Strategic marine research priorities for the Department of Environment and Conservation

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SUMMARY

This document outlines the WA Department of Environment and Conservation's (DEC) strategic marine research priorities. The purpose of the document is to provide research organisations, such as local universities, the UWA Oceans Institute, the Western Australian Marine Science Institution, the Australian Institute of Marine Science, CSIRO and Geoscience Australia, with a better understanding of the marine science needs of DEC. This will hopefully lead to better alignment of the research directions of these organisations with DEC's marine policy, planning and management programs and result in improved conservation, management and protection of WA's marine environment.

As well as more directly addressing the strategic priorities outlined in this document, another key factor in achieving better alignment would be to, where possible, focus coastal marine research programs within existing and proposed MPAs and in other areas/issues of DEC interest. Focussing research in DEC-managed MPAs, for example, will enhance the spatial relevance of the study, facilitate collaborations with DEC marine scientists, enable collaborators to benefit from the expertise of locally-based management staff and access the logistical support of DEC's statewide regional management capacity.

DEC also recognises the need to develop better marine research infrastructure, such as coastal research facilities and vessels capable of accessing remote locations, in regional WA. DEC is currently working towards improving this capacity in existing and proposed marine protected areas across the state and is keen to jointly explore options to address this issue with external research organisations.

1. INTRODUCTION

The Department of Environment and Conservation (DEC) in Western Australia (WA) has primary responsibility for conserving the State's biodiversity. This is achieved through the establishment and management of statewide networks of representative terrestrial and marine protected areas and the sustainable management of flora and fauna in relation to a range of human activities such as tourism and industrial development.

DEC establishes and manages marine protected areas (MPAs) gazetted under the *Conservation and Land Management Act 1984* (CALM Act) in WA state waters[1]. These reserves currently (2010) comprise about 12% of State waters and are being progressively implemented under CAR (i.e. Comprehensive, Adequate and Representative) principles as part of the National Representative System of Marine Protected Areas. Thirteen CALM Act marine reserves currently exist in WA, ranging from relatively remote offshore atolls to cool temperate estuarine systems. Some, such as the metropolitan MPAs, are adjacent to large population centres and others are relatively remote, iconic tourist destinations such as the Ningaloo Marine Park. Additional marine parks and reserves are currently being planned and numerous additional areas of WA coastal waters have been identified as candidate areas for reservation (see Attachment 1; MPRSWG, 1994).

Marine biodiversity, outside the MPAs, is primarily managed under provisions of the *Wildlife Conservation Act 1950* (WC Act). The act specifically lists threatened species that require particular management, are rare, threatened or likely to become extinct. Threatened fauna, such as marine turtles, pinnipeds and dugong are typically managed under specific fauna recovery plans, although particular species may also be included in marine reserve management plans in relation to particular issues, such as visitor access and/or commercial tourism.

DEC also protects marine biodiversity through the implementation of the *Environmental Protection Act 1986* (EP Act). This is achieved via regulations under Part V of the EP Act by ensuring an acceptable level of environmental quality is maintained in areas affected by urban and industrial development.

2. ROLE OF DEC'S SCIENCE DIVISION AND MARINE SCIENCE PROGRAM

DEC's Science Division conducts broad-based research that supports evidence-based conservation of WA's biodiversity (DEC, 2008). The Division comprises nine programs, of which the Marine Science Program (MSP) was established in 2006 to oversee the implementation of research and monitoring, particularly in relation to DEC's MPAs and threatened marine fauna conservation and management programs.

[1] *WA State waters are defined as all waters within three nautical miles of the state territorial 'baseline'. In some areas of the state (e.g. Pilbara, Kimberley) the 'baseline' can be up to 100 km from the mainland coastline. The 'baseline' also includes offshore islands and reefs where 'land' occurs above the high water mark (e.g. Rowley Shoals and Scott Reef).*

The roles of the MSP are:

(i) To conduct, or cause to be conducted, scientific research and monitoring programs necessary to manage existing marine parks and reserves; conserve marine biodiversity generally; assist in identifying and planning for new marine parks and reserves; and contribute to regional marine planning;

(ii) To provide policy advice to DEC Corporate Executive and the Minister for the Environment, and scientific and technical advice and support to DEC's regions and branches;

(iii)To provide a strategic focus for scientific and technical liaison with DEC's clients and stakeholders in relation to marine conservation; and

(iv) To assist the Marine Parks and Reserves Authority in the performance of its statutory duties as required.

The MSP comprises tropical and temperate research groups and a marine monitoring group (Attachment 2).

DEC marine research is aimed at increasing our understanding of the composition and functioning of ecosystems, how human activities affect and benefit from these ecosystems and informing the development and performance assessment of effective conservation and management programs. A statewide MPA and threatened marine fauna monitoring, evaluation and reporting (MER) program is also being developed and implemented. The Western Australian Marine Monitoring Program (WAMMP) measures status and trends in the environment, particularly in relation to the condition (i.e. 'health') of marine conservation assets, the natural and anthropogenic pressure/s on these assets and the management response to these pressures within an adaptive management framework.

A key responsibility of the MSP is to provide a strategic and integrated plan for the implementation of marine conservation research in WA, and to facilitate the implementation of that research through a variety of means, including collaborations with external agencies and research institutions (Simpson 2007).

It is imperative that new scientific knowledge effectively informs marine conservation policy, planning and management. The MSP is currently developing processes to facilitate scientific knowledge transfer, which will ensure that the outcomes of research are disseminated to relevant users in an appropriate form that will facilitate uptake.

Examples of specific research questions/information needs identified by DEC staff managing tropical MPAs in WA are outlined in Attachment 3.

3. MAJOR RESEARCH PRIORITY AREAS FOR MARINE CONSERVATION IN WA.

DEC recognises the following as broad priority areas for marine conservation research:

- Understanding biodiversity patterns and processes in WA's marine ecosystems and how these are affected by human pressures (including climate change);

- Establishing, managing and performance assessment of WA's marine protected areas in relation to marine biodiversity conservation and sustainable social benefits;
- Understanding and managing human pressures on threatened marine fauna in WA; and
- Developing environmental management frameworks to ensure WA's marine environment is appropriately protected from development.

3.1 Understanding patterns, processes and human use in marine ecosystems

The following areas broadly outline DEC's research priorities in relation to enhancing knowledge of marine biodiversity for conservation.

- Describing WA's marine biodiversity;
- Understanding the patterns of WA's biodiversity, both spatially and temporally, and what is causing these patterns;
- Understanding the key ecological processes that sustain WA's marine biodiversity; and
- Understanding human use (including climate change impacts) on and benefits of WA's marine biodiversity.

3.2. Establishing, managing and performance assessment of WA's marine protected areas

An appropriately designed and managed statewide system of marine protected areas is a major 'tool' currently being used to help conserve WA's marine biodiversity. Research in the following areas would contribute to improved planning, managing and performance assessment of the existing and proposed MPA network.

- Improving benthic habitat mapping as a broadscale surrogate for marine biodiversity;
- Improving understanding of how to optimise the design (i.e. location, size and zoning configuration) of MPAs;
- Improving understanding of how to best configure marine reserve networks for biodiversity conservation (e.g. Kimberley regional MPA network);
- Improving understanding of the patterns, effects and benefits of human usage in existing and proposed MPAs; and
- Improving understanding of broadscale threatening processes (e.g. fishing, climate change) that act on marine biodiversity.

3.3 Understanding and managing threatened marine fauna

A range of threatened marine species which require special management protection are specifically listed under the WC Act. These species include marine reptiles (e.g. marine turtles), mammals (e.g. cetaceans, pinnipeds and dugong) and numerous birds. Such fauna may be the subject of specific management programs or recovery plans, which include knowledge gaps and research requirements. However, the following broad research directions are typically relevant.

- Improved understanding of fauna population demographics;
- Improved understanding of habitat use and the identification of critical habitats for marine fauna;

- Improved understanding of reproductive and trophic ecology;
- Identifying threatening processes and sustainable levels of human interaction with marine fauna;
- Assessing the potential role of marine parks and reserves in fauna management; and
- Undertaking historical analysis of marine fauna populations.

3.4 Developing environmental management frameworks to ensure WA's marine environment is adequately protected from development

Several of WA's existing and proposed marine parks and reserves are adjacent to areas of urban and/or industrial development. This is particularly the case in the Pilbara and Kimberley, where major industrial resource developments are planned, currently exist or are being built on the coast and offshore. Understanding the impacts of such developments on conservation values is important for future management, and this warrants particular research investment in areas, such as:

- The impacts of disturbance such as dredging on marine communities;
- The effects of chronic and catastrophic pollution (e.g. oil and municipal waste discharge) of the marine environment and food webs; and
- The impacts of urban and industrial development on threatened marine fauna.

4. MONITORING, EVALUATION AND REPORTING OF WA'S MARINE BIODIVERSITY

The role of the WAMMP is to assess the condition of marine conservation assets and threatening processes over time and assess the efficiency and effectiveness of management responses. The WAMMP is currently being implemented across WA's MPAs and statewide in relation to threatened marine fauna. Research can assist development and implementation of the WAMMP in the following areas.

- Undertaking baseline surveys of marine conservation asset 'condition' and identifying potential monitoring indicator groups or species;
- Identifying key cause-effect pathways to assist MER program design;
- Developing cost-effective and robust monitoring protocols and methods for marine conservation assets;
- Developing historical perspectives of marine biodiversity asset 'condition' from the analysis of 'archived' (including reef growth and coral core data) data to help determine longer-term trends and appropriate management targets.

5. THREATENING PROCESSES

WA's marine biodiversity is subject to a wide range of threatening processes, and understanding how these processes operate over various spatial and temporal scales is important for effective conservation management. DEC will undertake and/or support research that will increase knowledge of threats that act on marine conservation assets, and enhance understanding of asset resilience, recovery and adaptation in relation to threats, such as:

- Climate change;
- Fishing;
- Industrial development, including the impacts of dredging;

- Introduced marine species; and
- Pollution, including oil spills/discharge and industrial and municipal waste discharge.

6. MARINE CONSERVATION RESEARCH: WHERE AND HOW?

DEC's marine research priorities relate to planning for marine conservation, improving management of WA's MPA and threatened marine fauna conservation programs and assessing the efficiency and effectiveness of these programs. While MSP staff will undertake independent research in priority areas, forming collaborations with external research institutions is recognised as an important vehicle for the delivery of DEC's marine research needs. Focussing research in DEC-managed MPAs, for example, will enhance the spatial relevance of the study, facilitate collaborations with DEC marine scientists, enable collaborators to benefit from the expertise of locally-based management staff and access the logistical support of DEC's statewide regional management capacity.

DEC also recognises the need to develop infrastructure, such as coastal research facilities and vessels capable of accessing remote locations, and is working towards improving this capacity in existing and proposed marine parks and reserves across the state.

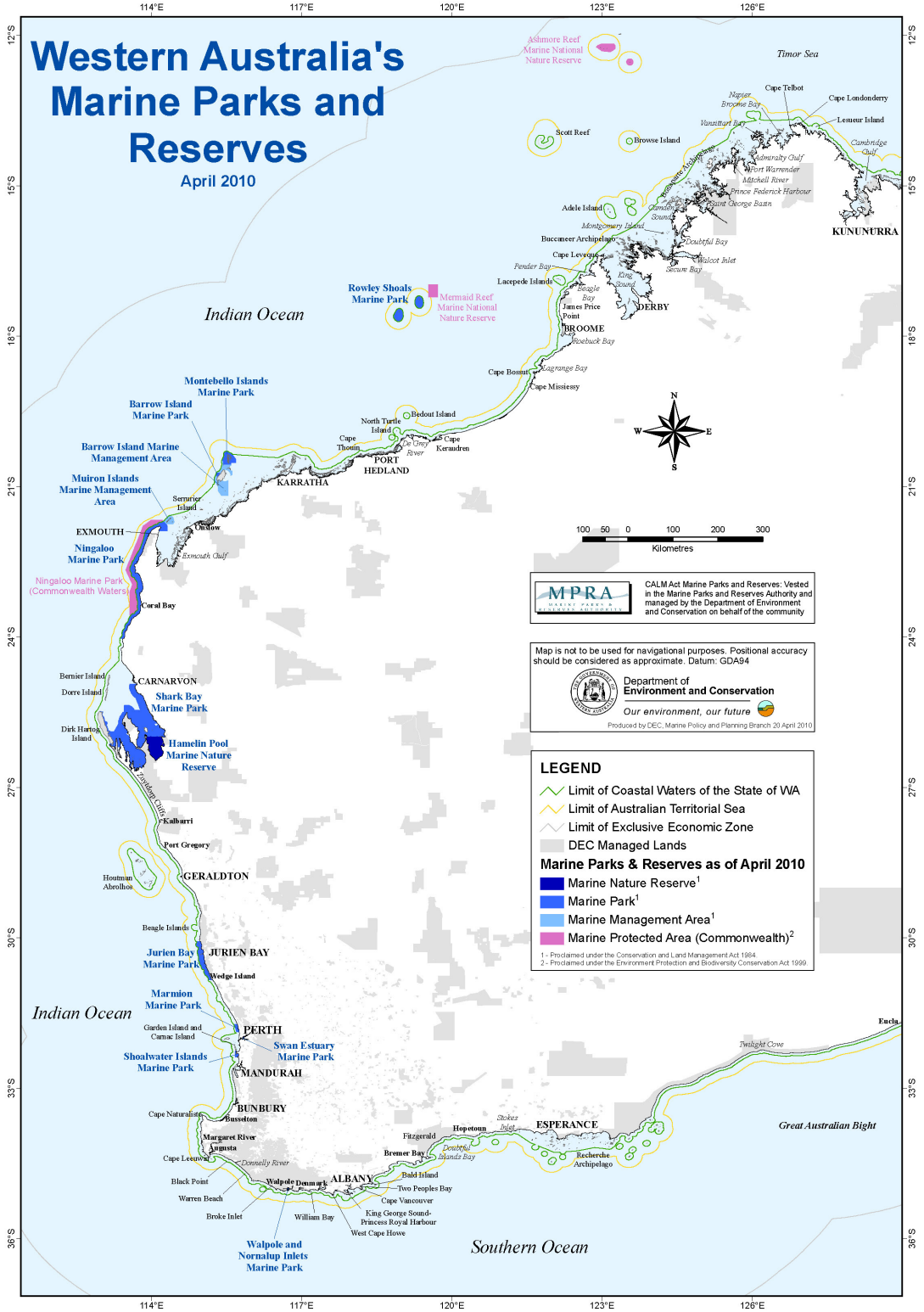
References

DEC (2008) *A strategic Plan for Biodiversity Conservation Research 2008-2017*. Department of Environment and Conservation. Perth, Western Australia.

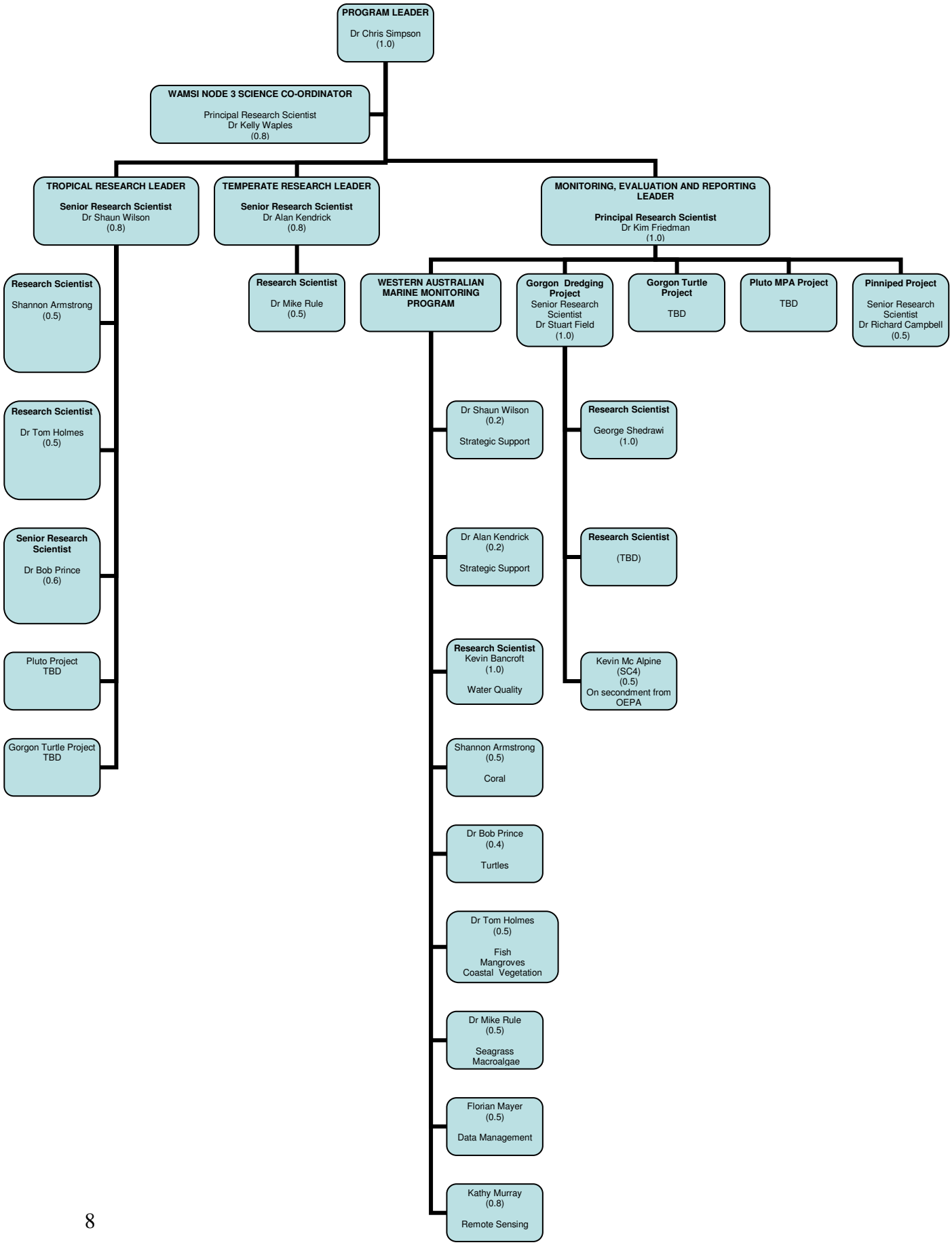
MPRSWG (1994) *A representative marine reserve system for Western Australia*. Report of the Marine Parks and Reserves Selection Working Group. Department of Conservation and Land Management. Perth, Western Australia.

Simpson CJ (2007) *Marine Science Strategy*. Department of Environment and Conservation. Perth, Western Australia.

Attachment 1: Map of existing and proposed (names only) MPAs in WA State waters.



Attachment 2: Marine Science Program



Attachment 3: Examples of specific marine research questions/information needs identified by DEC staff managing tropical MPAs in WA .

Research question / information need
High resolution bathymetric models (via LIDAR, acoustic or other method) provide a vital base layer for planning and management of marine parks and reserves. This provides a foundation on which to model and understand ecological and physical processes, and serves a multitude of planning and management needs (e.g. understanding physical diversity as a surrogate for biological diversity, habitat mapping, understanding current and sediment movement, information for representative management zoning when planning). Current maps are however low resolution and provide limited ability to distinguish between habitats. How does benthic habitat vary around our coastline and reefs?
How do we set the spatial scale of protected areas to ensure there is sufficient habitat for sustainability of important marine communities ?
How does the location of and connectivity between reserves and impacted areas ensure there is continued protection of the biodiversity locally, with continued spill over recruitment to impacted areas?
How do you define the optimal temporal and spatial scale for asset condition, pressure and response monitoring within MPAs?
How do we set management thresholds without a clear understanding of resource status and recovery capacity?
How can we share data on outcomes more effectively?
A common objective of marine parks is to maintain healthy brood stock whose larvae will repopulate and sustain populations outside of protected areas. How effective is this recruitment effect? Over what spatial range does it operate? And how does this vary among species?
The extent of compliance with park regulations mitigates success of park objectives? How can we achieve better compliance?
Some parks have zones where activities are restricted but not prohibited. How much do these zones contribute to the successful management of resources within prohibited zones?
What protection do MPAs provide to highly mobile pelagic species? How effective is that protection? What evidence do we have from tropical mpa systems?
What are the essential management actions to alleviate predicted impacts of climate change on coral reef ecosystems?
Is there evidence for increase in fish size and abundance from tropical MPAs? What evidence is there for 'spill over' from these areas? What reserve design best facilitates spill over? Is there any justification for re-opening previously closed areas once fish stocks have reached a 'target' level?
To maintain resilient ecosystems, what level of 'impact', if any is acceptable i.e. impact which will have negligible environmental effect or from which ecosystems will recover in a short time frame. I guess this question really relates to target setting and performance measures. What should we be measuring and what benchmark should we set?
What is the direction and strength of broad-scale connectivity among coral systems of northwest Australia (NWA)? Do these vary seasonally?
What is the long term stability of larval connections between reefs? Is connectivity likely to be effected by climate change?
What are the fine-scale patterns of connectivity that are relevant to ecological processes of replenishment?
What is the optimal positioning, size, distancing and shape of sanctuaries?
How do the movement patterns, life history and habitat use of key species interact with park design to determine zone effectiveness?
What are the key functional groups/species involved in herbivory and what is the nature and extent of herbivory? How do these compare between different habitats and regions and with other reef systems?
Do variations in the abundance of key predatory species (e.g. from fishing) measurably affect prey populations and/or reef ecosystem structure?

Are there sites within the marine park that are critical habitat for a life history stage of a key species/functional group?
How does abundance and distribution compare with 'natural' levels (historic) or other comparable sites?
What are people doing in the marine park, how often and where are they doing it?
What is the diversity, abundance, distribution and size composition of key species/functional groups in representative habitats inside and outside sanctuary zones and how do these compare with natural abundances?
Where are the areas of high biodiversity/high primary productivity?
Are current management schemes (fishing regulations, zoning) sufficient to improve or maintain biodiversity at the current levels of pressure?
Do the sanctuary zones provide adequate and representative cover of species/community diversity and distribution, including critical habitat?
Are management targets and associated monitoring methods sensitive enough to trigger management responses in a manner that is timely enough to protect the relevant value?
Which functional groups/species can be used as indicators of community condition and what spatial and temporal scales should be used to monitor them that will reliably identify changes that should trigger a management response?
How does water movement influence the distribution of biodiversity (e.g. connectivity, management units)?
Is there a relationship between geomorphology and sediment characteristics and the distribution of benthic habitats and communities?
What will be the implications should there be large scale changes to currents or oceanographic patterns?
What are the natural pressures, ecological processes and influences on biodiversity and its distribution
What are the primary factors influencing patterns in abundance and distribution (e.g. depth, geomorphology, substrate, currents) and can we use them to make predictions about biodiversity in unknown areas?
How does species diversity, abundance and distribution vary over a gradient of human pressure (exploited vs unexploited areas now and in the past)?
What direct and indirect impacts on biodiversity are caused by human activities in the marine park (anthropogenic pressures)?
To what extent are MPA's linked through larval connectivity over both local and regional scales?
What is the role of other major habitats in close proximity to coral reefs (e.g. salt marshes, mangroves, macro-algal beds, shallow coral reefs, deeper water communities) in maintaining ecological functionality, biodiversity and biomass in coral reef ecosystems?
What are the location, timing and seasonality of spawning aggregations for key (both ecological and commercial) fish and invertebrate species on coral reef systems?
How reliable are current estimates of recreational fishing catch (both fishes and invertebrates) and usage patterns within and surrounding MPA's?
Do smaller fragmented MPA's effectively conserve biodiversity and biomass over appropriate scales in coral reef systems?
Does the removal of top order predators (i.e. through fishing) modify the composition and abundance of middle and lower order predators within coral reef ecosystems?
Exploitation of marine species is often considered in terms of what is sustainable for a particular population or fishery. But how much of a population can be removed before function is impaired and we see ecosystem effects?
How effectively do MPAs conserve key ecological processes? While MPAs are typically created for the conservation of biodiversity and key ecological processes, they are more realistically implemented around a physical feature (e.g. Ningaloo Reef, Rowley Shoals etc). While this approach provides some certainty in relation to capturing elements of biodiversity, the effectiveness of MPAs in protecting ecological processes is largely unknown. How do we improve this?
Ningaloo MP has a number of special purpose zones where different combinations of activities are permitted, such as shore fishing but not boat fishing or trolling but not bottom fishing. Such zones were typically created to appease stakeholder groups during reserve planning. Do these management zones functionally work?

Connectivity between coral, seagrass and mangrove habitats is a feature of tropical systems as many organisms use different habitats at different life cycle stages. How does such connectivity function in northwest WA, where distances are large and the presence of such habitat complexity is spatially patchy? Are organisms typically opportunistic, or do some or many specifically rely on such complexity? How do we configure MPAs to accommodate this?
Research has identified the broad ecological significance of perennial seagrass as a key primary producer and habitat for many species in temperate WA, and these habitats are identified as key MPA values in most southern marine reserves. Little however is known of the ecological role of seagrasses in arid subtropical and tropical WA. What is this role, and does it differ from other tropical regions? How do these seagrasses relate to other key benthic habitats, such as coral and algae?
Many areas of conservation estate limit visitor numbers to protect ecological and/or social values. While considerable research has been devoted to assessing the impact of visitors on ecological values, many tropical MPAs in WA also list 'wilderness' or perceptions of remoteness and seclusion as a key social value. However, little research has been undertaken into the preservation of such key social values, despite their recognized importance as management objectives. How many visitors and/or what level of other activities (such as tourism or industry) can these MPAs sustainably support before such values are degraded?
Can MPAs effectively contribute to the conservation of pelagic, mobile, transient species or other large fauna? Opponents of MPA implementation often say that pelagic marine gain no benefit from marine reserves and in WA DEC primarily manages marine birds, reptiles and mammals under a different legislative regime to the MPA system. However, knowledge is increasing that critical habitats for foraging, breeding etc exist for many such species, so would better conservation outcomes be achieved by a greater emphasis on configuring reserves to protect such species?
How can MPA management structures cope with ecosystems under increasingly rapid ecological change? Protected area management is largely premised on assigning ecological and/or social value to an area, and the locations themselves may eventually become iconic. But what if these values change, and a better conservation outcome would be attained by moving the area? Is a new conservation management paradigm required to cope with issues like climate change?
Are our individual MPAs and MPA networks really conserving biodiversity? Could they be better located or configured to achieve this? These questions are typically obscured by popular debate on percentage of habitats or regions protected as marine reserves, without any critical examination or research into exactly what should be protected at various spatial scales to achieve the best conservation outcome. A robust examination of this question will ensure that we gain the best possible conservation outcome from MPAs, and ensure that limited conservation resourcing is being used to best effect