

Chapter 5: SOUTH ASIA

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Regional Findings

South Asia: India and Sri Lanka

- Dugong distribution in the South Asian Region is limited to: (1) the Gulf of Kutch in northwestern India; (2) Tamil Nadu and Sri Lanka; and (3) the Andaman and Nicobar archipelagos in Indian waters in the Bay of Bengal.
- No dugongs or seagrasses have been recorded in Pakistan. It is uncertain whether Bangladesh supports a resident dugong population. There is no evidence that dugongs ever occurred in the Maldives or the Lakshadweep Islands (India).
- The Gulf of Kutch supports a small, isolated, resident dugong population. The limited extent of the potential seagrass supporting habitat in this Gulf means that it is only able to support only a relatively small dugong population, a situation which makes their survival there very challenging.
- The southern Gulf of Kutch has been identified as an Important Marine Mammal Area with the dugong listed as a qualifying species.
- The transboundary Tamil Nadu-Sri Lanka region, which includes Palk Bay and the Gulf of Mannar, is the most important habitat for seagrasses and dugongs in South Asia. The 'Palk Bay and the Gulf of Mannar' has been identified as an Important Marine Mammal Area, with the dugong as the only qualifying species.
- Palk Bay and the Gulf of Mannar apparently support a much lower number of dugongs than in the recent past. Procedures need to be developed to enhance the governance arrangements, research findings and community support required to improve the management of dugong population in this area, especially the impacts of fisheries interactions on dugongs and seagrasses.
- Dugongs in the Gulf of Mannar-Palk Bay also likely face challenging development pressures from the high-level commitment to connect India and Sri Lanka by building a land link across Palk Strait.
- The Andaman and Nicobar archipelagos support a small, isolated, resident dugong population. The limited extent of shallow coastal water around the Andaman and Nicobar Islands means that these archipelagos can support only a relatively small dugong population, a situation that makes their survival there very challenging.
- The 'Southern Andaman Islands' have been identified as an Important Marine Mammal Area with dugongs as a qualifying species.
- Given the small sizes of dugong populations in both the Gulf of Kutch and the Andaman and Nicobar archipelagos, it may be effective and efficient to develop and implement conservation arrangements for marine megafauna, rather than dugongs *per se* in both these areas.
- Research is required to determine if dugongs are resident outside the northwestern region of Sri Lanka and along the Chittagong coast of Bangladesh.
- The status of dugong populations in South Asia remains data deficient. Dugongs in each of the Gulf of Kutch and the Andaman and Nicobar Islands, likely qualify for separate IUCN 'subpopulation' assessments.
- Robust quantitative information on the size of the Tamil Nadu-Sri Lanka dugong population would be essential for an IUCN 'subpopulation' assessment.

5.1 Regional Setting

5.1.1 Geographic Overview

This chapter considers the status of the dugong along the ~ 12,581 km coast of South Asia from the Pakistan-Iran border in the west (25.17° N, 61.62° E) to the Bangladesh-Myanmar border in the east (20.73° N, 92.37° E), including Sri Lanka. The region includes the following areas that support confirmed dugong populations: the Gulf of Kutch (Kachchh, Cutch, Kachh, GoK) on the north-west coast of India, the Gulf of Mannar and Palk Bay between the south-east of India and the north-west of Sri Lanka, the remaining coast of Sri Lanka and the Indian offshore island groups of the Andaman and Nicobar archipelagos in the Andaman Sea (Figure 5.1).

There has been no study of the dugong in Bangladesh despite its proximity to the Rakhine coast of Myanmar where dugongs are known to occur (Chapter 6). Shah-e-Alam (2011) notes that there are a few reports of dugongs in Bangladesh from the nineteenth and twentieth centuries including Maheshkhali Island, the mouth of the Matamuhuri River, and in 1976, the Maheshkhali Channel near Cox's Bazar just north of the Myanmar border (Figure 5.1). It is not known whether these animals were vagrants or part of a resident population. Kanal and Short (2009) reported five species of seagrass (published records of three) in Bangladesh including at Cox's Bazar, but there are no records of their extent.

Contemporary evidence indicates that dugongs do not occur in Pakistan. Len McKenzie (personal communication 2024) advises that there are no records of seagrass meadows or dugongs, even though the border between Pakistan and India is only 210 km from the mouth of the Gulf of Kutch. In the 1970s, researchers from the University of Karachi visited almost all major settlements around the Pakistan-Indian border. Pakistani fishers, who had operated in the Gulf of Kutch in the early 1940s and were aware of dugongs occurring there, claimed that dugongs did not occur in the Indus Delta. Fishers in Gwater Bay (between Pakistan and Iran) in the 1980s made the same claim. (M. Khan, personal communication 2024).

Husar (1975) reported that dugongs were extinct in the Maldives and Laccadive islands citing Snow (1970). Snow's paper does not mention the dugong at either location. The Laccadive (Lakshadweep) Islands are located in the Arabian Sea off the southwest coast of India. There are 36 islands, of which 11 are inhabited. Pandey et al. (2010) conducted interview surveys in 2008 to investigate past records of dugong's occurrence. Twenty-two fishers were interviewed across three villages. Seagrass patches were also surveyed in winter 2008, around Kavaratti, Bangaram, Agatti, Kalpetti and Pareli

Islands by boat and their GPS coordinates recorded. Fishers were unaware of dugongs; the boat surveys resulted in no sightings.

Husar's (1975) claims that the dugong is extinct in the waters of the Maldives and Laccadive islands appear to be without substance. There is no record of the dugong occurring in either location.

Apart from Table 5.1, Pakistan and Bangladesh are not considered further in this chapter, even though both are listed as Range States under the Memorandum of Understanding on the Conservation and Management of Dugongs (*Dugong dugon*) and their Habitats throughout their Range (Dugong MOU). Bangladesh is also a Signatory State.

The Gulf of Kutch (Figure 5.1) in the Indian state of Gujarat, opens towards the Arabian Sea facing the Gulf of Oman. It is a wedge-shaped embayment ~ 130 km long and ~ 43 km wide at the mouth with an average depth of 30 m and a maximum depth 60 m (Anand et al. 2017). There are two physical habitats in the Gulf: (1) the northern coast, which is characterised by mangroves and vast open mudflats, and (2) the southern coast, where seagrass has been detected (Sivakumar and Nair 2013; Kamboj 2014; Pathan et al. 2020; Anand and Highland 2021; Johnson et al. 2023), and which also has coral reefs, rocky and sandy shore environments, mudflats and mangroves.

The **Gulf of Mannar and Palk Bay** are to the south and north, respectively, of Adam's Bridge (also known as Rama's Bridge), a narrow peninsular extension of the Indian mainland on the southeast coast of India. These regions are connected to Palk Strait and Gulf of Mannar along the northwest coast of Sri Lanka. Palk Strait, which in places is only about 25 km wide, separates the Tamil Nadu state of India and the Mannar district of Sri Lanka. Palk Bay also connects the Bay of Bengal in the northeast with the Gulf of Mannar in the southwest of Adam's Bridge (Figures 5.1, 5.5).

The **Andaman and Nicobar Archipelagos** in the Bay of Bengal (Figures 5.1, 5.6) support biodiversity of global significance (Myers et al. 2000). These ~ 570 islands are divided into two groups by the Ten-Degree Channel, which is 140 km wide at its narrowest point (Figures 5.1, 5.6). Twenty-six islands in the Andaman group and 12 in the Nicobar group are inhabited (Pandey et al. 2010; D'Souza et al. 2013; Sivakumar and Nair 2013). The Andaman archipelago comprises 78% of the total geographical region and can be divided into North, Middle, South and Little Andaman and Ritchie's Archipelago, 20 km east of Great Andaman Island. The Nicobar archipelago is divided into Car Nicobar, Nancowry group and Great Nicobar group. The closest likely mainland dugong habitat to the Andaman and Nicobar Archipelagos is along the Tanintharyi coast of Myanmar (Figure 5.1), where unknown numbers of dugongs occur (Chapter 6). The closest distance between the Andaman Islands and Myanmar is ~ 295 km; between the Nicobar Islands and Myanmar, ~ 635 km. The closest distance between the Nicobar Islands and Southeast Asia is to Banda Aceh in Indonesia (~ 210 km).

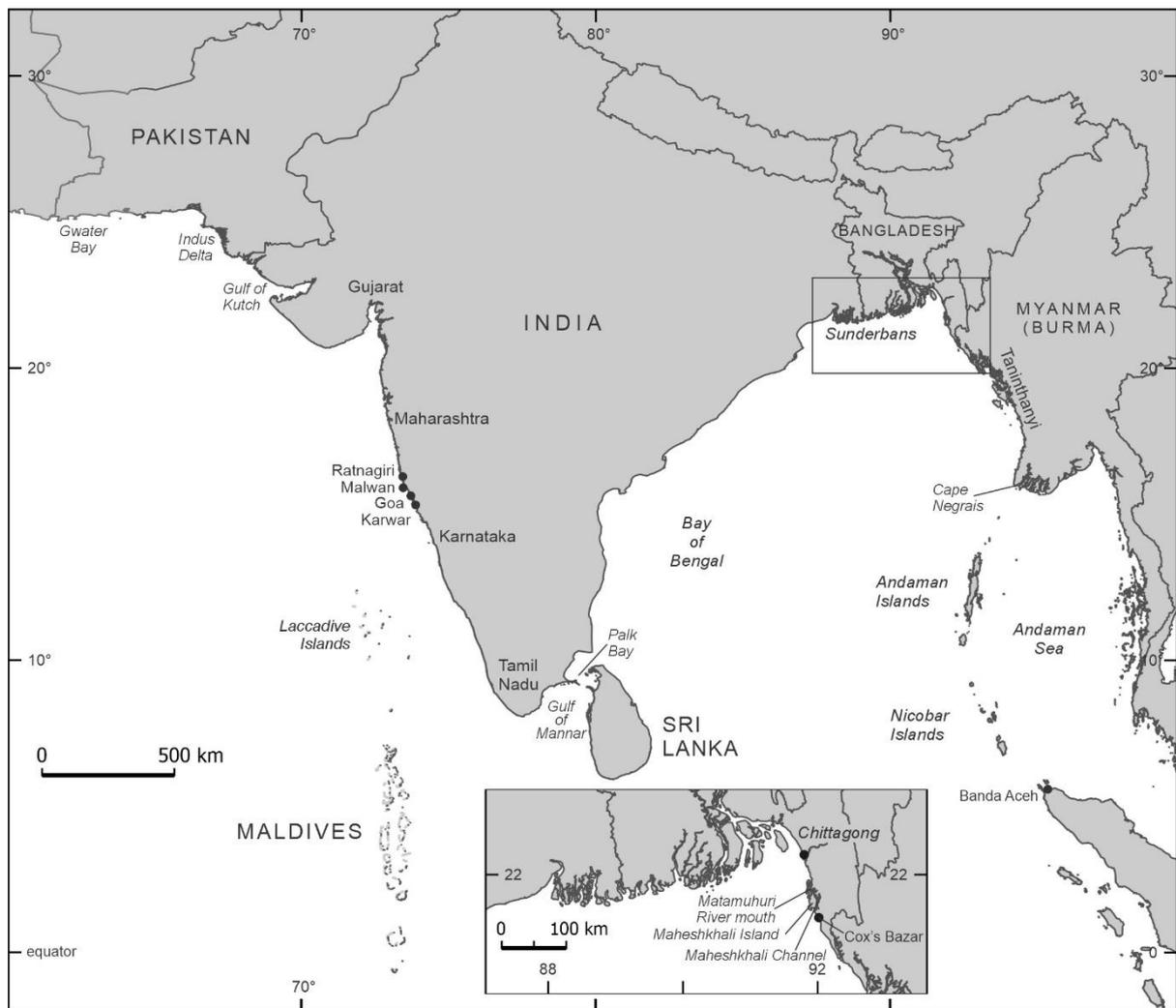
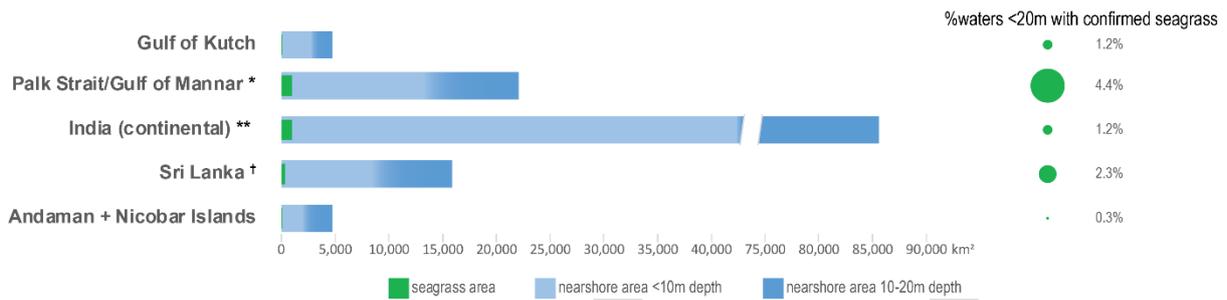


Figure 5.1. Geographic context of South Asia showing placenames mentioned in the text. Countries (ordered west to east) are Pakistan, India, Sri Lanka, and Bangladesh. Confirmed Dugong Range States are India and Sri Lanka. Inset: Bangladesh showing placenames mentioned in the text. Figure created by Adella Edwards; reproduced with permission.

The total area of seagrass in India (Figure 5.2) is estimated with moderate to high confidence to be 1,003 km² (Johnson et al. 2023; Pathan et al. 2020; Geevarghese et al. 2018). The total area for Sri Lanka is 371 km² (Ministry of Mahaweli Development and Environment [MMDE] 2018; Udagedara and Dahanayaka 2020; Suwandhahannad et al. 2024; Bandara et al. 2011).

- The Gulf of Kutch supports 56 km² of seagrass (Pathan et al. 2020; Geevarghese et al. 2018).
- Most (~ 77%) of India's seagrass grows in the state of Tamil Nadu (Geevarghese et al. 2018).
- The total area of seagrass within the Gulf of Mannar Biosphere Reserve (including the Gulf of Mannar and Palk Strait) is estimated to be around 979 km² (Johnson et al. 2023; MMDE 2018); the Sri Lankan component is estimated to be 133 km² (MMDE 2018).

- In the Andaman Islands, the area of seagrass is estimated to be approximately 5.79 km² (Geevarghese et al. 2018). The lagoons at Inglis and Henry Lawrence Islands of the Andaman Island group are reported to sustain dense, diverse seagrass coverage of up to 1.85 km² (Geevarghese et al. 2018). The Nicobar group is estimated to support 8.8 km² of seagrass meadows, mainly occurring around Great Nicobar and Car Nicobar Islands (Geevarghese et al. 2018).



* Includes India and Sri Lanka coasts; ** includes Gulf of Kutch, Palk Strait and Gulf of Mannar coasts, excludes Andaman and Nicobar Islands; † includes Palk Strait and Gulf of Mannar coasts

Figure 5.2. Histogram showing the areas of seagrass known with moderate to high confidence in the coastal waters < 10m deep and < 20 m for specified locations within the South Asian region. The areas of seagrass are almost certainly underestimates. While not all shallow coastal waters are potential seagrass habitat, the figure indicates the need to undertake additional seagrass mapping in this region and that neither the Gulf of Kutch or the Andaman and Nicobar Islands can support large dugong populations. Figure created by Len McKenzie; reproduced with permission.

5.1.2 Geo-Political and Socio-Economic Overview

This information is provided as an indication of the challenge for each of the Range States in the region to consider the conservation of dugongs and their habitats in the context of their socioeconomic development needs. Increasing human populations in coastal areas and the associated development adversely affect marine ecosystems, including dugongs and their habitats (Marsh et al. 2011). India has the largest human population of any nation, overtaking China in April 2023 (United Nations Department of Economic and Social Affairs [UNDESA] et al. 2023). Nearly 174 million people (~ 12% of the total population) live within 50 km of the coast of Indian and Sri Lankan jurisdictions in the dugongs' range (Gujarat, Tamil Nadu and the Union Territory of the Andaman and Nicobar Islands, whole of Sri Lanka); ~ 93 million within 10 km (~7 % of the total population). India's population is almost certain to continue to grow for several decades (UNDESA et al. 2023). The Indian economy ranks fifth largest in the world based on nominal gross domestic product (GDP). Table 5.1 summarises the Human Development Index and per capita GDP of the countries in the South Asian region.

The Andaman and Nicobar archipelagos are of immense strategic significance for India, securing the eastern seaboard and a geographic link between India and its Southeast Asian neighbours (Das 2011). The geographical isolation of these archipelagos presents serious challenges such as the poaching of marine and forest resources, illegal migration, arms smuggling and natural disasters (Das 2011). The archipelagos are home to some of the most isolated indigenous peoples in the world (Andaman and Nicobar Administration 2023). The Great Andamanese, Jarrawas, Nicobarese, Onges, Sentinalese and Shompen peoples inhabit the Andaman and Nicobar archipelagos, along with immigrant settler communities from mainland India. The Sentinelese, who live on North Sentinel Island, are probably the world’s only surviving Palaeolithic people without contact with any other group or community. Very little is known about them. All these tribes hunt wild pig, dugongs, turtles, and fish, etc. for their food requirements (Pandey et al. 2010). Indigenous islanders now account for just 8% of the total population of the Andaman and Nicobar archipelagos (Directorate of Health Services 2015), and there are protests around further contact with them. This situation has restricted scientific access to their lands and seas (but see Johnson et al. 2023).

Approximately 22 million people lived in Sri Lanka in 2022 (UNDESA 2022). Sri Lanka has been facing civil unrest since at least the 1980s (Leatherwood and Reeves 1989), and an economic crisis since 2019 (Hovan George et al. 2022). In August 2021, the Sri Lankan Government declared an economic emergency, in April 2022, the country experienced a double-digit consumer price inflation (CPI) rate of 29.8% (Khandre 2022). Such economic crises are challenging for many sectors including environment and conservation (Rodrigo 2022).

Table 5.1. Human Development Index (HDI) status rank and Gross Domestic Product (GDP) per capita rank of the Dugong Range States in South Asia. Consistent with the remainder of this chapter, the countries in this table are ordered west to east starting with Pakistan. Although it is uncertain whether the coastal waters of Pakistan and Bangladesh support resident populations of dugongs, both countries’ have been included in this table as they are listed as Range States under the Memorandum of Understanding on the Conservation and Management of Dugongs (*Dugong dugon*) and their Habitats throughout their Range (Dugong MOU). The ranks are ordered so that countries with the highest HDI or GDP have the lowest ranks. 189 countries were ranked for both indices.

Range State	HDI	HDI Rank 2023 ¹	GDP per capita rank ²
Pakistan	Low	161	136
India	Medium	132	125
Sri Lanka	High	73	105
Bangladesh	Medium	129	126

¹ 2023 HDI data from <https://hdr.undp.org/data-center/country-insights#/ranks> (downloaded from the internet January 2024);

² 2023 per capita GDP from [https://en.wikipedia.org/wiki/List_of_countries_by_GDP_\(PPP\)_per_capita](https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)_per_capita) (downloaded from the internet January 2024)

5.1.3 Genetics of Dugong Sub-Populations

For an overview of techniques, relevant genetic studies and general findings, refer to Chapter 1.

No nuclear genetic markers have been used for studies on dugongs from this region.

Jayasankar et al. (2009) and Srinivas et al. (2021) have collectively reported 22 sequences (410 bp or longer) from a portion of the mitochondrial control region from Indian locations (Gulf of Kutch, the shallow waters of Tamil Nadu between southern India and Sri Lanka, and the Andaman Islands). The 22 sequences represent seven haplotypes. Six of these haplotypes clearly fall within the WIO haplogroup (Chapter 1, Figure 1.x) and include one haplotype (shared by three individuals) from the Andaman Islands.

A further four short sequences from Sri Lanka were reported by Plön et al. (2019). Where known, the animals from which these came were sampled in the Gulf of Mannar/Palk Bay region. These four sequences are consistent with two of the haplotypes found in dugongs from adjacent Indian coastal waters (Srinivas et al. 2021) and therefore fall within the WIO haplogroup. Plön et al. (2019) regarded their Sri Lankan sequences as representing a separate sublineage within this haplogroup. But with the more recent addition of sequences from India (Srinivas et al. 2021), all sequences from mainland India and Sri Lanka appear to belong to the general WIO haplogroup, within which there is limited overall diversity (Figure 1.x).

The seventh, haplotype (MK986812) was from a single dugong from the Andaman Islands and was markedly different from those of the WIO haplogroup. This outlying sequence is very similar to that (KJ022719) from a single dugong from the Andaman Sea coast of Thailand (Chapter 6) reported by Bushell (2013) and a short sequence from Sri Lanka (MH704292) derived by Plön et al. (2019) from a bone registered in the National Museum of Scotland 1836. These three sequences represent a distinct haplogroup, here termed the East Indian Ocean (EIO) haplogroup (Figure 1.x). Two other sequences from Plön et al. (2019) appear to belong here; MH704314 (Belitung, Indonesia) and MH704371 (Moreton Bay, Queensland). The former location seems reasonable, but the latter is puzzling.

One sequence from Plön et al. (2019) from the Nicobar Islands (MH704374, registered in 1888 in the Natural History Museum, London) belongs to the widespread Australasian haplogroup (Chapters 9 and 10). This is therefore the third haplogroup to be represented in South Asia.

The presence of location-specific haplotypes in Tamil Nadu, Gujarat and the Andaman Islands led Srinivas et al. (2021) to infer regional differences among these locations. But the small number of samples and the slight differences among haplotypes call for caution in interpreting these results.

Similarly, various tests of demographic processes all yielded statistically non-significant results (Srinivas et al. 2021), likely as a consequence of the limited number of samples.

- Some mitochondrial sequence data are available for dugongs from India (including the Andaman Islands) and Sri Lanka.
- Most of these sequences can be referred to the Western Indian Ocean (WIO) haplogroup, but haplotypes from India differ slightly from those in East Africa.
- A small cluster of sequences (one each from Sri Lanka, Andaman Islands, Thailand, Indonesia and Queensland, Australia) apparently constitute a separate, previously unrecognised haplogroup, here termed the East Indian Ocean haplogroup.
- The widespread Australasian haplogroup is represented by a single sequence from the Nicobar Islands.
- There seems to be slight regional genetic differentiation within India.
- Priority should be given to obtaining data from nuclear markers, preferably via whole-genome sequencing, to estimate heterozygosity, levels of inbreeding and population fluctuations in South Asia over time. It would also be desirable to determine whether there is a largely unsampled Eastern Indian Ocean haplogroup and its distribution.

5.2 Distribution, abundance, and trends of dugongs in South Asia

The dugong population of the region occurs in three isolated populations: the Gulf of Kutch, Tamil Nadu-Sri Lanka, and the Andaman and Nicobar Islands, which are discussed separately below. If dugongs are resident in Bangladesh, that population is likely connected to the population in Myanmar (Chapter 6).

5.2.1 Gulf of Kutch

The Gulf of Kutch (Figure 5.3; 22.56° N, 69.54° E) is the only area on the west coast of India currently known to support dugongs. Historically, dugongs have been reported from further south along this coast of India. Jerdon (1894, p.311) reported they were sighted off the south Malabar and Konkan coasts, as far north as Canara (southern Maharashtra). There have not been any sightings since these records (Jones 1967); past sightings may have been vagrants. This high wave energy coast lacks appropriate conditions for seagrass (Jones 1967) and studies of the extent of seagrass in India such as Geevarghese et al. (2018) and Thangaradjou and Bhatt (2018) do not mention occurrences of mappable seagrass meadows on the west coast of India outside the Gulf of Kutch. Geevarghese et al. (2018) mention seasonal seagrass beds of *Halophila beccari* on the west coast in localised areas, specifically Karwar (Karnataka), Malwan and Ratnagiri (Maharashtra).

Research in the Gulf of Kutch was initially based on data collected from strandings, dead and captive dugongs (Jones 1967; Frazier and Mundkur 1990). The dugong population was described as probably consisting of 'very stray numbers' (Jones 1959). More recently, strandings (e.g., Singh et al. 2004;

Pandey et al. 2010; Hatkar et al. 2023), and fisher interviews (e.g., Singh 2003; Sivakumar and Nair 2013; Anand et al. 2017; Anand and Highland 2021; Johnson et al. 2023) have provided important information on dugongs and their habitats in the south-western Gulf of Kutch.

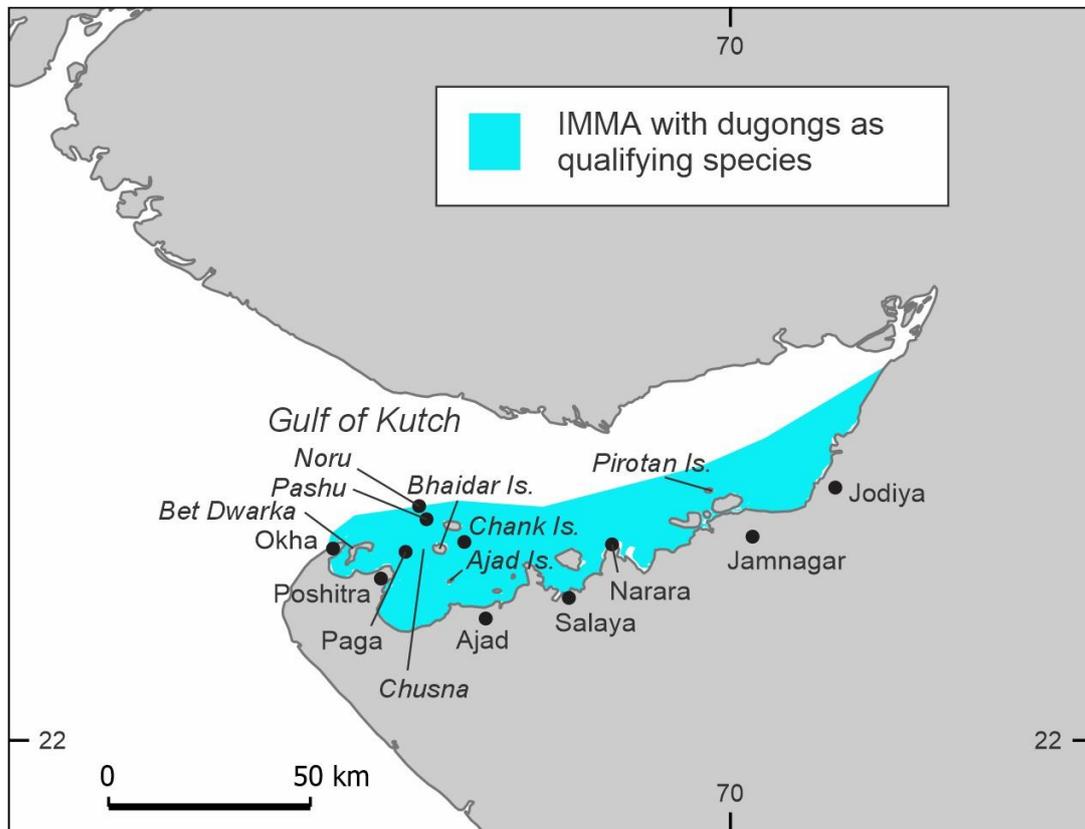


Figure 5.3. Geographic context of the Gulf of Kutch showing placenames mentioned in the text. Important Marine Mammal Areas with the dugong as a qualifying species are shown in blue. Figure created by Adella Edwards; reproduced with permission.

Seagrass mapping has been limited to the southern Gulf of Kutch because fisher survey results suggested this region is the main dugong area (Anand et al. 2017). Pathan et al. (2020) recorded ~ 39 km² of seagrass in the south-western Gulf of Kutch in a total of 12 meadows (seven intertidal, two mid-tidal and three sub-tidal, deepest 3.7 m). Anand et al. (2021) observed a seagrass area of approximately 23 km² exclusively within the intertidal zone, including large areas of seagrass observed at Chank Island, Noru Island, Bhaidar Island, Paga Reef and Pirotan Island. Johnson et al. (2023) report that the southwestern Gulf of Kutch harbours a vast network of interconnected seagrass meadows including > 10 reef top meadows (Figure 5.4), four vast intertidal meadows and >5 subtidal meadows but do not provide an updated extent. Pathan et al. (2020) recorded *Halodule uninervis*, *Halophila ovalis*, *Halophila beccarii*, *Halopila decipiens* in the Gulf of Kutch; Anand et al. (2021; unpublished data) also recently recorded *Halophila ovata*. *Halodule uninervis* and *Halophila ovalis* were the dominant species.

Hatkar et al. (2023) built on previous work (e.g., Singh et al. 2004; Anand et al. 2017) to compile stranding records for the Gulf of Kutch between 1877 and 2022. They documented 29 carcasses across 11 locations. Most of the stranding records occurred in the south-western Gulf but carcasses were also found as far east as Sachana (one carcass in 1877) and a stranded skull was located on the northwestern shore at Mandivi in 1893. The leading identifiable cause of death in the Gulf of Kutch at 21% was documented as net entanglement (Hatkar et al. 2023).

Anand et al. (2017) interviewed 723 fishers from 32 villages to obtain information on the distribution of and threats to dugongs in the southern Gulf of Kutch in 2008. Sightings were reported from the following locations (Figure 5.3): Ajad Island (3), Bet Dwarka (11), Chank Island (2), Okha (3), Pirotan Island (2), Poshitra (3), and Salaya (3). Only 7.6% (n=27) of fishers claimed to have seen one or more dugongs in the Gulf of Kutch between the 1980s and January 2008.

Parasharya et al. (2023) interviewed 100 locals across a wide age range from nine villages in the southwestern Gulf of Kutch to assess dugong distribution and abundance. Eighteen percent of participants confirmed at least one dugong sighting, but respondents lacked awareness of any change in the population, likely due to the dugong's low abundance. Dugong feeding trails (Figure 5.4) were reported from Paga, Chank, Bhaidar, Ajad, Pirotan and Narara (Anand and Highland 2021).

Recent scientific evidence of live dugongs in the southwestern Gulf of Kutch includes: (1) dugong feeding trails at several sites (Anand 2012; Pathan 2020; Johnson 2023) (Figure 5.4); (2) opportunistic sighting of a single dugong in 2019 near Bhaidar Island (the first live sighting in over 20 years) (Anand et al. 2023 unpublished); and (3) unoccupied aerial vehicle (UAV) footage of a dugong mother and calf pair in 2021-2022 (Johnson et al. 2023).



Figure 5.4. Dugong feeding trails at Chepri Reef in the Gulf of Kutch Marine National Park. Sameeha Pathan photograph; reproduced from Johnson et al. (2023) with permission.

The Gulf of Kutch has been identified as an Important Marine Mammal Area (IMMA) with dugongs listed as a qualifying species (IUCN-MMPATF 2021) (Figure 5.3).

- The Gulf of Kutch supports a small, isolated, resident dugong population. The limited extent of the potential seagrass supporting habitat in this Gulf means that it can support only a relatively small dugong population.
- It may be effective and efficient to develop and implement conservation arrangements for marine megafauna in the Gulf of Kutch, rather than dugongs *per se*.
- The Gulf of Kutch has been identified as an IMMA with dugongs listed as a qualifying species.
- The conservation status of the dugong in the Gulf of Kutch merits assessment as an IUCN 'subpopulation'.

5.2.2 Tamil Nadu-Sri Lanka

5.2.2.1 Historical situation

The importance of dugongs in the Gulf of Mannar and Palk Bay region between India and Sri Lanka (Figure 5.5) has been recognised for more than 160 years (e.g., Tennent 1861, Annandale 1905; Bertram and Bertram 1970a, b; Jones 1981; Leatherwood and Reeves 1989). This transboundary region, which is shared by India and Sri Lanka, is currently the most important habitat for seagrasses and dugongs in South Asia (Anand and Highland 2021; Johnson et al. 2023; Seal et al. 2024 [preprint]).

Twentieth century accounts indicate that this region must have supported large numbers of dugongs. For example, Annandale (1905) stated:

'...from what I was told by the native fishermen, who possess special nets for the capture of the Dugong, it is rare nowadays for more than one specimen to be taken at a time, whereas formerly, in the Gulf of Manaar [sic], flocks of many hundreds were said to occur.... I was told that as many as sixty were sometimes brought into Kilakarai, a large native port near the northern corner of the Gulf on the Indian shore, in a year; but this number is probably exaggerated.'

Government records suggest that native fishers may have been correct. A Sri Lankan government sponsored dugong fishery operated during the British colonial period, with 40-50 dugongs caught each season (Haley 1984). After Sri Lanka gained independence in 1948, the practice continued even though Leatherwood and Reeves (1989) could find no subsequent meaningful estimates of annual catch until the 1950s. Bertram and Bertram (1970a,b) estimated that 100-150 dugongs were taken per year in the Mannar district of Ceylon (sic) in 1957-1959 based on the catch data of Norris (1960). Leatherwood and Reeves (1989) summarised monthly catches for the years 1953, July 1957 – June 1959 based on Norris' data from government inspectors plus a Ceylon [sic] administrative report for

1953. These records indicate a total catch (over the three years) of 387 dugongs. Leatherwood and Reeves cautioned that these figures may be overestimates because some cetacean meat was marketed as dugong meat.

Jones (1981) estimated that catches on the Indian coast were ~ 150-175 dugongs per year, plus ~ 100-150 per year on the Sri Lankan side. Based on inquiries and personal visits, Jones concluded that catches in both countries were decreasing. Nevertheless, Silas and Fernando (1985) reported that > 250 dugongs were caught and killed between April 1983 and August 1984 in the villages of Kilakarai and Periyapattinam in Tamil Nadu.

Taken together, this information suggests that large numbers of dugongs were harvested from the Palk Bay–Gulf of Mannar region in the twentieth century and that concerns over the status of the dugong in the region have existed for many years.

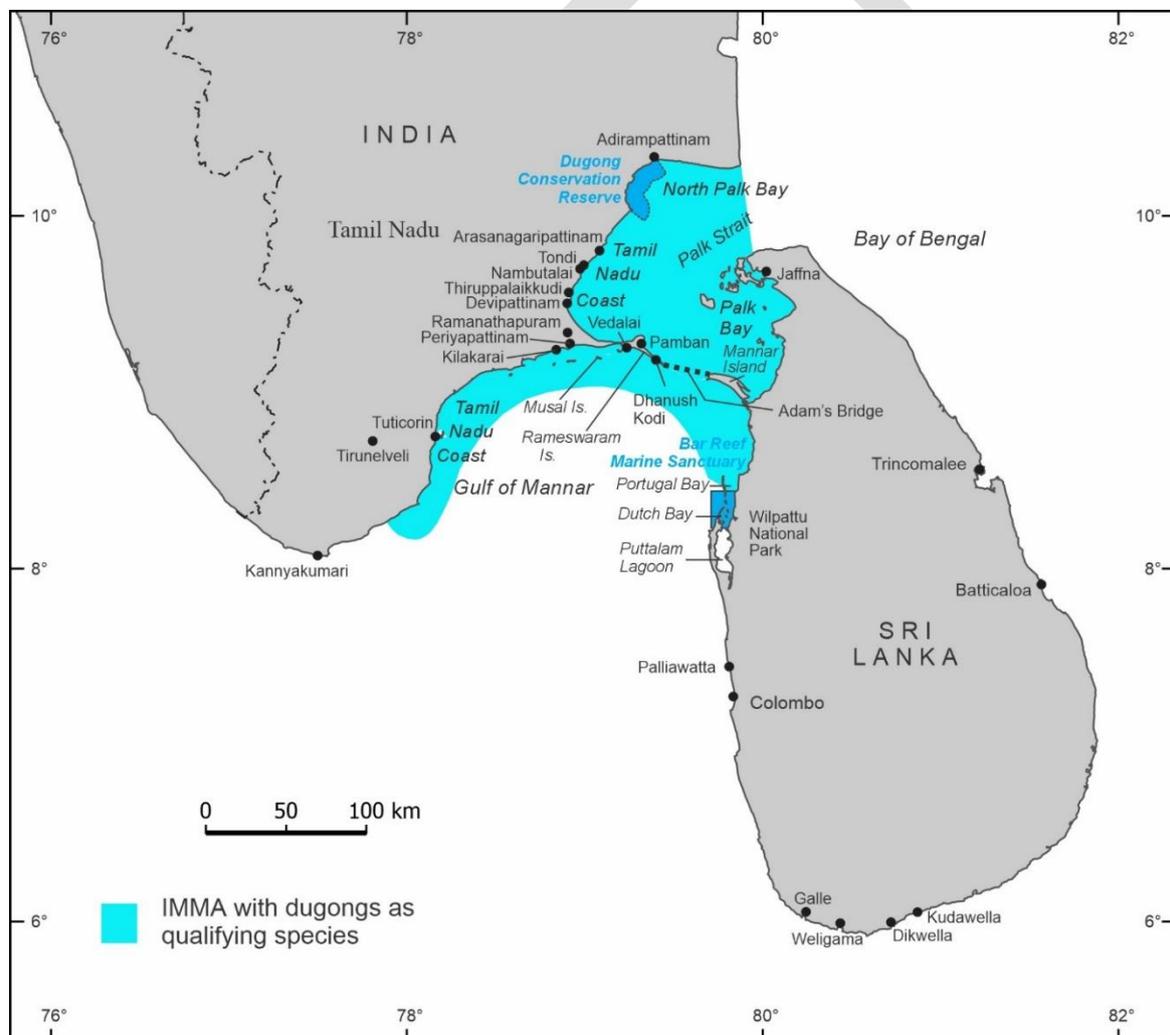


Figure 5.5. Geographic context of Tamil Nadu (India) and Sri Lanka showing placenames mentioned in the text. Important Marine Mammal Areas with dugong as a qualifying species are shown in light blue. Marine Protected Areas relevant to the dugong are shown in medium blue. Figure created by Adella Edwards; reproduced with permission.

5.2.2.2 21st Century

Palk Bay and the Gulf of Mannar collectively support at least 14 seagrass species (Balaji 2018; Geevarghese et al. 2018; Udagedara and Dahanayaka 2020; Ponde et al. 2021): *Cymodocea rotundata*, *C. serrulata*; *Enhalus acoroides*; *Halophila beccarii*, *H. decipiens*, *H. ovalis*, *H. major*, *H. minor*, *H. ovata*, *H. stipulacea*; *Halodule uninervis*, *H. pinifolia*; *Syringodium isoetifolium* and *Thalassia hemprichii*.

Extensive interview surveys of fishers in both Sri Lanka and India in the early 2000s suggest that the Palk Bay–Gulf of Mannar region now supports a much lower number of dugongs than in the recent past, and that fishers perceive a decline in sightings (Ilangakoon et al. 2008; Anand et al. 2015; Sivakumar and Nair 2013; Silva et al. 2017a, b; Tamil Nadu Forest Department (J. Patterson Edward, personal communication 2024; Johnson et al. 2023)). The fishers variously attributed the decline to at least one of the following: hunting, disturbance in dugong habitat, accidental bycatch in fishing gear, and destructive fishing practices such as dynamite fishing and trap nets, development projects, and cyclones (see also Table 5.2).

Johnson et al.'s (2023) exploratory UAV transect surveys of 6.34 km² of the inshore waters of the Dugong Conservation Reserve in Palk Bay in 2022–23 (Figure 5.5) recorded four dugong sightings. A systematic drone survey was pilot tested in the Palk Bay area covering 6.34 km² area and resulted in dugong encounter rate of 0.72 km⁻². The survey was limited to a maximum of 3 km from the coastline.

In 2023, dialogue between India and Sri Lanka has been initiated with support from the CMS Dugong MOU Secretariat, with the aim of strengthening joint research and management of dugongs and their habitat in the region (K. Sivakumar, personal communication 2024).

The Gulf of Mannar and Palk Bay area has been identified as an IMMA with the dugong listed as the only qualifying species (IUCN-MMPATF 2022a).

5.2.2.3 Other potential dugong habitats in Sri-Lanka

Although Bertram and Bertram (1970a,b) concluded that dugongs were "virtually absent" from the south coast of Sri Lanka, Leatherwood and Reeves (1989) concluded that '*although they have not been collated in any systematic way previously, there appear to be enough bits of information scattered in the literature to demonstrate that dugongs formerly occurred at least sporadically along most of the Sri Lankan coastline where suitable habitat exists (or existed)*'.

The records collated by Leatherwood and Reeves suggest that dugongs have occurred at: (1) several locations along the east coast, including near Trincomalee, where Udagedara and Dahanayaka (2020) found records of seagrass; and (2) at least five locations in the south-west of the Island where

carcasses have been recovered including Dikwella, Galle, Weiligama, Kudawella and Palliawatta (Figure 5.5). There is clearly a need to investigate the current situation regarding the distribution of dugongs and their seagrass habitats in Sri Lanka outside the northwestern region.

- The transboundary Tamil Nadu-Sri Lanka region, which includes Palk Bay and the Gulf of Mannar, is the most important habitat for seagrasses and dugongs in South Asia.
- Palk Bay and the Gulf of Mannar apparently support a much lower number of dugongs than in the recent past.
- The region has been identified as an IMMA with the dugong as the only qualifying species.
- Procedures need to be developed to enhance the governance arrangements, research findings and community support to improve the management of dugongs and their habitats in Palk Bay and the Gulf of Mannar, especially the impacts of fisheries interactions on dugongs and seagrasses.
- Dugongs in the Tamil Nadu-Sri Lanka region likely qualify for separate IUCN status assessment as a 'subpopulation'. Such an assessment would require quantitative data on dugong abundance in the region.
- The current situation regarding the distribution of dugongs and their seagrass habitats in Sri Lanka outside the Palk Bay and the Gulf of Mannar merit investigation.

5.2.3 Andaman and Nicobar Islands

Gole et al. (2023) recorded 12 species of seagrass from the genera *Enhalus Cymodocea*, *Halodule*, *Halophila*, *Thalassia* and *Syringodium* in this region.

Between 1994 and 1997, Das and Dey (1999) surveyed various parts of the Andaman and Nicobar Islands (Figure 5.6) for dugongs using boat, SCUBA, and snorkel surveys. They also conducted interview surveys, despite some fishers being reluctant to share information because of the illegality of deliberate hunting. The boat surveys failed to locate any dugongs. Dugong bones were examined on several occasions at the following locations: Maya Bunder, Port Blair, Havelock Island, Hut Bay, Katchall, and Camorta (Das and Dey 1999). Fishers and divers reported a total of five dugongs between 1990 and 1994 along the northwest of Camorta Island, another five individuals were sighted near Dugong Creek and Hut Bay, and four animals were sighted in Little Nicobar (Pilo Milo side) and in the Great Nicobar Islands (Das and Dey 1999; Figure 5.6).

Groups of five to six dugongs were reported by fishers and divers on at least five occasions between 1990 and 1997; six animals were seen near Landfall Island on a regular basis (Das and Dey 1999); a female dugong was incidentally caught in a net 500 m offshore from Hut Bay. Based on such reports, Das and Dey (1999) concluded that dugong populations in the Andaman and Nicobar Islands were very small and had been declining since the 1950s as evidenced by the sporadic nature of sightings and records of poaching.

D'Souza and Patankar (2009) undertook snorkel and SCUBA surveys around Interview, North Reef, Neil, Havelock, Chidiatapu, Burmanalla, Kodyaghat, Camorta, Nancowry and Trinket Islands (Figure 5.6) between February 2007 and March 2008 to better understand dugong behaviour. Their sites were chosen based on records of seagrass beds, dugong occurrence and anecdotal evidence from local authorities and islanders. Three male dugongs were sighted during the surveys: one on the eastern side of Havelock Island, one on Neil Island, and the other at Kodyaghat, South Adaman (Figure 5.6).

On the basis of interview surveys, Pandey et al. (2010, 2012) recorded a total of 81 incidental sightings in the Andaman and Nicobar Islands between 2007 and 2009. Forty-one percent (n=33) of the sightings were in the Little Andaman of the Andaman Group, 15% (n=12) of sightings were reported in the waters of Nancowrie Island of the Nicobar Group.

A citizen science program targeting fishers, defence personnel (Indian Navy and Indian Coast Guard), Forest Department staff and the Tribal Protection Police was established in the Andaman Islands in 2017 and extended to the Nicobar Islands in 2021, as part of the CAMPA Dugong Recovery program of the Ministry of Environment, Forest and Climate Change (MoEFCC) (Johnson et al. 2023). The resultant maps of dugong distribution throughout the Islands, which include information from tribal protected areas and defence restricted regions for the first time, identify locations where individual dugongs, pairs and larger groups and carcasses have been reported, and demonstrate that dugongs are more widely distributed than suggested by the earlier studies. The respondents reported 63 sightings of small groups of dugongs in the waters of the Andaman archipelago. The larger herds of seven to 13 individuals included several calves (Gole et al. 2023).

Under the CAMPA-Dugong recovery programme (CAMPA 2022), the Wildlife Institute of India conducted exploratory aerial surveys for dugongs using an UAV in 2021-22 (Johnson et al. 2023). Sixteen transects were flown in the North Andamans, 36 transects in Mahatma Gandhi Marine National Park and Chidiatapu, Pungi Balu and Collinpur, and 30 Transects in Ritchie's Archipelago. Dugongs were detected in the North Andamans, South Andamans and Ritchie's Archipelago. The repeated systematic drone survey yielded encounter rates of one dugong sighting per 0.6 km² in Ritchie's Archipelago and 1.85 km² in Mahatma Gandhi Marine National Park. The sightings included small groups of dugongs and calf sightings in two regions: the south-western coast of South Andaman and Ritchie's archipelago (Johnson et al. 2023).

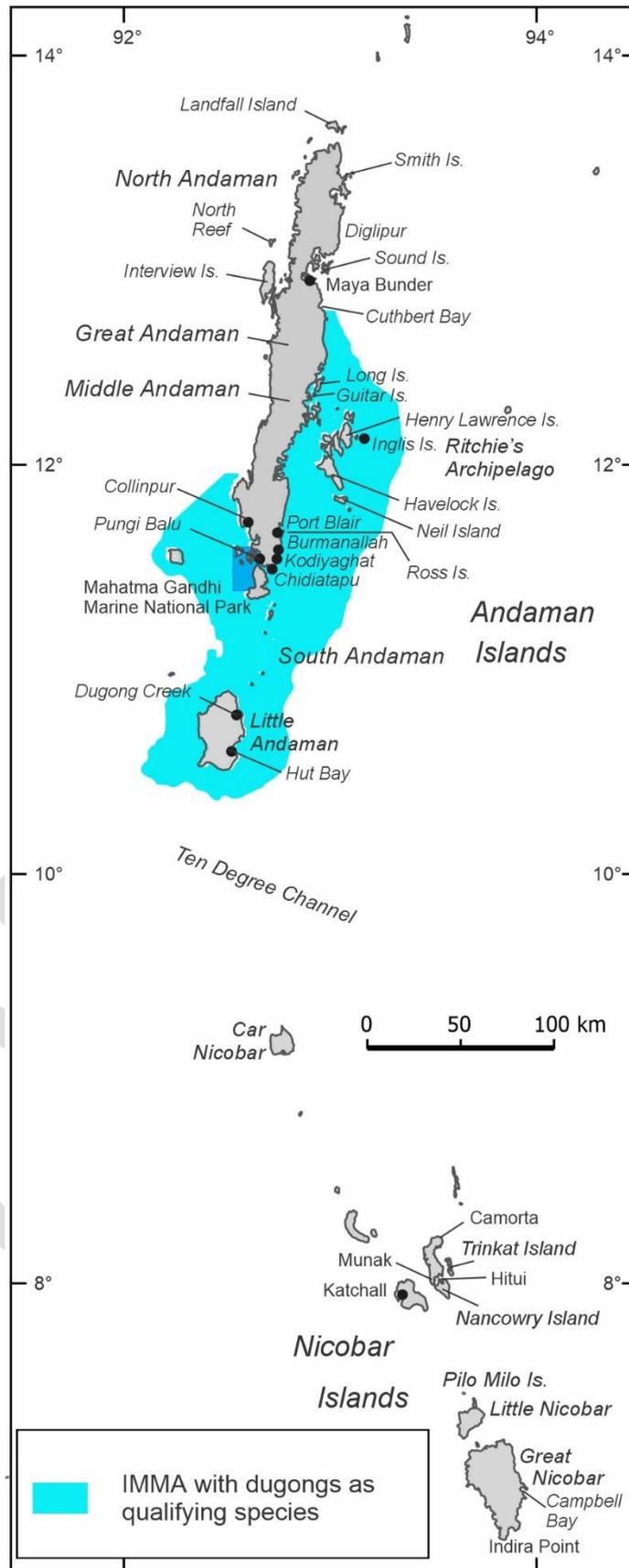


Figure 5.6. Geographic context of the Andaman and Nicobar archipelagos showing placenames mentioned in the text. Important Marine Mammal Areas are shown in blue. Figure created by Adella Edwards; reproduced with permission.

The only quantitative data on trends are from the occupancy modelling conducted by D'Souza et al. (2013), who estimated that dugong occupancy across the Andaman and Nicobar archipelagos had declined by 60% over the previous 20 years based on anecdotal historical and current data. They concluded that their modelled estimates of decline were at best conservative due to unreported, illegal hunting.

The Southern Andaman Islands were recognised as an IMMA in 2022 (IUCN-MMPATF 2022b), and the Nicobar Islands and North Andaman Island are listed as areas of interest.

- The Andaman and Nicobar archipelagos support a small, isolated, resident dugong population.
- The limited extent of the potential seagrass supporting habitat in the the Andaman and Nicobar Islands means that these archipelagos can support only a relatively small dugong population.
- It may be effective and efficient to develop and implement conservation arrangements for marine megafauna, rather than dugongs *per se* in this region.
- The Southern Andaman Islands have been identified as an IMMA with dugongs as a qualifying species.
- Dugongs in the Andaman and Nicobar Archipelagos likely qualify for separate IUCN status assessment as a 'subpopulation'.

5.3 Cultural values

As in most other parts of their range (Marsh et al. 2011, Ponnampalam et al. 2022), the cultural values of dugongs in South Asia are linked to their value as food, medicines and other traditional uses as well as the practice of hunting. Historically, dugongs were harvested in Tamil Nadu and Sri Lanka (Sivakumar and Nair 2013), where their meat has been a traditional delicacy (Ilangakoon et al. 2008), and by some tribes in the Andaman and Nicobar Islands (Das and Dey 1999). Many medicinal qualities have been attributed to the flesh and bones of the dugong. The meat is believed to have rejuvenating qualities, and the consumption of meat is believed to cure digestive issues (Nair et al. 1975). The indigenous tribes in the Andaman and Nicobar Islands have been legally exempt from the statutory ban on dugong hunting that has applied in the rest of India under the Indian Wildlife Protection Act 1972 due to the significant totemic and heritage value they place on the dugong (D'Souza et al. 2013).

Cultural practices differed in the three regions, in which dugongs occur in South Asia, as outlined below.

5.3.1 Gulf of Kutch

The local name for dugong used by Hindu people in the Gulf of Kutch is *Bai Manas* (woman human), while Muslim fishers refer to dugongs as *Suwar machi* (pig fish) (Frazier and Mundkur 1990). Kacchi locals have several names for the dugong, including *Pranjada*, *Suwarmachi*, *Pranjado*, *Pranj* and *Harundo* (Pandey 2010; Sivakumar and Nair 2013). People in the area used dugong oil as a preservative and conditioner for wooden boats (Frazier and Mundkur 1990), while the meat was consumed and believed to have medicinal, rejuvenating, and aphrodisiac properties (Jones 1967). Some fishers extracted dugong oil from dugong fat (Anand et al. 2017).

In Gujarat, there is a myth that the Lord Krishna, the King of Dwarka, loved cows and had many in his kingdom. Before Dwarka sank into the ocean, Lord Krishna provided features that would allow these cows to live in the sea, resulting in the creation of dugongs (Pandey et al. 2010; Sivakumar 2013). Interestingly, fossils of four species of extinct dugongs starting from 42 million years old were found from the Gulf of Kutch region, the highest diversity of sirenians reported from anywhere in the world (Bajpai and Domning 1997; Bajpai et al. 2006; Thewissen and Bajpai 2009).

5.3.2 Tamil Nadu-Sri Lanka

The Sinhala name for dugong is *mudu uru* and the Tamil names are *kadal kanni* 'angel of the sea', *kadal pandri*, *kadalpashu* and *kadalpanni* (*sea pig*) *orgil* and *avuliya*, the latter referring to the fact the mother dugong feeds its calf via its mammary glands (Leatherwood and Reeves 1989; Sivakumar 2013; Anand et al. 2015).

Archaeological excavations in Manthai, an ancient seaport in Sri Lanka, revealed fragments of dugong bone dating from 3,000 years b.p. (C. Deraniyagala, personal communication to R. Gunaratna in Leatherwood and Reeves 1989) suggesting that dugongs have been hunted there for thousands of years. Hines (2012) reported that dugong meat has long been a delicacy in Sri Lanka and demand persisted into at least the latter half of the twentieth century (see Section 5.2.2). For example, between 1955 and 1960, dugong meat was a featured dish at Catholic festivals and in the 1980s, it was commonplace for cetacean flesh to be sold as dugong due to the high demand and higher price that dugong meat could command (Leatherwood and Reeves 1989).

Prior to the declaration of the *Wildlife (Protection) Act 1972*, the capture of a dugong had to be announced to the residents of Kilakarai, a coastal town in southern Tamil Nadu (Figure 5.5), by a town crier (Silas and Fernando 1988). It is reported that the demand for dugong meat was once so high that the failure to inform a friend of the availability of the meat was despised and could strain relationships among friends and relatives (Silas and Fernando 1988).

Several dugongs were kept in captivity at the Central Marine Fisheries Research Station, Mandapam Camp, Tamil Nadu from 1955 (Jones 1959, 1967). Most died soon after being taken into captivity, but a male and female were maintained on a diet of seagrass for several years from 1959. Mating behaviour was observed; no calves were born.

5.2.3 Andaman and Nicobar Islands

Dugongs were known as *Pani suvar* or *Jal suvar* (sea pig) by Bangali and Telugu fishermen in the Andaman and Nicobar Islands (Pandey 2010). The Onge and Nicobare tribes call the dugong *Ena bonya* (Pandey et al. 2010).

Due to the isolated nature of the Indigenous islanders, cultural research in the Andaman and Nicobar Islands has been limited. Das and Dey (1999) reported that the Andamanese, Onges and Nicobarese tribes traditionally hunted dugongs with iron harpoons; members of the Shompen tribe, the indigenous people of the interior of Great Nicobar Island, had no knowledge of dugong hunting, suggesting that the meat was not traded with inland tribes. The Onge believed that carrying decorated dugong bones (tusks, ribs, pelvic or pectoral girdles) increased good fortune, especially when hunting (Sivakumar 2013; Sivakumar and Nair 2013). The Onge preserve the skull and lower jawbone of dugong and keep them above the cooking area. They believe that the smell released from the dead dugong would attract animals from the forest or sea, thus facilitating future hunts (Pandey et al. 2010).

The dugong is the state animal of the Union Territory of Andaman and Nicobar Islands (Pandey et al. 2012).

5.4 Threatening processes

Historically the greatest threat to dugong in the region was direct hunting for meat and other products as discussed in Section 5.2. With the exception of indigenous hunting in the Andaman and Nicobar archipelagos, hunting has been illegal in Sri Lanka since 1937 and in India since 1972. Illegal hunting is extremely difficult to quantify (D'Souza et al. 2013), so it is very challenging to obtain accurate data about its contemporary importance.

Anand et al. (2015, 2017) and Pandey et al. (2012) obtained fishers' views about the relative importance of the major causes of the perceived dugong decline. The results varied by area as summarised below (Table 5.2).

Sivakumar and Nair (2013) used the standard Pilcher et al. (2017) questionnaire to interview Indian fishers in Gulf of Kutch, Tamil Nadu and the Andaman and Nicobar archipelagos. The factors for the

decline in dugong numbers in their region identified by the two-thirds of fishers able to comment have many similarities with factors identified in the earlier surveys but emphasise the perceived impact of the 2004 Indian Ocean earthquake and tsunami (Table 5.2).

Table 5.2. Fishers’ views about the relative importance of the major causes of the perceived dugong decline in Indian waters. The figures are percentage respondents rounded to nearest integer.

Cause of dugong decline	Anand et al. 2015, 2017; Pandey et al. 2012; surveys conducted in 2008			Sivakumar and Nair (2013) ⁴
	Gulf of Kutch (n=16)	Gulf of Mannar-Tamil Nadu (n=1242)	Andaman Nicobar Archipelago (n=394)	All regions (n=1,616)
Hunting		43	46	21
Fisheries related ¹	75	48	17	33
Other anthropogenic	25 ¹	3		
Tsunami/cyclone		3	37	44
Other natural causes		3 ³		3

¹ industrial pollution

² incidental catches, damage to seagrass beds, noise disturbance

³ includes stingray barb injuries

⁴ % based on 67% who responded to this question only

Various threats to dugongs were prioritised based on a 2016 survey conducted by the Suganthi Devadason Marine Research Institute (J. Edward Patterson, personal communication 2024). The high priority threats identified were: (1) entanglement with fishing nets (gillnets such as sangili valai, thirukkai valai, salai valai); (2) poaching for meat; (3) habitat (seagrass destruction); and (4) propeller injury. Medium priority threats included (1) pollution (solid waste disposal, sewage, and wastewater disposal from aquaculture farms); (2) sedimentation caused by trawling and (3) lack of awareness about the importance of dugongs. Lack of capacity to identify dugongs and climate variability were identified as low-level threats.

5.4.1 Hunting and Poaching

Even though the data presented in Table 5.2 are somewhat dated and restricted to fishers, it is clear that illegal dugong hunting was likely a major problem in Tamil Nadu and the Andaman and Nicobar archipelagos, even though its current importance relative to other threats cannot be quantified. Sivakumar and Nair (2013) reported that in the Gulf of Mannar, the rarity and illegality of hunting dugongs have increased the meat’s sale value and poaching still occurs (Sivakumar 2013). D’Souza et al. (2013) believed that illegal hunting by non-indigenous groups in the Andaman and Nicobar Islands was significantly underreported and difficult to monitor.

5.4.2 Fishing impacts

Adverse impacts for artisanal fishing on dugongs and their habitats in South Asia range from incidental mortality in gillnets and shark nets and blast fishing to damage to seagrass from bottom trawling and anchors. Since the introduction of synthetic gillnets in the 1950s, incidental catch has become an increasingly significant threat to dugongs in South Asia and much of the dugong habitat in the Gulf of Mannar is under intensive fishing pressure (Hines 2012). In the past, the demand for dugong meat and lack of awareness exacerbated the issue, and there were continuous declining trends in the Gulf of Mannar and Palk Bay region.

In the Gulf of Mannar and Palk Bay, 19 dugongs (14 deceased, five live) were reported from shore seine nets in between 2016 and 2019 (Balaji and Sekar 2021). The five living dugongs were released by the Thanjavur and Pudukkottai divisions of the Tamil Nadu Forest Department, Wildlife Institute of India, and Coastal Security Group of Tamil Nadu Police Department, OMCAR Foundation and local volunteers. A further 26 dead dugongs were reported between April 2021 and March 2023 (V. Balaji, personal communication 2024). Twelve years of marine mammal stranding observations in Thanjavur and Pudukkottai district of northern Palk Bay recorded 19 dead dugongs along the coast of the two districts, which comprises only 20% of the total length of Palk Bay coast in India.

Since the introduction of rewards and incentive payments to rescue and release dugongs by MoEFCC's CAMPA Recovery Program and Tamil Nadu Forest Department (Section 5.5.5), 19 live dugongs have been released to the sea (Johnson et al. 2023; V. Balaji personal communication 2024). However, incidental net entanglements are still a significant problem.

During the civil war in Sri Lanka in 1980s, fishers from Sri Lanka migrated to the Indian coast of Palk Bay, and introduced trap nets, which now pose threats large areas of seagrass habitat. Each fisher typically operates from three to six trap nets. The routine maintenance of trap nets requires removing seagrasses from inside the area covered by the net. Dugongs also get caught in trap nets, though are later released (Figure 5.7).

Since 2023, trawlers from the Coromandel coast of Tamil Nadu have been moving further south to Palk Bay and operating within 3 km from the shoreline, damaging seagrass beds in the Dugong Conservation Reserve. The migration has also created issues between small scale fishers and trawlers who attempt to occupy their fishing grounds (V. Balaji, personal communication 2024).



Figure 5.7. Dugong caught in a trap net in Thanjavur District, Palk Bay in May 2023. Vedharajan Balaji (OMCAR) photograph; reproduced with permission.

Blast fishing was banned in 1896 under the *Indian Fisheries Act*. but resumed illegally in Palk Bay and was subsequently used to kill dugongs (Silas and Fernando 1985). Blast fishing is no longer practiced along the Tamil Nadu coast as the Fisherman Cooperative Society, the State Fisheries Department and Forests Departments have been more vigilant in policing the destructive technique (J. Johnson, personal communication 2024).

5.4.3 Habitat loss

The loss of seagrass habitat is clearly a major problem in all the major dugong habitats in the region. Anand et al.'s (2017) surveys indicate that fishers believe that pollution and trawling are major threats to the health of seagrass meadows in the Gulf of Kutch. Patterson Edward et al. (2019) found bottom trawling to be the most serious threat to the seagrass beds in their restoration site in the Gulf of Mannar in Sri Lanka. Das and Dey (1999) also reported habitat loss, which they attributed to land use change and increased boat traffic, to be the primary reason for the declining numbers of dugongs in the Andaman and Nicobar Islands.

5.4.4 Coastal infrastructure

The Gulf of Mannar-Palk Bay dugong population likely faces the most challenging development pressures in the region. The proposal to build the Sethusamudram shipping canal to link Palk Bay and the Gulf of Mannar between India and Sri Lanka has been met with continuous opposition from

environmental and religious groups, since its conception in the mid-1800s (Rodriguez 2007). Presently the proposal is dormant, however at any given time this shipping canal project may be reactivated since the Prime Minister of India and President of Sri Lanka agreed to improve their countries' economic and energy ties by connecting two countries by building a land link across Palk Strait (Agence France Presse 2023). The passage is projected to alter the complex marine ecosystems of the region, directly impacting marine megafauna habitat within the Gulf of Mannar and Palk Bay. Environmental concerns about the proposed land-link are likely to include its effects on dugongs and their habitats.

5.4.5 Extreme events and climate change

Extreme events can have direct impacts on dugongs through strandings and indirect impacts from seagrass loss, which causes dugongs to move from the affected area and/or postpone breeding and mortality due to starvation (Marsh et al. 2022). Fishers' reports indicated that large numbers of dead dugongs were washed ashore after a cyclone in the Gulf of Mannar in 1954 (Ilangakoon et al. 2008). The Andaman and the Nicobar archipelagos lost ~ 15 km² of seagrass between 2004 and 2007, likely due to the 2004 tsunami (Thangaradjou et al. 2010). Table 5.2 suggests that the 2004 tsunami likely caused more significant seagrass loss in the Andaman's and Nicobar archipelagos than the other dugong habitats in India (Pandey et al. 2010). This result can be explained by the proximity of the southern Nicobar Islands to the epicentre of the earthquake that caused the tsunami (Section 5.1.1). Sri Lanka and Tamil Nadu were also severely affected.

5.5 Conservation initiatives

5.5.1 International conventions

All countries in South Asia are signatories to the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and parties to the Convention on Migratory Species of Wild Animals. India, Sri Lanka, and Bangladesh have signed the Dugong Memorandum of Understanding.

5.5.2 National laws

5.5.2.1 India

Dugongs were granted the highest level of protection under *Schedule I of the Indian Wildlife Protection Act, 1972*. The Act outlaws the hunting, killing and capture of dugongs as well as the buying and selling of meat. These actions are punishable by imprisonment in India. Scheduled tribes in the Andaman and Nicobar Islands are legally exempt because of the *Andaman and Nicobar Islands Protection of Aboriginal Tribes Regulation (1956)*. Some identified critical habitat for dugongs has

also been protected as National Parks, Wildlife Sanctuaries and Conservation Reserve as per the *Wildlife (Protection) Act, 1972*. Other coastal areas with seagrass meadows are managed under the *Environment (Protection) Act, 1986*.

5.5.2.2 Sri Lanka

Dugongs in Sri Lanka are protected under the *Flora and Fauna Protection Ordinance of 1937*. They are also protected against misuse by the *Wildlife Policy of Sri Lanka* and the *Fisheries and Aquatic Resources Act (1996)*. Other relevant legislation includes: Marine Pollution Prevention Act No. 59 of 1981; Coast Conservation Act No. 57 of 1981 and *Amendment Act No. 64 of 1988*; *The National Environmental Act No. 48 of 1980* (amended by *Act No. 56 of 12988, No. 53 of 2000*).

Although dugongs are technically protected by these acts, resources for enforcement are often lacking, and illegal actions often occur without punishment (Hines 2012). Twenty-eight percent of the respondents in Silva et al.'s (2017a) focus groups with fishers in the Sri Lankan waters of Palk Bay and the Gulf of Mannar, reported that corruption was one of the main causes of the continuation of destructive and illegal fishing methods, plus a lack of law enforcement and negligence of government officials in implementing regulations.

5.5.3 Conservation status

5.5.3.1 India

Dugongs are listed under Schedule I of the *Wildlife Protection Act, 1972*. Dugongs are also listed as one of 21 threatened species under the Integrated Development of Wildlife Habitat (IDWH) Programme of India that gives utmost priority for the conservation of species through National Species Recovery Plans. The governments of Tamil Nadu, Gujarat and Andaman and Nicobar Islands have also given priority for the conservation of dugongs and their habitats. Recently, the Government of India has launched Project Dolphin which also covers the conservation of dugongs and their habitat at the national level.

Dugongs are listed as one of the four Critically Endangered species identified by the MoEFCC for species Recovery Programme under the Compensatory Afforestation Fund Management and Planning Advisory (CAMPA) scheme with funding support of INDR 23.58 crore (~ USD 3.15 million). This recovery program was launched in 2016 through the Wildlife Institutes of India across the dugong Range States (Gujarat, Tamil Nadu, and Andaman and Nicobar Islands) in India.

5.5.3.2 Sri Lanka

The Sri Lankan Red List of Threatened Animals mirrors the IUCN RED List, which categorises the dugong as Vulnerable at a global scale; its status at a national scale has not been evaluated.

5.5.4 Protected Areas

5.5.4.1 Gulf of Kutch

The Gulf of Kutch Marine Sanctuary was established in 1980 to conserve marine biodiversity and extended in 1982 when some areas were given increased protection with marine national park Status. The Marine Sanctuary covers an area of ~ 458 km²; the Marine National Park an area of 163 km². Marine Protected Areas in India are notified under the *Indian Wildlife Protection Act, 1972* and are established as category I and II IUCN protected areas. The Marine National Park and Sanctuary covers mainly intertidal zones along the southern coast of the Gulf, including the coral reefs, mangroves, seagrass meadows, mudflats, islands, and creeks, that support rich marine life including dugongs (IRADe 2017). The region has also been a hub of anthropogenic activities attracting huge investments in oil, petroleum, shipping, tourism, and salt production, all of which have created tensions between stakeholders regarding the management of the area. A workshop in 2016 recognized that appropriate management of the Marine National Park would require an evidence-based seascape/landscape approach. Magrota et al. (2020) surveyed artisanal fisher-folk fishing in and around the Marine National Park. Most fisher-folk (ranging from 89% in Bet Dwarka to 100% in Sachana) claimed that they were not aware of many of the management strategies of marine national parks but were concerned about the need for better management to help conserve coral reefs and mangroves around these areas. Magrota et al. (2020) did not mention dugongs.

5.5.4.2 Tamil Nadu

Biosphere Reserves (United Nations Educational, Scientific and Cultural Organisation [UNESCO] 2022) integrate the conservation of biological and cultural diversity with economic development and scientific research, education and training. Each reserve has a core area that is strictly protected for nature conservation, buffer zones and transition areas. The Gulf of Mannar Biosphere reserve (Figure 5.5) was established in 2001 in Indian waters in the Gulf of Mannar (UNESCO 2022). In 1986, the core zone of the reserve was declared as the Gulf of Mannar Marine National Park covering 526 km² that included all 21 islands and adjoining coral reefs and seagrass meadows off the coasts of the Ramanathapuram and Tuticorin districts in Tamil Nadu. The Global Environmental Facility (GEF) supported the establishment of this reserve, including the setting up and functioning of the Gulf of Mannar Biosphere Reserve Trust, which is responsible for coordinating the management plan for the reserve in concert with key stakeholders. The significance of the region to the dugong was part of the justification for establishing this reserve.

As part of the MoEFCC's Dugong Recovery program, the area around the North Palk Bay region has been identified as one of the critical dugong habitats. In 2019, the Wildlife Institute of India

recommended the establishment of a Dugong Conservation Reserve (Sivakumar 2021). In September 2022, the Tamil Nadu government declared an area of $\sim 448 \text{ km}^2$ in the northern part of the Palk Bay as a 'Dugong Conservation Reserve' notified by gazette order G.O. Ms. No.165, Environment, Climate Change and Forests (FR.5). The Dugong Conservation Reserve stretches from Adiramapattinam (Thanjavur district) to Amapattinam (Pudukkottai district) extending about 55 kilometres along the coast (Figure 5.5). This reserve is the first established in India specifically to protect dugongs. Figure 5.8 illustrates part of the challenge.



Figure 5.8. Artisanal fishing vessels and beach litter in the Dugong Conservation Reserve, North Palk Bay, Tamil Nadu, India. Swata Iyar photograph; reproduced from Johnson et al. (2023) with permission.

5.5.4.3 Sri Lanka

Established in 1992, the 310 km^2 Bar Reef MPA is just offshore from the Kalpitiya peninsula (Figure 5.5) and Puttalam lagoon in the Gulf of Mannar, a known dugong habitat.

5.5.4.4 Andaman and Nicobar Islands

One hundred Marine National Parks and Sanctuaries have been established across the Andaman and Nicobar Group of islands (Wildlife Institute of India 2021). The prominent and notable Marine National Parks (Figure 5.6) are:

- **Rani Jhansi Marine National Park** covering 256 km^2 of Ritchie's Archipelago, a regionally important dugong location.

- **Mahatma Gandhi Marine National Park** established in 1983, covering 281 km² including 15 uninhabited islands for the conservation of marine life including dugongs.
- **The Greater Nicobar Biosphere Reserve** was established in 2013. The dugong is mentioned in the description of the reserve (UNESCO 2022).

These protected areas have been managed with approved management plans prepared by Andaman Forests Department with inputs from the Wildlife Institute of India.

5.5.5 Other recent conservation initiatives

5.5.5.1 India

- In 2007, the Organization for Marine Conservation Awareness and Research (OMCAR) Foundation was established to improve dugong conservation in northern Palk Bay. This NGO, a member of the IUCN since 2012, has raised concerns regarding dugongs in Palk Bay at IUCN meetings, World Conservation Congresses and locally. The main office in Palk Bay collaborates with fishers, the Forest Department and Wildlife Institute of India researchers for collective efforts including the rescue of dugongs, seagrass acoustic mapping and marine mammal stranding responses. Ecofriendly seagrass restoration methods have been developed (Balaji et al. 2020) and replicated locally and internationally. In 2024, OMCAR shared its ecofriendly using bamboo frame for seagrass restoration method with stakeholders and NGOs in Trang Province, Thailand through IUCN.
- Since 2007, more than 20,000 students from coastal villages have attended 473 awareness events held by OMCAR. Each year 50 single women families are supported with an educational scholarship to pursue a university or college education. OMCAR has also established a Marine Conservation Leadership programme, which provides free food and accommodation for young researchers in India to work as interns and learn about seagrass mapping, UAV surveying and conservation.
- In the Andaman Islands, the Directorate of Fisheries banned the use of monofilament nylon nets in ~ 2008 because they are unselective (Advani et al. 2013). Most fishers support the ban, but some villages continue to use these nets despite their ecological consequences.
- Widespread seagrass restoration has been attempted in the Gulf of Mannar region (Patterson Edward et al. 2019).
- The Tamil Nadu Sustainability Harnessing Ocean Resources and Blue Economy (TN-SHORE) project is to be implemented by the Government of Tamil Nadu through the Tamil Nadu Coastal Restoration Mission with assistance from the World Bank at the estimated cost of INR 2,000 crores (USD 250 million) across the next five years. An International Dugong

Conservation Centre is proposed for Manora in Thanjavur District in Palk Bay at a cost of INR 90 crores (USD 11.25 million). Large-scale restoration of degraded dugong habitat (seagrass beds) in Palk Bay and Gulf of Mannar are also proposed (Government of Tamil Nadu, Environment, Climate Change and Forest (EC.4) Department G.O. (Ms.) No.11 dated 10.01.2024).

- In 2016, the Wildlife Institute of India launched the Dugong Recovery Program 2016 - 2025. The recovery program has four major objectives:
 1. Species conservation and management
 2. Habitat conservation and management
 3. Participatory management of dugong and their habitats
 4. Capacity-building of state forests department and local communities
- The major achievements of this Programme follow (Johnson et al. 2023).
 1. **Habitat conservation and management:** Under the CAMPA-Dugong recovery program, the extent of seagrass habitat, quality, and threat intensity in the following 'Critical Dugong Habitats' (CDHs):
 - **Gujarat:** 10 reef- meadows, four vast mid-intertidal meadows and more than five subtidal meadows,
 - **Tamil Nadu:** 6217 km² seagrass cover: 310 km² in South Palk Bay and 307 km² in the Gulf of Mannar),
 - **Andaman and Nicobar group** - 66 seagrass meadows,A **threat heat map** 2016- 2025 has been prepared for each key dugong habitat
 2. **Participatory management of dugongs and their habitats:** > **75,000 people** (including fishers, school children and local youths) have been educated through awareness campaigns.
 3. **Dugong Volunteer Network:** More than 1,000 people registered as volunteers including fishers, coast guards, marine police, local youth, tourist guides, and divers. A flagship **Dugong Scholarship Programme** provides financial support (IND 500 [USD 6] per month) towards the education of students from fishing backgrounds. These 'Dugong Ambassadors' were established to encourage the participation of the fishing community in dugong conservation. Since the inception of the program in 2017, 398 students in Gujarat, 447 students in Tamil Nadu and 80 students in the Andaman and Nicobar Islands have been awarded this scholarship.

4. Capacity-building of state forests departments and local communities:

- Under the CAMPA Dugong Recovery Programme, the Wildlife Institute of India organised a series of **Capacity building programs** to front-line forest staff, fisheries department, Navy personnel, Coast guard and Marine Police of dugong in Indian states (Gujarart, Tamil Nadu and Anadman and Nicobar Islands) to sensitize and train key stakeholders from 2017 to 2023 in dugong conservation and seagrass habitat monitoring:
 - > 60 frontline forests staff have trained in SCUBA diving and underwater monitoring techniques,
 - 120 frontline forest staff have been trained in drone flying and aerial monitoring dugongs and other marine megafauna,
 - > 60 Indian Forest Service Officers have been trained in the Management of Coastal and Marine Biodiversity, and
 - > 500 personnel from Indian Coast Guard, Indian Navy and Marine Police have been sensitized about the need for marine biodiversity conservation.

5. **Dugong Day celebrations** were launched as part of an outreach program through social media from 2020 to spread information regarding the importance and the status of the dugong. This initiative has been continued annually.

6. **Incentives to rescue and release dugongs caught in fishing gear:** As part of Dugong Recovery program, the Wildlife Institute of India introduced incentive programs for fishers who rescued and released live dugongs. The incentives include cash award (IND 10,000 (USD 120)), a medal, a certificate and dugong rescue kit. This scheme has been well received by fishers and is now supported by Forests of Tamil Nadu and the OMCAR Foundation. So far 35 fishers have benefitted from this scheme. In addition, the Forest Department of Tamil Nadu now provides IND 5,000 (USD 60.23) as compensation for net damages to fishers.

7. Marine mammal stranding responses:

- The Wildlife Institute of India organized the first “Marine Mammal Stranding Response Workshop” in Tamil Nadu for forest officers and veterinarians in 2022. Eighteen participants (14 Range Forests officers and 4 Veterinarians) were provided with hands-on training in stranding responses for both live and dead marine mammals, sample collection, and necropsy protocols.

- The Wildlife Institute of India published a Manual on Marine Mammal Stranding Response detailing the handling protocols for stranded marine mammals (Sivakumar et al. 2022)
8. From 2023, the Gulf of Mannar Marine National Park has implemented annual monitoring of dugong habitats (seagrass beds) in Palk Bay and Gulf of Mannar with 58 permanent monitoring sites (J. Patterson Edward, personal communication 2024).

5.5.5.2 Sri Lanka

The USD 622,000 Global Environment Facility Dugong and Seagrass Conservation Project (2015-2019) focussed on the Sri Lankan coast of the Gulf of Mannar and Palk Bay (Dugong and Seagrass Conservation Project no date).

Conservation projects were designed to:

1. Raise awareness and respect for dugongs and their seagrass habitat in Sri Lanka,
2. Establish a marine conservation centre in north-west Sri Lanka,
3. Establish dugong and seagrass conservation areas in Palk Bay and the Gulf of Mannar,
4. Provide incentives to local communities for stewardship of coastal habitats.

Achievements included:

- Conducting an **awareness campaign** including producing a dugong information booklet, dugong poster and a mini documentary.
- **Promoting alternative livelihoods** Project staff worked with selected fishing communities, where poverty was forcing fishers to resort to destructive practices that harmed seagrass meadows and dugongs. The interventions were designed to engage the community in non-destructive income avenues and raise their environment and socio-economic conditions. Communities were helped to develop alternative livelihoods by establishing small business such as: salt packaging, sewing, using of legally permitted fish nets, ornamental fish culture, crab fattening, sea bass culture and batik handicraft. Physical resources, coaching and training were provided to key beneficiaries. The program evaluation concluded that the environmental interventions contributed to the overall goal of promoting sustainable human development (Ekanayake 2017).

5.6 Research and monitoring initiatives

5.6.1 Current research and monitoring

- **Anand and Highland (2021)** assessed the status of dugong and its habitat in the Gulf of Kutch. The study utilised fisher interviews, land and boat-based surveys and walking

transects to map intertidal dugong habitats. Seagrass was mapped using remote sensing techniques. The study has provided information regarding dugong distribution, seagrass species richness and area, and indirect evidence such as a feeding trail of dugong and one live sighting of dugong after 20 years.

- **The Dugong Recovery Program** (Section 5.5.5) also includes a comprehensive research program. The research objectives included:
 1. assessing dugong population status through advanced census techniques and determine its abundance and distribution,
 2. identifying critical habitats, classifying threats, and
 3. characterizing critical dugong habitats.

In 2023, the program involved 19 researchers plus support staff (see Johnson et al. 2023). The work included: (1) seagrass surveys; (2) geospatial analysis of seagrass meadows; (3) ecological surveys for seagrass-associated benthic macrofauna and fish species; (4) threat mapping; (5) aerial surveys for dugong population monitoring; (5) citizen science for understanding dugong distribution.

- With more modest but still substantial funding from the Global Environment Foundation (GEF), research was conducted between 2015 and 2019 on dugongs and their habitats, in the Sri Lankan waters of the Gulf of Mannar and Palk Bay. The research included: (1) an assessment of what near-shore fisherman and villagers knew about the biological and ecological aspects of the dugong and their attitudes to conservation to provide the background for an awareness campaign (Silva et al. 2017a, b), and (2) seagrass mapping and ecological studies to determine the diversity and abundance of seagrasses in inshore and deeper (sub-tidal) areas (Pahalawattaarachchi 2018).

5.6.2 Future Research

Unfortunately, despite considerable recent investment, there are still major gaps in knowledge of the distribution and status of dugongs and their seagrass habitats in the Gulf of Mannar–Palk Bay area, the most important dugong habitat in the region, which should be a focus for future research and monitoring. The major problem, which has been recognised since at least the 1970s (Jones 1981), is the lack of bilateral coordination of research on the distribution and abundance of this shared population of dugongs and their seagrass habitats. Monitoring the dugong population in South Asia will require repeated standardised surveys with systematic protocols.

For the last 50 years, civil unrest in Sri Lanka has been a barrier to bilateral collaboration but the current geopolitical climate seems more promising. Research collaboration between Sri Lanka and India would facilitate the pooling of expertise and resources and provide the evidence base for cooperative management. Well-designed aerial surveys over the whole Gulf of Mannar- Palk Strait region have the potential to improve the current population estimates (Anand et al. 2015) based on reported sightings and enable IUCN status assessment of the sub-population.

5.7 Regional co-operation

India hosted the first South Asia sub-regional workshop on the Conservation and Management of Dugongs in June 2011, a joint effort by the Indian Ministry of Environment and Forests, UNEP/CMS Dugong MOU Secretariat, and the Wildlife Institute of India (UNEP-CMS 2011). Policy and conservation management experts attended from India, Pakistan, Sri Lanka and Bangladesh, government agencies and Non-Government Organisations. The workshop agreed to strongly encourage the Governments of Bangladesh, Pakistan, and Sri Lanka to sign the Dugong UNEP/CMS MOU; Bangladesh signed the MOU in 2013; Sri Lanka in 2012.

The workshop also agreed to develop and deliver a practical and resource-efficient strategy to collaborate in, and implement, regional conservation and management initiatives for the conservation of dugongs and their habitats and enhance communication among participating countries and organizations. This commitment does not seem to have been advanced since the meeting despite discussion about holding a second workshop. Another South Asia sub-regional workshop should be a high priority.

5.8 Regional summary

Dugong distribution in the South Asian Region is limited to: (1) the Gulf of Kutch, (2) Tamil Nadu and Sri Lanka, and (3) the Andaman and Nicobar archipelagos. Known areas of concentration are listed in Table 5.3.

In the Gulf of Kutch and the Andaman and Nicobar archipelagos, dugong populations are small, and it may be effective and efficient to develop and implement conservation arrangements for marine megafauna, rather than dugongs *per se*.

Research is required to determine if dugongs are resident in the remainder of Sri Lanka and the Chittagong coast of Bangladesh.

Procedures need to be developed to produce the governance arrangements research findings and community support to support the management of the most important dugong population in the region, the population in the Gulf of Mannar-Palk Bay Area, which is shared between India and Sri Lanka.

The status of dugong populations in South Asia remains data deficient. Each of the Gulf of Kutch, Tamil Nadu-Sri Lanka, and Andaman and Nicobar Islands dugong populations likely qualifies for separate IUCN status assessment as a ‘subpopulation’. Robust quantitative information on the size of the Tamil Nadu-Sri Lanka dugong population would be essential for that assessment.

Table 5.3. Confirmed areas of concentration for dugongs in South Asia

Region	Hotspot
Gulf of Kutch	Bural Chank Reef (Paga, Pashu, Kharamitha Chusna, Bhaidar, Noru, Chank, Ajad and nearby reefs, between Narara and Pirotan Island
Gulf of Mannar-Palk Bay region	<u>Gulf of Mannar:</u> Between Ramkrishnapuram and Rameshwaram, Threshpuram (Tuticorin) (including islands). <u>Palk Bay:</u> Dhanushkodi to Rameshwaram, between Thirapalkudi (Ramnathpuram) and Adiramanpattinam (Thenjavur)
Andaman & Nicobar Islands	<u>North Andaman:</u> Landfall Island, Smith Island, Ross Island and Sound Island, Interview Island <u>Middle Andaman:</u> Cuthbert Bay, Maya Bunder, Long Island and Guitar Island <u>South Andaman:</u> Ritchies Archipelago’s (Neil and Havelock Island) Southern portion of South Andaman <u>Little Andaman:</u> Eastern coast, from Hut Bay to Dugong Creek. <u>Nicobar Archipelago:</u> Between Nancowry islands (Trinkat Island, Camorta Island, Attahiak, Munak, and Hitui) and Northeast portion of Kachal island (Kapanga) <u>Great Nicobar Island:</u> Between the area of Campbell Bay and Indira point.

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5.10 References

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