

Chapter 4 Establishing robust, evidence-based decision-making for the management of the marine reserves

Over the last decade, understanding of Australia's marine environment has grown considerably, as evidenced by recent reports of the Marine Biodiversity Hub and Census of Marine Life (see, for example, Butler *et al.* 2010). This review of the Commonwealth marine reserve (CMR) estate has been informed by these developments and was greatly assisted by a Marine Science Expert Forum held on 11 June 2015.

In preparing to 'advise the government on the science underpinning the Commonwealth marine reserves including proposed zoning boundaries and allowed uses', the Expert Scientific Panel (ESP) reviewed the use of science leading up to the 2012 declarations. The ESP found that that the process of establishing the CMR estate made use of the best available scientific information and input from stakeholders to establish initial reserve boundaries, which were then finalised following further consultation with stakeholders. The principal source of information that provided scientific input into this process was the Marine Bioregional Planning Programme that led to the development of a series of Marine Bioregional Plans for Commonwealth waters (see section 2.2). This process was informed by a high level of engagement with the marine science community.

The development of the CMR 2012 zoning boundaries was guided by the Goals and principles for the establishment of a National Representative System of Marine Protected Areas in Commonwealth waters (the Goals and Principles) and CMRs were assigned International Union for Conservation of Nature (IUCN) categories, as required by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Again, the drawing of zone boundaries and zone management policies made use of the best available science at the time and was also informed by a process of consultation with experts and interested stakeholders (see chapter 2). This process exceeded the minimum statutory requirements of the EPBC Act.

There is a large body of scientific literature on marine reserves globally and in Australia. However, most pertain to the coastal zone and such is the size of the Australian Exclusive Economic Zone (EEZ) and the CMR estate that fine-scale biodiversity data for the estate is limited (see chapters 2 and 3). This necessitated the use of surrogate indicators (see section 2.2, box 2.1) and expert workshops to discuss options in relation to the defining of reserve boundaries and zones. The science of surrogates and knowledge of the distribution of biodiversity at finer scales can and should be progressively improved, as should our understanding of broad-scale oceanographic processes. While further insight has been gained in some areas since the 2012 proclamation, there are a number of areas where improved knowledge will assist in more precise targeting of management actions and increase management

effectiveness. Increasing knowledge will have to be addressed over future planning cycles and, given the extent of the CMR estate, will require an approach that embraces all the areas of science necessary for evidence-based management of the diverse range of reserves that make up the CMR estate. This clearly requires that needs be identified and information be delivered through a strategic framework of research. Specific needs will arise and these, as well as opportunities that might arise to conduct research outside this framework—such as might arise through the availability of a new facility or technologies—will have to be addressed in the course of a management plan cycle for the CMRs.

Establishing an efficient and effective monitoring system for marine biodiversity in the CMR estate that is fit for purpose is critical to effective management and performance evaluation.

Monitoring of marine biodiversity does not simply involve a survey that identifies the range of species that occur in different areas of the CMR estate at particular times. It also relates to the processes that influence these distributions. Such processes are complex and often either imperfectly understood or unknown. In addition, they are variable in time and space. To complicate these issues, threats which could modify species distribution and ecosystem function are often unknown either in an absolute sense (for example, an invasive species) or in terms of their long-term effect until expressed and observed over time. For example, a change in oceanographic processes can naturally occur or have an anthropogenic cause. In addition, localised changes can be the result of direct anthropogenic impacts such as oil spills, recreation and tourism. Addressing these information gaps for Australia's marine environment represents a project of national significance that will have to be established and maintained over generations. It is reasonable to assume that over the long term, as knowledge improves, zoning may need to change and some adjustments to reserve boundaries may even be necessary to improve the CMR estate in line with comprehensive, adequate and representative (CAR) principles. This is a future priority to be addressed in successive statutory management cycles.

The ESP has considered these issues and recommends a framework for resolving them over successive management planning cycles (each cycle is statutorily set at 10 years). A long-term perspective is needed, as there is no other practical way to deal with them quickly in either the current or any foreseeable future scenario of available Government resources.

4.1 Managing the Commonwealth marine reserves effectively

The marine environment, including the CMR estate, is subject to significant temporal and spatial variability. We do not understand in sufficient detail the seabed topography, its substrates and their variability in space and time and have even less understanding of the biota in these sediments and the sea above it. Furthermore, we

need to better understand how natural variability and climatic drivers affect currents, seawater layering and upwelling, as these affect important marine systems and processes (see section 3.4.1, for example).

The ESP is of the opinion that the establishment of the CMRs provides a framework in which Australia can build its capabilities for the management of both the reserve estate and the broader Commonwealth component of the EEZ. Managing these areas is in Australia's long-term strategic interests, as it more clearly elaborates and demonstrates Australia's responsibilities for its EEZ. However, the approach needs to be measured and clearly focused on the progressive building of national capability to undertake high-quality research and to monitor and evaluate performance of marine systems and their management. This must embrace the existing capacity of both the governmental and private sectors through partnerships with the marine research community more generally. The relevance of science to underpin the management of the CMR estate must be presented to the Australian people in such a way that they understand its value and importance.

In order to build on current knowledge and respond to new information, an adaptive management approach is needed.

ESP Recommendation 1

The Expert Scientific Panel recommends the adoption of an adaptive management approach for the Commonwealth marine reserve estate and that the first management planning cycle include a period for transition to this approach.

The ESP is of the opinion that there will be a need to emphasise research, monitoring and evaluation together with a significant communications effort over the next decade (see ESP Recommendation 2). This is done with the background assumption that this will not be at the expense of necessary day-to-day management of the CMR estate that, to be clear, cannot be achieved without a long-term, adequate and systematic investment. While this may initially be modest, the real challenge is to ensure that such investments are enduring, maintain their focus and demonstrate their usefulness. Any other approach would be, in the long term, ineffective and a waste of resources.

4.2 Research and monitoring needs and priorities

4.2.1 Overview

Research and monitoring, together with the evaluation of both for the CMR estate, takes place within the legislative framework set out for the management of the reserves under the EPBC Act. The statutory CMR management plans are implemented through a framework determined by the Director of National Parks (the Director) and approved by the Minister for the Environment.

To establish an effective management planning and subsequent management regime, Parks Australia must build and maintain strong links with the marine research

community and, as an extension of that, encourage the use of good citizen science (see section 4.4.2). One strategy requiring specific investment is the further building of a knowledge broker network involving Parks Australia, state jurisdictions, private enterprise, the research community and organised citizen science.

In its consideration of research and monitoring, the ESP had three primary sources of information: its own evaluation of the existing science, the views of the Director and the results of a national Marine Science Expert Forum conducted as part of this review.

4.2.2 Research in the Commonwealth marine reserve estate

The ESP sees the research requirements for the CMR estate at two levels:

- At the strategic level, the research investment would be geographically- and process-defined to improve understanding of the structure and function of the biophysical systems that constitute the reserves and the adjoining seas. It is evident that the resources currently available to the Director are not sufficient to address research and monitoring gaps at this level. Programs like the National Environmental Science Programme (NESP) and its successors, together with what may develop from the National Marine Science Plan (NMSP) (see box 4.1) will be very important for strategic CMR research. Opportunities for the Director to leverage funds through strategic partnerships to conduct such research will also be important at this level.
- At the tactical level, the research investment would be on high-priority issues that are directly relevant to the management of the CMR estate. These issues would vary significantly between components of the CMR estate, as they would be driven predominantly by interaction between management and stakeholders. This includes research in response to poorly understood or emerging threats. High-priority tactical research issues will not always be foreseen and will often require a fast response. For this reason, funding needs to be available to the Director to develop and enable effective and timely responses to issues and opportunities as they arise.

The strategic CMR research needs that are critical for successive planning cycles to continuously improve the management of CMR estate require a systematic approach. This will involve the application of objective evaluations of how the management framework is performing and interacting with research. Recently, significant progress has been made—the Marine Biodiversity Hub has held a series of workshops with a wide range of stakeholders and marine users to identify further research priorities for the hub, including one workshop specifically on research needs for the CMR estate. The Marine Biodiversity Hub is about to discuss and finalise its next five-year research plan with this input. In addition, the NMSP sets out a series of strategic

research needs, including for biodiversity, development of baselines, monitoring, decision-support models and tools, and better data management.

Management information needs to be designed in a framework that relates the research and monitoring effort to the management requirements of the CMR estate and other Commonwealth obligations under the EPBC Act. Table 4.1 is a systematic way of bringing these requirements together and some priority areas are elaborated on below.

ESP Recommendation 2

The Expert Scientific Panel recommends the development of a research, monitoring and evaluation framework that will support robust evidence-based decision-making in the management of the Commonwealth marine reserve estate. Such a framework should be designed in a way that it is consistent with that used for environmental reporting in Australia.

The Expert Scientific Panel recommends the development and management of knowledge brokering between Parks Australia, state jurisdictions, private enterprise, the research community and citizen science.

Box 4.1 The National Marine Science Plan 2015–2025: Driving the development of Australia’s blue economy

Launched in August 2015, the National Marine Science Plan (NMSC 2015) draws together the knowledge and expertise of marine research organisations, universities and government departments and individual scientists. It identifies critical challenges related to Australia’s marine estate and provides recommendations about how marine science can support Australia in meeting those challenges.

The plan recognises marine biodiversity and ecosystem health as one of a number of ‘grand challenges’ for Australia and makes the following statement in relation to that challenge:

To conserve marine biodiversity and keep ecosystems healthy, we must explore and map our marine estate to fill in knowledge gaps; undertake experimental research on ecological processes; monitor key indicators of variability and change; and develop modelling tools and other techniques for evidence-based management. Over the next 10 years, this science will focus particularly on building the knowledge base to support our new National Marine Reserve System.

The ESP supports this statement and, as noted elsewhere in this chapter, National Marine Science Plan recommendations for:

- the establishment of baselines and monitoring for Australia’s marine estate with a focus on helping manage Commonwealth marine reserves
- continued support for the Integrated Marine Observing System (IMOS).

The ESP is also supportive of the plan’s broad ambition to develop a more comprehensive scientific understanding of Australia’s marine estate to support good decision-making, and notes that in many cases Commonwealth marine reserves provide a sensible focus point for efforts to develop that understanding.

4.2.3 Information gaps identified by the Expert Scientific Panel

Advancing our understanding of the functioning of marine ecosystems

This represents a high priority for the next 10 years. While the ESP has found that the use of surrogates and expert opinion was the best way available to establish the CMR estate and has suggested this needs to be built on, the immediate priority is to ensure that management actions and investments are well targeted and ensure that the objectives that underpin the establishment of the CMR estate are met effectively and efficiently. If this is done in the long term, knowledge of the CMR estate can be refined in terms of its zoning and ultimately its outer boundaries. This can only be

done when better information about the CMR estate becomes available to evaluate and improve the existing situation. Success in this area will require novel and efficient approaches to data acquisition, including remote sensing, modelling, hypothesis-driven experimental management approaches, and the use of new technologies such as aerial, surface and underwater drones. It is suggested later that this should be part of a wider national investment in technology development.

Baselines and inventories

The ESP affirms the importance of baselines as being essential to the assessment of condition and trends in the CMRs. Benchmarks and targets against which progress can be measured need to be developed against this baseline information. They should not be confined to highly protected zones and no-take reference areas but should be distributed across the CMR estate and be in all zoning types. This approach would enable CMRs to be part of a long-term management approach for the EEZ that not only reports on condition and trends within the CMR estate but also provides reference and comparative information for areas under different management and/or zoning regimes. Particular outcomes of biophysical and socio-economic baselines and inventories would be the evaluation of the effects of zoning and management regimes and the early identification of emerging threats.

As new information emerges, the system of baselines and benchmarks could be extended to include cooperative research around newly identified areas of scientific, economic and social interest. Managing the estate in this fashion would place Australia in the first rank of international marine science and could help attract research investment from the international community.

The ESP recognises the magnitude of this task and accepts that comprehensive coverage will not be achievable in the short term. The ESP greatly welcomes the emphasis in the NMSP on national marine environmental baselines, a national marine monitoring system, national marine environment and socio-economic modelling, smart technologies and decision-support science, which can all benefit the monitoring of and research on the CMR estate.

ESP Recommendation 3

The Expert Scientific Panel (ESP) recommends the establishment of a series of baselines and development of benchmarks in each network across the Commonwealth marine reserve estate. Further, the ESP stresses that early baseline and benchmark establishment is critical to enable a sound assessment of the effectiveness of subsequent reserve management.

The ESP further recommends that this be done in partnership with the marine research community.

The ESP endorses the recommendation in the National Marine Science Plan 2015–2025 to *‘establish and support a National Marine Baselines and Long-term Monitoring Program to develop a comprehensive assessment of our estate, and to help manage Commonwealth and State Marine Reserves’*. In addition the ESP encourages a Government commitment to maintaining investment in marine infrastructure and capabilities.

Other values

Although the emphasis of the ESP has been on biophysical science, the importance of the social and economic sciences should not be ignored in the development of better understanding of CMR effects and benefits that go beyond the conservation values as defined by biophysical science. Such work is essential for the CMR estate given its multiple-use nature and is necessary for management to be acceptable to the public in the long term. It also provides Government and the community with information and builds confidence in the values of a well-managed estate.

ESP Recommendation 4

The Expert Scientific Panel recommends that the social and economic sciences be part of the research investment made to support management of the Commonwealth marine reserve estate.

Effectiveness of zones

The zoning of the CMR estate provides a range of opportunities to evaluate and compare the efficacy of different zone types and their management arrangements. The estate also provides an opportunity for the users of different zones in the CMRs to participate in the collection of information that will contribute to a better understanding and improved management of the zones. The paucity of hypothesis-driven, well-designed studies that evaluate and compare the efficacy of different zone types underscores the importance of undertaking these studies in the CMR estate. Here, the importance of baseline data cannot be overemphasised (see above). While of considerable scientific interest, the primary reason to invest in and support research into zone efficacy is to improve the effectiveness of management and to ensure future planning cycles are based on a improving knowledge base, and particularly to ensure that zoning and management arrangements are well targeted, soundly based, better understood and accepted by the community.

ESP Recommendation 5

The Expert Scientific Panel recommends that the Director of National Parks facilitate and encourage research and research collaborations that assist in the evaluation of the efficacy of different zone types.

Threats and mitigation of threats

Most of the literature dealing with threats in marine parks and reserves is based on studies in nearshore and coastal reserves. Far less information is available on the more extensive and remote marine areas such as those covered by the CMR estate. The exception to this is the risk of commercial fishing, which has been comprehensively assessed through the Fishing Gear Risk Assessments. A focus of future monitoring and research should be to improve understanding of other threats to CMR conservation values. This would include activity-generated threats (shipping, for example) and broader anthropogenic threats like climate change. Where multiple threats exist, these can have a cumulative impact on the marine environment.

The intensity and impacts of emerging and cumulative threats in particular are not well understood. Improved understanding of these and other threats can inform efficient and effective management responses, which may help to mitigate the risks posed by those threats. Different zoning arrangements across CMRs provide an opportunity to study changes in marine areas with different threat combinations. The approach proposed in this report is to design monitoring and research to analyse the effects of various stressors and thus ensure that this problem can be effectively addressed.

ESP Recommendation 6

The Expert Scientific Panel recommends that, in developing a research, monitoring and evaluation framework for the Commonwealth marine reserve estate, existing and potential threats be identified and prioritised. Some baseline and benchmark sites within the estate should be established to assist in detecting threats and their impacts.

Requirements for managing effectively

The ESP invited Parks Australia to outline their research and monitoring needs at the expert workshop. Their list was revised in the light of the workshop discussion and feedback from the ESP. This contributed to the summary presented in table 4.1, which provides a draft framework for understanding CMR research and monitoring with respect to CMR management obligations and objectives. Table 4.1 also maps other environmental reporting requirements, such as State of the Environment reporting, to the CMR needs.

ESP Recommendation 7

The Expert Scientific Panel recommends institutionalising a transparent approach to research and management within Parks Australia as part of building relationships with the research community.

The Expert Scientific Panel considers the research and monitoring requirements framework set out in table 4.1 is sound and recommends it as an input to the development of a Parks Australia research and monitoring strategy for the Commonwealth marine reserve estate, with the reserves in the South-east Commonwealth Marine Reserves Network included in its scope.

Table 4.1 The relationship between management and reporting requirements and research and monitoring requirement for the CMR estate

Driver → ↓ Research or monitoring requirement	Legal or other requirement	Key management issue	Baseline information	Long-term monitoring (including SoE)	Management of human pressures
Research that contributes to increased understanding of values of the reserves and that provides for establishing baselines and ongoing reporting of the condition of the values of the reserves, as required under legislation, and national and international agreements, such as:					
Systematic bathymetry mapping, including depth and locations of seafloor features.		✓ BIA, KEF	✓	✓	
Mapping of the sub-stratum types and depth of sea floor.		✓	✓	✓	
Stratified random sampling of the benthos, particularly habitat forming benthos such as sponges and corals (to build baselines and assess the extent of the differences between the actual habitats and biophysical proxies used to develop the reserve network).		✓ BIA, KEF	✓	✓	
Comprehensive surveys of biological assemblages associated with geomorphic features or habitats (to build baselines and assess the extent of the differences between the actual habitats and biophysical proxies used to develop the reserve network).		✓ BIA, KEF	✓	✓	
Comprehensive surveys of native species to provide baseline information against which to compare natural variation and human induced change.		✓ SoI, CC	✓	✓	✓

Driver → ↓ Research or monitoring requirement	Legal or other requirement	Key management issue	Baseline information	Long-term monitoring (including SoE)	Management of human pressures
Research into oceanographic features and processes that strongly influence the biodiversity patterns, including distribution of marine species and seabirds.		✓ BIA, KEF	✓	✓	
Development of indicators for use in long-term monitoring to detect changes in ecosystem condition and attribution to pressures (e.g. climate change, uses).		✓ CC		✓	✓
Estimating populations and monitoring trends of threatened species in reserves to assist the implementation of recovery plans and inform biologically important areas.	✓ RP, EPBC	✓ BIA			
Research and monitoring to contribute to the development and implementation of other recovery plans, action plans, Threat Abatement Plans and character assessment of Ramsar wetlands.	✓ RP, TAP, Ramsar	✓		✓	✓
Where practical, remote sensing of vegetation, benthic communities and habitats and other characteristics of islands, reefs and cays.			✓	✓	✓
Studies to better understand biological and hydrographical connectivity in CMRs, including between and within reserves and the broader Commonwealth marine area (e.g. food webs, source and sink locations).	✓ TAP	✓ BIA, KEF			

Driver → ↓ Research or monitoring requirement	Legal or other requirement	Key management issue	Baseline information	Long-term monitoring (including SoE)	Management of human pressures
Research and monitoring to further understand the impacts of human activities in and around the reserves and threats on the values of the reserves, such as:					
Monitoring the spatial extent and character of human disturbance of 'footprint' (such as the total area impacted by facilities, debris, historic sites, sampling sites, tracks).	✓ TAP	✓ KEF	✓	✓	✓
Monitoring changes in the degree to which anthropogenic threats affect threatened and other key species (e.g. interaction with fishers, marine pollution, disease outbreaks, direct disturbance).	✓ RP, TAP, EPBC	✓ SoI, BIA			✓
Identification of key impacts at a national, network and reserves scale where possible.	✓ TAP	✓ IS, SoI, CC	✓	✓	✓
Surveys to determine the presence and extent of any invasive species.		✓ IS			✓
Investigate the possible impacts on native biota of invasive species, including threatened and key species.		✓ IS, SoI			✓
Research and monitoring to contribute to developing management strategies that will prevent or minimise those impacts, such as:					
Investigating the cumulative impacts of activities on threatened species, key species and habitats and identifying particularly vulnerable areas.	✓ EPBC	✓ SoI, KEF			✓
Auditing of key areas for the presence of invasive species.		✓ IS			✓
Identifying the pathways for and mitigation of		✓ IS			✓

Driver → ↓ Research or monitoring requirement	Legal or other requirement	Key management issue	Baseline information	Long-term monitoring (including SoE)	Management of human pressures
risk of invasive species.					
Research and monitoring that will assist in addressing emerging reserve management issues consistent with the provisions of the CMR management plans:					
Research that contributes to and informs effective marine management through a nationally integrated approach.				✓	✓
Research to improve understanding of social and economic use and benefits of the reserves:					
Monitoring changing human use and socio-economic significance of CMRs.		✓	✓	✓	✓

(BIA—biologically important areas; CC—climate change; CMR—Commonwealth marine reserve; EPBC—*Environmental Protection and Biodiversity Conservation Act 1999*; IS—invasive species; KEF—Key Ecological Features; Ramsar—Wetlands of International Importance; RP—Recovery Plan; SoE—State of the Environment; SoI—Species of Interest; TAP—Threat Abatement Plan.

4.2.4 The Marine Science Expert Forum

The ESP convened a forum of national marine science experts to consider key management challenges related to the CMR estate. The questions put to the forum were:

- What are the key data and knowledge gaps in relation to CMRs, in terms of:
 - (a) biodiversity structure and functional distribution in space and time
 - (b) key threats?
- How can these gaps best be prioritised and resolved over the first 10-year management cycle?
- What research capability exists to assist with the above?
- What baselines should be established as a matter of priority?
- What key aspects should be considered for the development of a long-term monitoring program for CMRs?
- What approaches (systems, models, technology) exist and are best placed for facilitating the involvement of all stakeholders in the collecting, sharing, collating and interpreting data that can support adaptive management?

Forum participants considered these issues and came together for a day of discussion in Melbourne. A number key points (see box 4.2) were distilled from the discussion (a list of forum participants is provided at appendix 4).

Box 4.2 Key points distilled from Marine Science Expert Forum held on 11 June 2015

- There is a need for an inventory of current data to be available across government agencies and other sources.
- There is a need for ongoing and comprehensive science communication with stakeholders about progress with Commonwealth marine reserves (CMRs) in the first 10 years of management of the CMRs.
- There is a need for a tactical research capacity to exist within Parks Australia.
- There is a need for effectiveness measures to be developed by Parks Australia.
- The terms of reference of the CMR Review do not cover the South-east CMR Network; however, any research, monitoring and evaluation strategy must include the South-east CMR Network. Any organisations that undertakes relevant projects with any level of Government funding should be required to provide data to the Australian Ocean Data Network.
- Government agencies should invest in long-term data sets, including continued

investment in existing sets and facilities. 'Exemplar' long-term monitoring programmes (both in terms of geographic sites and process) should be highlighted.

- Formal research and other data (including citizen science) collected in CMRs should be done in a consistent manner (e.g. some researchers could be required to use the Collaborative and Automated Tools for Analysis of Marine Imagery and video (CATAMI) classification scheme) so the data can be compared.
- In encouraging the need to address data sharing / accessibility issues, consideration should be given to making available environmental impact statements and general mining and other industry data.
- Considering the CMRs represent over one-third of the Exclusive Economic Zone and that research within CMRs as reference areas informs the broader understanding of the marine system outside the CMRs, some Marine National Facility time should be dedicated to CMR research outside of the competitive programme.
- Performance measures should consider those aspects on which stakeholders seek information with regard to CMRs and their management, including:
 - improving recreational experience
 - the long-term sustainability of commercial and recreational fishing
 - resilience to climate change
 - the economy (through tourism, for example)
 - protection of threatened and endangered species
 - improving opportunities for Indigenous people.
- Research and monitoring in CMRs should consider:
 - how activities impact biodiversity
 - biophysical and socio-economic aspects
 - how the protection of different zone types compare
 - the importance of continuous learning and discovery
 - building on strengths, including through reinforcing the National Environmental Science Programme and the National Marine Science Plan.
- How to prioritise research between areas is a problem that needs addressing.
- There is a need for long-term monitoring sites within the CMRs to be established as baselines and for the consideration of shifting baselines (due to climate change and (associated) shifts in East Coast and Leeuwin currents, for example).

- There is a need to consider ways to address funding constraints. These include:
 - international partnerships and collaborations (e.g. collaborating with international bodies to develop automated processing capabilities; and collaborating with universities and individuals across all research needs)
 - opportunistic discovery should be encouraged, checked and incorporated into data holdings as part of non-government organisations and other projects
 - citizen science should be encouraged.
- Consider new technologies that may provide cost-effective mechanisms for effective research and monitoring (noting that all tools and their use require adequate monitoring program design and data analysis). The new generation of tools currently available (or becoming more cost-effective) include:
 - autonomous underwater vehicles (AUVs) and unmanned aerial vehicles (UAVs)
 - drones
 - genomics
 - lidar
 - satellite imagery (including Landsat 8 and the ‘Australian Geoscience Data Cube’)
 - acoustics.
- Consider modelling developments on system dynamics and structure.
- Recognise and address the difficulty of linking science to management objectives and the need for defining priorities for data collection.
- There is a need to encourage coordination between the marine science sector and stakeholders (including Government, industry, non-government organisations and the international research community) regarding data and techniques.

There is a significant convergence of the views of the ESP, Parks Australia and the Marine Science Expert Forum. While some details vary, it is clear that the objective of achieving ‘robust, evidence-based decision-making for the management of the marine reserves’ is a common objective. The establishment of an effective mechanism to facilitate necessary research, manage new and old data and ensure its effective use is also a common theme. ESP Recommendation 1 is for an adaptive management approach to the management of the CMR estate. This section has proposed a framework for identifying the research needs of the CMR estate. In the next section

the ESP recommends a system for managing the research necessary to support the adaptive management system by meeting its need for science-based data.

4.3 Managing the proposed research, monitoring, data and evaluation framework

4.3.1 Introduction

The development of a research, monitoring and evaluation framework that will support robust evidence-based decision-making in the management of the CMR estate is essential and it may be desirable to design this in a way that it is consistent with the framework used for environmental reporting in Australia. Adopting the Drivers, Pressures, State, Response and Implications framework (DPSIR) approach would allow data required for the purpose of managing the CMR estate to be applied more widely to reporting on the oceans component of Australia's State of the Environment reporting.

Three components are necessary for an effective and more systematic approach to research, monitoring and evaluation:

- (i) a governance structure
- (ii) a framework for data acquisition and management
- (iii) an evaluation framework that is objective and quality assured.

These need to operate across the geographical and temporal scales involved. If such a system is to enjoy public confidence and continuing government support, it has to be open and publicly accessible so that independent evaluation of the interpretation of data can be made.

ESP Recommendation 8

The Expert Scientific Panel strongly recommends that approvals and support for research and monitoring activities in the Commonwealth marine reserve estate require that the raw data and metadata obtained through these activities are made publicly accessible through the Australian Ocean Data Network to enable independent examination and analysis.

4.3.2 Governance

Beyond what it has recommended, the ESP believes that the details of the governance of any system of monitoring and evaluation are a matter for Government arrangements within the Australian Government and between Australian and international jurisdictions. That said, the principle of collecting once and using for many purposes is a good one and it should be applied. The ESP believes this is possible, but facilitation may be necessary.

4.3.3 Data acquisition and management

Data acquisition in the marine realm is expensive and the geographic extent of the CMR is vast. From the material considered by the ESP and the discussions held at the Marine Science Expert Forum, it is clear that surrogates will play a crucial role in data acquisition and will be assisted by the development of various autonomous platforms, remote sensing tools and other innovations that have the potential to reduce the cost and increase the quality and volume of data collected. National collaboration between research providers and research funders is essential. Information gathering will be complemented by citizen science programmes (for example, Reef Life Survey, Eye on the Reef, Tangaroa Blue, and fish tagging and volunteer programmes by recreational fishers) and should be encouraged.

The Australian Ocean Data Network (AODN) provides a strong national framework for managing marine datasets. The bulk of marine data collected by Commonwealth agencies is accessible through the AODN, which has been developed through a joint venture between six Commonwealth agencies with responsibility for marine data (CSIRO, Geoscience Australia, the Australian Institute of Marine Science, the Australian Antarctic Division, the Bureau of Meteorology and the Royal Australian Navy) with primary datasets contributed by the Integrated Marine Observation System (IMOS)—an Australian Government research infrastructure project. The AODN Data Portal provides a single access point for marine data published by Commonwealth agencies and a large number of other data contributors. The portal provides access to standardised data files and includes a catalogue of metadata and a map interface for AODN datasets. The Integrated Marine Observing System Marine Information Infrastructure is responsible for building and maintaining data and metadata standards and provides a sound basis for managing new data acquired from research in the CMR estate.

ESP Recommendation 9

The Expert Scientific Panel (ESP) recommends that existing marine research and monitoring data be maintained in the long term and that it is made readily accessible to the scientific community, reserve managers and other relevant users so that they may contribute to the adaptive management of Commonwealth marine reserves and the management of Australia's Exclusive Economic Zone.

The ESP recommends that Parks Australia becomes an active contributor and core partner in the Australian Ocean Data Network.

The ESP recommends the continuing support of the Integrated Marine Observation System (noting that the National Marine Science Plan also makes this recommendation) and the Australian Ocean Data Network as vital to the future success of the monitoring and management framework of the Commonwealth marine reserve estate.

The ESP recommends that the Australian guidelines for the ethical conduct of research be emphasised in the collection and use of data.

4.4 A staged approach

As stated earlier, the ESP is of the view that the resources available to the Director alone are unlikely to address the range of research, monitoring and evaluation issues that are needed to ensure the CMR estate is effectively managed. In the following sections the ESP recommends strategies for facing this reality.

One such strategy is to adopt a staged approach to the implementation of CMR monitoring, evaluation and research. Such an approach would recognise the need to focus implementation in particular priority areas over the course of a 10-year management cycle. Sensible priority areas have been identified at a high level by the recently released NMSP (see box 4.1) and at a more detailed level by the Director (table 4.1). However, the ESP notes that the monitoring, research and evaluation resources of the Director, even in conjunction with further strategies—for example, partnerships with the broader marine science community—are unlikely to extend to addressing all of these priority areas in all CMRs from the commencement of management.

A pragmatic approach could involve setting specific targets with an adaptive management approach for addressing information gaps in priority areas over two four-year blocks and finishing the 10-year management cycle with a two-year review period. The two-year review would assess the performance of the two four-year research periods and inform planning for the next 10-year management cycle. In addition to providing sensible time frames for science planning and implementation, a science component of a 4–4–2 adaptive management cycle could help to facilitate

more regular communication of new science and science needs between CMR stakeholders. The two-year review period should also involve formal assessment of CMR management effectiveness, preferably by an external reviewer.

4.4.1 Facilitating the setting of research priorities

The ESP was asked to identify specific priorities for research and the information gaps that hinder evidence-based decision-making for the management of the CMR estate.

In chapters 2 and 3 of this report, research gaps have been identified and relevant scientific judgements made to support the work of the Bioregional Advisory Panel (BAP).

Concurrent with the development of this report, the NMSP for Australia sets out expert views on marine research priorities for the coming decades. Many of these proposals are relevant to the management of the CMR estate and the strategic research discussed previously.

During the final stages of this review the Marine Biodiversity Hub released its National Environmental Research Program (NERP) final report, which provides a snapshot of marine biodiversity research findings from scientists. Hub scientists contributed to this review through the Marine Science Expert Forum and Hub outputs will continue to be useful for management planning for the CMR estate.

The ESP has considered what would be a practical list of research priorities that would improve management of the CMR estate (table 4.1). These generally fall into a category of tactical research and should form part of the Director's forward planning.

The critical strategic research investments that would support tactical research needs and significantly improve the management of the CMR estate are those that support and integrate on-going research with the recommendations of this report.

These proposals would be a basis for testing the approach outlined in this report and subsequently, as the approach matures, developing further critical research priorities that should be funded.

ESP Recommendation 10

The priority research investments that the Expert Scientific Panel recommends to the Government as making a significant contribution to the management of the Commonwealth marine reserve estate are:

- the research, monitoring, data and evaluation framework should be established, together with baseline studies
- if a national strategy for the development of platforms and sensors is established then linking research planning for the Commonwealth marine reserve estate with it is important
- if the National Marine Science Plan 2015–2025 is adopted in some form then there should be clear linkages between its execution and the needs of the Commonwealth marine reserve estate.

4.4.2 Research funding

It is unlikely that the scientific information needs for reserve management can be met under a single dedicated programme. As a result, information needs will be realised through a range of approaches:

1. **Research directly funded by the Director:** This is likely to be the way that information needs are realised, as the Director will fund some ongoing monitoring in relation to evaluation and reporting needs and will also have a limited capacity to respond to tactical research needs. A dedicated research budget for the Director would create the basis to leverage additional research investment from third parties.
2. **Research funded through departmental programmes or where the Director is a minor contributor:** Projects funded through the NESP (and analogous future programs), are likely to be the primary means, at least for the first decade of management, to deliver against strategic research priorities for the CMR estate. The Director should work closely with these programmes to seek to deliver key strategic research needs, such as establishment of baselines, development of decision-making tools and the identification of appropriate monitoring techniques.
3. **Other marine research programs and projects:** There are a range of organisations, including the in private sector, that conduct research in the marine environment that is relevant and can contribute to the knowledge base to help manage reserves more effectively. This will require the Director to clearly articulate needs, priorities and standards in order to attract such investments and to best utilise research opportunities that may arise from third-party interest.

4. **Citizen science:** Citizen science has already played a part in the NERP and the work elsewhere in the CMR estate. It is desirable that this be extended and, where possible, include work that is supported and funded by non-government organisations and interested foundations or undertaken by other users of the CMR estate. The ESP recognises that at times the priorities of these groups and the Government agencies at the core of our proposals may differ. The development of a knowledge network involving Parks Australia and its partners that is proposed in section 4.2.1 should develop the capacity to negotiate partnership agreements with these groups to allow them to contribute to the knowledge base for the CMR estate. Developing effective relationships through such a network would lower the potential for data misinterpretation and create a stronger basis for alignment of priorities and investment in future research and management.

4.4.3 Communicating progress

Given the scale of the CMR estate and the timelines involved in establishing and evolving its management, there will need to be a significant effort in building public understanding of the role that the CMR estate plays in Australia's future.

The approach to the management of research, monitoring and evaluation that has been proposed by the ESP means that the potential exists for an ongoing dialogue with the Australian people about the characteristics of, and issues associated with, the management of the CMR estate. Furthermore, such a dialogue should create the opportunities for communicating the concerns, issues and priorities of users of the estate and the general public. Building public understanding of the objectives, benefits and value of the CMR estate is as essential for its effective management into the future as is a good understanding by the managers of the expectations and aspirations of reserve users and the interested public. This would in turn guide the development and implementation of an effectively managed estate that is understood, appreciated and supported by the public.

The key messages of a communication plan would be that it informs the public of:

- where the estate is located
- the estate zoning system
- the legislative and scientific basis of the system
- the way the ongoing management cycle is planned and how new information can be progressively incorporated into the management of the CMR estate
- how threats to the system are identified, including some case studies on how they are dealt with. This may also be expanded to identify risks, but risks should not be speculative; they should be concrete—for example, the introduction of invasive biota. This can be supported by examples where this has already happened

- publication of data summaries, fact sheets and other educational resources
- the spatial and temporal issues associated with such a large system and also the way the system behaves. This is especially important in terms of either event-based or poorly understood stochasticity
- appropriate links that would allow the exploration of websites that are associated with contributors to the data system
- encouragement of involvement in specific, relevant citizen science programmes.