



AMSAwa
Australian Marine Sciences
Association WA

Chair: Dr Joanna Browne

8680 Bussell Hwy
COWARAMUP WA 6284
jbrowne@museum.vic.gov.au

Vice-Chair: Alicia Sutton

School of Veterinary and Life Sciences
Murdoch University
MURDOCH WA 6150
a.sutton@murdoch.edu.au

Secretary: Simone Strydom

Centre for Marine Ecosystems
Research
Edith Cowan University
s.strydom@ecu.edu.au

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Plan Coordinator: Proposed Nagulagun/Roebuck Bay Marine Park
Department of Parks and Wildlife
Planning Branch
Locked Bag 104
Bentley Delivery Centre WA 6983

SUBMISSION ON THE YAWURU NAGULAGUN MARINE PARK DRAFT INDICATIVE JOINT MANAGEMENT PLAN BY AMSA WA

The WA Branch of the Australian Marine Sciences Association (AMSA) is pleased to submit its comments on the Indicative Management Plan for the proposed Yawuru Nagulagun Marine Park and Yawuru Birragun Conservation Park. AMSA is the peak representative body for marine scientists in Australia with about 1,000 members representing all disciplines and associated primarily with universities, museums and marine consultancy companies in addition to State and Commonwealth Government agencies. AMSA provides independent scientific comment on matters of relevance to marine science; the opportunity to provide scientific comment on the indicative joint management plan for the proposed Yawuru Nagulagun / Roebuck Bay Marine Park is therefore welcome.

The following comments do not reflect a priority order, but are listed by the sequence in the submission form.

Part 1 Contact details

See attached submission form.

Part 2 Your primary interests

AMSA WA's two main interests/activities in the marine park are (1 = most important):

1. Research
2. Conservation
3. Other - Marine Science

Part 3 Reserve Boundary

AMSA WA has no other changes or suggestions to the proposed outside boundary

Part 4 Zoning

Please see online submission

Part 5 Management arrangements

Please see online submission

Part 6 Management programs

AMSA WA's comments are confined to three areas: 'Patrol and enforcement', 'Research' and 'Monitoring'.

AMSA WA strongly supports effective patrol and enforcement of the proposed park, particularly the development of a collaborative operation plan between Parks and Wildlife, Department of Fisheries and the Park Council. Marine protected areas (MPAs) with high levels of regulation and enforcement have greater fish biomass and species diversity of fish > 25 cm than those with lower levels of regulation and enforcement (Edgar et al. 2014). MPAs in which illegal harvesting or regulations which legally allow detrimental harvesting may fail to reach their targets (Guidetti et al. 2008).

AMSA WA would like to strongly emphasise the importance of good baseline data of sufficient spatial and temporal resolution to be able to "Assess the nature, level and potential impacts of human activities on cultural, ecological and social values within the proposed marine park" that the management plan indicates. The same obviously applies to ongoing monitoring programs. Habitat maps and data that have only coarse spatial and temporal resolution will not be able to detect anything other than the most major trends, anthropomorphically-induced or otherwise: such data will not support the strategic goal of ensuing healthy ecosystems and no loss of biodiversity in Roebuck Bay.

The proposed Yawuru Nagulagun Marine Park management plan states that scientific research needs:

"access to representative areas free of major human influences " (p.72).

However, the lack of no-take sanctuary zones within the proposed management does not ensure access to such areas. This concern is addressed in more detail within Section 5.0.

AMSA WA acknowledges the awareness of knowledge gaps and welcomes that further research is proposed for this region through the "Kimberley Science and Conservation Strategy". As noted in our response on the Camden Sound indicative management plan, we are cognisant of the wide range of expertise available within Western Australia, and indeed Australia, and encourage research by museums, universities and other institutions to assist with the management and monitoring of this proposed addition to WA's conservation estate.

Overarching comments

AMSA WA would like to preface its comments by noting its alignment with AMSA National in strongly supporting policies by both Commonwealth and State governments aimed at spatial management of the marine environment, including bioregional planning. We support the scientific foundations of the marine bioregional planning process, and within it, the National Representative System for Marine Protected Areas. In particular, we would like to refer you to AMSA's detailed position statement on MPAs (<https://www.amsa.asn.au/amsa-position-statements>) which is based on the extensive marine science supporting MPAs use as a conservation and management tool.

AMSA WA welcomes the proposed establishment of marine parks in the Kimberley region, an area of high biodiversity value. AMSA WA agrees with the proposal to classify the proposed Yawuru Nagulagun / Roebuck Bay Marine Park as a Class A reserve in order to provide the marine park with the greatest security of tenure.

AMSA WA congratulates the Government and Yawuru on the successful negotiations for joint management of the parks and for the inclusion of the important intertidal zone within the Yawuru Nagulagun Marine Park. This represents another important step towards the vision of protecting the Kimberley Coast through the Kimberley Science and Conservation Strategy.

Roebuck Bay is at the gateway to the Kimberley Coast and is of very high conservation value in its own right. The Bay was declared a Ramsar site in 1990 for its critical importance to at least 20 species of migratory shore birds on the East Asian-Australasian Flyway. Over 150,000 birds visit each year. Roebuck Bay has some of the most diverse mudflats in the world with between 300 – 500 species estimated to utilize the extensive intertidal area. In particular, the mudflats, seagrass beds and reefs of Roebuck Bay are home to animals of national and local conservation significance such as dugong, green turtles and the rare Australian snubfin dolphin. Roebuck Bay is also of high cultural significance to Traditional Owners and has important recreational fishing areas for Broome residents and visitors. Roebuck Bay was placed on the National Heritage Register in 2011.

Ensuring that the draft management plans protect Roebuck Bay is therefore of international, national, regional and local conservation significance. Comments by AMSA WA on the draft management plan are summarized below.

Key Strengths of the Plans

- The inclusion of cultural zones in both marine and terrestrial parks (including Yawuru only areas in the Yawuru Birragun Conservation Park) is welcomed. This recognizes the strong and ongoing cultural connection that Traditional Owners have to land and sea Country and the importance of long term recognition and protection for cultural sites and practices. The inclusion of a strategic goal to uphold and respect Yawuru people's culture and knowledge of the land and sea is also welcomed.
- The integrated protection of conservation and cultural values that will be achieved by the concurrent creation of the adjacent marine and conservation parks and complementary joint

management arrangements is welcomed. This recognizes the important interconnections between coastal, intertidal and subtidal biodiversity in Roebuck Bay.

- The inclusion of parts of Dampier Creek is an important addition to the marine park. This area is a popular recreational fishing area for Broome locals and tourists and has important cultural values. This inclusion in the marine park will ensure it continues to be managed to support these uses and values.
- The exclusion of commercial gillnet fishing from the marine park is strongly supported. Gillnets represent a major threat to many species as by-catch, notably turtles, dugong and dolphins.
- The exclusion of ground disturbing mining exploration and development is also strongly supported. Mining activities within the marine park would be incompatible with protecting the parks conservation, cultural and recreational values.

Key Areas for Improvement

- Allowing dredging and dredge spoil dumping within the marine park is not consistent with the strategic goal of ensuring healthy ecosystems. In particular, dredging and dumping of dredge spoil is likely to negatively impact the highly diverse benthic mudflat communities (Snelgrove 1999; Thrush and Dayton 2002). AMSA WA recommends that dredging should be prohibited in the marine park, except under permit for small scale maintenance of existing boating facilities. Dredge spoil dumping should be wholly prohibited and for permitted activities conducted outside of the marine park in an appropriate area.
- The plan lists seismic exploration as an existing or potential pressure upon marine mammals (p. 56), however, it is not clear whether seismic exploration would be allowed within the proposed marine park. As non-ground-disturbing activities are permitted subject to assessment (p. 70), it seems that seismic exploration and associated industry activities may potentially be allowed within or adjacent to the Yawuru Nagulagun / Roebuck Bay Marine Park.

Because organisms have evolved to sense sound and vibration as an adaptation for survival and reproduction in the marine environment, they are also susceptible to impacts from sound and vibration produced during human activities. Prolonged exposure to noise approaching and crossing the pain threshold can cause physical damage to the sensory organ and cause 'noise-induced hearing loss' (Southall et al. 2007). Noise-induced hearing loss can occur from intense sound exposure over a brief period, or from continuous exposure at high levels over an extended period. In addition other effects may be experienced, such as changes in physiology associated with stress. If the exposure is intense enough, it is thought that resonance of air spaces in organs or dissolved nitrogen gas bubble growth within tissues can result in ruptured tissues or organs. The potential effects resulting from exposure to sound and vibration depend directly on the characteristics (intensity, level, duration, frequency, etc.) of the sound as well as the animal's physiology and morphology. Based on research on impacts of sound on animals, the range of effects have been grouped according to the type and severity of impact. These include: masking of sounds animals produce for communication and navigation, or which are important cues for their survival; changes in behaviour which can affect energetics, such as displacement, attraction or avoidance; physiological stress-related responses; and in more

extreme situations, hearing impairment or non-hearing related physiological injury (Richardson et al. 2007; Southall et al. 2007 and references within). Noise sources with all of these potential impacts include seismic surveys, some other geophysical surveys and pile driving. Noise sources that generally have a lower source intensity but can have deleterious effects over long exposures include increased vessel traffic, dredging, drilling, and other noise sources related to development activity (see Southall et al. 2007 and references within). Roebuck Bay is known to have a significant community of resident snubfin dolphins (p. 54). These animals are thought to be endemic to the northern regions of Australia, and being coastal (and resident), are particularly susceptible to near-shore impacts of pollution, including underwater noise emissions (Thiele, D. pers. com. to Salgado Kent, C.P). Dugong also occur in the area (p. 54). Their population and status are also of concern, particularly since they depend upon what are often ephemeral seagrass beds that are affected by changes in the environment. These areas are also important to humpback whales reaching their calving grounds. Female humpback whales passing this area are either pregnant or have just had newly born calves. This life stage is a particularly sensitive period, and successful development depends upon it. Indo-Pacific humpback dolphins and bottlenose dolphins also use the Bay (p. 54). They are thought to occur less frequently, but appear to consist of the same individuals that use the Bay over long time periods (years) (Salgado Kent, C.P. pers. com.). AMSA WA recommends that activities known to have a high level of potential impacts from underwater noise, such as seismic surveys, are not allowed within the proposed Yawuru Nagulagun Marine Park.

- The lack of any marine sanctuary zones within the Yawuru Nagulagun Marine Park is a fundamental and critical flaw in the plan. Without marine sanctuary zones it will be difficult to design and implement sound scientific studies that assess the performance of the plan and the impacts of harvest. It is also unlikely that the marine park will meet the stated outcomes of the plan, or the purpose prescribed in the CALM Act 1984 to *'ensure that the management of the park is consistent with the proper conservation and restoration of the natural environment and the protection of indigenous flora and fauna'*. The lack of one or more marine sanctuary zones fails to recognize the strong scientific case that marine sanctuary zones are a well-documented management tool for conserving marine biodiversity. AMSA WA strongly supports a protective mix in MPAs that includes no-take sanctuary zones and zones available for other uses.

AMSA WA suggests the absence of no-take sanctuary zones in the Yawuru Nagulagun Marine Park Draft Indicative Joint Management Plan will directly impact on the achievability of a number of strategic goals as outlined in the plan. AMSA WA endorses the comprehensive, adequate and representative (CAR) planning approach for protection of Australia's marine biodiversity. AMSA WA would like to encourage a more encompassing systematic planning, management and review process guided by the CAR principles with respect to the inclusion and location of no-take sanctuary zones within the Yawuru Nagulagun/Roebuck Bay Marine Park. Where detailed planning has not been undertaken, the minimum requirement to fulfill Australia's international agreements of effective conservation is to protect all major marine ecosystems, with a target of at least 10% of all habitat types under full 'no-take' protection (AMSA 2012). It is the position of AMSA WA position that a figure of 10% under 'no-take'

protection would slow but not prevent loss of biodiversity. A 'no-take' level of 33% is more likely to achieve substantial and sustained biodiversity conservation benefits. By way of comparison, the Great Barrier Reef Marine Park currently has 33% of its total area in no-take zones. Within Western Australia, the Ningaloo Marine Park has 34% of its total area located in sanctuary zones and >20% of the area of each major habitat type is protected by sanctuary zones. Similar levels in Yawuru Nagulagun/Roebuck Bay Marine Park could result in more substantial and sustained biodiversity benefits.

Comments below relate to how the lack of a marine sanctuary zone means the plan will fail to meet key strategic goals as outlined on page 20 of the draft plan.

1 Impacts of fishing pressure

These comments relate to strategic goals: Provide for sustainable customary use; Ensure healthy ecosystems and no loss of biodiversity in Roebuck Bay; Maintain and provide opportunities for the Broome community and visitors to enjoy and benefit from Roebuck Bay.

Commercial and recreational fishing have been identified in the draft management plan as threats to the ecological values of finfish (p.52-53), intertidal and mudflat communities (p. 46-47) and marine mammals (p. 54-55). The main issues relating to fishing pressure are the attraction and/or repulsion of effort and displacement leading up to and following declaration of the Marine Park and potential (as recommended by AMSA) sanctuary zones. During the consultation for zoning of Jervis Bay Marine Park, for example, effort doubled to tripled to that of comparative months from a baseline study (Lynch 2014). Following the implementation of the zone plan, fishing effort significantly declined, despite by the exclusion of the most popular sites from no-take sanctuary zones (Lynch, 2006; Lynch, 2014). AMSA WA recommends the temporal and spatial movement of fishing effort in regard to declaration of no-take sanctuary zones within the proposed Yawuru Nagulagun / Roebuck Bay Marine Park should be carefully considered. The use of buy outs for the limited amount of commercial fishing activity remaining in the park (p. 65) is recommended, and the consideration of off-setting for recreational fishers (e.g. recreational only fishing areas). The draft plan suggests increasing visitors will increase pressure on fish stocks (p. 63-64) and states that recreational fishing is currently experiencing significant growth (p. 68; Department of Fisheries 2014). The plan discusses long term targets but has not sufficiently considered long-term pressures. These concerns are further explored below.

1.1 Finfish

The draft plan indicates that threadfin salmon have become locally depleted (p. 68) and that it is anticipated the decline will reverse following the removal of commercial gillnetting in 2013. However, there is no evidence presented to support the anticipated recovery of threadfin salmon populations or details about how this will be assessed. There is anecdotal evidence from Broome that the current fishing season has been good for recreational fishers, but this is to be expected following the removal of commercial fishing and it is not clear if populations are recovering or if recreational fishers are simply catching the fish that the gillnetters would otherwise have taken. Given the current and predicted

future recreational fishing pressure it should be anticipated that stocks of threadfin salmon and other target species in Roebuck Bay will remain under pressure and that this will also have an impact on their ecological function in the bay (e.g. as high level predators).

The proposed management strategies for finfish (p. 53) are vague and mention temporal (seasonal) closures as the management method of choice. Whilst temporal closures are fisheries management tools designed to reduce overall fishing mortality, a marine sanctuary is a much more scientifically accepted tool for protecting biodiversity from the impacts of fishing pressure. Roebuck Bay's discrete stocks of threadfin salmon (p. 16) which show strong site fidelity (p. 52) are likely well suited to the spatial management measures of a no-take sanctuary zone due to very small home ranges and natal homing life history strategies (Kramer and Chapman 1999; Horne et al. 2011; Moore et al. 2011). In the case of Roebuck Bay, a marine sanctuary zone is also likely to be a useful complement to fisheries management measures, a valuable tool for fisheries research, and may be able to reduce the need for seasonal closures. Spatial management is also a simpler management measure for visiting fishers than seasonal closures as there are no temporal restrictions to fishing activity.

There is significant evidence that no-take sanctuary zones provide a refuge for species that are heavily targeted by recreational fishing (Palumbi 2003; Sumpton et al. 2004). Examples from the Great Barrier Reef Marine Park and from Ningaloo Marine Park (both of which have over 30% no-take zones) show benefits of no-take sanctuary zones to other commonly targeted species in Roebuck Bay (p. 68) such as coral trout (Harrison et al. 2012) and emperor species (Westera et al. 2003).

Under the proposed management plan, without a no-take sanctuary zone, there is no part of Roebuck Bay that is preserved to protect the natural structure and health of the ecosystem and no scientific reference zone. With predicted growth in fishing pressure the decline in threadfin salmon is likely to continue and other important species are also likely to decline. This will prevent the achievement of 'Goal 2. Provide for sustainable customary use', 'Goal 4. Ensure healthy ecosystems and no loss of biodiversity in Roebuck Bay' and 'Goal 5. Maintain and provide opportunities for the Broome community and visitors to enjoy and benefit from Roebuck Bay'.

1.2 Intertidal and mudflat communities

Mud crabs are identified within the draft plan as an economically, recreationally and culturally significant species (p. 68) with fishing identified as a major threat (p.46). If fishing pressure in Roebuck Bay continues to increase, traditional fisheries management measures for mud crabs such as temporal closures and bag limits may not be sufficient to preserve the ecological role of mud crabs through their lifecycle throughout Roebuck Bay, and to preserve the health of the fishery. The life history strategy of mud crabs is well suited to the spatial management a no-take sanctuary zone provides with limited alongshore movement (<2 km) (Le Vay et al. 2007; Bonine et al. 2008; Ewel 2008). Further, there has been evidence of recovery of mud crab abundance and an increase in size within existing no-take sanctuaries in Northern Australia (Dumas et al. 2012; Dumas et al. 2013).

In a 2005 study of marine sanctuaries in Northern Australia there were clear benefits for both mud crab fisheries and the environment in intertidal mangrove habitats similar to Roebuck Bay, even from

relatively small (<6 km²) marine sanctuary zones (Pillans et al. 2005). The study recommended networks of no-take sanctuary zones to provide both fisheries and conservation benefits for mud crabs in sub-tropical Australia.

1.3 Marine Mammals

Entanglement in gillnets is identified as a threat to marine mammals (p.56) and the continued ban on commercial gillnets in the draft plan is an important management strategy to conserve the marine mammal populations in Roebuck Bay. However, decreased access to prey resources from recreational, customary and commercial fishing is also listed as a threat (p.56). As outlined above, this threat cannot be sufficiently addressed without the inclusion of a no-take sanctuary zone given the potential for increases in fishing pressure.

The increase in fish populations within and potentially outside a marine sanctuary zone is likely to benefit larger predators such as dolphins. Studies within marine sanctuaries in coastal tropical environments have suggested an increase in population size of fish from families recorded to be included in marine mammal diets (Jennings 2000; Parra and Jedensjö 2009).

Specifically, the resident population of snubfin dolphins and many migratory species may benefit through increased food availability both within the no-take sanctuary zone potentially through spillover effects. Careful consideration of disturbance levels within and outside no-take sanctuary zones should also occur.

1.4 Water birds including migratory shorebirds

A major threat to the internationally significant populations of water birds and migratory shorebirds is identified as disturbance from humans (p.49). Whilst no-take sanctuary zones would likely reduce boat traffic from fishers in the short and long term, traffic from eco-tourism operators may occur. Shore bird and other sensitive wildlife habitat should be considered for IUCN 1a Strict nature reserves (which offer greater protection than sanctuary zoning, see www.iucn.org/pa_categories) with only permitted access. Restricted access (spatially and temporally) and permitting is recommended to minimise disturbance. Temporal closures (as suggested by the plan p. 49) are most useful if there is extensive activity and strong compliance or if the activity is only undertaken by a small professional group of stakeholders who are supportive. Dedicated messages in educational products about how to best interact with key species such as shore birds and snubfin dolphins within the marine park are also recommended.

2 Biodiversity and Ecosystem Resilience

These comments relate to strategic goal: Ensure healthy ecosystems and no loss of biodiversity in Roebuck Bay

There is overwhelming scientific evidence across diverse marine habitats and numerous locations around the world that there are strong biodiversity conservation benefits from no-take marine

sanctuaries compared to all other types of marine management (Green et al. 2014). Beyond the direct benefits to targeted species discussed above, no-take sanctuary zones have also been scientifically proven to increase the resilience of marine ecosystems to higher order impacts such as climate change (Mumby and Harborne 2010; Micheli et al. 2012; Olds et al. 2014). Without the inclusion of a no-take sanctuary zone in the proposed marine park, the marine park is less likely to achieve the strategic goal to ensure healthy ecosystems and no loss of biodiversity in Roebuck Bay.

3 Achieving a Balanced Zoning Scheme

These comments relate to Strategic goal: Achieve a sustainable balance between the many users of Roebuck Bay

A balance has not been achieved in the current plan as the entire marine park remains open to recreational fishing. This does not provide a balanced allocation of resources to other users of Roebuck Bay's biodiversity, which increasingly include people interested in photography, nature watching, scientific research and conservation. There is an increasing demand for recreational space in the coastal zone and spatial planning can be used to reduce conflicts between users who can have diametrically opposed views on permitted activities. Some recent studies have described that extractive use can often be a minor component of actual use while having a major impact on amenity (Lynch et al. 2004, Wood 2015). A no-take sanctuary zone will provide an area for the users of Roebuck Bay who wish to engage in non-extractive activities, therefore achieving a better balance for all users. AMSA WA strongly supports the inclusion of a no-take sanctuary zone within a multi-zone marine park not only for biodiversity conservation but also for a more balanced distribution of the resource across stakeholders.

4 International, National and State Conservation Objectives

These comments relate to Strategic goal: Contribute to international, national and regional conservation initiatives.

The goal to contribute to international conservation objectives cannot be achieved without the inclusion of a no-take sanctuary zone. Recent recommendations from the IUCN World Parks Congress in 2014 created a target of at least 30% of the ocean to be included within non-extractive zones:

*"Recommendation 1. Urgently increase the ocean area that is effectively and equitably managed in ecologically representative and well-connected systems of MPAs or other effective conservation measures. This network should target protection of both biodiversity and ecosystem services and should include at least 30% of each marine habitat. The ultimate aim is to create a fully sustainable ocean, **at least 30% of which has no extractive activities.**" (IUCN 2014)*

If the marine park proceeds as currently proposed it would make no contribution to this international initiative.

Nationally, the Commonwealth Government's Goals and Principles for the National Representative System of Marine Protected Areas (NRSMPA) states:

“Zoning of marine reserves will seek to ensure that the conservation objectives of the area are protected, taking into account a precautionary approach to threats as well as the relative costs and benefits (economic, social and environmental) of different zoning arrangements.” (NRSMPA)

Without the inclusion of a no-take sanctuary zone, the draft plan does not sufficiently address the need for a precautionary approach to threats (Lauck et al. 1998; Murray et al. 1999), particularly as the long-term threats to the ecological integrity of Roebuck Bay have not been sufficiently identified.

The overarching strategic objectives for WA’s marine parks and reserves is:

“Conservation - maintain and enhance biodiversity and ecological integrity”

There is extensive scientific literature regarding the role of no-take sanctuary zones in the conservation of biodiversity. There is a scientific consensus is that for marine parks and reserves to have positive conservation effects, they must have significant proportions included within no-take zones (Lester et al. 2009; Edgar et al. 2014; Emslie et al. 2015).

5 Scientific Research

The draft plan states:

“A good understanding of ecology and knowledge about the cumulative long-term impacts of human use on the values of the proposed marine park are fundamental for effective management” (p.72)

Fishing activities have been identified in the plan as a threat to many ecological values (p.46-55). A ‘no-take’ sanctuary zone is the only scientifically robust method to determine the long-term impacts of fishing through the establishment of a ‘control’ zone free from extractive activities to isolate the effects of fishing from other drivers of change. Fishing effort should also be assessed and monitored.

The plan also states that scientific research needs:

“access to representative areas free of major human influences “(p.72).

It is clear that without a sanctuary zone there will be no controls to ensure that there are areas available ‘free of major human influence’.

The draft plan outlines the need for effective long term monitoring (p.88) and states:

“The detection of human induced changes requires an understanding of what is ‘natural’ as a benchmark and this information will be progressively established through ongoing monitoring of no-take reserves, or low impact sites, and the research program”

Particularly given the predicted increase in use of Roebuck Bay, it will become increasingly difficult for the monitoring program to use ‘low impact sites’. Thus a no-take reserve provides the only option to provide an effective control to monitor ‘natural’ versus man-made changes. AMSA highlights the need of

careful and well-designed research and monitoring of marine parks to assess their effects and management (Hillborn et al. 2004, Day 2008))

Final statement

AMSA WA regards this indicative joint management plan for the proposed Yawuru Nagulagun/Roebuck Bay Marine Park as being a substantial step in the creation of a representative system of MPAs across northern Australia. In particular we strongly endorse the removal of gill netting to reduce by-catch of threatened and endangered marine mammals and the consideration of disturbance to migratory shore birds. Nevertheless, we highlight the need for no-take sanctuary zones to be included within the Marine Park, the importance of adequate representation of all habitats in sanctuary zones, the consideration of IUCN 1a Strict nature reserves for the protection of shorebird and other sensitive wildlife habitat and the reconsideration of the potential for dredging and dredge spoil dumping, and activities known to have a high level of potential impacts from underwater noise, such as seismic surveys, are not allowed to occur within the Marine Park.

We thank you for the opportunity to comment on the management of the proposed Yawuru Nagulagun/Roebuck Bay Marine Park, and trust you will take our comments into consideration when finalizing the Management Plan.

Yours sincerely,



Dr Joanna Browne

Chair, WA Branch of the Australian Marine Science Association

References

- Australian Marine Sciences Association (2012). "Position statement on marine protected areas". Available at <https://www.amsa.asn.au/amsa-position-statements> (accessed 22nd Spetember 2015)
- Bonine, K. M., Bjorkstedt, E.P., Ewel, K.C., and M. Palik. 2008. "Population characteristics of the mangrove crab *Scylla serrata* (Decapoda: Portunidae) in Kosrae , Federated States of Micronesia : Effects of harvest and implications for management." *Pacific Science* 62 (1): 1–19.
- Day, J. (2008). "The need and practice of monitoring, evaluating and adapting marine planning and management—lessons from the Great Barrier Reef." *Marine Policy* 32(5), 823-831
- Department of Fisheries (2014). State of the fisheries and aquatic resources report 2013/14. Fletcher, W.J. and Santoro, K. (eds). Department of Fisheries, Western Australia
- Dumas, P., M. Léopold, L. Frotté, and C. Peignon. 2012. "Mud Crab ecology encourages site-specific approaches to fishery management." *Journal of Sea Research* 67 (1): 1–9.
- Dumas, P., Jimenez, H., Peignon, C., Wantiez, L., and M. Adjeroud. 2013. "Small-scale habitat structure modulates the effects of no-take marine reserves for coral reef macroinvertebrates." *PLoS ONE* 8 (3): e58998.

- Edgar, G.J., Stuart-Smith, R.D., Willis, T.J., Kininmonth, S., Baker, S., Banks, S., Barrett, N.S. et al. 2014. "Global Conservation outcomes depend on marine protected areas with five key features." *Nature* 506 (7487): 216–21.
- Emslie, M. J., Logan, M., Williamson, D. H., Ayling, A. M., MacNeil, M. A., Ceccarelli, D., Cheal, A. J., Evans, R. D., Johns, K. A., Jonker, M. J., Miller, I. R., Osborne, K., Russ, G. R., & H.P. Sweatman. 2015. "Expectations and outcomes of reserve network performance following re-zoning of the Great Barrier Reef Marine Park." *Current Biology*, 1–10.
- Ewel, Katherine C. 2008. "Mangrove Crab (*Scylla serrata*) populations may sometimes be best managed locally." *Journal of Sea Research* 59 (1-2): 114–20.
- Green, A. L., Fernandes, L., Almany, G., Abesamis, R., McLeod, E., Aliño, P. M., White, A. T., Salm, R., Tanzer, J., & R.L. Pressey. 2014. "Designing marine reserves for fisheries management, biodiversity conservation, and climate change adaptation." *Coastal Management* 42 (2): 143–59.
- Guidetti, P., Milazzo, M., Bussotti, S., Molinari, A., Murenu, M., Pais, A., Spanò, N., Balzano, R., Agardy, T., Boero, F., Carrada, G., Cattaneo-Vietti, R., Cau, A., Chemello, R., Greco, S., Manganaro, A., Notarbartolo di Sciarra, G., Russo, G. F., and L. Tunesi. 2008. "Italian marine reserve effectiveness: Does enforcement matter?" *Biological Conservation* 141(3): 699-709
- Harrison, Hugo B., Williamson, David H., Evans, Richard D., Almany, Glenn R., Thorrold, Simon R., Russ, Garry R., Feldheim, Kevin A., van Herwerden, L., Planes, S., Srinivasan, M., Berumen, Michael L., & G.P. Jones. 2012. "Larval export from marine reserves and the recruitment benefit for fish and fisheries." *Current Biology* 22 (11): 1023–28.
- Horne, J. B., Momigliano, P., Welch, D. J., Newman, S. J., & L. Van Herwerden. 2011. "Limited ecological population connectivity suggests low demands on self-recruitment in a tropical inshore marine fish (*Eleutheronema tetradactylum*: Polynemidae)." *Molecular Ecology* 20 (11): 2291–2306.
- IUCN (International Union for the Conservation of Nature). 2014. "The promise of Sydney: Recommendations of the 6th IUCN World Parks Congress 2014." IUCN World Parks Congress. Sydney.
- Jennings, S. 2000. "Patterns and prediction of population recovery in marine reserves." *Reviews in Fish Biology and Fisheries* 10 (2): 209–31.
- Kramer, D.L., and M.R. Chapman. 1999. "Implications of fish home range size and relocation for marine reserve function." *Environmental Biology of Fishes* 55 (1-2): 65–79.
- Lauck, T., Clark, C.W., Mangel, M., and G.R. Munro. 1998. "Implementing the precautionary principle in fisheries management through marine reserves." *Ecological Applications* 8 (1 SUPPL.): 72–78.
- Le Vay, L., Ut, V.N. and M. Walton. 2007. "Population ecology of the mud crab *Scylla paramamosain* (*Estampador*) in an estuarine mangrove system; a mark-recapture study." *Marine Biology* 151 (3): 1127–35.
- Lester, S.E., Halpern, B.S., Grorud-Colvert, K., Lubchenco, J., Ruttenberg, B.I., Gaines, S.D., Aïramé, S., and R.R. Warner. 2009. "Biological effects within no-take marine reserves: A global synthesis." *Marine Ecology Progress Series* 384 : 33–46.
- Lynch, T.P. 2006. "Incorporation of recreational fishing effort into the design of marine protected areas." *Conservation Biology* 20: 1466-1476
- Lynch, T. P. 2014. "A decadal time-series of recreational fishing effort collected during and after implementation of a multiple use marine park shows high inter-annual but low spatial variability." *Fisheries Research* 151: 85-90
- Lynch, T.P., Melling, L., Hamilton, R., Macready, A., Wilkinson, E., and S. Feary. 2004. "Conflict and impacts of divers and anglers in a marine park." *Environmental Management* 33(2): 196-211.
- Micheli, F., Saenz-Arroyo, A., Greenley, A., Vazquez, L., Montes, J. A. E., Rossetto, M., and G.A. De Leo. 2012. Evidence that marine reserves enhance resilience to climatic impacts. *PLoS ONE* 7(7): e40832
- Moore, B. R., J. Stapley, Q. Allsop, S. J. Newman, A. Ballagh, D. J. Welch, and R. J. Lester. 2011. "Stock structure of Blue Threadfin (*Eleutheronema tetradactylum*) across Northern Australia, as indicated by parasites." *Journal of Fish Biology* 78 (3): 923–36.

- Mumby, Peter J., and Alastair R. Harborne. 2010. "Marine reserves enhance the recovery of corals on caribbean reefs." *PLoS ONE* 5 (1): 1–7.
- Murray, S.N., Ambrose, R.F. and J.A. Bohnsack. 1999. "No-take reserve networks: sustaining fishery populations and marine ecosystems." *Fisheries* 24 (11): 11–25.
- NRSMPA Goals and Principles. <http://www.environment.gov.au/resource/goals-and-principles-establishment-national-representative-system-marine-protected-areas>
- Olds, A. D., Pitt, K. A., Maxwell, P. S., Babcock, R. C., Rissik, D. and R.M. Connolly. 2014. "Marine reserves help coastal ecosystems cope with extreme weather." *Global Change Biology* 20: 3050–58.
- Palumbi, SR. 2003. "Population genetics, demographic connectivity, and the design of marine reserves." *Ecological Applications* 13 (1): S146–58.
- Parra, G.J., and M. Jedensjö. 2009. Feeding habits of australian snubfin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphins (*Sousa chinensis*). Reef and Rainforest Research Centre Ltd. Cairns.
- Pillans, S., Pillans, R.D., Johnstone, R.W., Kraft, P.G., Haywood, M.D.E., and H.P. Possingham. 2005. "Effects of marine reserve protection on the mud crab *scylla serrata* in a sex-biased fishery in subtropical Australia." *Marine Ecology Progress Series* 295: 201–13.
- Richardson, W.J., Greene, C.R., Hanna, J.S., Koski, W.R., Miller, G.W., Patenaude, N.J. and M.A. Smultea. 1995. "Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska-1991 and 1994 phases: Sound propagation and whale responses to playbacks of icebreaker noise." OCS Study MMS 95-0051.
- Snelgrove, P.V.R. 1999. "Getting to the bottom of marine biodiversity : sedimentary habitats ocean bottoms are the most widespread habitat on earth and support high biodiversity and key ecosystem services." *BioScience* 49 (2): 129–38.
- Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R., Jr., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., and Tyack, P.L. 2007. "Marine mammal noise exposure criteria: initial scientific recommendations." *Aquatic Mammals* 33: 411-521.
- Sumpton, W. D., Sawynok, B., and N. Carstens. 2004. "Localised movement of snapper (*Pagrus Auratus*, Sparidae) in a large subtropical marine embayment." *Marine and Freshwater Research* 58 (8): 923–30.
- Thrush, S.F., and P.K. Dayton. 2002. "Disturbance to marine benthic habitats by trawling and dredging: implications for marine biodiversity." *Annual Review of Ecology and Systematics* 33 (1): 449–73.
- Westera, M., Lavery, P., and G. Hyndes. 2003. "Differences in recreationally targeted fishes between protected and fished areas of a coral reef marine park." *Journal of Experimental Marine Biology and Ecology* 294 (2): 145–68.
- Wood, G.V. (2015). "Novel applications of panoramic camera systems to assess human use of coastal and marine environments." Honours thesis, University of Sydney.