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Dugong

Status Report and Action Plans for Countries and Territories

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Dugong

Status Reports and Action Plans for Countries and Territories

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Executive Summary

- The dugong *(Dugong dugon)* is the only herbivorous mammal that is strictly marine, and is the only extant species in the Family Dugongidae. It is listed as vulnerable to extinction at a global scale by The World Conservation Union (IUCN). The dugong has a large range that spans some 37 countries and territories and includes tropical and subtropical coastal and island waters from East Africa to Vanuatu, between about 26° north and south of the Equator.
- The purpose of this document is to present a global overview of the status of the dugong and its management in the various countries in its range. We aimed to provide comparative information that will enable individual countries to develop their own, more detailed, conservation plans.
- This document contains information on dugong distribution and abundance, threatening processes, legislation, and existing and suggested research and management initiatives for 37 countries and territories in the dugong's *known* range. The report is organised in a geographical sequence from the Western Indian Ocean region, through to the South West Pacific. Chapter One introduces the Dugong; Chapter 2 comprises information on East Africa; the Red Sea and the Arabian Gulf. Chapter 3 discusses India and Sri Lanka; Chapter 4 presents data from Southeast Asia including Japan, Taiwan (China), China, the Philippines, Vietnam, Cambodia and Thailand; Malaysia, Singapore and Indonesia; Chapter 5 discusses Palau, Papua New Guinea, the Solomon Islands, New Caledonia and Vanuatu; and Chapter 6 presents information from Australia.
- Throughout much of its range, the dugong is believed to be represented by relict populations separated by large areas where its numbers have been greatly reduced or where it is already extirpated. However, the degree to which dugong numbers have dwindled, and its range has been fragmented, is not known for any country in its range. The dugong is still present at the historical limits of its global range, although there is evidence of a reduction in its area of occupancy within this range.
- In most countries in the dugong's range, our knowledge of dugong distribution and abundance is known only from anecdotal information. In ten or so countries, some information on dugong distribution and abundance has been obtained from spatially and temporally limited surveys generally conducted parallel to the shoreline. These surveys provide minimum counts only. Extensive quantitative aerial surveys using transects across the shoreline depth gradient have resulted in a more comprehensive knowledge of dugong distribution and abundance in the coastal waters of most (but not all) of the dugong's range in northern Australia and the Arabian region. However, even in these regions, the information is not comprehensive enough to establish trends in abundance for most areas, especially as there is increasing evidence that dugongs undertake large-scale movements.
- It is inappropriate to compare the abundance of dugongs estimated using shoreline and quantitative surveys. We believe that most of the estimates of dugong population size recorded in this document are underestimates, probably major underestimates. Nonetheless in most parts of its range the anecdotal evidence suggest that dugong numbers are declining.
- Dugongs are long-lived with a low reproductive rate, long generation time, and a high investment in each offspring. Population simulations indicate that even with the most optimistic combinations of life-history parameters (e.g. low natural mortality and no human-induced mortality) a dugong population is unlikely to increase at more than about 5% per year. This makes the dugong vulnerable to over-exploitation. The rate of change of a dugong population is most sensitive to changes in adult survivorship. Even a slight reduction in adult survivorship as a result of habitat loss, disease, hunting or incidental drowning in nets, can cause a chronic decline.
- Dugongs are seagrass specialists and frequent coastal waters. Major concentrations of dugongs tend to occur in wide shallow protected bays, wide shallow mangrove channels and in the lee of large inshore islands. Dugongs are also regularly observed in deeper water farther offshore in areas where the continental shelf is wide, shallow and protected. The dugong's fecundity is very sensitive to the availability of its seagrass food. When dugongs do not have enough to eat they delay breeding, making habitat conservation a critical issue.
- Dugongs are vulnerable to anthropogenic influences because of their life history and their dependence on seagrasses that are restricted to coastal habitats and

are often under pressure from human activities. The seagrass ecosystems on which dugongs depend are very sensitive to human influence. Seagrass beds may be destroyed directly by mining and trawling or lost through the effects of disturbances such as dredging, land clearing and land reclamation. These activities cause increases in sedimentation and turbidity which, in turn, lead to degradation of seagrass extent, density and productivity through smothering and lack of light. Episodic losses of hundreds of square kilometres of seagrass are associated with extreme weather events such as some cyclones, and floods. Most losses, both natural and anthropogenic, are attributed to reduced light intensity due to sedimentation and/or increased epiphytic growth caused by nutrient enrichment. In some cases, factors such as poor catchment management and sediment instability interact to make the processes more complex so that it is often difficult to separate natural and anthropogenic causes of seagrass loss. In addition, herbicide runoff from agricultural lands presents a potential risk to seagrass growth adjacent to sugarcane production areas.

- Accidental entangling in mesh nets and traps set by fishers is a major, but largely unquantified, cause of dugong mortality in many countries and was identified as a major concern in most of the countries covered by this document.
- Dugongs are culturally significant to communities throughout their range. In this document, we record information about the indigenous use of dugong products in most countries in the dugong's range. Dugongs are caught for meat, oil, medicaments, amulets and other products. In many countries hunting dugongs is banned and they are no longer hunted deliberately, however, dugong products are still highly valued and stimulate direct takes. Australia's indigenous peoples consider dugong hunting to be an important expression of their identity.
- Although there are few records of dugong deaths resulting from vessel strikes, increasing vessel traffic in the dugong's range increases the likelihood of strikes. Extensive shallow areas used by regionally important populations of dugongs and situated close to areas of high boat traffic, are particularly at risk.
- The expansion of ecotourism has resulted in the establishment of tourism operations involving dugong-watching cruises and/or swim with dugong opportunities in several countries, including Australia, the Philippines and Vanuatu.
- There are socio-political impediments to dugong conservation, particularly in developing countries. The displacement and urbanisation of rural human populations has led to the loss of traditional values and taboos to resource exploitation. The nearshore areas where dugongs occur have become an easy and convenient source of food and income. The provision of philanthropic aid from 'developed countries' increases the efficiency and level of exploitation. The situation is exacerbated by an absence of adequate legislation, enforcement and management.
- Unless human values change dramatically, we believe that it will be impossible to reduce anthropogenic impacts on the dugong throughout its vast and remote range. Detecting trends in dugong abundance is difficult, particularly at low densities. The objectives of maintaining dugong numbers at present or higher levels and facilitating the recovery of depleted populations will not be achieved if the only trigger for management intervention in an area is a demonstratively declining population.
- A survey by the World Resources Institute rates the risks from coastal development as medium to high for much of the dugong's range outside Australia because of high levels of human population growth and rapid rates of industrialisation. In view of the multiple impacts to which dugong populations are subjected, we consider that the optimum conservation strategies are to:
  1. identify areas that still support significant numbers of dugongs;
  2. extensively involve the community and jointly consider how the adverse impacts on dugongs can be minimised and their habitat protected (Ideally this should be done in the context of comprehensive plans for coastal zone management, perhaps using the dugong as a "Flagship" Species.).
- Control of direct mortality on dugongs in these key areas should reduce dugong mortality provided the areas chosen consistently support high numbers of animals (even though individual dugongs will move in and out of the areas). The long-term effectiveness of these areas will depend on community support and the maintenance of high-quality dugong habitat. This will hinge on the capacity to control land-based inputs.

- Candidate areas for dugong conservation have been identified in much of the dugong's range and in this document we have emphasised strategies for identifying additional areas. However, we acknowledge that in most situations there will be multiple demands on these areas necessitating complex tradeoffs, the solution to which will be location specific. In all cases, it will be essential for the socio-economic impediments to dugong conservation to be addressed.
- Individual dugongs can undertake long-distance movements of up to several hundred kilometres in a few days. Given the dugong's capacity to move across jurisdictional boundaries, it will be important to coordinate management initiatives for dugongs across jurisdictions.

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Doug Perrine generously allowed us to use his superb underwater photograph of a dugong stirring up mud as the frontispiece.

Data for Figure (6.5) was reproduced with the permission of the Cooperative Research Centre (CRC) for the Great Barrier Reef World Heritage Area.

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This is a long list and we apologise for any inadvertent omissions.

Chapter 1
Introduction

The dugong *(Dugong dugon)* is the only herbivorous mammal that is strictly marine and is the only extant species in the Family Dugongidae. The other members of the Order Sirenia, the three species of manatee, all use fresh water to varying degrees (Reynolds & Odell 1991). The only other recent Sirenian, Steller's sea cow *Hydrodamalis gigas,* was hunted to extinction within 27 years of its discovery in the eighteenth century (Stejneger 1887). All extant members of Order Sirenia (including the dugong) are listed as vulnerable to extinction (Anon. 1996a). All populations of the dugong are also listed on Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Prospects for the survival of the dugong are the best, because each manatee species has a more localized distribution than that of the dugong (Reynolds & Odell 1991). In addition, the estimates of dugong abundance in Australia (Chapter 6) are much greater than have been recorded or suggested for any species of manatee.

Distribution and Abundance

As summarised in this document, the dugong has a large range (Figure 1.1) that spans at least 37 countries and territories and includes tropical and subtropical coastal and island waters from east Africa to Vanuatu, between about 26° and 27° north and south of the equator (Nishiwaki & Marsh 1985). The dugong's historic distribution is believed to have been broadly coincident with the tropical Indo–Pacific distribution of its food plants, the phanerogamous seagrasses of the families Potamogetonaceae and Hydrocharitaceae (Husar 1978).

As detailed in this document, it is generally believed that throughout much of its range, the dugong is represented by relict populations separated by large areas where its numbers have been greatly reduced or it is already extirpated. However, the degree to which dugong numbers have dwindled, and their range fragmented, is not known for any country in its range. We are encouraged that dugongs are still present at the historical limits of their range (Figure 1.1, see also Chapters 2, 4 and 5),

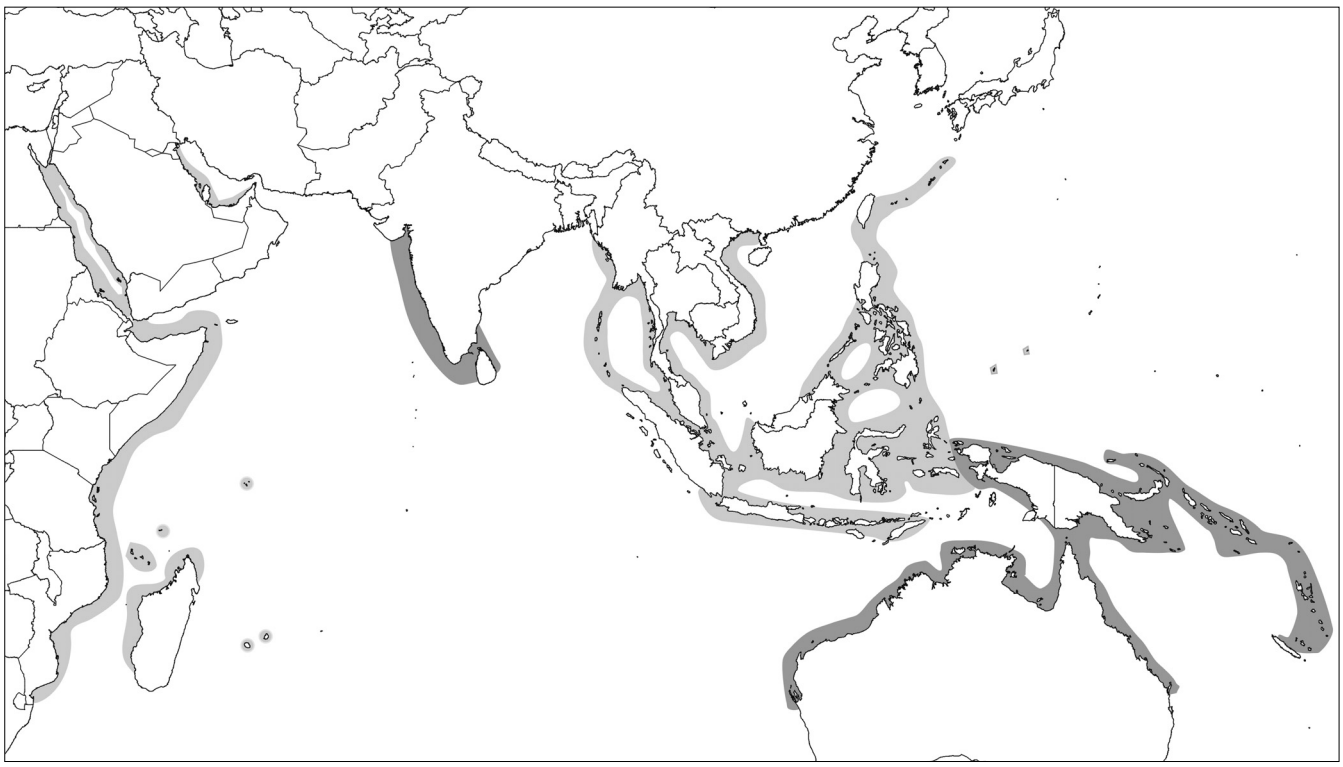


Figure 1.1 – The known range of the dugong.

although as discussed in this document there is evidence of a reduction in the dugong's area of occupancy within this range. Nonetheless, we consider that it is likely that dugong numbers are higher than previously supposed in many areas. For example, following the death of at least 37 dugongs during the 1983 Nowruz oil spill, it was feared that dugongs might have been extirpated from the Arabian Gulf. Aerial surveys in the region established that these fears were unjustified and that the estimated Arabian Gulf population was 7310 (± s.e. 1300) dugongs (Preen 1989a). Recent fixed-wing aircraft and helicopter surveys have confirmed that dugongs still occur in two areas where they had been presumed to be locally extinct: Ryukyu Islands in southwestern Japan and in a marine park in eastern Malaysia (Chapter 4).

In most of the 37 countries and territories in the dugong's range for which we have any information, our knowledge of their distribution and abundance is known only from incidental sightings, accidental drownings, and the anecdotal reports of fishers (Table **1.1**). In another fourteen countries, the dugong is known only from spatially and temporally limited surveys generally conducted parallel to the shoreline. These surveys provide minimum counts only. Extensive quantitative aerial surveys using transects across the shoreline depth gradient have resulted in a more comprehensive knowledge of dugong distribution and abundance in the coastal waters of most (but not all) of the dugong's range in the Arabian region (Chapter 2) and northern Australia (Chapter 6). However, even in these countries, the information is not comprehensive enough to establish trends in abundance for most areas, especially as there is increasing evidence that dugongs undertake large-scale movements at scales greater than those covered by individual surveys (even though the areas covered by these surveys is often very large (~30,000km^2)). In addition, even the population estimates resulting from transect surveys are probably underestimates because the correction for availability bias (the dugongs that are unavailable to observers because of water turbidity) are conservative (Marsh & Sinclair 1989a).

It is inappropriate to compare the abundance of dugongs estimated using shoreline and quantitative surveys. We believe that most of the estimates of dugong population size reported in this document are underestimates, probably major underestimates. Nonetheless in most parts of its range, the anecdotal evidence suggests that dugong numbers are declining.

In most of the developing countries that comprise the dugong's range, it may be impractical to use aerial surveys to improve knowledge of dugong distribution and relative abundance. More economical survey and research techniques, such as interviews, should be used at least initially, in areas where there is little or no information as suggested by Marsh & Lefebvre (1994) and detailed in Aragones *et al*. (1997).

Life History

Almost all information on dugong life history has been obtained from the analysis of animals accidentally drowned in shark nets or killed by native hunters in northern Australia. The age-determination method developed for pinnipeds and toothed cetaceans was adapted for dugongs enabling their age to be estimated from the number of growth layer groups in the tusks (see Marsh 1980). Life-history parameters are summarized in Marsh (1995a, 1999). Dugongs are long-lived with a low reproductive rate, long generation time, and a high investment in each offspring. The oldest dugong whose tusks have been examined for age determination was estimated to be 73 years old when she died. Marsh's research suggested that females do not bear their first calf until they are at least ten and up to 17 years old. Using the same age determination technique, Kwan (*unpublished data*) has recent evidence from Torres Strait of dugongs producing their first calf as early as age 6 years. Gestation is in the region of 13-15 months. The usual litter size is one. The calf suckles for 14-18 months or so, and the period between successive calvings is spatially and temporally variable; estimates range from 2.4 (Kwan *unpublished data*) to seven years. Dugongs start eating seagrasses soon after birth, but they grow rapidly during the suckling period when they also receive milk from their mothers. Population simulations indicate that even with the most optimistic combinations of life-history parameters (e.g. low natural mortality and no human-induced mortality) a dugong population is unlikely to increase more than 5% per year (Marsh 1995a, 1999). Although this figure will be revised slightly upward as a result of Kwan's *unpublished data*, the conclusion that its life history makes the dugong vulnerable to over-exploitation remains.

Dugong mating behaviour appears to vary spatially. Preen (1989b) observed mating herds in Moreton Bay, Queensland (Figure 6.6), where male dugongs violently compete for oestrous females, and similar herds have been observed in two localities in northern Queensland (Marsh *et al*. 1999). Several presumed males attempt to embrace the presumed female, each attempting to mate with her (Preen 1989b). In contrast, resident dugongs in South Cove in Shark Bay in Western Australia (Figure 6.1) exhibit mating behaviour consistent with the definition of a lek. "In a classic lek males aggregate on mutually exclusive display areas at a traditional site that

lacks resources required by females. Females visit this site only in order to mate" (Anderson 1997). Anderson (1997) observed male dugongs defending mutually exclusive territories in which unique behaviours were displayed in order to attract females. It is not known whether lekking occurs elsewhere in the dugong's range.

Diet

Dugongs are seagrass specialists, uprooting whole plants when they are accessible, but feeding only on leaves when the whole plant cannot be uprooted (Anderson 1982a; Marsh *et al*. 1982, 1999). Anderson (1998b) claims that his observations in North Cove, Shark Bay, Western Australia (Figure 6.1), suggest that dugongs selectively forage for *Halodule* rhizomes. Dugongs prefer seagrasses that are lower seral or 'pioneer' species (Preen & Marsh 1995), especially species of the genera *Halophila* and *Halodule*. Diet selection is correlated with the chemical and structural composition of seagrass (Lanyon 1991; Aragones 1996). The most frequently selected species are lowest in fibre and highest in available nitrogen and digestibility (Lanyon 1991; Aragones 1996). Selection for the species that are highly digestible *(Halophila)* and have high nutrients *(Halodule)* means that dugongs maximize the intake of nutrients rather than bulk (Aragones 1996). Marine algae are also eaten (Marsh *et al*. 1982), but this is believed to occur only when seagrass is scarce (Spain & Heinsohn 1973). Anderson (1989) and Preen (1995) have evidence that dugongs may deliberately forage for macro-invertebrates near the southern limits of their range in both western and eastern Australia. However, examination of stomach and faecal samples (Preen & Marsh 1995) suggests that dugongs do not deliberately forage on macro-invertebrates in more tropical areas in Australia. This conclusion must be regarded as tentative because of the differential digestibility of plant and animal material in the mammalian alimentary canal (Sheffield *et al*. 2001).

The highly specialized dietary requirements of the dugong suggest that only certain seagrass meadows may be suitable as dugong habitat (Preen *et al*. 1995). Preen *et al*. (1995), de Iongh (1996) and Aragones and Marsh (2000) suggest that grazing activities by dugongs alter the species composition of seagrass communities at a local scale. Thus, areas that support sizeable numbers of dugongs may have the capacity to provide better 'quality' food than areas that support few or no dugongs and rely only on natural turnover rates for recycling and redistribution of nutrients (Aragones & Marsh 2000).

Habitat

Dugongs generally frequent coastal waters. Major concentrations tend to occur in wide shallow protected bays, wide shallow mangrove channels and in the lee of large inshore islands (Heinsohn *et al*. 1979). These areas are coincident with sizeable seagrass beds. Dugongs are also regularly observed in deeper water further offshore in areas where the continental shelf is wide, shallow and protected. For example, in Torres Strait between Australia and Papua New Guinea, significant numbers of dugongs are seen more than 10km from land (Marsh & Saalfeld 1989, 1991). Marsh and Saalfeld (1989) have also sighted dugongs ~58km from the north Queensland coast, in water up to 37m deep. This distribution reflects that of deepwater seagrasses such as *Halophila spinulosa* (Lee Long *et al*. 1993). Dugong feeding trails have been observed at depths of up to 33m off north-eastern Queensland (Lee Long & Coles 1997). Whiting (1999) reported dugongs including calves at Ashmore Reef (12° 15'S, 123° 05'E) on the Sahul Banks on the edge of the Australian continental shelf. Although Ashmore Reef is only 140km from the Indonesian Island of Roti, these locations are separated by the Timor Trough which is 2000m deep.

There is evidence that dugongs use specialised habitats for various activities. Shallow waters, such as on tidal sandbanks (Marsh *et al*. 1984c) and estuaries (Hughes & Oxley-Oxland 1971), have been reported as sites for calving. Anderson (1981) suggested that this may be a strategy to minimise the risk of shark predation.

The physical characteristics of South Cove in Shark Bay, Western Australia (Figure 6.1) may make it especially suitable for the lek mating behaviour observed by Anderson (1997). At the higher latitudinal limits to their range, deeper waters may be used as a thermal refuge from cooler inshore waters (Anderson 1986; Marsh *et al*. 1990; Preen 1992) in winter.

Life history attributes of dugongs are likely to vary across such a huge range of habitat types (Reynolds *pers comm*. 2001).

Movements

Most movements of the more than 60 dugongs that have been tracked by means of VHF or satellite transmitters in Indonesian and Australian waters have been localised to the vicinity of seagrass beds (Marsh & Rathbun 1990; Preen 1992; de Iongh 1996; de Iongh *et al*. 1998; Preen 1999, 2001). Animals caught in the same region tend to show individualistic patterns of movement. Daily movements depend on tidal amplitude. At localities

where the tidal range is large (e.g. up to 8.5m in Shoalwater Bay in Queensland; Anderson & Birtles 1978) (Figure 6.6), dugongs can gain access to their inshore feeding areas only when water depth is 1m or more. In areas with low tidal amplitude such as Shark Bay in Western Australia (Anderson 1982b) (Figure 6.1) or in areas where seagrass grows subtidally, daily movements are not dictated by tides. At the high-latitude limits of their range, dugongs make seasonal movements to warmer waters. In winter in Moreton Bay, Queensland (Figure 6.6), many dugongs regularly make a round trip of 15–40km between their foraging grounds inside the bay and oceanic waters, which average up to 5°C warmer (Preen 1992). Dugongs also undertake winter movements of the order of 100km across Shark Bay Western Australia (Figure 6.1) to warmer waters in the westward part of that bay (Anderson 1982b, Marsh *et al.* 1994a; Gales, Holly & Lawler *unpublished data*). At least some individual dugongs undertake long-distance movements. An adult female moved 600km between two sites in the Gulf of Carpentaria in Australia (Figure 6.2) over about five days (Preen 1995). Another male travelled between two localities, in the Central Section of the Great Barrier Reef Australia (Figure 6.1), a straight-line distance of 140km, three times in six weeks (Marsh & Rathbun 1990). Of the ten dugongs fitted with satellite transmitters in Shoalwater Bay, Queensland (Figure 6.6) by Preen (1999), four made substantial trips out of that bay. Two made return trips: one 100km north, the other 220km north. Two other animals journeyed 400km south to Hervey Bay (Figure 6.1) where their transmitters came off. Thirteen dugongs were tracked between the Townsville and Hinchinbrook Island region in Queensland (Figure 6.6). Twelve trips were made of more than 30km beyond the area regularly used by these animals, six trips of more than 100km and one trip of more than 600km (Preen 2001). Most of these movements were return trips. For example, the animal that moved more than 600km north returned to her capture point after five months and almost immediately moved another 165km south along the coast. The movements of this dugong thus spanned about 800km of coast. Reports in 2001 of dugongs at Aldabra Atoll (Chong-Seng *pers comm.* 2001) 425km from Madagascar confirm their capacity to cross deep ocean trenches (up to 4km in depth) as dugongs have not been seen in this region for many years (Cockcroft *et al.* 1994; Cockcroft & Young 1998).

This capacity of dugongs to undertake long-distance movements indicates that the management of dugongs is an international issue in most parts of their range.

Genetic Population Structure

Molecular techniques are being used to investigate the genetic population structure of dugongs (Tikel 1998; McDonald *unpublished data*). Results to date are based on mitochondrial DNA which evolves relatively quickly and is considered a good index of population structure. It is transmitted only in the female lineage and can only be used to estimate female-mediated gene flow. Results are based on very small sample sizes from outside Australia and for many areas in the dugong's range within Australia. In addition in mammals, male-mediated gene flow is often markedly greater than female-mediated flow. To test for this in dugongs, a nuclear marker, or markers, will be used to make a more complete assessment of the genetic population structure. Thus the conclusions outlined below are tentative.

The results suggest that the haplotypes of dugongs from parts of Southeast Asia (Indonesia, Thailand and the Philippines) are generally distinct from those from Australia with overlap at Ashmore Reef between Western Australia and Timor, suggesting that there is (or has been in the past) limited genetic exchange between Australia and Asia. The genetic structure of dugong populations around the Australian coast appears to comprise two maternal lineages one of which has also been recorded from dugongs from Kenya and the Arabian Gulf (Tikel 1998). Torres Strait between Australia and Papua New Guinea is a major zone of overlap between the two lineages.

Threatening Processes

Dugongs are vulnerable to anthropogenic influences because of their life history and their dependence on seagrasses that are restricted to coastal habitats, and which are often under pressure from human activities. There are a number of socio-political impediments to dugong conservation, particularly in developing countries. The displacement and urbanisation of rural human populations has led to the loss of traditional values and taboos to resource exploitation. The nearshore areas where dugongs occur have become an easy and convenient source of food and income. The provision of philanthropic aid from 'developed countries' increases the efficiency and level of exploitation. The situation is exacerbated by an absence of adequate legislation, enforcement and management (Cockcroft *pers comm.* 2001).

The rate of population change is most sensitive to changes in adult survivorship. Even a slight reduction in adult survivorship as a result of habitat loss, disease,

hunting or incidental drowning in nets, can cause a chronic decline in a dugong population. As explained above, Marsh (1995a, 1999) suggested that the maximum rate of increase under optimum conditions would be on the order of 5% per year even when natural mortality is low (<5% per year). The sustainable harvest is likely to be in the order of 2% of the female population per year. The sustainable harvest rate will be lower in areas where the pre-reproductive period and/or calving interval are lengthened by food shortage (Marsh 1999). Dugongs may be short of food for several reasons including habitat loss, seagrass dieback, decline in the nutrient quality of available seagrass or a reduction in the time available for feeding because of acoustic disturbance such as boat traffic.

Habitat Loss and Degradation

Seagrass ecosystems are very sensitive to human influence (Fonseca 1987; Shepherd *et al.* 1989; Poiner & Peterken 1996). Seagrass beds may be destroyed directly by mining and trawling (Silas & Bastion-Fernando 1985), or lost through the effects of disturbances such as dredging, inland and coastal clearing, land reclamation and boat propeller scarring. These activities cause increases in sedimentation and turbidity which, in turn, lead to degradation through smothering and lack of light. Other threats include sewage, detergents, heavy metals, hypersaline water from desalination plants and other waste products. Most losses, both natural and anthropogenic, are attributed to reduced light intensity due to sedimentation and/or increased epiphytic growth caused by nutrient enrichment. In some cases, factors such as poor catchment management and sediment instability interact to make the processes more complex so that it is often difficult to separate natural and anthropogenic causes of seagrass loss. In addition, herbicide runoff from agricultural lands also presents a potential risk to seagrass functioning adjacent to sugarcane production areas (Haynes *et al.* 1998).

Episodic losses of hundreds of square kilometres of seagrass are associated with extreme weather events such as some cyclones, hurricanes and floods (Poiner & Peterken 1996). Jones (1967) reported the widespread loss of seagrass in the Gulf of Mannar–Palk Bay area between India and Sri-Lanka in 1954 as a result of a cyclone accompanied by very heavy rains. Large numbers of dugongs were reportedly washed ashore a few days after the cyclone. In the Gulf of Carpentaria in Northern Australia (Figure 6.2 and 6.3) in 1985, cyclone Sandy caused the loss of 151km^2 of seagrass, representing ~20% of the entire Gulf's seagrass area. In 1991–92 several hundred square kilometres of seagrass disappeared from Torres Strait between Australia and Papua New Guinea (Figure 6.4), possibly because of high turbidities resulting from flooding of river(s) in Papua New Guinea. Furthermore, more than 1000km^2 of seagrass was lost in Hervey Bay, Queensland (Figure 6.6) in 1992–93, possibly because of high turbidities resulting from flooding of local rivers, and runoff turbulence from a cyclone three weeks later (Preen & Marsh 1995). Such events can cause extensive damage to seagrass communities through severe wave action, shifting sand, adverse changes in salinity and light reduction (Heinsohn & Spain 1974; Kenyon & Poiner 1987; Preen & Marsh 1995; Preen *et al.* 1995). Recovery and recolonization after large-scale losses of tropical seagrasses may take a decade or more (Poiner & Peterken 1996).

Halophila ovalis, one of the preferred food species of dugongs, appears to be particularly sensitive to light reduction, with the duration and frequency of light-deprivation events apparently being the primary factors affecting the survival of this seagrass in environments that experience transient light deprivation (Longstaff *et al.* 1999). During light-deprivation experiments the biomass of *H. ovalis* declined rapidly and recovered slowly, with a complete die-off occurring after 30 days of deprivation (Longstaff *et al.* 1999). Members of the genus *Halophila* occur at greater depths than other species of tropical seagrasses and this sensitivity to light reduction is a plausible explanation of the large-scale loss of deep-water seagrasses in Torres Strait (Poiner & Peterken 1996) (Figure 6.4) and Hervey Bay (Preen *et al.* 1995) (Figure 6.6).

To date, the approach to seagrass protection has largely been through marine parks and fishing industry closures to prevent structural damage to seagrass beds through trawling. There have been few attempts to protect seagrass beds from adverse impacts on ecosystem processes associated with land use, even though such impacts have been recorded as of concern in most of the countries for which we obtained information for this document (Table 1.2). Localities that provide shelter and water conditions ideal for seagrasses are often the target for port developments and at the down-stream end of severely affected catchments (Lee Long & Coles 1997). As identified by Lee Long and Coles (1997), research is urgently required to describe the response of seagrasses to natural and human factors and to establish: (1) acceptable levels of change in response to such factors, and (2) the water-quality conditions that lead to these changes.

Fishing Pressure

Accidental entangling in gill and mesh nets or traps set by fishers is considered a major, but largely unquantified, cause of dugong mortality in many

countries (Perrin *et al*. 1996) and was identified as a major concern in virtually all countries covered by this document (Table 1.2). Throughout most of the dugong's range, this pressure comes from locally-based artisanal fisheries. Of more concern, are the industrial scale gill net fisheries which have developed in some areas. Fortunately for dugongs, these are in offshore waters which are not major dugong habitats. To our knowledge, the systematic collation of data on the incidence of dugong by-catch in fisheries has not been attempted by observer programs in any country in the dugong's range. No data are available on the take of dugongs by lost or discarded nets, although drowning in these nets presumably occurs.

The relationship between tides, bottom topography, turbidity and patterns of netting needs investigation. In relatively shallow bays with large tidal fluctuations and high turbidity, seagrass meadows are largely intertidal. In such circumstances, dugongs and netters are all forced to use intertidal areas on the high tide, increasing the chances that dugongs will be caught.

Acoustic alarms (pingers) are proving effective at reducing the mortality of the harbour porpoise, *Phocoena phocoena,* in gill nets (Trippel *et al*. 1999). These alarms are increasingly seen as a possible solution to the problem of marine mammals drowning in nets in developed countries, although the associated costs are likely to preclude their use throughout most of the dugong's range. The auditory capabilities of the West Indian manatee range from 0.4 to 46 KHz (Gerstein *et al*. 1999), spanning the range of acoustic alarms (10–12 kHz) (Trippel *et al*. 1999). The effectiveness of the use of acoustic alarms in reducing the mortality of dugongs in nets has not been tested. Given the dugong's specialised habitat requirements, it is important to test whether their use reduces the habitat available to dugongs before they are widely adopted in countries such as Australia and Japan.

Shark nets set for bather protection can be another source of dugong mortality. Between 1962 and 1995, shark nets set on swimming beaches in Queensland netted 837 dugongs (Anon. 1992). Most animals caught in shark nets die (Paterson 1990). In response to a Ministerial Committee of Enquiry (Anon. 1992), initiatives were begun in 1992 (Gribble *et al*. 1998) to reduce the capture of non-target species. Baited hooks have replaced shark nets in many localities and the mortality associated with this program is now low.

Indigenous Use and Hunting

Dugongs are culturally significant to communities throughout their range. In this document, we record information about the indigenous use of dugong products in most of the countries for which we have information (Table 1.2). Dugongs are caught for meat, oil, medicaments, amulets and other products.

In many countries dugong hunting is now banned and animals are no longer hunted deliberately however, dugong products from indirect takes are still highly valued. Australia's indigenous peoples consider dugong hunting to be an important expression of their identity. In the Western Islands of Torres Strait, the dugong harvest in the 1990s has been estimated to be on the order of 1000 per year (Marsh *et al*. 1997a).

Indigenous peoples' rights to utilise their sea country (for activities including hunting) have recently been recognised by the High Court of Australia (The *Commonwealth* v. *Yarmirr; Yarmirr* v. *Northern Territory* [2001] HCA 56 [11 October 2001] D72000 and D92000). This decision confirms that the indigenous people of Australia hold Native Title over the sea beyond the low water mark. These rights are non-commercial and non-exclusive. The Torres Strait Treaty between Australia and Papua New Guinea explicitly protects the traditional way of life of the local indigenous peoples including the right to hunt dugongs.

Vessel Strikes

Vessel strikes are a major cause of mortality for Florida manatees (Wright *et al*. 1995). Although manatees possess the intellectual and physical ability to recognise and avoid boats (Hartman 1979; Gerstein 1994, 1995), the results of Gerstein *et al*. (1999) suggest that the West Indian manatee possesses a limited low-frequency hearing sensitivity and therefore has difficulty detecting, as well as locating, approaching boats from safe distances. The relevance of these results to dugongs is unknown because the anatomy of the dugong ear differs from that of the manatee (Ketten *pers comm*. 2001). Although there are few documented dugong deaths due to vessel strikes (Table 1.2), increasing vessel traffic in the dugong's range increases the likelihood of strikes. Areas where there are extensive shallow areas used by regionally important populations of dugongs close to areas of high boat traffic are particularly at risk.

Ecotourism

The expansion of ecotourism has resulted in the establishment of tourism operations involving dugong-watching cruises at several locations in Australia (Chapter 6) and swim with dugong operations in the Philippines (Chapter 4) and Vanuatu (Chapter 5). The effect of these activities on the animals is unknown, although it is under investigation in Western

Australia. We are unaware of similar operations outside these regions.

Acoustic Pollution

Despite consistent anecdotal reports of dugongs ceasing to use areas with high boat traffic, there has been no formal attempt to study the effect of acoustic pollution from boat traffic on the dugong. Such a study has commenced in Queensland, Australia. Acoustic pollution could be particularly important in areas with large tidal ranges and little seagrass below the low tide mark. Presumably, high levels of vessel traffic in such areas could prevent dugongs from using available intertidal seagrass meadows. Defence Force exercises are conducted at several localities within the dugong's range in Australia. The exercises include surface and underwater explosion of bombs, amphibious landings, and firing of shells (Anon. 1997a). There have been no reports of dugong mortality as a direct result of these undersea detonations. Such explosions have the potential to cause indirect effects to the dugong such as injury, social disturbance, displacement or habitat damage (Anon. 1997a). The risk of adverse effects on dugongs from Defence Force activities must be evaluated in the context of the environmental protection afforded by these activities in comparison with those of other land uses.

Seismic surveys are an essential component of offshore oil and gas exploration and are used to study rock strata below the sea floor. Marine seismic surveys use high-energy, low-frequency sound produced by arrays of air-guns (Richardson *et al.* 1995) which are designed to project very strong sounds downward through the water. Considerable sound propagates horizontally as well (Richardson & Malme 1993). The sounds produced by air-gun arrays have most of their energy in the frequency range of 10–100 Hz. Some specialized surveys may have energy in the 500 Hz to 2 kHz range (McCauley *pers comm.* 2000), close to the frequency of sounds made by dugongs (Anderson & Barclay 1995). Effects might include: (1) interference with the animal's natural acoustic communication signals, (2) damage to their hearing systems, and (3) behavioural changes including disturbance reactions, ranging from brief alterations in behaviour to short- or long-term effects on individuals or populations (Richardson & Malme 1993; McCauley 1994). Although to date there has been no documented evidence of marine seismic surveys being detrimental to populations of dugongs, there have been no detailed studies.

Chemical Pollutants

Dugongs accumulate high levels of some heavy metals with age (Miyazaki *et al.* 1979; Denton *et al.* 1980; Haynes 2001). There is no evidence to suggest that the accumulation of heavy metals is unnatural or particularly harmful to dugongs, as it appears to be a response to the manner in which seagrasses store these minerals. However, metal levels can be so high that some dugong tissues may be unsuitable for human consumption. Elevated concentrations of chromium and nickel have been detected in liver samples from several animals collected from the southern Queensland coast (Haynes 2001). Where ports are established to load metal ores in areas with significant populations of both dugongs and indigenous hunters, this issue requires consideration in the design and operation of storage and loading facilities.

The information on pesticide accumulation in dugongs is very limited and restricted to South Sulawesi (Miyazaki *et al.* 1979) and to northern Australia where human population density is generally low (Haynes 2001). Tissue samples of liver and blubber were salvaged from 53 dugong carcasses stranded along the Queensland coast between 1996-2000 as part of the Necropsy Program conducted by the Queensland Parks and Wildlife Service. Blubber samples were analysed for organochlorine compounds and polychlorinated biphenyls (Haynes 2001). Dieldrin, DDT and/or DDE were detected in 59% of blubber samples. Concentrations of organochlorines were similar to those reported from dugongs 20 years earlier, and were low in comparison to concentrations recorded from marine mammal tissue collected elsewhere in the world. Polychlorinated dibenzodioxins appear to be the most significant organochlorine pollutant bioaccumulated in the dugong (Haynes *et al.* 1999). Necropsy sampling of dugong has determined that octachlorinated dibenzodioxins concentrations have been found to be up to twice as high in dugongs as found in any other marine mammal (Haynes *et al.* 1999; McLachlan *et al.* 2001). Organochlorine pesticides and polychlorinated biphenyl congeners have been implicated in reproductive and immunological abnormalities observed in other marine mammal populations (Kuiken *et al.* 1994; Johnston *et al.* 1996). The significance of their occurrence in dugongs is unknown. Nonetheless, these results suggest that chemical pollution should be investigated in the more highly populated regions typical of the dugong's range outside Australia.

Even though dugongs occur in areas that are important shipping lanes, there is limited information about dugongs being impacted by oil spills. At least 37 dugong carcasses were recovered in the months after the Nowruz oil spill in the Arabian Gulf in 1983 (Preen

1989a). Although the link with the oil spill was unproven, there is no evidence that another cause was responsible.

Diseases

Dugongs are susceptible to a wide range of diseases, some of them infectious or parasitic (Campbell & Ladds 1981). Blair (1981) lists an array of parasitic infestations of Sirenia. Specimens obtained from 15 dugongs found along the north-eastern coast of Queensland showed that six were infected by helminths, two by unidentified parasites. A dugong held in captivity died from a severe bacterial infection (Elliott *et al*. 1981). A species of *Cryptosporidium,* a small apicomplexan protozoan inhabiting the respiratory and gastrointestinal tracts of a wide range of vertebrates, was found in the small intestine of a dugong from Hervey Bay, Queensland (Hill *et al*. 1997) (Figure 6.6). It is not known whether *Cryptosporidium* can complete its life cycle in the dugong, whether the infection cycles within a herd, or whether the animals can become infected from an external source. Work is in progress to establish the prevalence of *Cryptosporidium* in dugongs.

In 1999, a dugong was found swimming aimlessly in the shallows near Townsville, Queensland (Figure 6.6). It died shortly after. It had a bacterial septicaemia and a verminous bronchopneumonia; numerous parasites identified as *Cochleotrema indicum* were removed from the affected lung. The dugong was severely wasted and had numerous nematode parasites identified as *Paradujardina halicoris* in the cardiac region of the stomach; extensive abscessation of the skin and gastro-intestinal tract and the body condition was very poor. Two further dugongs from this region died from acute peritonitis in 1999, with rupture of an abscess in the small intestine in each case. In 2000, a dugong in the Townsville region died from trauma. A 13cm long sting ray barb had penetrated the abdominal wall and had lodged within the small intestine.

Necropsies conducted on sick, injured or dead marine dugongs reported to the Queensland Parks and Wildlife Service indicate that disease is the cause of death for 30% of the 80 animals for which the cause of death has been determined since 1996 (Haines & Limpus 2000). Haines and Limpus hypothesise that interannual fluctuations in dugong mortality are related primarily to the negative impact of abnormally rainy wet seasons on seagrass pasture quality and a resultant deterioration on the dugong's health status. Other marine mammal groups are subject to dramatic population declines due to the impact of epizootic diseases. No epizootic outbreaks have been reported for dugongs to date.

Susceptibility to mortality during capture for research

There is a low risk associated with catching dugongs for research. Between 100 and 200 dugongs have been caught for research purposes; more than 60 of these were fitted with telemetry gear and released. Of all these individuals, two died during capture (one possibly of pre-existing heart disease). Both animals died in Moreton Bay at the southern limit of the dugong's range in Queensland in spring, the time of year when dugongs tend to be in poorest body condition. Both dugongs appear to have suffocated probably because capture was attempted as they were surfacing to breathe.

Many of the telemetered dugongs have undertaken significant movements with one individual giving birth while being tracked. The risk of a small percentage of mortality during capture needs to be appraised in the context of the expected information resulting from the capture. Given the risks (albeit low) associated with catching dugongs for research, it is important that the information obtained from each animal captured is maximised.

Approaches to Management

Unless human values change dramatically, we believe that it will be impossible to eliminate anthropogenic impacts on the dugong throughout its vast and often remote range. Detecting trends in dugong abundance, particularly at low densities, is very difficult (Marsh 1995b). Thus the objectives of maintaining dugong numbers at present or higher levels and facilitating the recovery of depleted populations will not be achieved if the only trigger for management intervention in an area is a demonstratively declining population. As pointed out by Wade (1998), it is often potentially easier to detect the circumstances that are likely to lead to a decline in the abundance of a marine mammal than it is to detect a decline *per se*. Methods have recently been developed in the USA (Wade 1998) for identifying populations of marine mammals with levels of human-caused mortality that could lead to depletion, taking account of the uncertainty of available information. Unfortunately, this technique cannot yet be used reliably to assess the status of the dugong, because we do not yet have the data required to estimate the necessary parameters. Once these data are available, the technique should have application in remote areas in northern Australia where indigenous hunting is the major adverse impact and the dugong harvest can be recorded. Unfortunately, this approach is likely to have limited application in most of the dugong's range where there are multiple adverse effects on dugongs. This is because of the difficulties of reliably

detecting and estimating mortality in such circumstances, especially incidental mortality.

A survey by the World Resources Institute rates the risks from coastal development as medium to high for much of the dugong's range outside Australia (Anon. 1996b) because of high levels of human population growth and rapid rates of industrialisation. The dugong is also subject to indirect fishing mortality throughout most of this range (Perrin *et al*. 1996) (Table 1.2). The other threatening processes discussed above are also widely distributed (Table 1.2). In view of these multiple impacts, we consider that the optimum conservation strategy is to: (1) identify areas that still support significant numbers of dugongs; and (2) consider with extensive local involvement how impacts on dugongs can be minimised and the habitat protected in these key habitat areas. Ideally this should be done in the context of comprehensive plans for coastal zone management, perhaps using the dugong as a flagship species.

The establishment of such areas as dugong sanctuaries should reduce dugong mortality provided the areas chosen consistently support high numbers of animals, even though individual dugongs will move in and out of these areas (Marsh *et al*. 1999; Marsh 2000). The long-term effectiveness of these areas will depend on whether high-quality dugong habitat can be maintained. This will hinge to a large extent on the capacity to control land-based inputs. Areas where anthropogenic impacts other than fishing are low are more likely to be effective than areas targeted for industrial development. Candidate areas exist in much of the dugong's range and in this document we have emphasised strategies for identifying them. However, we acknowledge that in most situations there will be multiple demands on these areas necessitating complex tradeoffs, the solution to which will differ in different areas. In all cases it will be essential for the socio-economic impediments to dugong conservation to be addressed. Identifying important dugong habitats and securing their protection before local land development occurs is vital. Once land is purchased or developed, options become difficult and expensive (Reynolds *pers comm*. 2001).

Given the difficulty of identifying stock boundaries and the capacity of dugongs to move across jurisdictional boundaries, it will be important to co-ordinate management initiatives across jurisdictions. The concept of a regional dugong workshop for Southeast Asia received wide support from international delegates at the workshop held in Davao City, Mindanao, in November 1998. Regional workshops would also be appropriate in many other parts of the dugong's range, such as East Africa, the Arabian region, the Indian sub-continent, and relevant island states in the south-west Pacific, including Australia. The conservation of marine turtles and their habitats is specifically addressed in the Memorandum of Understanding on Indian Ocean and Southeast Asian Marine Turtle conservation and protection. The proposed Australian government initiative to enhance dugong conservation by promoting a similar regional agreement and conservation and management plan is welcome. Similar to marine turtles, dugongs have a priority for conservation action through their listing in the Convention on the Conservation of Migratory Species of Wild Animals (CMS). Developing a plan for dugongs similar to that already developed for Indian Ocean and Southeast Asian turtle should not be unduly difficult as the dugongs' distribution is similar to the area covered by the marine turtle agreement (so the same countries will be involved), and they share many overlapping conservation and management issues (which are already negotiated and agreed in the marine turtle agreement). Therefore a well-established management group with international contacts and an agreed conservation and management plan is currently in place to negotiate and implement a regional agreement for dugongs. For management to be effective, the general public has to be concerned about dugong conservation. Accordingly, we have emphasised the importance of public education throughout this document. Although satellite tracking dugongs is likely to be prohibitively expensive for most countries in the dugong's range, its publicity and extension value is considerable and should be considered as part of a package of management initiatives.

The challenge of managing adverse influences on dugongs in highly populated developing countries also demonstrates the importance of the remote regions of tropical Australia to dugong conservation; this was emphasized by a workshop on the status of marine mammals in Southeast Asia (Perrin *et al*. 1996). In this context, it is important that the agencies responsible for environmental management in the remote tropical regions of Australia outside the Great Barrier Reef region take a more pro-active and comprehensive approach to dugong conservation than they have attempted to date (Preen 1998).

Layout of this Document

As explained above, our understanding of the genetic structure of dugong is insufficient to identify stock boundaries. Accordingly we have used geopolitical boundaries to organise the remaining chapters in this document. These chapters discuss the status of the dugongs in various countries and provide suggestions for management and research.

Table 1.1 – Summary of information on dugong status and management within its range.

COUNTRIES	Type of information available on dugong distribution and abundance					Management Actions		
	Anecdotal	Qualitative surveys		Quantitative surveys		Legislation	Marine Parks	
		Some Areas	Entire Coast	Some Areas	Entire Coast		Generic but should protect dugongs	Specifically designed for dugongs
CHAPTER 2								
East Africa								
Somalia	✓	✓						
Kenya	✓	✓				✓	✓	
Tanzania	✓						✓	
Mozambique	✓	✓		✓				
Madagascar	✓							
Comoros	✓							
Mayotte	✓							
Seychelles	✓						✓	
Mauritius	? extinct							
Red Sea								
Egypt	✓							
Sudan	✓						✓	
Eritrea	✓						✓	
Yemen	✓							
Djibouti	✓							
Saudi Arabia	✓		✓		✓			
The Arabian Gulf								
United Arab Emirates	✓		✓		✓	✓		
Qatar	✓		✓		✓			planned
Bahrain	✓		✓		✓	✓		
Saudi Arabia	✓		✓		✓			
CHAPTER 3								
India and Sri Lanka								
Mainland India	✓	✓				✓	✓	
Andaman Islands	✓					✓		
Nicobar Islands	✓					✓		
Sri Lanka	✓	✓						
CHAPTER 4								
East and Southeast Asia								
Japan	✓	✓		✓		✓		
Taiwan (China)	✓						✓	
China	✓	✓				✓	✓	✓
Philippines	✓	✓				✓	✓	in progress

COUNTRIES	Type of Information available on dugong distribution and abundance					Management Actions		
	Anecdotal	Qualitative surveys		Quantitative surveys		Legislation	Marine Protected Areas	
		Some Areas	Entire Coast	Some Areas	Entire Coast		Generic but should protect dugongs	Specifically designed for dugongs
CHAPTER 4 (cont'd)								
Thailand	✓		✓[1]			✓	✓	✓
Cambodia	✓							
Vietnam	✓						✓	
Peninsular Malaysia	✓	✓				✓	✓	
Singapore	✓	✓						
East Malaysia	✓	✓				✓	planned	
Brunei	✓							
Indonesia	✓	✓				✓	✓	
CHAPTER 5 Pacific Islands								
Palau	✓	✓				✓		
Papua New Guinea	✓	✓				✓		✓
Soloman Islands	✓							
New Caledonia	✓					✓		
Vanuatu	✓	✓				✓		
CHAPTER 6 Australia								
Western Australia	✓	✓		✓		✓	✓	
Northern Territory and Queensland coast of the Gulf of Carpentaria	✓		✓	✓		✓	✓	
Torres Strait to Northern Great Barrier Reef	✓	✓		✓		✓	✓	✓
Urban coast of Queensland	✓		✓	✓	✓	✓	✓	✓

[1] Entire coast of the Andaman Sea

Table 1.2 – Summary of information regarding current threats to dugongs.

A lack of information for a country or territory does not confirm that threats do not exist, rather that data are unavailable. Historical accounts of threats to dugongs that are currently questionable are denoted: ?

COUNTRY	FISHING			HABITAT LOSS/DEGRADATION			HUNTING			BOAT IMPACTS		
	Gill and Mesh Nets	Explosives	Other	Coastal Development	Fishing	Other	Meat	Medicine	Other	Deaths	Ecotourism	Other
CHAPTER 2												
East Africa												
Somalia	✓		✓	✓	✓[1]	✓[2]						
Kenya	✓	✓	✓	✓	trawl	✓[3]	✓?	✓?	✓?	✓		injuries
Tanzania	✓	✓	✓	✓	trawl	mining, logging, urban pollution, agricultural runoff	✓?					
Mozambique	✓	✓	✓	✓	trawl							
Madagascar	✓	✓	✓	✓	trawl							
Comoros	✓											
Mayotte	✓											
Seychelles	✓											
Mauritius	✓	✓	✓									
Red Sea												
Egypt	✓		✓	✓	trawl	oil/sewage pollution, mining, ballast water, agricultural runoff						injuries, habitat displacement
Sudan	✓			✓	trawl		✓	✓				
Eritrea	?		✓	✓	✓		✓	✓				
Yemen	✓		✓	✓	trawl		✓?	✓?	armour ?			
Djibouti	?			✓	✓		✓	✓	armour			
Saudi Arabia	✓		✓	✓	trawl		✓?	✓?	✓[4]			
The Arabian Gulf												
United Arab Emirates	✓			✓	✓	oil pollution, dredging, ballast water, land reclamation	✓?	✓?	✓[5]			
Qatar	✓			✓	✓		✓	✓	leather, oil			
Bahrain	✓			✓	✓		✓	✓				
Saudi Arabia	✓		✓	✓	trawl		✓?	✓?				
CHAPTER 3												
India and Sri Lanka												
Mainland India	✓	✓	✓	✓	trawl	agricultural runoff, dredging, seagrass mariculture, cyclones	✓	✓	✓[5]			
Andaman Islands	✓	✓	✓		trawl		✓?	✓?				
Nicobar Islands	✓	✓	✓		trawl		✓?	✓?				
Sri Lanka	✓	✓	✓	✓	trawl		✓?	✓?				
CHAPTER 4												
East and Southeast Asia												
Japan	✓		trap nets	✓		✓[6]	✓?		crafts			
Taiwan (China)	✓		trap nets	✓		✓[7]						

COUNTRY	FISHING PRESSURE			HABITAT LOSS/DEGRADATION			HUNTING			BOAT IMPACTS		
	Gill and Mesh Nets	Explosives	Other	Coastal Development	Fishing	Other	Meat	Medicine	Other	Deaths	Ecotourism	Other
CHAPTER 4 (cont'd)												
China	✓	✓	trawl	✓	✓	✓[8]	✓ ?	✓ ?		✓		✓[9]
Philippines	✓	✓	✓[10]	✓	✓	✓[11]	✓	✓	ornaments		✓	
Thailand	✓	✓ ?	✓[12]	✓	✓[13]	✓[14]	✓ ?	✓ ?	aphrodisiac	✓		
Cambodia	✓	✓	trawl		push nets	✓[15]	✓	✓	aphrodisiac			
Vietnam	✓	✓	trawl		✓	✓[16]	✓ ?	✓ ?				
Peninsular Malaysia	✓		traps		✓	agricultural runoff, urban pollution	✓ ?		leather, aphrodisiac	✓		injuries
Singapore	✓		traps	✓	✓	urban pollution				✓		✓[17]
East Malaysia	✓	✓	traps, trawl	✓	beach seine	✓[18]	✓ ?	✓	aphrodisiac	✓		injuries
Brunei	✓			✓			✓ ?					
Indonesia	✓	✓	✓[19]	✓		✓[20]	✓	✓	✓[21]	✓		injuries
CHAPTER 5 Pacific Islands												
Palau		✓		✓		agricultural runoff	✓		jewellery			?
Papua New Guinea	✓					agricultural runoff, mining	✓		crafts, drums			
Solomon Islands	?					agricultural runoff	✓					
New Caledonia	✓			✓		✓[22]	✓			✓		injuries
Vanuatu	✓			✓		runoff	✓		oil, crafts		✓	?
CHAPTER 6 Australia												
Western Australia	✓			✓	✓	✓[23]	✓		✓[24]	✓	✓	
Northern Territory and Queensland coast of the Gulf of Carpentaria	✓			✓	✓	cyclones, mining dredging	✓					habitat displacement
Torres Strait to Northern Great Barrier Reef	✓			✓	✓	land use, mining	✓		jewellery			
Urban coast of Queensland	✓			✓	✓	✓[25]	✓		jewellery	✓	✓	

[1] Trawling and traps
[2] Agricultural runoff
[3] Pollution, sedimentation
[4] Oil, leather, armour
[5] Oil, aphrodisiac
[6] Urban pollution, aquaculture and military activities
[7] Urban and thermal pollution, mining and agricultural runoff
[8] Aquaculture, mining, pollution, siltation
[9] Habitat displacement
[10] Trawling, baynets and fish corrals
[11] Aquaculture, logging, dredging, urban/oil pollution, agricultural runoff, submarine tailing placement
[12] Baynets, trawl, beach seines
[13] Push nets, trawl
[14] Mining, water pollution, sedimentation, boat propellers
[15] Agricultural runoff
[16] Sediment runoff, waste discharge, dam construction, typhoons
[17] Habitat displacement, injuries
[18] Urban pollution, agricultural runoff, salinity
[19] Trap nets, push nets, cyanide and fish weirs
[20] Logging, agricultural runoff, urban pollution, mining and dredging
[21] Aphrodisiac, ornaments, artefacts, oils/perfumes
[22] Agricultural runoff, sewage, mining
[23] Dredging, propeller damage to seagrass, aquaculture and cyclones
[24] Tusks (by the west Kimberley people)
[25] Agricultural runoff, urban pollution, cyclones

Chapter 2
Western Range: East Africa, Red Sea and the Arabian Gulf

EAST AFRICA

Distribution and Abundance

Dugongs appear to be rapidly declining in East Africa (Figure 2.1). The latest reports suggest that they are likely to become extinct in this region (Dutton 1998). Dugongs were known to occur off Somalia, Kenya, Tanzania, Mozambique, Comoros, Madagascar, and Mauritius (Figure 2.1). Currently there appear to be very few individuals remaining along the coasts of Somalia, Kenya, Tanzania, Mayotte (in the Comoros Archipelago), Madagascar and the Seychelles, and there have been no reports of dugongs off Mauritius for many years (Cockcroft & Young 1998). The population in Mozambique waters has also declined rapidly in recent years (Dutton 1998).

This assessment of the status of the dugong off East Africa is largely based on anecdotal information, and there are few confirmed data on numbers and no quantitative assessment of population viability. Research and management are required to estimate dugong distribution and relative abundance, educate locals about the importance of sustaining the remaining populations in East African countries, and provide incentives to fishers to reduce the direct and incidental capture of dugongs.

Somalia

Travis (1967) observed herds of up to 500 individuals in Somalia. There are few data on the current status of dugongs in this region however anecdotal information suggests that they occur in the south around the Bajuni Islands (Figure 2.2). Large groups have also been reported allegedly migrating between the north of Kenya (Lamu) and Somalia (Cockcroft & Young 1998) (Figure 2.2).

Three dugongs were seen along the north coast of the Gulf of Aden (Figure 2.1), during a recent aerial survey of the area. According to Cockcroft (*pers comm*. 1998), the south coast of Somalia is inaccessible to scientists for security reasons. As a result, it is impossible to make an overall assessment of either the status or the abundance of the dugong population in Somalia at this time.

Kenya

The general impression that emerges from aerial surveys conducted in Kenya in 1973, 1975, 1980, 1994 and 1996, is that the dugong population is declining rapidly (Wamukoya *et al*. 1997). In 1967, one herd of approximately 500 individuals was reported off Kenya's south coast (Husar 1975). Pre-1961, 'large' isolated populations of dugongs were sighted at both Mombasa Marine Park and Natural Reserve and Malindi Marine National Park; however low numbers have been recorded after this date (Jarman 1966). In 1994, a maximum of 16 dugongs was sighted during aerial surveys, all within Ungwana and Malindi Bays (Cockcroft *et al*. 1994) (Figure 2.2). Based on the aerial survey data and anecdotal information, Cockcroft (1995) estimated that Kenyan waters now contain a population of approximately 50 dugongs. In 1996, six dugongs were sighted: a herd of four individuals including one calf in the Siyu channel, and two lone animals near Manda Toto Island (Wamukoya *et al*. 1997) (Figure 2.2).

Dugongs have previously been reported from the south of Kenya, off Msambweni, and in the marine reserve at Shimoni (Cockcroft *et al*. 1994) (Figure 2.2). However, no dugongs were seen in the most recent aerial surveys in this area (Cockcroft & Young 1998). Anecdotal information suggests that a group of dugongs may migrate between Somalia and Lamu (Cockcroft *et al*. 1994) (Figure 2.2).

Tanzania

Dugongs formerly occurred in northern Tanzania, along the coast of the Tanga Region (Figure 2.1). Dollman (1933) described the Zanzibar Archipelago of Tanzania as the dugong's East African stronghold. However, fishers and fisheries officers now claim that dugongs no longer occur in this area. During the 1990s there were several recorded catches of dugongs in the Zanzibar area, though there has been none in 2000-2001 (Cockcroft *pers comm*. 2001). There are few other confirmed or anecdotal reports of dugongs along the Tanzanian coast. According to

Figure 2.1 – East Africa showing place names mentioned in the text.
Inset bottom left: The Bazaruto Archipelago.

Cockcroft (*pers comm.* 1998) dugongs no longer occur in the north coast of Tanzania; no information is available for the south.

Mozambique

The overall status and distribution of the dugong is considered to have changed significantly since Hughes (1969) conducted a survey along the Mozambique coast. Hughes, relying on information supplied by coastal fishers recorded that dugongs were relatively common, occurring in groups of two to four animals.

There are few historical data on the abundance and distribution of dugongs in either Maputo or Bazaruto Bays, however, anecdotal reports suggest that dugongs

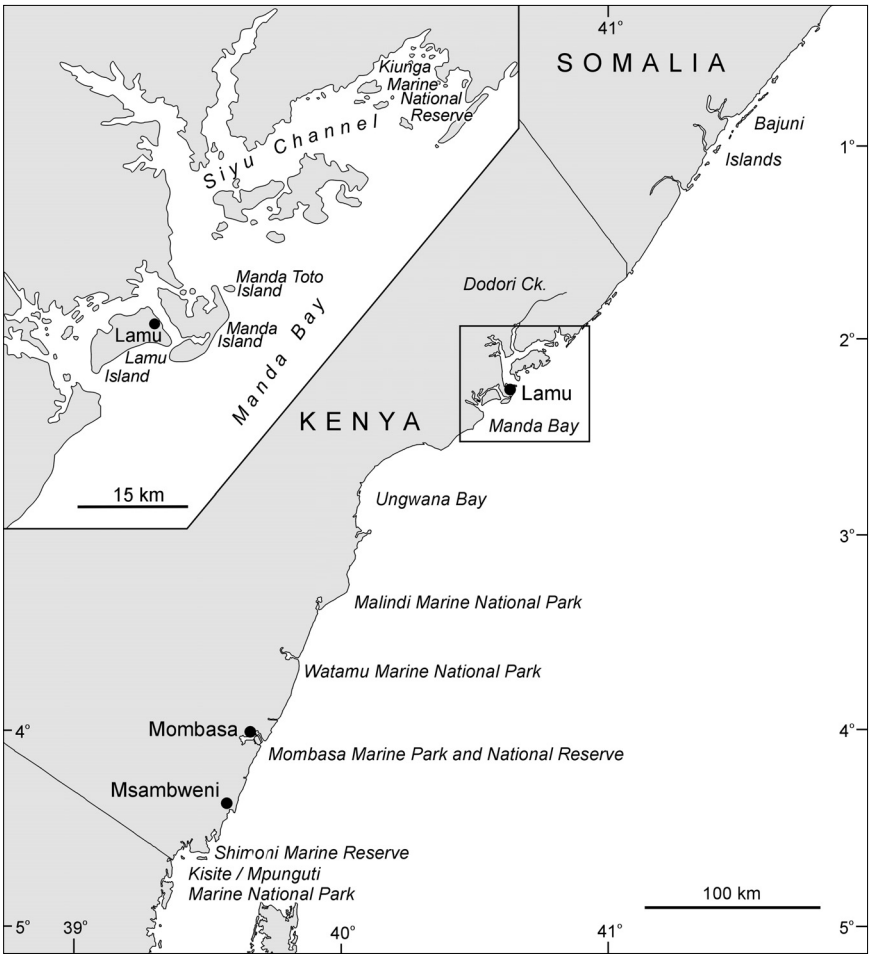


Figure 2.2 – Kenya showing place names mentioned in the text.

Inset top left: The Lamu Archipelago.

were once plentiful in Maputo Bay (Guissamulo & Cockcroft 1997).Guissamulo & Cockcroft (1997) mapped the distribution and relative abundance of dugongs in Maputo and Bazaruto Bays during 1992 using boat and aerial surveys respectively (Guissamulo & Cockcroft 1997). Dugongs were sighted in the eastern quarter of Maputo Bay, mainly around Inhaca Island however, too few sightings were available to estimate their abundance or density (Figure 2.1). Only single animals were sighted and very infrequently, although fishers occasionally report sighting groups of two dugongs. In the mid 1970s, dugong herd sizes of eight to ten individuals were reported for Inhaca Island (Guissamulo & Cockcroft 1997). Dugongs are no longer commonly seen by fishers, and Maputo Bay is believed to support only two or three individuals (Cockcroft & Young 1998).

In Bazaruto Bay, dugong distribution was widespread, although uneven. Thirty-four dugongs were sighted south of Santa Carolina Island (Guissamulo & Cockcroft 1997) (Figure 2.1). Estimates based on strip transect sightings indicated that 130 dugongs inhabited the Bay (Guissamulo & Cockcroft 1997).

Dutton (1994) considered that the waters around the Bazaruto Archipelago supported the last viable dugong population along the East African coast. Aerial surveys by Dutton (1998) suggest that the dugong population is declining rapidly throughout Mozambique waters with maximum counts down to approximately 21 dugongs per survey (Dutton 1998).

An aerial census of dugongs in Bazaruto National Park was conducted by WWF in May 2001 as part of an ongoing monitoring programme. The survey area covered 1543km^2 including the Bazaruto National Park (Bazaruto, Santa Carolina, Benguerua, Magaruque and Bangue) (Figure 2.1). Dugongs were distributed throughout the northern, central and south central areas of the Archipelago between Bazaruto Island and the mainland (similar to the 1999 distribution). Thirteen dugongs were reported in nine sightings (Mackie 2001).

Madagascar

Dugongs are no longer common along the Madagascan coastline (Figure 2.1), occurring only in small numbers along the central, northwestern and northeastern coasts (Cockcroft & Young 1998). Fishers believe that dugong numbers have declined because sightings and catches have been less frequent in recent years. However, some fishers attribute this to a change in dugong behaviour to avoid human contact (Cockcroft 1993). There are no data to support or reject this hypothesis. In some areas dugongs have not been sighted for up to 30 years. As a result, younger fishers do not know the Malagasy word for dugong. This creates difficulties in assessing the population numbers around Madagascar as dugongs can be confused with other marine mammals (Cockcroft 1993).

Anecdotal data collected during a preliminary survey by Cockcroft (1993), suggested that dugongs may occur at Toliara and Morombe (where six dugongs were caught in 1992), but do not occur between these two areas (Figure 2.1). The large section of coastline on the western side of the island between Morombe and Mahajanga is relatively uninhabited, and apparently supports extensive seagrass beds. Dugongs have reportedly been captured within this area at Soalala, and one dugong was captured in the Mahajanga region in 1991. Little information is

available on dugong distribution between Mahajanga and Diego Suarez (Figure 2.1) near the northern tip of the island, an area sparsely populated, but which is also thought to support extensive seagrass meadows. Between Diego Suarez and Antalaha, dugongs are known to occur and there have been confirmed sightings in the Bay of Diego Suarez. Dugongs are reported by fishers as being abundant but declining in numbers on the northwest coast between Maroantsetra and Antalaha, and there have been recent sightings of dugongs in the Bay of Antonglia (Cape Masoala) and the eastern extremity of the island. Prior to 1992, divers and tourists reported sightings of dugongs at Isle Saint Marie but no recent sightings have been reported (Cockcroft 1993) (Figure 2.1).

Comoros Archipelago, Mayotte, Seychelles and Mauritius

Dugongs occur in Comorian waters in small numbers. Dugongs also occur in small numbers within the lagoon waters of Mayotte. It is likely that dugongs are resident or semi-resident in these waters, as Mayotte is surrounded by deep water and is 100km from the nearest Comorian Island (Cockcroft *et al*. 1994; Cockcroft & Young 1998) (Figure 2.1).

Dugongs are thought to have occurred off all or most of the islands in the Seychelles and around Mauritius. Prior to sightings in 2001, dugongs were presumed to have been extinct in this region since the early 20th century (Cockcroft *et al*. 1994; Cockcroft & Krohn 1998). However, between August and October of 2001, dugongs were sighted and photographed at Aldabra Atoll (between Seychelles and the Comoros Islands; Figure 2.1) by staff of the Aldabra Research Station. The most recent sighting was in the shallow lagoonal waters of an area known as Bras Monsieur Clairemont. The dugongs are believed to be adults, are usually solitary, and were sighted in the same area (Chong-Seng *pers comm*. 2001).

Threatening Processes

Cockcroft (*pers comm*. 1997) believes that dugongs are one of the most endangered large mammals of the African continent. Dugongs continue to be threatened by direct human exploitation, habitat loss and destruction, and incidental capture during fishing operations in this region. Many western Indian Ocean states are developing countries, and are characterised by high population growth, limited industrial and infrastructure development and a tendency to subsistence economies. Thus environmental conservation is not a priority (Cockcroft *et al*. 1994).

Habitat Loss and Degradation

East African countries, particularly those along the coast, are experiencing massive population increases and demographic changes which are resulting in environmental degradation. This degradation results from poor farming practices such as overgrazing, and grazing livestock on coastal dunes; the clearing of coastal and inland forests including the clearing of wetland vegetation (for salt pan and shrimp farm construction), and mangrove stands (for firewood and building material); and sand mining. The result has been a massive increase in soil erosion and inshore silt loads. As a result of deforestation, much of the barrier reef off Madagascar is covered in fine, red silt. These processes are degrading estuarine and coastal habitats, including critical inshore dugong feeding areas (Cockcroft *et al*. 1994; Wamukoya *et al*. 1996a and b). Seagrass beds are also being destroyed by trawl nets (Wamukoya *et al*. 1996a and b).

Of particular concern for dugong conservation is Maputo, Mozambique's largest city, where approximately three million people live in an area with infrastructure for only 600,000 people. Much of the waste spills into Maputo Bay with resultant decline in water quality (Cockcroft *et al*. 1994).

Intensive exploitation of the marine biological resources in Kenya's inshore waters is apparently causing changes to food web structures as indicated by an abundance of the sea urchin *Diadema* in areas such as Diani, on the southern beaches of Mombasa (Wamukoya *et al*. 1995). These changes are decreasing the suitability of these areas as dugong habitats and are thus believed to be altering dugong distribution along the Kenyan coast (Wamukoya *et al*. 1996a and b). Poor land use practices causing increased sedimentation is a threat to the Malindi and Watamu areas (Muthiga *et al*. 1999) (Figure 2.2).

Seagrass beds have been reported along the south coast of Somalia from Adale to Chiamboni (UNEP 1987) (Figure 2.1). Agricultural growth and development may be affecting the coastal areas of Somalia. Overgrazing-induced erosion has lead to increasing siltation, particularly in the southern region (UNEP/PERGSA 1997). Further increases in the silt load have the potential for heavy impacts on seagrass. Several types of chlorinated and organo-phosphorous pesticides are used extensively (UNEP/PERSGA 1997). Runoff may have bioaccumulative impacts on dugongs and other marine organisms.

Fishing Pressure

Hughes (1969) reported that at least six dugongs per month were caught by artisanal fishers and sold at a market in Antonio Ennes, Mozambique (now Angoche;

Figure 2.1). Artisanal fisheries mostly operate in inshore waters along the East African coast. These fisheries involve the use of seine or drift and bottom set gill nets from small traditional boats (Cockcroft *et al.* 1994). The density of gill nets along the coast, particularly along the central coast is high. Semi-commercial shrimp trawling also operates within Maputo Bay (Mozambique). There are no records of the numbers of dugongs taken as by-catch in these fisheries however, surveys, including interviews with fishers, have revealed that dugongs are taken in the drift gill net fishery (Guissamulo & Cockcroft 1997). There have been reports, particularly from the Lamu Archipelago, Kenya (Figure 2.2) that dugongs commonly drown in set nets along this coast (Cockcroft *et al.* 1994; Wamukoya *et al.* 1997). Since 1997, at least seven dugongs, including a calf, have been killed either by drowning in fishing nets or through propeller damage (Muthiga *pers comm.* 2001). In Mozambique, where gill net use is extensive, there also appears to have been a decline in dugong numbers (Crockcroft & Krohn 1994). There is strong circumstantial evidence that fishing pressure has a strong influence on marine mammal abundance and distribution in Mozambique waters as well (Guissamulo & Crockcroft 1997).

A commercial fishery for sharks was established in Maputo Bay and the Bazaruto Archipelago in Mozambique using 40cm stretch size gill nets which are set for extended periods in known dugong habitats, resulting in many dugong mortalities (Dutton 1994; Cockcroft *et al.* 1994; Guissamulo & Cockcroft 1997).

Incidentally captured dugongs are eaten by fishers. The meat may also be disguised as pork and sold in restaurants (Dutton 1994; Christie 1997). There is evidence that the catch of dugongs has progressed into a directed fishery in Maputo and Bazaruto Bays (Guissamulo & Cockcroft 1997; Cockcroft & Young 1998). Nets of over 100m in length are stretched across seagrass beds in the evening. Dugongs using these feeding grounds get entangled and drown, or are ambushed by boats as they move onto or off the shallow seagrass beds. Fishers do not openly admit to taking dugongs however, dugong meat is prized (Cockcroft *et al.* 1994). Dynamite is used to exploit resources associated with the fringing coral reef (Cockcroft *et al.* 1994). Dynamite has been deliberately used to kill dugongs in some other parts of their range (e.g. Palau; see Brownell *et al.* 1981; Marsh *et al.* 1995).

The fisheries of Madagascar are an important source of food and income. Fishing pressure is particularly high in times of drought, when agriculture is abandoned in favour of food collection from the inshore zone, and the selling of food and items such as shells and bones to tourists (Cockcroft 1993). Fishing effort has increased as a result of the fisheries agreement between Japan and Madagascar in 1990 which opened up many sensitive dugong habitats to artisanal fisheries (Folkens 1989, 1990; Cockcroft *et al.* 1994).

Indigenous Use and Hunting

Dugongs have played an important role in the cultural heritage of Kenya as the focus of many legends and traditional stories. In Lamu (Figure 2.2), the dugong has been referred to for hundreds of years as the 'Queen of the Sea'. Traditional hunting of dugongs in Kenya involved the use of harpoons. Legislation now bans the hunting of dugongs. Hunting is considered to be one of the factors causing the decline in dugong numbers along the south coast of Kenya (Wamukoya *et al.* 1995). There is also evidence that dugongs were previously harvested along the Tanga Region (north Tanzania) (Cockcroft & Young 1998).

Kenyans traditionally use different parts of the dugong for food, medical and ornamental purposes. Dugong meat is very popular in Kenya among the coastal inhabitants, particularly the Bajuni tribe who live between Lamu and the Somali border, as it is preferred to veal or pork. The oil is used as fuel for lamps, and together with powdered dugong bones and the inhalation of smoke from burning dugong bones, is believed to cure a variety of ailments from tooth aches to labour pains. The tusks of the dugong are fashioned into ornaments and jewellery such as rings and nose plugs. Pieces of tusk and bone are also worn by children as charms to ward off evil spirits (Wamukoya *et al.* 1995).

Existing Conservation Initiatives

Legislation

Kenya

Dugongs have complete protection in Kenya (Wamukoya *et al.* 1995) however, they are not yet listed under Schedule I of the Protected Animals Law under the *Wildlife Act*, despite their apparently endangered status in Kenyan waters. The catching of marine mammals in Kenya is illegal (Cockcroft *et al.* 1994). In addition, the *Fisheries Act 1989*, restricts trawler activities to beyond five nautical miles from shore. However, because of the type of fisheries, the available trawling area, and the size of trawlers (which limits their offshore fishing capability), these restrictions are currently not implementable (Wamukoya *et al.* 1996a and b). *The Wildlife Conservation and Management Act* mandates the Kenya Wildlife Service to manage wildlife. The Kenya Wildlife Service is also the organisation that is responsible for

CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora).

Mozambique

Protective wildlife legislation which includes dugongs has been in place since 1955 however, this legislation has never been effective (Dutton 1994). Legislation currently sets a fine of 7.5 million Meticals (approximately R3000 in South African currency or about US$600) and 3 months in prison for killing a dugong, even in the case of an accidental gill net fatality. However, law enforcement efforts are insufficient to be an effective deterrent (Dutton 1998).

Legislation was passed in 1972 to give National Park status to the southern part of the Bazaruto Archipelago (Figure 2.1). However this legislation has had little success in protecting the dugongs (Dutton 1994).

Management

Kenya

A Festival of the Dugongs was held in 1996 by the Kenya Wildlife Service. The aims of the festival were to

- raise public awareness concerning the plight of dugongs among fishers and local communities;
- obtain information from the fishers and local people on the occurrence of dugongs;
- involve the coastal people in dugong conservation by introducing them to measures they can implement to curb dugong mortality; and
- seek the views of fishers on appropriate ways to enhance dugong conservation (Wamukoya 1996).

Since 1996, the Kenya Wildlife Service, World Wide Fund for Nature (WWF) and other key stakeholders have expanded the Dugong Festival into a Marine Environment Day with the broader objective of increasing awareness of the marine environment and its threats.

The following protected areas in Kenya may indirectly benefit dugongs:

- Mafia Island Reserves, South of Dar es Salaam, neighbouring area of the Rufiji delta (Tanzania Reserve); and
- Kisite/Mpunguti Marine National Park and Reserve, located on the northern Kenyan coastline, in the Lamu district, 16km south of the Somali Border (Figure 2.2). Dugongs have been reported to frequent some creeks in this reserve.

Mozambique

A pledge has recently been obtained from the Minister of Agriculture and Fisheries to have gill nets banned from all coastal provinces that contain suitable dugong habitat (Dutton & Dutton 1997). A UN supported Environmental Working Group, which is a Mozambican non-government organisation based in the Inhassoro district, works in conjunction with Bazaruto National Park aiding the local community in the management and conservation of natural resources (Christie 1997).

Seychelles

Aldabra Atoll is the world's largest raised coral atoll. In 1982 it was declared a Natural World Heritage Site under IUCN's management categories (WCMC 2001).

Suggested Conservation Initiatives

Research

Determining dugong distribution and abundance

The most urgent task is to determine the distribution and relative abundance of dugongs throughout the region concentrating on the areas where no recent systematic information has been collected, preferably using large-scale aerial surveys, based on the quantitative techniques developed for large remote areas in Australia (Aragones *et al*. 1997). However, if this is not possible for reasons of cost and/or logistics, useful baseline information can be obtained by interviewing local fishers (see Marsh & Lefebvre 1994; Aragones *et al*. 1997). Cockcroft (*pers comm*. 2001) recently approached the International Fund for Animal Welfare (IFAW) for funding for 'community monitors'. These will be members of local fishing communities and independent of any government organisations. The task of monitors will be to monitor catch, determine what is captured and tabulate information such as dates, type of fishing gear etc. This would be a relatively inexpensive method of obtaining such information (Cockcroft *pers comm*. 2001).

Priority areas:

Somalia: Entire coast (if possible) but especially around the Bajuni Islands
Tanzania: Entire coast
Madagascar: Entire coast
Cormoros Islands: entire coast
Seychelles: Aldabra Atoll

Habitat mapping

During aerial surveys, it is important to locate seagrass beds for subsequent mapping. Cockcroft *pers comm*. (2001) proposes the involvement of local university students in 'hands on' seagrass ecology such as

identifying species present and their distribution for habitat mapping.

Detailed habitat use by dugongs

More detailed information on dugong movements and habitat use should be obtained in areas identified as critical dugong habitats using local scale aerial surveys.

Priority areas:

Kenya: Manda Bay: assess what local fishers are seeing and catching.

Mozambique: Bazaruto Archipelago, northern Mozambique and north of Quelimane (towards the Querimba Archipelago): because this area is likely to be critical habitat where there are numerous reports of dugongs.

Satellite tracking (see Marsh & Rathbun 1990) could be used for mapping the movements and fine scale habitat use of individual dugongs if funds are available. Useful information on dugong habitat use can be obtained cheaply from incidental sighting programs from government or community organisations. Wamukoya *et al.* (1996b) suggest establishing observation watch towers on Manda Toto Island overlooking the Manda Bay Channel, from which local people could carry out daily watches on dugong movements as part of a general reporting system of dugong sightings (Figure 2.2).

Fishing and hunting impacts

Interview surveys of fishers could include questions on the extent of gill netting and of targeted hunting for dugongs. Such interviews could explore possible methods (religious, tribal beliefs and taboos etc.) of controlling or minimising hunting.

Management

The initiatives outlined below are suggested for all countries in the region, provided they can be implemented effectively and with community support. The establishment of 'paper sanctuaries' will be counter-productive. Specific initiatives which local experts have targeted as high priority are detailed. The suggestions for Kenya are based on Wamukoya *et al.* (1996a and b). In addition, we suggest that collaborative initiatives between East African countries should be encouraged, e.g., cooperation between Kenya, Tanzania and Somalia because of the capacity of dugongs to undertake long-range movements. Workshops which focus on the adoption of regional management strategies for the conservation of dugongs should be conducted.

Establish key habitat areas which protect seagrass from direct impacts and restrict net fisheries in critical dugong habitats.

Priority areas

Kenya: Manda Bay: assess what local fishers are seeing and catching.

Mozambique: Bazaruto Archipelago, northern Mozambique and north of Quelimane (towards the Querimba Archipelago): because this area is likely to be critical habitat where there are numerous reports of dugongs.

Madagascar: between Mahajanga and Diego Suarez: because this area is thought to support extensive seagrass meadows.

Control land use adjacent to dugong habitats.

Priority areas

Kenya: Manda Bay and Lamu Archipelago

Madagascar: Masoala Peninsula.

Develop culturally appropriate education and awareness programs targeting key fishing areas in critical dugong habitats.

Priority initiatives

Kenya: Support the Marine Environment Day in Lamu. Assess its applicability in other areas. Lack of funding is a major impediment to the continued success of the Marine Environment Day (which ran for one year only). Cockcroft *pers comm.* (2001) have proposed a 'Dugong March' along the Mozambique coast where university students will meet with local fishing villages and their children to raise awareness of dugongs and their conservation.

Conclusions

- The future for dugongs in East Africa is uncertain but appears bleak. Populations appear extremely small and fragmented.
- Pressures from gill netting, shark netting, and habitat destruction may lead to the extirpation of dugongs in East African waters. There is an urgent need to convert current fishing methods to sustainable practices.
- It is highly unlikely that the dugong population in the region can survive (let alone recover) unless immediate and effective actions are taken towards their conservation, and these actions are adopted by the local authorities and communities.

RED SEA

The Red Sea can be divided into three parts: the Red Sea proper, and in the north, the Gulfs of Aqaba and Suez. The Red Sea proper is bordered by the following countries: Egypt, Eritrea, Djibouti, Somalia, Saudi Arabia and Yemen. The Gulf of Suez (and the canal linking the Red Sea to the Mediterranean) is part of Egypt. The Gulf of Aqaba is part of Saudi Arabia, Jordan, Israel and Egypt.

Most of the information contained in this section is based on Preen (1989a) and Preen *et al*. (1989). We are unaware of any major research since this report was published. Preen's work was based on the Saudi Arabian coast, and thus little information is available for the African coastline of the Red Sea.

Distribution and Abundance

Aerial surveys conducted in 1986 by Preen (1989a) indicated that dugongs occur in three core areas along the Saudi Arabian coast of the Red Sea (Figure 2.3):

- around Sharm Munaibira, south of Al Wajh
- around Qishran Island and Al Lith, especially near Ash Sharifa behind Qishran Island
- from Khawr al Ja'afirah, north of Jizan (17°10'N, 42°20'E) to the Saudi Arabia-Yemen border (interviews with fishers indicated that this area extends to Al Hudaydah in Yemen).

Quantitative aerial surveys conducted in 1986 indicated that the estimated dugong population of Al Wajh, Al Qunfidhah and Jizan (including virtually all suitable dugong habitat within Saudi Arabian waters) was 1818 (± s.e. 382) dugongs. The dugong population of Yemen was estimated at approximately 200 individuals, based on fishers' comments, gill net mortality, habitat and bathymetry (Preen 1989a).

Dugongs have also been reported in Eilat Coral Reserve, south of Eilat in Israel (IMMRAC 1996).

There is little information on dugong distribution and abundance along the African Red Sea. Dugongs have been reported in Egypt, Sudan and Djibouti, where they are often caught in shark nets. Based on anecdotal reports of live sightings and the location of skulls, dugongs are thought to occur in most areas along the coast of Eritrea. The Gulf of Aqaba Protectorates Development Programme has started to interview Bedouin fishers along the Egyptian coast of the Gulf of Aqaba (Jeudy de Grissac *pers comm*. 2001).

Live sightings included one lone animal at Hergigo, 12km south of Massawa, one lone animal in the Gulf of Zula, and four animals within one square kilometre offshore in extensive seagrass beds near Mersa Fatma (approximately halfway between Massawa and the Sudanese border). This group possibly included a calf. The island of Norah is locally known to be a good site for dugongs and contains extensive seagrass beds, however, no live sightings have been reported, only confirmed reports of dugong skulls and skin.

In 1997 two calves were sighted in Abu Galum National Park, and between 1999 and 2000, two dugongs were found in the mangrove area of Nabq National Park. Each year incidental sightings occur between the island of Tiran (under Egypt and UN control) and Sanafir (Saudi Arabia), where important seagrass beds occur. A group of ten dugongs were reported in this area in June 2001, and an individual dugong has been photographed south of Quesir, along the African coast of Egypt (Jeudy de Grissac *pers comm*. 2001).

On the basis of the apparent similarity between the distribution of suitable dugong habitat along the African and Arabian coasts of the Red Sea, Preen (1989a) estimated that the African coast of the Red Sea could potentially support a dugong population similar in size to that along the Arabian coast. This assessment assumes that similar levels of human related dugong mortalities occur on each of these coasts. Therefore, in 1986 Preen estimated that the Red Sea potentially supported up to 4000 dugongs.

Threatening Processes

Habitat Loss and Degradation

Oil pollution is a problem in the Red Sea, although it is not as serious as in the Arabian Gulf. The Red Sea is a major sea route for oil tankers *en route* to the Suez Canal (Figure 2.3), and oil refinery capacity, loading capacity, and exports are increasing. Oil spills have previously occurred in the Red Sea, and are thought to affect dugongs through the degradation of seagrass beds (Preen 1989a). Untreated sewage disposal and the de-ballasting of ships are considered serious environmental threats to seagrass throughout the Red Sea region.

The coastline of Egypt is a site of extensive construction and habitat alteration including dredge and fill operations of shallow areas, mining, quarrying and tourism development (UNEP/PERSGA 1997). On Egypt's Hurghada coast, sediments from coastal alteration have spread along the coastline and to the adjacent islands and reefs. Dredge and fill activities around the Gulf of Aqaba have altered coastline morphology and created

Figure 2.3 – The Red Sea showing place names mentioned in the text.
Inset bottom left: Dahlac Islands region, Eritrea.
Inset top right: Sinai Peninsula and adjacent islands and marine parks.

many erosion and sedimentation problems affecting the entire area (UNEP/PERSGA 1997). Large-scale coastal developments including recreational facilities, hotels and restaurants have been developed in Saudi Arabia without adequate evaluation of potential environmental impacts. Sedimentation has suffocated benthic communities including seagrass (UNEP/PERSGA 1997). Inshore commercial trawling occurs in the Jizan area and is thought to have a detrimental effect on seagrass beds (Preen 1989a).

Along the Sudan coast, the extensive use of pesticides, insecticides and herbicides for agriculture are potential threats to the marine food chain (UNEP/PERSGA 1997).

Fishing Pressure

Gill netting occurs in the Al Wajh Bank area and around Yanbu (along the north eastern coast of Saudi Arabia), and is thought to occur around the Tiran Islands (southeast of the Sinai Peninsula). Some gill netting also occurs around Jizan and fishers at Al-Khokha, in the Yemen Arab Republic have reported incidental dugong catches in gill nets set mainly in winter to catch mackerel-type fish (Preen 1989a). In Sudan, large mesh nets are used to catch sharks and are the main cause of dugong mortalities in this area (Preen 1989a). Permanently set gill nets occur around the coral reefs at Siyara, Somalia, in the Gulf of Aden (Figure 2.3). Large amounts of by-catch including turtles and dolphins have been recorded (Pilcher & Alsuhaibany 2000).

Indigenous Use and Hunting

There is evidence of a 4,000 year old dugong-hunting culture in the Arabian Gulf (Bibby 1969) and it is likely that this culture also occurred in the Red Sea. Dugongs were actively hunted in the Red Sea up until 20 to 30 years ago. At Al Wajh, in northern Saudi Arabia, dugong hunting was carried out from boats using a harpoon-delivered detachable hook, which was jabbed into the back of the dugong as it surfaced. A bag was then placed over the dugong's head to drown it. A similar method was used in Jizan with a straight harpoon. Alternatively, in Al Hudaydah, in Yemen, dugongs were captured in nets. Currently, dugongs are not actively hunted in Saudi Arabia, however incidental catches in gill nets occur. These dugongs are eaten only by the fishers as there is no demand for dugong meat from the town people (Preen 1989a). Similarly there is no market for dugong meat in Eritrea, except in Assab where dugong meat occasionally appears for sale.

When dugongs were captured in the Red Sea, almost all parts were utilised. The meat was eaten and sometimes salted for preservation. Bone marrow was also eaten. Dugong oil was used for cooking and massage in Jizan, as a medicament in Al Wajh and Jizan, and as a substitute for cod-liver oil in Egypt. In Al Wajh, dugong skin was removed and sold to people in Egypt where it was used as shoe leather. The skin from dugongs caught in Yemen was sold in Aden and Djibouti and used to make shields and soldiers' helmets. Dugongs were also believed to have some medicinal properties. In Jizan, dugong meat was thought to cure kidney problems and to provide relief from stomach gases. In Jizan and Al Hudaydah, ground dugong bones were thought to cure rheumatism (Preen 1989a).

Boat-Related Impacts and Ecotourism

The area around Giftun Island in the northern Red Sea is very popular for its dive sites (Figure 2.3). Vincent (1996) suggested that dugongs may be avoiding boats and divers and may only be coming close to the shore to feed when the divers are absent (between dusk and dawn).

The fringing coral reef and good weather make Al Hudaydah, Yemen, an attractive tourist site. During the last decade, over 40 tourist resorts have been constructed along part of the 60km coastline, including Al Hudaydah (Frihy *et al.* 1995). There are increasing numbers of tourists in the area. They create demand for further tourist development projects. Pressure for building space has lead to reclamation projects extending seaward to around 700m with consequential loss of inshore habitats (Frihy *et al.* 1995).

The effects of the high level of boat use in dugong areas is of concern. Boat traffic is believed to cause disturbance to dugongs in surrounding waters and may degrade their habitat. Dugongs are also directly impacted through boat strikes and from cuts caused by fast rotating propeller blades (Preen 2001).

Existing Conservation Initiatives

Legislation

There is often overlap among institutions responsible for coastal management, and there are also ambiguous laws and regulations in most countries. Most of the Marine Protected Areas are 'paper parks' (Fouda 1998). Dugongs are not protected by written legislation in Eritrea.

Management

The following protected areas implemented in the Red Sea along the African and Saudi Arabian coasts may indirectly benefit dugongs (Figure 2.3):

- Gebel Elba Conservation Area (between the Egypt-Sudan border)
- Ras Mohammed Marine National Park, at the southern tip of the Sinai peninsula (northern boundary is the Sharm el Sheikhto El Tur Road)
- Eilat Coral Reserve, where dugongs have been reported in the south
- Shu'aiba, south of Jiddah.

In the Gulf of Aqaba, 100% of the Egyptian coastline is protected (Jeudy de Grissac *pers comm.* 2001). Important dugong feeding areas occur between Tiran Island (Egypt) and Sanafir (Saudi Arabia). The protection of Ras Mohammed National Park (1983), was extended to the marine area in front of Sharm El Sheikh and to the area of Tiran in 1992, where fishing is prohibited. The zoning plan does not allow access to the seagrass areas in the back of Tiran, where most dugongs are found. There are no protected areas designated on the Saudi Arabian side of the Gulf, although boats which enter the area are to be arrested by coast guards (Jeudy de Grissac *pers comm* 2001).

As the Red Sea and Gulf of Aden are shared by many countries, a regional approach is essential for effective management and conservation. The Strategic Action Programme (SAP) for the Red Sea and Gulf of Aden has been developed by countries of this region. The SAP process is coordinated by PERSGA (The Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden), with funding provided by the Global Environment Facility (GEF) and implementation support from the United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP) and the World Bank. Execution of the project is delivered by the United Nations Office for Project Services (UNOPS) (PERSGA 1998). The SAP aims to develop a regional framework for protection of the environment and sustainable development of coastal and marine resources. This includes increasing public understanding of the threats to the environment, introducing and strengthening environmental legislation and enforcement, and improving information systems about the health of the marine and coastal environment (Fouda 1998).

Suggested Conservation Initiatives

In order to conserve dugongs in the Red Sea, a regional approach is essential as fishers move freely between countries (Preen *et al.* 1989). The following recommendations closely follow those provided by Preen *et al.* (1989). Suggested conservation initiatives for the Red Sea–Arabian Gulf region are outlined on Page 34.

Research

Determining dugong distribution and abundance

The most urgent task is to determine the distribution and relative abundance of dugongs throughout the region concentrating on

1. areas where no recent systematic information has been collected
2. existing protected areas (see above for details).

Priority areas for large-scale aerial surveys, if logistically possible:

The coastal waters of all countries along the Red Sea coast should be surveyed. The Saudi Arabian Coast has not been surveyed since the mid 1980s.

Habitat Mapping

As funds permit, the seagrass habitats should be mapped in all major dugong areas which are confirmed or potential seagrass habitat, as identified through aerial surveys.

Priority area already identified:

Al Wajh Bank, Saudi Arabian Red Sea coast (site suitable for scientific study of dugong habitat use).

Fishing and hunting impacts

Interview surveys should also be conducted in priority areas to obtain further information on dugong distribution, abundance, and mortality (in particular, estimates of gill net mortalities).

Management

A series of management initiatives should be focused around areas where high densities of dugongs are known to occur or are identified by the surveys proposed above. These initiatives should be community-based and may include sanctuaries or other Marine Protected Areas. Education and awareness programs targeting key fishing areas in critical dugong habitats would also be valuable. If sanctuaries are appropriate, they should protect seagrass from direct impacts and restrict net fisheries in critical dugong habitats. The following areas suggested by Preen *et al.* (1989), are situated along the Saudi Arabian coast, the area he surveyed in the 1980s (Figure 2.3):

- Al Wajh Bank – Al Wajh to Ras Abu Madd, including all offshore islands
- Al Lith – Southern Saudi Arabian Red Sea coast from tip of peninsula south of Ushara to Ras Mahasin, including Qishran and Sharafiya

- Jizan – Southern Saudi Arabian Red Sea Coast from Khawr al Ja'afirah to Jizan and including Farafir Island.

Jeudy de Grissac (*pers comm.* 2001) suggests that a protected area be established in the southern area of Saudi Arabia in the Gulf of Aqaba, including the lagoons, seagrass beds and coral reefs between the coast and Tiran and Sanafir Islands.

Preen *et al.* (1989) also noted two other areas within the Red Sea which had moderate dugong densities and which he identified as candidate protected areas (Figure 2.3):

- Tiran Island and adjacent islands, north Saudi Arabia – adjacent reefs and surrounding waters
- Sharm al Khaur – between Ras Baridi and Sharm Yanbu.

The following areas in the Red Sea along the African and Saudi Arabian coasts have also been identified as possible candidate protected areas (Figure 2.3):

- Southern Egypt Marine Park, south of Hurghada to the Sudanese border (where dugong numbers are believed to be decreasing due mainly to gill netting)
- Dahlac Islands Marine National Park, South Red Sea, off Mits'iwa on the Eritrean coast (15°45'N, 40°00'E)
- Al Wajh to Qalib Island Chain (25°05'N, 37°15'E), including Al Wajh Bank
- Qishran-Ra's Mahasin, south of Jiddah, including Al Lith, Abulat Island (19°58'N, 40°7'60E), Dohra Island (19°49'60N, 39°53'60E), (19°49'60N, 39°53'60E), Al Jadir Island (19°49'N, 39°58'E), Malathu Island (19°45'N, 39°53'60E), as far as the islands Fara, Sirrain (19°37'31N, 40°36'46E), Safiq (19°31'60N, 40°36'60E), and Long (19°25'N, 40°49'E)
- Shu'aiba (20°41'60N, 39°25'60E)
- Strait of Tiran (Egypt), including Tiran and Sinafir Natural Reserve (Saudi Arabia), at the mouth of the Gulf of Aqaba
- Extensions of the existing protection in the Strait of Tiran in a joint marine park between Egypt and Saudi Arabia, including the surrounding seagrass formation north of Tiran and Sanafir Islands
- Yanbu Al-Bahr and the surrounding region.

Management problems occur in the protected waters shared by Egypt and Saudi Arabia due to lack of demarcation of responsibilities. A joint marine park with a shared management plan between these countries could avoid associated legal and political management conflicts.

Conclusions

It is difficult to assess the current status of dugongs in the Red Sea because of the lack of information and research. However, it is likely that the area supports significant numbers of dugongs.

In particular, Saudi Arabia could play a vital role in the preservation of dugong habitats and dugong conservation in the Red Sea as human population density along the Saudi coast is low and there are few anthropogenic pressures as a result.

THE ARABIAN GULF

The Arabian Gulf is bordered by the following countries: Oman, United Arab Emirates (UAE), Bahrain, Qatar, Saudi Arabia, Kuwait, Iraq and Iran (Figure 2.4). However, dugongs do not normally occur in the waters of Kuwait, Iran and Iraq (Preen 1989a) The coastal areas of Oman support seagrass beds which appear to be suitable habitat for dugongs. Occassional stray dugongs reported around Oman are believed to be the only residents.

Distribution and Abundance

The dugong population in the Arabian Gulf is believed to be the second largest in the world after Australia. Akab Island (Umm al Qaywayn, UAE) is the oldest site (6000 years) where dugong remains have been discovered (Jousse 1999). The Arabian Gulf is considered to contain the most important dugong habitat in the western half of the dugong's range (Preen 1989a).

Aerial surveys conducted in 1986 by Preen (1989a) indicated that in the Arabian Gulf, dugongs are restricted to the southern and south western coastline between Ras Tannurah in Saudi Arabia and Abu Dhabi in the United Arab Emirates (Figure 2.4). Within this area the population was estimated to be 7,307 (± s.e. 1302) animals. Baldwin (1995) suggests the seagrass habitat identified off the coastline of Abu Dhabi as the most important area in the region for dugongs. Four core areas were identified by Preen (1989a) as being the most important areas for dugongs in the Arabian Gulf (Figure 2.4):

- between Abu al Abyad Island, Jabal Dhannah and Bu Tinah shoal in the UAE
- Khawr Duwayhin including Ghagha Island section of Saudi Arabian coastal territory between Qatar and the United Arab Emirates, bounded by Al Qaffay Island and Ra's Mushayrib
- between Bahrain and Qatar, south of Fasht Adhm and north of the Hawar Islands
- between Saudi Arabia and Bahrain, south of the Saudi Arabia-Bahrain Causeway and north of Uqair.

During Preen's (1989a) summer survey, dugongs were mainly sighted as single individuals. These individuals usually occurred in clumps in which the inter-

Figure 2.4 – The Arabian Gulf showing place names mentioned in the text. Inset bottom left: Bahrain and Qatar.

dugong distance was less than five body lengths. During his winter survey, two large groups composed of 577 and 97 dugongs were sighted between Bahrain and Qatar within an area of less than one km^2. Very few dugongs were recorded outside of these two groups. The survey results corresponded with information obtained from interviews with fishers who also reported that dugongs tended to aggregate in large herds in winter. Interviewees claimed that Al Mutarid, where the two large groups of dugongs were sighted, was a nursery ground (Preen 1989a).

The Environmental Research and Wildlife Development Agency (ERWDA) conducted summer and winter aerial surveys of UAE waters in the Arabian Gulf in summer 2000 and winter 2001 (al-Ghais & Das 2001). The survey was conducted in five zones over 34 transects covering 6075km^2 in summer and 6697 in winter. The population of dugongs in the survey zones was estimated to be 1861 individuals in summer and 2185 in winter. No large groups were sighted during the survey. Nearly 40% of sightings were in seagrass beds, and over 50% in deep water. More than 80% of the population was sighted around the islands of Abu Al Abyad, Salalah, Marawah, Jananah, Al-Fayl, Al-Bazm and Bu Tinha (al-Ghais & Das 2001). These survey findings support Preen's (1989a) earlier conclusions that dugongs predominantly occur in the Abu Dhabi emirates of the UAE. Dugongs were seen near Abu al Abyad Island, Merawwah, Jananah, Al-Bazm al Gharb and Bu Tinah, islands north of Al Hamriya (25º47'N, 050º43'E), and Jabal Dhannah in both 1986 and 2000 (Figure 2.4). In contrast, Preen (1989a) reported that the highest concentration of dugongs in the UAE was in the area between Merawwah and Bu Tinah. Dugongs have usually been sighted in small groups or as solitary individuals in UAE waters.

Threatening Processes

Habitat Loss and Degradation

The Arabian Gulf, the world centre of the petroleum industry (Preen 1989a), is the most oil-polluted marine area in the world (WCMC 1991). The distribution of dugongs in the Arabian Gulf corresponds with the habitats most at risk from pollution. There are oil loading terminals in the immediate vicinity of identified important dugong areas. Furthermore, the counter-clockwise current in the Gulf means that water from the north-western section where the majority of oil extraction occurs, is likely to flow to the south-eastern section where the most important dugong habitat occurs. Seagrasses are sensitive to physical and physiological damage as a result of oil pollution (WCMC 1991). Dispersed oil can increase the mortality rate of seagrass and reduce its primary productivity (Preen 1989a).

The Arabian Gulf also receives other pollutants as a result of rapid industrial development along the coastline. These industries include steel production, plastics, fertilisers and chemicals. The shallow maximum water depth (35m) and long flushing time (5 years) of the Gulf, means that there is a limited capacity for these pollutants to be absorbed and diluted (Preen 1989a). Furthermore, the shallow waters and high water temperatures of the Gulf (above 30°C in summer) regulate the distribution of dugongs in this region (al-Ghais *pers comm.* 2000).

Seagrass beds in the Gulf are also under threat from trawling, land reclamation and dredging. Land reclamation is believed to be one the greatest threats to the marine environment of the Arabian Gulf. It is destroying and replacing intertidal and sub-tidal habitats, including seagrass communities. Reclamation is coupled with dredging and the dumping of dredged spoil, which may involve the direct excavation or smothering of seagrasses, or limit the growth and survival of seagrasses through increasing turbidity. Several large dredging and reclamation projects occur within important dugong habitats in the Gulf, including what is believed to be the most productive seagrass beds in the Gulf of Salwa. High salinity levels already occur in the Gulf of Salwa, and reclamation projects threaten to increase the salinity levels by impeding water flow into and out of the area. Salinity levels are also rising in the northern part of the Arabian Gulf coupled with a rise in water temperatures to 38°C. An Arabian environmental organisation suggested that indiscriminate dumping of wastewater in the region by oil companies and unchecked oil seepage may be a contributing factor to this increase in salinity (UNEP 1999). As the upper levels of salinity which can be tolerated by seagrasses are as yet unknown, there is potential for these increases in salinity levels to pose further threats to seagrass habitats.

Fishing Pressure

Gill netting is used in at least 25% of all artisanal fisheries in the Arabian Gulf. It is mainly carried out during the winter months. During surveys by Preen (1989a), it appeared that in the western Gulf, gill nets were concentrated in the Gulf of Salwa, particularly around Bahrain. Interviews with fishers in the UAE suggest that dugongs are most often caught in 14-18cm gill nets set for kingfish and sharks (Baldwin & Cockcroft 1997). A study currently conducted by the Environmental Research and Wildlife Development Agency (ERWDA) of the UAE found that almost all reported dugong deaths are caused by gill net fishing set for large pelagic fish

species(al-Ghais *pers comm*. 2000). Around 15 stranded dead dugongs are found every year along the UAE coast. In 1999, 11 dead dugongs (five females, two males and four unknown) were examined (al-Ghais *pers comm*. 2000). The vast majority of dead dugong remains have been found in, or near fishing villages and most of the stranded animals show clear evidence of having been caught by local fishers (Baldwin 1995). Fishers have admitted that dugongs get entangled in their nets at times. However, detailed information is not forthcoming, as fishers are aware of the law which bans dugong capture.

Indigenous Use and Hunting

Dugongs were traditionally utilised in the Arabian Gulf. The meat and bone marrow were eaten. In Abu Dhabi UAE, the preferred section was the tailstock, while dugong hide was used to make foot sandals. Sheiks and emirs of Bahrain used the tusks of dugongs in their sword handles (Preen 1989a). Information from the dugong fossils found at Akab Island adjacent to the town of Umm al Qaywayn suggests that dugong hunting was seasonal and focused on young individuals. The bones showed signs of butchering. The inhabitants of this area utilised dugong hide, meat and oil (Jousse 1999). Dugongs apparently formed the staple diet of people in Umm an-Nar, near Abu Dhabi up to 4000 years ago. The hunting method involved herding dugongs into shallow water with large groups of people hand capturing them by clubbing them to death (Preen 1989a). This active hunting method was apparently outlawed approximately 30 years ago.

In the UAE, dugongs were traditionally captured for meat and sold in fish souks. The caudal and rostral disk muscle were eaten fresh and salted, whereas the flukes, flippers, viscera and remaining head were discarded. The skin is no longer used. Some parts of the dugong were used medically (Preen 1989a). Only those dugongs accidentally caught in gill nets were allowed to be sold in Abu Dhabi. According to interviews by Preen (1989a) it is likely that most dugongs accidentally caught by non-national fishers (who make up a very significant portion of the total number of fishers in Abu Dhabi), are released. However, from interviews conducted between 1986 and 1988, it was estimated that between 70 and 100 dugongs were sold at the Abu Dhabi fish souk per year (Preen 1989a).

Prior to the discovery of oil in the Gulf, dugongs were a common food source in Bahrain, to the extent that a family tribe of traditional dugong hunters may have killed hundreds of dugongs annually

There is currently no hunting of dugongs permitted in UAE waters. Fishers and local people interviewed are aware of the law banning dugong hunting (al-Ghais *pers comm*. 2000). This awareness appears to be evident from the high number (around 15) of dead dugongs seen along the mainland coast every year, released or discarded from a net (sometimes with the net still entangled on the animal). In some cases, a portion of meat is found missing from the body. This observation suggests that some fishers, when they find a dugong dead in their net, take a portion of meat for consumption.

Existing Conservation Initiatives

Legislation

For more than two decades, dugongs in UAE waters have been protected by a Law of the President of the UAE (Federal Law No. 23) and Article 28/2000 Amiri Decree which prohibits the exploitation of dugongs in the UAE. In addition, a recent ban on drift net fishing in the UAE waters should minimise dugong mortalities in fishing nets (Das *pers comm*. 2001). Other aspects of protection of species and its habitat are under active consideration in the UAE.

In response to the sighting of over 600 dugongs south east of Bahrain by Preen in 1986, a Ministerial Decree was issued in Bahrain. This decree banned the deliberate killing or sale of dugongs (Preen 1989a).

As far as we can ascertain, no other country in the Arabian Gulf has imposed similar bans (Preen *et al*. 1989).

Research

In 1986, Preen conducted three quantitative aerial surveys of the Arabian Gulf (Preen 1989a). Preen also conducted 29 qualitative aerial surveys in this region between November 1985 and June 1987. In addition, fishers and fish sellers were interviewed at 29 locations throughout Saudi Arabia, Bahrain, Qatar, the United Arab Emirates and the Yemen Arab Republic between 1986 and 1988 (Preen 1989a).

A dugong research project initiated by ERWDA and funded by Total Abu Al Bukhoosh (an Oil Company in the UAE), is being conducted from 1999-2002. The project is designed to identify a suitable area off Abu Dhabi for designation as a marine protected area for dugong conservation, and to establish a dugong information network to encourage cooperative management arrangements of marine species among the Gulf countries

(al-Ghais & Das 2000). The project will further address information needs for the management of fishing along the western coast of the UAE, and will provide information on dugong biology, ecology and conservation using satellite tracking methods. Seasonal aerial surveys and monthly field surveys are being conducted to collect data on dugongs and seagrass. The study has the following objectives:

- to estimate the abundance of dugongs and assess their distribution pattern in UAE waters
- to identify and evaluate dugong habitats
- to study seasonal migration patterns of dugongs in UAE waters
- to develop conservation and management plans for dugongs of the UAE, in particular, and the Arabian Gulf in general.

This study will inform future management actions for dugongs within UAE waters.

Suggested Conservation Initiatives

The following recommendations follow those provided by Preen *et al*. (1989). Suggested conservation initiatives for the Red Sea–Arabian Gulf region are outlined on Page 33.

Research

- There is an urgent need to resurvey the entire coastal area of the Arabian Gulf between the Kuwait border and the Oman border using the same methodology as Preen used in 1986 (Preen 1989a).
- In order to determine the impact of oil and other pollution on dugong populations, it will be necessary to determine the impacts of oil on dugongs as well as seagrasses. A research and monitoring program should be developed with the following objectives:
    1. assess the current level and distribution of oil and other pollution in the Arabian Gulf
    2. conduct necropsies on dugongs thought to have died as a result of oil pollution to determine the cause of death for oil-related mortalities
    3. monitor and keep data base records of oil-related dugong deaths
    4. assess the impact of oil and oil clean-up procedures on seagrasses.

Management

Informed by the results of the research conducted to date and the current dugong research project underway in the UAE, the following management options should be considered in discussions with local peoples, especially fishers:

- Existing laws banning dugong hunting should be strictly enforced and advertised through the media.
- Culturally appropriate environmental awareness programs including audio-visual and poster displays should be distributed widely, covering educational institutes and coastal villages. Material has been developed for the UAE as part of a current dugong research project.
- If the local people agree, the major dugong habitats already identified in the Arabian Gulf and listed below should be the focus of community-based management initiatives, which may include the establishment of protected areas for which dugongs are the "flagship" species. Dugongs and their habitats in these areas should be protected from the impacts of gill netting and trawling, oil pollution and habitat degradation.

Highest priority areas for protection

1. Ghagha Island – section of Saudi Arabian coastal territory between Qatar and the United Arab Emirates
2. Bahrain-Qatar – between Bahrain and Qatar south of Fasht Adhm and north of, and including, the Hawar Islands, with the northern boundary being Al Askar (Bahrain) and Al Arish (Qatar) and the southern boundary being between Ras al Barr (25°48'N, 50°34'E) and Dukhan (25°30'N, 50°46'E)
3. Bu Tinah (UAE) – central western section of the United Arab Emirates, bounded by Bu Tinah Shoal, Abu al Abyad Island and Ruwais (24°09'N, 52°44'E).

Lower priority areas for protection

1. Qurayyah – north western section of the Gulf of Salwa between Saudi Arabia and Bahrain, bounded by the Saudi Arabia-Causeway in the north, extending south to latitude 25°14', north west to the Saudi Arabian coastline (excluding Dawhat Zalum), and east to the Saudi Arabia-Bahrain border
2. Saudi-Bahrain – west of Bahrain, between the Saudi Arabia-Bahrain Causeway and Ras al Barr and extending to Saudi Arabian Coast
3. Southern section of the Gulf of Salwa
4. Tarut Bay complex – Tarut Bay east to Fasht Farim (Bahrain) and south to Al Khobar.

- In recognition of the high concentration of oil related activities in the Arabian Gulf, and the high risk of oil spills, oil spill contingency plans should be developed for each of the dugong areas identified above. These should be incorporated into National Oil Spill Contingency Plans by Saudi Arabia and other Gulf States.
- All Gulf States should give consideration to signing the International Convention for the Prevention of Pollution from Ships (MARPOL 1973/78). The MARPOL 1973-78 Convention regulates the types and quantities of waste ships may discharge into the sea, taking into account the ecological sensitivity of different sea areas (NRC 1996).

Conclusions

- The majority of dugongs in the Arabian Gulf are found along the coast of Saudi Arabia, Bahrain, Qatar and the UAE.
- The dugong population in the Arabian Gulf is the second largest in the world. The Gulf is considered to contain the most important dugong habitat in the western half of the dugong's range.
- The dugong population in the Gulf occurs where the rates of coastal development and oil spill are very high. It is important that the countries harbouring dugongs in the Gulf develop management initiatives to protect dugongs and their habitats.

Suggested Conservation Initiatives for the Arabian Region (Red Sea and the Arabian Gulf)

Research

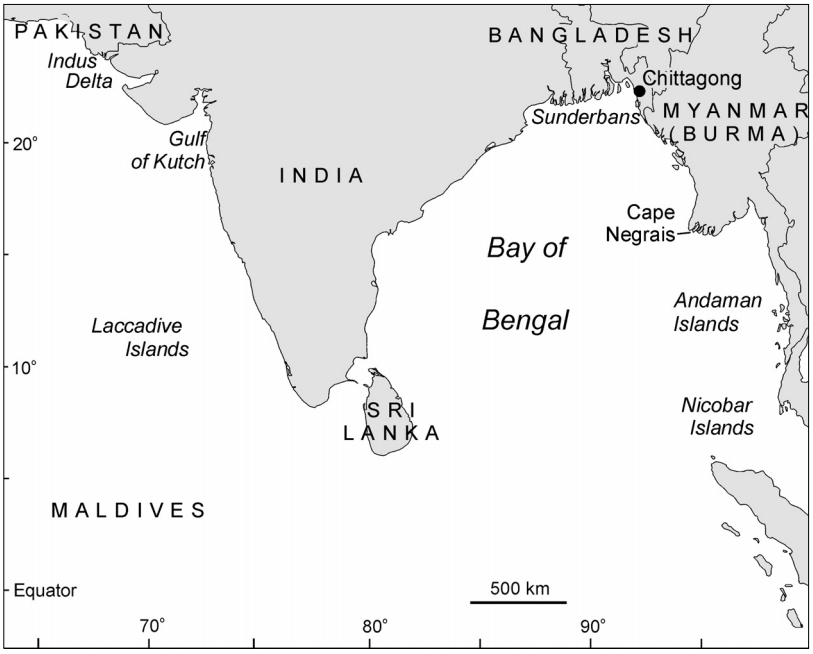
- A regional dugong or marine mammal Specialist Group should be established in Saudi Arabia to maintain continuity of dugong research, to aid in coordination of information and research efforts of the Meteorology and Environmental Protection Administration (MEPA), the National Commission for Wildlife Conservation and Development (NCWCD) and relevant universities, and to act as a focal point for all marine mammal related activities and events.
- A seagrass mapping program should be developed for the Red Sea region and the Arabian Gulf, particularly in areas known to be important dugong habitat.
- International training for dugong/marine mammal specialists should be encouraged in countries surrounding the Red Sea and the Arabian Gulf.

Management

- Seagrass beds should be protected from damage and destruction through compulsory environmental impact assessments on all dredging and land-fill activities, and significant coastal developments.
- Saudi Arabia, Bahrain, Qatar and the United Arab Emirates should work together to protect their dugong populations. Each country should consider enacting parallel laws to control coastal development and reduce impacts that might affect dugongs' feeding ranges and their normal behaviour.
- Regional dugong conservation education programs should be developed for the Red Sea and Arabian Gulf. These programs should be sensitive to national cultural differences.
- Dugongs should be included on national lists of protected species in all countries in the region which have not done so already.
- Countries surrounding the Red Sea and the Arabian Gulf should consider signing the Bonn Convention on Migratory Species.

Chapter 3
India and Sri Lanka

INDIA WITH THE ANDAMAN AND NICOBAR ISLANDS, AND SRI LANKA



(Above) Figure 3.1 – Indian subcontinent and islands showing place names mentioned in the text.

Distribution and Abundance

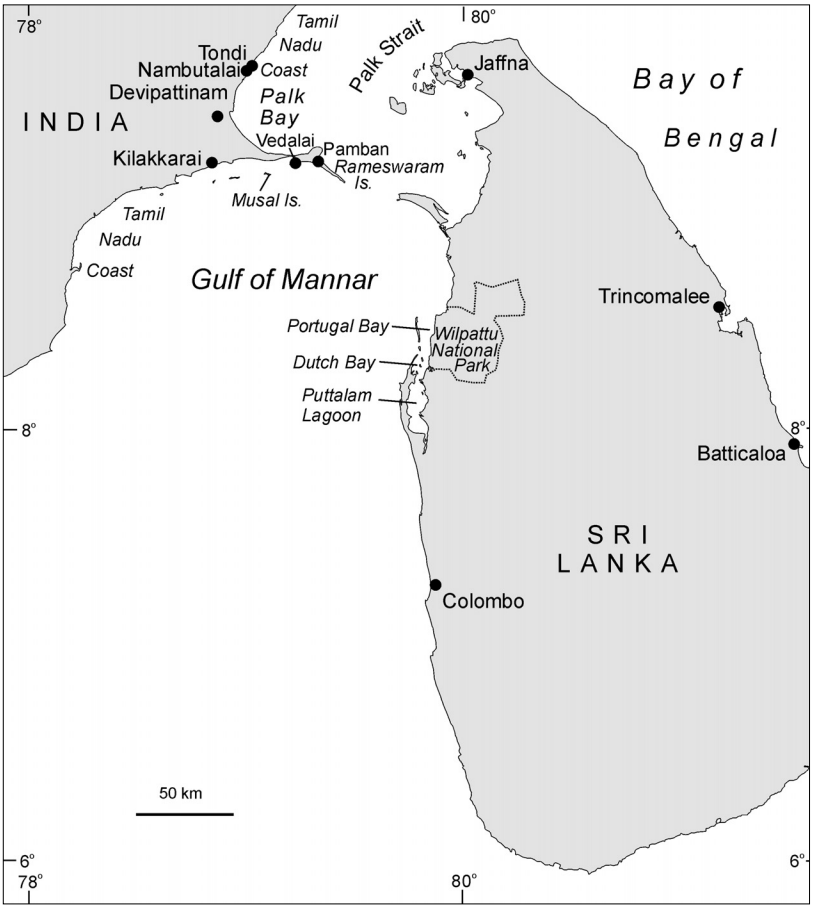
Dugongs occur along the west coast of Sri Lanka, and in India in the Gulf of Kutch (Lal Mohan 1963; Frazier & Mundkur 1990), Gulf of Mannar and Palk Bay (Jones 1967; James 1974; Lal Mohan 1976; Frazier & Mundkur 1990) and in the Andaman and Nicobar Islands (Das 1996; Das & Dey 1999) (Figure 3.2). Herds of many hundreds of dugongs were reported to have once occurred in Palk Strait between India and Sri Lanka (Figure 3.2) (Annandale 1905). However, dugongs were not sighted during separate aerial surveys conducted in 1983 of

1. the Palk Bay – Gulf of Mannar region (Leatherwood & Reeves 1984)
2. the waters off western Sri Lanka (Leatherwood & Clark 1984; Leatherwood & Reeves 1984) (Figure 3.2).

Dugongs are believed to be extinct in the Maldive and the Laccadive Islands (Husar 1975) (Figure 3.1).

India (including Andaman and Nicobar Islands)

Dugongs have often been reported to occur in the Gulf of Mannar and Palk Bay (Jones 1967; James 1974; Lal Mohan 1976; Frazier & Mundkur 1990) (Figure 3.2). The Gulf of Mannar encompasses a group of 21 islands and 81 slightly elevated pearl banks with seagrass meadows dominated by *Halophila ovalis* (Kelleher *et al.* 1995). Based on the composition of the seagrass communities and their bathymetry, Marsh



(Right) Figure 3.2 – Sri Lanka and the Gulf of Mannar showing place names mentioned in the text.

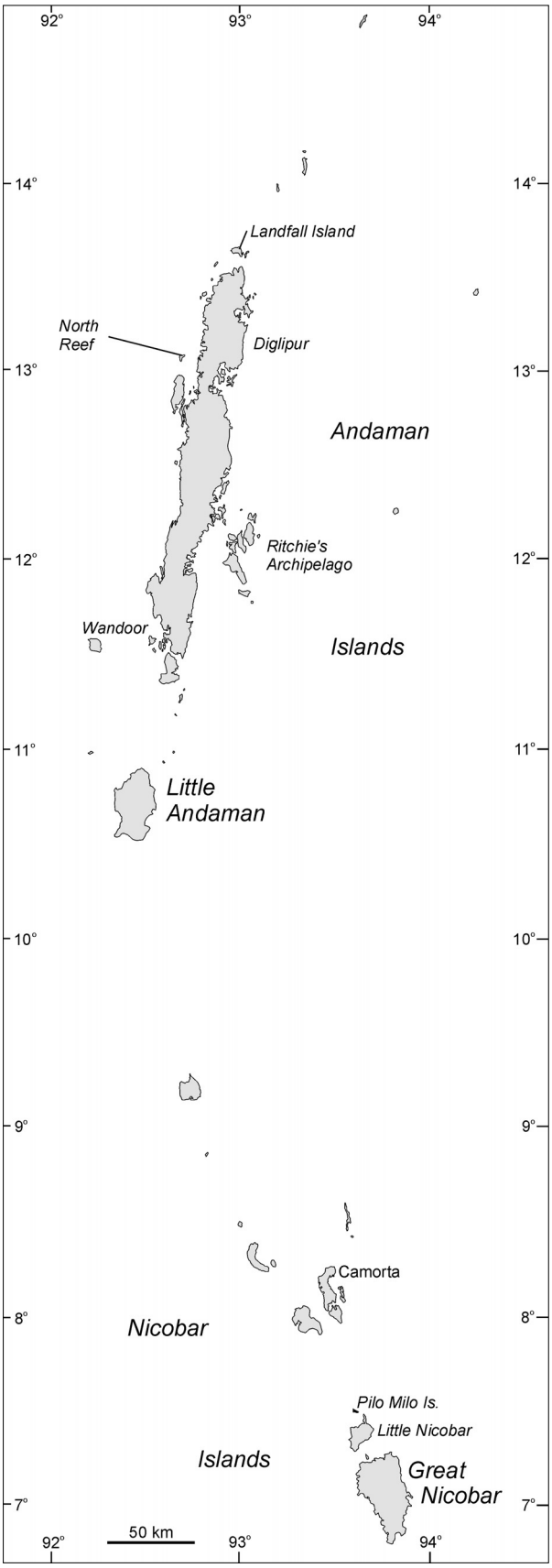


Figure 3.3 – Andaman and Nicobar Islands showing place names mentioned in the text.

(1989) concluded that Palk Strait and the Gulf of Mannar should be important areas for dugongs. The status of dugongs in this region is unknown, however it is suspected that they are almost completely depleted. Annandale (1905) reported "it is rare nowadays for more than one specimen to be taken, whereas formerly in the Gulf of Mannar flocks of hundreds were said to occur". Jones (1981) reported that the main area for dugong catching in Palk Bay was between Devipattinam and Pamban (Rameswaram Island), and in the Gulf of Mannar, the islands of the Gulf of Mannar and the mainland (Figure 3.2). There are no records of dugongs further north along the east coast or from the Sunderbans, although there have been records from the Chittagong coast of Bangladesh and Burmese waters (Frazier & Mundkur 1990) (Figure 3.1).

There are records of dugongs on the west coast of peninsular India (see Frazier & Mundkur 1990), however the area lacks the calm and shallow water characteristic of major seagrass habitats (Jones 1967). The only known dugong population remaining in western India is found in the Gulf of Kutch (also spelt Kachchh) (Lal Mohan 1963; Frazier & Mundkur 1990) (Figure 3.1). The Gulf of Kutch covers an area of 7,350 km^2 and has a maximum depth of 60m (Lal Mohan 1993). The status of dugongs in the Gulf of Kutch is unknown, however, Frazier & Mundkur (1990) report immature individuals which suggests a breeding population. This population is very isolated. To mix with other populations these animals would have to travel to the Arabian Gulf (approximately 1,500km to the west) or to the Gulf of Mannar (approximately 1,700km to the south).

Located in the Bay of Bengal, the Andaman and Nicobar Islands are a group of 572 islands that lie 193km south of Cape Negrais in Myanmar (Burma). The Nicobar Islands are located to the south of the Andamans, 121km from the little Andaman Island. The islands are located between 6° to 14°N and 92° to 94° E (Figure 3.1 and 3.3). The coastal waters around the islands contain large areas of seagrass (Lal Mohan 1993).

There are few records of dead or live dugongs from the Andaman and Nicobar coast (Das & Dey 1999). Dugong were common during the British era, but the population is now believed to be small as evidenced by the sporadic nature of sightings and records of poaching (Das 2000). Dugongs still occur around Ritchie's Archipelago, North Reef, Little Andaman, Camorta, Little Nicobar and part of the great Nicobar Islands (Figure 3.3) however, large populations are no longer seen and numbers are believed to have been declining since the 1950s (Das 1996). Based on snorkel and interview surveys, the number of dugongs around the Andaman and Nicobar Islands is estimated to be of the order of 100 individuals (Das & Dey 1999; Das 2000).

Motor and row boat surveys around Ritchie's Archipelago, North Reef Marine National Park, Wandoor, and off Diglipur in 1994 and 1997, and around Little Andaman, Camorta, Pilo Milo Island, Little Nicobar and Great Nicobar Islands during 1995 and 1997 failed to locate any dugongs (Das 1996; Das & Dey 1999). Interview surveys with local tribes and settlers revealed that dugongs occur in small numbers in this region. However, poaching is illegal and fishers were reluctant to provide information. Between 1990 and 1994, five dugongs were reported sighted along the northwestern side of Camorta Island, five near Dugong Creek and Hut Bay, Little Andaman Island, and four each around Little Nicobar and Great Nicobar Islands. The seagrass beds in Dugong Creek were surveyed by the Salim Ali Center for Ornithology and Natural History (SACON), Coimbatore, India, in 1998. Seven species of seagrass were discovered and eight dugongs were sighted during field visits (Das *pers comm.* 2001). In addition, around Ritchie's Archipelago (southern Andaman Islands), a group of five or six dugongs were seen by fishers and divers on at least five separate occasions between 1990 and 1997, and six dugongs were regularly seen near Landfall Island (Das & Dey 1999) (Figure 3.3).

Sri Lanka

During the 19th and early part of the 20th centuries, dugongs were common along the north western coastal waters of Sri Lanka from Puttalam lagoon in the south to the islands west of Jaffna in the north (Santiapillai *unpublished data*) (Figure 3.2). Occasionally dugongs were caught off Trincomalee and Batticalao in the east, but they appear to be absent from the extreme south of the island (Santiapillai 1981). As recently as the 1950s, 100 to 150 animals were taken annually in the Mannar district. However, dugongs are now rare in Sri Lankan waters as a result of harvests for their meat, hide and oil. Remaining individuals are believed to occur mainly around the Gulf of Mannar where the extensive continental shelf and the shallow coastal waters should provide ideal feeding grounds.

Threatening Processes

Habitat Loss and Degradation

Das & Dey (1999) suggest that the main reason for the apparent decline in dugong numbers in the Andaman Islands region is habitat loss (also see Das 2000). Habitat loss is attributed to increasingly heavy boat traffic, the conversion of coastal forests to banana, areca nut and coconut plantations with consequential toxic runoff from agricultural biocides, pollution from urban centers, oil spillage, bottom trawling and dredging and the commercial harvest of seagrasses (Lal Mohan 1993; Das & Dey 1999; Das 2000).

The coastal waters of the larger islands within the Andaman and Nicobar Archipelago are reported to have significant levels of terrigenous sediment runoff, with extremely turbid water in places (Arthur *pers comm.* 2001).

Deforestation has also increased silt loads of rivers opening into the Gulf of Mannar, Palk Bay, the Gulf of Kutch and the Andaman and Nicobar Islands (Mohan 1993). Extreme weather events such as cyclones and high energy tidal storms may also contribute to loss of seagrasses in the region (Das & Dey 1999). It is suspected that a cyclone in 1954 had a significant impact on dugong populations and seagrass habitat in Palk Bay. The cyclone was accompanied by heavy rains, which flooded the region (Jones 1967). According to reports from local fishers, large numbers of dugongs were found washed ashore and dead. Trawling nets also degrade seagrass beds in the Palk Bay-Gulf of Mannar region by uprooting rhizomes (Silas & Bastion-Fernando 1985).

Fishing Pressure

Fishing activities around the Indian, Andaman, Nicobar and Sri Lankan coasts include gill netting and dynamite fishing. Although banned under the *Indian Fisheries Act 1896,* dynamite-fishing was introduced in 1981 in Palk Bay. Fishers quickly realised that it could also be used to kill dugongs (Silas & Bastion-Fernando 1985). Although there are no data on accidental catches of dugongs in India, gill nets are believed to have had a significant negative impact on dugong populations around Palk Bay and the Gulf of Mannar. Approximately 1.28 million gill nets, each 2-3km long, are used on the Tamil Nadu coast which includes Palk Bay and the Gulf of Mannar, while approximately 7,383 nets are deployed along the Gujarat coast (Lal Mohan 1993). Nair *et al.* (1975) reported an average of 40 dugong deaths per year in gill nets set in Palk Bay.

In the Andaman and Nicobar islands, settlers who originated from the mainland of India are mostly Hindus and do not like dugong meat as it looks and tastes like beef. If dugongs die in their nets, these fishers (settlers/non-tribals) will pass them over to tribes who are exempted of the *Wildlife Protection Act 1972,* in order to avoid legal problems (Das & Dey 1999).

A commercial dugong fishery existed in Sri Lanka when dugongs were abundant, and before they were protected in 1970. The meat was considered highly palatable and nutritious and it could be easily sold in Colombo. Although the sale of dugong meat is now

banned under the *Fauna and Flora Protection Amendment Act No.1 1970,* the meat of animals caught in nets is still being sold in the Mannar district (Santiapillai *unpublished data*). In recent times, the expansion of offshore gill net fisheries in response to the needs of a burgeoning human population is considered to have been largely responsible for the decline in dugong numbers.

Indigenous Use and Hunting

In the Gulf of Kutch, dugong oil is valued as a preservative and conditioner for wooden boats (Frazier & Mundkur 1990). The meat is believed to have medicinal value and rejuvenating and aphrodisiac properties (Jones 1967).

Between April 1983 and August 1984 more than 250 dugongs were reported caught and killed in the Kilakkarai-Tondi region bordering the Gulf of Mannar and Palk Bay (Figure 3.2) (Nair *et al*. 1975). This figure does not include catches from Tondi, Karangadu, Tiruppalaikuki and other villages in the region where dugong meat is highly prized. In the fishing villages bordering the Gulf of Mannar (Pudumandam, Vedalai) and Palk Bay (Karangadu, Nambutalia, Morepanai and Mullimuani), killing dugongs for consumption also occurs in great secrecy. The price of dugong meat is high and therefore the meat is much sought after.

In the Andaman and Nicobar Islands, Das (1996) reported that dugong hunting occasionally occurs. Most of the tribes, namely the Andamanese, Onges and Nicobarese traditionally hunt dugongs with iron harpoons tied to their boats *(dunghi)* (Das & Dey 1999). Evidence of dugong hunting by Onges was collected during the seagrass survey of Dugong Creek, Little Andaman Island by the SACON in 1998 (Das *pers comm*. 2001). The Onges preserve the skull and lower jaw bone of dugongs by keeping them above the cooking area (Das 2000). The Onges believe that the smell, released from the dead animal, 'attracts animals from the forest or sea to its origin, thus facilitating future hunts' (Das 2000). However, regular hunting trips no longer occur because of the low number of dugong sightings, the decreasing numbers of skilled hunters, and conservation concern for the species (Das 2000).

Existing Conservation Initiatives

Legislation

Dugongs are protected in India under Schedule 1 of the *Indian Wildlife Act 1972* which bans the killing and purchasing of dugong meat. Dugongs became protected in Sri Lanka in 1970 under the *Fauna and Flora Protection Amendment Act No. 1 1970,* which bans killing of dugongs and the sale of their meat.

Research

An osteological study on two dugong skeletons from the Gulf of Mannar was conducted by James (1974). Frazier and Mundkur (1990) conducted informal interviews with fishers and boat people regarding common dugong names and other anecdotal information, and also presented morphometric details of an immature male dugong found dead in the Gulf of Kutch.

A study in the Andaman and Nicobar Islands was initiated by the Salim Ali Centre for Ornithology and Natural History (SACON) to evaluate the habitat status, resource potential and conservation value of the ecosystem (Das & Dey 1999). The primary objective of the study was to identify seagrass habitats for conservation. Information on dugongs was also collected during the study.

Management

The Gulf of Kutch Marine Protected Area (22°34'N, 69°40'E) was designated in 1982. The marine park area comprises 16,289 ha. The Gulf of Mannar Marine Protected Area (9°07'N, 79°36'E) was designated in 1986 and comprises 623 ha.

Suggested Conservation Initiatives

Research

Determining dugong distribution and abundance

The most urgent task is to determine the distribution and relative abundance of dugongs in the key areas: Gulf of Kutch, Gulf of Mannar–Palk Strait, and the Andaman and Nicobar Islands. The most informative technique would be to use large-scale aerial surveys, preferably based on the quantitative techniques developed for large remote areas in Australia (Aragones *et al*. 1997). It would be ideal if the Gulf of Mannar–Palk Strait region could be surveyed as a collaborative initiative between India and Sri Lanka. However, if this is not possible for reasons of

cost and/or logistics, useful baseline information could be obtained using less expensive techniques in association with surveys for cetaceans (see Marsh & Lefebvre 1994; Aragones *et al*. 1997). Because of the difficulty of detecting trends in small populations of dugongs, we suggest that local-scale surveys should have lower priority at least initially.

Habitat mapping

During aerial surveys, it is important to locate seagrass beds for subsequent mapping and studies of community composition.

Detailed habitat use by dugongs

More detailed information on dugong movements and habitat use should be obtained in areas identified as critical dugong habitats to inform subsequent management initiatives. The most effective way of doing this is by local-scale aerial surveys.

Satellite tracking is an excellent technique for mapping the movements and fine scale habitat use of individual dugongs provided funds are available to track at least ten dugongs. This minimum may be reduced if the primary objective is to gain publicity for dugong conservation.

Incidental sighting programs are an inexpensive source of useful information on dugong habitat use, provided funds are available for a person to collate the information and to feed it back to participants and other stakeholders (Aragones *et al*. 1997).

Fishing and hunting impacts

A project proposed by the IUCN/SSC Cetacean Specialist Group (CSG) to investigate the status of small cetaceans in the Indus Delta of Pakistan may assist in determining the range of dugong populations in this region (Smith *pers comm*. 2000) (Figure 3.1). Although dugongs have not been recorded in Pakistan, they do occur nearby in the Gulf of Kutch (see Distribution and Abundance above), and may yet be found in the Indus Delta. Collaboration between members of the IUCN Sirenia and Cetacean Specialist Groups should be considered in investigating the possibility that dugongs are present in this region.

Sources of mortality

A project to increase community awareness, assess populations, and monitor deliberate and accidental killing of coastal cetaceans in Sri Lanka has been proposed by IUCN Sri Lanka and the IUCN/SSC Cetacean Specialist Group (CSG) (Smith *pers comm*. 2000). The development of local capacity to conduct at-sea surveys, collect biological samples, estimate the species, age, and sex composition of landed catches, and assess fishing effort by area and season would be the major aim. Extension of the project to include dugongs would add greatly to our knowledge of the species in Sri Lanka and provide a basis for establishing conservation priorities (Smith *pers comm*. 2001).

Management

If key dugong habitats are identified as a result of the large-scale surveys advocated above, consideration should be given to using these habitats as foci for community-based management and education initiatives, using the dugong as a "flagship" species. These initiatives may include the development of dugong sanctuaries if the community wishes and has the resources to implement them effectively. It will be important for such initiatives to address land management practices to prevent deforestation and soil erosion which contribute to the loss of seagrass habitats.

For many years, the Wildlife and Nature Protection Society of Sri Lanka and several interested conservationists have called for the conversion of Dutch and Portugal Bays and the Puttalam lagoon into a marine sanctuary for dugongs (Figure 3.2) (Santiapillai *unpublished data*). Bertram and Bertram (1970) also recommended the inclusion of Puttalam Lagoon as a marine extension of the terrestrial Wilpattu National Park. Santiapillai (1981) recommends that if fishing activities are controlled and the use of dynamite is prohibited, the conservation of these areas would provide ideal conditions for the survival and management of dugongs. However, because of the current political climate of this region, this suggestion is probably impractical at present.

Conclusions

- There are no quantitative data on the status of dugongs or the extent or nature of seagrass communities along the coast of the Indian sub-continent or the associated offshore islands.
- In the absence of conservation measures to reduce the high mortality rates in the wild, there is a danger that dugongs will become locally extinct in this region.

Chapter 4
East and Southeast Asia

JAPAN

Distribution and Abundance

The presence of dugongs within the Nansei Shoto or the South Western Islands of Japan has been well established for many centuries. These islands extend as a 1,150km long arc from Kyushu to Taiwan (China) (Figure 4.1). However, little is known about the distribution of dugongs in this region. Dugong bones have been excavated from various archaeological sites on Okinawa Island (Figure 4.1) suggesting that dugongs were hunted in the region since before the 15th century (Anri *et al*. 1984; Kin & Kaneko 1985; Shimabukuro 1987; Brownell & Kasuya *unpublished data*). From 1979 to the present day, there have been numerous incidental dugong sightings off the northeast coast of Okinawa Island, the southern-most island prefecture of Japan and the northern-most range of dugong habitat in the world (Kasuya *et al*. 2000).

In 1979, a brief aerial survey was conducted around Iriomote Island (Figure 4.1), the Sakishima Shoto Islands area in southern Nansei Shoto. No dugongs were sighted despite the existence of significant areas of seagrass off Miyako, Ishigaki and Iriomote Islands (Brownell & Kasuya *unpublished data*). Uchida (1994) and Kasuya

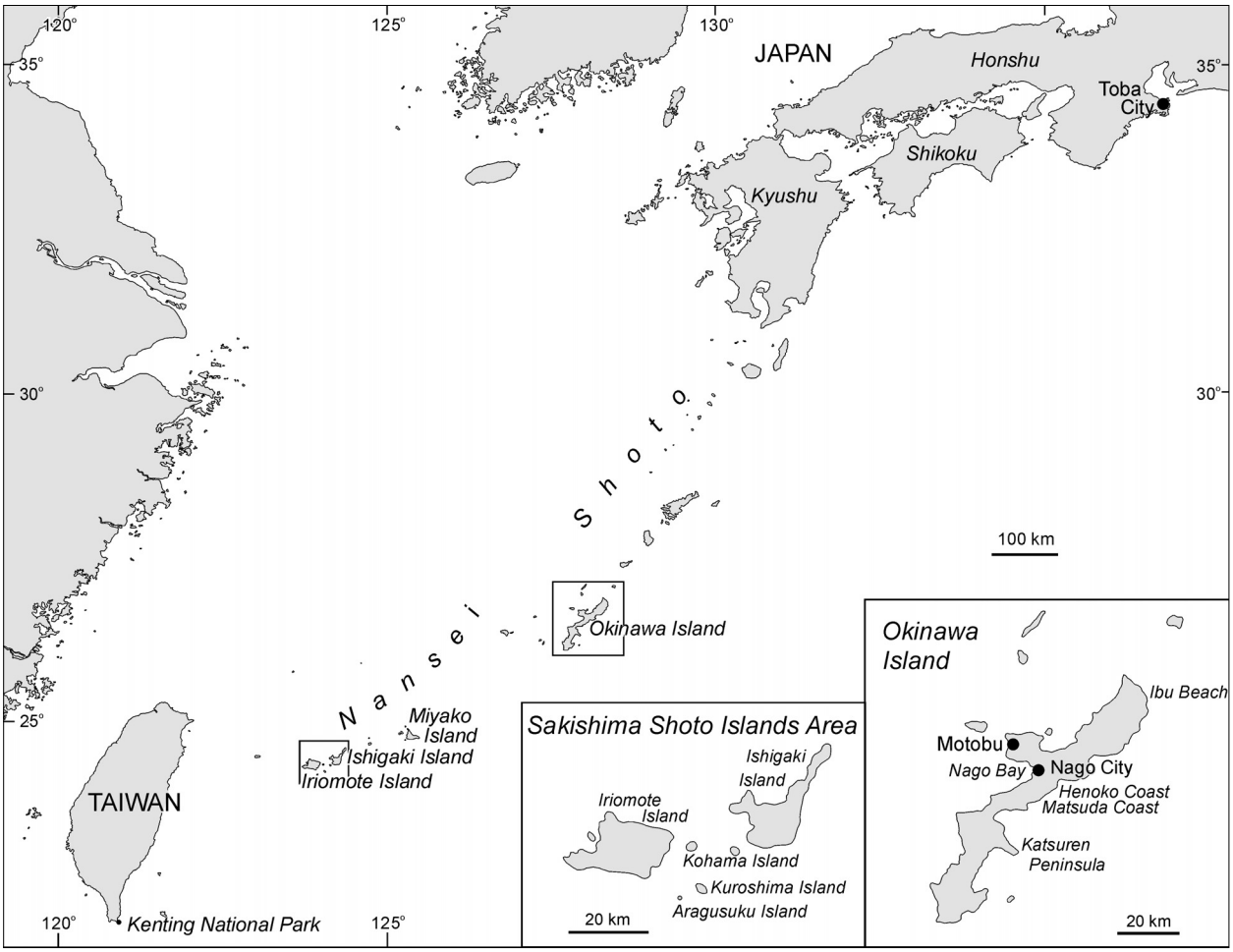


Figure 4.1 East and Southeast Asia showing place names mentioned in the text.
Inset on right: Okinawa Island.
Inset centre: Sakishima Shoto Islands.

(*unpublished data*) emphasized the need for further surveys around Iriomote Island where they believe pristine habitats exist. In 1999, an aerial survey covering 970km of the Iriomote, Kuroshima, Kohama, Aragusuku, Ishigaki and Miyako Islands was conducted (Kasuya *et al.* 2000). No dugongs were observed. However, a subsequent subsurface survey conducted at 44 sites located in seagrass beds in the same region confirmed nine species of seagrass distributed over one-third of the coastlines of the Iriomote, Kohama and Ishigaki Islands (Kasuya *et al.* 2000). Kasuya *et al.* 2000 concluded that dugongs are extinct or are in extremely low numbers off the Sakishima Shoto Islands on the basis that

1. there were no sightings of dugongs during the 1999 aerial survey
2. no feeding trails were observed on seagrass beds during the subsurface surveys
3. all known records of incidental mortalities, stranding or opportunistic sightings of dugongs in the Sakishima Islands occurred before 1970
4. numerous trap nets and gill nets now operate in the area presumably threatening the survival of dugongs in this region.

In April 1998, an aerial survey covering an area of 900km^2 off the east coast of Okinawa Island (Figure 4.1) sighted ten solitary dugongs north of Katsuren Peninsula (Kasuya *et al.* 1999). Some of these sightings may have been repeat sightings of the same animal. Most sightings were in deep waters (<90m) near the outer edge of the coral reef. However, subsequent subsurface surveys confirmed feeding trails in shallow seagrass beds inshore from the locations of the dugong sightings (Kasuya *et al.* 1999). In 1999, observers on a single opportunistic helicopter survey operated by the media sighted six dugongs at different places along the east coast north of the Katsuren Peninsula (Masako 2000; SDF 2000), indicating that at least six dugongs occur along this coast. Nonetheless, an accurate estimate of dugong abundance is not available. From October 30 to December 16, 2000, an aerial survey of Okinawa Island area was conducted by the Defence Agency. Six individual dugongs were sighted; five on the east coast and one on the west (Onishi *pers comm.* 2001).

Kasuya *et al.* (2000) conclude that the Sakishima Shoto Islands area may be unsuitable for dugongs as it appears from surveys that the area does not support a significant number of animals. In addition, it is unlikely that significant numbers of dugongs are left in other parts of the Nansei Shoto which have not been surveyed due to the lack of significant seagrass beds around the unsurveyed islands (Kasuya *et al.* 2000). However, areas off the coast of Okinawa Island, particularly on the east coast between Katsuren Peninsula and Ibu Beach (52km apart, Figure 4.1) potentially support significant numbers of dugongs. The east coast of Okinawa supports approximately 1,205 ha of seagrass in comparison to 125 ha on the west coast (DNO 2000).

Threatening Processes

Habitat Loss and Degradation

Seagrass meadows border only 10% of the coastline of Okinawa Island. Any historical changes in seagrass distribution along Japan's coast have not been documented (Japan Environmental Agency 1996). These meadows are threatened by terrestrial runoff, coastal construction, land reclamation and the expansion of seaweed aquaculture operations (Brownell & Kasuya *unpublished data*). Previously abundant seagrass beds in Nago Bay, western Okinawa Island (Figure 4.1) have been destroyed by inflows of red soil as a result of land development (DNO 2000). Nets set for seaweed culture are often set over seagrass beds. These nets are thought to be detrimental to seagrass beds and to decrease the availability of seagrass to dugongs (Kasuya *et al.* 2000).

Up to 75% of all US military bases in Japan are located within Okinawa, which makes up less than 1% of the total land in Japan. Damage to the marine environment resulting from military activities includes pollution resulting from noise caused by ammunition drills and military practice, hazardous chemicals, soil erosion and the disposal of depleted uranium weapons. The US Marines use the area offshore of the Henoko and Matsuda coasts (Figure 4.1), a confirmed important dugong area, for various military exercises (DNO 2000). The seagrass beds off these coasts are in the training fields of US Marines. Military exercises can be detrimental to dugongs and their habitat by contributing to marine pollution (i.e. oil leaks), acoustic pollution and habitat destruction resulting from vehicle operations. The effects of these activities on the dugongs and seagrass beds have not been quantified (Kasuya *et al.* 2000).

The US and Japanese Governments are planning to construct an offshore US military base at Camp Schwab, near Henoko (Figure 4.1) to replace the Futenma base on Okinawa Island which is to be returned to Japan (Masako 2000). In 1998, the region around Camp Schwab and Henoko was designated as a Rank 1 Area requiring the "most rigid" environmental protection in the "Guidelines on the Preservation of the Natural Environs of Okinawa. The construction of this military base threatens to destroy some of the most important known

remaining dugong habitat in Japan and will presumably result in additional disturbance to dugongs in the form of aircraft and boat noise and other activities in the area. The effect on the seagrass bed of the sewage from the expansion of Camp Schwab is also of concern. These impacts are potentially serious for such a small and presumably isolated dugong population.

Fishing Pressure

Dugongs are caught incidentally in fishing gear including trap nets and bottom gill nets. In the past, fish driving operations caught dugongs (e.g. in 1960s off Irabu Island, near Miyako Island (Figure 4.1)), however, fish driving is now considered inefficient and labour-intensive and is almost extinct in the Nansei Shoto region (Kasuya *pers comm.* 2000). Numerous locally-based gill net fisheries operate during the winter (Kasuya *et al.* 2000). During the 1999 survey (see above), large numbers of trap nets were sighted along most of the survey range. The highest density of traps was found in an area between Iriomote (east and north coast) and the Kohama Island region (Figure 4.1), where 17 sets of trap nets were seen along a 9km stretch of coasts (Kasuya *et al.* 2000). In contrast the density of trap nets is low along the east coast of middle and northern Okinawa Island where dugongs still occur (Kasuya *et al.* 2000).

Sixteen dead dugongs have been formally recorded in the region in the past 30 years. Six of these dugongs were killed in trap nets, three in gill nets, one in an unspecified fishery, and six were found on the beach. Some of the last may have been animals killed in fishing gear and later discarded (Kasuya *et al.* 2000). Most of these reports are from the eastern coast of Okinawa Island, which, in comparison with other areas, is least used by net fisheries.

Indigenous Use and Hunting

Carvings made from dugong ribs have been found throughout Okinawa. The most common is a carving of a butterfly, which is believed to take the spirit of the dead to another world (Kasuya *pers comm.* 2000).

Traditional dugong hunting was practised by people on Aragusuki Island, southern Nansei Shoto, who hunted along the coasts of nearby Iriomote, Kohama and Ishigaki Islands (Figure 4.1) (Brownell & Kasuya *unpublished data*). Aragusuki people hunted dugongs for tax payment. A Japanese article in late 1890s records opportunistic hunting of dugongs by the people of Ishigaki Island. Such opportunistic hunting was most likely common along the entire Japanese range of the species (Kasuya *pers comm.* 2000). At the present time, no seagrass beds are found around Aragusuki Island. It is not known when the Aragusuki dugong fishery stopped operating but dugong cranial remains from the fishery were found on the island in the 1970s and Kasuya (Brownell & Kasuya *unpublished data*) identified dugong cranial fragments at a sacred coral mound on Aragusuki.

Existing Conservation Initiatives

Legislation

- The dugong was designated as a 'Natural Symbol' according to the *Law to Protect Historical and Scenic Sites 1919*. However, the Agency for Cultural Affairs denies that this designation existed (DNO 2000).
- The Government of the Ryukyus, which was under US occupation at that time, listed Okinawa dugongs as a natural monument in 1955. The Government also issued a postal stamp with a drawing of a dugong in 1966. (This stamp was part of a series of animals protected by Okinawa law at the time.)
- In 1979, when Okinawa Prefecture was returned to Japan, the dugong was again listed as a natural monument.
- Since 1993, the Japanese Fisheries Agency has protected dugongs under the *Fishery Resource Protection Act*.
- The Japanese Society of Mammalogists has classified Japanese dugongs as "Critically Endangered" using the IUCN criteria.

The dugong protection measures implemented by the Japanese Government prohibit intentional kills and possible harassment of the species, and request reporting of incidental fishing mortalities. The laws do not address the current and most significant threats to dugongs; incidental mortality in fishing operations and habitat destruction (Kasuya *et al.* 2000).

Research

As detailed above, dedicated aerial surveys for dugongs and seagrass meadows have been conducted in the southern Nansei Shoto region in 1979, off the Okinawan coast in 1998, and over the Sakishima Islands in 1999 (Kasuya *et al.* 1999; 2000). Dugong post mortem examinations are conducted at the Okinawa Aquarium as required.

Two dugongs (one male and one female) currently at the Toba Aquarium in Toba City, central Japan, have provided information on dugong growth, feeding and

behavioural ecology and reproductive biology. The male dugong, from the Pacific coast of Luzon Island in the Philippines (Figure 4.3), has been kept at the aquarium since 1979; the female, also from the Philippines, has been at the aquarium since 1987 (Asano *pers comm*. 1998)

The Dugong Network Okinawa (DNO), a non-government organisation (NGO) established in 1997, collects opportunistic records of dugong incidental sightings and feeding trails around Okinawa Island and conducts public awareness programs. The Dugong Study Group conduct short-term systematic surveys on dugong distribution, seagrasses and feeding trails. Save the Dugong Foundation (SDF), established in 1999 to advocate dugong protection and ecosystem preservation, is organising funds to implement a survey of dugong habitat and ecology off Yambaru (northern Okinawa).

Management

The Japanese Fisheries Agency and the Agency for Cultural Affairs recognise the dugong as a species that needs special protection. The World Wide Fund for Nature (WWF) and The World Conservation Union (IUCN) listed the Nansei Island chain, which includes the dugong habitat around Camp Schwab in Okinawa, as one of the "Global 200" ecological hotspots to be protected in the name of biological diversity (SDF 2000).

In January 2000, the DNO released two documents, "Appeal for the Protection of the Dugongs in Okinawa" and "For The Protection of Dugongs Offshore Okinawa", to the Government of Japan, the Okinawa Prefectural Government and to other relevant authorities. The documents urge the Governments to urgently take immediate actions to conserve dugong populations around Okinawa (see below and DNO 2000). The Japanese Society of Mammalogists passed a resolution in September 2000 to request protection of the dugongs of Okinawa.

A "Draft Resolution on Conservation of Dugongs around the Okinawa Island" was submitted to the World Conservation Congress at its 2nd Session in Amman (Jordan) in October 2000. The Resolution called on the government of Japan to

- conduct a detailed study on dugongs and their habitat around Okinawa and prepare a conservation plan
- review and revise the plans of the military airport and military training in and around dugong habitats (Anon 2000).

A meeting chaired by the Chief Cabinet Secretary and the Director-General of the Okinawa Development Agency was held at the Prime Minister's Residential Office in Tokyo in October 2000 to discuss the new Military Base Facilities. Representatives from the Government, the Defence Agency, and the Okinawa prefecture (including the Governor of the Okinawa Prefecture and Nago City Mayor) were present. At this meeting the Director General of the Defence Agency stated that they plan to undertake a three month preliminary dugong survey with technical advice from the Environment Agency.

A dugong symposium, jointly organised by the Association to Save the Dugong of the northern-most Habitat, WWF-Japan, Save the Dugong Foundation and the Dugong Network Okinawa, was held in Kyoto and Tokyo in April 2000. In Nago, Okinawa, a dugong workshop was held in April 2000, followed by an International Dugong Symposium in July 2000. Recommendations for dugong research and management priorities resulting from this symposium are outlined below.

Large-scale seagrass maps have been completed by the Environmental Agency.

In May 2001, the Ministry of Environment unofficially announced that they will list the dugong as an endangered species and look at the possibility of setting up a dugong sanctuary.

Suggested Conservation Initiatives

Research

Most research should be directed at documenting dugong habitats at finer spatial scales and the factors likely to cause dugong death or habitat degradation. The nature and impacts of fishing in dugong habitat should be another research focus.

- Aerial surveys should be expanded to include the entire range of potential dugong habitats off Japan. In important dugong areas (e.g. the Okinawa region), aerial surveys should be repeated several times a year in order to provide temporal information on day time distribution and habitat use and a minimum population estimate. It will not be possible to document population trends using this technique as the population is too small. Kasuya (*et al*. 1999; 2000) recommend that surveys need to be conducted along the west coast of Okinawa Island north of Motobu Peninsula (Figure 4.1), where they believe that the previous survey effort was insufficient. These areas should be given highest priority.
- Additional valuable information on dugong distribution and abundance will be obtained from the incidental sighting program (see below) provided this program is adequately resourced.

- The location of seagrass beds should also be recorded during the aerial surveys as a basis for subsequent ground-truthing using vessel-based surveys.
- Priority should be given to detailed seagrass studies including distribution and community composition in the currently identified dugong habitat area (eastern Okinawa Island) and current threats. Information on day and night time dugong habitat use could be obtained by mapping dugong feeding trails in the seagrass and accumulating all such records in a Geographical Information System (GIS).
- The sources of potential pollution of the seagrass beds should be documented and recorded in a GIS.
- Obtaining information on the interaction between sea algae culture and/or military activities and seagrass is important and should be a high priority.
- A formal socio-economic assessment of the potential impact of closing the trap and gill net fisheries in various areas should be carried out as a precursor to actions to make these fisheries ecologically sustainable. This assessment should be based on detailed information on the income and demographic characteristics of the fishers, their fishing activities, locations and effort.
- Use of dugong carcasses in private scientific collections or museums for genetic and diet studies should be encouraged. Use of incidentally captured carcasses is also very important. The carcasses have been collected and necropsied by a local aquarium. The accumulated tissues and stomach contents have the potential to provide invaluable information on the stock identity and diet of the dugongs occurring around Okinawa. This information will be difficult if not impossible to obtain from any other source.

Management

- The most effective method of conserving dugongs in Japan would be to establish a sanctuary in the area of most important dugong habitat. Practices harmful to dugongs and their seagrass habitat should be prohibited or very restricted in this sanctuary. Negotiations should commence immediately to establish a dugong sanctuary along the east coast of Okinawa from Katsuren Peninsula to Ibu beach encompassing the coastal reef flats and extending about 52km in length and up to 15km out to sea beyond the reef crest to include areas where dugongs rest during the day. Such a sanctuary would be consistent with the WWF's "Global 200" status of the Okinawa region and the dugong could be used as the "flagship" species for the sanctuary. The following conservation controls associated with the sanctuary should be negotiated in consultation with the local community:
  1. bans on gill and trap netting
  2. measures to protect the seagrass beds from further destruction
  3. controls over boat traffic in the area.
- Environmental impact assessment guidelines need to be implemented and enforced before any plans for major developments (including the proposed offshore military base) are approved. The IUCN endorses these recommendations as well as the consideration of multiple options including alternative sites. It will be important to compare the environmental and social impacts of the eight alternative construction proposals for the base and the so-called "zero option" before plans are finalised. The terms of reference for the impact assessment need to be comprehensive and developed with input from the local community and relevant experts. As the dugong is listed under the *US Endangered Species Act 1973*, the IUCN recommends that the government of the United States be included in the Environmental Impact Assessment process to ensure the assessment complies with standards outlined in US environmental legislation. The *US National Environmental Policy Act 1969* and the *Endangered Species Act 1973* could be the basis for assessing environmental impacts of the construction in Okinawa of United States military bases by the United States Marine Corps.
- There is an urgent need for regulatory actions to reduce (or preferably ban) harmful fishing operations like trap nets in the dugong habitat on the east coast of Okinawa Island. Action to stop dugong mortality resulting from these fisheries is important for the survival and recovery of dugong populations in Okinawa. Compensation for the social and economic losses incurred by the fishing industry will need to be considered, preferably based on a formal socio-economic impact assessment based on detailed information on fishing locations and effort as outlined above.
- Further support is needed for public awareness programs and the collection of incidental sighting data. A community-based incidental sighting program has already provided valuable information and is an important public education tool. To ensure its long-term success, this activity will need to supply regular feedback to the community. A person could be employed part-time to collate sightings and provide feedback material at minimal cost.

- A conservation plan to protect dugongs in Okinawa needs to be developed. A priority for such a plan must be the protection of the seagrass habitats of Okinawa and the reduction of fishing impacts.
- Dugong populations off Okinawa are at the northern most limit of their range in East Asia. In addition, the adjacent Yambaru area in the northern part of Okinawa Island has high biodiversity. The World Conservation Union (IUCN) recommends that this sea area be nominated for World Heritage status. Application of relevant domestic laws such as the 'Nature Conservation Law', the 'Natural Parks Law' to the region would provide the prerequisite conditions for World Heritage designation. The government of Japan should seriously consider this recommendation.
- The "Law for the Conservation of Endangered Species of Wild Flora and Fauna (LCES)", the Japanese version of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), needs to be applied to dugongs and their habitats as soon as possible in Japan.
- Dugongs should be listed as an 'endangered species' in *"The Endangered Wildlife in Okinawa Prefecture"*. The dugong population around Okinawa is extremely small and is considered critically endangered by the Japanese Society of Mammalogists.
- Implementation of a comprehensive environmental policy to protect endangered species within the Nansei Shoto and surrounding reefs, including dugongs, should be considered by the Japanese government.

Conclusions

- Okinawan waters support a very small, presumably isolated population of dugongs. In the past 30 years (from 1970 to 2000) dugongs have been recorded only off the coasts of Okinawa Island. This coast is likely to be the only location currently supporting a dugong population in Japanese waters.
- The primary threats to the dugongs of Okinawa are net fishing and habitat loss and degradation. If the population is to recover, it will be necessary to limit both these threatening processes.
- Japan and Australia are the only two developed countries whose waters support dugong populations. These countries have a special role in dugong conservation. Unless measures are undertaken to protect dugongs in the Okinawan region they will soon be extinct in Japanese waters.

TAIWAN (CHINA)

Distribution and Abundance

Taiwan (China) lies at the southern end of the arc of islands that extend from Kyushu (Figure 4.1). The status of dugongs in Taiwanese waters and the extent of their distribution are unknown. Wang & Sun (1986) noted that dugongs are rare off this coast. Dugongs do not appear in the stranding records in this region from 1990-95 (Porter *pers comm*. 2000). No dugongs have been recorded despite increased interest in marine mammal research in Taiwan China since 1990 (Chou *pers comm*. 2001).

Threatening Processes

Habitat Loss and Degradation

The mainland and east coast of Taiwan (China) are undergoing extensive development. It is suspected that there is a high level of pollution and habitat degradation in these areas (Perrin *et al*. 1996). Threats to potential dugong habitat in this region include thermal pollution (nuclear power plant), coastal and tourism development, agricultural runoff and mining activities (Mackinnon *et al*. 1996).

Existing Conservation Initiatives

Kenting National Park (Figure 4.1) was established in 1984 as the first National Park in Taiwan (China). It covers a total area of 326km^2, with 149km^2 being a marine area established to conserve local coral reefs and the sandy and rocky shores. There are reports of dugongs having been sighted in this area in the 1950s and 1960s (Wang 1993).

Suggested Conservation Initiatives

Research

- The most significant initiative would be a large-scale aerial survey of the inshore waters of Taiwan Island for coastal marine mammals. Boat surveys conducted jointly for small cetaceans and dugongs would also be useful.
- An assessment of seagrass distribution should be conducted.
- If an aerial survey is not feasible, verbal interview surveys with local communities should be conducted in association with generic boat-based surveys for coastal marine mammals. Interview surveys might provide important information on former dugong distribution, abundance and mortalities including local knowledge of dugongs and beliefs about the species.

Management

- If dugongs are detected in Taiwanese waters (which seems unlikely), initiatives should be developed to conserve them. Options which might be considered include
  1. assessment of the feasibility of establishing one or more dugong sanctuaries in which direct mortality is banned and the habitat protected
  2. a culturally appropriate education program to inform fishers and other members of the local communities (including schools) on aspects of dugong biology, conservation and management.

Conclusions

- It is not known whether or not dugongs survive in Taiwanese waters. It seems likely that they do not.
- Dugong habitats (if they exist) need to be identified with high priority.

CHINA

Distribution and Abundance

The status of dugongs in Chinese waters is unknown and the extent of their distribution is uncertain. The few Chinese records and incidental catch information available suggest a distribution limited to warm coastal waters off the southern coast of mainland China, especially around Hainan Island, Guangxi (Dong 1980) (Figure 4.2).

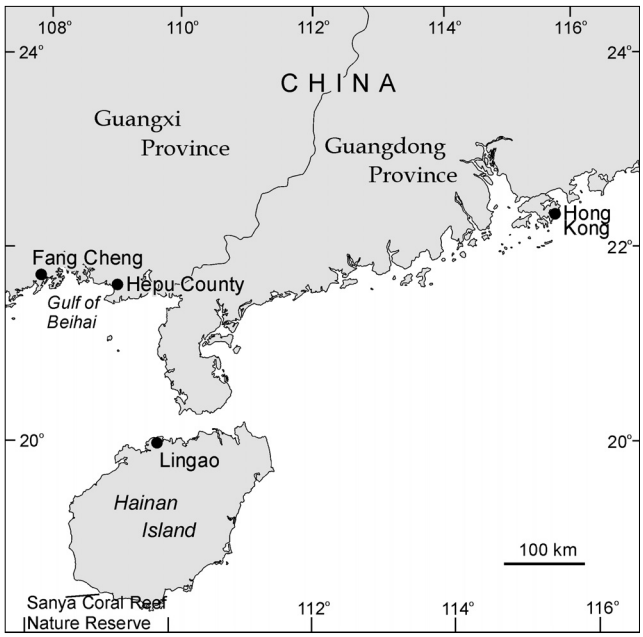


Figure 4.2 – Hainan Island and the southern coast of mainland China showing place names mentioned in the text.

The distribution of dugongs off the southern coast of China includes the waters between Hainan Island and the mainland and extends into coastal waters of both Guangxi (in the Gulf of Beihai) and Guandong Provinces (Figure 4.2). However, it is unknown if dugongs still occur throughout this entire area (Wong *pers comm.* 1998; Porter *pers comm.* 2000). In September 2000, a government funded land/boat based study of dugong distribution within the coastal waters of Guangxi fringing the eastern shores of the Gulf of Tonkin, west of Hong Kong, and Hainan Island, found five dugongs near Gangmen Village, near Dongfang city on the west central coast of Hainan Island (Morton 2001; Porter *pers comm.* 2001) (Figure 4.2). The seagrass species *Halophila ovata* and *Zostera japonica* were observed within the study area. In the Gulf of Beihai (Figure 4.2), Wong (*pers comm.* 1998), using a fishfinder over a two day period in 1987, sighted two dugongs on one day and five groups the next day (two groups of two individuals, two groups of three individuals and one group of five individuals). In 2000, a land/boat based study funded by Ocean Park Conservation Foundation, of dugong distribution in this region sighted five dugongs. Adjacent to the study area, on the western part of Hainan Island, it is reported that dugongs occur in greater numbers. Aerial surveys incorporating this area are currently being planned (Porter *pers comm.* 2001).

A population of dugongs once inhabited the seasonally cold waters of the Pearl River Estuary, adjacent to Hong Kong (Porter 1998). It is not known if the population resided there all year round or seasonally. No dugongs have been observed in the Pearl River Estuary in recent years, despite dedicated research on dolphins in this area.

Threatening Processes

Habitat Loss and Degradation

In the Gulf of Beihai and Hainan areas (Figure 4.2), the following activities occur which have potentially adverse affects on dugong habitat: reclamation, extensive harvesting of mudflats for invertebrates, construction of fish/shrimp ponds, aquaculture industries, saltpan farming, felling of coastal vegetation (for charcoal and timber), rising sea levels (causing erosion of coastal areas, particularly in Hainan), and sand, coral and mineral excavation. Siltation, caused by coastal modification and inland damming and irrigation projects, smothers sea grass (and coral) areas. In Hainan, over 80% of the coral reefs around the island have been destroyed by explosive fishing and coral mining (Mackinnon *et al.* 1996). As a result, the protection coral reefs once afforded the coastal areas is now reduced, leaving them unprotected against seasonal typhoons. This reduced level of natural protection against extreme weather events is significantly contributing to erosion problems.

Hainan is a Special Economic Zone (SEZ), designated by the national government for accelerated development. Free-trade and foreign investment are encouraged, resulting in extensive commercial and industrial

development on Hainan Island. This area is also popular as a tourist destination and coastal development (hotels and resorts) is extensive. The recreational activities of the tourists can damage the coastal habitat (e.g. coral reefs). In addition, a new airport is being developed in Sanya City, an area that has been designated as a coral reef nature reserve (Sanya Coral Reef Nature Reserve). Sources of pollution in this region include industry, agriculture, sewage, oil and gas exploitation, oil leakage (vessels and wells), fish farming, thermal effluent and silt (run off and dredging).

Fishing Pressure

Unsustainable and destructive fishing practices such as electric fishing, explosives and various poisons are common in Chinese waters (Perrin *et al*. 1996; Porter *pers comm*. 2000). Destructive fishing techniques are also causing damage to seagrass beds (Wong *pers comm*. 1998).

The Beihai area is over-fished and over-harvested. For those people who live outside the SEZ (the adjacent areas of Guangxi and Guandong Provinces) fishing is an important (sometimes the only) source of nutrition (Porter *pers comm*. 2000). In addition, as the neighbouring SEZ becomes more populated, there is a greater demand for fish products for consumption.

Indigenous Use and Hunting

Dugong oil was traditionally used in Chinese medicine to stem blood flow (Porter 1998). Dugong numbers were reported to be plentiful before 1960 when dugongs were described as 'miraculous fish'. Traditionally, local fishers revered the dugong and did not catch them; it was believed that catching a dugong would bring bad luck. As a result, dugongs were not hunted for centuries. In 1958, an influx of new immigrants who did not hold this belief moved into the Beihai region (Guangxi Province) and ate dugong meat. Local fishers observed that no harm came to these people and as a result, widespread hunting commenced. From 1957 to 1972, over 200 dugongs were caught for their meat (Wong *pers comm*. 1998).

Boat-related Impacts and Ecotourism

The Hainan Island area is a popular tourist destination. Recreational activities including boating and SCUBA diving damage the coastal habitat. The large number of divers around Hainan Island has contributed to reef disturbance and destruction. Repeated levels of disturbance may displace dugongs from their habitat.

Existing Conservation Initiatives

Legislation

Chinese legislation relevant to dugong protection includes:

- The *Propagation and Protection of Aquatic Resources*. In 1979, the Chinese State Council issued regulations under which all cetaceans and dugongs were listed as 'rare and precious species' and thus afforded stringent protection. Hunting, trading, smuggling and the incidental catch of dugongs are banned. In addition, dugongs are not allowed to be harassed or their habitat disturbed.
- In 1986, *Article 27 of the Fishery Law of the People's Republic of China* prohibited the capture of 'rare and precious' aquatic animals.
- In 1987, a *Circular Decree of the State Council* which banned the hunt of, trade in, and smuggling of rare and precious animals was issued. This was followed by the *Law on Protection of Wildlife 1988*. Under this law, dugongs are ranked as a *Grade I National Key Protected Species*. The capture, killing or trading of dugongs is banned under the *Aquatic Wildlife Protection and Implementation Regulations of the People's Republic of China 1993*. This is the national law under which CITES operates.

Research

Dong (1980) and Wang and Sun (1986) studied the distribution of dugongs in south China. Since then, no formal research has been carried out on dugongs as far as can be ascertained. Any stranded specimens found by Guangxi authorities (at Hepu County) are kept in a museum in the seaside park at Beihai City (Wong *pers comm*. 2001).

Management

The Action Plan for Marine Biodiversity Protection in China recommends establishing marine reserves as the best way to protect marine biodiversity and prevent the overall deterioration of the marine ecological environment (Wu *et al*. 1986). The first Marine Protected Area in China was established in the Beihai Sea in 1963. In the 1950s, fishing sanctuary zones and closed seasons

existed on this region. China has seven national marine reserves in addition to several local protected areas. Three national reserves are in the Beihai area, an area of known dugong habitat. The 864km^2 Hepurugen National Nature Reserve in Guangxi Province was designated in 1992 because of the area's importance to dugongs. Although not specifically designated for dugong conservation, additional locally-designated reserves under local authority exist within the known area of dugong distribution in China. These reserves include:

Guangxi Province:

- The Beilen estuary Mangrove Nature Reserve (27km^2) in Fang Cheng Xian
- The Shankou Mangrove Ecosystem National Nature Reserve (80km^2) in He Pu Xien (21°28'01'N, 109°43'01'E)°
- The Weizhoudaoniaolei Island Migratory Birds Nature Reserve (26km^2) just off Hainan Island in Bei Hai Shi (21°02'41'N, 109°06'27'E).

Hainan Province:

- The Baideibei Coral Reef Nature Reserve (44km^2) in Dan Lin Gao Xian (19°40'N, 109°30'E)
- The Dongzhaigang National Mangrove Nature Reserve (33km^2) in Qiong Shan Xian (19°55'N, 110°31'E)
- The Lingaujiao Coral Reef Nature Reserve (35km^2) in Lin Gao Xian
- The Lingau Xian Coral Reef Nature Reserve (324km^2) in Lin Gao Xian (20°00'N, 109°41'E)
- The Xingying Mangrove Nature Reserve (1km^2) in Hai Kang Xian (19°42'N, 109°15'E).

Guangdong Province:

- The Haikang Shellfish Nature Reserve (259km^2) in Hai Kang Xian
- The Luzhou Dao Coastal Resources Nature Reserve (15km^2) in Zhan Jiang Shi
- The Zhanjiang Mangrove Nature Reserve (15km^2) in Zhan Jiang Shi.

Trawl fishing is banned in the South China Sea from July to August, with all nets being locked onshore (Porter *pers comm*. 2000). The results of the ban have not been released.

Suggested Conservation Initiatives

Research

- The most potentially informative initiative would be a large-scale aerial survey of suspected dugong distribution (i.e. in Guangxi and Guangdong Provinces and Hainan Island). If an aerial survey is not logistically possible, boat-based surveys may yield some useful results provided they are conducted at a large spatial scale.
- Verbal interviews with local fishers and villagers could be carried out with the help of local fisheries officers and translators (if required), perhaps in conjunction with the surveys. Interview surveys can provide important information on dugong and seagrass distribution, abundance and mortalities including the Chinese knowledge of dugongs, beliefs about the species, traditional/modern use, sighting reports, and estimates of gill net mortalities. Such information aids the design of aerial or boat surveys.
- Seagrass distribution in Chinese waters needs to be mapped in order to help identify important dugong areas. Some information on seagrass distribution may be obtained from aerial surveys but the resultant information will need to be ground-truthed using boat-based surveys.

Management

- Sufficient legal protection for dugong conservation currently exists in China. The problem lies in implementing the legislation. Reasons for this include
  1. the lack of enforcement capacity over such a vast area;
  2. local people's direct dependence on the natural environment and the exploitation of natural resources, especially in areas such as Guangxi. It is unrealistic to require stakeholders to alter their livelihoods in response to conservation initiatives without alternative sources of income.

In view of these problems, the feasibility of introducing community-based management of coastal resources in China should be investigated with high priority.

- Effective habitat protection is essential for dugong conservation. Important dugong areas need to be identified and assigned sanctuary or protected area status in consultation with the local people.
- A culturally appropriate education program to inform fishers and other members of the local communities

(including schools) on aspects of dugong biology, conservation and management, and on methods to minimise incidental take should be developed as a prerequisite to exploring the potential for community-based management initiatives. Education and awareness materials could be developed appropriate for each community. Key fishing areas in critical dugong habitats should be targeted for education programs and the dissemination of information about dugong conservation. Awareness of legislation and conservation measures to protect dugongs should also be part of an education program.

The Institute of Oceanography, in Qing Dao (23° 15'0N, 116° 47'60E) where four dugong specimens are on display, would be an ideal venue for public education and promotion of the importance of dugong conservation (Wong & Peilie 2001).

Conclusions

- The status of dugongs in Chinese waters is unknown.
- Important dugong habitats need to be identified with high priority.
- The potential for community-based management of coastal resources using the dugong as a flagship species should be investigated in areas identified as having high conservation priority.

PHILIPPINES

Distribution and Abundance

Historically, almost all the islands of the Philippines (Figure 4.3) have recorded sightings of dugongs (Kataoka *et al*. 1995). Until the 1970s, dugongs were believed to be fairly common throughout the Philippine Archipelago (around most of the coastal islands) where they are called *duyong* or *baboy-dagat* (sea pig). There is no estimate of the abundance of dugongs in the Philippines.

Since 1985, the Pawikan Conservation Project (PCP) of the Protected Areas and the Wildlife Bureau-Department of Environment and Natural Resources (PAWB-DENR) has gathered data on dugong status and distribution in collaboration with the Toba Aquarium of Japan and WWF-Philippines. Information on the dugong's present distribution is based on aerial and interview surveys, local stakeholders' workshops, and sighting, stranding and incidental capture reports.

As summarised by Baltazar & Yaptinchay (1998), the distribution of dugongs in the Philippines includes Palawan Island (including Cuyo and Cagayan); the southern Mindanao coast; Sulu Archipelago; Quezon-Isabela-Aurora area (Luzon coastline); Lubang Island, Mindoro; Guimaras Strait; Panay Gulf and northeastern Mindanao (Figure 4.3). Aragones (1998) identified the following as areas where actual and/or reported sightings by fishers were highest: northeast coastlines of Luzon (Cagayan Valley, Isabela and Aurora provinces); Palawan and southern Mindanao (Figure 4.3). Overall, the dugong population in the Philippines is considered to be sparse and scattered (Yaptinchay *pers comm*. 2001). Palawan Island (Figure 4.3) is considered the dugong's stronghold in the Philippines.

Aragones (1994) conducted a study on dugong ecology around Calauit Island, Busuanga, Palawan (Figure 4.3) in 1989 and 1990. Calauit Island is surrounded by extensive seagrass beds. Aragones (1994) counted 15-24 individuals in this area with an average of five dugong sightings per survey. Calauit Island is a nature park and has a land area of 3760 ha. Buctot was the site most frequented by dugongs which were generally sighted during the summer. Seasonal movements by dugongs in this region appeared to be related to the monsoons. Dugongs were mostly sighted on the western portion of Calauit Island during the "Amihan" (Northeast Monsoon), and on the eastern portion during the "habagat" (Southwest Monsoon) (Aragones 1990).

A substantial dugong population exists in areas of southern Mindanao (Figure 4.3), particularly Sarangani and the Davao Provinces (Baltazar & Yaptinchay 1998). Malita, Davao del Sur; Talikud and Samal Islands; Balut and Sarangani Islands (including Sarangani Bay); and Pujada Bay are important dugong habitats on the southern Mindanao coast (Figure 4.3). Not much is known of the dugong population and its distribution around the Moro Gulf (Figure 4.3), which remains to be surveyed. There is a recent unconfirmed report of a population off Sultan Kudarat (Cola *pers comm*. 1999). Dugongs are also confirmed from northeastern Mindanao in the Surigao Provinces, particularly in the Siargao Islands and Hinatuan Bay (Figure 4.3).

Based on workshop reports, the Sulu Archipelago (Figure 4.3) may still have a substantial population of dugongs. However, this area has not been surveyed. There are no recent reports from the Turtle Islands (some of which are under Malaysian jurisdiction) but the dugong's presence (or former presence) in these islands was suggested through the discovery of remnant tusks.

The Quezon-Isabela-Aurora area (Figure 4.3) seems to support a viable population especially in the Polillo Islands and Palanan area. Recent marine mammal surveys in Palanan and Isabela, however, indicate that dugongs are quite rare in the area (van Lavieren 1999).

Other areas from where there have been isolated reports include the eastern Bicol coast (southern Luzon), Romblon and Masbate (Figure 4.3). Sporadic reports of incidental catches and strandings come from Masbate, Panay, Guimaras, and Negros Occidental (Figure 4.3). There have been past reports from Lubang Island, Mindoro (Figure 4.3), but no confirmed recent reports.

Dugongs are probably extinct in Zambales, Pangasinan, Tayabas, Batangas Bay, and Manila Bay in Luzon; Cebu Island, Negros Occidental, Samar Island, and Marinduque Island in the Visayas (Figure 4.3). Northern Mindanao, the rest of Luzon and Leyte (Figure 4.3) have yet to be surveyed to confirm the presence or absence of dugongs.

Threatening Processes

Habitat Loss and Degradation

Seagrass is widespread in nearshore areas, however, its extent is unknown. Sixteen species have been identified. Extensive seagrass beds occur in Bolinao, Palawan, Cuyo Islands, Cebu, Bohol, Siquijor, Zamboanga and Davao (Fortes 1990) (Figure 4.3). There are signs of seagrass degradation attributed to a combination of natural disasters, aquaculture, deforestation, siltation, destructive fishing

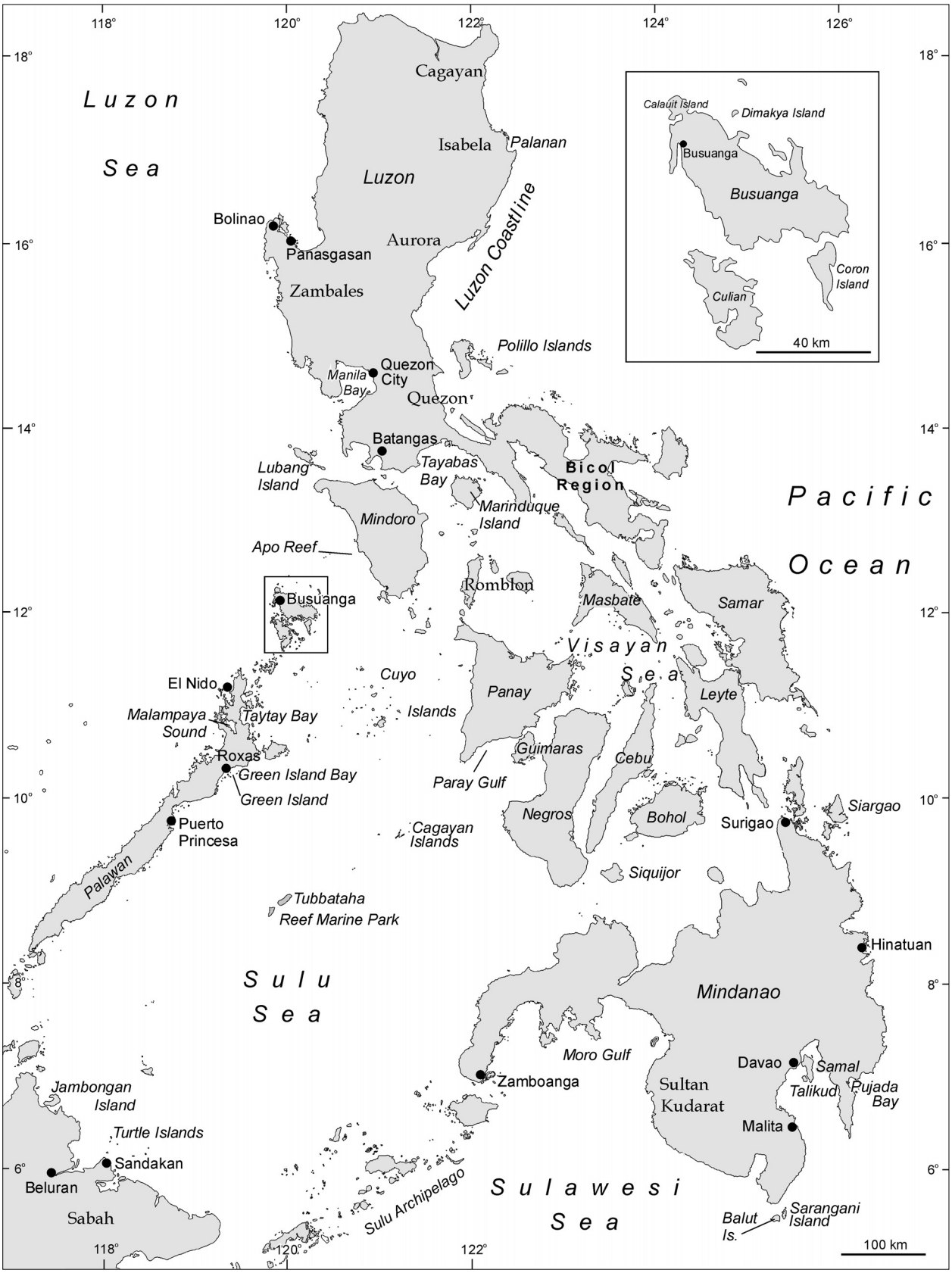


Figure 4.3 – The Philippines showing place names mentioned in the text.
Inset on left: Busuanga Island region.
Inset on right: The Bicol region.

methods, reclamation and development, dredging and recreation. Coastal development resulting from the high growth rate of the Filipino population is apparently reducing dugong access to feeding sites. Some 70% of the Filipino population lives within, or has access to, coastal waters. Uncontrolled coastal development is resulting in high levels of pollution, declining water quality and habitat destruction. Increases in industrial and domestic waste dumping, agricultural runoff, siltation, domestic sewage and oil spills have had destructive effects on seagrass beds, which are sensitive to increases in turbidity, toxic waste and chemicals (Perrin *et al.* 1996). DENR/UNDP (1997) reported a decline of 30 to 50% in seagrass beds in the last 50 years as a result of coastal reclamation and development, siltation, dredging, waste disposal, pollution, recreation and settlement.

A series of recent environmental disasters in the Philippines highlight the vexed question of whether toxic slag "tailings" from mining operations should be stored on land or dumped at sea. At Marinduque Island (where dugongs are belived to be extinct), researchers have found dangerously high levels of lead and cyanide in children's blood and soil samples from Calancan Bay. In 1999, a 13 year old child died from heavy metal poisoning. The fishing communities of Marinduque blame wastes from a copper mine for the poisoning (Pearce 2000). In other regions of the Philippines where major mining activity occurs, the acute and long-term impacts of heavy metals and persistent organic pollutants on seagrass may be of serious concern.

In Palawan (Figure 4.3), the most important threats to dugong habitat are siltation and sedimentation from deforestation. Anecdotal evidence suggests that the distribution of seagrass beds restricts dugongs to feeding at high tide in areas where there is significant tidal amplitude. In other areas, the seagrass extends to deeper water and dugongs have the opportunity to feed throughout the tidal cycle.

Uri *et al.* (1998) discussed the characteristics of three known dugong feeding sites in northern Busuanga, Palawan (Figure 4.3): Dimakya Island, Cheey (12°15'0N, 120°0'0E) and Medped (a small island on the northern Busuanga coast, north Palawan). The beds are from 0.25 to 1 hectare in extent and composed of *Halodule* and *Halophila* species.

Fishing Pressure

The majority of dugong deaths are believed to result from incidental catches in gill nets, beach seines, use of dynamite fishing methods, trawl, baby purse seines, baynets, and fish corrals. This is most evident in Palawan. Dugongs are accidentally caught in fish corrals, locally known as "baklad". Fishers purposely spear captured animals rather than release them (Kataoka *et al.* 1995). The meat is then consumed (Kataoka *et al.* 1995; Aragones *pers comm.* 1998). Dugongs are killed intentionally with dynamite, a quick, successful and illegal method that has been used in the Philippines since the 1960s (Kataoka *et al.* 1995).

Indigenous Use and Hunting

It is a common belief in some islands of the Philippines that parts of the skeletal, digestive, reproductive and integumentary systems of dugongs can be used for medicinal purposes. Dugongs are also believed to bring bad luck. Some parts are also used as amulets to ward against evil spirits.

Dugong meat is not a traditional food in the Philippines. However, the meat is desirable as it is more tender, leaner and tastier than beef and a high source of cheap protein, especially in remote areas. The meat is usually sun dried or cooked immediately. Meat was previously sold openly in public markets, however, because of the current protected status of dugongs, the meat is now sold secretly (Kataoka *et al.* 1995).

The directed catch of dugongs has been documented throughout its range in the Philippines. Previously, fishers hunted these animals using spears and other implements. This has stopped, presumably because numbers are so depleted that the effort to catch dugongs is too great for subsistence fishers. Despite their protected status, dugongs are still opportunistically hunted today. There are no estimates on the magnitudes of such takes. Directed takes of dugongs are reported from Zambales, the Bicol region, Isabela, Quezon, Palawan and the Sulu Archipelago (Perrin *et al.* 1996) (Figure 4.3).

Boat-related Impacts

According to Aragones (1990), dugongs in Calauit appear to have adapted to boat disturbance by concentrating their feeding between dusk and dawn when boat traffic and/or fishing activities are low. In Dimakya Island, Busuanga, however, a dugong was observed feeding in a seagrass bed adjacent to a boat docking area despite the boat traffic (Uri *et al.* 1998).

Ecotourism has developed in Dimakya Island where an adult male dugong appears unpredictably and allows SCUBA divers to observe it.

Existing Conservation Initiatives

Legislation

Dugongs were the first marine mammal in the Philippines to be legally protected. This resulted in the prohibition of taking, catching, selling, purchasing, possessing, transporting or exporting of dugongs (Perrin *et al*. 1996). In response to this legislation, direct hunting has decreased. However, monitoring has been made more difficult as fishers have become more secretive, fearing penalties.

Several policies and laws have been passed in the Philippines of direct relevance to dugong conservation:

Department of Environment and Natural Resources (DENR) Administrative Order (AO) No. 55, 1991 – Declaring Dugong or Sea Cow as Protected Marine Mammal of the Philippines.

This order prohibits the killing or taking of dugongs for any purpose except scientific research. It also prohibits the destruction of their habitats. Fines are now based on the Fisheries Code rather than those of the previous law (*Republic Act* 2590). Provisions are also outlined for the disposal of dugongs or their by-products to any research institution as determined by the DENR. This law further provides that the Protected Areas and Wildlife Bureau (PAWB) through the Pawikan Conservation Program shall be the lead agency in the implementation of the administrative order.

DENR Administrative Order No. 48 – The Establishment of a National List of Endangered, Threatened, Vulnerable, Indeterminate, and Insufficiently Known Species of Wild Birds, Mammals and Reptiles.

The dugong has been included in this list and is declared as a species of priority concern for protection and conservation. However, no specific actions have been delineated nor implemented with regard to its protection and conservation.

DENR Administrative Order No. 96.

This order delineates the permit system that is being adopted by DENR for the use of wildlife resources. It is closely related to and implemented in conjunction with *DENR Administrative Order No. 48.*

Republic Act 7586 – National Integrated Protected Area System Act of 1992.

The implementing regulations of this law are embodied in the *DENR Administrative Order No. 25* series of 1992. These regulations prohibit hunting, destroying or possessing any plant or animal or products derived from a Protected Area without permit from the Protected Area Management Board.

Executive Order 247 – Bio-prospecting Law.

This Executive Order from the President of the Philippines provides guidelines and establishes the regulatory framework for the prospecting of biological and genetic resources, their by-products and derivatives for scientific and commercial purposes as well as for other reasons. This law covers the dugong, under *Administrative Order No. 48.* Actions related to collection of the animal or its by-products (including tissue samples), whether for research or commercial purposes, are subject to this law.

Act 8550 – Fisheries Code of the Philippines.

The Fisheries Code emphasizes not only the utilization and exploitation of fisheries but also the "protection and conservation of fishery resources to provide food needs at sustainable levels". Section 11 of Chapter 2 declares a closed season for rare, threatened and endangered aquatic species. In addition, sections 86-107 of Chapter 6 list the prohibitions and penalties.

Refiled bills at the House of Representatives – Wildlife Resources Protection and Conservation Act refiled as House Bill No's. 182, 175 and 830.

The main objective of this Bill is to update Acts 2590, 3547 and 3983 and to attune these to current developments in wildlife conservation and management. It further strives to address the accelerated loss of the country's wildlife resources and habitat and to provide maximum protection for the country's endemic and threatened wildlife resources and promote their sustainable use. Better protection and steeper penalties are expected once this law is approved.

Research

Research to underpin the conservation of dugongs is carried out by three agencies: the Department of Environment and Natural Resources (DENR), WWF-Philippines, and the University of the Philippines.

The Protected Areas and Wildlife Bureau (PAWB) of the DENR is researching the distribution and ecology of dugongs and is aiming to develop procedures for the rescue of incidentally caught animals (Perrin *et al*. 1996).

Since 1997, researchers at the University of the Philippines have been conducting interviews and boat surveys of marine mammals within some selected bodies of water off the islands of Luzon, Visayas and Mindanao. The objectives of the project include (Aragones *pers comm*. 1997)

- determining the status and distribution of marine mammals within Philippine waters

- identifying important areas that support populations of dugongs and other marine mammals ("Hot Spots")
- documenting and identifying marine mammal and fishery interactions
- identifying sources of anthropogenic impacts on marine mammals.

WWF-Philippines has been involved in dugong conservation in collaboration with various agencies, including the DENR, the University of the Philippines Marine Science Institute (UPMSI), and local and non-government organisations. Initially, a study in Dimakya Island, (Busuanga, Palawan) identified and characterised dugong feeding grounds in Busuanga, gathered physical, biological and behavioural data, and disseminated information on dugongs and conservation efforts in the area (Uri *et al.* 1998). WWF has also been working for the conservation of the Sulu-Sulawesi Large Marine Ecosystem, one of the WWF "Global 200" Ecoregions of Priority. This program includes the conservation of species of special concern, including the dugong.

Management

Out of 204 protected areas in the Philippines only nine are marine (Perrin *et al.* 1996).

The first Marine Protected Sanctuary was established in 1988 on Tubbataha reefs. Since 1985, the DENR, through the Pawikan Conservation Project (PCP) of the Protected Areas and Wildlife Bureau (PAWB), has been involved in dugong research and conservation through initial surveys and research work with private groups in Palawan (Baltazar 1998). In 1991, the PCP-PAWB became the lead agency for the conservation and management of the remaining dugong population with the issuance of the *DENR Administrative Order No. 55* which mandated the DENR to implement a nationwide program to conserve dugongs involving three strategies: research, resource management, and information and education (Baltazar 1998). DENR field offices provide support for these tasks. They provide a network to facilitate the transmission of sighting, capture or stranding reports to the PCP in Manila. In 1994, this network was involved in a nationwide assessment of existing or possibly significant dugong habitats.

Taytay and Roxas Bays, in north-eastern Palawan (Figure 4.3), are being established as Protected Areas for dugongs by the PCP through the Biodiversity Division of the PAWB.

Several Protected Areas in the National Integrated Protected Areas System category are dugong habitats including Pujada Bay Protected Landscape/Seascape, Sarangani Bay Protected Seascape, Apo Reef Natural Park and Siargao Protected Area (Figure 4.3).

Other programs that may provide some degree of protection for dugongs and their habitats include the 'Conservation of Priority Protected Areas Project' in Apo Reef Natural Park and Siargao Protected Landscape/Seascape; the National Integrated Protected Areas Project in Coron Island, Malampaya Sound and El Nido Marine Reserve; the Coastal Environment Program in Sarangani and Pujada Bays; the Strategic Environmental Plan in Palawan; and the Fisheries Management and Development Plan (Figure 4.3).

Other areas that are dugong habitats may be protected through national marine parks and national marine reserves, game refuges, wilderness areas and mangrove swamp forest reserves, islands proclaimed as tourist zones and marine reserves, and protected areas declared through administrative and memorandum orders.

WWF-Philippines is attempting to initiate the coordination of dugong conservation in the Philippines by

- establishing a conservation network with local groups in critical areas
- raising awareness and appreciation for dugongs through information and education campaigns
- developing national dugong research and conservation programs
- gathering data on dugong distribution, population and exploitation
- campaigning for and supporting the establishment of Dugong Protected Areas
- raising funds and awareness through an adopt-a-dugong scheme
- building the capacity of local stakeholders and concerned groups through training on marine mammal biology, research and conservation
- promoting regional cooperation on conservation of dugongs in Southeast Asia.

With the Inter-Agency Task Force on Marine Mammal Conservation, a multi-sectoral group headed by the PAWB-DENR has been tasked to support conservation of marine mammals in the Philippines. WWF-Philippines is establishing a marine mammal rescue and conservation network. Concerned groups have been trained and active rescue response groups have been established in the provinces of Bohol, Negros Occidental, Palawan and Batangas (Figure 4.3).

The Crocodile Farming Institute (CFI) in Puerto Princesa City, Palawan (Figure 4.3), was designated in 1994 as the Wildlife Refuge and Rescue Centre (WRRC) for the province of Palawan. The CFI assists the DENR in responding to marine mammal stranding incidents. However, the technical team, composed of biologists, aquaculturists and a veterinarian, lack experience in marine mammals rescue operations, especially in the care

of dugong neonates. A training program was designed for local authorities which plans to include instructions in paramedical procedures for stranding cases (Aquino 1998, *pers comm.* 1998). In 1999, training in marine mammal rescue was conducted for various groups in Palawan, including the newly established Palawan Marine Mammal Rescue Society (PMMRS). Since then, the PMMRS has assisted in the rescue and salvage of at least 35 incidentally caught and stranded dugongs and cetaceans in Palawan.

Saguda-Palawan conducts information and education campaigns on dugong conservation using puppet theatre presentations along with slide shows and lectures to raise the awareness of people living near dugong habitats (Songco 1998). Other activities conducted in Palawan include a dugong poster-making contest, distribution of dugong activity books and posters to elementary schools and fishing villages, and a dugong quiz. The same activities have been undertaken by the Mindanao Environment Forum (MEF) in the Mindanao area.

The First National Dugong Seminar Workshop was held in November 1998 in Davao City. The objectives of this workshop, sponsored by WWF-Philippines and the DENR-PAWB included

- reviewing past and existing efforts (including research and conservation activities) and knowledge of dugongs in the Philippines
- determining the present status of dugongs and their habitats
- identifying significant information gaps and conservation issues
- identifying further research and conservation priorities
- formulating a five-year conservation and research action plan for dugongs.

Suggested Conservation Initiatives

Research

- Top priority should be given to conducting broadscale surveys, preferably aerial surveys, throughout the Philippines to obtain information on the patterns of distribution and abundance of dugongs, as a basis for identifying sites on which to develop community-based conservation and management strategies. Highest priority should be given to Palawan.
- Studies on the socio-economic impediments to effective dugong management should be given high priority at the key sites identified for dugong conservation.
- The conflict between dugongs and fishing activities should be studied to estimate incidental captures and other human-induced mortalities. It will be particularly important to identify and protect areas where dugong feeding is limited by tides, as the same areas are also used for corral fishing practices.
- Intensive interview surveys should be conducted in Quezon, Aurora, the Cagayan Valley and southern Palawan (Figure 4.3) to help activate education programs and to assess conservation concerns. This study should be done as a background for the "Protected Areas Suitability Assessment (PASA)" which will form the basis of selecting future protected areas.
- Research needs to be conducted on the distribution and abundance of seagrasses.
- Data about the dugong and its habitat should be consolidated, perhaps in a national data base.
- Satellite tagging studies would provide data on the movement of dugongs and their fine-scale habitat use.
- An annual meeting of dugong researchers should be held to ensure cooperative sharing of information and coordination and review of research proposals.
- Kahn (*pers comm.* 2001) reported that throughout the Philippines, STD (submarine tailings "dumping") mining proposals are currently under review for approval. Research into the ecological toxicological effects of mine waste disposal on the marine food chain (including dugongs and seagrass) should be thoroughly examined before disposal is approved.

Management

Non-government organisations in coastal areas supporting dugongs should establish community-based education campaigns addressing dugong conservation issues, and/or strengthen community-based coastal organizations to enable them to become active partners in resource and conservation management. Areas which support nationally significant dugong populations, and where dugong hunting is still practised should be top priority. Dugong conservation should be approached in the context of an integrated program of coastal zone management including reforestation, riverbank protection, and mangrove rehabilitation and pollution control. The social and economic impacts of conservation initiatives need to be addressed.

Sites identified by WWF-Philippines and others as priorities for dugong conservation include:

- Calauit Island, Busuanga (Palawan)
- Green Island Bay, Roxas (Palawan)
- Malita, and Davao del Sur; (southeast Mindanao)
- Sarangani Bay, Sarangani Province; (south Mindanao)
- Sulu Archipelago; (between Mindanao and Kalimantan) (Figure 4.3).

North Sulawesi (Indonesia) and the Philippines should collaborate regarding dugong conservation in the Sulawesi Sea (Figure 4.3).

Conclusions

- Dugongs were believed to be fairly common throughout the Philippine Archipelago until the 1970s. Anecdotal evidence suggests that most dugong populations in Philippine waters are declining. The waters around the Province of Palawan, Southern Mindanao and the Sulu Archipelago appear to be the only remaining regions in the Philippines which still support reasonable numbers of dugongs.
- Fishing practices such as gill netting and corral fishing and the increasing degradation of seagrass beds are considered the main threats to dugongs in the Philippines.

THAILAND, CAMBODIA AND VIETNAM

Distribution and Abundance

Thailand

In the past, dugongs were commonly seen along both coasts of Thailand: the Gulf of Thailand and the Andaman Coast (Figure 4.4). Now they are mainly reported from the waters surrounding islands off the Andaman coast (Lekagul & McNeely 1977; Hines 2000). Nateekanjanalarp and Sudara (1994) report that dugongs may still exist on the eastern coast of the Gulf of Thailand around the provinces of Rayong, Chanthaburi and Trat, but none has been reported on the west coast for a long time. Adulyanukosol (1999) mentions a dead calf found in Chon Buri province on the eastern coast in 1999. The Marine Endangered Species Unit at the Phuket Marine Biological Centre (the major centre for study of dugongs along the Andaman Coast) has heard anecdotal reports of stranding incidents in Chumphon, Nakhon Si Thammarat, and Surat Thani provinces on the west Gulf of Thailand (Adulyanukosol 1999, *pers comm.* 2000) (Figure 4.3).

Helicopter surveys conducted in 1991 and 1992 sighted 61 dugongs off Trang Province on the Andaman Coast (Figure 4.6) (Sae Aueng *et al.* 1993). Aerial surveys conducted in 1997 and 1999 using helicopters (Bell S76-B), Dornier-228 airplanes, and a Polaris flying boat, found a maximum of 50 and 38 dugongs respectively along the Andaman Coast (Adulyanukosol *et al.* 1997, 1999). In 2000, a three-day helicopter survey was conducted along the entire coast from Ranong to Satun Provinces (Figure 4.4) (Hines *pers comm.* 2000). During this survey, 21-22 adult dugongs and four calves were sighted associated with coastal seagrass beds. Microlite surveys were then used to assess dugong distribution and abundance in the two locations where most dugongs were sighted during the helicopter surveys. In Trang province, an area with the most extensive seagrass beds in south Thailand, an average of 33 adults and 5 calves were seen per day, with a maximum of 54 adults and 13 calves and a minimum of 13 adults and 2 calves. Microlite transects were also performed in Krabi province at the seagrass beds surrounding Ko Sriboya, Ko Pu (Figure 4.4) and Ko Hang (7°46'0N, 98°58'0E). After five days, the maximum daily sighting was one cow/calf pair, plus four additional adult dugongs. Some researchers now consider that there are less than 50 dugongs left in the Gulf of Thailand, and approximately 100 individuals in the Andaman Sea (Adulyanukosol 1999; Hines 2000; Pitaksintorn *pers comm.* 2000).

Hines (2001) reports that although the overall dugong population consists of small groups scattered along the Andaman coast, up to 89 individuals were observed by aerial survey at Muk and Talibong Islands in Trang Province. Based on aerial surveys in 2000 and 2001, the estimated minimum abundance in Trang is 123 animals, with a maximum of 13 calves. The largest group seen was 53 dugongs among the seagrass beds southeast of Talibong Island (Hines 2001).

During 1994-95, Adulyanukosol from the Marine Endangered Species Unit of the Phuket Marine Biological Centre (Department of Fisheries) conducted interview surveys with 200 local fisher families along the entire Andaman coast (Adulyanukosol 1995). Further interviews with local fishers were conducted by Suwan Pitaksintorn and Tippawan Sethapun in 1999 to determine potential dugong habitat. Results identified seven sites as potential dugong habitat (four provinces in the Gulf of Thailand (two in Trat, one in Rayong, one in Chumphon and three in Surat Thani) and six provinces in the Andaman Sea (Ranong, Phuket, Phang-nga, Krabi, Trang and Satun) (Figure 4.4) based on incidental sightings between 1996 and 2000 (Pitaksintorn & Sethapun *unpublished data*). Further analyses are currently taking place.

Hines (2000) also conducted interviews with villagers along the Andaman Coast in five areas where dugongs have been repeatedly sighted. Interviews were conducted in Kuraburi and Thap Lamu in Phang-nga province, in four villages in Trang province, three villages in Krabi, and six villages in the Yao Islands in Phang-nga Bay (Figure 4.4). The interviews sought information on the history of interactions with dugongs, legends, stories or beliefs, and incidental sightings. The interviews found that the dugong is very important to the villagers as their livelihoods depend on their awareness of life in the coastal and marine environment. For example, 97% have a strong awareness of the importance of dugong conservation, and knowledge of the critical nature of declining populations. Interview respondents reported seeing 12 dugongs in the past five years along the Andaman coast. One dugong regularly visits seagrass beds at Thuei Island (off Kuraburi). Sightings of feeding trails by Hines (2001), the extent of seagrass beds and incidental sightings by villagers indicate that Kuraburi supports a small population of dugongs. At the Yao Islands, where dense seagrass beds occur, respondents regularly saw between one and ten dugongs (Hines 2000). Eight dugongs were observed in the Yao Islands during an

Figure 4.4 – Thailand, Cambodia and Vietnam showing place names mentioned in the text. Inset top left: The South Andaman region of Thailand.

aerial survey conducted by Adulyanukosol in 1999 (Adulyanukosol *et al.* 1999). Seventy three per cent of interviewees considered that the dugong population in Thailand is declining. This is also the opinion of the government officials, scientists, and staff of non-government organisations (Hines 2000).

Hines (2000) conducted transects and boat-based sampling at ten seagrass beds along the Andaman coast and found a total of ten species of seagrass. *Halophila ovalis*, *Enhalus acoroides*, and *Cymodocea rotundata* were the most prevalent. Hines (2001), through past survey interviews and aerial surveys with Thai scientists (see Hines 2000), has identified regular foraging areas for dugongs. All areas described were surveyed at high tide, and complete diurnal movements of dugongs were not recorded (Hines 2000). From north to south, the primary feeding areas are

1. the islands and shoreline surrounding the Kuraburi estuary in Phang-nga province
2. two seagrass beds in the Yao Islands in Phang-nga Bay
3. the seagrass beds surrounding Sriboya and Pu Islands in Krabi province
4. the seagrass beds between Muk Island, and Laem Yong Lam beach, bounded at the north by Khao Bae Na and the seagrass surrounding Talibong Island in Trang Province
5. the seagrass beds bordering Tanyong Uma and Ridi Islands in Satun Province.

In addition, intermittent, or secondary feeding sites possibly include seagrass beds near Chang and Phayam Islands in Ranong Province, Thap Lamu and Ban Thalane in Phang-nga province, Ban Pak Lok in Phuket province, and Laem Sai in Trang.

Primary feeding sites are defined as areas where more than one dugong is currently seen regularly by villagers, and/or has been seen during recent aerial surveys. Secondary sites are areas where strandings have been reported in the past, villagers see single dugongs or cow/calf pairs occasionally or single animals or cow/calf pairs were seen in the aerial surveys (Hines 2001).

Vietnam and Cambodia

There have been several reports of dugongs in Vietnamese waters since the 1960s, but there have been no recent surveys (Lang Van Ken 1997; Porter *pers comm.* 1998). There are unconfirmed reports of a sizable population of dugongs in southwest Vietnam, along the Gulf of Thailand coast in the vicinity of Phu Quoc Island (Figure 4.4) (Perrin *et al.* 1996). A dead dugong was seen in Con Dao in 1994 by national park staff. Interviews with local people conducted by Con Dao national park staff in 1995 and a review of reference data revealed that dugongs have occurred in the Con Dao region (Figure 4.4) for some time (Hien *pers comm.* 2000). Van Bree & Gallagher (1977) examined seven dugong specimens from the Con Dao Islands which are currently kept in the Museum of Bordeaux, France. A group of seven to ten dugongs was recently seen in Con Dao National Park (around the east and offshore of Vung Tau near the southern tip) (Porter *pers comm.* 1998). It is estimated that approximately 10-20 individual dugongs occur in Con Dao (Deters *pers comm.* 2000; Hien *pers comm.* 2000). In Con Dao nine dead dugongs were found between 1997 and 2000, including four in 1997, and three in 2000. The most recent death in November 2000 (Cox *pers comm.* 2001). The causes of death have not been identified (Hien *pers comm.* 2000).

Reports of dugongs in Vietnamese waters suggest that there may not be a local population resident in the area. Alternatively, individuals may migrate from elsewhere when their food supply is low (Lang Van Ken 1997).

Dugongs were reported to be abundant on parts of the Cambodian coast until approximately 1975 (Nelson 1999). However, due to war and political upheavals, no data have been collected on marine mammals of the Cambodian coastline from this date until the early 1990s. In Ko Kong (near the Thailand border), dugongs were most abundant near Prek Ksach. They are now considered extinct in Ko Kong (Nelson 1999), although no dedicated surveys have been conducted recently. It was reported that six dugongs were accidentally snared in gill and trawl nets during 1995 in Kampot Bay (Tana 1998). Dugongs were also reportedly found near Stoeng Hau in Kompong Som Bay, but have now probably disappeared because of increased motor boat traffic (Tana 1998), loss of seagrass beds due to trawling and push-netting and incidental catch in monofilament gill nets.

Recent reports of dugongs near Kampot and Kep have been confirmed by the recovery of a dugong body by Department of Fisheries officials. The skull and postcranial skeleton are now housed in the Department of Fisheries Marine Museum, Kompong Som. In addition, Beasley *et al.* (2001), report that based on interview surveys, a potentially viable population of dugongs occurs along the southeastern coast of Cambodia, adjacent the Vietnam border.

Threatening Processes

Habitat Loss and Degradation

Thailand

Habitat loss is serious in the Gulf of Thailand as a result of effluent from shrimp farms. On the Andaman

coast of Thailand, habitat has been destroyed by fishing practices such as push netting (Perrin *et al.* 1996). Siltation from tin mining in Phuket, Phang-nga, and Krabi provinces in western Thailand (Figure 4.4) have resulted in degradation of seagrass communities in this region. Seagrass habitat degradation also continues from marine pollution, and sedimentation from housing and industrial developments (Nateekanjanalarp & Sudara 1994).

Chansang & Poochaviranon (1994) characterized seagrass beds along the Andaman Coast according to their associations with surrounding vegetation and substrate.

Poovachiranon and Adulyanukosol (1999) mention that it is difficult to measure the impacts of resource use on seagrass beds as comprehensive maps are not available, and no effective method has been established to estimate seagrass areas for monitoring.

The increasing tourism industry in Thailand is considered to be having indirect impacts on dugong feeding resources. Holiday resorts tend to be located in the most important dugong areas, such as the Trang, Krabi, and Phuket provinces (Figure 4.4).

Vietnam and Cambodia

Although there was little coastal development in most of the areas surveyed in 1995, dugong habitat may have been seriously compromised by fishing activities, especially around the Mekong River Delta and in the area north of Nha Trang (Figure 4.4). An extensive trawl fishery near Dai Lanh, an island fishing village near Nha Trang (Figure 4.4), and the extensive use of gill nets and other destructive fishing techniques in the Mekong River delta are of particular concern (Perrin *et al.* 1996). It is believed that in 1997, Typhoon Linda destroyed large seagrass areas at Con Dao (Figure 4.4), allegedly the most important dugong habitat in Vietnam (Hien *pers comm.* 2000).

In Con Dao National Park, the main seagrass beds are located in Con Son Bay (Lo Voi) and include areas to the east (Bai Dat Doc) and west (Mui Lo Voi). Smaller seagrass beds are located in Da Trang, Dam Quoi (Hon Ba) and Hong Dam (Ben Dam Bay) (Cox 2000). According to local fishers and park staff, dam construction, sediment runoff, and waste discharge are believed to have increased pollution into seagrass areas in Con Son Bay (Cox 2000).

During recent surveys, seagrass beds have been found throughout the coastal zone of Cambodia (Nelson 1999). Extensive seagrass beds occur in the waters off Kampot Province and Kep Municipality (near the Vietnamese border). Much of the muddy coast of Kampot Province supports seagrass beds, including patchy beds off the river mouth of Kampot town. Additionally, a limited survey in 1996 found one stand of seagrass between the mainland and Ko Kong Island, near the Thailand border (Ethirmannasingam 1996). According to reports by district fisheries officials, seagrass stands previously occurred in Kompong Som Bay (Nelson 1999). However, high intensity trawling and push netting have reportedly destroyed most of the seagrass. Small seagrass beds have been found around Ko Rong and Ko Rong Samlen, Kompong Som.

Seagrass beds in Cambodia can be divided into two main types: extensive seagrass meadows along the mainland, and patches of seagrass intermingled with corals around islands. Eight species of seagrass have been recorded from Cambodian waters (Ethirmannasingam 1996). As reported by Nelson (1999), seagrasses are under severe threat from destructive fishing practices and declines in water quality associated with agricultural use of fertilisers and pesticides. Trawling and fishing using weighted bottom nets destroy seagrasses by ripping them out of the substratum. Reports from socioeconomic surveys and workshops with the officers from Department of Fisheries indicate that the fisheries catch is declining in seagrass areas and local and government officials alike are very concerned about trawling in seagrass beds (Nelson 1999). Presently there is very intensive trawling and push netting around Kep, which is severely threatening one of the last strongholds for dugongs in Cambodia.

Fishing Pressure

Thailand

It is impossible to assess the impact of fishing practices on dugong populations as there are no quantitative data on incidental catches in Thai waters. By law, if dugongs are captured in fishing nets, they must be put back, or if injured, handed over to Department of Fisheries officials. However, anecdotal reports indicate that incidental drowning in nets is the most common cause of death among dugongs in this region (Manthachitra 1993; Perrin *et al.* 1996). From 1979 to 1998, 75 dugong strandings were recorded (Adulyanukosol *et al.* 1998). Of these, 59 were found on the Andaman coast, and 16 in the Gulf of Thailand. Most strandings were caused by incidental entanglement in gill nets (Adulyanukosol *et al.* 1998).

Dugongs are caught in gill nets operating in the provinces of Trang, Satun and Phuket (Figure 4.4) (Manthachitra 1993). The nets that cause the most serious impacts on dugongs are large pelagic gill nets and longlines (Pitaksintorn *pers comm.* 1998). Interview surveys with 200 local fisher families along the Andaman coast were conducted by Kanjana Adulyanukosol between

1994 and 1995. Forty dugongs were reported to have died in gill nets in this region between 1990 and 1995 (Adulyanukosol 1995). Illegal fishing techniques in seagrass beds in areas such as in the Gulf of Thailand (Rayong, Chanthaburi and Trat Provinces (Figure 4.4)) are still in operation (Manthachitra 1993). Destructive fishing practices such as pushnetting have also been destroying seagrass beds. Along the Andaman Coast, large fishing trawlers and push netters are encroaching into shallow coastal waters. The boats are illegal in these coastal areas, and have been the source of numerous conflicts, often violent, with small-scale fishers in coastal villages (Hines *pers comm.* 2000).

Vietnam and Cambodia

The major fishing gear used in Vietnam includes trawl (fish and shrimp), gill nets, left nets, longlines and handlines. The most predominate fisheries in the central region are gill nets and handlines. In contrast, trawl fishing contributes to almost 50% of the fish production in the southern province of Vietnam.

Although no direct catch is known for dugongs in Cambodia, incidental catch in monofilament gill and purse-seine nets, trawlers and other fishing gear is thought to be causing serious declines in population numbers. These fishing methods have increased the efficiency of catch and are thought to have contributed to the decline (Nelson 1999). For example, interviews with local fishers and recovery of skeletal material revealed dugong deaths in nets occurred within four villages in Kampot and Kep regions, during June 2001 (Beasley *pers comm.* 2001). Many fishers use prohibited gear such as motorised push nets that destroy the substratum, and dynamite and trawl nets in shallow water. By law, fishing is prohibited in water <20m deep, but nearly all fishing in Cambodia, including trawling, is conducted close to the shore in water as shallow as 1-2m (Nelson 1999).

Indigenous Use and Hunting

Thailand

It is believed by some Thai villagers that dugong skin, bones, tears, and tusks have aphrodisiac, protective, and anti-rheumatic properties. For example, a pair of tusks can be sold for 10,000 Thai baht (approximately US$230). Sometimes, this trade is done openly through village officials, who buy the tusks from the fishers, and resell them to an amulet-maker (Nateekanjanalarp & Sudara 1994; Hines *pers comm.* 2000). Nateekanjanalarp and Sudara (1994) tell of a legend on Talibong Island (off Trang province) where a woman became a dugong because of cravings for seagrass pods. As result of this legend, many villagers believe that the tears of a dugong are a powerful love potion. Hines (*pers comm.* 2000) heard variations of this legend repeated during interviews in all villages.

In March 2000, two dugongs were found dead in Trang Province; one tied to a mooring buoy, and the other washed up on the beach, both near Hat Chao Mai National Park (Hines 2000) (Figure 4.4). The dugong tied to the mooring buoy was a young female and was caught in a fishing trap; teeth and tusks, teats, and part of her tail were cut off. The Muslim villagers nearby use these items as aphrodisiacs. The second dugong was an adult male with its tail and tusks removed. Necropsy results confirmed that this animal had been struck in the chest and killed. Necropsy of the female showed a well-nourished dugong, but gave no indication of cause of death. These stranding events were well publicized throughout Thailand. In the Bangkok Post, the headline of an article read "Dugong death leads to extinction fears: Local beliefs blamed for falling numbers."

In April 2000, two dugongs were found dead in the nets of large fishing trawlers anchored off Libong Island in Trang. By the time the deaths were reported to local authorities, the heads of both of these animals were missing. The Bangkok Post read "Two more dugongs killed in Trang Park: Species threatened by amulet market". The article described that 30 dugongs have been found dead since 1992, 19 of which were found in Trang. The Department of Fisheries published articles in both Thai and English newspapers warning of a four-year jail term and 40,000 baht fine (US$920) for possession of parts of dead dugongs. In May 2000, another two dead dugongs were found stranded in Trang, with no clear indication of cause of death except for holes in the bodies (Pitaksintorn *pers comm.* 2000).

Local people consider dugong meat to be delicious (Sae Aueng *et al.* 1993), and have hunted dugongs in the past. Now that the species is considered threatened in Thailand and is protected by the *Fisheries Act 1961*, the public no longer admits to hunting dugongs. Most people will eat dugongs that have been caught in nets and drowned and will share the meat with the whole village (Hines *pers comm.* 2000). In some villages, if a dugong dies in a net, the tusks will be collected. The meat will be used, but rarely sold.

Vietnam and Cambodia

In Vietnam, dugongs used to be heavily targeted by local hunters because of their relative ease of capture and delicious meat, which is considered a delicacy. Hunting is considered to be one of the main causes of the disappearance of dugongs in this region (Hien *pers comm.*

2000). However, because of the dugongs' current low numbers, hunters can now rarely find them.

In Cambodia, it is not known whether dugongs were exploited in historic times as few data have been collected. Although dugongs are not directly hunted (apparently because numbers are low and they are difficult to find), they will be killed and consumed if accidentally caught in fishing nets. Local people are very superstitious about cetaceans and believe it is bad luck if a dolphin is caught in their net. Dugongs, however, are considered to bring "good" luck if caught and people will pay high prices for the meat, internal organs, bones and tusks (Beasley *et al*. 2001). The meat is either consumed locally or sold to local restaurants. In June 2001, a dugong was recovered from a restaurant in Kampot township. The carcass has been purchased for $US130 and the meat and internal organs (which are considered a delicacy) had been consumed. The tusks were believed to have value as an aphrodisiac and a medicine and had been sold to an unknown dealer in Phnom Penh for $US200. The skull and postcranial skeleton were kept to be cut into small pieces and sold for medicinal use. Small pieces of chopped bone can fetch US$1.10 per piece (Beasley *et al*. 2001).

Boat Related Impacts

In Thailand, there has been one report of a dugong death by boat strike. In August 1998, a dugong was struck in the Port of Phuket, the largest port in this province (Adulyanukosol *pers comm*. 2001). According to a necropsy performed by Kanjana Adulyanukosol, 7 or 8 vertebrae were broken and scarring was suggestive of impact by a boat.

Existing Conservation Initiatives

Legislation

Thailand

Thailand has policy to protect dugongs and has two pieces of enabling legislation (Karnchanakesorn *pers comm*. 2000):

1. The *Fisheries Act Be. 2490 (1947)*: By Ministerial Notification Date 9 August 2504 (1961) states "No one will be allowed to catch or harm dugongs or take any dugong body parts". This Act, executed by the Department of Fisheries (DOF), proclaimed the Ministerial Regulation to prohibit killing and taking dugongs in Thai waters. Under the Act, fishers are not permitted to use push nets or trawl within 3000m of the coastal zone. Enforcement strategies are ineffective (Pitaksintorn *pers comm*. 2001). Mu Koh Libong Non-hunting Area (including Talibong Island and adjacent smaller islands), Muk Island, and Hat Chao Mai National Park (Figure 4.4)are protected under this legislation and the *National Park Act,* as proposed by the Royal Forest Department. At present, a process is underway to introduce fishing gear restrictions into the Act to reduce incidental by-catch of dugong.
2. The *Wildlife Reservation and Protection Act Be. 2535 (1992)*. This Act, executed by both Royal Forest Department (RFD) and the DOF, proclaimed the Royal Decree to list dugongs as 1 of 15 animals on the Reserve Endangered Species List (similar to Appendix I of CITES) which prohibits killing, taking, possessing, trading, exporting and importing. This legislation affords the highest protection possible under the law.

In 1998, Thailand became a signatory to the Ramsar Convention on Wetlands, and nominated nine wetlands to become Ramsar sites, including Hat Chao Mai National Park and Mu Ko Libong non-hunting area in Trang province (7°15'0N, 99°22'60E), Phang-nga Bay and Kuraburi estuary in Ranong. (Figure 4.4). All these sites have extensive seagrass beds, supporting dugong populations (Bangkok Post, February 4, 2000).

Vietnam and Cambodia

There is no specific legislation enabling dugong conservation in Vietnam. However, dugongs are listed as an endangered species in the Red Data Book of Vietnam and catching dugongs is prohibited in the Con Dao National Park (Figure 4.4).

Presently there is no official legislation in Cambodia protecting marine mammals from direct or incidental take, capture or harassment. Limited resources within Cambodia have resulted in a lack of funds for patrols and arrests. Fisheries officers have the legal power to arrest illegal fishers and mangrove cutters, but have insufficient funds and slow boats (Nelson 1999). New legislation is being drafted for Cambodian fisheries which should provide increased protection for marine mammals and their habitat.

Research

Thailand

Two research units relevant to dugong conservation have been set up by the Department of Fisheries since 1991, one in the Andaman Sea, the other in the Gulf of

Thailand. Until recently, economic pressures have made it difficult to conduct the research that is needed. Helicopter aerial surveys were conducted off Trang Province in 1991 and 1992 by Suwan Pitaksintorn of the Royal Forest Department (see distribution and abundance). Subsequently, Adulyanukosol *et al.* (1997, 1999) conducted helicopter and small aircraft aerial surveys along the Andaman Sea coast (from Ranong to Satun provinces) and surveyed using microlite (Polaris Flying Boat) in eight specific areas in four provinces (Phang-nga, Krabi, Trang and Satun). Hines (2000) and Adulyanukosol (2001) completed helicopter and microlite surveys in the same provinces, with transect methods employed in specific areas within Krabi, Phuket and Trang in particular. From 1991 to 1998, the Royal Forest Department of Thailand has been investigating dugong movements in relation to the seagrass ecosystem in Hat Chao Mai National Park and Mu Ko Libong Non-hunting Area in Trang Province (Pitaksintorn *et al.* 2000). Aerial spectrogrammetric surveys of seagrass beds in Trang Province are planned (Hines *pers comm.* 2000).

Researchers at the Phuket Marine Biological Centre, Kasetsart University, and Prince of Songkhla University have done extensive research on the location and species composition of seagrass along the coast (Chansang & Poovachiranon 1994; Poovachiranon & Chansang 1994; Poovachiranon *et al.* 1994; Lewmanomont *et al.* 1996; Supanwanid 1996; Poovachiranon & Adulyanukosol 1999; Purintavaragul *et al.* 1999; Lewmanomont *pers comm.* 1998; Supanwanid *pers comm.* 1998). Extensive studies of seagrass beds have also been conducted at Ranong and Kuraburi by a team from Kasetsart University Department of Fisheries. A joint Japanese-Thai research project studied seagrass communities in Hat Chao Mai National Park in Trang province (Koike 1999).

Vietnam and Cambodia

The Nha Trang Institute of Oceanography conducted seagrass surveys in the Con Dao region (Figure 4.4) in 1995, 1996 and 1997 (Hien *pers comm.* 2000). The surveys found nine species of seagrass in Vietnamese waters. The total area of seagrass in Con Dao is approximately 300 ha with 200 ha concentrated in Con Son Bay (Con Son is the main island of the Con Dao Archipelago). Staff of the WWF-Vietnam, Institute of Oceanography, and Con Dao National Park recorded some information on dugong sightings and feeding areas while conducting surveys around the Con Dao Islands.

There has previously been no research focused towards assessing the abundance of marine mammals and in particular dugongs, in the coastal waters of Cambodia. Although many of the reports of dugongs are from interviews and strandings, they suggest a viable population of dugongs in the coastal waters of Kampot and Kep (near the Vietnamese border). Research on the marine mammals of Cambodian coastal waters has recently been initiated by the Wildlife Conservation Society, Cambodia. This research aims to:

1. Assess the abundance of marine mammals in the coastal waters of Cambodia.
2. Investigate the distribution and habitat usage of dugongs and identify seagrass habitat.
3. Collect data on mortality rates and causes, life history and feeding habits from stranded and incidentally caught dugongs.
4. Conduct interviews with local fishers.
5. Initiate a multi-species environmental education program to local schools and villagers to emphasise the importance of marine and species conservation.
6. Collaborate with local government departments to prepare a conservation strategy for dugongs and to encourage local involvement with surveys and training workshops.

Management

Thailand

A Marine Protected Area in Trang Province from Laem Sai to Palian District (Figure 4.4) was proclaimed in May 1992 through a Provincial Notification. During this time, gill nets, push nets, beach seines and trawlers (operating closer than 3km from the coast) were prolific. The aim of the Provincial Notification is to protect seagrass resources for dugongs and other marine organisms. Enforcement occurs via *The Fisheries Act B.E. 2490 (1947)* and is executed by the Department of Fisheries. Penalties have occurred for non-compliance and push nets have disappeared from north of Trang to around the Talibong Island area, although they still exists in Palian (Figure 4.4). Itis envisaged that the area comprising Muk Island to Talibong Island be claimed as a "Dugong National Sanctuary" (Adulyanukosol *pers comm.* 2001). At present, the dugong is considered a "flagship" species for this Marine Protected Area (Pitaksintorn *pers comm.* 2001).

In 1998, the Ministry of Agriculture and Cooperatives prohibited all trawlers, push nets, purse seine, or motorized vessels within 3,000 metres of the coastline from fishing in Phang-nga Bay.

As a result of the dugong stranding events discussed above, a meeting was called by the director of the Marine Education Support Centre at the Hat Chao Mai National Park in Trang. Scientists, academics, and community leaders discussed raising public awareness of dugong conservation, and the possibilities of further laws and regulations, and additional expansion of the present conservation area for dugongs and seagrass. The meeting

was considered successful and further meetings are planned with various government officials, scientists, and community members.

Non-Government Organisations (NGOs) such as Wildlife Fund Thailand and Yadfon Association, have used the media, legislators, governors, academics, and musicians to convey information on the plight of dugongs in Thailand. These campaigns have proven to be successful in some parts of Thailand where illegal fishing has declined (Manthachitra 1993).

Vietnam and Cambodia

Con Dao National Park, a Marine Protected Area, is believed to support approximately 10-20 dugongs at certain times (Deters *pers comm.* 2000; Hien *pers comm.* 2000). The staff at the Con Dao National Park and WWF-Vietnam conduct education and awareness campaigns with the local people on dugong conservation and the importance of seagrass beds. Local fishers, however, have not yet been included in these campaigns.

The Ministry of Fisheries is currently developing a program for the establishment of a National System of Marine Protected Areas for Vietnam. Phu Quoc and adjacent islands has been identified as a high priority site for the development of a Marine Protected Area (Hall *pers comm.* 2001). There is a small marine park around Cat Ba National Park (20°47'N, 107°03'N) in the Gulf of Tonkin (Figure 4.4) and a pilot marine protected area is being developed by IUCN/GEF (Global Environmental Fund)/Danida at Nha Trang in south-central Vietnam although dugongs are not known to occur in either of these areas (Hall *pers comm.* 2001).

Although to date, no management of marine mammals occurs in Cambodian waters, the Department of Fisheries is enthusiastic about developing conservation and management plans to initiate protective measures for marine mammals – especially the dugong which is currently Cambodia's most threatened mammal. This may include the establishment of Cambodia's first Marine Protected Areas. As a result of preliminary research by the Wildlife Conservation Society, Cambodia, the coastal area of Kampot and Kep (neighbouring Vietnam) has been identified as a high priority for dugong conservation efforts (Beasley *pers comm.* 2001).

Suggested Conservation Initiatives

Research

- Large-scale aerial surveys in Thailand, and along the southeast coasts of Cambodia and Vietnam to determine the overall pattern of distribution and abundance of dugong in these regions should be the highest priority.
- Aerial surveys of the Andaman Coast and the Gulf of Thailand and the collection of quantitative data on fishing intensity in these areas, and any obvious marine pollution and threats are essential. Once baseline surveys have been conducted, consideration should be given to performing regular surveys at appropriate intervals (as determined by power analysis) with the aim of assessing population trends.
- There is a need for baseline information on dugong distribution and abundance in Cambodia and Vietnam. Depending on the availability of resources, this information can be obtained using aerial and boat surveys. Postal and interview surveys also give a good indication of dugong status on a broad scale. For a complete report, the results of previous interview surveys conducted with villagers in Thailand need to be combined with the results of the surveys conducted in 2000.
- There is a need for regional cooperation to study dugong migration patterns and any inter-dependence between dugong populations in the Gulf of Thailand and the southeastern waters of Vietnam. Satellite tracking would be the most appropriate technique if funds were available.
- A survey on seagrass beds, abundance and community composition would provide an indication of the health of dugong habitats. These surveys should be concentrated in major dugong habitats and other seagrass bed locations where incidental sightings by local fishers have occurred. An assessment of human impacts on seagrass communities is also needed.
- Authorities should attempt to gather quantitative data on dugong by-catch. The Phuket Marine Biological Centre has a database on dugong and cetacean strandings but the records are believed to constitute a low percentage of the by-catch in some areas (Hines *pers comm.* 2000).
- Information on seagrass distribution, dugong distribution and fishing pressure should be entered into a Geographical Information System (GIS) database extending the initiative of the Phuket Marine Biological Centre.
- Waters of Thailand are very heavily fished and the incidental catch of dugongs is a significant problem. Information on dugong movements is needed so that dugongs can be protected by minimising conflict with fishers (Pitaksintorn *pers comm.* 2001).

Management

- It is critical to implement a comprehensive, integrated management campaign to conserve the remaining dugongs in Thailand. From the dugong and seagrass surveys already conducted, aerial photos and GIS maps will be created for the Royal Department of Forestry, Marine Parks Division and the Phuket Marine Biological Centre, as a basis for immediate management recommendations and ongoing monitoring. Bringing together scientific and traditional knowledge using the NGOs and local Fisheries Networks, and the inclusion of this knowledge in educational materials is a crucial step to attempt to halt the use of dugong body parts for amulets and medicine.
- Awareness and information campaigns need to be conducted. It is important that local fishers participate in these. Education and information about dugong status and conservation could be included in school curricula and in local media releases to appeal for local support. In Thailand, NGOs such as Yadfon Association and Wildlife Fund Thailand are working with scientists to create educational and presentation materials for tourists, fishers' organisations, and schools. Some examples include a video with excerpts from interviews with fishers, women in villages, conservationists, and scientists, a diorama of a dugong habitat, a skit, posters without words, t-shirts, maps, and teaching materials.
- It is very highly recommended that *community-based* management and research programs be developed in key dugong habitats (Pitaksintorn *pers comm.* 2001). These might involve training community members as either volunteer, part time or full time rangers to be responsible for surveying areas, writing reports of sightings and reporting illegal practices affecting dugongs and their feeding areas.
- There is a need to develop and implement management policy and legislation for dugong conservation in Vietnam. In Cambodia and Vietnam, high emphasis on community involvement in developing conservation strategies such as identifying critical dugong habitat and initiating and conducting environmental education programs is of high priority.
- The Malacca Strait, the world's second busiest commercial shipping channel, runs through the territorial waters of Thailand. To minimise threats to dugongs and seagrass in this region, Thailand, Indonesia, Singapore and Malaysia should work together regarding its management.

Conclusions

- Knowledge on dugong distribution in Thailand has improved greatly in recent years. In contrast, there is little information on dugong populations off Vietnam and almost no information from Cambodia.
- Incidental take as a result of unsustainable fishing practices, and habitat degradation are the major problems faced in the management of the coastal resources in these areas. A direct take of dugongs for aphrodisiac and medicinal by-products is a problem in some areas.

MALAYSIA, SINGAPORE AND BRUNEI

Distribution and Abundance

Dugongs occur in the waters of Malaysia, Singapore and Brunei including the waters of Peninsular Malaysia and the waters off the state of Sabah in East Malaysia (Figure 4.5). However, there are no estimates of the size of the dugong populations in any of these areas.

Peninsular Malaysia and Singapore

Dugongs were rarely reported in the waters of Peninsular Malaysia and Singapore prior to the 1990s. The few reports were from the coastal waters of Johor Baharu and Singapore (Figure 4.7). Records of dugongs in Singapore waters go back as far as 1821, but no quantitative data on population size and distribution are available (see Sigurdsson & Yang 1990). Dugongs were considered nearly extinct by the 1970s and were largely unheard of among Singaporeans, with the exception of a small number of concerned and interested people (Chew 1988). Older records from the early 1900s include sightings from Pulau Tekong and the Changi area (Figure 4.7). Sigurdsson and Yang (1990) report evidence of a viable breeding population in the Johor River estuary. Stranding reports from 1974 to 1989 include records of three young animals. In more recent times, most sightings have occurred northeast of Singapore around Pulau Ubin and Pulau Tekong as well as around the southern islands, and off the Changi area (Taylor *et al.* 1997; Douaze *pers comm.* 1998) (Figure 4.7).

There is strong anecdotal evidence to suggest that dugongs are resident in the Johor-Singapore region. The islands off the east coast of Johor support the largest known seagrass beds in Peninsular Malaysia (Kushairi *pers comm.* 1999). At least 17 adult dugongs and one calf were sighted by the Malaysian Fisheries Department during a helicopter survey of Pulau Sibu Hujong and nearby Pulau Besar and Pulau Rawa in May 1999 (Kushairi, Mat Isa & Marsh *unpublished data*) (Figure 4.8). These islands occur within the Pulau Tinggi Marine Park. Although the occurrence of seagrass in Johor Strait was very restricted in 1999, a total of at least ten dugongs were found stranded or caught in fishing nets in this region between 1994 and 1999. In addition, three dugongs were sighted off Pasir Puteh during an aerial survey in March 1999 and dugong feeding trails were observed in a meadow of *Halophila ovalis* at the mouth of Sungai Boh off Sungai Pulai in Johor Strait during the May 1999 survey (Kushairi, Mat Isa & Marsh *unpublished data*) (Figure 4.7).

The evidence that dugongs are resident in the Johor Straits is strengthened by the observation that the two animals for which microsatellite genetic information is available (a 1.1m male captured on 25 January 1999 and a 2.16m male found dead on 17 March 1999) were first order relatives. As both were immature, it is likely that they were brothers. If the animals using Johor Straits were vagrants from the islands off the east coast of Johor, the chances of two brothers using the same area, nearly two months apart would be expected to be low (Kushairi, Mat Isa & Marsh *unpublished data*).

According to fishers, the waters of Pulau Langkawi on the west coast of Peninsular Malaysia is another area frequented by dugongs (Figure 4.8).

East Malaysia and Brunei

There have been numerous sightings of dugongs by fishers in Sabah including at Kudat, Sandakan, and Semporna (Jaaman *et al.* 1997a) and viable populations are thought to exist on the west coast in the Kudat area, near Kota Kinabalu and in Brunei Bay between Labuan and Lawas (Figure 4.6). In 1999, four dugong strandings occurred near Kota Kinabalu and a live adult was sighted for a period of more than a week within the Kota Kinabalu harbour (Jaaman 2000). The occurrence of dugongs near Kota Kinabalu is attributed to the seagrass in Sepangar Bay, Tunku Abdul Rahman Marine Park (Figure 4.6), and Tanjung Badak (6ºN, 116º02'E). Since January 2000, there have been two live sightings of dugongs reported in Kota Kinabalu. In August 2000, a 2m dugong was found dead on Pulau Manukan (Tunku Abdul Rahman Marine Park). Aerial surveys have been conducted along the coast of Sabah by members of the Malaysian Marine Mammals and Whale Shark Working Group. A total of seven groups of adult dugongs have been sighted, including 14 animals in Brunei Bay and three dugongs near Kudat (Figure 4.6) (Jaaman *pers comm.* 2001). All dugongs were sighted in shallow waters and were feeding on seagrass close to shore. There have also been five reports of incidental catches of dugongs in gill nets in the Kudat area since August 2000.

Prior to these recent sighting and strandings, dugongs had been reported to occur near Muara breakwater, Brunei (Elkin 1992), Pulau Tambisan, Sabah (Dolar *et al.* 1997) (Figure 4.6) and Tanjong Datu, Sarawak (Banks 1931) (Figure 4.5), where they were commonly believed to have been hunted to near extinction. Banks (1931) believed they were not common in all coastal parts of Sarawak, however they may have

Figure 4.5 – Malaysia, Singapore and Brunei showing place names mentioned in the text.

occurred at Limbang and Lawas Districts to the north (Figure 4.6). A dugong skull, collected from a village in Pulau Banggi (Figure 4.6) in 1999, is kept at the Universiti Malaysia Sabah (Jaaman 1999). Sarawak Forest Department and Wildlife Conservation Society (2000) report that dugongs were once common in the Brunei/Limbang Bay area where the dugongs were sighted during the aerial survey in April 2001 (Jaaman *unpublished data*).

Threatening Processes

Dugong hunting, incidental catch from fishing activities, habitat loss including loss from land reclamation, and pollution from palm oil plantations and sedimentation, are the main threats to dugong populations in this region.

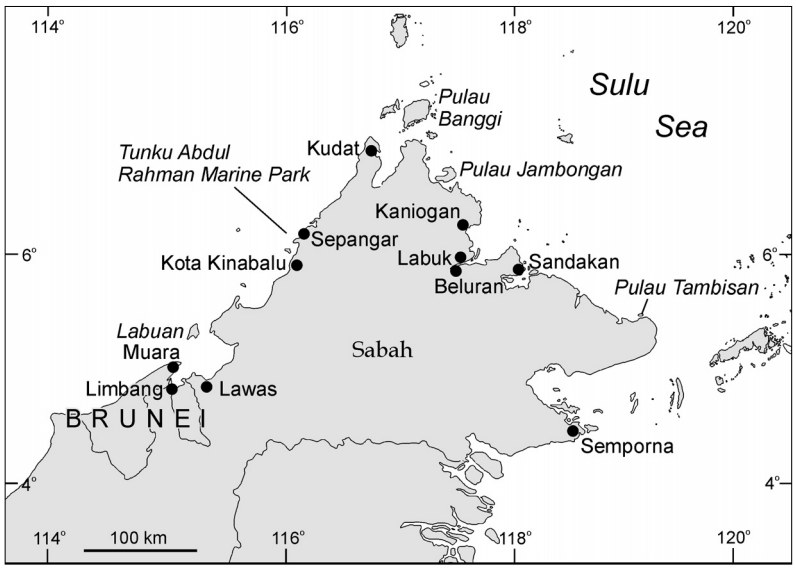


Figure 4.6 – East Malaysia and Brunei showing place names mentioned in the text.

Habitat Loss and Degradation

The southeast Asian region is being rapidly developed and 70% of its human population lives on or near the coast. Coastal development brings pollution and causes the loss or degradation of marine habitats including seagrass.

Peninsular Malaysia and Singapore

Kushairi (1992) conducted a SCUBA survey of seagrasses throughout the coastal waters of Peninsular Malaysia between mid 1986 and mid 1991 at the following locations: west coast north to south – Tanjong Rhu, Telok Ewa, Seberang Perai, Teluk Nipah, Telok Kemang; east coast north to south – Setiu, Pulau Tengah, Pulau Besar, Pulau Tinggi, Pulau Sibu Hujong (Figure 4.8). A total of eight seagrass species (*Halophila ovalis, H. minor, H. spinulosa, Halodule uninervis, H pinifolia, Cymodocea serrulata, Syringodium isoetifolium* and *Enhalus acoroides*) were recorded at the ten locations.

In Singapore seven seagrass species have been recorded but no extensive beds (Loo *et al*. 1994). The seagrass food of the dugong in captivity in Underwater World Singapore Aquarium is imported from Indonesia. Seagrass meadows can also be found around Pulau Tekong and Pulau Ubin (Figure 4.7), but many meadows in the south have been reclaimed and can no longer support dugong populations (Durville & Taylor 1996). Some seagrass beds have been destroyed off Pulau Tekong and Changi beach where extensive land reclamation has taken place. Land reclamation stirs up silt that can smother coral reefs and seagrass meadows, which are heavily dependent on light

Figure 4.7 – Peninsular Malaysia and Singapore showing place names mentioned in the text.

for photosynthesis and growth. The Johor River estuary, where a viable dugong population apparently still occurs (see above), is targeted for major development possibly involving further reclamation of shallow water areas and the destruction of seagrass beds.

Information from the necropsies of five dugongs found near the mouth of the Johor River in March 1999 suggests that starvation contributed to the death of at least two animals and that a third died of septicaemia.

East Malaysia and Brunei

East Malaysia has seagrass habitats with ten species of seagrass identified (Japar 1994) although little is known about their current status. Extensive coastal development is occurring in many areas and this is likely to have adverse impacts on the seagrass beds since there is little general appreciation of their value, even for economically important industries such as fishing.

The development of Sandakan (Figure 4.6) into a major industrialised town may have a detrimental effect on local seagrass. Pollution of waterways contributes to dugong habitat loss. In the past ten years many forests on the inner side and upstream of the rivers in the Sandakan and Beluran areas (Figure 4.6) have been transformed to cultivated lands including large scale palm oil plantations. During the wet season (November to February), rain washes the insecticides and fertilisers used in farming into the rivers and bays. Sedimentation also increases water turbidity. It is believed that the runoff from a severe flood in 1955 in Sabah, which decreased the water salinity in Sandakan Bay to zero for a few weeks, was responsible for a large-scale seagrass dieoff (Jaaman *et al*. 1997b).

Sarawak Forest Department & Wildlife Conservation Society (2000) report that large areas of seagrass were found in the Brunei/Limbang Bay area, where sightings of dugongs have been reported.

There is concern in the Palau Banggi region, Sabah (Figure 4.6), that dugongs may be eating the alga *Eucheuma cottonii* which is being cultivated by villagers on floating nylon lines (Rahman *pers comm*. 2001).

Fishing Pressure

Peninsular Malaysia and Singapore

The fisheries in Singapore waters are generally small-scale, largely using hooks and bait. In September 1998, a stranded female dugong calf found off the shores of Pulau Ubin (Figure 4.7) was transferred to Underwater World Singapore (Lin 1999). The calf was found close to a dead female dugong, assumed to have been its mother, which had been trapped in a net. Other records of stranded dugongs indicate entanglement in fishing nets (Sigurdsson & Yang 1990).

Malaysian Fisheries Department records show that at least five dugongs were captured in fishing nets and fish traps (kelong) in the Johor Straits between 1994 and 1999.

East Malaysia and Brunei

Historically, dugongs were mainly hunted for their meat, a delicacy that is considered by some to be more delicious than beef. Today, almost all catches are accidental, although sometimes fishers in Sabah take advantage of opportunities to catch dugongs. Dugongs can be caught in kelong and fish nets such as gill nets, beach and purse seines, and in bag nets. For example, a village from Palau Molleangan Kecil north of Kudat reported that three dugongs were caught in separate incidents in drift gill nets between April and June (inclusive) in 2001 (Rahman *pers comm*. 2001). One live adult dugong was found trapped and later released from a kelong in Kampong Gas (5°46'60N, 118°1'0E), Sandakan, Sabah in 1994. There are also anecdotal reports of dynamite fishing occurring in the waters of Sabah, which may cause dugong mortalities (Perrin *et al*. 1996). In some areas, dynamite fishing is also being used to hunt dugongs and dolphins (Jaaman *pers comm*. 2000). A dugong stranding was reported in August 1999 on the

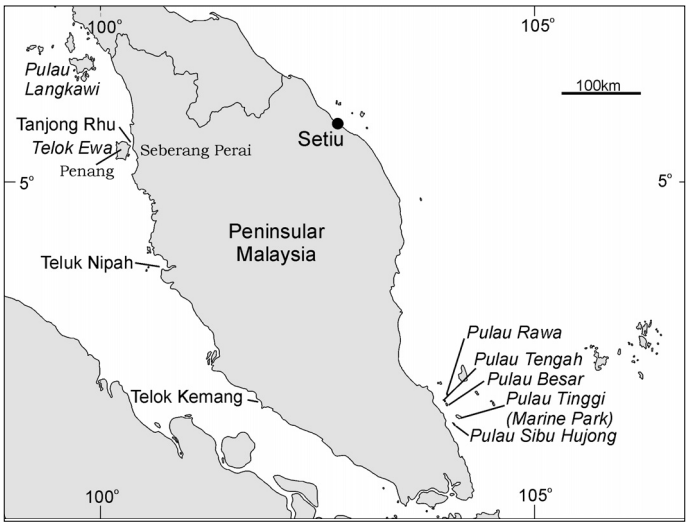


Figure 4.8 – Peninsular Malaysia showing place names mentioned in the text.

beach of Pulau Papan, Federal Territory of Labuan (Figure 4.6) (Jaaman *et al*. 1999). According to the post-mortem conducted by the Veterinary Department, the 2.60m, 250kg female did not die of starvation; a lack of external injuries indicated that the death may have resulted from dynamite fishing.

Fishers and/or local villagers from Sandakan and Labuk/Beluran Bays, Sabah (Figure 4.6) reported during interview surveys in 1997, that they had seen either dolphins or dugongs within the vicinity of their villages (Jaaman *et al*. 1997a). Sandakan and Labuk Bays serve as major fishing grounds for artisanal fishers in the area. Residents in seven of the nine fishing village interviewed in Sandakan Bay reported directed and/or incidental dugong takes, whereas residents of only three of the eight fishing villages visited in Labuk Bay reported takes. In both bays, villagers indicated that dugong populations have declined significantly in the past few decades and animals are no longer, or only very rarely, seen in the areas where they were once common (Jaaman *et al*. 1997a).

Indigenous Use and Hunting

Peninsular Malaysia and Singapore

Dugong hide was used as leather, which was appreciated for its good quality. The tusks were carved into knife handles and the "congealed mucous secretion of the eye-lid" was believed to be a powerful love potion. Dugongs were traditionally hunted from small boats with harpoons and then "played" until exhausted by means of a stout line which had previously been fastened to the harpoon head (Sigurdsson & Yang 1990). Approximately 12 dugongs per year were caught in the vicinity of Pulau Tekong (Figure 4.7). Dugong meat used to fetch a good price as the meat is much esteemed by the Chinese and Malays as a luxury generally eaten only at feasts (Sigurdsson & Yang 1990). The Malaysian Fisheries Department records indicate that dugongs were hunted in Johor in the 1970s.

East Malaysia and Brunei

Many local villagers and fishers around Sabah associate dugongs with various superstitious beliefs and some will release the animal when incidentally caught (Jaaman *pers comm*. 1998). Dugongs were considered mysterious and human-like, although some described them as monstrous. Dugongs were mainly hunted for their meat, which is considered a delicacy. In addition, dugong teeth are believed to cure asthma. The bones are used as medicine for internal organs and to ward off wild boars, and the tears used as a love potion. The animals were hunted using harpoon, javelin and nets in coastal areas off Sabah and Johor. Anyi and Jaaman (*in press*) report that in Semporna, east coast of Sabah (Figure 4.6), the Bajau Laut (Sea Nomads) consider dolphin and dugong meat a delicacy and they have been sources of red meat for years. These people hunt dugongs silently at night using spears and sail/row boats with help from "pawang" (medicine men). The meat is either cooked or dried, but many villagers prefer the animals' blubber, regarding it as the most delicious part. Dugongs caught are cut into small pieces before being sold to the villagers. A three-to five-inch piece of dugong meat fetches up to RM 5 (US$1.30) and a whole dugong can fetch up to RM 100 to RM 400 (US$25-100), depending on its size.

In the Sandakan Bay area, Sabah, dugongs were also hunted at night using spears tied to the bow of the boat with a rope about 100m long. According to local elder villagers interviewed by Jaaman *et al*. (1997a), an average of one dugong a month was caught in the Sandakan area before 1955. Reports of dugong sightings or killings in this area ceased by 1975. However, the villagers believe that the animals are still present, but in very small numbers. This is supported by the report of a dugong found trapped in a kelong in Kampong Gas (mentioned above). In addition, many older fishers interviewed in Labuk stated that Kaniogan, Tg Semangat at Pulau Jambongan and Pulau Nunuyan (5º54'0N, 118º4'60E) were some of the major dugong hunting areas before and during the 1970s (Jaaman *et al*. 1997a). Dugongs were believed to have been hunted to near extinction near Muara breakwater, Brunei, Pulau Tambisan (Figure 4.6), Tanjong Datu, Sarawak (Banks 1931), and Sabah (Figure 4.5).

Boat-related Impacts

Peninsular Malaysia and Singapore

The increasing popularity of leisure motor-boats poses a threat to dugongs in Singapore and Malaysia. In addition to the risk of collision, heavy boat traffic is likely to have an effect on dugong behaviour, forcing them to leave busy areas or modify their feeding habits. There is evidence that some stranded dugongs may have been victims of boat propeller strikes (Sigurdsson & Yang 1990; Jaaman *pers comm*. 2000). For example, severe propeller wounds were found on the back of an animal that died in February 1999 (Malaysian Department of Fisheries records). It is not known whether these wounds were inflicted before or after death.

East Malaysia and Brunei

In August 2000, a 2m dugong found dead on the beach of Pulau Manukan (Tunku Abdul Rahman Marine Park) (Figure 4.6) was believed to have been hit by a boat propeller. The fluke was severely damaged and almost cut off.

Existing Conservation Initiatives

Legislation

Malaysia

Dugongs are a protected species in Malaysia under

- *The Wildlife Protection Act 1972* (all of Malaysia)
- *The Fisheries Act 1985, Part VI* (aquatic mammals in Malaysian Economic Exclusive Zone)
- *The Wildlife Conservation Enactment 1997* (Sabah)
- *The Wildlife Protection Ordinance 1990* (Sarawak).

Article 27 of the *Fisheries Regulation 1985* specifies that endangered species should be released if they are found entangled in nets or stranded on shore; in cases where animals are found dead, reports should be made to relevant agencies for further actions. The penalty for hunting, killing or being in possession of the meat is two years jail and a RM 25,000 (US$6,600) fine (Sarawak Forest Department & Wildlife Conservation Society 2000).

Research

Peninsular Malaysia

The dugong was widely believed to have become extinct in Malaysian waters, and – possibly as a consequence of this misconception – no scientific research was undertaken on dugongs in Malaysia until recently. However, in 1999, a series of dugong deaths in Johor focused attention on the possible existence of a resident dugong population in the territorial sea and exclusive economic zone contiguous to Peninsular Malaysia. Earlier interview surveys in northern Pulau Langkawi (Figure 4.8) had also suggested that dugongs were present and aerial surveys conducted subsequent to the spate of dugong deaths in 1999 confirmed a resident population in Johor coastal waters. There is no specific legislation establishing dugong sanctuaries and policy is yet to be developed for managing the Malaysian dugong population (Herriman *pers comm*. 2001).

Singapore

A Singapore Wild Marine Mammal Survey (SWiMMS) program run by the Dolphin Study Group of the Tropical Marine Science Institute, National University of Singapore, was established in 1996 to study the ecology, behaviour, and health of local marine mammals. The objective was to develop recommendations for integrating coastal marine utilisation with responsible conservation of the natural marine resources on which marine mammals depend. Marine mammal distribution information was obtained from the public through a sighting program, boat surveys and stranding information (see Durville & Taylor 1996). Sighting forms were distributed to divers, sailing clubs, the Maritime and Port Authority of Singapore, ferry captains, and many other individuals. This program ceased in 1999. In 2001, we are unaware of any marine mammal studies being undertaken in Singaporean waters.

East Malaysia

In early 1996, the Marine Mammals and Whale Shark Research and Conservation Programme of Universiti Malaysia Sabah (UMS) was initiated (Jaaman & Palaniappan 1998). Members of the Marine Mammals and Whale Shark Working Group conduct interviews, habitat surveys and other basic studies related to the biology, ecology, and behaviour of dugongs and cetaceans to determine the presence, distribution and population status of marine mammals in the country. They also study the impact of human activities on the species. The specific objectives of the program are to

- identify and document marine mammals present in Malaysian waters, particularly in Sabah and Sarawak
- determine the distribution, abundance, ecological aspects, and economic importance of these animals in the area
- identify the nature and extent of human impacts including fisheries interactions and habitat degradation
- initiate studies on selected species
- investigate areas where suitable management policies can be implemented to protect vulnerable resources
- promote marine mammal awareness in both academia and the general public
- be the responsible body for collaboration and scientific networking with participating countries.

In addition, various government agencies and private sector organisations are helping to study, document, and protect marine mammals in Malaysia. Most of these agencies are members of the Malaysian Marine Mammals and Whale Shark Working Group. In 1996, Universiti Malaysia Sabah approved a short-term grant to initiate a preliminary survey of marine mammals and whale sharks in Sabah. In 1997, the Ministry of Science, Technology and Environment Malaysia provided funding to Universiti Malaysia Sabah for three years to support the Working Group in carrying out a research project titled "An Integrated Study of Marine Mammals and Whale Sharks in the Malaysian Exclusive Economic Zone". A technical report is in preparation at the time of writing this document.

The current members of the Malaysian Marine Mammals and Whale Shark Working Group include

- Universiti Malaysia Sabah
- Universiti Malaysia Sarawak
- Universiti Putra Malaysia Terengganu
- Department of Fisheries, Malaysia
- Department of Fisheries, Sabah
- Department of Wildlife, Sabah
- Sabah Parks
- Sabah Museum
- World Wide Fund for Nature, Malaysia
- Borneo Divers & Sea Sports (Sabah) Sdn. Bhd.

The Marine Mammals and Whale Shark Working Group prepared a research and development plan for marine mammal and whale shark research in Malaysia that listed several projects (Jaaman *et al*. 1997b). Phase I on the plan includes the following projects:

1. Increasing public awareness on the conservation of marine mammals by conducting interpretive talks, exhibitions and slide shows, especially to students and people who live in coastal areas or work at sea. Also, to encourage the general public (e.g. marine ecotourism operations) to participate in documenting marine mammal occurrences.
2. Gathering information and establishing a database to manage sightings, observations and survey records in the country. Continuous data analysis and results will be published for public viewing.
3. Documenting, salvaging and managing specimens (tissues and skeletons) of dead animals for future research and public viewing.
4. Conducting research expeditions and field surveys to identify species present in Malaysian waters and to study the biology, ecology and human related matters of resident species, especially in the coastal areas where many reports of the animals have occurred.
5. Organising seminars and workshops on marine mammals present in Malaysian waters attended by representatives from various agencies concerned, the public, and also experts from overseas.
6. Initiating local universities to join the programme and identifying local postgraduate students to be involved in research under a graduate assistant scheme. Collaborative research with foreign scientists should also be encouraged for staff development.

The projects listed above have been initiated by the Universiti Malaysia Sabah and are currently confined to the states of Sabah and Sarawak. The Marine Mammal Stranding Network (Project 3) has not been fully developed and is not yet operational.

The Malaysian Government has a grant scheme for "Intensified Research into Priority Areas" (IRPA) which is administered by the Ministry of Science, Technology and the Environment. An IRPA project, entitled 'The Dugong, Seagrass and Fisheries Management Project' has recently been approved for implementation. Associate Professor Dr Ridzwan Abdul Rahman of the Borneo Marine Research Institute (BMRI) of UMS is the project leader. Outputs expected from the project include

- a Malaysian 'Seagrass Ecosystem and Dugong Management (SEDM) Manual'
- maps of seagrass distribution and dugong sighting patterns (including seasonal variations) for Sabah
- a 'Dugong and Seagrass Public Information Centre' for environmental education and interpretation, at a site to be decided
- strengthened Malaysian capacity in dugong and seagrass research.

Management

Malaysia

There is no management plan for dugong populations in Malaysia (Rahman *pers comm*. 1998). The implementation of existing laws is addressed by the regional and local branches of relevant government agencies. The Working Group also produces information and education materials. Education campaigns targeted towards fishers, students, and law enforcers in critical areas, were conducted in Sabah and other states in Malaysia. The publicity generated by the capture, display and death of the dugong calf held in a kelong in Johor Strait and subsequently released in 1999, resulted in a greatly increased public awareness in the region about dugongs. This awareness is enhanced by the display of a dugong juvenile at Underwater World Singapore.

Suggested Conservation Initiatives

Research

- The Malaysian Cabinet has directed the Secretary General of the Ministry of Science, Technology and the Environment to ensure that research is undertaken on dugongs. We recommend that the highest priority should be given to surveys to determine the distribution and relative abundance of dugongs and their habitats throughout the waters of Peninsular Malaysia and Singapore and East Malaysia (especially Sabah). Priority areas should be selected with input from relevant stakeholders using criteria such as
  1. biodiversity importance, especially areas of known dugong and seagrass abundance (such as the east coast of Johor, Pulau Langkawi and the coast of Sabah)
  2. other relevant ecological data
  3. the degree of local commitment
  4. the probability of success in sustainable management of seagrasses in the context of the critical social and environmental factors affecting the proposed priority areas.
- We also suggest that interview surveys should be conducted simultaneously to assess the knowledge of the local people and the fishing communities with regard to dugong protection, their biology, seagrass distribution and fisheries. The techniques developed in Sabah can be used as a model. The magnitude of directed and incidental takes of dugongs for local consumption should be investigated as part of the interview surveys. The impacts of dugong by-catch in fishing gear (especially gill nets and traps) needs to be investigated and documented. Emphasis should be on the priority areas identified as suggested above.
- These data should be used to provide decision makers and local communities with data essential for coastal zone management in general and dugong and seagrass conservation in particular. These activities are likely to be most effective if community-based.
- Consideration should be given to extending the cooperative sea turtle research program that has been developed between the Philippines and Sabah (Perrin *et al*. 1996) to include dugongs and coastal cetaceans.

Management

- Collaboration in research and conservation efforts between relevant agencies including the Malaysian Department of Fisheries, other relevant national and state government departments, relevant universities, NGOs and local communities should be encouraged for effective protection of dugong populations.
- Consideration should be given to Malaysian authorities working in cooperation with the Philippine Government to protect dugongs, especially around the Sulu Sea and Palawan, with the Singapore Government to protect dugongs in the Johor region. The Malaysian, Thai, Indonesian and Singaporean governments could develop a cooperative initiative to protect dugongs in the Strait of Malacca.
- A culturally appropriate public information campaign regarding dugongs and their habitats could build on the recent high public profile of the dugong. A dugong and seagrass public information centre in Sabah could be a focus for this campaign.

Conclusions

Recent information suggests that populations of dugongs exist at several sites in the coastal waters of Peninsular Malaysia and East Malaysia. The profile of the dugong is currently high and the Malaysian Government is committed to a program of dugong research and management in Sabah.

INDONESIA

Distribution and Abundance

Little scientific information is available on the abundance, distribution and behaviour of dugongs *(Duyung)* in Indonesian waters. The size of the dugong population(s) is unknown. Most information is from interview and snorkelling surveys, and other incidental records (Perrin *et al*. 1996). Salm *et al*. (1982) (in Nishiwaki & Marsh 1985) considered that dugongs are scattered throughout Indonesia, usually in very low numbers. In the 1970s, the dugong population in Indonesia was estimated to be around 10,000. In 1994, the population was estimated at about 1,000. Both these population estimates are guesses and should not be considered as evidence for a decline in the intervening period.

According to Suwelo & Ginting (*pers comm*. 2000), the areas where dugongs have been observed within Indonesian territory include the coastal waters of

- Sumatra (Riau, Bangka and Belitung Islands (Figure 4.11)
- Java (Ujung Kulon National Park, Cilegon coast, Labuhan coast, south of Cilacap, Segara Anakan, southeast of Blambangan) (Figure 4.11)
- Kalimantan (Balikpapan Bay, Kotawaringin, Karimata Island Marine Reserve, Kumai Bay, Derawan Island) (Figure 4.10 and 4.11)
- Sulawesi (north – Arakan Wawontulap (Figure 4.9), Bunaken Island; central – Togian Islands Marine Park; south east and south coasts – Wakatobi and Taka Bonerate Marine National Parks (Figure 4.11))
- Bali (south Bali; Uluwatu and Padang-padang beaches) (Figure 4.11)
- Nusa Tenggara Timur (NTT) (Sikka, Semau, Sumba, Lembata and Flores Islands, Kupang Bay Marine Park and Komodo National Park) (Figure 4.11)
- Maluku (Aru Islands (including Aru Tenggara Marine reserve), Lease Islands (Haruku, Saparua, Nusa Laut, Seram, and south of Halmahera (Syamsudin *pers comm*. 2001)) (Figure 4.9)
- Papua Barat (formerly Irian Jaya) (Biak Island – Padaido Islands, Sorong, Fakfak coasts, Cendrawasih Bay Marine National Park and Wasur National Parks) (Figure 4.9).

Important dugong habitats are believed to occur from Arakan Wawontulap to Lembeh Strait between Lembeh and the mainland (North Sulawesi) (Figure 4.9 and 4.11); east coast of Biak Island and western Cendrawasih Bay Marine National Park (Papua Barat) (Figure 4.9), the Lease and Aru Islands (Maluku) (Figure 4.9), and Flores – Lembata Islands (East NTT) (Figure 4.11). All these areas are important refuges for a range of species that have disappeared elsewhere in Indonesia including dugongs, turtles, reef invertebrates and reef fish (SME 1996).

Cendrawasih Bay Marine National Park (Figure 4.9) is the only marine park in Papua Barat, and the largest in Southeast Asia (Putrawidjaja 2000). Data on the dugong population here are very limited. Salm *et al*. (1982) recorded 13 dugongs in the western beach of the park during an aerial survey in 1982. Dugongs are rarely found in seagrass beds in Mios Waar Island (small island group near Biak), Anggrameos Island and some mainland beaches in the southern part of the park (Salm *et al*. 1982). A sparse dugong population has been observed around northern Papua Barat during scientific research cruises (Syamsudin *pers comm*. 2001).

Anecdotal evidence suggests that the Aru islands (Maluku Province) once had a large population of dugongs. The remoteness of the archipelago makes it difficult to survey. Based on surveys carried out in East Aru and East Ambon (Figure 4.9) in 1975 and 1990, de Iongh and Wenno (1992) concluded that the dugong population in this area has been severely depleted. Dugong populations appeared to decline between 1978 and 1987 (de Iongh & Wenno 1992).

Aerial surveys were conducted in 1990 and 1992 around the coastal waters of the Lease Islands (east Ambon and the islands of Haruku, Saparua, and Nusa Laut) in Maluku Province (Figure 4.9). The minimum population of dugongs within the study area was estimated to be between 22 and 37 animals (de Iongh *et al*. 1995). This area is a very small fraction of the surface area of Indonesia and is not representative of the Indonesian dugong population. Suitable dugong habitat was also observed in Kayeli Bay (East Buru), Piru Bay (Buru), Seram and Fakfak (Nusantari *pers comm*. 2001) (Figure 4.9). Although the coastal area of North and East Seram was not surveyed, local fishers have reported the presence of dugongs (de Iongh *et al*. 1995) (Figure 4.9).

In northern Sulawesi, dugongs have been reported from around the seagrass bed of Arakan Wawontulap (southern portion of Bunaken Marine National Park) and other locations within Bunaken Marine National Park, and near Mantehage Island (Benoldi *pers comm*. 1997; Kahn *pers comm*. 2000) (Figure 4.9 and 4.11). In 1997 a Taiwanese fishing company caught and disposed of nine dugongs in the Lembeh Strait (Matindas *pers comm*. 1998 to Ginting). In Tumbak Village (Figure 4.9), locals often catch dugongs for their meat (Mantjoro *pers comm*. 2000 to Ginting). The seagrass bed of Arakan Wawontulap is a known dugong habitat, however, the resident dugongs often remain outside marine park boundaries (Maitimu *pers comm*. to Ginting 2000). Seagrass beds off

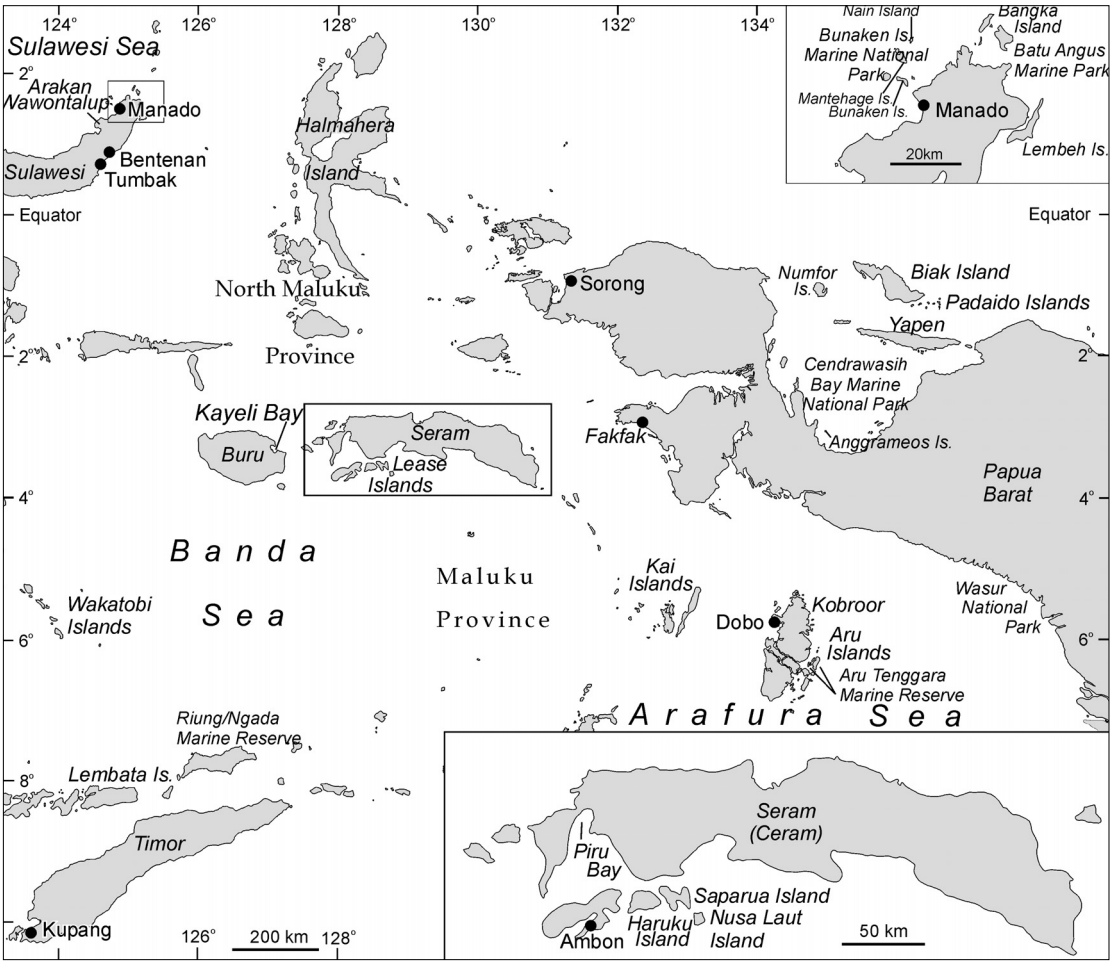


Figure 4.9 – Eastern Indonesia showing place names mentioned in the text.
Inset top right: North Sulawesi.
Inset bottom right: Seram and adjacent islands.

Mantehage and Nain Islands are also important dugong areas (Puspita Devi *et al*. 1997) (Figure 4.9).

A local NGO, "KELOLA", which has been studying dugongs in northern Sulawesi, estimated approximately 1,000 dugongs in the region (KELOLA 1994). The seagrass species reported from this area include *Thalassia hemprichii*, *Halophila ovalis* and *Cymodocea* sp. Dugongs have been observed in groups of between one and four. The total estimate is based on snorkel surveys carried out in 1994 around Arakan Wawontalup at the Bunaken Marine National Park. One hundred dugongs were sighted at this seagrass bed over a one month survey period (Dako *pers comm*. 1998). KELOLA has received funds to carry out more quantitative surveys including aerial surveys (Dako *pers comm*. 1998).

Incidental dugong sightings have been reported from the Togian Islands Marine Park in Central Sulawesi (Surjadi *pers comm*. 2001) (Figure 4.11), and also from Wakatobi Marine National Park in south east Sulawesi. In southern Sulawesi (Figure 4.11), some dugongs were caught in 1975 in the vicinity of the islands known as Lae-lae, Barrang Caddi (adjacent to Lae-lae), and Sanrabengi (5º19'28S, 119º20'2E). These waters were surveyed between 1975-1977, and at the time, were thought to support about 15 dugongs (Hendrokusumo *et al*. 1981). In more recent times, local fishers in the area have said that dugong sightings in this area are now very rare, whereas previously there had been many animals (Lankester *pers comm*. 1999).

The Bangka Islands were surveyed in 1976 by Jaya Ancol Oceanarium. Dugongs were reported to occur in Klabat and Tukak bays (Hendrokusumo *et al*. 1981) (Figure 4.9). According to Syah (2001), dugongs are found in the Bangka Island Sea, Sunda and Lombok Straits, Flores Sea, Palu Sea, Sulawesi Sea (Celebes Sea) (Figure 4.11), Ambon Bay and Arafura Sea (Figure 4.9).

Little is known of the dugong population in Bali (Figure 4.11). Individual dugongs are sometimes sighted by surfers at Uluwatu and Padang-padang beaches on the southwest extremity of the Bukit Peninsular. In November

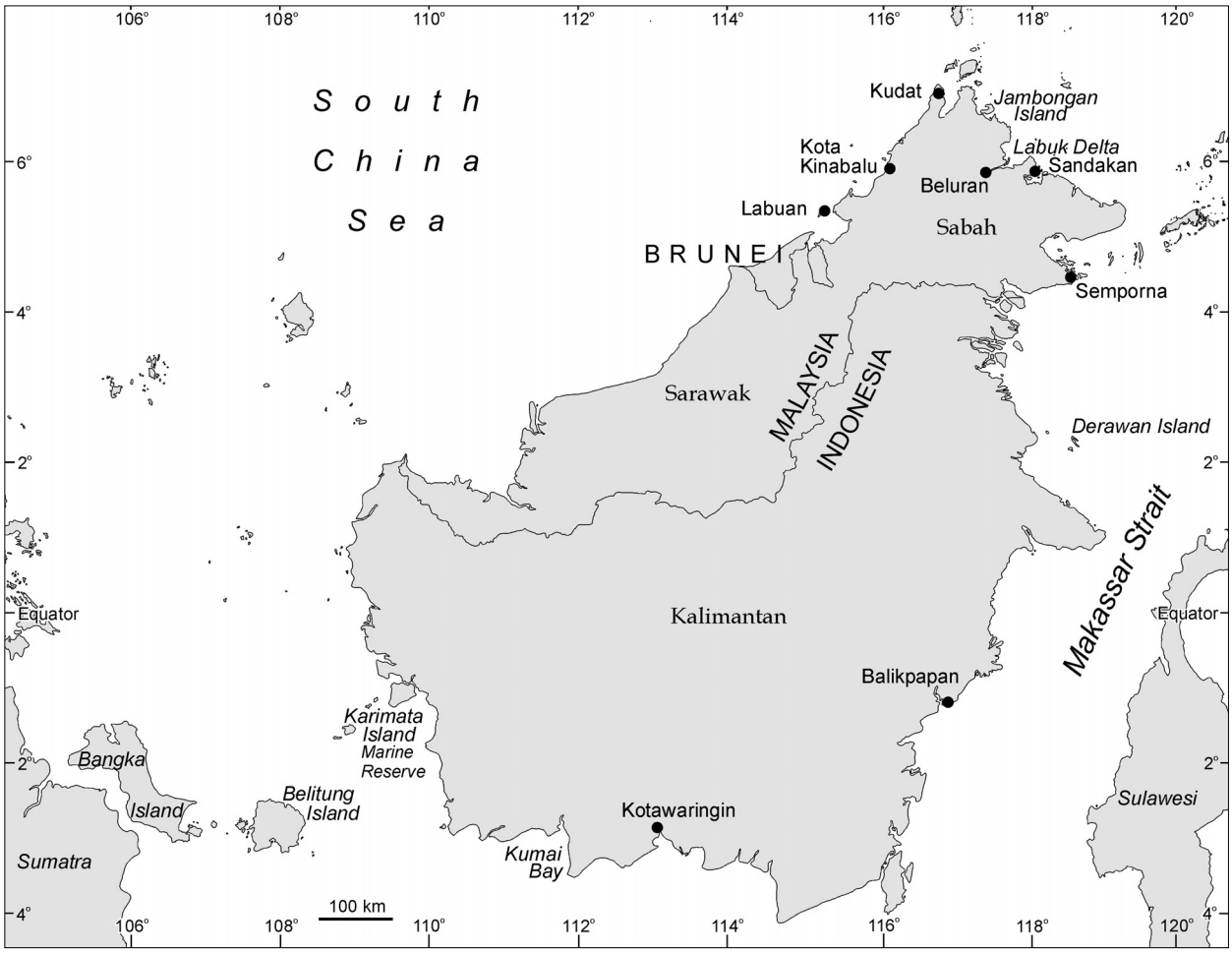


Figure 4.10 – Central Indonesia showing place names mentioned in the text.

2000, a dugong was sighted at Padang-padang beach, and locals report that an individual dugong visits the beach almost every day (Penrose *pers comm*. 2000).

Perrin *et al*. (1996) suggested that dugongs might be extinct in the waters of Kalimantan (Borneo). However, *Kompas Daily* 20/12/2000 reported that 'The Rare Aquatic Species of Indonesia Foundation and Coastal Resource Management Project' surveyed dolphins from Mahakam Delta to Balikpapan Bay in December 2000, and that Danielle Kreb found a dugong in Jenebara estuary – Balikpapan Bay, East Borneo (Figure 4.10 and 4.11). The report also said that the survey crew found dugong habitats along the Mahakam Delta – Balikpapan coast and Kotawaringin (central Kalimantan) (Figure 4.10 and 4.11).

Dugongs have also been reported to occur north of Serang (Banten Province), an area that is rich in seagrasses *Zostera* sp. and *Halodule universis* (Hendrokusumo *et al*. 1981). In October 1999, a dugong was accidentally caught by fishers in Cilegon who transferred it to Jaya Ancol Oceanarium in Jakarta (Kompas Daily 26/05/2000). Dugongs were also sighted in the Komodo National Park within Selat Lintah separating Flores and Sumbawa (Kahn & Subijanto *pers comm*. 2000) (Figure 4.11).

Jaya Ancol Oceanarium has kept dugongs in captivity since 1984, and presently has two dugongs in their collection (Syah 2001).

Threatening Processes

Habitat Loss and Degradation

LIPI (1997) estimated that the total area of seagrass in Indonesia is about 30,000km^2. Logging, forest fires, intensive steep-slope farming, soil erosion, pollution and coastal development are degrading coastal habitats. The dredging of seagrass beds and inshore waters are threatening dugong feeding areas, especially in Sumatra, Java and Bali where human population density is high. River runoff, the largest source of siltation and pollution to the nation's inshore waters, also threatens seagrass beds. Domestic pollution is not controlled, and elevates

Figure 4.11 – Indonesia showing place names mentioned in the text.
Inset bottom left: Sunda Strait and Banten Bay, Java. Inset bottom centre: The Bukit Peninsula, Bali.

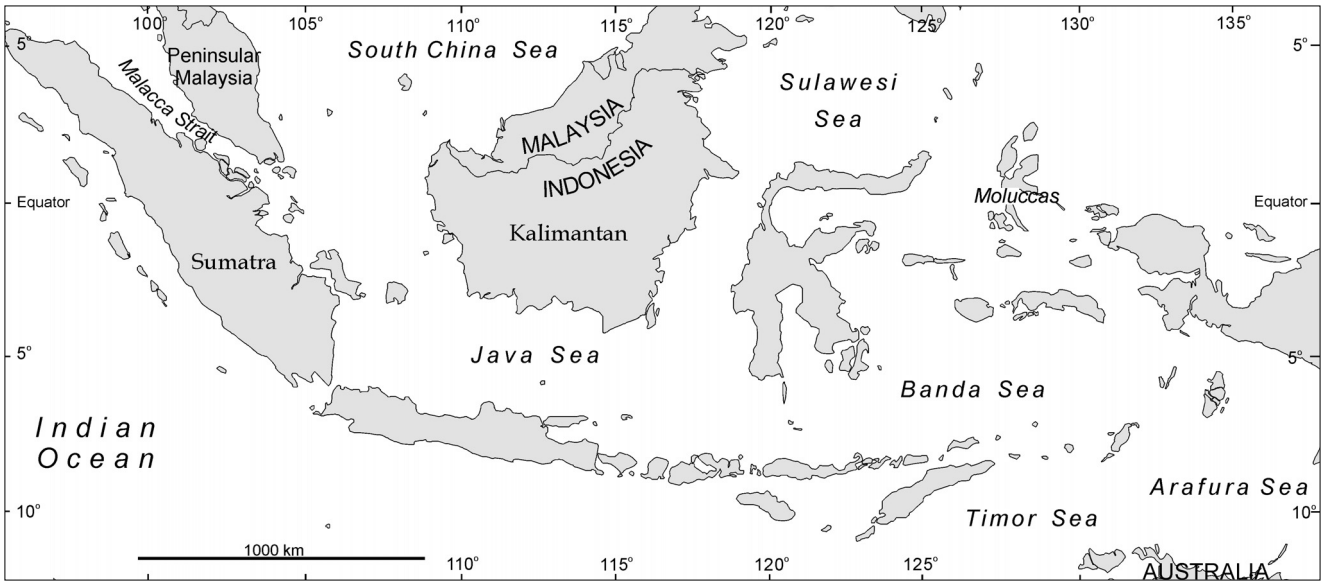


Figure 4.12 – The Seas and Oceans of Indonesian waters.

nutrients in rivers in crowded areas (SME 1996). Excessive nutrients originating from untreated sewage, contaminated ground water and agricultural runoff cause significant degradation to seagrass meadows. In Cilegon and Jakarta Bay (Figure 4.11), the seagrasses closest to the urban areas have the highest concentrations of heavy metals, that are presumably accumulated by dugongs feeding on the seagrass leaves. In Papua Barat, logging and mining pose significant threats to seagrass beds and other marine habitats. For example, in Cendrawasih Bay Marine National Park, Papua Barat, dugongs are rarely found since most of their habitat has been destroyed by deforestation-induced sedimentation. In north Sulawesi (Figure 4.9), major economic development is occurring on the coast of Manado city where reclamation for the development of hotels and shopping malls is in progress. This may have impacts on the seagrass beds of nearby Bunaken Island Marine National Park (Mandagi *pers comm.* 2001) (Figure 4.9).

In addition, illegal mining is known to occur in this region. The introduction of significant quantities of mercury into the marine ecosystem may have long-term health and reproductive implications for dugongs and other organisms within the food chain. Throughout Indonesia 'legal' mining occurs whereby tailings are disposed via submarine tailing placement (STP), also known as submarine tailing dumping (STD) by experts independent of the mining industry. Considering Indonesia's complex oceanography, the path taken by tailing is unknown and surface resuspension is a possibility (Kahn *pers comm.* 2001). The Minhasa mine in Sulawesi discharges tailings into Buyat Bay to depths of only 80 metres below the sea bed. Since it opened in 1996, local residents have complained that dead fish are washed up along the shore and contact with the water causes skin rashes (Pearce 2000). Toxicologist Rizal Rompas of Sam Ratulangi University in Manado, Sulawesi in 2000 found heavy metal contamination in fish and plankton. He blamed the mine discharges and warned that, contrary to the mine operator's claims, toxic tailings were returning to the surface (Pearce 2000).

Fishing Pressure

Blast and sodium cyanide fishing, fairly common fishing techniques in Indonesia, are major contributors to coral reef degradation in North Sulawesi, Taka Bonerate Marine National Park (South Sulawesi) (Figure 4.11), Biak Island and Cendrawasih Bay Marine National Park (Papua Barat) (Figure 4.9), Flores Island and Komodo National Park (East NTT) (Figure 4.11), and in other parts of Indonesia (Ginting *pers comm.* 2000). In Cendrawasih Bay, there are no permanent residents, however, migrant fishers from Serui (Yapen), Biak and Numfor islands (Figure 4.9) visit the reef and practice dynamite and cyanide fishing. These fishing techniques have destroyed the local reefs and associated ecosystems. In Arakan Wawontalup (Figure 4.9) dugongs are accidentally trapped in fish weirs (sero) almost every year (Maitimu *pers comm.* to Ginting 1999). Blast and cyanide fishing are practised in many coastal villages throughout Indonesia. Fishers and residents are reluctant to talk about such techniques as these practices are illegal (Mantjoro 1997). In 1997, an Indonesian-Taiwanese joint venture erected tiger mesh trap nets near the Bunaken Islands Marine National Park in North Sulawesi (Figure 4.9).

Along with many other marine mammals, nine dugongs were captured and killed (Morris 1997). At Taka Bonerate Marine National Park in South Sulawesi, Riau, Bangka and Belitung Islands in Sumatra, and Cilegon in Banten province, Java, incidental catches of dugongs in fishers' nets have occurred (Ginting *pers. comm.* 2001) (Figure 4.11).

By-catch in shark nets is a serious threat to dugongs in Indonesia. Gill netting for sharks is mainly concentrated in the waters adjacent to East Seram (Figure 4.9). Shark netting activities have also increased during recent years in the Aru Islands. Interviews carried out by de Iongh (1996) reported that a decline in dugong catches has been observed with an increase in shark netting activities. In 1979, off Kobroor in eastern Aru, 80 to 200 dugongs were reportedly caught in shark nets, whereas in 1989 only 20 to 40 individuals were caught (Figure 4.9).

A study on the exploitation of dugongs during 1979 and 1980 reported that 550 to 1,000 dugongs were caught each year using Taiwanese nets set originally for sharks in eight areas in the Moluccas (de Iongh & Wenno 1992) (Figure 4.12).

Dugongs are also caught in fish weirs or 'sero' which are large tidal traps constructed of mangrove wood, bamboo and netting. These weirs are large structures, usually more than 100m in length and are composed of progressively smaller circles with 'V' shaped entryways. In 1992 and 1996, two dugongs including a calf, and six dugongs respectively were accidentally trapped in seros set in Arakan Wawontulap in the Sulawesi Sea (Figure 4.9). Also, in Nain Island, fishers often regularly see dugongs (BKSDA 1996) (Figure 4.9). Dugongs are also caught in gill nets in the Kapoposang Islands region, South Sulawesi and in Bangka, South Sumatra (Ginting *pers comm.* 2000) (Figure 4.11).

Indigenous Use and Hunting

Around Lembata Island (West Timor) (Figure 4.11) and Arakan Wawontalup (North Sulawesi) (Figure 4.9), and many other parts of Indonesia, dugongs are believed to be reincarnations of women. Dugongs are called putri duyung (Dugong Lady) and are thought to bring luck and protection (Perrin *et al.* 1996; Ginting *pers comm.* 2000). In early February 1998, a stranded dugong on Meko Beach, Flores Island (Figure 4.11) was protected because of this traditional belief. After three days the animal was returned to the sea with assistance from the local coastal community (Ginting *pers comm.* 2001).

However, in Arakan Wawontalup and the southern part of Manado, and around Tumbak and Bentenan (Figure 4.9), beliefs are quite different, especially those of the Bajo people (sea gypsies from South Sulawesi and throughout Indonesia). In these areas, dugong products are believed to have magical powers (mainly aphrodisiac) and dugongs are killed for their teeth, tusks and teats. The remains are discarded. Dugong tears are extracted from live animals and either mixed with perfume or added to beauty products (de Iongh & Wenno 1992). Bajo men and women believe the tears have supernatural powers, and when mixed in perfume and worn, will attract the attention of the opposite sex. The Bajo men also believe that eating dugong meat will attract women (Mantjoro *pers comm.* 2000).

Bajo and Bugis (sea gypsies from South Sulawesi and throughout Indonesia) take dugongs for local consumption (Mantjoro 1997). These kills are opportunistic and occur when the animals migrate into shallow coastal waters. According to interviewees, even if five or six adult dugongs were available, they would not be enough to be shared among the community members of Tumbak (Mantjoro 1997). The frequency of dugongs visiting the Tumbak area has declined considerably over the last few decades (Mantjoro 1997). Dugong meat is also eaten by locals in Fakfak in northwest Papua Barat (Nusantari *pers comm.* 2001).

In Maluku, dugong meat was an important source of protein but also a source of oil and ivory (de Iongh & Wenno 1992). In 1998 dugong meat was sold at approximately 2,500 rupiah (US$1 per kg) (Ginting *pers comm.* 2001). In the Aru Islands (Figure 4.9), some parts of the dugong are very valuable. Chinese traders will pay a lot of money for the tusks, which are then subsequently transformed into cigarette holders and sold in Dobo and Ambon (de Iongh & Wenno 1992) (Figure 4.9). In other parts of Maluku, some parts of the dugong are also used for making religious artifacts. In Cendrawasih Bay Marine National Park, dugongs are hunted and their tusks are made into jewellery and handicrafts (Putrawidjaja 2000). In West Timor, the tusks are sold as tobacco pipes for 250,000 rupiah (US$25) and in Java, dugong bones are a medicament for high blood pressure and diabetes (Ginting *pers comm.* 2001). In 1996, the Kompas Daily reported that in Bangka, off the southeast coast of Sumatra, a dugong necropsy revealed the dugongs' teeth had been extracted while it was alive. The animal was released but subsequently died of starvation.

Previously, dugongs were actively killed with harpoons in the Aru Islands. However, since 1989 this practice has been abandoned and replaced by new and more profitable practices such as pearl diving, shark netting and shrimp trawling.

Boat-related Impacts

Fifty years ago, seagrass was abundant in the Malacca Strait (Figure 4.12) which probably supported a substantial dugong population (TED 2001). Today, this

seaway is the world's second busiest commercial shipping lane, with approximately 600 ships and boats using it each day. Slow-moving dugongs are killed or injured by vessels and forced away from their feeding areas, and an average of 30 shipping accidents, including oil spills, occurs each year. Pollution from passing ships is destroying seagrass beds and dugongs are often found trapped or dead in fishers' nets (TED 2001).

Existing Conservation Initiatives

Legislation

The legal protection of dugongs in Indonesia appears to be ineffective. Enforcement is complicated by the nation's large area and numerous islands. For example, in Aru, neither local people or officials are aware of the legal protection afforded to dugongs and restrictions on dugong-related products. People committing offences with respect to dugongs have not been prosecuted.

Prior to 1999, almost no legislation was directly aimed at protecting dugongs; they were indirectly protected by a Ministry of Forestry decree. The Ministry of Forestry, which has a legal mandate for nature conservation, added dugongs, seagrass beds, turtles and other endangered species to the CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) list in 1972. This ministerial decree is no longer effective. In 2000, the Indonesia Public Assembly (MPR) declared through TAP/MPR/V/2000 (Public Assembly Decree) that ministerial decrees are not part of the legislation system in Indonesia (Ginting *pers comm.* 2001).

The government of Indonesia has issued government regulations to operationalise the *Conservation of Flora and Fauna Act No. 7, 1999*. This is the only legislation which protects Indonesian dugongs and seagrass. On Appendix no. 20 of the Act, *Dugong dugon* is listed as Protected Fauna. In Article 4, Verse 2, the Act dictates that the conservation of flora and fauna is to be achieved by:

1. Management *in situ* through identification and inventory of species and habitats, monitoring, management, and research, and
2. Management *ex situ* through research, rehabilitation and protection of species and habitats. Threats to species listed as Protected Fauna and Flora under the Act will be managed by eliminating threats to listed species and their habitats by working with local communities and private operators by providing training, education and extension as well as by monitoring, surveillance, policing, and law enforcement. The legislation has been applied to prevent cyanide fishing impacts, one of the threats to dugongs, particularly in Bunaken (Ginting *pers comm.* 2001) (Figure 4.9).

Prior to December 2000, local government had no jurisdiction to manage marine resources, such as coral reefs, seagrass beds and dugongs. Therefore, no local government had a program to protect or encourage their local community to conserve dugongs or other marine resources. In the mid 1980s, the local government of NTT issued local regulations to protect dugongs and rewarded people that found and saved stranded dugongs. This local regulation was not successful because local government had no jurisdiction.

From January 2001, provincial governments have jurisdiction out to 12nm from the coastline, and district/municipal governments have jurisdiction over one third of the provincial waters (UU no. 22/1999 verse 10). Local governments can formulate regulations to protect marine resources such as dugongs. The drafting of such regulations needs to be strongly encouraged by agencies such as IUCN (Ginting *pers comm.* 2001).

Ginting (*pers comm.* 2001) advised that the following acts could be used to generate further government regulations or local government regulations (Perda) to protect dugongs and their habitats:

- *The Forestry Act No.5/1976*
- *The Fishery Act No.9/1985*
- *Biodiversity and Ecosystem Conservation Act No.5/1990*
- *Quarantine Act No.16/1992*
- *Biodiversity Convention Act No.5/1995*
- *Environmental Management Act No.23/1997*
- *Local Government Act No.22/1999*

The institutional arrangement to manage dugong protection is under the Directorate General of Nature Conservation – Ministry of Forestry. However, since 2001, the Ministry of Forestry has developed a memorandum of understanding which will lead to the gradual hand-over of management of Marine Protected Areas to the Ministry of Marine Affairs and Fisheries. The management of six marine national parks including Thousand Islands – (Daerah Khusus Ibukota, Jakarta Bay); Karimun Jawa (Central Java); Bunaken (North Sulawesi); Wakatobi (Southeast Sulawesi); Taka Bonerate (South Sulawesi) and Cendrawasih Bay (Papua Barat) (Figure 4.9 and 4.11) is currently being delegated to the Ministry of Marine Affairs and Fisheries. All these national parks support dugongs and their habitats. Terrestrial national parks which incorporate the coastal zone and support dugongs include Ujung Kulon (Banten); Komodo (NTT); Wasur National Park (Papua Barat) (Figure 4.9 and 4.11). The management of these three parks is under the Ministry of Forestry. In addition to these national parks, there are many marine parks

including Batu Angus, Aru Islands, Togian and Kupang Bay; marine reserves such as Gunung Krakatau, and specific marine reserves such as Riung/Ngada, NTT (Figure 4.9 and 4.11). The protection of dugongs and their habitat could potentially be strengthened through the management of these Marine Protected Areas.

Research

Research on the distribution, migration and feeding ecology of dugongs in Maluku has been carried out by staff and students at Leiden University in The Netherlands and Pattimura University in Ambon since the early 1990s. Aerial surveys were conducted along the coastlines of the Lease Islands in Maluku in 1990 and 1992 (de Iongh *et al.* 1995; distribution and abundance). The survey was part of the Dugong Management Development Fund, a project jointly implemented by the Environmental Study Centre of Pattimura University and the Foundation AID Environment in Amsterdam.

In North Sulawesi, Italian scientists, with the support of WWF-Italia, are planning to monitor the seagrass beds in deep and coastal waters of the Sulawesi Sea. They also aim to assess the status of dugong populations in this area. Interviews will be carried out with the local people who sometimes report dugongs and the results of these interviews will determine the areas where aerial surveys are to be conducted (Pecchioni & Benoldi *pers comm.* 1997).

The movements and home ranges of four individual dugongs in the Lease Islands were studied using conventional and satellite telemetry (de Iongh *et al.* 1998). As in Australia (Marsh & Rathbun 1990; Preen 2001), the dugongs displayed individualistic patterns of movement, with an immature male travelling 65km from one core area to another and three adult females using 2-3 preferred areas 17-47km apart (de Iongh *et al.* 1998). The home ranges for the four animals overlapped known seagrass beds.

In 1993, a dugong seminar was held in Ambon and the following recommendations were endorsed:

- further inventories of dugong populations in Indonesian coastal waters;
- the establishment of a national Conservation Strategy;
- an Action Plan for dugong in Indonesia.

Suggested Conservation Initiatives

Research

- The distribution and abundance of dugongs and their habitats in Indonesian waters need to be determined at an appropriate-sized but affordable spatial scale. We suggest that large-scale interview surveys should have high priority, particularly in fishing villages. A qualitative assessment of the direct and/or indirect effects of the fisheries and other impacts on dugongs and their habitat could be conducted as part of the interview surveys.
- The results of the interview surveys should then be used to plan aerial and/or vessel surveys of dugongs and their habitats in priority areas. These areas should be selected with input from relevant stakeholders using criteria such as:
  1. biodiversity importance, especially areas of known dugong and seagrass abundance
  2. other relevant ecological data
  3. the degree of local commitment
  4. the probability of success in sustainable management of dugongs seagrasses in the context of local critical social and environmental factors affecting the areas.
- The attention of policy makers in Indonesia to dugong conservation would be enhanced if agencies or donors such as IUCN (The World Conservation Union), UNDP (United Nations Development Programme) or GEF (Global Environmental Funds)–World Bank, developed a program in Indonesia. At present many policy makers are busy with political and economic crises and the protection of dugongs is of low priority.
- Kahn (*pers comm.* 2001) reports that throughout Indonesia, STD (submarine tailing "dumping") mining proposals are currently under review for approval. Research into the ecological toxicological effects of mine waste disposal on the marine food chain (including dugongs) should be examined before new disposal areas are approved.

Management

- The results of the surveys suggested above should be used to provide decision makers and local communities with data essential for coastal zone management in general and dugong and seagrass conservation in particular. These activities are likely to be most effective if community-based.
- Dugong protection should be emphasized in the marine parks established to protect them. In particular: Ujung Kulon National Park (Banten); Balikpapan Bay (East Kalimantan); Togian Islands Marine Park (Central Sulawesi), Komodo National Park (East NTT) (Figure 4.11); Aru Tenggara Marine Reserve (East Aru) (Figure 4.9); Wakatobi Marine National Park (Southeast Sulawesi) and Taka Bonerate Marine National Park (South Sulawesi) (Figure 4.11). The Cendrawasih Bay Marine National

Park (Papua Barat) is likely to be particularly important for dugong conservation in Indonesia. The park covers 14,530,500 ha and, if well managed, will provide a significant sanctuary for dugongs (Ginting *pers comm.* 2001). Community participation and stewardship need to be integral components of park management.

- Another important area for a marine park is Lembeh Strait in North Sulawesi (Figure 4.9). A suitable site for a village-based marine sanctuary is Balikpapan Bay in East Kalimantan (Ginting *pers comm.* 2001) (Figure 4.11). Proposals have been developed by local communities and NGOs.
- The number of marine conservation areas in critical dugong habitats needs to be increased. In particular, protected zones and sanctuaries could be added to the Aru Tenggara Marine Reserve and Lease Islands in Maluku (Figure 4.9).
- It is very important to obtain support from, and to involve local government leaders in the planning and implementation of marine parks. In addition to involving local community leaders, the involvement of the local NGOs and community groups will be crucial. Community-based support and efforts play an important role towards achieving conservation objectives.
- Indonesian traditional management practices could play a vital role in dugong conservation. For example, "sasi" in Maluku, is a practice built around the principle of 'prohibition' or of 'abstaining from' catching specific resources for a certain period of time. The local elders or local custom leaders may determine the timing of such temporal closures or they may be 'spirited from heaven' through seasonal changes or dictated by calendar years (Moermanto *pers comm.* 2000). Community-based conservation programs would need to be tailored to suit the local conditions at a village level.
- Traditional management practices need be supported by nation-wide legislation in order to ensure that non-locals (or 'outsiders') are required by law to abide to the local management regulations. Adequate enforcement of the legislation would also need to be implemented (Moermanto *pers comm.* 2000).
- The socio-economic effects need to be considered when local villages are likely to be affected by conservation initiatives (implementation of protected areas). Alternative job opportunities need to be provided to encourage locals to change from “illegal or non-environmentally-friendly” livelihoods (e.g. shark-netting and other destructive fishing techniques) (Moermanto *pers comm.* 2000)
- The success of marine conservation initiatives largely depends on an informed and educated stakeholder community (Maitimu *pers comm.* to Ginting 2000). Coastal residents should be informed of the protected status of dugongs thorough culturally appropriate education programs. Teachers, informal leaders, religious leaders should be trained on marine ecology to pass on the message of conservation and sustainable use of resources to the public.
- Seagrass meadows need to be protected specifically rather than through blanket legislation for marine ecosystems in general as at present.
- The cooperation between neighbouring countries on the management and conservation of threatened species and their habitats needs to be enhanced (Ginting *pers comm.* 2001). Adjacent countries should work in collaboration with Indonesia on dugong conservation initiatives. For example, the Malacca Strait (Figure 4.12) runs through the territorial waters of Indonesia, Malaysia and Thailand with the much shorter Singapore Strait at the southern end and would be an ideal site for inter-country collaboration. In addition, North Sulawesi and the Philippines should work together regarding the Sulawesi Sea (Figure 4.12). Also, negotiations between Papua Barat, Australia and Papua New Guinea are needed to extend the aerial surveys of Torres Strait to cover the coastal waters of Papua Barat. The surveys conducted to date by Australia do not cover all the dugong habitat in the region.
- The Indonesian, Japanese and Korean governments and the authorities in Taiwan (China) should develop protocols to obtain information on by-catch as the gill net fishery banned from Australian waters to protect marine mammals has moved north into Indonesian waters.
- Indonesia and Australia should consider conducting joint surveys of marine mammals in the Arafura Sea (Figure 4.12).

Conclusions

- Dugongs are now considered rare or depleted throughout their former range in Indonesia.
- The challenge of managing Indonesian marine resources is increased by the length of its coastline, its large area and widespread and numerous islands.
- Bycatch in fishing weirs (sero) and shark nets are the main threats to dugong populations. Illegal fishers from Taiwan (China) and Hong Kong are difficult to control and dangerous to arrest as the Indonesian navy is not large enough to be able to control the territorial seas.
- Indonesian traditional management practices could play a significant role in the development of

Chapter 5
Pacific Islands

PALAU

Encompassing about 340 islands, Palau forms the western end of the Caroline Islands chain. Its nearest neighbours include the Philippines (west), Yap Island in the Federated State of Micronesia (northeast), and the Indonesian province of Papua Barat (formerly Irian Jaya) (south) (Figure 5.1).

In the Micronesian area, dugongs occur only in Palau, apart from occasional sightings around Yap and Guam (Nishiwaki *et al.* 1979) (Figure 5.1). Palauan waters support one of the most isolated dugong populations in the world. The closest dugongs are found in Papua Barat, 800km to the south and the Philippines, 850km to the west (Nishiwaki & Marsh 1985). In both these areas, dugongs are believed to be under threat from human exploitation. Hence it is unlikely that the Palauan dugong population is supplemented by recruitment from these areas. The following information is reproduced from a report prepared by Marsh and Lawler (1998) for the U.S. Marine Mammal Commission (also see Marsh *et al.* 1995).

Distribution and Abundance

A small isolated dugong population occurs around Palau (Republic of Belau) (Figure 5.2). Dugongs in the waters surrounding Palau have been surveyed from the air on three occasions: 1978 (Brownell *et al.* 1981), 1983 (Rathbun *et al.* 1988) and 1991 (Marsh *et al.* 1995). All surveys used approximately the same design. The rate at which dugongs were sighted was lower in 1991 than on the previous two surveys. Marsh *et al.* (1995) consider this result suggestive of a reduction in the numbers of dugongs in Palauan waters. In 1978 and 1983; 34 and 38 dugongs (including three calves) were sighted respectively (Brownell *et al.* 1981; Rathbun *et al.* 1988). Only 26 dugongs were sighted during the 1991 survey, despite coverage of approximately 55% of the waters inside the barrier reefs. This is a minimum count as some dugongs on the surface are missed by observers, and others are not able to be seen as they are too far below the surface (Marsh & Sinclair 1989a).

The distribution of dugongs was similar for the three surveys with the most important habitats around the Malakal Harbour area and in the waters between Babelthuap Island and the barrier reef, especially to the west (Figure 5.2). Local hunters interviewed in 1991 confirmed the dugong distribution indicated by the surveys. They also indicated that dugong grazing typically occurs in lagoons with relatively low seagrass biomass in waters more than 7m deep. Dugongs are not generally found in the southern part of the archipelago (Rathbun *et al.* 1988).

Threatening Processes

Habitat Loss and Degradation

Destruction of seagrass beds may have serious impacts on the sustainability of dugong populations in Palauan waters. There are no data on the status of dugong habitats in Palauan waters. Most dugong grazing probably occurs in lagoons with relatively low seagrass biomass in waters more than 7m in depth. Non-point-source impacts such as deteriorating water quality resulting from land clearing are likely to be more serious threats to dugong habitats in Palau than point-source impacts such as sewage discharge or anchor damage. The Environmental Impact Statement for the Babeldaob Road project considered the potential impact of construction of the road on dugongs and seagrass (Idechong & Smith *pers comm.* 1998), setting a precedent for the evaluation of impacts on dugongs associated with future major developments.

Indigenous Use and Hunting

Dugong hunting in Palau is a deliberate rather than opportunistic activity and is often timed to obtain meat for special occasions. Dugong meat is frozen for home consumption, particularly for festive occasions, rather than sold. The meat may be served to guests without their knowledge as disapproval of killing dugongs is widespread. Hunters that were interviewed stated that they prefer the meat of female and juvenile dugongs to that of adult males. If this preference is reflected in the catch, it will put added pressure on the stock. There is evidence that some jewellery is made using dugong bones (e.g. the atlas vertebrae and ribs). However, obtaining the atlas vertebrae (Brownell *et al.* 1981) was of minor relevance by 1991. One hunter admitted in 1991 that he

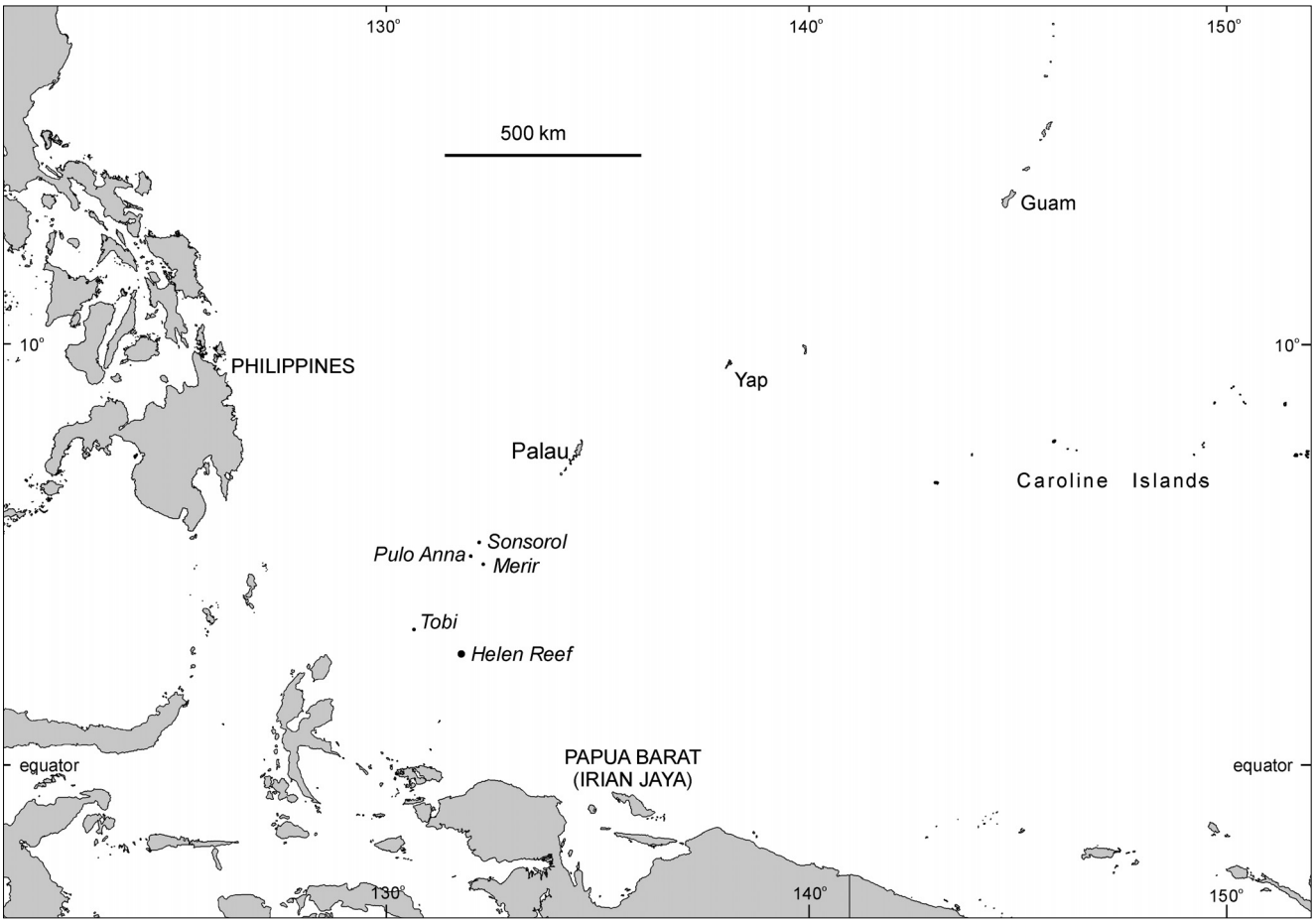


Figure 5.1 – The Palau region in relation to the Philippines and Indonesia.

used to give dugong ribs to a carver who had died recently. Locally crafted jewellery from dugong ribs was on sale at a minimum of four stores in Koror in 1991. At least two of the retailers knew that this was illegal (Marsh *et al*. 1995). This practice had stopped by 1997 (Idechong & Smith *pers comm*. 1998).

The major threat to dugongs in Palau is poaching. Although hunting is illegal, dugongs are still poached regularly in the Koror area and along the western coast of Babeldaob (Figure 5.2). The extent and nature of hunting was investigated by Brownell *et al*. (1981) and Marsh *et al*. (1995). The latter group interviewed 23 knowledgeable locals (including five admitted dugong hunters). One of these informants claimed that at least 13 dugongs had been killed in 1990, a level that was unlikely to be sustainable. Between December 1996 and December 1997, there were at least five dugongs taken despite the concurrent campaign conducted by the Palau Conservation Society (see below).

Traditionally dugongs were hunted with heavy spears from canoes (Rathbun *et al*. 1988). Interviews with residents indicated that in more recent times, dugongs are taken with spears, firearms or dynamite. Hunting is performed mainly at night from small boats powered with outboard motors (>35hp). Most dugongs are harpooned after being chased. A hunter who used to dynamite dugongs (Brownell *et al*. 1981) claimed that he had ceased this practice in 1978. The hunters interviewed in 1991 maintained that nets are never used to catch dugongs, although some of them knew that netting is an effective capture method. All the hunters were aware that killing dugongs is illegal. Their overwhelming motive for hunting is that it is an exciting way to obtain meat. The illegality adds to the thrill.

Two hunters who had commenced hunting in the 1960s conceded in 1991 that dugongs were much less common than in the 1960s and 1970s. However, they were reluctant to stop hunting while others continue to do so, particularly as the risk of significant punishment is slight. Thus, hunting continues, despite the identity of at least some hunters being well known, social pressure from non-hunters, and the legislation making it illegal. A significant decline in poaching has been reported in recent years. It is not known whether this reduction in poaching is a consequence of a decline in the availability of dugongs (Idechong & Smith *pers comm*. 1998).

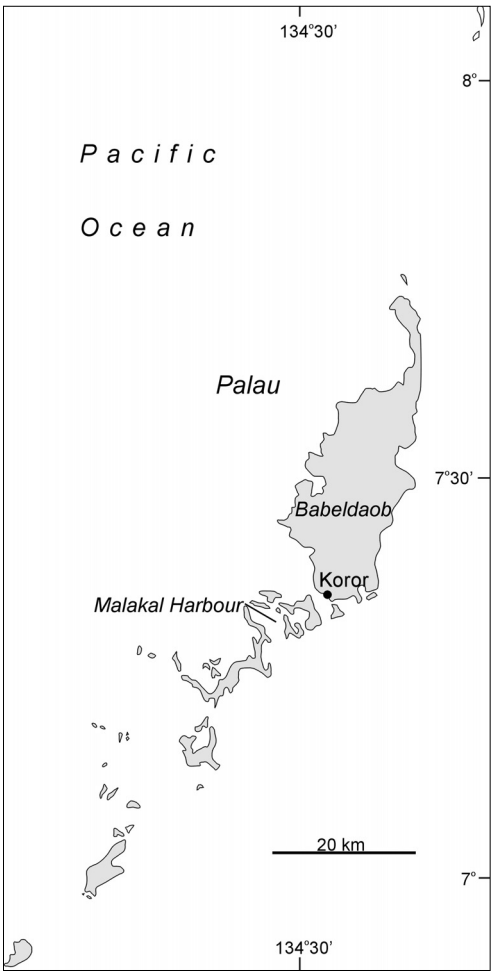


Figure 5.2 – Palau showing place names mentioned in the text.

The population models of Marsh (1995a) suggest that the sustainable level of exploitation may be of the order of only 2% of females per year. If five females are killed in Palau each year, at least 250 females (500 dugongs) would be needed in the waters surrounding the archipelago for the population to be maintained. Marsh *et al*. (1995) consider this extremely unlikely in the light of the low number of dugongs sighted during the aerial surveys (see above).

Boat-related Impacts and Ecotourism

Collisions with speed boats have not been a major cause of dugong mortality in Palau. However this has the potential to become a problem in Malakal Harbour, an important dugong area.

Existing Conservation Initiatives

Legislation

The Palauan legislation relevant to dugongs is the Protected Sea Life, subchapter iv on dugongs. Subsection (a) of this law states that 'No person shall kill, trap, capture, wound, possess, transport, restrain or otherwise have under his control any dugong or any part or product'. Violation of this law includes imprisonment for a period of six months and/or a fine of 'not more than' US$50 for the first offence. For every offense thereafter, the convicted person could be imprisoned for not more than one year and/or fined 'for not more' than US$100 (Subchapter iv is reproduced in full in Marsh & Lawler 1998).

Research

As detailed above, aerial surveys to assess the status of dugong populations in the waters surrounding Palau were conducted in 1978, 1983 and 1991. In 1991, interviews were also conducted with the local hunters of Palau to obtain information on dugong numbers and local hunting and poaching activities.

Management

A Dugong Management and Education Program conducted by the Palau Conservation Society in 1996 and 1997 used the dugong as a target species to stir national pride in Palau's natural heritage. Throughout the campaign, every effort was made to highlight the dugong's characteristics that are similar to humans. The campaign included interactive presentations to community leaders, school and other youth groups and traditional groups, the distribution of posters designed by a local volunteer artist, and fact sheets. The Palau Community College collaborated with the Palau Conservation Society in strengthening the image of the dugong as their college mascot. The Education Program was highly successful in

- raising the understanding of the general public about the status of the dugong in Palau
- stimulating interest in the dugong and the marine environment among Palauans
- increasing public support for tougher laws to protect dugongs.

The Dugong Management and Education Program played a role in changing the Palauan attitude towards dugongs. In 1998 hunting activities were still continuing,

albeit secretly. This reflects a change in community attitude, as in 1991, hunting was carried out openly even though Palauans gave Marsh *et al*. (1995) the impression that they appreciated dugongs as part of their fauna and natural heritage. At the conclusion of the Program, the Palau Conservation Society decided to

- continue the education program and school visits
- seek assistance in securing support for future dugong research in Palau
- increase public support for tougher laws to protect dugongs by providing information to Palau's lawmakers
- survey areas of known dugong habitat and make recommendations to protect these areas
- work with schools to develop curriculum material on endangered species.

Suggested Conservation Initiatives

An Action Plan detailed specific goals and objectives for dugong conservation in waters surrounding Palau is outlined in full in Marsh & Lawler (1998) and reproduced in part here.

Research

- Aerial surveys similar to those conducted in 1978, 1983, and 1991 should be carried out once every five years. The aerial surveys provide a qualitative indication of trends in abundance and in changes in the areas used by dugongs. The major reason for advocating a five-year interval is that funds for more frequent surveys could be better spent on education initiatives. A survey interval of more than five years reduces the likelihood of maintaining consistency in survey methodology because of the difficulty in ensuring continuity of personnel between surveys.
- A more cost-efficient alternative to aerial surveys would be to develop a 'dugong watch' (incidental sighting program) as part of a public education program, perhaps involving school children. Such an approach has been successful in Vanuatu and produced a great deal of useful information on dugong distribution and relative abundance (Chambers *et al*. 1989). A stranding network that encourages and facilitates public reporting of dugong carcasses could be implemented in conjunction with the sighting network.
- The status of seagrass beds throughout the Palauan archipelago needs to be assessed. Identification of habitats suitable for dugongs in Palau should be given priority. A dive survey to map the distribution of seagrass species would be a useful approach. Seagrass beds should be mapped at a fine spatial scale and resurveyed every five years. The frequency could be altered if major changes in the extent or species composition are detected.
- Likely sources of indirect impacts on dugong habitat including major developments and land use practices should be documented in a GIS in association with the seagrass survey.

Management

- High priority should be given to continuing the public awareness and education program developed by the Palau Conservation Society. Public education has the potential to foster Palauan pride in the dugong as a significant feature of their unique marine environment and as a "flagship" or "umbrella" species for marine conservation initiatives. A successful education and awareness program should increase community pressure against poaching. Education programs should include current national and state enforcement officers, police, maritime surveillance, rangers, conservation officers, tourist operators and known poachers.
- The causes of dugong mortality and disturbance in Palauan waters should be identified and minimised. Poaching is the most serious threat to dugongs in Palau and should be stopped as a matter of urgency. To do this it will be necessary to strengthen and enforce the legislation banning dugong hunting. Reactions from hunters indicate that civil penalties, such as confiscating the hunter's boat and motor, would be a more significant deterrent than fines and imprisonment. Strengthening the law must be accompanied by effective enforcement. Training of national and state conservation officers in enforcement is required in addition to an education program to educate known poachers on the impacts of poaching on dugongs (see above).
- The present law allows a person who finds a dugong dead in fishing gear to keep it after reporting the incident to the relevant official. This law should be modified to prevent hunters from using it to circumvent the ban on poaching.
- Dugong habitats need to be protected. Information on the distribution of dugongs and subaquatic vegetation including seagrasses should be incorporated into the design of Marine Protected Areas along with information on activities likely to damage these communities (e.g. changes in water quality resulting from sediment runoff from land clearing, major developments, especially in the Koror area (Figure

5.2), and increases in boat traffic). Although plans to establish local marine reserves in Palau are welcome, it may not be appropriate to set aside small reserves specifically for dugongs which generally occur in low abundance at a local scale in this region. However, dugongs could effectively be used as a 'flagship' or 'umbrella' species for more broadly based marine conservation initiatives.

- Regulations should be introduced which require proponents of major developments to consider dugongs and their habitats in the environmental impact assessment of their proposal as was done for the Babeldaob Road.

Conclusions

- The dugong population at Palau is small, isolated and subject to an unknown amount of human exploitation.
- Dugongs are a "flagship" species in Palau and have been a focus of marine conservation efforts.
- Nonetheless, the anecdotal evidence of hunters and the temporal reduction in the aerial survey sighting rate suggest that dugong numbers may be decreasing in Palau.
- The dugong population of Palau is unlikely to be able to sustain the level of poaching. Unless poaching is stopped as a matter of urgency, it is likely that dugongs will become extinct in Palau. Strengthening and enforcing the laws to protect dugongs in Palau from poaching should be the highest conservation priority.

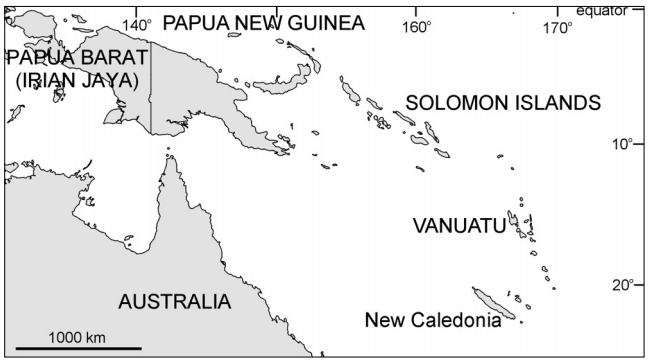
PAPUA NEW GUINEA, SOLOMON ISLANDS, NEW CALEDONIA AND VANUATU

Distribution and Abundance

Papua New Guinea

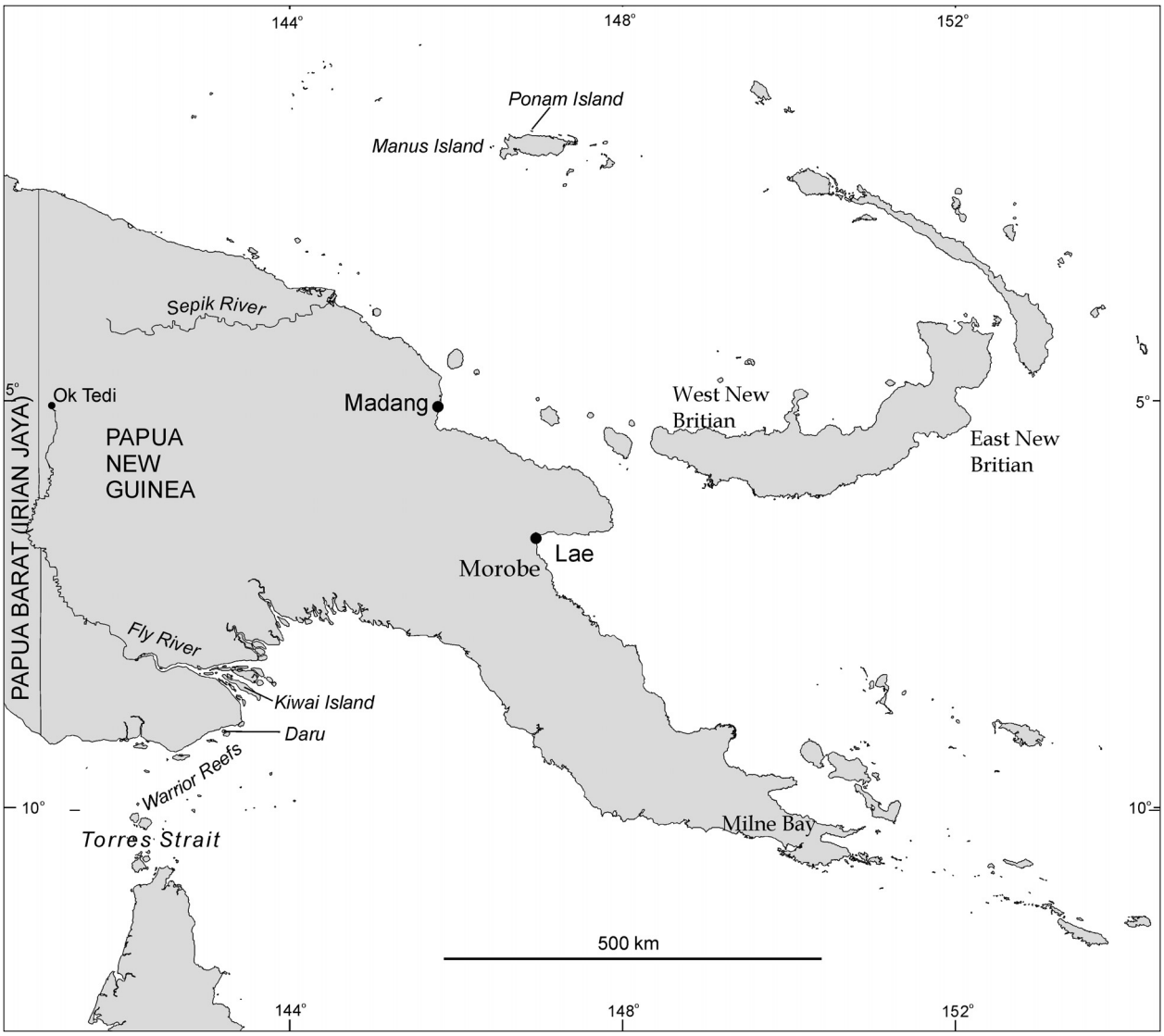
Papua New Guinea (PNG) occupies the eastern half of the island of New Guinea, located just south of the equator and 160km from northern Australia. The western half of New Guinea forms the Indonesian province of Papua Barat (formerly Irian Jaya). Papua New Guinea consists of over 600 islands bounded by coral reefs. To the west lies the Solomon Islands (Figure 5.3).

Dugongs have been reported to occur around the entire coast and islands of Papua New Guinea. A postal survey conducted in 1973-74 revealed the greatest concentrations (groups of 20-50) occurred around Manus Island, along the northern coast from the border to the mouth of the Sepik River, in the vicinity of Madang, in parts of West New Britain, and from the mouth of the Fly River along the coast to the Indonesian border (Hudson 1976) (Figure 5.4). In 1975, a shoreline aerial survey of



(Right) Figure 5.3 – Papua New Guinea, Solomon Islands, New Caledonia and Vanuatu

(Below) Figure 5.4 – Papua New Guinea showing place names mentioned in the text.



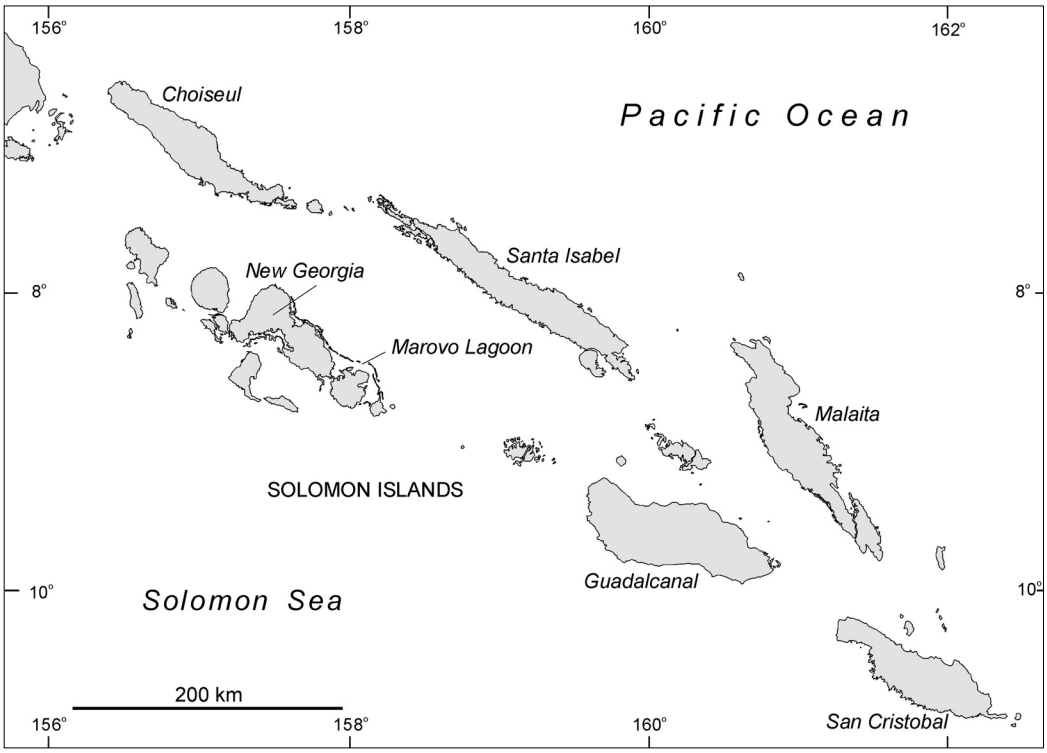


Figure 5.5 – Solomon Islands showing place names mentioned in the text.

the Daru-Warrior Reef area, the southeast Papuan coast, the Lae area and northwest coast of West New Britain covered over 750 miles of the Papua New Guinea coastline (Ligon & Hudson 1977) (Figure 5.4). A total of 186 dugongs were sighted with two concentrations of 29 and 39 dugongs over Warrior Reef. The survey results were not corrected for biases inherent in the survey technique, and so represent a minimum population estimate only.

Solomon Islands

The Solomon Islands comprise an archipelago of six main islands (Choiseul, Guadalcanal, Malaita, New Georgia, San Cristobal and Santa Isabel) and several hundred smaller islands in the southwest Pacific Ocean (Figure 5.5). Neighbouring islands include Papua New Guinea to the west and Vanuatu in the southeast (Figure 5.3).

We know of little information on the distribution and abundance of dugongs in the Solomon Islands. Dugongs have been reported in Marovo Lagoon, located in the Western Province, bounded in the northwest by the southern coast of New Georgia (Figure 5.5) and extending around the north, west and east sides of Vanuatu (UNEP/IUCN 1988) (Figure 5.3).

New Caledonia

New Caledonia lies in the south west of the Pacific Ocean between 18° and 23°S and between 158° and 172°E (Figure 5.3). It consists of a large island called "Grande Terre" and three groups of smaller islands: the Loyalty Islands to the east, the Belep Islands to the north and the Isle of Pines to the south (Figure 5.6). The main island is 400km in length, between 50 and 80km wide, and is surrounded by over 1600km of barrier reefs that bound a 26,000km lagoon.

The distribution of the dugong in New Caledonia is poorly known. Incidental sighting returns suggest that dugongs are distributed throughout most of the lagoons around the main island. They have not been reported from the Loyalty Islands. Most of the records come from the west and northeast coasts of the main island. No dugongs were sighted in the southern part of the lagoon during the humpback whale research programme, conducted every winter since 1995. WCMC (2000) report that dugongs are found in the Diahot Estuary, Grande Terre (Figure 5.6).

The status of dugongs in New Caledonian waters is unknown and there is no estimate of their abundance. Interviews, anecdotal reports and historical records suggest that dugongs were more abundant in the past.

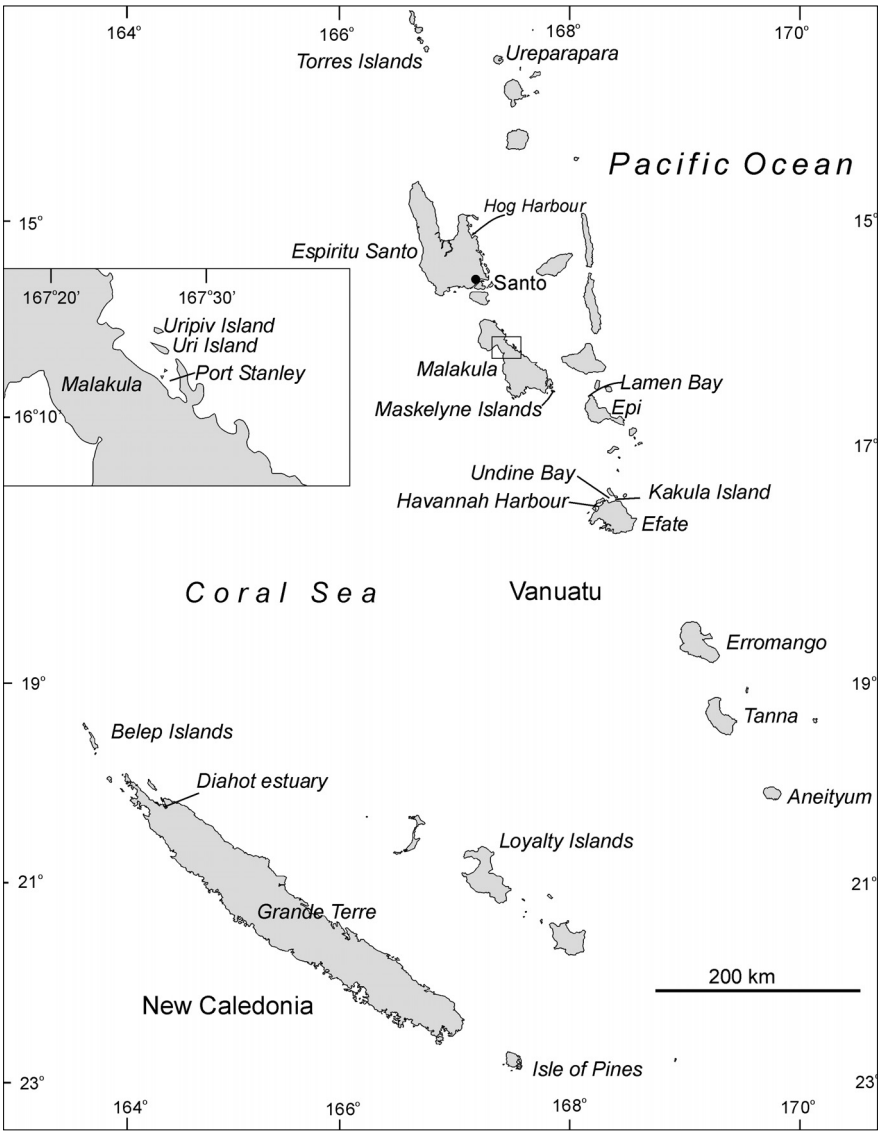


Figure 5.6 – The New Caledonia and Vanuatu region showing place names mentioned in the text.

Vanuatu

Vanuatu is comprised of a group of approximately 80 islands, situated in the southwest Pacific northeast of New Caledonia (Figure 5.3). The archipelago is scattered over a land area of approximately 12,200km^2. The country's largest islands are, in order of size, Espiritu Santo, Malakula, Efate, Erromango and Tanna.

The Vanuatu Archipelago is the eastern limit of the dugong's range. The population size or status of dugongs in this region is unknown. Seagrass beds become less frequent and less diverse progressing eastwards across the Pacific, placing a natural barrier to the eastward extension of the dugong's range. Most of Vanuatu's coasts is unsuitable as dugong habitat. These areas are mainly rugged with cliffs and rocky shores bordered by narrow fringing reefs. Sheltered shallow waters supporting seagrass beds are comparatively rare in this region and are mainly concentrated at Havannah Harbour and Undine Bay (Efate), Lamen Bay (Epi), the Maskelyne Islands, the southeast and east coasts of Malakula, Santo and Ureparapara (Chambers *et al*. 1989) (Figure 5.6).

Most information on dugongs in Vanuatu waters is outdated and there is little information on seagrass distribution. Several reports have cited the presence of dugongs in this region (e.g. Bertram & Bertram 1973; Nishiwaki & Marsh 1985). In 1987, Chambers *et al*. (1989) conducted an aerial survey of Vanuatu's coastline and a postal survey. During the aerial survey, 11 dugongs were sighted; five sightings were of single animals, two of mother/calf pairs and one of a pair of adults. Sightings from the aerial survey coincided with areas reported by the postal survey. Results of the aerial and postal surveys indicated that dugongs occurred in small groups (single or pairs of animals) throughout the sheltered waters of Vanuatu from Aneityum in the south to the Torres Islands in the north (Chambers *et al*. 1989) (Figure 5.6). Tame dugongs reside in Lamen Bay (Epi Island) and Tanna Bay (Tanna Island) (Pacific Island Travel 1999; Lohmann *pers comm*. 2001) (Figure 5.6).

Threatening Processes

Habitat Loss and Degradation

Papua New Guinea and Solomon Islands

We have no information on the loss of dugong habitat in Papua New Guinea or the Solomon Islands. However, there is widespread concern that changing land use may be increasing the input of sediments and nutrients into coastal waters (see Chapter 6 – Torres Strait).

New Caledonia

Data on dugong habitats in New Caledonian waters are limited to the southwest part of the lagoon where

about 220km^2 (11% of the total lagoon area) is covered by seagrasses (Garrigue 1995). Large shallow seagrass meadows exist in the northwest lagoon and a large shallow estuary in the northeast supports seagrass and is potential dugong habitat. A total of 11 species of seagrass has been recorded in New Caledonia (Garrigue *pers comm.* 2001).

The status of seagrass beds in New Caledonia has not been quantified (IFRECOR-NC 2000) but any destruction of these beds may have serious impacts on the sustainability of dugong populations. Potential threats to seagrass beds in this region include coastal development, agricultural runoff and mining activities. Sewage discharge and anchor damage cause local impacts.

Vanuatu

The major developments in Vanuatu are agriculture including coconuts, cattle and crops such as cocoa and coffee. In addition, the tourism and forestry industries are expanding. Overall, the level of development in this region is low, however, local instances of soil erosion and pollution are present and are expected to increase (Chambers *et al.* 1989).

Fishing Pressure

Papua New Guinea

In the 1970s, barramundi and lobster fisheries were initiated in PNG waters. The monofilament gill nets used for catching barramundi along the Papuan coast also entangled dugongs (Hudson 1976). At times of low fish catches, fishers often killed dugongs to compensate for financial losses in the fisheries. Some incidental dugong catches also occurred in trawl, shark and gill nets. The use of nets has been banned for catching dugongs in the adjacent Torres Strait Protected Zone (see Chapter 6).

Solomon Islands

We have no information on dugong-fishery interactions in the Solomon Islands.

New Caledonia

There is no known interaction between dugongs and commercial fisheries. There are anecdotal reports of dugongs being accidentally taken in recreational set nets (Burgess *pers comm.* 2001).

Vanuatu

Accidental dugong deaths appear to be rare in Vanuatu. When deaths occur they are usually attributed to fishing nets and/or boats (Chambers *et al.* 1989).

Indigenous Use and Hunting

Papua New Guinea

The dugong is regarded as very important to the culture of the residents of the island and coastal Papuan communities of the Torres Strait Region (Laba 1997). Many island groups in Papua New Guinea claim that the dugong is a totemic animal because of its large size and strength. It is believed that by using specific parts of the dugong in ritual ceremonies, plants and humans will be made strong and healthy (Laba 1997). In addition, drums and decorations are made out of the hide of dugongs and spoons and scrapers are carved from their bones (Hudson 1976). In the Morobe Province, the teeth and bones are made into hooks and laces, and in the Milne Bay region the teeth are used as betel nut crushers and as accessories for necklaces (Hudson 1976) (Figure 5.4).

In parts of Manus and the adjacent islands (Figure 5.4), dugong meat is an important component of the Islanders' traditional food while in other areas, such as Ponam Island, traditional taboos against killing dugongs exist (Sanders 1979). Hunting pressure on dugongs is greatest in the Western Province (Figure 5.4). The principal people involved in the dugong fishery are the Kiwai of the Western Province of Papua New Guinea to the north of Torres Strait (Hudson 1986) (Figure 5.4) (see also Chapter 6).

Dugong populations have been subjected to heavy exploitation as a result of increased efficiency of hunting techniques. By the early 1920s, use of traditional hunting platforms ceased, and double-outrigger canoes were developed by the Kiwai. This new boat allowed the Kiwai to extend their hunting range and quadrupled their capacity to carry dugong carcasses (the previous canoes could, with difficulty, bring back only one dugong to the shore) (Hudson 1986). In the 1980s, villagers caught dugongs by harpooning them from motorised or sail-powered canoes, or by netting (Marsh 1986). A combination of an increase in hunting effort along with the development of other fisheries is believed to have contributed to the decline of dugongs in Papua New Guinea.

In the 1970s the viability of the dugong population of Papua New Guinea started to attract concern. Prior to World War II about 25 dugongs were allegedly caught per year by Kiwai hunters (Hudson 1986). In the 1950s and 1960s, the Kiwai fishers were encouraged to kill dugongs, turtles and fish to supply the hospital, schools, jail and the local market at Daru. This resulted in an increase in dugong kills to 75 per year (Hudson 1986). Statistics collected in the late 1970s and early 1980s on the number of dugongs passing through the Daru markets indicated a significant decline. In the last six months of 1978,

68 dugongs were measured, 218 over all months in 1979, 97 in 1980, 70 in 1981, and 17 in the first three months of 1982 (Hudson 1986). Records have not been kept since then. Informal interviews failed to obtain a reliable estimate of the number of dugongs caught after 1982 however, there was general agreement that the number taken had declined further in 1983 (Hudson 1986). This decline occurred despite the increased availability of motorised boats and the extension of the hunting grounds. Between 1978-1981, it was estimated that over 450 dugongs were harvested (Hudson 1986).

The restriction of hunting to traditional practices (see Legislation) and the banning of the sale of dugongs at the Daru market have made it difficult to collect accurate catch statistics. Between 1992 and 1994, at least 17 individuals were sold at Daru market, despite a strong warning by the Maza Wildlife Authorities about the killings (Kare 1995). However, this estimate is inconclusive as the Kiwai fishers also catch dugongs for their own consumption and Government officers based at Daru have no record of these catches. Cosmas (*pers comm*. 2001) reports that dugongs are sold in the Daru market almost daily; 2-3 kg can cost K5-12 (US$1.7-4.0). More meat is sold on the 'blackmarket' to avoid prosecution from the Maza Wildlife Management Authority. The consumption of dugong meat is kept secret; locals know that the dugong is an endangered and protected animal so they are not willing to co-operate and provide information.

Solomon Islands

Dugong meat is highly prized in the Solomons (Palley *pers comm*. 1998).

New Caledonia

Dugongs hold an important place in Kanak culture and are still taken for customary purposes (mainly weddings, funerals and traditional yam feasts). No parts of dugong are used other than the meat. Permits are required for customary take, however, there is no monitoring of compliance with this requirement. Anecdotal reports suggest that dugongs are regularly poached in some areas. Dugong meat is rarely sold.

Traditionally dugongs were hunted with spears from canoes. Interviews with residents indicate that in more recent times, dugongs are mainly taken with spears and nets.

Vanuatu

Dugongs are traditionally hunted in Vanuatu, almost entirely for their meat, with oil being a subsidiary product. There are no records of the meat being sold in markets, however, some handicrafts made from dugongs exist. Hunting occurs in some areas of Vanuatu while in others it is considered taboo to kill them. UNEP/IUCN (1988) record the presence of a wide variety of traditional practices such as the seasonal custom 'tabu' which is applied in areas important for dugong conservation. Tabu is a practice implemented by village chiefs that restricts the use of certain resources to ensure sustainability of natural resources (Kile *et al*. 2000).

Dugongs appear to be hunted in three main regions Vanuatu – the Maskelynes area of southeast Malakula, northern Epi and parts of Efate (Chambers *et al*. 1989) (Figure 5.6). However, dugong meat is considered a minor component of the subsistence diet of the people of Vanuatu.

Boat-related Impacts and Ecotourism

New Caledonia

There is no requirement for boat strikes to be reported. Thus no information is available on the extent of this problem. Recently one dugong was observed with scars attributed to a boat collision (Garrigue *pers comm*. 2001). There is potential for dugong behaviour to be disturbed by boat traffic around the main urban centre of Noumea. Nonetheless, the presence of boat traffic may also afford the local dugong population with some protection from illegal take.

Vanuatu

At Lamen Bay (Epi Island), swimming with 'tame' dugongs is a major attraction for tourists from adjacent 'eco' resorts (Pacific Island Travel 1999; Lohmann *pers comm*. 2001). Seven male dugongs and one female dugong are reported to reside here (Lohmann *pers comm*. 2001). Similarly, at Port Resolution, Tanna Bay (Tanna), the famous resident dugong will 'come and interact with swimmers' (Pacific Island Travel 1999).

Dugong-tourist interactions such as that found at Lamen and Tanna Bays may increase the risk of boat strikes. In addition, habitat displacement and the potential for mother/calf separation are likely even when 'experienced eco-guides help tourists to approach dugongs' (Pacific Island Travel 1999).

Existing Conservation Initiatives

Legislation

Papua New Guinea

In 1976, dugongs were declared a 'national animal' under the *Fauna Protection Act*. This legislation permits the dugong to be caught only by 'traditional' methods and only for traditional purposes such as feasts. As a result, the law bans all commercial exploitation of dugongs (Ligon & Hudson 1977). A special exemption was made to allow the sale of dugongs in the Daru market on the condition that the resource was managed by the Maza Wildlife Management Committee. This exemption has lapsed and has not been renewed. In 1978, the capture of juveniles and mothers with calves was banned (Hudson 1986). Now only male dugongs >2.4m long can legally be caught. This must be done using a traditional harpoon from a canoe.

Solomon Islands

We have no information on legislation to protect dugongs in the Solomon Islands.

New Caledonia

The dugong has been protected by law since 1963. Catch is prohibited except for customary purposes under authorisation from the Maritime Service. The holder of the authorisation must return an information sheet indicating the date and the place of the catch, and details concerning the animal, such as its size, sex and weight.

Vanuatu

Dugongs are legally protected under the *Fisheries Act 1982,* which prohibits the capture of marine mammals in Vanuatu's territorial waters. This law is mainly geared to preventing the killing of whales for commercial reasons rather than the subsistence killing of dugongs.

Research

Papua New Guinea

An aerial survey of dugongs in PNG waters was conducted in 1976 (Ligon & Hudson 1977). In 1979, members of the Wildlife Division visited coastal areas of Manus and its islands to record local knowledge of the ecology of dugongs and sea turtles and to discuss the possibility of setting up Wildlife Management Areas in the province. During this time, a study of dugong feeding grounds in Manus was also carried out (Sanders 1979).

A dugong carcass salvage program was developed at Daru by the Wildlife Division of the PNG Department of Environment and Conservation from 1978 through to 1981 (Hudson 1986). Biological material collected in the program provided important information on dugong life history parameters (Marsh 1986).

Solomon Islands

We have no information on dugong research in the Solomon Islands.

New Caledonia

A study conducted in 1993 in the southern part of New Caledonia apparently provided no useful information. Interviews were also conducted in 1993 with the local fishers in the Northern Province to obtain information on the locations and times of their dugong sightings and on the use of this species for customary purposes.

Vanuatu

An aerial survey of dugongs covering approximately 1000km of Vanuatu's coastline was conducted in 1987 (Chambers *et al*. 1989). In 1988, a postal survey was distributed to acquire information on distribution and abundance and the cultural importance of dugongs in Vanuatu. The aerial and postal surveys were the first detailed studies on dugongs in Vanuatu waters and formed part of the program conducted by the Environment Unit of the Ministry of Lands, Minerals and Fisheries Unit to obtain information on major components of Vanuatu's fauna and flora.

Management

Papua New Guinea

In 1978, the 480,000 hectare Maza Wildlife Management Area, the first and largest totally marine conservation area in PNG was established in the southern region to conserve dugongs (Hudson 1986). A village education program was developed at Daru by the Wildlife Division of the PNG Department of Environment and Conservation from 1978 through to 1981. This initiative lapsed in the early 1980s and the Maza Wildlife Management Area Committee was essentially non-functional by 2001 (Cosmas *pers comm*. 2001). After the fishery collapsed, dugongs were banned from sale in the Daru market in 1984 (Hudson 1986). The ban on selling dugongs in Daru is no longer enforced despite the fact that females and young dugongs are supposed to be totally protected.

In 1985, Australia and Papua New Guinea signed the Torres Strait Treaty to resolve the maritime boundaries in

this region and to protect the way of life and livelihood of its traditional inhabitants. The Treaty established the Torres Strait Protected Zone (TSPZ) within which each country exercises sovereign rights for marine life according to agreed jurisdictions. The traditional fishery in the TSPZ is managed jointly by Australia and Papua New Guinea under Article 22 of the Treaty (Anon. 1994a).

A segment of the TSPZ and adjacent area was designated as a dugong sanctuary in which all hunting of dugong was nominally banned from 1985 (Figure 6.4). However, the limited capacity for surveillance and enforcement, the isolation of much of the sanctuary area, and its low density of dugongs have raised questions about the efficacy of the sanctuary as a component of management for dugongs in the region. Dugong hunting in the TSPZ and adjacent areas is limited to 'traditional' inhabitants only. In 1995, the Torres Strait Protected Area (TSPA) Joint Authority implemented a ban on hunting methods other than use of the traditional wap or spear. This was mainly to address a problem of PNG fishers netting dugongs in Australian waters around Saibai Island. There are currently no other limits on hunting effort, numbers of hunters or catch of dugongs.

In December 1996, a fisheries officer from PNG's Western Province was trained in Torres Strait by the Australian Fisheries Management Authority (AFMA), and the Island Coordinating Council (ICC) marine strategy coordinator in a program designed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The program entailed educating the officer on the technique used to monitor community catches. The aim was to commence a catch-monitoring program in the coastal villages of Western Province in 1997, similar to that existing in the Australian Islands of Torres Strait (see Chapter 6). However, this monitoring program has not commenced in PNG to date because of the lack of financial support from the PNG government. The coastal Kiwai people have shown interest in managing their resources and have asked for assistance to prevent the Kiwai Islanders based at Daru from harvesting their dugongs (Cosmas *pers comm.* 2001).

The need for community-based management of dugongs and turtles was discussed and agreed to by leaders of Australian and PNG communities at the Australia – Papua New Guinea Annual Traditional Inhabitants' Meeting in August 1998. In 1998, the Australian Fisheries Management Authority also discussed this issue with the PNG National Fisheries Authority at the annual Treaty Liaison Meeting. The need for complementary community-based management on both sides of the Torres Strait border was discussed further at the annual Australia-Papua New Guinea-Torres Strait Environmental Management Committee and the high level Torres Strait Joint Advisory Council meetings in October 1998, however, no such initiative has been implemented .

Solomon Islands, New Caledonia and Vanuatu

We have no information on non-legislative conservation initiatives designed specifically to protect dugongs in the Solomon Islands, New Caledonia and Vanuatu. However, the traditional practice 'tabu' may provide for more effective natural marine conservation than any government-imposed legislation. Consideration should be given to incorporating this important practice into written legislation.

Suggested Conservation Initiatives

Research

Papua New Guinea, Solomon Islands, New Caledonia and Vanuatu

- Surveys to identify the most important habitats for dugongs should be accorded highest priority in Papua New Guinea, Solomon Islands, New Caledonia and Vanuatu. The most appropriate survey techniques will depend on the survey objectives, spatial scale, location, budget and timing, and the availability of logistical support (see Aragones *et al.* 1997). Aerial surveys will provide the most comprehensive data, however if such surveys are not possible for reasons of expense and logistics, useful information can be obtained from interviewing local fishers.
- A genetic study to determine the relationship between the dugong populations of the region with those in Australia would provide useful information on the degree of isolation of dugongs in Papua New Guinea, Solomon Islands, New Caledonia and Vanuatu.
- In areas of major mining activity, research into the long-term impacts of heavy metals and persistent organic pollutants on the marine food chain (including dugongs and seagrass) is necessary. STD (submarine tailings "dumping") mining proposals are currently in review in PNG and New Caledonia (Kahn *pers comm.* 2001).

Papua New Guinea

- Support is needed for a Papua New Guinea-based fisheries officer to commence community-based monitoring programs to obtain estimates of the dugong catch along the Papuan coast to compliment similar surveys being conducted in the Australian islands of Torres Strait.

- Studies are need to determine whether Ok Tedi Mine is causing siltation of the seagrass beds along the Papuan coast as the locals claim (Figure 5.4).
- Negotiations between Australia, Papua New Guinea and Indonesia are needed to extend the aerial surveys of Torres Strait to cover the coastal waters of Papua New Guinea and Indonesia. The surveys conducted to date by Australia do not cover all dugong habitat in the region.

New Caledonia

- In conjunction with the dugong distribution surveys, seagrass beds should be mapped and the likely sources of indirect impacts on dugong habitat including major developments and land use practices should be documented (preferably in a Geographical Information System (GIS)).

Management

Papua New Guinea, Solomon Islands, New Caledonia and Vanuatu

- Areas which are known or identified to support relatively large numbers of dugongs should be given priority for dugong conservation initiatives in Papua New Guinea, Solomon Islands, New Caledonia and Vanuatu. The support and cooperation of local peoples will be crucial to the success of all management strategies as it will generally be impossible to enforce restrictions without the cooperation and involvement of local peoples. For example, as the dugong forms an integral component of traditional practices of some indigenous peoples in Papua New Guinea, it is likely to be unacceptable to them to ban traditional hunting practices in many regions, especially those bordering Torres Strait.
- In all the countries of the region, coastal development projects should be required to produce environmental impact statements detailing potential effects on coastal water quality and any potential impacts on dugongs and their habitats (i.e. boat activities).
- Culturally-appropriate public awareness campaigns need to be developed in all countries. The successful campaign developed for the Maza Wildlife Management Area in PNG in the 1980s may be a useful model for Papua New Guinea.

Papua New Guinea

- Effective cooperative management plans which outline mutually acceptable management objectives for the Torres Strait dugong fishery need to be negotiated between Australia and PNG.
- A community-based dugong hunting management plan needs to be developed for the Western Province.

Vanuatu

- Based on Chambers *et al*. (1989), candidate areas for dugong conservation initiatives in Vanuatu include:
  - Havannah Harbour, Undine Bay and the extensive intertidal reef flats to the east of Kakula Island (This area may serve as one continuous dugong habitat.)
  - the Maskelyne Islands
  - the Port Stanley area of Malakula, including Uri and Uripiv Islands
  - the Hog Harbour area of Santo
  - Lamen Bay (Epi Island) and Tanna Bay (Tanna Island) where dugong watching occurs (Figure 5.6).

New Caledonia

- An Action Plan containing detailed specific goals and objectives for dugong conservation in the lagoons of New Caledonia needs to be developed.
- Anecdotal evidence suggests that the dugong population of New Caledonia may be unable to sustain the current level of illegal poaching. Strengthening and enforcing the laws to protect dugongs in New Caledonia from poaching should be one of the highest conservation priorities. Strengthening the law must be accompanied by education programme to encourage compliance, and to inform the people of the consequences of killing dugongs.
- Dugong habitats need to be protected once they are mapped. Information on seagrasses should be incorporated into the design of Marine Protected Areas along with information on activities likely to damage these communities (e.g. changes in water quality resulting from sediment runoff from land, major developments, anchoring).

Conclusions

- Scientific information on dugong distribution and abundance is outdated or non-existent. It is likely that dugongs are widely distributed in small numbers in much of Papua New Guinea, the Solomon Islands, New Caledonia and Vanuatu and that larger numbers occur in the Papua New Guinea waters of Torres Strait. The status of the dugong is unknown throughout the region.

Chapter 6
Australia

WESTERN AUSTRALIA

Distribution and Abundance

Shark Bay

Quantitative surveys of dugongs in the Shark Bay area (Figure 6.1) were carried out in the winters of 1989 and 1994. These surveys suggested that the total dugong population was stable with 10,146 (± s.e. 1,665) dugongs in 1989 and 10,529 (± s.e. 1,464) in 1994 (Preen *et al.* 1997). The aerial survey was repeated in July 1999. The resultant population estimate was 13,929 (± s.e. 167) (Gales *pers comm.* 2001). A plausible but unproven explanation for the difference between the results of the 1999 survey and the earlier surveys is large-scale movements of dugongs into Shark Bay, presumably from further north in Western Australia.

In both 1989 and 1994, the region between Dirk Hartog Island and Peron Peninsula (Figure 6.1) supported large numbers of dugongs. However in 1989, the highest densities were found between the northern tip of Peron Peninsula and the coast. During both surveys, few dugongs were sighted in waters colder than 18°C, a result which is in accord with observations from Anderson (1982a and b, 1986 and 1994). An aerial survey was conducted in the summer of 1990 covering only a small area between Faure Island (Figure 6.1) and the coast (Marsh *et al.* 1994a) including the Gladstone/Wooramel Delta area, an important dugong feeding area, particularly in the summer months. In the winter of 1989, Marsh *et al.* (1994a) estimated that this region was used by only 170 (± s.e. 68) dugongs. In contrast, the summer surveys of 1990-1991, covering less than half the area of the 1989 winter survey, produced estimates of between 3,000 and 5,000 dugongs. The results of these surveys reinforce Anderson's evidence (1986) that the distribution of dugongs within Shark Bay changes seasonally, a result confirmed by recent satellite tracking studies. Gales, Holly and Lawler (*unpublished data*) caught 11 dugongs in March of 2000 in the shallow water in the east of the bay. Six of these animals retained their tags for several months. All of them moved north and west from the capture site over winter, most travelling across to the far west of the bay, a distance of over 100km. The three that still had tags at the end of winter moved back to the same area in the east with the onset of warmer conditions.

Ningaloo Marine Park and Exmouth Gulf

The Ningaloo coast and Exmouth Gulf (Preen *et al.* 1997) were quantitatively surveyed for dugongs in the winters of 1989 and 1994 (Figure 6.1). The population estimates for Exmouth Gulf were similar in both years with 1,062 (± s.e. 321) animals in 1989 (Marsh *et al.* 1994a) and 1,006 (± s.e. 494) in 1994 (Preen *et al.* 1997). In both surveys the majority of sightings were on the eastern side of Exmouth Gulf, although in 1994 the dugong distribution did not extend as far south as in 1989 (Preen *et al.* 1997). This distribution coincided with the distribution of beds of *Halodule* and *Halophila*. Density estimates from the two surveys were similar. In 1989 there were 1.142 (± s.e. 0.229) dugongs km^2, and in 1994 the estimate was 1.114 (± s.e. 0.368) dugongs km^2. However, the 1994 survey of the Ningaloo Marine Park region extended the area covered by the 1989 survey and thus, the population (as opposed to density) estimates are not directly comparable.

The area was surveyed again in July 1999. Few dugongs were sighted and the resultant combined population estimate for Ningaloo and Exmouth Gulf was only 337 (± s.e. 108) (Gales *pers comm.* 2001). Exmouth Gulf was surveyed again in April 2000. Two adult dugongs were sighted, too few animals to estimate the population size (Prince *et al.* 2001). A plausible explanation for the movement of dugongs from this region is the destruction of seagrass beds caused by severe topical cyclone Vance which passed through the middle of Exmouth Gulf in March 1999. The results of the 1999 surveys of Shark Bay, Exmouth Gulf and Ningaloo and the 2000 survey of Exmouth Gulf and Ningaloo support the hypothesis of large-scale movement of dugongs into Shark Bay from further north after the cyclone.

Pilbara Coastal and Offshore Region (Exmouth Gulf to De Grey River)

Reasonable concentrations of dugongs were observed in this region during shoreline surveys in the 1980s especially in areas such as Mangrove and Passage Islands, Regnard Bay, Nickol Bay and within the Dampier Archipelago (Prince *et al.* 1981; Prince 1986) (Figure 6.1). (Prince *et al.* 2001) conducted a quantitative aerial survey of this region in April 2000. The resultant

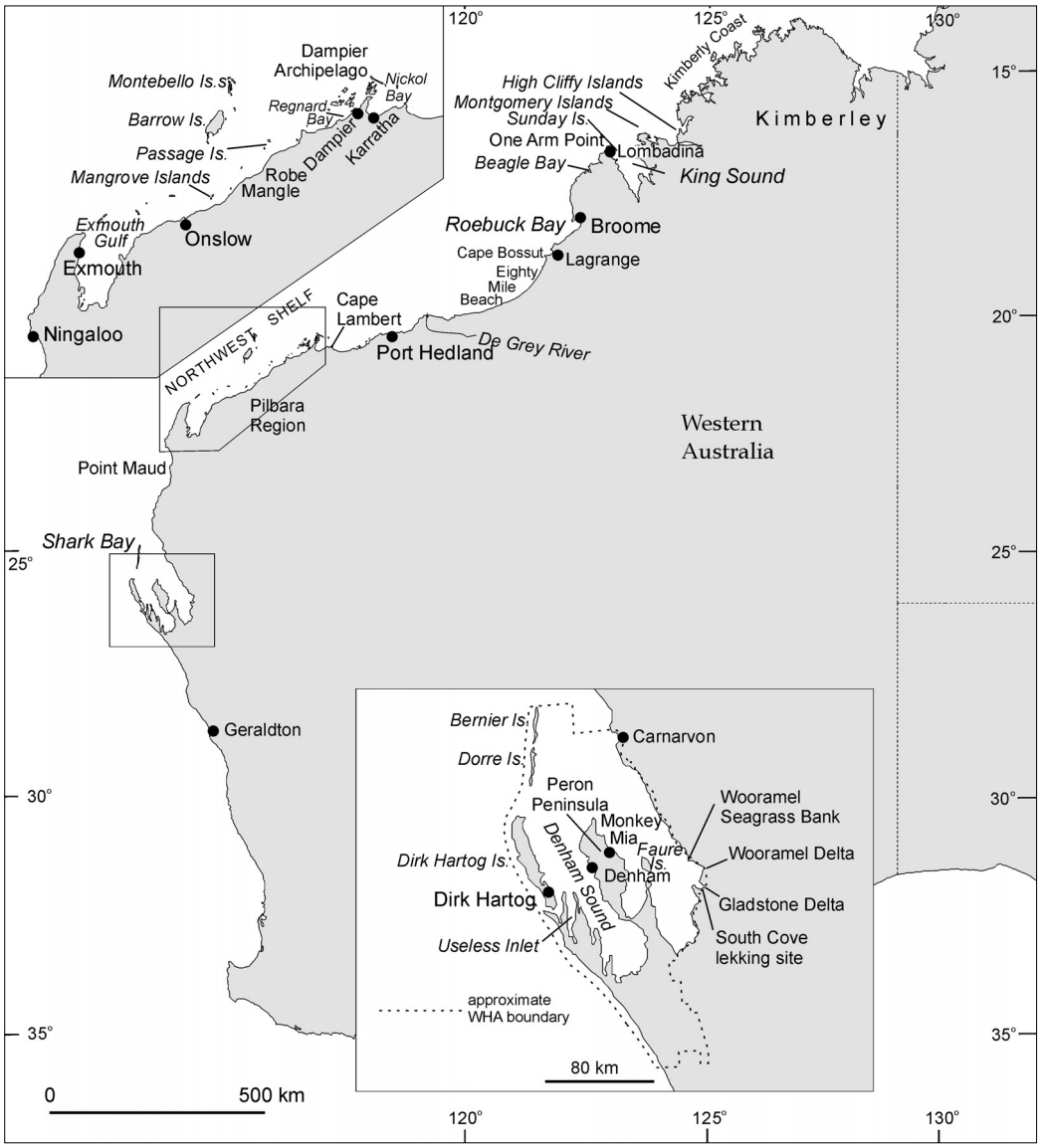


Figure 6.1 – Western Australia showing place names mentioned in the text.
Inset top left: Exmouth Gulf and the Northwest Shelf region.
Inset bottom right: Shark Bay region and Ningaloo Reef. **(WHA= World Heritage Area)**

population estimate was 2,046 (± s.e. 376) dugongs, at an average density of 0.10 dugongs per km^2. Most of the dugongs were in the locations identified from the earlier surveys and incidental reports of sightings or strandings (e.g. see Prince *et al*. 1995). These areas are expected to support substantial seagrass resources, but these have not been quantified. Dugong feeding trails have been observed in dense seagrass meadows of *Halodule* mixed with *Halophila* and *Cymodocea*, between Middle and North Mangrove Islands (Pendoley & Fitzpatrick 1999). The region has extensive areas of shallow water, extending to the seaward side of Barrow Island and the Monte Bello Islands (Figure 6.1). Some deepwater seagrass meadows have also been documented (Bowman Bishaw Gorham 1995). Consequently, there are large areas of potential dugong habitat in this region. Knowledge of seagrasses in the region is slowly increasing through the application of a statutory environmental management process to activities of the offshore petroleum industry (Prince *pers comm*. 2001).

Eighty Mile Beach and Kimberley Coast

A scant amount of data exists on dugong numbers in this region. Prince (*pers comm*. 2001) flew reconnaissance surveys for dugongs in offshore coastal waters from Cape Bossut through to King Sound (Figure 6.1). He reports that seagrasses are quite abundant locally in this region and there are small concentrations of dugongs

(Prince 1986). Coastwatch surveyors from Broome who fly over the region have also counted dugongs during their surveys. A cumulative count of approximately 130 dugongs was sighted during all surveys flown in 1997, and between February to August 1998 (Adam *unpublished data*).

Whiting (1999) reported dugongs including calves at Ashmore Reef (12° 15'S, 123° 05'E) on the Sahul Banks on the edge of the Australian continental shelf. Although Ashmore Reef is only 140km from the Indonesian Island of Roti, the two locations are separated by the Timor Trough which is 2000m deep. The shallow sandy areas of the Ashmore Reef flat support seagrass meadows of *Thalassia* spp. and *Halophila* spp. Dugongs were first recorded in this area in 1986 and subsequently, on six other occasions. In 1996, Whiting (1999) counted dugongs while accompanying a Coastwatch surveillance aircraft on a routine flight over Ashmore Reef, and estimated a density of 0.72 dugongs km^2.

Threatening Processes

Habitat loss and Degradation

Shark Bay

The status of dugong habitats in Shark Bay is generally good. There are a few concerns that are outlined below. Shark Bay Salt Joint Venture Ltd has completed a sea wall that isolates a $26km^2$ area of Useless Inlet (Figure 6.1). The area contained some seagrass, but there is no evidence that it was important to dugongs. The most visible seagrass banks are covered with *Posidonia* and *Amphibolis*. Currently, Shark Bay Salt proposes to construct additional salt crystalliser ponds, which will destroy approximately 40 hectares of this seagrass. The impacts on the seagrass community adjoining the seawall and changes to water circulation are unknown. Once production reaches its maximum, Shark Bay Salt has identified a requirement for larger vessels to export their product, which will involve dredging shipping channels to accommodate these large draft vessels. This could have a significant impact on the seagrass banks east of Dirk Hartog Island (Figure 6.1) These banks are dugong habitat in winter (Anderson 1994) and lie within the Shark Bay Marine Park and World Heritage Area. Some seagrass beds within Shark Bay show evidence of propeller damage from boat traffic. The current enhanced aggregation of dugongs within Shark Bay and their concentrated browsing on *Amphibolis,* points to a need for caution (Prince *pers comm.* 2001). Seismic surveying and petroleum exploration are permitted within Marine Parks in Western Australia subject to appropriate approvals, and petroleum exploration leases exist over parts of Shark Bay (Preen 1998). The impact of seismic surveys on dugongs is unknown.

Aquaculture is receiving strong support from the State Government, and the protected bays and inlets of Shark Bay have been identified as prime aquaculture locations (Barton *pers comm.* 1998). Aquaculture farms may affect dugongs and their habitat through acoustic disturbance, eutrophication, pesticides, boat strikes, or the dragging of moorings on the seabed. Aquaculture sites also have the potential to compete for space with dugongs by restricting their feeding ground access, and interfering with their use of preferred travel routes and resting refuge locations (Prince *pers comm.* 1998). Shark Bay contains a major trawl ground for prawns and scallops. Permanent and seasonal closures of the prawn and scallop fisheries have been implemented in various areas. Some of these closures also overlap with dugong areas, and therefore provides some added protection for the animals.

Exmouth Gulf and Ningaloo

There are no data on long term trends in seagrass distribution or abundance. Surveys post tropical cyclone Vance in March 1999 showed that macroalgae and soft bottom communities were severely affected (Prince *pers comm.* 2001). It is likely that seagrass loss is responsible for the movement of dugongs from the area. Permanent closures have been implemented in Exmouth Gulf to protect prawn (shrimp) nursery areas, while seasonal closures in other areas of the Gulf are prescribed to allow the capture of prawns at sizes producing the best yield and marketability (Joll *pers comm.* 1998). The number of trawlers in the fishery has been reduced from a maximum of 23 to 15, as part of the rationalisation of the industry (Fisheries Western Australia *pers comm.* 1998).

An urban development and tourist resort have been proposed for Maud's Landing at the southern end of Ningaloo Marine Park. This development is currently being subjected to an Environmental Impact Assessment which will include an evaluation of its likely impact on dugongs. Prince (*pers comm.* 2001) suggests the proposed development may have important generic consequences for coastal and reef management.

Pilbara Coastal and Offshore Region (Exmouth Gulf to De Grey River)

There is increasing pressure from port expansion in the Dampier Archipelago and Cape Lambert area, mostly associated with the petroleum and iron ore industries. Seismic surveys and petroleum explorations are permitted throughout Western Australian waters. The North West Shelf is one of the three sites where most of Australia's

current oil, and gas exploration and extraction activities takes place.

Small-scale trawl fisheries operate from Onslow, and from Dampier to Port Hedland. However, there is not much knowledge of these fisheries and their impacts. In response to concerns about their effects on benthic communities, permanent and seasonal closures have been implemented along this section of the coast (Joll *pers comm*. 1998). Pearling aquaculture operations are active within the Dampier Archipelago area and may have some impacts on dugongs.

Eighty Mile Beach and Kimberley Coast

The data are insufficient to determine any trend in seagrass distributions or abundance, and anthropogenic influences are expected to be slight. Tropical cyclones are common on this coast. The Roebuck Bay intertidal seagrass communities are predominantly *Halophila*/*Halodule*, and are regularly used by dugongs (Prince 1986). There is an occasional loss of these seagrass beds in rough weather. Reef-top seagrass community in the Buccaneer Archipelago are species rich (Walker & Prince 1987) and provide forage for small numbers of dugongs. Limited trawling is permitted in this area, but occurs in deep water that is believed to be remote from dugong habitat. Deep water seagrass communities off the West Kimberley coast are used by dugongs. These communities include *H. spinulosa* and *H. ovalis* at depths to >10m in some places (eg, Beagle Bay–Lacepede Islands region; Prince *pers comm*. 2001). Apart from a small area just northwest of Broome, all other waters are closed to trawling by licensees in this fishery (Joll *pers comm*. 1998).

Fishing Pressure

Shark Bay

Wet lining and beach seining, both of which pose little threat to dugongs, are the major commercial and recreational charter fisheries in Shark Bay. Although recreational gill netting is permitted, set nets are not used in the Shark Bay Beach Seine and Mesh Net Fishery, so dugongs are unlikely to get caught in nets. Legal recreational gill netting requires net attendance. Impacts from the prawn and scallop trawl fisheries have not been studied since the early 1960s, however, there have been isolated instances of fatal trawler interactions with dugongs (Prince *pers comm*. 2001), despite a ban on trawling in shallow coastal areas.

Exmouth Gulf and Ningaloo

Exmouth Gulf supports a prawn trawl fishery, in which fishing is now banned in shallow water areas. There are few known cases of accidental drownings of dugongs in both legally and illegally set nets. Trawl fisheries are excluded from Ningaloo Reef Marine Park (Prince *pers comm*. 2001).

Pilbara Coastal and Offshore Region (Exmouth Gulf to De Grey River) and Eighty Mile Beach and Kimberley Coast

While there is some commercial mesh netting in these regions, which overlap the dugong population, the effects on these dugongs are considered low. Recreational mesh-netting is restricted.

Indigenous Use and Hunting

Shark Bay

Limited hunting of dugongs still occurs in this area. Although the indigenous harvest has not been quantified, it is not considered to pose a significant threat. Recent inquiries and other reports concerning Denham-based indigenous hunting activities suggest that shooting is the main mode of capture (Western Australian Department of Conservation and Land Management [CALM] *pers comm*. 1998). The dugong take by indigenous residents of the major regional centres of Geraldton and Carnarvon (Figure 6.1) is not known, but is estimated to be similar to, or higher than, the number taken by Denham residents. Dugong research is being conducted in collaboration with the local Yadgalah Aboriginal Community with a view to developing community-based management of dugong hunting in the region (Gales, Holly & Lawler unpublished).

Exmouth Gulf and Ningaloo

There is no known hunting of dugongs in this area at present.

Pilbara Coastal and Offshore Region (Exmouth Gulf to De Grey River)

Some hunting of dugongs occurs within the Dampier Archipelago. The principal hunters are believed to be expatriate Torres Strait Islanders. The communities at Onslow and Port Hedland both include a high proportion of indigenous peoples. Most indigenous people from Onslow have a non-marine focus. There are no records of dugong take.

Eighty Mile Beach and Kimberley Coast

The indigenous west Kimberley dugong "fishery" presently extends from north of the Buccaneer Archipelago to the southern extremity of Eighty Mile Beach. The system of distributing the catch is determined by complex customary practice (Prince *pers comm.* 2001).

In 1998, the community of One Arm Point hunted about 12 dugongs between One Arm Point and Sunday Island (Wiggan *pers comm.* 1999). The catch of the other communities is not known. This is the only part of Western Australia where there are reasonably large coastal Aboriginal communities which have a tradition of using the marine environment. Torres Strait Islanders and Aborigines who are traditionally associated with other parts of Australia also live and hunt in these communities. The level of dugong hunting in this area, especially One Arm Point, is thought to be high and may not be sustainable at a regional scale (Prince 1986; Gales *pers comm.* 2001).

Dugong tusks are highly prized among the west Kimberley people. Exchange trading of dugong body parts with non-indigenous people for manufactured detachable 'harpoon heads' for hunting has occurred in the past. Recipients made artifacts such as cigarette holders from the tusks. Current use of dugong tusks for this purpose is reported from the Aru Islands, Maluku region in Indonesia. Traditionally, body parts are returned to customary story sites (Prince *pers comm.* 2001).

Boat-related Impacts and Ecotourism

Shark Bay

Shark Bay attracts tourists who participate in recreational fishing and other boating activities, resulting in increased boat traffic. There are currently four interaction licenses for commercial dugong watching in Shark Bay working under strict guidelines (Gales *pers comm.* 2001). Despite these rules, Gerrard (1999) found that these tourism vessels disturbed dugongs from their daily routine in 37% of observed encounters. With increased speeds, this impact increases significantly (Gerrard 1999). There have been prosecutions for non-compliance, including the prosecution of a Shark Bay operator in 2000 for separating a mother and her calf (Morton 2001). Another business was convicted of approaching a dugong too closely during a sight-seeing trip off Monkey Mia in late 2000 (ABC 1999a). Wildlife sailing cruises operate out of Monkey Mia and Denham (Figure 6.1) (Anderson 1998a). Shallow-draft boats travel over seagrass and bank areas where wave action is diminished and high speeds can be maintained. In 1998, a dugong death from a boat collision off Monkey Mia was confirmed, and another death from a boat strike has been reported.

Commercial filming of dugongs in Shark Bay has become increasingly popular, with between five and ten film crews, and several photographers visiting Shark Bay each year. While a license is required from the Western Australian Department of Conservation and Land Management (CALM) for both filming and interacting with dugongs, potential impacts on the animals from these activities have not been investigated. Impacts may occur as helicopters and light aircraft are often used for aerial shots and filming crews operate underwater. The Western Australian Department of Conservation and Land Management (*pers comm.* 1998) is attempting to restrict flying heights above animals to 300-500m. However, this will be difficult as it has no regulatory control over airspace.

Exmouth Gulf and Ningaloo

The close proximity of the reef to the shore in Ningaloo Marine Park contributes to a high level of shore-based tourist boat activity within the vicinity of seagrass beds. The high usage of this area by tourists increases the risk of dugong boat strikes and may potentially affect dugong habitat. There are two licensed operators within the marine park who conduct regular tours to favoured dugong habitats. One operator conducted "swim with dugong" tours. This operation has now ceased.

Pilbara Coastal and Offshore Region (Exmouth Gulf to De Grey River)

There is increasing interest in tourism in this area, particularly diving and day trips. There are shacks on many of the islands of the Dampier Archipelago, which are regularly used by Karratha/Dampier residents. This area has one of the highest levels of boat ownership per capita in Australia, placing significant pressure on the waters of the archipelago (Barton *pers comm.* 1998). Occasionally, there are reports of dugongs being killed by ship collisions in this region.

Eighty Mile Beach and Kimberley Coast

There are anecdotal reports from this region of dugongs being injured in boat collisions (Prince *pers comm.* 2001).

Existing Conservation Initiatives

Dugongs are protected in the state waters of Western Australia under the *Wildlife Conservation Act 1950*. The *Wildlife Conservation (Close Season for Marine Mammals) Notice 1998* issued under the *Wildlife Conservation Act 1950* manages interactions between humans and marine mammals in state waters. The notice does this by setting limits on interactions and by preventing some activities that may injure, disturb, molest or otherwise interfere with, or result in the taking of marine mammals. Dugongs are protected in the Commonwealth waters off the Western Australian coast by the *Environment Protection and Biodiversity Conservation Act 1999*.

Research

Quantitative aerial surveys for dugongs have been conducted in Shark Bay in 1989, 1994 and 1999 (Marsh *et al*. 1994a; Preen *et al*. 1997; Gales *pers comm*. 2001), Exmouth and Ningaloo in 1989, 1994, 1999 and 2000 (Exmouth only: Marsh *et al*. 1994a; Preen *et al*. 1997; Prince *et al*. 2001) and along the Pilbara coast in 2000 (Prince *et al*. 2001). Studies of the ecology and general behaviour of dugongs in Shark Bay have been carried out by Prince *et al*. (1981), Anderson (1982a and b, 1986, 1989, 1994, 1997, 1998b), and Anderson & Prince (1985). Anderson and his group studied dugong ecology and tourism interactions in Shark Bay until the late 1990s. Current studies of dugongs in Shark Bay by Nick Gales and his group include studies of movements and foraging ecology. These are being conducted in collaboration with the local Yadgalah Aboriginal Community (Gales *et al*. 2001). A limited opportunistic program of carcass salvage and information gathering, including tissue samples for genetic studies, tusks for ageing and other related studies (Edmonds *et al*. 1997), museum specimen acquisition etc., has been maintained (Prince *unpublished data*).

Management

Shark Bay

A list of recommendations for the management of aquaculture operations has been provided in the Shark Bay Management Paper for Fish Resources. The Fisheries Department of Western Australia is currently reviewing aquaculture activities in Shark Bay and is preparing a strategic planning document.

In 1986, Fisheries Western Australia closed Shark Bay to mesh netting to protect dugong populations. The closures were promoted and implemented as a result of earlier research by Bob Prince and Paul Anderson in Shark Bay. All other commercial net fisheries are managed on a limited entry basis. Fisheries Western Australia continues to remove surplus fishing effort through buy-backs of commercial fishing licenses under the *General Fishing Adjustment Scheme 1987* and the *Resource Sharing Initiative 1996-2000* (Francesconi & Clayton 1996).

Education opportunities for the recreational netting sector are available through direct mail, as a license is required to undertake this activity and licenses are generally mailed out to applicants. Fisheries Western Australia has also recently initiated winter education activities in Denham. These education programs are open to the general public but are targeted at children. The focus of these programs is fisheries education, which includes information activities on seagrasses and dugongs (Vanstien *pers comm*. 1998). The visitor centre for Monkey Mia provides educational information on the Shark Bay Marine Park. Dugong information is a feature of the centre. There are plans to build a World Heritage Centre in Shark Bay in the next two to five years. This will provide information on all the values of the World Heritage Property including dugongs, which are recognised as being of significant importance.

Ecotourism in marine parks is controlled by licensing under the *Conservation and Land Management Act 1984* (for commercial vessels) and the *Western Australia Wildlife Conservation Act 1950* (licenses for marine mammal interactions). The Western Australian Department of Conservation and Land Management has implemented a policy (Code of Conduct) that restricts each current licensed charter vessel operating from Monkey Mia, to one trip per day to the seagrass banks where dugongs frequent. The vessels must also abide by an interaction license, which prescribes how interactions with dugongs are to occur. New closed season notices have been gazetted regulating access to marine mammals by non-licensed operators. Closed season notices and licensing outside marine reserves is controlled under the *Western Australia Wildlife Conservation Act 1950*.

Exmouth Gulf and Ningaloo

The Western Australian Department of Conservation and Land Management regularly reviews the habitat protection provisions for the Ningaloo Marine Park, to assess their capacity to protect dugongs and their habitats. The report 'A representative marine reserve system for Western Australia' (Anon. 1994b) has identified

additional marine areas as "worthy of consideration" including

- a southern extension of the Ningaloo Marine Park
- the nearshore waters on the eastern and south-western sides of Exmouth Gulf.

Part of the justification of this reserve is the protection of important dugong feeding grounds in Exmouth Gulf waters. Ningaloo Marine Park has a management plan that details the permitted fishery activities by recreational and commercial fishers. There are some restrictions on the use of gill nets in the region.

Pilbara Coastal and Offshore Region (Exmouth Gulf to De Grey River), Eighty Mile Beach and Kimberley Coast

There have been no management actions developed that are specifically designed to protect dugongs in these regions. The report 'A representative marine reserve system for Western Australia' (Anon. 1994a) has identified additional marine areas as "worthy of consideration" including the Robe mangal and adjacent nearshore areas, and the waters surrounding Montgomery and High Cliffy Islands (Figure 6.1). Commercial gill netting is being reduced through a non-transferable license policy.

Suggested Conservation Initiatives

Research

The highest priority should be to conduct quantitative aerial surveys along the parts of the Western Australian coast that have not been surveyed i.e. the region between the mouth of the De Grey River and the Northern Territory border.

Other research initiatives of high priority include:

1. Monitoring dugong distribution and abundance using aerial surveys replicated at five yearly intervals in appropriate weather conditions.
2. Conducting summer surveys of Shark Bay to determine the seasonal distribution of dugongs and the regional significance of different parts of the Wooramel Seagrass Bank and the South Cove lekking site (Figure 6.1). Funding has been approved for this and it is scheduled for 2002.
3. Investigating the location and season of birthing in Shark Bay.
4. Collecting and/or collating data on the effects of commercial mesh netting and other fishing activities, and indigenous hunters on dugong populations. These data should include (for each fishery)
   - number and fate of animals caught
   - data and circumstances of catch
   - size and sex of animals caught.

   Priority should be given to the indigenous fishery operating out of One Arm Point.
5. Conducting detailed studies on the extent and range of dugong movements and habitat use to determine the appropriateness of management measures in specific locations with priority being given to Shark Bay, Beagle Bay, Roebuck Bay and One Arm Point because of the likelihood of resident dugong populations.
6. Genetic studies to determine stock boundaries.
7. Monitoring seagrass throughout Western Australian waters following the recommendations developed by the Commonwealth Scientific Industrial Research Organisation (CSIRO) which reviewed the status of fisheries-related seagrass research within Australia (Butler & Jernakoff 1999).

Management

Habitat Protection

New information on dugong distribution and habitat use, not available when the boundaries of the Marine Protected Area within Shark Bay were established, suggests that the capacity of the current Marine Protected Areas to conserve dugongs needs to be re-examined (Preen 1998). Following the recommendations of the Shark Bay Regional Plan and the Marine Parks and Reserves Selection Working Group, consideration should be given to adding the waters east of Bernier and Dorre Islands to the Shark Bay Marine Park (Figure 6.1).

Following the recommendation of the report 'A representative marine reserve system for Western Australia' additional marine reserves should be considered including

1. a southern extension of the Ningaloo Marine Park
2. the nearshore waters on the eastern and south-western sides of Exmouth Gulf
3. the Robe Mangal and adjacent nearshore areas
4. the waters surrounding the Montgomery and High Cliffy Islands.

Specific processes that threaten dugongs should be considered in environmental assessment programs. The relevant Commonwealth, state and local government departments, and major corporations operating in known dugong areas, should be made aware of the need to incorporate these considerations in assessment and planning processes.

Indigenous Management

Processes to involve indigenous people in the co-management of sustainable traditional hunting should be established in centres where there are significant numbers of indigenous people who wish to hunt dugongs and turtles. An integrated research approach between the indigenous communities, government, non-government and other research institutions is vital. Such centres include (but may not be limited to) Denham, Geraldton, Carnarvon, Onslow, Port Hedland, Lagrange, Broome, Beagle Bay, Lombadina and One Arm Point (Figure 6.1). Torres Strait Islanders and Aborigines who are traditionally associated with other parts of Australia live and hunt in these communities, and should be included in further negotiations. Preliminary work to date has recognised the diversity of groups already hunting dugong', including all the people known to have customary priority, and recognise the shared dugong stock resource base supporting this fishery (Prince *pers comm.* 2001). The development of a culturally appropriate education program tailored to each community in conjunction with management, may assist in encouraging indigenous people to take responsibility for managing their dugong harvest.

Fishery Interactions

Fisheries Western Australia is committed to working with the industry in the preparation of By-catch Action Plans (consistent with the National Policy on By-catch), for all commercial fisheries on a priority basis. Work has commenced on the plans for the Shark Bay Scallop and Prawn Trawl Fisheries, and the Pilbara Fish Trawl Fishery. It is anticipated that work will commence on a plan for the Exmouth Trawl Fishery in the near future. During the preparation of these plans, the issue of dugong protection needs to be carefully considered. The plans will address the need to improve the reporting of any interactions between dugongs and fishing operations and if necessary, outline the mechanisms required to minimise impacts. To parallel the *Environment Protection and Biodiversity Conservation Act 1999,* where it is a legal requirement to report the incidental death of a dugong in Commonwealth waters, we recommend that the failure to report incidental catch be considered a serious fisheries offence under the *Fisheries Regulation 1995*.

An education program to inform commercial fishers on aspects of dugong conservation biology, management, and on methods to minimise incidental dugong take would be beneficial. This may include workshops run by the industry associations, the Fisheries Industry Training Council, and appropriate government agencies on dugong conservation biology and fishing methods.

Ecotourism

The *Wildlife Conservation (Closed Season for Marine Mammals) Notice 1998* issued under the *Wildlife Conservation Act 1950* sets limits on interactions between humans and marine mammals. These regulations provide controls over dugong watching activities. For example, a contact vessel or aircraft must not, without reasonable excuse, block or otherwise cause a dugong to alter its direction or speed of travel. Contact vessels must not exceed a speed of 10 knots without reasonable cause within 100m of a dugong and must abandon interaction with a dugong at any sign of the animal becoming alarmed or disturbed except in case of remedial action. Gerrard (1999) suggests that this speed be further reduced to 2 knots. Swimming with dugongs is banned in Western Australia. A visitor education/awareness program would address many of the unknowns or untruths about dugongs in Western Australia. Pamphlets or interpretive talks on ecotourism ventures are useful in informing visitors of the issues dugongs face (Gerrard 1999).

Conclusions

- Western Australian waters support large numbers of dugongs, which currently appear to be subject to relatively low levels of anthropogenic impacts in areas such as Shark Bay. The threats to dugongs in the Kimberley Region need to be quantified and their significance assessed.
- There is already a substantial knowledge base regarding dugongs in Shark Bay. Information and management intervention are required for other lesser known regions of Western Australia such as in the West Kimberley where unresolved dugong-related management issues occur.

NORTHERN TERRITORY AND THE QUEENSLAND COAST OF THE GULF OF CARPENTARIA

Distribution and Abundance

Cape Londonderry to Daly River

Cape Londonerry is located in Western Australia approximately 2° west of the Western Australian/ Northern Territory border. The Daly River is situated on the Northern Territory west coast (Figure 6.2). There is no information on dugongs in this region and it will not be considered further in this document, except under "Suggested Conservation Initiatives".

Northern Coast (Daly River to Milingimbi)

As a result of a quantitative aerial survey conducted in 1984, Bayliss (1986) estimated that 2,953 (± s.e. 530) dugongs occurred in the coastal waters of the Northern Territory between the Daly River and Milingimbi (Figure 6.2). However, he did not correct for availability bias (Marsh & Sinclair 1989b). Re-calculation of the estimate using the correction factor methodology of Marsh & Sinclair (1989a and b) and Marsh and Saalfeld (1989) gives a population estimate of 13,800 (± s.e. 2,683) (Bayliss & Freeland 1989). Bayliss described the distribution of dugongs along this coast as patchy, with higher densities generally associated with shallow water, larger islands and bays.

Gulf of Carpentaria Coast of the Northern Territory

The coastal waters of the western Gulf of Carpentaria were surveyed in 1984/85 by Bayliss and Freeland (1989) using the methodology of Marsh and Sinclair (1989a and b). The surveys produced very similar population estimates, in the dry season 16,816 (± s.e. 2,946) and wet season 16,846 (± s.e. 3,257). Most dugongs occurred between the Sir Edward Pellew Islands and the mouth of the Limmen Bight River (9,635 ± s.e. 2,622 in 1984 and 10,812 ± s.e. 2,967 in 1985) (Figure 6.2). Preen resurveyed this area of high dugong density in the dry season of 1994 and the wet season of 1995. Preliminary analyses indicate a 61-77% reduction in dugong abundance (Preen 1995). Given the tendency of dugongs to undertake large-scale movements, it is difficult to assess the significance of these results without a resurvey of the whole region, including the adjacent Queensland coast. Each of the four surveys documents slightly different distribution patterns, and most areas between the Sir Edward Pellew Islands and the mouth of the Limmen Bight River were used by large numbers of dugongs at some stage. The area around the Sir Edward Pellew Islands was consistently important dugong habitat.

Gulf of Carpentaria Coast of Queensland

Aerial surveys were conducted in the 1970s using a shoreline survey technique that identifies inshore dugong habitats and provides minimum uncorrected counts (Heinsohn & Marsh 1977; Marsh *et al.* 1980). These surveys indicated that the area around the Wellesley Islands was the most important dugong habitat along the Queensland coast of the Gulf of Carpentaria with 91 animals counted in April 1975 (Ligon 1976), 160 in April 1976, 271 in July 1976 (this survey did not include the South Wellesley Islands), 265 in November 1976 and 213 in April 1977 (Marsh *et al.* 1980) (Figure 6.3). The surveys also suggested that there was a seasonal movement of dugongs within the Wellesley Islands area (Marsh *et al.* 1980). These seasonal changes in distribution agreed with the knowledge of traditional hunters (Marsh *et al.* 1980), suggesting that it was not an artefact of the shoreline survey design.

Marsh and Lawler (1993) resurveyed the Wellesley Island region for marine wildlife in December 1991 using the transect technique developed by Marsh and Sinclair (1989a and b) and Marsh and Saalfeld (1989). The survey indicated that dugong numbers were high in shallow waters within the 3m depth contour. This result was consistent with the results of surveys by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), which found that most of the seagrass beds in this region occur at depths of less than 3.7m (Poiner *et al.* 1987). The estimated dugong population in the Wellesley Islands region in December 1991 was 4,067 (± s.e. 723) animals at an overall density of 0.46 (± s.e. 0.082) dugongs km^2 (Marsh & Lawler 1993). When compared with surveys using the same technique of other parts of the dugongs' range in Australia, this result indicated that the Gulf of Carpentaria region supported Queensland's third largest population of dugongs, and that it is among the six most important dugong habitats in Australia.

The coastal waters of the Gulf of Carpentaria adjacent to Queensland were surveyed in December 1997 (Marsh *et al.* 1998). The survey was designed to facilitate comparison with the 1991 survey of the Wellesley Islands. It is impossible to interpret the differences between the 1997 survey and the shoreline surveys of the west coast of

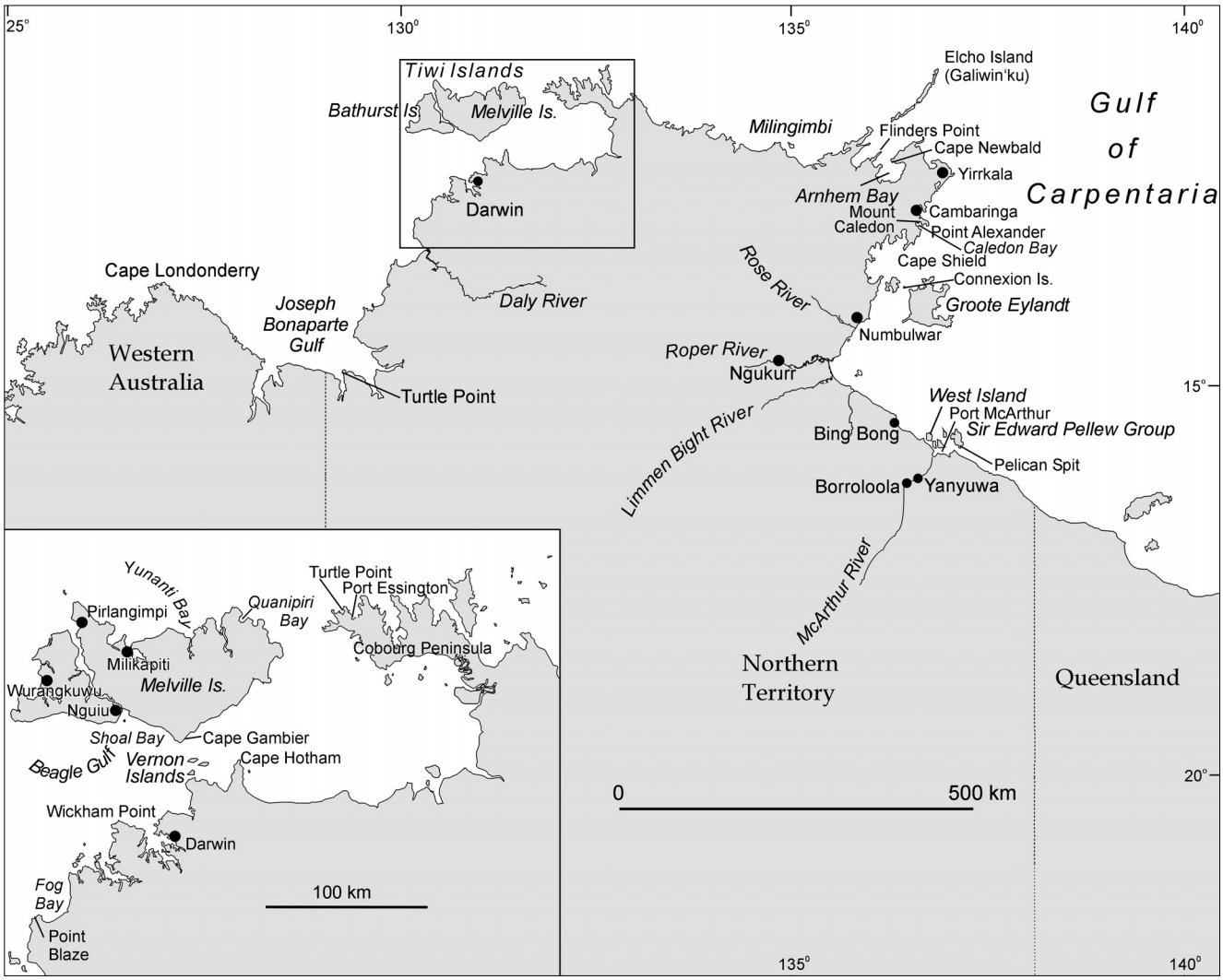


Figure 6.2 – The Northern Territory Coast of the Gulf of Carpentaria showing place names mentioned in the text. Inset bottom left: The northwest coast of the Northern Territory and the Melville Island region.

the Gulf of Carpentaria conducted in the 1970s, because of differences in survey technique. However, the fact that the 1997 survey sighted only one dugong between the mouth of the Staaten River and Cape Keer-weer (Figure 6.3), a region where shoreline surveys had sighted large numbers of dugongs in the 1970s (Heinsohn 1976; Ligon 1976; Heinsohn & Marsh 1978) is of concern, but may simply reflect large-scale movements. The total dugong population of the coastal waters of the Gulf of Carpentaria adjacent to Queensland in December 1997 was estimated to be 4,266 (± s.e. 657) dugongs with an overall density of 0.12 (± s.e. 0.02) dugongs km^2. The highest density was in the Wellesley Islands area. The estimated dugong population of the Wellesley Islands area was 2,648 (± s.e. 524) dugongs (62% of the total). There was no significant difference between the estimated number of dugongs in these areas in 1991 and 1997. However, it should be noted that the 1997 estimate was only 65% of the 1991 estimate, and the power of the surveys to detect a significant decline is weak.

Quantitative aerial surveys were carried out in the regions around Weipa (in November 1991 and December 1997) and Karumba (in December 1994 and December 1997) (Figure 6.3). The numbers of dugongs sighted were too low to estimate population size in all cases. The available evidence suggests that the vicinities of these ports are not important dugong habitats.

Marsh *et al*. (1998) compared the estimated dugong population of the Queensland coast of the Gulf of Carpentaria with other areas surveyed in Australia using the same technique, and found there were far more dugongs in the waters of the Gulf of Carpentaria adjacent to the Northern Territory (16,846 ± s.e. 3,259) in the 1980s than in the waters adjacent to Queensland in 1997 (4,266 ± s.e. 657 or 20% of the Gulf of Carpentaria population). Presumably, this partially reflects the much greater area of seagrass along the

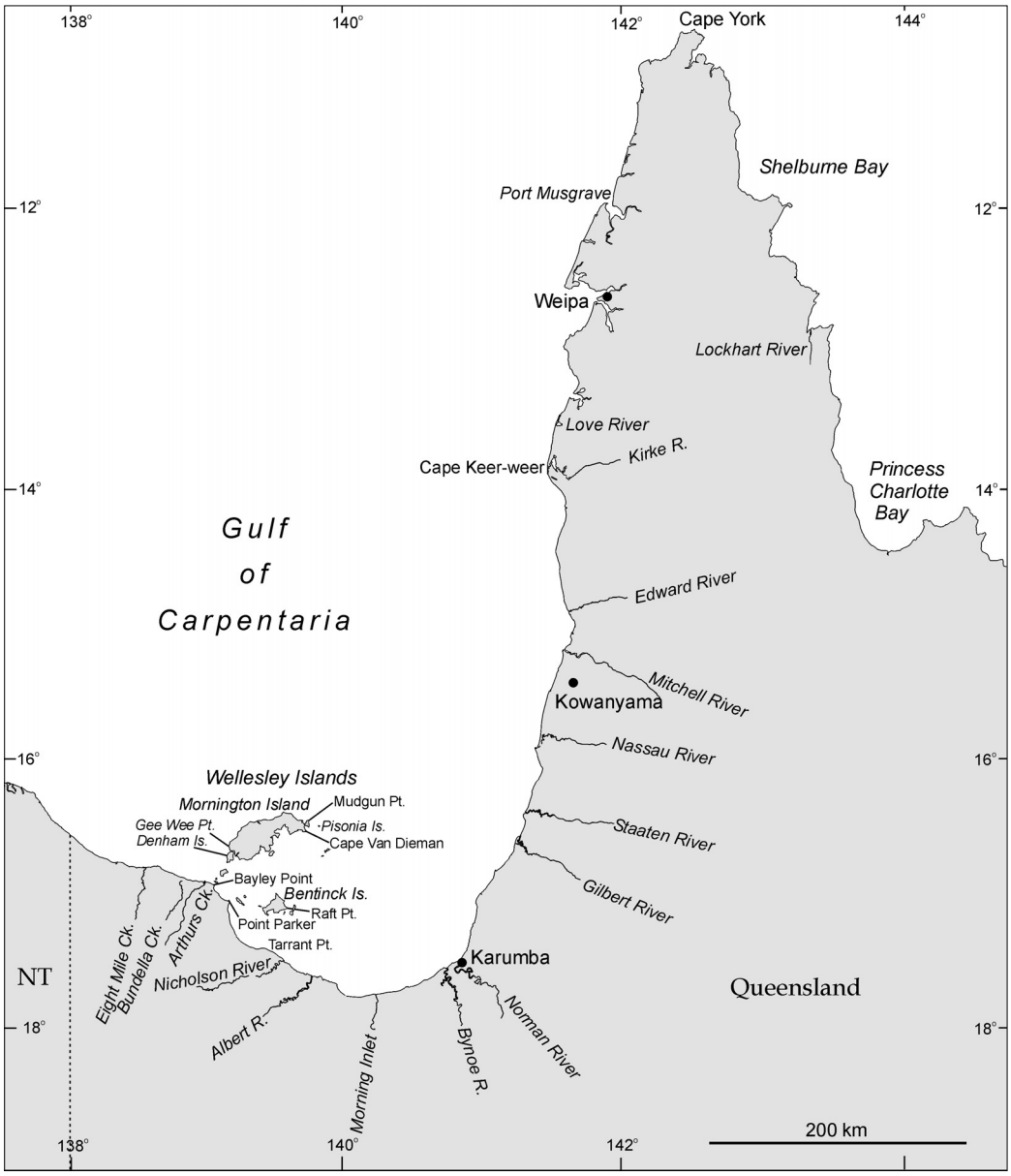


Figure 6.3 – The Queensland coast of the Gulf of Carpentaria showing place names mentioned in the text.

Northern Territory coast (751 km^2) than in Queensland (155.3 km^2 (17% of total)) (Poiner *et al*. 1987).

Threatening Processes

Habitat Loss and Degradation

Northern Coast (Daly River to Milingimbi)

There are no quantitative records of habitat loss or degradation in this region. However, destruction of seagrass beds and fringing mangrove communities is presumed to have occurred with the development of Darwin Harbour. There are concerns about the status of the dugong population in Darwin Harbour, especially around the development site of the proposed gas liquidification plant at Wickham Point. The Northern Prawn Fishery is also active along this coast. The effects of trawling on seagrass beds have not formally been investigated, but there is concern that it is detrimental. As a result the Northern Prawn Fishery has closed specific areas to trawling (see below).

Gulf of Carpentaria Coast of the Northern Territory

The only record of habitat loss or degradation is from the area between the Sir Edward Pellew Islands and the mouth of the Limmen Bight River (Figure 6.2). Poiner *et al*. (1987) estimated that this area contained some 300km^2 of seagrass. These meadows were severely damaged by Cyclone Sandy in 1985. The 183km^2 of seagrass between West Island and the Limmen Bight River were completely destroyed (Thorogood *et al*. 1990). The recolonisation process was slow. By 1988, about 20% of the area had been recolonised by seagrass, but by 1994 much of the area had fully recovered to pre-cyclone Sandy conditions (Poiner & Peterken 1996). *Halodule uninervis* and *Halophila ovalis* were the predominant recolonising species.

Dredging for the port of the McArthur River mine (Figure 6.2) has had little impact on seagrasses, destroying an estimated 0.1km^2 in the Bing Bong area. There is potential, however, for ore spillage associated with this port to cause heavy metal pollution. Given the dietary importance of dugongs to the Aborigines at Borroloola (Figure 6.2) and the capacity of dugong to bioaccumulate such toxins, the potential of heavy metal contamination as a result of the McArthur River ore loading facility is of concern.

The Northern Prawn Fishery is active in this area and has closed off specific areas to trawling to protect seagrass beds.

Gulf of Carpentaria Coast of Queensland

Anthropogenic inputs into this area are low except for two areas of industrial development: Weipa (site of the Comalco bauxite mine and the associated port) and Karumba (site of the loading facility for the proposed Century Zinc and Lead Mine) (Figure 6.3). The development of the Karumba loading facility requires the dredging of a channel up to 16km long and 54m wide, as well as maintenance dredging every two years (Dames & Moore 1994). Dredging is likely to generate a plume of sediment which could affect the nearby seagrass beds. Spills of ore from ship loading operations present a risk of heavy metal accumulation in sediments, however, the loading operations are some 5km from the seagrass beds at the mouth of the Norman River where dugong feeding trails have been observed (Dames & Moore 1994) (Figure 6.3). Loss or damage to these small, but isolated seagrass meadows, may affect the ability of dugongs to move between their feeding grounds in the southern Gulf of Carpentaria.

Fishing Pressure

Northern Coast (Daly River to Milingimbi)

Nets used in the Northern Territory commercial net fisheries, catch and kill dugongs. These fisheries include: the Barramundi Fishery using nets set in some river mouths and on tidal flats, the inshore Shark Fishery using pelagic nets, the Bait Net Fishery and the Coastal Net Fishery using coastal nets that may be staked at one end.

Gulf of Carpentaria Coast of the Northern Territory

Few records of fishery-related mortalities are available. Marsh *et al*. (1986), reported conversations with local fishers who stated that dugongs were frequently caught in the nets of barramundi fishers in the Borroloola area (Figure 6.2). In mid-1995, the death of 36 dugongs which drowned in a gill netting incident in the vicinity of the mouth of the McArthur River was widely reported (see *Northern Territory News* July 11, 17, 23, and 26 1995). In August 2001 eight dugong deaths in the McArthur River, near the town of Borroloola, were linked to nets from a commercial fishing boat (ABC 1999b). Other possible sources of mortality include commercial barramundi fishing using nets set in river mouths (Bayliss & Freeland 1989), inshore shark fishing using pelagic nets or longlines, bait fishing using nets to catch bait for mudcrab fishers and staked coastal nets used by the coastal net fishery. There are reports of dugong meat being used as bait by crab fishers in the Limmen Bight region (Mitchell *pers comm*. 2001).

Gulf of Carpentaria Coast of Queensland

The region supports a major component of the commercially important Northern Prawn Fishery, and a limited entry inshore finfish fishery involving 109 licensed operators with a total annual catch of about 1,100 tonnes, worth $5.7 million (QFMA 1998). The area of the inshore finfish fishery comprises all tidal waters in the Gulf of Carpentaria and adjoining waterways between the 25 nautical mile line and the shore.

There are no contemporary quantitative data on the incidental take of dugongs along the Queensland coast of the Gulf of Carpentaria. However, anecdotal information suggests that incidental captures were not uncommon in the late 1970s and early 1980s when the number of mesh-netters operating along the Queensland coast of the Gulf of Carpentaria (Garrett *pers comm*. 1998), and the fishing effort (Magro *et al*. 1996) were much higher than today. Concern persists about the incidental by-catch of protected species as reflected in the Draft Management Plan for the Inshore Finfishery (QFMA 1998). In addition,

there has been community concern about the by-catch of marine wildlife in nets set by boats fitted with power-assisted hauling devices.

Marsh *et al*. (1998) report data from the Queensland Fisheries Management Authority (QFMA) C-Fish Logbook Program, which indicates that in 1996 about 84% of netting effort (days fished) in the Queensland waters of the Gulf of Carpentaria (to 25 nautical miles offshore), occurred in inshore waters. Approximately 90% of this effort occurred along the coast between Weipa and Karumba. An average of 8.6% of the netting effort in Queensland waters of the Gulf of Carpentaria occurs in the Wellesley Island area, with 7.7% occurring in the region which supports the greatest numbers and highest densities of dugongs.

Indigenous Use and Hunting

Northern Coast (Daly River to Milingimbi)

There are few quantitative records of mortality associated with indigenous hunting. The four communities of the Tiwi Islands (Figure 6.2); Nguiu (population 1300), Milikapiti (population 450), Pirlangimpi (population 300) and Wurangkuwu (population 35) hunt dugongs mainly during turtle hunting trips. Most dugongs are caught around the Cape Gambier, Cape Hotham and Vernon Islands region. Yunanti and Quanipiri Bays located on the northeast tip of Melville Island (Figure 6.2) are known dugong breeding grounds, and are considered off limits to hunting by the Tiwi People. The Tiwi Land Council estimated that approximately one dugong a fortnight is taken (Hicks *pers comm*. 1999).

The Aboriginal people of northeast Arnhem Land, the Yolngu, are the traditional owners of lands consisting of about 8500km^2. Most Yolngu people reside at Elcho Island (Galiwin'ku) (Figure 6.2). The coastal-marine environment and resources (including dugongs) are an integral component of their economic and cultural identity. The Larrakia are the traditional owners of the Darwin region. A dugong dreaming site called Mamuruldjamul at Talc Head (ECNT 2001) signifies their important cultural and spiritual link with dugongs. The Larrakia are referred to as 'salt-water' people by the central Aboriginal tribes because of their link with the sea and their reliance on marine resources. Both the Yolngu and Larrakia hunt dugongs, however, information on this activity was lacking at the time of writing.

A recent decision by the High Court of Australia (*The Commonwealth* v *Yarmirr; Yarmirr* v *Northern Territory [2001] HCA 56 (11 October 2001) D7/2000 and D9/2000*) confirms that the indigenous people of the Croker Island region (Figure 6.2) hold Native Title over 3300km^2 of sea beyond the low water mark. Although these sea rights are not exclusive or commercial, the Native Title Tribunal announced that 120 Native Title applications around Australia can now proceed. This decision strengthens the rights of indigenous peoples to hunt in their sea country.

Gulf of Carpentaria Coast of the Northern Territory

Bertram and Bertram (1973) reported that an average of 62 dugongs were harvested per annum by the residents of the Numbulwar community at the mouth of the Rose River during the 1960s (Figure 6.2). In 1985, Bayliss and Freeland (1989) reported on the basis of interviews that residents had noted an apparent decrease in dugong abundance at this community, where the dugong harvest had dropped to approximately 10 per annum. It was not certain whether this apparent decrease in abundance was a result of a reduction in the dugong population from overhunting, limited hunting effort or a change in dugong behaviour.

Bradley (1997) recorded approximate dugong catches over a 70 year period by Yanyuwa indigenous hunters between the ages of 25 and 45 years around the Sir Edward Pellew Islands (Figure 6.2). This age range represents the peak period of a hunter's life. The data were collected from informal conversations with both men and women from local groups and from Bradley's own observations in the 1990s. The average number of dugongs caught per hunter per year was: in 1920, ten dugongs (total 450); in 1950, seven dugongs (total 135); in 1970, four dugongs (total 48); and in 1994, two dugongs (total 14) (Bradley 1997).

Anecdotal evidence (Monkivitch *pers comm*. 1998) suggests that dugong numbers around Groote Eylandt (Figure 6.2) have been reduced to zero from what used to be a large population. Despite this, dugongs are still a part of the regular diet of the people of Groote Eylandt. Hunters from this area reportedly travel to the mainland to hunt. Hunting parties of three to five individuals are alleged to take an aluminium boat to the mainland and remain there for a month of hunting. The meat is frozen and then sent back to the island to feed many people. There are no data about the dugong catch of other communities in this region, such as Yirrkala, Cambaringa and Ngukurr (Figure 6.2).

Gulf of Carpentaria Coast of Queensland

The residents of Mornington Island (Marsh *et al*. 1980) and coastal communities in the Wellesley Island region hunt dugongs (Figure 6.3). Two respondents to the

postal questionnaire distributed in 1974 by Anderson and Heinsohn (1978) variously reported an annual catch of 21-50 and 51-100 dugongs. Marsh *et al*. (1980) estimated that indigenous hunters at Mornington Island (Figure 6.3) killed about 40 dugongs per annum in the late 1970s, as recorded by a biologist who spent extensive periods residing on the island in 1976, 1977 and 1978. There are no data on the level of the current harvest by this community, and it is impossible to evaluate its likely sustainability.

Dugongs were not hunted traditionally along the western coast of Cape York (Chase 1981), and Heinsohn (1976) noted that dugongs were not being hunted by the residents of Kowanyama and Edward River (now Pormpuraaw) (Figure 6.3). However, there is anecdotal evidence that people resident in Weipa and Karumba hunted dugongs in the 1970s (Anderson & Heinsohn 1978; Marsh 1984), and that dugong meat was sold in Weipa South (Marsh 1984). By the 1990s, people from Weipa were travelling across Cape York to hunt dugongs in the region around Lockhart River, (Marsh & Corkeron 1996) and dugong meat was being illegally traded with non-indigenous residents of the area (Deirings 1993) (Figure 6.3). This information suggests that local indigenous peoples consider the likelihood of dugongs being hunted successfully in the Weipa region to be low, a result consistent with the aerial survey data.

Boat-related Impacts and Ecotourism

There are no data for the entire region, but impacts are generally expected to be low, except near the isolated sites of industrial development such as Darwin, Numbulwar, Groote Eylandt (Figure 6.2), Karumba and Weipa (Figure 6.3). The use of the Sir Edward Pellew Group of Islands as a tourist destination has caused a recent increase in boat traffic in the area. Dugong hunters from the Yanyuwa group believe that this increase in boat traffic in their sea country has fragmented the large herds of dugongs that used to occur in the region and alienated them from inshore seagrass beds. Furthermore, damage to seagrass beds by boat propellers is evident in some areas near river and creek mouths (Bradley 1997).

Other Mortalities

Dugongs are killed as a result of extreme climatic events in the Gulf of Carpentaria. A respondent to Anderson and Heinsohn's (1978) postal survey reported that between 11 and 20 dugong carcasses had washed up on the beaches at Mornington Island after the unusually heavy wet season in 1973-74. At least two dugongs were stranded at Mornington Island in 1977 by Cyclone Ted (Heinsohn & Marsh 1977). In March 1994, tropical cyclone Kathy crossed the Northern Territory coast in the southwest Gulf of Carpentaria, adjacent to the Sir Edward Pellew group of islands. An accompanying storm surge stranded large numbers of marine mammals, including dugongs, over an area of about 250km^2 (Marsh *et al*. 1986).

Existing Conservation Initiatives

Legislation

The dugong is protected in the Commonwealth waters in this region by the *Environment Protection and Biodiversity Conservation Act 1999*, in Northern Territory waters by the *Northern Territory Parks and Wildlife Conservation Act 2000* and in Queensland waters by the *Nature Conservation Act 1992*.

The indigenous take of dugongs in Northern Territory waters is exempt as prescribed under Section 122 of the *Northern Territory Parks and Wildlife Conservation Act*. This Act strengthened penalties for illegal take of protected wildlife such as dugongs. To meet the requirements of this Act, the Northern Territory Parks and Wildlife Commission has drafted a Dugong Management Program, which is scheduled to be released for public comment in 2001. The Program will outline the approach to dugong research and management in the Northern Territory for the next five years.

Research

The aerial surveys conducted above have been the major research initiative in the region. In addition, Dr Tony Preen caught several dugongs in the Borroloola area for satellite tracking. One animal travelled across to the Wellesley Islands area (Figure 6.3) (Preen 1995). Whiting (2001) reported on dugongs feeding on algae in Darwin harbour.

Management

Northern Coast (Daly River to Milingimbi)

Habitat Protection

Cobourg Marine Park has been declared by the Parks and Wildlife Commission of the Northern Territory under the *Cobourg Peninsula Aboriginal Land Sanctuary and Marine Park Act 2000*. The Marine Park management plan has no special provisions for the protection of dugongs, but relies on their status as protected wildlife under Northern Territory legislation. Another marine park

has been proposed for Beagle Gulf, which would include the mouth of the Darwin harbour. This is an area where dugongs are regularly seen (Whiting *pers comm*. 1999). The Parks and Wildlife Commission has a draft Strategy for Marine Protected Areas in the Northern Territory, but implementation is being delayed by indigenous land claims.

Fishery Interactions

The Northern Territory Fishing Industry Council released an information kit in mid-1997, which complemented and paralleled the 1996 strategy to minimise the incidental capture of dugongs in barramundi nets in the area inshore of the Sir Edward Pellew Islands. The information kit, distributed to every Northern Territory licensee, details species at risk, including dugongs. The kit outlines specific practices and precautions when fishing in dugong areas, and includes the overall risk that commercial fishing presents to threatened species.

Fishers intending to operate in Northern Territory commercial fisheries have to undergo a pre-nomination interview by the Fisheries Division, during which they are informed of their legal obligations and restrictions on the use of fishing gear. These fisheries also have a code of practice in place that addresses fishing practices and interactions with marine mammals. There are net mesh sizes, attendance and length restrictions for some fisheries. At this stage, coastal net fishers must be within 500m of their nets and restricted net fishers (mainly crab fishers fishing for bait) must be at the net. Other net fisheries are in the process of defining attendance requirements (Callogeras *pers comm*. 1998).

The Northern Prawn Fishery has made considerable efforts to close off all known areas of seagrass to prawn trawling (Anon. 1998). There has been a total ban on trawling and navigation in specific coastal waters, except in the specific transit corridors (Darwin Harbour and Fog Bay) from Point Blaze due west to a point 3 nautical miles offshore, continuing to Shoal Bay and waters within Port Essington (from Turtle Point and Cobourg Peninsula) (Figure 6.2).

Indigenous Management

Representatives from the Tiwi Land Council (TLC) who comprise the Tiwi Coastal Water Committee, manage their resources in conjunction with the Northern Territory Department of Fisheries and Primary Industries. The Tiwi people have acknowledged the need for a consultative system of management with the Northern Territory government and are hopeful that resources will be provided for training of indigenous people to co-manage the extensive coastline.

Gulf of Carpentaria Coast of the Northern Territory

Habitat Protection

There are currently no marine parks or sanctuary areas in the Gulf of Carpentaria coast of the Northern Territory.

Fishery Interactions

The Northern Land Council and the Northern Territory Fishing Industry Council jointly released a strategy in October 1996, to minimise accidental capture of dugongs in barramundi nets. The strategy applies to the area from Bing Bong Creek to Pelican Spit along the coast adjacent to the Sir Edward Pellew Island Group (Figure 6.2). Strategies included the protection of parts of a well-known seagrass feeding area in the region of the McArthur River mouth. Fishing practices to minimise their interaction by prohibiting the use of nets in and around the mouth of the McArthur River and the Sir Edward Pellew Islands (termed Port McArthur) have been introduced. The use of bait nets is prohibited in the area extending from Bing Bong to the Queensland border, including the Sir Edward Pellew Islands. Limited coastal net fishing activity occurs in this region with 3-4 barramundi fishers in operation.

Bait net fishers are required to attend their nets at all times and must ensure the net is cleared and the catch sorted in no less than 30cm of water. Coastal net fishers are required to remain within 500m of their net at all times and to sort their catch in the same manner as bait net fishers. The Shark Fishery has instigated a three for one license reduction scheme, which came into force in 1998. Furthermore, shark nets are prohibited within 2nm of the low water mark. This is intended to minimise interactions with dugongs.

The Northern Prawn Fishery has closed off specific areas to prawn trawling in the Gulf of Carpentaria (Anon. 1998). These areas include

1. waters within Caledon Bay inside Point Alexander and the point north east of Mt. Caledon
2. specific coastal waters from Cape Shield to Connexion Island, then south-westerly to the point 14°30'S latitude and 136°E longitude, then west to a point 2 nautical miles offshore and continuing south and south-easterly to West Island (Sir Edward Pellew Group)
3. waters in five areas around Groote Eylandt
4. waters within Arnhem Bay inside a line running from Cape Newbald to Flinders Point
5. waters surrounding the Sir Edward Pellew Group.

Gulf of Carpentaria Coast of Queensland

Habitat Protection

A marine park has been proposed for the waters around the Wellesley Islands in view of their high conservation value.

Fishery Interactions

In 1977, in recognition of the cultural and social needs of other resource users, 17 of the Gulf's 27 rivers in Queensland were partially closed to mesh netting. Extensions of the existing closures have been implemented in addition to the closure of waters at Port Musgrave to set mesh nets (QFMA 1999). One of the reasons why there is a closure at the mouth of the Norman River is to protect dugongs (QFMA 1998). The inshore finfish fishery is also closed from October through January each year to protect barramundi stocks. Although there are no marine parks in the Queensland waters of the Gulf of Carpentaria, the benthos is protected by the following Fisheries Habitat Areas: Eight Mile Creek, Morning Inlet-Bynoe River, Staaten-Gilbert and Nassau River (Figure 6.3).

Net attendance requirements legislated in the *Queensland Gulf of Carpentaria Inshore Finfish Fishery Management Plan 1999,* state that a person using nets in inshore fishery areas, rivers and creeks must be within five nautical miles of the net; for foreshore nets a person must be within six nautical miles, and for offshore nets, a net attendance of 100m is required.

The Northern Prawn Fishery (NPF) has closed specific areas to prawn trawling in the Gulf of Carpentaria (Anon. 1998). These areas include

- from Bundella Creek on the mainland to Gee Wee Point (Mornington Is.) along the southern shore of Mornington Is. to Cape Van Dieman, southwest to Raft Point (Bentinck Is.) to the mainland at Tarrant Point and around the shoreline to Bundella Creek (Figure 6.3)
- from Cape Van Dieman to Pisonia Island, northwest to Mudgun Point (Linguanguanje Is.), then along the 2 nautical mile line northwest, west and southwesterly to Longitude 139°28', south to the shoreline, and east and southeasterly to the commencement at Cape Van Dieman (Figure 6.3).

There is an exempt transit corridor between Mornington and Bentinck Islands in this region.

Suggested Conservation Initiatives

Research

1. The most important areas for dugongs in the Northern Territory need to be identified at a local scale and publicised as a basis for negotiations with the indigenous peoples who own 86% of the coastline.
2. Monitoring dugong distribution and abundance should be undertaken using aerial surveys replicated at appropriate intervals. Aerial surveys should include waters from Cape Londonderry in Western Australia to Daly River in the Northern Territory in order to obtain baseline data for this data-deficient area. Co-ordination of aerial surveys of the Gulf of Carpentaria between Western Australia and the Northern Territory, and also Queensland and the Northern Territory would be highly desirable as dugongs are known to cross jurisdictional boundaries in this region. This quantitative information would benefit from research on the state of the dugong habitats.
3. Research programs should be established to collect and/or collate data on the take of dugongs by commercial and recreational fishing activities and indigenous hunters. These data should include (for each fishery)
   a) number and fate of animals caught
   b) data and circumstances of catch
   c) size and sex of animals caught.
4. Detailed studies on the extent and range of dugong movements, and habitat use in key regions should be conducted to determine the appropriateness of management measures in specific locations. These studies and subsequent management measures could be implemented by
   - satellite tracking individual dugongs
   - an analysis of dugong sightings from aerial surveillance flights.
5. Seagrass monitoring, including effects of trawling on seagrass communities, should be carried out following the recommendations developed by Butler and Jernakoff (1999).
6. As Australia and Indonesia share the Arafura Sea, they should consider conducting joint surveys of marine mammals in this region (see Figure 4.12, page 75).

Management

Northern Territory

Habitat protection

We suggest that the Parks and Wildlife Commission of the Northern Territory upgrade habitat protection where appropriate in consultation with relevant indigenous peoples. We further recommend the inclusion of any impacts on dugong populations in Environmental Impact Assessments on proposed coastal developments in the region.

Fishery interactions

We suggest the Northern Territory Fisheries Industry Council and the Northern Territory Department of Primary Industry and Fisheries incorporate a specific endangered species awareness module into fishing industry training courses. Such education programs may need to address cultural sensitivities. Such a program could include workshops on dugong conservation biology and fishing methods, and could be run by the industry associations, the Fisheries Industry Training Council, and appropriate government agencies.

Indigenous management

Mechanisms to empower indigenous peoples to manage their traditional harvesting should be negotiated in centres where there are significant numbers of indigenous people who wish to hunt dugongs and turtles. Effective cooperative management will require the development of a long-term strategy for the training, career structure and resourcing of indigenous community rangers, so that they can participate effectively in dugong management and research programs as well as playing an increasingly important role in managing their lands (Anon. 1996a). Legal mechanisms should also be investigated to enable management powers to be divided to local indigenous communities.

The Dhimurru Land Management Aboriginal Corporation based at Yirrkala is a Yolngu peoples organisation involved in management of the natural resources within the homelands of the constituent groups. They have a focus project called Miyapunu "sea meat", which was inititated by Yolngu elder, Kjalalingpa Yunupingu who noted a decline in marine turtles (Prince *pers comm.* 2001). By combining traditional and contemporary Aboriginal knowledge with non-Aboriginal data and research methods the project improves Yolngu understanding of Miyapunu distribution and ecology in the region to quantify the harvest of Miyapunu, and to record traditional management practices. Although the group focuses on turtles, the potential for collation of similar information on dugongs within this project should be investigated.

Gulf of Carpentaria Coast of Queensland

Habitat protection

The declaration of the area along the coast from the mouth of the Albert River to the mouth of Arthur's Creek (west of Bayley Point) and north to latitude 16° 20'S as an Indigenous Protected Area, would provide a structure for the community-based management of the dugong and green turtle catch. This area is currently under Native Title Claim, and the arrangement could be achieved by agreement between the traditional owners and the state. This initiative would be a significant step in protecting dugongs in Queensland waters of the Gulf of Carpentaria, as this area consistently supports high numbers of dugongs (i.e. 62% of the 4,266 animals along the Queensland coast of the Gulf of Carpentaria in December 1997).

Indigenous management

Declaring an Indigenous Protected Area in the Wellesley Island region would also assist in formally recognising the special significance of the dugong and green turtle to Aborigines living in Gulf communities, especially Mornington Island. Strategies to regulate traditional hunting must consider green turtles as well as dugongs, as the two species are hunted together using the same technique (Marsh 1996). Effective cooperative management regimes will require the development of a long-term strategy for the training, career structure and resourcing of indigenous community rangers. This initiative is necessary if indigenous Australians are to participate effectively in dugong and sea turtle management and research programs, as well as playing an increasingly important role in managing their land and sea country (Anon. 1996a). This approach is consistent with the Oceans Policy (Environment Australia 1998).

Fishery interactions

Given that more than 60% of dugongs in the Queensland waters of the Gulf of Carpentaria occur in the Wellesley Islands area, establishing an Indigenous Protected Area in which commercial netting is banned as outlined above, should significantly reduce the effects of fishing on protected wildlife. Closing this most important area for marine wildlife to netting would be a significant step towards meeting the objective of the QFMA Draft Management Plan for the inshore Finfish Fishery of the Gulf of Carpentaria, 'to minimise the effects of fishing on protected wildlife' (QFMA 1998).

Fishing practices throughout the Queensland waters of the Gulf of Carpentaria need to be modified in close consultation with local fishers, with the aim of reducing the incidence of dugong and other marine wildlife drowning in gill nets. We suggest:

- Compulsory participation in Queensland Commercial Fishing Organisation's Endangered Species Awareness Course. Since the course commenced in Karumba in May 1998 there have been more than 50 participants. Because of the remoteness of the area, enforcement capacity is limited and thus education is vital.
- A requirement for all vessels operating in the Gulf of Carpentaria inshore finfish fishery to complete a dugong sighting log and return it to the Queensland Fisheries Service, with a view to developing a chart to inform fishers about dugong distribution in the Gulf.
- Development of a chart detailing the distribution of seagrass beds to allow fishers to identify potential dugong areas.
- An observer program for the net fisheries to monitor catches.
- A formal requirement that any incidents involving protected species be formally reviewed each year at the October meeting of the Karumba Branch of the Queensland Seafood Industry Council .
- A penalty for failing to record incidental catches. We suggest that such a failure should be a serious fisheries offence under the *Queensland Fisheries Regulation 1995*. It is a legal requirement under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* to report the incidental death of a dugong in Commonwealth waters in Australia.
- Modifications to the attendance at net rules to minimise the incidental capture of marine wildlife. The difference between the net attendance for the inshore net fishery in the Queensland waters of the Gulf of Carpentaria (5 nautical miles), and the distance presently adopted in the same fishery in the Northern Territory (500m) is striking.
- Modifications to the net specifications to minimise the incidental capture of protected wildlife.
- Development of 'dugong friendly' alternatives to gill netting for inshore fisheries.

Conclusions

- Dugongs occur all along the Northern Territory coast in reasonable numbers. The area between the mouth of the Limmen Bight River and the Sir Edward Pellew Islands is the most important dugong area in the Northern Territory, and the fourth most important dugong habitat in Australia.
- The Wellesley Islands are the most important dugong habitat in Queensland apart from Torres Strait and Princess Charlotte Bay.
- The status of dugongs along this entire coast is unknown.
- Mesh netting, habitat destruction by natural events such as floods and cyclones, and traditional hunting are the main sources of dugong mortality in this region.
- Human-induced impacts are generally expected to be low in this region. The risk of heavy metal pollution from port facilities is of concern. However, the regions in the estuaries associated with the major ports of Weipa and Karumba are not particularly important dugong habitats.

TORRES STRAIT AND NORTHERN GREAT BARRIER REEF

The region discussed in this section includes Torres Strait between Australia and Papua New Guinea (Figure 6.4), and the waters of the Great Barrier Reef region between Hunter Point and Cape Bedford (Figure 6.5). In the Australian waters of Torres Strait, the dugong is managed by the Australian Fisheries Management Authority (AFMA). The Great Barrier Reef region is within the Great Barrier Reef World Heritage Area and is managed jointly by the Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Parks and Wildlife Service (QPWS). The entire region is remote with a very low human population density.

Distribution and Abundance

Torres Strait

Torres Strait is the most important dugong habitat in the world. The Australian and some of the Papua New Guinean waters of Torres Strait (Figure 6.4) were quantitatively surveyed using modern techniques in November 1987, February 1988, November-December 1991 and November 1996. These surveys do not represent all the dugong habitat in Torres Strait, as the survey area is limited by the endurance of the aircraft and the political boundary with Papua Barat (formerly Irian Jaya). It is likely that there is extensive dugong habitat in the adjacent coastal waters of Papua Barat. Dugong density was highest in the seagrass beds around Badu, and extending north across Orman Reef around Buru Island (Turnagain Is. on most maps) and east to Gabba Island (Figure 6.4). The minimum dugong population estimates for the region were 13,319 (± s.e. 2,136) in 1987, 24,225 (± s.e. 3,276) in 1991 and 27,881 (± s.e. 3,216) in 1996. Population estimates for 1987, 1991 and 1996 differed significantly. *Post-hoc* comparisons showed that the significant differences were between 1987 and 1991, and 1987 and 1996. Marsh *et al*. (1997a and b) consider that the most likely explanation for the observed difference between surveys is that dugongs moved into the survey area between 1987 and 1991, probably from the adjacent coastal waters of Papua Barat.

Northern Great Barrier Reef Region (Hunter Point to Cape Bedford near Cooktown)

This region (Figure 6.5) was surveyed in 1985, 1990, 1995 and 2000 using quantitative survey techniques. There were minor differences in the survey designs. These were accounted for in statistical comparisons between surveys. The resultant minimum population estimates were 8,110 (± s.e. 1,037) in 1985, 10,471 (± s.e. 1,578) in 1990, 8,190 (± s.e. 1,172) in 1995, and 9,436 (± s.e. 1,053) in 2000. The differences in dugong densities between surveys were not significant. However the dugongs were distributed differently in some surveys. For example in 1995, the highest numbers of dugongs were in Bathurst Bay and Princess Charlotte Bay (Figure 6.5). This region accounted for almost half the dugongs in the survey area. In 2000 there were far fewer animals in Princess Charlotte Bay and more animals in the region between Lookout Point and Cape Melville, a consistently important dugong area (Marsh & Lawler *unpublished data*) (Figure 6.5).

Dugongs tend to occur in inshore waters throughout the region. Dugongs have also been sighted on some midshelf reefs. Extensive deepwater seagrass meadows are also important to dugongs in the northern Great Barrier Reef, especially in the area between Lookout Point and Barron Point (Lee Long *et al*. 1993; Coles *et al*. 1995) (Figure 6.5). Seagrasses have been found to depths of 58m in the Cairns and Far North Sections (Lee Long *et al*. 1996). Dugong feeding trails have been recorded to depths of 33m (Lee Long *et al*. 1996).

This region is the most important dugong habitat within the Great Barrier Reef Marine Park, and is one of the most important in Australia. These surveys suggest that dugong numbers are being maintained in this area. However, the survey techniques employed are appropriate only for depicting macro-scale trends and cannot accurately detect changes on a local spatial scale. For instance, it would be inappropriate to use these macro-scale aerial survey techniques to provide definitive evaluations of changes in dugong populations in the areas that are used for hunting by the Hope Vale and Lockhart River communities (Figure 6.5).

Threatening Processes

Habitat Loss and Degradation

Torres Strait

Anecdotal reports (Johannes & MacFarlane 1991) suggest that there was a major dieback of seagrasses in Torres Strait in the mid-1970s. The cause of this dieback has not been confirmed; the Islanders blame the "Oceanic Grandeur" oil spill and the resultant use of dispersants.

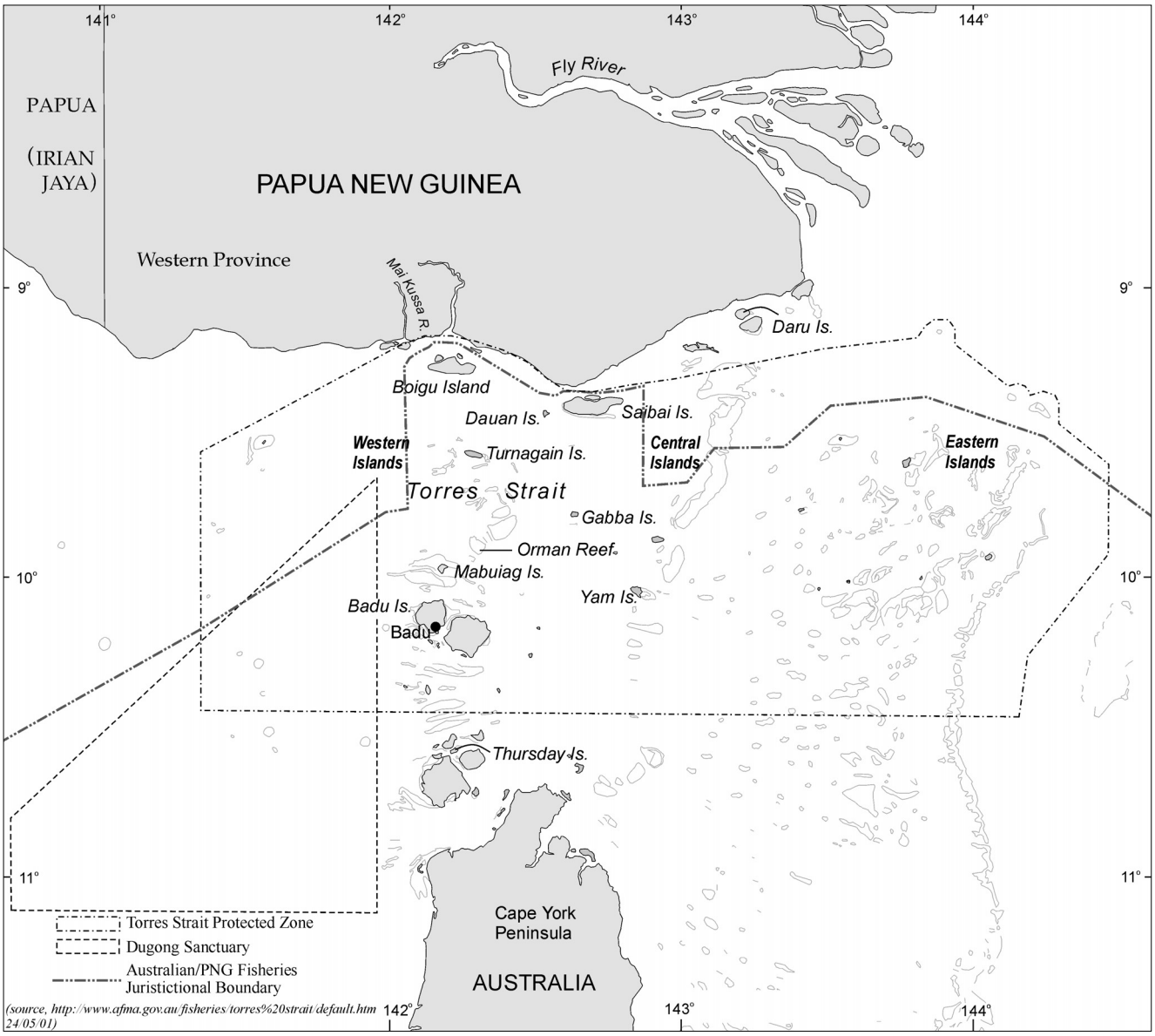


Figure 6.4 – Torres Strait showing place names and legal boundaries mentioned in the text.

Some scientists have disputed this conclusion (see Johannes & MacFarlane 1991). Nietschmann and Nietschmann (1981) observed that *wati dangal* (lean dugongs with poor-tasting meat) were quite common in Torres Strait during this period. The proportion of both adult male and female dugongs passing through the Daru market that had active gonads was very low in the late 1970s, but increased in the early 1980s (Marsh 1995a). Fecundity was extremely low over this period, and this gap in recruitment was still reflected in the age composition of dugongs hunted in the Western Islands of Torres Strait in 1997-99 (Kwan *unpublished data*). The proportion of pregnant females sold in Daru increased significantly between 1978-82 (Marsh 1995b). The number of males with active testes also increased, suggesting that a common factor was affecting reproductive activity during this period (Marsh 1995b). The seagrass dieback and subsequent recovery is a plausible, but unproven cause of these changes in dugong condition.

The CSIRO Division of Marine Research, which monitors the status of seagrass in Torres Strait, documented another extensive seagrass dieback along their lobster transects north of Buru Island in 1991-92. The dieback has been linked with high water turbidity resulting from the flooding of the Mai Kussa River in Papua New Guinea (Poiner & Peterken 1996) (Figure 6.4). There has been no recent formal re-assessment of the status of seagrass in Torres Strait.

This is a remote area where anthropogenic impacts on seagrass are generally expected to be slight. However, there is concern that changing land-use activities such as

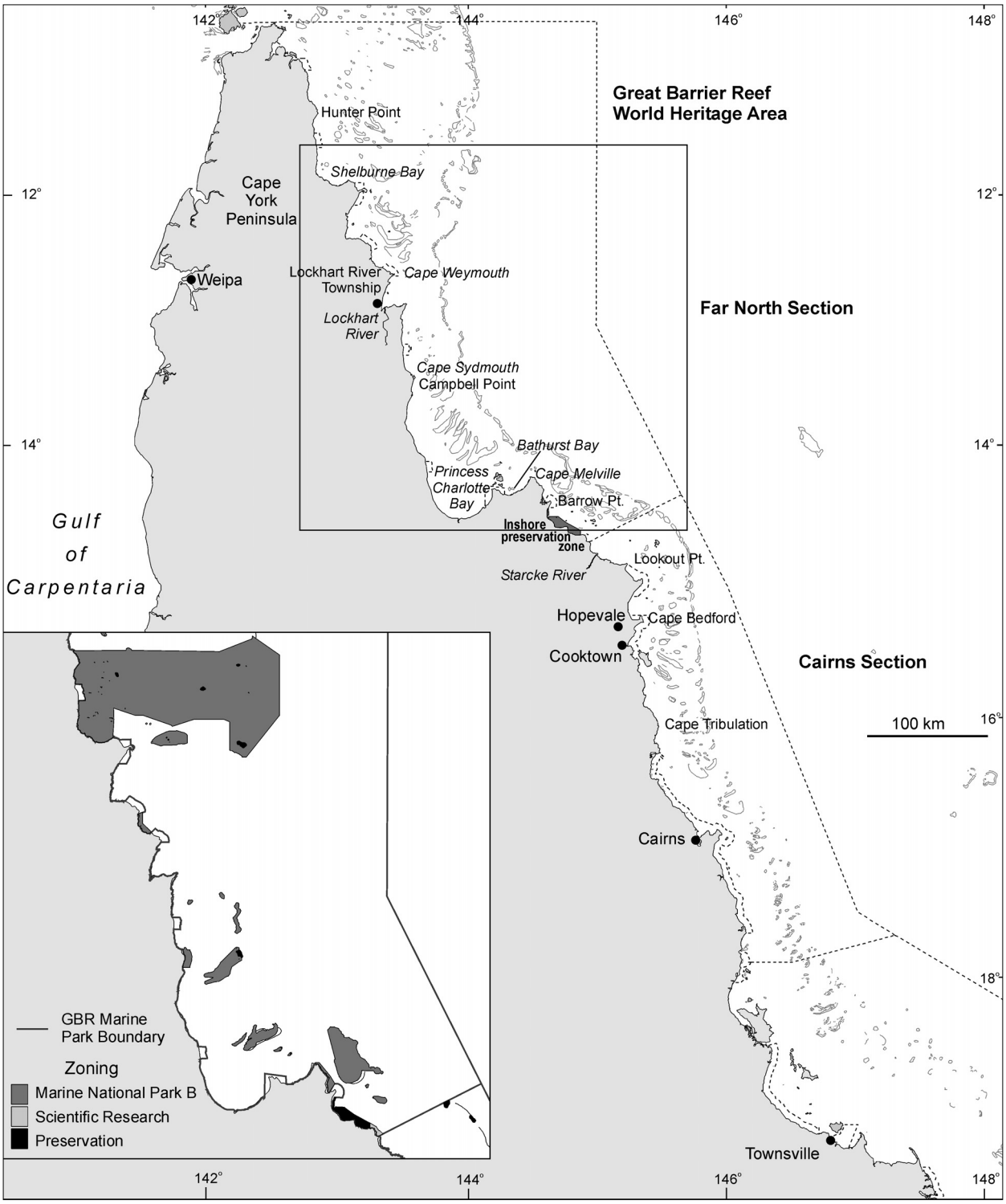


Figure 6.5 – The northern section of the Great Barrier Reef World Heritage Area, Australia, showing place names mentioned in the text and areas zoned to protect dugongs.

The area covered in this section of the Plan extends as far south as Cooktown. This zoning is currently being amended by the GBRMPA. The amendments are likely to increase dugong protection.

development of forestry industries, and introduction of palm oil plantations, particularly in south-western Papua New Guinea, may impact seagrass beds in this area. There are a number of major river systems that flow into the waters of Torres Strait from Papua New Guinea. The Fly River is the largest of these, but the sediments from this river apparently do not influence Torres Strait. The results of the Torres Strait Baseline Study (Dight & Gladstone

1993) suggest that most of the sediment from the Fly River Delta is deposited close to the Papuan coast (see Chapter 5), away from the most important dugong areas. The Baseline Study also measured heavy metal concentrations in muscle, fat and in various organs of dugongs. The Baseline Study reported that the concentrations of cadmium, arsenic and selenium in dugongs in Torres Strait exceeded the guidelines set by the National Medical Research Council for foods such as beef. This information was understandably of great concern to the Islanders. However, these levels are unlikely to reflect anthropogenic influences, and are more likely to reflect natural heavy metal levels in the seagrasses (Mauger 1997), especially as high levels of several metals including cadmium have been recorded in dugongs from other areas (Townsville and Mornington Island) in the 1970s (Denton *et al.* 1980). Denton *et al.* (1980) did not test for arsenic or selenium. A follow up monitoring program to assess heavy metals in dugongs is currently in process (Wright *pers comm.* 2001).

The overall impact on dugongs from the natural gas pipeline (Papua New Guinea Gas Project) proposed for the Torres Strait region is expected to be low. This project involves a pipeline laid on the ocean floor across Torres Strait. Although the future of this project remains uncertain, the impacts are of concern to local people. Disturbance during installation of the pipelines may trigger erosional processes and have continuing effects on local current flow and sediment distribution, posing a potential threat to seagrass.

An issue of greater concern is the pending re-evaluation of the Mining Moratorium for Torres Strait, which was instituted under the Torres Strait Treaty 1985 between Australia and Papua New Guinea. This seven-year moratorium is due for renewal in 2003, subject to negotiations between the Australian and Papua New Guinean governments. If the moratorium is not renewed, there is potential for the area to be opened up to mining exploration. Exploration for resources such as hydrocarbons may result in direct impacts to habitat, and dugongs. There has been little relevant research on the acoustic impacts of mining exploration on dugongs in shallow tropical waters. It is likely that any acoustic exploration survey would cover a large area, including important dugong habitat areas in western Torres Strait (Dews *pers comm.* 2001).

Northern Great Barrier Reef Region

This region has by far the largest areas of seagrass in the Great Barrier Reef. In 1989 approximately 1500km^2 of predominantly "deep-water" seagrass habitat (>15m) were mapped between Lookout Point and Barrow Point (Lee Long *et al.* 1989) (Figure 6.5). This area coincides with one of the largest populations of dugongs on the eastern Queensland coast (Marsh & Saalfeld 1989). In November 1994, surveys carried out between Cape Tribulation and Cape Weymouth found that the region supports an estimated 2000km^2 of deepwater seagrass (Coles *et al.* 1995). Most seagrass beds are remote and are subject to little human influence (Morissette 1992).

Fishing Pressure

Torres Strait

There is anecdotal evidence of some dugong mortality from incidental drowning in nets from Indonesian and Taiwanese vessels operating illegally in this region. There have been reports of incidental or deliberate catches of dugongs in nets in waters in the Papua New Guines sector of the "Protected Zone" and Boigu and Saibai Islands (Figure 6.4).

Northern Great Barrier Reef Region

There are no data on the number of dugongs drowned in mesh nets set by commercial fishers in this region. Dugongs are also allegedly caught in nets set by unlicensed fishers in the northern Great Barrier Reef region. Aboriginal communities in the region have been raising these concerns for many years (e.g. Anon. 1996a). Although many important dugong areas in the Great Barrier Reef Marine Park have been closed to fishing, gill netting persists in adjacent intertidal waters under the control of Queensland.

Indigenous Use and Hunting

Torres Strait

There has been disquiet about the sustainability of Indigenous dugong catches by communities of Torres Strait since the early 1980s (see Johannes & MacFarlane 1991; Hudson 1986; Marsh 1986; Marsh *et al.* 1997a and b). Of particular concern is the increase in the availability of outboard-powered boats, which might be expected to improve the effective hunting effort. There is no evidence to support or refute this assertion. Hunters report that while powered boats extend their hunting range, the boats are noisy and make approaching animals more difficult (Harris *et al.* 1991; Johannes & MacFarlane 1991).

The data of Marsh *et al.* (1997a and b) indicate that, in the "Protected Zone" established by the Torres Strait Treaty 1985 between Australia and Papua New Guinea (Figure 6.4), most dugongs are now caught by hunters from the Western Islands (particularly Mabuiag and Badu) and Top Western Islands (especially Boigu) on dedicated hunting expeditions. Residents of the Central Islands hunt

smaller numbers of dugongs, with Yam having the highest catch. Virtually no dugongs have been recorded as being caught by residents of the Eastern Islands (Figure 6.4).

On an average day in the "Protected Zone" in 1991-1993, four boats landed 645 (± s.e. 102) kg of dugong. Most animals were greater than 170cm long (Harris *et al.* 1994), which suggested that hunters were avoiding suckling calves (Marsh *et al.* 1984c). Illegal hunting of dugongs for commercial purposes has also been reported (Johannes & MacFarlane 1991).

The results of Harris *et al.'s* (1994) monitoring suggest that there is substantial inter-annual variation in the catch of dugongs (but not turtles). The catches recorded in 1991-1993 were the highest on record and contrast with earlier fears (e.g. Johannes & MacFarlane 1991) that catches were declining. The size of the catch in the "Protected Zone" is probably dependent on the spatial distribution of dugongs within Torres Strait. It is interesting to note that the high catches recorded by Harris *et al.* (1994) paralleled the increase in dugong numbers recorded by Marsh *et al.* (1997a and b) in their aerial surveys in 1987 and 1991.

The average annual catch between June 1991 and May 1993 was equivalent to 1,226 (± s.e. 204) dugongs (Marsh *et al.* 1997b). The 1994 catch was estimated to be 860 (± s.e. 241) animals (Harris *et al.* 1994). However, the total catch must have been higher than this, as the data do not include the catch from Australian communities south of the Protected Zone (estimated to be 283 in 1996; Bishop *pers comm.* 1997) or Papua New Guinea. It is impossible to evaluate the situation more accurately without information on

- absolute estimates of dugong numbers (research currently being conducted)
- current life history statistics for dugongs in Torres Strait (research currently being conducted)
- catch monitoring throughout Torres Strait (research currently being conducted)
- catch statistics for Papua New Guinea and northern Cape York Peninsula communities
- catch statistics and estimates of dugong numbers in adjacent Indonesian waters.

Nonetheless, current estimates of dugong populations and harvest suggest that the present level of dugong harvesting may not be sustainable in Torres Strait. The mean estimate of the annual dugong catch in Torres Strait for 1991-1994 is approximately 5% of the mean estimate of the dugong population size in 1991. In 1997, on the basis of available estimates of the dugong population, life history parameters and harvest, the Torres Strait Fisheries Scientific Advisory Committee advised that it believed the level of dugong harvesting in Torres Strait to be unsustainable.

Northern Great Barrier Reef Region

Residents of Hope Vale and Lockhart River (Figure 6.5) (Smith & Marsh 1990) and the five communities in the Northern Peninsula Area hunt in this region (Roberts *et al.* 1996; Phelan *pers comm.* 2000). There are few up to date statistics on their dugong catch. Residents from Weipa on the western coast of the Cape York region also use the area to hunt on occasion (Marsh & Corkeron 1996). Weather and the small size of the boats used, limit the spatial extent of dugong hunting in this region. Extensive travel to hunting grounds is generally limited by road access.

Boat-related Impacts and Ecotourism

There is no information available for this area regarding boat-related or ecotourism impacts on dugongs. However, they are likely to be low given the remoteness of the area.

Existing Conservation Initiatives

Legislation

Torres Strait

In 1985, Australia and Papua New Guinea signed the Torres Strait Treaty to resolve the maritime boundaries in this region, and to protect the way of life and livelihood of its traditional inhabitants. The Treaty established the Torres Strait Protected Zone (Figure 6.4), within which each country exercises sovereign rights for marine life according to agreed jurisdictions, and a process of cooperation and consultation between the two countries. The traditional fishery in Australian waters of the Torres Strait Protected Zone is managed by the Torres Strait Protected Zone Joint Authority under the *Torres Strait Fisheries Act 1984*.

Torres Strait and the Northern Great Barrier Reef Region

The dugong is protected under the *Environment Protection and Biodiversity Conservation Act Commonwealth 1999* and the *Nature Conservation Act Queensland 1992*.

Research

Torres Strait

The Australian Fisheries Management Authority has funded the following research with the overall objective

of evaluating the sustainability of the indigenous catch of dugongs in Torres Strait. The objectives of the various projects are

1. to determine the stock structure of dugongs (see Tikel 1998)
2. to estimate trends in dugong catches (Harris *et al.* 1994; Dews 1995; Marsh *et al.* 1997a and b)
3. to estimate dugong abundance using aerial surveys (Marsh & Saalfeld 1991; Marsh *et al.* 1997a)
4. to improve methods of estimating dugong abundance (Postal *in progress*)
5. to revise life history parameters to be incorporated into population models to predict the natural rate of change in the size of the population (Kwan *in progress*).

Northern Great Barrier Reef Region

In 1984, 1985, 1990, 1996 and 2000 dugongs were counted during aerial surveys of the inshore waters between Cape Bedford and Hunter Point (Marsh & Corkeron 1996). Satellite tracking of dugongs has been conducted to obtain information on their movements and habitat use (Marsh & Rathbun 1990; Preen 2001). Smith (1987) conducted a detailed ethnobiological study of the attitudes to western biology and resource management of indigenous communities in the northern section of the Great Barrier Reef. He also reviewed the effectiveness of current management arrangements, and options for incorporating Aboriginal knowledge and understanding into such arrangements (also see Smith & Marsh 1990).

The Great Barrier Reef Marine Park Authority has developed a Dugong Research Strategy, which contains a prioritised plan for dugong research and monitoring in the Great Barrier Reef World Heritage Area (Oliver & Berkelmans 1999). A research project is underway involving collaboration between scientists (Marsh, Lawler, Nursey-Bray & Pollock), management (GBRMPA) and indigenous representatives (traditional owners and Hope Vale Aboriginal Council), to assist indigenous communities and natural resource management agencies to develop community-based management of dugongs with the Hope Vale Aboriginal Community near Cooktown. This project is

- assisting the community to document Aboriginal knowledge of dugong ecology and behaviour and to present it back in a form accessible to the community
- developing methodology to estimate the absolute abundance of dugongs to enable the calculation of a robust estimate of a sustainable annual catch.

This information is being used to inform the plan to manage dugong hunting, which has been developed jointly by the Hope Vale community and the relevant management agencies. This project will provide an example of a dugong management strategy that could be considered by other communities.

Management

Torres Strait

A segment of the Torres Strait Protected Zone and adjacent area was designated as a dugong sanctuary, in which all hunting of dugong was nominally banned from 1985 (Figure 6.4). However, the limited capacity for surveillance and enforcement, the isolation of much of the sanctuary area, and the low density of dugongs have raised questions about the efficacy of the sanctuary as a component of management for dugongs in the region. Dugong hunting in the Torres Strait Protected Zone and adjacent areas is limited to traditional inhabitants only. In 1995, the Torres Strait Protected Zone Joint Authority implemented a ban on hunting methods other than use of the traditional wap or spear. This was mainly to address the problem of fishers from Papua New Guinea netting dugongs in Australian waters around Saibai and Dauan Islands. There are currently no other limits on hunting effort, numbers of hunters or catch of dugongs.

A CSIRO program monitored the marine catch of communities in the Australian Sector of the Protected Zone between June 1991 and May 1993 (Harris *et al.* 1994; Dews 1995). The program trained Islander observers to monitor the marine catch with the aim of detecting changes in the fishing pattern, catch and levels of seafood use in the "Protected Zone". The Australian Fisheries Management Authority has continued this program in collaboration with CSIRO since December 1993.

The Australian Fisheries Management Authority (AFMA) is a member of the Australia-Papua New Guinea Torres Strait Environmental Management Committee, which reviews the progress of dugong and turtle management programs in Torres Strait. AFMA staff take an active role in dugong conservation and management. They conduct an education program for school children in the Australian Sector of the "Protected Zone", the Thursday Island area and northern Cape York Peninsula (Figure 6.4). Islander officers teach the children about the life cycle of dugongs and turtles, and the need for a conservative approach to their harvesting. The children also collect dugong and turtle catch data using calendars and stickers. The main emphasis of this program is to educate future hunters on turtle and dugong biology. Similar education of adult hunters occurs through community meetings, and a weekly fisheries radio program. The Australian Fisheries Management Authority has prepared videos, posters, books and other material on dugong and turtle conservation in Torres Strait.

In December 1996, a fisheries officer from Papua New Guinea's Western Province was trained in the technique used by the Australian Fisheries Management Authority used to monitor community catches. The training was conducted in Torres Strait by the Australian Fisheries Management Authority and the marine strategy coordinator for the Island Coordinating Council. The aim was to commence a similar catch-monitoring program in the coastal villages of the Western Province in 1997. However, this monitoring program has not commenced in Papua New Guinea to date because of a lack of financial support.

In September 1997, the Torres Strait Fisheries Management Committee recommended to the Protected Zone Joint Authority that a community-based management strategy be developed, to ensure that traditional hunting of dugongs and turtles in the Torres Strait is sustainable. A workshop "Towards Community Based Management of Dugongs and Turtles in Torres Strait" was held on Thursday Island in June 1998 bringing together Torres Strait elders, hunters, community chairpersons, scientists, fisheries managers and representatives from the Queensland and Commonwealth environment departments and the Great Barrier Reef Marine Park Authority. The workshop affirmed the special role of dugongs and turtles as inherent in the cultural practices of Torres Strait Islanders. The following vision statement was developed and agreed by the workshop:

> *Effective community based management of dugongs and turtles conducted in a way which maintains Ailan Kastom and ensures the long term survival of these species as an essential component of Torres Strait culture, identity and sea life.*

To ensure dugongs and turtles are in abundance for future generations, the workshop identified the following needs:

- community rangers or others with equivalent roles;
- elder guidance in the maintenance of traditional practices, and
- provision of resources and management links with relevant government agencies and neighbours like Papua New Guinea and Papua Barat.

The need for community-based management of dugongs and turtles was discussed and agreed on by leaders of Australian and Papua New Guinea communities at the Australia-Papua New Guinea annual traditional inhabitants' meeting in August 1998. In 1998, the Australian Fisheries Management Authority also discussed this issue with the Papua New Guinea National Fisheries Authority at the annual Treaty Liaison Meeting. The need for complementary community-based management on both sides of the Torres Strait border was discussed further at the annual Australia-Papua New Guinea Torres Strait Environmental Management Committee, and the high level Torres Strait Joint Advisory Council meetings in October 1998.

Concern over the lack of information available to indigenous communities on the levels of heavy metals and cadmium in parts of the meat, fat and organs of dugongs, and the effect this may have on their health (AFMA *pers comm*. 1996) prompted a poster campaign. This campaign warned indigenous communities about the possible health risks of eating internal organs of dugongs and turtles (Queensland Tropical Public Health Unit *pers comm*. 1998).

Northern Great Barrier Reef Region

Habitat Protection

The protection of inshore dugong habitats in this region is generally high, and is likely to be improved as a result of current rezoning initiatives by the Great Barrier Reef Marine Park Authority. The region also contains a large inshore "Preservation Zone" designed to protect dugong habitat. Extractive activities are banned from this region and entry by people is strictly controlled.

Permanent trawling strip closures in seagrass habitats are implemented under the Queensland Fisheries Regulations 1995 and marine park zoning. Trawlers are fitted with Vessel Monitoring Systems that use satellites to track their movements in this remote area. This technology increases compliance.

Fishery Interactions

Within the Great Barrier Reef Marine Park, commercial net fishing has been prohibited or restricted from several areas for which dugong protection has been part of the rationale for zoning. These areas (Figure 6.5) include the Inshore Preservation (no take) Zone south of Cape Melville and offshore between Shelburne Bay in the north and Lookout Point to the south; the Marine National Park 'B' Zone including the Shelburne Bay region, Cape Melville and smaller areas scattered beetween Shelburne Bay and Lookout Point; and the Scientific Research Zone immediately south of the Inshore Preservation Zone south of Cape Melville (see GBRMPA 1985). The Great Barrier Reef Marine Park is currently being rezoned through the Representative Areas Program. This is expected to result in an increased proportion of seagrass habitats being incorporated into highly protected areas. In addition, attendance at net rules are being strengthened for commercial net fishers, an initiative which should reduce dugong by-catch. However, there is an urgent need for complimentary zoning in the intertidal water of

Queensland to prevent the incidental drowning of dugongs (Marsh & Lawler 2001b).

Indigenous Management

The Great Barrier Reef Marine Park Authority recognises the need to establish cooperative management arrangements with Aboriginal and Torres Strait Islander peoples. Proposed strategies and actions to incorporate Aboriginal and Torres Strait Islander interests have been outlined in Anon. (1997b). Some strategies relating to this document include

1. providing for traditional hunting with a permit in all zones in the Great Barrier Reef Marine Park other than Preservation (no entry) Zones
2. developing hunting management strategies with Hope Vale and Lockhart River indigenous communities
3. conducting a survey on the importance of dugongs in the lifestyles and economies of indigenous communities.

A hunting management plan has been developed by the Hope Vale Aboriginal community. The objective of the plan is to develop and implement controlled and sustainable hunting practices that will minimise the impact on, and contribute to, the protection and survival of dugongs and turtles. The management plan regulates: annual hunting quotas informed by research, hunting seasons and areas, prohibition on hunting pregnant female dugongs or calves, and transport of meat outside of the community. The plan further provides provisions for

- a Community Management Group (the Turtle and Dugong Hunting Management Group) involving a committee which will resolve disputes and impose penalties for infringements
- a community permit involving individual hunting authorities distributed by the Hope Vale Natural and Cultural Management office
- catch monitoring by community rangers.

Hope Vale community is finding the implementation of the plan more challenging than expected, and is attempting to have its provisions incorporated into relevant Commonwealth and Queensland laws. A dugong and turtle education program is also in operation in this community and includes posters, the production of booklets on the history of hunting at Hope Vale and a CD.

Suggested Conservation Initiatives

Research

The long-term monitoring of dugong distribution and abundance should continue in both the northern Great Barrier Reef region and Torres Strait. A cooperative program involving Australia, Indonesia and Papua New Guinea would be a significant initiative for the Torres Strait region. There is a need for cost-effective protocols for monitoring temporal changes in the seagrasses at regional scales. This is a serious issue for the conservation of seagrasses in remote northern regions such as the northern Great Barrier Reef region and Torres Strait. Butler and Jernakoff (1999) have prepared a research and development plan that includes various recommendations for seagrass research priorities.

Management

Torres Strait

The most important initiative will be the development of cooperative management, based on the support and co-operation of Torres Strait Islanders and the Australian Fisheries Management Authority. As Torres Strait Islanders move towards regional autonomy, it will be impossible to enforce management restrictions without the cooperation and involvement of local peoples, especially given the remoteness of the area. Native Title is expected to be recognised over most inhabited and associated islands. There are also plans for a regional sea claim over Torres Strait. These initiatives are expected to have significant implications for future management strategies of all the marine resources of the region, including dugongs.

Although the present dugong sanctuary was designated in 1985 after extensive community consultation, its location is probably irrelevant to most hunters as it is outside the traditional hunting grounds of the major dugong hunting communities. We suggest that the boundaries of the dugong sanctuary be reviewed, or that additional protected areas be considered for establishment in areas with higher densities of dugongs (see Marsh & Saalfeld 1991; Marsh *et al.* 1997a and b). This will need to be considered by the communities in the context of developing their management strategies.

In 1998, the Islanders and the relevant government agencies developed mutually acceptable management objectives for the dugong fishery. Little or no progress has been made since then. We suggest that the Torres Strait Regional Authority and the Islander Co-ordinating Council be empowered to manage dugong resources under Australian jurisdiction in a formal cooperative management arrangement with the Australian Fisheries Management Authority. Parallel arrangements should be developed for the fishery in Papua New Guinean waters. Given that dugongs and green turtles are hunted together, complementary co-management processes should be developed for both species.

Torres Strait Islanders need to play a key role in the design of appropriate educational, research and management strategies to ensure that dugong and turtle hunting in the region becomes sustainable. Initiatives may include

- a wider community information program in cooperation with the Islander Co-ordinating Council
- maintenance and expansion of the school-based monitoring (which is likely to be more accurate than monitoring conducted by intermittent community visits; Kwan *pers comm*. 2001) and education programs after a comprehensive review
- cooperative development and implementation of management plans for the major hunting communities of Boigu, Mabuiag and Badu (Figure 6.4), fostering wider community involvement in the development of all aspects of dugong management
- a community role in determining priorities and direction for dugong conservation action in the region
- the development of a longer-term strategy for training and the provision of resources for indigenous community rangers.

Negotiations between Australia, Papua New Guinea and Papua Barat (formerly Irian Jaya) are needed to extend the aerial surveys of Torres Strait to cover the coastal waters of Papua Barat and Papua New Guinea.

Northern Great Barrier Reef Region

Indigenous Management

The most important initiative will be to develop and implement cooperative management arrangements between the indigenous communities in the region and the managing agencies. Given the extent of dugong movements in the region, these arrangements may be facilitated by a regional agreement between the dugong hunting communities in the region (Marsh & Lawler 2001b). These arrangements should be informed by the results of the Hope Vale initiative.

In his detailed study on the attitudes to marine resource use of indigenous communities in the northern section of the Great Barrier Reef, Smith (1987) outlined several management options incorporating Aboriginal knowledge and understanding. His recommendations (also outlined in Smith & Marsh 1990) include

- the need to customise management measures to individual communities
- the use of indigenous people as Rangers and Liaison Officers to assist in communication between the community and management
- the desirability of involving indigenous people from the community in the development of public education programs
- the need to tailor education/extension programs to suit each community situation, especially if western-style management systems are to be imposed on indigenous hunters and fishers (It is impractical to make management systems culturally appropriate if they are not adequately explained to the user groups.)
- the need for the relevant management agency to have the capacity to respond to escalating demands from indigenous hunters who want to assume a more active role in both developing and administering management policies.

Fishery Interactions

A holistic approach to dugong protection needs to be developed by the various agencies responsible for fisheries management and conservation in this region. The area is remote and regulations are extremely difficult to enforce. Thus, regulations to protect dugongs need to be as unambiguous as possible and could include community enforcement. Satellite tracking demonstrates that dugongs use inter-tidal areas and the tidal areas of rivers and creeks in the region. We recommend that this be taken into account in revising fisheries regulations as a matter of urgency.

Conclusions

- Torres Strait and the northern Great Barrier Reef region support the largest known population of dugongs in the world.
- The seagrass on which dugongs depend is susceptible to extensive dieback events, particularly in Torres Strait. The cause of these diebacks is unknown but are likely to be the result of extreme climatic events. Dugongs delay breeding in response to large-scale seagrass diebacks.
- The status of the dugong in this region is unknown. There is no evidence of a decline, however, there are some indications that the indigenous harvests may not be sustainable.
- The highest priorities are:
  1. the development of cooperative management arrangements between the major dugong hunting communities and the relevant managing agencies;
  2. measures to reduce gill netting in intertidal waters adjacent to important dugong areas in the Great Barrier Reef Marine Park.

URBAN COAST OF QUEENSLAND

For the purposes of this document, the "urban" coast of Queensland (Figure 6.6) is defined as extending from Cooktown to the border of Queensland and New South Wales at Coolangatta. The area from Cape Bedford near Cooktown to the southern boundary of the Great Barrier Reef Marine Park (Figure 6.6), is within the Great Barrier Reef World Heritage Area, and is jointly managed by the Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Parks and Wildlife Service (QPWS). South of this region, dugong management is the responsibility of the Queensland Parks and Wildlife Service.

Distribution and Abundance

Relative to the northern Great Barrier Reef and Torres Strait (see above), dugongs are generally sparsely distributed throughout the southern Great Barrier Reef region. This is not surprising considering the small known area of inshore seagrass (approx. 540km^2, Lee Long & Coles 1997), compared to the region north of Cape Bedford (2252km^2, Lee Long *et al*. 1993) and the relatively small size of individual meadows. Five seagrasses from the genus *Halophila* have been found at depths down to 60m between 10° to 25°S and from inshore to the reef edge (up to 120 nautical miles from the coast). These deepwater meadows (>15m) of *H. ovalis* and *H. spinulosa* are important feeding habitat for dugongs. Cross-shelf patterns in seagrass presence, species and biomass are likely to be linked with coastal influences (Coles *et al*. 2000).

The most important dugong areas along the urban coast (Hinchinbrook Island area, Cleveland Bay and Shoalwater Bay in the Great Barrier Reef region, and Hervey Bay and Moreton Bay to the south; Figure 6.6) are typically large, northward facing bays, which are sheltered from the prevailing southeast winds. These bays support much of the large areas of seagrass on this coast.

Our capacity to interpret the long-term trends in dugong abundance along the urban coast of Queensland is complicated by increasing evidence of the dugongs' large-scale movements. Overall, the available evidence suggests a long-term decline at a regional scale, with shorter-term fluctuations in dugong numbers at more local scales. The evidence for a long-term decline comes from anecdotal information and records of dugong by-catch from a government shark control program. Marsh *et al*. (2001) used these records to hindcast changes in dugong numbers over the last four decades along a 10^0 latitude between Cairns and the Sunshine Coast (Figure 6.6). The results from six locations indicate that the overall capture rate declined at an average of 8.7% per year. The estimated decline in shark net by-catch of dugongs was used to estimate the decline in dugong numbers from all causes averaged over the areas where nets were deployed. This hindcasting suggests that dugong numbers have declined to about 3% of the 1960s level. This hindcasting makes the untested assumptions that dugongs have not learned to avoid the nets, or been alienated from beaches where nets have been deployed due to increased human use. The causes of this decline are complex and probably vary in different areas along the coast (see below).

A series of standardised aerial surveys between 1986/87 and 1994 suggested a decline in dugong numbers in the Great Barrier Reef World Heritage Area between Hinchinbrook Island and the southern boundary of the region (Figure 6.6). The number of dugongs in the region changed from an estimated 3,479 (± s.e. 459) in 1986/87 to 1,857 (± s.e. 292) in 1992 and 1,682 (± s.e. 236) in 1994 (Marsh *et al*. 1996). The population estimate derived from the 1994 surveys was only 48% of the 1986/1987 population estimate. Comparison of the results of the 1986/7, 1992 and 1994 surveys indicated that the decline in dugong numbers was spread throughout much of the region, but was most serious between Cape Cleveland and Broad Sound (Figure 6.6).

Another standardised aerial survey in the time series was conducted in 1999 (Marsh & Lawler 2001a). The results of this survey indicate that dugong numbers in the southern Great Barrier Reef region in October-December 1999 were significantly higher than the corresponding estimate in 1994, but not significantly different from that obtained in 1986/87. Most of the increase was in the northern part of the survey region between the Whitsunday and Hinchinbrook areas (Figure 6.6).

An aerial survey of the Hervey Bay-Great Sandy Strait region in 1988 indicated that this area supported the largest population of dugongs (estimated at 2,206 ± s.e. 420) and the largest area of seagrass (>1000km^2) (Lee Long *et al*. 1993) on the east coast of Australia south of Cape York. The seagrass was predominantly in water deeper than 5m, and in the southwest of Hervey Bay. The survey was repeated in 1992. It revealed a large decrease in dugong numbers in southern Hervey Bay *per se* from 1,753 (± s.e. 388) in August 1988 to approximately 71 (± s.e. 40) in 1992. Most of the animals appear to have travelled south to Great Sandy Strait where the population was estimated to be 943 (± s.e. 377) in 1992 (Preen & Marsh 1995). By December 1993, the dugong population

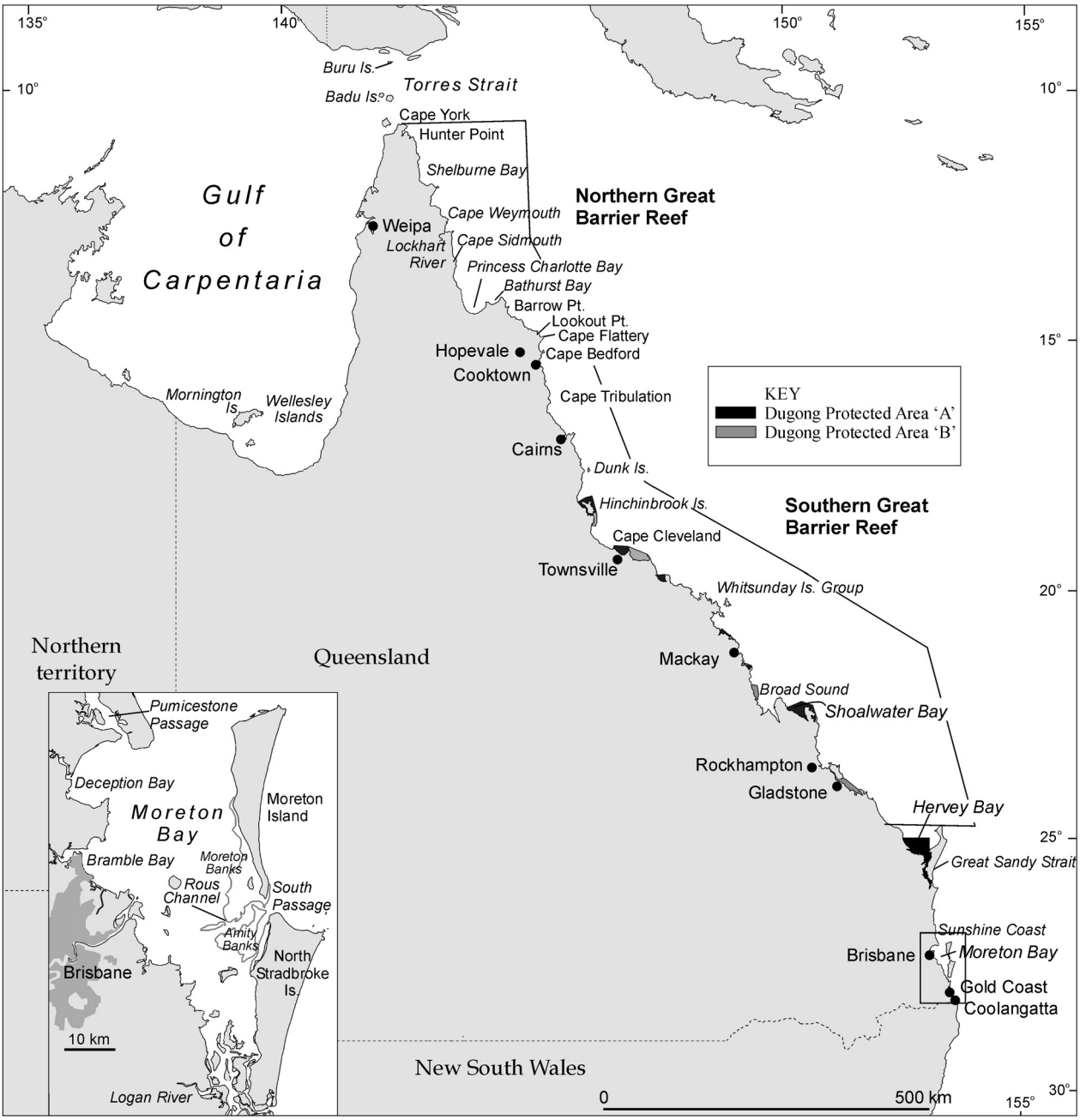


Figure 6.6 – The urbanised coast of Queensland (from Cooktown south on this map) showing place names mentioned in the text and the Dugong Protection Areas.
Inset bottom left: Moreton Bay region, southeast Queensland.

of the Hervey Bay-Great Sandy Strait region was estimated to be 579-629 (± s.e. 126) animals (Figure 6.6). Based on a survey in November 1994, a minimum population estimate of 807 (± s.e. 151) dugongs was calculated for the region (Marsh *et al*. 1996). When this survey was repeated in November 1999, dugong numbers were estimated to be 1654 (± s.e. 248) (Marsh & Lawler 2001a). The April 2001 aerial survey estimate was 919 (± s.e. 146) dugongs, including 8.5% calves (Lawler 2001b). The increase in dugong population estimates for the Southern Great Barrier Reef region and Hervey Bay between 1994 and 1999, were too great to be attributed simply to natural increase in the absence of migration (Marsh & Lawler 2001a). Satellite tracking of individual dugongs provides evidence of such migrations. For example one dugong travelled from Hinchinbrook Island to Princess Charlotte Bay and back, and then to Cleveland Bay (near Townsville), a distance of about 800km, while two others moved from Shoalwater Bay to Hervey Bay (Preen 1999, 2001). Of the 29 animals that were tracked,

over half moved linear distances of greater than 70km (Lawler *pers comm*. 2001).

Although there are many historical accounts of Moreton Bay as an important dugong area (e.g. Welsby 1905), dugongs were not recorded there by scientists from the air until the mid 1970s. The animals were sighted on the sandbanks to the west of South Passage (Heinsohn *et al*. 1978). Only one quantitative survey of the entire Bay was conducted prior to 1995 (in August 1988). This survey resulted in a population estimate of 458 (± s.e. 78) dugongs, most of which were found in the South Passage and associated banks (Marsh *et al*. 1990). Between July 1988 and February 1990, Preen (1992) conducted 28 standardised surveys of the South Passage area and concluded that it supported between 500 and 569 dugongs all year round. Following a repeat survey in April 1993, Preen and Marsh (1995) estimated a population of about 650 dugongs in the same area. In 1995, Lanyon and Morrice (1997) counted dugongs during six repeat bi-monthly aerial surveys. Population estimates ranged from 366 (± s.e. 159) in July, to 896 (± s.e. 201) in January, with a mean population estimate of 658 (± s.e. 87) over the entire survey period. Lawler (2001a) estimated the dugong population of Moreton Bay to be 344 (± s.e. 88) in December 2000. In April 2001, the population estimate was 366 (± s.e. 41) individuals, including 10.7% calves (Lawler 2001b). The methodology of all these surveys has not been consistent, so comparisons between the various population estimates are problematic. However, all surveys concluded that the eastern Amity and Moreton Banks, and the areas adjacent to these sandbanks, are the most critical areas for dugongs in Moreton Bay (Figure 6.6). The waters through Rous Channel and east of South Passage (up to 10m offshore from Moreton Island) are frequently used in cooler months (Preen 1992; Lanyon & Morrice 1997). Satellite tracking of individual dugongs confirmed that they leave Moreton Bay on an almost daily basis in winter to seek thermal refuge in the warm oceanic water outside South Passage (Preen 1992).

Threatening Processes

Habitat Loss and Degradation

Anthropogenic influences on seagrass beds range from being minimal in areas in the north of the urban coast of Queensland such as Cooktown, to high in industrial and residential areas around cities such as Cairns, Townsville, Mackay, Gladstone and especially Brisbane (Figure 6.6). Southeast Queensland is one of the fastest areas for human population growth in Australia.

The most immediate threats to seagrass beds are from urban and agricultural runoff, and coastal developments. Cattle grazing and sugar cane farming in the catchments that feed into the coastal waters of this region may have detrimental effects on seagrass, through increasing turbidity, altering levels of nutrient loading and the introduction of herbicides. Localities that provide shelter and water conditions ideal for productive seagrass habitat, are often sites for port development and/or are at the downstream end of heavily disturbed catchments.

Following two floods and a cyclone in early 1992, more than 1000km^2 of seagrass were lost from Hervey Bay (Preen *et al*. 1995). Between March 1992 and May 1993, a total of 99 dugong carcasses were recovered in the Hervey Bay area, on the southern and central Queensland coast and along the New South Wales coast. Most appeared to have been suffering from starvation. This is likely to be a substantial underestimate of dugong mortality during this period (Preen & Marsh 1995). A seagrass survey in early 1993 confirmed that virtually all the seagrass from southwestern Hervey Bay had disappeared (Preen *et al*. 1993). Some recovery of the seagrass beds in Hervey Bay was reported by Preen *et al*. 1995. Coles (*pers comm*. 1999) reported an almost complete recovery by late 1998. Hervey Bay again experienced significant flooding in February 1999, with substantial loss of intertidal seagrasses in the northern Great Sandy Straits, and of shallow subtidal seagrasses in the Bay itself (McKenzie *et al*. 2000). At the time of the 1999 aerial survey, the shallow water seagrasses showed little evidence of recovery (McKenzie *et al*. 2000), and this is reflected in a change in the dugong distribution in Hervey Bay with more sightings in deeper water than recorded in 1994. McKenzie *et al*. (2000) suggest that sufficient seagrasses remain to support the current dugong population, but that some individuals may experience stress due to reduced food availability. The future of dugongs in Hervey Bay probably depends on both the intensity and frequency of major cyclone and flood events in the catchments feeding in to the Bay and on the management of land-use in these catchments.

Over 60% of Queensland's population lives within 160km of Brisbane (Figure 6.6). The Moreton Bay catchment supports approximately two million people and is the most populated catchment in Queensland (EPA 2001). Much of the effluent from this population centre, the discharges from local industries and the runoff from gardens, roads and surrounding farms, ends up in the Bay. Furthermore, Moreton Bay is a focus area for recreational activities in southeast Queensland. Maintaining the habitat quality of dugongs in Moreton Bay in the face of this increasing pressure will be the major challenge for dugong conservation in this region.

The most extensive seagrass beds occur in the sandbanks of eastern Moreton Bay. Over a five year period, decreases in seagrass depth range (the maximum depth of seagrass growth) were recorded in western Bay areas, which are affected by river plumes (Abal *et al.* 1998). Seagrass loss has also been documented near the mouth of the Logan River, a turbid river with increased land use in its watershed (Abal & Dennison 1996) (Figure 6.6). Abal *et al.* (1998) report that the ongoing loss of seagrass in southern Moreton Bay and the inferred seagrass losses in Bramble and Deception Bays, have resulted in an estimated 20% loss of seagrass habitats since European settlement (Figure 6.6).

Lyngbya majuscula, a cyanobacterium, is considered to be the biggest challenge to the ecological health of seagrass beds on Moreton Bay. *Lyngbya* blooms smother seagrass, particularly *Zostera marina*. Intermittent *Lyngbya* blooms have been reported from Deception Bay for several years. In 2000, these blooms extended over 38km^2 in eastern and northern Moreton Bay (Haines & Limpus 2000), including favoured dugong habitats. This bloom was followed by the largest number of dugong deaths (20) recorded in the Bay for the six years of comprehensive monitoring (Haines & Limpus 2000). The Annual Report Card of Ecosystem Health of the major waterways in Southeast Queensland is derived each year using a range of water quality and biological indicators including the extent and duration of *Lyngbya* blooms. In 2001, significant *Lyngbya* blooms occurred in Northern Deception Bay and on the Eastern Banks of Moreton Bay during summer. These banks include Amity and Moreton Banks (see Figure 6.6). The *Lyngbya* blooms on the Eastern Banks persisted into winter (Holland *pers comm.* 2001). The extent and duration of blooms in this area may have serious impacts on the seagrass and consequently dugongs (Holland *pers comm.* 2001; Lemm *pers comm.* 2001). On the basis of this finding, the 2001 Annual Report Card of Ecosystem Health has downgraded the health of the Eastern Banks from good to fair within a year. This is a dramatic decrease which illustrates the serious nature of this issue (Holland *pers comm.* 2001; Lemm *pers comm.* 2001).

The impact of extreme weather events on the dugong's seagrass habitat seems to be influenced by land-use. For example, anecdotal evidence suggests that the loss of seagrass from Hervey Bay following the 1992 floods and cyclone was unprecedented in the past 100 years, even though the magnitude of the flood was not (Preen *et al.* 1995). Preen *et al.* concluded that the impacts of natural disturbance on seagrass beds can be exacerbated by poor catchment management. Catchment activities including vegetation clearing, grazing, agriculture, aquaculture and urban and industrial development may result in increased sediments and nutrients entering coastal waters. In the central Great Barrier Reef World Heritage Area for example, 39% of all nitrogen and 52% of phosphorous originate from river inputs (Cosser 1997). The increase in sediment and nutrient load from these activities may affect the ability of seagrass beds to recover from damage caused by natural events (Wachenfeld *et al.* 1998). The amount of sediments, nitrogen and phosphorous entering Queensland's oceans each year has increased three to fivefold since European settlement (~1850), with most originating from large areas of agricultural land in central and northern Queensland (Moss *et al.* 1993). Probably the greatest threat to seagrass habitat is land runoff and its effect on water quality (Wachenfeld *et al.* 1998). Herbicide runoff from agricultural lands also presents a potential risk to seagrass functioning adjacent to sugarcane production areas (Haynes *et al.* 2000 a and b). Unfortunately data are not available to indicate the extent of change in seagrass habitats off the east coast of Queensland, over a significant time-frame. However, it is likely that the changes in water quality have reduced the depth range of at least some species of subtidal seagrasses in the region (Abal & Dennison 1996).

Fishing Pressure

Mesh Netting

The anecdotal information available in 1997 suggested that by-catch of dugongs in commercial mesh nets was a significant source of anthropogenic mortality for dugongs in the southern Great Barrier Reef region and Hervey Bay. Anecdotal evidence also suggests that unlicensed mesh netting is relatively common, and is increasing in northern Queensland waters despite its illegality (see *The Queensland Fisherman July 1999*). There are no data on these nets as a source of dugong mortality, but we regard some mortality as inevitable. A series of Dugong Protection Areas in which gill and mesh net fishing has been modified or banned was established in 1997 (see below and Marsh 2000). Statistics from a necropsy program conducted since the introduction of the Dugong Protection Areas indicate that few of the animals necropsied show evidence of having been killed in nets. For example, in 2000 no dugong mortality from netting activity was identified in the Dugong Protection Areas (Haines & Limpus 2000). However, two dead dugongs recovered from the Cairns–Port Douglas area were entangled in monofilament nylon net (Haines & Limpus 2000).

The Yarrabah Aboriginal Community near Cairns operates a mesh net fishery in the bay adjacent to the community to supply community food needs. There are anecdotal reports (but no quantitative data) of multiple dugong captures in this fishery in 2000. One animal was released alive from a net (Haines & Limpus 2000).

The Queensland Shark Control Program (QSCP)

The Queensland Shark Control Program is designed to protect bathers by reducing shark populations on meshed beaches. The program resulted in a by-catch of a total of 837 dugongs between 1962 and 1992 Anon. (1992), an average of about 27 per year. Between 1962 and 1978, 101 dugongs were killed in nets off Cairns (Paterson 1979), an area where there are now so few dugongs that the population cannot be estimated (Marsh & Saalfeld 1989; Marsh *et al*. 1994b; Marsh & Lawler unpublished). Between 1963 and 1978, 229 dugongs were killed in nets off Townsville (Paterson 1979).

As outlined below, a series of initiatives since 1992 have reduced the capture of non-target species in the Queensland Shark Control Program, and the number of dugongs now taken is relatively low (approximately 2 per year; see Haines & Limpus 2000).

Indigenous Use and Hunting

The contemporary cultural significance of the dugong to urban Aboriginal and Torres Strait Islander peoples in Queensland has not been studied formally, however there are strong indications that it is considerable and widespread. Some 27,509 indigenous males reside along the urban coast (i.e. within census collection districts whose centrepoint is within 20km of the coast) (Australian Bureau of Statistics 1996). This is almost ten times the number in the northern Great Barrier Reef and Torres Strait. It is unknown however, how many of these men living on the urban coast aspire to hunt dugongs. Many are Torres Strait Islanders who are accustomed to having dugong in their diet (Johannes & MacFarlane 1991; Harris *et al*. 1994).

There are few historical data on the magnitude of indigenous hunting along the urban coast of Queensland. As a response to declining numbers of dugongs in the southern Great Barrier Reef region, the managing agencies no longer issue permits for hunting dugongs in that region. Some indigenous communities agree with this action, while others object to it.

There is an established tradition of bartering and trading dugong meat along this coast. The selling of dugong meat by indigenous and non-indigenous people also occurs throughout this region even though it is illegal. Current State and Commonwealth Marine Parks legislation identifies traditional hunting as an activity that requires a permit. However, under State waters, this provision must now be considered in conjunction with Section 211 of the *Native Title Act 1993* and Queensland Parks and Wildlife Policy to determine whether a permit is required. The situation is complex and as yet unresolved.

There are several indigenous communities in the Hervey Bay region. Although no formal agreement exists, a voluntary cessation of traditional hunting for dugongs is currently in effect. Although not extensive, indigenous dugong hunting does occur. In the past three years, four or five dugongs were hunted 'illegally' (Winderlich *pers comm*. 2001).

Dugongs are of cultural significance to the Quandamooka community of North Stradbroke Island in Moreton Bay (Figure 6.6). Discussions with the dugong hunting group at North Stradbroke Island indicate that at least 30 dugongs have been hunted in Moreton Bay over the last 10 years. There is also information that some unrecorded poaching by other hunters has also occurred (Lemm *pers comm*. 2001). There is currently a Native Title Claim on some of the islands and waters in Moreton Bay and the adjacent land. In addition, Native Title claims also exist over various parts of the Great Barrier Reef (Stokes *pers comm*. 2001).

Boat-related Impacts and Ecotourism

Boating activities potentially impact seagrass beds along the urban coast of Queensland. Boat traffic causes disturbance to dugongs in the surrounding waters and may degrade dugong habitat. In addition, direct impacts to dugongs occur through boat strikes and from cuts caused by propeller blades. These concerns are greatest in areas of high recreational use such as the Hinchinbrook Island area, Cleveland Bay, Hervey Bay and Moreton Bay (Figure 6.6). Eleven dugong mortalities from boat strikes have been recorded in the Queensland Wildlife Stranding and Mortality Data Base since 1996 (Haines & Limpus 2000). In September 2001, a dead dugong was discovered on the southern end of Lamb Island, Moreton Bay (towards the southern end of North Stradbroke Island; Figure 6.6). A number of propeller marks were evident along its body. A commercial dugong watching operations is permitted to operate in Commonwealth waters in the Hinchinbrook Island region. Other operators in significant dugong habitat along this coast provide passengers with opportunities to observe dugongs on an incidental basis.

Chemical Pollution

Tissue samples of liver and blubber were salvaged from 53 dugong carcasses stranded along the Queensland coast between 1996-2000 as part of the Queensland Necropsy Program. Liver tissue was analysed for a range of heavy metals and blubber samples were analysed for organochlorine compounds and polychlorinated biphenyls (Haynes *et al. in review*). Concentrations of toxic metals were generally low and in the range typically found in marine mammals. Average metal concentrations were generally higher in mature animals and elevated

concentrations of chromium and nickel were detected in liver samples from several animals collected from the southern Queensland coast. Dieldrin, DDT and/or DDE and/or heptachlo-epoxide were detected in 59% of dugong blubber samples. Concentrations of organochlorines were similar to those reported being present in dugongs 20 years earlier, and were low in comparison to concentrations recorded from marine mammal tissue collected elsewhere in the world. Polychlorinated dibenzodioxins (PCCDs) appear to be the most significant organochlorine pollutant bioaccumulated in dugongs (Haynes *et al*. 1998; Haynes *et al. in review*). Coastal contamination for dugongs in this region are likely to be indirect through herbicide impacts to nearshore seagrass beds (Haynes *et al*. 2000a and b; Haynes *et al. in review*).

Disease

Necropsies conducted on sick, injured or dead dugongs reported to the Queensland Parks and Wildlife Service indicate that disease is the cause of death for 30% of the 80 animals for which the cause of death has been determined since 1996 (Haines & Limpus 2000). Haines and Limpus (2000) hypothesise that interannual fluctuations in dugong mortality are related primarily to the negative impact of abnormal wet seasons on seagrass pasture quality and a resultant deterioration on the dugong's health status.

Existing Conservation Initiatives

Legislation

The dugong is protected under the *Commonwealth Environment Protection and Biodiversity Conservation Act, 1999* and the *Queensland Nature Conservation Act 1992*. *A Nature Conservation (Dugong) Conservation Plan* for Queensland waters was adopted in 1999.

Research

Dugong research in this region began with the study of carcasses in the late 1960s (Heinsohn 1972). These studies formed the basis of modern understanding of dugong anatomy (e.g. Spain & Heinsohn 1974, 1975; Spain *et al*. 1976; Marsh *et al*. 1978; Marsh & Eisentraut 1984; Rowlatt & Marsh 1985), life history (Marsh 1980; Marsh *et al*. 1984 a,b,c), diet (Heinsohn & Birch 1972; Spain & Heinsohn 1973; Marsh *et al*. 1982) and heavy metal status (Denton *et al*. 1980). Aerial surveys for dugongs have been conducted in the region since the 1970s (Heinsohn *et al*. 1978; Marsh & Saalfeld 1989; Preen 1992; Marsh *et al*. 1996; Lanyon & Morrice 1997; Marsh & Lawler 2001a). Most of our knowledge of dugong-seagrass interactions (Preen 1995; Preen & Marsh 1995; Marsh *et al*. 1998; Aragones & Marsh 2000) and movements (Marsh & Rathbun 1990; Preen 2001) has come from this region. In 1999 the Great Barrier Reef Ministerial Council accepted a Dugong Research Strategy (Oliver & Berkelmans 1999) as a guide to setting priorities, allocating funds and assessing performance of dugong recovery and conservation actions in the Great Barrier Reef and Hervey Bay-Great Sandy regions.

The Department of Defence has commenced the formal integration and management of its Dugong Research Program for the Shoalwater Bay Military Training Area (SWBMTA). The Department of Defence plans to fund dugong research in the form of four independent projects:

1. mapping of the presence of dugongs in the SWBMTA
2. analysis of aural anatomy of dugongs
3. acoustic modelling of the SWBMTA
4. aerial surveillance before and after clearance diving exercises in the SWBMTA.

Since 1996 the Queensland Marine Wildlife Stranding and Mortality Database has summarised all records of sick, injured or dead marine wildlife (including dugongs) reported to the Queensland Parks and Wildlife Service from Cairns south to the Queensland–New South Wales border (Haines & Limpus 2000).

Management

Most of the dugongs and their habitats on the urban coast of Queensland occur in marine parks: the Great Barrier Reef Marine Park and the associated Queensland Marine Parks in the Great Barrier Reef region, the Hervey Bay Marine Park and the Moreton Bay Marine Park.

In 1997 the Australian and Queensland governments agreed to several measures specifically aimed at arresting the decline of dugongs along the urban coast of Queensland, including a resolution not to issue permits for the indigenous hunting of dugongs from Cooktown *down to the southern border of the Great Barrier Reef Marine Park*. The most controversial measure was to establish a two-tiered system of Dugong Protection Areas (DPAs) (Figure 6.6). Gill and mesh netting are greatly restricted or banned in seven Zone A DPAs totalling 2,407km^2, and subject to lesser modifications in eight Zone B DPAs totalling 2,243km^2 *(Fisheries Amendment Regulation [No. 11] 1997 [Queensland])*. An additional Zone A DPA of 1703km^2 in which gill and mesh netting practices were modified was established in Hervey Bay (Marsh 2000). A conservation plan for dugongs in Queensland was implemented by the Environmental

Protection Agency in 1999. This plan further reinforced the functions of the Dugong Protection Areas (DPAs).

There is concern that boat racing, water skiing and jet skiing place dugongs at risk from vessel strikes and noise in the Hinchinbrook Island region (Figure 6.6). The Great Barrier Reef Ministerial Council has developed transit lanes with marker buoys to designate a *voluntary* 25 knot speed limit transit lane and a 10 knot speed restriction zone within identified important dugong feeding areas or on observing a marine animal at close range (GBRMPA 2001). Other proposed strategies outlined in the Draft Hinchinbrook Plan of Management (2001) to protect marine mammals include the introduction of a maximum overall length of 20m for all vessels in Missionary Bay; prohibiting aircraft to land, depart or taxi in any location of the Hinchinbrook Island Dugong Protection Area (Figure 6.6); and the requirement of tourism operators to operate in accordance with booking limits to the Planning Area and sensitive location restrictions (GBRMPA 2001). In addition, the Council has requested the Queensland Parks and Wildlife Service to refuse requests for permits to conduct boat races in excess of 40 knots in the Hinchinbrook Zone A DPA (Figure 6.6). This issue is to be addressed in the Cardwell/Hinchinbrook Regional Coastal Management Plan. Signs have been placed at boat ramps in the DPAs informing boaters about DPA areas and regulations. An education campaign is underway to seek a voluntary reduction in boat speeds in shallow waters. 'Sunfish', which represents recreational fishing interests, has published a 'Code of Conduct' with suggested measures to minimise boat strikes on dugongs.

In its 1999 review of measures for dugong conservation, the Ministerial Council also directed that a strategy be developed to form cooperative management agreements with indigenous communities; welcomed a commitment from the Queensland Government to pursue to efforts to minimise the impact of land-based activities on DPAs; and upgraded procedures for responding to reports of stranded dugong including refining processes to establish 'cause of death' and fast release of information to the public.

The Department of Defence has agreed to a moratorium on the use of explosives in all DPAs along the coast, except the Shoalwater Bay Military Training Area. The Department of Defence has ceased underwater detonation activities in important seagrass meadows near Triangular Island in Shoalwater Bay, and has altered other practices to minimise their risk to dugongs. In July 1999 the Great Barrier Reef Ministerial Council endorsed negotiations to secure a phasing out of the use of high explosives within the GBR World Heritage Area.

In 1997, the Great Barrier Reef Marine Park Authority finalised a plan of management for dugong conservation in Shoalwater Bay. Plans of management for the major tourist regions of Cairns and the Whitsundays were finalised in 1998. A plan of management for the Hinchinbrook region is in preparation. These plans include protective measures for dugongs.

The Moreton Bay Marine Park covers most of the Bay's tidal lands and tidal waters seawards to the limit of Queensland waters. There are five areas designated as "turtle and dugong" areas. Within these areas there are speed regulations which state that boat operators are not permitted to motor their boats on the plane. A publicity campaign was launched to assist in informing boaters of the new regulations. A Moreton Bay Dugong Watch monitoring program was launched in March 1998.

An education and information program has been developed by the Great Barrier Reef Marine Park Authority to enhance public awareness of the value and plight of dugongs, and to advise people on how they can assist in minimising impacts. The program includes information kits, media releases, community service announcements, reef user workshops and liaison with advisory committees and interest groups.

The Fishing Industry Training Council in conjunction with the Queensland Seafood Industry Council and scientists have set up an Endangered Species Awareness Course. The industry encourages this course as a prerequisite for holding a license for commercial net fishing. All fishers operating in the Dugong Protection Areas are expected to participate in this course.

Suggested Conservation Initiatives

Research

The goal of research in this region is to acquire information to assist in the recovery and maintenance of dugong populations. A series of research projects have been identified, which reflect a wide range of priorities among managers, researchers and stakeholders with interests in dugongs. These projects have been incorporated into the Dugong Research Strategy for the Great Barrier Reef World Heritage Area and Hervey Bay (Oliver & Berkelmans 1999).

The categories include

- projects designed to assess the effectiveness of the current dugong protection measures
- projects likely to result in information which will directly assist in maintaining or enhancing dugong numbers
- projects that will assist with the development and implementation of cooperative management arrangements

- projects designed to minimise the impacts of management decisions on industry and other affected groups.

High priority should be given to monitoring dugong distribution and relative abundance using regular aerial surveys. Regular seagrass surveys are also required to assess temporal changes in seagrass meadows, and the impacts of extreme climatic events on dugong habitats in the region. Research is also needed to study seasonal changes in seagrass growth rates and productivity with a view to developing a model of dugong grazing. Satellite tracking of dugongs in key areas will provide detailed information on dugong habitat use. Such information would be very useful for assessing the local impacts of proposed developments on dugongs and for other local-scale planning.

The CSIRO Division of Marine Research has reviewed the status of fisheries-related seagrass research within Australia for the FRDC (Fisheries Research and Development Corporation). The research and development plan (Butler & Jernakoff 1999) includes various recommendations for seagrass research priorities. Of particular concern in this region is the lack of knowledge on the relationship between human activities and the effects of nutrient loading on seagrass beds.

Management

Habitat protection

The DPA strategy depends on high priority being given to habitat protection in these areas. The effectiveness of the mesh netting closures and restrictions depends on there being no overall movement of dugongs from the DPAs to other areas. To minimise the risks of this happening, it is particularly important to conserve dugong habitat, especially in the DPA Zone As.

The relevant management agencies should collectively review the zoning of the relevant sections of the Great Barrier Reef Marine Park, State Marine Parks and Fisheries Habitat Areas with a view to assessing their capacity to protect dugongs and their habitats. Key areas such as the Hinchinbrook Island area, Cleveland, Shoalwater, Hervey and Moreton Bays should be the focus of this review. The Great Barrier Reef Marine Park Authority is reviewing the protection of inshore habitats in the Great Barrier Reef Marine Park in association with their Representative Areas Program. This initiative will provide rigour in the selection of seagrass and dugong habitat for inclusion in highly protected zones in the marine park.

The Great Sandy Region Management Plan 1994 recommends extensions of existing marine parks to include all appropriate tidal lands and waters in the area. If adopted, the resulting marine park will be zoned in consultation with user and interest groups, and will enhance the prospect of dugong survival in the area. Seagrasses and mangroves are given specific protection in Fisheries Habitat Areas under Section 123 of the *Fisheries Act 1994* where all marine plants are protected, and can only be damaged or removed under permit (Section 51(c)).

Indigenous Management

Although some indigenous communities have agreed to a moratorium on hunting in the Southern Great Barrier Reef region, there is still a strong desire within the indigenous communities to hunt dugongs as they are of considerable cultural, social and economic importance. Indigenous communities in this region have made it clear that they will not give up their native title rights to hunt dugongs and they wish to have these rights formally recognised by governments through the development of cooperative management arrangements.

The need for the development of cooperative management arrangements for marine resources between management agencies and indigenous peoples is recognised by all parties. The success of cooperative management arrangements will involve communities being a full partner in all stages of the management process, bringing together traditional owners, science and management. The next step in this process is a formal agreement between the State and Commonwealth, which will need to provide the resources required to operationalise cooperative management.

In order to develop a better understanding of small-scale population changes in dugong populations near indigenous communities, community-based dugong watch programs could be developed incorporating local expertise, provided personnel are available to coordinate such programs. This activity would contribute to developing appropriate mechanisms and tools for integrating local knowledge and scientific data.

Fishery Interactions

The effectiveness of the mesh netting restrictions and attendance rules implemented in 1998 in the DPAs needs to be monitored. It is important to note that a significant proportion of dugongs along the urban coast of Queensland occur outside these DPAs (Marsh 2000). Therefore management regimes for areas within the dugong's area of occupancy but outside the DPAs need to be considered if the objective of management is to minimise human impacts on dugongs.

We support the following initiatives to maximise the effectiveness of fishing closures in the DPAs:

- legislation of attendance at net rules under the *Fisheries Management Act Queensland 1994;*
- the enhancement of surveillance and enforcement patrols to focus on the DPAs. The intensity of patrolling and surveillance varies based on pre-determined priorities (i.e. knowledge of illegal activity and records of dugong deaths);
- severe penalties for breaching netting regulations;
- the development of performance indicators to assess the impacts of the DPA.

Further initiatives we recommend include:

- The implementation of a penalty for failing to record incidental catch. We recommend that this be a serious fisheries offence under the *Queensland Fisheries Act 1994*. It is a legal requirement under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* to report the incidental death of a dugong in Commonwealth waters in Australia, and a requirement in Queensland waters under the *Queensland Nature Conservation Act 1992,* through adoption of the *Nature Conservation (Dugong) Conservation Plan 1999.*
- An investigation of opportunities for employing displaced fishers and Aboriginal hunters in activities associated with dugong management in the southern Great Barrier Reef and Hervey Bay.
- The introduction of further measures to address impacts on dugongs other than mesh netting, especially in the DPA Zone A's (i.e. coastal runoff, habitat degradation).
- An independent socio-economic investigation of the operations of fishers with netting endorsements that are operating in the DPAs. The study should include
  - an investigation on which fishers are using the current DPAs
  - a documentation of any problems with the new regulations
  - a social impact assessment on resource use (commercial and recreational fishing and tourism) in each of the DPAs to assess the implications of any further modifications to regulations in the DPAs.
- Enforcement of the 'voluntary' 25 knot speed restriction transit lane and <10 knot speed restriction zone in important dugong feeding areas where necessary (particularly the Hinchinbrook Dugong Protection Area).
- An investigation of how the current regulations in the DPAs could be further modified to reduce adverse impacts on dugongs.

Conclusions

- The Dugong Protection Areas or DPAs are an important first step in the recovery of dugongs along the urban coast of Queensland. Marsh (2000) points out that the success of the DPAs depends on there being no overall movement of dugongs from these areas to other areas and no illegal fishing. To minimise the risks of this happening, it is particularly important to conserve the dugong habitats in the DPAs.
- Dugong conservation initiatives in this region should be expanded to address all possible causes of the dugong decline, especially habitat loss.
- Management regimes for areas within the dugong's area of occupancy along the urban coast of Queensland but outside the DPAs, need to be developed if the objective of management is the minimisation of human impacts on dugongs throughout the region.
- It is important to encourage indigenous people and commercial fishers to participate in the management of dugongs throughout the urban coast of Queensland.

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"There are many reasons for fighting climate change. Securing the future of the dugong, a wonderous and compelling creature, has emerged as a possible new one. The report also shows that we must strengthen our efforts to reduce marine pollution. Late last year in Montreal, nations met and agreed to re-vitalise the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA/LBA). The health of dugong populations could become a key indicator in many parts of the globe as to whether this renewed initiative is succeeding."

Klaus Toepfer, Executive Director of the United Nations Environment Programme