



Status of Sea Cow, Dugong (*Dugong dugon*) in Andaman and Nicobar Islands

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ABSTRACT

Sea cow (*Dugong dugon*) is the only extant species in the Family Dugongidae and true herbivorous marine mammal. It is listed as vulnerable to extinction at a global scale by the World Conservation Union (IUCN). The present paper documents the status of dugong in Andaman and Nicobar Islands by collating the published data as well as investigation through undersea surveys in selected places of this archipelago. Based on the existing data on dugong in Andaman and Nicobar Islands, it is observed that over the period of 51 years since 1959, a total of 76 dugongs were recorded either in the form of live or dead. Among them 47 dugongs were from Andaman Islands, whereas 29 encountered from Nicobar Islands. The distribution of this mammal is comparatively high in north Andaman, Ritchie's Archipelago and Great Nicobar Island. Potential threats and managerial strategies for the effective conservation of dugongs in Andaman and Nicobar Islands have also been discussed in the paper.

INTRODUCTION

The sea cow *Dugong dugon* (Müller) is a large herbivorous marine mammal which, together with the manatees, is one of four living species of the Order Sirenia. It is the only living representative of the once-diverse family Dugongidae. 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). It is also the only sirenian in its range, which spans the waters of at least 37 countries throughout the Indo-Pacific (Marsh et al. 2002), though the majority of dugongs live in the northern waters of Australia between Shark Bay and Moreton Bay (Lawler 2002). All extant members of Order Sirenia (including the dugong) are listed as vulnerable to extinction (Anon 1996). 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).

The word "dugong" derives from the Tagalog term *dugong* which was in turn adopted from the Malay *duyung*, both meaning "lady of the sea" (Winger & Jennifer 2000). Other common local names include "sea cow," "sea pig" and "sea camel" (Reeves 2002). Dugong was first classified by Müller in 1776 as *Trichechus dugon*, a member of the manatee genus previously defined by Linnaeus. It was later assigned as the type species of *Dugong* by Lacepede and further classified within its own family Dugongidae by Gray and subfamily Dugonginae by Simpson.

The dugong has a large range and includes tropical and subtropical coastal 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). Feeding is the principal activity of dugongs and typically occurs in water 1-5 m deep. It is estimated that these animals live more than 50 years in the wild, with one estimate suggesting that they may live up to 73 years (Nowak 1999).

Breeding occurs throughout the year and peak months for birth vary geographically. The exact length of gestation is 374 days. Single calves are the norm and twins are rare. Parturition takes place in shallow water, and newborn calves are able to swim immediately to the surface for their first breath of air. Newborn calves are about 100-120 cm long and weigh 20-35 kg. Newborns cling to the mother's back and ride from the surface to grass beds along with the feeding mother. Young suckle underwater beneath the mother in an inverted position. Lactation lasts approximately 18 months, but young are known to eat grass at 3 months. Young may remain with the mother for a year. Sexual maturity is reached in both sexes by an age of 9-10 years, though it can occur as late as 15 years.

In India Dugongs occur along the coast of Gulf of Kutch (Lal Mohan 1963, Frazier & Mundkur 1990), Gulf of Mannar and Palk Bay (Jones 1967, James 1988, Lal Mohan 1976, Frazier & Mundkur 1990), and in the Andaman and Nicobar Islands (Rao 1990, Das 1996, Das & Dey 1999). Herds of hundreds of dugongs were reported to have once occurred in Palk Strait between India and Sri Lanka (Annandale 1905) while dugongs are believed to be extinct in the Maldives and the Laccadive Islands (Husar 1975).

Andaman and Nicobar Islands are one of the biodiversity hotspots of the world, located between Lat. 06°45' to 13°41'N and Long. 92°12' to 93°57'E in Bay of Bengal (Fig. 1). This archipelago comprised of 572 islands with a coastline of about 1,962km and total area of 8,249 km². Andaman group consists of 4 large islands, North, Middle, Baratang and South Andaman forming greater island of over 5000 km² in area surrounded by archipelagoes and isolated islands. The Nicobar Islands are divided into three distinct subgroups. The south is the Great Nicobar group consisting of two islands larger than 100 km², nine islets smaller than 5 km² and few rocks. The Nancowry group is located 58km north of Great Nicobar and it consists of three islands larger than 100 km², two of 36 and 67km², three less than 17km², two islets and a few rocks. The northern most subgroup is 88km north of Nancowry and has Batti Malv and Car Nicobar Islands.

There are few records of dead or alive dugongs from the Andaman and Nicobar coast (Das & Dey 1999). Dugongs 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, Kamorta, Little Nicobar and part of the great Nicobar Islands. However, large populations are no longer seen and numbers are believed to have been declining since 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). Between 1990 and 1994, five dugongs were reported to be sighted along the northwestern side of Kamorta 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) in 1998. Seven species of seagrass were reported by SACON and eight dugongs were sighted during field visits (Das *pers. comm.* 2001). In addition, around Ritchie's Archipelago, 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). Recently, Zoological Survey of India sighted the live dugongs at Kodiaghat, South Andaman in August 2008 and at Teresa Island in July 2009 while conducting undersea surveys by SCUBA diving at the depth of 5-10m. D'Souza & Patankar (2009) sighted three dugongs at Havelock Island, Neil Island and Kodiaghat in South Andaman respectively at 5-9 m deep and observed feeding on seagrass *Halodule* sp. and *Halophila* sp. while D' Souza et al. (2010) summarized the status of dugongs in these is-

lands. Considering the declining population of this mammal, dugongs are protected under Schedule-I category of Wildlife (Protection) Act, 1972. It is also declared as state animal of the Union Territory of Andaman and Nicobar Islands. However, legal hunting by aboriginal tribes and illegal poaching mostly by neighbouring countries are continued to be unabated and posing a threat to insular population of these mammals. The aim of the present investigation is to understand the current status of dugong in Andaman and Nicobar waters and to suggest possible threats for population depletion as well as to draft effective managerial measures to conserve these endangered animals.

MATERIALS AND METHODS

Undersea surveys were conducted along the waters of Andaman and Nicobar Archipelago during the year 2009-10 to investigate the present status of dugong, while monitoring the health of coral reefs (Fig. 2). Dinghy boats were engaged to conduct the intensive surveys in promising areas inhabited by the dugongs. Apart from that, secondary data on the reports of dugongs in these islands were collected through published literature. Consultations and interactions were made with scientific departments as well as fisher-folk communities and local inhabitants to collect the information on sightings of dugong in recent past.

RESULTS

The data on the earlier records of dugong in Andaman and Nicobar Islands collected through the published literature, reports from government departments, personal communications and observations are depicted in Table 1.

Based on the existing data on dugong in Andaman and Nicobar Islands, it is observed that over the period of 51 years since 1959, a total of 76 dugongs were recorded either in the form of live or dead. Among them 47 dugongs were from Andaman Islands, whereas 29 encountered from Nicobar Islands. However, only 44 dugongs were reported live from these islands while 27 and 7 dugongs found dead in Andaman Islands and Nicobar Islands respectively. The distribution of these mammals is comparatively high in north Andaman region, Ritchie's Archipelago in Andaman group and Great Nicobar Island in Nicobar group. Main causative factor for the mortality of dugong is fishing nets especially gillnet and shore seine net.

The undersea observation through surveys and enquiries with local people on the occurrence of dugongs were conducted by the authors with a team of researchers from Zoological Survey of India during the year 2009-2010 while undertaking coral reef monitoring studies along the Andaman and Nicobar Islands, with a view to find management

measures to conserve this threatened marine mammal. The finding of the surveys are summarized as below.

North and Middle Andaman: Surveys and enquires about dugongs were made in Ross Island (Lat 13°18.167'N, Long. 93°04.261'E), Smith Island (Lat. 13°18.406'N, Long. 93°04.207'E), Lamia Bay (Lat. 02°24.879'N, Long. 97°05.516'E), Ariel Bay (Lat.13°16.093'N, Long. 93°02.433'E), North Reef Island (Lat 12°56.084'N, Long. 92°57.345'E), Interview Island (Lat.12°59.125'N, Long. 92°42.981'E), Mayabunder (Lat. 12°56.312'N, Long. 92°33.414'E), Avis Island (Lat. 12°56.210'N, Long. 92°33.066'E), Sound Island (Lat. 12°56.084'N, Long. 92°57.345'E), Rail Island (Lat. 12°56.860'N, Long. 92°54.620'E), Karlo Island (Lat. 12°56.084'N, Long. 92°53.378'E) and Karmatang (Lat. 12°51.322'N, Long. 92°56.050'E) in North and Middle Andaman. According to the local fishermen, few years ago, very sparse population of dugongs was present in these islands, particularly in sheltered bays and creeks. However, nowadays they become rare and hardly seen in these areas. Rao (1990) reported that eastern part of middle Andaman especially Rangat Bay with several islands viz., Baratang, Long, Parkinson, Purlob, Strait, etc. and some extensive creeks are potential zones for dugong colonization. The aboriginal tribes, the Great Andamanese inhabited in Strait Island are traditional hunters of dugong in this middle Andaman region.

South Andaman: Several areas such as Burmanella (Lat. 11°33.468'N, Long. 92°43.873'E), Rangachang (Lat. 11°34.350'N, Long. 92°44.133'E), Chidyatapu (Lat. 11°29.460'N, Long. 92°42.530'E), Pongibalu (Lat. 11°31.030'N, Long. 92°39.159'E), Rutland (Lat. 12°08.522'N, Long. 93°06.551'E), North Wandoor (Lat. 11°37.270'N, Long. 92°37.035'E), Grub Island (Lat. 11°35.391'N, Long. 92°35.637'E), Jolly Buoy Island (Lat 11°30.251'N, Long 92°32.591'E), Tarmugli Island, (Lat. 11°33.261'N, Long. 92°36.809'E), North Bay (Lat. 11°42.068'N, Long. 92°45.116'E), Collinpur (Lat. 11°41.598'N, Long. 92°37.035'E) and Kurumadera (Lat. 11°39.933'N, Long. 92°35.903'E) were surveyed in south Andaman. One adult dugong about 3m long was observed at a depth of 5m in the seagrass bed of Kodiaghat near Chidyatapu during the undersea survey. Besides, information collected from the fisher-folk along these places shown the sighting of these animals become rare in recent past.

Richie's Archipelago: In Ritchie's archipelago, Inglis (Lat.12°08.639'N, Long. 93°06.786'E), Henry Lawrence (Lat. 12°05.000'N, Long. 93°06.312'E), John Lawrence (Lat. 12°04.075'N, Long. 93°00.398'E), Outram (Lat. 12°00.574'N, Long. 92°56.808'E), Peel (Lat. 12°03.315'N, Long. 92°59.929'E), Wall & Nicolson (Lat. 12°13.467'N, Long. 92°01.334'E), South Button (Lat. 12°13.467'N, Long.

92°01.334'E), North Button (Lat. 12°18.974'N, Long. 92°03.826'E), Middle Button (Lat. 12°16.473'N, Long. 93°01.334'E), Neil (Lat. 11°50.826'N, Long. 93°00.554'E) and Havelock (Lat. 12°00.005'N, Long. 92°56.808'E) Islands were surveyed. According to fishermen and local inhabitants, sporadic sightings of dugong were found in Neil and Havelock Islands especially in the seagrass meadows. In general, Richie's archipelago is considered as potential zone for the habitation of this animal. As noticed by Rao (1990), the Great Andamanese settled on the nearby Strait Island were hunting fish and dugong in this archipelago leads to the reduction in population of dugongs.

Little Andaman: The places in Little Andaman viz., Butler Bay (Lat. 10°40.232'N, Long 92°56.808'E), Kalapathar (Lat. 10°39.558'N, Long. 92°34.109'E), Haminder Bay (Lat. 10°32.975'N, Long. 92°32.651'E), Ramkrishnapur (Lat. 10°42.630'N, Long. 92°33.066'E), Sister Island (Lat. 10°55.830'N, Long. 92°07.023'E), Hut Bay (Lat. 10°35.419'N, Long. 92°33.066'E) and Dugong Creek (Lat. 10°48.385'N, Long. 92°64.000'E) were surveyed. According to local fishermen, dugongs can be sighted rarely in these areas, whereas they were in good numbers in Dugong Creek. The aboriginal tribes, the *Onges* are traditional hunters of dugong in Little Andaman. *Onges* are experts in harpooning these animals when they are grazing grounds. These tribes are very fond of dugong meat and a catch of the animal is a festive occasion. The Dugong Creek once famous for this mammal, no longer seemed to support any dugong having possibly been overexploited by the *Onges* (Rao 1990).

Car Nicobar: Areas such as Malacca (Lat. 09°10.490'N, Long. 92°49.714'E), Kakaana (Lat. 09°07.750'N, Long. 92°48.678'E), Tamaloo (Lat. 09°11.350'N, Long. 92°49.498'E), Kimos (Lat. 09°07.587'N, Long. 92°46.316'E), Perka (Lat. 09°11.203'N, Long. 92°49.877'E) and Lapati (Lat. 09°13.978'N, Long 92°48.002'E) were surveyed. No record of existence of the dugong in this island could be made upon the interaction with the fishermen. Moreover, this island is exposed by heavy wave action and currents which may not provide a suitable habitat for this animal. Earlier, surveys made by Rao (1990) in Car Nicobar and Battimalay Islands revealed that the fishermen especially the Nicobarese were not aware of existence of dugong in these islands.

Nancowry: Surveys were conducted in Kamorta (Lat. 12°51.322'N, Long. 92°56.050'E), Champin (Lat. 08°01.670'N, Long. 93°33.123'E), Trinket (Lat. 08°02.806'N, Long. 93°34.556'E), Munak (Lat. 07°59.813'N, Long. 93°30.534'E), Katchal (Lat. 07°58.952'N, Long. 93°24.351'E), Teresa (Lat. 08°13.686'N, Long. 93°10.913'E) and Kundol (Lat. 07°10.023'N, Long. 93°42.949'E) Islands of Nancowry group. Single specimen of dugong about 2.7m long was ob-



Fig.1: Andaman and Nicobar Islands.

served at a depth of 7m in Teresa Island during the survey. During the course of observation this animal was surfaced thrice. According to local fishermen, this mammal could be noticed frequently in the near-shore area of this island. The Nancowry harbour with many inlets and sheltered areas offers excellent habitat for colonization of dugong in this region (Rao 1990). However, in other islands, although there were some earlier reports on the occurrence of dugong, they were not been encountered in recent years.

Great Nicobar: In Great Nicobar Island, Campbell Bay (Lat. 06°59.749'N, Long. 93°56.718'E), Lakshman Beach (Lat.



Fig. 2: Area surveyed.

07°01.482'N, Long. 92°37.456'E), Gandhi Nagar (Lat. 06°50.496'N, Long. 93°53.680'E), Laxmi Nagar (Lat. 06°53.827'N, Long. 93°53.976'E), Johinder Nagar (Lat. 06°57.226'N, Long. 93°55.495'E), Chingem Basthi (Lat. 06°58.307'N, Long. 93°55.748'E), Navy Dera (Lat. 07°07.571'N, Long. 93°53.133'E), Indira Point (Lat. 06°45.428'N, Long. 93°49.541'E), Kopen Heat (Lat. 06°50.923'N, Long. 93°47.983'E) and Afra Bay were surveyed. It is observed that, though dugongs were large in numbers during 1990s particularly during pre-monsoon periods, present days their population is declined and became rare. Surveys conducted by Rao (1990) in the year 1990 stated that, dugongs were reported more commonly around Great Nicobar, which is quite extensive in the area offering several sheltered bays. Ranganatha Bay, Changappa Bay, Campbell Bay, Bonnington Bay, Galathea Bay and Casuarina Bay are potential areas for the habitation of dugong on the island (Rao 1990).

DISCUSSION

The dugong is classified as vulnerable to extinction by the World Conservation Union on the basis of decline in area of extent of occupancy, habitat quality, and actual or potential levels of exploitation. The global distribution of this endangered species is limited to the warm temperate and tropical

coastal waters of Indo-Pacific region between the east coast of Africa and Red Sea to the west coast of Australia. Within the Indian region, it was recorded only from Gulf of Kutch (Mani 1960, Mohan 1963), Gulf of Mannar (Thomas 1966) and Andaman Islands (Jones 1988). In India, dugongs were common in the 1950s, but the population has dropped drastically in the recent past, as evidenced by sporadic sightings and rare records of poaching. Due to overexploitation, the dugong completely disappeared in many areas, while its residual populations still existed at other places (Rao 1990).

Most of the places surveyed, the sea-grass beds in shallow waters are quite sparse. The killer tsunami in December 2004, made a drastic change in the coastal ecosystem of Andaman and Nicobar Islands including seagrass meadows. Post tsunami surveys indicated that most of the places in these islands, seagrass beds were buried by deposition of sand and sediments (Kannan et al. 2005). It is also observed that only Henry Lawrence Island has good growth of seagrass, as this island is in middle Andaman group which is less affected by tsunami when compared to south Andaman and entire Nicobar group of islands (Thangaradjou et al. 2010). Impact of tsunami coupled with scarcity of seagrasses in the coastal waters might be a cause for the reduction in dugong population in these islands. Many of the sheltered bays and inlets on the eastern side of the islands which once formed traditional abodes of dugong are now largely disturbed and utilized for fishing and navigational activities. Due to increasing human interferences, the residual population of dugong is struggling for its very survival in a few pockets of these islands (Rao 1990).

Rare records of poaching and hunting also plays a vital role to reduce the population density of dugong in these islands. Most of the tribes, namely Great Andamanese, Onges and Nicobarese, traditionally hunt dugongs with iron harpoons tied to the boat. However, none of the tribes except Andamanese in Strait Island practices regular hunts because of the time and effort it takes to catch this animal. Fishing in seagrass bed region is also a potential threat as mortality and stranding of dugong reported in the past by the entanglement of this mammal in gillnets. Habitat loss is one the prime reasons for the decrease in the dugong population in these islands due to anthropogenic activities such as boat traffic and natural calamities like cyclones, tidal waves, high energy tidal storms, and frequent tremors and earthquakes.

The present study opined that the dugongs are less abundant than in recent past. Although dugong numbers are greatly reduced and large populations are no longer seen, dugong still exists at least around Ritchie's Archipelago, North Reef, Little Andaman, Nancowry, Little and Great Nicobar Islands. However, more intensive studies are required to locate all the areas inhabited by dugong in order to ascertain its exact population density.

Threats to Dugong Population

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. 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.

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

Fishing pressure: Accidental entangling in gill and mesh nets or traps set by fishers is considered a major, but largely not quantified, cause of dugong mortality in many countries (Perrin et al. 1996) and was identified as a major concern.

Hunting: Dugongs are culturally significant to communities throughout their range. Dugongs are hunted for meat, oil, medicaments, amulets, hides for leather, and bones and teeth for ivory artefacts, and charcoal for sugar refining, 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.

Vessel strikes: Although, there exists no report on the mortality of dugongs due to vessel strikes in Andaman and Nicobar Islands, increasing vessel traffic in the dugong's range increases the likelihood of strikes. Extensive shallow areas used by regionally important population of dugong and situated close to areas of high boat traffic, are particularly at risk.

Pollution: Dugongs accumulate high levels of some heavy metals with age (Miyazaki et al. 1979, Denton et al. 1980, Haynes 2001). However, there is no evidence to suggest that

Table 1: Record of *Dugong dugon* in Andaman & Nicobar Islands.

Sl. No.	Year	Place	Region	No. of animals	State of record	Source	Remark
1.	1959	Pokkadera, Mayabunder	Andaman	1	Dead	Fishermen	Entangled in gillnet
2.	1960	Diglipur	Andaman	1	Live	CMFRI	Undersea observation
3.	1961	Diglipur	Andaman	1	Live	CMFRI	Undersea observation
4.	1963	Diglipur	Andaman	1	Live	CMFRI	Undersea observation
5.	1964	Diglipur	Andaman	1	Live	CMFRI	Undersea observation
6.	1967	Teressa Island, Nancowry	Nicobar	1	Live	CMFRI	Undersea observation
7.	1972	Campbell Bay, Great Nicobar Island	Nicobar	1	Live	Local inhabitant	Entangled in gillnet
8.	1975	Magar nallah, Great Nicobar Island	Nicobar	1	Live	Local inhabitant	Entangled in gillnet
9.	1976	Lakshman Beach, Great Nicobar Island	Nicobar	1	Live	Local inhabitant	Entangled in gillnet
10.	1976	Teressa Island, Nancowry	Nicobar	1	Live	CMFRI	Undersea observation
11.	1977	Campbell Bay, Great Nicobar	Nicobar	1	Live	CMFRI	Undersea observation
12.	1979	Paschim Sagar, Mayabunder	Andaman	1	Dead	Fishermen	Entangled in gillnet
13.	1979	Tarmugli, Diglipur	Andaman	1	Dead	Fishermen	Entangled in gillnet
14.	1974	Ross Island, Diglipur	Andaman	1	Dead	Local inhabitant	Entangled in gillnet
15.	1974	Durgapur, Diglipur	Andaman	1	Dead	Fishermen	Entangled in shore seine net
16.	1976	Aberdeen Jetty, Port Blair	Andaman	1	Dead	CMFRI	Entangled in gillnet
17.	1980	Long Island, Rangat	Andaman	1	Dead	Fishermen	Caught by shore seine net
18.	1981	Campbell Bay, Great Nicobar	Nicobar	1	Live	CMFRI	Undersea observation
19.	1982	Laful Bay, Great Nicobar	Nicobar	1	Live	Local Inhabitants	Entangled in gillnet
20.	1983	Little Andaman (near Jetty)	Andaman	2	Live	Fishermen	Entangled in gillnet
21.	1984	Lakshman Beach., Great Nicobar	Nicobar	4	Live	Local inhabitants	Entangled in gillnet
22.	1984	Laful Bay, Great Nicobar	Nicobar	1	Live	Local inhabitants	Entangled in gillnet
23.	1985	Ross Island (Mayabunder)	Andaman	1	Live	Fishermen	Entangled in gillnet
24.	1985	Laful Bay, Great Nicobar	Nicobar	1	Live	Local inhabitant	Entangled in gillnet
25.	1986	Lakshman Beach, Great Nicobar Island	Nicobar	1	Live	Local inhabitant	Caught by shore seine net
26.	1986	Sound Island, Mayabunder	Andaman	1	Dead	Fishermen	Entangled in gillnet
27.	1986	Long Island, Rangat	Andaman	1	Dead	Fishermen	Entangled in gillnet
28.	1986	Aberdeen jetty, Port Blair	Andaman	1	Dead	ZSI	Stranded on shore
29.	1987	Long Island, Rangat	Andaman	1	Dead	Fishermen	Entangled in gillnet
30.	1987	Tarmugli, Mayabunder	Andaman	1	Dead	Fishermen	Entangled in gillnet
31.	1987	Paschimsagar, Diglipur	Andaman	1	Dead	Fishermen	Entangled in gillnet
32.	1987	Chidyatapu	Andaman	1	Dead	ZSI	Stranded on shore
33.	1987	John Lawrence Island	Andaman	1	Live	ZSI	Undersea observation
34.	1988	Lakshman Beach, Great Nicobar Island	Nicobar	1	Live	Local inhabitant	Caught by shore seine net
35.	1988	Little Andaman	Andaman	1	Live	Fisheries Department	Caught by shore seine net
36.	1988	Smith Island, Diglipur	Andaman	1	Live	ZSI	Undersea observation
37.	1988	Hut Bay, Little Andaman Island	Andaman	1	Dead	ZSI	Caught by shore seine net
38.	1988	Campbell Bay, Great Nicobar Island	Nicobar	1	Live	Local inhabitant	Caught by shore seine net
39.	1988	Nancowry	Nicobar	1	Dead	Fisheries Department	Entangled in gillnet
40.	1988	Paschimsagar, Diglipur	Andaman	1	Dead	Fishermen	Entangled in gillnet
41.	1988	North Reef Island, Mayabunder	Andaman	1	Dead	Fishermen	Entangled in gillnet
42.	1988	Smith Island	Andaman	1	Live	ZSI	Entangled in gillnet
43.	1989	Campbell Bay, Great Nicobar Island	Nicobar	1	Live	Fishermen	Caught by shore seine net
44.	1989	Chengappa Bay, Great Nicobar Island	Nicobar	1	Dead	ZSI	Caught by shore seine net
45.	1989	Campbell Bay, Great Nicobar Island	Nicobar	1	Dead	ZSI	Caught by shore seine net
46.	1989	Mayabunder	Andaman	1	Live	ZSI	Underwater observation
47.	1989	Pilo Kunji, Great Nicobar Island	Nicobar	1	Dead	Fisheries Dept.	Stranded on shore
48.	1990	Henry Lawrence Island	Andaman	2	Live	ZSI	Undersea observation
50.	1990	John Lawrence Island	Andaman	1	Dead	ZSI	Entangled in gillnet
51.	1990	Bonnington Bay, Great Nicobar Island	Nicobar	1	Dead	ZSI	Caught by shore seine net
52.	1990	Long Island , Rangat	Andaman	1	Live	ZSI	Undersea observation
53.	1990	Purlob Island, Rangat Bay	Andaman	1	Live	ZSI	Undersea observation
54.	1990	Stwert Island, Diglipur	Andaman	1	Live	ZSI	Undersea observation
55.	1990	Bomila Creek, Little Andaman Island	Andaman	1	Live	ZSI	Undersea observation
56.	1990	South Brother Island, Little Andaman	Andaman	1	Live	ZSI	Undersea observation
57.	1990	Nancowry harbour	Nicobar	1	Live	ZSI	Undersea observation
58.	1990	Renganatha Bay, Great Nicobar Island	Nicobar	1	Live	ZSI	Undersea observation

Cont Table...

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59.	1990	Galathea Bay, Great Nicobar Island	Nicobar	2	Live	ZSI	Undersea observation
60.	1997	Netaji nagar, Little Andaman	Andaman	1	Dead	Fisheries Dept.	Entangle in gillnet
61.	1999	Burmanallah, South Andaman	Andaman	1	Dead	ZSI	Entangled in gillnet
62.	2000	Campbell Bay, Great Nicobar Island	Nicobar	1	Dead	Forest Dept.	Stranded on shore
63.	2002	Hitui, Nancowry	Nicobar	1	Dead	Nicobari tribe	Harpoon fishing
64.	2006	Karmatang, Mayabunder	Andaman	1	Dead	Local inhabitant	Harpoon
65.	2007	Neil Island	Andaman	1	Dead	Reef Watch Marine	Conservation Stranded on shore
66.	2007	Corbyn's Cove, Port Blair	Andaman	1	Dead	Pondicherry University	Stranded on shore
67.	2008	Laxmi Nagar, Great Nicobar Island	Nicobar	1	Dead	Local inhabitants	Stranded on shore
68.	2008	Neil Island	Andaman	1	Dead	Greenlife Society	Undersea observation
69.	2008	Kodiaghat, Chidyatapu	Andaman	1	Live	ZSI	Undersea observation
70.	2009	Teresa Island, Nancowry	Nicobar	1	Live	ZSI	Undersea observation

ZSI – Zoological Survey of India, CMFRI – Central Marine Fisheries Research Institute

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. Necropsy sampling of dugong has determined that the pesticide 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).

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 and two by unidentified parasites. 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). 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).

RECOMMENDATIONS FOR THE EFFECTIVE MANAGEMENT

Based on the observations on dugongs made in the present study, the following recommendations are drafted for the effective management of this mammal in Andaman and Nicobar Islands.

1. High priority should be given to monitoring dugong distribution and relative abundance using regular aerial surveys.

2. 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.
3. Research is also needed to study seasonal changes in seagrass growth rates and productivity with a view to develop a model of dugong grazing.
4. 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.
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.
6. All vessels/boats operating in Andaman and Nicobar Islands should have a dugong sighting log which will enable to understand the distribution of dugong in all over these islands as well as effective management.
7. Development of a chart detailing the distribution of seagrass beds in Andaman and Nicobar Islands to allow fishermen to identify potential dugong areas and to avoid fishing in those zones.

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