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Recent developments

Identifying biologically and physically special or unique sites for inclusion in the protected area design for the Great Barrier Reef Marine Park

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ABSTRACT

A method to identify special and/or unique sites was developed when reviewing the zoning of the Great Barrier Reef Marine Park. Fifty-three (totalling approximately 10,445 km^2) of 408 sites were identified as special or unique based on the amount, detail and nature of justification; geographic explicitness; type of information sources; number of independent sources; and national or international obligations. All but four special or unique sites increased in protection after the Zoning Plan was revised, increasing the area of no-take protection for all special or unique sites from 1614 km^2 (15.4%) to 4013 km^2 (38.4%).

1. Introduction

The Great Barrier Reef is widely acclaimed as one of the world's great natural treasures. Established under the *Great Barrier Reef Marine Park Act 1975*, the 344,400 km^2 Great Barrier Reef Marine Park (GBRMP) supports one of the most complex and biologically diverse ecosystems on earth. The GBRMP comprises over 99% of the Great Barrier Reef World Heritage Area (GBRWHA), which was inscribed on the World Heritage List in 1981 on the basis of its outstanding natural value and its ecological integrity [1]. The Great Barrier Reef ecosystem extends beyond even the boundary of the GBRWHA and is managed jointly by the Commonwealth and Queensland State governments through, amongst other mechanisms, complementary zoning.

The GBRWHA is the world's largest and is one of only a few World Heritage Areas that satisfy all four natural World Heritage criteria. However even within those values listed as important to the World Heritage Area [2,3] there are some particularly special and/or unique attributes of the GBRWHA that warranted specific attention as part of the Representative Areas Program (RAP) for the GBRMP.

In 1999, a review of the comprehensiveness, adequacy and representativeness of the existing network of highly protected areas within the GBRMP highlighted shortcomings in biodiversity protection. Scientists and managers' understanding of marine ecosystems and of the habitat requirements and life histories of the component species had increased significantly since 1980s and as such, they were able to make more informed decisions about a comprehensive and adequate network of representative no-take marine reserves, known in the GBRMP as no-take zones. Day et al. [4] and Fernandes et al. [5] provide more details on the RAP through which a complete revision of zoning of the GBRMP was conducted.

To allow both for protection and ecologically sustainable use, the GBRMP is separated into different zones that offer increasing levels of protection by restricting the types of activities that can occur within each zone (Fig. 1). For the purposes of this paper, no-take or highly protected zones equate to both Marine National Park (MNPZ) and Preservation Zones (PZ). A review of zoning in the GBRMP requires 5 main steps: (1) the public notice of intent to revise the zoning and an invitation for submissions, (2) development of a draft Zoning Plan, (3) release of the draft Zoning Plan for public comment, (4) revision of the Zoning Plan based upon those comments and then (5) presentation of the revised Zoning Plan to both houses of federal parliament for consideration. A similar process, albeit with only one round of public comment, is required to alter adjacent GBRWHA waters under State jurisdiction. Once any new Zoning Plan has passed through parliament it becomes law and replaces the "old" zoning plan or plans. For more detailed information about the Zoning Plan, zoning process, zone objectives and types of permitted activities see the Great Barrier Reef Marine Park Zoning Plan and Zoning Report [6,7].

One of the objectives for the rezoning for the GBRMP was to develop a comprehensive, adequate and representative network of no-take zones. One way to maximise the comprehensiveness and adequacy of the new network was to also consider special or unique

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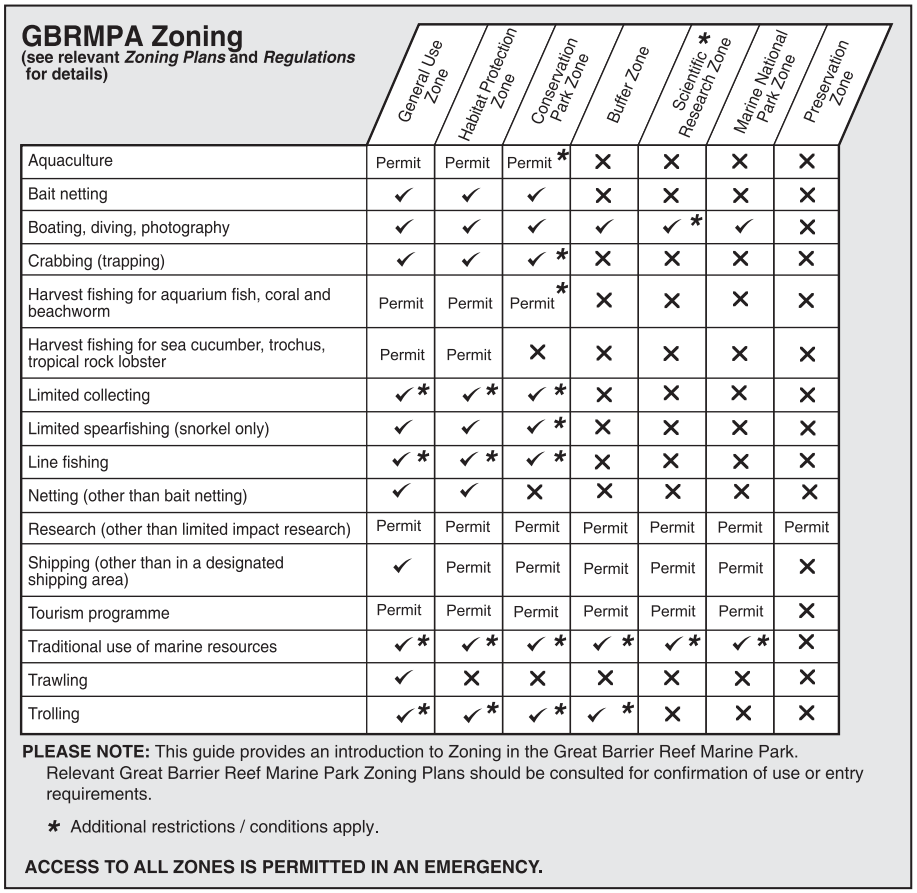

GBRMPA Zoning
(see relevant *Zoning Plans* and *Regulations* for details)

	General Use Zone	Habitat Protection Zone	Conservation Park Zone	Buffer Zone	Scientific * Research Zone	Marine National Park Zone	Preservation Zone
Aquaculture	Permit	Permit	Permit *	✗	✗	✗	✗
Bait netting	✓	✓	✓	✗	✗	✗	✗
Boating, diving, photography	✓	✓	✓	✓	✓ *	✓	✗
Crabbing (trapping)	✓	✓	✓ *	✗	✗	✗	✗
Harvest fishing for aquarium fish, coral and beachworm	Permit	Permit	Permit *	✗	✗	✗	✗
Harvest fishing for sea cucumber, trochus, tropical rock lobster	Permit	Permit	✗	✗	✗	✗	✗
Limited collecting	✓ *	✓ *	✓ *	✗	✗	✗	✗
Limited spearfishing (snorkel only)	✓	✓	✓ *	✗	✗	✗	✗
Line fishing	✓ *	✓ *	✓ *	✗	✗	✗	✗
Netting (other than bait netting)	✓	✓	✗	✗	✗	✗	✗
Research (other than limited impact research)	Permit	Permit	Permit	Permit	Permit	Permit	Permit
Shipping (other than in a designated shipping area)	✓	Permit	Permit	Permit	Permit	Permit	✗
Tourism programme	Permit	Permit	Permit	Permit	Permit	Permit	✗
Traditional use of marine resources	✓ *	✓ *	✓ *	✓ *	✓ *	✓ *	✗
Trawling	✓	✗	✗	✗	✗	✗	✗
Trolling	✓ *	✓ *	✓ *	✓ *	✗	✗	✗

PLEASE NOTE: This guide provides an introduction to Zoning in the Great Barrier Reef Marine Park. Relevant Great Barrier Reef Marine Park Zoning Plans should be consulted for confirmation of use or entry requirements.

* Additional restrictions / conditions apply.

ACCESS TO ALL ZONES IS PERMITTED IN AN EMERGENCY.

Fig. 1. Activity matrix for the Great Barrier Reef Marine Park Zoning Plan 2003.

biological and/or physical habitats or sites when developing the final zoning network. Special sites were those considered particularly important for any biophysical reason to do with any particular species, habitat or ecological process. Unique sites were those considered very rare. Some sites may, of course, be both. The process used to identify such special or unique sites for the RAP is described below and the resulting level of protection offered to special or unique sites is presented. The approach taken, and criteria developed, may be informative to other efforts to develop comprehensive networks of marine protected areas.

2. Methods

An independent Scientific Steering Committee (SSC) recommended eleven biophysical operational principles (see [5] for a description of these principles) to help guide the establishment of a new network of no-take areas. Another independent committee recommended four additional principles (social, economic, cultural, management) and collectively both sets of principles helped to achieve the objectives of the RAP.

One of the eleven biophysical principles recommended by the SSC was to include biophysically special or unique places. The Committee's rationale was that these places might not otherwise be included in the network but would help ensure the network is comprehensive and adequate to protect biodiversity and the known special or unique areas in the GBRMP. They initially recommended the zoning should aim to capture as many biophysically special or unique places as possible (refer to the 'Approach to zoning decisions' section below for further discussion).

The GBRMP starts at the mean low water mark along the Queensland coast and extends seaward. The GBRMP does not include the majority of the 900 or so islands that occur within the outer boundaries of the GBRMP nor their surrounding tidal lands or tidal waters (however some 70 Commonwealth islands are part of the GBRMP). Similarly, some bays, inlets and channels are regarded as State waters (e.g., internal waters of Queensland) and consequently are not part of the GBRMP. Scientists, users and other experts did not consider these jurisdictional boundaries as relevant to their definition of special or unique areas. Hence, some of the special or unique sites identified through the process described below could not be zoned as part of the RAP because they were outside the GBRMP boundaries; however, these data were then available for future use in planning for adjacent waters, islands and land. For planning purposes, and from an ecological point of view, when islands or cays were mentioned as special or unique sites, the GBRMPA included the 500 m around the associated reef flat as the boundary of the identified site.

Developing a list of special or unique sites comprised three main steps. The first step was to identify potential special or unique sites. Three methods were used:

1. A questionnaire had been developed as part of the overall collation of biophysical data and was used in interviews with 82 scientists and experts from private industry, academia, research and management institutions. The questionnaire aimed to gather biophysical data and advice on patterns of species distribution and environmental driving forces. While it did not specifically ask questions about special and unique sites, many experts provided relevant information. Those

interviewed were selected for their expertise in specialised fields, comprehensive general knowledge of the GBR ecosystem, and/or experience in establishing protected areas in either terrestrial or marine environments [8].

2. Two panels of experts were formed by GBRMPA to produce a comprehensive bioregionalisation of the Great Barrier Reef as an important part of the RAP. Separate workshops on the reef and non-reef environs were convened, followed by a plenary session. The aim was to bring together a group of experts that maximised collective experience and diversity of disciplines. The Reef Panel drew upon over 120 combined years of knowledge and research in the Great Barrier Reef and similar habitats, while the Non-reef Panel drew upon over 100 combined years. Specific guidelines were developed to ensure that the two workshops (Reef and Non-reef) followed a similar process, and produced outputs that, as far as possible, were justifiable and of high scientific integrity [8]. One of the pieces of information sought from these experts was sites that were potentially special or unique.
3. A pre-existing list of people who had expressed interest in past zoning processes for the GBRMP were invited to attend Marine Park user workshops from October 2000 to February 2001. Over 300 people attended, representing a range of peak bodies and interest groups including recreational and commercial fishing, tourism, and other groups including the ten Local Marine Advisory Committees affiliated with the GBRMPA. One of the objectives of these workshops was to identify areas of special or unique interest.

All sites identified from the above three methods were entered into an Access database in which data were centralised and from which queries were made. Some information from both scientists and users was classified as 'confidential'. The source and justification for the information was listed in a separate field and could be 'hidden' if necessary. The exact geographical location of all sites was digitised for use in the analytical and reporting phases of the RAP.

Some of the sites identified by various scientists as well as by user groups were the same. Where possible, these were amalgamated so that each specific site was listed once. This amalgamation worked well for discrete reefs (e.g. Myrmidon Reef) or particular bays (e.g. Upstart Bay). However, amalgamation of larger reef and non-reef areas (e.g. a site described as 'all mid- and offshore reefs from Hinchinbrook to Townsville') with smaller, more discrete locations was not attempted.

The second step was to assess each potential special or unique site. The following criteria were developed considering the advice provided by the SSC and the Reef and Non-reef Panel experts:

i. **Justification** – What was the amount, nature and detail of information that supported the labelling of the site as special or unique. How clear, abundant and convincing were the descriptions and the information supplied to justify the site as special or unique? Justifications may have included, but were not limited to, whether the site supported a rare, vulnerable or unusual habitat or an area used by rare or threatened species; it could be to do with a particular life stage of key species, or to do with physically or biologically outstanding attributes, e.g., high species diversity of any particular group of plants or animals or a unique geomorphological feature.
ii. **Geographic explicitness** – How well-defined and justified were the boundaries of the site? This criterion was important, because without well-defined and justified boundaries there was little scope for incorporating the information into the process of identifying prospective candidate areas for enhanced protection [9] or for assessing the success of any network of candidate areas in protecting special or unique sites (termed post-hoc accounting in the RAP [5]).
iii. **References** – References were examined to determine the reliability of the information provided. It is possible to have a detailed, substantive and convincing justification for a site (see Justification criteria above) that is based upon no reliable references or verifiable sources. This "reference" criteria helped ensure the reliability of the information provided. Were, for example, peer-reviewed scientific publications, grey literature, attributable or anonymous communications used to justify the site as a special or unique area? How well did the information collected, as part of identifying special or unique sites in the RAP, complement data that already existed on biophysical characteristics and use patterns within the GBRMP? Additional information to substantiate sites identified by the scientists and users included:

- A bibliographic reference library database of over 1200 references developed for the RAP of relevant literature including reports, publications, scientific journal papers;
- The basis for zoning information developed in 1980s as part of the zoning processes for the GBRMP;
- The Island and Reef dataset based on the Australian Littoral Society database; and
- Discussions with scientists and other experts.

iv. **GBRMPA's obligations** – Did the species or habitats associated with the site relate to obligations at an international level (e.g. World Heritage Convention, Convention for the Conservation of Migratory Species of Wild Animals), national level (e.g. species protected under the *Environment Protection and Biodiversity Conservation Act, 1999*) or local level (e.g. species protected under Queensland's *Nature Conservation Act, 1992*) (refer [10]).
v. **Number of independent sources** – This was not a numbers game but allowed for cross-referencing and triangulation of information. The same information coming from multiple unrelated sources increased the likelihood that the information was accurate for the purposes of input to the RAP.

The overriding motivation with respect to selecting a site to be considered special or unique was that it needed to be defensible to stakeholders, scientists and the community as well as within the GBRMPA.

The last step was to assess each site against each of the above-mentioned criteria along an ordinal scale: each site was assessed as having met each of the criteria to a high, medium or low level. In this way, all identified sites were prioritised as part of the planning process for the RAP. These sites were then categorised into one of three priority levels: special or unique, medium or low:

Special or unique: These sites achieved each of the criteria to a high level, were clearly defensible and had attributes that were special or unique relative to other locations in the GBRWHA.

Medium: These sites were lacking in references or substantiating material and had limited justification/descriptions provided by either the scientists and/or the stakeholders. In the future, if further information becomes available to corroborate the claims then it is possible that these sites could be re-prioritised as special or unique.

Low: These sites were those where at least one of the criteria were judged to have been relatively poorly achieved. They had little justification and/or poor geographic detail, few to no corroborating references or statements, or were described as just being 'representative' of a particular habitat type (hence, not special or unique).

To help explain the meaning of the criteria and their application we offer two sample sites: see Boxes labelled Site 1 and Site 2. Detailed information such as this is available on each of the special and/or unique sites in GBRMPA (in press) [11].

Once the list of special or unique sites was finalised, a dedicated spatial dataset of these sites was built and stored in an ArcInfo Coverage. These data were then used to inform and influence the design of the final network of protected areas within the GBRMP.

2.1. Approach to zoning decisions

After special or unique sites were identified, the SSC [5] initially recommended that as many as possible of the special or unique sites be captured in the final network of no-take areas. The Committee was asked to revise this recommendation due to the variety of features that comprised the special or unique sites and the recognition that zone types other than no-take zones could still provide adequate levels of protection in some situations. The most appropriate kind of zoning protection might vary depending upon the impacts likely to affect the site's biophysical attributes. For example, if the site was special because of dugong, then prohibiting large mesh netting would significantly improve protection of the attribute (dugong) that makes the site special; highly protected zoning was not essential to protect the main values of this site. The SSC therefore recommended that the GBRMPA should judge which zoning protection best matched each special or unique site. Therefore, classifying a site as special or unique did not automatically mean it required zoning in a no-take (or highly protected) area.

Site 1. All waters from Clump Point south to Upstart Bay

Coastal: All coastal waters from Clump Point south to Upstart Bay

Justification – Low level of achievement
Inshore breeding area for many fish species
Geographic explicitness – Low level of achievement
- External boundaries not identified. Represents an unknown area of km^2
- Some portions of this area were likely to be covered already as part of incorporating a minimum of each bioregion within the network of highly protected areas.

References – Low level of achievement
None because of a lack of geographic explicitness and of any justification to highlight the particular species or habitats of significance
GBRMPA obligations – Low level of achievement
Lack of detailed information made it difficult to ascertain distinct responsibilities that were not already covered by marine park legislation
No. of independent sources of information – (1 source), Low level of achievement
1 source
Priority: Low

Site 2. Shoalwater Bay

Site: Shoalwater Bay

Justification – High level of achievement
- Largest population of dugongs along the urban GBR coast
- Largest population of green turtle from southern GBR stock within WHA
- Wetlands of international and national significance
- Major migratory shorebird roost sites.
- Largest pelican nesting site in GBRWHA
- Is important and unique in terms of algae: 10 taxa are present that are not recorded elsewhere; corals are similarly important and unique.
- Rich and productive seagrasses, some unusual seagrass morphologies and possibly new species.
- High planktonic productivity, reasonable correlation between water column nutrients and occurrence of significant densities of epibenthos.
- Major undeveloped estuarine and high-energy beaches/coast, protected catchment, mangroves, cultural sites.
- Relatively pristine catchment, good mangrove system.

Geographic explicitness – High level of achievement
Discrete bay so that it is possible to delineate a boundary across the mouth of the bay.
References – Medium-high level of achievement
Marsh et al., 1992, 1996, 2001
Coles (pers. comm.) – seagrass
Shoalwater Bay Inquiry
GBRMPA obligations – High level of achievement
International: WHA, RAMSAR, CMS, CBD; JAMBA; CAMBA
Threatened species (EPBC Act, NCA Act)
Listed migratory species (EPBC Act)
No. of independent sources of information – (sources = 15) High level of achievement
15 sources
Priority: Species or unique

3. Results

Through the bioregionalisation process, user workshops and scientist surveys, 408 sites within the GBRWHA were initially identified as having potential to be special or unique. The survey of scientists and scientist workshops identified 85 sites. Via their input to the bioregionalisation and in workshops, users identified 287 sites. In addition, 36 sites were identified by both the scientists and Marine Park users.

Of the 408 potential sites initially identified, 53 (13%) were selected as meeting the aforementioned criteria to be considered as special or unique. They spanned the length of the GBRMP (Table 1, Fig. 2).

The types of justifications provided for the sites identified as special or unique ranged from threatened species to geomorphologic formations that are rare within the GBRWHA.

Sixteen special or unique sites comprised just reefs, 11 comprised just non-reef seabed areas and 26 sites were a combination of reef, non-reef and/or islands.

Of the 53 sites identified as special or unique, two are outside the GBRMP and hence were not subject to zoning decisions within the GBRMP. Some parts of the special or unique sites outside the Marine Park have previously had been afforded protection as National Parks by the Queensland Government (e.g. Hinchinbrook Island, Peak Island, Flinders Group of islands and Orpheus Island), hence GBRMP zoning adjacent to these sites helped ensure a complementary approach to protecting the values of those

Table 1
Distribution of and priority assigned to sites identified by the scientists and stakeholders.

Marine Park Management Area	Special or unique (High)	Medium	Low	Total
Far Northern	14	3	60	77
Cairns	4	2	88	94
Townsville/Whitsunday	10	7	87	104
Combination of Townsville/Whitsunday & Mackay/Capricorn[a]	0	0	1	1
Mackay/Capricorn	25	13	90	128
All Management Areas[a]	0	0	4	4
Total	53	25	330	408

[a] Where the sites span more than one management area, this means they are quite large in extent. In particular, the proposed special or unique sites spanning all Management Areas refer to suggestions that the entire GBRMP was special and unique.

locations. Results presented below refer only to those parts of the 51 special or unique sites that are within the GBRMP (Table 1). They cover 10,481 km^2.

In total, the area of no-take protection of all the 51 special unique sites in the GBRMP increased from 1614 km^2 (15.4%) to 4013 km^2 (38.4%) at the conclusion of the RAP (Table 2).

Twenty-two (43% of 51 sites) of the special or unique sites were already zoned as no-take or highly protected. The large majority of these sites had been previously zoned as no-take because of seabird or marine turtle nesting significance or importance as dugong foraging habitat. Of these 22 sites, the protection level for five sites (totalling 1.85 km^2) increased to the highest level of zoning, i.e., Preservation Zone (in effect a no-entry zone set aside as a scientific baseline).

Of the remaining 29 sites, 25 increased in overall protection with regard to no-take zoning. Three of the 25 sites already had well over 50% of their area highly protected and this was further improved. Another twelve of the 25 sites changed to having at least 20% of their area highly protected (and one additional site went from 0% to 19.1% as a no-take zone); five of these twelve went to 100% no-take zoning. Lizard Island, the Palm Island Group and Heron Island Reef received improved protection through significant increases in Scientific Research zoning. These sites host scientific research stations and, historically, access for scientists to the adjacent areas was an important consideration when reviewing the zoning pre and post the RAP.

The four special or unique sites for which no-take area protection did not increase were: Avoid Island, northern Repulse Bay, the area around the Howick Group of islands and Masthead Island Reef. The reasons for this are outlined in the Discussion.

In sum, 92% (47/51) of the special or unique sites gained increased zoning protection through the RAP or were already totally within no-take zones. Furthermore there was a 150% increase in the areal extent of special or unique sites protected in no-take zones.

4. Discussion

The status of the Great Barrier Reef as a World Heritage Area means the entire area is internationally regarded as being of 'outstanding universal value'[2] and hence 'special' [2]. Clearly within such a huge area,[3] there are some locations or sites that are more significant than others; furthermore, from most biological and physical perspectives, the entire area is not homogenous. Similarly human use of the area is not spread evenly across the entire area, and some areas are more threatened than others. Management of the GBRMP therefore does not regard the entire area as homogenous, and when zoning decisions had to be made, there was a need to balance human uses against conservation.

GBRMP managers and the SSC for the rezoning concurred with Lucas et al. [2] that there were some specific attributes or sites within the broader ecosystem that makes up the Great Barrier Reef World Heritage Area that were particularly significant. It was these sites that the SSC considered required specific consideration in zoning decisions like during the RAP.

The special or unique sites identified for the RAP reflect the information that was known at the time (2000–2001) and were identified through surveys and workshops. This information drew upon hundreds of years of knowledge, experience and previous research. The GBRMPA chose to gather information on biophysically special or unique sites from the scientists and users to augment GBRMPA staff perspectives. This helped enhance the breadth of information collected, enhanced communications about and interest and ownership in the RAP and minimised any potential bias in sites identified. Further sites throughout the GBRWHA are likely to be identified as more and better information becomes available.

The fact that 43% of the special or unique sites had been previously identified and included within no-take zones is testament to two things: the previous basis for zoning decisions remained valid and the process presented here to select those special or unique sites has been cross-validated. That the remaining 57% of sites were not already better protected indicates the level of protection that was considered appropriate when zoning was first undertaken, and the recognition that greater protection was warranted when the zoning plan was reviewed. In the same manner that the SSC advised that the previous zoning was inadequate overall, hence the implementation of the RAP, the previous zoning was also considered to be inadequate in protecting the entire suite of special or unique sites [5].

This work identified more reef than non-reef special and unique sites. This result supports previous assessments that there was more information available about individual reefs than there was for non-reef sites. This reflects the past priority placed on studying reefs as opposed to non-reef areas. That more quantitative information is needed on soft sediment communities in coastal, tropical areas in the Southern Hemisphere has been identified as a broader problem [12]. With regard to the Great Barrier Reef ecosystem, Kerrigan et al. [8] stated, "*Despite over 30 years of underwater research on reefs, limited empirical data is available on biota … within the pelagic habitat, continental slope and abyssal plain… (and) on inter-reefal fauna (infauna and epifauna) and flora*". Beeton et al. [13] also identified that, beyond reefs and seagrasses, there were significant data gaps for the Great Barrier Reef and Australia's marine environment more generally.

Application of the precautionary principle allows management decisions to be made despite such imperfect information [14]. It is in this environment of limited data, combined with a requirement to implement the best possible management regime, that the criteria used for prioritising the identified sites as special or unique were developed. The criteria used to assess the attributes of special or unique sites also provided the justification for the final list of sites.

Much has been published about how to select ecologically or biophysically significant areas for marine conservation planning. Green et al. [15] describes special and unique sites as including areas resistant or resilient to coral bleaching, fish aggregation sites,

[2] An important basis for World Heritage is the notion that properties are assessed and inscribed in total, not in part; hence the application of the term 'outstanding universal value' to the entire World Heritage property.

[3] The largest World Heritage Area on earth, the GBRWHA covers an area bigger than the United Kingdom, Holland and Switzerland combined.

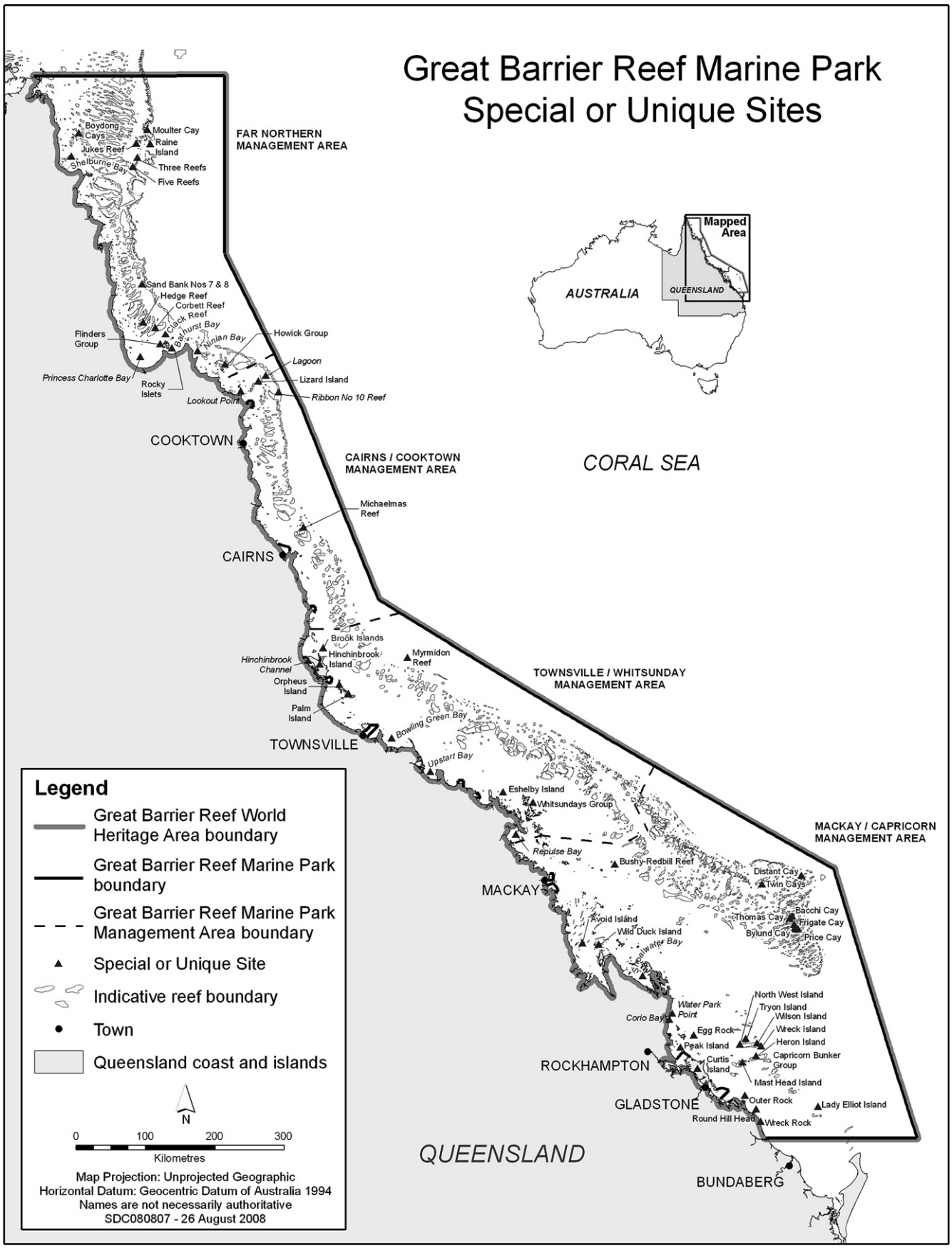

Fig. 2. Special or unique sites in the Great Barrier Reef World Heritage Area identified for the Representative Areas Program.

Table 2
Comparison of zoning for special or unique sites within the Great Barrier Reef Marine Park before and after the Representative Areas Program.

Zoning	Pre-Representative Areas Program		Post-Representative Areas Program	
	Percentage	Area (km^2)	Percentage	Area (km^2)
Unzoned	1.93	201.9	0	0
General Use	28.4	2967.3	16.7	1742.1
Habitat Protection	42.3	4414.6	26.2	2736.8
Conservation Park	11.6	1211.4	17.0	1778.4
Buffer	0.06	6.2	0.02	2.6
Scientific Research	0.3	29.8	1.0	100.8
Marine National Park	13.9	1455.7	36.9	3856.2
Preservation	1.5	158.1	1.5	156.4

turtle nesting areas, cetacean habitats, highly diverse areas (for either species or habitat), areas supporting species with limited distribution and abundance and habitats for vulnerable species. Australia's Department of the Environment, Water, Heritage and the Arts has defined key ecological features as species, groups of species or a community with a regionally important ecological role or that is regionally or nationally important for biodiversity, habitats or areas nationally or regionally important for productivity, aggregations of marine life, biodiversity or endemism and also regionally unique seafloor features (http://www.environment.gov.au/coasts/mbp/south-west/ecology.html; accessed 14/5/08) Breeze [16] consider criteria for identifying ecologically and biologically significant areas as including uniqueness, level of use of area for aggregations, and degree to which sites contribute to the fitness of a population resilience and naturalness. Roberts et al. [17] presented a list of criteria for selection of marine reserves that, arguably, addresses protection of special or unique sites through inclusion of species of special interest, vulnerable habitats and life stages; these were applied by Airame et al. [18]. Annex V to the Protocol on Environment Protection to the Antarctic Treaty 2002 refers to protecting, *inter alia*, sites with important or unusual assemblages of species, type localities and only known habitats of species or sites with outstanding geological or wilderness features (see http://cep.ats.aq/cep/apa/aspa/index.html). Kelleher [19] identifies as special or unique, sites of rare biogeographic qualities, unique or unusual geology and habitat for rare or endangered species. The approaches have similarities with that taken here, although most are tailored to meet local situations and that type of flexibility is important because each ecosystem is different.

Considering the work discussed above, the approach applied here is different in three ways:

1. The process whereby potential special or unique sites were identified was as open and inclusive as possible. Through ten Local Marine Advisory Committees comprising community members who use the GBRMP, through surveys and workshops, hundreds of interested parties were offered opportunities to suggest areas that should be labelled as special or unique.
2. Unlike others, the GBRMPA did not prescribe a list of biophysical features that would be considered acceptable to be labelled special or unique. Implicitly, there was no list of biophysical features that were inherently unacceptable as special or unique. Each case was made on its own merits against the criteria.
3. Many of the criteria used to assess the status of a site were to do with the certainty, detail, and reliability of the justifications put forward, and the legal and policy management obligations that might pertain to the site, given the GBRMPA's mandate through specific legislation (i.e. the *Great Barrier Reef Marine Park Act, 1975*). In other work, these criteria are rarely discussed. The certainty, detail and reliability of the sites identified is either clearly justified from primary data sources, acknowledged as limited or presumed to be adequate. Criteria to help transparent, systematic but still qualitative assessments of proposed sites as special or unique were not developed. For managers with policy and legal obligations to progress management, limited secondary data, information acquired outside scientific sampling designs and decisions to make such criteria can be very important. Consequently, this third difference was almost certainly due to the fact that the criteria were developed and applied by 'on-the-ground' managers working to implement new legislation to protect these sites within a broader program to improve zoning protection of a marine park. The criteria developed helped to ensure defensible recommendations (and, finally, outcomes) towards the development of a new Zoning Plan to protect the GBRMP. This statutory framework (that is, the new Zoning Plan for the GBRMP and the associated Regulations) came under significant scrutiny and needed to have a solid foundation to ensure they passed through the Australian Parliament.

The dataset of special or unique sites allowed a comprehensive analysis of the level and kind of zoning protection proposed to special or unique sites before any zone options were canvassed. In this way, special or unique sites were able to help assess the relative value of alternative networks of candidate no-take areas (refer to [4,9,20] for a description of these processes). Sites finally chosen for enhanced protection were not necessarily included because of the presence of special or unique features. Rather, this was one of eleven biophysical principles that helped guide the final zoning network, and ensured the final network was comprehensive in protecting the range of biodiversity.

It is common to find a level of redundancy within any one set of biophysical criteria or principles used to guide selection of areas for protection e.g. [21]. There is explicit overlap in the case of, for example, the use of umbrella or indicator species as one of a set of principles to ensure protection of habitats and other species in the community [22–24] or in the case of using hotspots (sites of importance to the greatest number of species) [25] as one of the principles, it may overlap with principles to do with rare or threatened species. While this kind of redundancy is obvious, in the case of the Great Barrier Reef, it was more implicit and (predictably) co-incidental. By this we mean that implementing one principle often co-incidentally contributed to implementation of another principle. Some special or unique sites overlapped with sites important for implementation of other Biophysical Operational Principles, for example, the need to consider habitats significant for marine turtles or dugongs [5,26,27]. A case in point, Bowling Green Bay (see Fig. 2) was identified as incorporating habitat significant for foraging dugongs and for the southern Great Barrier Reef genetic stock of green turtles, in part, due to the seagrass beds there. Implementing the Biophysical Operational Principles that aimed to protect examples of every type of habitat (e.g. bioregion) as well as those that aimed to protect special or unique features, ensured that the particular seagrass habitats important for both dugongs and green turtles were incorporated into the new zoning network. In this way, 27% of those seagrass habitats were zoned in no-take areas and a further 22% of the area had an increase in protection (i.e., within a limited fishing zone).

Overlap between guiding principles for protected area selection is not considered to be problematic. In practice, such redundancy ensures that all the available information and all the relevant features of importance for protection of an ecosystem have a greater opportunity to be offered the desired level of protection.

This is useful when working in a human (management) environment where people may make mistakes, for example, in the sufficiency of their data collation, interpretation, assessment, presentation or application of data to reporting procedures or when data along any one dimension are limited.

Despite the values of some of the special or unique sites, improvements in protection needed to be balanced, as far as possible, with minimising impacts on other users of the GBRMP. Matching human uses and values with zoning placement was guided by the social-economic–cultural-management operational principles [5]. The two sets of principles (biophysical and social-economic-cultural-management) worked in concert. The following example illustrates the kinds of outcomes achieved by balancing protection with use:

> 91.2% of the coastal waters from Round Head to Wreck Rock (see in Fig. 2) in an area of the southern GBRMP were previously zoned General Use and 8.8% was unzoned. Post the RAP nearly 75% of these waters was zoned as no-take. However, in recognition of the adjacent coastal beach uses, 10% of waters were zoned for limited fishing and collecting and the remainder (15%) was zoned General Use to continue to allow a broad range of activities including trawling, large mesh netting and shipping.

The four sites that did not increase in no-take areas are examples of the need to attain adequate levels of biodiversity protection while minimising social and economic impacts of the management regime both in specific areas and overall.

- Around Avoid Island (see Fig. 2) commercial large mesh netting was important for a small but socio-economically vulnerable group of fishers. Nearby other islands, associated reefs and non-reef habitats were in the same reef and non-reef bioregion as Avoid Island (including two special or unique sites) and were totally protected in a large, new no-take zone of 2089 km^2; this was the compromise zoning decided upon for this area.
- Northern Repulse Bay (Fig. 2) was identified as being important for a small, vulnerable group of low income, low mobility commercial fishers and so the existing zoning for the area was maintained for socio-economic reasons.
- The Howick Group (Fig. 2) was already protected within Conservation Park zoning that prohibits trawling and large mesh netting but allows limited fishing and collecting. The values identified for the Howick area (big algal garden beds, large areas of deep-water corals, highly important areas for a range of taxa and habitats including solitary corals, significant hawksbill turtle foraging area) were considered already adequately protected with the existing zoning.
- Prior to the RAP, Masthead Island Reef (Fig. 2) had a small no-take zone comprising 12% of the area with the remaining 88% available to all kinds of fishing except trawling. This split-zoning approach around the quite small island of Masthead was not easily recognised nor understood and hence was difficult to enforce; implementing a single type of zoning for the whole reef was considered more effective. After the rezoning, the entire area was protected in a limited fishing zone that excluded trawling (Conservation Park Zone). Additionally, Masthead Island is biophysically similar to the rest of the Capricorn-Bunker Group of reefs and islands, which overall, ended up with an increase in highly protected areas from 4% to 39%. While the amount of no-take area at Masthead Island decreased, the enforceability of the final zoning arrangement will mean improved protection of the site in the long term.

Future identification of biophysically special or unique sites should concentrate on the currently lesser-known and lower profile species (e.g. marine plants, marine invertebrates and marine fish) and habitats (e.g. soft seabed habitats where there is limited knowledge of communities other than seagrasses). Most special or unique mega-fauna assemblages (dugong and marine turtle foraging habitats, marine turtle and seabird nesting sites) have already been identified with the possible exception of critical habitat for inshore dolphins; some recent work has started to elucidate the habitat requirements of some of the inshore dolphin species (e.g. Australian snubfin [28–30]). Yet to be determined are the biophysically special or unique sites of less commonly seen marine mammals (e.g. Bryde's whales), marine fish, marine invertebrates, and marine plant species. The Overview of the Conservation Status of Australian Marine Macroalgae [31] has begun the identification process for some marine plant species in certain locations, whilst the Overview of the Conservation of Australian Marine Invertebrates [32] noted that the state of knowledge of many marine invertebrates, apart from those that were commercially fished, was lacking. Of the three overviews, the Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes [33] which details conservation status for 114 species of Australian marine and estuarine fishes, contained the most detail for various species. This is likely a result of the species involved being of commercial significance and hence more widely studied. A synthesis of the information from these three overviews relevant to the GBRMP can be found in Stokes et al. [10].

New information is constantly being published that indicates there may be important sites for other species assemblages. This information should be collated in such a way as to be retrievable for future planning processes with less reliance upon expert individuals to ensure that the information is considered. As more species and communities with commensurate interactions and processes are identified and their relationship with the overall functioning of the Great Barrier Reef ecosystem is understood, the number of special or unique sites is expected to increase. A method of future identification of special or unique sites, suggested by Roff and Evans [34] is to develop a better understanding of the interrelationships between distinctive habitats (which they describe as having 'anomalous physical structures and unique oceanographic processes occurring within them') and representative habitats. Roff and Evans [34] identify a range of benefits for taking such an approach, which still has a focus on species conservation, but broadening the focus beyond the species itself to include how the wider ecosystem drivers influence particular species.

For the GBRMPA, future identification exercises of special or unique sites also should ensure the cultural relationships between people and their natural resources be included as part of the assessment. Attempts were made to collect such information in a comprehensive manner, especially Indigenous cultural values, but at the time of compiling this list of special or unique sites (October 2000–February 2001), there was little available information that could be readily incorporated into the process described here. The future development of sea country management arrangements and databases of cultural information should assist with the identification of Indigenous cultural sites and also how that information can or should be incorporated into management.

From the perspective of an ecosystem-based approach to management, it is also important to note that ensuring the future protection of an ecosystem, as a whole, including its entirety of values, species and processes, requires far more than protection of just its special or unique sites. In the case of the GBRMP, this criteria in the RAP was one of 11 biophysical operational principles that collectively helped guide the planning that led to the new zoning network comprising a range of zone types, including no-take zones.

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