2016 National Research Infrastructure Roadmap
Chief Scientist
9 September 2016

NATIONAL MARINE SCIENCE COMMITTEE

Dear Dr Finkel

Re.: Submission to the 2016 National Research Infrastructure Roadmap Capability Issues Paper

This submission augments the broader National Marine Science Committee (NMSC) submission, and is specific to a proposed National Research Vessel Alliance (see Attachment).

The submission 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 in order to fully realise the significant benefits from our blue economy. The submission focuses on large scale research vessels that have the capacity to operate distances to at least the continental shelf. The scale of these vessels enables 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. The submission covers the benefits, logistics and networks for operating a coordinated national research vessel fleet, including how best to support and use international infrastructure.

The blue economy is a significant opportunity for economic growth, employment and investment that will be realised over the next decade and beyond. By 2025, it is estimated that Australia's marine industries will contribute around $100 billion each year to the economy. The blue economy is projected to grow three times faster than the national GDP over the next decade, more than doubling its current contribution of $47 billion a year.

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

In 2015, the NMSC published a decadal plan, *National Marine Science Plan 2015-2025 Driving the development of Australia's blue economy* (NMSP), which focusses investment on the highest priority capabilities, including infrastructure, required to fulfil our blue economy's potential. The NMSP details the critical research infrastructure required to realise these goals including an adequately funded national research vessel fleet consisting of blue water, polar and coastal-shelf vessels.

The NMSC looks forward to continuing to work with you and the Australian Government to realise the full potential of Australia's blue economy.

Yours sincerely

Prof Gavin Begg
Chair – NMSC Working Group National Research Vessel Alliance

Submission

2016 National Research Infrastructure Roadmap Capability Issues Paper

Submission No:	
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Would you like your submission to remain confidential, i.e. not published on the website?	**NO**

Question 1: Are there other capability areas that should be considered?

This submission relates to the need for an appropriately resourced National Research Vessel Alliance to service Australia's significant marine estate in order to unlock the full benefits of our blue economy and keep our marine science at the leading edge and internationally competitive. This is specifically covered in the Environment and Natural Resource Management capability area. Marine science and the need for marine research vessels, however, is broader than this area and relevant to the other capability areas in National Security, Underpinning Research Infrastructure, and Data for Research and Discoverability, as well as the National Science and Research Priorities in food security, energy security and resources security.

Question 2: Are these governance characteristics appropriate and are there other factors that should be considered for optimal governance for national research infrastructure?

Yes, these governance characteristics are appropriate for national research infrastructure.

It is proposed that investment in a national alliance of a coordinated fleet of large-scale (greater than 20 metres in length), offshore research vessels that cover Australia's marine estate, from the coast to the blue water, and the tropics to Antarctica, will provide the capability required for our marine scientists, industry and policy makers to derive the benefits from the nation's blue economy and ensure our marine science capabilities remain world leading. The proposed coordinated and funded national research vessel fleet will increase the opportunities for scientific collaboration and discovery, both domestically and internationally. The proposed formation of a national alliance of research vessel owner-operators that recognises institutional governance structures, strategies and business drivers will greatly enhance coordination, efficiencies and potential cost-effectiveness, enabling leveraging off each other by increased sharing/coordination of voyages and capabilities.

Question 3: Should national research infrastructure investment assist with access to international facilities?

Yes, it is important that national research infrastructure investment assists with access to international facilities.

Globally, the blue economy is viewed as a significant opportunity for economic growth, employment and investment that will be realised over the next decade and beyond; marine science and the necessary related infrastructure, such as offshore research vessels will be critical to achieving these goals. Marine science is multinational and multidisciplinary in character, and increasing international cooperation is in everyone's interests. As noted in the Issues Paper, Australian marine science is enhanced through the use of international research infrastructure, such as Australia's Integrated Marine Observing System (IMOS) being enhanced by its integration into the Global Ocean Observing System (GOOS). Another example, is ongoing access to the International Ocean Discovery Program (IODP), which carries out scientific ocean drilling around the world, and is a continuation of the world's longest running and most successful international geoscience research program. Both programs have a key dependency on the Australian research vessel fleet – blue water, polar and coastal-shelf.

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. Australia is 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. 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.

International researchers and scientific programs sometimes 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 (e.g. IODP). 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, for which the nation's research vessel fleet is well suited. Participation in the global IODP directly improves our understanding of Australia's marine region, benefits Australia's research performance and greatly enhances our national scientific reputation. Similarly, 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. 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.

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.

A national marine research vessel fleet will enable the collection of critical data and information on marine environmental baselines and impacts, ocean conditions, petroleum and mineral resources, climate change, fish stocks, ecosystem effects of fishing and biosecurity threats; all of which will contribute to meeting the nation's obligations to unlock the wealth and opportunities from our blue economy. Longer-term, the national research vessel 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, or using foreign equipment on joint programs on our vessels.

Question 4: What are the conditions or scenarios where access to international facilities should be prioritised over developing national facilities?

Where the scale of facility required is well beyond our national capacity to design, build, operate and maintain, and/or where it is in Australia's strategic interest to partner rather than go it alone.

In terms of developing a national research vessel fleet, this would be limited to larger scale blue-water vessels that have specialised infrastructure, such as the unique long coring capacity of the French *RV Marion Dufresne II* (120.5 m in length) that has been used for geoscience research occasionally under contract.

Question 5: Should research workforce skills be considered a research infrastructure issue?

Yes – to the extent required to operate and maintain the research infrastructure.

The proposed National Research Vessel Alliance will greatly enhance coordination, efficiencies and potential cost-effectiveness amongst vessel operators, enabling leveraging off each other by increased sharing/coordination. The proposed alliance would include operational and technical networking to increase knowledge and skills exchange between vessel operators.

Question 6: How can national research infrastructure assist in training and skills development?

Marine science training and skills development requires significant hands-on experience. As such, research infrastructure, such as the proposed National Research Vessel Alliance, is required to be available not only for research activities but also for training of future marine scientists.

The National Research Vessel Alliance would provide the necessary infrastructure to support a training ground for the next generation of marine scientists; thereby providing the succession plan for at-sea capable scientists that will be needed to explore and discover the breadth of Australia's marine estate. A number of examples already exist where research vessels are used to assist in training and skills development, such as the MNF *RV Investigator* Collaborative Australian

Postgraduate Sea Training Alliance Network (CAPSTAN) and Next Wave Program that targets postgraduate students studying marine science to fill cruise vacancies, as well as the *TV Bluefin* that is a purpose built fisheries training vessel. These types of training programs would be enhanced if additional days at sea on the *RV Investigator* and other vessels in the national alliance were made available. An increase from 180 to 300 funded operating days for full utilisation of the Marine National Facility (MNF), and 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 would support these programs.

Question 7: What responsibility should research institutions have in supporting the development of infrastructure ready researchers and technical specialists?

Increased collaboration between educational and research institutions will ensure students complete their education with the skills required to effectively use national research infrastructure.

The National Research Vessel Alliance will support the development of the next generation of marine scientists; thereby providing the succession plan for at-sea capable scientists that will be needed to explore and discover the breadth of Australia's marine estate.

Question 8: What principles should be applied for access to national research infrastructure, and are there situations when these should not apply?

Priority access to national research infrastructure should be granted to high quality applicants whose research aligns with national priorities.

Access to the MNF 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. Likewise, allocation of time for marine science use in the Australian Antarctic Science Program is undertaken within a competitive application process that includes rigorous assessment against Australia's strategic priorities for the Antarctic and Southern Ocean in accordance with *Australia's Antarctic Science Strategic Plan*. Applications are open to researchers worldwide and are highly competitive.

Overall, the requirements for access with respect to the MNF and polar vessels are 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.

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 (*RV Investigator* and *RV Aurora Australis*), with their different but overlapping capacity in the Southern Ocean, better coordination 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 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.

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.

Access to the research vessels will also be available on a cost-recovered basis depending on the requirements, which will contribute to annual operating expenses.

Question 9: What should the criteria and funding arrangements for defunding or decommissioning look like?

A whole of life cycle approach is required to design, build, operate, maintain, decommission and, refresh national marine research infrastructure. This is particularly relevant for marine research vessels, where their life cycle is expected to be 25-30 years.

Question 10: What financing models should the Government consider to support investment in national research infrastructure?

The proposed National Research Vessel Alliance would require capital and operating investment from the Commonwealth Government, with significant co-investment from the respective institutions involved in operating the vessels.

Research vessels require sustained capital expenditure to ensure they are fully capable for the duration of their operating life. This entails the ongoing commitment from the respective owner-operator jurisdiction/institution. For example, based on current capacity, the build cost of a new coastal-shelf vessel is $15-30 million, with annual operating costs about $1-4 million; demonstrating the co-contribution from the respective institution to the proposed capital investment from the Commonwealth. This commitment demonstrates the capacity for an institution to take on this responsibility as part of the National Research Vessel Alliance. The proposed funding to support the

full operating costs of the MNF (i.e. 300 days) and part funding for the coastal-shelf vessels (i.e. up to 50 days per region) will assist in this initiative, while strengthening the commitment to the national alliance.

Question 11: When should capabilities be expected to address standard and accreditation requirements?

The National Research Vessel Alliance would expect to have vessels within the fleet operating at the highest level in terms of maintenance, data collection and sharing protocols and at-sea safety. State-of-the-art and specialised equipment operated from the vessels may also need to meet certain standards. This will vary depending on the equipment/capability and need.

Question 12: Are there international or global models that represent best practice for national research infrastructure that could be considered?

Yes – there are a number of countries that operate national research vessel fleets at a much greater scale than Australia. These include the USA, Japan, Germany, France and Russia.

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. On a per capita basis, Australia's research vessel capability is modest (i.e. seven vessels greater than 20 metres in length), poor with respect to the size of our marine estate, which is the third largest globally, and the coastal-shelf vessel fleet is ageing and in serious need of replacement and/or upgrade.

Question 13: In considering whole of life investment including decommissioning or defunding for national research infrastructure are there examples domestic or international that should be examined?

There are many examples of managing whole of life investment in marine research vessels, both domestically and overseas. All research vessel owner-operators have demonstrated experience in this area, none more so than the MNF and the Australian Antarctic Program.

Question 14: Are there alternative financing options, including international models that the Government could consider to support investment in national research infrastructure?

Health and Medical Science

Question 15: Are the identified emerging directions and research infrastructure capabilities for Health and Medical Sciences right? Are there any missing or additional needed?

Question 16: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 17: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Health and Medical Sciences capability area?

Environment and Natural Resource Management

Question 18: Are the identified emerging directions and research infrastructure capabilities for Environment and Natural Resource Management right? Are there any missing or additional needed?

The National Marine Science Plan (NMSP) identifies the following seven grand marine challenges: marine sovereignty, security and safety; energy security; food security; biodiversity conservation and ecosystem health; urban coastal environments; climate variability and change; and resource allocation. Only some of these are included in the Issues Paper, although it would be valuable to include all of them in the 2016 Roadmap.

In terms of the National Research Vessel Alliance there is reference made to the MNF, icebreaker and marine vessels to support ongoing research in the coastal zone.

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. 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.

In order for Australia to maintain its leadership in marine science, we need an adequately funded national research vessel fleet consisting of blue water, polar and coastal-shelf scale vessels which allow exploration of the open oceans, Antarctic regions and continental shelf and coastal waters. Infrastructure investment to support a National Research Vessel Alliance includes:

- an increase from 180 to 300 funded operating days for full utilisation of the Marine National Facility;
- build replacement/upgrade of four ageing coastal-shelf research vessels;
- 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.

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 needs. At present the coastal-shelf vessels do not work along a considerable part of Australia's coastline, but if our proposal is accepted and funded (see Attachment) this will no longer be the case. Longer-term, the national alliance could expand to international cooperation through a vessel exchange program, and models for sharing international research vessel capacity could be explored, with the IODP scientific drilling program a successful example of this approach. 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, or using foreign equipment on joint programs on our vessels.

Question 19: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Australia should continue to engage with the IODP and Global Ocean Observing System (GOOS). The National Research Vessel Alliance will be critical to ensuring Australia has a place at the table, and is part of these key international initiatives.

Most international research vessels are occasional visitors to our waters rather than regular operators, and Australia cannot depend on these visits to build our knowledge base. Australia is 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.

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 (e.g. IODP and Antarctic research vessels). 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.

Question 20: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Environment and Natural Resource Management capability area?

Advanced Physics, Chemistry, Mathematics and Materials

Question 21: Are the identified emerging directions and research infrastructure capabilities for Advanced Physics, Chemistry, Mathematics and Materials right? Are there any missing or additional needed?

Question 22: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 23: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Advanced Physics, Chemistry, Mathematics and Materials capability area?

Understanding Cultures and Communities

Question 24: Are the identified emerging directions and research infrastructure capabilities for Understanding Cultures and Communities right? Are there any missing or additional needed?

Question 25: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 26: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Understanding Cultures and Communities capability area?

National Security

Question 27: Are the identified emerging directions and research infrastructure capabilities for National Security right? Are there any missing or additional needed?

Marine sovereignty, marine (bio)security and marine safety are important components of national security, yet are missing from the Issues Paper. Our marine estate is a vital contributor to Australia's sovereignty, national security and safety. Governments and marine industries all require accurate and up-to-date information about sea state, atmospheric conditions and geohazards, to support their operations to utilise the blue economy. In addition, as highlighted in the National Marine Science Plan, national security should also encompass food security, energy security and resources security.

A national marine research vessel fleet will enable the collection of critical data and information on marine environmental baselines and impacts, ocean conditions, petroleum and mineral resources, climate change, fish stocks, ecosystem effects of fishing and biosecurity threats; all of which will contribute to unlocking the wealth and opportunities from our blue economy. A coordinated national research fleet will provide the ability to support national marine science and industry initiatives, including the collection of scientific data of national significance on the state of the environment, whilst maintaining our status as a world class, leading marine research nation.

Knowledge about Australia's marine estate is not only critical to Australia but also for global understanding. The United Nations' Law of the Sea arrangements require us to satisfactorily manage our marine jurisdiction, and that management requires scientific understanding. Australia requires

its marine science community to explore, understand and monitor our marine estate at a high spatial resolution to conduct research that underpins effective management and development of marine resources. Only 28% of Australia's marine estate has been mapped with any detail. A systematic program 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.

The Australian research vessel fleet also has 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.

Question 28: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 29: Is there anything else that needs to be included or considered in the 2016 Roadmap for the National Security capability area?

Underpinning Research Infrastructure

Question 30: Are the identified emerging directions and research infrastructure capabilities for Underpinning Research Infrastructure right? Are there any missing or additional needed?

The identified emerging directions and research infrastructure capabilities align with the marine science research infrastructure requirements detailed in the NMSP.

Research vessels are also considered as key underpinning infrastructure required to explore and discover Australia's vast marine estate. 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 the geological context for our biological understanding and documents geological events that have occurred throughout history and shaped our marine estate.

IMOS has a key dependency on the Australian research vessel fleet as an underpinning research infrastructure for the collection of its data streams. 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 also 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 largest component is the moored buoy program, which includes deep water 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.

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 the National Research Vessel Alliance, is essential for maintaining the nation's capacity for collecting these data and deriving information and decision-support tools from them.

Question 31: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Australia is already beneficially engaged in the International Ocean Discovery Program (IODP) and in the Global Ocean Observing System (GOOS), and that engagement should continue. [See details provided in Question 3; and in the separate submission entitled *Australian Membership of the International Ocean Discovery Program*].

Question 32: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Underpinning Research Infrastructure capability area?

Data for Research and Discoverability

Question 33: Are the identified emerging directions and research infrastructure capabilities for Data for Research and Discoverability right? Are there any missing or additional needed?

The Australian Ocean Data Network (AODN) needs to be added to the list of potential new infrastructure.

Question 34: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 35: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Data for Research and Discoverability capability area?

Other comments

See Attachment for detailed paper on the proposed National Research Vessel Alliance.