



Australian Government

Great Barrier Reef
Marine Park Authority

**Marine turtle and dugong habitats
in the Great Barrier Reef
Marine Park used to
implement biophysical operational
principles for the
Representative Areas Program**

Compiled by
Kirstin Dobbs

our great barrier reef
let's keep it great



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Compiled by
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Marine Park Authority**

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EXECUTIVE SUMMARY

Marine turtle and dugong habitats were taken into consideration when reviewing the zoning of the Great Barrier Reef Marine Park as part of the Representative Areas Program. Guiding principles were developed to assist with incorporating marine turtle interesting and foraging habitats and dugong habitats into the overall network of no-take areas.

The biophysical operating principle pertaining to marine turtles recommended the incorporation of known major turtle nesting and foraging sites into no-take areas (100 per cent of about 30 sites of the 115 identified). For the marine turtle interesting habitat adjacent to the major nesting sites, the principle was refined as follows:

- Very high priority nesting beaches for each genetic stock should include a 5 km radius in no-take zones
- High priority nesting beaches for each genetic stock should include a 5 km radius and be included in no-take areas whenever possible
- Medium priority nesting beaches for each genetic stock including a 5 km radius should be used as a parameter during reporting on how well the biophysical operational principles were achieved (refer to Lewis et al. 2003 for a description of this process).

For marine turtle foraging habitats, the principle was refined to include 20 per cent of the different turtle foraging sites incorporated into no-take zones and to include inshore coastal strips of turtle foraging habitat with a 12-kilometre buffer and reefal areas of turtle foraging habitat with a 1 kilometre buffer.

In the current Zoning Plan, marine turtle interesting habitat increased in no-take areas from 781km² to 1 886km² (23.4 per cent to 56.5 per cent of all identified sites); marine turtle foraging habitat increased in no-take area protection from 3 063km² to 12 489.8km² (7.1 per cent to 29.1 per cent of all identified sites).

The biophysical operating principle pertaining to dugongs was that no-take areas should represent identified dugong habitat areas summing to about 50 per cent of all high priority dugong habitat. The area of dugong habitat increased in no-take areas from 1 396km² to 3 476km² (or 16.9 per cent to 42.0 per cent of all identified sites).

Although the marine turtle and dugong principles were not achieved in total for all sites, overall the level of protection afforded by the *Great Barrier Reef Marine Park Zoning Plan 2003* increased for all locations identified.

Also, other protection measures that came into effect through the *Great Barrier Reef Marine Park Zoning Plan 2003* that should benefit marine turtle and dugong habitats include:

- Designating the Far Northern Management Area of the Great Barrier Reef Marine Park as a Remote Nature Area where works involving dumping spoil, reclamation, beach protection works, harbour works and constructing or operating a structure other than a vessel mooring or a navigational aid are prohibited
- Surrounding the important marine turtle nesting sites of Raine Island, Moulter Cay and MacLennan Cay with a Restricted Access Area that prohibits access unless the written permission of the Great Barrier Reef Marine Park Authority has been obtained

- Categorising dugongs and all six species of marine turtle as Protected Species, which prohibits their direct take without the written permission of the Great Barrier Reef Marine Park Authority
- Controlling or preventing activities through zoning such as dredging, aquaculture, and other activities which may effect benthic communities such as seagrass
- Developing a reef-wide framework for the sustainable traditional use of marine resources
- Creating Special Management Areas (Dugong) to complement commercial mesh netting requirements under the Queensland *Fisheries Regulations 1995*.

INTRODUCTION

Between 1999 and 2003, the Great Barrier Reef Marine Park Authority (GBRMPA) undertook a program called the Representative Areas Program (RAP) to increase the protection of the Marine Park (Figure 1). The aim of the RAP was to help protect biodiversity through protecting 'representative' examples of all the different habitats and communities in the Marine Park while minimising negative and maximising positive impacts on current users and industries.

To achieve the aim, the old Marine Park zoning was evaluated and principles were developed to guide the development of the new zoning¹. A review of the comprehensiveness, adequacy and representativeness of the existing network of protected areas within the Marine Park highlighted inadequacies in protection for biodiversity (for example, pre 1 July 2004, less than 5 per cent of the Marine Park was protected in no-take zones). The RAP involved rezoning the entire Marine Park, and provided an opportunity to develop a consistent reef-wide framework for managing use.

A draft Zoning Plan was released for public comment in mid 2003. That plan was revised in light of the 21,500 submissions that were received and the final Zoning Plan was implemented on 1 July 2004. Day et al. (2002) provide an overview of the RAP in the Great Barrier Reef.

The treatment and prioritisation of biophysical data in the RAP (Lewis et al. 2003) was assisted by advice from an independent Scientific Steering Committee and other reef and non-reef experts, including expertise in marine mammals and turtles. Biophysical operational principles (Appendix 1) were recommended by the Scientific Steering Committee to guide the establishment of a new network of no-take areas² that would achieve the objectives of the RAP (Fernandes et al. 2005).

A summary of Zoning Plans for the Great Barrier Reef Marine Park

Up to 1999, there were five main Sections of the Marine Park, with the Far Northern, Cairns, Central and the Mackay/Capricorn Sections being declared and originally zoned between 1983 and 1987. The smaller Gumoo Woorjabaddee Section was incorporated into the Marine Park in 1998 and zoned in 2002. Each of these sections had a separate Zoning Plan in place before the RAP commenced.

Because each Zoning Plan was developed separately (1987 to 2002), definitions for activities and the access conditions varied between them and created inconsistencies in the way the activities were managed.

The *Great Barrier Reef Marine Park Zoning Plan 2003*, created as part of the RAP, replaced the five Zoning Plans and also amalgamated all five sections, as well as 28 new coastal sections, into one (Figure 1). This plan also standardised the names and objectives for each zone (Appendix 2). For ease of presentation in this report, the terms '*previous zoning*' and '*previous Zoning Plans*' are used to collectively refer to the five Zoning Plans in effect prior to 1 July 2004. The term '*current zoning*' is used to refer to

¹ Under the *Great Barrier Reef Marine Park Act 1975*, Zoning Plans are the primary management instrument for the conservation and management of the Great Barrier Reef Marine Park.

² No-take areas means those areas zoned as Marine National Park (Green) or Preservation (Pink).

the *Great Barrier Reef Marine Park Zoning Plan 2003*, which came into effect on 1 July 2004.

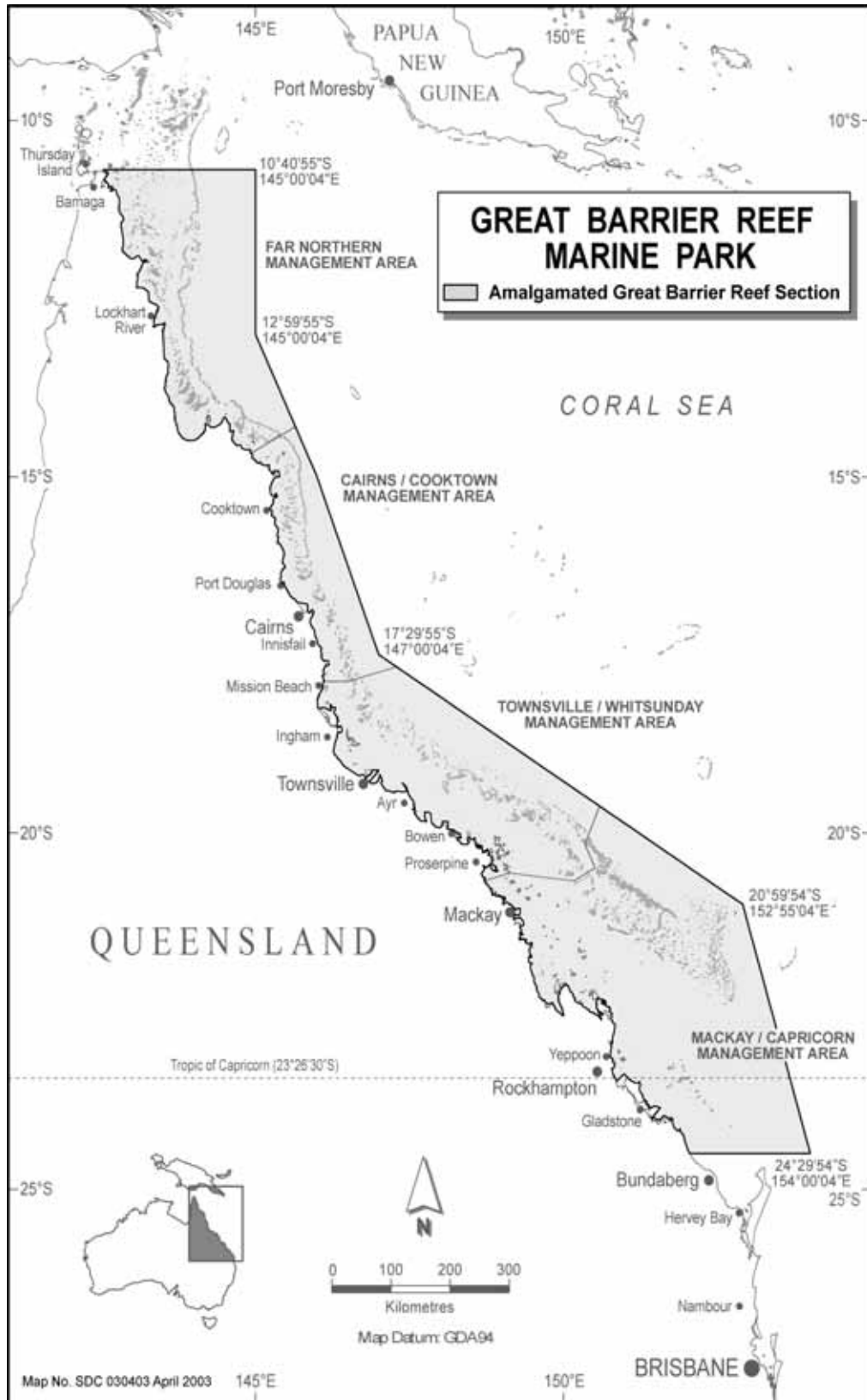


Figure 1. Amalgamated Great Barrier Reef Section and Management Area boundaries.

Figure 2 provides a summary of the purposes for which each zone (other than the Commonwealth Island Zone) may be used or entered without permission (as shown by a tick in the figure) or with the written permission of the GBRMPA. For the purposes of the Marine Park, no-take areas are those areas zoned as Marine National Park or Preservation. Refer to the Zoning Plan for full details of all use and entry provisions for each zone.

ACTIVITIES GUIDE (see relevant Zoning Plans and Regulations for details)	General Use Zone	Marine Protection Zone	Conservation Park Zone	Buffer Zone	Scientific Research Zone ²	Marine National Park Zone	Preservation Zone
	Aquaculture	Permit	Permit	Permit ¹	X	X	X
Bait netting	✓	✓	✓	X	X	X	X
Boating, diving, photography	✓	✓	✓	✓	✓ ²	✓	X
Crabbing (trapping)	✓	✓	✓ ³	X	X	X	X
Harvest fishing for aquarium fish, coral and beachworm	Permit	Permit	Permit ¹	X	X	X	X
Harvest fishing for sea cucumber, trochus, tropical rock lobster	Permit	Permit	X	X	X	X	X
Limited collecting	✓ ⁴	✓ ⁴	✓ ⁴	X	X	X	X
Limited spearfishing (snorkel only)	✓	✓	✓ ¹	X	X	X	X
Line fishing	✓ ⁵	✓ ⁵	✓ ⁶	X	X	X	X
Netting (other than bait netting)	✓	✓	X	X	X	X	X
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	X
Tourism program	Permit	Permit	Permit	Permit	Permit	Permit	X
Traditional use of marine resources	✓ ⁷	✓ ⁷	✓ ⁷	✓ ⁷	✓ ⁷	✓ ⁷	X
Trawling	✓	X	X	X	X	X	X
Trolling	✓ ⁵	✓ ⁵	✓ ⁵	✓ ^{5,8}	X	X	X

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

- Restrictions apply to aquaculture, spearfishing and harvest fishing for aquarium fish, beachworm and coral in the Conservation Park Zone.
- Except for One Tree Island Reef (SR-23-2010) and Australian Institute of Marine Science (SR-19-2008) which are closed to public access and shown as orange, all other Scientific Research Zones are shown as green with an orange outline.
- Limited to 4 catch devices (eg. crab pots, dillies and inverted dillies) per person.
- By hand or hand-held implement and generally no more than 5 of a species.
- Maximum of 3 lines/rods per person with a combined total of 6 hooks per person.
- Limited to 1 line/rod per person and 1 hook per line. Only 1 dory detached from a commercial fishing vessel.
- Apart from traditional use of marine resources involving an activity otherwise 'as of right', a permit or an accredited Traditional Use of Marine Resources Agreement is required.
- Pelagic species only. Seasonal Closures apply to some Buffer Zones.

Detailed information is contained in the Great Barrier Reef Marine Park Zoning Plan and Regulations.

- Permits are required for most other activities not listed above.
- Commonwealth owned Islands in the Great Barrier Reef Marine Park are zoned "Commonwealth Islands Zone" - shown as cream.
- All Commonwealth Islands may not be shown.
- Special Management Areas may provide additional restrictions at some locations.
- The Zoning Plan does not affect the operation of s.211 of the *Native Title Act 1993*.

ACCESS TO ALL ZONES IS PERMITTED IN AN EMERGENCY.

Figure 2. Summary of activities allowed in zones in the Great Barrier Reef Marine Park.

Aim of this report

The stated aims of the GBRMPA include:

- Protecting the natural qualities of the Great Barrier Reef while providing for reasonable use of the Great Barrier Reef region
- Minimising regulation of, and interference in, human activities, consistent with meeting the GBRMPA's goal and other aims.

Consistent with these obligations, the Authority is responsible for conserving marine turtles and dugongs in the Marine Park. This is achieved through managing human activities occurring in the Marine Park that impact on these species, including both current activities and predicted future activities.

The aim of this document is to describe the GBRMPA's approach to the biophysical operational principles relating to marine turtle nesting and foraging habitats and dugong habitats. The Scientific Steering Committee established the biophysical operational principles in Appendix 1 including the one outlined below by taking into account:

- The level of uncertainty about the biodiversity of the Great Barrier Reef World Heritage Area
- The fact there is already a basic level of protection across the Marine Park
- Other efforts to ensure protection of the Marine Park by improvements in, for example, water quality and sustainable fishing.

Biophysical Operational Principle 7: Represent all habitats.

Represent a minimum amount of each community type and physical environment type in the overall network. This principle is to ensure that all known communities and habitats that exist within bioregions are included in the network of no-take areas. Communities and habitats were identified for protection in no-take areas based upon the reliability and comprehensiveness of available data. The following advice helps implement this principle, which is intended to ensure that particularly important habitats are adequately represented in the network of no-take areas.

Major turtle sites: ensure no-take areas include known major turtle nesting and foraging sites (100 per cent of about 30 sites of the 115 identified – these include both nesting site and foraging sites).

Dugong sites: ensure no-take areas represent identified dugong habitat areas summing to about 50 per cent of all high priority dugong habitat.

The turtle component of this principle was refined further for foraging and nesting sites. The dugong component of this principle was refined further to prioritise key habitats. Both of these refinements are detailed below.

The biophysical operational principle that pertains to dugong and turtle were carefully implemented for marine turtles and dugongs because all six species of marine turtle in the Great Barrier Reef are threatened and they are part of the World Heritage values associated with the Great Barrier Reef. Also, there is a need to address impacts on marine turtles and dugongs for a number of reasons, but especially as there is good evidence that the populations of some marine turtle species (loggerhead, green, hawksbill) have declined or are declining (Chaloupka 2002, 2003; Limpus and Miller 2000; Limpus et al. 2003, Limpus and Reimer 1994) and that dugong numbers along the urban coast of Queensland, south of Cooktown have declined substantially since the 1960s (Marsh et al. 2001).

MARINE TURTLE NESTING SITES

Marine turtles return to the region of their birth (Allard et al. 1994, Meylan et al. 1990); therefore, they are classified as management units based upon their genetic differences between breeding areas. Turtle nesting sites were identified by genetic stock for each species (loggerhead, green, hawksbill, flatback) and prioritised on published and spatial information (Dobbs et al. 1999; Limpus 1980; Limpus et al. 1981; Limpus and Miller 2000; Limpus and Reimer 1984; Limpus et al. 2000; Limpus et al. 2003; Miller et al. 1995; Parmenter 1994).

For the RAP, it was important to protect sites for each genetic stock of each species present in the Great Barrier Reef World Heritage Area and to protect adequately sized inter-nesting sites to preserve the integrity of breeding populations as much as possible:

- For green turtles there are two genetic breeding populations which are delineated by the area North and South of Princess Charlotte Bay; these stocks are termed the northern Great Barrier Reef stock and the southern Great Barrier Reef stock
- For the loggerhead, flatback, leatherback and hawksbill turtles in the Great Barrier Reef World Heritage Area, there is only one genetic breeding population
- For olive ridley turtles, there are no known nesting locations in the Great Barrier Reef World Heritage Area.

Seven very high, ten high and 20 medium priority sites were identified (Table 1).

Inter-nesting Habitat³

The Marine Park extends seaward from mean low water on the mainland and from Queensland owned islands. For the purposes of the RAP, all nesting sites included a 5km buffer for the protection of inter-nesting habitat based upon the best available scientific advice. Nesting female turtles generally do not feed during the breeding season (Limpus 1973; Tucker and Read 2001); however they use water depths up to 40 metres during the inter-nesting period (Bell 2005) and habitat up to tens of kilometres from the nesting beach (Tucker et al. 1996). Some species (for example, loggerhead turtles) appear to show quite strong fidelity to inter-nesting habitats (Limpus and Reed 1985; Tucker et al. 1996), where as other species may be less tied to one specific location (for example, green turtles Carr et al. 1974; Meylan 1982).

Biophysical Operational Principle

The principle pertaining to marine turtles aimed to ensure no-take areas include known major turtle nesting and foraging sites (100 per cent of about 30 sites of the 115 identified – these include both nesting site and foraging sites). For marine turtle inter-nesting sites, this was refined to:

- Very High priority nesting sites (including a five kilometre buffer) to be included in no-take zones
- High priority nesting sites (including five kilometre buffer) include in no-take zones whenever possible
- Medium priority sites (including five kilometre buffer) should not be chosen explicitly in the planning process but their inclusion or not in sites to be protected

³ Marine turtle inter-nesting sites refer to the waters used by breeding female turtles in between their approximately fortnightly trips to the nesting beach to lay eggs. Typically marine turtles lay from three to six clutches of eggs each breeding season, so the inter-nesting site is the area used during the six to 12 weeks the breeding female turtles are in the vicinity of the nesting beach.

for other reasons should be factored into the decision-making process (refer to Lewis et al. 2003 for a description of this process).

Table 1. Marine turtle nesting sites in the Great Barrier Reef World Heritage Area identified for the Representative Areas Program.

Location	Inter-nesting Area (km ²)	Species by genetic stock (when relevant)	Priority	Tenure
Avoid Is	95.6	Flatback	High	Broad Sound Shire Council
Bacchi Cay	76.4	Southern GBR green /Loggerhead	Medium	National Park (Qld)
Bell Cay	79.1	Southern GBR Green	Medium	National Park (Qld)
Bird Is	90.7	Hawksbill	Medium	National Park (Qld)
Boydong Is	91.1	Hawksbill	High	National Park (Qld)
Bylund Cay	77.4	Southern GBR green /Loggerhead	Medium	National Park (Qld)
Curtis Is	1265.1	Flatback	Medium	National Park (Qld) (part)
Douglas Is	82.9	Hawksbill	Medium	Cook Shire Council
Erskine Is	74.5	Southern GBR green /Loggerhead	Medium	National Park (Qld)
Facing Is	264.3	Flatback	Medium	National Park (Qld) (part)
Farmer Is	82.5	Hawksbill	Medium	National Park (Qld)
Frigate Cay	80.8	Southern GBR green /Loggerhead	High	National Park (Qld)
Gannet Cay	78.4	Southern GBR green /Loggerhead	Medium	National Park (Qld)
Heron Is	80.4	Southern GBR green /Loggerhead	Very High	National Park (Qld)
Hoskyn Is	87.6	Southern GBR green /Loggerhead	High	National Park (Scientific) (Qld)
Lady Elliot Is	83.3	Southern GBR green /Loggerhead	Medium	Commonwealth (GBRMPA)
Lady Musgrave Is	78.5	Southern GBR green /Loggerhead	Medium	National Park (Qld)
MacLennan Cay	84.2	Northern GBR Green	Medium	Nature Refuge (Qld)
Masthead Is	86.3	Southern GBR green /Loggerhead	High	National Park (Qld)
Milman Islet	90.9	Hawksbill	Very High	National Park (Qld)
Moulter Cay	84.7	Northern GBR Green	High	Nature Refuge (Qld)
Newry Is	90.5	Flatback	Medium	National Park (Qld)
North West Is	93.6	Southern GBR green /Loggerhead	Very High	National Park (Qld)
Outer Newry Is	89.7	Flatback	Medium	National Park (Qld)
Peak Is	83.3	Flatback	Very High	National Park (Qld)
Price Cay	77.2	Southern GBR	High	National Park (Qld)

Location	Inter-nesting Area (km ²)	Species by genetic stock (when relevant)	Priority	Tenure
		green /Loggerhead		
Rabbit Is	124.6	Flatback	Medium	National Park (Qld)
Raine Is	88.8	Northern GBR Green	Very High	Nature Refuge (Qld)
Russell Is	83.5	Flatback	Medium	National Park (Qld)
Sandbank No 7	81.7	Northern GBR Green	High	National Park (Qld)
Sandbank No 8	81.4	Northern GBR Green	Medium	National Park (Qld)
Sinclair Islet	83.6	Hawksbill	High	National Park (Qld)
Thomas Cay	76.5	Southern GBR green /Loggerhead	Medium	National Park (Qld)
Tyron Is	80.0	Southern GBR green /Loggerhead	Medium	National Park (Qld)
Un-named Cay 11-034	81.1	Hawksbill	High	Cook Shire Council
Wild Duck Is	126.2	Flatback	Very High	National Park (Qld)
Wreck Is	77.3	Loggerhead	Very High	National Park (Scientific) (Qld)

Results

A complete summary of all zoning (previous and current) for each inter-nesting site by priority for each genetic stock and by each individual location for each stock is provided in the tables below. A synthesis of this information follows.

An overall, increased level of protection of marine turtle inter-nesting habitat was achieved in the *Great Barrier Reef Marine Park Zoning Plan 2003*. Of the total area of 3338km² of inter-nesting habitat, the area contained within no-take zones (Marine National Park and Preservation) increased from 7815km² to 1886km² and represented an increase from 23.4 to 56.5 per cent of the identified habitat within the Marine Park (Table 2).

Table 2. Comparison of marine turtle inter-nesting habitat zoning within the Great Barrier Reef Marine Park between previous and current Zoning Plans.

Zone Type	Previous Zoning		Current Zoning	
	Percentage	Area (km ²)	Percentage	Area (km ²)
Unzoned ⁴	0.6	21	0	0
General Use	51.0	1704	18.3	612
Habitat Protection	23.9	799	10.2	341
Conservation Park	1.0	34	14.4	482
Buffer	0	0	0	0
Scientific Research	0	0	0.5	16
Marine National Park	22.2	741	52.6	1755
Preservation	1.2	40	3.9	131

⁴ Under the previous Zoning Plan certain coastal areas were previously excluded from the Marine Park and were therefore not zoned. The majority of these areas were incorporated into the Amalgamated Great Barrier Reef Marine Park and zoned as part of the RAP.

Only one very high priority inter-nesting site was 100 per cent in no-take zones under the previous Zoning Plans (northern Great Barrier Reef green turtle site at Raine Island) (Table 3). However, this increased under the current Zoning Plan to include the one very high priority hawksbill turtle (Milman Island) and one high priority (Moulter Cay) and one medium priority (MacLennan Cay) northern Great Barrier Reef green turtle inter-nesting site (Tables 3, 5).

When assessed by priority against all the zoning, each genetic stock of marine turtle increased in the overall protection afforded by the Zoning Plan (Table 4). For all the identified very high, high and medium priority marine turtle inter-nesting sites, protection was increased at all locations with most achieving greater than 50 per cent of the area in no-take zones (Table 4). Under the previous Zoning Plans, eleven sites did not have any Marine Park waters within no-take zones (MPNZ or PZ); under the current Zoning Plan only two sites (Facing Island, Farmer Island) were outside of no-take zones (Table 4).

Reasons for not completely incorporating each site in no-take zones arose from the need to minimise impacts on other users and/or to allow access for limited extractive activities such as fishing and hence not being able to encapsulate a complete five kilometre buffer around some sites.

Table 3. Percentage of very high, high and medium marine turtle inter-nesting habitats in no-take zones under the previous and current Zoning Plans.

Priority and Species by Genetic Stock (No. sites)	Percentage in no-take zones (MNPZ or PZ)	
	Previous Zoning	Current Zoning
Very High		
Flatback (2)	2	87
NGBR Green (1)	100	100
SGBR Green/Loggerhead (2)	14	20
Hawksbill (1)	14	100
Loggerhead (1)	15	36
High		
Flatback (1)	0	27
NGBR Green (2)	81	100
SGBR Green/Loggerhead (4)	45	74
Hawksbill (3)	37	98
Medium		
Flatback (6)	0	13
NGBR Green (3)	41	89
SGBR Green/Loggerhead (8)	16	56
Hawksbill (3)	22	48

MNPZ=Marine National Park Zone; PZ=Preservation Zone

Protection of marine turtle inter-nesting sites also increased in addition to the areas in no-take areas. Overall in these inter-nesting habitats there was a general reduction in less protected zones (for example, General Use) and an increase of more protective zoning (for example, Habitat Protection or Conservation Park) (Table 4).

Table 4. Percentage of very high, high and medium marine turtle inter-nesting sites in all zones under previous and current Zoning Plans for the Great Barrier Reef Marine Park.

Previous Zoning (per cent)								Prioritised Inter-nesting Habitat	Current Zoning (per cent)						
Unzoned	GUZ	HPZ	CPZ	BZ	SRZ	MNPZ	PZ		GUZ	HPZ	CPZ	BZ	SRZ	MNPZ	PZ
3.0	80.6	14.4					2.0	Flatback (VH)	8.7	4.2				83.9	3.3
						100.0		NGBR Green (VH)						100.0	
	31.8	40.1	14.2			13.9		SGBR Green and Loggerhead (VH)	17.2		53.1		9.4	20.2	
	85.4	0.2				14.3		Hawksbill (VH)						83.9	16.1
		84.9					15.1	Loggerhead (VH)			64.9			4.5	30.6
	88.8	11.2						Flatback (H)	18.7	54.5				26.8	
	19.4					74.0	6.6	NGBR Green (H)						92.1	7.9
	14.9	39.8				44.3	0.9	SGBR Green and Loggerhead (H)	3.7	6.8	15.9			70.9	2.6
	57.3	5.2				37.5		Hawksbill (H)	2.4					97.6	
2.0	82.6	14.5	0.8			0.1		Flatback (M)	52.1	5.2	29.9			12.8	
	54.6	4.2				36.9	4.2	NGBR Green (M)		10.8				73.3	15.9
	28.2	54.8	0.5			16.4		SGBR Green and Loggerhead (M)	5.7	27.6	10.8			51.8	4.1
	70.1	7.5				22.4		Hawksbill (M)	42.8	8.7				48.5	

Priority: VH = Very high; H = High; M = Medium

Table 5. Comparison of very high, high and medium marine turtle inter-nesting sites under previous and current Zoning Plans for the Great Barrier Reef Marine Park.

Previous Zoning (per cent)								Inter-nesting Habitat	Current Zoning (per cent)						
Unzoned	GUZ	HPZ	CPZ	BZ	SRZ	MNPZ	PZ		GUZ	HPZ	CPZ	BZ	SRZ	MNPZ	PZ
	88.8	11.2						Avoid Island	18.7	54.5				26.8	
		87.1				12.9		Bacchi Cay		86.4					13.6
	89.7					10.3		Bell Cay		7.8				61.0	31.2
	36.3					63.7		Bird Island – 11167	39.5					60.5	
						100.0		Boydong Island						100.0	
						100.0		Bylund Cay						96.2	3.8
2.4	97.6							Curtis Island	40.1	4.9	28.7			26.3	
	97.0	3.0						Douglas Island	16.6					83.4	
	29.1	70.6				0.3		Erskine Island	15.5		63.8			20.7	
7.0	93.0							Facing Island	80.1	19.9					
	79.9	20.1						Farmer Island	72.9	27.1					
		10.0				86.2	3.8	Frigate Cay		6.4				85.4	8.2
		95.6				4.4		Gannet Cay		17.4				80.4	2.2
	3.3	40.5	30.6			25.5		Heron Island	2.8		44.6		20.3	32.3	
	21.0	79.0						Hoskyn Island	0.7	18.3				81.1	
	95.7		4.0			0.3		Lady Elliot Island						100.0	
	51.6	46.9				1.5		Lady Musgrave Island	19.4	33.8				46.8	
	25.3					74.7		MacLennan Cay						100.0	
	36.1	61.9				2.0		Masthead Island	13.5		61.4			25.1	
	85.4	0.2				14.3		Milman Islet						83.9	16.1
						99.5		Moulter Cay						98.9	1.1
	47.9	52.1						Newry Island	39.0	1.1	57.1			2.9	
	56.5	39.7				3.8		North West	29.8		60.5			9.7	
	50.0	50.0						Outer Newry Island	45.5		51.9			2.6	
7.5	87.6						4.9	Peak Island	21.5	6.6				63.7	8.1
		1.9				98.1		Price Cay		1.7				95.4	2.8
	66.1	33.9						Rabbit Island	56.1	2.2	39.5			2.2	
						100.0		Raine Island			0.0			100.0	
	92.0		7.3			0.7		Russell Island	74.9		17.0			8.1	
	50.1	12.5				24.8	12.5	Sandbank No 7		24.9				57.7	17.4
	40.0					46.9	13.1	Sandbank No 8						84.9	15.1
	93.1	0.3				6.7		Sinclair Islet	5.6					94.4	
		87.1				12.9		Thomas Cay		86.4					13.6
	43.4	56.1				0.5		Tyron Island	11.1		24.8			64.1	
	83.8	16.2						Un-named 11-034 (Crocodile Cay)	1.7					98.3	
	75.9	24.1						Wild Duck Island		2.6				97.4	
		84.9					15.1	Wreck Island			64.9			4.5	30.6

MARINE TURTLE FORAGING HABITAT

Virtually all of the Great Barrier Reef World Heritage Area is used as a foraging area for marine turtles. However, for the purposes of the RAP, seven marine turtle foraging areas were identified by Dr Col Limpus (pers. comm. Queensland Parks and Wildlife Service) (Table 6) as a high priority for inclusion in the network of no-take zones. These sites captured both cross-shelf and latitudinal diversity (as required in the previously mentioned biophysical operational principles) and were further described by genetic stock where relevant. No sites were identified specifically for flatback, olive ridley or leatherback turtles because of a lack of information about known aggregations of these species.

Table 6. Marine turtle foraging habitats in the Great Barrier Reef World Heritage Area identified as high priority areas for the Representative Areas Program.

Location	Area	per cent outside Marine Park*	Management Area	Species by genetic stock (where relevant)
Hedge Reef to Howick Group	2768.3	0	Far Northern	Hawksbill, Northern Great Barrier Reef green turtle
Hinchinbrook to Cape Bowling Green	2860.2	12.6	Townsville / Whitsunday	Southern Great Barrier Reef green turtle
Upstart Bay to Midge Point	765.9	7.1	Townsville / Whitsunday	Southern Great Barrier Reef green turtle
Shoalwater Bay to Corio Bay	1314.4	0	Mackay / Capricorn	Southern Great Barrier Reef green turtle
Gladstone Harbour**	239.2	100	Mackay / Capricorn	Southern Great Barrier Reef green turtle
Capricorn Bunker Group	1533.3	8.9	Mackay / Capricorn	Loggerhead, Southern Great Barrier Reef green, hawksbill turtle
Hydrographers Passage to Swains	33516.6	0	Townsville / Whitsunday and Mackay / Capricorn	Loggerhead, Southern Great Barrier Reef green turtle

*Includes waters such as those managed by Ports. The value does not include Hinchinbrook Channel and does not include State and Commonwealth Islands.

**Note, because this entire site is outside the Great Barrier Reef Marine Park it is not considered further in this analysis.

Refined Biophysical Operational Principle

The principle relating to marine turtles specified no-take areas should include known major turtle nesting and foraging sites (100 per cent of about 30 sites of the 115 identified – these include both nesting site and foraging sites). For marine turtle foraging habitats, this was refined to:

- Include 20 per cent of the different turtle foraging sites incorporated into no-take zones
- Include inshore coastal strips of turtle foraging habitat with a 12 km buffer and reefal areas of turtle foraging habitat with a 1 kilometre buffer (see examples below). Turtles are localized feeders. As such a 12 km buffer on areas adjacent to coast and one kilometre buffer from reefal boundaries was seen as sufficient for implementing the biophysical operational principle.

Results

Overall, marine turtle foraging habitats increased in the level of zoning protection from 7.1 per cent in no-take zones to 29.1 per cent. This represented an increase in area from 3 063km² to 12490km² (Table 7).

Table 7. Comparison of marine turtle foraging habitat zoning within the Great Barrier Reef Marine Park between previous and current Zoning Plans.

Zoning	Previous Zoning		Current Zoning	
	Percentage	Area (km ²)	Percentage	Area (km ²)
Unzoned	1.7	729.1	0	0
General Use	36.0	15 460	20.9	9 004
Habitat Protection	52.5	22 555	44.7	19 205
Conservation Park	0.6	268	3.4	1 451
Buffer	0.3	120	0.000001	4
Scientific Research	0.1	30	0.2	71
Marine National Park	6.9	2 956	28.6	12 296
Preservation	0.2	107	0.5	194

For specific identified areas, protection of marine turtle foraging habitats increased up to 50 per cent in no-take areas (Table 8). There was only one foraging habitat where the biophysical operational principle of incorporating 20 per cent into no-take areas was not met in the Marine Park (Hinchinbrook to Cape Bowling Green). The reason for not meeting the biophysical operational principle for this site was that although the area represents an important foraging area for the southern Great Barrier Reef green turtle stock, its is also an important recreational and commercial fishing area for the adjacent communities. In recognition of these uses protection was increased from 0 per cent to 15 per cent in the final Zoning Plan.

Overall there was a general reduction in less protected zones (for example, General Use) in these turtle foraging areas and more of these areas in more protective zoning (for example, Habitat Protection or Conservation Park) (Table 8).

Table 8. Zoning arrangements in marine turtle foraging habitats under previous and current Zoning Plans for the Great Barrier Reef Marine Park.

Unzoned	Previous Zoning (per cent)							Foraging Habitat	Current Zoning (per cent)						
	GUZ	HPZ	CPZ	BZ	SRZ	MNPZ	PZ		GUZ	HPZ	CPZ	BZ	SRZ	MNPZ	PZ
1.4	34.6	31.1	7.0	4.3		21.6		Hedge Reef to Howick Group	12.5	14.4	41.2	0.2		45.0	
18.9	64.9	3.3	0.2		0.1			Hinchinbrook to Cape Bowling Green	54.8	2.7	16.4		0.1	13.4	
19.5	46.6	26.3	0.5					Upstart Bay to Midge Point	68.7	25.4	3.4			25.4	
	57.7	30.1				3.5		Shoalwater Bay to Corio Bay		36.8	3.9			50.4	
	19.9	70.0	4.3		1.8	3.3	0.8	Capricorn Bunker Group	12.5	14.4	41.2		4.4	26.0	1.5
	33.5	59.5				6.7	0.3	Hydrographers Passage to Swains	18.9	52.5				28.1	0.5

DUGONG HABITATS

Existing management arrangements for dugong conservation relevant to the previous Zoning Plans were reviewed to determine suitability of those arrangements in the context of streamlining provisions for the current Zoning Plan. A panel of independent scientific experts on dugongs and dugong habitats identified 31 areas important for dugongs (Table 9) based on information from aerial surveys (Marsh and Lawler 2001, 2002) and seagrass surveys (Coles et al. 2000; Coles et al.2002; Coles et al. 2003; Lee Long 1993) for use in the RAP.

Table 9. Dugong habitats in the Great Barrier Reef Marine Park used in the Representative Areas Program

Habitat (in alphabetical order)	Area (km ²)	Management Area
13-093, Magpie and Lytton Reefs	493	Far Northern
Area behind Turtle Island	0.2	Far Northern
Bathurst Bay	202	Far Northern
Batt and Tongue Reefs	335	Cairns / Cooktown
Bowling Green Bay	190	Townsville / Whitsundays
Cape Direction Green Zone	160	Far Northern
Clairview Bluff Carmilla Creek DPA	18	Mackay / Capricorn
Cleveland Bay	101	Townsville / Whitsundays
Edgecumbe Bay	8	Townsville / Whitsundays
French Point to Bobardt Point	147	Far Northern
Hedge, Grubb and Corbett Reefs	1127	Far Northern
Hinchinbrook Area	425	Townsville / Whitsundays
Ince bay DPA	14	Mackay / Capricorn
Lookout Point to Barrow Point	1266	Cairns / Cooktown
Lucinda to Allingham-Halifax Bay DPA	0.7	Townsville / Whitsundays
Magnetic Island	8	Townsville / Whitsundays
Margaret Bay	34	Far Northern
Orford Ness	32	Far Northern
Pallarenda	13	Townsville / Whitsundays
Port Clinton including Island Head Creek	1	Mackay / Capricorn
Port Douglas- Low Isles, North	115	Cairns / Cooktown
Port Douglas- Low Isles, South	337	Cairns / Cooktown
Port of Gladstone-Rodds Bay DPA	2	Mackay / Capricorn
Port Stewart	488	Mackay / Capricorn
Princess Charlotte Bay	1441	Far Northern
Repulse Bay	4	Townsville / Whitsundays
Shelburne Bay	419	Far Northern
Shoalwater Bay	764	Mackay / Capricorn
Stewart peninsula, Newry Islands, Ball Bay	13	Mackay / Capricorn
Temple Bay	96	Far Northern
Upstart Bay	25	Townsville / Whitsundays

Refined Biophysical Operational Principle

The principle relating to dugongs was to ensure no-take areas represent identified dugong habitat areas summing to about 50 per cent of all high priority dugong habitat. Independent scientists made the following recommendations with respect to implementing this biophysical operational principle:

- *Hinchinbrook Area* – Recommended Yellow Zone with speed restrictions would be a good outcome for this area. A Green Zone from headlands of Missionary Bay extending northerly to encapsulate Goold Island may reduce traffic.
- *Cleveland Bay* – Recommended Yellow Zone with speed restrictions. Priority is the back of Pallarenda. Reduction of traffic and protection of sea-grasses are important but local banana prawn industry should be considered. Shallow areas < 3 m with seagrass are the priority
- *Bowling Green Bay* – Recommended Yellow Zone with speed restrictions. The southeastern portion of Bowling Green Bay was the priority
- *Upstart Bay* – Recommended Yellow Zone with speed restrictions
- *Shoalwater Bay* - Recommended Green Zone
- *Port Clinton* - Recommended Green Zone.

Results

The biophysical operational principle for dugong habitats was to ensure no-take zones represent identified dugong habitat areas summing to about 50 per cent of all high priority dugong habitat. The total area of identified priority dugong habitat was 8 278km². Greater than 40 per cent of this habitat was incorporated into no-take zones (Marine National Park or Preservation zones) in the current Zoning Plan (Table 10), which represents more than double the original amount in no-take zones.

Table 10. Comparison of dugong habitat zoning within the Great Barrier Reef Marine Park between previous and current Zoning Plans

Zoning	Previous Zoning		Current Zoning	
	Percentage	Area (km ²)	Percentage	Area (km ²)
Unzoned	6.2	513	0	0
General Use	40.2	3330	23.9	1976
Habitat Protection	23.9	1980	20.3	1680
Conservation Park	11.5	955	13.8	1145
Buffer	1.3	104	0	0
Scientific Research	0.011	0.9	0.013	1
Marine National Park	15.0	1242	40.2	3326
Preservation	1.9	154	1.8	150

In a detailed analysis of each identified dugong habitat (Table 11), four dugong habitats (Cape Direction, Lookout Point to Barrow Point; Shelburne Bay, Temple Bay) had 50 per cent or more no-take zones in the previous zoning. In the current zoning, two additional sites had 50 per cent or more in no-take zones: Hedge, Grubb and Corbett Reefs; Shoalwater Bay.

Table 11. Zoning arrangements in dugong habitats under old and new zoning for the Great Barrier Reef Marine Park

Previous Zoning (per cent)								Dugong Habitat	Current Zoning (per cent)						
Unzoned	GUZ	HPZ	CPZ	BZ	MNPZ	SRZ	PZ		GUZ	HPZ	CPZ	BZ	MNPZ	SRZ	PZ
	37.1	62.9						13-093, Magpie and Lytton Reefs	32.0	66.9			1.0		
		100.0						Area behind Turtle Island		100.0					
17.1	8.7		74.1					Bathurst Bay			100.0				
		100.0						Batt and Tongue Reefs		95.6			4.4		
	99.2		0.3			0.5		Bowling Green Bay	16.4	21.7	38.3		23.0	0.6	
	13.3		2.9		83.9			Cape Direction Green Zone	3.5		1.8		94.7		
94.7	5.3							Clairview Bluff Carmilla Creek DPA	11.8	3.1	85.1				
46.2	53.8							Cleveland Bay	9.8		90.2				
34.1	16.0	44.6	5.2					Edgumbe Bay	50.1	44.2	5.7				
21.3	16.8	58.9	1.1		1.9			French Point to Bobardt Point	5.2	76.7	10.1		8.0		
	40.5	29.8		8.9	20.8			Hedge, Grubb and Corbett Reefs	25.7	9.8			64.5		
	67.8	29.4	1.3		1.5			Hinchinbrook Area	14.7	0.8	55.7		28.8		
	9.0	91.0						Ince Bay DPA	9.0	91.0					
1.6	60.0	3.0	1.3		21.9		12.2	Lookout Point to Barrow Point	40.8	3.5	1.9		42.0	11.9	
100.0								Lucinda to Allingham-Halifax Bay DPA	48.8	51.2					
	99.0				1.0			Magnetic Island	4.0	12.3	82.0		1.7		
100.0								Margaret Bay Section	17.6	5.4	77.0				
		100.0						Orford Ness		100.0					
17.2	74.0		8.8					Pallarenda			100.0				
	100.0							Port Clinton including Island Head Creek	91.8		8.2				
36.7	51.7	9.0	1.2	1.1	0.3			Port Douglas- Low Isles, North	46.4	36.6	4.2		12.8		
49.0	49.5			0.8	0.7			Port Douglas- Low Isles, South	40.3	18.8	23.1		17.8		
	100.0							Port of Gladstone-Rodds Bay DPA	91.6	8.4					
10.1	34.5	54.5			0.9			Port Stewart	16.6	24.1	57.3		2.0		
4.6	38.9	0.1	53.7		2.7			Princess Charlotte Bay	40.8	24.7			34.5		
	100.0							Repulse Bay	100.0						
					100.0			Shelburne Bay					100.0		
	42.7	51.3			6.0			Shoalwater Bay		9.7	6.6		83.6		
	19.4	80.6						Stewart Peninsula, Newry Islands, Ball Bay	13.3	2.0	80.5		4.2		
	21.2	0.2			78.6			Temple Bay	15.0		6.3		78.7		
	14.1	84.4	1.4					Upstart Bay		53.2	36.1		10.7		

DPA=Dugong Protection Area

MIGRATORY PATHWAYS

There are no known areas of specific migratory pathways in the Great Barrier Reef World Heritage Area for any species of marine turtles or for dugongs. It is known that turtles may migrate from as much as hundreds to thousands of kilometres between nesting and foraging sites (Limpus et al. 1992, Miller et al. 1998).

Aerial surveys and satellite tracking of dugongs have shown that their movements occur at several spatial scales. Large-scale movements are likely to occur as a result of episodic loss of seagrass from events such as cyclones, floods and outbreaks of toxic algae such as *Lyngbya* species (Preen and Marsh 1995; Marsh et al. 2003; Gales et al. 2004; Marsh et al. 2004; Sheppard et al. 2006). There is considerable individual variation in dugong movement patterns, with the home ranges of tracked individuals varying from 1.6 to 127.9 km² (de Iongh et al. 1998; Marsh and Rathbun 1990; Preen 1992; Sheppard et al. 2006). The movements of a dugong tracked by Preen (2001) spanned some 860 km of the Queensland coast.

Therefore, no specific recommendations were made as part of implementation of the RAP to account for the pathways that may be used by marine turtles or dugongs in the Great Barrier Reef World Heritage Area.

DISCUSSION

The RAP achieved many of the desired biophysical operational principles. For example, all 70 'bioregions' achieved a minimum of 20 per cent in no-take zones (Fernandes et al. 2005). Overall no-take protection across the Marine Park was increased from less than five per cent to more than 33 per cent. Another key principle of the RAP was to minimise social, economic and cultural impacts on users. So as to minimise potential negative impacts on users, protection of significant turtle and dugong sites was achieved in some areas and for some genetic stocks although it was not for others.

Marine megafauna are being used increasingly in the justification for and design of marine protected areas around the world (Hooker and Gerber 2004; Hoyt 2004). The GBRMPA's ability to set specific biophysical operational principles incorporating marine turtle and dugong requirements was the result of the significant amount of research and monitoring of these species that had occurred in the Great Barrier Reef World Heritage Area over the past 30 years. This meant that the habitats important to these species could be specifically identified and incorporated into the current Zoning Plan.

Marine turtles exhibit strong fidelity to foraging areas and nesting beaches (Limpus et al. 2005; Limpus 1984, 1985). Therefore basing zoning protection around such sites is appropriate from a management perspective. This approach complements recommendations that protected areas should concentrate on protecting the most important life history stages of migratory species (Gerber and Hepell 2004). For marine turtles, population modelling suggests that adults and subadults are the most important life history stage for maintaining a stable marine turtle population (Crouse et al. 1987; Heppell et al. 1996). The fact that most of the important nesting sites were already included in protected areas (for example, Queensland National Parks) meant through the RAP, protection of inter-nesting habitat adjacent to those beaches could occur.

For dugongs, less information was known about calving locations and movements; however seagrass surveys and aerial surveys since the mid 1980s (summarised in Marsh and Lawler 2001, 2002) indicated parts of the Great Barrier Reef coast where dugongs could be regularly found. For example, results of four aerial surveys (1985, 1990, 1995, 2000) conducted in the north of Cooktown indicated that the number of dugongs in the region has not changed significantly since the mid 1980s (Marsh and Lawler 2002). However, within this region, the results have also highlighted that between 24.5 per cent and 56 per cent of dugongs were recorded regularly in Princess Charlotte Bay and Bathurst Bay (Marsh and Saalfeld 1989, Marsh et al. 1993, Marsh and Corkeron 1996, Marsh and Lawler 2002). There has been no significant difference in the overall number of dugongs recorded in the region north of Cooktown during these aerial surveys but there have been changes in the numbers recorded in individual bays. The reasons for such movements are not fully understood but are believed to result from changes in seagrass habitats and forage quality (Sheppard et al. 2006). However, given the migratory nature of dugongs and marine turtles, zoning is not the only management tool that will result in the conservation of these threatened species.

A more in-depth analysis of human-related mortality factors (for example, commercial gill netting and trawling, water quality, Indigenous harvest and boat strike) that impact dugong populations within the Great Barrier Reef World Heritage Area

indicates that approximately 96 per cent of high conservation value dugong habitats are highly protected as a combined result of the new zoning network and other management arrangements (for example, improving water quality and fisheries management arrangements) that have been put in place (Grech and Marsh in review). However, Marsh et al. (2005) still caution that human-related mortality of dugongs along the urban coast of Queensland, south of Cooktown, should be managed to be as close to zero as possible.

Protection measures other than zoning that came into effect through the *Great Barrier Reef Marine Park Zoning Plan 2003* that should benefit marine turtle and dugong habitats include:

- All dugong and marine turtle sites within the Far Northern Management Area are contained within the Remote Nature Area where works involving dumping spoil, reclamation, beach protection works, harbour works and constructing or operating a structure other than a vessel mooring or a navigational aid are prohibited. These sites will benefit from being contained within the Remote Natural Area.
- Raine Island, Moulter Cay and MacLennan Cay are surrounded by a Restricted Access Area that prohibits access unless the written permission of the Authority has been obtained or access is for navigating a vessel (except a ship or a managed vessel or aircraft) to a part of Queensland. In this instance, equipment normally used for fishing or collecting must be stowed and secured and access to the islands is in accordance with all relevant laws of Queensland. In fact, the waters directly around Raine Island would have been considered suitable for inclusion in the Preservation Zone if the need for photography, filming or sound recording that would benefit the Raine Island Nature Reserve or the Great Barrier Reef World Heritage Area was not seen as a necessary activity to allow in the area.
- Dugongs and all six species of marine turtle were categorised as Protected Species and the written permission of the Authority is required to take any of these species from the Marine Park. This led to the development of a reef-wide *Policy on managing the direct take of Protected Species from the Marine Park*.
- Controlling or preventing activities through zoning such as dredging, aquaculture, and other activities which may effect benthic communities such as seagrass
- Having Traditional Owners develop traditional use of marine resources agreements that allow for sustainable hunting of dugongs (north of Cooktown) and marine turtles
- Special Management Areas (Dugong) were created that have management arrangements the same as for the corresponding Dugong Protection Area under the *Queensland Fisheries Regulations 1995*. The provisions are such that they should also benefit marine turtles.

The effective conservation of marine turtles and dugongs requires the protection of key habitats, including nesting, inter-nesting and feeding areas and migratory pathways. For the purposes of determining best way to protect these habitats, the Zoning Plan alone is not a sufficient management response. Other tools that the GBRMPA is using to further protect dugongs and marine turtles in the Marine Park include:

- Improving water quality (Reef Water Quality Protection Plan) to increase the protection of near shore habitats
- Promoting sustainable fisheries (Queensland Fisheries Management Plans)
- Encouraging responsible use practices by reef users
- Developing national codes of conduct for marine turtle and dugong tourism

- Being involved in regional and international initiatives such as the Convention on Conservation of Migratory Species of Wild Animals
- Developing a Climate Change Action Plan to minimise impacts on the Great Barrier Reef ecosystem

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Appendix 1 Biophysical Operational Principles

Biophysical Operational Principle	Explanation
<p>1. Ensure local integrity Have no-take areas the minimum size of which is 20km along the smallest dimension (except for coastal bioregions)</p>	While no-take areas may be of various shapes and sizes, 20km should be the minimum distance across any no-take area in order to ensure that the size of each area is adequate to provide for the maintenance of populations of plants and animals within no-take areas and to insure against edge effects resulting from use of the surrounding areas.
<p>2. Maximise amount of protection Have larger (versus smaller) no-take areas</p>	For the same amount of area to be protected, protect fewer, larger areas rather than more smaller areas, particularly to minimise 'edge effects' resulting from use of the surrounding areas. This principle must be implemented in conjunction with principle 3.
<p>3. Replicate Have sufficient no-take areas to insure against negative impacts on some part of a bioregion</p>	"Sufficient" refers to the amount and configuration of no-take areas and may be different for each bioregion depending on its characteristics. For most bioregions, 3-4 no-take areas are recommended to spread the risk against negative human impacts affecting all no-take areas within a bioregion. For some very small bioregions fewer areas are recommended, whilst for some very large or long bioregions, more no-take areas are recommended.
<p>4. Avoid fragmentation Where a reef is incorporated into no-take zones, the whole reef should be included</p>	Reefs are relatively integral biological units with a high level of connectivity among habitats within them. Accordingly, reefs should not be subject to 'split zoning' so that parts of a reef are no-take and other parts are not.
<p>5. Set minimum amount of protection Represent a minimum amount of each reef bioregion in no-take areas Represent a minimum amount of each non-reef bioregion in no-take areas</p>	<p>In each reef bioregion, protect at least 3 reefs with at least 20 per cent of reef area and reef perimeter⁵ included in no-take areas. The number and distribution of no-take areas per bioregion is described in principle 3.</p> <p>In each non-reef bioregion, protect at least 20 per cent of area. Two coastal bioregions⁶, which contain finer scale patterns of diversity due to bays, adjacent terrestrial habitat and rivers require special provisions. The number and distribution of no-take areas is described in principle 3.</p>
<p>6. Maintain geographic diversity Represent cross-shelf and latitudinal diversity in the network of no-take areas</p>	Many processes create latitudinal and longitudinal (cross-shelf) differences in habitats and communities within the GBR World Heritage Area. This diversity is reflected partly in the distribution of the bioregions, but care should be taken to choose no-take areas that include differences in community types and habitats that cover wide latitudinal or cross-shelf ranges.

⁵ These bioregions are excepted:

- Capricorn-Bunker Mid-Shelf Reefs (RCB2) – include one of the inner 2 and one of the outer 2 reefs. This exception exists because RCB2 has only 4 reefs
- Deltaic Reefs (RA1) – minimum 25 per cent and minimum 15 reefs in one continuous area. This exception exists because the bioregion is too small for multiple no-take areas
- High Continental Island Reefs (RHC) – 20 per cent of reef perimeter only. This exception exists because reef perimeter makes more biological sense for fringing reefs
- Central Open Lagoon Reefs (RF2) – 3 reefs. There are very few reefs in this bioregion.

⁶ For coastal bioregions:

- Coastal Strip-Sand (NA1) – protect at least six no-take areas, each at least 10km in length, spaced approximately every 70-100km apart. (This bioregion is approx. 800 km long)
- High Nutrient Coastal Strip (NA3) – at least eight no-take areas, each at least 10km in length, spaced approximately every 70-100 km apart. (This bioregion is approx. 1400 km long).

Biophysical Operational Principle	Explanation
<p>7. Represent all habitats Represent a minimum amount of each community type and physical environment type in the overall network (see footnote 7)</p>	<p>This principle is to ensure that all known communities and habitats that exist within bioregions are included in the network of no-take areas. Communities and habitats were identified for protection in no-take areas based upon the reliability and comprehensiveness of available data. Footnote⁷ helps implement this principle, which is intended to ensure that particularly important habitats are adequately represented in the network of no-take areas.</p>
<p>8. Apply all available information on processes Maximise use of environmental information to determine the configuration of no-take areas to form viable networks</p>	<p>The network of areas should accommodate what is known about migration patterns, currents and connectivity among habitats. The spatial configurations required to accommodate these processes are not well known and expert review of candidate networks of areas will be required to implement this principle.</p>
<p>9. Protect uniqueness Include biophysically special/unique places</p>	<p>These places might not otherwise be included in the network but will help ensure the network is comprehensive and adequate to protect biodiversity and the known special or unique areas in the Marine Park. Aim to capture as many biophysically special or unique places as possible.</p>
<p>10. Maximise natural integrity Include consideration of sea and adjacent land uses in determining no-take areas</p>	<p>Past and present uses may have influenced the integrity of the biological communities and the GBRMPA should consider these effects, where known, when choosing the location of no-take areas. For example, existing no-take areas and areas adjacent to terrestrial National Parks are likely to have greater biological integrity than areas that have been used heavily for resource exploitation.</p>

7 Data and objectives to implement principle 7:

- *Halimeda* beds – ensure no-take areas represent 10 per cent of known *Halimeda* beds
- shallow water seagrass – ensure no-take areas represent 10 per cent of shallow water seagrass habitat
- deepwater seagrass – ensure no-take areas represent 10 per cent of known deepwater seagrass habitat
- algae – ensure no-take areas represent 10 per cent of known algal habitat
- epibenthos – ensure no-take areas represent different faunal classes (5 per cent each of echinodermata, sponges, bryozoans, solitary corals, soft corals, foraminifera, brachyura)
- dugong – ensure no-take areas represent identified dugong habitat areas summing to about 50 per cent of all high priority dugong habitat
- cays – where cays exist within a bioregion, try to include at least two examples of them in potential no-take areas
- reefs size - capture 5 per cent of reef area in each of five reef-size classes
- inter-reef channels - capture at least one inter-reef channel in bioregions where they exist
- exposure - ensure the entire network captures 5 per cent of reef and non-reef area in each of five wave exposure classes
- islands – where islands exist within a bioregion try to include one example of them in no-take areas
- oceanographic diversity in water quality – ensure representation of reefs within the “natural” diversity of water quality (5 per cent of reef and non-reef area in each of nine oceanographic “bioregions”; 5 per cent of reef and non-reef area in each of four flood frequency classes)
- adjacent coastal and estuarine habitats (including islands) – locate no-take areas adjacent to mangroves, wetlands and protected areas rather than adjacent to suburbs
- major turtle sites – ensure no-take areas include known major turtle nesting and foraging sites (100 per cent of about 30 sites of the 115 identified – these include both nesting sites and foraging sites).

Appendix 2 Objectives of zones used in the Great Barrier Reef Marine Park.

Zone Name	General Use Zone	Habitat Protection Zone	Conservation Park Zone	Buffer Zone	Scientific Research Zone	Marine National Park Zone	Preservation Zone	Commonwealth Islands Zone
Zone colour	Light Blue	Dark Blue	Yellow	Olive Green	Orange	Green	Pink	Cream
Zone Objectives	<p>The objective of the Zoning Plan for the General Use Zone is to provide for the conservation of areas of the Marine Park, while providing opportunities for reasonable use.</p>	<p>The objectives of the Zoning Plan for the Habitat Protection Zone are:</p> <p>(a) <i>to provide for the conservation of areas of the Marine Park through the protection and management of sensitive habitats, generally free from potentially damaging activities; and</i></p> <p>(b) <i>subject to (a), to provide opportunities for reasonable use.</i></p>	<p>The objectives of the Zoning Plan for the Conservation Park Zone are:</p> <p>(a) to provide for the conservation of areas of the Marine Park; and</p> <p>(b) subject to (a), to provide opportunities for reasonable use and enjoyment, including limited extractive use.</p>	<p>The objectives of the Zoning Plan for the Buffer Zone are:</p> <p>(a) to provide for the protection of the natural integrity and values of areas of the Marine Park, generally free from extractive activities; and</p> <p>(b) subject to (a), to provide opportunities for:</p> <p>(i) certain activities, including the presentation of the values of the Marine Park, to be undertaken in relatively undisturbed areas; and</p> <p>(ii) trolling for pelagic species.</p>	<p>The objectives of the Zoning Plan for the Scientific Research Zone are:</p> <p>(a) <i>to provide for the protection of the natural integrity and values of areas of the Marine Park, generally free from extractive activities; and</i></p> <p>(b) subject to (a), to provide opportunities for scientific research to be undertaken in relatively undisturbed areas.</p>	<p><i>The objectives of the Zoning Plan for the Marine National Park Zone are:</i></p> <p>(a) to provide for the protection of the natural integrity and values of areas of the Marine Park, generally free from extractive activities; and</p> <p>(b) subject to (a), to provide opportunities for certain activities, including the presentation of the values of the Marine Park, to be undertaken in relatively undisturbed areas.</p>	<p>The objective of the Zoning Plan for the Preservation Zone is to provide for the preservation of the natural integrity and values of areas of the Marine Park, generally undisturbed by human activities.</p>	<p>The objectives of the Zoning Plan for the Commonwealth Islands Zone are:</p> <p>(a) to provide for the conservation of areas of the Marine Park above the low water mark; and</p> <p>(b) to provide for use of the zone by the Commonwealth; and</p> <p>(c) subject to (a), to provide for facilities and uses consistent with the values of the area.</p>
<p>NOTES:</p> <p>1. <i>Specific activities that are prohibited or may be undertaken in a Zone with or without a permit are specified in the Use and Entry Provisions for each Zone..</i></p>								