Assessment of Dugong distribution, habitat and risks due to fisheries and other anthropogenic related activities in India

FINAL REPORT (*July 2012 to June2013*)

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Preface

The dugong (*Dugong dugon*), is the only existing species of herbivorous mammal that lives in Indian sea waters. This protected species occurs in the Gulf of Mannar, Palk Bay, Gulf of Kutch and Andaman and Nicobar Islands. The population of the dugong and its habitats are continuously declining in India. Several reasons have been attributed to the decline in the dugong population, including sea grass habitat loss, gill netting, disease, water pollutants, indigenous use and poaching. Wildlife Institute of India has initiated a study to understand the dugong's current distribution range and the magnitude of the anthropogenic threats faced by it and its habitat in India. Region-specific threats to the dugong and its habitat have been identified through this study. Dugong occupancy was greatest in the Gulf of Mannar and Palk Bay, followed by the Andaman and Nicobar Islands, and lowest in the Gulf of Kutch. Overall, the dugong distribution range has significantly decreased by about 85% in distribution range in India.

Dugongs are also exist in regions outside the protected areas (PA) network. Thus, conservation planning should also focus on dugong habitats outside PAs. Preventive measures, such as affording greater protection to dugongs and making fisheries sustainable with dugong-friendly gear and craft, especially in the critical dugong habitats identified are needed. It is of utmost importance to secure and strengthen community participation in the management of dugongs and their habitats in India. National Board for Wildlife under the Chairmanship of the Hon'ble Prime Minister constituted two Sub-Committees comprising conservation experts for recovery of threatened Terrestrial and Aquatic species in India. These Committees have developed Guidelines for Threatened Species Recovery Plan. These Committees after detailed deliberations have chosen the dugong along with other 15 highly threatened species for preparation of recovery plans in the first phase. In this context, this study would be immense use for developing the 'Species Recovery Plan' for dugong in India.

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Gulf of Kutch

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Summary

The dugong (Dugong dugon), also called the sea cow, is one of the four surviving species in the order Sirenia, and it is the only existing species of herbivorous mammal that lives exclusively in the sea, including Indian waters. Conservation of the dugong, which is a flagship species, represents coastal conservation. This protected species occurs in the Gulf of Mannar, Palk Bay, Gulf of Kutch and Andaman and Nicobar Islands. The population of the dugong, which was once abundant, is assumed to have reduced to about 200 individuals in India. This number and the range of the dugong are believed to be continuously declining.

Several reasons have been attributed to the decline in the dugong population, including sea grass habitat loss and degradation, gill netting, disease, water pollutants, indigenous use and poaching. This study was initiated to understand the dugong's current distribution range and the magnitude of the anthropogenic threats faced by it and its habitat in India. The objectives include (1) determining the status and distribution of the dugong population in India, (2) understanding the risks faced by the dugong populations and their habitats, (3) assessing the status of artisanal fisheries in identified dugong habitats, (4) identifying the key areas where dugongs are present to conserve them and (5) understanding the attitudeof fishermen towards conservation of dugongs. Three zones, namely the Gulf of Kutch, Andaman and Nicobar Islands and Gulf of Mannar–Palk Bay were identified as the study area on the basis of information published on dugong sightings, stranding records and seagrass presence. A standardised dugong catch/bycatch questionnaire developed by the CMS-UNEP Dugong MOU Panel was used for interview surveys after it was translated into regional languages.

Region-specific threats to the dugong and its habitat were identified. Occupancy models were built in the program PRESENCE to identify critical dugong habitats using dugong sighting data from the past 5 years (2008 to 2012). The range of variables that influenced occupancy and detection were also assessed. Dugong occupancy was greatest in the Gulf of Mannar and Palk Bay, followed by the Andaman and Nicobar Islands, and lowest in the Gulf of Kutch. At present, the overall occupancy of the dugong in Indian waters is estimated to be 11% of the total surveyed area. Only 21% of the area sampled in Tamil Nadu was found to be occupied by dugongs. The corresponding proportion was 12% in the

Andaman and Nicobar Islands and 1% in the Gulf of Kutch. Overall, the dugong distribution range has significantly decreased by about 85% in the distribution range of the dugong in India.

Dugongs are also exist in regions outside the existing protected area (PA) network. Thus, conservation planning should also focus on dugong habitats outside PAs. Preventive measures, such as affording greater protection to dugongs and making fisheries sustainable with dugong-friendly gear and craft, especially in the critical dugong habitats identified, are recommended. It is of the utmost importance to secure and strengthen community participation in the management of dugongs and their habitats in India.

Model of dugout canoe (Hodi) - Little Andaman, Andaman Islands

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1. INTRODUCTION

Dugongs (*Dugong dugon* Müller, 1776*),* also known as sea cows, are herbivorous marine mammals belonging to the family Dugongidae and order Sirenia. They are distributed in the Indo-Pacific region and their diet consists mostly of seagrasses of the genera *Cymodocea*, *Halophila*, *Thalassia* and *Halodule* Marsh *et al.* 1999, 2002). Developmental activities and an economic dependence of coastal populations on marine resources threaten near-shore seagrass beds, which are declining globally at a rate of 7% per year (Waycott *et al.* 2009; Green and Short 2003). Restricted to the inshore waters due to their dependence on seagrass beds, dugongs remain vulnerable to hunting, boat strikes and habitat disturbances . Additionally, incidental entanglement in gill nets has been identified one of the prime causes of the decline of the dugong population in all the sub-regions of its current distribution, which extends across the waters of 37 countries (Marsh *et al*. 2002).

In Indian waters, the dugong population is facing a risk of local extinction due to high mortality in the wild (Marsh *et al.* 2002). Fishery-related factors such as accidental capture in gill nets, hunting and boat strikes are responsible for the dwindling dugong numbers and degradation of its habitat in this region (Marsh *et al.* 2002; Nair *et al*. 1975; Das and Dey 1999). There is paucity of information on the region-specific magnitude and distribution of anthropogenic threats. Additionally, with limited resources, it is vital to identify and focus research and conservation action in key locations. The logistic and economical constraints of aerial and boat surveys make an interview-based survey the ideal method for conducting marine mammal surveys in developing nations (Aragones *et al.* 1997; Marsh *et al.* 2002). Verified information from the interviews can help establish priority areas for detailed technologically advanced surveys and form the baseline for formulating future research hypotheses (Aragones *et al.* 1997). Therefore, a standardized dugong catch/incidental catch survey was undertaken to rapidly obtain data rapidly on the spatial and temporal occurrence of the dugong, threats faced by it, artisanal fisheries and the perceptions of fishermen.

The major objectives of the study were:

To determine the status and distribution of the dugong population in India

1. To understand risks faced by dugong populations and their habitats
2. To assess the status of artisanal fisheries in identified dugong habitats
3. To identify key areas of dugong presence for conserving them
4. To understand the attitude of fishermen towards conservation of dugongs.

2. BACKGROUND

2.1 Classification

The order Sirenia contains five species of aquatic marine mammals under two families; three species of manatee in the family Trichechidae and two in the family Dugongidae. The four surviving species include the Amazon manatee (*Trichechus inunguis*), the West Indian manatee (*Trichechus manatus*), the West African manatee (*Trichechus senegalensis*) and the dugong (*Dugong dugon*). Another member of the family Dugongidae, Steller's sea cow (*Hydrodamalis gigas*), was exterminated by North Pacific seal hunters in the 18th century.

Phylum	:	Chordata
Class	:	Mammalia
Order	:	Sirenia
Family	:	Dugongidae
Genus	:	Dugong
Species	:	*Dugong dugon* (Müller, 1776)

2.2 Characteristics features

The dugong (*Dugong dugon*) is a grey brown animal that looks a bit like a cross between a seal and a whale. It has a powerful fluked tail and small front flippers, which act like paddles to stabilize it when it swims. The forelimbs are also used for scratching, mouth-cleaning and supporting the body when resting on the bottom. The movement of a dugong is often slow and graceful. It measures 2-4 meters in length and weighs up to 400 kg. An air-breathing mammal, totally adapted to life in

the sea, the dugong spends much of its time grazing on seagrasses. It is for this reason that it is often called a sea cow.

Dugongs are shy, secretive animals that are very difficult to approach. They have poor eyesight, but their hearing is sharp. Even though the external ear opening is tiny, their large internal ears enable them to hear well, both on the surface and under water. Dugongs are capable of staying submerged for 6 minutes or more. They must surface regularly, albeit for only 1–2 seconds at a time (Anderson 1981). They are hard to see as they can take a breath by exposing only the nostrils, which are placed on the top of their snout.

2.3 Breeding behaviour

Dugongs can live for about 70 years. They breed very slowly, and females start breeding when they are aged between 10 and 17 years. Breeding occurs throughout the year, and peak months for birth vary geographically. The exact length of gestation is unknown, but it is presumed to be about 12–14 months (Marsh 1986). 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 above the surface to grass beds along with the feeding mother. The young suckle underwater beneath the mother in an inverted position. Lactation lasts approximately 18 months, but calves are known to eat grass at 3 months and may remain with the mother for a year. Dugongs have a slow reproductive rate. A female will raise only one calf every 3–7 years (Marsh *et al.* 1984; Marsh 1986).

2.4 Feeding behaviour

The dugongs are the only strictly marine herbivores and feed mainly on seagrasses. If the seagrass is short, they root at the bottom, eating rhizomes, stems and leaves, and cause sediments to cloud the water. If the seagrass is tall, they just strip the leaves from the stems. Given a choice, they select younger and softer plants, but they will eat any species available. A small amount of algae is also eaten in the

process. Seagrass has low nutritional value, and so dugongs must consume vast amounts. In captivity, they eat 20 to 30 kg a day. Most marine animals do not eat seagrass for they cannot digest cellulose. Dugongs crush the leaves and roots against the special horny plates in their mouth before passing them back to their teeth. The seagrasses quickly wears the teeth down, and to compensate, dugongs have molars that continue to grow throughout their lives.

Feeding is the principal activity of dugongs and typically occurs in water 1–5 m deep. Wear on the tusks and trails through grass beds provide evidence that some digging or rooting is part of the feeding behaviour. Head-shaking has been notedduring feeding and appears to be useful in cleaning sediments from the food before ingesting, as little sediment is reported in the stomach contents of animals examined. The timing of feeding seems to be most closely related to tides and not photoperiodic.

2.5 Habitat use and movement

Dugongs inhabit shallow tropical coastal waters and are more strictly marine than are manatees. Since their main source of food is seagrasses, by and large their habitat mirrors that of seagrasses. Thus, they are shallow-water animals feeding in waters just a few metres deep. Long-distance migration of dugongs is unknown, but some daily and seasonal movements do occur in some populations. The tides, water temperature and food abundance are probably the main factors involved in these movements.

2.6 Economic and cultural significance

Traditionally dugongs were hunted by some of the tribes in the Andaman and Nicobar Islands, fishermen and local people in Tamil Nadu and Sri Lanka. However, currently, due to their low abundance, dugongs are not the target species for hunting in most of these areas. The Onge, on Little Andaman, use bones of dugongs (tusks, rib bones, pelvic/pectoral girdles) as ornaments. There are several myths related to dugongs and their bones. For example, there is one myth that carrying

decorated dugong bones makes hunting successful. Seagrasses are utilised for paper production and as green manure and fodder in many South-East Asian nations.

2.7 Seagrass beds – Dugong habitat

Seagrasses are submerged vascular plants belonging to two families, Hydrocharitaceae and Potamogetonaceae. They are adapted to the marine environment and complete their life cycle underwater. In contrast to other submerged marine plants (e.g. seaweeds), seagrasses flower, fruit and produce seeds. They also have true roots and an internal system for transport of gases and nutrients. They generally grow in shallow coastal waters from the intertidal zone to depths of up to 10 m. In turbid estuarine environments, such as the Indian coast, where there is enormous deposition of silt into the sea by the major rivers, seagrasses are rarely encountered at depths below 10 m. In less turbid areas, such as the Caribbean Sea and Australian coast, seagrasses can be found at depths of 50 m .

Extremely widespread and occurring in the shallow waters of every coast and sea except the polar region, seagrasses fall within 12 genera. Seven of these are considered tropical, while the remaining five are mostly confined to temperate waters. The tropical seagrasses are not homogeneously distributed . The Indo-West Pacific region has all seven genera of seagrasses of the tropics. The geographic distribution of the seagrasses is well known in South-East Asian countries and along the Australian and Caribbean coasts. Areas from which records are scarce include parts of South America, Africa and the Indian subcontinent.

A range of fishes, molluscs, crustaceans and echinoderms are among the predominant fauna of seagrass habitats. The macrofauna living in these habitats mainly comprise oligochaetes, polychaetes, crustaceans and nematodes, while the meiofaunal groups mainly consist of turbellarians, nematodes and harpacticoids . The leaves of the seagrass plants provide space for microscopic plants and animals (epiphytes) to colonise. When the leaves die they are degraded by microbes. Many species of fish, echinoderms, crabs, shrimps and snails feed on the tiny organisms on both the live and decomposing seagrass leaves. While few animals, namely sea

turtles and dugongs, feed on seagrass leaves, the dense canopy formed by the leaves under the water provides valuable shelter from predators for a variety of animals.

Seagrass meadows thus play a significant role in the processes and resources of near-shore coastal ecosystems as they have physical, chemical and biological effects on habitats. These include prevention of erosion; trapping and binding of sediments and organic detritus; providing a stable habitat for epiphytes; raising therate of production; and contributing to the detritus food chain .

A number of biotic and abiotic stresses can affect seagrasses, depending on both the nature and severity of the particular environmental challenge. Generally, if only leaves and above-ground vegetation are impacted, seagrasses are generally able to recover from damage within a few weeks; however, when the damage affects roots and rhizomes, the ability of the plant to produce new growth is severely impacted, and the plant may never be able to recover (Orth *et al*., 2006)).

In recent decades, destruction of seagrass meadows has occurred worldwide (Orth et al., 2006)). Some of the loss is a result of natural events, such as high-energy storms, but most seagrass loss has resulted from human activities, such as eutrophication (Orth *et al*. 2006)), land reclamation and changes in land use. The apparent sensitivity of seagrasses to external environmental change, often induced by man, can be expected to cause wide fluctuations in the populations of the marine fauna that they support (Orth *et al*. 2006), for example the dugong (*Dugong dugon*) which is one of the most threatened marine mammals of the Indian Ocean (Das 1996).

2.8 Distribution and status of seagrass habitat in India

Although seagrass beds are distributed sporadically all along the Indian coast, including the Andaman and Nicobar Islands and Lakshadweep Islands, the major concentrations are in the Gulf of Mannar, the Andaman and Nicobar Islands, the Lakshadweep Islands and the Gulf of Kutch. The dugong occurs in all these regions except the Lakshadweep Islands (Lal Mohan 1963; Nair *et al.* 1975; Silas 1961; Marsh *et al.* 2002). The flora is dominated by *Cymodocea rotundata, C. serrulata, Thalassia*

hemprichii, Halodule univervis, H. pinifolia, Halophila beccarii, H. ovata and *H. ovalis*. The distribution occurs from the intertidal zone to a maximum depth of ~15 m. A significant correlation was observed between depth and biomass in major seagrass meadows. The Gulf of Mannar is well known for its rich diversity of sea grasses, along with the dugong. The Wildlife Institute of India (2009) estimated that the total extent of seagrass beds around all islands of the Gulf of Mannar Biosphere Reserve is about 80.7 km^2. The species composition of the seagrass community in the Gulf of Mannar region includes *Enhalus acoraides, Halophila ovalis, Halophila ovata, Halophila beccari, Halophila stipulacea, Thalassia lemprichii, Cymadocea serrulata, Cymadocea rotundata, Halodule uninervis* and *Syringodium isoetifolium*. In the Andaman and Nicobar Islands, seven species of seagrass were discovered at a single site in Dugong Creek (Das and Dey 1999).

2.9 Threats

The dugong is a long-lived animal with a life span of up to 70 years, a minimum pre-reproductive period of 9–10 years and an estimated mean calving interval of 3–7 years (Marsh *et al.* 1984; Marsh 1986). With the low reproductive rate, long generation time and large interval between offsprings, it is estimated that the maximum rate of increase is likely to be about 5% per year (Marsh 1995). As such, dugongs are susceptible to over-exploitation. Their vulnerability is increased by their dependence on a specialized environment, the seagrass habitat.

There is an increasing demand to use the coastal zone for residential, recreational and agricultural purposes. These activities will make the coastal zone more susceptible to pollution, which causes destruction and degradation of the seagrass beds (Sivakumar 2012). Pollution can also affect dugongs physiologically through bioaccumulation of toxic compounds. The dugong has been reported to accumulate mercury and organochlorine compounds in the muscles .

Several reasons have been attributed to the decline of the dugong population, including seagrass habitat loss and degradation, gill netting, disease, chemical pollutants, indigenous use and hunting. Dugongs are vulnerable to anthropogenic pressures as they are solely dependent on seagrasses in coastal areas, which now

have been seriously damaged by fishing, trawling and dredging (Marsh *et al*. 2002, Nair *et al.* 1975; Das and Dey 1999). Dugongs have also been hunted for their meat, oil, hide, bones and teeth. However, hunting has been totally banned in several countries, including India.

The feeding grounds of the dugong, i.e. seagrass beds, are highly degraded due to changes in fishing methods. Traditionally, fishermen used non-mechanised boats for fishing in shallow water, especially seagrass beds; however, due to modernization of fishing technology, traditional crafts have been gradually replaced by mechanized crafts that have never been friendly with seagrass beds and degrade this habitat swiftly (Sivakumar 2012Moreover, water pollution and siltationare also hampered this unique habitat of dugong. Although the dugong is getting the highest level of protection under law, the species continues to be poached by fishermen for its meat.

2.10 Historical status and distribution of dugong in India

In India, dugongs have been reported from the Andaman and Nicobars Islands, Gulf of Mannar, Palk Bay, Gulf of Kutch and Lakshadweep Islands (Annandale 1905; Prater 1928; Pocock 1940; Moses 1942; Jones 1959, 1980, 1981; Mani 1960; Silas 1961; Lal Mohan 1963, 1976; Nair *et al*. 1975; Husar 1975; Frazier and Mundkur 1990; Marsh *et al.* 2002). The recent absence of sighting records is indicative of local extinction of the dugong from the Lakshadweep Islands (Husar 1975).

Recent dugong records from the Gulf of Mannar, Palk Bay, Gulf of Kutch and Andaman and Nicobar Islands are based on instances of stranding (Annandale 1905; Prater 1928; Pocock 1940; Moses 1942; Jones 1959, 1967, 1980, 1981; Mani 1960; Silas 1961; Lal Mohan 1963; James 1974; Nair *et al*. 1975; Silas and Fernando 1985; Frazier and Mundkur 1990; Singh 2003; Marsh *et al*. 2002). Detailed studies on dugong ecology are rare (Das 1996; D'souza and Patankar 2009). Currently the largest population of dugongs in India is believed to be in the Gulf of Mannar and Palk Bay region, followed by the Andaman and Nicobar Islands, although the population size in each of these regions is presumed to be very small (Sivakumar 2006; Choudhury and Sivakumar 2007). After an interview-based study conducted by GEER in 2009, it was speculated that the dugong population in India is between 131

and 254 individuals, of which 77 to 158 individuals are in the Gulf of Mannar, 44 to 81 individuals are in the Andaman and Nicobar Islands and 10 to 15 dugongs are in the Gulf of Kutch (Pandey *et al*. 2010).

2.11 Status of regional conservation measures

Assessed as Vulnerable by the IUCN, the dugong is considered to be facing a high risk of extinction in the wild. In India, dugongs are protected under Schedule-I of the Wildlife (Protection) Act, 1972 (WPA), which makes hunting, killing and capture of dugongs and buying and selling dugong meat punishable by imprisonment. The Government of India is a signatory to CITES, and dugongs are listed in Appendix-I of CITES, which prevents international trade in the species. At present, a few dugong habitats fall within the existing protected area network, for example, the Gulf of Kutch Marine Protected Area (22°34′ N, 69°40′ E), Gulf of Mannar Marine National Park (9°07′ N, 79°36′ E) and M.G. Marine National Park (11°34′ N, 92°39′ E).

In April 2008, the Government of India signed the Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range (UNEP/CMS Dugong MoU) to strengthen the protection and management of dugongs and their habitats in Indian waters with the support of international community. The UNEP/CMS Dugong MoU, which has 11 range states to date as signatories (Australia, Eritrea, France, Madagascar, Myanmar, the United Arab Emirates, the United Republic of Tanzania, India, the Comoros, Kenya and the Philippines), provides a platform for coordinating conservation and management throughout the dugong's extensive range to ensure its long-term survival.

Dugong is one of the eight critically endangered species identified by the Ministry of Environment and Forests, GOI under the species recovery component of Integrated Development of Wildlife Habitats (CSS-IDWH), a centrally sponsored scheme. Additionally, the Task Force for Conservation of Dugongs was constituted to ensure implementation of the UNEP/CMS Dugong MoU in India and to prepare an action plan aimed at increasing dugong numbers and preventing degradation of its habitat.

Dugong, Neil Island, Andaman Islands

Three zones, namely the Gulf of Kutch, Andaman and Nicobar Islands and Gulf of Mannar–Palk Bay were identified as the study area based on previous publications of dugong sightings, stranding records and seagrass presence (Figure 1). The Gulf of Kutch situated on the western coast of India and covers an area of 7350 km^2. It has 42 islands clustered in its southern part. *Halophila* and *Halodule* are reported to be the dominant seagrass genera of this region (Kannan *et al.* 1999). The Andaman and Nicobar archipelago, situated in the Bay of Bengal, consists of about 570 islands divided into two groups by the Ten-Degree Channel. Of these, 26 islands in the Andaman group and 12 in the Nicobar group are inhabited. Nine species of seagrass have been recorded from this region, with *Thalassia hemprichii* and *Cymodocea rotundata* being the predominant species (Kannan *et al.* 1999). The Gulf of Mannar and Palk Bay lie south and north, respectively, of the narrow peninsular extension of the Indian mainland on the southeast coast of India. The Gulf of Mannar encompasses 21 islands and 81 pearl banks and extends from Tuticorin to Rameswaram. The Palk Bay, a shallow flat basin, stretches from Rameswaram to Kodikkarai. Thirteen species of seagrass occur in the Mannar region, with *Halophila*, *Halodule* and *Cymodocea* being the common genera, while the Palk Bay has 11 species of seagrass, with *C. serrulata* and *H. ovalis* being the dominant species (Kannan *et al* 1999). A total of 32 villages between Porbunder and Mandavi in Kutch,

91 villages in the Andaman and Nicobar Islands and 34 villages between Tuticorin and Kodikkarai were visited to conduct the interview-based survey.

3. STUDY AREA

Three zones, namely the Gulf of Kutch, Andaman and Nicobar Islands and Gulf of Mannar–Palk Bay were identified as the study area based on previous publications of dugong sightings, stranding records and seagrass presence (Figure 1). The Gulf of Kutch situated on the western coast of India and covers an area of 7350 km^2. It has 42 islands clustered in its southern part. *Halophila* and *Halodule* are reported to be the dominant seagrass genera of this region (Kannan *et al.* 1999). The Andaman and Nicobar archipelago, situated in the Bay of Bengal, consists of about 570 islands divided into two groups by the Ten-Degree Channel. Of these, 26 islands in the Andaman group and 12 in the Nicobar group are inhabited. Nine species of seagrass have been recorded from this region, with *Thalassia hemprichii* and *Cymodocea rotundata* being the predominant species (Kannan *et al.* 1999). The Gulf of Mannar and Palk Bay lie south and north, respectively, of the narrow peninsular extension of the Indian mainland on the southeast coast of India. The Gulf of Mannar encompasses 21 islands and 81 pearl banks and extends from Tuticorin to Rameswaram. The Palk Bay, a shallow flat basin, stretches from Rameswaram to Kodikkarai. Thirteen species of seagrass occur in the Mannar region, with *Halophila*, *Halodule* and *Cymodocea* being the common genera, while the Palk Bay has 11 species of seagrass, with *C. serrulata* and *H. ovalis* being the dominant species (Kannan *et al* 1999). A total of 32 villages between Porbunder and Mandavi in Kutch, 91 villages in the Andaman and Nicobar Islands and 34 villages between Tuticorin and Kodikkarai were visited to conduct the interview-based survey.

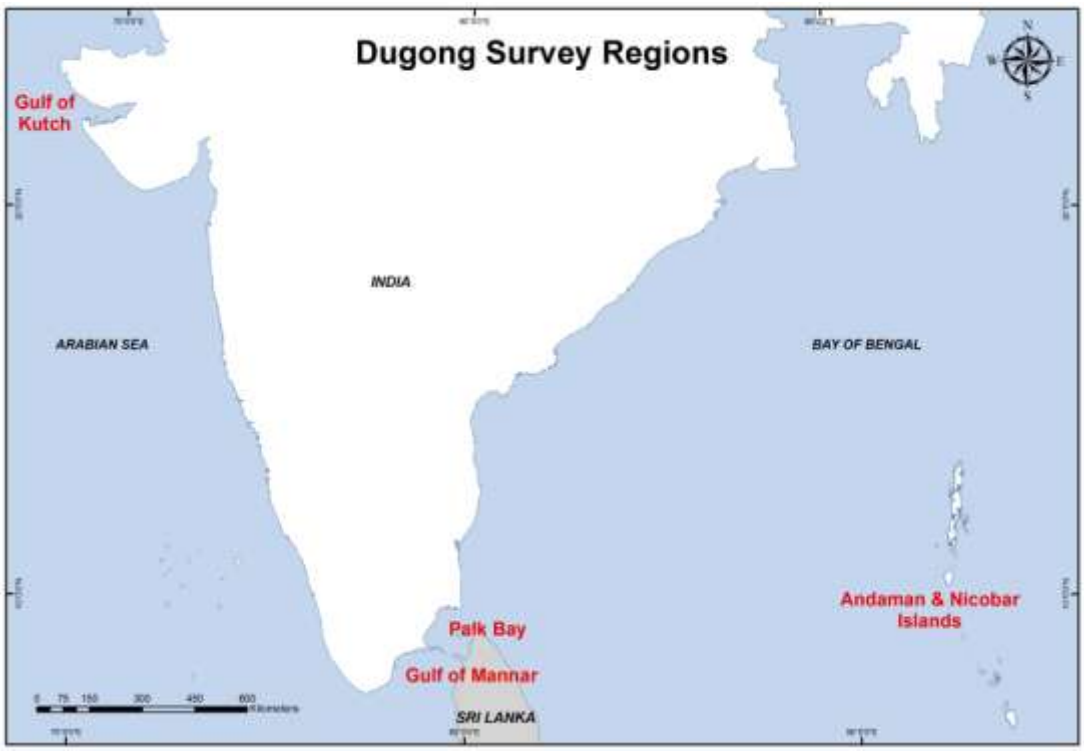

Figure 1 - Map showing dugong survey regions

4. Methodology

Questionnaire surveys are increasingly being utilised for conservation research involving human–wildlife interactions as well as species-level ecological studies on mammals (White *et al*. 2005; Moore *et al*. 2010). Interview surveys have already proved to be an effective research tool in collecting information on dugongs in Australia, Palau, Tanzania, Mayanmar and Papua New Guinea (Anderson 1978; Marsh *et al*. 1995; Muir *et al.* 2003; Ilangakoon and Tun 2007; Kinch 2008). Therefore, this study utilised the standardised dugong catch/bycatch questionnaire developed with the support of the CMS-UNEP Dugong MOU (Pilcher and Kwan 2011). The questionnaire was translated into local languages, and interpreters conversant with regional languages assisted with data collection. Information on marine fishing villages was obtained from the National Marine Fishery Census report (FSI 2005Interviewees were randomly chosen and consisted of active fishermen, a few old, retired fishermen and women who have been actively involved in fisheries-related activities. Information on the occurrence of dugongs, threats to the dugong and its habitat, status of artisanal fisheries, attitudeof fishermen towards the dugong, etc. were collected and analysed. Detailed coastal area maps were provided

to respondents to mark dugong sighting locations and their routine fishing areasand known seagrass areas.

Further, each dugong sighting referred to by the fishermen was located using a compass and GPS in the map. Occupancy models were built to identify critical dugong habitats using sighting data from the past 5 years (2008 to 2012) in the program PRESENCE (MacKenzie *et al.* 2006) Spatial information on sightings and fishing areas was plotted in ArcGIS 9.3. A large grid size of 10×10 km^2 was chosen for analysis to reduce any loss of accuracy due to errors in theinformation provided. The fishing area included a total of 894 grids, and each grid was defined as a single site. Respondent visits to grids were considered as sampling occasions. Site co-variates used were Site (Gulf of Kutch, Andaman and Nicobar Islands and Gulf of Mannar–Palk Bay) and Distance (the distance from centre of the grid to the coastline, taken as a surrogate for seagrass presence). Fishery pressure, as a factor derived from PCA, was used as another co-variate since it explains 68% of the variation among components that were based on fishing months, motor type and power and gear type used by fishermen visiting each grid. Gear types were scored on the scale of 0.5 to 1.5 based on their level of disturbance to the dugong and its habitat. Gear types were scored as follows: long line, hook and line, purse seine, boat seine—0.5; trawl net—1; gill net—1.5. Sampling co-variates that may influence observations were used: (a) Crew (number of crew members in the boat of respondent); (b) Men (total number of respondents that visited each grid); (c) Experience (number of years a respondent has been a fisherman, averaged for each grid).

5. Results and Discussion

A. Respondent Profile

Interview surveys were conducted along the coastlines of the three zones in a span of 8 months (August 2012 to March 2013). A total of 1616 interviews were conducted across the Gulf of Kutch (villages=32, n=301), Andaman and Nicobar Islands (villages=91, n=906) and Gulf of Mannar & Palk Bay (villages=34, n=409). Fishing is a male-dominated industry, and mainly active fishermen (97% of the

respondents) were targeted (Figure 2). The majority of the respondents belonged to the age group of 26–35 years, and their average age was about 39±13 years (Figure 3).

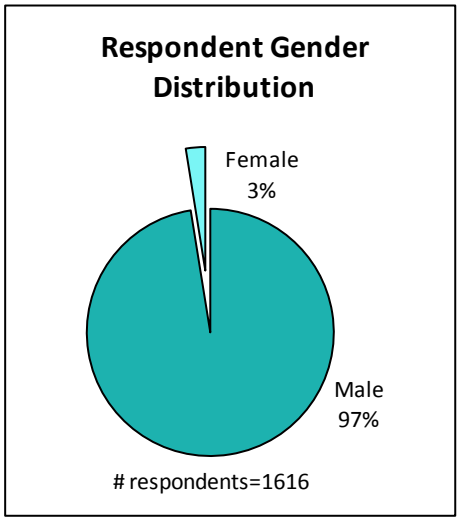

Figure 2 – Gender distribution of respondents

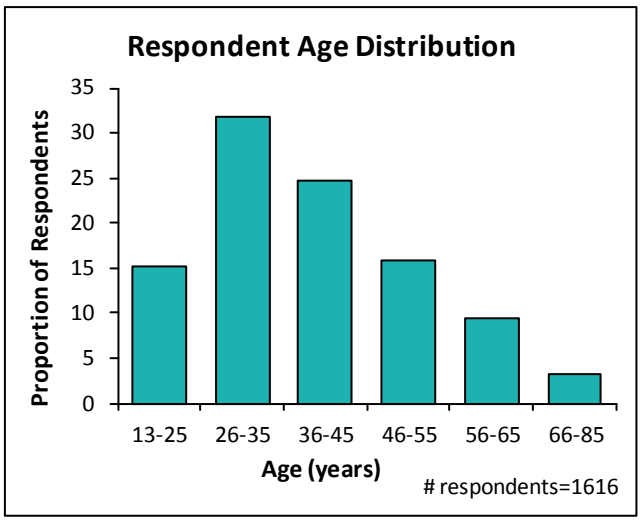

Figure 3 – Age distribution of respondents

Of the sampled population of fishermen, 98% had parents who were fishers, while 88% had grandparents also involved in fishery-related activities (Figure 4).

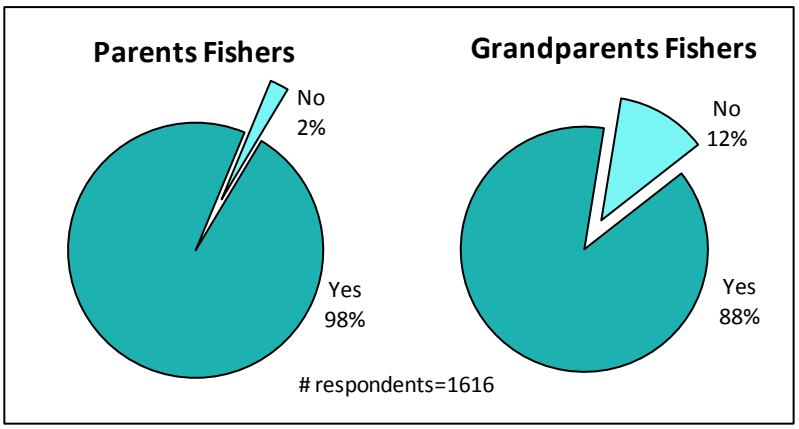

Figure 4 – Respondents with parents and grandparents who were fishers

On an average, the respondents from all three zones had been involved in fishing for about 24±13 years of their life (Figure 5).

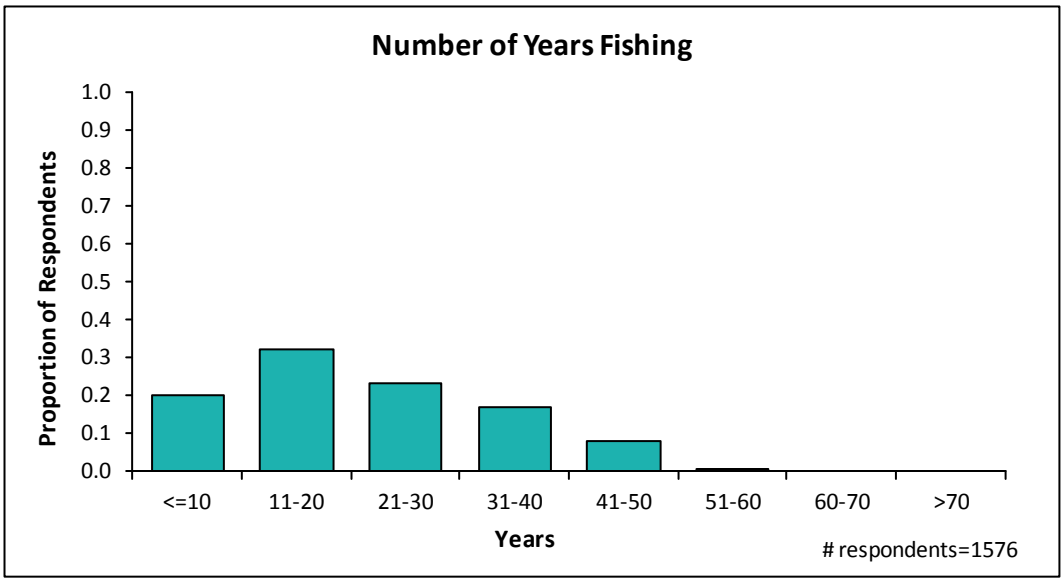

Figure 5 – Years of occupation as fisherman

Overall, 88% of the respondents said that fishing was their main source of livelihood. For 63% of the interviewees, fishing is the only way of earning a living, while the remainder (37%) supplement their income through other activities (Figure 6).

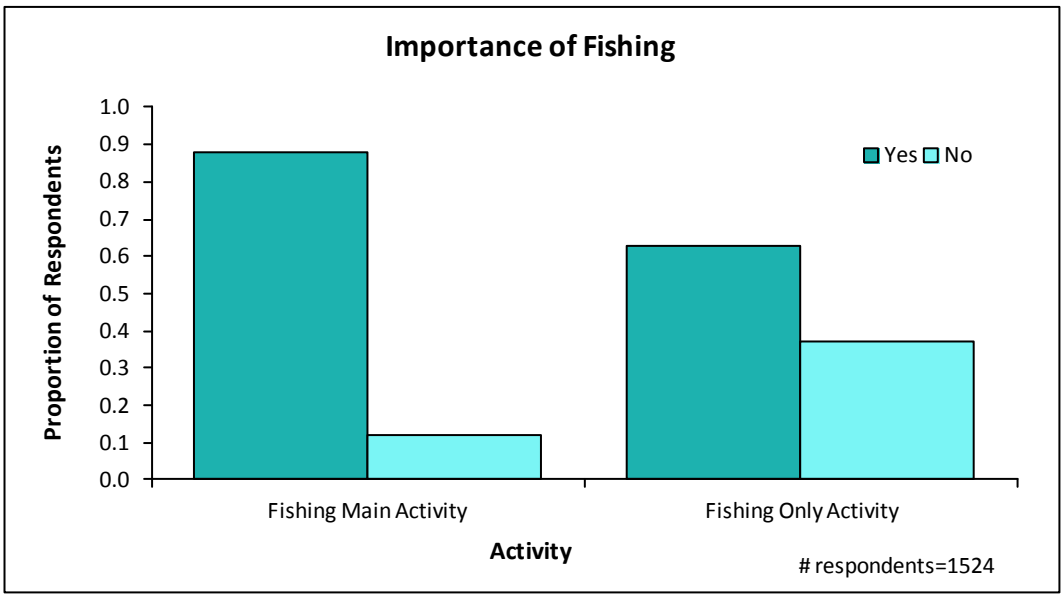

Figure 6 – Respondents with fishing as source of livelihood

At a regional level, it was observed that in all sites except the Nicobar Islands over 96% of the respondents were completely dependent on fishing for their livelihood. In the Nicobar Islands, 47% of the respondents were dependent on agriculture-related activities for their livelihood (Figure 7).

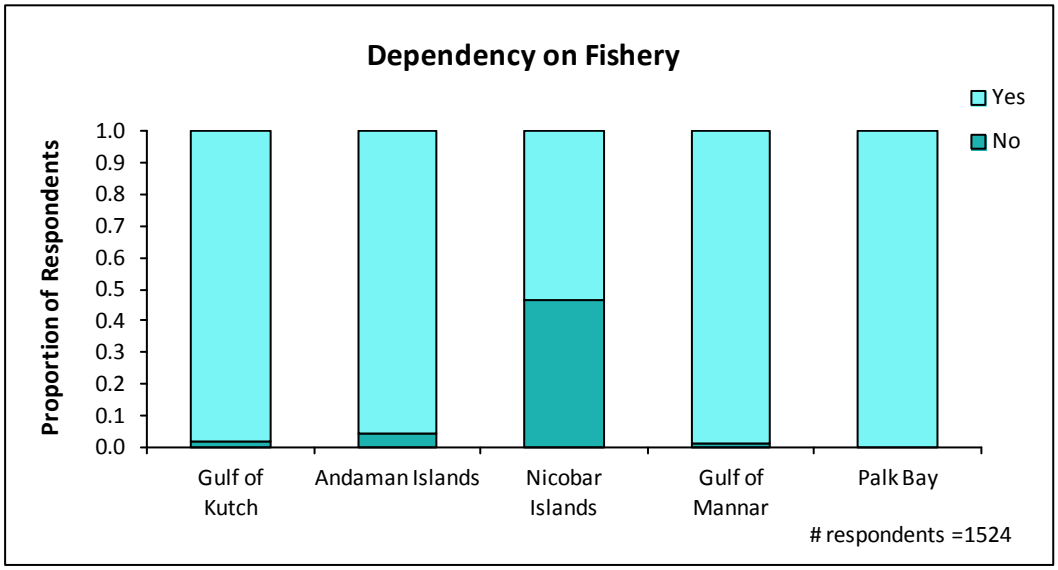

Figure 7 – Region-wise dependence of respondents on fishing

Since a large proportion of interviewees listed fishing as their main occupation, with an average of 24 years of experience and had parents and grandparents also involved in the same profession, it is assumed that a significant proportion of the information gathered was reliable. The extent of reliance of local communities on resources from the dugong habitat should be considered during formulation of conservation and management plans in these regions.

B. Dugong Status and Distribution

The dugong has different local names across its distribution range in India, where there are different regional languages (Table 1). In the Gulf of Kutch, it is called *Suwarmachi, Pranjado, Pranjadi, Pranj* and *Harundo*; in the Andamans it is known as *Panisuwar, Suwarmachi, Jalsuwar, Haunmai, Neerpanni* and *Thoti*; in the Nicobar Islands, *Haunmai, Hippot, Hipput* and *Neerpanni* are the commonly used names; and in the Gulf of Mannar and Palk Bay, the dugong is called *Avoli, Kadalpanni* and *Kadalpashu*.

Table 1 – Local names of the dugong

Gulf of Kutch	Andaman Islands	Nicobar Islands	Mannar and Palk Bay
Harundo	*Haunmai*	*Haunmai*	*Avoli*
Pranj	*Jalsuwar*	*Hippot*	*Kadalpanni*
Pranjadi	*Neerpanni*	*Hipput*	*Kadalpashu*
Pranjado	*Panisuwar*	*Neerpanni*	
Suwarmachi	*Suwarmachi*		
	Thoti		

The results show that among the younger respondents only 16% between the ages of 13 and 25 years had seen a dugong compared with 55% of the respondents of aged more than 66 years (Figure 8). The significantly lower percentage of younger fishermen who had seen dugongs is indicative of a decline in dugong numbers as suggested by previous reports (Jones 1967; Das and Dey 1999; Das 2000; Marsh *et al.* 002; Singh 2003; D'souza and Patankar 2009**.**

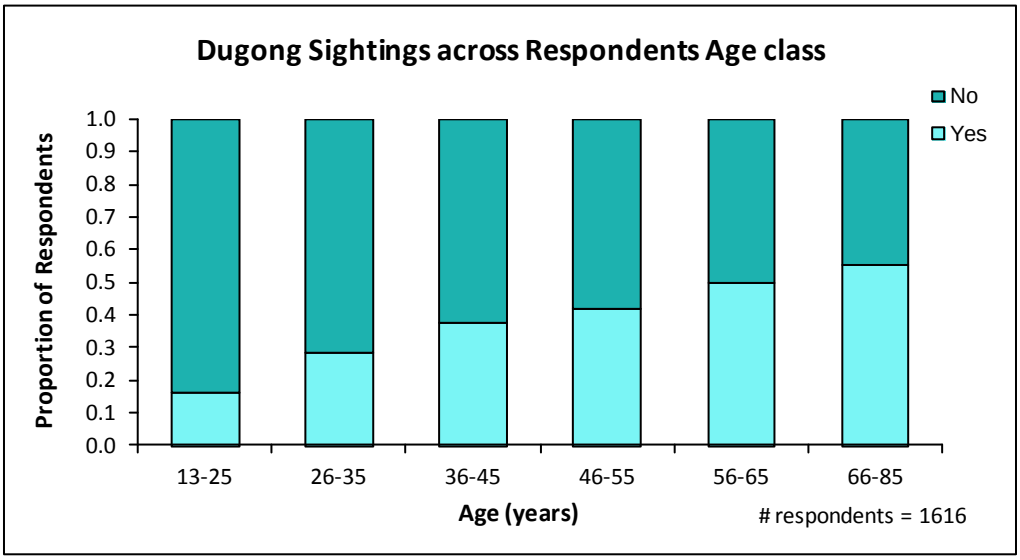

Figure 8 – Proportion of respondents in different age classes who had seen dugongs

During the survey, 623 sightings were reported in a time frame extending from 1960 to the present, and of these, 45% of the dugongs were sighted during transit to a fishing area and 36% during fishing, and the remainder were observations of netted (5%), hunted (10%) or stranded (4%) animals (Figure 9). A large percentage of the reported dugong encounters were made during transit to a fishing area and during

fishing. This is suggestive of a high overlap between primary fishing activity areas and the dugong habitat.

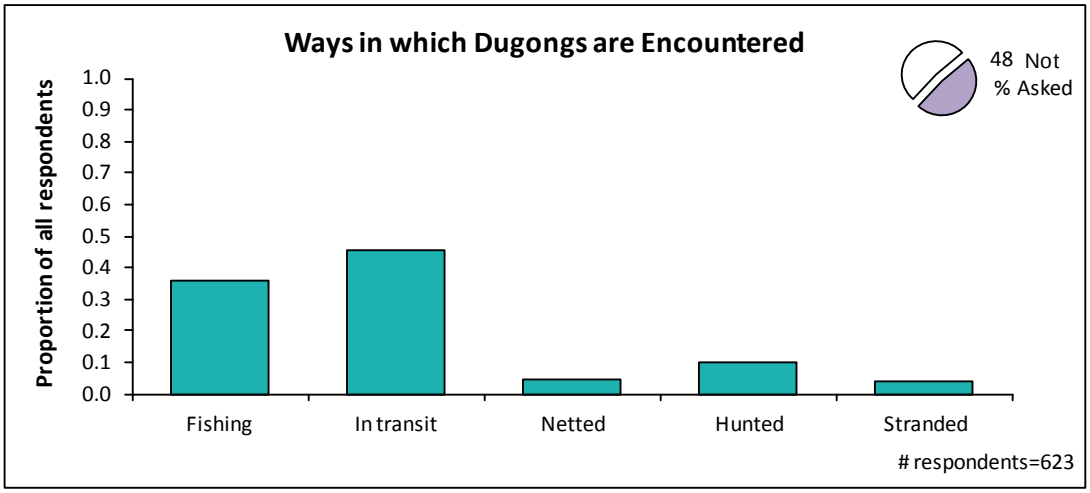

Figure 9 – Ways in which dugong are encountered

The percentage of respondents who had sighted dugongs was highest in the Gulf of Mannar (70%), followed by the Palk Bay (57%) area. Overall, 262 encounters (Mannar, n=158; Palk Bay, n=104) with live/dead dugongs were recorded from Gulf of Mannar–Palk Bay (Figure 10). It was observed that 44% of the respondents from the Andaman Islands had sighted dugongs, whereas in the Nicobar Islands, 30% of the fishermen had encountered a dugong. A total of 352 sightings (Andaman, n=247; Nicobar, n=105) were recorded during the interview. In the Gulf of Kutch, only 2% of the respondents had seen a dugong in their lifetime, supporting the view that only a small population of dugongs persists in the area.

Though the exact size of the dugong population in Indian waters is unknown, the proportion of respondents with dugong sightings was highest in the Gulf of Mannar and Palk Bay, followed by the Andaman and Nicobar Islands, and lowest in the Gulf of Kutch, the trend being similar to that suggested by other studies (Pandey *et al*. 2010). Although the dugong numbers seem to be greater in the Gulf of Mannar and Palk Bay area, the dugong population is much smaller than what it has been historically (Annandale 1905; Jones 1967; Nair *et al*. 1975; Marsh *et al.* 2002; Pandey *et al*. 2010) and probably migrates between India and Sri Lanka (Silas and Fernando 1985).

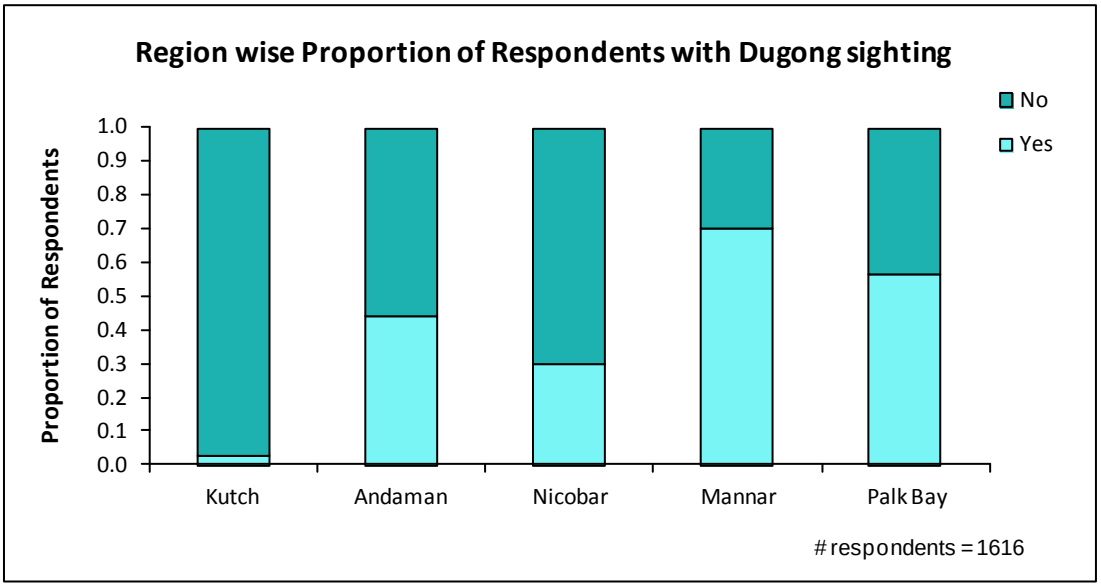

Figure 10 – Region-wise proportion of respondents who have seen dugongs

On average, 18% of the sighting records across all the regions were of dead stranded animals, indicative of a high level of dugong mortality (Figure 11). The proportion of dead-dugong encounters was highest for the Gulf of Kutch (33%), followed by the Gulf of Mannar (22%), Andaman Islands (19%), Palk Bay (13%) and Nicobar Islands (13%). The dugongs of Kutch are an isolated population (Marsh *et al.* 2002), and with the low numbers (Pandey *et al*. 2010) and high mortality levels, immediate steps are required to reduce the mortality to ensure the survival of the species.

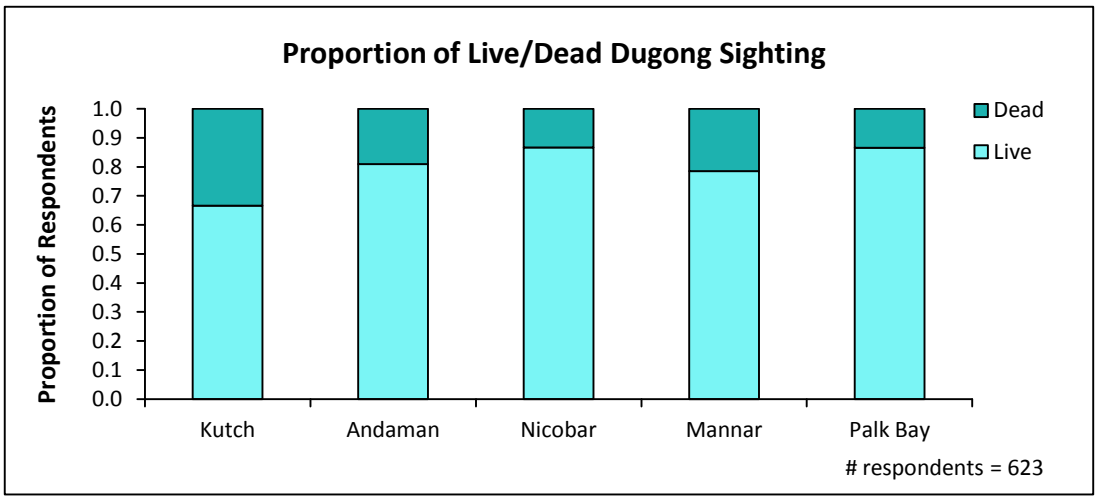

Figure 11 – Proportion of dead and live dugong sightings

Records of sightings in the past 10 years (2003-2012, n=268) were analysed to study the distribution of dugong groups. In all the three zones, the majority of the sightings were of solitary large individuals. Only a minor portion of the records from the Andamans (24%), Nicobars (12%), Mannar (29%) and Palk Bay (16%) were of mother–calf pairs (Figure 12). Sighting of mother–calf pairs confirms the presence of breeding populations in these zones. In the Andaman and Nicobar Islands alone, respondents (11%) reported sighting larger groups (3–6 individuals) of the mammal. Studies suggest that aggregations of female with calf could be beneficial in reducing time spent on vigilance (Anderson 1998). Respondents from the Gulf of Mannar, Palk Bay and Andaman Islands additionally mentioned sighting groups of 10–20 animals 30 years ago.

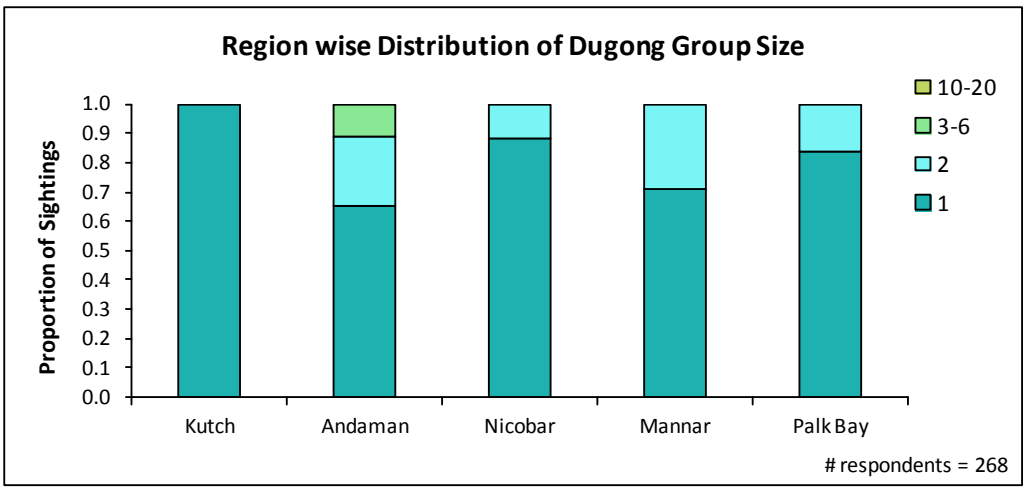

Figure 12– Region-wise distribution of size of dugong group sighted

C. Threats to Dugong Population and Habitats

Respondents were asked about the factors responsible for the declining dugong numbers in their region. Even though 33% of the respondents were unable to comment, others listed the damage caused to seagrass beds by tsunamis as one of the major factors (29%). Other causes mentioned by fishermen were hunting for meat (14%), destruction of seagrass beds and noise disturbance caused by fishing boats (9%), accidental catch and damage to seagrass beds by trawlers (9%), accidental deaths due to entanglement in gill nets (4%) and the low reproductive rate of dugongs (2%), which delays the recovery of a dugong population (Figure 13).

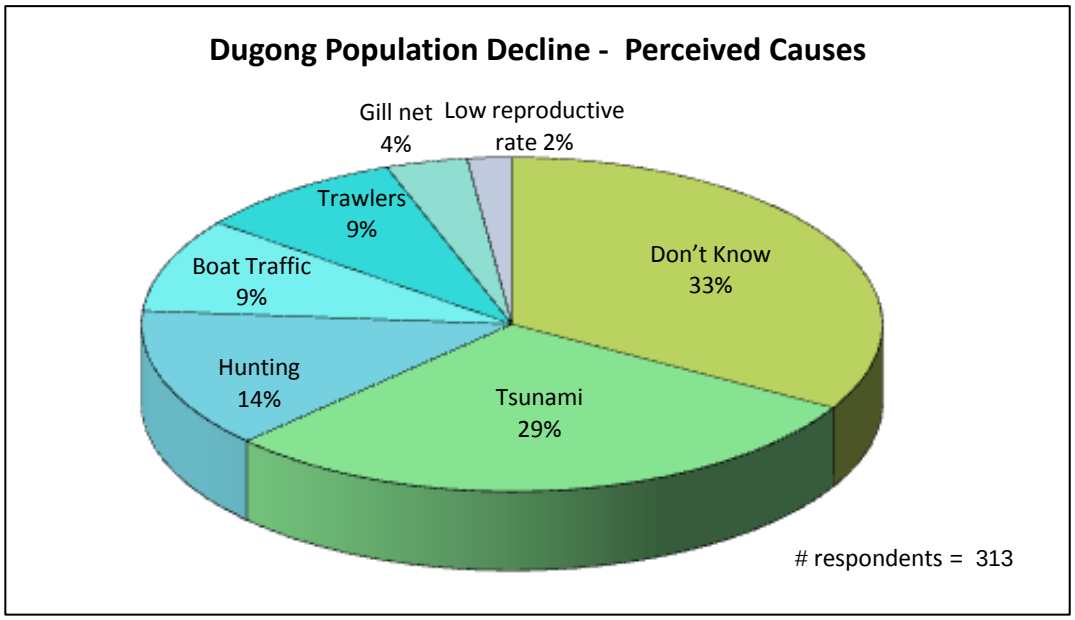

Figure 13 – Perceived causes for decline in dugong population

Tsunami

Severe wave action, shifting sediment and light reduction cause extensive damage to seagrass beds (Kenyon and Poiner 1987; Thorogood *et al*. 1990; Preen1993). In response to the loss of feeding areas, dugongs are known to move extensively in search of seagrass, resulting in increased catches in nets (Heinsohn and Spain 1974). Furthermore, these seagrass specialists delay breeding in response to seagrass loss (Preen and Marsh 1995; Marsh and Kwan 2008), which makes habitat protection a priority. Habitat loss can also cause localised declines in dugong populations (Thorogood *et al*. 1990; Preen1993; Preen and Marsh 1995).

After the 2004 earthquake and tsunami, the Andaman Islands experienced an uplift of 1–2 m, while the Nicobar group of islands subsided by 4 m (Bilham *et al*. 2005; Malik and Murthy 2005). In addition to these geomorphological changes, the seagrass beds were severely damaged aroundInterview Island, North Reef Island and the Nicobar region (Sivakumar 2006; Thangaradjou *et al.* 2010). Reports indicate that the seagrass meadows of North Reef, Interview Island and Lakshman Beach, of Great Nicobar Island, are recovering slowly (Thangaradjou *et al.* 2009).

Hunting

Although hunting has been totally banned in India, dugong meat is highly prized and considered a delicacy. Its consumption in the Gulf of Mannar, Palk Bay and Andaman and Nicobar Islands has been reported (Nair *et al.* 1975; Bensam and Menon 1996; Ilangakoon *et al.* 2004; Das 1996, pers. comm. (K. Sivakumar, WII)). In the Gulf of Mannar and Palk Bay, gill nets, shore seines, trawl nets, drift nets, ray nets and explosives were used to hunt dugongs, and captures of 25 dugongs per year in 1960–1980 and 200 dugongs per year in 1983–1984, dropping to 9 dugongs per year in 1986–1988, were reported (Bensam and Menon 1996).

On being enquired about the trend in hunting of dugongs, 44% respondents in the Andaman and Nicobar Islands and 73% of the respondents in the Gulf of Mannar and Palk Bay said the practice was prevalent only in the past. A small proportion of respondents (Andaman and Nicobar Islands, 6%; Gulf of Mannar and Palk Bay, 5%) reported that dugongs were still deliberately hunted for their meat and added that in the Gulf of Mannar region the rarity of dugongs and the illegality and complexity of catching dugongs has resulted in a further increase in the meat's sale value (Figures 14 and 15). Additionally, respondents were asked what they would do with an unintentionally caught dugong, to which 81% (n=239) replied that they would release the dugong alive. A small fraction of respondents said they would eat or sell (12%, 7%) the dugong meat. A large proportion of respondents were not asked these questions due to the sensitivity of the issue.

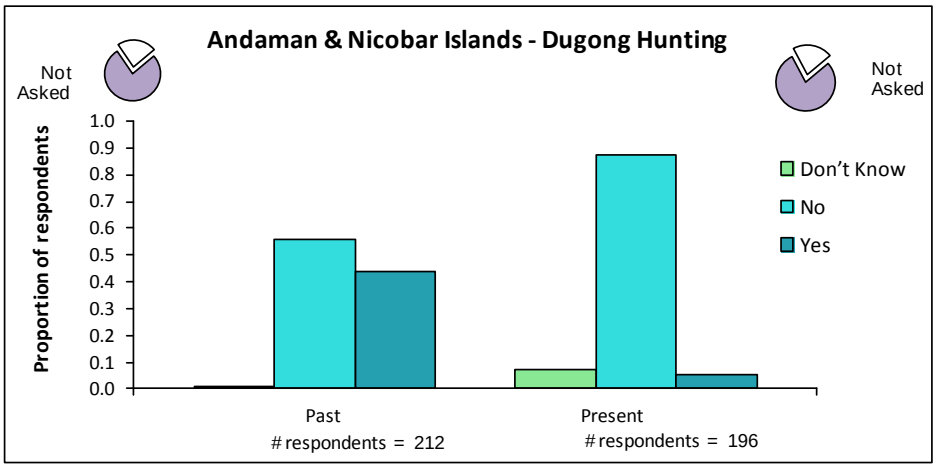

Figure 14 – Dugong hunting trend in Andaman and Nicobar Islands

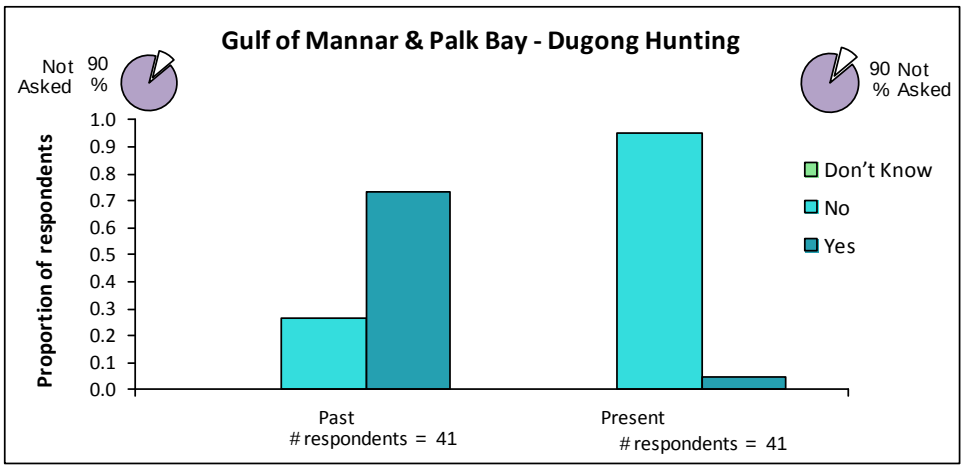

Figure 15 – Dugong hunting trend in Gulf of Mannar and Palk Bay

Boat Traffic

Unintentional dugong mortality is caused by boat strikes and propeller injuries when motorised boats traverse shallow feeding grounds. Fast-moving boats give dugongs less time to evade a collision (Marsh *et al*. 2002, Hodgson 2004). With 3.5% of the day time spent resting at the surface of the water and routine surfacing at >2 minute intervals, dugongs are vulnerable to boat strikes (Anderson 1981; Hodgson 2004). Compared with solitary individuals, mother–calf pairs spend more time near the surface, making them more susceptible to boat strikes (Hodgson 2004).

To assess the overlap between dugong feeding areas and fishing areas, respondents were asked if they fished in seagrass areas. About 39% of the respondents in the Gulf of Kutch, 39% in the Andaman and Nicobar Islands and 56% of the respondents the Gulf of Mannar and Palk Bay answered in the affirmative (Figure 16).

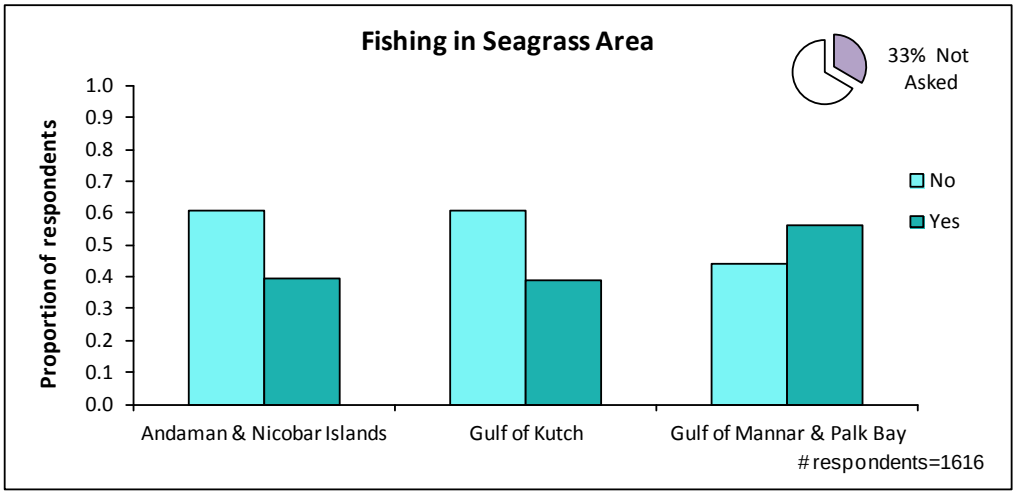

Figure 16 – Fishing in seagrass areas

Trawlers

Another threat to dugong habitat is trawl net usage, which degrades seagrass meadows by uprooting rhizomes and removing healthy leaves (Silas and Fernando 1985; Thangaradjou et al. 2009). It is estimated that trawling removes 30–40 kg of seagrass in a single day in the Gulf of Mannar and Palk Bay area (Thangaradjou et al. 2009).

Gill Nets

According to a UNEP (Marsh et al. 2002) report, incidental catches of dugongs in gill nets are one of the major causes of dugong mortality. In the waters off the Gulf of Mannar and Palk Bay, extensive use of gill nets was reported to have caused yearly dugong mortality, with an average of 40 dugong deaths in a year (Lal Mohan 1976; Nair et al. 1975). Recent reports suggest that awareness and protection provided by joint efforts of the Government of India and Tamil Nadu Forest Department have greatly reduced incidental catches of dugong (Ilangakoon et al. 2008).

When respondents were asked if they thought the accidental capture of dugongs in fishing nets was increasing, declining or stable, 64% were unsure of any trend, while 28% respondents stated that the numbers had reduced. The respondents further elaborated that the decrease in chance entanglement and death of dugongs was due to the drastic decline in the dugong population (Figure 17).

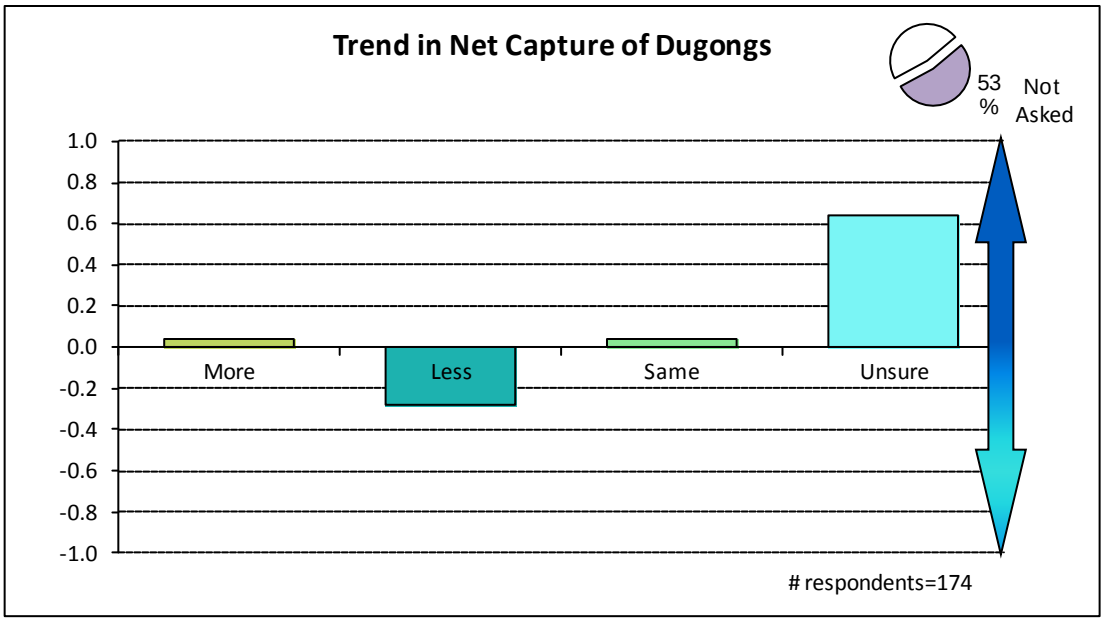

Figure 17 – Trend in capture of dugongs in fishing nets

Low Reproductive Rate

Dugongs, like other long-lived marine mammals, take a long time to reach breeding age. They give birth to a single offspring, have a long gestation period and provide extended maternal care followed, after which the calf attains physical and sexual maturity slowly, which further limits the frequency of reproduction (Marsh *et al*. 1984). With such life history traits, the maximum rate of population increase is estimated to be about 5% per year, and thus if adult survival is reduced due to various anthropogenic pressures, populations may take a long time to recover (Marsh 1995; Marsh *et al.* 1999).

Region-Specific Perceived Threats to Dugong

With dugong numbers declining in all three areas of its occurrence in Indian waters, understanding the threats at the regional level is vital in formulating a region-specific management plan for the conservation of the species.

It was observed that in the Gulf of Kutch the heavy fishing boat traffic was listed (50%, n=6) as the major threat to the dugong and its habitat (Figure 31.Excessive damage to seagrass beds due to the tsunami of 2004 was mentioned by 63% of the respondents in the Andaman and Nicobar Islands as the main factor behind the dwindling dugong numbers (Figure 32). Additionally, 12% of the respondents from the islands mentioned excessive hunting in the past and low levels of illegal hunting in the present to be responsible for the decline in dugong occurrence. In the Gulf of Mannar and Palk Bay area, the possible causes of dugong mortality were varied. Habitat damage by trawlers (17%), sound pollution and seagrass damage due to fishing boat (16%) and hunting for dugong meat (14%) were the factors identified by the respondents (Figure 18).

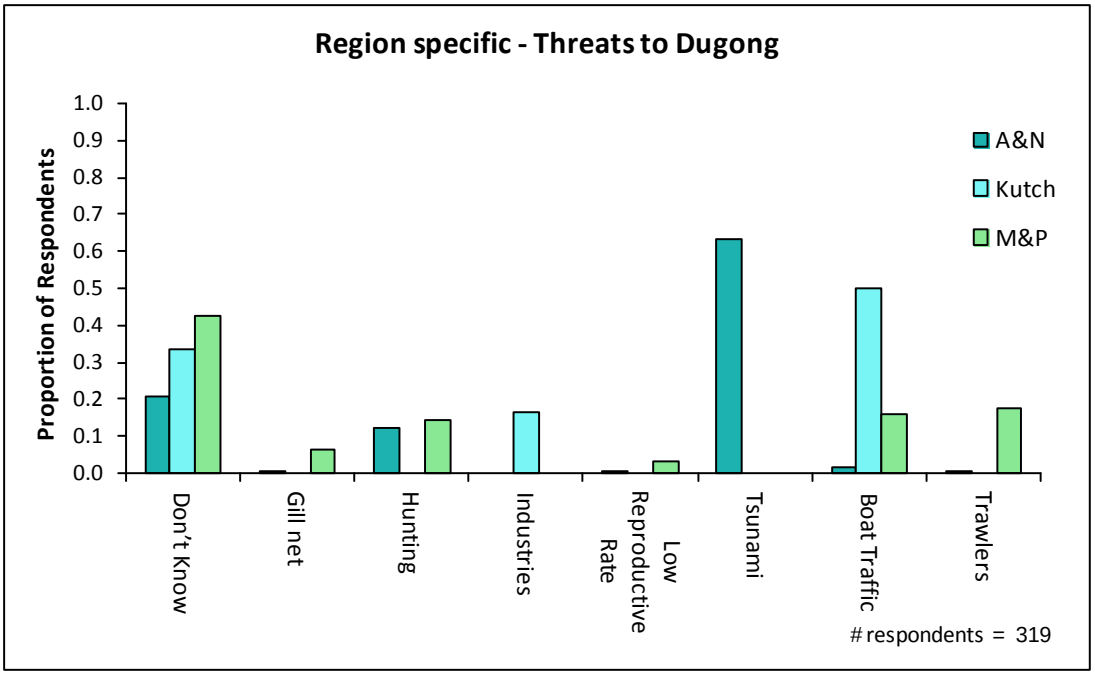

Figure 18 – Region-specific perceived causes for declining dugong numbers

D. Status of Artisanal Fisheries

About 96% of the catch of respondents from all three regions, the Gulf of Kutch, Andaman and Nicobar Islands and Gulf of Mannar–Palk Bay comprised fish. The greatest fishing effort was recorded in the months between December and March, while June and July were months of comparatively less fishing activity due to the prevalence of the monsoons. Details of different types of craft in motorised (outboard, inboard) and non-motorised categories are presented along with the length of the craft in Figures 19, 20 and 21. Motorised craft include plank-built boats and fibreglass boats, while non-motorised craft consist mainly of dugout canoes, catamarans and plank-built boats.

Crafts in all the regions were mainly of length 5-10 m (–Gulf of Kutch, 70%; –Andaman and Nicobar Islands, 62%; –Gulf of Mannar–Palk Bay, 69%). In the Gulf of Kutch, the respondents mainly had inboard motorised boats (98%). Fishermen from the Andaman and Nicobar Islands possessed inboard motorised boats (51%) as well as non-motorised fishing boats (49%). In the Gulf of Mannar and Palk Bay, 67% of the respondents' crafts were inboard motor boats, and 33% were outboard motor boats.

It is evident that motorised boat traffic is high in the Gulf of Mannar, Palk Bay and Gulf of Kutch. Compared with other regions, the motorised boat traffic is lower in the Andaman and Nicobar Islands, and additionally this zone has a higher proportion of non-motorised crafts that are non-threatening to the dugong and its habitat.

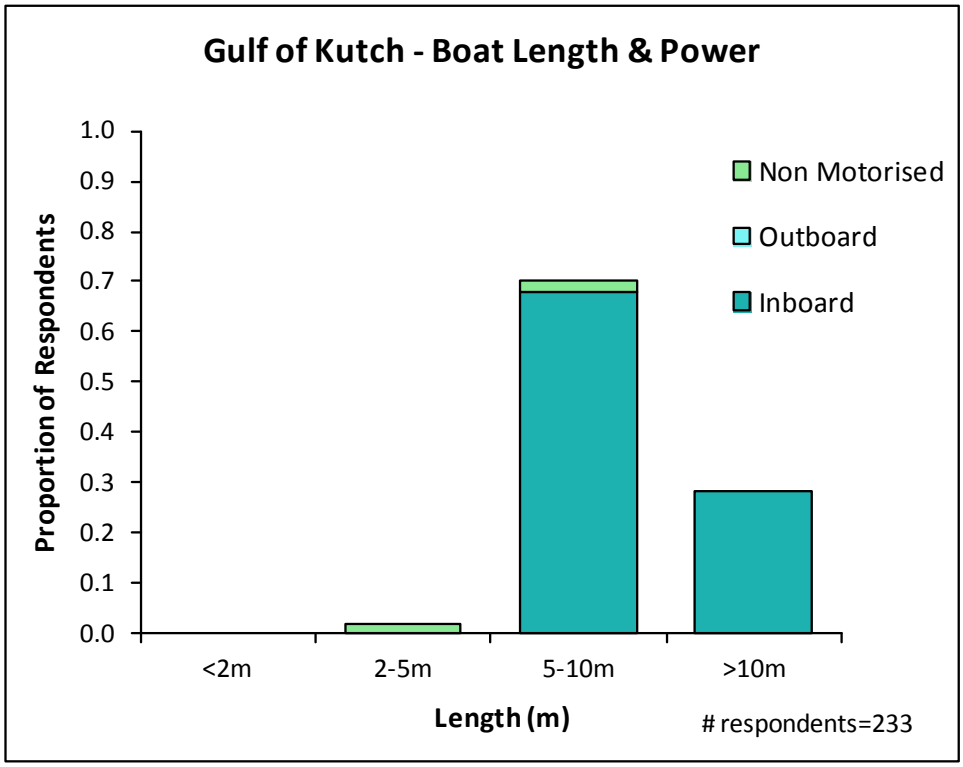

Figure 19 – Craft details, Gulf of Kutch

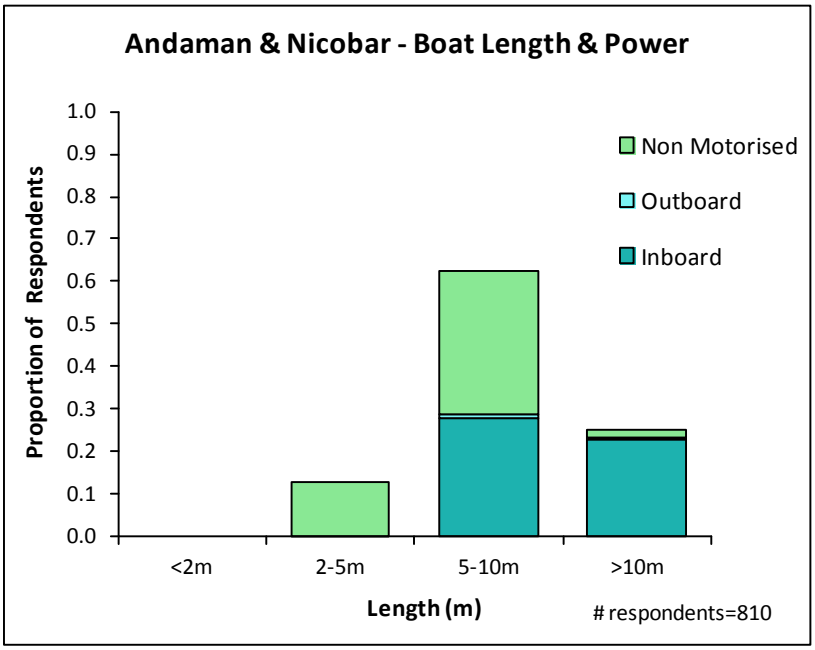

Figure 20 – Craft details, Andaman and Nicobar Islands

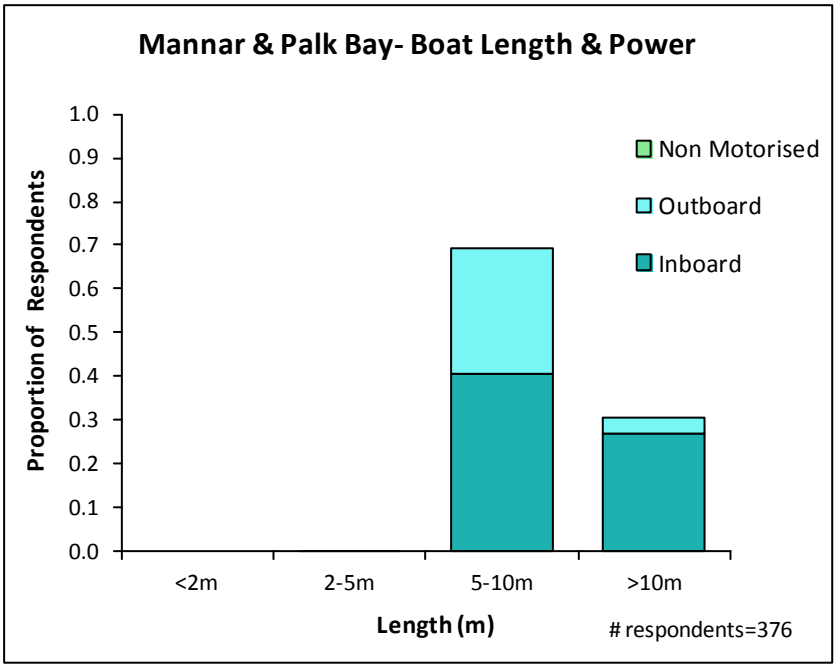

Figure 21 – Craft details, Gulf of Mannar and Palk Bay

The fishing gear usage pattern across the regions (Figure 22) shows that gill nets (40%) and hooks and lines (36%) are the most commonly used gear. In order of usage frequency, the other gear are purse seines (12%), trawl nets (5%), long lines (5%), others (2%) and beach seines (1%). The results indicate that gill nets are the gear most detrimental to dugongs. Our results indicate that gill nets are the most commonly used gearby the majority of the respondents.

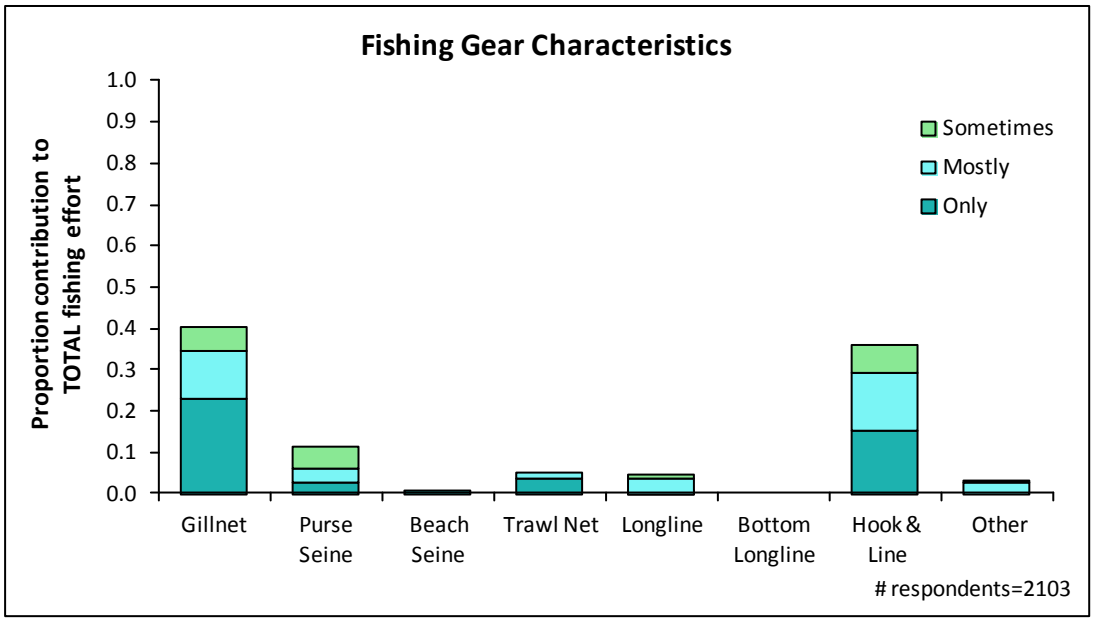

Figure 22 – Fishing gear usage for all three zones

Gill nets and purse seines are the main fishing gear used in the Gulf of Kutch (Figure 23). Gill nets alone form 63% of the total gear used, followed by purse seines (35%), beach seines (1%) and long lines (1%). In the Andaman and Nicobar Islands, the hook and line is the preferred fishing gear, used by 56% of the respondents (Figure 24). Other fishing gear used in the islands are the gill net (27%), purse seine (8%), others (7%) and the long line (2%). About 60% of the respondents in the Gulf of Mannar and Palk Bay use gill nets in addition to the trawl net (21%), long line (7%), hook and line (5%), purse seine (5%) and beach seine (2%). The usage of gill nets was highest in Kutch and the Mannar–Palk Bay area. Moreover, high usage of trawl nets was also reported in Gulf of Mannar and Palk Bay (Figure 25). Use of non-destructive gear such as the hook and line in the Andaman and Nicobar Islands indicates comparatively low levels of fishery-induced threats to the dugong in this zone.

Fishing in mangrove creeks near Nimbutala Jetty, Andaman Islands

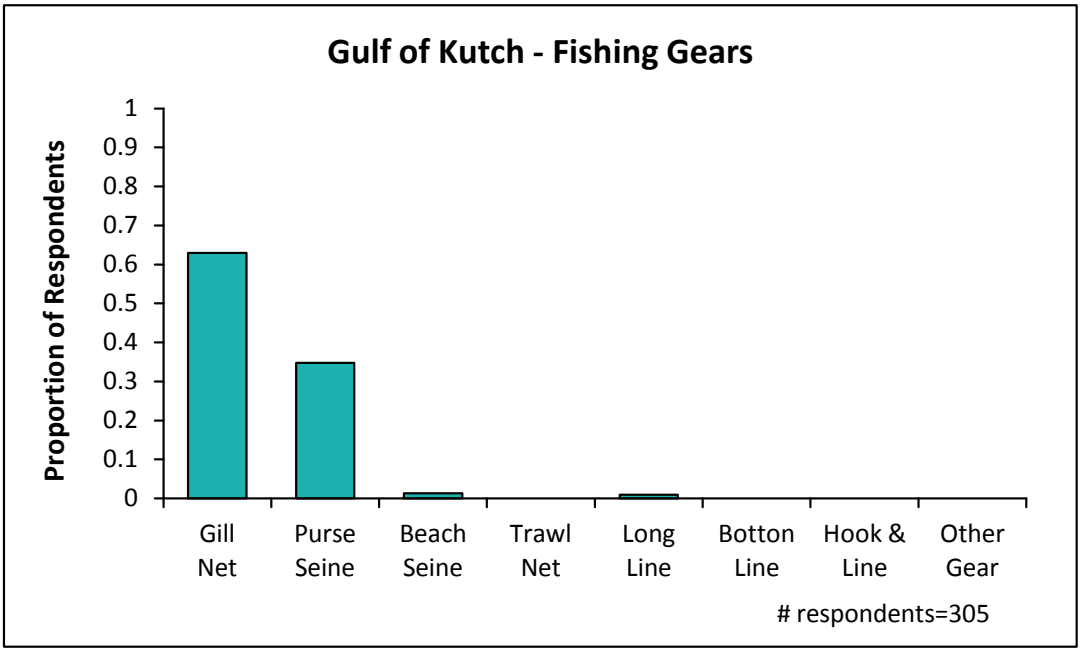

Figure 23 – Fishing gear characteristics of the Gulf of Kutch

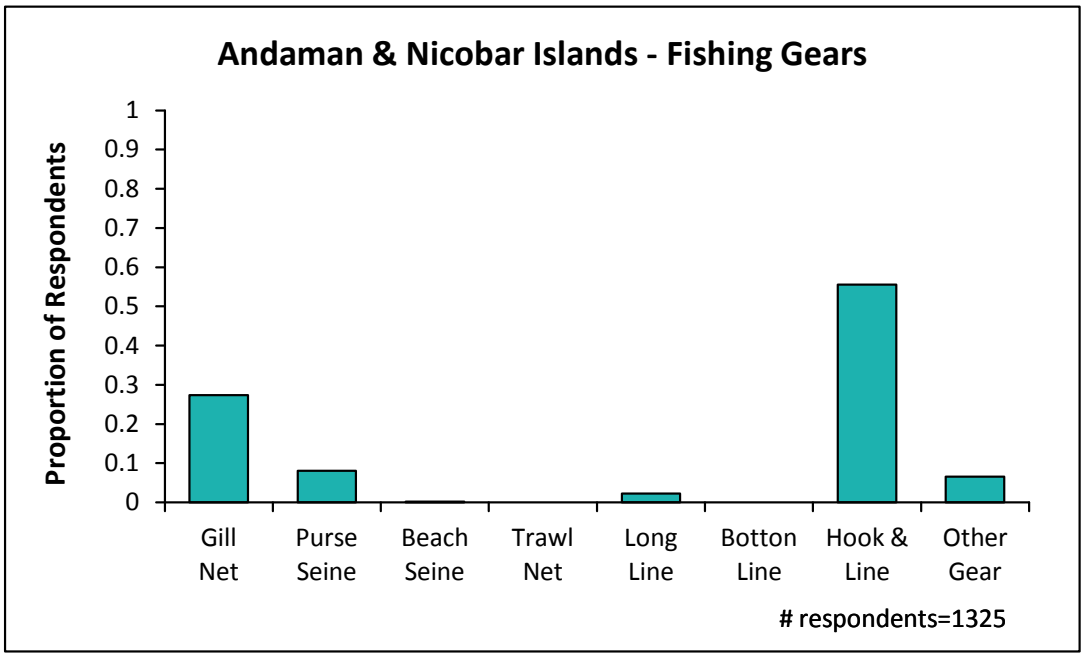

Figure 24 – Fishing gear characteristics of the Andaman and Nicobar Islands

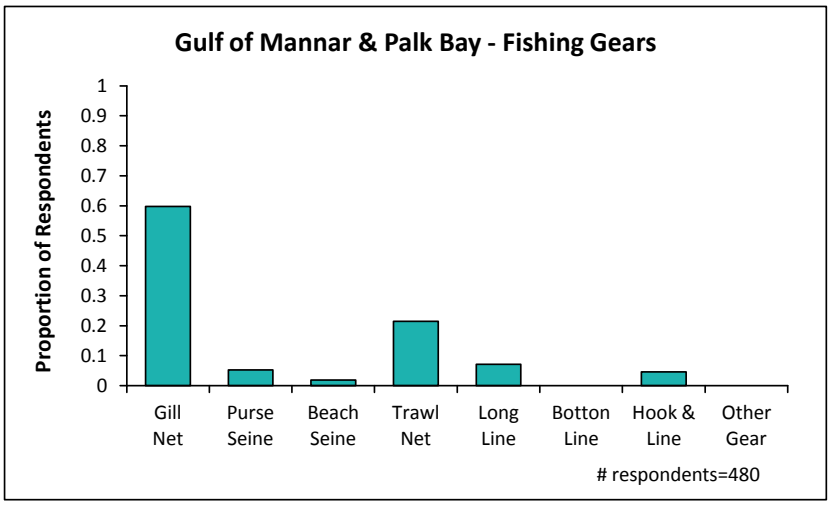

Figure 25 – Fishing gear characteristics of the Gulf of Mannar and Palk Bay

The results show that 78% of respondents use surface-set gill nets, 17% use bottom-set gill nets and the remainder 5% use mid-water-set gill nets. About 76% of the gill nets used by the respondents are between 51 and 500 m in length, and 54% are between 11 and 100 m in length. About 77% of the respondents utilised their fishing nets during the daytime and left their nets untended. The proportion of respondents who fished at night and left their nets untended is 11Only 11% of the fishermen used nets at night and tended their nets, and 1% of the respondents fished during the day and tended their nets (Figure 26). It was observed that a high proportion of the respondents left their gill net untended for over 2–3 hours, effectively reducing the possibility of an entangled dugong being spotted and released in time.

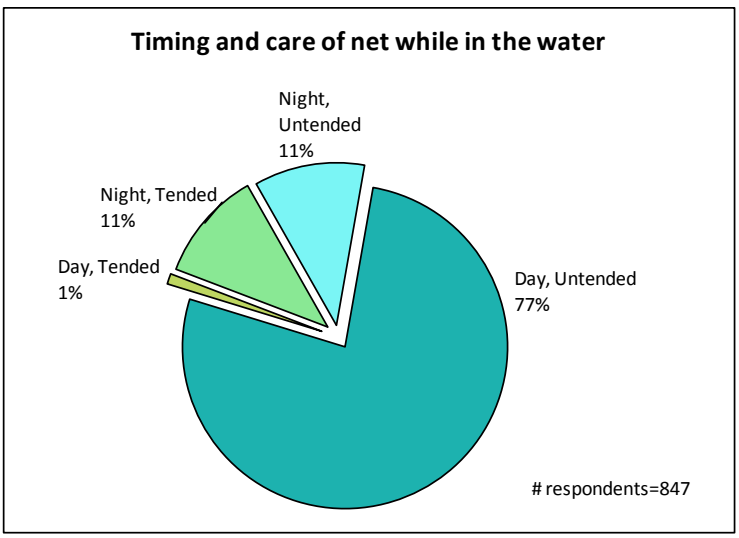

Figure 26 – Timing and care of nets when in the water

Knowledge of the kind of craft and gear used in a specific area should be taken into consideration when formulating measures to reduce dugong mortality. The results indicate that in the Gulf of Kutch, fishermen mainly used motorised boats and gill nets. In the Andaman and Nicobar Islands both motorised and non-motorised boats are used, while the preferred gear is the hook and line, followed by the gill net. Fishermen in the Gulf of Mannar and Palk Bay mostly used motorised boats, and the commonly used gear are gill nets and trawl nets.

E. Critical Dugong Habitat

Identifying key dugong habitats is important for landscape-level planning and for directing limited management resources to locations that are likely to have the greatest return on conservation efforts for the protected species. These identified locations can serve as focal points for research initiatives and can be added to as additional information on habitat usage becomes available.

Critical dugong habitats across the three zones were identified using occupancy modelling. The selected modelwas *psi(site+dist+pc), p(crew+men+exp)* (AIC=3066.48, AIC wqt=1, -2LogLikelihood= 3048.48) (Table 2). Site occupancy (psi) showed a strong association with region: highest in the Gulf of Mannar–Palk Bay, followed by the Andaman and Nicobar Islands, and lowest in the Gulf of Kutch. The results indicate that although dugongs occupied areas with high fishery pressure, the probability of detecting them in these areas was low. Distance from coastline, which was taken as a surrogate for seagrass presence, was a key determinant of local dugong presence. The probability of detection of dugongs (p) was influenced by the number of crew members, the number of fishermen visiting a single site and experience of the fishermen. A greater crew size correlated with lower detection. A larger crew is a feature of larger boats that venture farther into deeper waters, spending less time in dugong habitats, where detection is less.

Table 2 – Occupancy model selection for dugong priority areas

No.	Model	AIC
1	Psi(site+dist+pc), P(crew+men+exp)	3066.48
2	Psi(dist+pc), P(crew+men+exp)	3108.13
3	Psi(site), P(crew+men+exp)	3170.36
4	Psi(site), P(crew+men+hp+exp)	3171.2
5	Psi(site), P(crew+men)	3175.06
6	Psi(site), P(crew+men+hp)	3176.27
7	Psi(site), P(men+exp)	3192.33
8	Psi(site), P(men)	3200.8
9	Psi(site), P(men+hp)	3202.57
10	Psi(pc), P(crew+men+exp)	3237.05
11	Psi(site), P(crew+exp)	3255.81
12	Psi(site), P(crew)	3259.61
13	Psi(site), P(exp)	3285.92
14	Psi(site), P(hp)	3295.2
15	Psi(.),P (.)	3378.31

Utilising the factor derived from PCA for fisheries activities,maps were prepared to illustrate the region-specific magnitude and distribution of fishery-induced disturbances in the three zones and their overlap with areas occupied by dugongs.

Gulf of Kutch

The waters off Sikka and Vadinar, the inter-island area between Ajad Island, Chank Island, Bhaidar Island and Bet Dwarka, were identified as a critical dugong habitat (Figure 27). The region around Poshitra and Bet Dwarka is reported to be suitable for dugongs due to the presence of seagrass and the low anthropogenic stress due to the absence of major ports (Singh 2003). Fishery pressure was found to be of medium level in the critical habitat.

Andaman and Nicobar Islands

The critical dugong habitat identified in the Andaman Islands includes the waters off Landfall Island, Reef Island, White-Cliff Island, Smith Island, North Reef Island, Interview Island, Sound Island, Mayabunder, Karmatang, Long Island, North Passage,

Ritchie's Archipelago, M.G. Marine National Park, Sister Islands and Brother Islands, as well as parts of Jarawa Reserve and the east and south coast of Little Andaman (Figure 28). About 45% of the priority areas identified in this region experience high to very high levels of fishery pressure. In the Nicobar Islands, the waters around Trinket Island, Nancowry Island and Kamorta Island and the area between Kamorta and Katchal islands were identified as a critical dugong habitat (Figure 29). A study conducted in 2011 reported the finding of dugong feeding trails in a few grids identified as a critical dugong habitat (D'souza and Patankar 2011). Fishery pressure was found to be of medium intensity in the priority areas of the Nicobar Islands.

Gulf of Mannar–Palk Bay

In the Gulf of Mannar region, the Tuticorin–Tharuvaikulam and Roachamanagar Dhanushkodi stretches, including the offshore islands, have been identified as critical for dugongs. This includes the villages of Threspuram, Vellapatti, S. Mariyur, Keelmondal, Valinokam, Ervadi, Keelakkarai, Tirtakkarai, Pududmadam, Sundaramadaya, Vedhalali, Mandapam, Pamban and Kundhukal (Figure 30). The priority areas in Palk Bay region comprise the waters off Dhanushkodi, Rameshwaram, Devipattinam, Thiruppalaikudi, Morepannai, Mullimunnai, Pudupattinam, Thondi, Mimisal, Kottaippattanam, Manamelkudi and Manora (Figure 31). The fishery pressure ranged from high to very high in the Mannar region, while it was of medium intensity in critical habitats of the Palk Bay.

In all three zones, only part of the critical dugong habitat identified fell within existing protected areas, while in the Palk Bay and Nicobar Islands, there are no protected areas. Thus, more areas need to be brought under the wildlife protected area network, with the participation of local communities.

Additionally, the habitat occupancy of dugongs was estimated to be 11% of the surveyed area in India. On a regional level, only 21% of the sampled area in Tamil Nadu, 1% of the sampled area in Gulf of Kutch and 12% of the sampled area in the Andaman and Nicobar Islands was found to be occupied by dugongs.

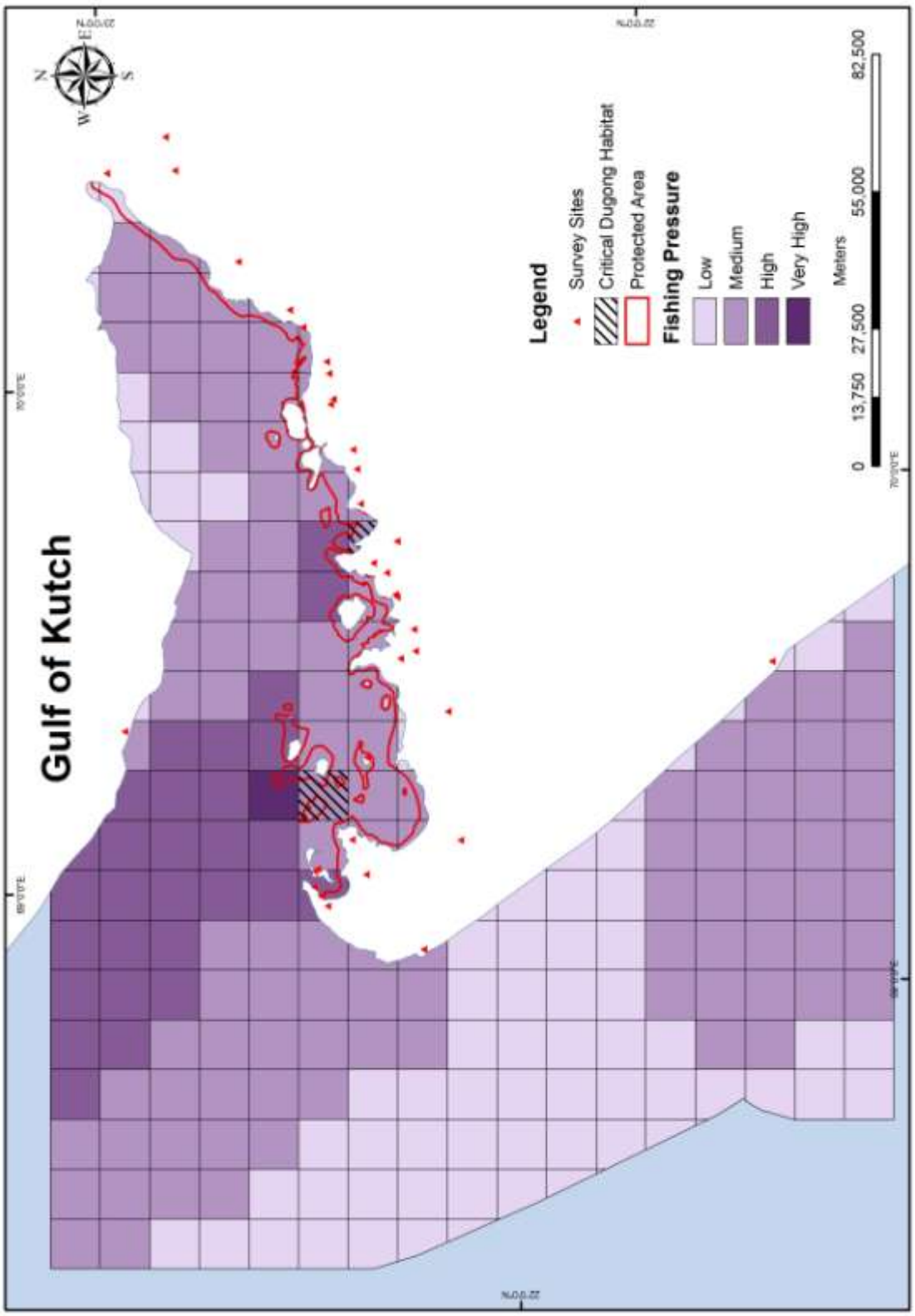

Figure 27 – Critical dugong habitat in the Gulf of Kutch

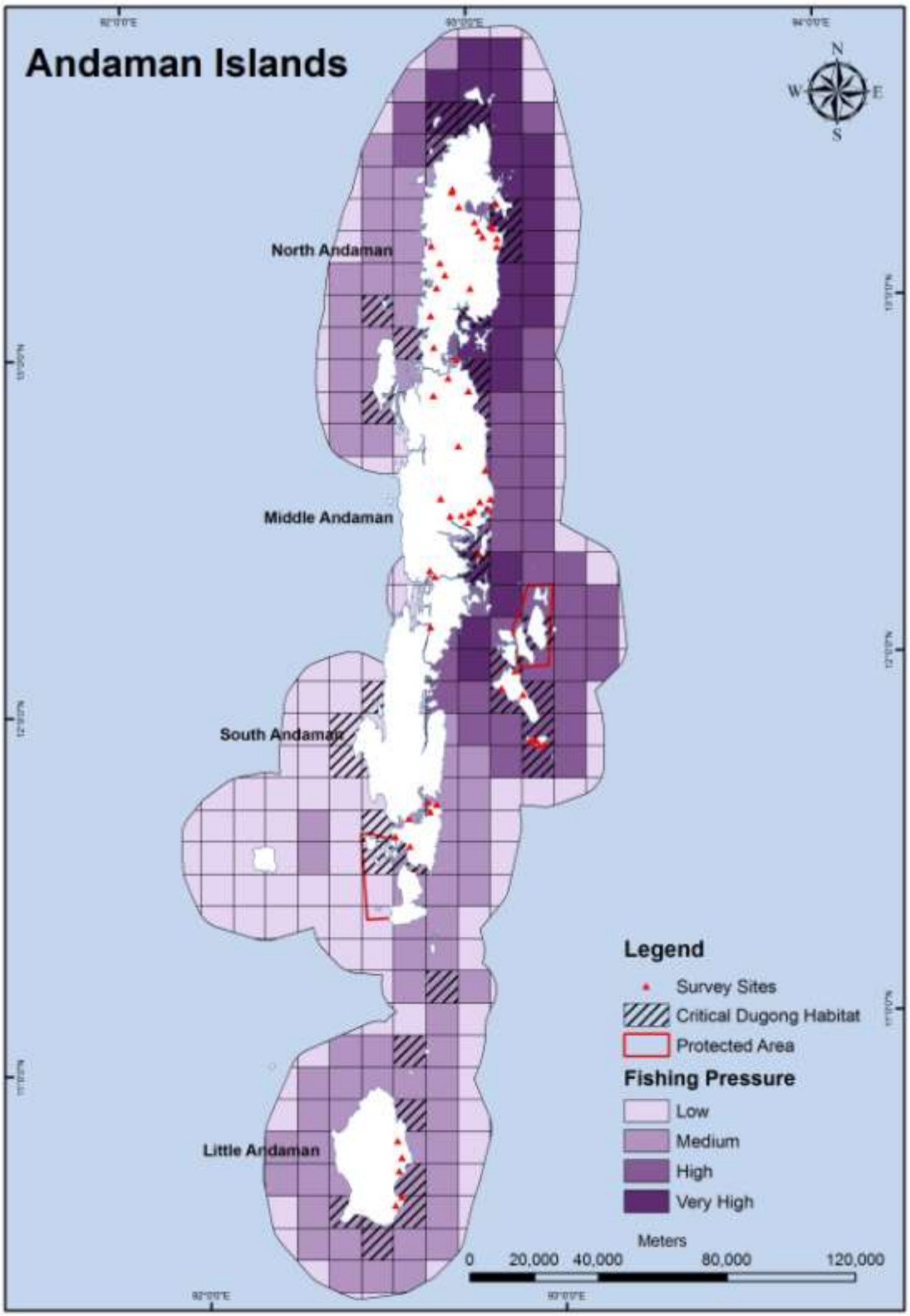

Figure 28 – Critical dugong habitat in the Andaman Islands

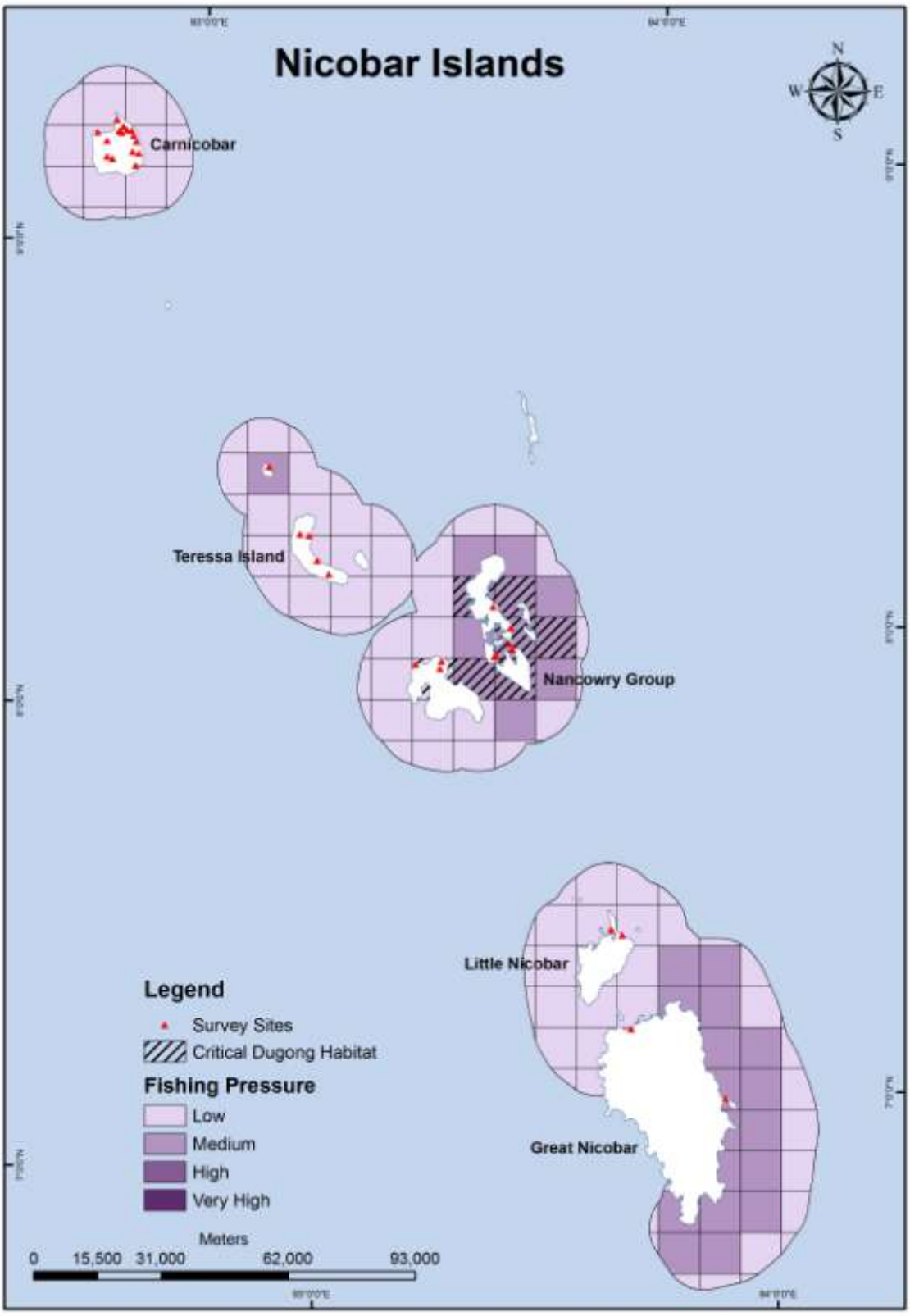

Figure 29 – Critical dugong habitat in the Nicobar Islands

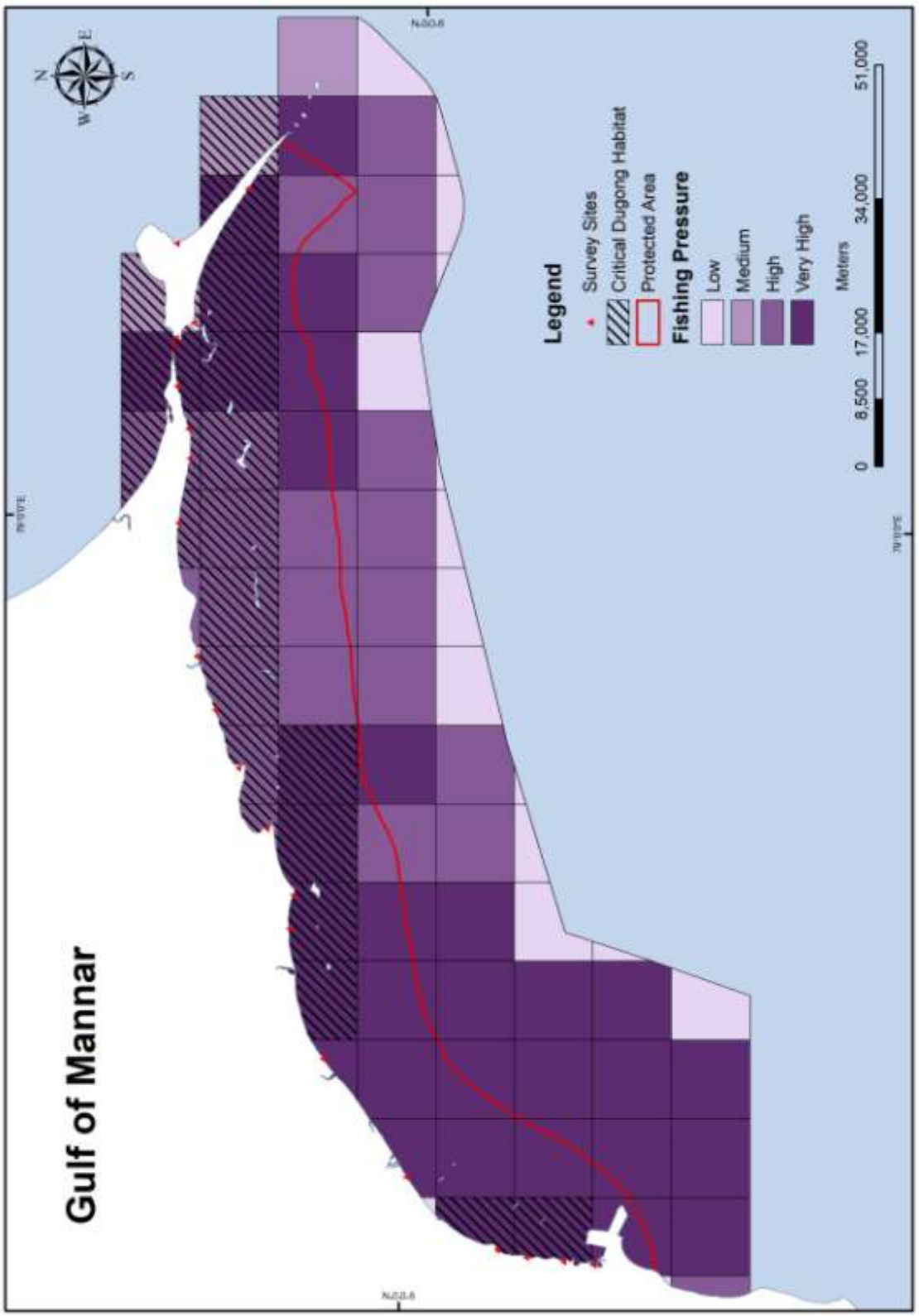

Figure 30 – Critical dugong habitat in the Gulf of Mannar

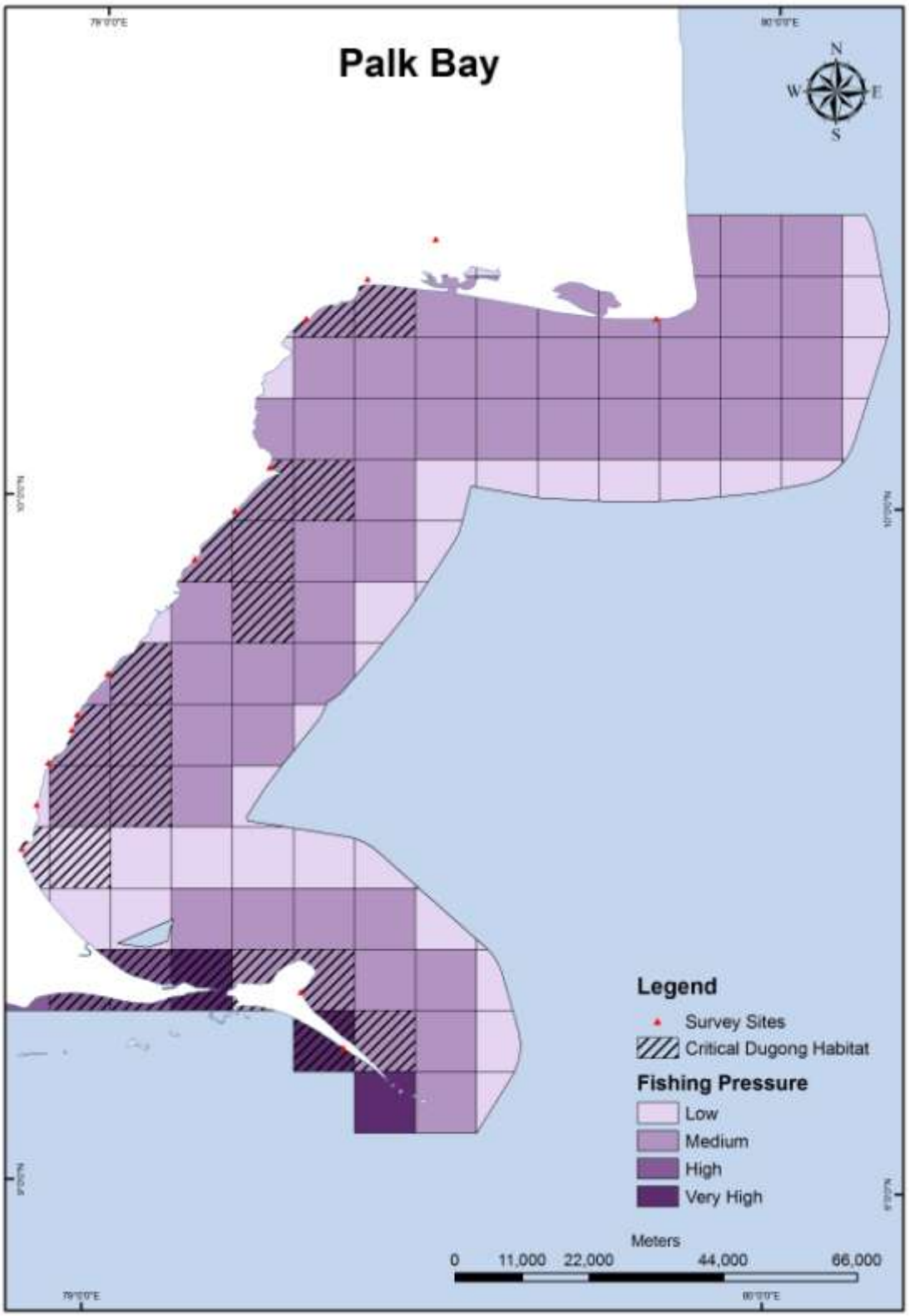

Figure 31 – Critical dugong habitat in the Palk Bay

F. Sea Turtles and Cetaceans in the dugong habitats in India

In all regions, sightings of marine turtles and cetaceans were reported weekly, indicating that the dugong habitat supports diverse and abundant marine fauna. One or two dead turtles and dolphins were washed ashore each year in the villages of all the three zones, highlighting the need for better conservation measures. It is estimated that about 9000 to 10,000 dolphins are accidentally caught in gill nets annually along the Indian coast (Yousuf *et al*. 2008).

In the Gulf of Kutch, fishermen identified incidental catches in nets, oil pollution and chemical pollution as the major causes for the decline in the numbers of sea turtles and cetaceans. Respondents in the Andaman and Nicobar Islands identified accidental deaths caused by shark nets to be the main factor behind the decreased numbers of turtles and dolphins. Additionally, the damage to the habitat due to the tsunami of 2004 was identified as a factor. In the Gulf of Mannar and Palk Bay area, overfishing, propeller injuries, dynamite fishing and habitat destruction by trawlers were listed as the factors detrimental to turtle and dolphin numbers. Direct hunting for consumption of meat and eggs of turtles was reported in the Andaman Islands, Nicobar Islands, Gulf of Mannar and Palk Bay. Though there were no reports of consumption of dolphin meat in the Andaman Islands and Gulf of Mannar, a small fraction (1%) of respondents mentioned the use of intentionally hunted and accidentally caught dolphin meat as bait.

Sorting of fish catch – Okha, Gulf of Kutch

G. Perception towards Conservation

Significantly, 51% of the fishermen reported a decline in the dugong population over the years as the sightings had become increasingly rare. Even though 30% of the respondents were not aware of any trends in the population, the remainder (20%) said that the numbers were the same, while a few respondents (1%) believed that dugong numbers had increased owing to the ban in hunting (Figure 32).

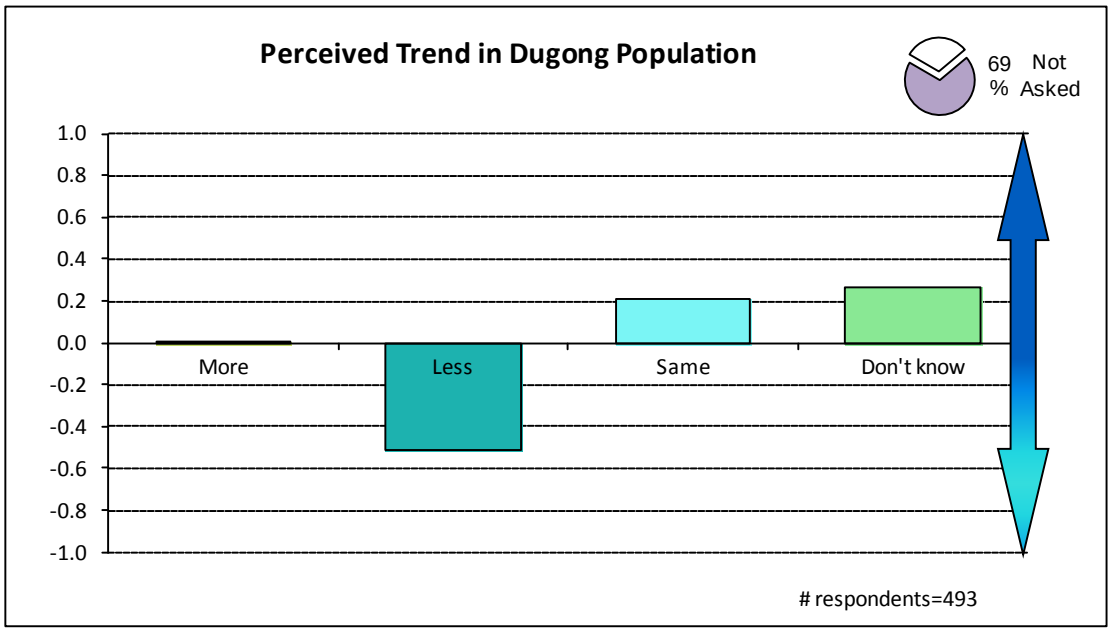

Figure 32 – Perceived trend in dugong population

Most of the fishermen (66%) were unable to comment on the future of dugong population in their region, and 21% said that the animal would survive because of the increased protection given to its habitat and the prohibition on its hunting, while a small proportion (13%) of respondents felt that excessive hunting in the past, current fishery practices and events such as the tsunami have already decimated dugong numbers beyond recovery. Only 5% of the respondents replied positively, highlighting the role of dugongs in maintaining seagrass beds (Figure 33). One elderly fisherman from Wandoor, in the Andaman Islands, mentioned an old practice of using dugong bone parts to cure body pain (Figure 34). A sizeable fraction of the fishermen (72%) were unaware of the ecological importance of dugongs, and a few (23%) believed the marine mammal's presence to be of no real significance. This finding emphasizes the need for increasing the awareness of local people about the significance of the dugong and why the species needs to be conserved.

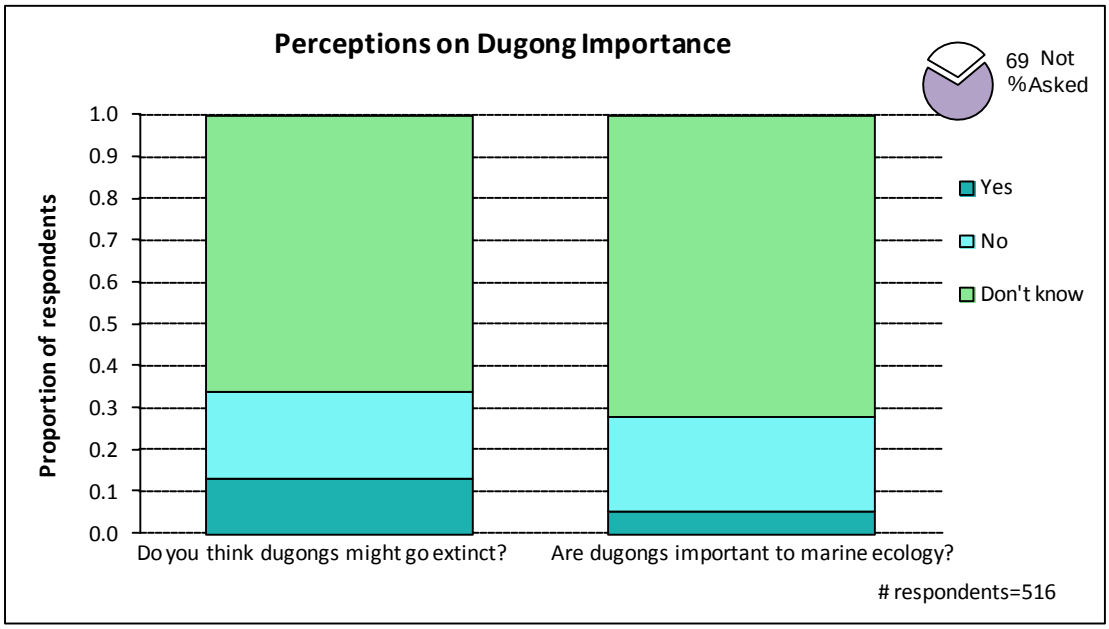

Figure 33 – Perceptions of respondents on the importance of the dugong

Part of vertebral bone of a dugong, used for curing body pain in the past – Wandoor, Andaman Islands

About 70% of the respondents were acquainted with the seagrass areas of their region and identified some of the common genera such as *Halophila*, *Zostera*, *Cymodocea* and *Thalassia*. Only 9% of the fishermen perceived the seagrass areas to be of significance as a source of food for dugongs and turtles, as a nursery for fishes and as areas abundant in prawns and chanks. The rest of the respondents (Don't know, 55%; No, 24%) were ignorant about the role of the seagrass ecosystem (Figure 34). These figures highlight the importance of educating the local community about the significance of seagrass species and the greater implications of conserving seagrass beds.

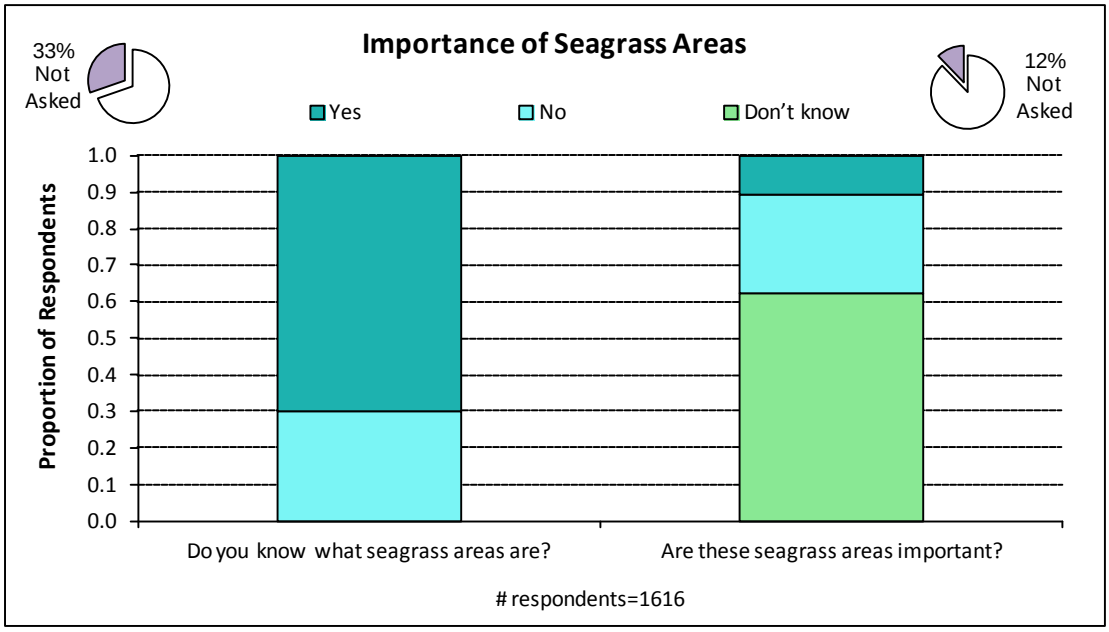

Figure 34 – Perceived importance of seagrass systems

Results show that the level of awareness of the protected status of the dugong was high in all three zones. About 92% of all the respondents knew about the illegality of intentionally killing a dugong and additionally believed that even accidentally caused dugong mortality carried the same legal consequences. Due to the sensitivity of the issue, about 53% of respondents were not asked these two questions (Figure 35).

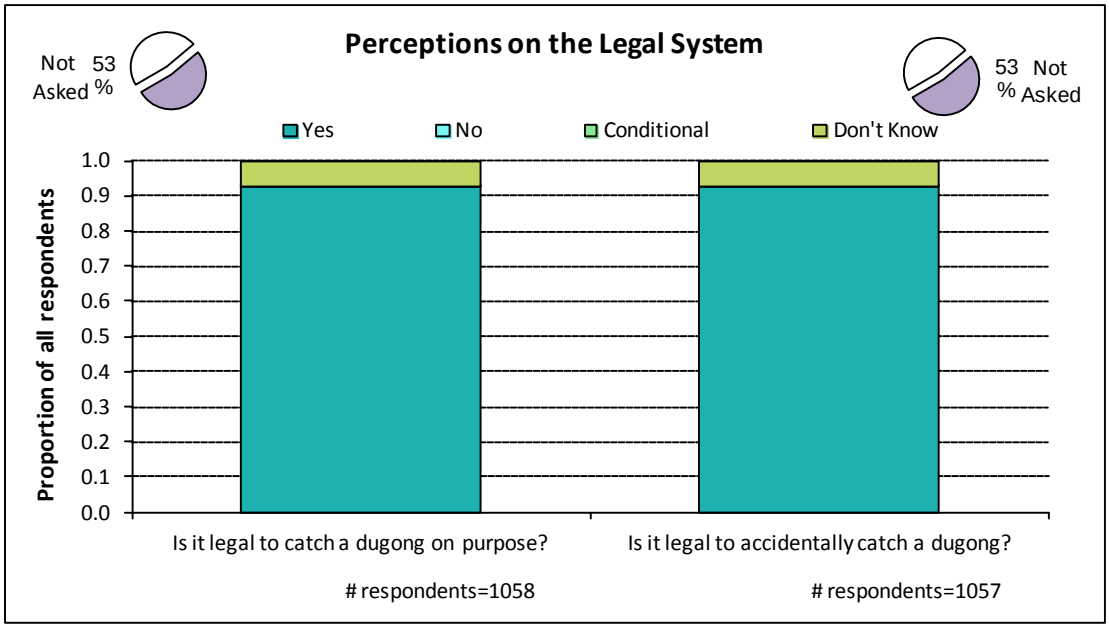

Figure 35 – Perceptions of respondents on legal system

Regarding enforcement of laws, respondents opined that patrols were infrequent (57%), while 30% said their areas were never monitored. As for prior events of imposition of penalties for violation of laws meant to safeguard the dugong and its habitat, 84% of the respondents answered in the negative and 1% answered in the affirmative. Due to the sensitivity of the issue, about 41% of the fishermen were not asked these two questions (Figure 36).

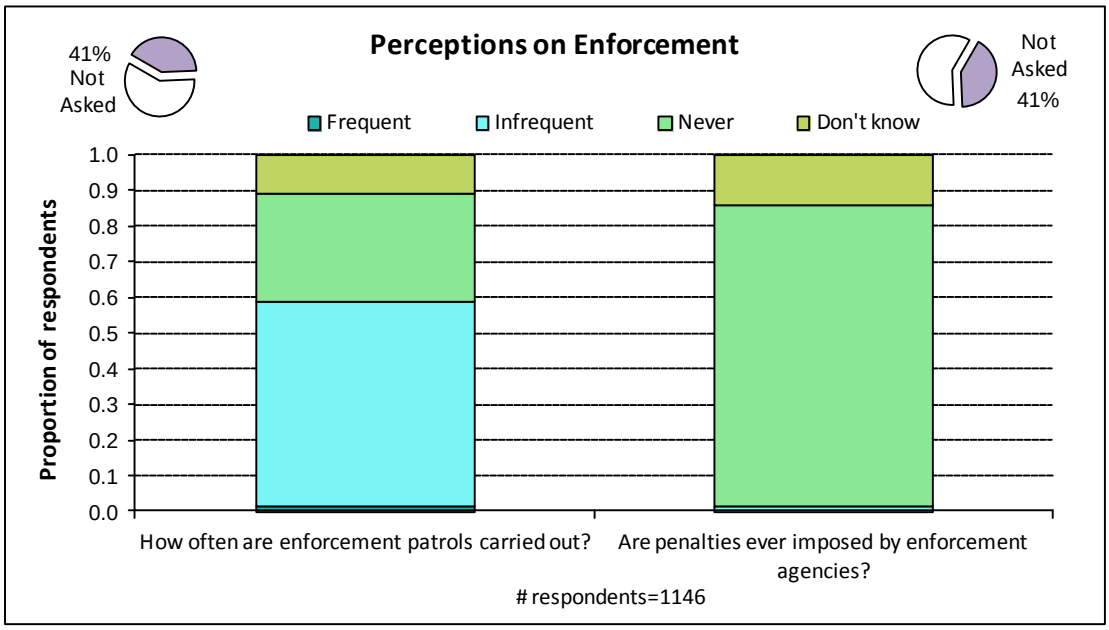

Figure 36 – Perceptions of respondents of enforcement

These results indicate that although strong legislation, such as the Wildlife (Protection) Act, 1972, exists and is being enforced to a certain degree, the fallout. It is probably because the process of penalisation is inadequate.

Shifting to nets made of natural fibres due to a ban on synthetic nets, Andaman Islands

6. Conclusions

We are still unaware of the size of the dugong population in India, which could be below critical levels, as suggested by earlier works. Priority should be given to improving the management of the critical habitats of dugongs that have been identified in this study. The actual distribution range of the dugong in India is 85% reduced compared with its historical range. Some of the findings of this study that will be important in region-specific conservation and management plans for the dugong are presented in Table 3, 4 & 5.

- Management measures must be formulated involving the local stakeholders' opinions as fishing is their major source of livelihood.
- The Gulf of Kutch has the lowest dugong occupancy and highest level of mortality, and there is no evidence of a breeding population from the sighting records from the past 10 years. The greatest threats to the dugongs of this region are industrial pollution and high boat traffic.

- The Andaman and Nicobar Islands have a medium level of dugong occupancy and a lower level of mortality, and there are indications of the presence of a breeding population. Damage caused to seagrass beds due to the tsunami and illegal hunting were identified as the prime causes of the decline in dugong numbers.
- The Gulf of Mannar and Palk Bay have a comparatively high level of dugong occupancy and high mortality. There is evidence of a breeding population. The major threats to dugongs in this region are seagrass damage by trawlers, high boat traffic, illegal hunting and entanglement in gill nets.
- Dugongs exist in regions outside the protected area network. Thus, conservation plans should include areas outside protected networks. The Palk Bay and Nicobar Islands have no MPAs.
- There is a high overlap between the critical dugong habitats and intensively fished areas. Except the Andaman and Nicobar Islands, in all the regions most of the craft are motorised, and the gill net is the preferred gear. Although fishing cannot be completely stopped, measures such as speed limits on boats and shifting to less damaging gear in these critical areas can reduce the accidental mortality of dugongs.
- The distribution of the dugong is directly linked to seagrass presence, and thus detailed seagrass mapping is required in all three regions.
- Large proportions of respondents are unaware of the importance of the dugong and the seagrass ecosystem, and thus the focus should be on educating the locals and getting them involved in dugong conservation.
- The state forest departments need to be commended for the high level of awareness about the illegality of dugong capture, but poaching is still occurring, which could be because of the low level of penalisation.

Table(3) - Specific action plans for conservation of the dugong and its habitats in the Gulf of Mannar and Palk Bay region in accordance with the UNEP/CMS Dugong MoU

Objective	Action	Priority	Time Scale	Remarks
Objective 1. Improve our understanding of the dugong through research and monitoring	1.1 Determine the distribution and abundance of dugong populations inside the critical dugong habitat using an aerial survey with the help of the Coast Guard.	High	Immediate (1 year)	Collect demographic profile of dugongs (such as numbers of adults and young).
	1.2 Conduct research on and monitor dugongs, especially in the identified critical dugong habitats.	High	Continuous	
	1.3 Perform satellite tracking of dugongs in the Gulf of Mannar Biosphere Reserve (GoMBR)/Palk Bay to understand their movements and habitat use because this population seems to be moving between the coastal habitats of India and Sri Lanka.	Medium	Continuous	
Objective 2. Improve our understanding of dugong habitats through research and monitoring	Conduct research on and monitor dugong habitats.	High	Continuous	Promote dugong conservation on the basis of findings of research and monitoring.
Objective 3. Reduce direct and indirect causes of dugong mortality	3.1 Identify, assess and evaluate threats to dugong populations and develop appropriate measures to address these threats.	High	Continuous	The data will help develop appropriate conservation measures for the different types and levels of threats.
	3.2 Reduce illegal take of dugongs.	High	Continuous	Control illegal take of dugongs by providing alternate livelihoods.
	3.3 Reduce incidental capture and mortality of dugongs.	High	Continuous	Reduce mortality rates and withadditional livelihoods.
	3.4 Reduce dugong mortality due to other direct anthropogenic activities such as boat hits.	High	Continuous	Reduce mortality rates.
	3.5 Reduce indirect anthropogenic threats, e.g. marine pollution.	High	Continuous	Reduce mortality rates.
Objective 4. Conserve and manage dugong habitats	4.1 Identify and map dugong habitats.	High	Immediate	Classify and map dugong habitat in terms of threat status

	4.2 Identify direct and indirect pressures on dugong habitats.	High	Immediate	Prioritise pressures on dugong habitats.
	4.3 Rehabilitate degraded dugong habitats.	Medium	Continuous	Promoterecovery of degraded dugong habitats.
	4.4. Involve fisheries departments and Coast Guard in the enforcement of the WPA and Fisheries acts.	High	Continuous	
	4.5 Preparation of coastal resource maps of GoMBR and Palk Bay.	Medium	Soon	
Objective 5. Develop awareness for conservation of the dugong and its habitat	5.1 Develop and implement education and awareness programmes.	High	Continuous	Increase awareness of the different stakeholders.
	5.2 Encourage participation of local communities, other line departments such as the fisheries and private sector in conservation efforts.	High	Continuous	Involve local communities and private sector in conservation activities.
	5.3 Encourage the involvement of other line departments in all conservation programmes, including awareness education.	High	Continuous	Involve the fisheries, social welfare, tourism and education departments, the Coast Guard, etc.
	5.4 Involve religious heads in the awareness programmes.		Continuous	
Objective 6. Protection and Management Strategies	6.1 Strengthen protection force of management.	High	Immediate	
	6.2 Convert poachers to protectors of the dugong by instituting them as watchers	High	Immediate	
	6.3 Involve local communities (fishermen) in decision making and governance.	High		
	6.4 Identify other stakeholders (fisheries, tourism and social welfare departments, Coast Guard etc.) and involve them in decision making and governance.	High		
	6.5 Develop facilities for rescue and rehabilitation of dugongs and other associated species in the region.	Medium		Attach a veterinary unit to the GoMBR.

	6.6 Enhance and strengthen incentives for informers.	High	
	6.7 Resolve issues related to violation of mechanized boats/trawlers in the traditional fishing grounds of fishermen	High	Trawling in near-shore waters should be prohibited strictly.
	6.8 Strict implementation of enforcement related to the types of fishing gear and mesh sizes of nets used.	High	Shore seines, believed to be destroying sea grass beds, may be discouraged in dugong habitats.

Table 4- Specific action plans for conservation of dugongs and their habitats in the Andaman and Nicobar Islands in accordance with the UNEP/CMS Dugong MoU

Objective	Action	Priority	Time Scale	Remarks
Objective 1. Improve our understanding of the dugong through research and monitoring	1.1 Determine the distribution and abundance of dugong populations through an aerial survey with the help of the Coast Guard.	High	Immediate (1 year)	Collect demographic profile of dugongs (such as numbers of adults and young).
	1.2 Conduct research on and monitor dugongs, especially in the critical dugong habitats identified.	Medium	Continuous	
	1.3 Identify causes of mortality and other possible threats to dugongs and their habitat.	Medium	Continuous	
Objective 2. Improve our understanding of the dugong habitats through research and monitoring	2.1 Identify dugong habitats, including foraging areas and migratory routes.	Medium	Immediate	Already done
	2.2 Conduct research on and monitor dugong habitats.	High	Continuous	Promote dugong conservation on the basis of findings of research and monitoring efforts.
Objective 3. Reduce direct and indirect causes of dugong mortality	3.1 Identify, assess and evaluate threats to dugong populations and develop appropriate measures to address these threats.	Medium	Continuous	Already done
	3.2 Reduce illegal take of dugongs.	High	Continuous	Control illegal take of dugongs by providing alternate livelihoods.
	3.3 Reduce incidental capture and mortality of dugongs.	High	Continuous	Reduce mortality rates and with**[**additional livelihoods.
	3.4 Reduce dugong mortality due to other direct anthropogenic activities such as boat hits.	High	Continuous	Reduce mortality rates.
	3.5 Reduce indirect anthropogenic threats, e.g. marine pollution.	High	Continuous	Reduce mortality rates.
Objective 4. Conserve and manage dugong habitats	4.1 Identify and map dugong habitats.	High	Immediate	Classify dugong habitats according to threat status and map them
	4.2 Rehabilitate degraded dugong habitats.	Medium	Continuous	Promote recovery of degraded dugong habitats

	4.3. Involve the Fisheries Department and the Coast Guard in the enforcement of the WPA and Fisheries acts.	High	Continuous	
Objective 5. Develop awareness for conservation of the dugong and its habitat	5.1 Develop and implement education and awareness programmes.	High	Continuous	Increase awareness of the different stakeholders.
	5.2 Encourage the participation of local communities, other line departments such as the Fisheries Department, and the private sector in conservation efforts.	High	Continuous	Involve local communities and the private sector in conservation activities.
	5.3 Involve religious heads in the awareness programmes.	High	Continuous	
Objective 6. Protection and Management Strategies	6.1 Strengthen protection force of management.	Medium	Immediate	
	6.2 Convert poachers to protectors of the dugong by instituting them as watchers.	Medium	Immediate	
	6.3 Involve local communities (fishermen) in decision making and governance.	High		
	6.4 Identify other stakeholders (the fisheries, tourism and social welfare departments, Coast Guard, etc.) and involve them in decision making and governance.	High		
	6.5 Develop facilities for rescue and rehabilitation of the dugong and other associated species in the region.	Medium		Attach a veterinary unit trained in handling marine mammals.
	6.6 Enhance and strengthen incentives for informers	High		
	6.7 Resolve issues related to violations by mechanised boats/trawlers in the traditional fishing grounds.	High		Trawling in near-shore waters should be prohibited strictly.
	6.8 Implement enforcement related to the use of types of fishing gear and mesh sizes of nets strictly.	High		Shore seines, believed to be destroying seagrass beds, may be discouraged in dugong habitats.

Table 5- Specific action plans for conservation of dugongs and their habitats in the Gulf of Kutch in accordance with the UNEP/CMS Dugong MoU

Objective	Action	Priority	Time Scale	Remarks
Objective 1. Improve our understanding of the dugong through research and monitoring	1.1 Determine the distribution and abundance of dugong populations through an aerial survey with the help of the Coast Guard in the critical habitats identified.	High	Immediate (1 year)	Collect demographic profile of dugongs (such as adults and young).
	1.2 Conduct research on and monitor dugongs, especially in the critical dugong habitats identified.	High	Continuous	
	1.3 Identify causes of mortality and other possible threats to dugongs and their habitat.	Medium	Continuous	Already done, but continuous monitoring is required.
Objective 2. Improve our understanding of dugong habitats through research and monitoring	2.1 Identify dugong habitats, including foraging areas and migratory routes.	Medium	Immediate	Already done, but continuous monitoring is required.
	2.2 Conduct research on and monitor dugong habitats.	High	Continuous	Promote dugong conservation on the basis of findings of research and monitoring efforts.
Objective 3. Reduce direct and indirect causes of dugong mortality	3.1 Identify, assess and evaluate threats to dugong populations and develop appropriate measures to address these threats.	High	Continuous	Data will help develop the appropriate conservation measures for the different types and levels of threats.
	3.2 Reduce illegal take of dugongs.	High	Continuous	Control illegal take of dugongs by providing alternate livelihoods.
	3.3 Reduce incidental capture and mortality of dugongs.	High	Continuous	Reduce mortality rates and with**.** additional livelihoods.
	3.4 Reduce dugong mortality due to other direct anthropogenic activities such as boat hits.	High	Continuous	Reduce mortality rates.
	3.5 Reduce indirect anthropogenic threats, e.g. marine pollution.	High	Continuous	Reduce mortality rates.
Objective 4. Conserve and manage dugong habitats	4.1 Identify and map dugong habitat.	High	Immediate	Classify dugong habitats according to threat status and map them.
	4.2 Identify direct and indirect pressures on dugong habitats.	High	Immediate	Prioritize pressures on dugong habitats.
	4.3 Rehabilitate degraded dugong habitats.	Medium	Continuous	Recovery of degraded dugong habitats.

	4.4. Involve the Fisheries Department and the Coast Guard in enforcement of the WPA and Fisheries acts.	High	Continuous	
	4.5 Preparation of coastal resource maps of the Gulf of Kutch region.	Medium	Immediately	
Objective 5. Develop awareness for conservation of the dugong and its habitat	5.1 Develop and implement education and awareness programmes.	High	Continuous	Increase awareness of the different stakeholders.
	5.2 Encourage participation of local communities, other line departments such as the Fisheries Department, and the private sector in conservation efforts.	High	Continuous	Involve local communities and the private sector in conservation activities.
	5.3 Encourage the involvement of other line departments in all conservation programmes, including awareness education.	High	Continuous	Fisheries, social welfare tourism and education departments, the Coast Guard, etc.
	5.4 Involve religious heads in the awareness programmes.		Continuous	
Objective 6. Protection and Management Strategies	6.1 Strengthen protection force of management.	High	Immediately	
	6.2 Convert poachers to protectors of dugong by instituting them as watchers.	High	Immediately	
	6.3 Involve local communities (fishermen) in decision making and governance.	High		
	6.4 Identify other stakeholders (the fisheries, tourism and social welfare departments, the Coast Guard, etc.) and involve them in decision making and governance.	High		
	6.5 Develop facilities for rescuing and rehabilitation of the dugong and other associated species in the region.	Medium		Attach a veterinary unit for GoMBR.
	6.6 Enhance and strengthen the incentives for informers.	High		
	6.7 Resolve issues related to violations of the traditional fishing grounds of fishermen by mechanized boats/trawlers in	High		Trawling in near-shore waters should be prohibited strictly.
	6.8 Implementation of enforcement related to the use of types of fishing gear and mesh sizes of nets strictly.	High		Shore seines, believed to be destroying seagrass beds, may be discouraged in dugong habitats.

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8. Annexure

Annexure 1 – GPS locations of the survey sites

Gulf of Kutch								
Town	**Province**	**Latitude**			**Longitude**			
Bhatiya	Ajad Island	22	22	53.5	69	20	17.5	
	Gurgadh	22	11	41.4	69	11	29.5	
Dwarka	Arambhada	22	25	44.6	69	2	13.3	
	Bet Dwarka	22	27	32.4	69	6	13.6	
	Bet Dwarka—Balapur	22	27	13.3	69	6	32.9	
	Dwarka	22	14	39.4	68	58	7.5	
	Poshitra	22	23	42.2	69	10	23	
	Rajpara	22	21	47.4	69	6	25.4	
Jamnagar	Bedi Bandar	22	30	5.6	70	2	31.4	
	Jodia Bhunga	22	30	21.6	70	1	55.1	
	Khijadiya	22	31	11.4	70	6	55.9	
	Mithapur	22	30	49.5	70	5	33.9	
	Sachana	22	34	8.1	70	10	48.2	
Jodia	Balachadi	22	35	47.8	70	12	42.1	
	Dhui	22	49	47.8	70	28	9.6	
	Jodia	22	41	55.8	70	17	56.3	
Khambhaliya	Chudeshwar	22	22	30.4	69	42	26.9	
	Goinj	22	18	33.2	69	33	29.1	
	Nana Amla	22	21	8.9	69	39	42.7	
	Salaya	22	18	56.7	69	36	1.9	
Mandavi	Mandavi	22	49	59.4	69	20	46.9	
Navlakhi	Navlakhi	22	57	20.2	70	27	9.6	
Okha	Dalda Port	22	27	28.7	69	4	22.7	
	Mori	22	26	38.9	69	3	23.8	
Porbandar	Porbandar	21	38	56.3	69	35	59.9	
Sikka	Jakhar	22	21	41.8	69	46	17.7	
	Sarmat	22	27	27	69	56	43.6	
	Rasul Nagar	22	26	48.6	69	54	28.2	
	Sikka	22	26	7.2	69	50	23.2	
	Vadinar	22	24	6.5	69	43	28.8	

Andaman Islands							
Town	**Province**	**Latitude**			**Longitude**		
Diglipur	Aerial Bay	13	16	56.5	93	1	33
	Desh Bandhu Gram	13	16	20.4	92	59	21.4
	Durgapur	13	16	36.5	93	1	50.2
	Kala Pahar	13	2	41.2	92	49	59.1
	Kalighat	13	6	46.8	92	57	9.3
	Kalipur	13	13	29	93	2	17.1
	Kishori Nagar	13	11	27	92	52	16
	Laxmipur	13	17	53.7	92	58	44.9
	Mohanpur	12	57	16.7	92	50	7.4
	Parangara	13	9	20.8	92	53	1.8
	Radha Nagar (D)	13	23	13.8	92	55	17.9
	Ram Nagar	11	49	13.2	93	2	52.4
	Shivpur	13	14	53.4	93	2	28.6
	Shyam Nagar	13	23	40.9	92	55	24.7
	Smit Island	13	20	41.2	93	2	45.9
	Sri Nagar	13	7	18.3	92	51	21.9
	Swaraj Gram	13	20	39.6	92	56	17.6
	Tal Bagan	13	14	24.2	92	51	3.7
	V.S. Palley	13	15	19.1	92	59	58.9
Havelock Island	Govind Nagar	12	1	52.2	92	59	46.1
	Radha Nagar (H)	11	59	9.1	92	57	15.8
	Vijay Nagar	11	57	48.9	93	0	48.2
Kadamtala	Kadamtala	12	19	50.6	92	46	28.2
Little Andaman	Harvinder Bay	10	33	54.2	92	32	31.4
	Hut Bay	10	35	16	92	33	39.1
	Netaji Nagar	10	39	32.6	92	34	30.8
	Ramkrishnapur	10	41	49.5	92	34	12.7
	Vivekanandpur	10	44	40.1	92	33	42.1
Long Island	Long Island	12	21	59.2	92	55	8.1
Mayabundar	Fishing Colony	12	55	0.4	92	53	50.8
	Karma Tang	12	49	32.9	92	55	31.6
	Tuga Pur	12	49	12.2	92	49	25.2

	Webi	12	51	58.5	92	52	12.7
Neil Island	Bharatpur	11	49	58.5	93	2	27.8
	Laxmanpur	11	49	59.8	93	1	23.9
	Neil Kendra	11	49	59.4	93	1	59.9
	Sitapur	11	49	13.2	93	3	41.4
Port Blair	Chouldhari	11	38	27	92	39	39.9
	Dignabad	11	40	29.8	92	44	38.7
	Guptapara	11	33	46.8	92	39	32.1
	Haddo	11	40	55.1	92	43	12
	Jungli Ghat	11	39	20.9	92	43	26.9
	Wandoor	11	35	37.3	92	37	9.3
Rangat	Amkunj	12	31	3.7	92	57	50.1
	Araru	12	36	1.3	92	57	21.9
	Bishnupur	12	28	42.2	92	52	38.7
	Dashrathpur	12	29	16.4	92	54	52.1
	Harinagar	12	40	22.1	92	53	3.2
	Janak Pur	12	30	45.5	92	55	56.9
	Kaushlya Nagar	12	31	45.8	92	49	18.5
	Nimbutala	12	29	29.4	92	57	21.9
	Oral Kutccha	12	10	20	92	45	55
	Sebri	12	28	57.6	92	54	6.3
	Shyamkund	12	28	42.8	92	50	41.2
	Uttara	12	18	46.6	92	47	15.5
	Yerrata	12	27	25.6	92	53	40.4

Nicobar Islands							
Town	**Province**	**Latitude**			**Longitude**		
Campbell Bay	Afra Bay	7	11	8.5	93	44	8.5
	Makachua	7	24	8.5	93	42	41.8
	Pillopanja	7	23	20.6	93	44	0.6
	Rajiv Nagar	7	1	10.4	93	55	34.6
Car Nicobar	Arong	9	9	41.8	92	45	3.3
	Chuck Chucha	9	12	46.7	92	48	32.4
	Jayanti	9	13	27.3	92	47	31.8
	Kakana	9	8	13.3	92	48	44.8

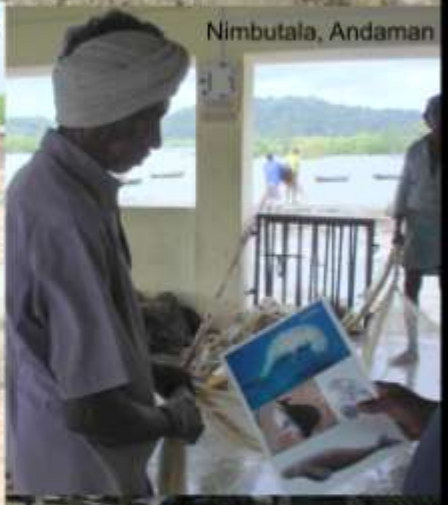
	Kimois	9	9	20.7	92	45	45.1
	Kinmai	9	12	52.7	92	46	54.5
	Kinyuka	9	12	8.51	92	48	45
	Malaca	9	9	46.1	92	49	15.1
	Mus	9	14	23.6	92	46	47.9
	Perka	9	10	3.5	92	48	28.2
	Sawai	9	12	55	92	44	4.6
	Small Lapathy	9	12	39.6	92	47	11.2
	Tamaloo	9	11	19.9	92	49	3.2
	Tapoming	9	12	54.2	92	47	55.7
	Tee Top	9	11	44.2	92	45	12.9
Chowra	Chowra	8	27	42	93	3	6.5
Kamorta	Bada Inaka	8	4	15.8	93	32	50.1
	Kamorta	8	2	16.9	93	32	33.5
	Munak	8	0	45.1	93	30	24.5
	Ramjok	8	0	50.9	93	30	35.5
	Vikas Nagar	8	7	11.1	93	30	48.4
Katchal	Alpam	8	0	34.1	93	20	8
	E Wall	7	59	46.4	93	23	13.3
	Meenakshi	8	0	43.7	93	23	29.4
Nancowry	Champion	8	1	25.2	93	32	53.2
Teressa	Alurong	8	18	39.2	93	6	25.9
	Bengali Basti	8	18	21.1	93	7	35.5
	Galashi	8	13	7.4	93	9	46.1
	Minuka	8	15	0.9	93	8	22.5

Gulf of Mannar							
Town	**Province**	**Latitude**			**Longitude**		
Ramanathapuram	Ervadi	9	11	53.2	78	42	58.8
	Keelakkarai	9	13	34.4	78	46	56.7
	Keelmondal	9	7	56.6	78	34	23.8
	Kundhukal	9	15	37.7	79	13	26.6
	Mandapam	9	16	39.8	79	9	4.8
	Pamban	9	16	47.4	79	12	22.5
	Pudumadam	9	16	22	78	59	43.2

	Rameshwaram	9	16	51.5	79	18	51.6
	Rochamanagar	9	5	39.3	78	23	12.2
	S. Mariyur	9	8	12.2	78	32	2.9
	Sundaramadaya	9	15	42.1	79	4	8.7
	Tirtakkarai	9	14	55.3	78	50	35.6
	Valinokkam	9	9	51.2	78	38	53.5
	Vedhalali	9	15	49.4	79	6	9.9
Tuticorin	Tuticorin F.H.	8	46	51.3	78	9	35.3
	Keezhavaipar	8	59	46.9	78	15	16.3
	Tharuvaikulam	8	53	25.8	78	10	25.8
	Threspuram	8	48	54.2	78	9	45.4
	Vellapatti	8	51	25.6	78	9	59.3
	Vembar	8	59	46.9	78	15	16.3

Palk Bay							
Town	**Province**	**Latitude**			**Longitude**		
Nagapattinam	Kodiyakkarai	10	16	30.5	79	49	23
Pudukkottai	Kottaippattanam	9	58	57.9	79	12	12.5
	Manamelkudi	10	2	49	79	15	11.9
Ramnathpuram	Devipattinam	9	28	56.4	78	53	51.9
	Dhanushkodi	9	12	4.1	79	22	43.3
	Mimisal	9	54	36.2	79	8	41.7
	Morepannai	9	36	31.3	78	56	5.1
	Mullimunai	9	39	26.1	78	58	6.3
	Pudupattinam	9	40	48.6	78	58	34.2
	Thiruppalaikudi	9	32	49.1	78	55	9.2
	Thondi	9	44	24.5	79	1	10.7
Thanjavur	Adirampattinam	10	19	32.8	79	23	35.3
	Manora	10	15	58.7	79	18	15.2
Thiruvarur	Muthhupettai	10	23	10.2	79	29	38

Annexure 2 - Survey Images



भारतीय वन्यजीव संस्थान
Wildlife Institute of India

UNEP/CMS OFFICE – ABU DHABI

United Arab Emirates

STANDARDISED DUGONG CATCH / BYCATCH QUESTIONNAIRE

Interviewer Name:_____Date:_____Data Sheet Serial Number:_____

Town:_____Province:_____

INTRODUCTION STATEMENT

Note: Reading this statement to the interviewee is compulsory. It ensures all interviews are treated equally.

My name is_____. I work for a project run by the _____ , which is an organization based in_____ (*insert location*) that supports research to help protect the ocean for fishers and wildlife. The goal of this project is to learn more about capture of dugongs and any other marine wildlife in coastal fisheries of_____(*insert location*). In most countries where dugongs and other marine mammals and sea turtles occur, numbers are small and believed to be declining. If we wait too long before initiating conservation actions, they will have disappeared before we get the data to understand the problem. We need to be able to identify the areas where the likelihood of dugongs being killed is greatest due to hunting, capture in fishing gear and vessel strikes, so that dugongs can be protected. We hope that your participation in this study will help us learn more about this. Information from our research could be used to help reduce the capture of dugongs, sea turtles and marine mammals, maybe through community support for our goals, or possibly through more effective regulations and enforcement. Your participation in this survey is voluntary and confidential. We will not record your name or any personal information you share with us unless this is ok with you. Individual answers will be collated and reported on as a group to provide a general idea of current status, and we will absolutely not share your individual answers to anyone outside of the research team. You do not have to answer questions you do not want to.

INTERVIEWEE BACKGROUND

Note: Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

☐ 1. Name:_____

☐ 2. Age:_____

☐ 3. Gender: Male ☐ Female ☐

☐ 4. Have you previously participated in interviews related to:

Fishing ☐ Marine Mammals ☐ MPAs ☐ Ecotourism ☐ Sea Turtles ☐ Other ☐ None ☐

When did you participate?_____

Describe: _____

☐ 5. For how many years has fishing been your occupation?_____

☐ 6. Were your parents fishers? Yes ☐ No ☐ Grandparents? Yes ☐ No ☐

☐ 7. Is fishing the main way you earn a living? Yes ☐ No ☐

☐ 8. Is fishing the only way you earn a living? Yes ☐ No ☐

If No, what is (or are) your other occupation(s)?_____

☐ 9. Which months do you normally fish (out of the last 12)?_____

(*if seasonal, indicate season start and end*)

☐ 10. How many days each week do you fish?_____days (low season)_____days (peak season)

☐ 11. What is your position on the boat? The captain ☐ A crew member ☐ We have no fixed positions ☐

I do not work on a boat ☐ (*Skip next questions if this is the response*)

☐ 12. How many fishers, including yourself, work on the boat?_____

☐ 13. How long is the boat?_____

(*Note to interviewer: convert and provide answer in meters*)

☐ 14. Is the boat motorized? Yes ☐ No ☐ (if yes) Inboard ☐ Outboard ☐

☐ 15. What is the horsepower of the motor?_____

DUGONG CATCH / BYCATCH

☐ 16. Have you ever seen a dugong? Yes ☐ No ☐

Do you have another name for it?_____

☐ 17. Tell me about the difference between a dugong and a dolphin?_____

☐ 18. How long do you think a dugong lives?_____Don't know ☐

☐ 19. How do you get to see dugongs? Seen while fishing ☐ Seen while travelling to fishing areas ☐

Accidentally caught in nets ☐ Hunted ☐ Stranded on the beach ☐

(*Note to interviewer: Refer to and complete attached table and mark all locations on maps*)

☐ 20. How frequently have you seen dugongs? Never ☐ Once in my life ☐ Only a few times in my life ☐

Frequently ☐ Every year for the last five years ☐

In the last year, only once ☐ several times ☐ every month ☐ every week ☐ every day ☐.

☐ 21. Do you have any dugong specialists or catchers in your village? Yes ☐ No ☐ How many?_____

☐ 22. Have people in your community ever hunted dugongs? Yes ☐ No ☐ Don't Know ☐

(*if yes*) How many (people)?_____For how long?_____

Do they do so now? Yes ☐ No ☐ Don't Know ☐

☐ 23. Do people from other villagers / communities hunt dugongs? Yes ☐ No ☐ Don't Know ☐

Who?_____What village?_____Any other details?_____

Is the catch accidental or on purpose? Accidental ☐ On purpose ☐ Both ☐

☐ 24. Compared to when you started fishing, are there more ☐, less ☐, or the same number of dugongs ☐ captured in fishing gear? Don't Know ☐ (*Note to interviewer: based on actual numbers, not perception*)

(if more or less) Why do you think this?_____

☐ 25. Do you know of any areas where dugongs regularly occur? Yes ☐ No ☐

Where are these dugong areas?:_____

(*Note to interviewer:* Regular *means certain times of year when they are always found*. *Indicate on maps*)

☐ 26. Do these dugong areas change over time? Yes ☐ No ☐ Don't Know ☐

☐ 27. Have you ever seen dugongs calving? Yes ☐ No ☐ When?_____(*what month?*)

Where did you see them calving? (*use maps*)?_____

☐ 28. How many dugongs do you think might live in the important areas? 1 ☐ <10 ☐ >10 ☐ Don't Know ☐

☐ 29. When do you see dugongs? (*indicate months or seasons where possible*):_____

☐ 30. When was the last time you saw a dugong?_____(*if long time ago note the year*)

☐ 31. Did you catch any dugongs in the last year? Yes ☐ No ☐ (*accidentally or hunted*)

(if yes) How many in the last year? 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

Was this is a typical number to catch in a year? Yes ☐ No ☐

(if no) Was it higher or lower than usual? Higher ☐ Lower ☐

Was the catch accidental or was it something you were fishing for? Accidental ☐ Hunted ☐ Both ☐

☐ 32. How many in the last five years? 0 ☐ 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

How many in your life? 0 ☐ 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

☐ 33. What do you do (or would you do) with a dugong if you caught one? *(do not lead interviewee)*

Eat ☐ Sell ☐ Use as Bait ☐ Other Use ☐ Discard (*dead*) ☐ Release (*alive*) ☐

☐ 34. Have you ever found ☐ or heard of ☐ dugongs stranded on the shore? Yes ☐ No ☐ (*explain stranded*)

Or have you ever found ☐ or heard of ☐ dugongs dead at sea? Yes ☐ No ☐

(if yes) Where (*also indicate on maps*)?_____

When and how many?_____

What happened to the animal?_____

☐ 35. What would you do or did you do if you found a stranded dugong?_____

PERCEPTIONS

☐ 36. Compared to when you started fishing, do you think there are more dugongs ☐, less ☐, or the same numbers of dugongs ☐? I don't know ☐

(if more or less) Why do you think this?_____

(*Note to interviewer: Try to determine what other impacts may be driving the trend*)

☐ 37. Do you think there will always be dugongs in the sea? Yes ☐ No ☐ Don't Know ☐

(if yes or no) Why?_____

☐ 38. Do you think having dugongs around is important? Yes ☐ No ☐ Don't know ☐ Why?_____

☐ 39. Do you know what seagrass areas are? Yes ☐ No ☐ (*Note to Interviewer: show graphics*)

Are there any seagrass areas around here? Yes ☐ No ☐ Don't know ☐ Where?_____

(*Note to Interviewer: mark on maps*)

Do you fish in these seagrass areas? Yes ☐ No ☐

Are these seagrass areas important for anything else? Yes ☐ No ☐ Why?_____

☐ 40. Is it illegal to (intentionally) kill a dugong? Yes ☐ No ☐ Don't know ☐

What about by accident (maybe caught in a net unintentionally)? Yes ☐ No ☐ Don't know ☐

☐ 41. Are any areas routinely / periodically patrolled? Frequently ☐ Infrequently ☐ Never ☐ Don't know ☐

☐ 42. If yes, are penalties ever imposed? Frequently ☐ Infrequently ☐ Never ☐ Don't know ☐

☐ 43. Are there any local customs, beliefs, legends or rituals or stories related to dugongs? Yes ☐ No ☐

(if yes) Please describe:_____

Where / from whom did you hear this?_____

☐ 44. Additional stories / incidents you wish to report:_____

_____

_____

FISHERY INFORMATION

Note to interviewer: Respondent should answer these questions to describe his/her individual experience, not that of their community. Use illustrations to assist where necessary.

Habitat Codes: (D) Deep Water; (C) Coral; (S) Seagrass; (F) Fine Sediments; (M) Mangroves; (R) Rocks; (E) Estuaries; (U) Unknown

☐ 45. What type of fishing gear do you use?

Longline	Only ☐ Mostly ☐ Sometimes ☐ Season:_____
(*many hooks*)	Habitat:_____ Target:_____
Bottom longline	Only ☐ Mostly ☐ Sometimes ☐ Season:_____
(*many hooks set at depth*)	Habitat:_____ Target:_____
Hook and line	Only ☐ Mostly ☐ Sometimes ☐ Season:_____
(*one or few hooks*)	Habitat:_____ Target:_____
Purse seine	Only ☐ Mostly ☐ Sometimes ☐ Season:_____
(*or surround nets*)	Habitat:_____ Target:_____
Beach seine	Only ☐ Mostly ☐ Sometimes ☐ Season:_____
	Habitat:_____ Target:_____
Trawl nets	Only ☐ Mostly ☐ Sometimes ☐ Season:_____
(*or other towed net*)	Habitat:_____ Target:_____
Traps	Only ☐ Mostly ☐ Sometimes ☐ Season:_____
	Habitat:_____ Target:_____
Gill or trammel nets	Only ☐ Mostly ☐ Sometimes ☐ Season:_____
	Habitat:_____ Target:_____
	Do you tend the nets when they are in the water? Yes ☐ No ☐
	How long do you leave the nets in the water?_____hours
	Do you fish during the day ☐ or night ☐? Both ☐?

What is the position of the gear? Surface ☐ Midwater ☐ Bottom ☐

Describe the net: Length_____Depth_____Mesh size_____

Other (describe):_____

Only ☐ Mostly ☐ Sometimes ☐ Season:_____

Habitat:_____Target:_____

☐ 46. In what places do you normally fish?_____

(*Use prepared road maps, charts, Google maps and have interviewee point out areas*)

Do you use different gears in different areas? Yes ☐ No ☐ If yes, please describe:_____

_____

(*Use prepared road maps, charts, Google maps, and have interviewee point out areas*)

☐ 47. Do people in your village / community target sharks? Yes ☐ No ☐ No, but they are occasionally landed

Please elaborate:_____

(*Note to interviewer: This can be area sensitive*)

SEA TURTLE CATCH / BYCATCH

(*Optional if time permits and interviewee is keen*)

☐ 48. Have you ever seen sea turtles? Yes ☐ No ☐ Do you have another name for them?_____

☐ 49. What species of turtles do you see?Green ☐ Hawksbill ☐ Olive Ridley ☐ Loggerhead ☐

Flatback ☐ Leatherback ☐ Don't know ☐

Do you know the difference between these turtle species? Yes ☐ No ☐ Don't know ☐

(*Note to Interviewer; Show ID chart or graphics*)

Please describe:_____

Do they have different names? (if yes) Please list:_____(*determine for each species*)

☐ 50. How long do you think a turtle lives?_____Don't know ☐

☐ 51. How do you get to see turtles? Seen while fishing ☐ Seen while travelling to fishing areas ☐

Coming ashore to lay eggs ☐ Accidentally caught in nets ☐ Hunted ☐ Stranded on the beach ☐

(*Note to interviewer: Refer to and complete attached table and mark all locations on maps*)

☐ 52. How frequently have you seen turtles? Never ☐ Once in my life ☐ Only a few times in my life ☐

Frequently ☐ Every year for the last five years ☐

In the last year, only once ☐ several times ☐ every month ☐ every week ☐ every day ☐

☐ 53. Do you have any turtle experts in your village? Yes ☐ No ☐ Who?_____

☐ 54. What about in other villages? Yes ☐ No ☐ Who?_____What village?_____

☐ 55. Have people in your community ever hunted turtles? Yes ☐ No ☐ Don't Know ☐

(if yes) How many?_____For how long?_____

☐ 56. Do they do so now? Yes ☐ No ☐ Don't Know ☐

☐ 57. Do people from other villagers / communities hunt turtles? Yes ☐ No ☐ Don't Know ☐

Who?_____What village?_____Any other details?_____

☐ 58. Compared to when you started fishing, are there more ☐, less ☐, or the same number of ☐ turtles captured in fishing gear? Don't Know ☐ (*Note to interviewer: based on actual numbers, not perception*)

(if more or less) Why do you think this?_____

☐ 59. Do you know of any areas where turtles regularly occur? Yes ☐ No ☐

Where are these turtle areas?:_____

(*Note to interviewer: also indicate on maps*)

☐ 60. Do these turtle areas change over time? Yes ☐ No ☐ Don't Know ☐

☐ 61. Do you see mating turtles? Yes ☐ No ☐ When?_____Where (*use maps*)?_____

☐ 62. How many turtles do you think might live in these areas? <10 ☐ >10 ☐ >100 ☐ Don't Know ☐

☐ 63. When do you see turtles? (*indicate months or seasons*):_____

☐ 64. When was the last time you saw a turtle?_____(*if a long time ago note the year*)

☐ 65. Did you catch any turtles in the last year? Yes ☐ No ☐

(if yes) How many in the last year? 1-2 ☐ ≤10 ☐ >10 ☐ What species? (*if available*):_____

Was this is a typical number to catch in a year? Yes ☐ No ☐

Was the catch accidental or was it something you were fishing for? Accidental ☐ Hunted ☐ Both ☐

☐ 66. How many in the last five years? 0 ☐ 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

☐ 67. How many in your life? 0 ☐ 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

☐ 68. What do you do (or would you do) with a turtle if you caught one?

Eat ☐ Sell ☐ Use as Bait ☐ Other Use ☐ Discard (*dead*) ☐ Release (*alive*) ☐ (*do not lead interviewee*)

(*Note differences by species where possible and if available*)

☐ 69. Have you ever found ☐ or heard of ☐ turtles stranded on the shore? Yes ☐ No ☐ (*explain stranded*)

Or have you ever found ☐ or heard of ☐ turtles dead at sea? Yes ☐ No ☐

(if yes) Where? (*also indicate on maps*)_____

When and how many?_____

What happened to the animal?_____

☐ 70. What would you do or did you do if you found a stranded turtle?_____

☐ 71. Compared to when you started fishing, do you think there are more turtles ☐, less ☐, or the same numbers of turtles ☐? I don't know ☐

(if more or less) Why do you think this?_____

(*Note to interviewer: Try to determine what other impacts may be driving the trend*)

☐ 72. Do you think there will always be turtles in the sea? Yes ☐ No ☐ Don't Know ☐

(if more or less) Why?_____

☐ 73. Do you think having turtles around is important? Yes ☐ No ☐ Why?_____

☐ 74. It is illegal to (intentionally) kill a turtle? Yes ☐ No ☐ Don't know ☐

What about by accident (maybe caught in a net unintentionally)? Yes ☐ No ☐ Don't know ☐

☐ 75. Are there any local customs, beliefs, legends or rituals or stories related to turtles? Yes ☐ No ☐

(if yes) Please describe:_____

_____

Where / from whom did you hear this?_____

DOLPHIN CATCH / BYCATCH

(*Optional if time permits and interviewee is keen*)

☐ 76. Have you ever seen dolphins? Yes ☐ No ☐ Do you have another name(s) for them?_____

_____(*list by species*)

☐ 77. What species of dolphins do you see (*describe*)?_____

Any other cetaceans (*describe*)?_____Don't know ☐

☐ 78. How long do you think dolphins live?_____Don't know ☐

☐ 79. How do you get to see dolphins? Seen while fishing ☐ Seen while travelling to fishing areas ☐

☐ Accidentally caught in nets ☐ Hunted ☐ Stranded on the beach ☐

Are these areas different by species? Yes ☐ No ☐ Don't Know ☐

(if yes) Please explain:_____

(*Note to interviewer: mark locations on maps by species*)

☐ 80. How frequently have you seen dolphins? Never ☐ Once in my life ☐ Only a few times in my life ☐

Frequently ☐ Every year for the last five years ☐

In the last year: Only once ☐ Several times ☐ Every month ☐ Every week ☐ Every day ☐

☐ 81. Do you have any dolphin experts in your village? Yes ☐ No ☐ How many?_____

☐ 82. What about in other villages? Yes ☐ No ☐ Who?_____What village?_____

☐ 83. Have people in your community ever hunted dolphins or other mammals? Yes ☐ No ☐

Don't Know ☐ (if yes) How many?_____For how long?_____

☐ 84. Do they do so now? Yes ☐ No ☐ Don't Know ☐

☐ 85. Compared to when you started fishing, are there more ☐, less ☐, or the same number of ☐ dolphins captured in fishing gear? Don't Know ☐ (*Note to interviewer: based on actual numbers, not perception*)

(if more or less) Why do you think this?_____

☐ 86. Do you know of any areas where dolphins regularly occur? Yes ☐ No ☐

Where are these dolphin areas?:_____

(*Note to interviewer: also indicate on maps*)

☐ 87. Do these dolphin areas change over time? Yes ☐ No ☐ Don't Know ☐

☐ 88. How many dolphins do you think might live in these areas? <10 ☐ >10 ☐ >100 ☐ Don't Know ☐

☐ 89. When do you see dolphins? (*indicate months or seasons*):_____

☐ 90. When was the last time you saw one?_____(*if long time ago note the year*)

☐ 91. Did you catch any dolphins in the last year? Yes ☐ No ☐

(if yes) How many in the last year? 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

Was this is a typical number to catch in a year? Yes ☐ No ☐

Was the catch accidental or was it something you were fishing for? Accidental ☐ Hunted ☐ Both ☐

☐ 92. How many in the last five years? 0 ☐ 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

☐ 93. How many in your life? 0 ☐ 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

☐ 94. What do you do (or would you do) with a dolphin if you caught one? *(do not lead interviewee)*

Eat ☐ Sell ☐ Use as Bait ☐ Other Use ☐ Discard (dead) ☐ Release (alive) ☐

☐ 95. Have you ever found ☐ or heard of ☐ dolphins stranded on the shore? Yes ☐ No ☐ (*explain stranded*)

Or have you ever found ☐ or heard of ☐ dolphins dead at sea? Yes ☐ No ☐

(if yes) Where (*also indicate on maps*)?_____

When and how many?_____

What happened to the animal?_____

☐ 96. What would you do or did you do if you found a stranded dolphin?_____

☐ 97. Compared to when you started fishing, do you think there are more dolphins ☐, less ☐, or the same numbers of dolphins ☐? I don't know ☐

(if more or less) Why do you think this?_____

(*Note to interviewer: Try to determine what other impacts may be driving the trend*)

☐ 98. Do you think there will always be dolphins in the sea? Yes ☐ No ☐ Don't Know ☐

(if more or less) Why?_____

☐ 99. Do you think having dolphins around is important? Yes ☐ No ☐ Why?_____

☐ 100. It is illegal to (intentionally) kill a dolphin? Yes ☐ No ☐ Don't know ☐

What about by accident (maybe caught in a net unintentionally)? Yes ☐ No ☐ Don't know ☐

☐ 101. Are there any local customs, beliefs, legends or rituals or stories related to dolphins? Yes ☐ No ☐

(if yes) Please describe:_____

Where / from whom did you hear this?_____

CONFIDENTIAL INTERVIEWER COMMENTS

102. How open and honest did the fisher seem about answering bycatch questions?

Very open/honest ☐ Somewhat open/honest ☐ Not honest ☐

103. How interested and engaged did the fisher seem with interview?

Very interested ☐ Moderately interested ☐ Bothered/ Not interested ☐

104. How certain did the fisher seem about answers to numerical questions?

Very sure ☐ Reasonable sure ☐ Unsure ☐

105. How comfortable were you about the respondents' ability to discriminate between the species

Very comfortable ☐ Reasonable ☐ Not comfortable ☐

106. Why do you think this?_____

_____

_____

107. Please indicate why (if any) questions were not asked _____

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

Survey ID Number	Sighting Record #	# Individuals seen	Habitat	Size S,L	Mother - Calf Pair Y / N	Day / Night (time)	Year	Month	Dead / Alive	Cause	Condition	Accidental / Direct	Reported Y/N	Notes

Habitat Codes: *(D) Deep Water; (C) Coral; (S) Seagrass; (F) Fine Sediments; (M) Mangroves; (R) Rocks; (E) Estuaries; (U) Unknown*
Cause: *(G) Gill net, (O) Other Fishing Gear (specify in notes), (B) Boat Strike, (H) Hunting (D) Don't Know*
Condition: *(F) Fresh, (D) Decomposed*