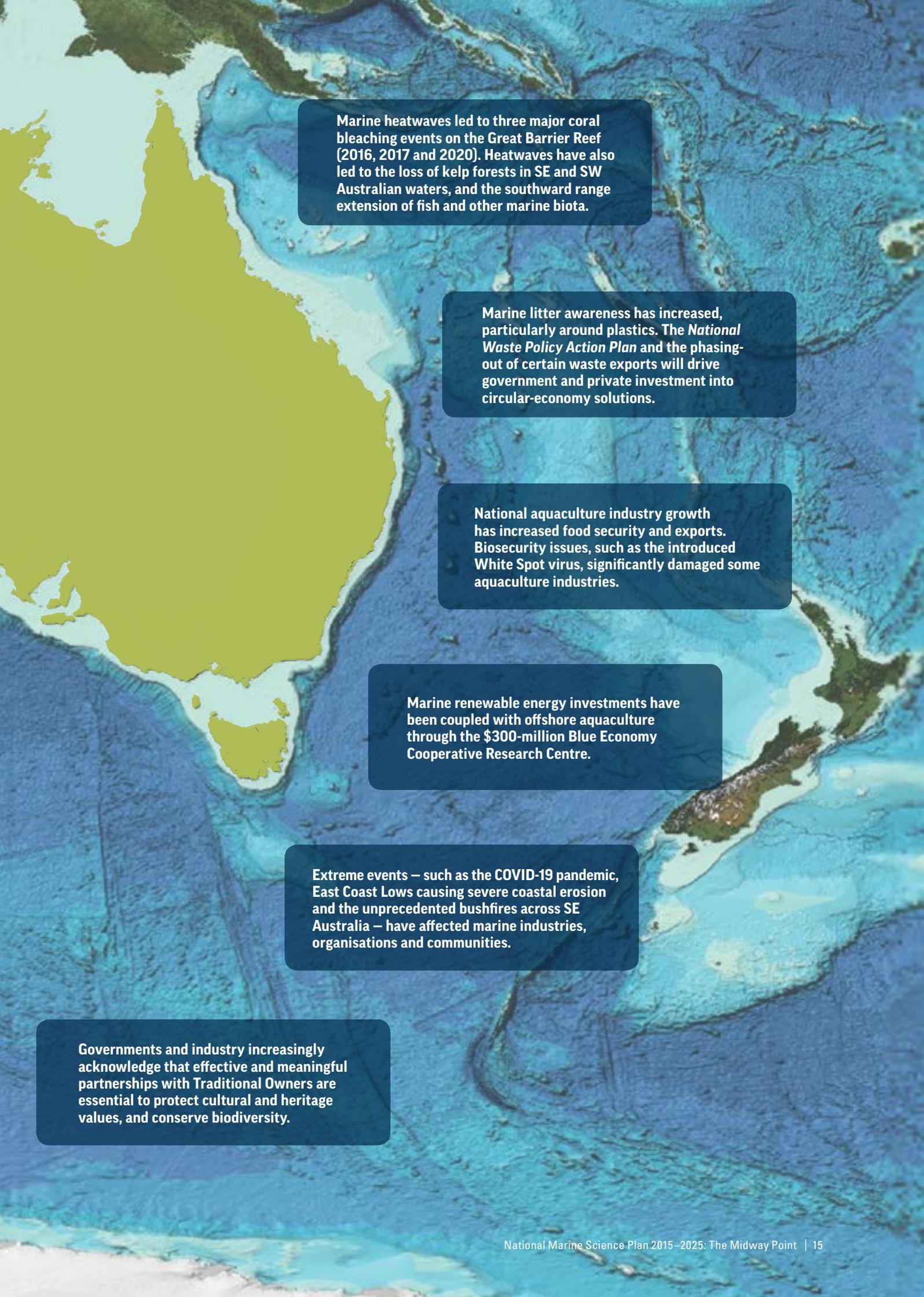
The need to shift to a future less reliant on fossil fuels is spurring industrial change, including in the marine sectors where some companies are innovating rapidly.

The International Convention for the Prevention of Pollution from Ships (MARPOL) imposed limits on the sulfur content of fuel oil that may be used and carried by a ship. These requirements apply to all ships and vessels globally, including those operating in Australia.

There were advances in mobile technology and citizen science (e.g. apps and websites such as iNaturalist, Birdata and Redmap).

Offshore plants processing liquefied natural gas for domestic and international markets are expanding a traditionally land-based activity into the marine estate.

The role of the Southern Ocean and Antarctica in the global climate system, as well as the vulnerability of the East Antarctic ice sheet to ocean warming and its consequent contribution to future sea level rise, is better understood.



Marine heatwaves led to three major coral bleaching events on the Great Barrier Reef (2016, 2017 and 2020). Heatwaves have also led to the loss of kelp forests in SE and SW Australian waters, and the southward range extension of fish and other marine biota.

Marine litter awareness has increased, particularly around plastics. The *National Waste Policy Action Plan* and the phasing-out of certain waste exports will drive government and private investment into circular-economy solutions.

National aquaculture industry growth has increased food security and exports. Biosecurity issues, such as the introduced White Spot virus, significantly damaged some aquaculture industries.

Marine renewable energy investments have been coupled with offshore aquaculture through the \$300-million Blue Economy Cooperative Research Centre.

Extreme events – such as the COVID-19 pandemic, East Coast Lows causing severe coastal erosion and the unprecedented bushfires across SE Australia – have affected marine industries, organisations and communities.

Governments and industry increasingly acknowledge that effective and meaningful partnerships with Traditional Owners are essential to protect cultural and heritage values, and conserve biodiversity.

2025 outlook: increasing and emerging challenges |

The *National Marine Science Plan's* 2015 implementation and its significant outcomes have strengthened the ability of the Australian marine science community to meet the seven challenges facing our marine estate. They have also strengthened our community's ability to support the industries, governments and communities who depend on our achievements.

However, five years on, the scale and speed of environmental, social and economic changes, and their impacts on the marine estate, have highlighted the need to double down and build on the Plan's original eight recommendations. To achieve this, the NMSC reviewed and refined the Plan. We strengthened it against a backdrop of increasing pressures on our oceans and coasts, extreme events, a pandemic and the need to build Australia's resilience against future shocks.

Increasing pressures: the reality |

The use of ocean and coastal assets is expanding at an almost exponential rate, and competition between different users means the pressures on coastal and marine assets are also increasing rapidly. Likewise, the cost to government, industry and the community in addressing this resource demand is also growing.

For new developments, Australian industry measures its annual losses from delayed decisions at tens of millions of dollars. However, ecological degradation is estimated globally to cost US\$13 billion annually due to lost resources and clean-up efforts.

Increasing and cumulative pressures on coastal and marine assets from a variety of sources means decision-makers must balance the needs and desires of competing stakeholders and interests across jurisdictions. Sectors such as fisheries, oil and gas, marine renewable energy, seabed mining, shipping, tourism and coastal development have potentially competing or conflicting objectives, which can make decisions regarding access contentious.

Environmental, conservation and cultural considerations, including the perspectives and priorities of Traditional Owners, add further complexity. The rapid change in coastal and marine environments due to shifting climate drivers amplifies this complexity further still.

Extreme events: the magnifier |

The *Australian State of the Environment 2016* report noted an increase in the frequency and magnitude of extreme events, including floods, bushfires, storm surges and marine heatwaves, as well as other rapid changes to physical ocean characteristics (e.g. pH, CO₂). These changes impact heavily on coastal and marine environments, infrastructure, communities, biota and, consequently, Australian livelihoods in tourism, fisheries and related industries.

In the coastal zone, extreme events such as storm surges add to other manifestations of climate change, such as increased sea levels and coastal erosion, extending their impact from the near-sea coast to vulnerable, but often highly populated, low-lying inland areas.

Continual growth of coastal populations, expansion of marine industries, and use of our coastal and marine environments means that the social and economic impacts of extreme events will only increase. With over 85 per cent of Australians living in coastal regions, there are already concerns about the impacts on property values and insurance premiums resulting from extreme events.

Multiple extreme events often produce cascading and compounding effects, as was witnessed with the combination of bushfire, flood and COVID-19 impacts on marine and coastal tourism, local economies, and fisheries and aquaculture. When extreme events occur, they attract considerable attention and increase public pressure on government, industry and marine estate managers to act.

These sectors rely on the scientific community to provide information and support the rapid response required to assist decision-making. But a lack of data, and a lack of national coordination in consistently integrating and interpreting data and information, limits their response to extreme events and the impact of their efforts.

Better decision-making in planning, emergency preparedness and response relies on an improved understanding of the global climate system and extreme events. Industrial risk management in coastal and marine environments requires the same.

Pressures of a pandemic |

Midway into the *National Marine Science Plan 2015–2025*, the world is coming to grips with the COVID-19 pandemic. The pandemic, and the measures to contain it, have disrupted all aspects of daily life. It has negatively affected Australian economic activity, livelihoods and wellbeing, and the impacts are likely to be felt for many years to come.

Australia may be an island, but it is far from isolated. International trends and drivers are cascading with national impacts to increase pandemic's pressure in Australia. Some of these international trends include a projected shrinking of advanced economies, fluctuating global markets and disrupted supply chains. And this pressure is being felt by Australia's blue economy, and the oceans and coasts that support it.

In the seafood industry, the businesses that rely on the export market, dine-in food service and international air freight have been brought to their knees as their means and markets vanished almost overnight. The decrease in Chinese demand and a 45 per cent drop in price for tropical rock lobsters was particularly hard to bear for Indigenous fishers in Torres Strait, who have few alternatives to make money.

Maritime supply chains – the shipping, ports and accompanying industries that make up the oceanic bloodline of Australian and world trade – have grappled with their own impacts. The pandemic exposed the vulnerability of maritime networks, port efficiency and hinterland connectivity. Seafarers were either left stranded on ships or unable to join their ships due to travel restrictions, creating safety, mental wellbeing and operational issues.

Coastal tourism and communities were severely hit in many places. In Queensland, all tourism activity in the Great Barrier Reef stopped completely when international arrivals were suspended and the state went into a local lockdown, closing down a \$6 billion industry. Despite government assistance, many tourism operators were forced to lay off staff. There have been attempts to relaunch domestic tourism in the area, with limited success. Operators report that domestic tourists are unwilling or unable to pay the same prices as international tourists.

Meanwhile, lost livelihoods, uncertain food security and restrictions on other recreational activities saw increased fishing in no-take areas within Marine Park Areas. This puts pressure on environments that depend on these zonings for their ongoing health. From April–June 2020, the Reef Joint Field Management Programme recorded a 30 per cent increase in illegal fishing.

The loss of international markets also hit universities, including marine science education. This sector is heavily reliant on international students for income, and Universities Australia reported that the sector lost an estimated \$1.8 billion in revenue compared to 2019. Science and Technology Australia has also reported anticipated impacts on the science, technology, engineering and mathematics (STEM) workforce, with university job losses of up to 21,000 jobs, including 7,000 in research roles.

Left to right: Storms have eroded Byron Bay's Clarke Beach over a number of years; bushfires rage near Blackhead beach during Australia's Black Summer in 2019 (Credits: Byron Shire Council, Martin Von Stoll)



Building resilience and preparedness: additional recommendations |

The *National Marine Science Plan* makes it clear that sustainable management of Australia's marine estate is essential for future proofing the health of our oceans, coasts, economy and people. This requires government and industry decision-making based on environmental, social, cultural and economic data and information, which are integrated at the appropriate scale and in a coordinated way.

However, increasing pressures on our oceans and coasts, extreme events and the need to build Australia's resilience against future shocks require us to drive completion of the eight recommendations. We also need to build on these recommendations by developing and refining marine science's foundational elements and activities over the next five years.

These priorities align with and complement other important national strategies and decadal research plans such as *Climate Science for Australia's Future*, *A decadal plan for Australian Geoscience 2018–27*, the *National Research Infrastructure Roadmap*, the *Australian Antarctic Science Strategic Plan*, *Future Earth Australia's Sustainable Oceans and Coasts National Strategy 2021–2030*, and the *Reef 2050 Plan*. This ensures that the Australian marine science community is focused on current and future threats and opportunities that will provide sustainable benefits to the nation.

The Midway Point therefore identifies three new recommendations.

Below: A scientist assesses the health and carbon sequestration capacity of a saltmarsh in Bass, Victoria (Credit: I. Noyan Yilmaz/Shutterstock)



Recommendation 9 |

Develop a nationally coordinated approach to integrate the knowledge, rights, capability and aspirations of Traditional Owners into conventional marine science

There is growing recognition among government and research organisations (e.g. NESP) that Aboriginal and Torres Strait Islander peoples should play a greater role in the delivery of marine science and management of Sea Country. There are also a number of national and international drivers for improved recognition of Traditional Owners' rights to be involved in measures that affect them. These include the UN Declaration on the Rights of Indigenous Peoples, The Convention on Biological Diversity, Australia's national environmental management legislation, and the Commonwealth's Closing the gap policy agenda.

The inherent rights and interests of Traditional Owners in Australia's Sea Country are widely acknowledged and documented, formally and informally, but the marine science community is still grappling with how best to integrate these values into the scientific process.

The combination of Traditional knowledge and Western science to co-design and co-deliver programs provides the best possible knowledge base to inform modern marine management decisions, and articulate research and management actions within culturally endorsed frameworks and protocols. It will also result in greater research impact and value.

A collaborative approach will build on substantial Commonwealth, state and territory government support, and increase charitable and industry funding for Aboriginal and Torres Strait Islander ranger programs around Australia. It will also expand our ecological and biocultural knowledge, and increase the capability, capacity and geographic reach of Traditional Owners' marine monitoring, research and management.

A national synthesis of the capacity, capability, knowledge needs and science priorities of Aboriginal and Torres Strait Islander peoples, which collates and builds on existing information, will form the basis of the national approach. The marine science community commits to integrating Traditional knowledge, two-way knowledge exchange and partnerships with Traditional Owners wherever possible.

Recommendation 10 |

Establish national policy guidelines for open access to government-funded or regulatory data, provide historical-dataset access, and expand the Australian Ocean Data Network (AODN)

Understanding the status and trends of our complex marine ecosystems, including the human dimension, is crucial to the blue economy's sustainable management of marine resources, industries and coastal communities, and for emergency preparedness. This requires the integration of many multidisciplinary data streams and performant digital infrastructure.

Over the past decade, development of computational power, software systems, data storage and access platforms, and vast improvements in communications speed, means we have the potential to integrate the terabytes (trillions of bytes) of data needed to deliver state-of-the-art information products to industry, the public and decision-makers in near real time. This technological revolution is transforming marine science, along with autonomous vehicles and aerial drones, micro-sensors, enhanced machine learning, and a vast array of other new technologies. New knowledge is being generated at scales ranging from micro (genetics and eDNA) to macro (earth-observing satellites), and over intervals of nanoseconds to geological time scales.

The collection of key marine datasets across our vast ocean and country is costly and time consuming. In addition, data is held by various sectors. While many of these datasets are collected using public funds or to address regulatory requirements, relatively few are made publically available. This is primarily due to the lack of nationally agreed policies for 'open access' data, commonly-agreed data standards, and suitable repositories or funding to ingest data and make it interoperable.

A range of datasets are delivered via AODN, a dedicated public repository providing access to key marine datasets. However, AODN is primarily focused on oceanographic data and would need redesign and/or funding to accommodate multidisciplinary datasets from many sources.

AODN expansion will help unlock the power of data. It will develop and enhance Australia's capability and capacity in managing, delivering, analysing and visualising a wide range of marine data from various sources. This will require support for a well-connected and coordinated network of expert hubs, and adoption of the Findable, Accessible, Interoperable and Reusable (FAIR) data principles and CARE principles for Indigenous data governance (collective benefit, authority to control, responsibility and ethics).

Recommendation 11 |

Develop a coastal resilience-building approach firmly based in the proactive use of our natural environment

The need for novel approaches to sustain and protect our coastal ecosystems has never been more urgent. They bear the brunt of all factors affecting our marine environment, including climate change and pressures associated with development and coastal population growth. These ecosystems are some of the most challenged in Australia's marine estate, and yet they are socioculturally, economically and environmentally valuable to Australia as a nation.

Despite the widespread application of conventional management and conservation practices, degradation of these ecosystems and their value continues. To build better coastal habitats and infrastructure, we need rapid development of a more interventionist, multidisciplinary approach. In particular, an approach that combines science and engineering such as nature-based solutions (NBS), 'building with nature' and green or eco-engineering.

Using NBS to restore coastal ecosystems supports a myriad critical services, such as coastal defence, blue water purification functions, nurseries for fish stocks and enhanced spaces for wildlife and recreation. It is also more sustainable and generally more cost effective than conventional coastal engineering solutions.

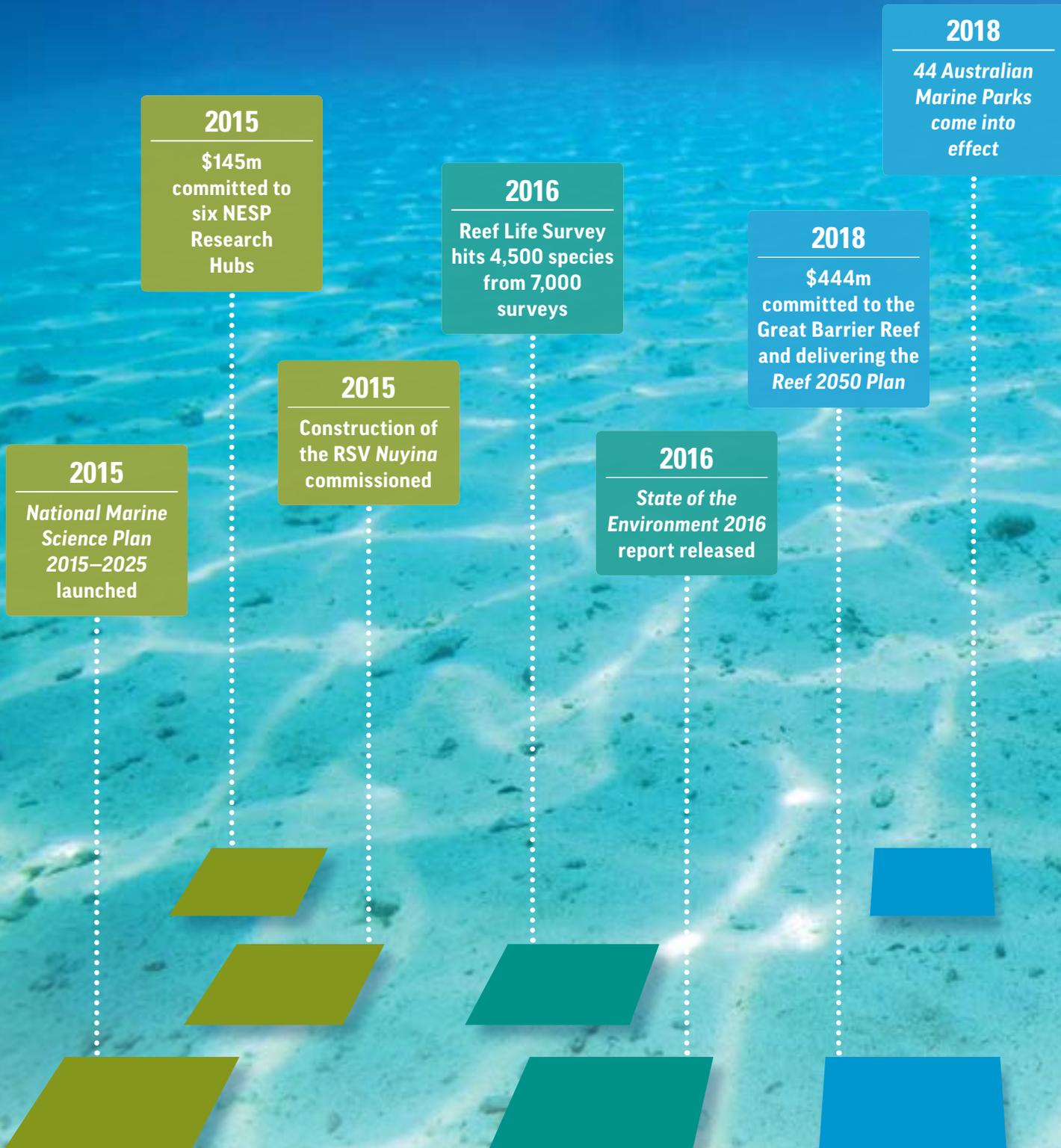
These coastal ecosystems can sequester carbon via marine macrophytes, and through restoration of seagrass beds, mangroves and, potentially, kelp forests. Such 'blue carbon' programs could help fulfil Australia's commitments to the Paris Climate Agreement. They are also consistent with current priorities for investing in soil-carbon based technology solutions for an Australian economy shifting its focus from fossil fuels.

Another NBS example includes using habitat-forming organisms to protect against coastal inundation and storm surge. Coral and oyster reefs, saltmarshes, mangroves and seagrasses attenuate local currents, dampen wave energy, and accrete and stabilise sediments. They act as an effective buffer against flooding and erosion, and grow vertically with changes in sea level to form a biological barrier that mitigates climate change-induced sea level rise.

Nature-based solutions, including those based on the knowledge and practices of Traditional Owners, are increasingly reflected in global initiatives such as the UN Decade of Ecosystem Restoration 2021–2030. They also parallel approaches for greening urban infrastructure on land. Coastal solutions may need to cover hundreds or even thousands of kilometres of coastline, so critical to NBS success is understanding how to build at scale.

Australia's marine science sovereign capability |

Since 2015, Australia has been building its national marine science capability through a range of major plans, programs, reports, infrastructure and investments.



2018
National-scale hazard estimates of extreme events delivered

2018
The national seabed mapping program AusSeabed launched

2018
Funding for IMOS and RV Investigator increased

2019
Blue Economy Cooperative Research Centre established

2019
Climate Science for Australia's Future report released

2020
Australian Antarctic Science Strategic Plan released

2020
2050 Science Framework: Exploring Earth By Scientific Ocean Drilling launched

2020
National Sea Simulator expansion announced

Call to action |

Droughts and flooding rains have surpassed the stuff of poetry as Australia grapples with increasingly intense and frequent cyclones, bushfires, marine heatwaves and floods. Rising coastal populations and competition for marine resources are turning the screws further still on our precious coastal systems. Meanwhile, the COVID-19 pandemic has been a wrecking ball, flaying industries and communities.

The 'new normal' means we can no longer return to business as usual. Indeed, we should not strive to do so. Instead, we have an opportunity to transform the way we use and prosper from one of our greatest resources: our oceans and coasts.

The blue economy has enormous potential to secure Australia's long-term economic future, including our recovery from COVID-19 and our resilience-building and preparedness for future shocks.

This economic prosperity and preparedness are intertwined with the health and sustainability of our oceans, coasts and people. And developing the blue economy will maximise economic, environmental, cultural and social benefits for all Australians for many years to come.

With the appropriate support, collaboration and investment, the blue economy's value is projected to rise to \$100 billion per annum by 2025. And its impacts will be felt across all states and territories.

The blue economy can enable Australia to lead the world in rebuilding industries such as marine tourism and education, and support the sustainable future of marine industries such as shipping, oil and gas, and commercial fishing. It can help fulfil the potential of industries such as aquaculture, marine renewable energy and innovative technology development across sectors. And it can ensure that all Australians can continue to enjoy their cultural birthright of healthy oceans and coasts, and Indigenous people their connection to Sea Country.

But we need to rapidly dial up our efforts so that we don't fall behind the global sustainable development already underway.

To achieve this, *The Midway Point* has highlighted the effort, collaboration, coordination and investment that are still needed to meet the recommendations of the *National Marine Science Plan 2015–2025*. It has also identified emerging priorities, such as the integration of Indigenous marine knowledge, unlocking the power of data and using nature-based solutions and habitat restoration to build resilience of our coastal environments.

Furthermore, the response of Australia's communities to the pandemic has laid bare our greatest power: collective action. In this spirit, we call on the research community, industry, government and the public to all play their part in supporting and developing our blue economy and ensuring a future where all Australians can prosper.



Researcher community |

We call on the research community to build on and amplify existing resources to establish truly national research programs, which incorporate all stakeholder needs, and underpin decision-making and policy-making by industry and government.

- Continue and expand collaborations across disciplines, sectors and borders, including citizen scientists and areas of society that have not been traditional science collaborators.
- Establish national policy guidelines for open data access, provide digital access to historical datasets and expand the role of the AODN to provide tools for non-specialist users.
- Develop a nationally coordinated approach to integrate the rights, interests, capacity and aspirations of Traditional Owners into conventional marine science.

Industry |

We call on industry to engage and work with scientists to ensure science underpins their operational decision-making, risk assessments and future planning, and to create businesses that are both efficient and sustainable.

- Use monitoring data to inform future food and offshore energy production, transport, marine security and urban coastal development.
- Join the open data movement to make data publicly available or usable by researchers, and partner with government to make this happen.
- Co-design a national-scale coastal modelling and forecasting system that addresses end-user needs in industry, government and community.

Government |

We call on government to focus on and invest in the blue economy as an important plank in post-COVID economic recovery and resilience-building, as well as the key to creating long-term social, cultural and environmental benefits for all Australians.

- Resolve political and jurisdictional issues that constrain the implementation of coastal system programs and national studies.
- Continue and increase support for critical foundational infrastructure, such as IMOS beyond 2023, extended operational capacity on RV *Investigator* (300 days per year beyond 2022) and capability (coastal fleet), and a coordinated national research vessels fleet.
- Establish national open data policies across sectors, and support and extend the AODN.

Community |

We call on the community to recognise the responsibility we all share as a marine nation, and to play an active role in ensuring the long-term health of our oceans and coasts for all Australians.

- Take part in citizen science projects such as Reef Life Survey, Witness King Tides, ClimateWatch Australia, ReefWatch, Waterwatch, RedMap, Coastal Walkabout and more.
- Engage with marine science and the conversation around climate change, pollution and sustainable coastal development.
- Encourage national and local governments, and industries to develop sustainable practices and undertake nature-based initiatives to build resilience of coastal areas.



From left to right: an AIMS scientist and an Indigenous ranger go over monitoring information; a deep water mooring is set for deployment as part of IMOS' Southern Ocean Times Series; citizen science projects like Eye on the Reef enable the community to get involved and help collect information on vast marine areas; the RV *Investigator* in action off the Queensland coast (Credits: Tristan Simpson, Gloria Salgado Gispert, M. Knapton ©Commonwealth of Australia, GBRMPA, Owen Foley)

Acknowledgements |

The NMSC developed the *National Marine Science Plan 2015–2025: The Midway Point*, with special mention to the following people for their valued inputs throughout the process –

Lynnath Beckley	Toni Moate
Penny Berents	Julian Partridge
Anthony Boxshall	Kim Picard
Martina Doblin	Rachel Przeslawski
Libby Evans-Illidge	Ben Preston
Shane Fava	Andreas Schiller
Paul Hardisty	David Smith
Michelle Heupel	David Souter
Patrick Hone	Carolyn Stewardson
Alan Jordan	Tim Ward
Johnathan Kool	Peter Steinberg
Catherine Maher	Luke Twomey
Sebastien Mancini	Peter Veth
Tara Martin	Tony Worby

Jane Lyons and Sophie Schmidt wrote and edited *The Midway Point*, and Louise Bell designed the document.

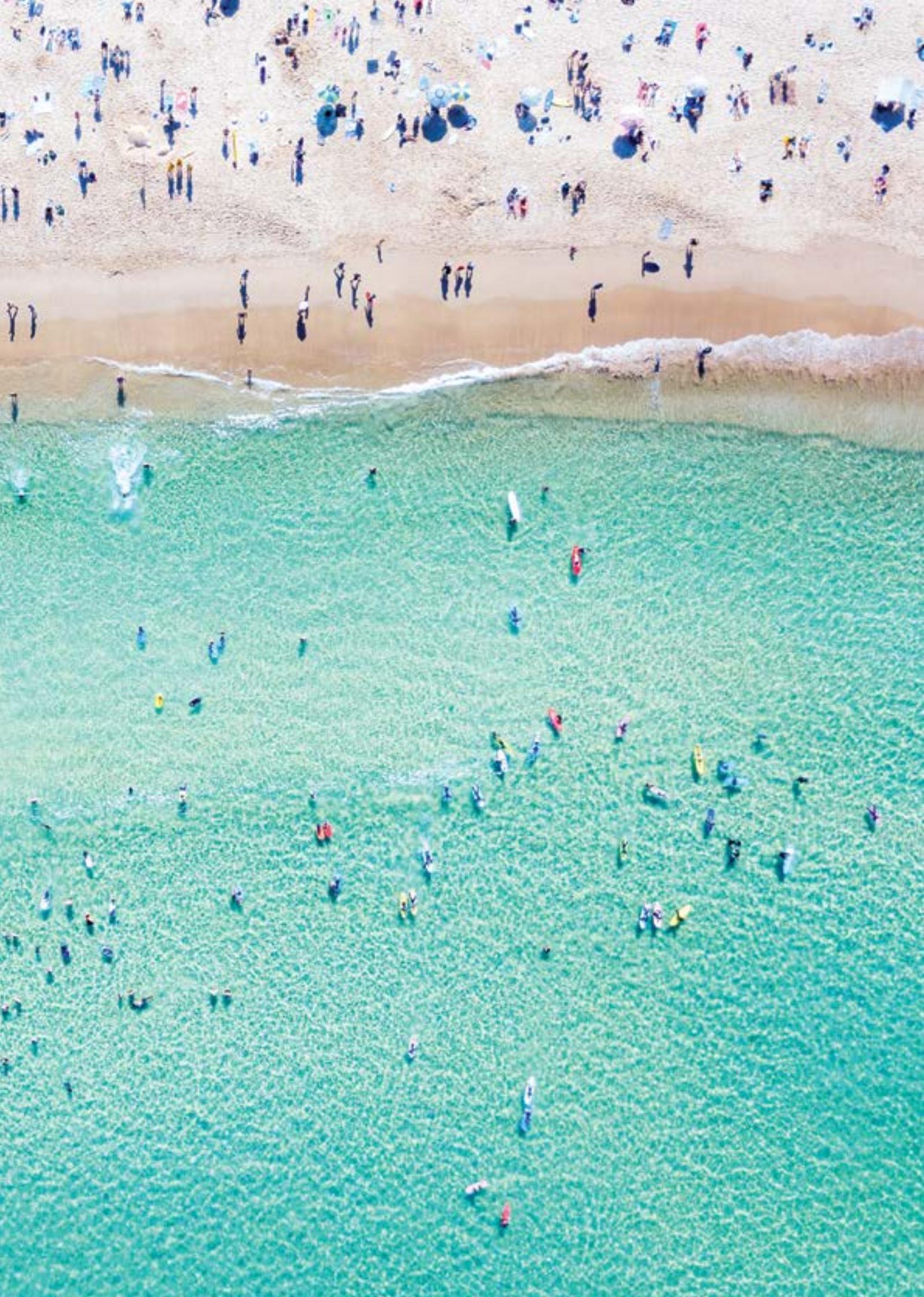
The NMSC would also like to acknowledge Ian Poiner for reviewing this report.

Endnotes |

1. Oceans Policy Science Advisory Group (2013), *Marine Nation 2025: Marine Science to Support Australia's Blue Economy*, Australian Government, Canberra
- 2.3. Australian Institute of Marine Science, *The AIMS Index of Marine Industry* www.aims.gov.au/publications.html (from 2017/2018 data, which is the most recent).
4. Australian Institute of Marine Science, *The AIMS Index of Marine Industry* www.aims.gov.au/publications.html (from 2015/16 and 2017/18 data). These output figures represent marine industry revenue. While this is a useful metric for the blue economy's value, the output of one industry can become the input of another industry and lead to double-counting. Therefore, *The Midway Point* focuses primarily on the blue economy's value-added economic contribution. This framework focuses on the flow value of Australian marine industries to the national economy and employment. This approach is consistent with the National Accounting Framework used by the Australian Bureau of Statistics to measure GDP. It also enables comparisons between the value of marine industries and the value of other industries to the economy.

Oceans and coasts are part of Australia's cultural heritage and psyche – Sydney's Bondi Beach on a summer's day (Credit: Darren Tierney/Shutterstock)







Australian Government



Bureau of Meteorology

Department of Agriculture, Water and the Environment
Australian Antarctic Division
Australian Bureau of Agricultural and Resource Economics and Sciences
Australian Fisheries Management Authority
National Parks Australia



Department of Defence

Australian Hydrographic Office
Defence Science and Technology Group



Department of Education, Skills and Employment

Department of Foreign Affairs and Trade



Department of Industry, Science, Energy and Resources
Geoscience Australia



Great Barrier Reef Marine Park Authority



The National Marine Science Committee developed the *National Marine Science Plan 2015–2025: The Midway Point*

**NATIONAL
MARINE
SCIENCE
— COMMITTEE —**

