

Scientific Principles for Design of Marine Protected Areas in Australia: A Guidance Statement

This statement aims to provide clear science-based guidance on design principles and criteria for scientifically-qualified conservation planners involved in the selection, design and implementation of Australia's National Representative System of Marine Protected Areas.

This document represents a broad consensus of the contributed opinions of more than 40 scientists who have an active involvement in the planning and management of marine protected areas in Australia. Development of the document has been moderated by researchers from The University of Queensland's Ecology Centre.

Professional scientists active in this field of research and their organisations are invited to add their names to the endorsement page to show their support for the guidance statement.

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Background

Marine Protected Areas

A Marine Protected Area (MPA) is a clearly defined geographical area of land and water that is recognised, dedicated and managed through legal or other effective means to achieve the long-term conservation of nature with associated ecosystem services and cultural values (after Dudley 2008). The primary goal of IUCN resolution 17.38 called for “the creation of a global representative network of MPAs” linked to “management in accordance with the principles of the World Conservation Strategy of human activities that use or affect the marine environment” (Resolution 17.38 of the 17th General Assembly of the IUCN, 1988).

The World Conservation Strategy objectives are:

- Maintenance of essential ecological processes and life support systems,
- Preservation of genetic diversity, and
- Sustainable utilisation of species and ecosystems.

An MPA may address or contribute to addressing all of these objectives and may contain dedicated management zones permitting multiple uses, a combination of use and reserve zones, or reserve zones only. Where an MPA contains reserve zones, they must provide for the high protection of biodiversity from threats and human activities.

MPA networks are *in situ* management tools that can deliver both on- and off-MPA conservation benefits. Connectivity within and across coastal and marine systems requires complementary management arrangements in off-MPA areas to achieve a high level of conservation of Australia’s marine biodiversity. Some of the external (off-MPA) human-impact issues are difficult to manage, and it is likely that a number of different types of conservation solutions will be needed, both in terms of MPA design and off-MPA management.

Irrespective of the governance or regulatory context, effective marine conservation requires a whole-of-ocean integrated management regime that addresses well-defined conservation objectives. This regime may include a multiple use MPA system, but must always include zones of high protection within MPAs that provide for effective conservation outcomes. The regime consists of MPAs as well as integrated strategies and actions that operate outside of the MPAs to provide complementary management to assist with achievement of whole-of-ocean conservation outcomes.

The challenge for conservation planners is to design options that meet the needs of intersectoral issues. Working with a range of management tools, a well-designed MPA network is the cornerstone of the long term conservation of Australia’s marine biodiversity.

Australia’s Progress

Australia’s progress towards establishing the National Representative System of Marine Protected Areas (NRSMPA) is falling well short of its stated goal of establishing at least 10% of each marine bioregion within MPAs by 2012. As of 2004, the NRSMPA covered just 7% of Australia’s marine jurisdiction, compared to the terrestrial National Reserve System which

holds more than 11% of the landmass in protected areas. The NRSMPA system expanded to nearly 9.5% of Australia's marine waters by 2008. However, much of this increased area of MPAs is not on the continental shelf nor within the nearshore state's waters, where much of the highly valued biodiversity is located. Also, many of the protected area designations (in both terrestrial and marine reserve systems) are unclear and have resulted from piecemeal or *ad hoc* decision making (Pressey 1994). While the NRSMPA is intended to be underpinned by the principles of Comprehensiveness, Adequacy and Representativeness (CAR: <http://www.environment.gov.au/coasts/mpa/nrsmpa/index.html>), the level of understanding and implementation of the CAR principles varies across the different Australian marine jurisdictions and there is considerable concern about a lack of attention to CAR principles in elements of the NRSMPA (Scientific Peer Review Panel for NRSMPA 2006). The development of clear guidelines for the application of the CAR principles within an operational framework is needed to inform the prioritisation and selection of areas and to implement an effective and efficient NRSMPA for the conservation of Australia's marine biodiversity.

This Document

The aim of this guidance statement is to present a broad consensus of scientific opinion on operational principles that reflect the contemporary issues of MPA design and management in Australia. The statement promotes a rigorous interpretation of the CAR principles that is based on scientific evidence and current understanding of marine ecosystems in Australia, and promotes a nationally consistent interpretation and operational application of the CAR principles. The scientific principles are drawn from experience in the biophysical sciences, decision science, and social science. The target audience is scientifically-trained conservation planners.

The terminology used through this guidance statement follows the hierarchy advocated by the Resource Assessment Commission (RAC 1993):

goal - the desired overall, long-term outcome of a policy, plan or strategy (for example, ecologically sustainable development);

objectives - the components of a goal that, if met, would ensure that the goal is achieved.

Objectives are derived from goals and should provide clear statements of what management is to achieve;

principles - statements that guide decision makers by setting out the factors that should form the basis for reasoning when management or resource-use decisions are made;

criteria - statements that set out the detailed characteristics or qualities by which proposed resource uses should be judged or tested. The criteria must be consistent with the principles. They can be stated in a number of ways; for example, they might be expressed in qualitative terms to define specific matters that warrant attention or they might be stated in quantitative terms to define standards that should be met.

Framework for the Principles

The intention of this statement is to identify a set of science-based operational principles that:

- are flexible to available data, ecosystem types, and Australian jurisdictional settings;
- are robust to scales of planning;
- are practical to implement;
- reflect operational management issues;
- incorporate risk, uncertainty, precaution; and
- lead to measurable criteria for MPA management.

The principles are specifically focused on managing the uncertainty and risks inherent in designing effective and efficient MPAs in the absence of full knowledge of the biodiversity, the contemporary and developing threats, or the effectiveness of management strategies within and outside MPAs. The principles also provide a basis for MPA-based conservation to assist in maintaining the resilience of Australia's marine populations, habitats and ecosystems in the face of the world's changing ocean climate.

The principles assume that a jurisdiction's MPA planning framework includes a science-based planning process, using expert-based analytic and systematic conservation planning approaches to MPA design. This guidance document therefore uses the systems logic and lexicon of systematic conservation planning (see Ardron *et al* 2008 for a detailed description).

In the design and planning for MPAs, the decision-making processes should effectively integrate both long term and short term environmental, economic, social and equity considerations. These Principles therefore endorse the concept of 'least cost', or efficiency, where an optimal MPA configuration is established to deliver on defined conservation objectives with the minimal economic and social cost to the community. The Principles presented here provide for the socio-economic values to be considered as an integral part of the design process to ensure that costs can be minimised while meeting quantitative conservation outcomes through zoning configurations.

The principles strive to provide robust guidance at the operational science level, but they are limited in the extent to which they can assume/anticipate specific MPA design contexts, and this limits the extent to which any generic statement can provide detailed guidance. The intention is to provide a consensus of opinions on operational level science issues from current science practitioners for scientifically-qualified conservation planners. The guidance provided is expected to inform and contribute to, but not replace, a competent MPA design process operated within a suitable planning framework.

The endnotes present a sample of the analyses and reports that have been prepared over the last decade relating to various aspects of the NRSMPA where these principles are used in MPA design.

Operational Principles

The Operational Principles set out the criteria that should be used in the design phase of MPAs in the NRSMPA to minimise the risks inherent in planning MPAs with an uncertain knowledge-base and changing threats.

1. Biodiversity Primacy

Intent: Nature conservation and maintenance of ecological integrity are the primary outcomes for the MPA network.

1.1 Planning Frameworkⁱ

1.1.1 The IMCRA4 mesoscale bioregions and the National Marine Bioregionalisation (NMB) provincial bioregions provide the spatial framework for planning and delivery of the NRSMPA. MPAs should satisfy CAR objectives within the IMCRA framework at both the mesoscale and provincial level (hereafter termed bioregions).

1.1.2 The biodiversity of each bioregion (~58 IMCRA (shelf) and ~24 NMB (off-shelf) provinces) should be represented within the NRSMPA at levels appropriate to the distribution of biodiversity within the bioregions.

1.2 Biodiversity Dataⁱⁱ

1.2.1 Conservation features for MPA planning should be drawn from the full range of biodiversity represented in the bioregion. Data and surrogates describing features should therefore normally include biodiversity information from the benthic and pelagic ecosystems, and ecosystem processes. Biodiversity data should cover various taxa including algae, higher plants, invertebrates, fish, reptiles, mammals and birds. These features may be represented by a variety of spatially explicit metrics, such as predicted species distributions (abundance or presence-absence), proportion of endemism, depth zones, biomes, critical habitat, process variability, refugia, and so on.

1.2.2 The biodiversity that the MPA is being established to protect must always be clearly expressed, and be resolved into the objectives of management of the MPA. For biodiversity that will not be fully protected within the MPA alone, the contribution that the MPA is expected to provide in relation to whole-of-ocean conservation objectives should be specified, to inform the need for specific conservation management initiatives outside the MPA system.

1.2.3 The limited availability of high resolution data for many taxa or processes requires biodiversity to be identified from a combination of fine and coarse-scale biodiversity surrogates, and commonly including data that are patchy or incomplete (eg community types, physical environment types). In such circumstances, conservation planning practitioners should make the best use of all available environmental and biological data (Possingham *et al.* 2006), acknowledging and accounting for the bias that this may impose. For some

features, information of lower resolution (e.g. taxonomic, spatial, temporal) may be needed to reduce design bias that might otherwise occur through a narrow choice of conservation features. This is preferable to planning based solely on surrogates such as geomorphic classifications that may have data coverage across the whole planning region but only limited relationships with patterns of biodiversity. Regardless of the quantity and quality of data available, planning and implementation should not be significantly delayed while waiting for new data because the costs are likely to outweigh the benefits.

1.2.4 A comprehensive NRSMPA should capture special interest features that may be considered atypical of the surrounding biodiversity (unique), areas of high biodiversity value (exceptionally limited human influence, of global significance, high levels of endemism), and areas considered to be especially speciose or productive.

1.2.5 Threatened and highly range-restricted species and habitats should be targeted for full reservation, provided that reserves are considered to be an effective management tool for those species (eg Edgar *et al* 2008).

1.2.6 Treat trans-boundary issues of biodiversity representation explicitly, particularly where the planning region does not fully enclose or nest coherently within the distribution of conservation features, or where there are jurisdictional trans-boundary issues (eg increase levels of reservation for conservation features that are not adequately conserved within adjacent jurisdictions).

1.2.7 Incomplete knowledge of biodiversity of the planning region, or any major subset of the planning region, should be managed by:

- representing cross-shelf and latitudinal diversity,
- representing the range of depth classes and environmental types, and
- higher proportional levels of representation.

1.3 Maintaining Biodiversityⁱⁱⁱ

1.3.1 Systematically identify ecosystem processes and ecological linkages that function as contributors to the maintenance of the conservation features, eg major river inflows, migration pathways, upwellings, major ocean currents, topographical features such as seamounts, reef systems, and represent these in the spatial configuration (spacing, orientation, location) of MPAs.

1.3.2 Understand and account for socio-economic drivers of human impacts on biodiversity in the MPA design and management through the development of conceptual models and scenarios/maps that link human activities (on and off-MPA) to impacts on the biodiversity.

1.3.3 Incomplete knowledge of ecosystem processes, human impacts and environmental change should be managed by implementing strategies to maintain natural connection regimes and increase the likelihood of persistence and resilience by:

- configuring a complementary network of MPAs,
- replicating each conservation feature in at least three spatially separated occurrences, either within the individual MPA or as part of the MPA network (with replication measured according to the specific conservation feature),
- using larger, rather than smaller MPAs,

- spacing individual MPAs at various ranges within the network (eg inter-MPA distance up to 200km) to accommodate the potential for movement of a wide variety of species,
- configuring MPA networks to maintain land-sea and freshwater-sea connections,
- establishing better integration between MPA and off-MPA management and governance arrangements for the delivery of conservation objectives, and
- implementing buffers around high protection areas.

1.4 Levels of Representation^{iv}

1.4.1 **Individual conservation features** should all be represented in high protection zones at a **minimum** of 30% as a proportion of their distribution within each bioregion, although greater proportional representation within high protection zones will be required if only high level or indirect surrogates for biodiversity are used (Ward *et al* 1999, Airame *et al* 2003).

1.4.2 Conservation features reserved in high protection zones should be preferentially of high quality (i.e. the most undisturbed state that is available within the bioregion).

1.4.3 Conservation features that are known to be significant, threatened or in a degraded state will normally require greater proportional representation and specific design consideration, up to full reservation, depending on their conservation status in the bioregion.

1.4.4 Additional representation of conservation features beyond that within high-protection zones (as above) can be achieved across other management zones of MPAs within a bioregion.

1.4.5 Where a physical structure/feature is incorporated into the MPA, the whole feature should be included.

1.4.6 The final MPA network should consist of a minimum of 30% of the area of each bioregion.

2. Management Constraints

Intent: Recognise the constraints in the likely management arrangements, and the need to minimise management costs consistent with achieving effective biodiversity conservation.

2.1 Business Management

2.1.1 An MPA must be created with a clear and explicit business plan, where goals, objectives, strategies to achieve the objectives, agency responsibilities, compliance regime, performance measures and funding sources are clearly expressed, and all measures are capable of being implemented.

2.2 Complementary Management^v

2.2.1 The persistence of conservation features may rely on habitats, or ecological or biophysical processes that are outside the boundaries of the MPA (such as through recruitment or productivity dependencies). These external areas and processes should be taken into consideration and managed through formal complementary management arrangements (such as agreements between agencies).

2.2.2 Consider specifically the capacity and impacts of off-MPA management on achieving the objectives of conservation for the MPA.

2.2.3 Recognise the contributions of other management arrangements and complement these where possible, including arrangements for effective joint monitoring and surveillance activities.

2.2.4 Recognise the risks and threats posed by off-MPA activities and the capacity of the MPA to mitigate them.

2.3 Management Practicality^{vi}

2.3.1 Strategies to maximise the public understanding and the manageability of the zones within each MPA include:

- having MPAs and management zones that are simple shapes with simple zoning rules;
- having boundaries that are easily identified;
- having fewer and larger high protection zones rather than more and smaller zones;
- minimise the number of zoning categories and ensure they clearly reflect the management objectives;
- having MPAs in close proximity to existing terrestrial reserves, where management capacity exists, to increase the management effectiveness at reduced cost;
- striving for jurisdictional alignment on policy and harmonisation of investment decisions and management activities.

2.3.2 Foster intersectoral institutional arrangements that are flexible and allow integration of new information and new management arrangements on- and off-MPAs for the purposes of conservation

3. Multiple objectives

Intent: Low-impact uses may be permitted in an MPA system within appropriate management zones, providing that biodiversity conservation outcomes and protection of ecological integrity can be demonstrated.

3.1 Use of Biodiversity

3.1.1 Activities/low-impact uses occurring within the MPA should be managed according to sets of criteria established for each use to accredit management activities and targets relevant to the conservation objectives of the MPA (eg through formal inter-agency agreements).

3.1.2 Management of marine systems outside MPAs does not necessarily contribute to conservation or assist with achievement of the objectives of an MPA. Therefore, criteria may also need to be developed to accredit activities outside the MPA (such as management of upstream catchment activities or coastal infrastructure, management of marine pests, and uses of species outside the MPA boundaries - such as within recreational fisheries), so that conservation features within the MPA boundaries may be conserved at adequate levels.

3.2 Zoning^{vii}

3.2.1 Within multiple-use MPAs, zoning offers the opportunity to maximise conservation benefits by spatially separating activities that pose different degrees/types of threats, including those, such as tourism, that may provide benefits.

3.2.2 Zoning also offers the opportunity for some conservation objectives to be achieved within zones of protection lower than high-protection, such as where specific uses can be demonstrated to pose insignificant risk to a conservation feature.

3.2.3 Recognising that the burden of proof should rest with the user to demonstrate that any impacts will be maintained within acceptable levels, zoning should be based on:

- The consideration of the threat that specific activities pose and the capacity of MPA management arrangements to mitigate that threat;
- The status of the conservation features potentially affected;
- Opportunities to maximise complementarity of reserve areas with human values, activities and opportunities (ie to minimise conflict with users);
- Consideration of how to efficiently minimise socio-economic costs and maximise socio-economic benefits while simultaneously continuing to deliver conservation outcomes.

3.3 Support Traditional Owners

3.3.1 The network should include MPAs and management zones in locations that, where practical:

- complement existing or proposed coastal and sea country management areas (such as Indigenous Protected Areas, sacred sites, sea closures);
- complement existing or proposed sea country plans, strategies and aspirations for their Sea Country;
- include places that Traditional Owners have identified as important and in need of high protection, and
- have opportunities for indigenous participation, economic development, training and management.

3.4 Support Low-impact Fisheries

3.4.1 The design of permitted fishing zones within an MPA should seek to include relevant management controls that maximise fisheries conservation benefits and complement existing or potential fisheries conservation management tools, provided that biodiversity conservation outcomes are achieved. Permitted fisheries should only use low-impact gear types that have minimal by-catch or habitat impact issues, and be required to maintain high stock levels and contribute directly to conservation goals for the MPAs using these criteria for the MPA population of fished species:

- Abundance of mature individuals maintained above 80% of the median levels of never-fished populations;
- Age/size structures and sex ratios that resemble never-fished populations;
- Retention of historic geographic range and habitat occupancy; and
- Retention of connectivity pathways among populations within their historic range to ensure long-term metapopulation persistence.

These criteria may need to be applied both within the MPA and in areas surrounding the MPA, depending on the life history characteristics of the species.

3.5 Displaced Users

3.5.1 The design of both MPA boundaries and zones should carefully consider where uses and users are likely to be displaced by the declaration of an MPA, their possible impacts on adjacent areas, and the compliance issues this may raise (eg considering changes to local fishing regulations or Total Allowable Catch in areas adjacent to no-fishing zones).

4. Managing the Threats

Intent: The location of MPAs should avoid or minimise exposure to any known and potential threats to the biodiversity, provide for maximum resistance and resilience to the impacts of increasing threats, and minimise the potential for compliance violations.

4.1 Avoid Known and Potential Threats

4.1.1 Locate MPAs to minimise the impact from, or avoid, any present or likely emerging threats (eg major river discharges from modified catchments, proximity to industrial developments or coastal infrastructure such as ports), and to minimise the risk from any suspected threats. Such threat assessments should be based on conceptual models and scenarios derived from tools such as scenario development, risk assessments, population modeling, and fate/effects models.

4.1.2 Locate the MPAs to maximise surveillance and minimise the potential for compliance violations (eg where possible avoiding very popular recreational fishing areas).

4.2 Build Climate-change Resilience

4.2.1 Include areas spanning the natural biophysical gradients and ecological processes of the planning region that include habitats/species sensitive or vulnerable to climate-driven changes (from drivers such as rainfall, storms, sea level, ocean temperature, ocean currents driving species recruitment, mortality and distribution patterns). Such areas should provide for resilience to climate impacts through:

- providing inherent natural resilience to impacts (eg including areas that are naturally highly diverse),
- being source areas or refugia, with an emphasis on the southern end of existing ranges, or
- protecting the critical ecological processes driving biodiversity to promote connectivity and assist recovery, replenishment and range shifts/extension.

4.3 Identify and Account for the Uncertainty

4.3.1 Propagate the uncertainty in knowledge and process understanding throughout the planning process using appropriate tools, such as Bayesian analysis, sensitivity analysis and scenario planning.

4.4 Spread the Risks

4.4.1 Apply explicit risk-spreading strategies in the design of MPA networks to reduce the possible impact of single large design failures, data deficiencies, or failures of planning assumptions and models of threats.

5. Monitoring, Assessment & Reporting

Intent: Given the high levels of uncertainty confounding the problem of MPA design, individual MPAs and MPA networks must provide for adaptive management including, at a minimum, scientifically robust monitoring and reporting of biodiversity outcomes and management to confirm the effectiveness of the MPA design, and provide reference areas for assessing impacts of broad-scale threats and the effectiveness of off-MPA management.

5.1 Performance Assessment

5.1.1 Individual MPAs must be supported by a monitoring assessment and reporting system focused on biodiversity objectives, outcomes and management effectiveness.

5.1.2 Provide a major public report on the performance of each MPA and MPA network at 10-year intervals, and where possible provide interim reports at least each 3 years.

5.1.3 Publicly report the performance of the MPA through accessible tools (such as a report card system) to encourage the involvement of stakeholders and development of partnerships in the process of data acquisition, and so the effectiveness and efficiency of MPA management can be subjected to continuous improvement.

5.2 Practical Monitoring

5.2.1 The monitoring must be practical, affordable, and transparent, and should complement existing monitoring efforts in the region (partnerships to acquire data should be encouraged).

5.2.2 Monitoring programs should be explicitly linked to management decisions and biodiversity outcomes. Given the usually limited resources, priority should be accorded to monitoring of biodiversity outcomes and management issues based on a sample of the key issues (eg using tractable assemblage types and indicator species from across the taxonomic range of the planning region's biodiversity).

5.2.3 Develop adequately resourced monitoring designs to detect important changes relative to benchmarks/thresholds that are based on the design/zoning surrogacy assumptions, estimated resilience thresholds, and status of the biodiversity of the MPA, and provide for early warning of adverse impacts from threats.

5.3 Scientific Reference Sites

5.3.1 The network should seek to select MPAs and management zones in each bioregion that will contain undisturbed samples of the conservation features to monitor the performance and adequacy of the MPA and MPA network.

5.3.2 Sites dedicated as scientific reference sites should maximise the potential for scientific research or monitoring, and ensure that there are appropriate areas maintained in a condition that will permit effective monitoring and adaptive management to be applied.

5.4 Fund Adaptive Management

5.4.1 An adequate amount of funding that is independent of the major stakeholders should be allocated so that appropriate research designs can be developed using the reference sites to examine the effectiveness of site selection and management zones, and to assess and report on the effectiveness of compliance activities and off-MPA management of issues that may affect the MPA biodiversity objectives.

6. Stakeholder Engagement

Intent: Wide engagement with stakeholders is required in selection, declaration, zoning and management to ensure that robust local and traditional knowledge is used in the design/planning, and that existing

use rights and potential threats are considered in the planning process. This engagement assists to provide a framework for designs to best recognise local knowledge, minimise effects on users, assist with local management (thus enhancing the likelihood of persistence of the MPA and limiting compliance violations), and the management of surrounding/upstream areas to avoid compromising the objectives of the MPA network.

6.1 Complementary Local Knowledge

6.1.1 Stakeholders should be broadly consulted to secure data and local knowledge that might otherwise not be available to the planning process, and particularly knowledge of unique and special places (such as spawning grounds for fish) and places of locally high value uses (such as popular fishing grounds). This assists in establishing the details of existing use areas that have a high priority for users, so that the MPA design may protect important areas while avoiding the inadvertent inclusion of high-use areas in MPAs (assuming that there are viable alternative areas where the same conservation features may be secured into an MPA).

6.2 Community Acceptance and ‘Ownership’

6.2.1 The planning process should adopt stakeholder consultation processes that are participatory, balanced, open and transparent to all stakeholders irrespective of their capacity to participate, to provide for broad stakeholder acceptance of the MPA values and ultimately better persistence of the MPA and its features. This is particularly important at the objective-setting stages of planning, to ensure that all available local and historical knowledge is used in setting realistic objectives for the MPA within the management plan, and to assist with the monitoring of conservation features and reporting of compliance issues (eg Department for Environment and Heritage 2009).

6.3 Community Engagement in Management

6.3.1 Devolve management of the MPAs to the lowest practical level to assist with integration of management, development of incentives across spatio-temporal scales and levels, and improve learning, monitoring and compliance systems (Armitage *et al* 2008).

Some Key Terms

Biodiversity

“The variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecosystem diversity”. ” (From: National Strategy for the Conservation of Australia’s Biological Diversity, *Department of the Environment, Sport and Territories, 1996. ISBN 0 6422 4427 8*).

Conservation

In the Australian context, conservation is “The protection, maintenance, management, sustainable use, restoration and enhancement of the natural environment” (From: National Strategy for the Conservation of Australia’s Biological Diversity, *Department of the Environment, Sport and Territories, 1996. ISBN 0 6422 4427 8*).

Conservation Feature

A Conservation Feature is any aspect of the environment/ecosystem/biodiversity for which a target is set to be achieved within the decision problem of designing an effective and efficient MPA. Conservation Features may be areas containing the populations of individual species, or distributed metapopulations of a species; areas with high proportions of locally endemic species; areas of specific habitats; areas where upwelling consistently occurs; other identifiable features of an ecosystem such as places where fish regularly spawn or feed; structural formations such as reefs, canyons or seamounts; or processes such as migration pathways that are seasonally important. A Conservation Feature is therefore normally an element of the biodiversity to be conserved, has a specific supporting function, or is a surrogate for biodiversity.

In systematic conservation planning: “A conservation feature is a measurable, spatially definable component of biodiversity that is to be conserved within a reserve network. Conservation features can be defined at different levels of ecological scale, e.g. it is possible to protect species, communities, habitat types, populations, and genetic subtypes. In a Marxan analysis, each conservation feature is given a target, which is the amount of the conservation feature to be included within the reserve network, e.g. 10 000 ha of a habitat, or 30% of its original extent, or one occurrence.” (Ardron *et al* 2008).

Representation

The extent to which a conservation feature is contained within an MPA or an MPA system.

Planning Region

The Planning Region is the single large area that contains most of the relevant issues and aspects of the problem to be solved, normally the bioregion within which the MPAs will be located. The planning region will not contain **all** aspects of the problem (for example climate change drivers will probably lie outside the planning region), but the region chosen should be large enough to contain most of the directly relevant issues so that outcomes from the decision analysis incorporates as many as possible of the major drivers or issues that will affect the biodiversity, and minimises drivers from outside the region. There will always be exceptions to this, and planning regions should be chosen to minimise the externalities but balanced with the available data and knowledge and resources available to conduct the decision analysis.

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Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

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ⁱ Planning Region

IMCRA provides the national and regional planning framework for developing the NRSMPA, with ecosystems used as the basis for determining representativeness.

ANZECC (1998). Guidelines for Establishing the National Representative System of Marine Protected Areas. Australian and New Zealand Environment and Conservation Council's Task Force on Marine Protected Areas. Canberra, Environment Australia.

<http://www.environment.gov.au/coasts/mbp/publications/imcra/pubs/imcra4.pdf>

Each IMCRA bioregion occurring in the Region should be represented at least once in the MPA network. Priority will be given to bioregions not already represented in the NRSMPA

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

MPAs should satisfy CAR objectives within the IMCRA framework at both the provincial, and bioregional level. The network should ensure that appropriate sample of all known conservation features, communities and habitats that exist within the bioregion, along with areas of high level surrogates such as geomorphic attributes (taking account of the uncertainty involved in using physical surrogates) are included.

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Department for Environment and Heritage (2009). A technical report on the outer boundaries of South Australia's marine parks network. Department for Environment and Heritage, South Australia. 136pp.

ii Biodiversity Data

The NRSMPA will include the full range of ecosystems identified at an appropriate scale within and across each bioregion.

ANZECC (1998). Guidelines for Establishing the National Representative System of Marine Protected Areas. Australian and New Zealand Environment and Conservation Council's Task Force on Marine Protected Areas. Canberra, Environment Australia.

Those marine areas that are selected for inclusion in MPAs should reasonably reflect the biotic diversity of the marine ecosystems from which they derive.

ANZECC (1998). Guidelines for Establishing the National Representative System of Marine Protected Areas. Australian and New Zealand Environment and Conservation Council's Task Force on Marine Protected Areas. Canberra, Environment Australia.

the network should contain appropriate samples of each known conservation feature, community type and physical environment type of each Province in the overall network. This is to ensure that all known features, communities and habitats that exist within a Province, along with areas of geomorphic surrogates, are included in the MPAs

Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.

Represent cross shelf and latitudinal diversity in the network of no-take areas. Represent a minimum amount of each community type and physical environment type in the overall network; Include biophysically special/unique places

*GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #6.***

The MPA network should cover all depth ranged occurring in the region, or other gradients of light penetration in waters over the continental shelf

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

The MPA network should seek to include examples of benthic/demersal biological features (ie habitats, communities, subregional ecosystems, particularly those with high biodiversity value, species richness and endemism) known to occur in the region at a broad sub-provincial scale (100s km)

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

The MPA network should include all types of seafloor features (21 across the EEZ). Some bioregions will be characterised by the presence of a certain subset of features, such as continental slope or seamounts.

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

<p><i>The occurrence of known small-scale (10s km) ecosystems associated with the benthic/demersal environment</i></p> <p><i>Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.</i></p>
<p><i>Relevant available information about small-scale distribution of sediment types and sizes and other geo-oceanographic variables</i></p> <p><i>Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.</i></p>
<p><i>The occurrence of ecologically important pelagic features which have a consistent and definable spatial distribution</i></p> <p><i>Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.</i></p>
<p><i>Selection – The occurrence of spatially defined habitats for and/or aggregations of threatened and/or migratory species</i></p> <p><i>Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.</i></p>
<p><i>MPAs should satisfy CAR objectives within the IMCRA framework at both the provincial, and bioregional level. The network should ensure that appropriate sample of all known conservation features, communities and habitats that exist within the bioregion, along with areas of high level surrogates such as geomorphic attributes (taking account of the uncertainty involved in using physical surrogates) are included.</i></p> <p><i>Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.</i></p>
<p><i>Represent a minimum amount of each 'habitat type' in no-take areas Moreton Bay</i></p> <p><i>Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.</i></p>
<p><i>Outstanding Places</i></p>
<p><i>Include biophysically unique sites – the network should include such biophysically special/unique places that may be identified for each Province. These places will help ensure the network is comprehensive and adequate to protect biodiversity and any known special or unique areas.</i></p> <p><i>Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.</i></p>
<p><i>Include biophysically special/unique places</i></p> <p><i>GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. Technical Information Sheet #6.</i></p>

Productivity, Richness, Uniqueness & Rarity – The network should include such biophysically special places (productive, rich, unique, rare) and places that encompass key biogeographic qualities or features that may be identified for each NT bioregion

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

*Special or **Critical** Habitats/Species – For each NT bioregion, MPAs should, where possible, include the full range of special or critical habitats that provide for the needs of rare, vulnerable, threatened, or depleted species and/or ecological communities*

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Global-Regional Significance – Within each NT bioregion, MPAs should capture areas that host species or assemblages of national or international significance, and particularly if they are subject to an international or national conservation agreement

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Naturalness – within each NT bioregion, MPAs should seek to include the places that display outstanding naturalness, amenity or cultural landscape values

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Include species, populations and areas of special interest in no-take areas (eg threatened, rare, restricted-range species)

Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.

iii Maintaining Biodiversity

Size and number – each region should include a small number of large MPAs rather than a greater number of small MPAs. This is to assist with (a) minimising edge effects and the influence of off-reserve impacts (b) minimising the risk of failing to include unknown aspects of biotic diversity, and (c) more practical and feasible management arrangements.

Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.

Location – The goals should be met with the least number of separate MPAs (ie smaller number of larger MPAs rather than many small MPAs) to maximise conservation outcomes

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Ecological robustness – Each Province should include MPAs of a size and shape that are ecologically robust in terms of protecting what is known about the conservation values of the Region. This is to ensure that there is a low level of risk that conservation features are not appropriately protected in each Province. Achieving ecological robustness may require replication of features within MPAs across the Province to provide insurance against human or natural impacts at single locations, and to sample gradients within Province level conservation features.

Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.

Ecological robustness – Each NT bioregion should include a small number of large MPAs, rather than a greater number of small MPAs. Replicates of each conservation feature (where achievable at least 3 occurrences) should be sought for inclusion within high-protection zones of MPAs, within each NT bioregion

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Provide for future resilience against natural or human induced changes or threatening processes (preferably protect areas with high degree of naturalness/less impacted)

Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.

Ecological connectivity – the network should represent the best possible arrangement of MPAs in terms of spacing and orientation according to what is known about migration patterns, currents, ocean features and connectivity among ecosystems. This is to minimise the risk of failing to include unknown functional relationships that may be important in maintaining the on and off reserve biotic diversity. Many processes may create along-slope and cross-slope differences in habitats and communities. This diversity is reflected partly in the distribution of the provincial and finer scale bioregions, but care should be taken to choose highly protected areas that include differences in known community types and habitats that occur along and across-slope ranges.

Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.

Connectivity – Within and between each bioregion, MPAs with zones of high protection should represent the range of diversity of size, spacing and orientation of migration routes and patterns, currents, ocean features, coastal inputs and connectivity among ecosystems, habitats and species

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Sensitivity, Vulnerability, Resilience – Areas should be chosen to include habitats/species sensitive or vulnerable to climate-driven changes (such as rainfall, storms, sea level, ocean temperature, ocean currents, species recruitment and distribution patterns), and to provide for their resilience to such impacts. These areas should include places that (a) have natural resilience to impacts, (b) are source areas or refugia, or (c) promote connectivity to assist recovery, replenishment and range expansion

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

<p><i>Provide connectivity within the network of no-take areas (spaced to ensure movement of species in various ranges)</i></p> <p><i>Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.</i></p>
<p><i>Design – Size and shape should be orientated to account for inclusion of connectivity corridors and biological dispersal patterns within and across MPAs</i></p> <p><i>Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.</i></p>
<p><i>Design – Features should be replicated wherever possible within the system of MPAs (ie included more than once)</i></p> <p><i>Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.</i></p>
<p><i>Include consideration of ecosystem links among habitats and of sea and adjacent land uses in determining no-take areas</i></p> <p><i>Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.</i></p>
<p><i>Ecological connectivity – the network should represent the best possible arrangement of MPAs in terms of spacing and orientation according to what is known about migration patters, currents, ocean features and connectivity among ecosystems. This is to minimise the risk of failing to include unknown functional relationships that may be important in maintaining the on and off reserve biotic diversity. Many processes may create along-slope and cross-slope differences in habitats and communities. This diversity is reflected partly in the distribution of the provincial and finer scale bioregions, but care should be taken to choose highly protected areas that include differences in known community types and habitats that occur along and across-slope ranges.</i></p> <p><i>Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.</i></p>
<p><i>Have no-take areas the minimum size of which is 20km along the smallest dimension (except for coastal bioregions)</i></p> <p><i>GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. Technical Information Sheet #6.</i></p>

iv **Levels of representation**

Adequacy - The NRSMPA will have the required level of reservation to ensure the ecological viability and integrity of populations, species and communities.

ANZECC (1998). Guidelines for Establishing the National Representative System of Marine Protected Areas. Australian and New Zealand Environment and Conservation Council's Task Force on Marine Protected Areas. Canberra, Environment Australia.

Represent a minimum amount of each community type and physical environment type in the overall network taking into account principle above

*GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #6.***

Representativeness – a minimum representative sample of 10% of each individual habitat feature should be reserved in each NT bioregion. However, for some vulnerable habitats, considerably greater proportions may be required. Where a physical feature is incorporated into the MPA, where practicable, the whole feature should be included.

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Represent a minimum amount (10% target) of each habitat type in no-take areas

Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.

Design – Whole seafloor (geomorphic) features should be included

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Design – Individual areas should, as far as practicable include continuous depth transects (eg from shelf to abyss)

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Where a reef is incorporated into no-take zones, the whole reef should be included

*GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #6.***

Physical features – where a physical feature is incorporated into the MPA, where practicable the whole feature should be included. Identifiable physical features (such as seamounts, canyons, persistent upwellings) are relatively integral biological units with a high level of connectivity among habitats within them, and risks should be managed to achieve adequate protection of the entire feature by appropriate zoning

Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.

To achieve comprehensiveness, the full range of ecosystems and habitats occurring within and between each bioregion were incorporated within marine parks. Representativeness: for South Australia's marine park design, habitats and recognisable features such as depth and water temperature were used as surrogates for biodiversity within the marine parks network.

Department for Environment and Heritage (2009). A technical report on the outer boundaries of South Australia's marine parks network. Department for Environment and Heritage, South Australia. 136pp.

High protected areas - The NRSMPA will aim to include some highly protected areas (IUCN Categories I and II) in each bioregion.

ANZECC (1998). Guidelines for Establishing the National Representative System of Marine Protected Areas. Australian and New Zealand Environment and Conservation Council's Task Force on Marine Protected Areas. Canberra, Environment Australia.

Level of protection –Each province should include sufficient high-level protection MPA zones, and/or multiple use zoning where risks are appropriately managed, that will satisfy regional and CAR objectives, in a manner consistent with the precautionary principle. This is to ensure that the size, shape and zoning of MPAs are developed to be most appropriate for achieving conservation outcomes, rather than for logistic or other reasons. Sufficient refers to the amount and configuration of high protection areas and may be different for each Province depending on its characteristics.

Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.

The regional MPA network will aim to include some highly protected areas (IUCN Cat I and II) in each bioregion

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Represent a minimum amount of each reef bioregion in no-take areas

*GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #6.***

Represent a minimum amount of each non-reef bioregion in no-take areas

*GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #6.***

Have sufficient no-take areas to insure against negative impacts on some part of a bioregion

*GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #6.***

Each NT bioregion should include sufficient high-level protection MPA zones, and/or sustainable use zoning where risks are appropriately managed, that will satisfy regional CAR objectives, in a manner consistent with the precautionary principle. "Sufficient" refers to the amount and configuration of high-protection areas and may be different for each bioregion depending on its characteristics

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Include adequate size (larger reserves preferred to smaller reserves) and replication (>1) of habitat types in no-take areas.

Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.

Protect in no-take areas an adequate amount (may be $\geq 10\%$) of vulnerable habitats (ie easily disturbed/threatened)

Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.

Include species, populations and areas of special interest in no-take areas (eg threatened, rare, restricted-range species)

Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.

^v Complementary Management

MPAs will be located taking into account the occurrence and location of existing spatial management arrangements (eg existing Pas and sectoral measures) that contribute to the goals

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Occurrence of listed heritage sites (where inclusion in the MPA network would improve administration of protection regime)

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Include consideration of sea and adjacent land uses in determining no-take areas

*GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #6.***

The capacity of an MPA to mitigate identified threats to conservation values

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Complementary management – The MPA network is designed and reflects, where appropriate, identified threats and risks to achieving the objectives of the MPAs that can be addressed through other management regimes that are in place in the Region (ie MPAs or other sectoral management arrangements, provided they are secure and formalised and support for conservation objectives can be verified).

Scientific Peer Review Panel for NRSMPA (2006). Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas, Department of Environment, Water, Heritage and Arts.

*Maximise placement of no-take areas in locations which complement and include present and future management and tenure arrangements. GBRMPA (2002). Social, economic, cultural and management feasibility operational principles prepared by the Social, Economic and Cultural Steering Committee for the Representative Areas Program.. GBRMPA. **Technical Information Sheet #7.***

Complementary and Regional Management – Optimise placement of MPAs in areas to complement (a) existing or proposed marine and coastal (mainland and islands) zoning plans, management plans or other related management strategies, arrangements by federal, state, territory or LGA, or (b) potential opportunities for regional, cross-jurisdictional and international marine biodiversity cooperation and management.

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Catchment-Coast Impacts – the network and location of MPAs zones should consider the impacts of coastal and riverine processes, and where possible avoid existing & proposed catchment activities and development impacts.

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Complement, where possible, other management mechanisms and arrangements that affect the Marine Park

Moreton Bay Independent Expert Advisory Panel (2008). Moreton Bay Marine Park Zoning Plan Review. Scientific Guiding Principles Recommended by the Expert Advisory Panel. Brisbane, Australia, Environmental Protection Agency.

^{vi} **Management Practicality**

Size and number – each region should include a small number of large MPAs rather than a greater number of small MPAs. This is to assist with (a) minimising edge effects and the influence of off-reserve impacts (b) minimising the risk of failing to include unknown aspects of biotic diversity, and (c) more practical and feasible management arrangements.

Location – The goals should be met with the least number of separate MPAs (ie smaller number of larger MPAs rather than many small MPAs) to maximise conservation outcomes

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Design- Boundary lines should be simple, as much as possible following straight lat/longitude lines

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Practicality, Feasibility – Maximise public understanding and manageability of MPAs through (a) having MPAs and management zones that are simple shapes with simple zoning rules; (b) having boundaries that are easily identified; (c) having fewer and larger highly protected zones rather than more and smaller zones; (d) having clearly expressed requirements for monitoring of the effectiveness of the zoning plans; and (e) provision of public reporting of compliance assessments and monitoring outcomes.

Ward, T., K. Edyvane, et al. (2008). Scientific Design and Implementation Principles for a Network of Comprehensive, Adequate and Representative Marine Protected Areas in the Northern Territory.

Maximise the understanding of the Marine Park and the manageability of zones

Have larger (versus smaller) no-take areas

*GBRMPA (2002). Biophysical Operational Principles as recommended by the Scientific Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #6.***

vii **Zoning**

Zoning – Zoning will be based on the EPBC Act/World Conservation Union categories of protection

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Zoning – will be based on the consideration of the threat that specific activities pose to the conservation objectives of each MPA

Australian Government (2008). The South-West Marine Bioregional Plan - Bioregional Profile. Department of the Environment Water Heritage and the Arts, Commonwealth of Australia.

Maximise complementarity of no-take areas with human values, activities and opportunities (ie minimise conflict)

*GBRMPA (2002). Social, economic, cultural and management feasibility operational principles prepared by the Social, Economic and Cultural Steering Committee for the Representative Areas Program. GBRMPA. **Technical Information Sheet #7.***