Yawuru Nagulagun / Roebuck Bay Marine Park supporting information: bioregional and social setting

Legislative and policy context

State context

The marine parks and reserves system in Western Australia is being progressively established to represent the rich and varied marine biodiversity of the state and to provide a variety of other social benefits that parks can give. Enhanced management of the state's marine biodiversity provides conservation, social and economic benefits to Western Australia.

A set of overarching strategic objectives has been adopted for Western Australia's marine parks and reserves:

- Conservation – maintain and enhance marine biodiversity and ecological integrity.
- Aboriginal culture – provide for the protection and conservation of the value of the area to the culture and heritage of Aboriginal people.
- Science and education – encourage and promote scientific research and education.
- Public participation – encourage and promote community involvement in and support for marine parks and reserves.
- Recreation – provide equitable and sustainable opportunities for recreational use and enjoyment, where appropriate.
- Commercial – provide equitable and sustainable opportunities for commercial use and benefits, where appropriate.

The marine park will be jointly managed by Parks and Wildlife and the Yawuru Registered Native Title Body Corporate through the Joint Management Body, in accordance with the joint management agreement.

The *Conservation and Land Management Act 1984* (CALM Act), administered by Parks and Wildlife, is the State legislation under which marine parks and reserves are created in state waters. The Conservation and Parks Commission (Commission) is the statutory body in which marine parks and reserves are vested (legally entrusted). As such, it plays a pivotal role in the development of management plans, establishment of marine parks and reserves and in assessing the implementation of the management plan and effectiveness. The Commission's assessment function is fundamental to ensuring that management of these reserves is achieving stated objectives and targets. The management plan provides the principal framework to enable the Commission to carry out this function.

The *Wildlife Conservation Act 1950*, which is also administered by Parks and Wildlife, provides legislative protection for flora and fauna across the state's lands and waters. The *Wildlife Conservation Regulations 1970* regulate interaction with fauna and flora through a licensing system. In addition, the *Conservation and Land Management Regulations 2002* provide a mechanism to manage human impacts in marine parks and reserves through enforcement and licensing.

The Department of Fisheries (DoF) remains responsible for the management and regulation of recreational fishing, commercial fishing, pearling and aquaculture in marine parks and reserves in accordance with the *Fish Resources Management Act 1994* and the *Pearling Act 1990*. The *Fishing and Related Industries Compensation (Marine Reserves) Act 1997* provides the mechanism by which the holder of an existing authorisation for commercial fishing, pearling, aquaculture and/or fish processing may apply for compensation if the commercial value of the authorisation is apparently diminished due to the establishment of a marine reserve. Events that can give rise to compensation are the establishment of a marine nature reserve, or the classification of an area of a marine park as sanctuary, recreation or special purpose zone in which commercial fishing activity has full or partial fishing restrictions beyond that which normally would be applied by DoF.

The *Western Australian Marine Act 1982* and *Navigable Waters Regulations 1958* regulate boating in all state waters. These acts are administered by DoT.

Developments that may have a significant effect on the environment in a marine park or reserve may be referred to the Environmental Protection Authority (EPA) to determine if it needs to be assessed under Part IV of the *Environmental Protection Act 1986* by the EPA.

Responsibilities of relevant bodies and government agencies

As the joint managers of the Yawuru Nagulagun / Roebuck Bay Marine Park, Parks and Wildlife and Yawuru RNTBC, through the Joint Management Body, will collaborate with other authorities and agencies that have responsibilities for marine and/or coastal areas to ensure that various regulatory and management practices are complementary. In some cases, Memorandum of Understandings (MoU) are developed to facilitate cooperation and promote operational efficiency. For example, in 2005 a MoU was developed between the then Minister for the Environment and the then Minister for Fisheries to establish principles of cooperation and integration between Parks and Wildlife and DoF in the management of the state's marine protected areas. Under this MoU, Parks and Wildlife works closely with DoF through collaborative operational plans for efficient and effective delivery of the strategies in the management plan for which there is overlapping or shared agency responsibility, or mutual interest.

National and international context

At the national level, the conservation of marine biodiversity, maintenance of ecological processes, and the sustainable use of marine resources are addressed by the Intergovernmental Agreement on the Environment. This agreement is implemented through national strategies such as:
- the National Strategy for Ecologically Sustainable Development (Commonwealth of Australia 1992)
- the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996)
- Australia's Oceans Policy (Commonwealth of Australia 1998)
- the Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for Action by Australian Governments (ANZECC TFMPA 1999).

The marine park contributes to the 'National representative system of marine protected areas' (NRSMPA), which contain representative samples of Australia's marine ecosystems. The NRSMPA is being developed cooperatively by government agencies responsible for conserving, protecting and managing the marine environment. The primary goal of the NRSMPA is to establish and manage a comprehensive, adequate and representative (CAR) system of marine protected areas to contribute to the long-term ecological viability of marine and estuarine systems; to maintain ecological processes and systems; and to protect Australia's biological diversity at all levels (ANZECC TFPMA, 1999). The principles of the CAR reserve system are outlined below:
- comprehensive – include marine protected areas in all the major bioregions of Australia
- adequate – include marine protected areas that are of appropriate size and configuration to ensure the conservation of biodiversity and the integrity of ecological processes
- representative – include the flora, fauna and habitats that are representative of the bioregion.

Development of the NRSMPA fulfils Australia's international responsibilities and obligations as a signatory to the Convention on Biological Diversity (United Nations Environment Program, 1994), provides a means of meeting obligations under the Convention on Migratory Species (Bonn Convention) and Australia's bilateral migratory bird agreements with Japan, China and the Republic of Korea (JAMBA, CAMBA and ROKAMBA, respectively). In addition, it supports the International Union for the Conservation of Nature's (IUCN) Protected Areas Program that promotes the establishment and management of a global representative system of marine protected areas (ANZECC TFPMA, 1999).

The Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*, which is administered by the Commonwealth Department of Environment, includes provisions to protect matters of national environmental significance. These include the ecological character of internationally important wetlands, nationally listed threatened species and ecological communities, listed migratory species, the commonwealth marine environment, the values of World Heritage properties, the values of national heritage places, and protection of the environment from the impact of nuclear actions. Listed migratory species include those listed under the Bonn Convention and bilateral agreements for protection of migratory birds with Japan, China and Republic of Korea. This list also includes a number of whales and dolphins, the dugong (*Dugong dugon*), whale shark (*Rhincodon typus*) and great white shark (*Carcharodon carcharias*). Other listed marine species include seals, marine turtles, sea snakes, crocodiles, seahorses, sea dragons and pipefish.

Areas of marine parks or reserves (both state and commonwealth) above low water mark are defined as 'onshore' places under the *Commonwealth Native Title Act 1993* (NT Act), while areas below low water mark are defined as 'offshore' places. For 'offshore' places, the native title representative body and native title holders or claimants must be notified of the Government's intention to create the reserves and provided with the opportunity to make comment. For 'onshore' places, native title must be either protected by registration of an Indigenous Land Use Agreement (ILUA) or extinguished by compulsory acquisition prior to the creation of the marine park or reserve. In the case of Roebuck Bay, ILUAs have been agreed to and provide clear guidance to create and jointly manage the Yawuru Nagulagun / Roebuck Bay Marine Park.

Bioregional and social setting

Climate and seasons

The Roebuck Bay area is located on the boundary between two large climatic zones, the monsoonal wet/dry north and subhumid/dry inland north, and has a tropical climate with hot and humid summers and warm winters (Bennelongia 2009; Bureau of Meteorology 2010). Yawuru traditional ecological knowledge defines six seasons with strong climatic drivers, a summary of which is provided below. More generally, two seasons are referred to: the ‘wet’ usually from December to March, and the ‘dry’ for the remainder of the year.

Table 1. Summary of Yawuru seasons (adapted from the Yawuru cultural management plan 2011)

Yawuru season	Description	Approx. timing	Ave. temp. (°C)	*Wula* (rain)	*Wangal* (wind)	Humidity
Man-gala	The ‘wet’	December - March	24 – 35	Heavy falls may occur. Majority of annual rainfall occurs during this season	Strong north-west winds and *wirdu wanga* (cyclones)	Very high, averaging near 70%.
Marrul	Changing season	April - May	22 - 34	Occasional rain at start of season	No winds at start of season, south-easterly winds begin at end of season	High, averaging 55%
Wirralburu	Cooling season	May - June	19 - 32	No rain and clear skies	South-east winds begin to blow steadily but can sometimes blow hard	Lower, averaging 49%
Barrgana	Cold season	June - August	15 – 31 (but can drop to 8 at night)	Occasional winter rain, *mujungu*, in some years	Strong, dry south-easterly winds and *guju-guju* (dust storms)	Low, averaging 47%
Wirlburu	Warming season	September - October	17 – 33	Clouds appearing but no rain	*Yaman* (westerly wind) begins to blow	Low, averaging 48%
Laja	Hot time	Late September – November / December	26 – 34 (but can reach 44)	Clouds appearing but no rain	Westerly and north-westerly, with varying intensity	High, averaging 60%

The median annual rainfall is 532 mm over an average of 44 days, although there is considerable variation from year to year. Evaporation is high, with the average daily rate of evaporation in November being 9.5 mm per day. Wind and weather patterns of the region are dominated by Hadley Cell circulation and the seasonal location of the subtropical high pressure belt over the Australian continent (Bureau of Meteorology 2010; Oldmeadow 2007). The location of the high pressure belt during the dry season results in persistent, dry, easterly to south-easterly winds between 10-30km/h, across much of the northwest, including Broome (Kenneally *et al*. 1996; Pepping *et al*. 1999). Preceding the onset of summer the high pressure belt begins to migrate pole wards, drawing moist tropical air into the northern region of Australia and precipitating the onset of the hot and humid Man-gala or 'wet' season. Westerly winds during this time of year suppress the usually dominant east to south-easterly trade winds but are often restricted to the coastal districts, and may be intermittently replaced by the easterly trade winds (Pepping *et al*. 1999).

Localised sea breezes are also common with resulting afternoon/evening winds being stronger and having a larger westerly component. This feature is accentuated during the wet season. From October to April average temperatures range from a minimum of 26°C to a maximum of 33°C. The highest temperature ever recorded was 44.8°C on 10 December 1951 however the temperature seldom rises above 40°C. By contrast winters are mild, with July average minimum and maximum temperatures being 12.0°C and 26.9°C respectively. Overnight temperatures rarely fall below 5.0°C and only fall below 10°C about once a week during July on average. The lowest temperature ever recorded is 3.3°C on 21 July 1965 (Bureau of Meteorology 2010).

Over 75 % of the average annual rainfall (532mm) falls from January to March associated with thunderstorms and tropical lows or cyclones. These events can produce heavy rain in short periods, and a significant proportion of the yearly total can fall in just one or two days. The unreliable nature of the occurrence and movement of thunderstorms and tropical systems result in rainfall being highly variable. Rainfall during the cooler months is usually associated with cloud bands originating from tropical waters to the northwest. The highest recorded daily rainfall occurred on 30 January 1997 when 476.6 mm fell (Bureau of Meteorology 2010).

Tropical cyclones bringing strong winds, high seas and heavy rain can be experienced during the months from November to April, but are most common in January and February. These high intensity but low frequency events can have a significant impact on the ecology of Roebuck Bay and the surrounding hinterland.

It is not uncommon for very little rain to occur for months on end. The median rainfall for the months of July to October is zero. Longer dry periods of over 12 months are associated with the failure of the wet season.

Oceanography

Located in the regular, semi-diurnal, macro-tidal region of northern Western Australia, Roebuck Bay has a very large tidal range of more than 9 metres and locally generated wind waves. Lowest and highest astronomical tides are -0.9m and 9.6m below and above the Broome Tidal Datum respectively (Bennelongia 2009). The highest and lowest tides occur bimonthly (monthly lunar cycle), three days after the full and new moons (spring tides). The lowest tidal ranges occur 3 days after the half-moon (neap tides). The highest and lowest annual tides occur during the spring tidal cycles closest to the autumn and spring equinoxes (Pepping *et al*. 1999).

The twice daily tides and high tidal range are dominant features of Roebuck Bay and provide strong drivers for the geomorphology and ecology of the area (Bennelongia 2009; Watkins 1993). Spring high tides flood the saltmarshes located landward of the mangrove systems, whilst the low tides expose approximately 190km2 of intertidal flat. This allows fish to feed on the vast intertidal area during high tides and *gamirda-gamirda* (shorebirds) to feed there when the intertidal area is exposed at low tide (Bennelongia 2009).

Tidal currents of Roebuck Bay are generally low (<0.5m/s), except around tidal creeks and through Roebuck Deeps where tidal currents can reach up to 1.75m/s (Oldmeadow 2007; Wallace 2000). Past research indicates high tidal current turbulence in the surface waters of Roebuck Deeps (to 15m depth) but highest current velocities were recorded at 50m depth (Oldmeadow 2007; Wallace 2000).

More broadly, the South Equatorial Current and Indonesian Throughflow supply warm, low salinity, nutrient poor water to northern Western Australia (Suthers and Waite 2007). The expansive continental shelf in the area however, reduces the ability of these broad-scale regional currents to make significant incursions into the nearshore waters.

Nearshore water movements and mixing patterns in Roebuck Bay are thought to be driven primarily by the large tidal ranges, seabed topography, and local winds. Although the tidal and wind driven circulation patterns remain largely unknown it is generally understood strong tidal currents flow through the Roebuck Deeps in north-west to south-east and south-east to north-west directions on flood and ebb tides respectively (Wallace 2000). Research indicates that despite the large tidal ranges, some areas of the bay are not well 'flushed' and modelled retention times for nutrients in the water column can be more than 20 days at certain times of the year (Gunaratne 2015). The protected waters of Roebuck Bay are relatively turbid due to the area's shallow bathymetry, strong tidal flow, wave action and fine carbonate sediments.

Geology and geomorphology

Located in the northern onshore component of the Canning Basin, Roebuck Bay is a large irregular curved embayment with intertidal sand and mud-flats intersected by small linear tidal creeks (Bennelongia 2009). The geological record suggests the evolution of this section of the Canning Basin included series of alternating periods of marine flooding and retreat, with shallow marine and coastal depositional environments being common within the basin as a result (Gibson 1983a, 1983b).

The underlying structure of the unique Roebuck Bay and *Gumaranganyjal* (Roebuck Plains) environment ('the Roebuck Bay system') is provided by a natural lowland between the northern Dampier Peninsular and the Edgar Ranges, and an ancient drainage system (Brunnschweiler 1957, cited in Gibson 1983a; Gibson 1983a Pepping *et al*. 1999; Semeniuk 2008; Vogwill 2003). Hydrogeological studies have further identified the potential position of an ancient river channel through Gumaranganyjal and linking it with the now drowned river valley of Roebuck Deeps (Vogwill 2003; Wallace 2000).

Analysis of Roebuck Bay sediments suggests sea levels rose to a height approximately 2m above present levels around 7,500 years ago, flooding into a deeply indented embayment that is today *Gumaranganyjal* (Oldmeadow 2007; Semeniuk 2008). Sea levels remained high for about the next 2000 years, during which time fine carbonate sediments began to be deposited in the most protected areas of the embayment (Semeniuk 2008). Sea levels then began to fall and the coast rapidly retreated west creating the carbonate mud-filled *Gumaranganyjal* in the process (Oldmeadow 2007; Semeniuk 2008). Modern sea levels were reached around 2000 years ago and at this time the coastline extended a little further offshore than the current position, as defined by mean sea level (Semeniuk 2008). Sea levels have been relatively stable since that time and active erosion and reworking of sediments on the coast have formed the Roebuck Bay we know today (Semeniuk 2008). Importantly for the ecology of the Roebuck Bay system, erosion associated with the scouring of tidal channels transports fine carbonate rich sediments from *Gumaranganyjal* and tidal creeks and deposits them onto the intertidal flats (Semeniuk 2008), helping to create one of the most biodiverse and productive tropical intertidal flat communities in the world (Bennelongia 2009).

Limited information is available on the subtidal geomorphic features within the marine park. Relatively flat, undulating carbonate shoals and low relief reef is thought to make up much of the marine park, particularly in the areas further offshore (Oldmeadow 2007). Areas of mobile and semi-mobile sediment are also expected to be found throughout the marine park. The more exposed areas in the south are thought to contain coarser more mobile material than the deeper central parts of Roebuck Bay, and exhibit features such as sand ripples and waves. Rubble and stone substrate has also been recorded from offshore areas in the south (Fry *et al*. 2008). Outcrops of higher relief rock and reef are expected, particularly offshore from *Minyirr* (Gantheaume Point) around features such as Roebuck Deeps, North Rock and Escape Rock.

Bioregional setting

The marine park is located in the Canning IMCRA bioregion (meso-scale) at the base of the Dampier Peninsula on the north-west coast of Western Australia (Department of Environment and Heritage 2006). The Canning bioregion forms the north-eastern most component of a tropical body of water recognised as the North West Province, and is bordered by the Kimberley bioregion to the north-east, Eighty Mile Beach bioregion to the south-west and North West Shelf bioregion further offshore (Interim Marine and Coastal Regionalisation for Australia Technical Group 1998). The Canning bioregion stretches from west of *Kooljaman* (Cape Leveque) to Cape Missiessy and is characterised by alternating embayments and headlands, very large tidal ranges and little or no riverine input (Interim Marine and Coastal Regionalisation for Australia Technical Group 1998). For Roebuck Bay this means the sediment in this protected embayment is dominated by carbonate mud. In turn this has facilitated the establishment of abundant and diverse benthic invertebrate communities and prolific birdlife.

The sub-regionalisation of Australia's terrestrial bioregions identified the coastal hinterland of the Eighty Mile Beach area together with the Dampier Peninsula, including the lands adjacent to Roebuck Bay, as the Pindanland subregion (Department of Sustainability, Environment, Water, Population and Communities 2012). The recognised special values of the Pindanland subregion that relate to Roebuck Bay include: the extensive mudflats of Roebuck Bay resulting from marine mud infilling of a major ancient drainage system; the enormous numbers of migratory birds found at Roebuck Bay; and the vast grasslands of the *Gumaranganyjal* (Graham 2001).

Habitats, flora and fauna

Marine habitats, flora and fauna of the area are predominantly tropical and are well adapted to the large tidal range, turbid waters and low wave energies experienced in the region.

Very little is currently documented about the subtidal habitats of Roebuck Bay. Local knowledge and limited research indicate offshore habitats predominantly consist of invertebrate rich sand and filter feeding communities including *wurrja* (sponges) and soft corals such as gorgonians (also known as sea whips or sea fans). Soft sediment communities are likely to dominate the more protected subtidal waters of Roebuck Bay, whilst the adjacent extensive intertidal sand and mud-flat communities are recognised globally as one of the most productive and diverse found in the tropics (Bennelongia 2009).

The large tidal amplitudes and fine carbonate sediment supplied from the intertidal and adjacent areas of Roebuck Bay result in a relatively turbid environment, particularly closer to shore. This limits the distribution of many benthic primary producers (such as seagrasses, macro-algae and hard corals) to areas where there is sufficient light such as less turbid offshore waters, shallower areas of the subtidal and the intertidal. Significant areas of seagrass communities are found in the lower intertidal and immediate subtidal areas of Roebuck Bay, dominated by *Halophila ovalis* and *Halodule uninervis*. Some species adapted to tolerate lower light conditions, such as *H. ovalis*, may be found in deeper and/or more turbid areas, however further research is necessary to determine presence, abundance and distribution of such species.

Brown algae are the most abundant macroalgae in the region, with *Sargassum spp*., *Dictyopteris spp*. and *Padina spp*. dominating. The most common green algae are the articulate coralline *Halimeda sp*., while prominent red algal species include crustose corallines, non-corallines and algal turf (Pendoley and Fitzpatrick 1999; Wells *et al*. 1995).

Subtidal and intertidal rock/reef habitats are found throughout the region, particularly in areas associated with surface outcrops of Broome Sandstone such as *Minyirr* (Gantheaume Point) and Entrance Point, Disaster Rock and Escape Rock, and the Roebuck Deeps. Lying less than 2km from shore and reaching depths of 100m, the Roebuck Deeps is regionally unique with no other remotely comparable geomorphic feature known from the Canning bioregion. Although little is known about the Roebuck Deeps, the diversity of habitat types it provides and its ecological importance to Roebuck Bay are likely to be significant, particularly in regard to its effect on mixing and circulation patterns of coastal waters.

Eleven species of *gundurung* (mangrove communities) are found in Roebuck Bay with well established stands located around the major tidal creeks and fringing the eastern shores. However, the majority of Roebuck Bay mangrove stands are species depauperate, being dominated by *Avicennia marina* (Semeniuk 1983). Inshore areas of protected embayments like Roebuck Bay also provide critical habitat, such as nurseries, for many types of fauna, including finfish and crustaceans.

Limited subtidal benthic surveys indicate that echinoderms (heart urchins in particular) are the most abundant benthic fauna for offshore areas in the region (Fry *et al*. 2008). At least 205 benthic taxa have been recorded from the intertidal flats with polychaetes the most abundant invertebrate. Bivalves, crustaceans and gastropods contribute to a lower proportion of the biomass (Bennelongia 2009; Pepping *et al*. 1999).

Key marine fauna with a particular conservation interest in the region include *nganarr* (dugong), Australian snubfin dolphin, *yari* (humpback whale), five species of *gurlibil* (marine turtle), three species of *yalwarr* (sawfish) and at least 22 species of *gamirda-gamirda* (shorebird).

Social setting

Population growth in Broome has been significantly higher than the rest of the state for a number of years, driven primarily by growth in the tourism and resources sectors and government services (Department of Planning and Infrastructure and Landcorp 2008). Broome is the principal port servicing the Kimberley Region and has one of the highest vessel visitation rates for regional ports in Western Australia (Broome Port Authority 2009). Although trade levels through the port decreased slightly between 2008–2010 they still remain high and are expected to increase as the Kimberley region experiences further industrial, agricultural, tourism and economic development. Currently there are about 1600 recreational boats and 120 commercial boats at Broome and this number is expected to grow to at least 3000 and 180 boats respectively by 2031 (Department of Transport 2010). Consideration of these broad social factors over the longer-term will be needed to ensure the conservation and management of the cultural, ecological and social values of the marine park and surrounding conservation reserves.

The social uses and values of Roebuck Bay include port activities, maritime heritage, seascapes, marine nature-based tourism, pearling, recreational fishing and research opportunities.

Broome, and Roebuck Bay, has an extensive maritime heritage, strongly influenced by the coastal Yawuru people and the development of the pearling industry. Roebuck Bay also became an important evacuation and refuelling point during World War II and came under direct attack from Japanese aircraft on 3 March 1942. Wreckage of Allied flying boats destroyed during this attack can still be found in the intertidal areas next to the marine park.
Roebuck Bay has been synonymous with pearling since the 1870's and was widely known as the pearl capital of the world. Roebuck Bay is an ideal location for pearl production with strong tidal currents that provide a flow of nutrients and carry waste away. There are currently seven pearl leases in the central part of Roebuck Bay, with two completely within the marine park and five partially overlapping.

Vistas of turquoise waters, mangroves and tidal creeks, vast intertidal flats, reefs and shoals, beaches, red pindan cliffs and abundant wildlife provide a diverse range of compositional elements that contribute to the seascape values of the marine park. In many places this occurs in remote or isolated areas, offering a 'wilderness' type experience and providing a major draw card for marine nature-based tourism. Popular activities for marine nature-based tourism include whale watching, kayaking, cruising (sailing) and wildlife appreciation.
Recreational fishing is highly valued by the local community and is experiencing significant growth in the region driven by an increase in tourism, and population growth (Department of Fisheries 2010). Although a number of commercial fisheries can legally operate in the marine park, it is generally understood little commercial fishing actually takes place. The intertidal areas of the marine park were fished commercially through the Kimberley Gillnet and Barramundi Managed Fishery until the end of 2013, mainly targeting threadfin salmon and barramundi.

Culturally, ecologically and socially, Roebuck Bay provides many unique and interesting opportunities for research. Local, national and international research initiatives have characterised many aspects of the intertidal areas but in comparison the subtidal environment has been little studied. Facilitating and conducting research to support long term management of Roebuck Bay will form a significant component of management actions during the life of this management plan.

Outcome based management

Outcome-based management involves measuring management effectiveness as the extent to which management objectives (or desired outcomes) are achieved (Jones 2000).

An outcome-based management framework can be defined as:

- objectives (specific, measurable, issue-based)
- standards (outcomes, clear relationship to objectives)
- performance indicators (measurement of outcomes)
- reporting
- feedback into management (Meredith 1997).

Best practice management model

In 1997, a working group of Australian and New Zealand Environment Conservation Council (ANZECC) undertook a project to review the status of management of protected areas across natural resource management agencies in Australia and set benchmarks for best practice management. The ANZECC working group identified criteria that they considered critical for natural resource management which were included in a best-practice model outlined in the report Best Practice in Performance Reporting in Natural Resource Management (Meredith 1997). In 2000, a taskforce of the IUCN World Commission on Protected Areas developed a management effectiveness framework (Hockings *et al*. 2000). This framework is now being used widely around Australia and overseas to help guide and structure management approaches and performance reporting.

These best-practice approaches and principles have implications for management planning and have been incorporated into the development and structure of this 'outcome-based' management plan.

Cultural, ecological and social values

Cultural values relate to the strong historical and contemporary connection Aboriginal people have with their country. All facets of country are encompassed including the ecology, customary practices and dreaming stories and songlines that have ongoing significance.

Ecological values are the intrinsic physical, chemical, geological and biological characteristics of an area. For convenience, the major ecological values are listed individually in the joint management plan. However, in reality, the marine environment is a structurally and functionally complex array of relationships between plants, animals (including humans) and the physical environment.

The ecological values should (where appropriate) include:

- species and communities that have special conservation status (for example, endangered or rare species)
- species endemic to the reserve (if known)
- key structural components of the ecosystem (for example, macroalgae, finfish and bird communities)
- exploited species and communities (for example, targeted fish populations)
- key physical–chemical components of the ecosystem (for example, water quality, sediment quality and geomorphology).
- Social values are the major aesthetic, recreational and economic uses of the area.

Management objectives

Management objectives are presented for each management program and value in sections 4 to 5 of the joint management plan and identify what the primary aims of management are. They also reflect the statutory responsibilities required by the CALM Act for marine parks. The management objectives for each value provide broad direction for management in relation to protecting or managing the value from existing or likely pressures.

Management strategies and actions

Management strategies provide direction on how the management objectives will be achieved. The seven overarching management programs provide strategies to guide implementation of specific strategies developed for each cultural, ecological and social value. The agency with primary responsibility for implementing a management strategy appears first in the bracketed list following the action. Other agencies listed provide support, as necessary, to implement the strategy within the scope of their statutory roles and responsibilities. All strategies have been prioritised as high **(H)**, medium **(M)** or low **(L)** to provide an indication of their relative importance. A number of management strategies considered to be critical to achieving the strategic objectives of the joint management plan (section 3), are presented as 'high-key management strategies' **(H–KMS)**.

The actions recommended for the marine park focus on managing pressures while providing opportunities for use and enjoyment consistent with the management plan's objectives. Impacts on the ecological values can be direct effects such as damage to seagrass habitats by indiscriminate anchoring or impacts on fish stocks due to fishing. Indirect effects on the marine park's values may arise from activity such as littering, inappropriate sewage disposal and downstream effects of activities such as introduction of pests from ballast water discharge or downstream impacts of dredging or nutrient enrichment from catchment based activity. With a projected rise in users of the marine park in the next decade, the pressures on the cultural, ecological and social values of the reserve will likely increase and potential conflicts between users will need to be managed.

Prioritised management strategies and actions for specific cultural, ecological and social values are also stated to guide operational work programs over the life of the joint management plan.

Performance measures

Performance measures are indicators of management effectiveness in achieving the objectives and targets for the park. Performance measures should ideally be quantitative, representative and, where possible, simple and cost-effective. The management plan usually contains generic performance measures (for example, often diversity and abundance or biomass). Specific performance indicators will be developed during the design and implementation of the monitoring program. Performance measures for indirect (for example, nutrient enrichment impacts on seagrass meadows) and direct (for example, mooring impacts on seagrass meadows) impacts should focus on surrogate (for example, changes in phytoplankton biomass and species composition) and direct (for example, changes in seagrass biomass) measures of the value, respectively. These will be developed during the early phase of the implementation of the joint management plan.

In regard to the 'active' social values (that is, those social values that have the potential to impact negatively on the cultural and ecological values of the marine park) a different approach to performance assessment is required. This has been termed "reporting" in section 4.3 of the joint management plan and incorporates information on the status, nature, level and trend of the human activity. This information is important in monitoring human activities to assist in determining trends in use, and to assist in assessing impacts of the social values on the cultural ecological values of the marine park. The same "reporting" approach has been used for the cultural values section (4.1) of the joint management plan.

Management targets

Management targets represent the end points of management. Targets should be measurable, time bound and apply to defined areas. Ecological targets will be set as either the 'natural state' or some acceptable departure from the 'natural state'. The long-term targets provide specific benchmarks to assess the success or otherwise of management actions within the life of the management plan. A short-term target, where identified, provides a rehabilitation milestone and is used when the condition of the value is well below the desired condition (that is, the long-term target). Where no short-term target is identified, it is considered that the condition of the value is close to or at the desired condition and, as such, the long-term target applies. The targets for active social values (for example, nature-based and cultural tourism and recreational and customary fishing) are process-based (or 'output' based) and are generally stated as ‘Implementation of management strategies within agreed timeframe’.

Key performance indicators (KPI)

KPIs are a measure of the overall effectiveness of management in relation to the strategic objectives of the reserves. Management targets of key cultural, ecological and social values of the reserves are used as key performance indicators of management effectiveness. The key cultural, ecological and social values reflect the highest conservation (biodiversity and ecosystem integrity perspectives) and management (cultural and social) priorities of the Yawuru RNTBC, the Commission, Parks and Wildlife, and the community. KPIs are a key element of the management assessment process.

Determining management priorities

A pro-active and precautionary approach to conserving marine biodiversity is used to determine management priorities. A risk assessment is undertaken by considering the likelihood of existing and potential pressures affecting the cultural, ecological and social values and their associated cultural, ecological and social consequences. The relative level of risk posed by existing and/or potential pressures on the values of the reserves can be assessed by considering the following factors:

- the biological intensity of the pressure – pressures that impact lower trophic levels (for example, primary producers, such as seagrasses and macroalgal communities) are often of greater concern than pressures on higher trophic levels
- the temporal scale of the pressure – ongoing pressures are generally of greater management concern than pressures that are short-lived
- the spatial scale of the pressure – pressures that occur over a large area are often of greater management concern than localised pressures
- the social consequence – acknowledges that different pressures have different social and political consequences. A high social, economic or political consequence is often of greater management concern
- the probability of a pressure occurring within the timeframe of the management plan.

It is therefore necessary to determine how each value is, or is likely to be, affected by existing or future pressures. The ecological values and the major uses of the area are generally understood. However, the short-term and long-term cumulative ecological effects of pressures are not fully understood. For the purposes of developing management priorities, pressures on the values are confined to current pressures and those likely to occur during the life of the management plan and considered to be manageable within a marine park context. By definition, this excludes global pressures such as climate change. The vision, long term goals and strategic objectives of the management plan detail the longer-term outcomes to be achieved.

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