SUBMISSION TO THE 2016 NATIONAL RESEARCH INFRASTRUCTURE ROADMAP INITIATIVE – NATIONAL RESEARCH VESSEL ALLIANCE

Prepared by the National Marine Science Committee Working Group – National Research Vessel Alliance

NATIONAL MARINE SCIENCE COMMITTEE

SUBMISSION TO THE NATIONAL RESEARCH INFRASTRUCTURE ROADMAP INITIATIVE
NATIONAL RESEARCH VESSEL ALLIANCE

Proposal

To invest $165 million across the next decade to establish a national coordinated fleet of purpose-built large-scale (greater than 20 metres in length), offshore research vessels capable of covering Australia's marine estate from the coast to the blue water, and the tropics to Antarctica. This involves:

- An increase in funded marine research days from 180 to 300 on the Marine National Facility, Australia's world class blue water research vessel, to enable full utilisation of funded infrastructure in line with established science demand, advancing research activities of national or international significance;
- Replacement and/or upgrade of Australia's independently operated, ageing coastal vessels to establish a coordinated coastal-shelf research vessel fleet fitted with specialised equipment capable of operating in deeper, offshore waters; and
- Funding for 50 dedicated sea days in each of Australia's four regions covered by our coastal-shelf research vessel fleet, to provide an additional 200 days per year to address national marine research priorities with a focus on the coastal-continental shelf zone.

National Benefit

The development of a national research vessel alliance will be a strategic long-term investment for Australia and is increasingly critical to the future of marine science in Australia and the sustainable development of our seas and oceans. It will provide the necessary capacity and capability to:

- Unlock the wealth and opportunities from Australia's blue economy, estimated to double to $100 billion by 2025;
- Ensure that by international standards Australia maintains its modest national research vessel capability relative to our marine estate, the third largest in the world;
- Undertake core marine research to underpin sustainable management of Australia's fisheries and environment;
- Provide essential support to national science programs, such as the Integrated Marine Observing System, and to attract international initiatives to our region such as the International Ocean Discovery Program;
- Support industry by providing direct access to specialised vessels for specific projects;
- Respond to nationally significant maritime events if required, safeguarding Australia's marine estate; and
- Maintain Australia's status as a world class marine research nation.

A nationally coordinated fleet of large-scale offshore research vessels to support the sustainable development of Australia's oceans, seas and marine resources

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The development of a coordinated national fleet of research vessels will be a **strategic long-term investment** for Australia and is critical to the future of marine science and the sustainable development of our seas and oceans.

EXECUTIVE SUMMARY

This submission from the National Marine Science Committee (NMSC) details the necessary infrastructure required to form a national alliance of a coordinated fleet of research vessels that cover Australia's extensive and valuable marine estate.

With Australia having the third largest marine estate in the world, the NMSC considers that for our nation to fully realise the significant benefits that our blue economy can generate (an anticipated increase from the current $47 billion to $100 billion by 2025), investment in the order of at least $165 million[1] over the next decade in the foundational marine science capability provided by research vessels is required.

This investment over the next decade should include:

- an increase from 180 to 300 funded operating days for full utilisation of the Marine National Facility (MNF; $80 million);
- build replacement/upgrade of four ageing coastal-shelf research vessels ($65 million)[2];
- a scheme to enable the marine science community to fully utilise coastal-shelf research vessel capability, such as providing up to 50 funded operating days for contestable marine science in each region (northern, southern, western, eastern) across the range of the coastal-shelf research vessels ($20 million).

This submission focuses on research vessels greater than 20 metres in length that can operate out to the edge of the continental shelf or in 'blue water' (the open sea). These vessels are large enough to enable the use of specialised and state-of-the-art equipment to sample deeper, offshore waters, as well as to accommodate the necessary teams of scientists to conduct the research. Currently, Australia's cohort of research vessels is unable to service the research and knowledge needs of the entire Australian marine estate. In addition to having a cohort of research vessels capable of operating across this large and diverse geography, Australia also needs to invest in the technical capability carried by these vessels and better coordinate their effort and capacity. This includes using international research vessels, which Australia draws upon to investigate the deep ocean.

A healthy marine environment underpins our important marine industries including fisheries, aquaculture, shipping, petroleum, mining and ecotourism. It is therefore critical that Australia's research vessel capability is modern, fully funded and fully utilised to produce the robust scientific evidence required for sustainable growth in these industries. Such evidence will enable the nation to protect and expand our marine industries, optimise resources, and support sustainable development and job creation.

A national alliance of a coordinated fleet of large-scale, offshore research vessels that cover Australia's marine estate, from the coast to the blue water, and the tropics to Antarctica, will increase the opportunities for scientific collaboration and discovery and enable the necessary data and information to be collected to derive the benefits from the nation's blue economy, while ensuring Australia's marine science infrastructure and capabilities remain world leading, innovative and cutting-edge. Such a fleet will also increase highly beneficial research cooperation with other countries.

[1] Investment ranges from an estimated $10 million to $25 million per year from 2017-18 to 2026-27; all investment figures are indicative and have not been indexed, are ex-GST and depreciation has not been included.

[2] If Australia were to expand its coastal-shelf research vessel capability to fill the capability gap between the 35 metres *RV Solander* and 94 metres *RV Investigator* (i.e. a research vessel about 45 metres in length), it has been estimated this would require a capital investment of $40 million with a further $60 million required over the decade for operations and maintenance

VALUE OF MARINE SCIENCE TO THE AUSTRALIAN ECONOMY

Globally, the blue economy is becoming increasingly important, with investment plans and ocean policies being developed around the world[3]. In 2015, United Nations (UN) member countries adopted a set of 17 Sustainable Development Goals and associated targets designed to end poverty, protect the planet and ensure prosperity for all. Goal 14 is 'conserve and sustainably use the oceans, seas and marine resources'[4].

The UN has set out ten targets to be achieved between 2020 and 2030 in support of this goal. High quality marine science, and the necessary infrastructure including research vessels to support the science, are critical for Australia and other nations to achieve almost all of these targets.

In Australia, our marine environment supports fishing, aquaculture, ship building, ecotourism and mining, all of which are key sources of employment and important to the nation's economy, security and regional communities. The pressures on our marine environment from these industries, however, have been steadily increasing, highlighting the need for robust scientific evidence underpinning sustainable management of Australia's marine estate. By 2025, it is estimated that Australia's marine industries will contribute around $100 billion each year to the economy, more than double its current contribution of $47 billion a year[5] and growing three times faster than the national GDP. Marine ecosystem services will add another $25 billion through carbon dioxide absorption, nutrient cycling and coastal protection.

To realise these economic benefits while maintaining ecosystem health, Australia's *National Marine Science Plan 2015 2025 Driving the Development of Australia's Blue Economy* (NMSP) focuses on investment supporting the major development and sustainability challenges facing Australia's marine estate[6]. This also aligns with several Government priorities, including:

- Two of the six government's Industry Growth Centre's include marine industries: fisheries and aquaculture, as well as offshore oil and gas[7];
- Australia's National Science and Research Priorities of food; transport; energy; resources; soil and water; and environmental change[8], strongly align with aspects of Australia's blue economy such as fishing and aquaculture; ship building and ecotourism; offshore oil and gas mining; seabed mining; and a healthy marine environment;
- The National Collaborative Research Infrastructure Scheme has invested $158 million to date into the Integrated Marine Observing System (IMOS), with a further $228 million cash and in kind support from research agencies, universities, State governments and industry. The recent National Innovation and Science Agenda has committed an additional $1.5 billion 10 year investment to national research infrastructure capability and is likely to apportion funding towards continuing IMOS[9];
- In April 2016, the Australian Government signed a contract to design, build, operate and maintain a new resupply and research icebreaker for the Australian Antarctic Division (Department of Environment and Energy) committing $1.9 billion for the 30 year life of the vessel.

[3] IOC/UNESCO, IMO, FAO, UNDP (2011) A Blueprint for Ocean and Coastal Sustainability. Paris: IOC/UNESCO
[4] Sustainable Development Goal 14, http://www.un.org/sustainabledevelopment/oceans/
[5] Australian Institute of Marine Science Index of Marine Industry www.aims.gov.au/publications.html (from 2011/12 data)
[6] National Marine Science Plan 2015 2025: Driving the development of Australia's blue economy
[7] http://www.industry.gov.au/industry/Industry Growth Centres/Pages/default.aspx
[8] http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Pages/default.aspx
[9] Commonwealth of Australia, Department of the Prime Minister and Cabinet, National Innovation and Science Agenda

To ensure the nation's blue economy potential is realised, Australia needs to *protect* our unique, endemic natural assets and marine resources; *build* on our leading science capability and infrastructure to the benefit of our decision makers and industry; and *grow* our marine dependent fishing, aquaculture, petroleum, mining, ecotourism and bioprospecting industries.

None of this can be achieved without the capability for Australian marine scientists to go to sea, so we can measure, monitor and understand our coasts and oceans. A national alliance of modern and safe research vessels (defined as greater than 20 metres in length) that can support science from the Antarctic to the tropics is critical to Australia's prosperity to derive the benefits from our blue economy. These vessels and the technologies they carry need to remain world leading, current, be fully utilised and work effectively and efficiently.

PURPOSE
EFFECTIVE AND COORDINATED RESEARCH VESSEL INFRASTRUCTURE

This National Marine Science Committee (NMSC) submission to the National Research Infrastructure Roadmap details the necessary components of a national alliance of research vessels.

The NMSC recommends that Australia needs at least the following research vessel capability to ensure Australia's marine science community, from both the public and private sector, is able to deliver the knowledge required to manage and capitalise upon Australia's vast marine estate:

- Marine National Facility (MNF) – increase to full working capacity from 180 to 300 days at sea;
- Australian Antarctic Program icebreaker – allocation of sea days for dedicated marine science use (now agreed for future icebreaker);
- Coastal-shelf research vessels – providing for 1) replacement and/or upgrade of ageing coastal research vessels, and extending this capability where feasible, and 2) funding to ensure the coastal research vessels are fully utilised (where applicable).

The submission focuses on large scale (greater than 20 metres in length) research vessels able to operate out to the edge of the continental shelf or in blue water. The scale of these vessels enables the use of specialised equipment to sample deeper, offshore waters, as well as to accommodate the necessary teams of scientists to conduct the research.

The submission also covers the technical capability that research vessels carry and provisions that will enable better coordination of effort and capacity, including how best to support and use international research vessels.

The purpose of this submission, therefore, is to:

- outline the long-term research vessel infrastructure Australia needs to build and sustain its future marine science and innovation capability in support of its blue economy; and
- prioritise required investment in the nation's research vessel infrastructure.

BENEFITS
INVESTING IN AUSTRALIA'S RESEARCH VESSELS

Australia's marine research vessels support collection of critical data and information from across our diverse geography enabling understanding of environmental baselines and impacts, ocean conditions, petroleum and mineral resources, climate change, fish stocks, ecosystem effects of fishing and biosecurity threats; all of which can unlock the wealth and opportunities from our blue economy.

Coverage and use

Our highly complex marine estate is largely unexplored, covering millions of square kilometres. It includes deep sea canyons, undersea mountains, and the world's largest coral reef. It extends from the Antarctic to the tropics and is subject to weather extremes such as cyclones and intense polar storms. Increased capability and diversification of available functionality, especially at the mid size coastal-shelf vessel range, will ensure all regions within Australia's domain are accessible, as and when required. This includes the technologies/capabilities that they carry because maintaining technological currency and maximising the area able to be covered from these platforms (e.g. by using autonomous and remotely operated underwater vehicles) increases the return on research vessel investment.

Knowledge about Australia's marine estate is not only critical to Australia but also for global understanding and for those regions that connect to our marine jurisdiction. Increased investment in research vessel capability is required to maintain and/or extend our current leadership position in different marine science disciplines. We cannot depend on the regional and international marine science community to deploy research infrastructure to understand our marine estate. International research vessels only occasionally visit our waters (see Box 1: International Ocean Discovery Program), and Australia cannot depend on these visits to build our knowledge base. Australia is also uniquely positioned to be a leader in marine science as the custodian of globally significant systems, such as the Southern Ocean, Great Australian Bight, Great Barrier Reef, Ningaloo Reef and the North West Shelf. Being able to lead science in these locations gives us a place at the table in international initiatives and also ensures we remain competitive under those international obligations dependent on science leadership, such as the UN Law of the Sea and the Antarctic Treaty. As a developed nation, the international community expects Australia to play its part and invest in building greater knowledge of our oceans which will be significantly enhanced by ensuring our research vessels, from the coasts to the blue water, are fully utilised and remain at the leading edge in terms of their design and functionality.

Undersea exploration, particularly in the deep oceans, is conducted using cutting edge technologies deployed from research vessels such as the use of autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs) that enable accurate mapping and analysis of the sea-floor. Maintaining technological currency and maximising the area covered by these explorations is important as it provides essential information, such as the geological context for our biological understanding and documentation of geological events that have occurred throughout history and shaped our marine estate.

Only 28% of Australia's marine estate has been mapped with any detail through multi beam echo soundings and benthic samples. A systematic program of multi beam data capture and analysis needs to be undertaken from suitably equipped research vessels to continue to build foundation knowledge of our marine environments that may contain significant untapped resources and ecosystems of national ecological significance. Coordination of coastal-shelf and blue water research vessel surveys is a necessary and cost effective step toward efficiently mapping Australia's marine estate, as well as consideration of new capability to be deployed from these vessels. This is critical as resource exploration activities are intensifying and reaching further offshore, such

as in the Great Australian Bight. These locations are among our least known, logistically difficult to access and most expensive areas of operation, outside of the Antarctic. Being able to access these waters is critical, if we are to unlock their resources in an informed and sustainable manner.

Australian research vessels also have an important role to play in responses to nationally significant maritime events. The Montara oil spill on the North West Shelf, the *MV Shen Neng 1* grounding in the Great Barrier Reef, and trapping of *MV Akademik Shokalskiy* in the Antarctic, all triggered responses involving ships from the Australian research vessel fleet. These were either direct responses to assist vessels at risk or to quickly map impacts or obtain environmental baselines prior to an oil slick reaching environmentally sensitive sites. The knowledge gained through these activities has contributed to long term policy making; thereby, improving future management of risks and the provision of baseline information for monitoring impacts and protecting our marine estate.

Access

All of Australia's research vessels are used collaboratively, by both domestic and international stakeholders, even though the coastal-shelf vessels are owned by specific institutions. For instance, the two research vessels currently operated by the Australian Institute of Marine Science (AIMS), *RV Solander* and *RV Cape Ferguson*, incorporate national or international collaborators on more than 50% of all of their trips. The access models used for such collaborative use vary depending on the institute that owns and operates each research vessel. In general, operators of coastal-shelf vessels charge for access as these vessels are either not fully funded or they are a key part of the institution's business model.

Australia's research vessels support project-specific science voyages, as well as national science programs such as IMOS (see Box 2), the National Environmental Science Program and the Australian Antarctic Program. Research vessels are also platforms to enable servicing of other, often remote, marine science infrastructure including observing technologies. All our research vessels provide a national benefit, while the coastal-shelf vessels are also critical to the missions of the various institutions that own and operate them.

International researchers and scientific programs access Australian research vessels as part of broader collaborations and as part of Australia's involvement in international programs, and the reverse applies for Australian scientists accessing international vessels (see Box 1: International Ocean Discovery Program). Marine science is multinational and multidisciplinary in character, and increasing international cooperation is in everyone's interests. Because foreign vessels often have different capabilities from ours, and foreign institutions often have different but complementary research skills and interests, there is great value in cooperating in foreign-led expeditions inside and beyond our marine jurisdiction. Australian scientists can also use their equipment on our vessels, or deploy our equipment and scientists on theirs.

A relatively small number of university academics access major research vessels, usually as part of larger consortia. Vessel use by universities is often required for teaching and training requirements; activities often incompatible with research voyages. This can limit the research and training opportunities within a university as their planning and funding is constrained by availability and scope of research infrastructure. Keeping cost barriers as low as possible, as well as enabling competitive access to the MNF and other funded research vessels, will encourage greater engagement by the university sector with the broader research vessel fleet.

Besides gaining data and information from broader scientific programs collected on the nation's research vessels, industry also accesses Australia's research vessels by contracting the institution that owns a particular vessel to conduct a specific research project. For example, for several years the oil and gas sector has occasionally used Australian research vessels on the North West Shelf and more recently in the Great Australian Bight. The alternative, accessing commercial vessels for marine science, is far from ideal as these vessels are difficult to source, not adequately equipped or surveyed for operating technical scientific instrumentation or carrying large numbers of scientific crew.

INTERNATIONAL OCEAN DISCOVERY PROGRAM (IODP)

Marine geoscience information from the world's oceans is vital in understanding the Earth's past, present and future, in fields such as plate tectonics, climatic and oceanographic changes, evolution of life forms, geological hazards, and petroleum and mineral resources.

Geoscience information is important as an aid to establishing science policy and industry initiatives in areas such as mapping the sea-floor sediments to assess their potential for mineral resources, characterising the subsurface geology to aid in the assessment of petroleum potential, and building an understanding of global climate change.

Marine geoscience surveys using the *RV Investigator*, the new icebreaker, and coastal vessels working on the continental shelf are essential in attracting the International Ocean Discovery Program (IODP) to our region.

The IODP is a continuation of the world's longest running and most successful international geoscience research collaboration. Its scientific ocean drilling program has an annual operating budget of US$180 million and 25 countries are involved. The program deploys two large drilling vessels and other drilling platforms on expeditions that take continuous deep ocean cores to address global scientific problems related to climate and oceanographic change, planetary dynamics and natural hazards, and informs petroleum exploration. The IODP can provide continuous cores of sediment and rocks in water as deep as 7000 metres, and up to 5000 metres below the sea-floor. The IODP has drilling assets worth US$1.1 billion, and repositories holding more than 400 kilometres of cores. All information goes into the public domain and the moratorium on core material is less than two years. Over the next three years Australia's offshore jurisdiction and neighbouring regions will be a major focus of this scientific activity, with nine drilling expeditions planned in our region, each costing about US$14 million, amounting to a total operational outlay of more than US$120 million.

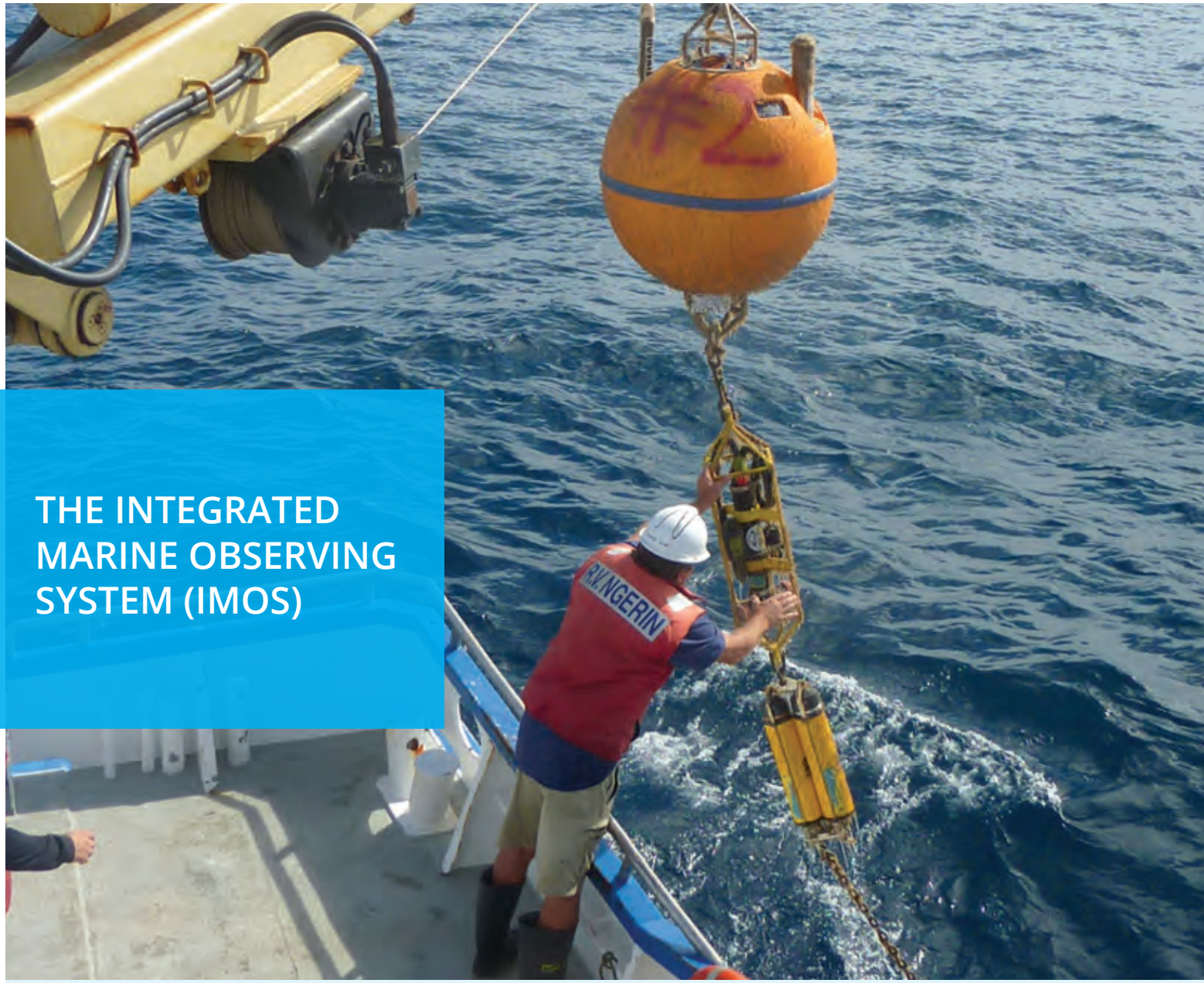
Left: IODP's main deep drilling vessel, *JOIDES Resolution*

The Australian and New Zealand IODP Consortium (ANZIC) consists of 18 universities and four science agencies, and is a small but scientifically important part of the program. Since 2008, when Australia joined ANZIC, six regional expeditions had been carried out by mid-2016, and many more elsewhere, with our scientists aboard almost all expeditions. With Australia's IODP membership funded until 2020, the scientific and economic multiplier is large. A review of Australia's participation in the IODP concluded 'that the benefits to Australia of direct involvement of the IODP Consortium far exceed the modest costs of participation'[10].

The scientific ocean drilling carried out under the IODP allows Australia to obtain access to international infrastructure to address global scientific problems. It builds naturally on Australia's marine geoscience infrastructure and capabilities. Most of the annual funding of $3.2 million (which includes a US$1.8 million annual membership fee) comes from the Australian Research Council's (ARC's) Linkage Infrastructure, Equipment and Facilities scheme. However, membership of the IODP, with the long research lead times, calls for a more assured long-term basis than ARC funding allows, along with other similar multinational infrastructure programs like those involving astronomical telescope facilities.

IODP research drilling is a valuable tool for testing and building on concepts developed by satellite observations, geophysical profiling and geological sampling. Not only does Australian marine geoscience make great use of the IODP, but building successful IODP proposals in our region depends on suitable broad surveys and more detailed site surveys, to which our nation's marine research vessel fleet, particularly the *RV Investigator*, is well suited. Participation in the global IODP has our scientists working closely with and learning from outstanding foreign scientists, and directly improves our understanding of Australia's marine region, benefits Australia's research performance and greatly enhances our national scientific reputation.

[10] http://iodp.org.au/publications/independent-review-of-australian-participation-in-integrated-ocean-drilling-program/



THE INTEGRATED MARINE OBSERVING SYSTEM (IMOS)

The Integrated Marine Observing System (IMOS) is one of the national research infrastructure capabilities currently supported under the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS).

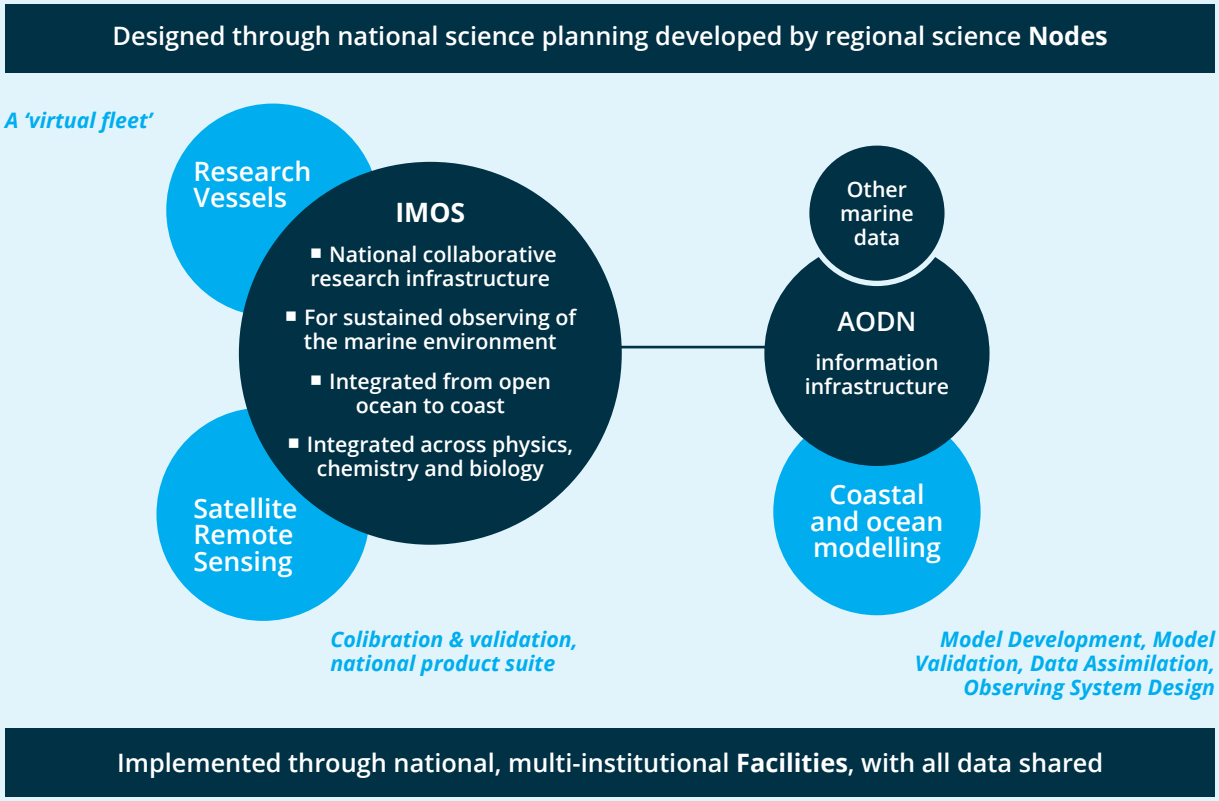
The Australian Government has invested $158 million into IMOS, with a further $228 million cash and in-kind support from research agencies, universities, State governments and industry[11].

IMOS has a key dependency on the Australian research vessel fleet – blue water, polar and coastal-shelf. The IMOS long-term strategy and multi-year forward plan[12] make this clear, as illustrated on the following page.

The research vessels are the flagships of the IMOS Ships of Opportunity fleet, carrying fixed instruments that take a wide variety of underway measurements that are transmitted back to shore in near real time. Research vessels provide broad spatial coverage through implementing their scheduled voyages. They also enable IMOS to use more sophisticated underway instruments than can be used on commercial vessels because of the scientific and technical support available on research vessels.

Research vessels provide the capacity for IMOS to implement a very large *in situ* observing network of platforms and sensors that require deployment, recovery and redeployment at routine intervals. The

[11] http://imos.org.au/about.html
[12] http://imos.org.au/plans.html#c2675



largest component is the moored buoy program, which includes deepwater moorings (requiring blue water and polar research vessel capacity), shelf mooring arrays (requiring coastal-shelf research vessel capacity), and coastal reference stations. Other redeployable equipment requiring research vessel support includes AUVs, ROVs, ocean gliders, acoustic animal tracking receivers and ocean noise data loggers. Research vessels also provide IMOS with access to remote regions of the ocean in order to deploy expendable instruments, including Argo profiling floats, expendable bathythermographs (XBTs), and satellite animal tags.

IMOS operates a wide range of observing equipment throughout Australia's coastal and open oceans, making data accessible to the marine and climate science community, other stakeholders and end users, and international collaborators. IMOS operates as a multi-institutional collaboration and is designed to be a fully-integrated, national system, observing at ocean-basin and regional scales, and covering physical, chemical and biological variables. Many of the data streams collected in IMOS are dependent on access to suitably equipped marine research vessels. Greater coordination of the national research vessel fleet would further enhance the collection of these data streams.

Data provided by ocean moorings and biogeochemical sampling as part of IMOS are an essential input into decision-making tools (i.e. computer models) to support government, policy makers, industry and the community to make evidence-based decisions regarding the sustainable management of individual industries, and their interactions and cumulative impacts on the marine environment. These tools improve the speed, efficiency and confidence with which decisions about sustainable economic growth and the state of the environment and ecosystems can be made. Importantly, these decision-making tools allow evaluation of the ecological and economic trade-offs associated with various multiple-use options and are critical to the implementation of integrated ocean management. These tools include hydrodynamic, biogeochemical, biosecurity risk, carrying capacity, population dynamics and ecosystem models.

The capacity to model key physical oceanographic parameters such as waves, currents, temperature and salinity provides an increased capability to understand climate variability, predict extreme weather conditions, and predict pathogen and pollutant transport and dispersal. Outputs of these hydrodynamic models are critical inputs to other decision-support tools including biogeochemical and ecosystem models. Early detection systems and flow mapping of ocean currents provide the government and industry with a vastly improved capacity to mitigate risks from natural hazards and developments. These underpin confidence and understanding when impacts are observed. Following the Gulf of Mexico oil spill, the lack of baseline information significantly hampered efforts to clean up the spill, and led to damaging legal disputes over compensation.

The collection of relevant data streams through IMOS is critical for underpinning our marine industries to optimise and grow the blue economy. Investment in key infrastructure, such as a national research vessel fleet, is essential for maintaining the nation's capacity for collecting these data and deriving information and decision-support tools from them.

CURRENT NATIONAL MARINE RESEARCH FLEET CAPABILITY

Australia's current fleet of marine research vessels is limited, with vessels ranging from the large specialist icebreaker *RV Aurora Australis* (95 metres in length) (and the new replacement icebreaker 156 metres in length, currently being built) and multi-purpose *RV Investigator* (94 metres in length), to five smaller vessels (21 to 35 metres in length) operating in coastal waters out to the continental shelf (Table 1).

On a per capita basis, Australia's research vessel capability is modest (i.e. seven vessels greater than 20 metres in length), while poor with respect to the size of our marine estate, which is the third largest globally. In addition, the coastal-shelf vessel fleet is ageing and in need of replacement and/or upgrade. The national research vessel fleet capability is within the mid-range on an international scale, being on par in terms of size and number with nations such as Argentina and Brazil, but is dwarfed by the USA, Japan, Germany, France and Russia. China, and to a lesser extent India, have been investing strongly in their research vessel fleet as the benefits of the blue economy are realised.

The limited capacity of Australia's research vessel capability provides little redundancy both in geographic scope of operation (see Figure 1 and Table 1), as well as in functionality (e.g. only one each of an icebreaker, a multi-purpose blue water vessel, and a coastal-shelf vessel operating in each region, such as throughout the Great Barrier Reef). Due to the differing marine conditions and large distances involved, it is impractical and not cost effective for coastal-shelf vessels designed for northern tropical Australia to also operate in southern temperate waters; hence the need for a network of vessels, purpose-built for different environments and conditions to cover all regions. Vessel size also limits the capability that Australia's research vessels can currently deliver. The coastal-shelf vessels are limited in the degree of deep water exploration that can be undertaken. For example, research vessels operating on the Great Barrier Reef and in coastal waters off South Australia are not currently capable of supporting research in the adjacent Coral Sea and much of the adjacent Great Australian Bight; yet these are both areas of high national interest.

The relevance of each vessel to users is correlated to vessel capability – polar, blue water, shelf and coastal, tropical and temperate. With a single polar vessel (which is highly constrained in terms of support for marine science), single blue water vessel (which has limited operational funding), and five coastal-shelf vessels, one of which is mainly used for teaching purposes, capability is inadequate for future needs. Commercial vessels (i.e. merchant vessels, ferries, fishing vessels) are used as 'ships of opportunity', where possible, and there is potential to grow their contribution, but there will always be issues about operational areas, logistics, adaptability, access and use, because they are driven by commercial imperatives and not research needs.

There is some commonality between the infrastructure needed for continental shelf research and that required for blue water, deep ocean research. For example, a large deep ocean vessel is, in some instances, highly suitable for research on the continental shelf. However, deep ocean vessels such as the *RV Investigator* and the Antarctic vessel *RV Aurora Australis* (and the new replacement icebreaker) have significantly higher running costs than those smaller vessels that are designed to work on the continental shelf such as the *RV Solander*, *RV Cape Ferguson*, *RV Ngerin*, *RV Naturaliste* and *TV Bluefin*; limiting their use for routine operations and for projects where charter costs need to be met by the user.

The larger vessels can operate in water depths down to 6000 metres and are mainly involved in activities of national or international significance. They often cover a wide range of marine science activities with some combination of oceanography, biology, fisheries science, marine geoscience and weather science. The expeditions can range far afield, including to the Antarctic margin, and can stay at sea for up to 60 days at a time. They normally have a large and diverse scientific crew carrying out any one research voyage, and involve expensive and complicated equipment to profile and sample the water column and sea-floor, and are capable of deploying specialised equipment like submersibles, large remotely operated vehicles (AUVs, ROVs) and sea-floor drills.

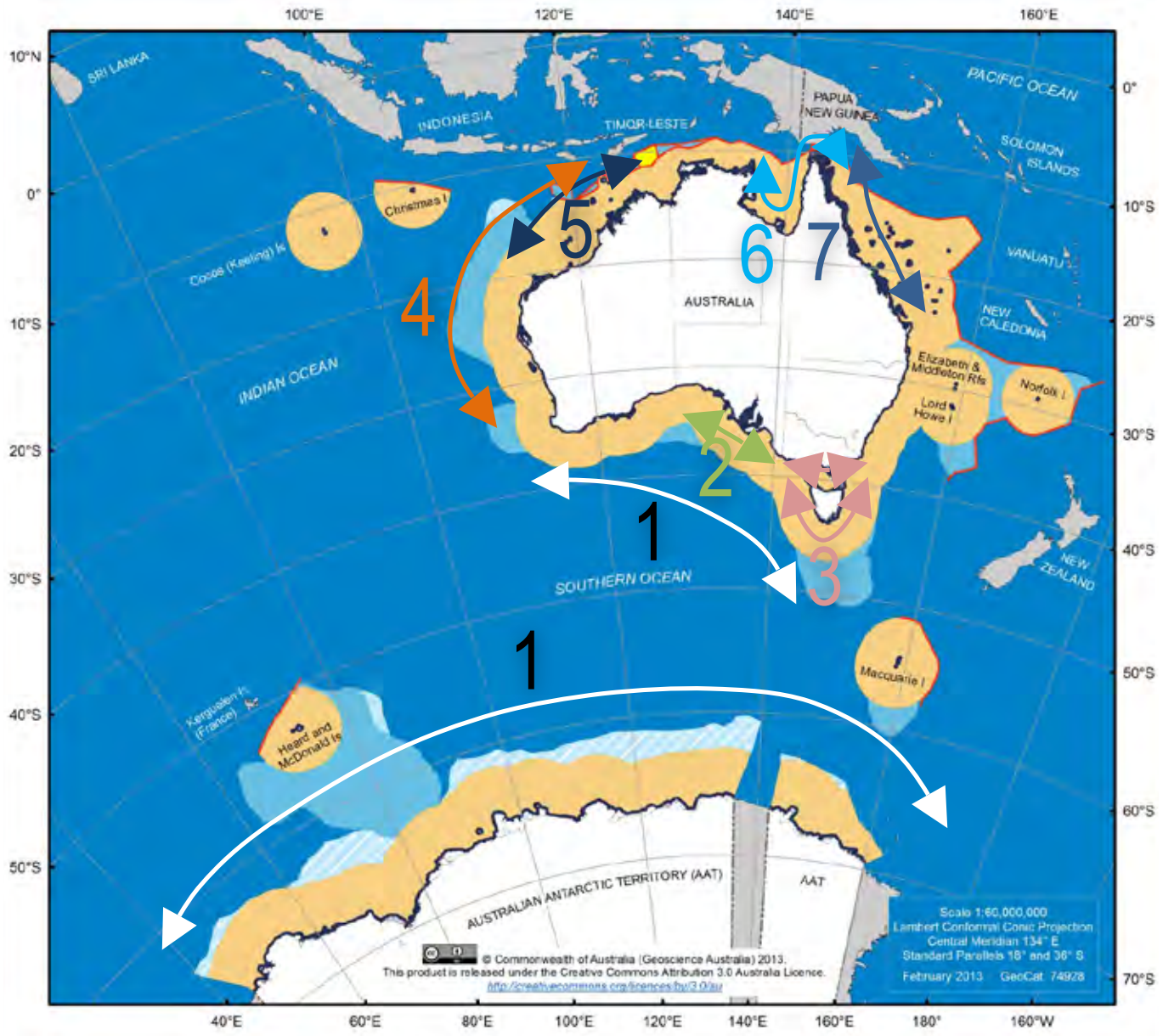
The *RV Investigator* is a world-class blue water research vessel, meeting all the above requirements with its expanded suite of research capabilities. It can accommodate up to

40 scientists to support the large, multidisciplinary teams required to conduct modern marine and climate science, go to sea for up to 60 days at a time, and is capable of working from the tropics down to the ice edge in the Southern Ocean.

The ageing *RV Aurora Australis* is our existing Antarctic research and resupply icebreaker. It is the main lifeline to Australia's Antarctic and sub-Antarctic research stations and the main platform of our Antarctic scientific research in the Southern Ocean. The amount of ship time for dedicated marine science is necessarily limited due to its multifunction role and operating budget. The new research and resupply icebreaker will provide more efficient and reliable access to Antarctica and be a modern, sophisticated and multidisciplinary science platform in the Southern Ocean that is essential to Australia's scientific research and leadership in the region.

The coastal-shelf research vessels operate in shallower waters and can sample down to 500 metres. They are often involved in activities of regional significance that are critical to the missions of the institutions that own and operate them and tend to be used to collect data for studies on oceanography, biology, fisheries or sea-floor mapping related to petroleum activities. The coastal-shelf vessels have a limited range and berth capacity compared to the larger blue water and Antarctic vessels (Table 1), and each research voyage tends to have a single research aim, albeit these voyages are often conducted as part of a collaboration.

The development of a coordinated national fleet of research vessels will be a strategic long-term investment for Australia but is increasingly critical to the future of marine science in Australia. Our current capacity and capability is internationally weak and we sometimes rely on other nations for this capability, putting us at the mercy of other nation's priorities and schedules. For example, Australia has used research vessels from France, USA and Korea during the last few years to undertake research in the Southern Ocean and Antarctica. Until this capability limitation is addressed through a funded, coordinated and dedicated marine research vessel fleet, the full benefits of Australia's blue economy will not be realised.



Australia's Maritime Jurisdiction

- Treaty boundary with opposite or adjacent state
- 200 nautical mile line off an opposite or adjacent state
- Area of Australia's territorial sea and internal waters
- Area of Australia's exclusive economic zone as defined by the Un Convention on the Law of the Sea and certain treaties (not all in force)
- Joint Petroleum Development Area under Timor Sea Treaty 2002
- Area of Australia's continental shelf beyond the exclusive economic zone as proclaimed by the Sea and Submerged Lands (Limits of Continental Shelf) Proclamation 2012 and/or as defined by certain treaties (not all in force)
- Area of Australia's continental shelf beyond the exclusive economic zone considered by the Commission on the Limits of the Continental Shelf and yet to be resolved
- Area of Australia's continental shelf beyond the exclusive economic zone off the Australian Antarctic Territory that Australia requested the Commission not consider for the time being

Figure 1. Australia's maritime jurisdiction and coverage by current national research vessel fleet (greater than 20 metres in length); see Table 1 for vessels covering the 7 areas shown. Regions represented by the respective areas: Area 1 – Antarctic/ Southern Ocean; Area 2 – Southern region; Area 3 – Eastern region; Area 4 – Western region; Area 5, 6, 7 – Northern region.

Table 1. Summary of national research vessel (greater than 20 metres in length) fleet

Vessel (Owner/ Operator)	Type	Length (m)	Year Built	Expected Life Span	Usual Annual At-Sea Days	Typical distance travelled pa (NM)	Number crew + researchers	Main area of operations	Main activities
Aurora Australis[a] **(AAD)**	Icebreaker	95	1989		180	17000	20-27 + <5 (resupply), 50-70 (science)	Antarctic, Southern Ocean (see Area 1, Figure 1)	Resupply stations, transport personnel, marine science
Investigator (CSIRO)	Ocean	94	2014		180[b]		20 + 40	Australasian region (see Areas 1-7, Figure 1)	Oceanography and climatology, fisheries, marine ecosystem and marine environmental research, marine geosciences, atmospheric sciences
Solander (AIMS)	Shelf	35	2007		260	27000	6 + 12	Northern region; North West Tropical Australia (see Area 5, Figure 1)	Environmental surveys, small oceanographic equipment service / deployment, scientific dive support
Cape Ferguson (AIMS)	Shelf	24	2000		270	16000	4 + 8	Northern region; Great Barrier Reef (see Area 7, Figure 1)	Environmental surveys, small oceanographic equipment service / deployment, scientific dive support
Ngerin (SARDI)	Shelf	25	1985	2020	150	9500	4 + 8	Southern region; South Australia - shelf/gulfs (see Area 2, Figure 1)	Fisheries, oceanography and climatology, marine ecosystem and marine environmental research, IMOS-SA moorings, monitoring Threatened, Endangered and Protected Species
Naturaliste (DoF WA)	Shelf	21.6	2001	2027	165	7500-9000	5 + 6	Western region; all west coast (see Area 4, Figure 1)	Fisheries including ecosystem effects of fishing
Bluefin (Uni Tas)	Shelf	34.5	1981	2020	105	6000	5 + 20	Eastern region; Coastal Tasmania /Furneaux Islands, Victorian Coastal (see Area 3, Figure 1)	Student/mariner training and retraining, fishing and fisheries, environmental surveys, oceanographic equipment deployment, marine biodiversity, AUV

[a] The RV Aurora Australia is currently being replaced with a new purpose-built icebreaker (156 metres in length).
[b] The RV Investigator is operating as a research vessel with 180 sea days funded.


INVESTIGATOR
DREDGEN
TRIPLEX

MARINE NATIONAL FACILITY

Funded by the Australian Government since 1984 and operated by CSIRO under direction of an independent Steering Committee, the Marine National Facility (MNF) provides a keystone element of the nation's research infrastructure by providing the only blue water research capability available to Australian marine researchers and their international collaborators for work in Australia's vast marine estate.

Access is provided through an independent and peer reviewed applications process focused on scientific and/or technical excellence, the potential to contribute to Australia's national benefit and the ability of the research team. This ensures research undertaken through the MNF is specifically selected for excellence and contribution to Australia's national benefit, and provides key information to government, industry and other stakeholders to support evidence-based decision-making focused on research challenges in fisheries management, geological resources, regional and global climate, coastal and offshore developments and marine operations.

In 2014, delivery of the new purpose-built 94 metres multi-purpose *RV Investigator* provided a step-change in Australian marine and atmospheric research capability acting as a catalyst for international collaboration. The *RV Investigator* can undertake voyages from the tropics to the Antarctic ice edge, carry up to 40 scientists and support staff on voyages up to 60 days in duration and spend 300 days per year at sea. The *RV Investigator* also hosts an extensive suite of state-of-the-art scientific research equipment and is one of a handful of research vessels globally designed for very quiet operation with the ability to undertake research to the deepest parts of our oceans. Demonstrating Australia's research demand for the *RV Investigator's* capabilities, for the 2017-18 scheduling year the MNF received 25 applications for 752 days at sea, with ~90% of these assessed as supportable by an independent Science Advisory Committee should sufficient sea time be available.

The MNF is currently funded to operate the *RV Investigator* 180 days at sea per year to deliver merit granted voyages in accordance with the fundamental principle behind the establishment of the Facility. While limiting operations to 180 days compared to full utilisation at 300 days reduces operating costs in some areas, inefficiencies reduce these cost savings. For example, crew and maintenance costs do not reduce pro-rata with operating days; corrosion and machinery require ongoing attention to maintain a science ready platform; and rotating machinery has a reduced service life if not operated continuously. While not at sea, additional costs arise with port charges while an accelerated rate of hull fouling increases fuel consumption on subsequent voyages until the next scheduled dry-docking. As the fixed costs of ownership such as insurance, marine survey and baseline crewing remain static, the incremental increase of $8 million per annum in the operating budget required to move from 180 to 300 days per year, compared to the present budget of $26 million, is a small investment compared to the greater value to the science community. The cost per day for the additional time would be $67,000, compared to $144,000 for the 180 days, bringing the cost per day for the whole 300 days to $113,000 per day.

NEW TECHNOLOGIES AND LEVERAGE

An investment in Australia's offshore research vessels will provide substantial economic returns with each voyage leveraging significant funding from other sources, most notably the in-kind salaries of the teams of scientists on board. It will also secure and advance the use of technology to collect critical data, complementing vessel based research.

Technology is increasingly expanding the reach of marine research with tools that collect data virtually autonomously. For example, as part of IMOS, marine animals, deep sea floats and gliders have been used to autonomously collect time-series oceanographic data to complement and expand more traditional means such as the use of research vessels (albeit these are required as the necessary platforms to access the deep ocean and coastal-shelf waters to deliver and service the new technologies).

An example of the interplay between existing research vessel activities and new technology was a research voyage along 170°W in April/May 2016 on the *RV Investigator*. This voyage represented Australia's regional contribution to the international GO-SHIP program to monitor decadal ocean change, with a consortium of countries undertaking repeated occupation of hydrographic stations from the poles to the equator. Vessel based hydrography remains the only method for obtaining high-quality, high spatial and vertical resolution measurements over the full water column which is essential for documenting ocean changes, especially for the deep ocean below 2000 metres where 52% of the global ocean volume is not sampled by profiling floats.

The *RV Investigator's* 170°W voyage also gathered high precision baseline data to calibrate the international Argo array, XBT program, and other autonomous observations made by ocean gliders, moorings and satellites which provide more detailed understanding of dynamic ocean processes occurring between research vessel visits. These autonomous observations are part of highly co-operative international efforts to meet global research challenges. For example, Australia is a member of the international Argo program and the second largest contributor globally after the USA. Argo Australia is operated by CSIRO, with financial and operational support from the Bureau of Meteorology, IMOS, the Antarctic Climate and Ecosystem Cooperative Research Centre, the Royal Australian Navy and the Department of Environment and Energy.

Australia's participation in the international research community is very important as a key beneficiary of the value derived from data streams critical to weather prediction globally and in our region. Geographically located in a vast ocean area, it would be difficult or impossible for other countries to replace Australia's research efforts, presenting the risk of losing our leadership and opportunity to influence international initiatives.

It is also important to note that the operational costs of research voyages, such as those undertaken as part of these initiatives, typically leverage significant funding from a range of sources. This was demonstrated in the 170°W voyage onboard the *RV Investigator* whereby the MNF ship time cost of $4.5 million leveraged an additional $3.9 million in co-contributions and in-kind support provided by the science team and its partners to bring the total value of the voyage to $8.4 million; excluding the supplementary and piggy-back projects that were able to be undertaken alongside this primary voyage.

Line Item	Cost ('000)
MNF Investment	
MNF Ship Time	**$4,489**
TOTAL	**$4,489**
Science Team Investment	
Pre Voyage Planning Costs	$205
Voyage Costs	$1,768
Argo Floats	$1,675
Post Voyage Costs	$274
TOTAL	**$3,922**
TOTAL Investment	**$8,411**

AUSTRALIAN ANTARCTIC PROGRAM ICEBREAKER

The *RV Aurora Australis* is Australia's only icebreaker, and fulfils multiple roles within the Australian Antarctic Program, including marine research, cargo resupply, refuelling and expeditioner transport to and from Australia's Antarctic and subantarctic research stations.

RV Aurora Australis ice station with scientists at work on the sea ice 2012. Photographer credit Caitlin Gionfriddo.

Graphic of proposed new Australian icebreaker. Damen, DMS Maritime, Knud E. Hansen

Recently, the Australian Government announced it is delivering a new world-leading Antarctic icebreaker to replace the ageing *RV Aurora Australis*. This once in a generation commitment is the centrepiece of the *Australian Antarctic Strategy and 20 Year Action Plan* launched on 27 April 2016. The $1.9 billion package will cover the design, build and 30 year operational and maintenance lifespan of the icebreaker.

This next-generation successor to the *RV Aurora Australis* will provide a step-change in Australia's Antarctic capabilities and is uniquely tailored to meet the needs of the Australian Antarctic Program. It will have greater icebreaking and cargo capacity, increased endurance and operational flexibility, a high standard of environmental performance, and state-of-the-art research, rescue and resupply capabilities.

Scientific equipment will include a moon pool, drop-keel, multi-beam bathymetric and scientific echo sounders, fisheries sonar systems, hydrophones and underwater cameras to support a wide range of scientific research and offer scientists unprecedented and extended access to the Southern Ocean and Antarctica. Importantly, the new icebreaker will enable at least 60 days per year of dedicated marine science time.

The new icebreaker is being designed to maximise inter-operability of marine science equipment and containerise laboratories between it and the *RV Investigator* to provide an unprecedented level of efficiency to benefit the research community within Australia.

The Australian Antarctic Program draws on international partnerships to trade logistic support between various national Antarctic programs operating in East Antarctica and the Southern Ocean. For example, providing flights on the Australian A319 for partner countries enables transport of Australian scientists and cargo on other countries ships, which can enable more ship days for marine science on the *RV Aurora Australis* (and new icebreaker).

This together with strong international collaborations draws together considerable logistic support for marine science (and Antarctic science more broadly). An example of these collaborations was the Kerguelen Axis marine science project led by the Australian Antarctic Program in 2015/16 where the *RV Aurora Australis* was joined by the *RV Investigator*, the USA *RV Roger Revelle*, the French *RV Marion Dufresne* and the Japanese *RV Umitaka Maru* and *RV Hakuho Maru*, with each vessel taking samples and measurements in multiple locations around the Kerguelen Axis.

Allocation of time for marine science use is undertaken within a competitive application process in the Australian Antarctic Science Program. Applications are open to researchers worldwide and are highly competitive. Dedicated marine research ship time is limited to accommodate the multiple roles the vessel has to undertake.

COASTAL-SHELF CAPABILITY

Australia's coastal-shelf research vessel capability is the nation's most limited, and in need of renewal. There are five coastal-shelf research vessels (greater than 20 metres in length; Table 1) to cover Australia's entire coastline, two of which are over 30 years old and beyond the expected age of operations, and one of which is mainly used for teaching/training purposes.

With one of the largest coastlines in the world (~36,000 km mainland[13]), and over 80% of Australians living within the coastal zone, it is imperative the nation has the infrastructure to explore and utilise its natural resources, while collecting the data to understand the balance required to ensure our marine environment is sustainable and appropriately managed. There is significant marine science to be undertaken within the coastal-continental shelf range; which is contingent on the capacity to enable this to occur.

The coastal-shelf science from our five main existing research vessels is limited by capability, funding and aims. If it could be better resourced and better coordinated, the needs of the nation would be better met. The two AIMS research vessels, *RV Solander* and *RV Cape Fergusson*, are deployed in northern Australia on a range of research programs and are funded via the AIMS appropriation budget and external revenue contracted by AIMS. The research vessels operated by SARDI, *RV Ngerin*, the Department of Fisheries Western Australia, *RV Naturaliste*, and the Australian Maritime College, *TV Bluefin*, are more limited in their capability, nearing the end of their life or in need of an upgrade, and are funded by the respective State governments or tertiary institute.

Unlike the MNF and new icebreaker that have funded dedicated sea days that can be applied for under competitive arrangements, there are no similar arrangements for the coastal-shelf research vessels. Such an arrangement would provide a foundation for the proposed national research vessel alliance and further advance marine science in the nation.

Northern Australia

Most of Australia's coastal-shelf scale research vessel capability across the tropical north is provided by AIMS. The *RV Cape Ferguson* and *RV Solander* are institutionally owned and operated, with collaborative access provided through project level engagement and co-investment. Their area of operation covers Commonwealth waters, as well as State/Territory waters of Queensland, Northern Territory and Western Australia, from Ningaloo Reef, through the North West Shelf to the southern Great Barrier Reef.

The *RV Cape Ferguson* and *RV Solander* are heavily used across northern Australia, covering nearly 40,000 nautical miles and over 500 sea days each year between them. However, this is not enough because AIMS has to supplement its research vessel time by chartering a further ~120 vessel days from commercial operators so that it can satisfy the demands for its research program.

The *RV Cape Ferguson* will reach its end-of-life in the next 5-10 years. In vessel planning timeframes, this means that the process to decide on a replacement will need to commence soon to ensure that a suitable replacement is designed and built that meets the needs of AIMS, its stakeholders and the broader marine science community.

There is also a substantial capability gap between the size of the largest coastal research vessel, the 35 metres *RV Solander* operated by AIMS, and Australia's blue water vessel, the *RV Investigator*, which is 94 metres in length. The *RV Solander* is the minimum size a research vessel can operate in the highly important North West Shelf. The coastal-shelf is broad in tropical Australia meaning oceanographic infrastructure will be deployed many hundreds of kilometres from shore and the sea conditions require larger vessels to safely deploy oceanographic infrastructure. This capability gap needs to be filled if we are to properly service Australia's growing marine science needs. For example, the National Marine Science Plan calls for increased observing infrastructure, with increased coverage in the coastal and littoral zone, which will need to be deployed and serviced by the coastal-shelf research vessels as the *RV Investigator* cannot service all of the needs of the Australian coastal-shelf.

Southern Australia

The *RV Ngerin* is owned and operated by SARDI and has been a critical research infrastructure for the past 30 years, being used to collect invaluable data to assess and grow the

[13] http://www.ga.gov.au/scientific-topics/national-location-information/dimensions/border-lengths

RV Cape Ferguson (left) and *RV Solander*

marine industries and environments in southern Australia. The research vessel is now past its intended useful life and, with increasing maintenance costs, is expected to be decommissioned in five years; thereby, leaving southern coastal temperate Australia ill-equipped to take advantage of the significant opportunity of the blue economy.

The *RV Ngerin* was originally designed as an inshore trawler to service the gulfs and inshore coastal waters of South Australia, and is not suitable to service deep offshore waters of the Great Australian Bight, the far west coast or the south east where the Bonney upwelling occurs; all regions that now need to be accessed to optimise the value of the blue economy. As part of this submission, it is proposed that the *RV Ngerin* is replaced as a matter of priority in order to design a new multi-purpose coastal-shelf research vessel to service southern Australia, from Western Australia, across the Great Australian Bight, and to the west coast of Tasmania. The new vessel would contribute to the national research vessel alliance.

Without a replacement research vessel, the government and marine industries will not be provided with timely data and information on environmental impacts, mineral exploration, coastal/offshore developments, climate change, fish stocks and biosecurity threats in southern temperate Australia. This will impact our ability to service the IMOS-SA moorings to understand the oceanic circulation, climate and climate change of our marine environment; limit the ability to support national marine science and industry initiatives; and reduce our status as a world class, leading marine research nation.

The replacement vessel would be an important long-term (25+ years) infrastructure that would contribute to a national alliance of coastal-shelf research vessels, covering southern temperate Australian waters and increasing the opportunities for collaborative use across the Australian/international marine industries and science communities. Collaboration and co-investment opportunities between industry and science will contribute to driving the development of Australia as a knowledge creation and innovation nation, leading to job and wealth creation. The replacement of the *RV Ngerin* would result in a large number of benefits, conservatively estimated at ~$29-35 million per annum.

The replacement of the *RV Ngerin* aligns with the National Marine Science Plan and associated Infrastructure White Paper[14] where development of a coordinated fleet of vessels around the country is considered critical to the future of marine science, particularly in southern Australia where there is limited capability. There is a need to expand the nation's research fleet capability to ensure access to the substantial fraction of our waters, particularly the deep, offshore waters that are relatively unknown, such as the Great Australian Bight where significant petroleum exploration activities are occurring, and the Bonney upwelling which is the cornerstone of ocean productivity in southern Australia. A new research vessel would result in a major upgrade of the knowledge base and decision-support tools available to underpin policy development and risk assessment for future industry development, including the capacity to support offshore oil/gas exploration and drilling, as well as meet national strategic priorities.

The proposed replacement research vessel would be a 16 berth ship, 30 metres in length, with a speed of 11 knots and a range of 4,000 nautical miles; capable of operating in offshore waters across southern temperate Australia. It would have wet and dry laboratories, as well as computing facilities, scientific equipment to sample pelagic and benthic

RV Ngerin

[14] National Marine Science Committee (2015) National Marine Science Plan Infrastructure Theme White Paper: Research Vessels, Experimental Facilities, Observing Systems and e-Research

Rendered view of the new coastal-shelf research vessel to support southern Australia (left) and *RV Naturaliste*

habitats, hydrographic and trawl/sledge winches, and a Hiab seacrane. The new vessel is estimated to cost $15 million and could be built in South Australia; thereby supporting the local ship building industry and re-investing funds back into the nation.

Western Australia

Commissioned in 2001, the *RV Naturaliste* undertakes research in the tropical north-west and coastal waters of Western Australia, and has provided excellent service to the State government and industry research programs. However, planning is now required for the major upgrade to the vessel, hull and machinery, as expected for a steel hulled vessel of its age, and to meet the changing research requirements of the fisheries and other marine industries.

The *RV Naturaliste* is specifically designed to operate all forms of fishing gear and has the ability to deploy and retrieve specialised research equipment with its heavy lift capacity. The vessel is capable of operating in all sea conditions experienced off the Western Australian coastline. The vessel has a maximum speed of 9 knots and an operational speed of 8 knots, a fuel range of 2000 kilometres, and accommodation for up to 11 crew and scientists.

The *RV Naturaliste* is designed to provide core at-sea specialised research capacity for the State's fisheries within an annual at sea research program. The vessel's primary role is to gather standardised fish abundance data needed for the stock assessments underpinning the sustainable management of the State's commercially and recreationally utilised fisheries resources. These fisheries resources generate a direct revenue of approximately $500 million annually and this creates commercial economic activity in the order of $1 billion per year. In addition these fisheries resources support recreational activities by about 700,000 fishers which generate significant further economic activity.

The demand for at sea research is forecast to continue to expand, consistent with commercial industry growth in terms of catch and value, as well as the continued expansion of the recreational fishery. In addition to the traditional stock assessments of target species, the State government is also committed to an ecosystem-based fishery management (EBFM) approach which requires broader monitoring of the ecosystem. This broadens the at sea research required to include monitoring of the habitat, bycatch and interaction with protected species. Further the government initiative in collaboration with the commercial and recreational fisheries to adopt the Marine Stewardship Council (MSC) certification process for research and management of Western Australian fisheries and EBFM has become a significant driver for at sea research and monitoring of stocks. All significant Western Australian commercial fisheries have now gone through the MSC pre-assessment process and a number of major fisheries have achieved or are undergoing full assessment.

In order to meet the ongoing heavy research needs, the *RV Naturaliste* is in need of a major upgrade, including lengthening the vessel by 2.4 metres to increase its research capacity in line with anticipated demand changes. The vessel design is such that the fitting of a new 2.4 metres extension to the hull, in the middle of the vessel is a relatively straight forward shipyard process as the 2.4 metres hull module could be constructed in advance and fitted during an extended refit period. A larger vessel would provide increased fuel and water capacity, storage capacity, accommodation for additional scientists, and facilities for processing samples to increase the efficiency of research programs. This would enable the vessel to operate in the more remote areas of the State for longer periods, and importantly contribute to the national research vessel alliance.

Eastern Australia

The *TV Bluefin* is owned and operated by the Australian Maritime College (AMC) at the University of Tasmania, and is a purpose built fisheries training vessel, 35 metres in length. The vessel commenced operations at the AMC in 1981 and is capable of carrying out a range of fishing methods, including stern trawling, both bottom and mid-water, purse seining and prawn trawling.

Mostly used as a training vessel, the *TV Bluefin* operates in south-east Australian waters with up to 25 students and staff on training voyages from two days to two weeks. Studies on board include habitat monitoring, fish sampling, fishing technology, machinery operation and maintenance, environmental

assessment, oceanographic instrument mooring, and ship design and function.

The *TV Bluefin* has been chartered by a diverse range of maritime companies and has been used extensively by the offshore industry for underwater pipeline work and hydrographic surveying. The vessel has also been chartered for such diverse work as:

- Rescuing stranded Antarctic scientists from Macquarie Island;
- Minesweeping trials for the Royal Australian Navy;
- Survey work for undersea cables in Bass Strait.

The *TV Bluefin* is in need of replacement within the next five years at a likely cost of $18-20 million. The replacement vessel would integrate the expanded AUV capability being developed at the AMC; this AUV capability extending from coastal to polar vehicles, such as the International Submarine Engineering Ltd Explorer series. The *TV Bluefin* replacement would contribute to the national research vessel alliance in the eastern Australian region.

In summary, considering the limited nature and ageing coastal-shelf scale research vessel capability, Australia does not have world class capability under current arrangements. This is counter to the significance of Australia as a marine nation, and the benefits that can be realised from our blue economy. The proposed investment in long-term infrastructure and strategic activities in this submission will address these short-comings.

TV Bluefin

COORDINATED NATIONAL RESPONSE AND CAPABILITY

A national alliance model of a coordinated fleet of large-scale offshore research vessels will provide the capability required for our marine scientists, industry and policy makers to deliver national benefits by sustainably growing the national blue economy and ensuring our marine science capabilities remain world leading.

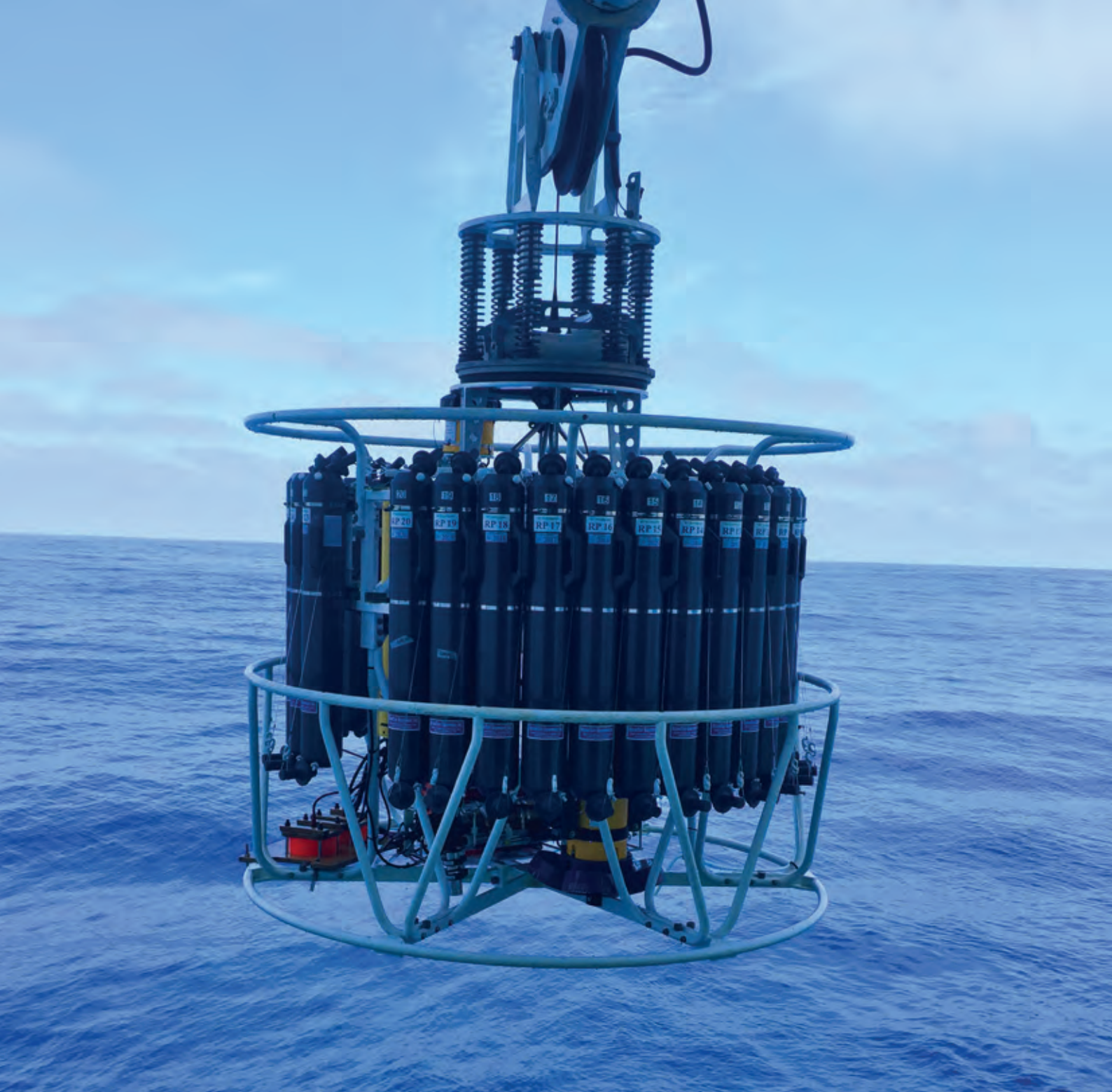
Management and access with respect to the MNF and polar vessels is considered to be in place and working from a national perspective; albeit these are managed at the institutional level (i.e. CSIRO, AAD). Similarly, the coastal-shelf research vessels are managed at the institutional level (i.e. AIMS, SARDI, DoF WA, AMC). AIMS has a national mandate as Australia's tropical marine science agency, and *RV Solander* and *RV Cape Ferguson* collectively provide a capability for the tropical north that is institutionally owned and operated, with collaborative access provided through project level engagement and co investment. However, there is no equivalent institutional or coordinating mechanism with a national mandate in the other regions. An effective mechanism for creating a multi-institutional, multi-jurisdictional, 'virtual fleet' is required.

The NMSC considers that Australian marine science will be better served by developing a national alliance of large scale (greater than 20 metres in length), offshore research vessels that cover our marine estate. This alliance of research vessel owner-operators would recognise institutional governance structures, strategies and business drivers, but greatly enhance coordination, efficiencies and potential cost effectiveness, enabling leveraging off each other by increased sharing/coordination of voyages where possible. The proposed alliance would include operational and technical networking to increase knowledge and skills exchange between vessel operators. Increased coordination of vessel operations and transparency of schedules will increase opportunities for access/utilisation and cooperative/collaborative vessel based science and fill some of the gaps in the marine estate coverage provided by our vessels. Such an alliance carries costs and will require increased government investment because operating budgets for all of Australia's research vessels are strained, if not simply insufficient. Many of the costs are increasing at rates above inflation and increasing the price to access the facility will not alleviate this pressure as this will raise the cost barriers to users who are increasingly struggling to obtain sufficient funding for project costs, over and above vessel operating costs.

The proposed coordinated and funded national research vessel alliance would increase the opportunities for scientific collaboration and discovery. The intention is that our coastal-shelf marine research capability would extend to the entire Australian coastline, which it does not do at present.

Spare capacity on research vessels is often left to the vessel owner-operator to find funding, people or collaborators to fill the vacancy, sometimes at short notice. While the MNF has a mature process of allocating spare capacity through both supplementary applications and a Next Wave program that targets post graduate students studying marine science, these programs would be enhanced if additional days at sea on the *RV Investigator* were made available. Such mechanisms do not exist for the coastal-shelf vessels and the proposed alliance could assist community efforts to utilise spare capacity by spreading the effort to pursue contingency funding and projects. Spare capacity may be as small as some vacant bunks on scientific voyages and the likelihood of opportunistic use of these vacancies will be increased by the alliance.

A more coordinated approach for the large-scale research vessels would lead to more efficient use of appropriate vessels for the various scientific projects that are proposed. For the two deep-ocean vessels, with their different but overlapping capacity, this could lead to reduced transit times and earlier scheduling. For the coastal-shelf vessels, if they became part of a nationally scheduled and funded fleet, their use could be more cooperative and more broadly address high-priority national and regional needs. For example, the coastal-shelf vessels may be applicable to conduct some of the research requested through the MNF. To strengthen the benefits from the inclusion of the coastal-shelf vessels in the national alliance, it is proposed that up to 50 days are funded for each of the four regions covered by the five coastal-shelf vessels (i.e. $2 million per annum) that scientists could competitively apply for, similar to the process conducted by the MNF. This would provide up to an additional 200 days to research the nation's marine estate with a focus on the coastal-continental shelf zone.



Longer term, the national alliance could expand to international cooperation through a vessel exchange program. Such a program could enhance our scientific research by using foreign vessels in areas far from Australia or where those vessels have capabilities that ours do not. It could also allow the use of foreign equipment for joint programs on our vessels.

Therefore, it is proposed to establish an alliance of large-scale research vessel operators to provide (a) national coordination of scheduling, enhancement and reporting of collaborative research, (b) national collaboration on common issues such as cost management and operational/technical expertise so as to improve efficiency and effectiveness, and (c) national planning for fleet replacement and enhancement so as to better match capability and capacity with demonstrated scientific need and demand. Initially, the alliance would involve the MNF, icebreaker and five coastal-shelf vessels, and is critically about management and access arrangements for research infrastructure. For a coastal-shelf research vessel to be sustainable and part of the alliance it will require the continued commitment from the respective owner-operator institution. Funding for capital replacement and refits, as well as dedicated sea days to address national priorities will enhance the operations and inclusion of these vessels in the alliance.

PRIORITY AREAS FOR FUTURE RESEARCH INFRASTRUCTURE INVESTMENT

An indicative investment of at least $165 million[15] across the next decade is proposed to establish a national alliance of a coordinated fleet of large-scale offshore research vessels that cover Australia's marine estate. This will enable Australia to address critical research infrastructure gaps in utilisation of the MNF and coastal-shelf research vessel capability.

This investment includes funding for the following priority infrastructure:

- an increase from 180 to 300 funded operating days for full utilisation of the MNF ($80 million);
- replacement/upgrade of four ageing coastal-shelf research vessels ($65 million)[16];
- a scheme to enable the marine science community to fully utilise coastal-shelf research vessel capability, such as providing up to 50 funded operating days for contestable marine science in each region (northern, southern, western, eastern) across the range of the coastal-shelf research vessels ($20 million).

The issue of inadequate operational funding can be seen in the case of the MNF. Australian marine scientists and their international collaborators now have access to a world class blue water research vessel in the form of the *RV Investigator*. Yet even though there is clearly demonstrated scientific demand for more than a single vessel capacity on an annual basis, there is currently funding to only operate for 180 days per annum. It makes both scientific and economic sense to enable full utilisation of funded infrastructure in line with established science demand. While limiting operations to 180 days compared to full utilisation at 300 days reduces operating costs in some areas, inefficiencies reduce these cost savings. For example, crew and maintenance costs do not reduce pro rata with a reduced number of operating days, port charges increase, and corrosion, hull fouling and machinery require ongoing attention to maintain a science ready platform. The incremental cost of increasing the MNF operating budget to enable 300 days use of the *RV Investigator* will almost double the available ship-time, while reducing some of the unproductive costs that the MNF currently has to bear.

Capital investment in blue water research vessels needs to be complemented by investment in coastal-shelf research vessels. Australia's coastal-shelf research vessels are ageing and in need of replacement and/or upgrade. Vessels requiring replacement over the next 10 years, in sequential order, are the *RV Ngerin*, *TV Bluefin* and *RV Cape Ferguson*. The *RV Naturaliste* also requires an upgrade. Projecting costs of vessel builds over the next decade is difficult but can cost in the order of $15 - 30 million per vessel. As an example of the investment required, it has been estimated that $15 million is required to build a new replacement vessel for the *RV Ngerin*[17]. This capital investment will ensure the nation maintains the minimum capability to service our marine estate for the next 25+ years and it may need to be expanded. These vessels could be built in Australia, thereby re-investing funds back into the nation to create jobs and support the local ship building industry through a period of high uncertainty.

The proposed investment includes the increase in funded operating days for full utilisation of the MNF ($8 million per annum), and part funding for the coastal-shelf vessels ($2 million per annum; up to 50 days each year in each region – northern, southern, western, eastern; pending individual vessel charter costs); noting that a scheme to enable the marine science community to fully utilise coastal-shelf research vessel capability is required. Funding for the coastal-shelf vessels would provide a contestable pool of dedicated sea days in addition to those of the MNF and the Australian Antarctic Program. The proposed funding to support the full operating costs of the MNF (i.e. 300 days) and the coastal-shelf vessels will assist in this initiative, while strengthening the commitment to the alliance.

[15] Investment ranges from an estimated $10 million to $25 million per year from 2017-18 to 2026-27; all investment figures are indicative and have not been indexed, are ex-GST and depreciation has not been included.

[16] If Australia were to expand its coastal-shelf research vessel capability to fill the capability gap between the 35 metres RV Solander and 94 metres RV Investigator (i.e. a research vessel about 45 metres in length), it has been estimated this would require a capital investment of $40 million with a further $60 million required over the decade for operations and maintenance.

[17] International Maritime Consultants (2015). SARDI Research vessel Ngerin replacement project – budget costing report.

NATIONAL MARINE SCIENCE COMMITTEE WORKING GROUP – NATIONAL RESEARCH VESSEL ALLIANCE

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GLOSSARY

AAD	Australian Antarctic Division
AIMS	Australian Institute of Marine Science
ANU	Australian National University
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoF WA	Department of Fisheries Western Australia
IMOS	Integrated Marine Observing System
IODP	International Ocean Discovery Program
MNF	Marine National Facility (R.V.Investigator)
NMSC	National Marine Science Committee
SARDI	South Australian Research and Development Institute
U Tas	University of Tasmania


ASP