ANNEX 7

The Ecology and Conservation of the Dugong (*Dugong dugon*)

1.0 **Introduction**

The dugong (*Dugong dugon*), is a seagrass-dependant marine mammal of tropical and subtropical coastal waters, with high genetic biodiversity value. It is the sole member of the genus *Dugong*, which is the only extant member of the Family Dugongidae (UNEP, 2002; Bryden *et al*. 1998). The Dugongidae shares the Order Sirenia with just three species of manatee. Hence, the dugong's genes are more unique than those of most species, which, more typically, have genera and Family-level relatives. The dugong is also one of a suite of large, long-lived marine vertebrates, including turtles and inshore cetaceans, which are under pressure from human activities (Preen, 1998). Dugong conservation therefore represents the opportunity and responsibility, to contribute significantly to the conservation of ocean biodiversity.

Currently dugongs are classified as vulnerable to extinction under the 1996 World Conservation Union (IUCN) Red List of Threatened Species. This classification describes taxon that face a high-risk of extinction in the wild in the medium-term future. In the case of the dugong, it is deemed A1: Population reduction in the form of the following: an observed, estimated, inferred or suspected reduction of at least 20% over the last 10 years or three generations, whichever is the longer [Bryden *et al*. 1998, IUCN].

The long-term survival of the dugong will depend on adequate conservation and management throughout its extensive range. For further information on regional arrangements see "The Conservation of the Dugong Across its Range – A Framework Paper". Protection, conservation and management must be based upon the best available scientific literature. The purpose of this paper is to take a step in that direction by providing a brief outline of dugong biology, and threats to its survival.

2.0 Biology of the Dugong

2.1 Distribution and Abundance

The dugong has a large range that spans at least 37 countries and territories and includes tropical and subtropical coastal and inland waters from east Africa to Vanuatu to Japan (Figure 1). The UNEP published the *Dugong Status Report and Action Plans for Countries and Territories* in 2002. It states 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. 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 its range. In most parts of its range, the anecdotal evidence suggests that dugong numbers are declining'.

Dugongs have already disappeared from some places including Mauritius, western Sri Lanka, the Maldives, Japan's Sakishima Chains, Hong Kong's Pearl River Estuary, several islands in the Phillipines, Cambodia, and Vietnam (CRC, 2003). Remaining major populations have been reported in Australia, Persian Gulf, and parts of the Red

Sea, northern and eastern coast of east Africa, west coast of Sri Lanka, Indonesia and, the Pacific islands (Agrolink, 1996).

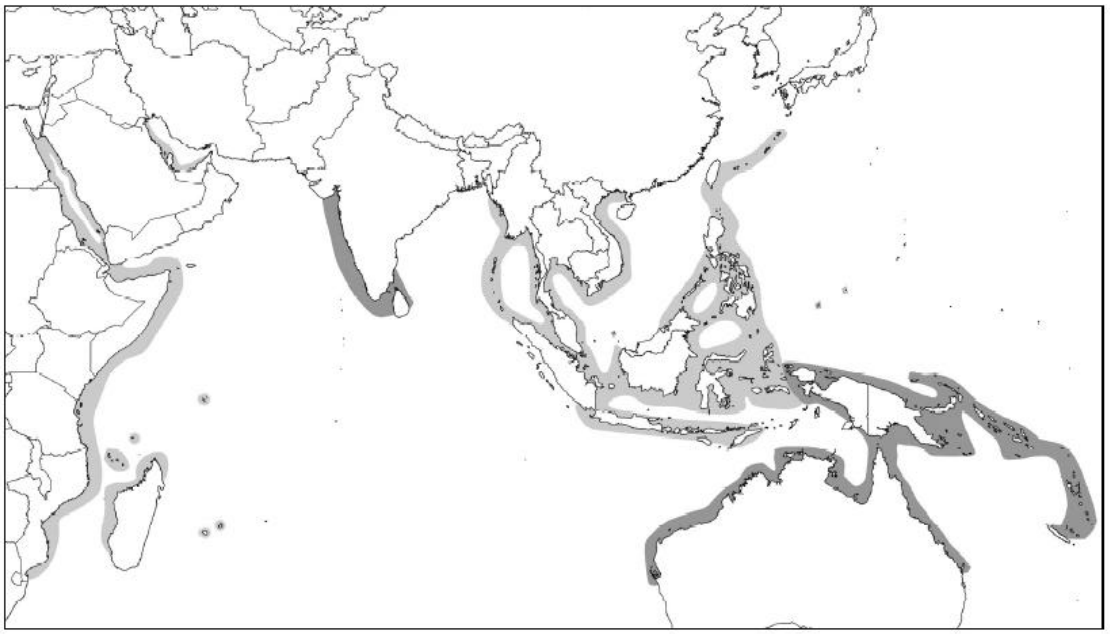

Figure One: The known range of the Dugong (Source: UNEP, 2002)

2.2 Habitat

Dugongs generally frequent coastal waters. Major concentrations tend to occur in wide shallow protected bays; wide shallow mangrove channels and on the lee of large inshore islands (Heinsohn *et al.* 1979). These areas are coincident with sizeable seagrass beds. However dugongs are also observed in deeper waters further offshore where the continental shelf is wide, shallow and protected. This distribution corresponds with that of deepwater seagrasses such as *Halophila spinulosa* (UNEP, 2002). There is evidence that dugongs use specialised habitats for various activities such as calving and mating (Anderson, 1981; Anderson, 1997). Life history attributes of dugongs are likely to vary across its range of habitat types.

2.3 Diet

Dugongs are seagrass specialists, uprooting whole plants when they are accessible, but feeding only on leaves when the whole plant cannot be uprooted. Dugongs prefer seagrasses that are pioneer species (Preen & Marsh, 1995), especially species of the genera *Halopphila* and *Haladule*. Diet selection is correlated with the chemical and structural composition seagrass (Lanyon, 1991). 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).

The highly specialized dietary requirements of the dugong suggest that only certain seagrass meadows may be suitable as dugong habitat (Preen *et al.* 1995). It has been

suggested that grazing activity by dugongs alters the species composition of seagrass communities at a local scale to favour their dietary requirements. 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).

2.4 Life History

Dugongs are long-lived with a low reproductive rate, long generation time, and a high investment in each offspring (Marsh, 1999). Females do not bear their first calf until they are at least ten and as late as 17 years old. Gestation varies between 13-15 months, with a usual litter size of one. The calf will suckle for 14-18 months, and the period between successive calvings is spatially and temporally variable; estimates range from 2.4 to seven years (UNEP, 2002). Calving intervals may lengthen as a result of food shortages. The dugong's low reproductive rate means that a very high proportion (more than 95%) of adult animals have to survive each year for a dugong population to be maintained (Bryden et al. 1998). 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, 1999). Thus the dugong's life history makes it particularly vulnerable to rapidly increasing human pressures.

2.5 Movements

Dugong movement has been tracked spatially and temporally using VHF or satellite transmitters. Dugongs have exhibited individualistic patterns of movement within the same region, daily movements depending on tidal amplitude, and seasonal movements (UNEP, 2002). The capacity of dugongs to undertake long-distance movements indicates that the management of dugongs is an international issue over most parts their range.

3.0 Threatening Processes

Dugongs are vulnerable to anthropogenic influences due to their life history and their dependence on seagrasses that are restricted to coastal habitats, and which are often under increased pressure from human activities. 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. Given the extensive distribution of the dugong there are a range of threats, some of which are unique to particular regions and some which span its entire range. Nevertheless by dividing the species range into subregions, it is possible to gain an understanding of region-specific threats (Table One).

	Threatening Process						
Subregion	**Habitat Loss and degradation**	**Fishing Pressure**	**Indigenous Hunting and Use**	**Vessel Strikes**	**Acoustic Pollution**	**Ecotourism**	**Diseases**
Western Range (East Africa, Red Sea and the Arabian Gulf)	✓	✓	✓	✓		✓	✓
India & Sri Lanka (India with the Andaman and Nicobar Islands, Sri Lanka)	✓	✓	✓				✓
East & Southeast Asia (Japan, China, Philippines, Thailand, Cambodia, Vietnam, Malaysia, Singapore, Indonesia)	✓	✓	✓	✓		✓	✓
Pacific Islands (Palau, Papua New Guinea, Solomon Islands, New Caledonia, Vanuatu)	✓	✓	✓	✓		✓	✓
Australia (Western Australia, Northern Territory and the Queensland Coast of the Gulf of Carpentaria, Torres Strait and Northern Great Barrier Reef, Urban Coast of Queensland)	✓	✓	✓	✓	✓	✓	✓

Table One: Summary of information regarding current threats to dugongs (Source: Modified from UNEP, 2002)

3.1 Habitat Loss and Degradation

Seagrass ecosystems are very sensitive to human influence (Poiner & Peterken, 1996). Seagrass beds may be destroyed directly by trawling and mining, 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.

Episodic losses of hundreds of square kilometers seagrass are associated with extreme weather events such as some cyclones, hurricanes and floods (Poiner & Peterken, 1996). Such events can cause extensive damage to seagrass communities through severe wave action, shifting sand, adverse changes in salinity and light reduction (Preen & Marsh, 1995; Preen *et al.* 1995). For example an unusual flood and cyclone event resulted in the near total loss of 1000 sq km of seagrass meadows in Hervey Bay, in eastern Australia. Many dugongs starved and eventually died, although some dugongs emigrated as far as 900km (Preen & Marsh, 1995).

Most losses, both natural and anthropogenic are attributed to reduced light intensity due to sedimentation and/or increased epiphytic growth caused by nutrient enrichment. *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.

Global warming is an indirect threat to the dugong. The United Nation's Intergovernmental Panel on Climate Change (IPCC) has speculated that climate change due to increasing amounts of anthropogenic "greenhouse" gases may result in increased tropical sea surface temperatures (SSTs) and increased tropical rainfall associated with a slightly stronger intertropical convergence zone (ITCZ) (Houghton *et al.*, 1990, 1992, 1996). Because tropical cyclones extract latent and sensible heat from the warm tropical oceans and release the heat in its upper tropospheric outflow to fuel the storm's spin up, early work of the IPCC expressed concern that warmer SSTs will lead to more frequent and intense hurricanes, typhoons and tropical cyclones.

Thus global warming has the potential to interfere with the feeding patterns, as well as altering seasonal distributions, geographic ranges, migration patterns, nutritional status, reproduction success, and ultimately the abundance of the dugong.

3.2 Fishing Pressure and Shark nets

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, and is identified as a major concern in all subregions (UNEP, 2002) (Table One). 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. However these fisheries usually operate in offshore waters, which are not major dugong habitats. No data is available on the take of dugongs by lost or discarded nets, although drowning in these nets presumably occurs (UNEP, 2002).

Shark nets set for public safety can be another source of dugong mortality. Between 1962 and 1995, shark nets set on swimming beaches in Queensland netted 837 dugongs (UNEP, 2002).

3.3 Traditional Use and Harvest

Within traditional communities great emphasis is placed on social sharing of dugong meat. In Australia for example, utilizing marine food resources demonstrates a continued connection with tradition and sea country, and dugong hunting in particular can be seen as an important expression of a person's Aboriginality (Smith and Marsh, 1990). Dugong is also an important source of protein for many communities and dugong oil is used as a panacea for a variety of illnesses (Smith and Marsh, 1990). The status of dugong meat in traditional culture is reflected in seasonal trends in take, with highest catch rates reported during the period around Christmas (Marsh, 1996).

3.4 Vessel Strikes

Whilst there is a dearth of information on this issue, vessel strikes are a potential source of mortality for dugongs. 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.

3.5 Ecotourism

The expansion of ecotourism has resulted in the establishment of tourism operation involving dugong-watching cruises at several locations in Australia, and swim with dugong operations in the Phillipines and Vanuatu. The effect of these activities on the animals is unknown, although it is under investigation in Western Australia (UNEP, 2002).

3.6 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. Acoustic pollution could be a potential impact in areas with large tidal ranges and little seagrass below the low tide mark. High levels of vessel traffic in these areas could prevent dugongs from using available intertidal seagrass meadows, by restricting their movement.

Seismic surveys are an essential component of offshore oil and gas exploration and are used to study rock strata below the seafloor. Marine seismic surveys use high-energy, low-frequency sound produced by arrays of air-guns which are designed to project very strong sounds downward through the water. A considerable amount propagates horizontally as well. Effects might include: interference with the animal's natural acoustic communication signals; damage to their hearing systems; behavioural changes including disturbance reactions, ranging from short-term to long-term effects on individuals and populations.

4.0 Conservation Initiatives

Managing adverse impacts on dugongs throughout its vast and often remote range presents a challenge, which will require a pro-active and comprehensive approach. Ultimately conservation initiatives would seek to conserve dugong across both their historic and current range. Such a systematic and co-coordinated approach will benefit not only dugong populations but also the ecological integrity of the marine environment.

4.1 Habitat Protection

Measures for seagrass protection to date, have 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 landuse, even though it is an issue of concern for all subregions (Table One). 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. Research is required to gain an understanding of seagrass responses to natural and human factors and what the critical thresholds of change are.

4.2 Fishing Controls

Acoustic alarms (pingers) are proving effective at reducing the mortality of the harbour porpoise, *Phocoena phocoena*, in gill nets (UNEP, 2002). These alarms are increasingly being seen as a possible solution to the problem of marine animals drowning in nets in developed countries, although the associated costs are likely to preclude their use throughout most of the dugong's range. The effectiveness of the use of acoustic alarms in reducing the mortality of dugongs has not been tested. Given the dugong's specialized habitat requirements, it is important to test whether their use reduces the habitat available to dugongs before they are widely adopted (UNEP, 2002).

4.3 Traditional Use

The majority of coastal communities are aware of concerns in regards to dugong management, and many are exploring options for cooperative management. Measures which have been demonstrated to be effective include culturally appropriate education programmes (including posters and videos) for indigenous communities regarding dugong conservation, presenting research results to indigenous communities, and a

programme to collate indigenous knowledge of dugongs. Community-based management of dugong take is also being investigated.

4.4 Boating Best Practice

The answer to reducing the number of vessel strikes lies in speed restrictions and community education. Voluntary speed restrictions and higher speed transit lanes might be options to be considered in the preparation of management plans. Education initiatives might include a series of signs placed at boat ramps to alert boaters to the risks of collisions with dugongs, and community service announcements or newsletters asking boat users to reduce speeds in shallow waters.

4.5 Education

For management to be effective the general public must have an awareness and concern for dugong conservation, and therefore public education will be an important component of any conservation plan. Dugong education strategies should aim to enhance public awareness of the value and plight of dugongs, and outline how people can assist. Strategies could include: information kits; media releases; community service announcements; reef user workshops and liaison with advisory committees and stakeholders. Education and information about dugong status and conservation could be included in school curricular and in local media releases to generate community support. Such strategies will coordinate many of the actions aimed at particular interest groups such as boaters, fishers, and indigenous communities. Other initiatives which may raise awareness of dugongs, their threats and possible solutions may include a dedicated 'Dugong Awareness Day' and information displays at regional fora.

4.5 Research and Monitoring

The threatening processes described above are widely distributed throughout the dugong's range due to high levels of human population growth and rapid rates of industrialization. Given the potential for multiple impacts research would be best targeted at determining a) which areas still support significant areas of dugongs; and b) identifying with extensive local involvement how impacts on dugongs can be minimized and the habitat protected in these key areas. Ideally this should be done in the context of comprehensive plans for coastal zone management (UNEP, 2002). The establishment of such areas as dugong protected areas should reduce dugong mortality provided the areas chosen consistently support high numbers of animals (see 4.1), even though individual dugongs will move in and out of these areas. The long-term effectiveness of these areas will depend on whether the high-quality habitat can be maintained. This will depend on the capacity to control land-based inputs. Candidate areas exist through much of the dugong's range (UNEP, 2002).

4.6 Legislation

Conservation and management of dugong populations through domestic policy may be afforded through initiatives such as: formally declaring dugong protection areas, regulation and enforcement of activities within these areas; prohibition of direct take (except for traditional purposes); and the implementation of a rigorous and effective EIA process in areas of significance.

4.7 Regional Arrangements

Recognition of the need for a cooperative international approach to the problems of threats to marine mammals is growing and there have been numerous international forums, agreements and conventions that have contributed to the conservation of marine mammals. Dugongs have a priority for conservation through their listing in the Convention on the Conservation of Migratory Species of Wild Animals (CMS). The dugong was identified as an Appendix II species for cooperative action (COP & Rec 7.1). In addition, the CMS 7th Meeting of the Conference of the Parties recommended that all Range States of dugongs cooperate among themselves and participate actively to develop and conclude a memorandum of understanding and an action plan for the conservation and management of dugong throughout the species' range (Rec 7.5). The CMS and a range state arrangement for dugongs presents an opportunity for States to develop and implement conservation actions to restore the dugong to a favourable conservation status.

6.0 Conclusion

It is clear that dugongs are vulnerable to anthropogenic influences due to their life history, extensive range, and distribution along rapidly developing coastal habitats. Given the dugong's capacity to move across jurisdictional boundaries, coordinating management initiatives across these boundaries will be crucial to its long-term survival. Without cooperative decision-making and action the future of the dugong looks uncertain.

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