



# Review of stranding records of megaherbivore the Dugong (*Dugong dugon*, müller, 1776) in the Gulf of Kutch, India- an implication to the conservation of marine mammals in Gujarat

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## Abstract

In India, dugong populations and their habitats are under pressure from several factors, including seagrass degradation caused by high turbidity and pollution, ghost nets, bycatch, poaching, fragmentation of seagrass habitats, and climate change. We reviewed the strandings of vulnerable Dugongs (*Dugong dugon*, Müller, 1776) in the Gulf of Kutch, Gujarat with prevailing threats factors. Dugong strandings data was collected through the Friends of Dugong Network, established in the Gulf of Kutch, to promote citizen science to recover obscure dugongs and records from the published literature. We could document 24 incidents of strandings with 29 dugongs between 1877 and 2022. In the Gulf of Kutch, dugong mortality incidents were reported with discontinuous occurrences, and the causes for their strandings were also unknown. However, fisheries bycatch and ghost nets in the seagrass meadows seem to be major causes for recent strandings of dugongs.

**Keywords:** Dugong, megaherbivore, threats, population, stranding, Gulf of Kutch

## Introduction

The Dugong (*Dugong dugon* Müller, 1776) is one of at least 31 marine mammal species found in India and the only existing species of the order Sirenia (Kumaran 2002; Dudhat *et al.*, 2022; MMRCNI 2022). Dugongs accounted for 22% of marine mammals stranded in India from 1800 to 2016, based on stranding records collected across the country (Jeyabaskaran *et al.*,

2016). They inhabit the waters of more than 40 countries, including tropical and subtropical coastal and inland waters from East Africa to Vanuatu. They are distant relatives of the elephant, an herbivorous mammal feeding on seagrass with a low maximum rate of increase  $\leq 5\%$ /year (Boyd *et al.*, 1999). This slow-producing medium-sized marine mammal grows to about four meters and 500 kilograms.

Additionally, it is included in Appendix II of the Convention on Migratory Species (CMS) and Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The Wildlife Protection Act of 1972 schedule I protect dugongs. The IUCN has classified the dugong population as vulnerable worldwide. Dugongs play a critical ecological role in maintaining coastal marine habitats, particularly seagrass ecosystems, by maintaining seagrass beds, nutrient recycling, and shaping the composition of invertebrate communities (Sheppard *et al.*, 2006).

Due to their cryptic nature, dugongs are globally vulnerable marine megaherbivores that are notoriously difficult to study. They spend little time at the water's surface, are unidentifiable by sight alone (Lanyon *et al.*, 2002; Broderick *et al.*, 2007; McHale *et al.*, 2008), and typically live in turbid water in relatively remote areas (Marsh *et al.*, 2001). The Dugong population is considered present in relict numbers over much of this range, separated by large areas where its numbers have been significantly reduced or are already locally extinct (Marsh *et al.*, 2011). The population of Dugongs and their habitats are continuously declining in India, with only 200 surviving individuals (Sivakumar and Nair, 2013). Stranding is important in understanding dugong populations and the current threats to the dugongs in the Indian ocean.

The local name of Dugong used by Hindu fishers in the Gulf of Kutch is Bai Manas, meaning woman human. Muslim fishers call Suwar machi (meaning pigfish) and Lulli (meaning female cripple) (Frazier and Mundkur, 1990). The Kachhi locals call it Pranjada, Suwarmachi, Pranjado, and

Harundo (Sivakumar and Nair, 2013). In Gujarat, there is a mythological belief that the King of Dwarka (a coastal town in the Gulf of Kutch), Lord Krishna, who always loved cows, had many in his kingdom. Before Dwarka sank into the ocean, Lord Krishna gave these cows adaptive features that allowed them to live in the sea (Sivakumar, 2013). In the Gulf of Kutch, dugong oil was valued as a preservative and conditioner for wooden boats (Frazier and Mundkur, 1990). The meat was believed to have medicinal, rejuvenating, and aphrodisiac properties (Jones 1967). In recent years, there has not been any reported information or incidence of poaching or hunting. The last live sightings of dugongs by fishermen in the Gulf of Kutch were reportedly in a group of 10–15 individuals (Frazier and Mundkur 1990).

In 2015, the MoEF&CC entrusted the Wildlife Institute of India to prepare and implement Endangered Species Recovery Plans (ESRP) for Dugong along with three other wild animal species (Great Indian Bustard, Gangetic Dolphin, and Sangai Deer) under the National Compensatory Afforestation Fund Management and Planning Advisory Council (NCAC). The Dugong ESRP includes research and management actions imperative to stop the population decline and support the recovery of this highly threatened species. Necessary ground interventions were initiated to ensure the long-term survival of dugongs in the wild through multi-stakeholder partnerships and the support of the local communities with substantial funding under this program. This project aims at implementing the 'National Action Plan for Dugong Conservation in India' jointly with various stakeholders such as state forest departments, other line agencies, and local

communities to recover the population and habitat of dugongs in India within the next two decades. Stranding records are used indirectly to monitor marine mammals' status, distribution, season, and abundance (Jeyabaskaran *et al.*, 2016). Utilizing existing knowledge on Dugong populations and seagrass habitats, a wide range of activities have been undertaken to address the ecological data gaps and mitigate the threats through on-ground action.

## Materials and methods

### Study area

Gujarat has a long coastline of about 1600 km (Sanjeevi *et al.*, 2014). The Gulf of Kutch (GoK), with an area of 7,300 km<sup>2</sup>, is located between 22° 22'N and 22° 43'N latitudes and 68° 58'E and 70° 21'E longitudes. The average depth of the Gulf is 30 meters, but it varies from 20 meters at the head to 60 meters in the outer region (Lal Mohan 1963). The average annual rainfall of 40 cm is received from the southwest monsoon, and the average maximum and minimum temperatures are 15°C and 35°C, respectively (Singh *et al.*, 2004). The Gulf of Kutch covers an area of 7,350 km<sup>2</sup> (Lal Mohan 1993). Seagrass meadows are one of the dynamic habitats in GoK with diversity of *Halophila ovalis*, *Halodule uninervis*, *Halophila beccarii*, *Halophila decipiens* (Pathan *et al.*, 2020).

Information on stranding and other events related to dugongs in Gujarat was obtained from secondary literature and published reports and through local informants. All information regarding sightings of dead dugongs and carcass recoveries, was collated and assessed. A total of 24 records, comprising 29 carcass observations from 1877 to 2022 were obtained. Additional

information attached to the records, which often detailed morphometric information (sex, length and weight) and the circumstance of the observation, was used to identify patterns associated with dugong observations and critical threats present in our study area. The Dugong stranding dataset was plotted in ArcMap 10.5 according to the number of strandings.

Interviews and regular boat surveys are being carried out to collect information on dugong distribution in Gujarat. Hence, they can indicate the relative importance of dugong habitat areas, the movements between them, and whether these areas change over time. This place needs more quantitative data on the status of dugongs and seagrass beds.

### Result

A total of 24 stranding records for 29 individuals have been documented from 1877 to 2022 (detailed in Table 1). Most dugongs died of unknown causes. The highest stranding records were reported from Beyt Dwarka, followed by Poshitra. The region around Poshitra and Beyt Dwarka is reported to be suitable for dugongs due to the presence of seagrass and the low anthropogenic stress due to the absence of essential ports (Singh 2003). The semi-diurnal tides get amplified nearly twice from mouth-to-head areas in the Gulf of Kutch (Unnikrishnan *et al.*, ., 2001). According to Unnikrishnan and Luick, 2003, the tidal propagation in GoK forms a deep central region, where the currents are strong and shallow regions on either side of the central Gulf, with the weaker currents strongly influenced by friction. Hence, areas like Beyt Dwarka and Poshitra are prone to being hotspots for strandings. The sex of most individuals (n = 19) was unknown and seven males and six females

were identified from the stranding record (Fig 1, 2). The age of most captured dugongs was unknown. Stranding records did not show any specific monthly patterns since the records were found all around the year (Table 1). Most of the stranded dugongs were not examined for the cause of death.

In a recent stranding on February 2, 2018, one badly decomposed carcass of one mature adult female Dugong was stranded on Ajad Island (22°23' N, 69°19' E) (Pathan *et al.*, 2022). The colour of the carcass was orange and black due to sunburn. The carcass condition was assessed based on the categories outlined in (Eros *et al.*, 2007). Some rope burn marks were observed around the neck. One cavity on the thorax was observed, we suspect that might be due to parasitic infestation. The carcass bloated due to very advanced decomposition or gas release through wounds. The skin had been sloughed off completely, but the remaining attached skin on the mid-dorsal side was retained (Pathan *et al.*, 2022).

On May 20, 2018, the second stranding report of the sub-adult male Dugong at Poshitra island (22°25'59.56"N, 69°13'23.86"E) died due to suffocation after getting entangled in a gillnet near Poshitra region of the Gulf of Kutch was reported. The fluke was entangled in rope.

The skin was whitish grey. Rope burn marks are visible around the snout. Numerous healed wounds on the back were also noted (Pathan *et al.*, 2022).

The last stranding of a dead dugong was reported near Maan and Marudi Islands on November 6, 2018. The photographic evidence showed its colour was cream-white ventrally. Unfortunately, the carcass was not found. The sex of the individual was unknown due to post-mortem evisceration in the abdomen. The information was received from a fisherman who is a part of the Dugong volunteer network. Boats were set out strategically to access the stranding-prone areas for the animals. The carcass was positively buoyant. The morphometric measurements of the strandings are given in Table 1. The deaths of dugongs are suspected to be from entanglement in fishing nets. Interview surveys and regular boat trips are being carried out for information on dugong distribution. Therefore, they can indicate the relative importance of dugong habitat areas, the movements between them, and whether these areas change over time. Dugong populations and distribution reports are very few, and we need quantitative data on dugongs and seagrass beds from this place.

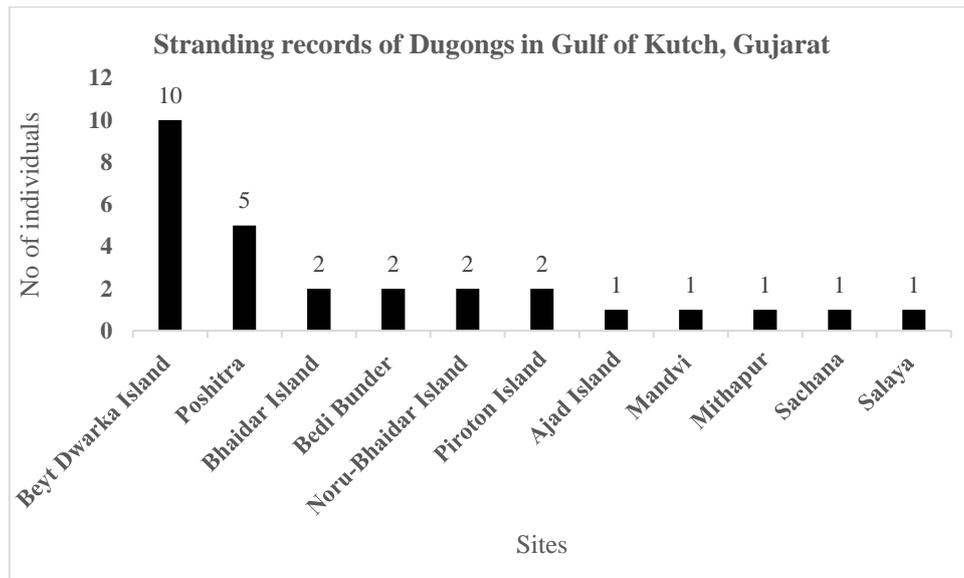


Figure 1: Stranding records of Dugongs in the Gulf of Kutch, Gujarat, from 1877- 2022

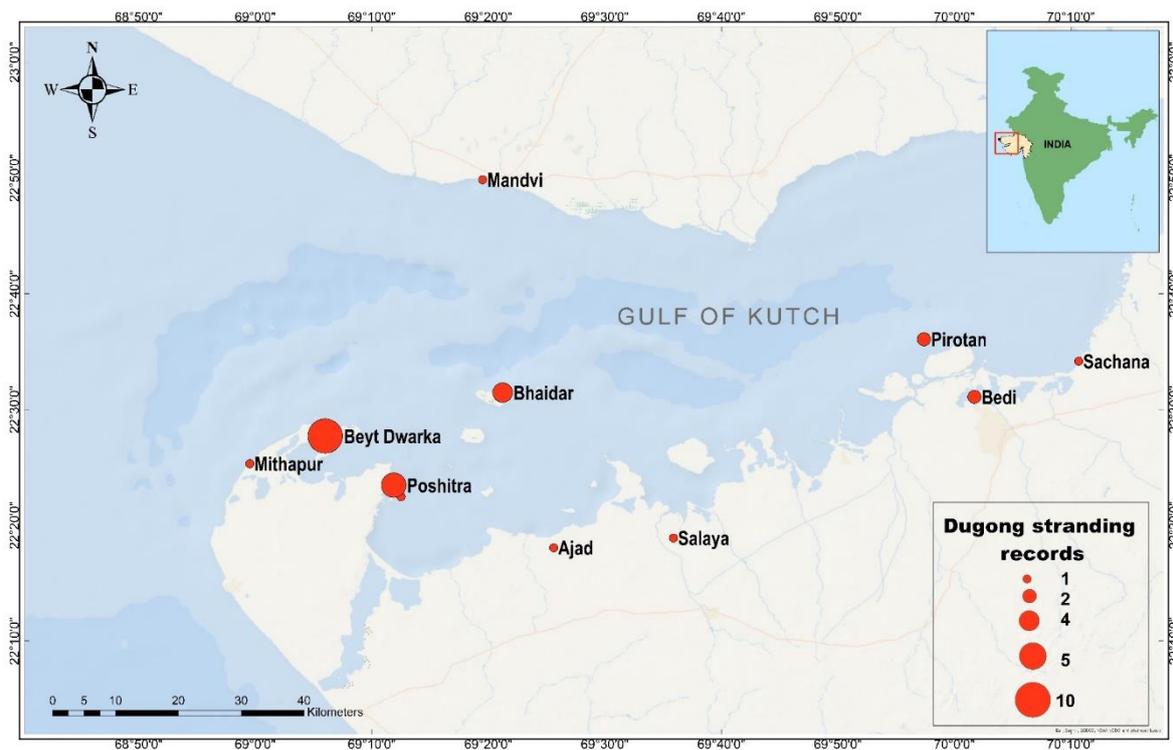


Figure 2. Bubble map showing Dugong stranding hotspots in the Gulf of Kutch, Gujarat from 1877- 2022

Table 1: Dugong stranding records in the Gulf of Kutch from 1877- till date

S N	Date /year	Place	Information	No of Individual	Length Meters	Weight Kg	Sex	Source	Causes of mortality
1	1877	Sachana, Jamnagar	Accidental catch	1	NA	NA	Unknown	Moses, 1942, Frazier & Mundkur, 1990	Net entanglement
2	April-1893	Mandvi Kutch	The stranded (skull) carcass washed ashore at Mandvi, Kutch coast, and the skull was presented to the Bombay Natural History Society by C.M. Sykes	1	NA	NA	Unknown	Phipson, 1895	Unknown
3	17-Jul-1959	Bedi Bunder	Stranded (Dead animal found floating near Kalyan lighthouse)	1	NA	NA	M	Mani, 1960; Silas, 1961	Unknown
4	30-Jul-1959	Bedi Bunder	A stranded female landed by the same fisherman who found the 1959 Kalyan specimen	1	4.06	NA	F	Mani, 1960; Silas, 1961	Unknown
5	7-Jan-	Piroton Island	Stranded (Bones of two dugongs stranded at Piroton Island, Gulf of Kutch)	2	NA	NA	Unknown	Lal, 1963	Unknown

S N	Date /year	Place	Information	No of Ind ividual	L e n g t h M e t e r s	W e i g h t K g	S e x	Source	Ca us es of m o r t a l i t y
	19 62						o w n		
6	6- Mar- 19 62	Salaya	Accidental catch 2.725 m long specimen entangled in gillnet brought to Salaya, Gulf of Kutch	1	2 · 7 2	N A	F	Lal, 1963	En tan gle d in gil lne t
7	15 - Ju n- 19 78	Bhaidar Island	Stranded (Decomposed Carcass of male)	1	N A	N A	M	Bhaskar 1978; Frazier & Mundkur, 1990	Sh ar k att ac k
8	3- Se p- 19 83	Beyt Dwarka island	Stranded on beach	2	N A	N A	M & F	Frazier and Mundkur, 1990	Un kn ow n
9	5- Ja n- 19 87	Beyt Dwarka island	Stranded (Bones 1 lower mandibles, 1 upper mandible and 1 premaxilla) Bones from at least three individuals were found on Beyt Dwarka Island, Gulf of Kutch	3	N A	N A	U n k n o w n	Frazier and Mundkur, 1990	Un kn ow n

S N	Date /year	Place	Information	No of Ind ividual	L e n g t h M e t e r s	W e i g h t K g	S e x	Source	Ca us es of m or tal ity
1 0	7- Ja n- 19 87	Poshitra	Stranded	1	1 · 7 2	1 2 0	M	Frazier and Mundkur, 1990	Gi ll net ent an gle me nt
1 1	Ja n- 19 94	Poshitra	Stranded	1	N A	N A	U n k n o w n	Singh, H.S., 1994	Un kn ow n
1 2	M ar- 20 00	Noru- Bhaidar Island	Accidental catch	2	N A	N A	M	Singh et al., 2004	Ne t ent an gle me nt
1 3	7- De c- 20 00	Bhaidar Island	Stranded (Skull)	1	N A	N A	U n k n o w n	Singh et al., 2004	Un kn ow n

S N	Date /year	Place	Information	No of Ind ividual	L e n g t h M e t e r s	W e i g h t K g	S e x	Source	Ca us es of m o r t a l i t y
1 4	13 - Feb- 20 02	Beyt Dwarka Island	Stranded	1	N A	N A	U n k n o w n	Mr. Bhavesh Trivedi Pers. Communi cation	Un kn ow n
1 5	20 - Feb- 20 02	Poshitra (Shaan point)	Stranded	1	N A	N A	U n k n o w n	Singh et al., 2004	Un kn ow n
1 6	20 03	Poshitra	Stranded	1	N A	N A	U n k n o w n	Singh et al., 2004	Un kn ow n
1 7	14 - Jan- 20 04	Poshitra	Stranded	1	N A	N A	U n k n o w n	Mr. R.J. Asari pers comm.	Un kn ow n
1 8	20 05	Beyt Dwarka Island	Stranded	1	N A	N A	U n k	Mr.Rajen drasinh	Un kn

S N	Date /year	Place	Information	No of Ind ividual	L e n g t h M e t e r s	W e i g h t K g	S e x	Source	Ca us es of m or tal ity
							n o w n	Jadeja,Per s. comm	ow n
1 9	De c- 20 07	Beyt Dwarka Island	Stranded	1	N A	N A	U n k n o w n	Kumar et al., ..,2013	Un kn ow n
2 0	15 - Ja n- 20 10	Beyt Dwarka Island	Stranded	1	N A	N A	F	Marine National Park & Sanctuary	Un kn ow n
2 1	8- Ja n- 20 13	Mithap ur,	Stranded	1	2 · 8 5	N A	F	Kumar et al., 2013	Un kn ow n
2 2	2- Fe b- 20 18	Ajad Island	Stranded	1	2 · 6	N A	F	Pathan et al., 2022	Bo at col lisi on
2 3	20 - M ay-	Beyt Dwarka	Drifted from Man-Marudi	1	2 · 0	N A	M	Pathan et al., 2022	Ne t ent an

S N	Date /year	Place	Information	No of Ind ividual	L e n g t h M e t e r s	W e i g h t K g	S e x	Source	Ca us es of m o r t a l i t y
	20 18								gle me nt
2 4	6- Nov 20 18	Floatin g near Maan Marudi Island	Stranded	1	2 .4	N A	U n k n o w n	Pathan et al., 2022	Un kn ow n
			Total	29					

### Discussion

The status of the breeding population of dugongs in the Gulf of Kutch still needs to be discovered. However, Silas, 1961 suspects them to be seasonal visitors to the Gulf of Kutch. But Frazier and Mundkur, 1990 reported immature individuals, which suggests a breeding population. This population is very isolated. To mix with other populations, these animals would have to travel to the Arabian Gulf (approximately 1,500 km to the west) or the Gulf of Mannar. The Gulf of Kutch has the lowest dugong occupancy and the highest level of mortality, but evidence of recent stranding records gives hope to the thriving dugong population. The dugong population in Gujrat waters was estimated at 10–15 dugongs based on

the interview survey conducted by the GEER foundation during 2007–2009 (Pandey *et al.*, 2010). However, there is no evidence of a breeding population from the sighting records from the past few years. The length of dugong specimens in this study was known from six records. Kumar *et al.*, 2013 reported the previous stranding Dugong in 2012, with a body length of 2.85 meters. Females reach a mature size of about 2.3 meters. Dugongs can reach a height of three meters (James and Lal Mohan, 1987). The average size of an Indian dugong is about 2.5 meters, but it can grow to be as tall as 3.5 meters (Silas, 1961). One of the smallest carcasses was 172 cm, as reported by Poshitra (Singh, 2003).

The most significant threats to the dugongs of this region are industrial pollution and high boat traffic (Sivakumar and Nair 2013). The strandings were observed throughout the year. Only one live stranding was reported in 1877 in Gujarat. Dugong feeding trails were reported in Pirotan Island (22°34'40.4" N, 69°59'07.3" E) by Anand *et al.*, 2012 and Narara reef (22° 25.8' to 22° 28.3' N and 69°42.1' to 69 44.7' E) by Apte *et al.*, 2019 during 2012 and 2017 respectively. Dugong grazing trails, as well as recent sightings and stranding events, have been documented in this area, where seagrass beds are under constant pressure from industrial growth along the coast (MMPATF, 2020).

Thus, based on interview surveys of fishers, Dugongs might have been distributed between Okha and Pirotan Island in the GoK. The cluster of islands/reefs near Okha (i.e., Chank, Bhaidar, Noru, Ajad, Beyt Dwarka, Paga and Boria) area near Salaya and Pirotan island constitutes the Important Dugong Area (Anand *et al.*, 2012). The waters off Sikka and Vadinar, Beyt Dwarka, the inter-island area between Ajad Island, Chank Island, Bhaidar Island were identified as critical dugong habitats (Sivakumar and Nair 2013). Spatial threat assessment sampling was conducted in the Southwestern part of the Gulf of Kutch, Gujarat, from December 2020- May 2021 (Pathan *et al.*, 2021). The average fishing boat traffic was low in the winter (83%) compared to summer (91%). Comparison with spatial replicates showed a slightly higher density of boat traffic localized around Beyt Dwarka and Pindara in both seasons (Pathan *et al.*, 2021).

Boat surveys and the formation of the Friends of Dugong Network in Gujarat have led to the stranding and sighting reporting of dugongs in the Gulf of Kutch. Monitoring human-induced mortalities rather than trends in the population size is a more reliable alternative for assessing whether a population is likely to decrease (Hodgson, 2012). Human impacts vulnerable dugongs because of their life history and dependence on seagrass, which grows in shallow coastal habitats, often near human settlements. Dugongs are seagrass community specialists whose health depends on access to healthy coastal meadows. The dugong population experiencing pressures such as seagrass loss due to weather, incidental drowning in commercial mesh nets, and traditional legal hunting.

The most significant threats to the dugongs of this region are industrial pollution and high boat traffic. Critical dugong habitats across the Gulf of Kutch were identified using occupancy modelling (Sivakumar and Nair, 2013). The results indicated that although dugongs occupied areas with high fishery pressure, the probability of detecting them in these areas was low (Sivakumar and Nair, 2013). The waters off Sikka and Vadinar, the inter-island area between Ajad Island, Chank Island, Bhaidar Island, and Beyt Dwarka were identified as a critical dugong habitat (Sivakumar and Nair, 2013). The region around Poshitra and Beyt Dwarka is reported to be suitable for dugongs due to the presence of seagrass and the low anthropogenic stress due to the absence of essential ports (Singh, 2003). Fishery pressure was at a medium level in the critical habitat. In the Gulf of Kutch, heavy

fishing boat traffic was listed (Sivakumar and Nair 2013) as a significant threat to the Dugong and its habitat. Crafts were mostly 5-10 meters long in all regions (Sivakumar and Nair, 2013). Gill nets and purse seines are the main fishing gear used in the Gulf of Kutch (Sivakumar and Nair, 2013). Gill nets alone form 63% of the total gear used, followed by purse seines (35%), beach seines (1%), and long lines (1%) (Sivakumar and Nair, 2013). The occurrence of plastic, fishing net fragments and wood debris reveal a potential risk to dugongs in their foraging grounds (Prajapati *et al.*, 2022).

This baseline study will enable us for long-term studies to improve conservation management and biological understanding of the Dugongs in Gujarat since there is limited information on the population of this region. Necropsy of dugongs needs to be carried out to characterize the circumstantial causes of mortality and stranding. Aerial surveys are being carried out for abundance and monitoring population trends of dugongs in the Gulf of Kutch, Gujarat. Periodic refresher training workshops must be conducted on stranding protocols for all lifeguards, coastguards, and Forest Department personnel. These workshops must be conducted at least on an annual basis to provide responders with updated skills and response protocols. Training sessions need to be conducted for veterinarians to continue to build their skills in conducting necropsies and treating marine mammals. The continuity of the conservation of dugongs and seagrass is beneficial for people to understand how to conserve the dugongs and their food habitats in the Gulf of Kutch, Gujarat.

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