

## 1. INTRODUCTION

In August 1997, the Commonwealth and Queensland Governments established 16 coastal Dugong Protection Areas (DPAs) to reduce the threat of mesh nets to dugongs (*Dugong dugon*). The DPAs are situated in the Central and Mackay / Capricorn Sections of the Great Barrier Reef Marine Park (GBRMP) and the Hervey Bay–Great Sandy Strait region (Figure 1), and were enacted by Regulation No. 11 (1997) under the Queensland *Fisheries Act 1994* and the *Nature Conservation (Dugong) Conservation Plan 1999* under the *Nature Conservation Act 1992*. The establishment of DPAs was considered the key strategy to address the rapid decline of the Great Barrier Reef (GBR) dugong population south of Cooktown.

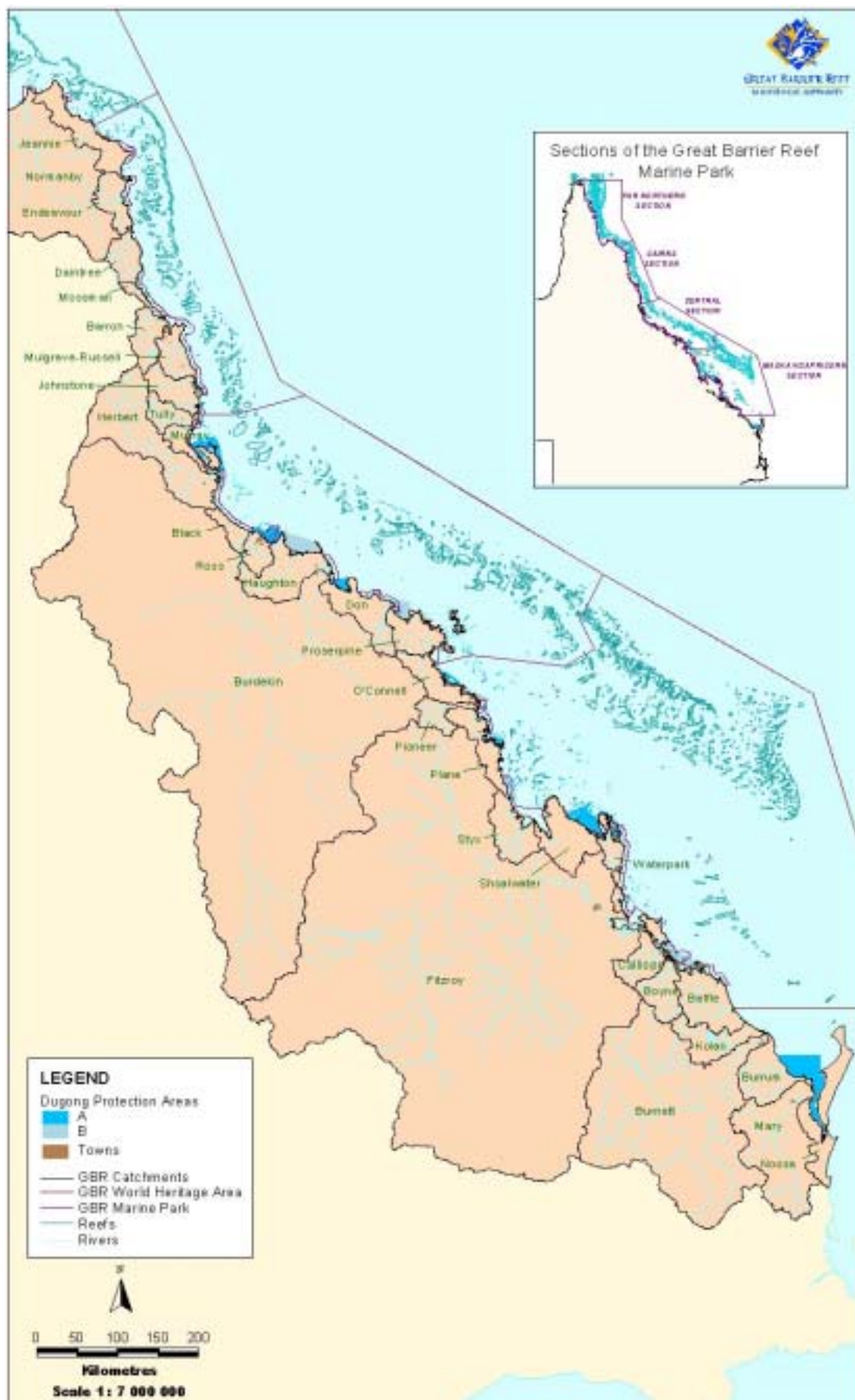
There are two types of DPAs. The Dugong Protection Area 'A' (DPA 'A') zones prohibit or restrict the use of fishing nets considered to pose a threat to dugong, while Dugong Protection Area 'B' (DPA 'B') zones are less restrictive in the use of nets. The DPAs are:

<u>Dugong Protection Area 'A'</u>	<u>Dugong Protection Area 'B'</u>
Hinchinbrook	Taylors Beach
Cleveland Bay	Cape Bowling Green Bay
Upstart Bay	Edgecumbe Bay
Newry Region	Repulse Bay
Ince Bay	Sand Bay
Shoalwater Bay	Llewellyn Bay
Port Clinton	Clairview Region
Hervey Bay–Great Sandy Strait	Rodds Bay

The seagrass meadows in the GBR region are important feeding grounds for a critical proportion of the world population of the dugong species *Dugong dugon* (Great Barrier Reef Marine Park Authority 1981). The dugong is considered by the IUCN to be vulnerable to extinction (IUCN 1990). Aerial surveys of the dugong population in the inshore waters of the GBRMP were conducted in 1986 and 1987 and then repeated in 1992 and 1994 (Marsh et al. 1995). The surveys indicated a dramatic decline over the eight year period with approximately a 50% reduction of dugong numbers (Marsh et al. 1995). Reasons for the reported decline in dugong numbers are unclear, however, because dugongs have very low rates of population growth (Marsh 1992) any impacts such as loss of seagrass habitat and deterioration of water quality have the potential to threaten the integrity of dugong populations (Marsh 1992; Marsh et al. 1995).

Dugong are threatened by both direct anthropogenic impacts such as entanglement in fishing nets, boat strikes, displacement by boating activities in feeding areas, indigenous hunting, and indirect anthropogenic impacts such as deterioration of water quality and degradation of seagrass meadows. The indirect anthropogenic impacts are difficult to determine and define, and consequently it is problematic to mitigate their impact on dugong populations. Such impacts are predominantly caused by changes in water quality that cause either either direct adverse effects on dugong health or indirect effects on the distribution and performance of seagrasses, the main food source of dugong.

Changes in water quality as a result of agriculture, urban expansion and industrial activities include increased exports to coastal waters of sediments, nutrients, and other



**Figure 1.** Location of Dugong Protection Areas and the adjacent river catchment areas of the Great Barrier Reef World Heritage Area

contaminants such as heavy metals, organochlorine compounds, and polycyclic aromatic hydrocarbons (PAHs) (Fowler 1990; Tatsukawa et al. 1990; Brodie 1995; Connell 1993). These pollutant groups present a potential risk to dugongs and seagrass meadows.

The purpose of the present review is to synthesise available information to address the following questions:

What and how severe are the effects of water quality on habitat quality in the existing DPAs?

How do water contaminants affect dugongs and their food source, seagrasses and other dugong habitat features?

Using this information the risks to dugong health and habitat quality in DPAs associated with poor water quality are assessed, and options to better manage these risks are suggested.

## **1.1 Geographical and Biological Setting**

The GBRWHA covers an area of about 350 000 km<sup>2</sup> on the north-eastern Australian continental shelf. It encompasses the long, narrow band of the GBR, stretching 2000 km along the coast from 10.5°S at Cape York to 24.5°S near Bundaberg. The GBR is the largest assemblage of coral reef ecosystems found anywhere in the world and comprises nearly 3000 individual reefs. Approximately 350 species of hard coral, 1500 species of fish, 240 species of seabirds, more than 4000 species of molluscs and numerous other biota are found in the GBR region (GBRMPA 1981). In general, there is a strong cross-shelf component in the abundance and diversity of both reef and inter-reefal taxa in the GBR. These cross-shelf patterns vary with latitude due to variability in key physical factors (Kerrigan et al. in press). The principal habitats of the system have only existed in their present form since the sea level rose 9000 years ago, flooding the shelf. Mangroves are widespread along the coastline with a total area of about 2000 km<sup>2</sup> (Galloway 1982), interspersed with areas of low energy, sandy beachline and limited rocky shorelines. In the shallow areas along the coast, seagrass meadows are present and have been documented to cover an area of approximately 3000 km<sup>2</sup> (Lee Long et al. 1993). Deep water (> 10 m) seagrasses have been discovered further offshore in the northern GBR with an area of about 2000 km<sup>2</sup> (Lee Long et al. 1996a). The soft-bottom of the GBR lagoon floor is colonised by communities of algae, sponges, bryozoans and echinoderms (Birtles & Arnold 1988).

## **1.2 Dugong Habitats**

Dugongs inhabit coastal areas of the GBRWHA. They can travel distances of several hundred kilometres (Marsh & Corkeron 1997) and have been observed on the outer shelf of the Far Northern Section of the GBRMP (Marsh & Saalfeld 1989). The Far Northern Section of the GBRMP is the most important dugong habitat in the GBRWHA with a relatively large and stable dugong population (approximately 10 000 animals; Marsh & Corkeron 1997). The dugong population from Cooktown to the southern boundary of the GBRWHA is smaller and from 1986 to 1994 has been critically reduced by approximately 50% to about 1700 animals (Marsh & Corkeron 1997).

Generally the coastal dugong habitats correspond with the distribution of shallow water seagrasses in the GBR. However, dugongs have also been observed feeding on deep water seagrass meadows at depths of more than 20 metres (Lee Long et al. 1989, 1996a). Most seagrasses found in the GBR region grow in the inshore lagoon in shallow waters (< 10 m), less than 10 kilometres from the coast (Lee Long et al. 1993). In deeper waters (10 to 60 m depth), considerable areas of seagrass meadows have recently been discovered in the inter-reefal areas of the GBRWHA (Lee Long et al. 1996a). Baseline seagrass surveys carried out by the Queensland Department of

Primary Industries in the 1980s provide important information on the large scale distribution of seagrass meadows in most areas of the GBRWHA inner lagoon (Lee Long et al. 1993). This information, however, is now dated. Recent re-surveys at a few locations indicate that at a small spatial scale (hundreds of metres) distribution of seagrass meadows can change markedly over time (Lee Long et al. 1996b, 1998). There is also very limited information on seasonal changes in seagrass abundance (Mellors et al. 1993; Lanyon & Marsh 1995). The current survey information regarding the extent of seagrass meadows in the GBR is incomplete so is not presented in this report.

The main food source for dugongs are ephemeral seagrasses of the genera *Halophila* and *Halodule* (Preen 1993a), however, all seagrass species described for the GBRWHA have been found in stomach contents of dugongs (Lanyon et al. 1989). The 15 seagrass species described to date for the GBRWHA are: *Cymodocea rotundata*, *C. serrulata*, *Enhalus acoroides*, *Halophila decipiens*, *H. ovalis*, *H. ovata*, *H. spinulosa*, *H. tricornata*, *Halodule pinifolia*, *H. uninervis* (possibly two species), *Syringodium isoetifolium*, *Thalassia hemprichii*, *Zostera capricorni*. (Lee Long et al. 1993) and *Halophila capricorni* (Larkum 1995). *Enhalus acoroides* only occurs in the Far Northern Section of the GBRMP (Lee Long et al. 1993). *Cymodocea serrulata*, *H. spinulosa*, *Z. capricorni*, and the wide-leafed form of *H. uninervis* contribute most of the seagrass biomass between Cape York and Hervey Bay (Lee Long et al. 1993).

In addition to being the essential food sources for dugong and green sea turtles (*Chelonia mydas*), seagrass communities are of major importance to coastal ecosystems. Seagrasses stabilise bottom sediments; are important benthic primary producers; are part of the nutrient cycle in the aquatic system; supply habitat for adult fish, juvenile fish and invertebrates; contribute substratum for encrusting animals and plants. In the GBR region seagrass meadows are also important as habitat for juvenile prawns (Coles et al. 1987), and the seeds of *Z. capricorni* are a seasonal food source for juveniles of the species *Penaeus esculentus* (Dall et al. 1992).