Chief Scientist

AUSTRALIA 2025: SMART SCIENCE

THE CONVERSATION

We need to play our cards right if Australia's marine environments are to keep us afloat. Saspotato/Flickr, CC BY-NC-SA

Marine science: challenges for a growing 'blue economy'

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AUSTRALIA 2025: How will science address the challenges of the future? In collaboration with The Conversation, we're asking how each science discipline will contribute to Australia now and in the future. Written by luminaries and accompanied by two expert commentaries to ensure a broader perspective, these articles run fortnightly and focus on each of the major scientific areas. In this instalment we dive into marine science.

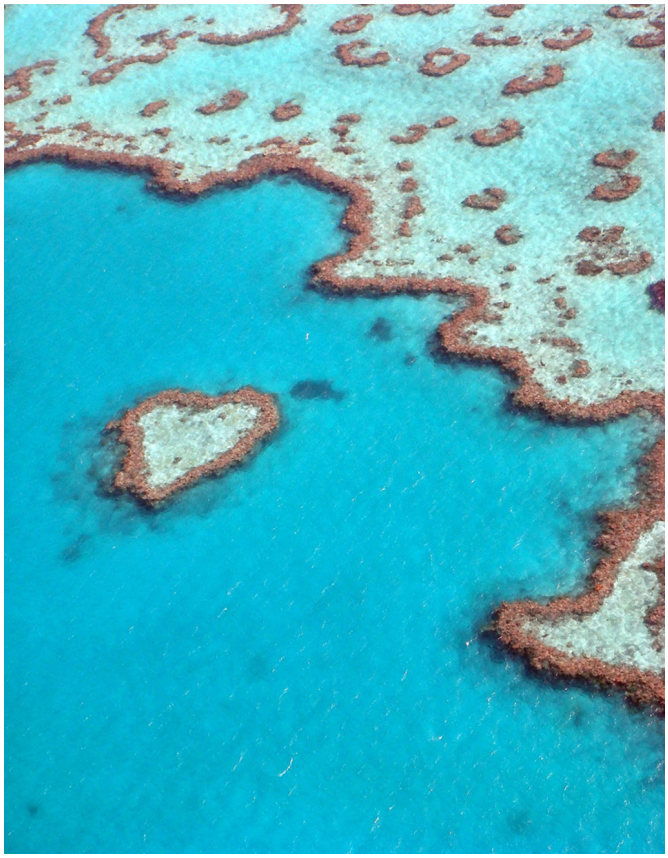
Why are our oceans important to us? How is our health, the health of the environment, the strength of our economy and indeed, our future, dependent on the seas? How can marine science help us, collectively, to sustainably develop our marine-based industries and at the same time protect our unique marine ecosystems so that they can be appreciated and enjoyed by future generations?

In many ways, Australia is defined by the oceans that surround us. We have the third largest ocean territory in the world. The majority of our trade travels by sea, vast offshore oil and gas resources earn vital export income and offer a long term, cleaner energy source than coal and our fisheries and aquaculture industries provide healthy food.

We are custodians of two magnificent marine World Heritage Areas – the Great Barrier Reef and Ningaloo Reef – and we are a nation that loves to sit by, swim, surf, dive, fish and sail in the (mostly) clean waters and healthy marine ecosystems that surround our continent.

Australia's affinity with our ocean estate is perhaps best exemplified by the fact that 85% of our population lives within 50km of the coast.

Marine industries contributed approximately A$42 billion to our economy in 2010. This is projected to grow to approximately A$100 billion by 2025 with the expansion of current industries and development of new opportunities in areas such as renewable energy. As a nation we will increasingly be dependent on our "blue economy" for our future prosperity.



Birds eye view of the Great Barrier Reef. Su Fuidge/Flickr, CC BY-NC-ND

In addition to their economic and aesthetic value, our oceans also provide a suite of essential "ecosystem services" – most importantly in their role within the global climate system. Since the end of the 18th century, about 30% percent of human-induced carbon dioxide emissions have been taken up by the oceans while over the past 50 years, they have absorbed about 90% of the extra heat generated through the impacts of the greenhouse effect.

The moderating influence of the oceans as our planet warms, and their very strong influences on our island continent's weather, impact on every Australian, every day.

Six grand challenges facing our marine nation

If Australia, and indeed the world at large, is to continue to enjoy and grow the benefits accrued from our oceans, we need to face up to and meet a number of significant (and in some cases urgent) challenges.

Australia's marine science community recently collaborated with governments, not-for-profit organisations and the private sector to produce the report Marine Nation 2025: Marine Science to Support Australia's Blue Economy.

Marine Nation 2025 outlined six, interconnected "grand challenges" facing Australia, each of which has a significant marine dimension with gaps in understanding or requirement for tools that can be addressed by marine science:

1. sovereignty, security, natural hazards: needs improved operational oceanographic forecasting and increased effort on fine-scale hydrographic data and charts
2. energy security: needs support for developing energy resources, particularly liquid natural gas and renewable energy and research to support carbon sequestration
3. food security: needs research to support a booming aquaculture industry, as well as data and tools to improve management of wild-catch fisheries

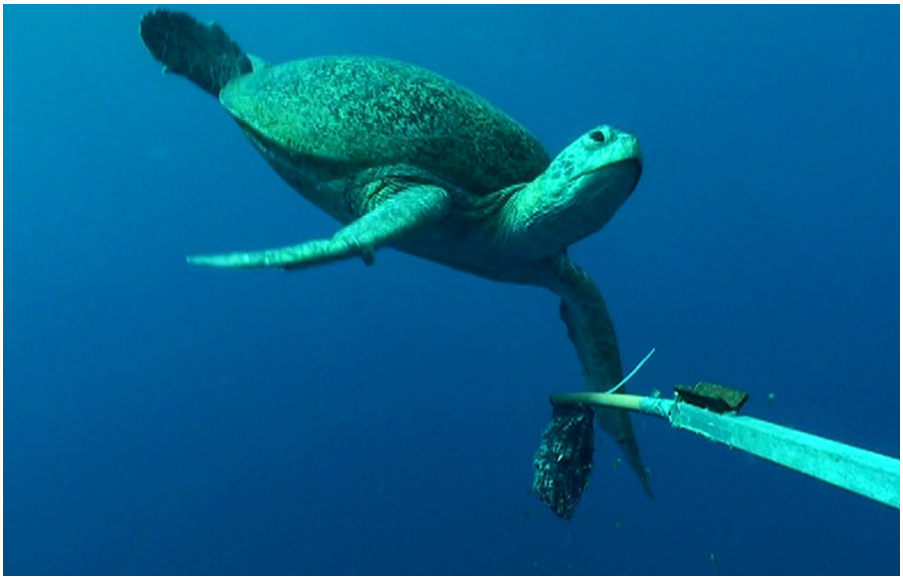
4. biodiversity conservation and ecosystem health: needs environmental baselines, effective indicators of ecosystem health to guides national marine environmental monitoring, and tools to predict impacts of development on marine biodiversity

5. dealing with changing climate: needs enhanced understanding and skill in prediction of the impacts of sea level rise, increasing sea temperature and ocean acidification and the role of the ocean as a carbon sink

6. optimal resource allocation: needs integrated social, economic and environmental information and tools to assist transparent, robust and accountable decision-making.

The multidisciplinary nature of marine science, the geographic scale and connectedness of marine systems, and the complexity of the challenges above mean that in the majority of cases no one institution (or in the case of industry, one company) can build the evidence base or tools required to adequately address these challenges, even at local scales.

Thus, a dedicated and coordinated effort across our national marine science community, governments and industry is required.



Oceans Institute/Flickr, CC BY-NC-SA

Coordination can (and should) ensure that resources are used efficiently and strategically, and allow the full breadth of the marine science community – from the fundamental work conducted across the university sector, to the translational and applied science conducted by national science agencies such as CSIRO, Geoscience Australia and the Australian Institute of Marine Science (AIMS) – to have the maximum impact.

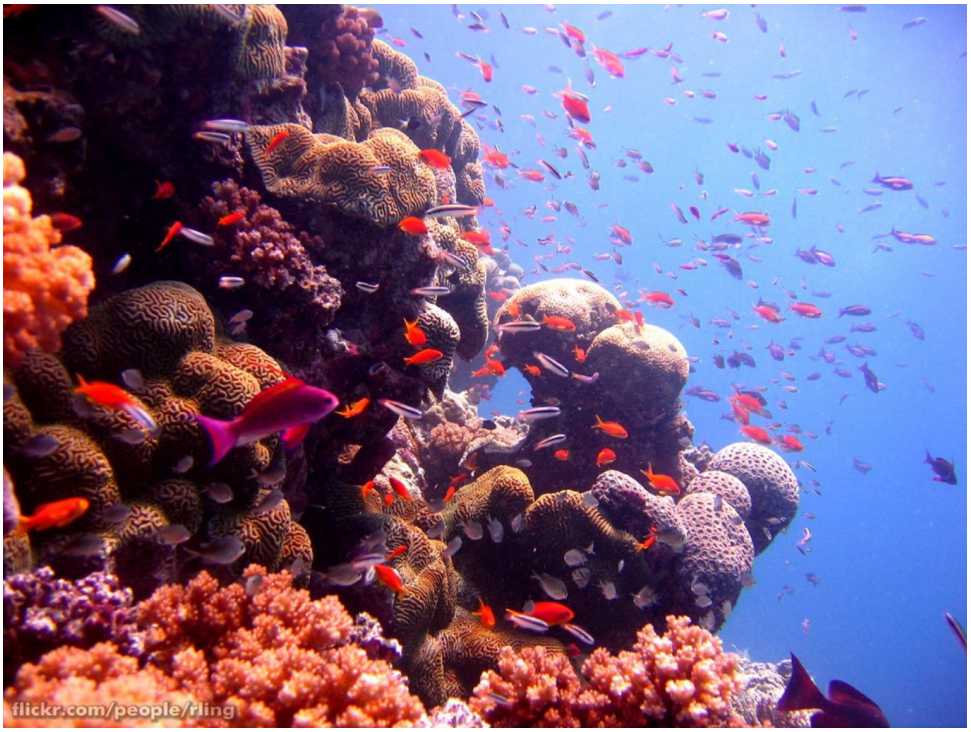
A couple of recent cases illustrate of how strategic, collaborative efforts across organisations and sustained investment in national-scale infrastructure provide vital support for decision makers across government and private sectors.

CSIRO oceanographer David Griffin has been involved in the search for Malaysian Airlines flight MH370 this year.

He used advanced models of ocean currents around Australia developed through a collaboration between CSIRO, the Bureau of Meteorology and the Australian Navy over the past decade, to determine likely movement of wreckage and allow search and rescue operations to pinpoint their activities.

The same models can also be used to track and predict oil spills, missing boats, valuable fish stocks and guide Navy operations.

The critical data required by the models comes from Australia's Integrated Marine Observing System (IMOS), a national, collaborative infrastructure facility set up eight years ago. IMOS has become an international leader in ocean observing and is now the critical observational foundation for much of Australia's marine science.



A shoal of anthias (Pseudanthias sp.) swarm over a coral garden, Great Barrier Reef. Richard Ling/Flickr, CC BY-NC-ND

Two strategic and sustained marine science investments – in ocean observations and modelling – provide the fantastic capability for David's work, and many other applications to come.

Similarly, following the UNESCO World Heritage Committee's questions about our management of the Great Barrier Reef World Heritage Area, Australia's response has relied heavily on the body of evidence provided by strategic investment in marine science conducted over the past 30 years.

Science doesn't always tell a good news story – the AIMS long term monitoring has shown that half of the Great Barrier Reef's coral cover has been lost over the past 27 years due to the cumulative impacts of cyclones, Crown of Thorns starfish and bleaching (caused by heat stress).

Importantly though , the research conducted by AIMS, the ARC Centre of Excellence for Coral Reef Studies (lead by James Cook University) and others also provides the evidence base for understanding ecosystem health and development of policy and regulation to stop the decline and rebuild the reef.

The way forward

Australia has world class, and in many areas world leading, marine science capability. Appropriately, over the past few years the marine science community has recognised the need to work together and is increasingly collaborating in providing big-scale science focused on national and global needs.

But if we are to rise to the challenges of our growing "blue economy", we will need to do much more. We will need to take a long-term outlook and focus effort on both the development of science capability (human and physical) and securing the best possible returns to Australia through its effective coordination and utilisation.

The first steps along this pathway are clear:

1. a stable, sustained and genuinely national approach to maintaining, updating and transforming the infrastructure needed to conduct world-class marine research, along with the human resources to run it

2. targeted training and skills development in marine science (in particular, advanced quantitative skills), along with mechanisms to support and incentives for collaboration

3. direction of greater effort into communicating the relevance and benefits accruing from marine science, to ensure optimal awareness and uptake in policy, legislative and regulatory domains.

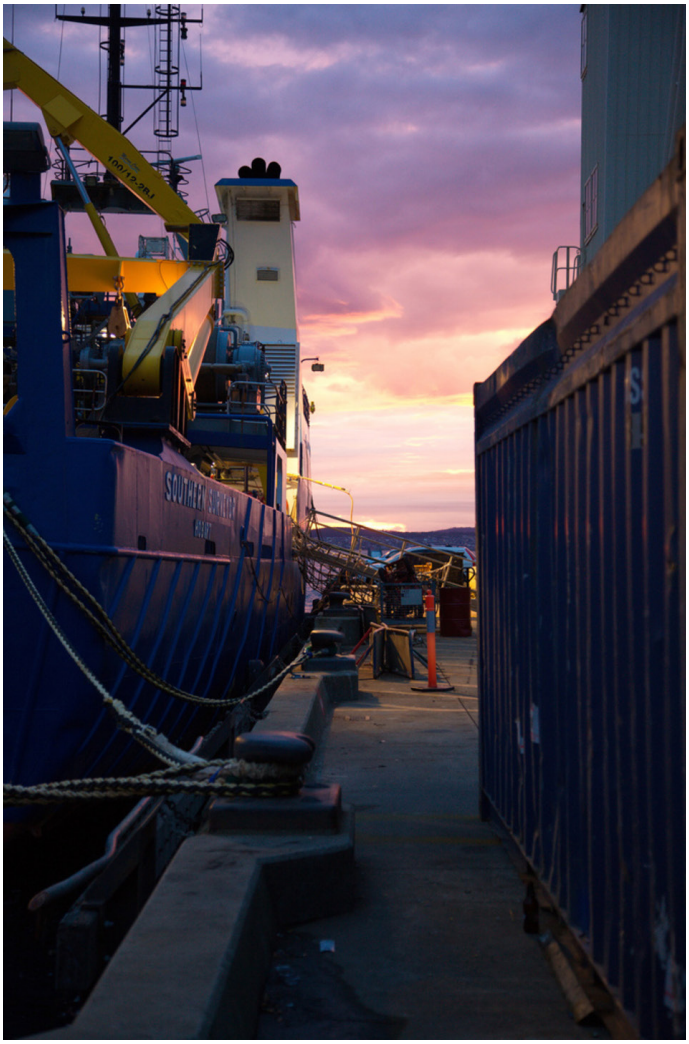
Sabine Dittmann, Associate Professor of Marine Biology at Flinders University

Marine sciences deliver data and modelling on oceanographic patterns benefiting weather forecast and maritime safety, provide information underlying sustainable seafood harvesting and production and knowledge on marine life underpinning biodiscoveries.

Yet it is a challenge to carry out marine research throughout the huge realm of Australia's maritime jurisdiction. Australia has only a small fleet of research vessels for coastal and offshore waters and needs a better alliance of shore-based marine field stations. Ocean exploration relies on technological innovations.

As much of the oceans are still unexplored, curiosity driven research can provide useful discoveries such as alternative products to benefit human health. The Census of Marine Life illustrated the highly diverse marine life in Australia's seas, but taxonomy is a threatened skill unless the tide turns for museum research funding.

Rigorous experimental hypothesis testing, using shore- and sea-based facilities equipped with operating funds, technical and research staffing, can support mitigation of cumulative impacts and global warming. Marine research strengthens monitoring into the health of Australia's seas facing growing economic use, the effectiveness of marine protected areas and biosecurity of marine invasive species.



The RV Southern Surveyor is a national facility available to marine scientists to explore and study Australia's oceans. longreach/Flickr, CC BY-NC-SA

Understanding marine ecosystems requires multidisciplinary approaches and a well-connected network of scientists. At times of highly competitive research circumstances, appreciation for collaborative skills has to increase.

Higher education in marine sciences, including maritime engineering, provides an informed and versatile work force to address challenging scientific questions and generate knowledge for decision making on the wise use of the seas around us. Continued participation in international programs on ocean exploration will strengthen Australia's position as a leading nation for marine sciences.

Mike Coffin, Professor and Executive Director, Institute for Marine and Antarctic Studies at University of Tasmania

How inappropriate to call this planet Earth when it is quite clearly Ocean.
- Arthur C Clarke

The global ocean is humankind's common heritage and responsibility. Ocean under Australian jurisdiction is significantly larger than the nation's landmass. Our 0.3% of the world's population is custodian for 3.8% of the world's ocean, by far the greatest responsibility per capita among the G20 nations.

Effectively managing our vast public marine domain requires understanding it, yet our ignorance of the dynamic ocean is profound:

- of an estimated 2.2 million species of marine life, 91% await discovery and description
- how changes in factors such as ocean temperature, acidity, light supply, nutrients and trace metals combine to drive marine life to acclimate, adapt or extinction is not understood
- 95% of the world's seafloor remains to be mapped in detail
- the soundscape of the 98% of the ocean beneath the surface zone, where light doesn't penetrate and most life uses sound as its primary sense, is virtually unknown.

Australia's vital and growing blue economy critically depends on understanding and managing the sea, through both national efforts (such as the Integrated Marine Observing System) and international partnerships (such as the International Ocean Discovery Program).

Erik Veland/Flickr, CC BY-NC

But much of the nation's capability in the three pillars of marine research — observation, experimentation and modelling — across the major marine scientific disciplines — biology, chemistry, geoscience and physics — is precarious due to short-term and therefore vulnerable support.

In the context of a to-be-developed national strategy for marine science, increased and sustainable investment in exploratory, basic, applied and translational marine research — in both human capability and infrastructure — as well as improved underpinning primary, secondary and tertiary education in science and mathematics are needed to ensure a healthy, productive and resilient ocean for present and future generations.