2020-21

RECOVERY OF DUGONGS AND THEIR HABITATS IN INDIA

An integrated participatory approach

Annual Progress Report V

Recovery of Dugongs and their habitats in India An integrated participatory approach

Project Duration:	5 years (2016 – 2020)
Total Budget:	23.58 crore INR
Year 1 release:	5.17 crore INR
Year 2 release:	2.4054 crore INR
Year 3 release:	1.636 crore INR
Funding agency:	National Compensatory Afforestation Fund Management and Planning Advisory Council, Ministry of Environment, Forest and Climate Change, Government of India
Implementing agencies:	Tamil Nadu Forest Department (TNFD) Department of Environment & Forest, Andaman & Nicobar (ANFD) Gujarat Forest Department (GFD) Indian Coast Guards (ICGS) Indian Navy
NationalPartners:	Zoological Survey of India (ZSI) Indian Institute of Science, Education, and Research, Kolkata (IISER-K) National Centre for Sustainable Coastal Management (NCSCM), Central Marine Fisheries Research Institute (CMFRI), Kochi Bombay Natural History Society, Mumbai University of Petroleum and Energy Studies, Dehradun
Regional Partners:	State Fisheries Department GEER Foundation Centre for Environment Education (CEE) Wildlife Trust of India (WTI) OMCAR Foundation Suganthi Devadasan Marine Research Institute (SDMRI) Jehovah Shamma Centre for Marine and Wildlife Research Marine Police (Coastal Security Group) Fisheries Department Andaman Nicobar Environment Team (ANET) Temple Adventures
International Partner:	Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats (Dugong MoU) Signatories

Team:

Dr. K. Sivakumar, Scientist-F (Team Leader)
Dr. J.A. Johnson, Scientist-E (Investigator)
Dr. Samrat Mondal, Scientist-E (Co-investigator)
Dr. K. Ramesh, Scientist-E (Co-investigator)
Dr. Parag Nigam, Scientist-F (Co-investigator)
Dr. Anant Pande, Project Scientist
Mr. Srinivas Yellapu, CAMPA- Project Fellow (Genetics)
Dr. Swanti Sharma, Research Associate
Ms. Swapnali Gole, Project Fellow
Ms. Sohini Dudhat, Project Fellow
Ms. Rukmini Shekar, Project Fellow
Ms. Sameeha Pathan, Project Fellow
Ms. Chinmaya Ghanekar, DST- Inspire Fellow
Mr. Sohom Seal, UGC Fellow
Mr. Sharad Bayyana, Project Fellow
Ms. Shivani Patel, Project Fellow
Dr. K. Madhu Magesh, Project Fellow
Mr. Sagar Rajpurkar, Project Fellow
Ms. Himani Saini, Project Assistant
Mr. Sumit Prajapati, Project Assistant
Ms. Prachi Hatkar, Project Assistant
Ms. Srabani Bose, Project Assistant
Mr. Vabesh Tripura, Project Assistant
Mr. Gem Christian, Project Assistant
Ms. Rashmi Semwal Intern
Ms. Sweta Iyer, Intern
Ms. Ankita Anand, Intern
Mr. Ankit Pacha, Intern

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Sivakumar K., Johnson J.A., Pande A., Gole S., Dudhat S., Shekar S., Pathan S., Ghanekar C., Magesh M.K, Rajpurkar S., Seal S., Bayyana S., Patel S., Prajapati S., Saini H., Hatkar P., Tripura V., Bose S., Christian G., Annual Progress Report V (2020-21), CAMPA-Recovery of dugongs and their habitats in India: An integrated participatory approach, Wildlife Institute of India, (Ministry of Environment, Forest & Climate Change), Dehradun.

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1. Executive summary

Dugong (*Dugong dugon*), commonly known as sea cow, is found to occur in three states/Union Territories of India viz. Andaman & Nicobar Islands, Tamil Nadu (Gulf of Mannar, Palk Bay), and Gujarat (Gulf of Kutch). Being primarily herbivorous, these marine mammals depend on underwater seagrass habitats for forage and require large areas to breed along the nearshore waters of these sites. Dugongs are assessed as vulnerable to extinction in the IUCN red list and are listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Appendix II of the Convention on Migratory Species (CMS). Their population along the Indian coast has declined considerably mostly due to human-mediated threats such as fishnet entanglement, hunting for meat, seagrass habitat loss, and degradation, coastal pollution apart from natural threats such as climate change.

With substantial funding from the National CAMPA Authority under the aegis of Endangered Species Recovery Program, Dugong Recovery Program was initiated with major objectives to a) Assess dugong population status through advanced census techniques and determine its abundance and distribution, identify critical habitats, classify threats and develop a site-specific monitoring plan to reduce poaching and incidental entanglements, b) Characterize the critical dugong habitats, reduce direct and indirect threats, c) Raise awareness on the species and encourage the participation of the local communities; and d) Enhance the capacity of the State Forest Department staff and develop/implement smart patrolling tools to improve protection enforcement; train forest staff and local communities in underwater surveys for long-term habitat monitoring. In the last five years of its implementation, an integrated participatory approach was adopted to ensure recovery of dugong populations and conservation of seagrass habitat in India. Some key achievements of this program have been listed below:

1. **Habitat assessment of Critical Dugong Habitats** conducted at Gulf of Kutch, Palk Bay, and the Andaman Islands have revealed new foraging grounds for dugongs at these sites helping further delineation of critical dugong habitats. At the Gulf of Kutch, several new meadows, homogenous as well as patchy, were mapped at Paga (Hadkiwala and Betiwala reefs), Chusna (Chepri reef) Nakya reef, Bhaidar, and Noru (Tam reef). Seagrass surveys in the Gulf of Kutch revealed new dugong foraging trails in the Pashu islands reef and Chepri reef. Hydrocharitaceae family members like *Halophila ovalis, Halophila decipiens, Halophila beccarii*, etc are the most commonly found seagrasses in the GoK. These seagrasses along

with the turfgrass *Halodule uninervis* are considered to be the most resilient seagrasses with high colonization ability, seed stock, and extreme tolerance to fluctuating salinity and light. Paga intertidal fringing reef has the most contiguously growing yet topographically different meadows in its western and eastern parts. Epiphytes were observed to be seasonal and their cover may reach a peak of around 55-65 % of the whole leaf area during the dry summer season. Epiphytes majorly are composed of brown or green microalgae on the Hankiwala reef and Bhaidar islands. Paga reef, our representative site for monitoring epiphytic variations, experienced a gradual decline in microalgal-epiphytic cover during winters of 2020 when temperatures drop by about 10°C. Temperature loggers placed in the seagrass meadows provided new information on temperature fluctuations experienced by meadows of Paga, Bhaidar and Taam reef in the Gulf of Kutch, and it was observed that the cover of each seagrass in all three sites exponentially increased with the temperature trend along the seasons.

In Tamil Nadu, seagrass meadow assessment was done in South Palk Bay and off the Gulf of Mannar coast of Rameshwaram and marine mammal assessment surveys were conducted off Thanjavur coast in North Palk Bay. Overall, a seagrass cover of 10.61% (± 21.51) was observed from all locations sampled. *Cymodocea* spp. was the most dominant genera of species present (7.65 ± 18.16% cover). The second most common genera were that of *Halophila* spp. at 1.47% cover (± 8.43%). In the Andaman, the survey was carried out across 16 sites from South, North, and Middle Andaman namely; Channel (Between Landfall and East), Landfall, Craggy, Shibpur, Kalipur, Smith Island, Temple, Excelsior, Dalgarno, Radhanagar channel, Paget, Point, Reef, North Reef, Pokkadera, Haddo. A total of 7 species belonging to 5 genera were recorded from 16 sampled sites across the Andaman Islands in the present study viz; *Halophila ovalis, Halophila decipiens, Halodule uninervis, Halodule pinifolia, Thalassia hemprichii, Enhalus acoroides,* and *Cymodocea rotundata.*

2. Ecological surveys for seagrass-associated benthic macrofauna in the Gulf of Kutch were expanded from Bural Chank reef, Paga Reef, Taam reef, Dabdaba Island, Balapur, Bhaidar, and Chusna Pir, Chandri reef. Total 23 groups viz Gastropods, Pelecypod, Crustaceans such as Tanaidceans, Cumaceans, Amphipods, Isopods, Oligochaetes, Polychaetes, Foraminiferans, Holothuroidea, Echinoids, Ophiuroidea, Crinoids, Scaphopoda, Polyplacophora, Marine insects, etc. For further taxonomic level identification, samples were identified in collaboration with the Centre of Advanced Study in Marine Biology, Annamalai University, and Tamil Nadu. The status and validity of all taxa were checked and updated using the World Register of Marine Species (WoRMS Editorial Board 2016). In the Andaman

Islands, 30 samples have been collected from Henry Lawrence Island, Shaheed Island, and Rani Jhansi Marine National Park. The Polychaete community (29%) is dominant, the biomass of Gastropod (42.87%) is highest in Henry Lawrence. The Nematode community (36.26%) is dominant, the biomass of Bivalve (62.54%) is highest in Rani Jhansi Marine National Park (RJMNP). Polychaete community (31%) is dominant, the biomass of Bivalve (62.5%) is highest in Shaheed Dweep Island.

4. Assessing environmental contaminants from Critical Dugong Habitats of India was conducted in the tissue samples collected from 19 dugong strandings from Palk Bay and the Gulf of Mannar, Tamil Nadu during 2018-2021. This study was the first to determine the trace metal concentrations in dugongs and elucidate the status of essential and toxic metal accumulations in the tissue samples. 12 Trace metals Magnesium (316.617 ppb), Aluminum (21.150 ppb), Chromium (1.541 ppb), Manganese (1.959 ppb), Iron (245.682 ppb), Cobalt (230.308 ppb), Nickel (7.253 ppb), Copper (30.371 ppb), Zinc (294.379 ppb), Arsenic (0.073 ppb), Cadmium (9.632 ppb), and Mercury (0.221 ppb) were detected in the samples. Exploratory analyses of dugong tissues, food plants, and sediments should also be undertaken in attempts to identify yet unknown substances to which dugongs may be exposed. This study paves the way for future research to understand how trace elements infiltrate the marine ecosystem. Pollution Assessment on the Habitat of Dugongs in the Palk Bay and Gulf of Mannar, Southeast coast of India was taken place to work for estimating Physico-chemical parameters of water, pollution indicating parameters in sediments, heavy metal concentrations in sediment using Atomic Absorption Spectrophotometry (AAS). With the findings, it was concluded that the continuous increase in heavy metal contamination of coastal water is a cause of concern as these metals can bioaccumulate in the tissues of various biota.

5. Surveys for seagrass-associated fish were conducted to understand their ecological and economic importance. In fish market surveys of Palk Bay, half of the total fish caught were sourced from seagrass meadows in the area, highlighting their importance in the fishery. Thirty fish species belonging to nineteen families were observed, with costs ranging from Rs. 20 to Rs. 400 per kilogram. In underwater point-counts conducted in the seagrass meadows of the Gulf of Mannar, fishes belonging to 16 genera and 12 families were observed. The average fish density was found to be 5.4209/sq.m in seagrass meadows of Palk Bay.

6. Threat mapping of Critical Dugong Habitats was carried out in the south-western Gulf of Kutch, Palk Bay, Mayabunder and Diglipur – the North and Middle Andaman district.

Through the present study, threats to the dugong population have been quantified, which not just spatially helps us to understand threats to dugongs and their habitats, but provides the intensity of these threats and in turn, highlights areas with a strong need of management as well. Recreational boats, trawlers are a major concern as it poses the risk of collision with dugongs, not to mention the disturbance caused due to noise pollution. Such activities need to be regulated by the management authorities at the identified locations to avoid such incidents, which our study has successfully highlighted. Abandoned, lost, or otherwise discarded fishing gear were also found in numbers in surveyed areas which is the deadliest form of marine debris. They entangle many threatened animals along with dugongs such as seabirds, sea turtles, dolphins, and whales along the way. Seagrass habitat is also smothered and fouled by nets causing further damage to the associated fish and macrobenthic fauna. Collection of ghost nets was encouraged among local fisherfolk. Awareness programs for the local fishing community were organized to not throw fishing gear and single-use plastic items in the ocean and reuse them.

7. Aerial surveys for dugong population monitoring were undertaken from Bet Dwarka, Ajad Island, Paga Reef, Bhaidar Island, and Chusna Pir at the Gulf of Kutch. A total of 22 flights were undertaken during these surveys during the pre-monsoon period in January 2021. During the surveys, seagrass meadows were detected, aerially confirming the presence of seagrasses. Marine megafauna like marine turtles, sea birds, etc. were observed during the surveys. A high number of boats and fishing pressure were observed in the region. The areas selected for the surveys spanned in locations where the presence of seagrass meadows was confirmed. Intensive surveys to increase the spatial coverage will be undertaken to estimate the dugong population in the region. In the Andaman Islands, the study areas surveyed spanned over Mahatma Gandhi Marine National Park. The area was extensively surveyed for the presence of dugongs. A total of 112 transects covering 25 grids were undertaken from February to March 2021. During the surveys, marine megafauna like Bottlenose Dolphins (*Tursiops* sps), Manta Rays (*Mobula* sps), Spotted eagle rays (*Aetobatus* sps), marine turtles, and shoals of fish were observed. Dugong was not sighted in the region during the survey efforts. Increasing the spatial coverage and extensive surveys in other critical dugong habitats is the target for the upcoming season.

8. Citizen science approach was adopted targeting several stakeholders to supplement dugong sightings through all the sites including fisherfolk, forest department frontline staff, Indian Coast Guard and Indian Navy, school children of fisherfolk, and tourism sector viz; SCUBA divers, Lifeguards, and informants from other local NGOs were involved in the

Dugong Monitoring Network. From February 2017 to May 2021, eight different stakeholder groups were engaged in the Dugong Monitoring Network including fishers, tourism-allied operators, patrolling agencies, and school children. In the last year, >10 mother-calf sightings were received which highlights the importance of habitats in India for dugong conservation as it supports a breeding population.

9. Mass boat surveys were conducted in Palk Bay. Each boat was led by a researcher from our team, a forest guard, a boatman, and one or two others from the fishing community to help in an efficient sighting of marine megafauna and macroplastic litter.

10. Comprehensive assessment of the genetic status of Indian dugongs

The mitochondrial DNA fragment of dugongs generated was aligned with already submitted sequences of Dugongs (Srinivas *et al*., 2019) in MEGA v.7 (Kumar, 2016) and cleaned for further analysis. We looked for common haplotypes in DnaSP v5.10(Librado, *et al*., 2005) and determine if there was any structuring between the Dugong sequences obtained from various field sites using Bayesian Analysis for Population Structure (BAPS) v6.2 (Corander *et al.,* 2007). A haplotype network, using PopArt v1.7 (Leigh, *et al*., 2015), containing all the haplotypes was made to get a picture of the variability amongst the population. Both mitochondrial and microsatellite analysis points towards populations mixing and being connected. For a deeper understanding and a precise picture, we need to look into migration rates, any bottleneck event, and inbreeding signatures to comment about how well the populations are connected. However, the baseline analysis does point towards the importance of conserving sea-grass patches between these sampling sites since they play a major role in sustaining the dugong habitat.

11. Dugong Scholarship Programme was initiated as a unique participatory program to engage local fisherfolk communities at the grass-root level. This program targets school-going children of local communities (most of them are fisherfolk) and provides them with a scholarship of Rs. 500/month for two years to support their education. A total of 153 students were selected under this program in Phase-I starting from July 2017. Out of these, 57 were from Andaman & Nicobar Islands, 53 were from Tamil Nadu, and 40 students were selected from Gujarat field sites. Under phase-IV, 100 more students from Tamil Nadu and 75 students from Andaman & Nicobar Islands, and 66 students from Gujarat have been selected as Dugong Ambassadors in 2021. We have completed four years of this program from July 2017 to July 2021. Till now, a total of 877 students have been awarded the dugong scholarship and the students selected under this program are identified as **Dugong ambassadors**. This multi-pronged strategy involves school children in Dugong conservation awareness activities. It integrates their families as part of the broader network of forest department frontline staff, divers, tourist boat operators, and coastal village communities. This network provides us with information on dugong sightings/stranding and participates in outreach events to generate awareness in the areas of Dugong occurrence. With continuous streaming of data on dugong distribution or stranding, the field team and forest department are enabled to respond swiftly and initiate necessary action on the ground. Outcomes of this program include the volunteer release of entangled dugongs into the sea, reporting of ANNUAL PROGRESS REPORT 2020-21 dugong sightings from the sea, reporting of dugong and sea turtle stranding and release by fishermen, reduction in the poaching incidents of dugongs, reporting of poaching by fishermen, reduction in the illegal collection of other protected marine animals, etc. Thanks to all three State Forest, Fisheries, and Education Departments, especially the frontline officers at Gulf of Kutch National Park, Gulf of Mannar Biosphere Reserve, Palk Bay, Andaman, and Nicobar Islands that helped the WII Team to successfully implement this program.

12. Outreach and awareness programs consist of a variety of tools including community workshops, presentations, beach clean-up activities, radio programs, etc. So far, we have conducted over 57 outreach programs at all three field sites targeting over 3500 stakeholders. Due to covid restriction, outdoor activities were not conducted in this season. At Gulf of Kutch, a total of 27 outreach and awareness activities were conducted to make people aware of the species, its importance, and major project activities to the school students, teachers, locals, and fishermen. Out of 27 events, 12 events were conducted for awareness and scholarship and 9 meetings were conducted with different stakeholders like the forest department, marine police, and head of various schools to involve them in the conservation activity, as the involvement of local people is very crucial for any species conservation. A total of 11 outreach and awareness activities were conducted at the Tamil Nadu field site, to aware people of dugongs, their importance, and major project activities to the school and college students, teachers, locals, and fishermen. Out of 11 events, 4 events were conducted for awareness and scholarship, 6 meetings were conducted with stakeholders like education officers and forest officials. Most of the awareness efforts were published and highlighted in the local Newspapers and News channels. National Science Day, World Environment Day, World Dugong Day, World Wildlife Day. Endangered species day was celebrated creating awareness regarding wildlife and Environment conservation among the school students. At the Andaman Islands, a total of 14 outreach and awareness activities were conducted to aware people of the species, its importance, and major project activities to the school students, teachers, locals, and fishermen. Out of 14 events, 7 events were conducted for awareness and scholarship and 12 capacity building programs were conducted with different stakeholders like the forest department, Navy, and coastguard to involve them in the conservation activity, as the involvement of local people is very crucial for any species conservation.

13. World Dugong Day Celebration on 28th May 2021: This day was dedicated to dugong conservation awareness anywhere in the world. The significance of the day comes from the signing of the CMS-UNEP MoU by India on 28th May 2008 for the conservation and management of dugongs and their habitats. Due to the ongoing COVID-19 pandemic and restrictions on travel and organizing gatherings, this day was commemorated as Dugong Day with online events conducted over one month. It included a social media campaign from 28th April- 28th May 2021. The campaign was organized in collaboration with ENVIS resource partner "Wildlife and Protected Area" (http://www.wiienvis.nic.in) and was channelized through social media platforms like Facebook, Twitter, and Instagram. The campaign included the daily posting of one infographic poster on dugongs on social media platforms and online photography and quiz competitions were organized. The campaign saw active participation of >10000 people from across the country making it one of the biggest events so far on dugong conservation in the country. More than two hundred entries each were received for the quiz (210) and photography (86) competitions.

14. International Day for Biodiversity Conservation on 22nd May 2021

Biodiversity plays a major role in maintaining the balance of the earth. It is the foundation of ecosystem services to which human well-being is intimately linked. All the variety of animals, plants, fungi, and even microorganisms like bacteria make up our natural world. International Day for Biological Diversity is celebrated each year on May 22. "We're part of the solution" was the theme for this year.

15. Celebration of Endangered Species Day

National Endangered Species Day is observed on the **third Friday of May** every year. This day is celebrated to highlight the increasing need to protect endangered species across the world. The National Endangered Species Day initiative was introduced in 2006. The webinar series was organized by the CAMPA Dugong team as a virtual event. The talk was showcased on the social media platforms

16. Webinar series on Marine Mammal Conservation in India: Status, challenges, and opportunities were conducted during 12- 14 October 2020. The aim of conducting webinar was to address marine mammal conservation issues and scope of the research opportunities also to create awareness among the young researchers, provide a platform for spreading knowledge on current research conducted on marine mammals, to provide them a platform for exchanging ideas, identifying opportunities for future research on marine mammal conservation in India. The participants got the opportunity to interact with eminent scientists working for marine mammal conservation on the national and international levels.

1**7. Capacity building programs** were conducted to provide orientation to State Forest Departments of Andaman & Nicobar Islands, Gujarat, and Tamilnadu for dugong conservation. In addition, key partnerships with the Indian Navy, Indian Coast Guard, Marine Police, Coastal Security Group, State Fisheries Departments, and State Education Departments were included in these programs. It was done by conducting a series of sensitization, orientation, and training workshops on marine biodiversity conservation, marine mammal stranding response, SCUBA diving for underwater marine biodiversity monitoring, etc. So far, over 2000 personnel from these departments have been trained and sensitized for dugong conservation in the country. These trainings have helped us get aerial footages of dugongs from the Indian Navy and Indian Coast Guard, helped us to identify priority sites for dugongs, reduce mortalities due to poaching by increased in active patrolling and enhance the capacity of these frontline stakeholders in the conservation of marine biodiversity in the country. A similar integrated approach was adopted to include school children, local universities, Non-Governmental Organisations, tourism operators, and staff for marine biodiversity monitoring and management. This training was given to fisherfolk, boat operators, divers, local NGOs, college and school students, and multiple conservation activities were conducted to increase their direct participation. These trainings were given through unique community workshops conducted periodically at all sites. In Gujarat, two training sessions for identification of seagrass and threats to marine mammals were given to 4 marine police officers and two Indian Navy officers on the field at Chushnapir Island. Dugong monitoring Logbooks were distributed among them. A special training course on hands-on training of drone operation with forest department staff was conducted in Gujarat and Andaman Islands. The frontline staff was introduced to UAVs, their use in Wildlife Conservation and monitoring, and detailed information regarding drone specifications. Another training session was conducted to operate the application for drone use, arming and disarming the aircraft and briefing about the application use and included drone flight Demonstration and hands-on drone survey. Total 40 frontline staff nominated by the forest
the effective capacity building benefits both the partners and local stakeholders by generating inclusive processes that strengthen trust and build commitment and good relationships. With continuous streaming of information on dugong distribution and stranding,

the WII field team and forest department have been enabled to respond swiftly and initiate necessary action on the ground.

18. Seagrass field guide for easy identification of seagrass species in India has been developed and published. This guide will provide key information on the seagrasses of India and their associated faunal species. The field guide was distributed to all the forest officials.

19. Nutrients in the sediments and seagrasses were assessed at all field sites as important parameters in influencing the growth, reproduction, and metabolic activities of biotic components. The concentration of nutrients is based on the season, tidal conditions, and flow of fresh water from the land. The distribution of nutrients is also mainly based on these seasons, tidal conditions, and freshwater flow from land. The concentration of nutrients in the sediments among the study sites varied significantly. All the parameters were observed to be maximum in the site Gujarat, except for phosphorus the concentration of which was observed to be higher in Andaman and Nicobar Island. The concentration of nutrients in the seagrass samples also varied significantly among the study sites. Nitrogen, Phosphorus, Potassium, Sodium, and ash content were observed to be more in the seagrasses of Tamil Nadu.

20. Spatial analysis to map seagrass distribution using machine learning algorithms on Google Earth Engine (GEE) from high-resolution satellite images at the Gulf of Kutch, Palk bay, and the Andaman Islands. Seagrass classification is performed using the pixel-based image classification method. Andaman & Nicobar Islands support a rich underwater habitat, including various seagrass species and coral reefs. The Palk Bay in Tamil Nadu consists of a dense patch of seagrass. Whereas in the low tide regions of the Gulf of Kutch, Gujarat, only two classes were observed, namely seagrass and non-seagrass.Geospatial analysis of seagrass meadows at Ritchie's archipelago was done using satellite imageries to attempt the detection of submerged seagrass meadows along the coast of islands of Ritchie's archipelago. Machine learning algorithms such as Random Forest, Support Vector Machine, and Nearest Neighbour were incorporated for seagrass detection and mapping. This work was carried out in collaboration with the Centre for Space Science and Technology Education in Asia and the Pacific (affiliated to the United Nation) at the Indian Institute of Remote Sensing, Dehradun as part of dissertation work. This work was eventually published as a research communication article in the Current Science journal on 25th April 2020.

21. Management Recommendations:

At the Gulf of Kutch, we recommend enhancing patrolling around Bhaidar Island, Nauru Island, and Taam, Paga reef as these are 'Critical Dugong Habitats'. These sites must be regarded as slow speed zones wherein it should be made mandatory for operational fishing vessels to sail at an 'idle speed' to avoid harmful collisions. We recommend increased threat monitoring efforts in the southeastern part of the Gulf of Kutch. Dugong sighting and monitoring efforts need to be increased in 'Critical Dugong habitats' like Chepri, Nor, Bhaidar, Balapur, Paga, and Taam reef. The connecting habitats between foraging meadows need to be established and monitored regularly using the drone and boat-based surveys. At Tamilnadu, patrolling should be upscaled in Palk Bay. More surveys are required to generate data to demarcate critical dugong habitats in the region. The frontline staff needs to be trained in conducting seasonal seagrass monitoring surveys and marine mammal monitoring surveys. We plan to organize 'Dugong handling training' in the upcoming season for state forest department personnel and other key stakeholders at all the sites. At Andaman & Nicobar Islands, we recommend imparting structured training to frontline forest staff in data collection and documentation, dugong stranding response, and sample collection from dead dugongs, using standard protocols is strongly recommended, as this stakeholder group is the first responder to marine mammal strandings. More frontline forest staff to be trained in certified SCUBA courses and involved in long-term seagrass and coral monitoring in the islands. Rigorous patrolling is recommended jointly by the forest department, Indian Coast Guard in all the sites identified as 'dugong trouble spots'. Engaging crucial stakeholders like the tourism department, directorate of shipping services, chamber of commerce, SCUBA diving associations, and other tourism allied sectors, to help minimize direct or indirect impacts caused by tourism activities on dugongs.

22. Future plan of action:

Drone surveys will be conducted at all the sites to determine the dugong population at all sites. It is planned to establish and build capacity for mobile 'Dugong Rescue and Rehabilitation Facilities' in three regions. Seeking the support of fishers in the conservation of dugongs in India will continue. It is planned to further enhance the network of 'Dugong Ambassadors' and 'Friends of Dugongs.' After the drone surveys get underway, there are plans for acoustic surveys so that they will be closely monitored.

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ANNUAL FIELD REPORT 2020-21

GULF OF KUTCH, GUJARAT

Team Members:

Sameeha Pathan (Project Fellow), Shivani Patel (Project Fellow), Sagar Rajpurkar (Project Fellow), Prachi Hatkar (Project Assistant), Gem Christian (Project Assistant), Junus Babbar (Field Assistant), Bhargav Bhadreshvara (Field Assistant)

Volunteers:

Chitrangee Bose, Sonal Yadav, Kanak Prajapati, Satyam Gupta, Sandhya Chak, Elis Parmar, Ronak Maradiya, Maksud Chhatra, Fatema Hirkani, Rajat Joshi, Karnik Bose, Riddhi Makwana, Jyotil Dave, Dheer Bhatt, Prakash Doriya, Akram Bhaya, Hamid Kadar

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2.1 RESEARCH AND MONITORING

2.1.1 Seagrass surveys Seasonal changes in seagrass meadows of the south-western Gulf of Kutch, Gujarat.

Intertidal meadows- A monthly visit to three topographically different meadows was done to study the seasonal changes in the seagrass community. Seagrass and sediment samples were sampled using random quadrats in a fixed plot on each site. The plot area was fixed; approximately 300 m^2. With the consultation and permission of the Gujarat Forest Department, HOBO temperature and light loggers were carefully set near meadows on each site. The logger was cleaned off crustose algae and dust every month and data was off-loaded every two months.

All seagrass species were observed to grow at a rapid pace after February. Although the growth rates amongst the four species, i.e., *Halophila ovalis*, *Halophila decipiens*, *Halophila beccarii,* and *Halodule uninervis*, differed across the winter to transitional summer months. Increments in seagrass covers at each site seem to have a temperature cue (Figure 2.1, 2.4). Although the overall algal growth changed across the reefs, the algal cover substantially remained limited to the rocky reef area. It did not seem to have caused any spatial disturbance to the seagrasses. Epiphytic cover on seagrasses remained limited to the early winter months and only showed a dramatic decrease on the Patthiwadi reef-top (JHW-MHQ in Fig 2.8).

A meadow can be patchy and still have high cover during the peak summer. The implication of monitoring seasonal changes in seagrasses has an important value in the conservation of dugongs. Dugongs, being a strategic forager, may have a foraging pattern that relates to the seasonal patterns in seagrasses. This may further reveal the movement patterns of dugongs across these meadows.

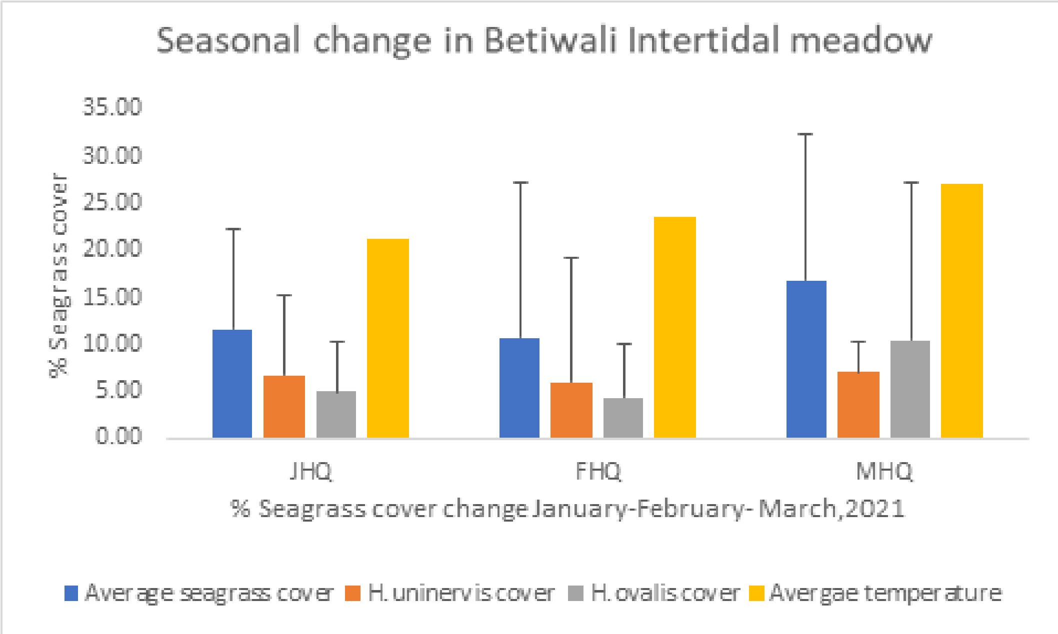


Figure 2.1: Seasonal change of seagrass percentage cover in Betiwali region of Paga reef in Gulf of Kutch, Gujarat

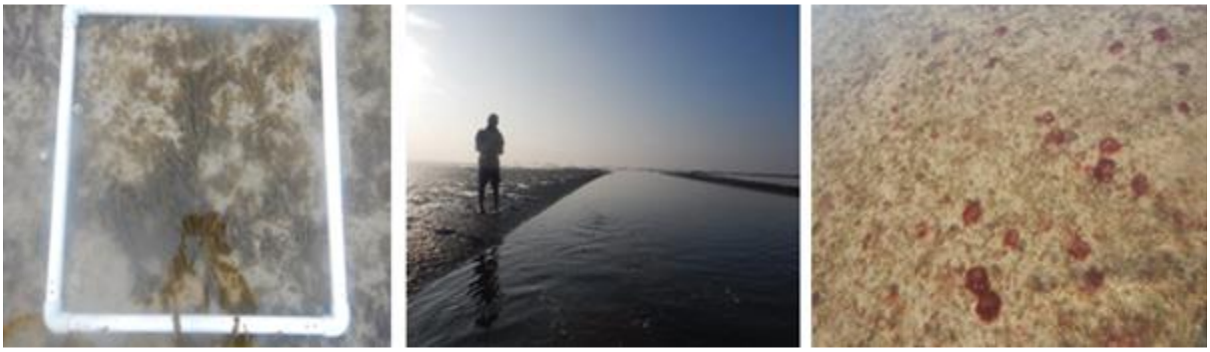


Figure 2.2: Seagrass monitoring on Taam reef, 2021. (a) Quadrat showing Epiphytic load of seagrasses in January. (b) Researcher standing at the bank of an exposed channel during the low tide period. (c) Bryopsis sp. of macroalgae growing along the Taam meadow, which is dominated by *Halophila decipiens* and *Halophila ovalis* in the Gulf of Kutch, Gujarat

Figure 2.3: (a) Quadrat showing growth of *Halophila beccarii* on Bhaidar reef, (b) Researcher during exploratory surveys at Noru reef, (c) Dugongs feeding trail on monitoring site at Bhaidar reef in February at the Gulf of Kutch, Gujarat

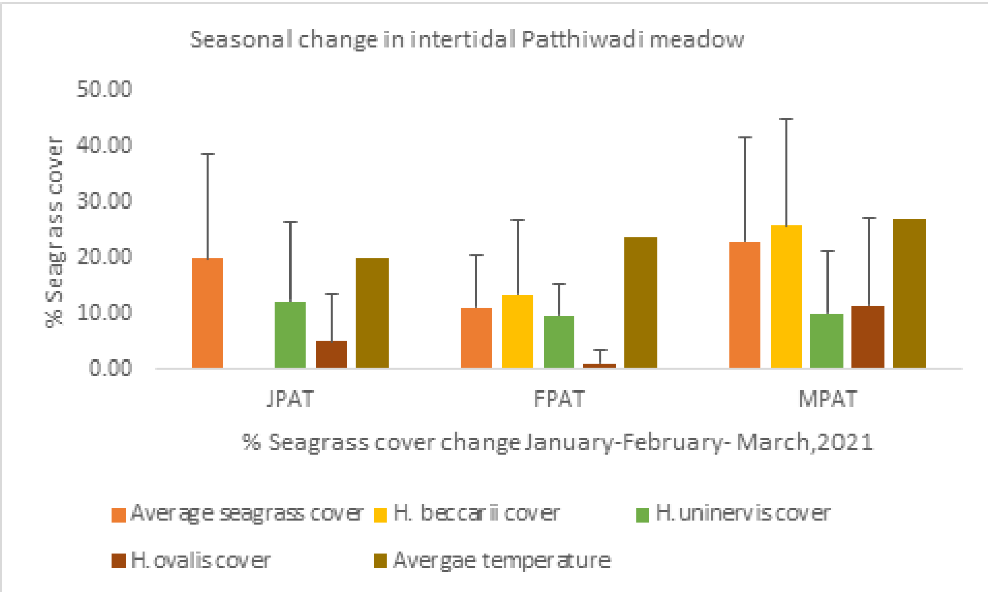


Figure 2.4: Seasonal change of % seagrass cover in Patthiwadi region of Bhaidar's reef) in Gulf of Kutch, Gujarat

Figure 2.5: (a) High Halophila cover on Paga reef. (b) Field researcher sampling seagrass and sediment samples from mud-flats in Gulf of Kutch, Gujarat

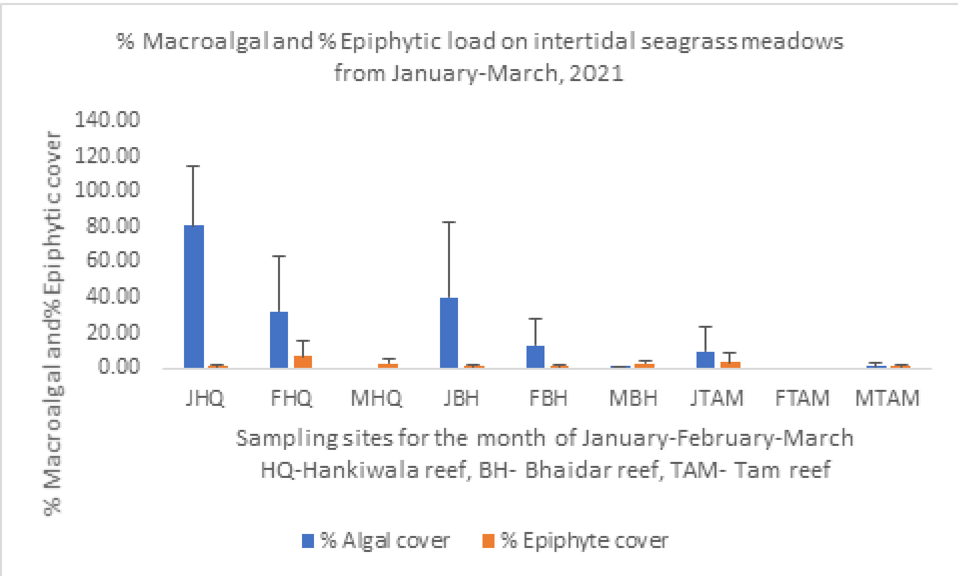


Figure 2.6: Seasonal change of seagrass percentage cover in Taam region of Noru reef (HQ- Betiwala reef, BH- Bhaidar reef, TAM- Taam reef) in Gulf of Kutch, Gujarat

Figure 2.7: (a) Researchers cleaning seagrass samples, (b) Researchers working during flooding tide on Taam reef in Gulf of Kutch, Gujarat

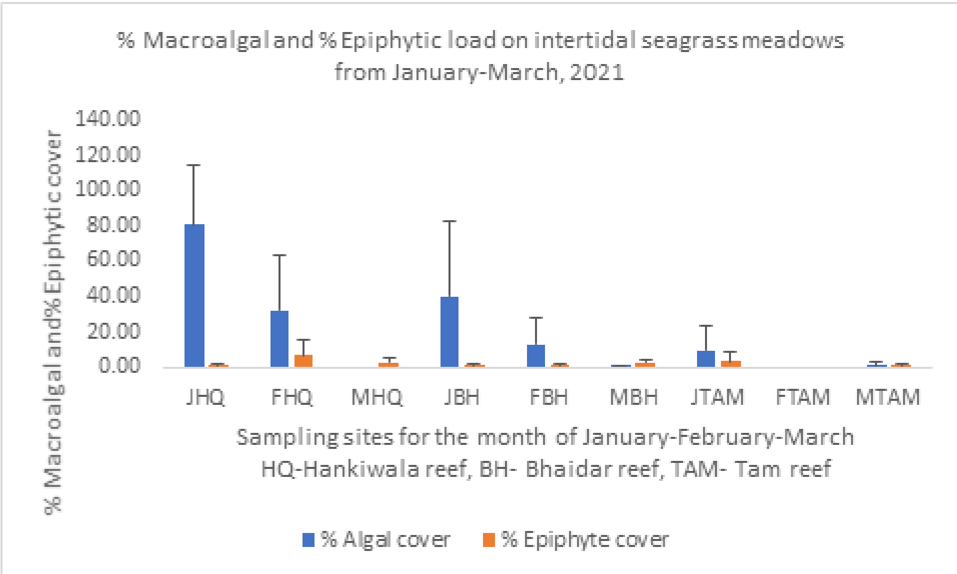


Figure 2.8: Macroalgal percentage and Epiphytic cover across the three monitoring sites (HQ- Betiwala reef, BH- Bhaidar reef, TAM- Taam reef) in Gulf of Kutch, Gujarat

Figure 2.9: Microalgal epiphytic load on seagrasses is more common during the winter months at Gulf of Kutch, Gujarat.

Seagrass mapping in subtidal zones of Paga reef and Bhaidar Island

To map the extent of seagrasses in the subtidal zone a Van Veen grab was used to check for seagrass' presence and absence. Before mapping, regional knowledge became a substantial prerequisite. A small 12 feet dinghy was used for mapping smaller coves. Associated data; depth, temperature, salinity was taken.

It was observed that; 11 out of 22 sampling points were seagrass-absent points in Paga's subtidal zone for an area of 393.4 hectares and 10 out of 22 sampling points were seagrass absent points in Bhaidar Island's southern cove of a total survey area of 86 hectares.

Seagrass *Halophila decipiens* was the only species observed so far to be dominating these shallow subtidal meadows.

Subtidal mapping efforts were stopped after a rough sea state due to the arrival of southwestern tropical winds.

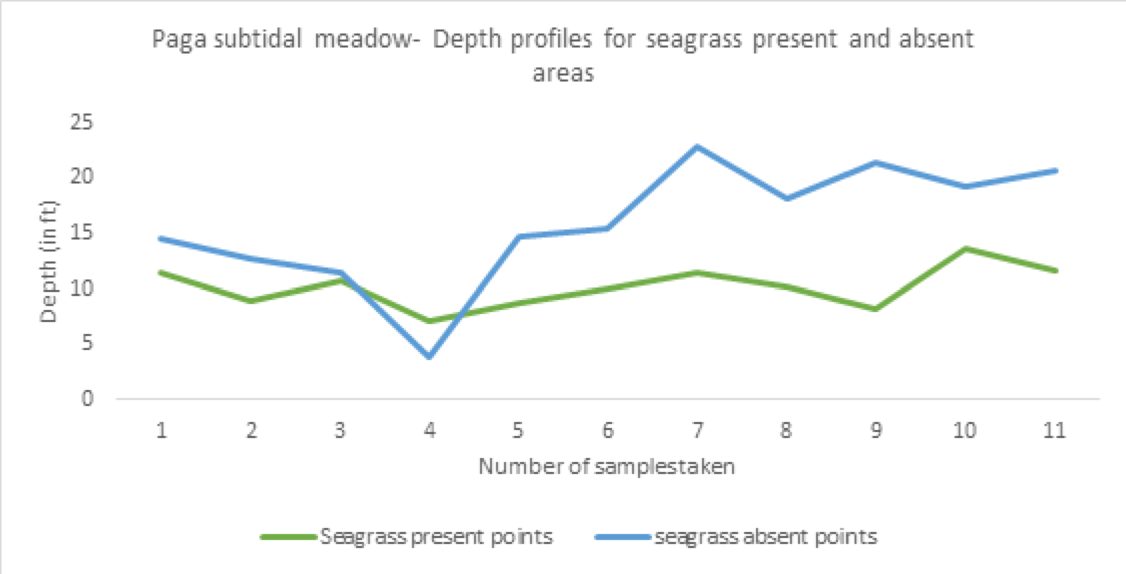


Figure 2.10: Depth profile of a typical subtidal seagrass meadow in Gulf of Kutch, Gujarat

As observed from the above (Figure 2.10), seagrass colonizes low tide shallower zones in the subtidal waters of southwestern GoK. The average depth for colonization of seagrasses is 15 feet (water depth during high water period).

2.1.2 Ecological surveys for estimating seagrass-associated benthic macrofauna

The organisms inhabiting the sediment are referred to as benthos. Depending upon their size, benthic animals are divided into macrofauna, microfauna, and meiofauna and macrofauna. Benthic community responses to environmental perturbations are useful in assessing the impact of anthropogenic perturbations on environmental quality. Macrobenthic organisms which are considered for the present study are animals with body sizes larger than 0.5 mm. The presence of benthic species in a given assemblage and population density depend on numerous factors, both biotic and abiotic. Benthic invertebrates can be differentiated by the position they occupy on or in bottom sediments: infauna – animals that live in sediments, almost all worms and bivalves belong to this category, and epifauna – organisms that live on the surface of bottom sediments; many crabs and gastropods are considered epifauna (Tagliapietra & Sigovini. 2010).

A rich community of infaunal organisms directly or indirectly contributes to the success of seagrasses. Bioturbation by mobile infauna can aid in nutrient cycling and seed burial. Different mixtures of seagrass species alter environmental conditions and food availability within the sediment through a range of processes (ranging from sediment trapping to interspecific differences in photosynthate production), affecting differences in nematode community structure directly or through indirect pathways (Somerfield *et al*., 2002).

The abundance and biomass patterns of macrofaunal assemblages associated with seagrass habitat were investigated in the Gulf of Kutch from December 2020 to May 2021.

Objectives

1. To study species composition of benthic macrofauna associated with seagrass in Gulf of Kutch, Gujarat
2. To study the functional composition of the fauna associated with seagrass in the Gulf of Kutch, Gujarat
3. To study the temporal variations in abundance of benthic macrofauna associated with seagrass meadows in the Gulf of Kutch, Gujarat

Study areas

Paga reef is located between 22°28.8’ to 22°30.0’N latitude and 69°11.6’ to 69°15.0’E longitude, covering an area of 1472.4 ha which remains submerged during high tide and gets exposed only during low tides. Paga=A foot (An island having a foot shape) is 5 km away from the coast. It is an excellent reef with a high diversity of corals and coral associates and remains submerged in high tides. Earlier workers reported pearl oyster beds from these reefs. It is totally devoid of mangroves because of its total submergence during high tides. The 654 ha area is covered by reef vegetation. A total of 591 hectares of reefs with corals are found on this island. This island was leased in the past by the fisheries department for the collection of shells and pearls.

Bhaidar island is located between 22°7.9’N – 22°-28.2’N and 69’°17.6’ E – 69°19.5’ E stands 3rd with an area of 3660 hectares and situated 11 Km away from the coast (Venkataraman, et al., 2004). This island stands 6th in the coverage of mangroves. The mangroves cover an area of 416 hectares. *Avicennia*, *Ceriops,* and *Rhizophora* are the dominant mangroves found on this island. It is recorded as a nesting site for Indian Reef Heron, Darter, Grey Heron, and large Egret. Mudflats cover an area of 134 hectares, Sandy beach is found on the western side of the island and the total sandy area on this island is recorded as 31 hectares. Island proper has a coral reef with degraded corals in patches. As well-known as a nesting site for Sea turtles. Fishermen, carry out fishing on the reef and stay on the island, especially during rough weather conditions.

Chank/ Boria reef is located south of Mangunda. It is located 22 32.7'N 69 16.2'E is the largest reef close to the Saurashtra coast in the Gulf of Kutch A Major portion of Boria is covered with heaps of well-eroded broken branches of Acropora formed into pebbles. This substratum supports the survival of sea anemones, which bury themselves a bit deep into the pebbles during low tide to keep them exposed to the water retained between the pebbles. A large number of Sea anemones belonging to the same species are found on the island during low tide. Few coral species mostly dominated by Monipora spp. are found on the surface of the island in pools where seawater is found trapped even during low tide. Corals are found on the eastern and western sides of the island. Evidence indicates fishing on this reef. It has on it three high islets, Bhaidar Tapu, Narara Tapu, and Chank Tapu. They are separated from Bural by shallow channels. Chank reef lies north to Noru bet. A lighthouse was located on the northern side of the island. The surface of the island is with half-dead coral species mostly belonging to *Porites* sp. Much of the reef is covered by mud and the algal invasion (*Uiva* sp.) is more on this island. The channels and crevices on the island harbours rich in Ichthyic and other fauna.

Nora/Noru tapu 22° 30' 59" N 69° 20' 22" E is an island – a tract of land, smaller than a continent, surrounded by water at high water. These islands support dense and diverse mangrove species and are surrounded by the fringing coral reefs. Algae and seagrasses are also witnessed along the reef area and mudflats (Bhatt *et al*., 2008).

Taam reef is situated on the outer rim of the western part of the reef making it closer to the off-shore open sea of the gulf. The fossilized coral reef acts as a barrier between the meadow and the high-energy currents as they cover a significant area of the very reef itself. Seagrass meadows are located towards the inner sheltered part of the reef.

Devdi, Dhabdhaba, Lefa are rocky islands located between 22°22.0'N 22°23.0'N and 69°11.1 'E 69°12.0'E. Close to Poshitra point and was connected to the mainland in the past. They are all rocky islands with scrub forests composed of *Aloe*, *Euphorbia* (Goral), etc., similar to the scrub forests on the coast of Poshitra. They are almost devoid of mangroves and coral formations when some *Avicennia* patches are found on Dhabdhaba. Rocks sprinkled at high tide were supported by small scattered colonies of few coral species. Rich windowpane oyster beds attract fishermen. Local people also occasionally visit these areas for recreation and fishing around these islands is also not ruled out.

Mitha Chusana (Chusana Bet) is a small rocky islet with an islet close to it lying at the South point of the Bural reef. Khara Mitha Chusana island groups.

Chandri reef is located between 22°30.4’N – 22°31.8’N and 69°07.0’E – 69°08.4’E and situated 10 km away from the coast. It is without mudflats and mangroves. The reef vegetation occupies an area of 175 Km². It is the westernmost reef of the Gulf of Kutch subjected to heavy currents because of its location in the open sea. It covers an area of 266 Km². And remains underwater during high tide. Sandy beach is found on the southern side of the island. Good growth of corals is found on the western and northern sides. The most dominant group on the surface of the reef is Porites and in the areas on the western side which are mostly found submerged in the sea, good growth of *Montipora* sp. is seen without a gap to tread across, *Goniastrea, runcate* and *Platygyra pini* are also found in abundance on this island. High diversity of associated fauna including eels were observed in the numerous crevices and channels formed on the island due to continuously flowing high-velocity currents. Fishermen and tourists rarely visit this island due to its location in the open sea.

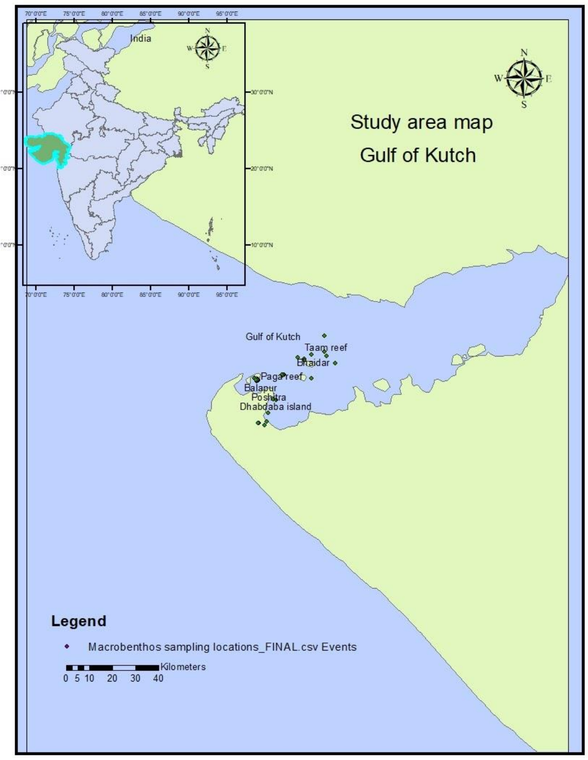


Figure 2.11: Sampling locations for macrobenthic fauna associated with seagrass in Gulf of Kutch, Gujarat

Methodology

Seagrass-associated invertebrates were collected during the low and high tide in the season from December 2020-May 2021.

Intertidal seagrass associated faunal collection

Natural Geography inshore areas (NAGISA) sampling protocol for seagrass and macroalgae coastal areas was followed for intertidal macrobenthos collection. GPS Garmin eTrex 30 was used for making waypoints. The intertidal seagrass meadows were exposed during low tide. In intertidal seagrass meadows, quadrats were randomly placed. Macrobenthic samples were collected from quadrates of 25x25 Cm in high, mid, and low tide intertidal zones, which were 100 meters spaced apart. Quadrates are the square sampling plots of fixed length and width generally used to study sedentary or slow-moving animals. In total six quadrates were placed. Five replicates were taken from each quadrat, and a depth of 5-10 cm of sediment was collected in seagrass present and absent areas each. Samples were sieved and preserved in 5%, formalin and stained with Rose-Bengal. The benthos in the sediment sample was recorded after sieving through 500 mesh size sieves on board. The total population was estimated as the number of animals in 1 meter and biomass on a wet weight basis.

Upon receipt in the laboratory, samples were washed and transferred to a preservative. The washed and preserved sediment with benthic invertebrates were poured into a white enamel tray. The organisms were sorted with the help of a stereomicroscope and arranged into different groups in separate vials and preserved in 70% Ethanol. The preserved animals were later identified to their lowest taxonomic group under Leica DM100 stereomicroscope using relevant identification guides and counted. Photographs were taken using Optikam Pro 8 camera in Wildlife Institute of India, Dehradun. For further identification, it was carried out in a collaboration with Annamalai University, Tamil Nadu.

Subtidal seagrass associated faunal collection

Van Veen grabs with an area of 0.04m^2 were used to collect subtidal benthic samples. The Van Veen grab is easily operated by a rope. Once on the boat, the grab was opened above a plastic bucket and the sample was gently removed. Samples were sieved to remove fine sediments and any other extraneous material. Depth was measured onboard using the DEPTH TRAX 1H handheld depth finder with the inbuilt temperature sensor. Dissolved oxygen (DO), Salinity, pH was measured with the help of recalibrated portable Dissolved

Oxygen meter, salinity, and pH meter. Seagrass cover could not be estimated due to turbidity. Seagrass biomass composition and shoot density were estimated post-field trips.

The sample was then sieved; water was sprinkled directly onto the sample with a low-pressure nozzle to prevent any damage to animals. The samples were kept in watertight plastic bags. The delicate process of sieving was performed very carefully to avoid any damage to the fragile organisms and to ensure that all animals present in the sample were collected. To separate macrofauna, a sieve of 0.5 mm mesh was used. The samples were preserved in 5% formalin and stained with Rose Bengal. The Rose Bengal dye at the strength of 0.1% selectivity colored all the living organisms in the sample.

Figure 2.12: Macrobenthic sample collection and post-processing

Results

Total 959 samples were collected from Bural Chank reef, Paga Reef, Taam reef, Dabdaba Island, Balapur, Bhaidar, and Chusna Pir, Chandri reef during the study period of December 2020- May 2021. Total 23 groups viz Gastropods, Pelecypod, Crustaceans such as Tanaidceans, Cumaceans, Amphipods, Isopods, Oligochaetes, Polychaetes, Foraminiferans, Holothuroidea, Echinoids, Ophiuroidea, Crinoids, Scaphopoda, Polyplacophora, Marine insects, etc. Further taxonomic level identification was carried out in collaboration with the Centre of Advanced Study in Marine Biology, Annamalai University, and Tamil Nadu institute. The status and validity of all taxa were checked and updated using the World Register of Marine Species (WoRMS Editorial Board 2016).

The highest wet weight biomass and groups were found at Paga reef. Average biomass varied from 2.11 – 85.12 gm/m^2 wet weight). Density is one of the simplest analysis factors (the number of individuals per unit area or volume). The highest density was observed in Bhaidar island average population varied 64.58- 1054.35 nos/m^2) and the highest number of groups was observed in Paga reef during the study period.

The standing stock of macrobenthic fauna in terms of population and biomass varied widely during the present study (Table 2.1). The range and average faunal standing stock and composition of macrobenthos are given below.

Seasonal variation in the faunal composition of macrobenthic associated with seagrass meadows

Seasonal variation in macrobenthic faunal composition was observed in 2 sites Dabdaba Island and Bhaidar Island. In December only two groups were observed and seagrass was absent. In the pre-monsoon season, *Halophila decipiens* were observed and 6 faunal groups were observed. In Dabdaba island, the benthic biomass wet weight in December 0.0-1.7 Avg 0.88 SD$\pm$ 1.18 gm/m^2 April varied from 0.0- 15.75 gm/m^2 (Avg 2.11 SD$\pm$ 4.60), population 25-225 nos/m^2 Avg 64.58 SD$\pm$ 60.73), faunal nos 4 Avg 4 SD $\pm$0).The flowering and fruiting season of *Halophila decipiens* is from January – March (Dilipan et al., 2020).

Halophila ovalis and *Halodule uninervis* were found during the survey. In the case of Bhaidar Island, on January 13 faunal groups were observed, and in April only 3 groups were observed. The biomass varied from 0.0-125.7 gm/m^2 Avg 20.45 $\pm$ 90.32) in January 2021 and in April 2021 0.0-90.75 (Avg 23.62 SD $\pm$ 34.62) . The population 16-1472 nos/m^2 Avg 470 SD$\pm$ 2724.32).

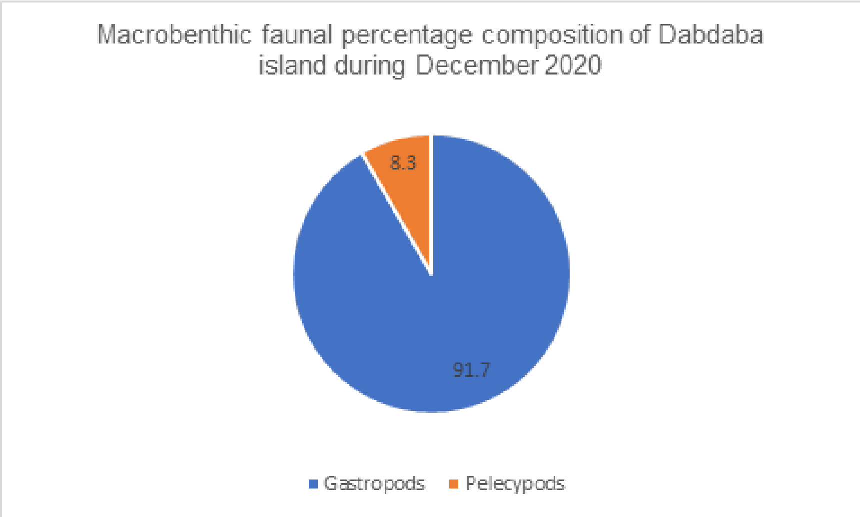


Figure 2.13: Benthic faunal percentage composition of Dabdaba Island, Gulf of Kutch, Gujarat during December 2020

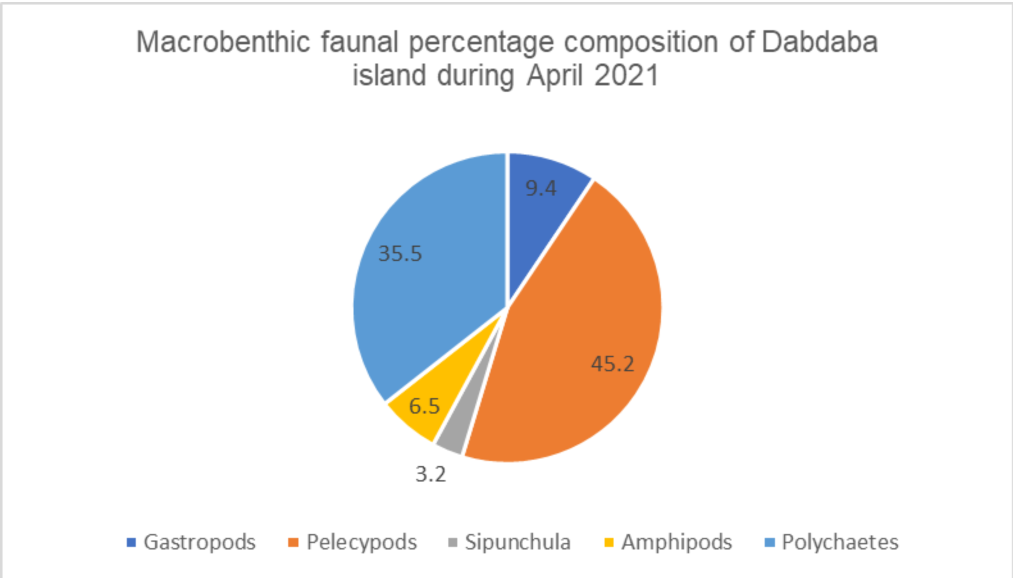


Figure 2.14: Benthic faunal percentage composition of Dabdaba Island, Gulf of Kutch, Gujarat during April 2021

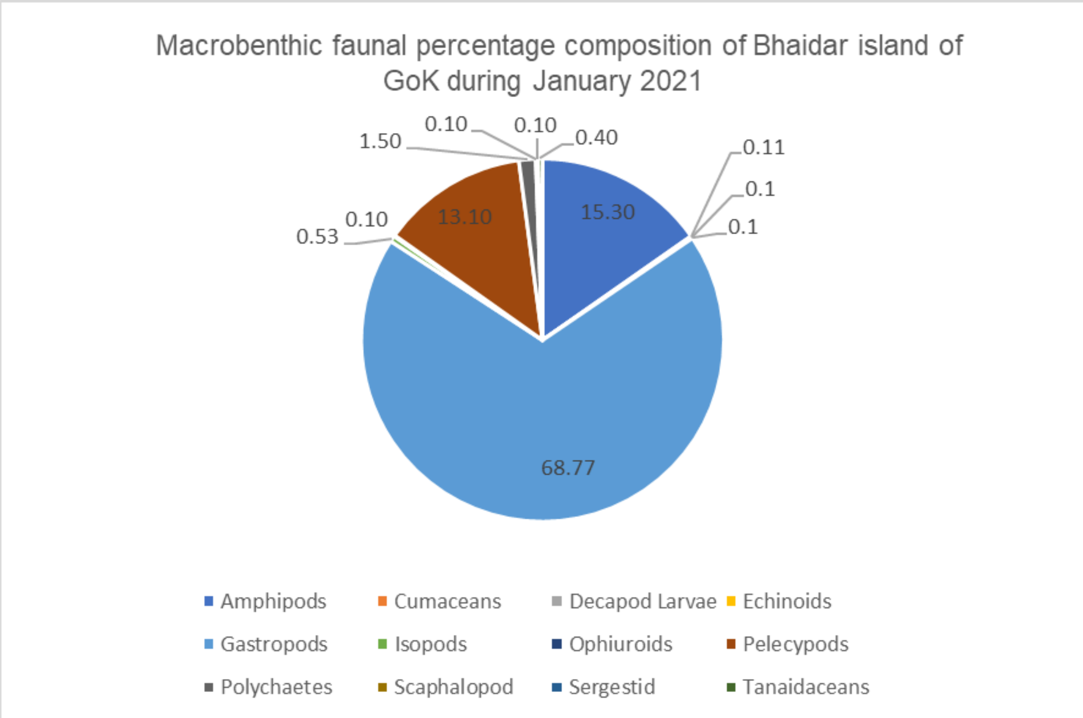


Figure 2.15: Benthic faunal percentage composition of Bhaidar Island, Gulf of Kutch, Gujarat during January 2021

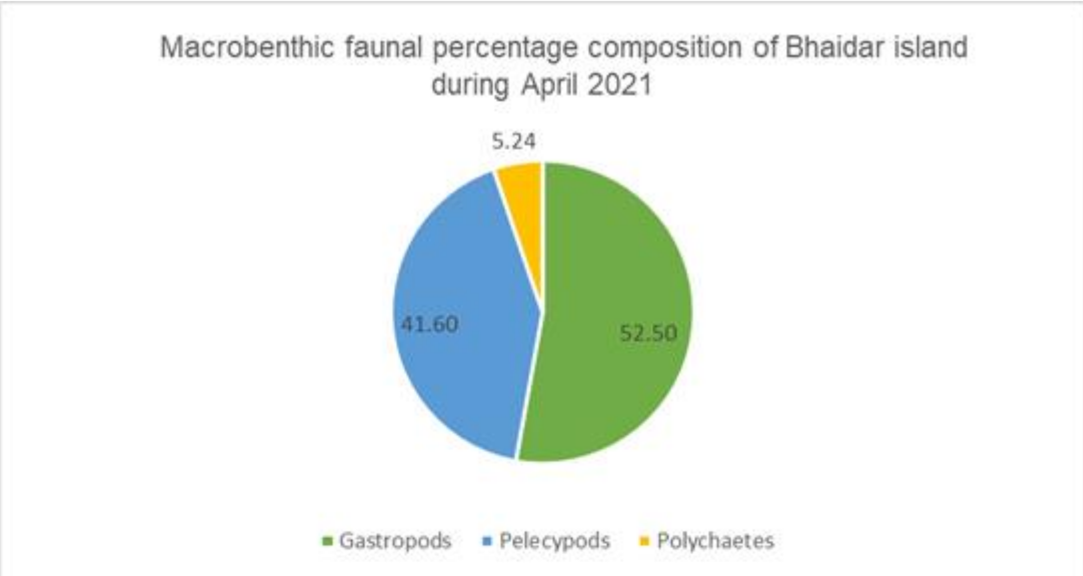


Figure 2.16: Benthic faunal percentage composition of Bhaidar Island, Gulf of Kutch, Gujarat during April 2021

Bhaidar Island, the site shows the highest abundance and Dabdaba Island showed the lowest abundance from December 2020 to May 2021 as shown in (Figure 2.17). Paga reef showed the highest faunal richness and Balapur showed the lowest faunal richness as shown in (Figure 2.18).

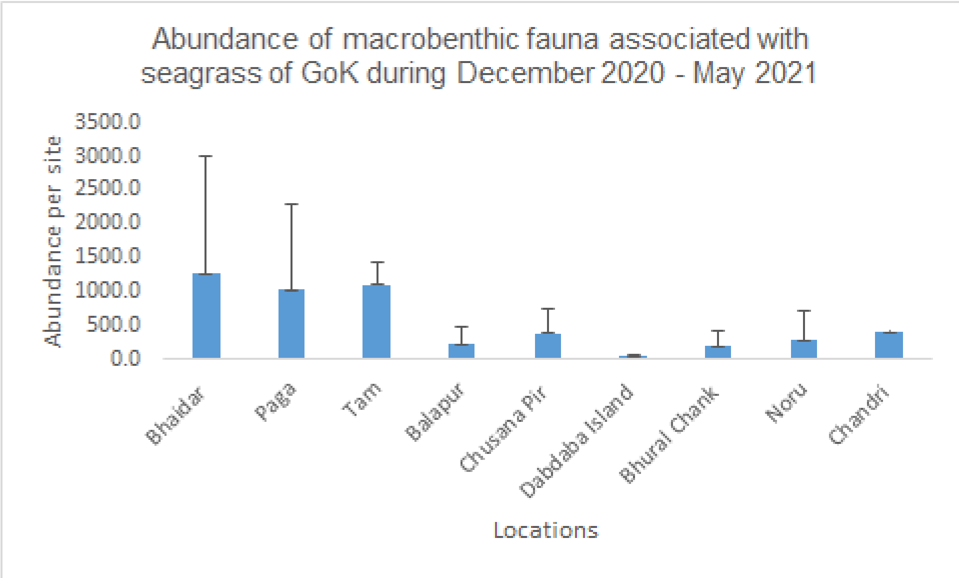


Figure 2.17: Abundance of macrobenthic faunal groups associated with seagrass of Gulf of Kutch, Gujarat during December 2020 – May 2021

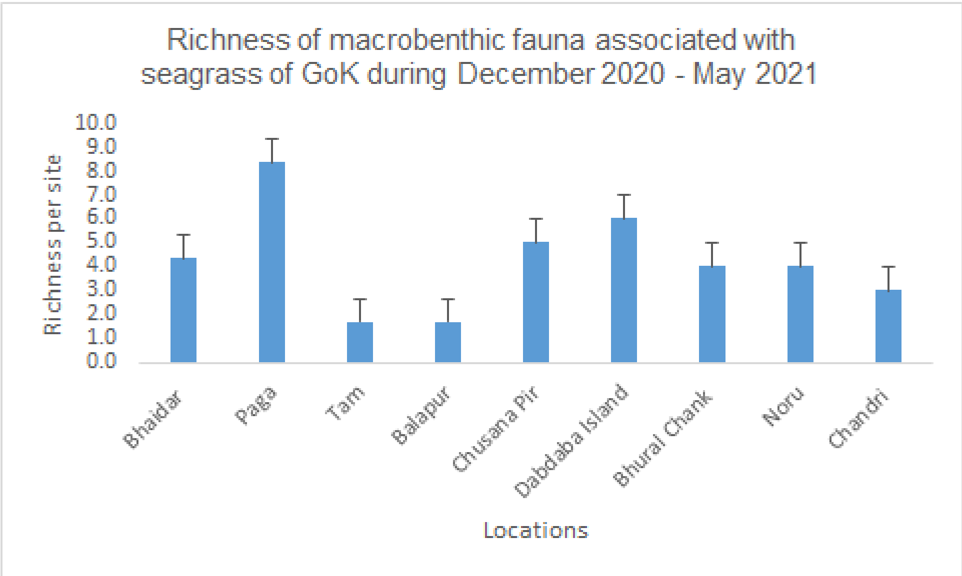


Figure 2.18: Richness of macrobenthic faunal groups associated with seagrass of Gulf of Kutch, Gujarat during December 2020 – May 2021

Figure 2.19: *Nassarius pullus* (Gastropod) and Sea spider Class: Pycnogonida

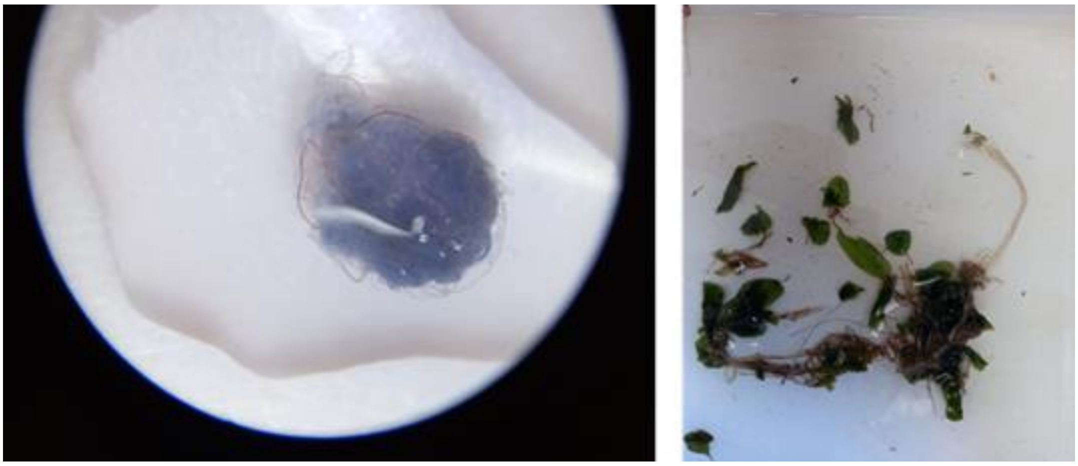


Figure 2.20: Microplastic (filaments of ghost net) in macrobenthic sediment and seagrass samples

Table 2.1: The range and average faunal standing stock and composition of macrobenthos associated with seagrass meadows in Gulf of Kutch, Gujarat

Locations	Parameter		
	Population (no/m^2)	Biomass (g/m^2; wet weight)	Groups (no.)

	Range	Average	Range	Average	Range	Average
Paga Reef	16-1936	534.7	0.0-2727.6	85.12	1-8	8
Tam Reef	16-576	148	0.0-18.72	10.56	3-9	5
Bhaidar Island	16-1728	593.22	0.0-990.20	21.14	3-6	4
Balapur Island	25-1325	207.95	0.0-57.25	6.07	1-2	2
Chusana Pir	50-1275	383.33	0.0-13	8.77	4-6	5
Dabdaba Island	25-225	64.58	0.0-15.75	2.11	4-4	4
Bhural Chank reef	16-1040	191.15	0.0-153.52	11.82	2-6	4
Noru	16-2064	281.04	0.0-447.68	37.07	1-6	4

Table 2.2: List of Polychaetes found during a survey of Gulf of Kutch, Gujarat

SN	List of Polychaetes	Family
1	*Perinereis cultrifera* (Grube, 1840)	Nereididae
2	*Phyllodoce mucosa* Örsted, 1843	Phyllodocidae
3	*Perinereis capensis* (Kinberg, 1865)	Nereididae

4	*Platynereis sp.*	Nereididae
5	*Eunice indica* Kinberg, 1865	Eunicidae
6	*Prionospio cirrifera* Wirén, 1883	Spionidae
7	*Pterocirrus macroceros* (Grube, 1860)	Phyllodocidae
8	*Spiophanes bombyx* (Claparède, 1870)	Spionidae
9	*Scalibregma capensis*	Scalibregmidae
10	*Exogone heterosetosa* McIntosh, 1885	Syllidae
11	*Glycinde capensis* Day, 1960	Goniadidae
12	*Syllis gracilis* Grube, 1840	Syllidae
13	*Ophelina longicaudata* (Caullery, 1944)	Opheliidae
14	*Capitella capitata* (Fabricius, 1780)	Capitellidae

Table 2.3: List of Mollusc found during survey at Gulf of Kutch, Gujarat

SN	***Mollusc***	**Family**
Gastropod		
1	*Pirenella runcate (Gmelin, 1791)*	Potamididae
2	*Turritella runcate (Linnaeus, 1758)*	Turritellidae

3	*Turritella runcate Reeve, 1849*	Turritellidae
4	*Bullia runcat (Linnaeus, 1767)*	Nassariidae
5	*Umbonium vestiarium (Linnaeus, 1758)*	Trochidae
6	*Nassarius conoidalis* (Deshayes, 1833)	Nassariidae
7	*Nassarius castus (Gould, 1850)*	Nassariidae
8	*Oliva sp.*	Olividae
9	*Littoraria scabra* (Linnaeus, 1758)	Littorinidae
10	*Euplica scripta* (Lamarck, 1822)	Columbellidae
11	*Calistoma sp.*	Calliostomatidae
12	*Mitrella blanda* (G. B. Sowerby I, 1844)	Columbellidae
13	*Clypeomorus bifasciata* (G. B. Sowerby II, 1855)	Cerithiidae
14	*Trochus kotschyi Philippi, 1849*	Trochidae
15	*Cerithium coralium* Kiener,1841	Cerithiidae
16	*Rissoina costulata* Dunker, 1860	Patellidae
Scaphalopoda		
1	*Laevidentalium eburneum (Linnaeus, 1767)*	Laevidentaliidae
SN	***Mollusc***	**Family**
2	*Dentalium elephantinum Linnaeus, 1758*	Dentaliidae
Pelecypod or Bivalve		
1	*Mesocibota bistrigata* (Dunker, 1866)	Arcidae

2	*Solen* sp.	Solenidae
	Meretrix meretrix (Linnaeus, 1758)	Veneridae
3	*Donax sp.*	Donacidae

Table 2.4: List of crustaceans found at Gulf of Kutch, Gujarat

SN	List of Amphipods	Family
1	*Gammarus locusta* (Linnaeus, 1758)	Gammaridae
2	*Birubius rostratus* (Dana, 1853)	Phoxocephalidae
3	*Caprella mutica* Schurin, 1935	Caprellidae
4	*Caprella linearis* (Linnaeus, 1767)	Caprellidae
5	*Phoxocephalus holbolli* (Krøyer, 1842)	Phoxocephalidae
6	*Ampithoe ramondi* Audouin, 1826	Ampithoidae
7	*Orchestia gammarellus* (Pallas, 1766)	Talitridae
8	*Harpinia laevis* Sars, 1891	Phoxocephalidae
List of Echinoderm		
1	*Ophioplocus imbricatus* (Müller & Troschel, 1842)	Hemieuryalidae
2	*Jacksonaster depressum* (L. Agassiz, 1841)	Laganidae
List of Isopod		
1	*Cymodoce runcate Leach, 1814*	Sphaeromatidae
2	*Anthura gracilis* (Montagu, 1808)	Anthuridae

Figure 2.21: Macrobenthic groups found during a survey in the Gulf of Kutch, Gujarat 1. Isopods 2. Brachyurans (Crab Family-Portunidae) 3. Sea spider 4. Sponge 5. Gastropod (*Turricula javana*) 6. Brittle star (Ophiuroids) 7. Polychaete 8. Pelecypod (Bivalve) 9. Amphineurans (Chiton) 10. Tube anemone (order Ceriantharia) 11. Sipuncula (Peanut worm) 12. Holothurian (Sea cucumber) 13). Bivalve (Solen sp.) 14. Sergestidae (Prawn) 15. Isopoda (Family- Anthuridae)

Table 2.5: Diversity of macrobenthic faunal group associated with seagrass meadows in Gulf of Kutch, Gujarat during December 2020 – May 2021

SN	**Faunal Groups**	**Bhaidar Island**	**Balapur**	**Tam Reef**	**Chank reef**	**Noru reef**	**Paga Reef**	**Chusana Pir**	**Dabdaba**
Phylum Arthropoda									
1	Amphipods	+	+	+	-	+	+	+	+
2	Anomuran	-	-	-	+	+	+	-	-
SN	**Faunal Groups**	**Bhaidar**	**Balapur**	**Tam**	**Chank**	**Noru**	**Paga**	**Chusana Pir**	**Dabdaba**

		Islan d		**Re ef**	**reef**	**ree f**	**Re ef**		
3	Tanaidaceans	+	-	+	-	+	+	-	-
4	Brachyuran	-	+	+	-	+	-	-	-
5	Isopod	-	-	+	-	+	+	+	-
6	Cumaceans	+	-	+	+	+	+	-	-
7	Decapod (Unid)	+	-	+	-	+	+	-	-
8	Marine Insect	-	-	+	-	-	-	-	-
9	Pycnogonida	-	-	+	-	-	+	-	-
	Phylum Echinodermata								
1	Echinoids	+	-	-	-	-	-	+	-
2	Holothuroidea	+	-	+	-	-	+	-	-
3	Crinoidea	-	-	-	-	-	-	+	-
4	Ophiuroids	+	-	+	-	-	+	-	-
5	Asteroidea	-	-	-	-	-	-	-	-
	Phylum Sarcomastigophora								
SN	**Faunal Groups**	**Bhaidar Island**	**Balapur**	**Tam Reef**	**Chank reef**	**Noru reef**	**Paga Reef**	**Chusana Pir**	**Dabdaba**
9	Foraminifera	-	-	+	-	-	+	-	-

Phylum Nematoda									
1	Nematode	-	-	-	+	+	-	-	-
Phylum Mollusca									
1	Gastropods	+	+	+	+	+	+	+	+
2	Pelecypods	+	+	+	+	+	+	+	+
3	Polyplacoplaco phora	-	-	-	-	+	+	-	-
4	Scaphalopod	+	+	-	-	-	+	-	-
Phylum Annelida									
1	Polychaetes	+	-	+	+	+	+	+	+
2	Oligochaete	-	-	-	-	-	+	-	-
Phylum Porifera									
1	Porifera	+	-	+	-	-	-	-	-
Phylum Sipuncula									
1	Sipuncula	-	-	-	-	-	-	+	+
Note: + : Present , -: Absent									

2.1.3 Threat mapping of Critical Dugong Habitats

Introduction

Human activities that may threaten dugong populations directly or indirectly include net entanglement, habitat destruction, fishing pressure, vessel strikes, hunting or poaching, uncontrolled mariculture and tourism, coastal development, and industrial activities that cause water pollution, are the major threat to Dugongs and their habitats (Marsh *et al.*, 2012). The main objective of threat mapping is to quantify density threats in terms of boat traffic and plastic litter and to assess the distribution pattern of these threats with seasonal changes (Winter: December 2020 to February 2021, Summer: March 2021 to May 2021).

Study area

The present study was carried out across critical dugong habitats of marine national parks and marine sanctuary areas situated in the southwestern part of the Gulf of Kutch, Gujarat. Around 1190 Square Kilometers area from 22°30’24.11”N to 69° 8’0.31”E has been covered.

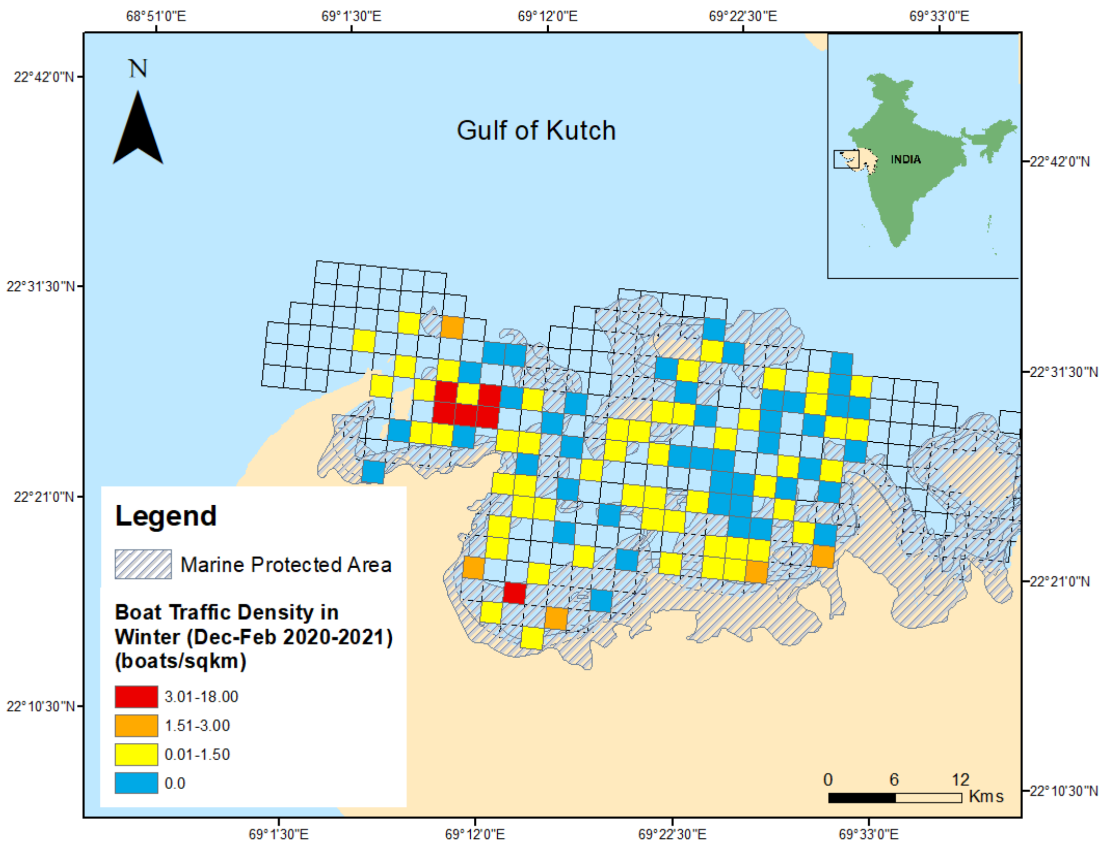
Methodology

A grid-based distance sampling approach was used, where grids of 2X2 km were divided as near and offshore grids. At each point in the selected grid, a 360º point count method was followed, by scanning an area of 1 km for 10 minutes, to document threats in terms of boat traffic, plastic pollution, and animal activities. A total of 109 grids were randomly sampled in winter and repeated in summer. Parameters like distance of the subject (boat, Marine megafauna, marine litter, etc.) from the observer’s boat, angle of spots, types of the boat (fishing/ ferry/ cargo vessels), and size (in case of plastic litter) was recorded along with GPS location. Additionally, variables like the depth of the water column and environmental variables (pH, Dissolved Oxygen, Temperature, and Salinity) were also recorded. A Van-Veen grab was used to confirm the presence and absence of seagrasses with sediment collection. Total 61 samples of sediments and 10 samples of seagrasses were taken for nutrient and pollutant analysis that will be analyzed in the future.

Results and discussion

Spatial sampling of threat assessment was carried out in the Southwestern part of the Gulf of Kutch, Gujarat in December- February 2020-2021. These grids were resampled in March-May 2021 to understand the difference in temporal scale.

The average fishing boat traffic was low in the winter season (83%) compared to summer (91%). Comparison with spatial replicates showed a slightly higher density of boat traffic localized around Bet Dwarka and Pindara in both seasons (Figure 2.22 and 2.23). Collectively a varied nature of boat traffic was observed for both the spatial replicates. 13% of the total boats observed were ferry vessels in the winter season and it was at 3% in summer, and the remaining proportion of the cargo ship and defence patrolling vessels



(Figure 2.24).

Figure 2.22: Density of boat traffic in and around Gulf of Kutch Marine National Park, Gujarat in winter 2020- 2021

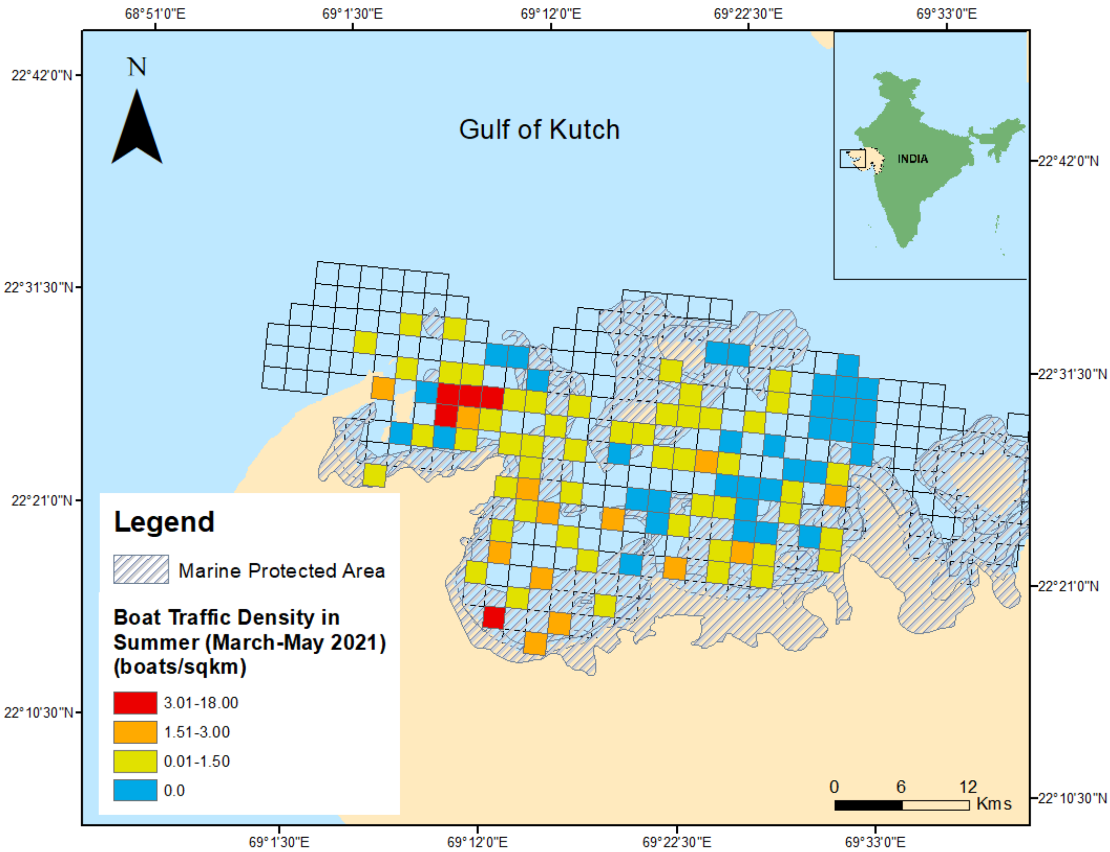


Figure 2.23: Density of boat traffic in and around Gulf of Kutch Marine National Park, Gujarat in summer 2021

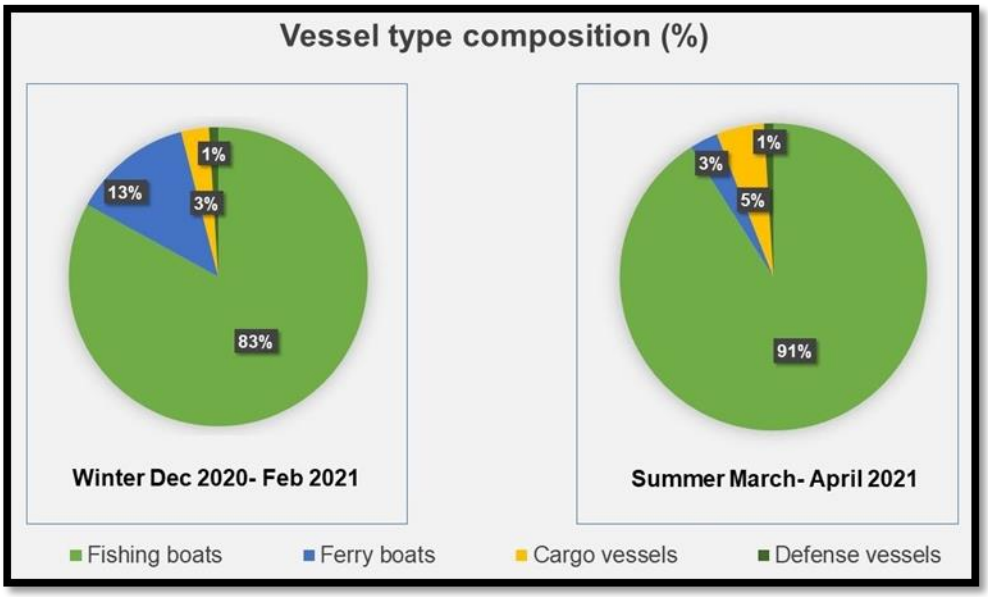


Figure 2.24: Comparison of the composition of vessels found across the Gulf of Kutch Marine National Park Gujarat between winter and summer season

In the case of plastic litter, winter 2020-2021 had comparatively less litter distribution as compared to summer 2021. (Figure 2.25 and 2.26) Comparison with spatial replicates showed a higher proportion of plastic wrappers and bags in summer (45%) than winter (29%). Ghost nets, discarded fishing nets, and buoys are almost in the same proportion in both seasons. (Figure 2.27)

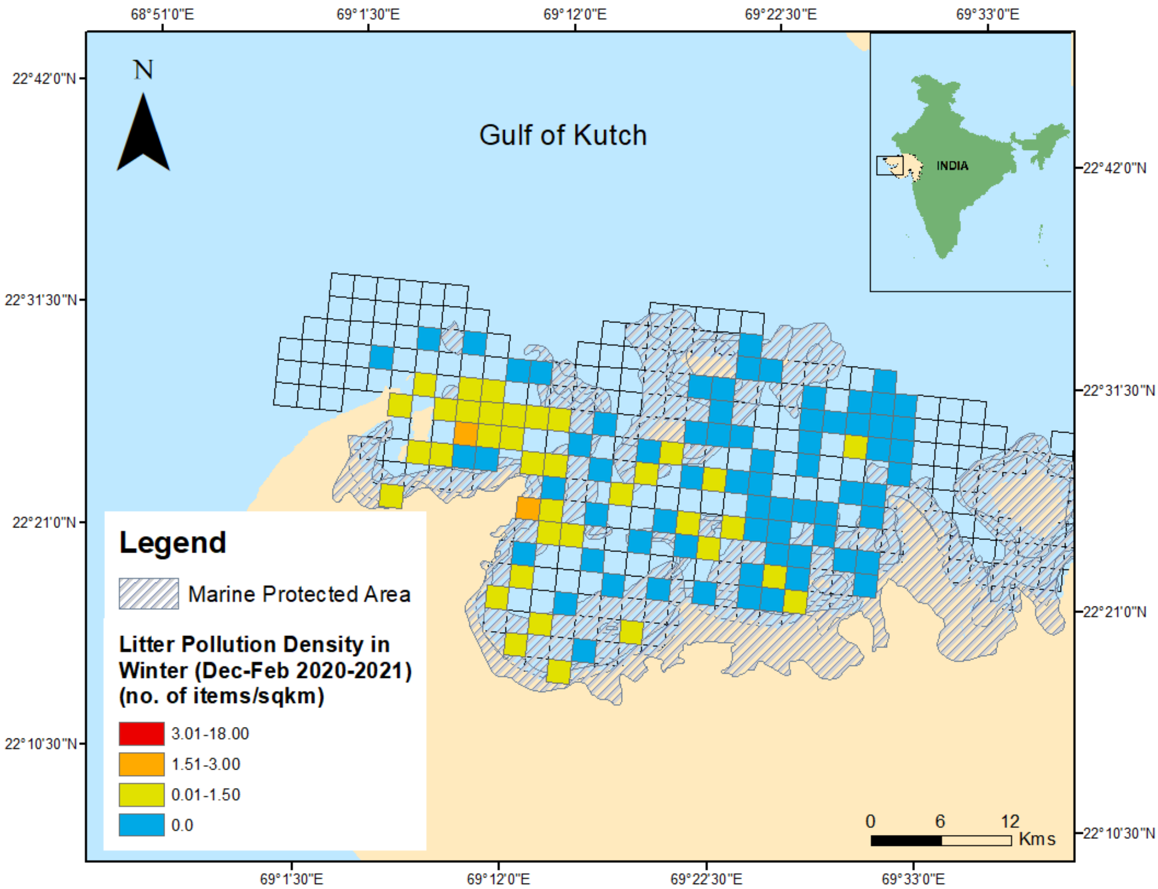


Figure 2.25: Density of macro-litter pollution found in and around Gulf of Kutch Marine National Park, Gujarat in winter 2020- 2021

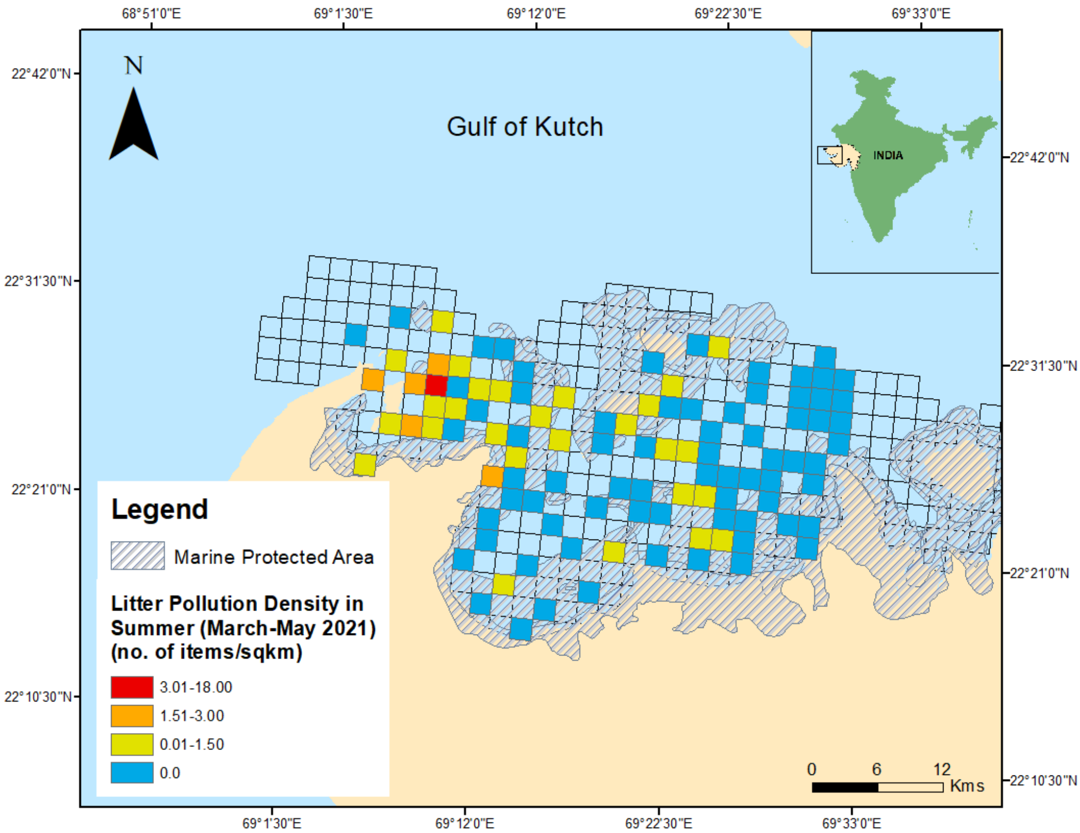


Figure 2.26: Density of macro-litter pollution found in and around Gulf of Kutch Marine National Park, Gujarat in summer 2021

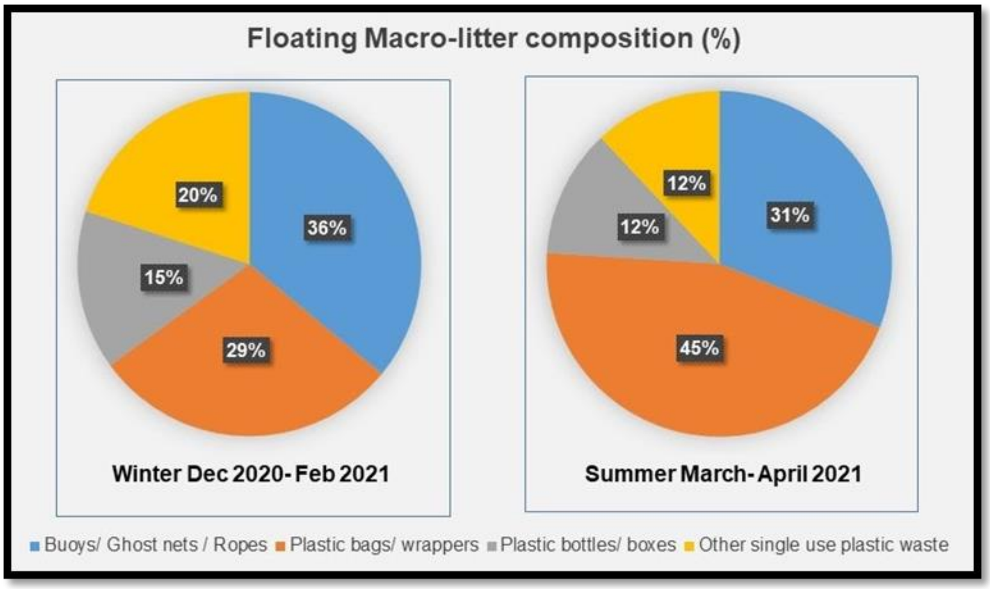


Figure 2.27: Comparison of the composition of floating macro litter percentage across the Gulf of Kutch Marine National Park, Gujarat between winter and summer season

Figure 2.28: Ghost nets in surveyed regions of Marine protected area Gulf of Kutch, Gujarat

Figure 2.29: Macro-plastic in surveyed regions of Marine protected area Gulf of Kutch, Gujarat

Figure 2.30: Vessel types (line of trawlers and cargo ship) in surveyed regions of Marine protected area Gulf of Kutch, Gujarat

2.1.4 Underwater survey for the assessment of seagrass meadows

Seagrass habitat assessment study conducted in Mithapur- Arambada coast from February – March 2021. Underwater surveys were conducted using GoPro6 at 15-point locations generating a large number of images and videos. A comparison of video still images with data derived from diver observations indicates consistent results in terms of the presence and absence of seagrass on the seafloor in these two months. A systematic sampling method and extensive diving are suggested to map the extent of a seagrass meadow in this region.

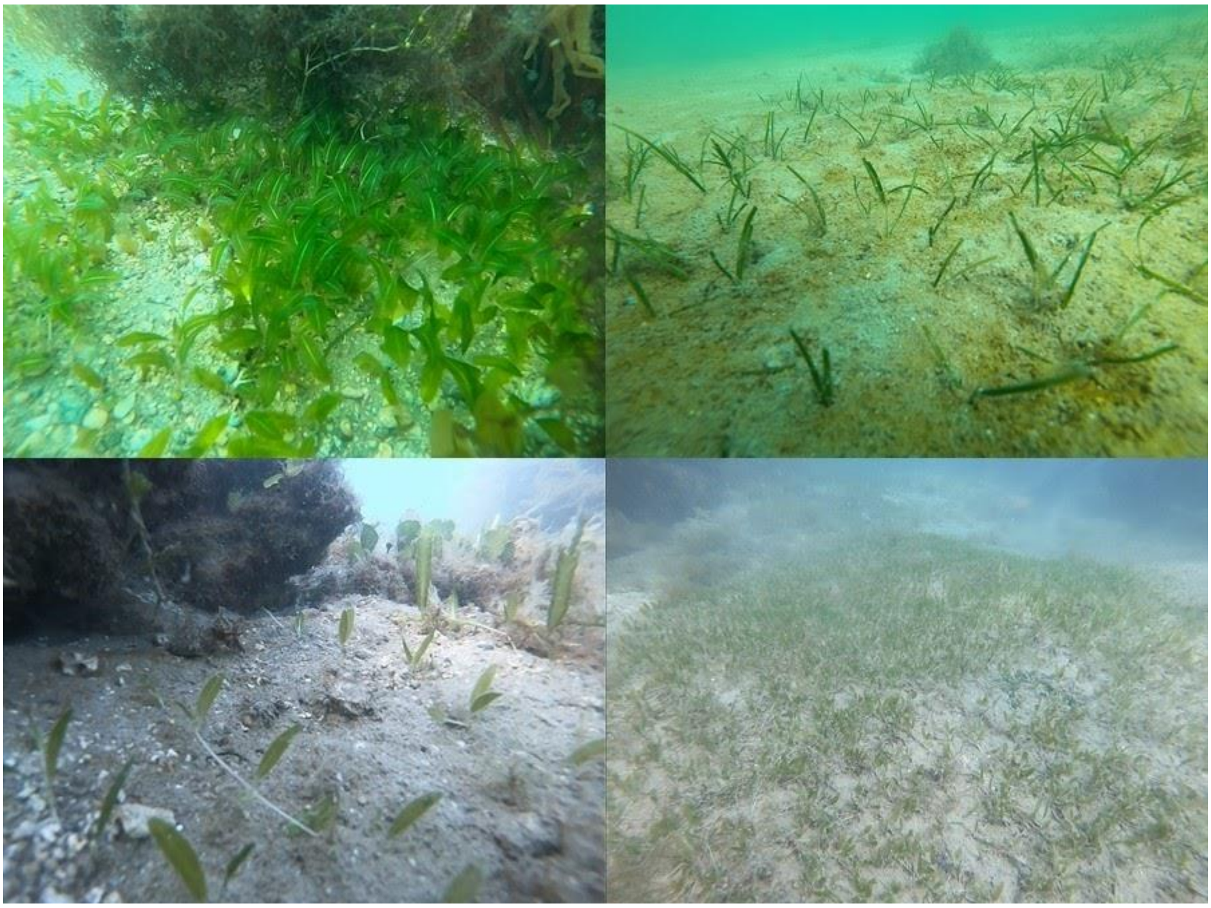


Figure 2.31: Subtidal seagrass meadows at Mithapur- Arambada area, Gujarat.

2.1.5 An Assessment of Heavy Metal Contamination on the Surface Sediment of Seagrass beds of Gulf of Kutch, Gujarat

During the study period, sediment samples were taken at a depth of 0-5 cm from the surface in each sampling site. Three replicates were collected at each site. The sediment was kept in acid-washed polyethylene bags. Seagrasses were washed thoroughly with ambient water to remove sediment, debris, and associated fauna. Cleaned seagrasses were placed in acid-washed polyethylene bags and transported to the laboratory in an icebox. The samples will be analyzed for heavy metal contamination collaboration with the Indian Institute of Technology (IIT), Roorkee.

This study will provide baseline data for heavy metal exposure in seagrass meadows of Dugong's critical habitat in Marine National Park, Gujarat.

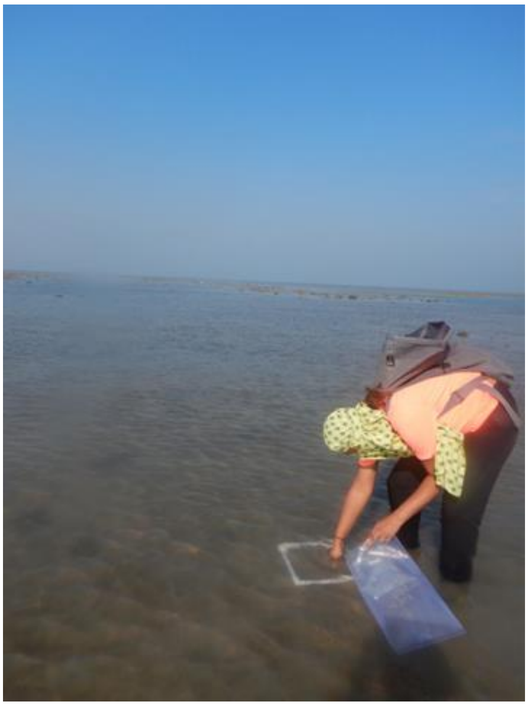


Figure 2.32: Collection of samples for heavy metal analysis near Noru Island, Gulf of Kutch, Gujarat

2.1.6 Interview surveys

Interview surveys were conducted at Dalda port and Arambhada. Since the fish population has been decreasing, fishers of the gulf are forced to venture into the open sea. Common fish-catches this season were Silver pomfret, Indian mackerel, Tuna, Croaker, seer fish, sailfish, conger eel, Dolphinfish, grey mullet, unicorn leather jacket, grouper, and blacktip shark. Illegal fishing practices like beach seines are still in use around reefs of Bhaidar, Paga, and Nor. These fishing practices are mostly chosen by small-scale fishermen via gillnetters. Most shallow-water fishers were sensitive to the entanglement issue of dolphins, dugongs, and green sea turtles. Several incidences of fishers releasing entangled animals were observed. The relationship between the number of entanglement incidences and fishing practices/efforts will be studied in the coming season to check for any reasonable patterns.

Figure 2.33: Interview surveys conducted in Gulf of Kutch, Gujarat

2.1.7 Dugong feeding trails

Dugong feeding trails were observed and reported at Narara by the Gujarat Forest department. Previously Apte *et al.*, 2019 have recorded feeding trails of Dugong on the *Halodule uninervis* meadow in the Gulf of Kachchh, i.e., northwestern part of India. Most of the records of this species from this area are stranding records.

Figure 2.34: Dugong feeding trails at Narara, Gulf of Kutch, Gujarat

2.1.8 Records of marine megafauna sightings and stranding off Gujarat coast

- **Marine turtle stranding**

1. One carcass of a female green sea turtle (*Chelonia mydas*) was observed during a field survey near Manmarudi Island on 08.12.2020.

Figure 2.35: Carcass of dead green sea turtle observed during field survey at Gulf of Kutch, Gujarat

2. One adult Green sea turtle (*Chelonia mydas*) around 1.5-meter long adult green sea turtle was found stranded on Okha beach near the lighthouse on 14th April 2021. The reason for its death is unknown. Tissue samples of backbone vertebra, gut, and dermal skin have been collected for further analysis.

Figure 2.36: Carcass of Dead Sea turtle washed ashore Okha beach, Gujarat

3. One adult green sea turtle (*Chelonia mydas*) was stranded at Shivrajpur beach on 14th May 2021. The carcass was old and the carapace broken. Viscera was still contained inside the body cavity. The cause of death is unknown.

Figure 2.37: Green sea turtle stranded on Shivrajpur beach, Gujarat

4. Rescue of sea turtle entangled in a fishing net

Dugong volunteering team shared information on the sea turtle rescue in February 2021 which was successfully released back into the sea.

Figure 2.38: Trawler crew trying to release one of the caught turtles by lifting it using a rope tied to its hind flipper at Gulf of Kutch, Gujarat

5. One carcass of an adult Green sea turtle was observed in Bhaidar Island during a field survey in December 2020.

6. Stranding of Dwarf Pygmy sperm whale near Dwarka coast

One female Pygmy sperm whale (*Kogia breviceps*) washed ashore on the Dwarka coast on 7th June 2020 and was reported by Dwarka Range Forest Officer Mr. Kamlesh Chudasama. The tissue samples were taken by the forest department. This is the 2nd record of stranding of Dwarf Pygmy sperm whales on the Gujarat coast after 2006.

Figure 2.39: Dwarf Pygmy sperm whale stranded along Dwarka coast, Gujarat

- **Dugong sighting**

A mother-calf pair was spotted near the western nor reef on 17th March 2021. Unfortunately, no pictures could be taken as the animals surfaced for a second or two on a very choppy sea.

- **Dolphin sighting**

The pod of Indian Ocean Humpback dolphins is often sighted near Samiyani, Beyt-Dwarka, Paga, Marudi, Bhaidar, and Noru Islands during boat surveys. Local tourist campsites are increasing boat safaris for Dolphin watching near Beyt- Dwarka, and Paga which causes an increase in plastic pollution around these Islands.

Figure2.40: Indian Ocean Humpback Dolphin sighted in the south-western part of Marine National Park of the Gulf of Kutch, Gujarat

2.2 AWARENESS & OUTREACH

In the field season 2020-2021, a total of 21 outreach and awareness activities were conducted to inform people of the species, its importance, and major project activities to the school and college students, teachers, locals, and fishermen. Out of 21 events, 12 events were conducted for awareness and scholarship and 9 meetings were conducted with different stakeholders like the forest department, marine police, and head of various schools to involve them in the conservation activity, as the involvement of local people is very crucial for any species conservation. The purpose of outreach activities was to sensitize our important stakeholders about the importance of marine biodiversity (flora and fauna), the role and importance of seagrass and Dugong habitats in the marine ecosystem. The major threats to biodiversity were also addressed to the people. Dugong comic books and pamphlets were distributed in the schools where awareness events and scholarship programs were continued, as pictorial guides are a helpful and effective measure to convey an important message to common people.

Table 2.12: Details of outreach and awareness activities conducted in different areas of the Gulf of Kutch, Gujarat in the year 2020-21

SN	Location	Date	Name of event	Type of stakeholders	The total no of people who attended the events
1	Okha	5th June 2020	World environment day	School students and teachers	11
2	Okha	8th June 2020	World ocean day	School students and teachers	24
3	Dwarka	30th November 2020	Meeting stakeholder	Forest officials	2

SN	Location	Date	Name of event	Type of stakeholders	The total no of people who attended the events
4	Okha	22nd December 2020	State-level Webinar	College students and teachers	800
5	Jamnagar	03 December 2020	Meeting stakeholder	DCF	2
6	Okha	30th November 2020	Meeting stakeholder	Marine Police	1
7	Okha coast guard district headquarter	30 November 2020	Meeting stakeholder	District Commanding officer	1
8	Fisheries Research Station Okha	02 December 2020	Meeting stakeholder	Senior research officer	2
9	Okha	26th January 2021	Republic day celebration	Research staff	6
10	Okha	22nd February 2021	Awareness program	School students and teachers	20
11	Okha	24th February 2021	Webinar	College students and teachers	85
12	Okha	25th	Science day	School students	25

		February 2021		and teachers	
13	Okha	26th February 2021	Awareness program	School students and teachers	19
SN	**Location**	**Date**	**Name of event**	**Type of stakeholders**	**The total no of people who attended the events**
14	Okha	26th February 2021	Live webinar	National and international people	694
15	Beyt Dwarka	15th January	Meeting stakeholder	School Teacher and principle	3
16	Beyt Dwarka	20th February	Meeting stakeholder	School Teacher and principle	3
17	Jamnagar	3rd March 2021	Meeting stakeholder	DCF	1
18	Bhimrana	14th March 2021	Awareness program	Fishermen	22
19	Okha	19th March 2021	Webinar	College students and teachers	53
20	Surajkaradi	4th April 2021	Awareness program	Fishermen	20
21	Okha	28th April 2021	Meeting stakeholder	Fisheries officers	2

1. World environment day celebration organized by local school

Date: 5th June 2020

Venue: Okha

The program was organized by Nagar Palika Sanchalit Okha High school teacher Pooja Dave and her NGO, 11 students attended the program 6th to 12th std from two schools K.V Okha Port and O.N.P.S Highschool, Nagar. The students presented a small project as an initiative towards environmental protection.

2. World ocean day

Date: 8th June 2020

Venue: Okha beach

A beach is a sensitive environment that supports numerous plants and animals. All of these benefits, of course, depend on our coasts being safe and healthy. The beach clean-up is essential because it improves the coastal and ocean ecosystem. The coastal clean-up drive was undertaken by local 24 Dugong ambassadors.

3. State-level Webinar on 'Conservation of Dugongs and Their Habitats in Gulf of Kutch, Gujarat

Date: 22nd December 2020

Venue: Okha

One state-level webinar on Conservation of Dugongs and Their Habitats in Gulf of Kutch, Gujarat.' Along with D.K.V. Arts college of Jamnagar. Around 800 Students, Researchers of college attended the webinar and were enlightened about the conservation measures in Gujarat. E-certificates were provided to the registered participants.

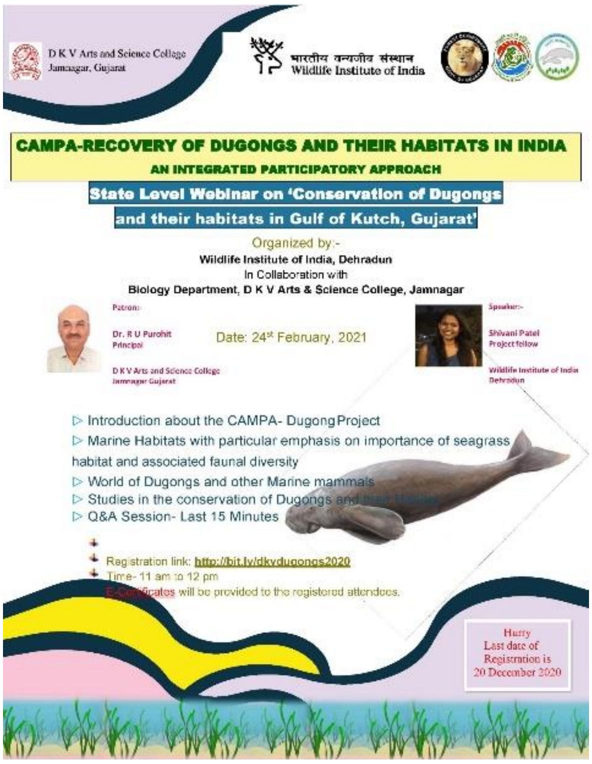


Figure 2.41: Flyer for the Gujarat state level workshop

4. Independence day celebration

Date: 26th January 2021

Venue: Okha

Republic day was celebrated with the Fisheries Research Station, Okha on 26th January 2021.

5. Awareness program for Saraswati Shishumandir Primary School, Okha

Date: 22nd February 2021

Venue: Okha

A total of 20 students of 6th to 8th std. of Saraswati Shishumandir Primary School at Okha were sensitized about Dugongs and their habitat, other marine mammals, plastic pollution, and other threats to marine life. Outreach material, Notebooks, and storybooks have been given to students on 22nd February 2021.

7. Webinar series for Fisheries College of Veraval Junagadh Agriculture University

Date: 24th February 2021

Venue: Okha

Webinar on "Conservation of Dugongs and their habitats in Gulf of Kutch, Gujarat" with Fisheries college of Veraval, Junagadh Agriculture University. A total of 73 participants were registered and e-certificates were given to those participants on 24th February 2021.

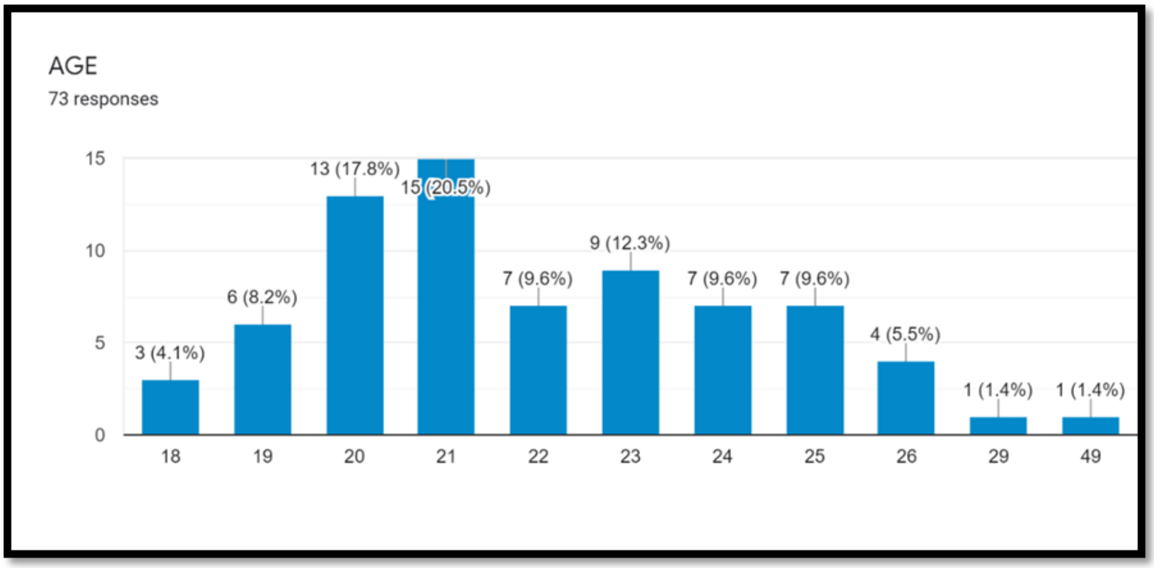


Figure 2.42: Age composition of the webinar respondent

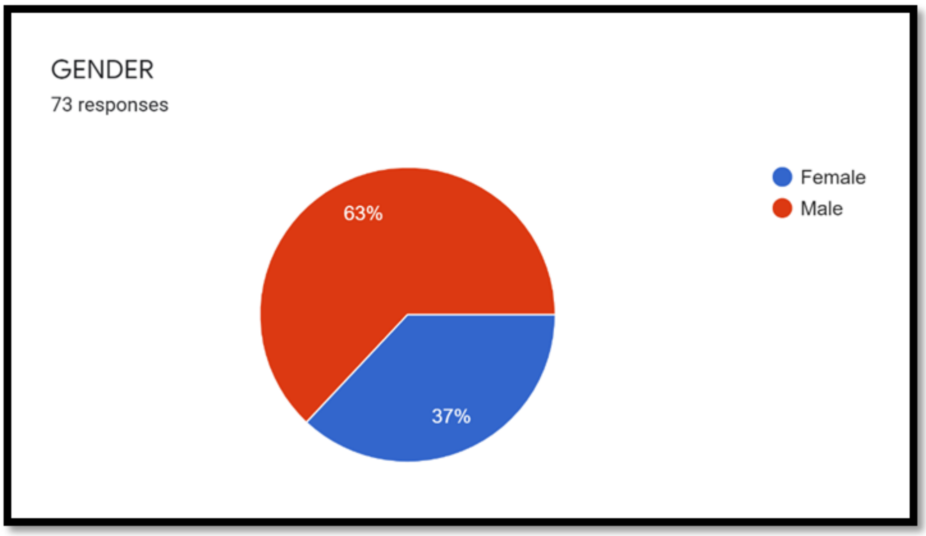


Figure 2.43: Gender composition of the webinar respondent

8. Science day program at Okha Nagar Palika Sanchalit High school, Okha

Date: 25th February 2021

Venue: Okha

We conducted an awareness lecture on birds for the upcoming occasion of Science day with a special emphasis on marine birds one of our volunteers, Mr. Ronak Maradiya, briefed students about marine birds. A total of 25 students of the 8th std. of Okha Nagarpalika School was sensitized about Sea birds, plastic pollution, and other threats to marine birds. Outreach material, Notebooks, and storybooks have been given to students on 25th February 2021.

9. Awareness program at Bansi School, Okha

Date: 26th February 2021

Venue: Okha

A total of 19 students of 6th std. of Bansi School of Okha was sensitized about Dugongs and their habitat, other marine mammals, plastic pollution, and other threats to marine life. Outreach material, Notebooks, and storybooks have been given to students on 26th February 2021.

10. Live webinar with Wildlife Awareness Network

Date: 26th February 2021

Venue: Okha

Live webinar on the Facebook page about Marine mammals: Dugong in collaboration with Wildlife Awareness Network on 26th February 2021. A total of 683 viewers have seen the webinar till now.

11. Fisherman community workshop

Date: 14th March 2021

Venue: Bhimrana

A total of 22 fishermen of Bhimrana village were sensitized about Dugongs and seagrass ecosystem, clues for Dugong's feeding trials to detect their presence and threats to marine mammals on 14th March 2021. We distributed masks, t-shirts along with awareness pamphlets. Few of the fishermen told us about the past records of seagrass location near Bhimrana.

12. Webinar for Sardar Patel University, Aanand

Date: 19th March 2021

Venue: Okha (Webinar)

Webinar on "Conservation of Dugongs and their habitats in Gulf of Kutch, Gujarat" with Sardar Patel University, Aanand. The session was attended by graduates, postgraduates, and faculty members. A total of 58 participants were registered and e-certificates were given to those participants on 19th March 2021.

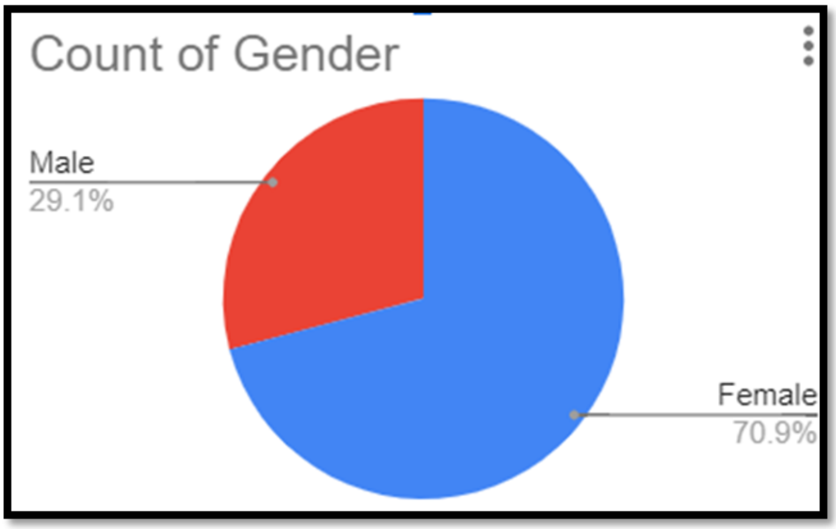


Figure 2.44: Gender percentage of the webinar participants

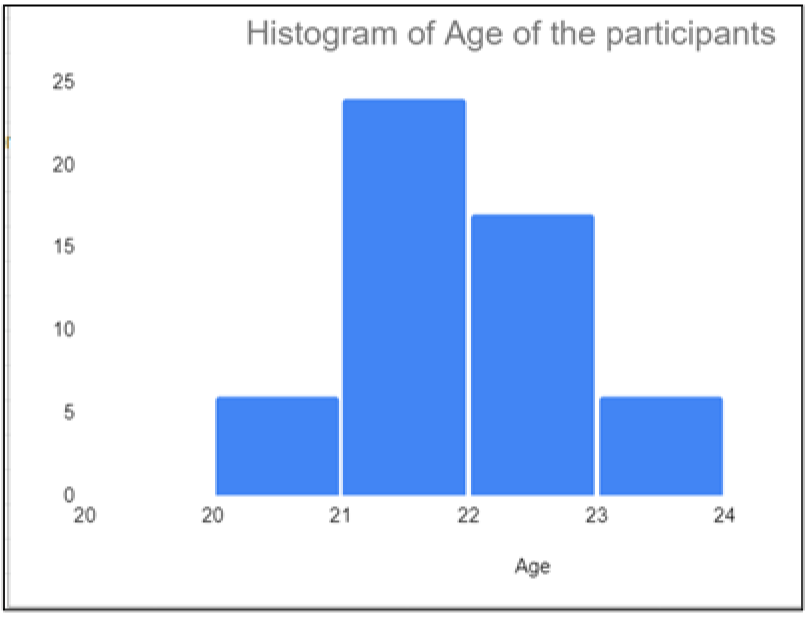


Figure 2.45: Age class of the webinar participants

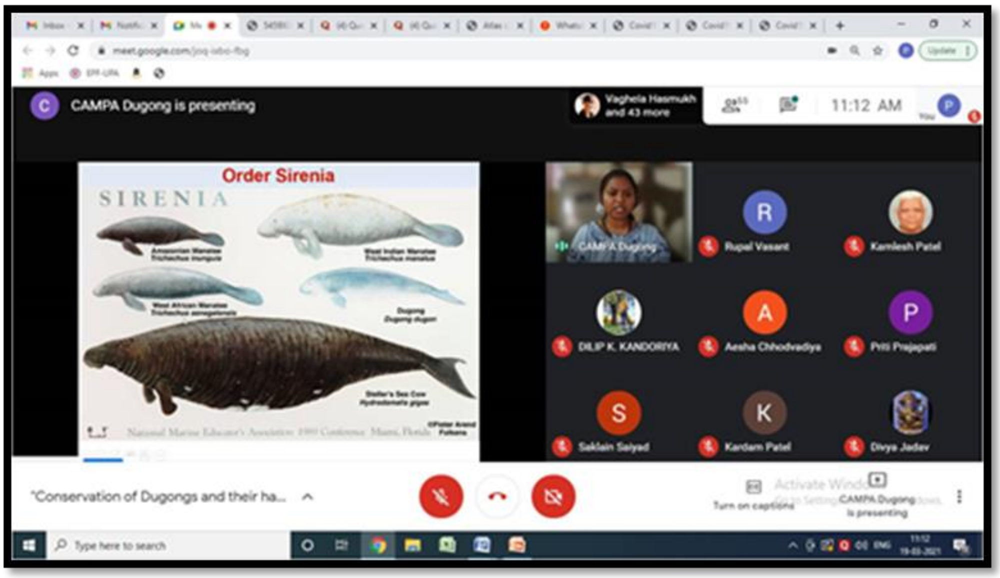


Figure 2.46: Webinar for Sardar Patel University, Anand, Gujarat

13. Community workshop

Date: 4th April 2021

Venue: Surajkaradi

Total 20 fishermen of Mithapur and Surajkaradi villages were sensitized about Dugongs and seagrass ecosystem, clues for Dugongs feeding trails to detect their presence and threats to marine mammals on 4th April 2021. We distributed masks, t-shirts along with awareness pamphlets. The fishermen told us about the seagrass location near Mithapur and illegal fishing activities in the Mithapur- Arambada area.

Figure 2.47: Glimpse of outreach activities conducted at Gujarat

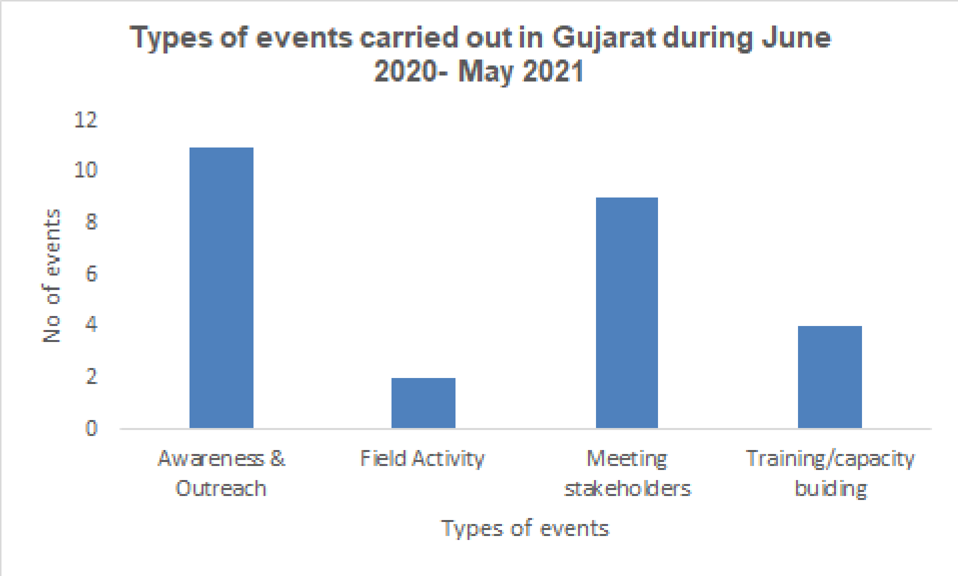


Figure 2.48: Details of various events conducted at Gujarat during the field season

In this field season 2020-21, school and college students were targeted as the children in the learning phase and understanding phase are our supreme stakeholders, the involvement of children is beneficial to save the species in the longer run. The second highest targeted stakeholders were locals as the knowledge and experience of fishermen and locals is important to conserve the species on the ground. Figure 2.49 shows a percentage of stakeholders targeted in the last two field seasons.

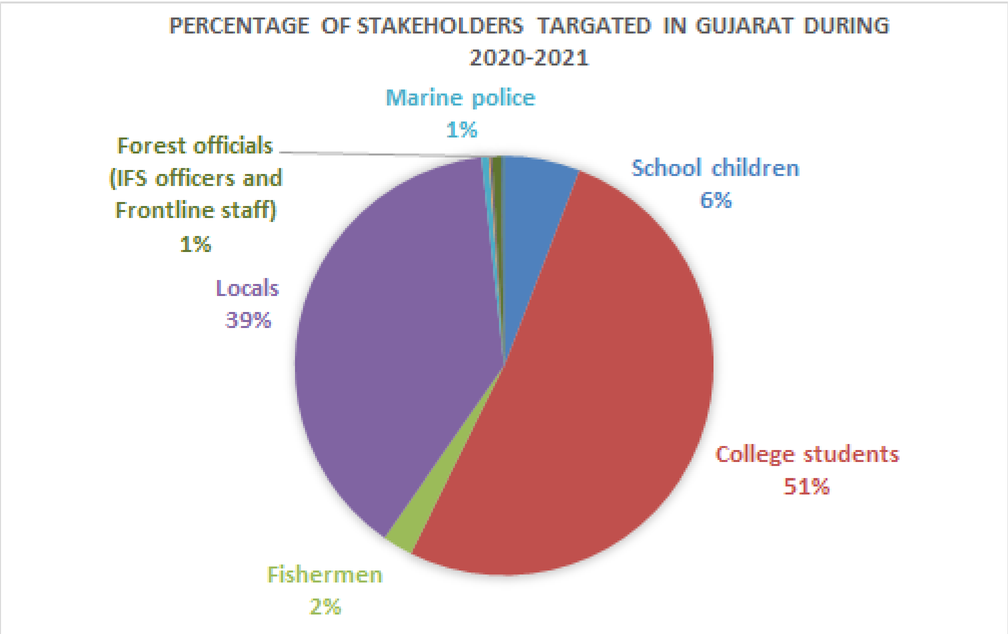


Figure 2.49: Percentage of stakeholders targeted in the year 2020-21

- **Paintings by Dugong volunteers**

Project Volunteer Ms. Chitrangee Bose recreated wall painting for creating awareness, and the team similarly painted marine life for creating awareness among locals.

Figure 2.50: Wall painting by Dugong volunteer at Okha beach, Gujarat

- **Dugong Scholarship Programme**

A unique participatory program, the Dugong Scholarship Scheme was initiated to engage local fisherfolk communities at the grass-root level. This program targets school-going children of local fisherfolk communities and provides them with a scholarship of Rs. 500 / month for two years to support their education. The motive behind the Dugong Scholarship program is to encourage the fisherfolk students to study and financially help them. This scheme has helped us to build a strong network of informants. The beneficiaries are selected through the competitive written examination followed by several participatory programs conducted at schools to raise awareness about Dugong and seagrass conservation. In Gujarat, we have completed three years of this program from July 2017 to July 2021. Due to the pandemic, we couldn't conduct any offline examination. Till now 208 students have been awarded this scholarship and the students selected under this program are identified as Dugong ambassadors. The list of Dugong ambassadors is attached as annexure III.

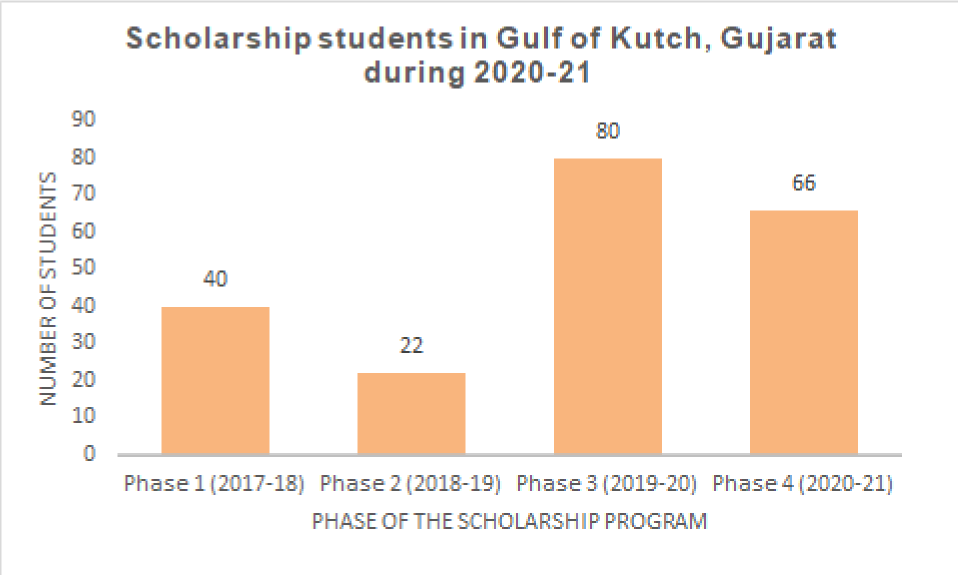


Figure 2.51: Number of scholarship students over three years in Gulf of Kutch, Gujarat

Table 2.13: Details of Dugong scholarship programs in Gujarat

School Name	Village/ Town	District	Students Phase 1 2017-2018	Students Phase 2 2018-2019	Students Phase 3 2019-2020	Students Phase 4 2020-2021
Mithapur High school	Mithapur	Devbhumi Dwarka	3	5	4	4
Swaminarayan Highschool	Beyt Dwarka	Devbhumi Dwarka	0	8	7	3
OkhaGrampanchayat High School and Higher Secondary School	Okha	Devbhumi Dwarka	6	7	10	4
PVM Girls Highschool High School and Higher Secondary School	Dwarka	Devbhumi Dwarka	8	2	8	7

NDH School	Dwarka	Devbhumi Dwarka	1	0	0	0
Government High School- Vasai	Vasai	Devbhumi Dwarka	9	0	0	0
Government High School- Bharana	Bharana	Devbhumi Dwarka	13	0	0	0
Shri Karmayog Madhyamik Shala	Varvala	Devbhumi Dwarka	0	0	5	4
Shree Dwarka Taluka School 1	Dwarka	Devbhumi Dwarka	0	0	1	1
Shree Varvala Wadi Primary School	Varvala	Devbhumi Dwarka	0	0	11	11
School Name	**Village/ Town**	**District**	**Students Phase 1 2017-2018**	**Students Phase 2 2018-2019**	**Students Phase 3 2019-2020**	**Students Phase 4 2020-2021**
RMSA Government Highschool Vasai	Vasai	Devbhumi Dwarka	0	0	3	3
Okha Primary School	Okha	Devbhumi Dwarka	0	0	13	13
Shree Varvala Primary School	Varvala	Devbhumi Dwarka	0	0	7	6
Shree Rupen Bandar Primary School	Varvala	Devbhumi Dwarka	0	0	11	10
Total			**40**	**22**	**80**	**66**

2.3 CAPACITY BUILDING PROGRAMS CONDUCTED AT GUJARAT

Table 2.14: Details of capacity building programs conducted in different areas of Gujarat in the year 2020-21

SN	Location	Date	Name of the event	Type of stakeholders	No people attended the event
1	Poshitra	16th December 2020	Special training course on hands-on training of drone operation with forest department staff	Forest department officials	5
2	Jamnagar	23rd December 2020	Special training course on hands-on training of drone operation with forest department staff	Forest department officials	5
3	Samiyani	24th January 2021	Training program for sightings and recording marine mammals	Marine commando officers (Marine Police)	5
4	Chushnapir Island	8th March 2021	Training program for sightings and recording marine mammals	Navy and Marine commando officers (Marine Police)	6

1. Special training course on hands-on training of drone operation with forest department staff

Date: 16-24 December 2020

Venue: Poshitra and Jamnagar

Mr. Sagar Rajpurkar introduced the participants to UAVs, their use in Wildlife Conservation and monitoring, and detailed information regarding drone specifications. He and Gem Chistrian conducted training sessions to operate the application for drone use, arming and disarming the aircraft, and briefing about the application use. Drone flight demonstrations were given to participants. All participants took independent flights, following a prior instructed path, and operated the drones. RFOs of Dwarka and Bhatiya range of Gujarat forest department the workshop at Poshitra and Jamanagar on 16-24 December 2020.

2. Training program for sightings and recording marine mammals

Date: 24 January 2021 and 8th March 2021

Venue: Samiyani Island, Chusana Pir, Poshitra

Ms. Shivani Patel and Mr. Gem Christian trained five marine commando officers of Okha Marine Police and two Navy officers too for sightings and recording marine mammals. Logbooks and other outreach materials were distributed.

Figure 2.52: Glimpse of Capacity building training program in the Gulf of Kutch, Gujarat

2.5 OUTPUTS AND ACCOMPLISHMENTS

Research and monitoring

Seagrass surveys

Seagrass exploratory surveys were extended till Mithapur and new seagrass meadows were discovered at Mithapur reef.

Ecological surveys for estimating seagrass-associated benthic macrofauna

Total 959 samples were collected from Bural Chank reef, Paga Reef, Taam reef, Dabdaba Island, Balapur, Bhaidar, and Chusna Pir, Chandri reef during the study period of December 2020- May 2021. Total 23 groups viz Gastropods, Pelecypod, Crustaceans such as Tanaidceans, Cumaceans, Amphipods, Isopods, Oligochaetes, Polychaetes, Foraminiferans, Holothuroidea, Echinoids, Ophiuroidea, Crinoids, Scaphopoda, Polyplacophora, Marine insects, etc. For further taxonomic level identification samples were identified in collaboration with the Centre of Advanced Study in Marine Biology, Annamalai University, and Tamil Nadu institute. The status and validity of all taxa were checked and updated using the World Register of Marine Species (WoRMS Editorial Board 2016).

Threat Mapping

Figure 2.52: Ghost net removal from the subtidal area of Mithapur, Gujarat

Ghost nets were successfully removed from Mithapur, Paga, Noru, Chushna pir, and Beyt-Dwarka regions. Collected net pieces and fishing nets were then given to the local fishermen for possible recycling in making new fishing nets. Fishermen were introduced to the harmful effects of ghost nets and encouraged to remove them from their fishing areas.

Outreach and awareness

Total 12 outreach programs were conducted which majorly covered school and college students, along with major stakeholders viz Marine Police and Indian Navy. We reached out to 1767 people through outreach and awareness campaigns this field season. Most of the awareness efforts were published and highlighted in the local Newspapers and News channels. National Science Day, World Environment Day, World Ocean Day, World Dugong Day, World Wildlife Day was celebrated creating awareness regarding wildlife and Environment conservation among the school and college students.

Dugong scholarship program

In Gujarat, we have completed three years of this program from July 2017 to July 2021. Till now 208 students have been awarded this scholarship and the students selected under this program are identified as Dugong ambassadors.

2.6 MANAGEMENT RECOMMENDATIONS

1. We recommend a series of strategized awareness programs be conducted with the local fishing community to manage plastic and other solid waste. Some of the waste types encountered during our surveys are:

   (i) **Plastic on-board:** Milk bags, water pouches, disposable plastic bottles, etc. Their use should be discouraged especially along the MNP area.

   (ii) **Ghost-net**: Ghost nets are fishing nets that have been abandoned, lost or discarded, at sea, on beaches, or in harbors. They are a major contributor to the bigger problem of ghost gear, which refers to all types of fishing gear, including nets, lines, traps, that are no longer actively managed by fishers or fisheries. Marine mammals and sea turtles are particularly vulnerable to the effects of ghost gear since ghost gear can be found in all three of their key habitats: nesting grounds, foraging grounds, and the open ocean. We suggest incentivizing gill-netters and small-scale fishers, who venture in the gulf for fishing, to bring back disused/discarded and abandoned fishing nets, ropes, and other plastic waste to the dock. Moreover, microplastics that break down from a weathered ghost net become bio-available to a variety of marine organisms consequently leading to diseases and death. Regular ghost net removal should be conducted during the threat-mapping survey and sensitization programs to be conducted for fisherfolk informing the dangers of discarded nets. Developing solutions to prevent gear loss in the first place would be far more sustainable in the long term than costly clean-up operations.

(iii) **Plastic for tourists**: Paga and Beyt-Dwarka are becoming a tourism hot-spot for dolphin watching as a result of which tonnes of plastic is also drawn in. Poor waste management on the island has resulted in the settlement of tourism-caused garbage patches in the subtidal areas of Beyt-Dwarka cove. There should be restrictions on the use and sale of single-use plastic items by corporations in Beyt-Dwarka. The entire marine ecology is highly susceptible to plastic waste and thereby prompting preventive action.

Proper waste management needs to be established for segregating and recycling plastic wastes on the coasts of the Marine National Park of the Gulf of Kutch.

2. **Coral monitoring:** Corals of Gujarat coast have already faced two bleaching events, one in 1998 and the other in 2010. High sedimentation is also another factor in coral reef degradation, and there was no reasonable literature found related to the Gujarat coast. The timely mannered biophysical monitoring is highly recommended to conserve these pristine habitats.
3. **Awareness among fishermen:** Create awareness among fisherfolks for using sustainable fishing practices and an alternative livelihood for fishing communities during monsoon can be implemented.
4. **A compensation scheme** to fishermen who rescue and release endangered marine life can be provided once they submit proof of the release and damage to nets.
5. We recommend enhancing patrolling around Bhaidar Island, Pashu Island and Taam reef as these are ‘Critical Dugong Habitats’. Forked channels intersect these areas and are used by fishing vessels for navigation purposes. These sites must be regarded as slow speed zones wherein it should be made mandatory for operational fishing vessels to sail at an ‘idle speed’ to avoid harmful collisions. However, for the Gulf of Kutch, commonly used small gill-netters which can efficiently sail in water as shallow as 2 m should be mandated to sail at a speed of at least 4 km/hr. The wisdom behind slow-speed zones is to give fisherfolk a good chance to spot a passing animal and to avoid harmful or fatal collisions.

6. We recommend increased threat monitoring efforts in south-eastern zone of the Gulf of Kutch. Overall, seagrass meadows of the Gulf of Kutch have a high turnover rate which gives it the resilience needed to re-colonize post-monsoon, after a shedding period in monsoon. Detrimental activities like sedimentation and subsequent seagrass burial due to trawling and illegal docking in 'seagrass-priority areas' like North Beyt-Dwarka should be stopped and measures should be taken to forestall it.
7. Trawler docking in Beyt-Dwarka also causes sediment resuspension which could increase the turbidity of associated coral outcrops in the Balapur cove and North Beyt- Dwarka. Such docking also uproots seagrasses and has been heavily criticized by the native community which depends on seagrass meadows for small-scale crab fishing.
8. Some areas falling under the Marine National Park, Paga reef, and Bhaidar Island, need to be monitored for infiltrating activities like illegal poison fishing and beach seining. Although, these activities may be minimal in number but have the potential to leave a long-lasting effect on corals and seagrass meadows. We report the use of mangrove branches used as stakes for building a seine.
9. Dugong sighting and monitoring efforts need to be increased in 'Critical Dugong habitats' like Chepri and Taam reef. The connecting habitats between foraging meadows need to be established and monitored regularly using the drone and boat-based surveys.
10. The frontline staff of the Gujarat Forest Department needs to be trained in conducting seasonal seagrass monitoring surveys and marine mammal monitoring surveys. We plan to organize such training in the upcoming season for state forest department personnel and other key stakeholders.

ANNUAL FIELD REPORT 2020-21

GULF OF MANNAR AND PALK BAY, TAMIL NADU

Team Members:

Rukmini Shekar (Project Fellow), Madhu Magesh K (Project Fellow), Chinmaya Ghanekar (DST-INSPIRE Fellow), Noah Shinde (Field Assistant), T Andrews (Field Assistant), G Thangapandi (Field Assistant), Noah Shinde (Field Assistant), M Rajeshwaran (Field Assistant)

Volunteers:

Akila P, Vanmathi B, Sathiya Jothi A, Tharshini S, Anes Jerina J K, Keerthiga M, Arthi G, Mangala Gowri V

Citation: Rukmini S., Madhu M. K., Ghanekar C., Andrews T., Thangapandi G, Shinde N., Rajeshwaran M. (2021), Annual Field Report 2020-21, Tamil Nadu, In Annual Progress Report IV (2020-21), Recovery of Dugongs and their habitats In India: An Integrated Participatory Approach, Wildlife Institute of India, Dehradun.

Acknowledgment:

Thiru T. P. Raghunath IFS (Principal Chief Conservator of Forests and Chief Wildlife Warden, Tamil Nadu Forest Department), Dr. Sanjay Kumar Srivatsava IFS (Additional Principal Chief Conservator of Forest (Wildlife), Tamil Nadu Forest Department), Thiru. A. S. Marimuthu (Wildlife Warden, Gulf of Mannar Marine National Park, Ramanathapuram and District Forest Officer, Ramanathapuram), Thiru. Anand Kumar IFS (District Forest Officer, Pudukkottai District), Thiru. Ilayaraja (District Forest Officer, Thanjavur District), Thiru. T. K. Ashok Kumar (District Forest Officer, Kanyakumari District), Thiru. Nagendran (Commanding Officer, Indian Coast Guard Station, Mandapam), Thiru. Ilamvazhudi (District Director of Fisheries, Tamil Nadu Fisheries Department, Ramanathapuram District), Thiru. V. Abdul Kadhar Jailani (Assistant Director of Fisheries, Mandapam), Thiru. Satish Nirmal (Range Forest Officer, Ramanathapuram), Thiru. Palanikumar (Range Forest Officer, Kilakarai, Ramanathapuram), Thiru. Venkatesh (Range Forest Officer, Mandapam, Ramanathapuram), Thiru. Kumar (Range Forest Officer, Thanjavur District), Smt. Manjula (Inspector of Police, Coastal Security Group, Pattukottai, Thanjavur), Thiru. Rajkumar (Sub-Inspector of Police, Coastal Security Group, Pattukottai, Thanjavur), Dr. V. Balaji (Director, OMCAR Foundation, Velivayal, Thanjavur District), Dr. Sesh Serebiah (Director, Jehovah Shamma Centre for Marine and Wildlife Research, Mudiveeranpattinam, Ramanathapuram District), Mr. S. B. Aravind (Dive Instructor and Director, Temple Adventures, Pondicherry), Dr. C. Stella (Head of the Department, Department of Oceanography and Coastal Area Studies, Alagappa University, Karaikudi), Quest Adventure Sports academy (Pirappanvalasai, Ramanathapuram district)

3.1 RESEARCH AND MONITORING

As part of the research and monitoring component, in Tamil Nadu, we conducted seagrass meadow assessment in South Palk Bay and off the Gulf of Mannar coast of Rameshwaram, marine mammal assessment survey of Thanjavur coast in North Palk Bay, and seagrass associated fish surveys in parts of Palk Bay and Gulf of Mannar. We also had a M.Sc. Marine Science student from Bharatidasan University, who finished her dissertation project entitled 'Pollution Assessment on the Habitat of Dugongs (*Dugong dugon*) in the Palk Bay and Gulf of Mannar, Southeast coast of India' in collaboration with our team.

3.1.1 Seagrass Surveys

Study Area

South Palk Bay and a part of the insular coast of Rameshwaram island facing towards the Gulf of Mannar Biosphere Reserve were chosen for the seagrass meadow assessment from January to March 2021. Nine parallel transects extending up to 9 kilometers from the coast were surveyed for seagrass meadow characteristics such as seagrass cover, seagrass diversity (genus level), and shoot density. Quadrats were placed at half-kilometer intervals on each transect (n=135 quadrats). Five locations were chosen in South Palk Bay in such a manner that each transect was parallel to each other with a distance of 5 kilometers between each. Quadrats were placed at half-kilometer intervals on each transect (n=135 quadrats). Five locations were chosen in South Palk Bay in such a manner that each transect was parallel to each other with a distance of 5 kilometers between each transect (Figure 3.1). Three westward transects parallel to each other were chosen off the Rameshwaram coast. Each transect was 5 kilometers away from the other (Figure 3.2).

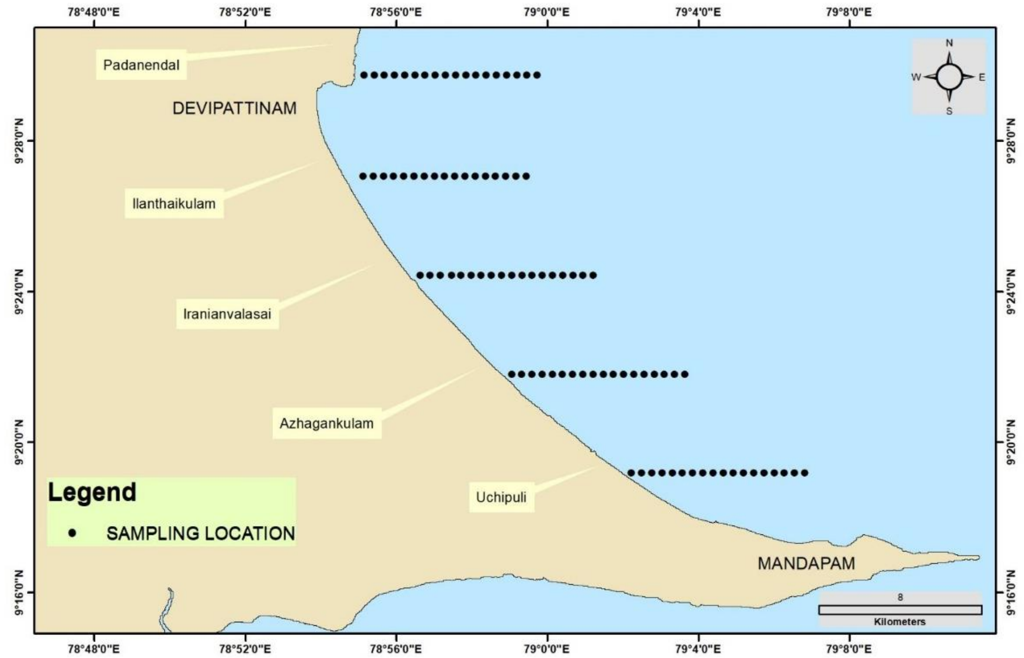


Figure 3.1: Sampling locations for seagrass meadow assessment in South Palk Bay, Tamilnadu

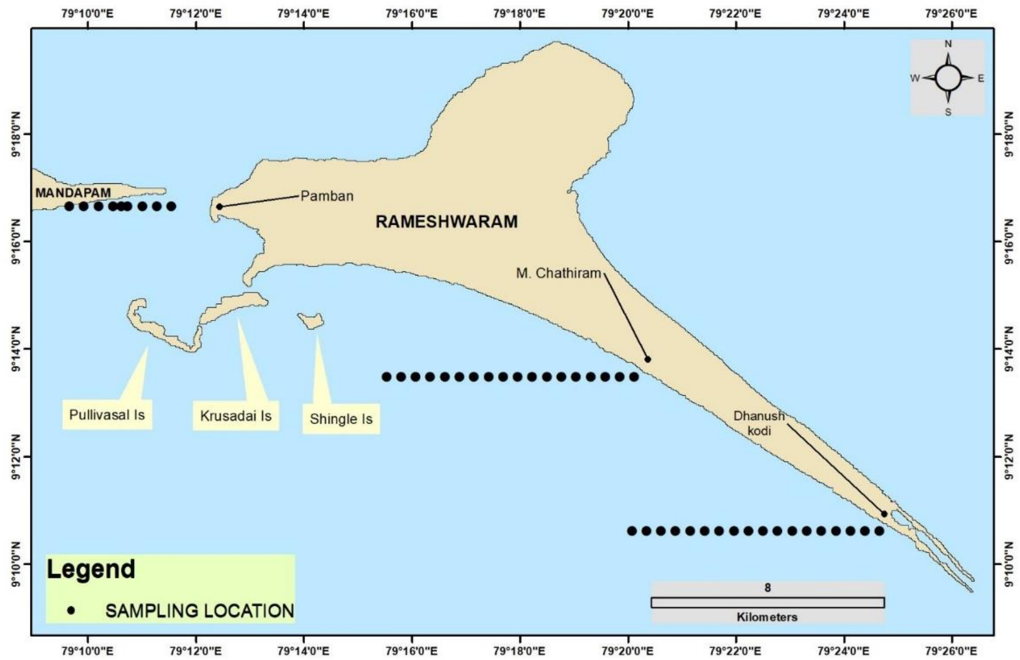


Figure 3.2: Sampling locations for seagrass meadow assessment off Rameshwaram coast facing Gulf of Mannar, Tamilnadu

Methodology

The methodology used included on-board deployment of drop-down quadrat of 0.5 x 0.5 m (Figure 3.4b), a Van Veen grab (Figure 3.4a), and a water sampler (Figure 3.3b) from trawl or traditional fishing vessels. Environmental parameters were recorded using a thermometer, depth meter, Secchi disc (Figure 3.3a), and a hand-held refractometer for air and water temperature, water depth, water clarity, and water salinity, respectively.


Figure 3.3a (left) Water clarity determination using a Secchi Disc
Figure 3.3b (right) Collection of water from desired depth using Niskin Water Sampler at Tamil Nadu

Figure 3.4a (left) Collection of sediment and seagrass sample using Van Veen Grab
Figure 3.4b (right) Collection of quadrat data using a drop-down camera at Tamilnadu

Results

3. **Seagrass Cover**

Overall, a seagrass cover of 10.61% (± 21.51) was observed from all locations sampled. *Cymodocea* spp. was the most dominant genera of species present (7.65 ± 18.16% cover). The second most common genera were that of *Halophila* spp. At 1.47% cover (± 8.43%). (Figure 3.5)

Seagrass presence was not recorded in 3 out of 9 transects. Two of these transects were off Rameshwaram Island (Mukundaraiyar Chathiram and Dhanushkodi). Of the one transect that showed the presence of seagrass off Rameshwaram Island (Rameshwaram), seagrass was recorded at only one point at 1km off the coast. *Cymodocea* spp. was the only species recorded, with a cover of 0.56% (± 3.69).

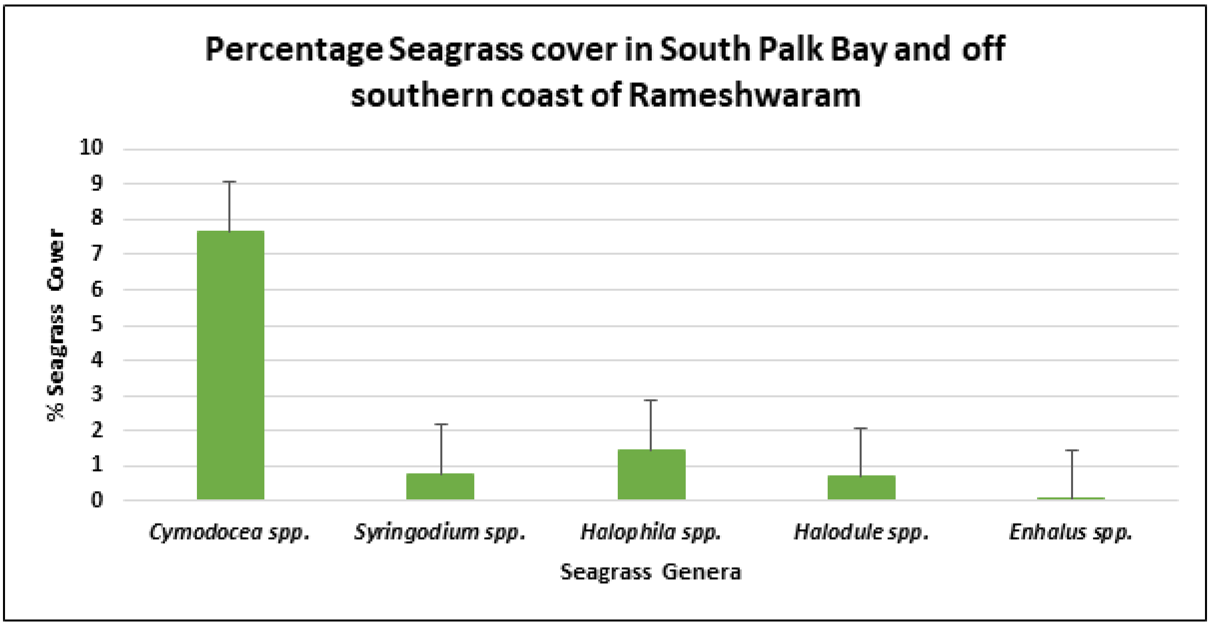


Figure 3.5 Percentage Seagrass cover in South Palk Bay and off the southern coast of Rameshwaram, Tamil Nadu

The transect off Padanendal showed the highest cover (36.89% ± 26.41) and diversity of seagrass (n = 5 species). One transect in South Palk Bay (Uchipulli) showed no presence of seagrass. The transect off Azhagankulam in South Palk Bay had seagrass only at one location at 2 km off the coast. In South Palk Bay, *Cymodocea* spp. Showed the highest cover (11.2% ± 21.22) and *Enhalus* spp. Showed lowest cover (0.03% ± 0.31). The overall seagrass cover of South Palk Bay was at 15.64% (± 24.73). Five genera of seagrasses were recorded from the region (Figure 3.6).

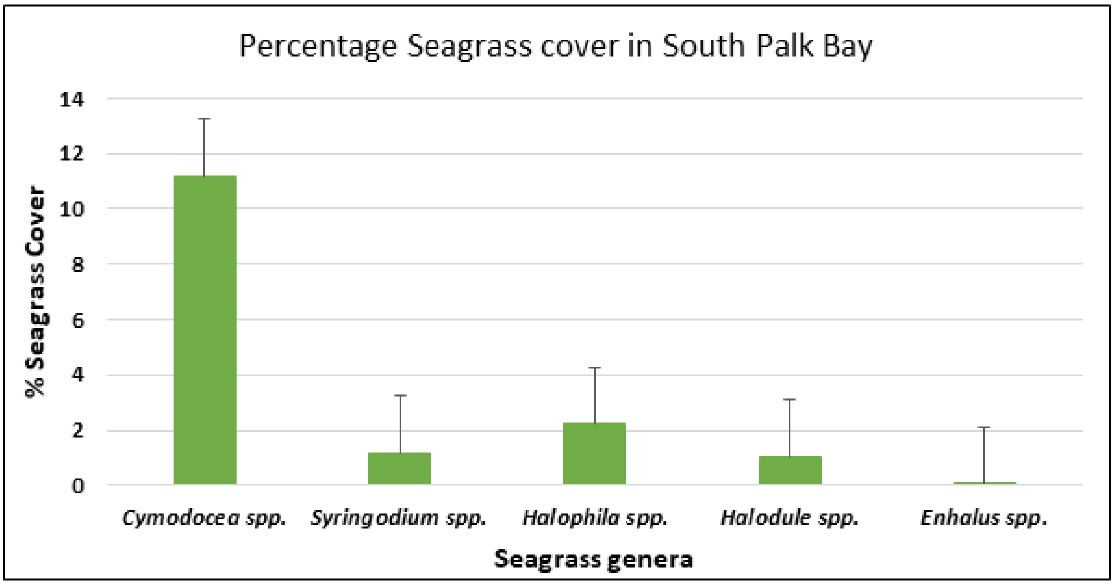


Figure 3.6: Percentage Seagrass cover in South Palk Bay, Tamil Nadu

b. Seagrass Shoot Density

The shoot density of *Cymodocea* spp. was found to be highest (68.44 ± 152.52 shoots per m^2) compared to all other genera of seagrass in South Palk Bay and off the southern coast of Rameshwaram island. *Enhalus* spp. was seen to have the least shoot density (0.74 ± 7.06 shoots per m^2). *Halophila* spp. was found in dense meadows and exhibited the second highest shoot density of 34.96 ± 193.26 shoots per m^2) in the (Figure3.7).

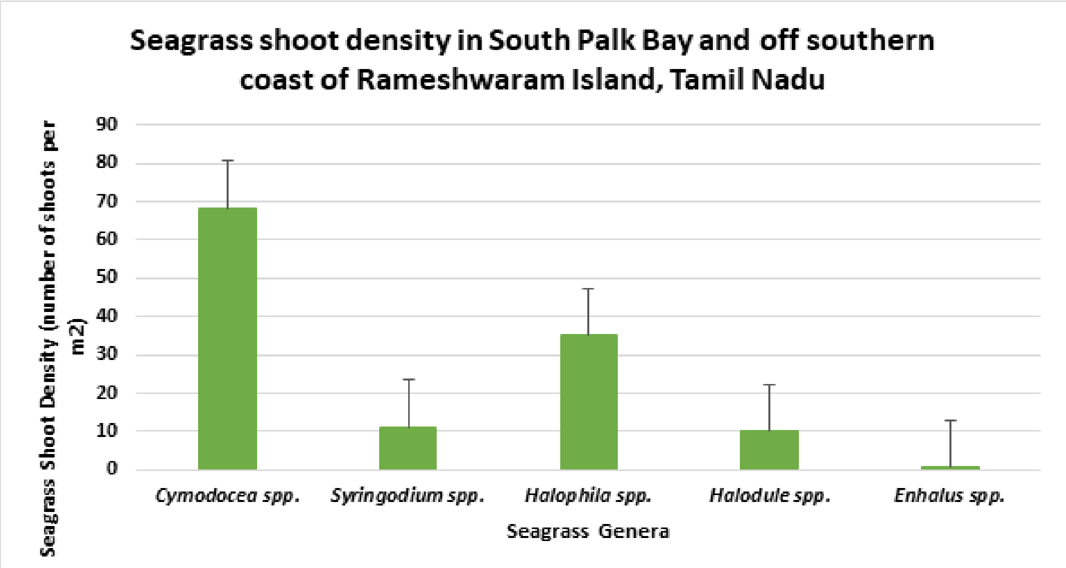


Figure 3.7 Shoot density of seagrass genera in South Palk Bay and off the southern coast of Rameshwaram Island, Tamil Nadu

As no seagrass genera were recorded from the southern coast of Rameshwaram Island, except for a small patch of *Cymodocea* spp. From only one location, data of shoot density of seagrasses from South Palk Bay was 81nalysed separately. (Figure 3.8).

In South Palk Bay alone, *Cymodocea* spp. And *Halophila* spp. showed highest shoot densities with 100 (± 176.86) shoots per m^2 and 52.44 (± 234.75) shoots per m^2, respectively. *Halodule* spp. And *Syringodium* spp. Have similar shoot densities at 15.33 (±72.48) shoots per m^2 and 16.89 (± 110.79) shoots per m^2, respectively.

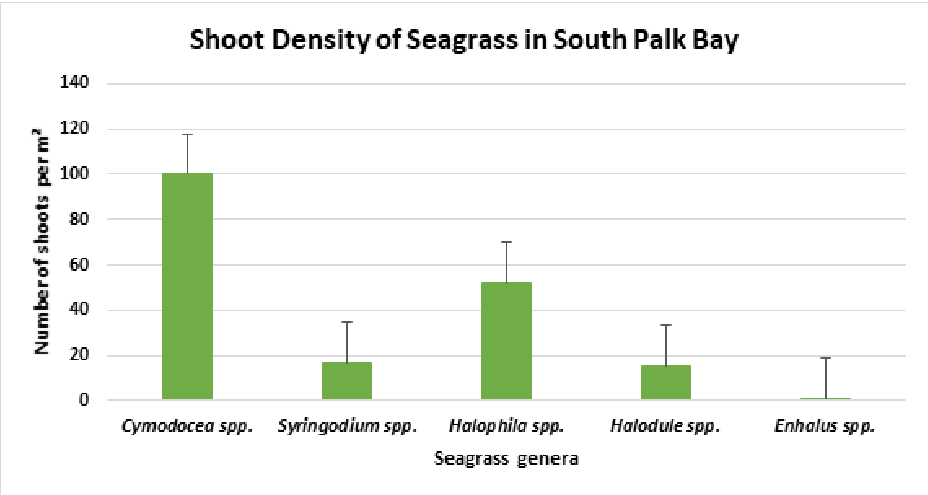


Figure 3.8 Shoot Density of Seagrass in South Palk Bay, Tamilnadu

Figure 3.9a (Left) Seagrass bed with very low (4%) seagrass cover;

Figure 3.9b (Right) Seagrass bed with 50% seagrass cover

3.1.2 Marine Mammal Survey

This study was focused on surveying the nearshore (5 kilometers from shore) waters of the proposed North Palk Bay Conservation Reserve for the presence of marine mammals, litter, and fishing activity.

Study Area

The study was conducted off the North Palk Bay coast. The area has been proposed to be declared as a Conservation Reserve. 11 predefined parallel transects 5kilometres in length were used for the survey. The total surveyed area was 205 km2 off the coasts of the Thanjavur and Pudukottai districts.

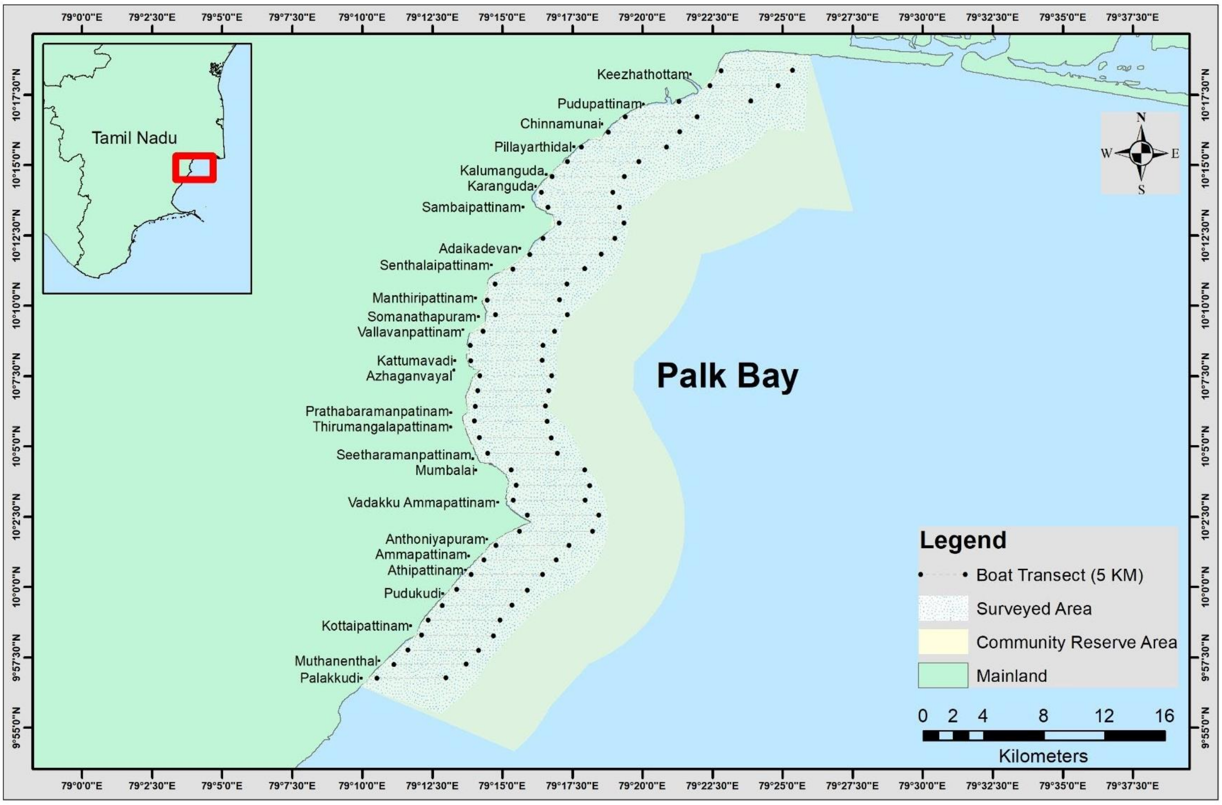


Figure 3.10 Transect locations for marine mammal survey in the proposed North Palk Bay Conservation Reserve (Pudukottai and Thanjavur district coasts), Tamilnadu

Methodology

Each survey was carried out using 5 boats (either motorized or mechanized) that would traverse simultaneously along 4 transects (each 5 kilometers long) at a speed, not more than 10 kilometers an hour. On each boat, 2 observers (researchers from the Wildlife Institute of India team and one volunteer) would look for marine mammals, other marine life, litter, and fishing activity along the transect. A boatman and a fisherman also accompanied the team to sail the boat and for safety purposes. Observations were made by positioning the observer at the front of the boat. Each observer was equipped with a GPS and a pair of binoculars. The observational limit was estimated to be a half kilometer to each side of the observer, thereby allowing a width of one kilometer to be scanned along each transect line. Therefore, each transect line was spaced at a 1-kilometer distance from the other.

A total of 205 km2 area was surveyed by conducting two such surveys. The survey conducted from Kottaipattinam to survey the coast off Pudukottai District used larger trawl boats. These boats were chosen as they produce less sound and provide a higher point of observation. We had to use traditional boats for the survey off Thanjavur district (starting from Sethubavachathiram), as the nearshore depth was insufficient for large boats to sail. Only one boat had to travel for 5 transects to cover the necessary area (Figure 3.10).

A total of 22 fishermen, 7 Student volunteers from Alagappa University, Karaikudi and Bharatidasan University, Trichy, 1 volunteer from Jehovah Shamma Centre for Marine and Wildlife Research (a local NGO) and 4 fishermen volunteers took part in these surveys. The event ensured community involvement and we distributed T-shirts to all participants beforehand. A briefing was conducted before the commencement of each survey to explain the importance of conserving marine life, the importance of dugongs and seagrasses, and the method in which the survey would be conducted.

Results

This survey marks the successful completion of marine mammal surveys in the proposed North Palk Bay Conservation Reserve Area. A total of 262 observations were made: 93 observations of marine organisms, 142 observations of litter, and 27 observations of fishing activities in the area. (Figure 3.11)

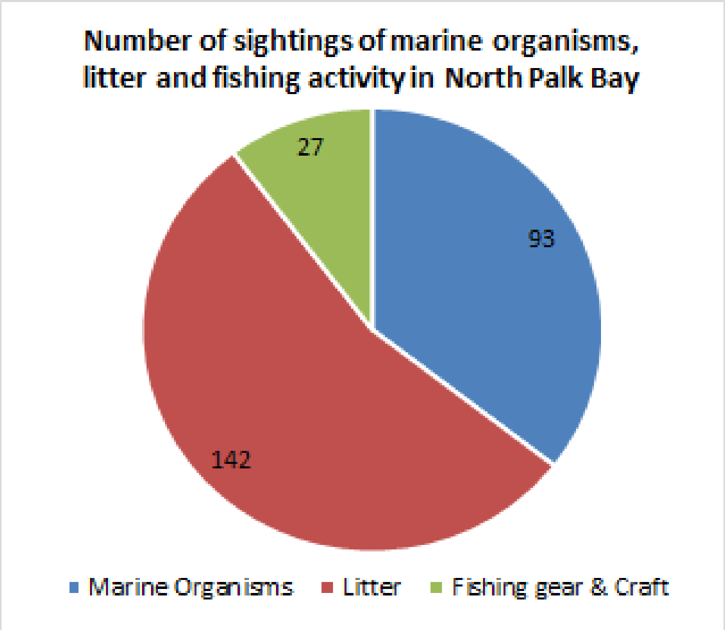


Figure 3.11 Number of sightings of marine organisms, litter, and fishing activity in North Palk Bay, Tamilnadu

Other than dugongs (n=2), the marine organisms recorded were sea jellies (n=20), crabs (n=2), fish (n=34), rays (n=1) and sea turtles (n=1). Several sea birds like gulls and terns were found (number of observations=33) to be fishing and feeding, indicating the abundance of prey in these waters. The floating foam was the most abundant form of litter recorded (n=82), followed by plastic (n=57) in the form of discarded food packets, water bottles, and small buoys. This is a result of active fishing and nearshore human habitation in this region. Several set nets (n= 21) and fishing vessels (n=6) were recorded during the survey (Figure 3.12)

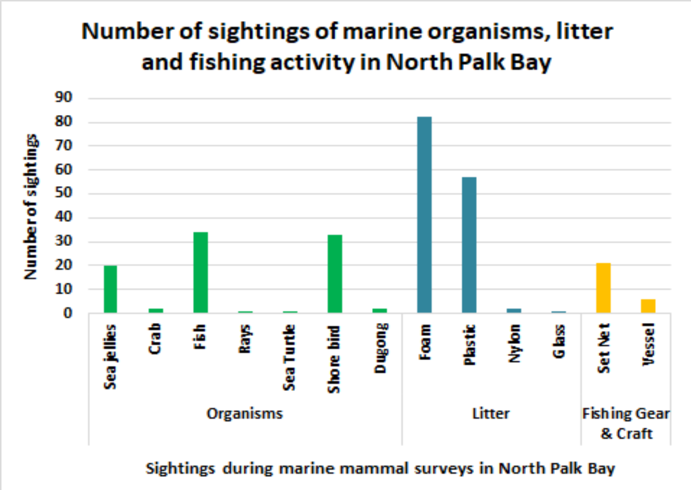


Figure 3.12 Number of sightings of marine organisms, litter, and fishing activity in North Palk Bay, Tamil nadu during marine mammal surveys

Figure 3.13 A trawling boat used for the survey off Pudukottai coast, Tamilnadu

a. Marine Mammal Survey off Pudukottai district coast

Two dugongs (unfortunately, pictures could not be captured) and a dead turtle were some of the significant sightings. Jellyfish were also abundant in the area. Attributing to the nearshore human habitation, a lot of litter was found during the survey.

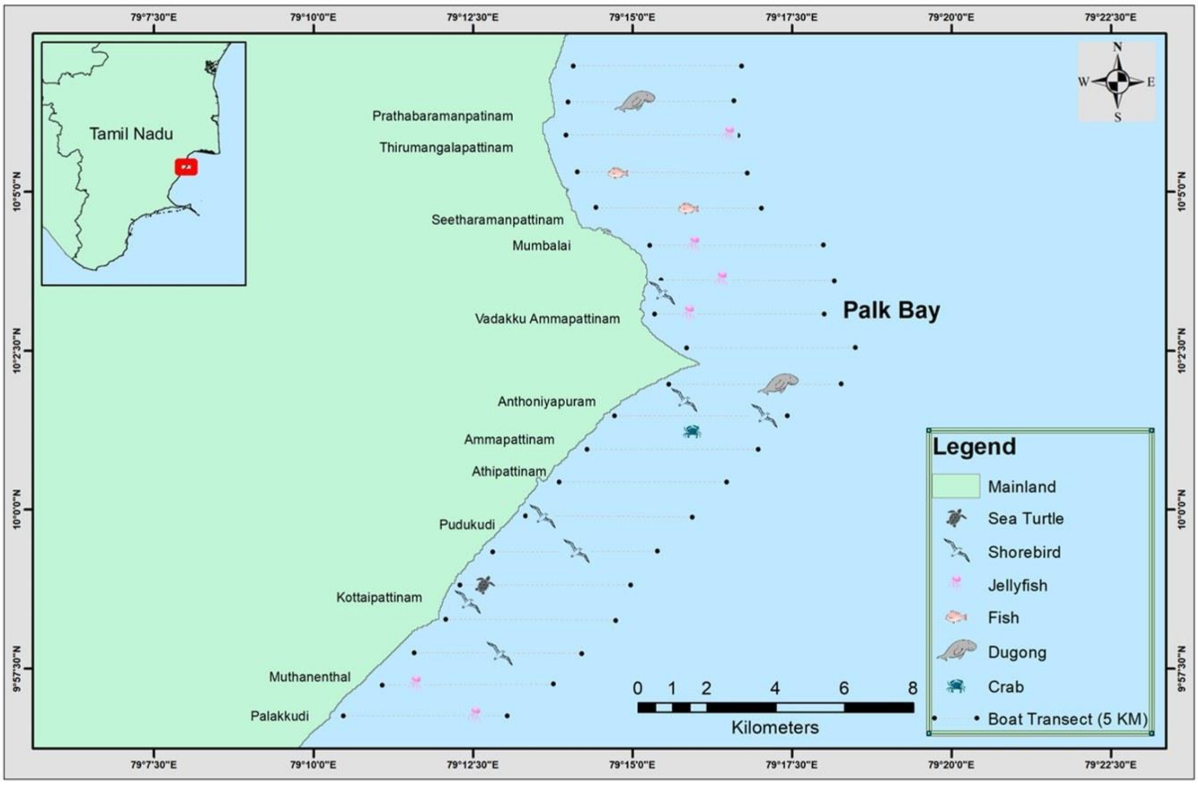


Figure 3.14 Map of marine organisms recorded during marine mammal survey off Pudukottai District, Tamilnadu

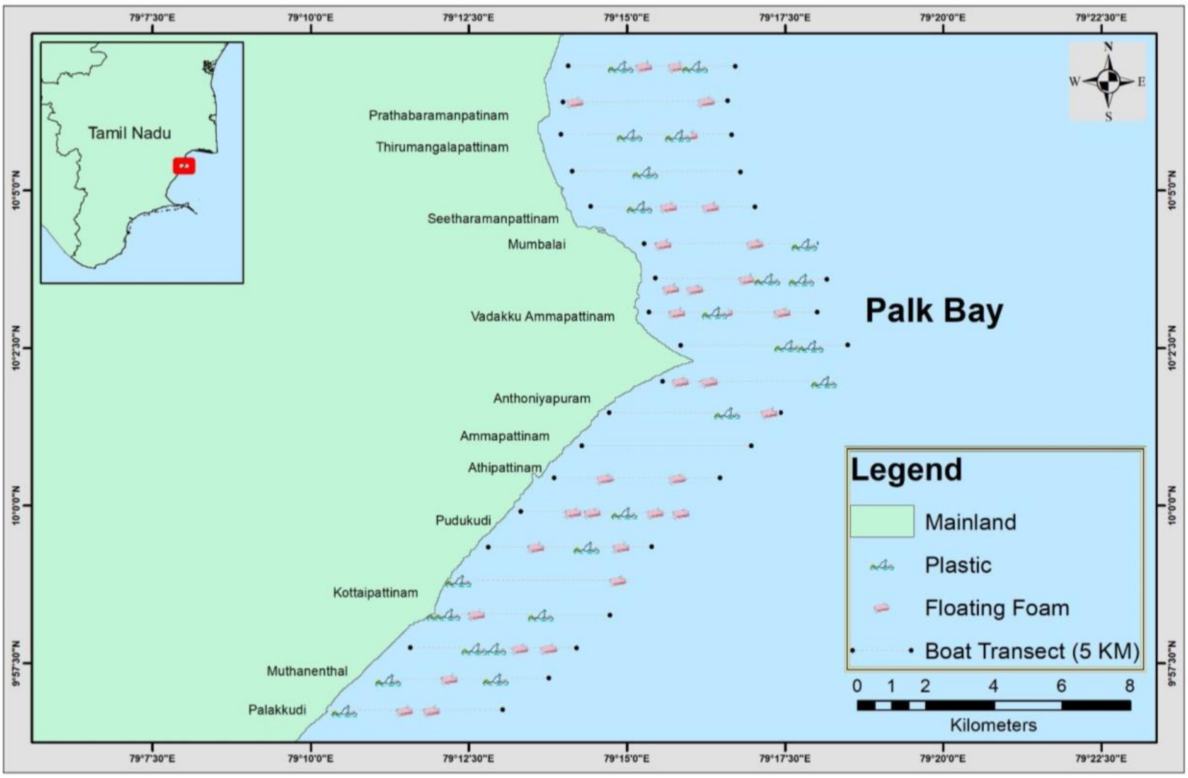


Figure 3.15 Map of litter recorded during marine mammal survey off Pudukottai District, Tamilnadu

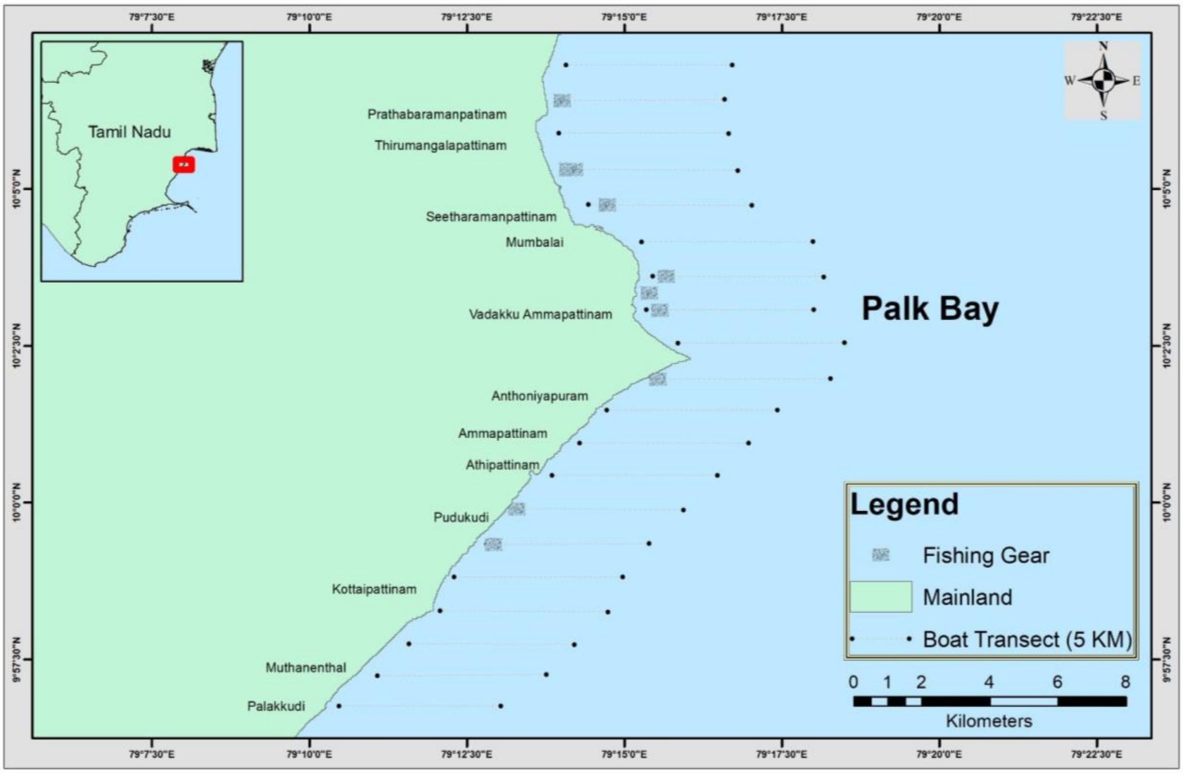


Figure 3.16 Map of fishing gear recorded during marine mammal survey off Pudukottai District, Tamilnadu

b. Marine Mammal Survey off Thanjavur district coast

Figure 3.17 Traditional fishing boat with observer and team on board during the marine mammal survey off Thanjavur district, Tamilnadu

Unfortunately, no dugongs were sighted in the region. Jellyfish were also abundant in the area. Attributing to the nearshore human habitation and high fishing pressure, a lot of litter was found during the survey.

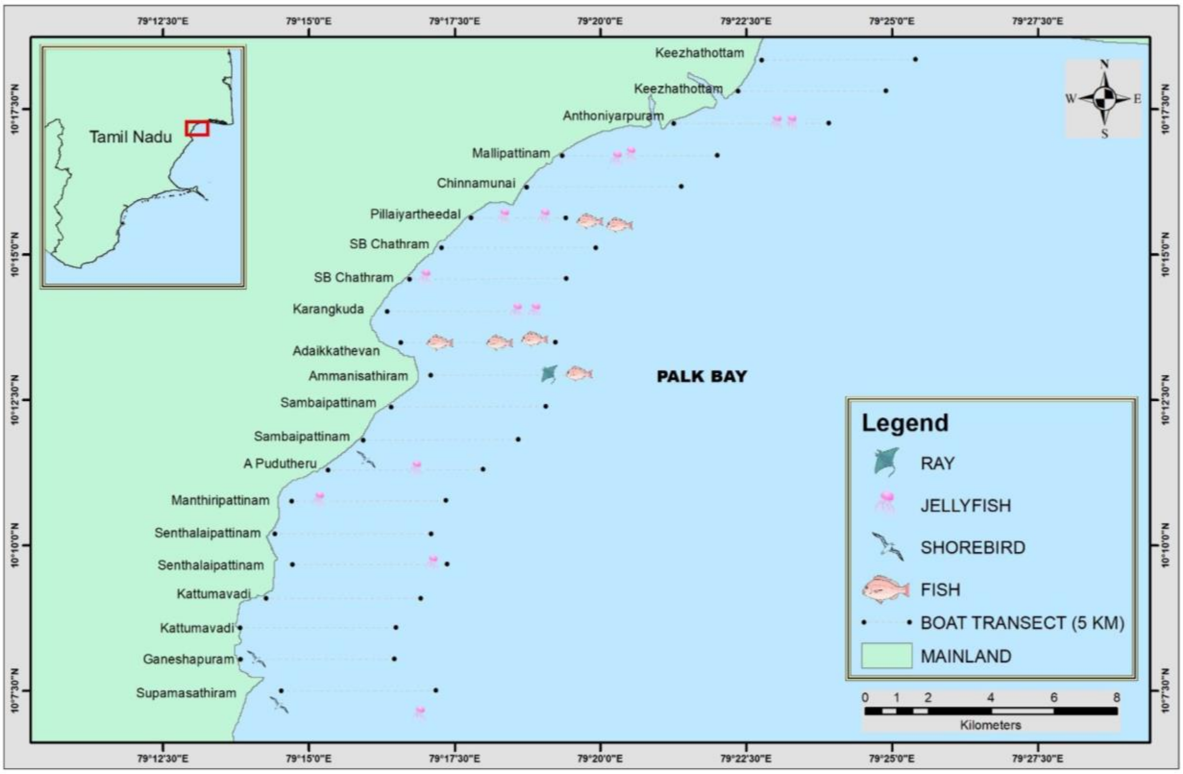


Figure 3.18 Map of marine organisms recorded during marine mammal survey off Thanjavur coast, Tamilnadu

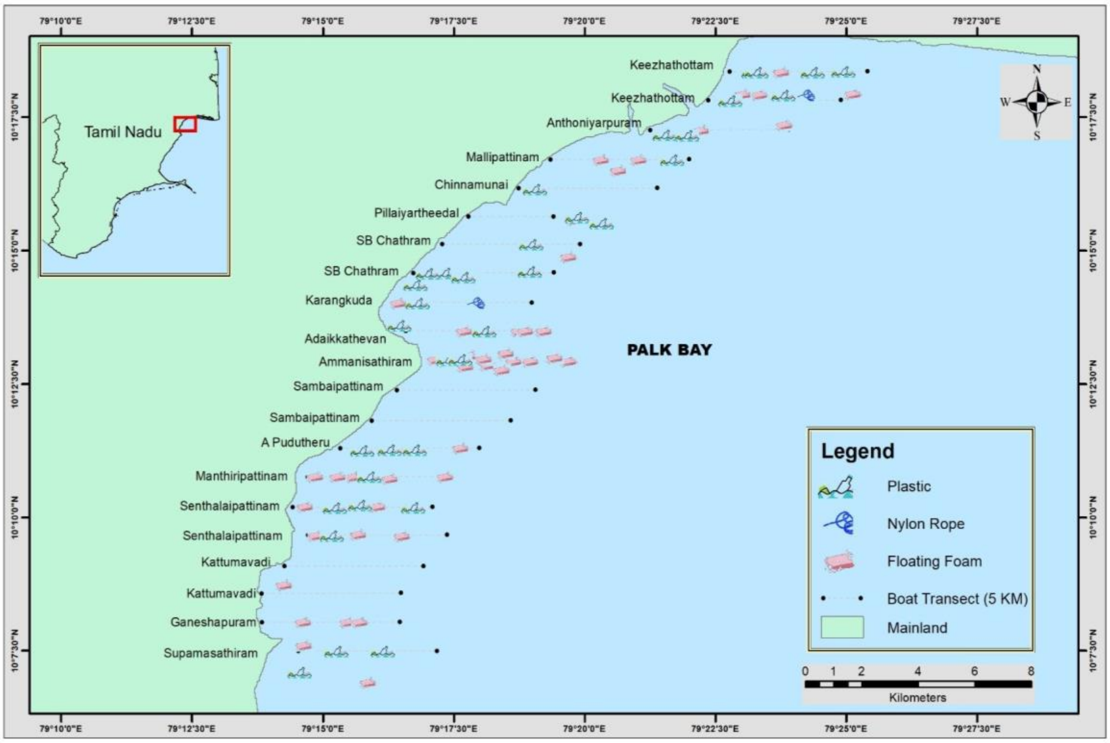


Figure 3.19 Map of litter recorded during marine mammal survey off Thanjavur coast, Tamilnadu

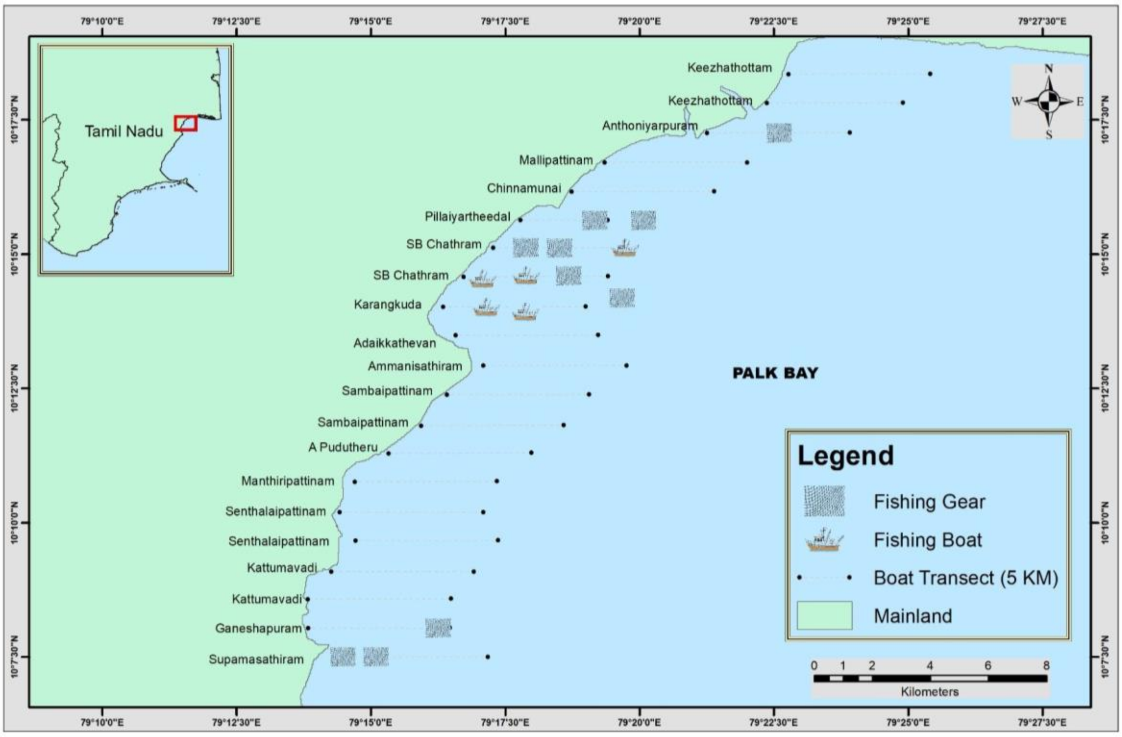


Figure 3.20 Map of fishing gear and craft recorded during marine mammal survey off Thanjavur district coast, Tamilnadu

Figure 3.21a (top) Team that conducted marine mammal survey off Pudukottai district coast, Tamilnadu

Figure 3.21b (far left) Dead turtle sighted during the survey

Figure 3.21c (left) Plastic litter- a water bottle sighted during survey

Figure 3.22a (top) Team that conducted marine mammal survey off Thanjavur district coast, Tamilnadu

Figure 3.22b (bottom left) floating foam sighted during the survey

Figure 3.22c (bottom right) A fishing vessel sighted during survey

3.1.3 Seagrass Associated Fish Survey

Study Area

The study is conducted in the Mandapam group of islands of the Gulf of Mannar and Palk Bay. Fourteen manual point counts were conducted near four islands for fish density assessment. Three fish market surveys were conducted at Morapannai, Tamaraipattinam, and Tiruppalaikudi situated along the Palk Bay coast, which all are small markets in the area.

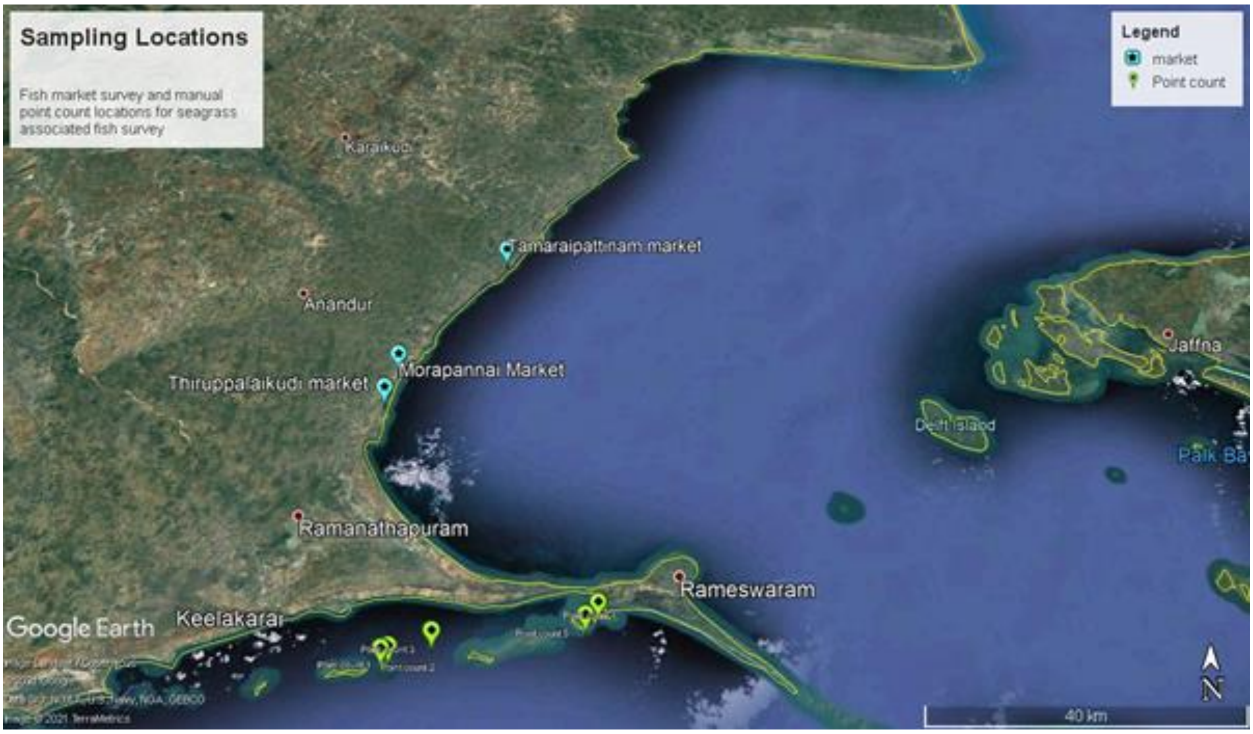


Figure 3.23: Fish sampling locations surveyed in Tamilnadu, 2021

Fish Market Survey

Methodology:

Fish species available at each vendor were recorded along with their source and selling price. Photographs were taken of individual species for identification.

Result:

Thirty fish species belonging to 19 families were observed in these fish market surveys. The selling price for Hemiramphus far, Hemiramphus lutkei, and Tylosurus acus melanotus was the highest at Rs. 400/kg, whereas it was the lowest for Terapon puta at Rs. 20/kg (Figure

3.24). In surveyed markets of Palk Bay, 51.85% of fishes were caught from seagrass beds, followed by 25.9% which were caught in the pelagic area (Figure 3.25). Around 18% of fish were also sourced from wholesale markets, signifying Palk Bay's interdependent fish market system (Figure 3.25).

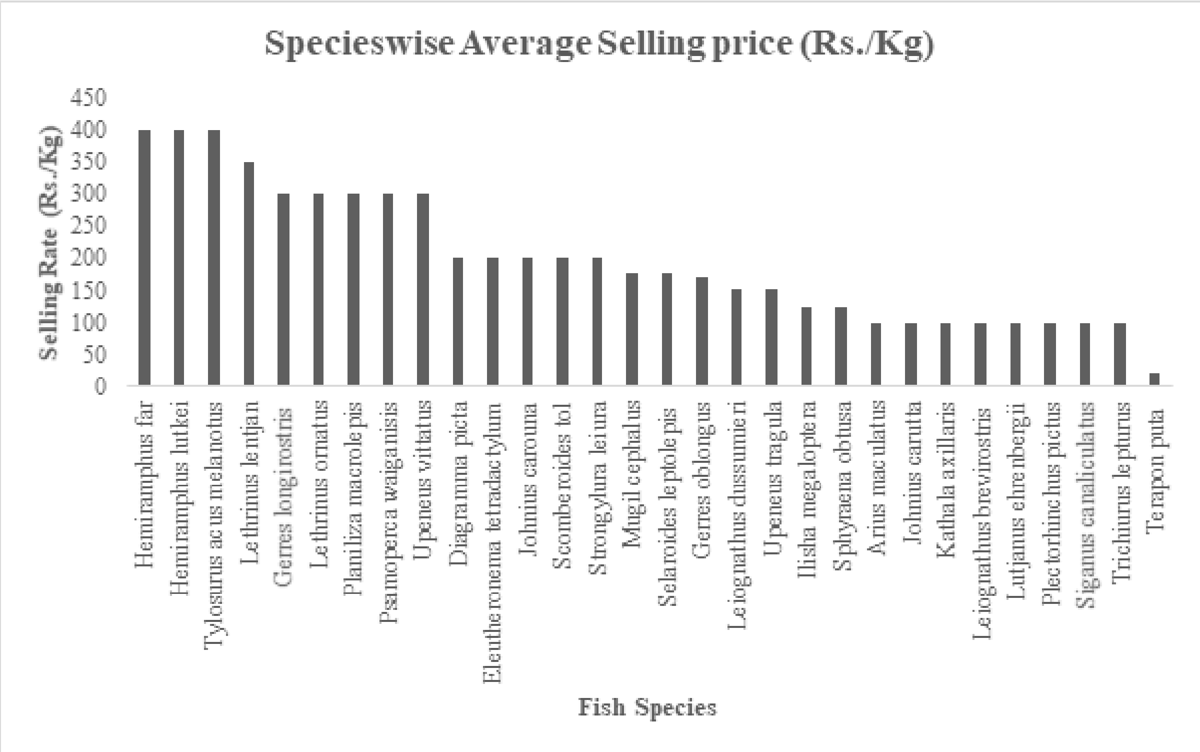


Figure 3.24: Species wise fish selling price in Palk Bay, Tamilnadu

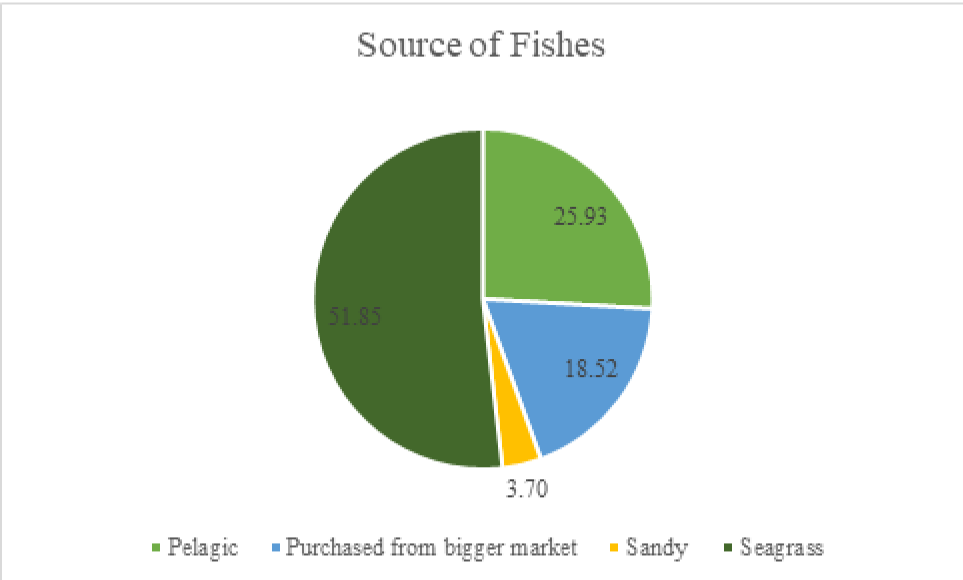


Figure 3.25: Sources of fish sold in markets of Palk Bay, Tamilnadu

The density of Seagrass associated Fish

Methodology:

To understand fish density and seagrass meadow usage by fish, random point counts were conducted at the Gulf of Mannar (n=50) from January 2020 to March 2021. Variable radius point counts were performed by noting down each fish sighting in the imaginary circle. The observer hovered not more than 2m above the center of the point for 10 minutes. The behavior of every fish species, individual or shoal, was noted along with seagrass characteristics. Position of fish individual/ shoal in seagrass column was also noted. The selection of the next point was made by swimming in a random direction. Distance between two points was kept at a minimum of 20 m.

Results

Fish Density in seagrass meadows of Gulf of Mannar

Fishes belonging to 16 genera and 12 families were observed in the point counts conducted. Family-wise average fish densities were calculated for the sampled area by Distance software version 7.3 (Thomas et al., 2010). Models were selected based on minimum values of Akaike's Information Criterion (AIC). For fish density estimation, a half-normal model was selected (AIC=915.89, chi-square value=0.6199, $p>0.05$) over Negative exponential, uniform, and hazard rate models (Figure 3.26). The average fish density was found to be 5.4209/sq.m with an average cluster size of 9.2517 (Table 3.1)

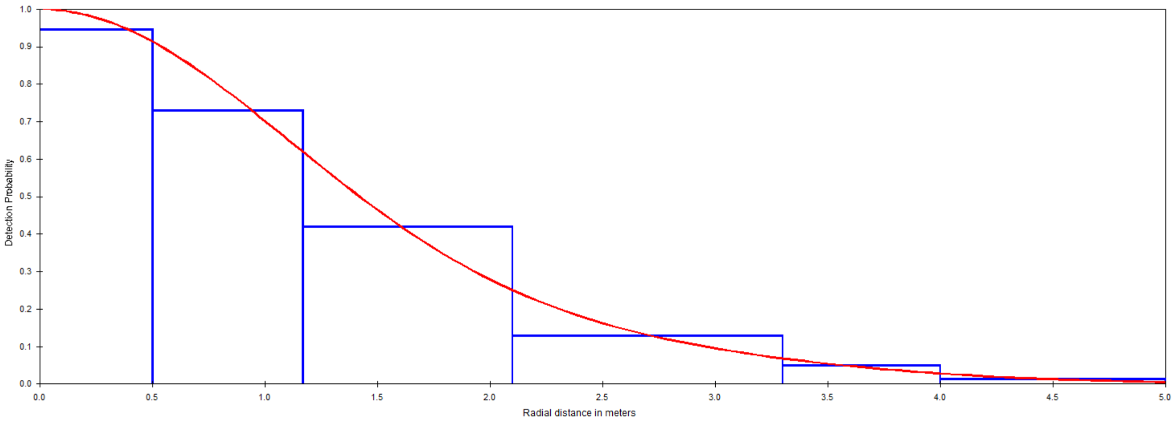


Figure 3.26: Detection probability for fish in seagrass meadows of Gulf of Mannar, Tamilnadu

Table 3.1: Fish density and cluster size estimates

	Estimate	**%CV**	**df**	**95% confidence interval**	
Average cluster size	9.2517	22.65	297.00	5.9569	14.369
Density of cluster	0.58593	14.48	163.36	0.44086	0.77874
D (Density)	5.4209	26.89	452.08	3.2254	9.1107

Figure 3.27: Fish Market survey: 1. Survey at Uchipuli market, Gulf of Mannar, 2. Hemiramphus far, 3. Syngnathoides biaculeatus, 4. Fish vendor at Uppur market, Palk Bay, Tamilnadu

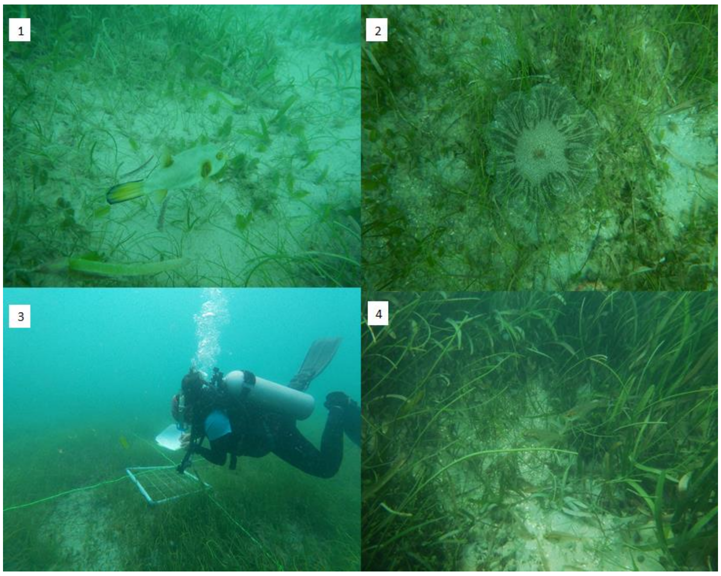


Figure 3.28: Fish point counts in seagrass meadows in Tamilnadu: 1. *Arothron immaculatus*,
2. Carpet anemone, 3. Observer performing point count, 4. Cardinalfish

3.1.4 Dissertation Project

Ms. V. Mangala Gowri, and M.Sc. Marine Science student from Bharatidasan University, collaborated with our field team to carry out her dissertation project entitled '**Pollution Assessment on the Habitat of Dugongs (*Dugong dugon*) in the Palk Bay and Gulf of Mannar, Southeast coast of India'**. Her work aimed at estimating Physico-chemical parameters of water, pollution indicating parameters in sediments, heavy metal concentrations in sediment using Atomic Absorption Spectrophotometry (AAS).

Seagrass, water, and sediment samples were collected from six sites (Figure 3.29) chosen based on site characteristics like estuaries, and seaweed farming areas. Samples were collected from 3 locations at each site. The sampling was conducted in March 2021. Sites were compared for levels of pollution. Site A (Athangarai) and F(Senthukarai) had interference of freshwater runoff, Site B (Mandapam) and C (Pamban North) were seaweed farming sites, Site D (PambanSouth) was a site of litter accumulation, and Site E (Padhumadan) had no disturbance, and was considered as a control site.

Samples were collected using snorkeling and SCUBA diving as tools. Water samples were collected with 1-liter polyethylene-terephthalate (PET) bottles for Physico-chemical analyses. Sediment and seagrass samples were collected in polythene bags, sealed, and stored. All samples were frozen until further analysis.

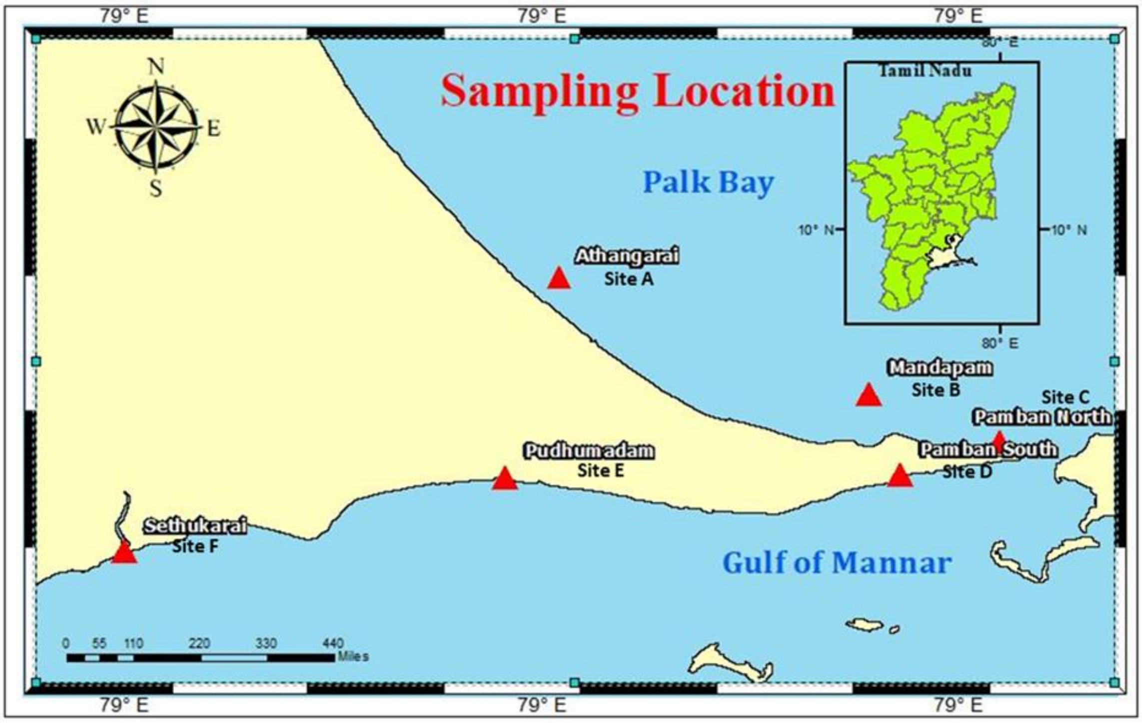
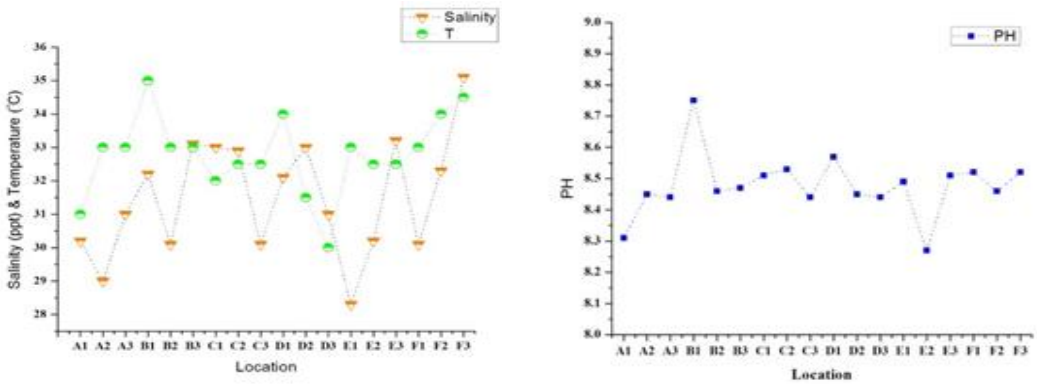


Figure 3.29: Sampling sites for contaminant analysis from Palk Bay, Tamil Nadu

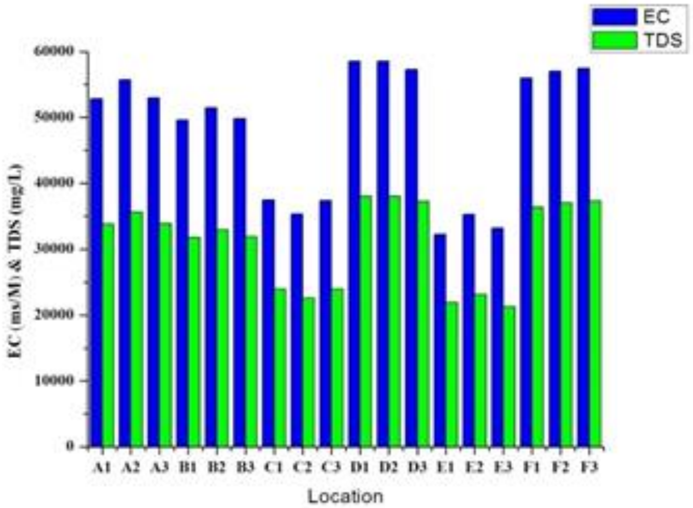
Results

Results of Physico-chemical Parameters Water samples showed high amounts of

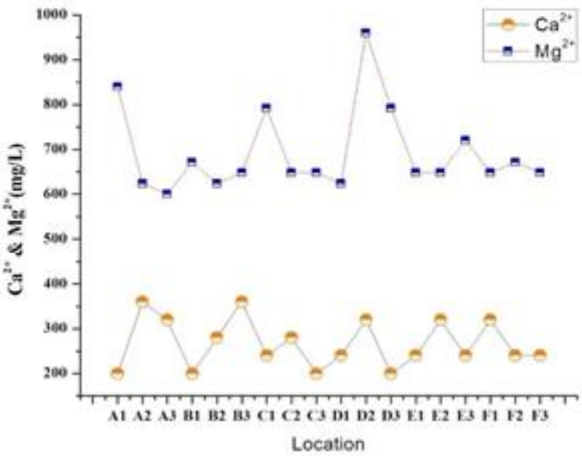


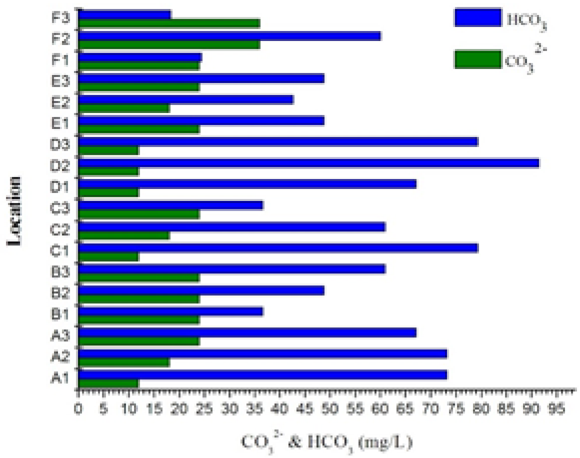
magnesium and phosphates where human interference was more (Site D). (Figure 3.30).

3.30a (Left) Graph depicting temperature and salinity differences in water samples collected at each sampling location in Tamilnadu, 3.30b (Right) Graph depicting pH variation in water samples collected at each sampling location



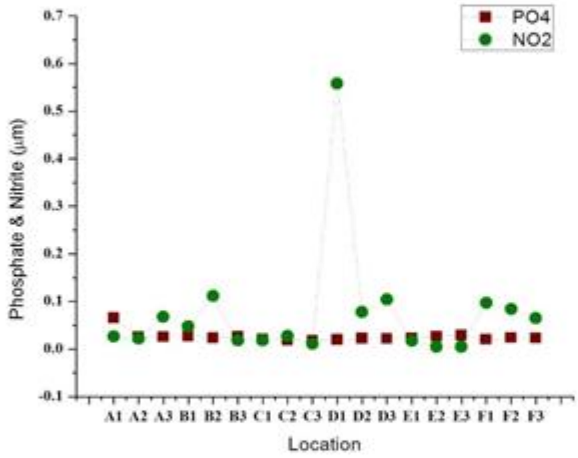
3.30c Graph depicting electrical conductivity and total dissolved studies in water samples collected at each sampling location in Tamilnadu



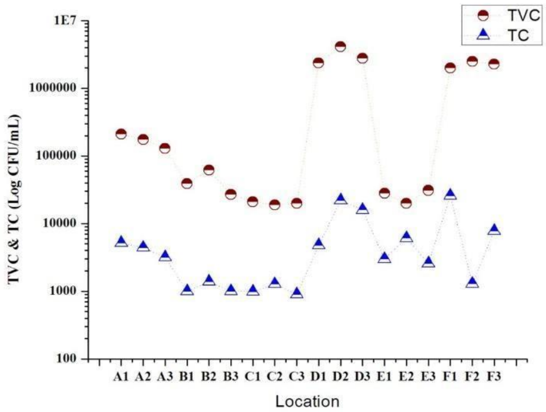


3.30d (Right) Graph depicting carbonate and bicarbonate content in water samples collected at each sampling location in Tamilnadu

3.30e (Left) Graph depicting Calcium and Magnesium contents in water samples collected at each sampling location in Tamilnadu



3.30f Graph depicting Phosphate and nitrate content in water samples collected at each sampling location.



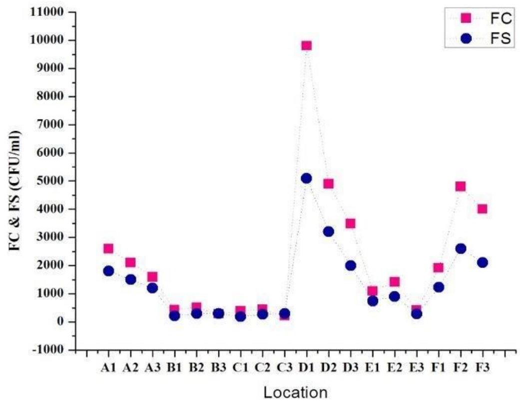


Figure 3.31a (Left) Graphs depicting total viable counts and Total coliforms presence across sampling locations in Tamilnadu

Figure 3.31b (Right) Graph depicting fecal *coliforms* and fecal *streptococci* presence across sampling locations in Tamilnadu

Bacteriological analysis of water was the pollution indicator chosen for the study. The results indicate that water is polluted by fecal contamination to an extent that it is unsuitable for recreational activities. The total viable counts (TVC) were an order of magnitude above 10^4mL^{-1} for all sites, which is substantially high. The mean TVC ranged from 23.8–41[×10^4] mL$^{-1;}$ 20 – 25[×10^4] mL^{-1}; 1.3–2.1[×10^4] mL^{-1};2.7 –6.2[×10^3] mL^{-1}; 1.9–2.0 [×10^3] mL^{-1}and 2.0 – 2.8[×10^3] mL^{-1} at Site D, F, A, B, C and E, respectively. Variations in total viable counts (TVC) were large in Site D. Similar to TVC, the Total Coliforms, *Faecal Coliforms, and Faecal*

Streptococci ranges were higher in Sites D and F. All sites were found to have high TVC and the values were relatively higher in most of the places which may be due to the presence of populations residing in these coastal areas. (Figure 3.31).

High *Fecal coliforms* (40%) present in water samples are explained by a lack of sewage treatment in inhabited areas as well as by stormwater drains or seepage running into adjacent nearshore areas. (Figure 3.31).

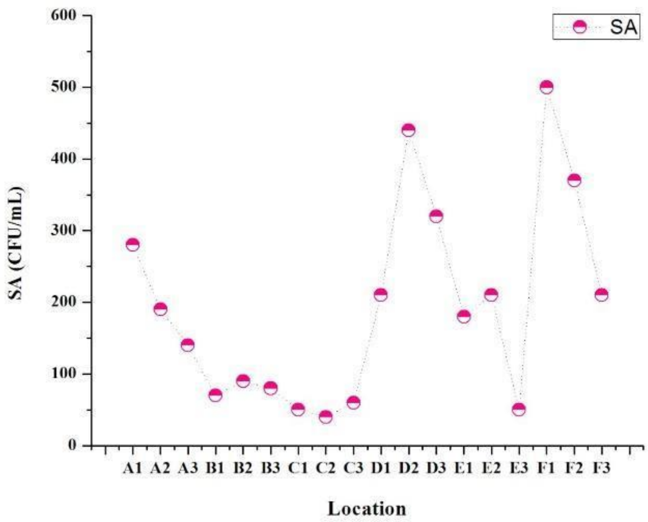


Figure 3.32: Graph depicting the presence of *Salmonella/Shigella* spp. across sampling locations in Tamilnadu

The counts of *Salmonella* sp (SA) ranges from 0 – 400 mL^{-1} respectively. During the monsoon season discharges including sewage waste from dumping sites contaminated groundwater sources additionally increasing bacterial loads compared to other seasons. Results of the bacteriological parameters revealed that coastal samples were highly affected with high bacterial populations at all locations. In conclusion, our study indicates the high extent of microbial pollution, and hence any further addition of wastes containing microbes may deteriorate the existing hygienic quality of the study area. (Figure 3.32)

c) Heavy Metals:

Heavy metal concentrations were relatively high and the average metal concentration was in the range for Fe (0 to 73.4 mg/L), the maximum concentration of Copper (Cu) was observed in Site D and the minimum was in Site F (Figure 3.33). The higher concentrations at these sites might be due to domestic sewage from industrial/shipping activities and fishing communities dotted along the study area. The presence of Cu in the seawater/aquifer could be attributed to the urban and industrial runoff as well as traffic emission/fossil fuel paints and agrochemicals. The continuous increase in heavy metal contamination of coastal wateris a cause of concern as these metals can bioaccumulate in the tissues of various biota.

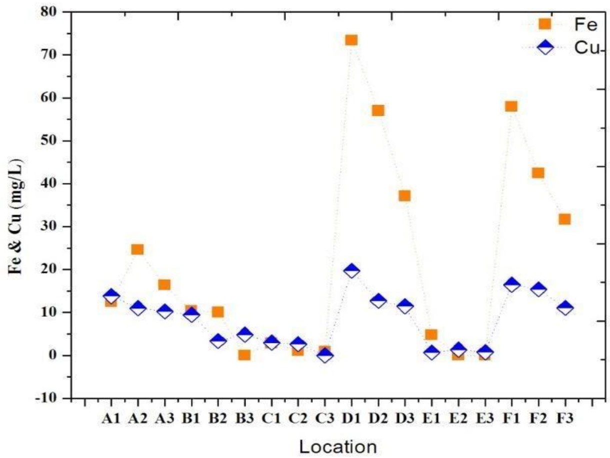


Figure 3.33: Graph depicting heavy metals- Iron and Copper presence across sampling locations in Tamilnadu

Figure 3.34 Sample collection- seagrass, sediment, and water samples in Tamil Nadu

3.1.5 Dugong Stranding

A total of 6 dugong strandings were recorded in the last year. There were no stranding events in February, March, April, May, July, and November. As March has been observed to be a month of the year when maximum dugongs have stranded, it is unusual that the number of strandings was zero in March 2021. Morphometric measurements and tissue samples were collected from the stranded dugongs.

Table 3.2 Details of stranded dugongs from July 2020 to July 2021 at Palk Bay and Gulf of Mannar, Tamil Nadu

Date	Place	Species	Sex	Maturity Stage	Status	Informer
06-08-2020	Manamelkudi, Palk Bay	*Dugong dugon*	Unknown	Adult	Dead	TN Forest Department
09-08-2020	Nambuthalai, Palk Bay	*Dugong dugon*	Unknown	Sub-Adult	Dead	Fishermen and TN Forest Department
12-12-2020	Kanyakumari, Gulf of Mannar	*Dugong dugon*	Unknown	Calf	Dead	TN Forest Department
06-01-2021	Valinokkam, Gulf of Mannar	*Dugong dugon*	Female	Adult	Dead	TN Forest Department
15-01-2021	Manamelkudi, Palk Bay	*Dugong dugon*	Male	Adult	Dead	TN Forest Department
29-01-2021	Sanguthoppu, Palk Bay	*Dugong dugon*	Female	Sub-Adult	Dead	Fishermen and TN Forest Department

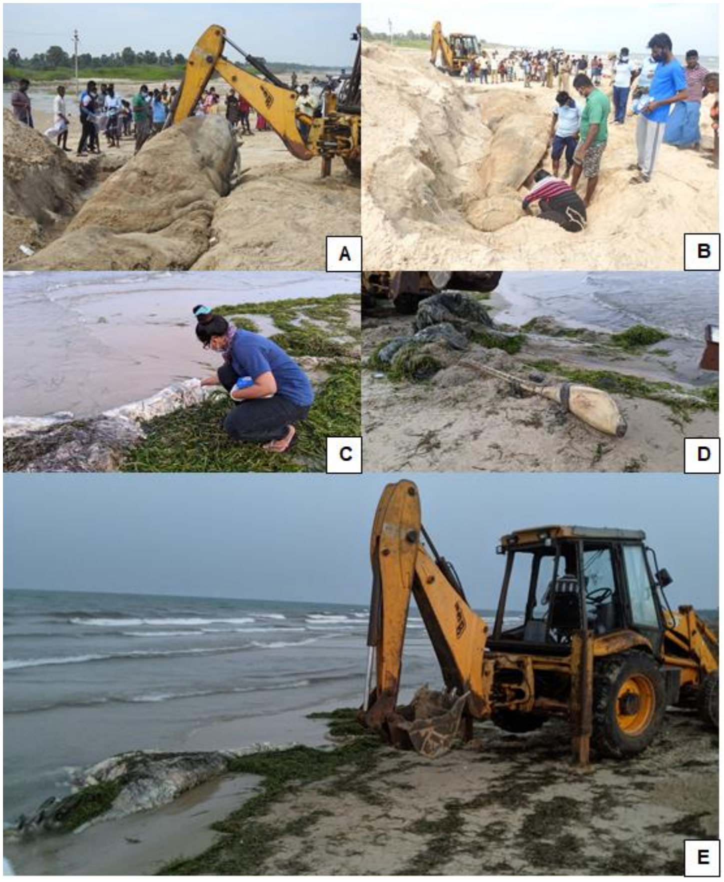
Figure 3.34 A-Dugong Stranding at Manamelkudi, Palk Bay; B- Dugong Stranding at Manamelkudi, Palk Bay; C- Dugong stranded at Nambuthalai beach, Palk Bay; D- Dugong Stranded at Kanyakumari beach; E- Morphometric data collection from dugong stranded at Kanyakumari; F- Dugong Stranding at Valinokkam, Gulf of Mannar; G- Dugong stranding at Manamelkudi, Palk Bay; H & I- Dugong stranding at Sanguthoppu, Palk Bay

3.1.6 Other Marine Mammal Stranding

Table 3.3 stranded marine mammals (other than dugongs) from July 2020 to July 2021 at Palk Bay and Gulf of Mannar, Tamil Nadu

Date	Place	Species	Sex	Maturity Stage	Status	Informer
22-11-2020	Athankarai, Palk Bay	*Physeter macrocephalus*	Unknown	Adult	Dead	Fishermen and TN Forest Department
11-12-2020	Azhagankulam, Palk Bay	*Physeter macrocephalus*	Unknown	Adult	Dead	Fishermen and TN Forest Department

Figure 3.35 A & B- Sperm whale stranded at Attrankarai beach



C, D & E- Sperm whale carcass washed ashore Azhagan-kulam Beach, Palk Bay, Tamil nadu

3.2 OUTREACH, AWARENESS, AND CAPACITY BUILDING PROGRAMME

Community perspectives and conservation needs for dugongs. Various approaches ranging from stakeholder consultations, orientation workshops, oral & poster presentations, community workshops, hands-on training, field visits, etc, were utilized to sensitize and train the stakeholders in dugong conservation and seagrass habitat monitoring. In the field season 2020-21, we conducted a total of eleven outreach, awareness, and capacity-building programs around Palk bay and the Gulf of Mannar, Tamil Nadu to raise awareness about the importance of dugongs and their habitats and the need for conservation. Out of these events, five were conducted for awareness & scholarship and five meetings were conducted with different stakeholders (Table 3.2). 4th Special training course with hands-on training towards underwater marine biodiversity monitoring with SCUBA diving program (Figure 3.43). The participants of the course were fifteen in number, with five from the Tamil Nadu Forest Department, five from the Tamil Nadu Coastal Security Group, Two from Fisheries Department, and Three participants from the fishing community, who are also active Dugong Volunteers (Table 3.2). The dugong recovery program has been supported by multiple stakeholders across Tamil Nadu.

Table 3.4: Details of outreach & awareness activities and capacity building programs conducted in different areas of Tamil Nadu in the year 2020-21

SN	Location	Date	Name of the Event	Type of stakeholders	The total No of people who attended the events
1	Chennai	29th to 31st July 2020	State-level Webinar	College students, Research scholars, and teachers	300

SN	Location	Date	Name of the Event	Type of stakeholders	The total No of people who attended the events
2	Wildlife warden office, Ramanathapuram	07-08 October 2020	Meeting and Discussion with Wildlife Warden regarding marine mammal webinar	Forest officials	150
3	Wildlife warden office, Ramanathapuram	12th October 2020	Marine Mammal Webinar	Wildlife warden	1
4	Govt. GHS School, Thondi	05th November 2020	The final round of the Scholarship exam	School student	41
5	Ramanathapuram	17th to 21 November 2020	4th Special hands-on training towards Underwater marine biodiversity monitoring with SCUBA diving program	Forest department, Marine Police (Coastal Security Group), Fisheries department and Fishing community	15

SN	Location	Date	Name of the Event	Type of stakeholders	The total No of people who attended the events
6	DFO Office, Thanjavur	25th January 2021	Meeting with District Forest Officer, Thanjavur regarding the proposed conservation reserve	DFO	1
7	Temple Adventure, Pondicherry	5th February 2021	Regarding our next biodiversity monitoring training program with the SCUBA diving course	Director, Temple Adventure	1
8	WLW Office Ramanathapuram	26th February 2021	Obtain permission for the preservation of marine mammal carcass to be used at the Marine Mammal stranding workshop.	Wildlife warden	1

SN	Location	Date	Name of the Event	Type of stakeholders	The total No of people who attended the events
9	DFO, Thanjavur	5th March 2021	Zoom Meeting with finalized the subject expert list for conservation reserve at north palk bay	Forest officials	2
10	Mohamed Sathak Kabeer School, Ramanathapuram	22nd March 2021	Forest day	School students, teachers, and Forest staffs	50
11	Alagappa University, Thondi	24th March 2021	Dugong recovery program presentation and SCUBA diving demonstration	Marine biology & Oceanography students and Professors	60

1. Webinar series on National Capacity Building Training on Marine Biodiversity and Its Conservation

Date: 29th to 31st July 2020
Venue: Chennai

Webinar series- Presented about Dugong recovery and conservation on National Capacity Building Training on Marine Biodiversity and Its Conservation, Organized by Post Graduate & Research Department of Zoology, Dr. Ambedkar Govt. Arts College, and Chennai. Around 300 viewers have participated.

Figure 3.36: Webinar series- National Capacity Building Training on Marine Biodiversity and its Conservation in Tamilnadu

2. Webinar series on Marine Mammal Conservation in India: Status, Challenges, and opportunities

Date: 12th to 14th October 2020
Venue: Ramanathapuram.

Webinar on Marine Mammal Conservation in India: Status, Challenges, and Opportunities, zoom meeting in Marine mammal webinar at forest office, Ramanathapuram. Around 150 viewers have participated.

Figure 3.37: Wildlife Warden presenting Marine Mammal, Gulf of Mannar in Marine Mammal Webinar

3. Final round of scholarship exam

Date: 05th November 2020

Venue: Govt. GHS School, Thondi.

The exam was conducted separately in one school in the Ramanathapuram district. 41 (out of 48 applied) students appeared for the examination at Government Girls' Higher Secondary School, Thondi.

4. Special training course on hands-on training towards Underwater marine biodiversity monitoring with Scuba diving program on 17-21 November 2020 (4th Biodiversity Monitoring Training Course with SCUBA Diving in Tamil Nadu)

Date: 17th to 21st November 2020

Venue: GoM, Ramanathapuram.

Day 1 (17.11.2020) Inaugural program: The occasion was graced by Mrs. J. Jayanthi IPS, Superintendent of Police, Coastal Security Group, Tamil Nadu, Mr. A.S. Marimuthu IFS, Wildlife Warden, Gulf of Mannar Marine Biosphere Reserve, Mr. Arun Kumar, District Forest Officer, Ramanathapuram, Mr. T. Elamvaluthi, Deputy Director of Fisheries and Mr. S. B. Aravind (dive instructor for the course) Director, Temple Adventures, Pondicherry. The participants of the course were 15 in number, with 5 from the Tamil Nadu Forest Department, 5 from the Tamil Nadu Coastal Security Group, 2 Fisheries Department, and 3 participants from the fishing community, who are also active Dugong Volunteers.

After the session was handed over to Mr. Aravind, marking the beginning of the theory classes of this course which continued, the sessions were aided with videos followed by knowledge review tests for each session (chapter).

Day 2 (18.11.2020) four remaining theory sessions were conducted at the Wildlife Warden Office, Ramanathapuram.

Day 3 (19.11.2020) the participants and the Temple Adventures team, along with the WII team assembled at the Kunthukal beach for the confined water dive. All concepts and skills that were till then taught theoretically, were practically carried out in shallow water.

Day 4 (20.11.2020) The fourth day of the training started with a briefing and a demonstration of a few techniques, followed by the first open water dive assisted by the Temple Adventures team and a second dive near the coral patches of Mandapam in two batches respectively. After the discussion was conducted at the Forest Guesthouse, Thangachimadam.

Day 5 (21.11.2020) The first batch of the participants (marine police team) were taken for a 40-minute dive, while the remaining two batches (consisting of a fisheries Department & fisherman and the last batch forest department team) attended the theory and practical session of biodiversity monitoring conducted. The final examination for the participants was conducted in the afternoon at the Thangachimadam Forest Guesthouse.

The valedictory event was attended by the Ramanathapuram District Collector, Mr. Dinesh Ponraj Oliver IAS, and Mr. T. Elamvaluthi, Deputy Director of Fisheries, who presented the participants with the course completion certificate and a memento and delivered a speech highlighting the importance of the course and the significance of this collaborative work. Mr. Aravind along with our WII team gave a small speech encouraging the participants to dive more and to use this skill for a better purpose. The participants shared their experiences and opinions (Figure 3.43).

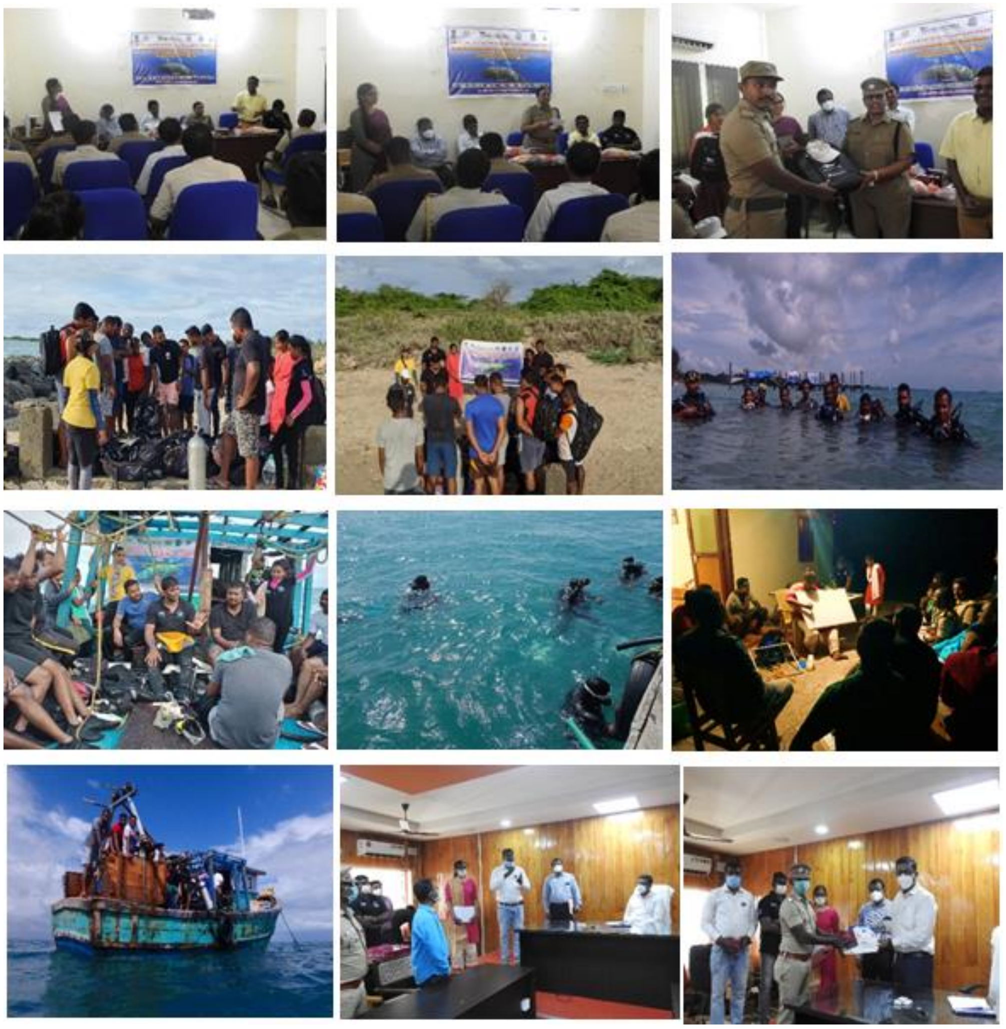


Figure 3.38: Fourth Biodiversity Monitoring Training Course with SCUBA Diving in Tamil Nadu

6. Palk Bay Conservation Reserve meeting

Date: 25th January 2021

Venue: District Forest Officer, Thanjavur

The Dugong team from TN met the District Forest Officer of Thanjavur at Thanjavur Forest Office, to discuss how to introduce the concept of North Palk Bay Conservation Reserve to the locals, potential alternate livelihood options for the community, and the required documents to prepare the initial official reports to declare the area as a Conservation Reserve.

7. SCUBA diving training program meeting

Date: 05th February 2021

Venue: Temple Adventure, Pondicherry

Met the Director, Temple Adventure regarding our next biodiversity monitoring training program with the SCUBA diving course**.**

8. Verification of Dugong Ambassadors

Date: 08th February 2021to 11th February 2021

Venue: Verified Dugong ambassadors details

The team Visited 60 schools from Thanjavur, Puthukkottai, Ramanathapuram, and Tuticorin district, verified the bank details of 100 dugong ambassadors who were getting Dugong scholarship installment on regular basis.

9. Permission for Marine Mammal standing workshop

Date: 26th February 2021

Venue: Wildlife Warden, Gulf of Mannar, Ramanathapuram

A meeting with Wildlife Warden and Rangers, Gulf of Mannar was conducted to obtain permission for the preservation of marine mammal carcass to be used for the Marine Mammal stranding workshop.

10. Finalising Dugong scholarship result

Date: 03rd March 2021

Venue: Mohamed Sathak Dasthagir B.Ed College, Ramanathapuram

Discussed with Dr. S. Somasundaram, Principal, Mohamed Sathak Dasthagir B.Ed College, and Ramanathapuram for finalizing the result for Phase IV Dugong ambassadors.

11. Finalising the subject expert for Conservation reserve

Date: 05th March 2021

Venue: Zoom Meeting with the DFO, Thanjavur

We discussed and finalized the subject expert list for the conservation reserve at north palk bay with Mr. Ilayaraja, DFO, and Thanjavur via Zoom Meeting.

12. Forest day celebration

Date: 22nd March 2021

Venue: Forest Day celebration at Ramanathapuram

Thirty students from Mohamed Sathak Kabeer School, Ramanathapuram, and Forest department staff participated in celebrating Forest day, on 22nd March 2021.

13. Awareness and Training program at Alagappa University, Thondi

Date: 24th March 2021

Venue: Alagappa University at Thondi campus

Forty students of Marine biology and Oceanography from Alagappa University participated in the Dugong recovery program training session and with SCUBA diving and biodiversity & monitoring training at the Thondi campus on 24th March 2021.

14. Dugong hero award

Date: 30th April 2021

Venue: Dugong hero video making for Dugong day celebration

We took some video clips from Anti-poaching watchers and Fishermen who released dugong for the Dugong day celebration

Figure 3.39: Glimpse of outreach activities conducted at Tamil Nadu

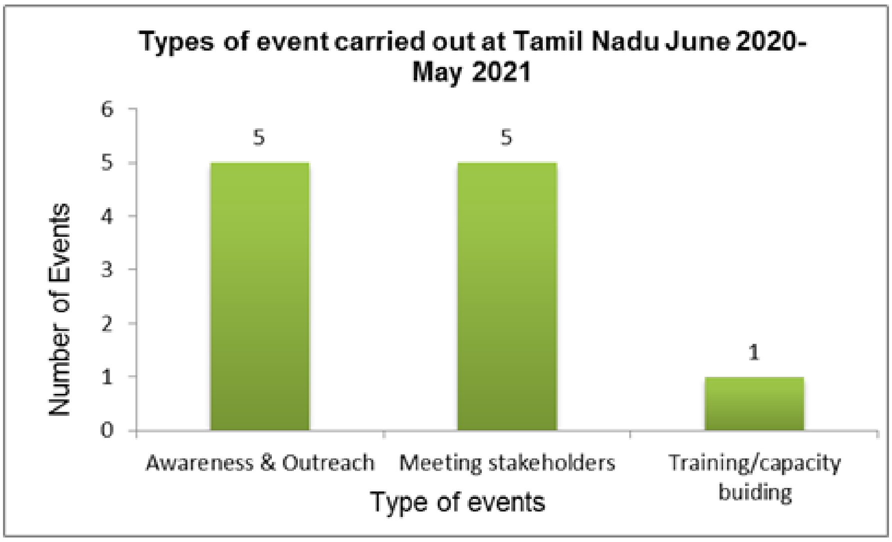


Figure 3.40: Details of various events conducted at Tamil Nadu during the field season

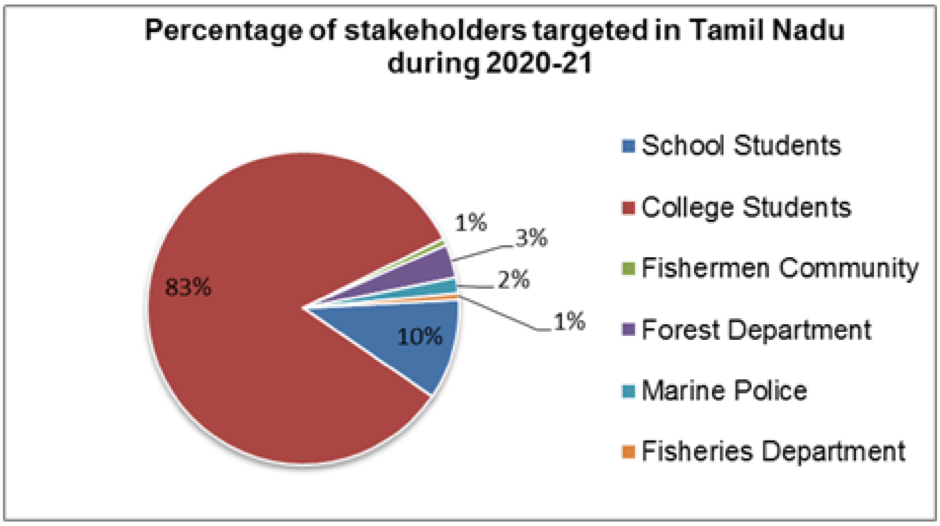


Figure 3.41: Percentage of stakeholders targeted at Tamilnadu in the year 2020-21

Dugong Scholarship Programme

One of the objectives of the project is to get the support of fishermen communities in the conservation of dugongs. In this context, it is planned to reach out to the fishermen's parents through their school-going children. In this connection, it is planned to provide 'Dugong Scholarships' to 60 schools-going children of fishermen communities for two years Rs.500/month, on a merit basis through a competitive exam. In Tamil Nadu, we have completed three years of the dugong scholarship program from July 2017 to July 2020. Till now, a total of 303 students have been awarded the dugong scholarship and the students selected under this program are identified as Dugong ambassadors.

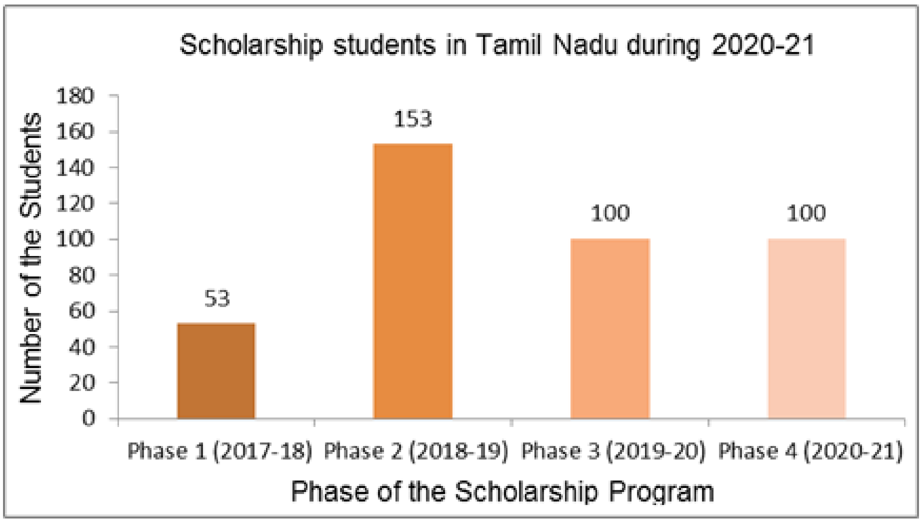


Figure 3.42: Number of students awarded scholarship over three years at Tamil Nadu

Table 3.5: Details of Dugong scholarship programs in Tamil Nadu

SN	School Name	Village/ Town	District	Phase 1 2017 - 2018	Phase 2 2018 - 2019	Phase 3 2019 - 2020	Phase 4 2020 - 2021
1	Govt. Girls Hr. Sec. School, Adiramapattinam	Adirampapattinam	Thanjavur	2	5	3	3
2	Govt. Hr. Sec. School, Rajamadam	Rajamadam	Thanjavur	4	5	1	1
3	Govt. Hr. Sec. School	Mallipattinam	Thanjavur	4	7	3	3
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
4	Govt. High School, Sethuma Chathiram	Sethuma Chathiram	Thanjavur	2	5	3	3
5	Govt. High School, Pudutheru	Puduthueru	Thanjavur	2	3	1	1

6	Govt. Hr. Sec. School, Kattumavadi	Kattumavadi	Pudukkottai	4	6	2	2
7	Govt. Boys Hr. Sec. School, Manamelkudi	Manamelkudi	Pudukkottai	4	5	1	1
8	Govt. Girls Hr. Sec. School, Manamelkudi	Manamelkudi	Pudukkottai	4	6	2	2
9	Govt. Hr. Sec. School, Jagathapattinam	Jagathapattinam	Pudukkottai	2	3	1	1
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
10	Govt. Hr. Sec. School, Kottaipattinam	Kottaipattinam	Pudukkottai	4	5	1	1
11	Govt. Hr. Sec.	Gopalapattina	Pudukkottai	0	1	1	1

	School, Gopalapattinam	m					
12	Govt. Hr. Sec. School, Mimisal	Mimisal	Pudukkottai	4	6	2	2
13	Govt. High School, Vattanam	Vattanam	Ramanathapuram	2	3	1	1
14	Govt. Hr. Sec. School, S. P. Pattinam	S. P. Pattinam	Ramanathapuram	1	2	1	1
15	Govt. Hr. ec. School, Solaganpettai	Solaganpettai	Ramanathapuram	1	1	0	0
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
16	Wilhelm High School, Thondi	Thondi	Ramanathapuram	1	1	0	0
17	IMMS HR. Sec. School, Thondi	Thondi	Ramanathapuram	2	2	0	0

18	S. M. Govt. Hr. Sec. School, Thondi	Thondi	Ramanathapuram	4	6	2	2
19	Govt. Girls Hr. Sec. School, Thondi	Thondi	Ramanathapuram	2	4	2	2
20	Govt. High School, Nambuthalai	Nambuthalai	Ramanathapuram	2	4	2	2
21	Amala Annai Hr. Sec. School, Karangkadu	Karangkadu	Ramanathapuram	2	5	3	3
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
22	Govt. Hr. Sec. School, Uppoor	Uppoor	Ramanathapuram	0	3	3	3
23	Govt. Hr. Sec. School, Tiruppalaikudi	Tiruppalaikudi	Ramanathapuram	0	3	3	3

24	Govt. High School, Sambai	Sambai	Ramanathapuram	0	1	1	1
25	Govt. Hr. Sec. School, Devipattinam	Devipattinam	Ramanathapuram	0	1	1	1
26	Mohamedia Hr. Sec. School, Chittar Kottai	Chittar Kottai	Ramanathapuram	0	2	2	2
27	Govt. High School, Palanivalasai	Palanivalasai	Ramanathapuram	0	1	1	1
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
28	Arabi Oliyullah High School, Puduvalasai	Puduvalasai	Ramanathapuram	0	1	1	1
29	Govt. Girls Hr. Sec. School, Panaikulam	Panaikulam	Ramanathapuram	0	2	2	2

30	Bahrurdin Govt. Boys High School, Panaikulam	Panaikulam	Ramanathapuram	0	1	1	1
31	Govt. Hr. Sec. School, Alagankulam	Alagankulam	Ramanathapuram	0	2	2	2
32	Govt. Hr. Sec. School, Uchipulli	Uchipulli	Ramanathapuram	0	3	3	3
33	Govt. Hr. Sec. School, Irumeni	Irumeni	Ramanathapuram	0	2	2	2
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
34	Govt. Hr. Sec. School, Vedalai	Vedalai	Ramanathapuram	0	5	5	5
35	Govt. Hr. Sec. School, Mandapam Camp	Mandapam Camp	Ramanathapuram	0	1	1	1

36	Govt. Girls Hr. Sec. School, Mandapam	Mandapam	Ramanathapuram	0	4	4	4
37	Govt. Hr. Sec. School, Pamban	Pamban	Ramanathapuram	0	1	1	1
38	Govt. Hr. Sec. School, Thangachimadam	Thangachimadam	Ramanathapuram	0	3	3	3
39	Punitha Yagappar Hr. Sec. School	Thangachimadam	Ramanathapuram	0	4	4	4
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
40	Govt. Hr. Sec. School, Rameswaram	Rameswaram	Ramanathapuram	0	6	6	6
41	Govt. High School, Karaiyur	Karaiyur	Ramanathapuram	0	2	2	2
42	Govt. Hr. Sec.	Pudumadam	Ramanathapur	0	2	2	2

	School, Pudumadam		am				
43	Govt. Girls Hr. Sec. School, Pudumadam	Pudumadam	Ramanathapuram	0	1	1	1
44	Govt. High School, Thamaraikulam	Thamaraikulam	Ramanathapuram	0	1	1	1
45	Govt. Hr. Sec. School, Periyapattinam	Periyapattinam	Ramanathapuram	0	2	2	2
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
46	Govt. high School, Kalimankundu	Kalimankundu	Ramanathapuram	0	1	1	1
47	Govt. Hr. Sec. School, Thinaikulam	Thinaikulam	Ramanathapuram	0	2	2	2
48	Mahdhoomia Hr. Sec.	Kilakarai	Ramanathapur	0	1	1	1

	School, Kilakarai		am				
49	Islamiah High School, Kilakarai	Kilakarai	Ramanathapuram	0	1	1	1
50	Hameediah Girls Hr. Sec. School, Kilakarai	Kilakarai	Ramanathapuram	0	2	2	2
51	Hameediah Boys Hr. Sec. School, Kilakarai	Kilakarai	Ramanathapuram	0	1	1	1
SN	**School Name**	**Village/ Town**	**District**	**Phase 1 2017 - 2018**	**Phase 2 2018 - 2019**	**Phase 3 2019 - 2020**	**Phase 4 2020 - 2021**
52	Govt. Hr. Sec. School, Ervadi	Ervadi	Ramanathapuram	0	6	6	6
	Total			**53**	**153**	**100**	**100**

3.3 OUTPUTS AND ACCOMPLISHMENTS

1. Mass boat surveys over a 205 square kilometers area to sight marine mammals, litter, and fishing activity mark the successful surveillance of the nearshore waters of the proposed North Palk Bay Conservation Reserve.
2. 135 quadrats have been photographed, and seagrass, sediment, and seawater samples have been collected from these locations for seagrass abundance, seagrass species diversity, and shoot density.
3. The fourth master's dissertation of a student from Bharatidasan University, Trichy was successfully completed at the Tamil Nadu field station.
4. Two dugongs were successfully rescued from the Palk Bay region.
5. Conducted an awareness program for the School & College students and Fishing community.
6. Completed next phase dugong scholarship exam 2019-21.
7. Completed Fourth Biodiversity Monitoring Training Course with SCUBA Diving for the stakeholders (Forest department, Marine Police and Fisheries department including Fishermen).

3.4 MANAGEMENT RECOMMENDATIONS

1. As the North Palk Bay region has been proposed as a potential Conservation Reserve with a high dugong population and a high fishing pressure, the following recommendations are suggested:

a. **Steps to stop littering**: Litter has been found along the coast and at sea. Garbage bins should be placed at more regular intervals and these must be sturdy with lids to prevent the flying of plastic and other light litter. The community must be taught the importance of keeping their surroundings clean because these fishing communities live within a meter from the high tide line.

b. **Outreach activities** to make the community aware of the importance of their region to dugongs. All classes of fishermen need to be involved in these meetings.

c. **Fishing regulations** are to be made to curb near-shore trawling, illegal fishing gear employment, and overfishing. Enforcement of existing laws is to be more stringent. Trawling must be restricted beyond 3 nautical miles from the coast. Drag nets of any kind should be banned within this ‘no-trawl zone’.

d. **Felicitation** must be given to rescuers of dugongs and other protected species, to ensure continuous and dedicated support from the community towards the protection of the species and its habitat.

e. Dugong acoustic studies

ANNUAL FIELD REPORT 2020-21

ANDAMAN AND NICOBAR ISLANDS

Team Members:

Swapnali Gole (Project Fellow), Sagar Rajpurkar (Project Fellow), Sohom Seal (UGC Research Fellow), Sumit Prajapati (Project Assistant), Esha Gokhale (Field Assistant), Aashish Gokhale (Field Assistant)

Volunteer: Ajay Kumar, Saw Tapori

Citation: Gole S., Rajpurkar S., Seal S., Prajapati S., Gokhale E., Gokhale A., (2021) Annual Field Report 2020-21, Andaman and Nicobar Islands, In Annual Field Report V (2020-21), Recovery of Dugongs and their habitats in India: An Integrated Participatory Approach, Wildlife Institute of India, pp

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DRM (Forest Department)

Sh. Justin (Boat Master, Mahatma Gandhi Marine National Park, Wandoor), Sh. Nikunju (DRM, South Andaman), Saw Emuyi (DRM, Mayabunder, N&M Andaman), Saw Darius (DRM- Boat Master, Mayabunder, N&M Andaman), Sh. Pratap (DRM- Boat Master, Mayabunder, N&M Andaman), Saw Keybow and Crew (Boat-Master, Karmatang range, N&M Andaman), Sh. Surojit Das and Crew (DRM- Boat Master, Aerial Bay, Diglipur, North Andaman), Sh. Parimal and Crew (DRM- Boat Master, Radhanagar, Diglipur, North Andaman)

Indian Navy

Captain Vishal Roy (Commanding Officer, INS Utkrosh), Lieutenant Commander. Vivek Tamilmani (INS Utkrosh, South Andaman), Lieutenant

Commander. Prafful Itape (INS Utkrosh, South Andaman), Commander Manas R Moharana (Commanding Officer, INS Kohassa) Surg Lt. Cdr.Vinod Chavan (INS Kohassa, Shibpur)

Indian Coast Guard

DIG Ashish Sinha (Port Blair Headquarters), Comdt. Rishab Saxena (Port Blair Headquarters), Sh. S. M. Singh (DHQ-9, Aerial Bay), Comdt. P. R. Lochan (DHQ-9, Rampur), Deputy Commandant Manmohan Singh (DHQ-9, Rampur), Assistant Commandant Shubham Sharma (DHQ-9, Aerial Bay)

Police Marine Force

Sh. Amit Singh (PCR, Headquarters Port Blair), Sh. Arun Kumar Rai (North and Middle Andaman). Sh. Rajendran (North Andaman)

Directorate of Fisheries, Port Blair
Fishers Community, Andaman
SCUBA Divers Community, Andaman
Lifeguards, South and North Andaman

4.1. RESEARCH AND MONITORING

4.1.1 Understanding dugong distribution in the Islands, through a participatory multi-stakeholder citizen science approach

Field period: June 2020 to May 2021

Understanding dugong distribution is primary in managing the extant population on the islands, especially in the wake of growing anthropogenic pressures on dugong habitats.

Further, the inaccessibility of sites due to geographical vastness and limitations in conducting boat-based surveys collectively affects our understanding of dugong distribution in the islands. To fill this gap, a citizen science-based approach called the 'dugong monitoring program' was initiated in 2017 and has been successfully expanded throughout the North Andaman this season.

In this field season, the program was expanded spatially to North Andaman, amongst the previously identified stakeholders viz; fishers, tourism allied sectors, forest department, the Indian Navy, the Indian Coastguard, and marine police, with the latter being a new stakeholder.

All the included stakeholders in the dugong monitoring network were followed up monthly via phone calls to collect data regarding dugong sightings. Inventory of number, age class, time, location, photographs, and video of sighted dugongs was recorded and maintained to understand the movement patterns and distribution of dugongs in the islands.

Results:

Through 21 orientation programs conducted in a span of one year (June 2020 to May 2021), a total of 547 personnel were engaged in the dugong monitoring program across five major stakeholder groups viz; Fishers, Indian Coastguard & Indian Navy (INS & ICG), forest department, marine police and tourism allied sector (Table 4.1).

Table 4.1: Table showing different stakeholders engaged in 'Dugong Monitoring Network'

Stakeholders	No. of Programs	No. of personnel targeted
Fishers	5	192
Tourism allied sectors	4	20
ICG and INS	5	160
Forest Department	4	129
Marine Police	3	46

A total of 93 sightings were reported (Figure 4.1) from the North and South Andaman. By contributing to more than 50% of the total sightings, fishers were the most active informants followed by the tourism allied sector, defense bodies, forest department, and newly added stakeholder group of marine police (Figure 4.2).

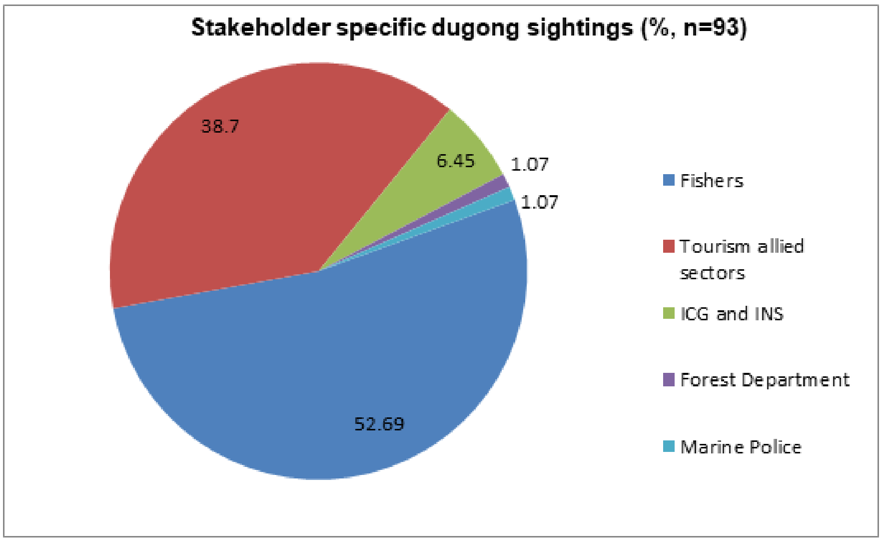

Figure 4.1: Stakeholder specific dugong sightings reported from June 2020 to May 2021 in Andaman Islands

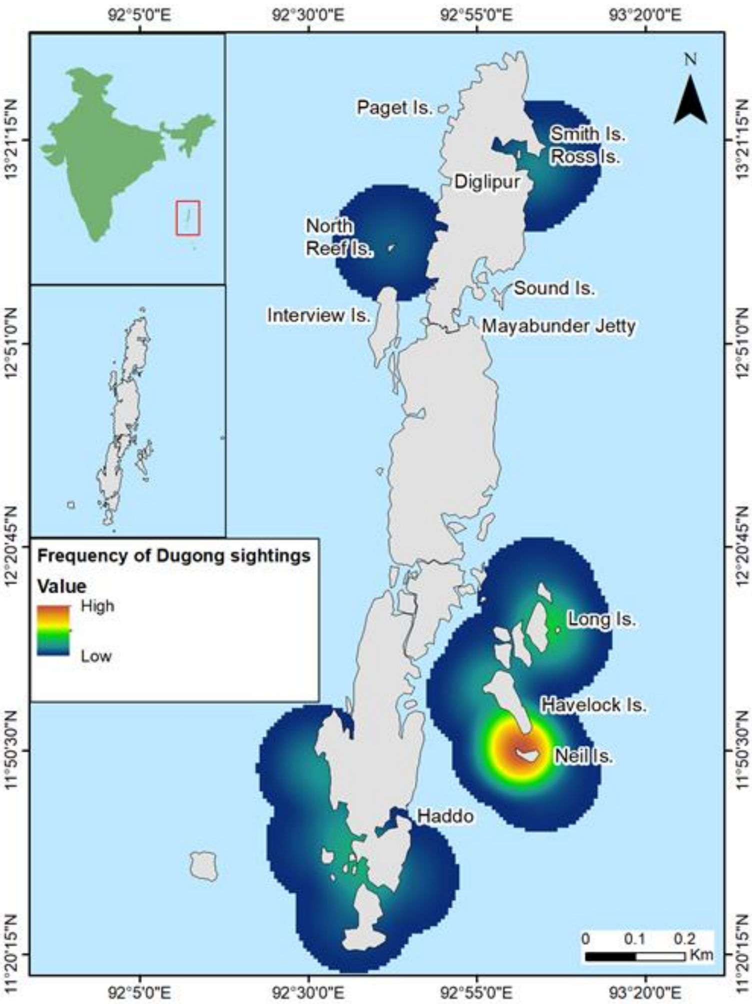

Figure 4.2: Heat map showing dugong distribution in the Andaman Islands, based on Dugong Monitoring Program

Maximum sightings reported were of solitary individuals (65.65 %), followed by pairs (25.25 %), with five sightings of calves throughout the study period from South Andaman. Group size varied from three to five individuals (8.08%).

Since the monitoring program was spatially expanded this season, INS- Kohassa, an Indian Navy unit based in Diglipur, and the police marine force were targeted for the first time. In line with previous field seasons, we were successful in getting sightings from inside tribal protected areas by the defense bodies, a region inaccessible to researchers. Three out of the five calf sightings were reported from unprotected, heavy tourism-influenced areas of Shaheed Dweep and Swaraj Dweep Islands, which highlights the need of managing the habitats used by the extant breeding dugong population in the Islands.

4.1.2 Quantifying and mapping threats to 'Critical Dugong Habitats in the Andaman Islands in terms of boat traffic and plastic litter

Background and Objective:

Dugongs are threatened majorly by net entanglement, habitat destruction, and fishing pressure in their habitats (Marsh et al., 2012). Despite knowing these threats, there is a lack of studies to quantify these threats for understanding the intensity of pressure. A threat mapping survey was carried out in the identified dugong trouble spots of the North and Middle group of the Andaman Islands

Study area:

The present survey was carried out in the North and Middle Andaman district; Mayabunder and Diglipur to quantify and characterize threats to dugongs and their habitats in terms of boat traffic and floating macro-litter**.**

Methodology:

A grid-based sampling method was used for the survey, where 2×2 km of grids were divided as near and offshore grids (approximately 20km offshore) from the island. The nearshore grids were selected based on the distribution of seagrass habitats, dugong sightings from literature, ground sampling, and interview surveys, whereas equal no. Offshore grids were randomly selected to represent the area spatially. At each point of the chosen grid, a 360-degree point count method was used by scanning the area up to 1km for 15 minutes to document the floating macro-litter and boat traffic.

Data variables like; Litter-type, boat-type, angle of the sighting, the distance of object was recorded. Environmental parameters like sea state, cloud cover, pH, and salinity, temperature, and GPS location of boat position were also taken down. For this study, we considered marine-litter only from anthropogenic sources, which we classified as "plastic bottles/caps'', "plastics bags" (i.e., wrappers, sheets, films, packaging sheets), "Styrofoam" and "buoys" and nature of boats (fishing, cargo, defense, and inter-island ferries).

Results:

A total of 35 grids were sampled from Mayabunder (n=18) and Diglipur (n=17) during the study period.

Collectively, boat traffic was majorly contributed by fishing boats (70.83%) which were either actively fishing or in transit followed by passenger boats (20.83%) used for inter-island movement, and lastly by cargo and defense ships (Figure 4.3).

Macro-litter observed included plastic bottles, bags, thermocol, and buoys in which plastic bottles contributed to 4.44% followed by plastic bags (37%), thermocol (15%), and buoys (3.7%) (Figure 4.4)

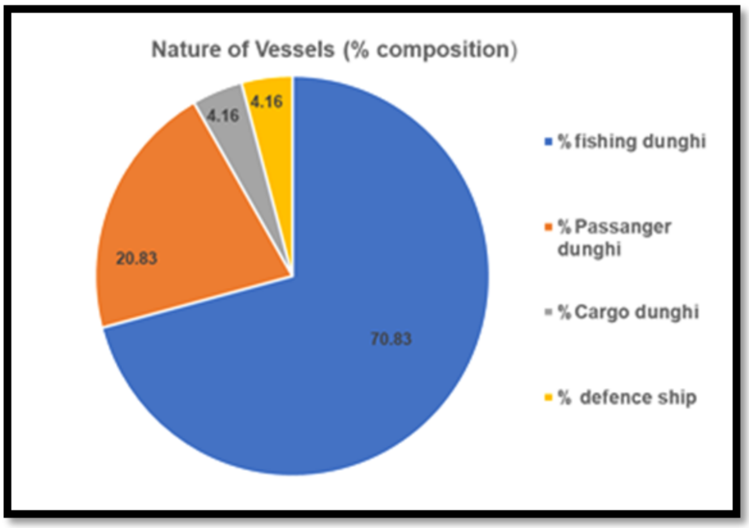

Figure 4.3: Nature of Boat-traffic found during the threat-mapping survey in North and Middle Andaman

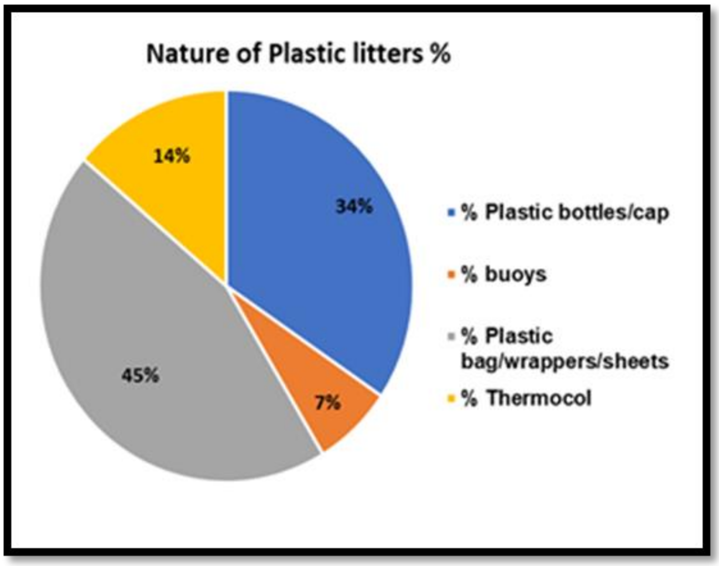

Figure 4.4: Nature of Plastic-litter found during a threat-mapping survey in the north and middle Andaman

Mayabunder

Total 18 grids were sampled during the survey on the East and West coast of the Mayabunder. Low to moderate level of boat traffic observed. Only two grids showed a moderate level of boat traffic near-shore whereas the rest of the grids showed zero boat traffic level. Illegal fishing was observed during the survey. Very low to moderate levels of floating macro-litter were observed during the survey. Only two grids showed a slightly high level of floating macro-litter in the map. Some of the offshore grids could not be covered due to unfavorable weather conditions (Figure 4.5).

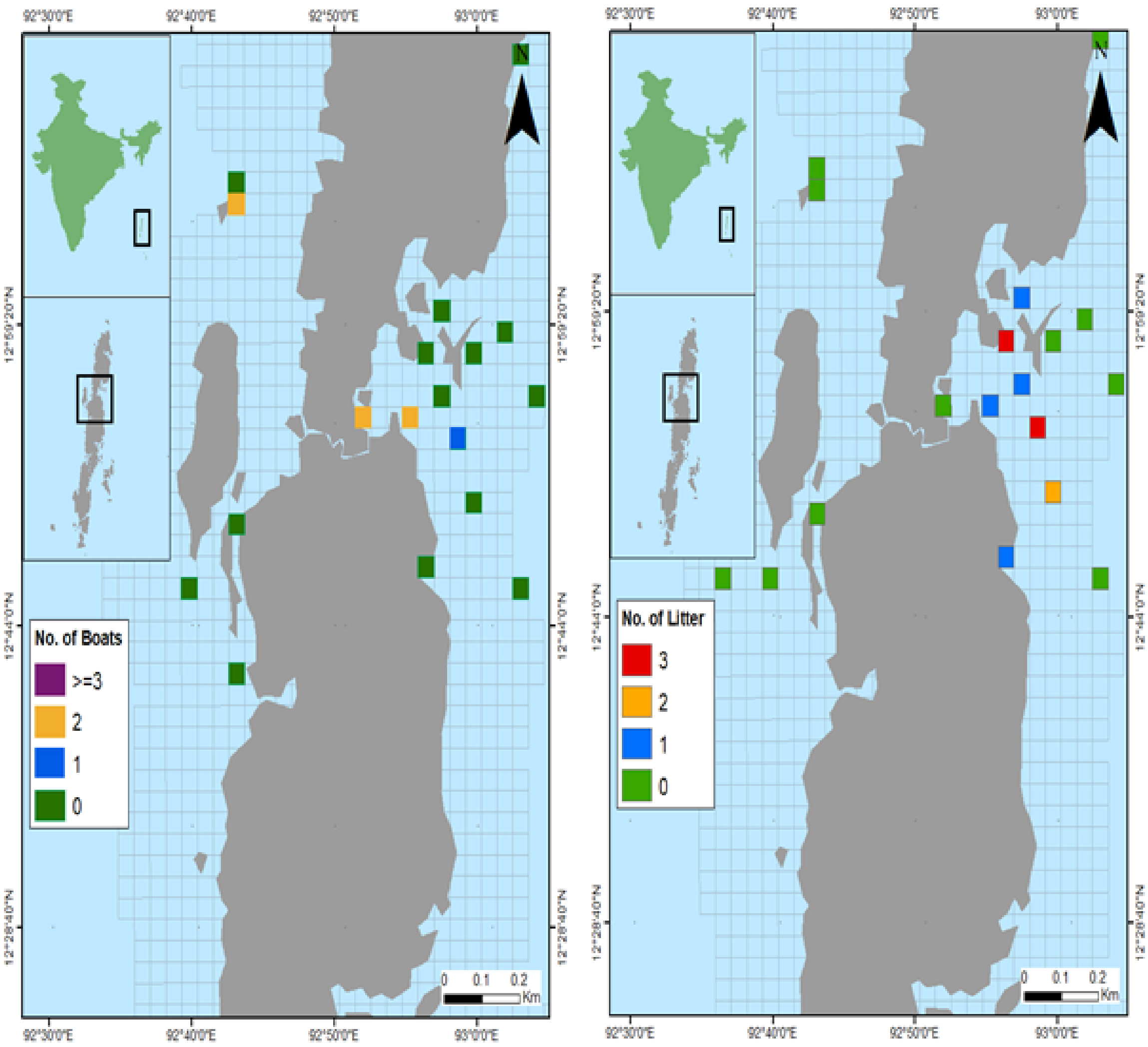

Figure 4.5: Map showing boat traffic (left) and floating macro-litter (right) in Mayabunder, Andaman from January to April 2021

Diglipur

A total of 17 grids were sampled during the survey from the east and west coast of Diglipur. Low to nil levels of boat traffic and floating macro-litter were observed during the survey. Only two grids showed a high level of boat traffic near the shore because boats were either anchored or fishing near the jetty. Only one grid showed a slightly high level of floating macro-litter (Figure 4.6).

In the present study, boat traffic and floating plastic litter was observed to be low throughout the sampled area, with an exception of few grids closer to the port area. Our study is the first time, where threats to dugong habitats have been quantified, and seasonal replicates will help to understand the intensity of threats to dugongs and their habitats, which would help in robust management interventions.

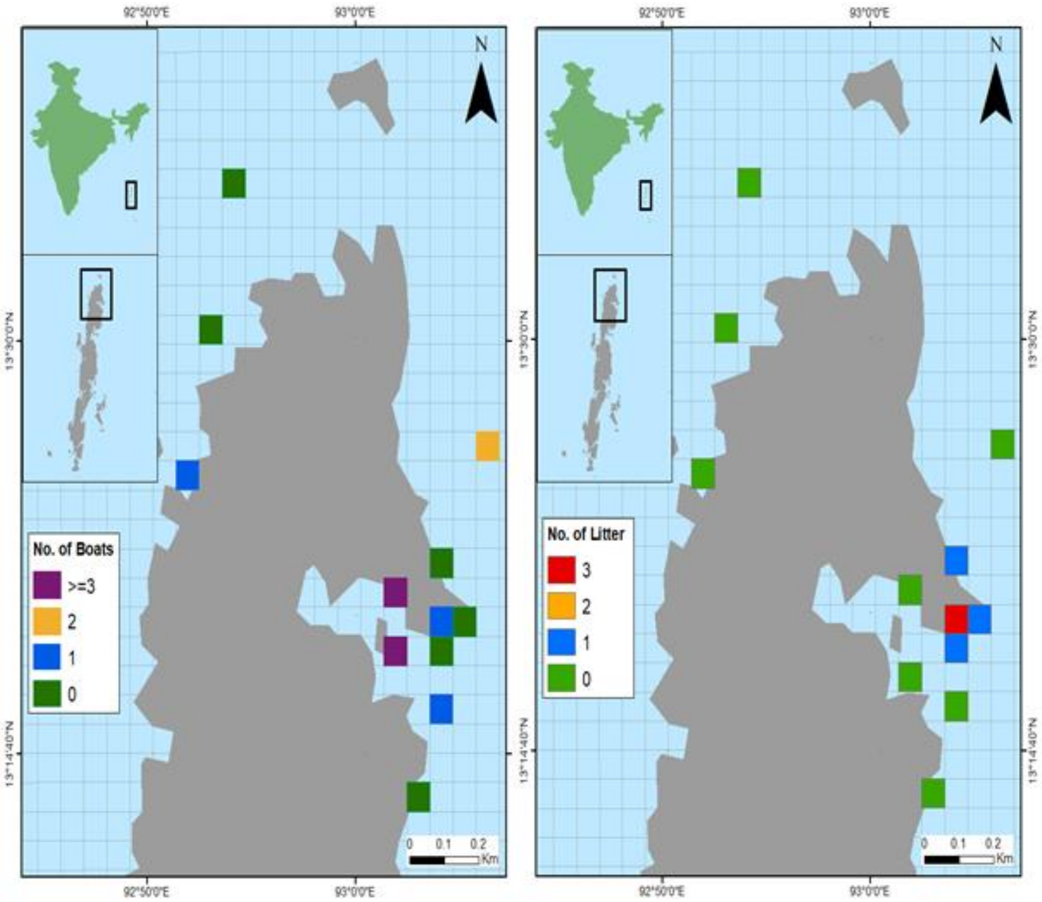

Figure 4.6: Map showing boat traffic (left) and floating macro-litter (right) in Andaman Islands

4.1.3 Habitat characterization of seagrass habitats in 'Critical Dugong Habitats'

Intensive Seagrass exploratory surveys: Intertidal (on foot) and subtidal (using SCUBA)

Background and Objective:

Seagrass meadows provide key habitats for various faunal groups (Jones *et al.,* 2020) and serve as the only feeding ground for threatened species like dugong which are distributed in pockets throughout Andaman and Nicobar Islands. Several studies have been carried out on seagrasses which suggest these habitats are threatened by anthropogenic activities such as coastal development, boat anchorage, and increasing tourism activity, and by natural calamities (tsunami, cyclones) which directly hampers the associated fauna, including dugongs. Thus, it is important to understand these seagrass habitats which will aid in the management and conservation of dugongs.

In the present study, we aimed to understand the distribution of seagrasses in critical dugong habitats.

Study area:

The present study was carried out across 16 sites from South, North, and Middle Andaman namely; Channel (Between Landfall and East), Landfall, Craggy, Shibpur, Kalipur, Smith Island, Temple, Excelsior, Dalgarno, Radhanagar channel, Paget, Point, Reef, North Reef, Pokkadera, Haddo

Methodology:

After exploration and locating the seagrass meadow, a Line Intercept Transect (LIT) methodology was used to understand the depth-wise seagrass distribution, species composition, and seagrass cover.

A 50m long LIT'S were laid perpendicular to shore and at each site three replicates were taken spaced apart 150-200m. On this line at every 5m; a 50X50 cm quadrat was used to record the meadow characteristics. For biomass, shoot density, and shoot length estimation three samples (from 0m, 25m, and 50m on the transect line) were collected using a 20 X 20 cm quadrat area within the larger (50 x 50cm) quadrat of one shoot length, total biomass (above and below ground, dry weight) and non-epiphytic algal cover using McKenzie and Yoshida, 2012) LIT.

Results:

A total of 7 species belonging to 5 genera were recorded from 16 sampled sites across the Andaman islands in the present study (Figure 4.9) viz; *Halophila ovalis, Halophila decipiens, Halodule uninervis, Halodule pinifolia, Thalassia hemprichii, Enhalus acoroides,* and *Cymodocea rotundata.*

The highest number of species (n=4) were recorded from Reef and Point Island from North Andaman, and mixed-species intertidal meadows of Haddo, South Andaman (Figure 4.7).

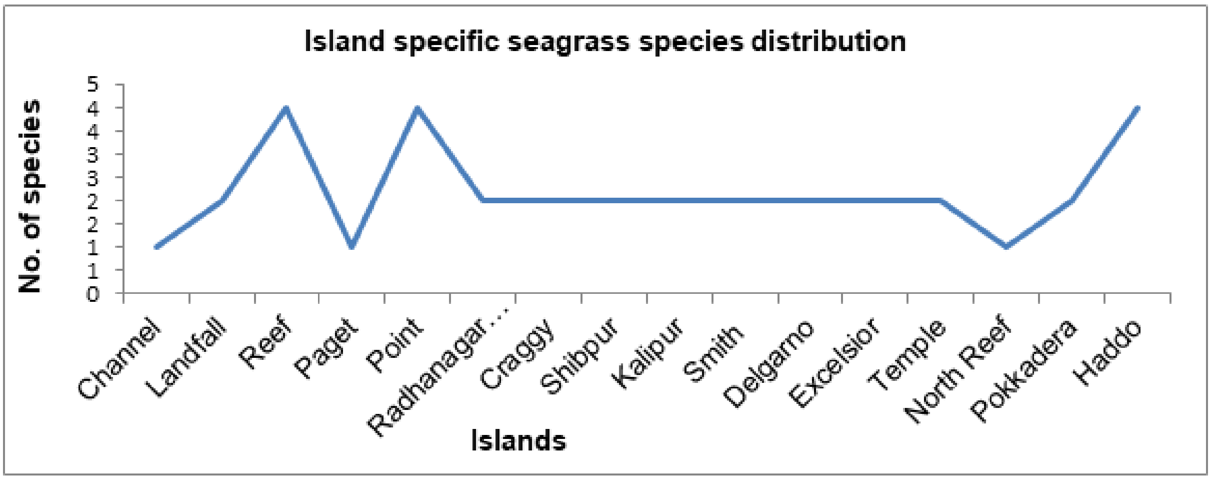

Figure 4.7: Island specific seagrass species distribution in Andaman

Three of the 16 sampled sites were mixed-species intertidal meadows namely; Kalipur, Haddo, and Pokkadera, whereas the rest of the sites were shallow sub-tidal (Table 4.2).

The highest seagrass percentage cover was observed at Temple (73.1%), followed by Haddo (61.7%), and the least cover was recorded from intertidal mixed meadows of Pokkadera (Figure 4.8). The highest shoot density was recorded from mixed intertidal meadows of Haddo, South Andaman whereas total above-ground biomass was the highest at Kalipur (Table 4.2).

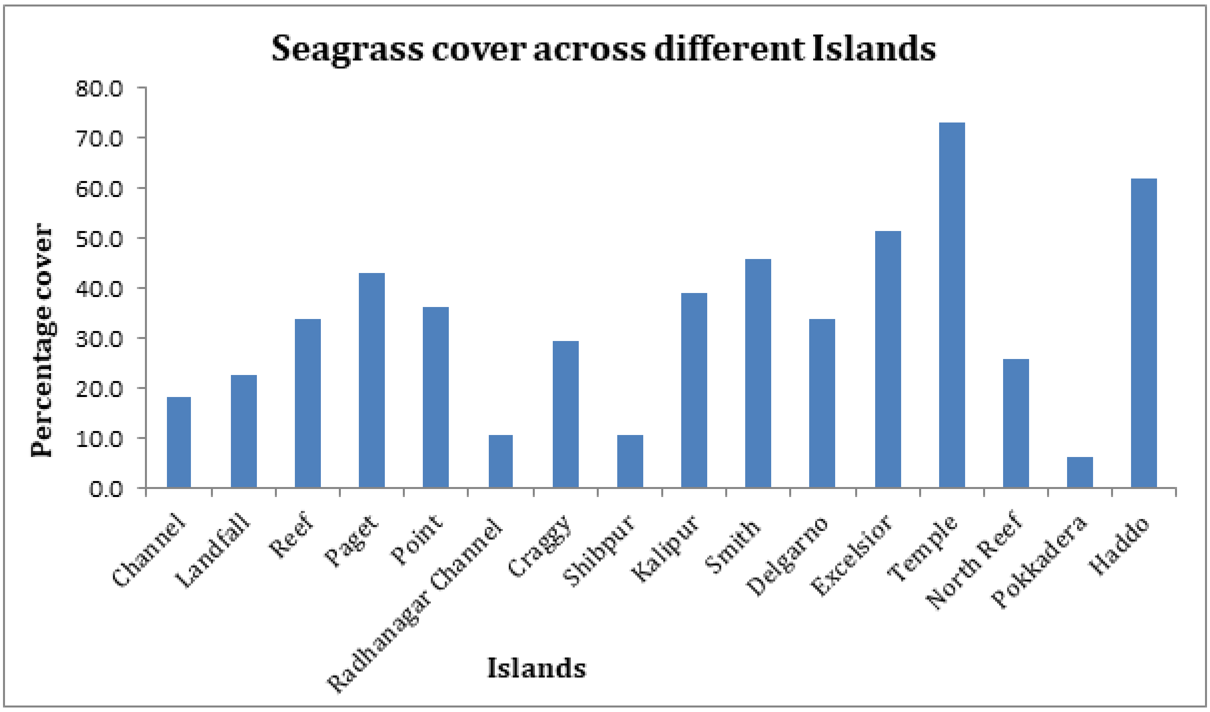

Figure 4.8: Island specific seagrass cover across study sites in Andaman

Table 4.2: Seagrass meadow characteristics of sampled sites

Sr. No.	Island	depth (in m)	Total no. of speci	Species composition	Total seagrass_cover (%)	shoot density (/m2)	meadow canopy	total biomass (gm/	epiphytic algae (%)	non-epiphytic algae (
1	Channel	2.4	1	*Halophila ovalis*	18.2	3150	2.74 ± 1.50	12.88 ± 12.16	23.3	10.9
2	Landfall	4.8	2	*Halophila ovalis, Halodule pinifolia*	22.5	950 ± 433.01	3.42 ± 2.66	7.42 ± 2.11	10	0

Sr. No.	Island	depth (in m)	Total no. of speci	Species composition	Total seagrass_cover (%)	shoot density (/m2)	meadow canopy	total biomass (gm/	epiphytic algae (%)	non-epiphytic algae (
3	Reef	7.3	4	*Halophila ovalis, Halophila decipiens*	34	1512.5 ± 1087.25	1.83 ± 1.63	9.72 ± 6.15	1.5	0
4	Paget	5.8	1	*Halophila decipiens*	42.9	1350 ± 648.56	1.53 ± 0.37	22.17 ± 17.33	61.1	0
5	Point	3.5	4	*Halophila ovalis, Halophila decipiens*	36.4	880 ± 791.24	4.28 ± 2.82	17.60 ± 13.49	0	0.9
6	Radhanagar Channel	3.3	2	*Halodule uninervis, Halodule pinifolia*	10.5	458.33 ± 250.47	8.89 ± 3.23	11.41 ± 7.17	15.3	0
7	Craggy	7.4	2	*Halodule pinifolia, Halophila ovalis*	29.5	780 ± 208.72	5.42 ± 5.34	6.51 ± 2.87	6.5	0
8	Shibpur	5.5	2	*Halodule pinifolia, Halophila ovalis*	10.5	437.5 ± 194.45	4.28 ± 3.39	12.53 ± 13.05	0	10.2

Sr. No.	Island	depth (in m)	Total no. of speci	Species composition	Total seagrass_cover (%)	shoot density (/m2)	meadow canopy	total biomass (gm/	epiphytic algae (%)	non-epiphytic algae (
9	Kalipur	0.3	2	*Thalassia hemprichii, Cymodoc*	39.3	1293.75 ± 1002.16	8.38 ± 2.51	106.73 ± 60.89	12.2	6.9
10	Smith	4.4	2	*Halodule pinifolia, Halodule uninervis*	46.1	371.88 ± 175.99	8.19 ± 2.34	11.98 ± 8.23	25.6	8.8
11	Delgarno	8.5	2	*Halodule pinifolia, Halophila ovalis*	33.8	2050 ± 388.91	1.81 ± 0.13	16.02 ± 12.59	0.7	0
12	Excelsior	3.2	2	*Halodule pinifolia, Halophila ovalis*	51.6	775 ± 480.02	4.79 ± 3.35	9.44 ± 10.25	2.2	9.8
13	Temple	1.9	2	*Halodule pinifolia, Halodule uninervis*	73.1	866.67 ± 284.31	1.43 ± 0.07	10.29 ± 9.89	89.1	0
14	North Reef	5.8	1	*Halodule uninervis*	26	1075	5.38 ± 2.22	12	44.5	3

Sr. No.	Island	depth (in m)	Total no. of speci	Species composition	Total seagrass_cover (%)	shoot density (/m2)	meadow canopy	total biomass (gm/	epiphytic algae (%)	non-epiphytic algae (
15	Pokkadera	0.2	2	*Thalassia hemprichii, Enhalus*	6.3	340 ± 1258.40	8.38 ± 5.54	45.23 ± 34.21	2.9	9.3
16	Haddo	0.3	4	*Thalassia hemprichii, Halodule*	61.7	3843.75 ± 4179.78	2.92 ± 2.01	17.40 ± 17.04	97	2.7

Depth specific species distribution

All species except *Halophila decipiens* were distributed in the intertidal regions while early successional species belonging to 2 genera; *Halodule spp.* and *Halophila spp.* were distributed in sub-tidal regions (Table 4.2).

Substratum

Substratum composition was mainly characterized by Sand (Sn), Sand and Rubble (Sn & Ru), deal coral (dc), live coral (lc) and rock (rc), and rubble (ru) substratum. All the seagrass species preferred either sandy substratum with rubble and rock or fine sediment substratum composition also changed to depth observed during the study period. Substratum composition changed from intertidal to sub-tidal habitats, with course to sand mixed with rubble, occupying intertidal regions. On the other hand, subtidal habitats were characterized by extremely fine sand.

In this present study, we recorded only six species from the intertidal regions; each distributed in a micro-scale regime influenced by substratum. *Thalassia hemprichii* and *Enhalus acoroides* were found predominantly in the coarse sand mixed with rubble, as these species are more fibroid in structure and have a strong-rooted system, aiding in substratum penetration, heavy wave action, and tidal fluctuations.

Species with delicate root systems (*Halodule spp.* and *Halophila spp.)* were found in extremely fine sediments, mostly in sheltered areas.

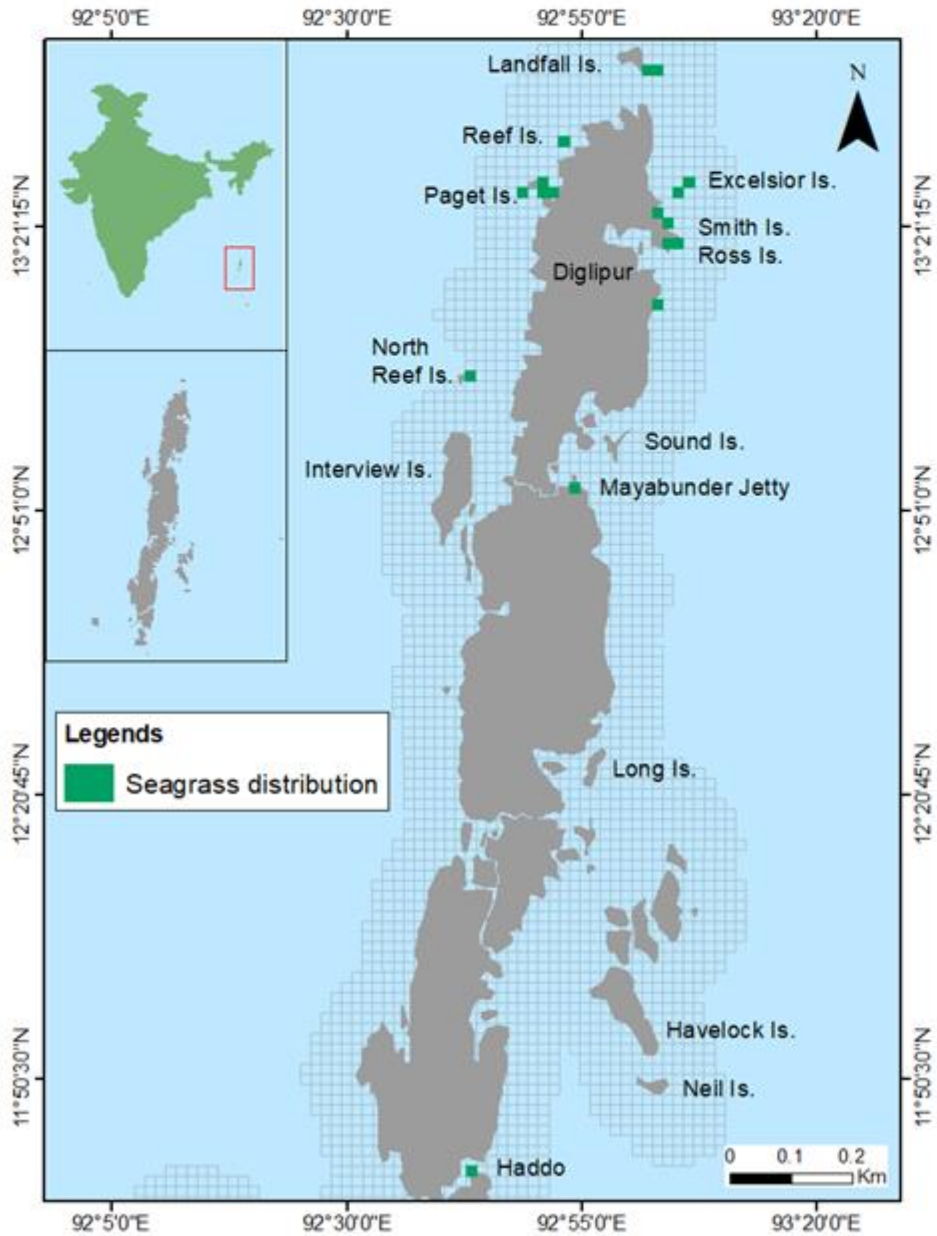

Figure 4.9: Map showing seagrass distribution across sampling sites in Andaman & Nicobar Islands

4.1.4 Extensive surveys using remote sensing and GIS technology

Background and objective:

Understanding the dynamics of change in seagrass ecosystems over time and space provides the basis for developing and assessing seagrass management strategies. Any such study of ecology and environmental management requires extensive data for various seagrass properties over suitable extant and temporal scales. Conventional survey methods are labor-intensive and time-consuming due to the constraints in working in the marine environment (Nobi and Thangaradjou, 2012). Hence, remote sensing provides a handy tool for seagrass distribution and change detection studies with Geographic Information System (GIS) techniques (Kendrick *et al.,* 2002; Dekker *et al*., 2005; Gullstrom et al., 2006; Wabnitz *et al.,* 2008).

Mapping of seagrasses distribution started long back in 1871, where Ascherson and Beccari (1871) made the first attempt to map the geographical distribution of seagrasses. Since then, various attempts have been made to map seagrass meadows at national and global levels. In India, satellite imaging for seagrass detection and mapping studies has been very few (Table 4.3).

Table 4.3: Studies related to the mapping of seagrasses from India

SN	Imageries Used	Spatial Resolution	Study area	Accuracy (%)	Citation
1	IRS LISS III	23.5 m	Lakshadweep	67.5	Nobi E. P. & Thangaradjou T. (2012)
2	Landsat 8 OLI	30 m	(i) Palk Bay (ii) Gulf of Mannar (Tamil Nadu) (iii) Gulf of Kachchh (Gujarat) (iv) Chilika Lake (Odisha) (v) Islands of Andaman & Nicobar and (vi) lagoons of Lakshadweep Islands	64 to 83.5	Geevarghese G.A. *et al*., 2017)
3	IRS-1D, LISS III	23.5 m	Gulf of Mannar		Umamaheswari *et al*., 2009)

SN	Imageries Used	Spatial Resolution	Study area	Accuracy (%)	Citation
4	IRS P6 LISS IV	5.8 m	Lakshadweep Islands	73.16	Nobi *et al*.,2012)
5	LANDSAT ETM+	30 m	i. Gulf of Mannar	85.19	Gunasekara and Mishra (2014)
			ii. Palk Bay	92.59	
6	IRS P6 LISS III	23.5 m	Andaman and Nicobar Islands	40	Paulose *et al.,* 2013)

Though seagrasses are reported to provide 28 ecosystem services, and several of these services vary across genera and bioregions, there is no report on seagrass ecosystem service values (Nordlund *et al.,* 2016). India stands 16th regarding the number of publications on seagrasses (York *et al*., 2017), whereas countries with a much lesser coastal extent and EEZ are in the lead. Therefore, in India, seagrass ecosystems have hardly gained attention from the scientific fraternity in terms of management and conservation (Thangaradjou & Bhatt, 2018) despite their sharp decline worldwide at a rate of ~7% annually since 1980 (Waycott *et al.*, 2009, Fourqurean *et al.,* 2012; Duarte *et al.,* 2013), hence, globally, 24% of seagrass species are now classified as either threatened or near-threatened on the IUCN's Red List (Short *et al.,* 2011). Moreover, regular mapping of seagrasses is also neglected. In India, unlike mangroves (mapped at every two years' interval) and corals (mapped at decadal interval), there is no such regular mapping scheme available for seagrasses (Thangaradjou and Bhatt, 2018). In connection to bridge this gap and to provide a regular mapping schema for seagrass monitoring, we try to map seagrass habitats using satellite imageries (Sentinel-2).

Study area:

South Andaman: Mahatma Gandhi Marine National Park (MGMNP)- Tarmugli (east coast), Boat, Belle, Snob, Chester, Grub, Alexandra, Red Skin, Malay, Hobday, Pluto, Jolly Buoy Islands.

North Andaman: Mayabunder, Karmatang.

Duration: December 06, 2020 – May 31, 2021.

Methodology:

Field surveys were carried out at the Andaman Islands from December 06, 2020, till Feb 2021 and collected ground truth data on the presence and absence of seagrasses and their coverage. Surveys were conducted in intertidal and subtidal areas:

1. **Intertidal survey:**
    1. Line intercept transects (LITs) were used in intertidal areas of seagrass surveys.
    2. For intertidal surveys, straight transects were walked from high tide line (HTL) to low tide line (LTL) during low tide, and point locations were recorded at an interval of 50m. Distance between the two transects was kept as 100m.
    3. Intertidal surveys were conducted.

2. **Subtidal survey:**
    1. Boat-based surveys were also conducted in sub-tidal areas.
    2. Quadrats were laid with a drop-down camera to estimate the percentage of seagrass cover. For boat-based surveys, point locations were noted at a minimum distance of 50meters from each other at different depths.
        1. South Andaman
            1. To run the quadrat's drop-down camera and proper functioning, a reconnaissance survey was conducted at Mahatma Gandhi Marine National Park (MGMNP), Wandoor.
            2. On finalizing the methodology, boat-based surveys were conducted from January 28, 2021, to February 02, 2021, in the Wandoor region. The number of point locations collected: 38
            3. (Thirty-eight). Species recorded: Halophila sp. was recorded from 01 (one) point. North Andaman
            4. Mayabunder, North Andaman, from February 23

Results:

During boat surveys in the subtidal region, 97-point locations were surveyed, of which 10 locations were recorded with seagrass presence. The depth of all ten present locations has a shallow depth, ranging from 1.0 – 2.5 m; two locations were recorded with moderate to high depth, one with 9.7m and another with 16.1m. Therefore, it proves the fact that seagrasses as photosynthetic plants majorly grow in the photic zone. The transparency of all 10 points ranges from 1.0 – 14m.

Intertidal areas were explored by walking as a line intercept transect method. Of 53-point locations, 37 points had seagrasses of varied density. Photographs were analyzed for seagrass percentage cover in the sampled point locations.

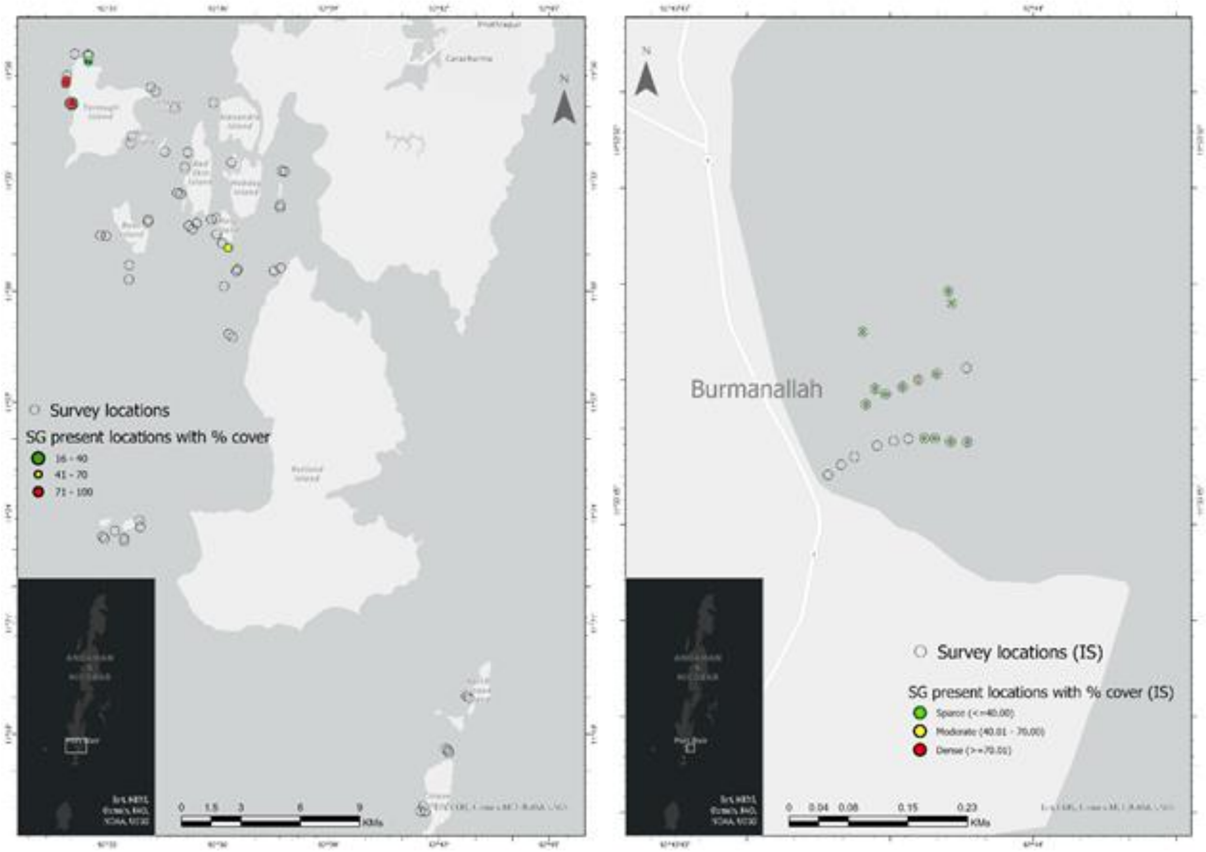

Figure 4.10: Survey locations of South Andaman with their respective seagrass percentage cover

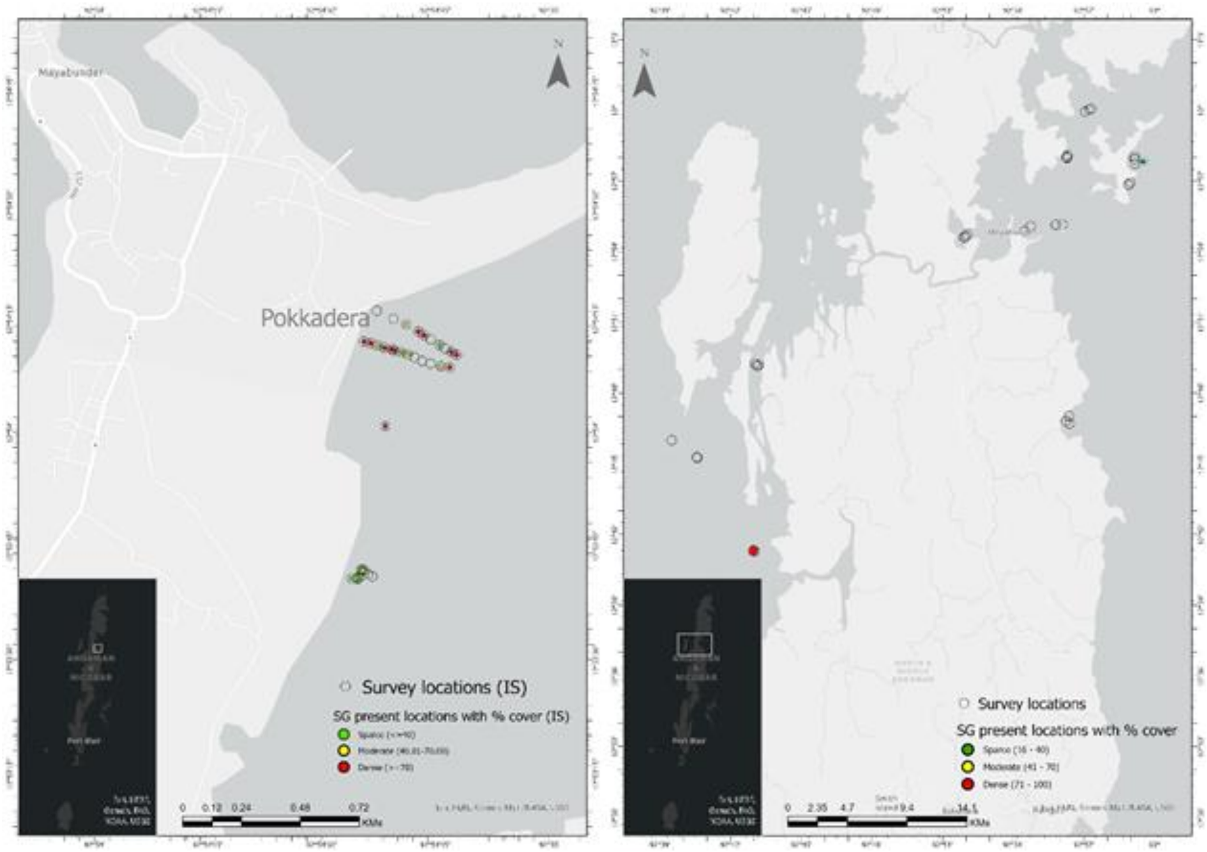

Figure 4.11: Survey locations of North Andaman with their respective seagrass percentage cover

4.2 OUTREACH, AWARENESS, AND CAPACITY BUILDING PROGRAMME

Community-based conservation by targeting and engaging diverse stakeholders, will aid in understanding dugong distribution, strengthen species monitoring and contribute to sensitization and capacity building of the local communities.

In this field season, we conducted a total of 21 outreach, awareness, and capacity-building programs across the Andaman Islands to raise awareness about the importance of dugongs and their habitats and the need for conservation (Table 4.4). Out of these events, five were fisherfolk targeted, one with School Children and the general public to raise awareness about their state animal of the islands, four capacity building programs with the frontline forest staff with training on the rapid emergency response of dugongs and other marine mammal handlings. New Patrolling agencies viz; marine Police were involved in the 'Dugong Monitoring Network' to obtain the dugong's sightings. The rest of the events were follow-up programs and expansion of the ‘Dugong Monitoring Network’ in the other areas of the islands with other patrolling agencies.

Table 4.4: Summary of awareness, outreach, and capacity building programs conducted in the Andaman Islands

Sr no.	**District**	**Location**	**Name of the event**	**Type of stakeholders**	**No. of attendees**	**Type of event**
1	South Andaman	Manjery	Awareness program with the fishing	Fisherman	15	Outreach and awareness
2	South Andaman	Mini Bay, Port Blair	Dugong Awareness programme	School children	60	Outreach and Awareness
3	South Andaman	Flag Point, Marina Park	Mass sensitization dugong	General Public	300-400	Outreach and Awareness
4	South Andaman	Port Blair	Dugong Monitoring follow up	Indian Navy	50	Capacity Building Programme
5	South Andaman	Wimberlygunj	Dugong Monitoring Programme	Forest Department	40	Capacity Building Programme
6	South Andaman	Port Blair	Dugong monitoring program	Indian Coast Guard	10	Capacity Building Programme

7	South Andaman	Port Blair	Dugong Monitoring Programme	Marine Police	35	Capacity Building Programme
Sr no.	**District**	**Location**	**Name of the event**	**Type of stakeholders**	**No. of attendees**	**Type of event**
8	North and Middle Andaman	Karmatang, Mayabunder	Dugong Awareness Programme	Fishing Community	200	Outreach and Awareness
9	North and Middle Andaman	Interview island, Mayabunder	Dugong Monitoring Programme	Forest department and Police	30	Capacity Building Programme
10	North and Middle Andaman	Mayabunder	Dugong Monitoring Programme	Marine Police	06	Capacity Building Programme
11	North and Middle Andaman	Rampur, Mayabunder	Dugong Monitoring Programme	Indian Coast Guard	20	Capacity Building Programme
12	North and Middle Andaman	Mayabunder	Dugong Monitoring Programme	Forest Department	25	Capacity Building Programme
13	North and Middle Andaman	Mayabunder Fishing Colony	Dugong Awareness Programme	Fishing Community	10	Outreach and Awareness
14	North Andaman	Aerial Bay, Diglipur	Dugong Monitoring Programme	Marine Police Force	05	Capacity Building Programme

15	North Andaman	Aerial Bay	Dugong Monitoring Programme	Indian Coast Guard	30	Capacity Building Programme
Sr no.	**District**	**Location**	**Name of the event**	**Type of stakeholders**	**No. of attendees**	**Type of event**
16	North Andaman	INS Kohassa, Shibpur (Diglipur)	Dugong Monitoring Programme	Indian Navy	50	Capacity Building Programme
17	North Andaman	Diglipur Forest Division	One day orientation workshop on	Forest Department	30	Capacity Building Programme
18	North Andaman	Durgapur, Diglipur	Dugong Awareness programme	Fisherman	25	Dugong Awareness Programme
19	South Andaman	Wandoor	Dugong Awareness programme	Fisherman	30	Dugong Awareness Programme

In this field season (2021-22), maximum programs were patrolling agencies targeted (Indian Navy, Indian Coast Guard, and Marine Police force) to get dugong sightings from restricted areas. This was followed by capacity-building programs with the forest department (21%), in emergency response to dugongs and other marine mammal strandings. The rest of the events targeted fishers, local masses, and school children to raise awareness about their state animals (Figure 4.12).

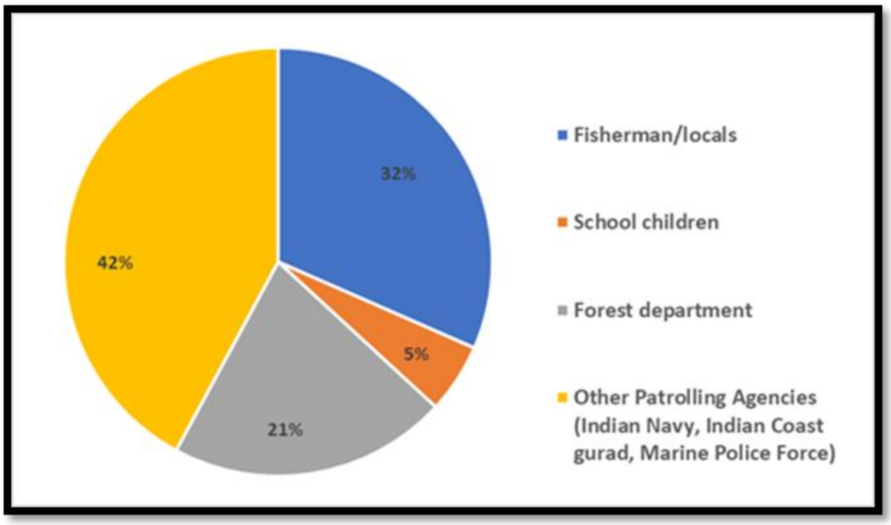

Figure 4.12: Percentage of events conducted with targeted stakeholders in the year 2021-22 for Outreach, Awareness, and Capacity Building Programme in the Andaman Islands

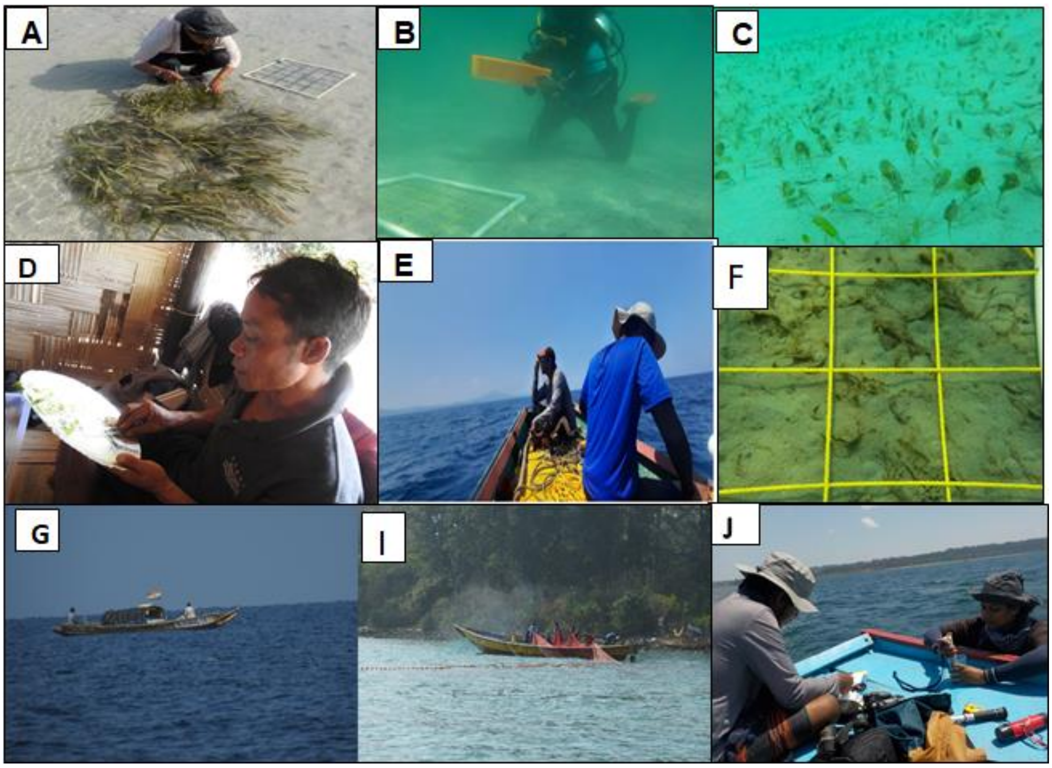

Figure 4.13: Pictures showing field activities held these field seasons:

A) Seagrass habitat characterization in an intertidal seagrass meadow, Kalipur B) Subtidal seagrass habitat characterization at smith island C) Subtidal seagrass meadow at reef island D) Post-processing of seagrass samples in Paget island E) Threat-mapping survey at East coast of Mayabunder F) Seagrass habitat characterization at the subtidal region of Point island G) & I) Boats were observed during threat mapping survey at the east coast of Mayabunder J) Threat-mapping survey at the west coast of Mayabunder

Figure 4.14: Pictures showing Outreach and Capacity Building Programmes held from January- March 2021 in the Andaman Islands:

A) Awareness Programme conducted for the fishing community of Manjery Village, South Andaman B) Capacity Building Programme Conducted in Wimberlygunj Forest Division for Frontline Forest Staff, South Andaman C) Dugong Monitoring Programme conducted for Marine Police of Port Blair, South Andaman D) Awareness Programme conducted for Fishing Communities of Karmatang Village, Mayabunder E) Capacity Building Programme Conducted for Frontline Forest and Police Staff Posted in Interview island, Mayabunder F) Dugong Monitoring Programme Conducted for Marine Police in Mayabunder G) Capacity Building Programme with Indian Navy, INS Utkrosh H) Capacity building program conducted with Indian Coastguard, DHQ-9 Aerial bay I) Dugong Awareness Programme conducted at flag point, Marina Park

Dugong Scholarship Programme

Dugong scholarship programme was initiated to provide financial support to school students from fishing backgrounds. It started in 2017. Since its commencement, 7 schools have been targeted across the Andaman Islands. In this field season due to the pandemic, we couldn't conduct any scholarship programs in schools. Till this field season, a total of 80 students have received the scholarship and the students selected under this program are identified as dugong ambassadors.

We shall be expanding the dugong scholarship program in this coming field season.

Table 4.5: Details of Dugong Scholarship Programmes in Andaman and Nicobar islands

School Name	**Village/ Town**	**District**	**Students Phase 1 2017-2018**	**Students Phase 2 2018-2019**	**Students Phase 3 2019-2020**	**students Phase 4 2020-2021**
Government Secondary School	Shaheed dweep (Neil)	South Andaman	19	19	15	15
Government Middle School	Shaheed dweep (Neil)	South Andaman	3	3	3	3
Government Secondary School	Swaraj Dweep (Havelock)	South Andaman	35	35	22	21
Government Middle School	Guptapara	South Andaman	-	10	10	10
Government Middle School	Wandoor	South Andaman	-	11	9	9

School Name	**Village/ Town**	**District**	**Students Phase 1 2017-2018**	**Students Phase 2 2018-2019**	**Students Phase 3 2019-2020**	**students Phase 4 2020-2021**
Government Senior Secondary School	Rangachang	South Andaman	-	16	11	7
Government Senior Secondary School	Bambooflat	South Andaman	-	16	16	15

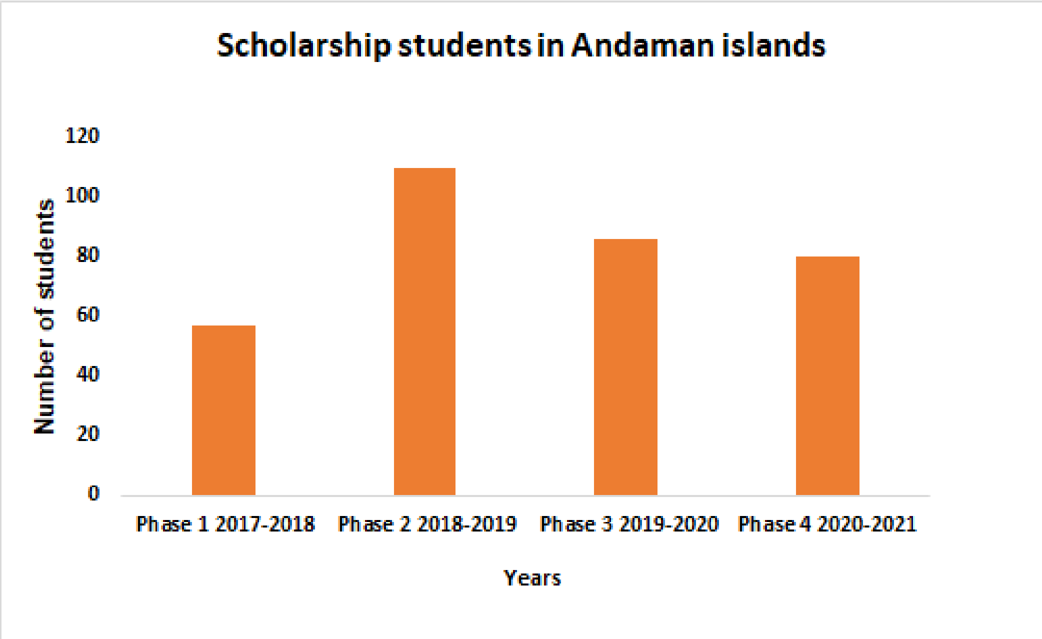

Figure 4.15: Number of scholarship students over four years in the Andaman Islands

4.4 MANAGEMENT RECOMMENDATION

4.4.1 COMMUNITY-BASED CONSERVATION:

Rationale: A bottom-up approach is an irreplaceable move to save dugongs in the Islands, as the success of conservation projects depends on local support. Engaging local communities, sensitizing, and encouraging them for dugong conservation is the need of this hour. Dugongs are threatened by fisheries-driven factors like incidental net entanglement, direct consumption by locals, and boat hits.

a) Intensive community workshops should be conducted with fishers, especially in villages identified as 'dugong trouble spots', encouraging them to rescue and release entangled individuals and report dugong sightings.

Target stakeholders: Fishers of Manjery, Guptapara, Rutland, Tirur, Wandoor, Burmanallah, Shaheed Dweep, Swaraj Dweep Islands, Mayabunder fishing colony, Pokkadera, and Durgapur.

Implementing agency/ group: Researchers

4.4.2 ENHANCED PATROLLING

Rationale: The forest department is the first line of defense to protect and conserve wildlife and habitats. If supplemented with potential dugong habitats (demarcated using approach II), these regions can be further intensively monitored.

b) Enhanced patrolling by frontline forest warriors in regions highlighted as hotspots for dugong distribution and trouble spots of threats (illegal fishing inside protected areas).

c) Regular fixed interval patrolling is recommended (7 to 15 day's interval) in the regions with frequent dugong sightings (Figure 1).

Target stakeholders: Forest department, Marine Police, Indian Coastguard

Implementing agency/ group*:* Forest department, Marine Police, Indian Coastguard

4.4.3 CAPACITY BUILDING:

Rationale: The first line of response bodies, who sight/ witness a dugong (live, entangled, or dead), must be given appropriate training to respond in the most precise way. Potential stakeholders for these training are frontline forest staff, fishers, lifeguards, and local veterinary doctors.

d) Training sessions must include:

- Explaining photo/ video aided presentations on dugong identification from the boat, air, and underwater at different angles, altitudes (in case of an aerial sighting, gender detection, morphometric), and lastly difference between a dugong and other marine mammals (to avoid misidentification).
- Dugong sightings: Reporting a dugong sighting and data collection which can be used by researchers to fill research gaps.
- **Dugong Strandings:** Handling of a live stranding (beached) making sure the animal is least/ or not harmed in the process.
- **Incidental net entanglement:**

  Rescue and release a net entangled individual by cutting the nets if required.
- **Sample collection:**
- Collection of samples from stranded dugongs can be used by researchers to address the gaps in dugong biology (genetics, diseases).
- Training sessions must emphasize standard sampling protocols to collectmorphometric measurements, standard formats for photographic documentation, necropsy protocol, genetic and gut content samples, and their preservation.

Target stakeholders: Veterinary doctors, Frontline Forest staff, Fishers, Life Guards

Implementing agency/ group*:* Wildlife Institute of India

4.4.4 EMERGENCY STRANDING RESPONSE TEAM:

Rationale: Many dugongs have died due to stranding or entanglement, majorly due to the lack of a trained team to rescue the animals in distress. Frontline warriors and other bodies who form the first line of defense to reach the site should be the target groups for such programs.

e) Frontline forest staff, lifeguards and fishers can be trained to provide emergency first aid to stranded animals, making sure minimum damage is caused in the process.

f) Model-based stranding response training can be imparted to these groups from respective forest divisions.

g) Lifeguards from tourism allied regions should be targeted.

h) Community workshops must be conducted with fishers from adjoining villages

Target stakeholders: Frontline forest staff, Marine Police, lifeguards, and fishers

Implementing agency/ group*:* Wildlife Institute of India

4.4.5 PROMOTING ACADEMIC RESEARCH:

For the management of crucial dugong conservation hotspots, managers should be provided with current knowledge of dugong biology, movement patterns, habitat use pattern, and important feeding grounds. These gaps could be filled by promoting academic research. Few focal research topics may include:

a) Determining dugong abundance and distribution: Boat-based and aerial/ drone surveys

b) Evaluation of habitat status: Mapping of potential feeding habitats of dugongs through a 5-year long term monitoring of seagrass meadows

c) Habitat use pattern of dugongs by tagging: to exactly demarcate habitats used by dugongs

d) Dugong acoustic studies

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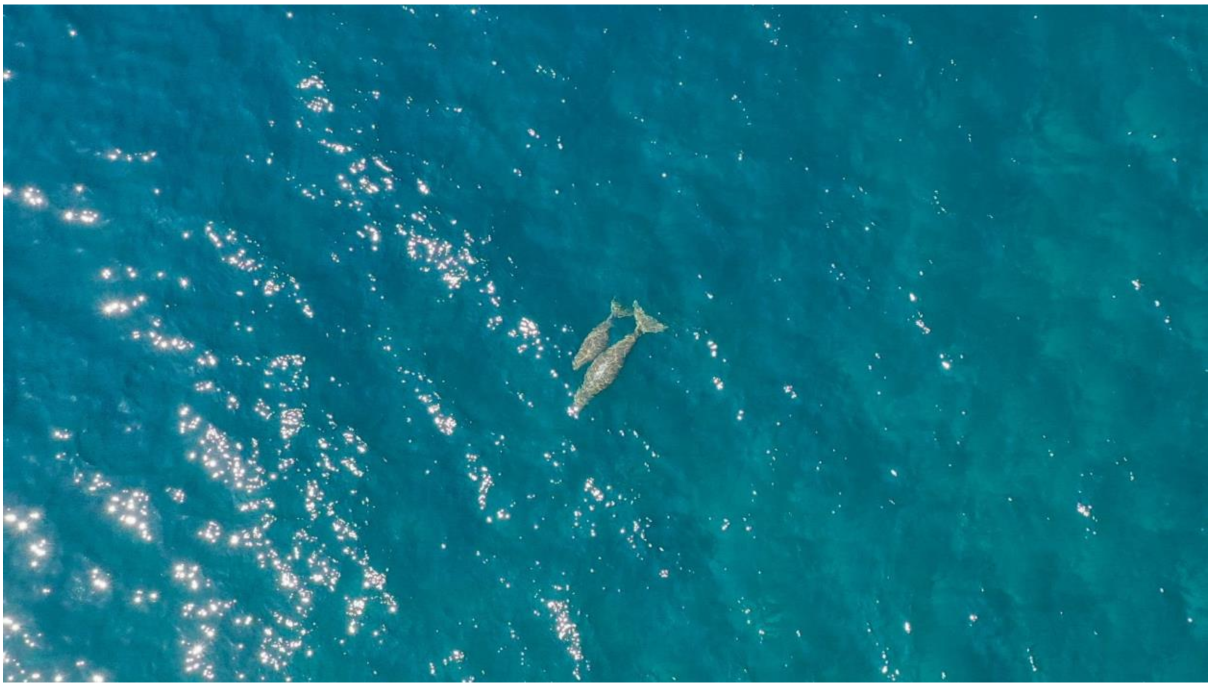


Team Members:

Mr. Srinivas Yellapu (Project Fellow (Genetics), Dr. Swanti Sharma (Research Associate), Mr. Sagar Rajpurkar (Project Fellow), Mr. Sharad Bayyana (Project Fellow), Ms. Sohini Dudhat (Project Fellow), Ms. Srabani Bose (Project Assistant), Ms.Himani Saini (Project Assistant), Vabesh Tripura (Project Assistant), Ms. Rashmi Semwal (Intern), Mr. Ankit Pacha (Intern), Ms. Ankita Anand (Intern), Ms, Sweta Iyer (Intern)

Citation- Yellapu S., Sharma S., Rajpurkar S., Bayyana S., Dudhat S., Bose S., Saini H., Tripura V., Semwal R., Pacha A., Anand A., Iyer S.(2021) Ex-situ analysis for dugong conservation, In Annual Progress report V (2020-2021), Recovery of dugongs and their habitat in India: an integrated participatory approach, Wildlife Institute of India, Dehradun, pp 191-249.

Aerial surveys are widely undertaken in the study of marine mammals globally, as they cover larger areas in a short duration and reduce the survey effort thus, making this approach cost effective. Drone surveys serve as an extremely useful tool for marine mammal distribution and population studies, especially for species thriving in shallow coastal waters like dugongs. Dugongs being marine herbivores spend most of the time feeding on seagrasses in coastal waters and surface every 5-6 minutes, making their detectability using drones much easier, as compared to oceanic marine mammals which dive for longer intervals in deep seas. Manned aerial surveys using aircrafts have been widely used throughout dugong distribution ranges, to estimate populations (Marsh and Sinclair 1989a, b, Marsh 1995, Miller et al., 1998) or understand distribution trends and habitat use patterns (Anderson 1985). Unmanned aerial surveys using drones have been effective like manned aerial surveys and are excellent tools for monitoring rare and elusive marine species. Unmanned Aerial Vehicles have been used to study dugongs (Hodgson et al. 2013), manatees (Landeo-Yauri et al SS 2020) and dolphins (Fettermann et al 2019). But a similar approach is lacking in Indian waters, due to cost associated with such surveys and logistics. Further, unlike their Australian counterparts', dugongs in Indian waters exhibit fragmented populations, distributed in pockets, with no solid population estimates given till date. In such a scenario, where boat based detection of dugongs is rare due to low population, drones can prove to be extremely useful in filling major research gaps in dugong research.

5.1.1 Aerial Surveys using UAVs in Gulf of Kutch Marine National Park, Gujarat

Situated in Devbhoomi Dwarka district of Gujarat, the Gulf of Kutch Marine National Park has been assessed as critical habitat for dugongs and seagrasses. The waters in the region are highly turbid and boat surveys to detect and study dugongs in the region have not been successful, thus Unmanned Aerial Vehicles (UAVs) were used to detect dugongs in the region. Small unmanned aerial drones have been proven effective to study marine megafauna like dugongs, thus in this premise, UAVs were used to detect study dugongs in the region. The main objective of the study was to survey seagrass habitats aerially using drones for detecting dugongs and another marine megafauna.

Study Area-

The Gulf of Kutch Marine National Park and Marine Sanctuary was selected as a study area. The present study was carried out across critical dugong habitats of marine national parks and marine sanctuary areas situated in the southwestern. Aerial surveys were undertaken from Bet Dwarka, Ajad Island, Paga Reef, Bhaidar Island, and Chusna Pir.

Methodology-

Aerial surveys were undertaken using the DJI Mavic 2 Pro UAV manufactured by SZ DJI Technology Co, China. It is a micro quadcopter with 4 rotors weighing 907 g. The flight paths were designed in order to cover maximum areas over known seagrass meadow locations. The flights were planned using the DJI Go 4 and Litchi Hub applications. Random scan sampling and Transect sampling were undertaken according to the standard methodology suggested by Raoult et al. 2020 for studying sirenians. The altitude of the flight was kept constant at 100 meters with a speed of 35 km/hr. The width of the survey strip was 75 meters. The continuous video was recorded during each flight and was stored and saved in a hard drive for analysis.

Results-

A total of 22 flights were undertaken during these surveys during the pre-monsoon period from Jan 01 to Jan 15, 2021. During the surveys, seagrass meadows were detected, aerially confirming the presence of seagrasses. No dugongs were observed during the surveys. Sea turtles were observed during the survey in high numbers. Other faunas detected during the surveys were Indian Ocean Humpback Dolphins, birds, etc. Fishing boats, mainly trawlers, were also observed during the survey effort. Fishing nets, ghost nets, etc. were the threats that were observed to dugongs during the study. A total of 24 sea turtles were observed during a single 17 min flight from Chusna Pir. Turtles were seen congregating over the seagrass meadows there probably for grazing.

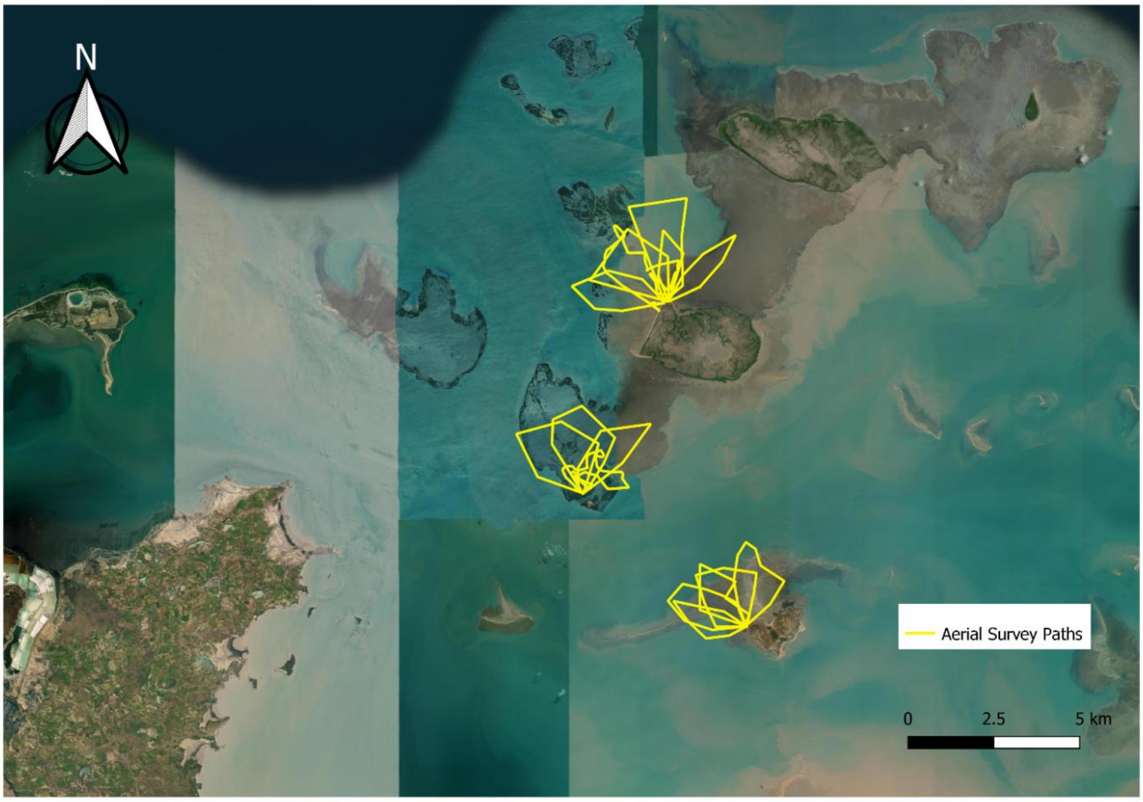


Figure 5.1: Gulf of Kutch, Gujarat Aerial Survey Map

Figure 5.2: Boats anchored in Gulf of Kutch Marine National Park, Gujarat

Figure 5.3: Marine turtle detected during Aerial Survey in Gulf of Kutch Marine National Park, Gujarat

5.1.2 Aerial Surveys using UAVs in Mahatma Gandhi Marine National Park, South Andaman Islands

Background and Objective-

Situated in South Andaman Islands near Port Blair, Mahatma Gandhi Marine National Park has been assessed as critical habitat for dugongs. Aerial surveys were conducted here in 2019, and we were successful in detecting dugongs within the boundaries of the Marine National Park. Small unmanned aerial drones have been proven effective to study marine megafauna like dugongs, thus in this premise, UAVs were used to detect dugongs and other megafauna in the region.

The main objective of the study was to systematically survey the Marine Protected Area, aerially using drones for detecting dugongs and other marine megafauna.

Study Area-

Mahatma Gandhi Marine National Park was selected as the study area. The area of the Marine National Park is about 281sq km. The study areas surveyed included Wandoor, North Wandoor, Grub Island, Red Skin Island, Alexandria Island, Tarmugli Island, Boat Island, Jolly Buoy Island, Chester Island, Snob Island, Rutland, Twins, and Cinque Islands.

Methodology-

Aerial surveys were undertaken using the DJI Mavic 2 Pro UAV manufactured by SZ DJI Technology Co, China. It is a micro quadcopter with 4 rotors weighing 907 g. The area was divided using grids. The grid size was fixed at 2x2km. The flights were planned using the DJI Go 4 and Litchi Hub applications. Random scan sampling and Fixed width transect sampling was undertaken according to the standard methodology suggested by Raoult et al. 2020 for studying sirenians. The altitude of the flight was kept constant at 100 meters with a speed of 35 km/hr. The width of the survey strip was 75 meters. The surveys were conducted along with the patrolling staff of the Forest Department, covering the maximum possible grids using fixed-width aerial transects. The maximum length of the transect was 1.5 km. The continuous video was recorded during each flight during grid-based transect sampling as well as random scan sampling. The videos were then saved in external hard drives for further analysis.

Results-

A total of 112 transects covering 25 grids were undertaken during the study. The list of transects undertaken and grids covered is given below. (Table 5.1) The study spanned from February to March 2021. Random scan sampling was also undertaken from each survey site.

The list of areas surveyed is given below. The video analysis is ongoing for the same. Manta Rays, Dolphins, Sea Turtles, shoals of sardines and other fish, etc. were detected during the surveys.

Table 5.1: Areas surveyed using Fixed Width Aerial Transects

SN	Survey Area	No of Transects	No of Grids
1	Boat Island	16	4
2	Jolly Buoy	8	2
3	Cinque	8	2
4	Red Skin	18	3
5	Tarmugli	16	4
6	Twins	10	2
7	Wandoor	12	2
8	Chester	6	1
9	Rutland	4	1
10	Snob	4	1
11	North Wandoor	4	1
12	Pungi Balu	6	2

During the surveys, marine megafauna like Bottlenose Dolphins (Tursiops sps), Manta Rays (Mobula sps), Spotted eagle rays (Aetobatus sps), unidentified shark species, marine turtles, and shoals of fish were observed. No dugongs were observed during the initial phases of the analysis.

Figure 5.4: Pod of Bottlenose Dolphins in Andaman Islands

Figure 5.5: Manta Ray (Mobula sps.) detected during the survey near Twins Islands, Andaman

Figure 5.6: Anchored boats off North Cinque Islands at Andaman

Figure 5.7: Shoal of fish forming a bait ball observed off Jahaji beach, Rutland, Andaman

Figure 5.8: Researcher surveying in Mahatma Gandhi Marine National Park, Andaman

5.1.3 CAPACITY BUILDING PROGRAM OF AERIAL SURVEYS

Gujarat-

Poshitra

A three-day Capacity Building workshop for Hands-on Drone Training for marine megafauna monitoring was undertaken at Poshitra Forest Camp, from 16th to 18th December 2020. A total of 5 frontline forest staff were trained during the workshop. The flights were undertaken from Poshitra Forest Camp in the Marine National Park area and around Lakhu Point. Skills like drone maneuvering, waypoint flight missions, transect sampling and focal follow missions were undertaken independently by each participant. The main aim of the workshop was to train the staff to operate UAVs in order to monitor marine megafauna in critical habitats in the Gulf of Kutch. The participants later accompanied the research team during research surveys at Bhaidar, Chusna Pir, Beyt Dwarka, and Paga Reef.

Figure 5.9: Theory session conducted at Poshitra Drone Training Workshop in Gujarat

Figure 5.10: Poshitra Drone Training Workshop participants in Gujarat

Balachadi

A capacity building workshop for Hands-on Drone Training of Forest Department staff for marine megafauna monitoring was undertaken at Jamnagar Forest Department office, Balachadi and Jodiya, from 21st to 23rd December 2020. A total of 5 frontline forest staff were trained during the workshop. The flights were undertaken from the Balachadi and Jodiya areas of the Marine National Park. Introduction to use of drones in wildlife monitoring, application in research, etc., and other presentations were made to explain to the participants about the basics of the same. Drone maneuvering, waypoint flight missions, transect sampling and focal follow missions were undertaken independently by each participant. The main aim of the workshop was to train the staff to operate the drone to help understand and monitor marine megafauna in critical habitats in the Gulf of Kutch.

Figure 5.11: Participant operating the UAV during a training exercise in Gulf of Kutch, Gujarat

Figure 5.12: Group photograph of all participants in the Drone Training Workshop, Balachadi, Gujarat

Andaman Nicobar Island

Chidiya Tapu-

A three-day Capacity Building workshop for Hands-on Drone Training for marine megafauna monitoring was undertaken at Chidiya Tapu, Biological Park from 2nd to 4th March 2021. A total of 5 frontline forest staff were trained during the workshop. The flights were undertaken from Chidiya Tapu Biological Park, Mundapahar Beach, and Forest Department Guest House. Skill like drone maneuvering, waypoint flight missions, transect sampling and focal follow missions were undertaken independently by each participant. The main aim of the workshop was to train the staff of the South Andaman division to operate the drone in order to monitor marine megafauna in critical habitats. The participants later accompanied the research team during research surveys.

Figure 5.13: Theory session during the UAV training workshop, Chidiya Tapu, Andaman Islands

Figure 5.14: Participants flying the UAV during the workshop at Chidiya Tapu at Andaman

Swaraj Dweep-

A three-day Capacity Building workshop for Hands-on Drone Training for marine megafauna monitoring was undertaken at Swaraj Dweep (Havelock) island, from 9th to 12th April 2021. A total of 5 frontline forest staff were trained during the workshop. The flights were undertaken from Havelock Forest department beach and Kala Patthar areas of the Marine National Park. Introduction to use of drones in wildlife monitoring, application in research, etc., and other presentations were made to explain to the participants about the basics of the same. Drone maneuvering, waypoint flight missions, transect sampling and focal follow missions were undertaken independently by each participant. The main aim of the workshop was to train the staff to operate the drone in order to monitor marine megafauna in critical habitats in Rani Jhansi Marine National Park.

Figure 5.15: Participant operating the UAV during a training exercise in Rani Jhansi Marine National Park, Andaman Islands

Figure 5.16: Drone survey team from Rani Jhansi Marine National Park, Andaman Islands

Table 5.2: List of Forest Department staff trained so far for Aerial Surveys using UAVs

Sr no	State	Forest Division	Location	Name	Designation	Level/Skills	Date of training
1	Andaman &	MGMNP	Wandoor	Sharath	Forest Ranger	Basic	24th to 26th Jan
2	Andaman &	MGMNP	Wandoor	Prakash Rao	Forester	Basic	24th to 26th Jan
3	Andaman &	MGMNP	Wandoor	Pradeep Mondal	Forest Guard	Basic	24th to 26th Jan

4	Andaman &	MGMNP	Wandoor	Pankaj Suis	Forest Guard	High	24th to 26th Jan
Sr no	**State**	**Forest Division**	**Location**	**Name**	**Designation**	**Level/Skills**	**Date of training**
5	Andaman &	MGMNP	Wandoor	P. Umeer	Forester	Moderate	24th to 26th Jan
6	Andaman &	MGMNP	Wandoor	Mohammed Hussain	Forest Guard	High	24th to 26th Jan
7	Gujarat	GOKMNP	Poshitra	Nimesh Gagiya	Forest Guard	High	16th to 18th Dec
8	Gujarat	GOKMNP	Poshitra	Sunil Kanjariya	Forest Guard	Moderate	16th to 18th Dec
9	Gujarat	GOKMNP	Poshitra	Urmila Sadhiya	Forest Guard	Basic	16th to 18th Dec
10	Gujarat	GOKMNP	Poshitra	Pravinkumar Gordiya	Forest Guard	Basic	16th to 18th Dec
11	Gujarat	GOKMNP	Poshitra	Devabhai Karir	Forest Guard	Moderate	16th to 18th Dec
12	Gujarat	GOKMNP	Balachadi	Dhruvrajsinh Jadeja	Forest Guard	Moderate	21st to 23rd Dec
13	Gujarat	GOKMNP	Balachadi	Yuvraj Singh Jadeja	Forest Guard	Moderate	21st to 23rd Dec

Sr no	**State**	**Forest Division**	**Location**	**Name**	**Designation**	**Level/Skills**	**Date of training**
14	Gujarat	GOKMNP	Balachadi	Hemal Dangar	Forest Guard	High	21st to 23rd Dec
15	Gujarat	GOKMNP	Balachadi	Vasim Sama	Forest Guard	High	21st to 23rd Dec
16	Gujarat	GOKMNP	Balachadi	Gulab Barariya	Forest Guard	Moderate	21st to 23rd Dec
17	Andaman &	MGMNP	Chidya Tapu	Mohammed Hussain	Forester	High	2nd to 4th March
18	Andaman &	MGMNP	Chidiya Tapu	Mohammed Basheer	Forest Guard	High	2nd to 4th March
19	Andaman &	MGMNP	Chidiya Tapu	Jaykumar	Forest Guard	Moderate	2nd to 4th March
20	Andaman &	MGMNP	Chidiya Tapu	K Netaji	Forest Guard	Moderate	2nd to 4th March
21	Andaman &	MGMNP	Chidiya Tapu	C Ramayya	Forest Guard	High	2nd to 4th March
22	Andaman &	RJMNP	Swaraj Dweep	M Syed Hussain	Forest Guard	High	9th to 12th April
23	Andaman &	RJMNP	Swaraj Dweep	Javed Ali	Forest Guard	Moderate	9th to 12th April

24	Andaman &	RJMNP	Swaraj Dweep	Abdul Rehman T	Forest Guard	High	9th to 12th April
Sr no	**State**	**Forest Division**	**Location**	**Name**	**Designation**	**Level/Skills**	**Date of training**
25	Andaman &	RJMNP	Swaraj Dweep	Musal Naidu	Forest Guard	Moderate	9th to 12th April
26	Andaman &	RJMNP	Swaraj Dweep	J. Aneeth Anand Raj	Forest Guard	High	9th to 12th April
27	Tamil Nadu	GOMMNP	Ramanathapuram	C. Rajkumar	ACF	Demonstration only	4th Jan 2019
28	Tamil Nadu	GOMMNP	Ramanathapuram	S. Sathish	Forest Ranger	Demonstration only	4th Jan 2019
29	Tamil Nadu	GOMMNP	Ramanathapuram	P. Gunasekaran	Forester	Demonstration only	4th Jan 2019
30	Tamil Nadu	GOMMNP	Ramanathapuram	P. Sudhakar	Forester	Demonstration only	4th Jan 2019
31	Tamil Nadu	GOMMNP	Ramanathapuram	K. Sudhakar	Forester	Demonstration only	4th Jan 2019
32	Tamil Nadu	GOMMNP	Ramanathapuram	S. Madhivanan	Forester	Demonstration only	4th Jan 2019
33	Tamil Nadu	GOMMNP	Ramanathapuram	P. Ananthan	Forester	Demonstration only	4th Jan 2019

34	Tamil Nadu	GOMMNP	Ramanathapuram	A. Kalidass	Forest Guard	Demonstration only	4th Jan 2019
Sr no	**State**	**Forest Division**	**Location**	**Name**	**Designation**	**Level/Skills**	**Date of training**
35	Tamil Nadu	GOMMNP	Ramanathapuram	M. Radhakrishnan	Forest Guard	Demonstration only	4th Jan 2019
36	Tamil Nadu	GOMMNP	Ramanathapuram	R. Rajesh	APW	Demonstration only	4th Jan 2019
37	Tamil Nadu	GOMMNP	Ramanathapuram	K. Chinichandran	APW	Demonstration only	4th Jan 2019
38	Tamil Nadu	GOMMNP	Ramanathapuram	N. Nehru raj	APW	Demonstration only	4th Jan 2019
39	Tamil Nadu	GOMMNP	Ramanathapuram	K. Vijaya Baskar	APW	Demonstration only	4th Jan 2019
40	Tamil Nadu	GOMMNP	Ramanathapuram	M. Nagarajan	APW	Demonstration only	4th Jan 2019
41	Tamil Nadu	GOMMNP	Ramanathapuram	M. Palanivel	APW	Demonstration only	4th Jan 2019
42	Gujarat	GOKMNP	Poshitra	Kamlesh Chudasama	Forest Ranger	Basic	17th December
43	Gujarat	GOKMNP	Poshitra	Vanda	Forest Ranger	Basic	17th December

Sr no	State	Forest Division	Location	Name	Designation	Level/Skills	Date of training
44	Gujarat	GOKMNP	Balachadi	Jadeja	Forest Ranger	Moderate	21st to 23rd Dec
45	Gujarat	GOKMNP	Jamnagar	Joshi	Forest Ranger	Moderate	23rd December
46	Andaman &	RJMNP	Neil Island	Surendra	Camp Officer	Basic	24th June 2019
47	Andaman &	Lohabarrack	Rutland	Sayyed	Camp Officer	Basic	26th March 2021
48	Andaman &	Mt Harriet	Cinque Island	Jagdip	Camp Officer	Basic	25th March 2021

5.1.4. Sediment and Seagrass Sample Analysis

Introduction

Seagrasses have been reported as a source of nutrients, nursery area, and habitat for fishes, benthic organisms, and marine mammals in many studies. Seagrass habitats are highly dynamic but a decrease in their extent due to human disturbance has been documented over the last centuries in many studies (Cambridge *et al.,* 1986; Morris and Viknstein, 2004 and Waycott *et al.*, 2005). Seagrasses can change their environment by fixing sediment and enhancing sediment and organic matter trapping (Moriarty and Boon, 1989). This benefits seagrass by stimulating its growth and decreasing the chances of mortality from erosion (Cardoso *et al.* 2004). The study of the effect of sediment and seagrass on each other could help understand the seagrass distribution and associated faunal species (Fonseca *et al.* 1983; Healey and Hovel, 2004). Seagrasses require two key nutrients Nitrogen and Phosphorus for their growth in the coastal region (McKenzie, 2008).

Study points, collection, processing, and analysis of samples

For the year 2020-2021, samples were received during December from the two study sites i.e. Gulf of Kutch, Gujarat, and the Andaman Islands. 200 sediment samples were received from Gujarat and 33 seagrass and 43 sediment samples from the Andaman Islands for the nutrient analysis (Table 5.3).

Table 5.3. Sampling points and observed species in the study sites

Site	Number of sampling points	Seagrass species observed
Gulf of Kutch, Gujarat	3	*Halophila ovalis, Halophila decipiens Halodule uninervis*
Andaman Islands	3	*Halodule pinifolia, Thalassia hemprichii, Enhalus acoroides, Halodule uninervis, Syringodium isoetifolium, Halophila ovalis, Cymodocea rotundata, Halophila decipiens*

Seagrass samples were collected using stratified random sampling methods. Quadrats of size 50x50 cm² were plotted randomly on a meadow. Seagrass samples were collected from 20x20 cm² within each quadrant. The samples were uprooted and gently washed with water to remove loose sediment from the roots. The root hairs were pulled off with tweezers and placed in microcentrifuge tubes. The samples were then sun-dried and further processed to remove sediment particles like small pebbles, dead calcareous biota like algae, and gastropods adhered to the plants. The samples were then oven-dried for 48 hours at 60ºC and on drying they were powdered in a pestle and mortar and stored in an air-tight container for further analysis.

Sediment samples were collected from the same 20x20 cm² quadrant. Around 50 gm of samples were collected from each quadrant. Care was taken to avoid excavating sediment from the same area as seagrass samples. The samples were air-dried and composited by a grid to make them homogeneous. The composite samples were sieved through a 200 mm sieve to remove coarse sediment and detrital materials. The samples were then ground and homogenized with a mortar and pestle and stored in air-tight poly-bags before analysis.

Organic carbon in the sediment samples was determined using Walkley and Black's (1934) rapid titration method while in seagrass samples total organic carbon was determined by dry combustion technique (Bojko and Kabala, 2016). Nitrogen was determined using the Micro-Kjeldahl method (Miller and Houghton, 1945). Sodium and Potassium were determined using the Flame Photometer method (Barnes et al. 1945). 0.1 gm seagrass samples and 1 gm sediment samples were taken for the analysis.

		
1.Organic Carbon estimation in sediment samples	2. Ash content estimation in seagrass samples	3. Nitrogen estimation in sediment and seagrass samples

Figure 5.17: Laboratory analysis of the sediment samples

Result

The concentration of sodium, organic carbon and organic matter varied among the study points in the sediment samples of Andaman Island (Figure 5.17).

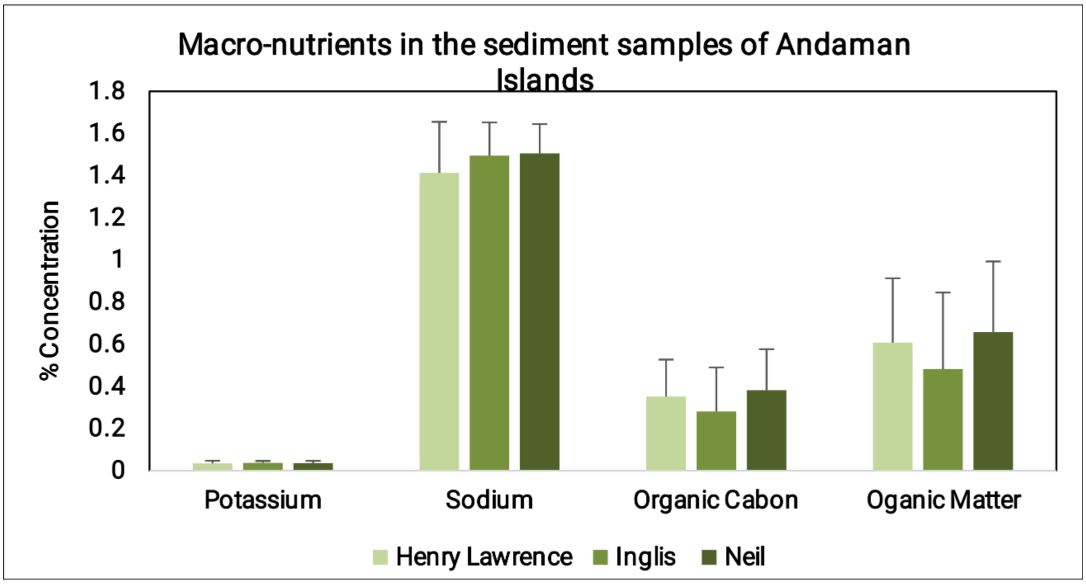


Figure 5.18: Concentration of nutrients in the sediment samples of Andaman Islands

Variation was also observed in the concentration of macro-nutrients in the seagrass samples. The highest concentration of sodium, organic carbon, and organic matter was observed in the samples of Henry Lawrence (Figure 5.19).

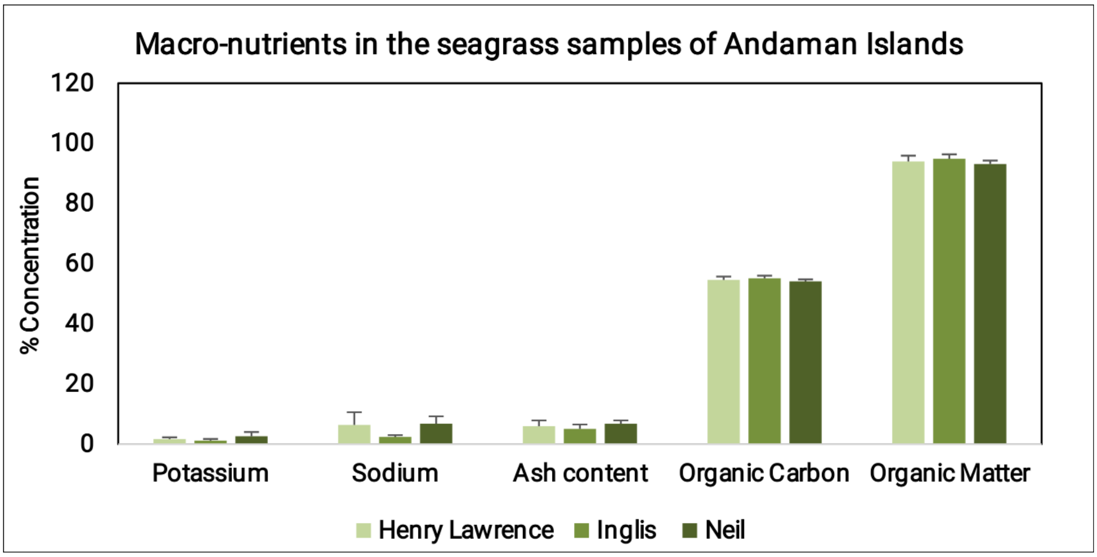


Figure 5.19: Concentration of nutrients in the seagrass samples of Andaman Islands

In the site Gujarat, the concentration of nutrients in the sediment samples also varied. The highest nitrogen content was observed in the samples of Manmarudi. Whereas, organic carbon and organic matter in the samples of Nor Reef (Figure 5.20).

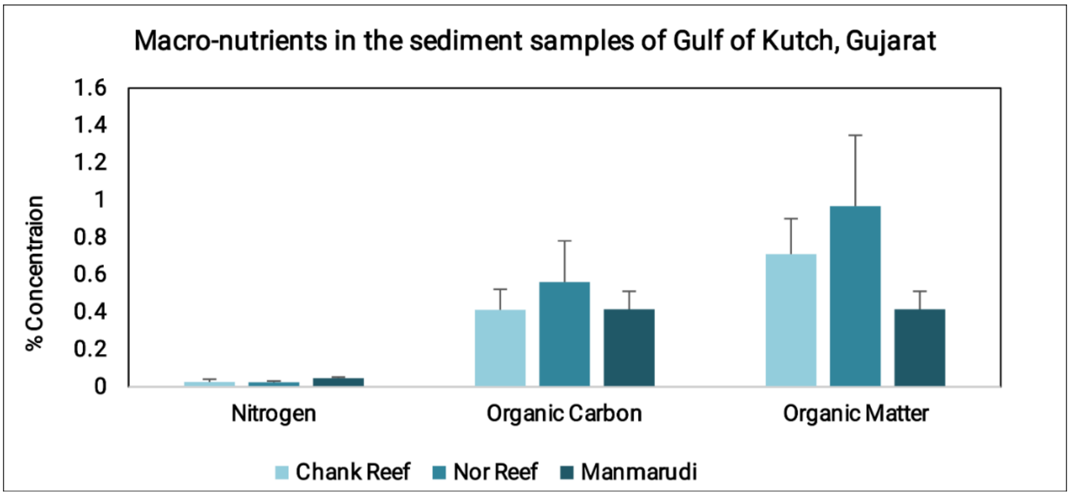


Figure 5.20: Concentration of nutrients in the sediment samples of Gulf of Kutch, Gujarat

Way Forward

1. Factors influencing the concentration of nutrients in the sediments and seagrasses are being analyzed and observed. Samples collected for this season will be analyzed and for next season the collection is in process. On receiving, they will be analyzed for the same.

5.1.5 Seagrass- associated infaunal benthic macrofauna from seagrass meadows of Andaman Islands (Ritchie's Archipelago)

Introduction

Seagrass beds are an important part of the coastal and estuarine ecosystem which influences several ecosystem services (Bos, *et al.,* 2007). Seagrasses are represented by 72 species belonging to 12 genera and 6 families (Short *et al.,* 2011). Seagrass habitat supports macrofauna species diversity, abundance, and biomass than adjacent unvegetated habitats. Due to their sensitivity to adjust in water and habitat for immoderate biodiversity, they are comprehended as important indicator species that replicate the general health of coastal ecosystems (Thayer *et al.,* 1978).

Macrobenthos are invertebrates that live on or in sediment or are attached to a hard substrate. Annelid worms, bivalves, gastropods, crustaceans, tunicates, and insect' larvae are the most commonly encountered Macrofauna in an estuarine or freshwater environment. Macrofauna can be retained using a 500 µm sieve. When macrofauna lives within the substrate it is called infauna and when macrofauna lives on or just above the substrate it is called epifauna (Lenihan & Micheli 2001).

Macrofauna communities are known to play an important role in ecosystem & ecosystem services as they help in bioturbation and bio-irrigation in areas where physical disturbance is low (Kristensen & Kostka 2005, Meysman *et al*., 2006). In the process of searching for food, these organisms actively help in rework and irrigate the sediment. As a result, it helps to alter physical and chemical conditions at the sediment-water interface, promote decomposition of sediment organic matter (OM), and are important mediators in nutrient recycling from the sediment to the water column through bioturbation and suspension-feeding activities (Yingst & Rhoads 1980, Aller & Yingst, 1985, Blackburn 1988, Mermillod-Blondin *et al*., 2004).

This study focuses on an infaunal community of seagrass beds for the health assessment of seagrass habitat.

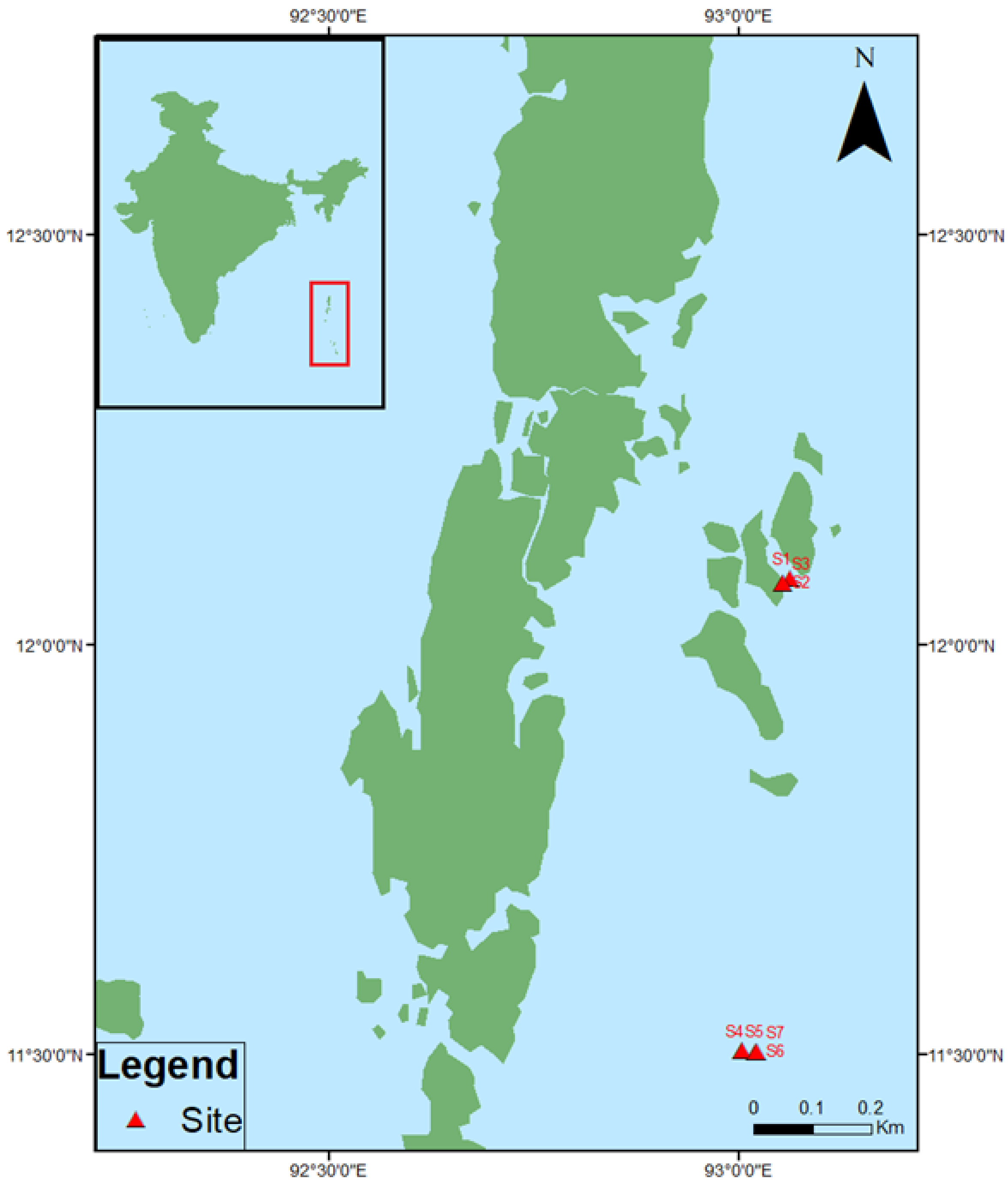
Study Area

For the study of macrobenthic fauna of seagrass meadows, the samples have been collected from 9 transects in the Andaman Islands.

Henry Lawrence is the second largest island in Ritchie's Archipelago. The total area of the island is 54.7 Km^2 with a coastline of 36.5 Km.

Shaheed Dweep, formally known as Neil Island, is located in Ritchie's Archipelago, South Andaman. The total area of the island is 13.77 Km^2 with a coastline of 19.4 Km^2.

Rani Jhansi Marine National Park is located in the Ritchie's Archipelago Andaman and the Nicobar Islands in the Bay of Bengal. It was founded in 1996 and covers 256 km^2.



. Figure 5.21: Sampling locations for seagrass associated macrobenthic fauna at Andaman Islands (Ritchie's Archipelago)

Methodology

Sample collection

The samples were collected from a 20x20 Cm quadrat from a seagrass bed. The collected sediments were hand-scooped from a 10 cm topsoil layer. The collected samples were kept in zip lock bags and later preserved in 4% Rose Bengal buffered formalin solution.

Sieving and sorting

The sediment samples collected were further sieved using a 500μ sieve and segregated in the lab at Wildlife Institute of India's Headquarters. From each sediment sample, 4 subsamples of 100gm were isolated for sorting of macrobenthic organisms. From all 36 samples, the macrobenthic organisms were sorted and preserved in 2 and 5 ml tubes with 5% formalin respectively to their sub-sample identification.

Identification and analysis

The individuals have been identified and sorted to group level and its diversity has been analyzed per m^2.

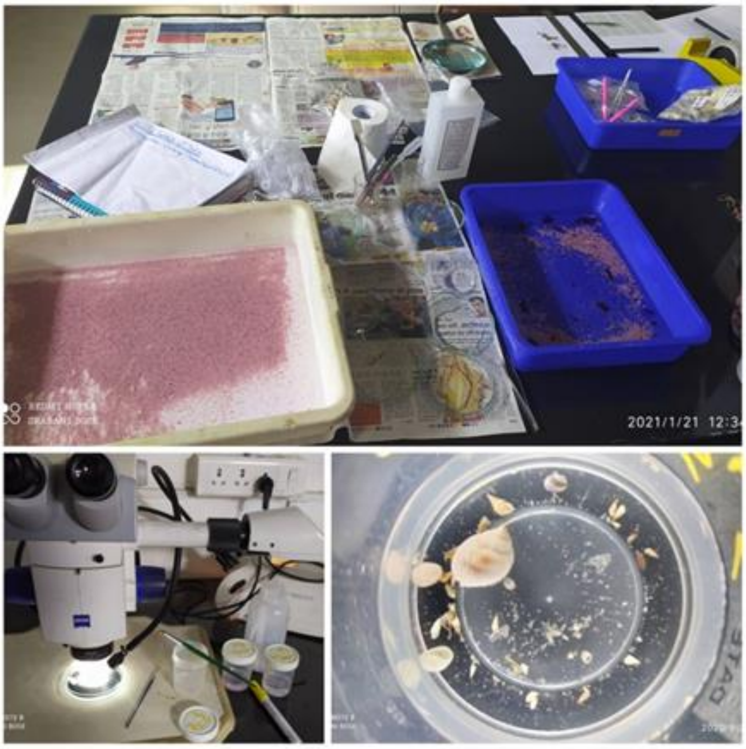


Figure 5.22 Process of sorting and identification till group level

Results

A total of 30 samples have been collected from Henry Lawrence Island (n=13), Shaheed island (n=9), and Rani Jhansi Marine National Park (n=8) from December to March 2020. All the sorting of the samples is done. The number of individuals from each group and its biomass has been calculated of about 21samples, rest is needed to be done.

The Individual has been sorted and classified into 8 groups' viz. Gastropod (GS), Bivalve (BV), Polychaete (PL), Nematode (NM), Foraminifera (FM), Crustacean (CR), Cnidaria (CN) and Nemertea (NT).

The overall biomass of organisms varied from 0.18-110 gm/m² and the number of individuals varied from 25-6175 no. /m².

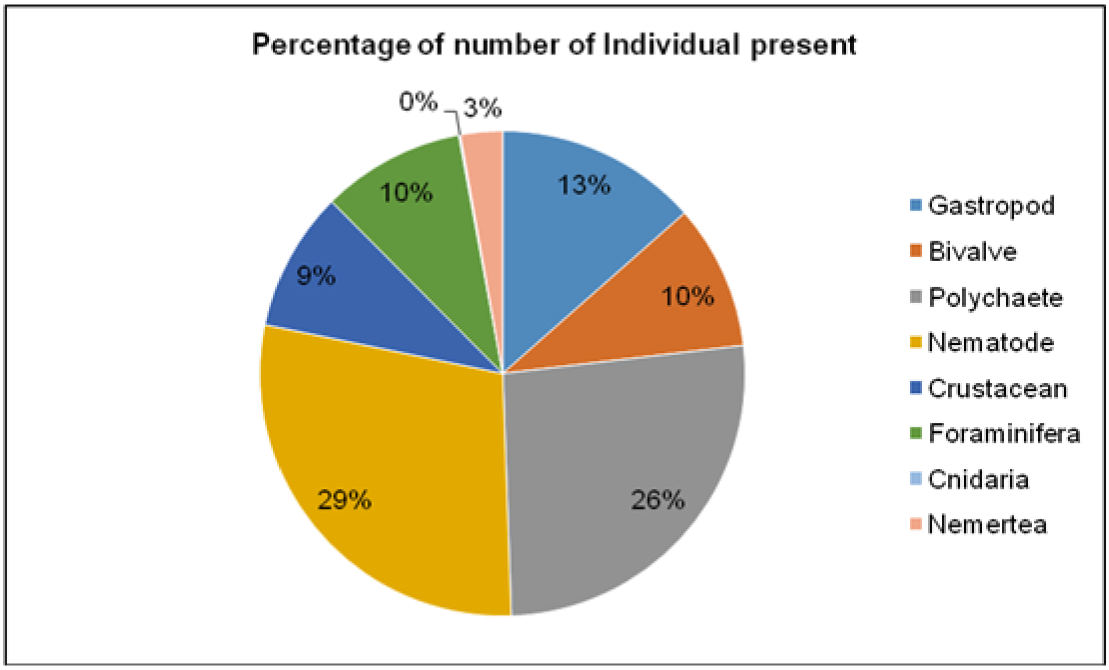


Figure 5.23: Macrobenthic faunal percentage compositions of Andaman Islands

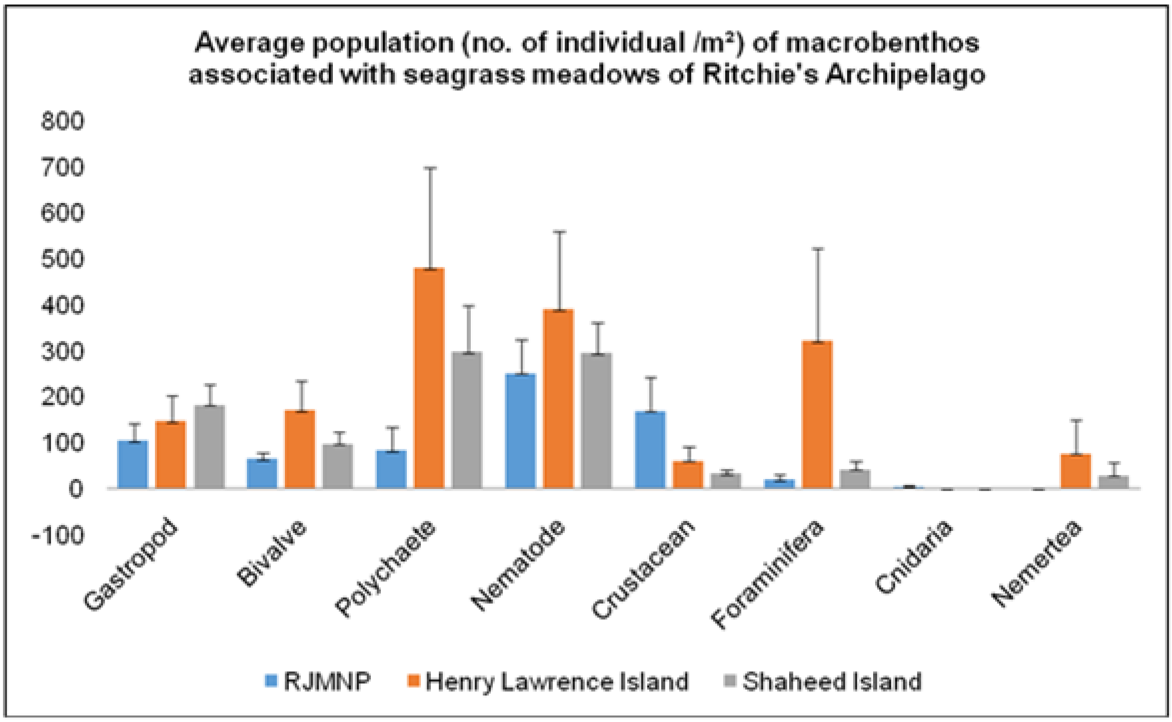


Figure 5.24: Average population (no. of individual/m²) of seagrass associated macrobenthos of Ritchie's Archipelago

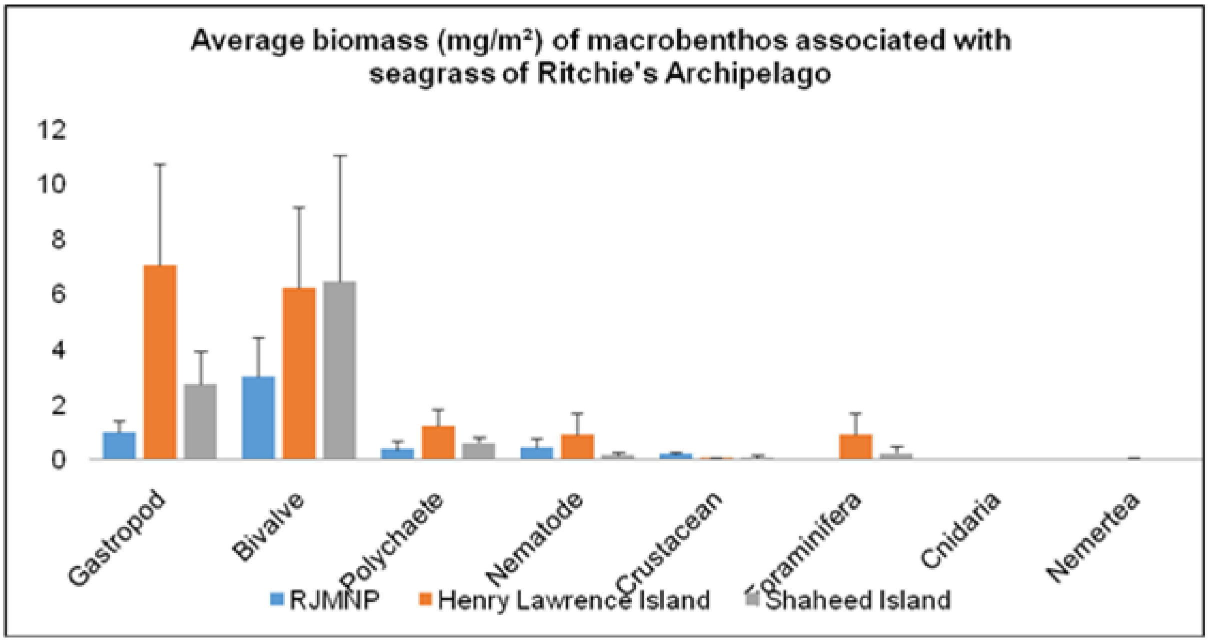


Figure 5.25: Average biomass (g/m²) of *seagrass associated* macrobenthos of Ritchie's Archipelago

Rani Jhansi Marine National Park (RJMNP)

Total 8 quadrats {3 transect} were laid. The seagrass composition in the area was dominated by *Halophila pinifolia.* Total 8 samples from this area constituted six groups viz. Gastropod (15%; 0-275 individual/m², N=8; Avg 103.57; SE±37.96), Bivalve(9.33%; 0-100 indi/m², N=7; Av 64..28; SE±14.28), Polychaete (12%; 0-350 indi/m², N=8 ; Avg 82.14 indi/m²; SE± 52.53), Nematode (36.26%; 0-500 indi./m², N=8; Avg 250; SE±73.39), Crustacean (24.35%; 0-450 indi./m², N=8; Avg 167.8; SE±74.6), Foraminifera (2.59 %; 0-75indi,/m², N=8; Avg 17.8; SE±2.6) and Cnidaria (0.51%; 0-25indi,/m², N=8; Avg 3.57; SE±3.6)

Though the Nematode community (36.26%) is dominant, the biomass of Bivalve (62.54%) is highest in Rani Jhansi Marine National Park (RJMNP).

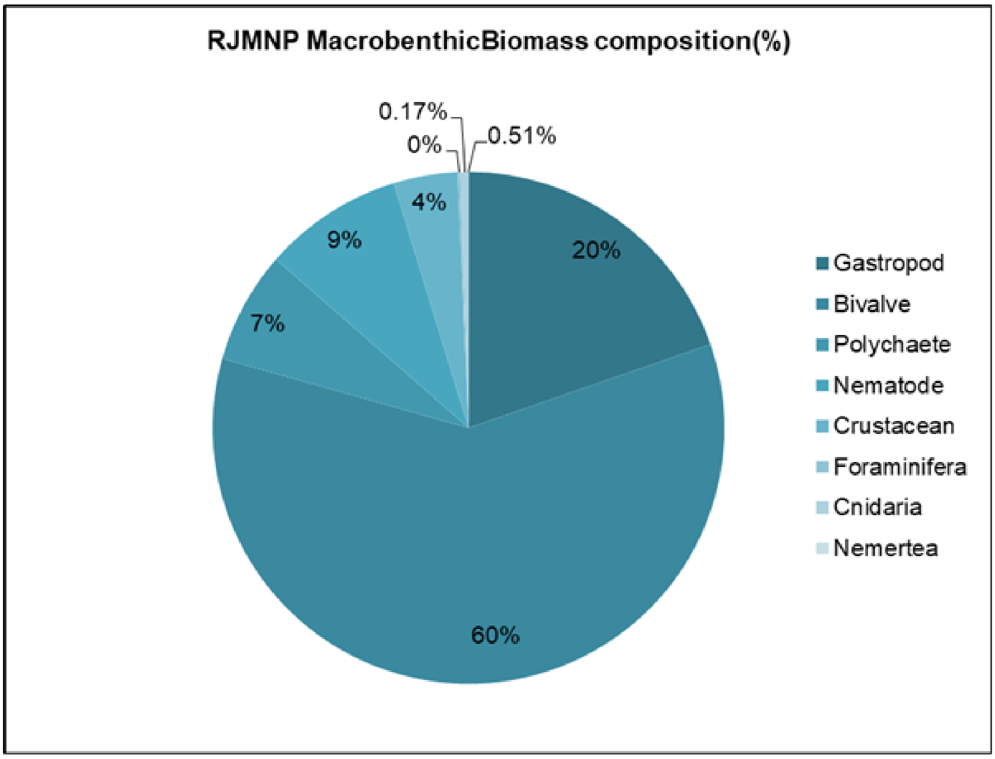


Figure 5.26: Percentage abundance of various benthic taxonomic groups in RJMNP, Andaman Islands

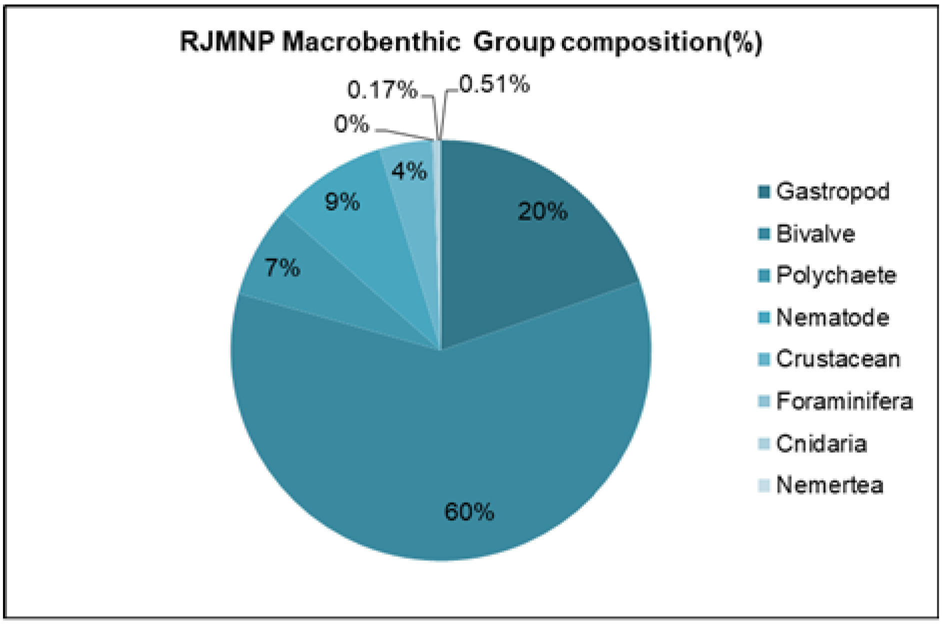


Figure 5.27: Percentage biomass of various benthic taxonomic groups in RJMNP, Andaman Islands

Henry Lawrence

Total 13 quadrats {5 transect} were laid. The seagrass composition in the area was dominated by Halophila pinifolia. Total 13 samples from this area constituted 7 groups but only 5 samples individual and biomass count has been done. Hence the found groups are viz. Gastropod (8.84%; 0-350 individual/m², N=5; AvgkSE±57.2), Bivalve(10.4%; 0-375 indi/m², N=5; Av 170; SE±63.4), Polychaete (29%; 0-1300 indi/m², N=5 ; Avg 480 indi/m²; SE± 217), Nematode (23.8%; 0-1000 indi./m², N=5; Avg 390; SE±171), Crustacean (3.65%; 0-175 indi./m², N=5; Avg 60; SE±30.2) , Foraminifera (19.5 %; 0-975 indi,/m², N=5; Avg 320; SE±204) and Nemertea (4.6%; 0-375 indi,/m², N=5; Avg 75; SE±4.6).

Here the Polychaete community (29%) is dominant, the biomass of Gastropod (42.87%) is highest in Henry Lawrence.

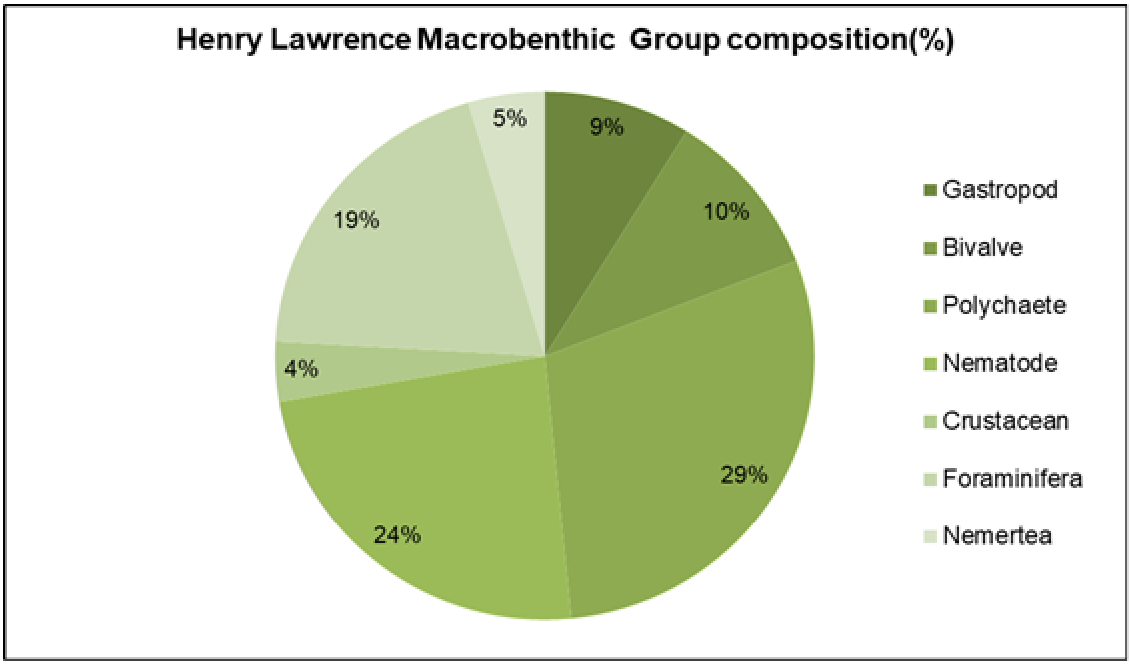


Figure 5.28: Percentage biomass of various benthic taxonomic groups in Henry Lawrence at Andaman

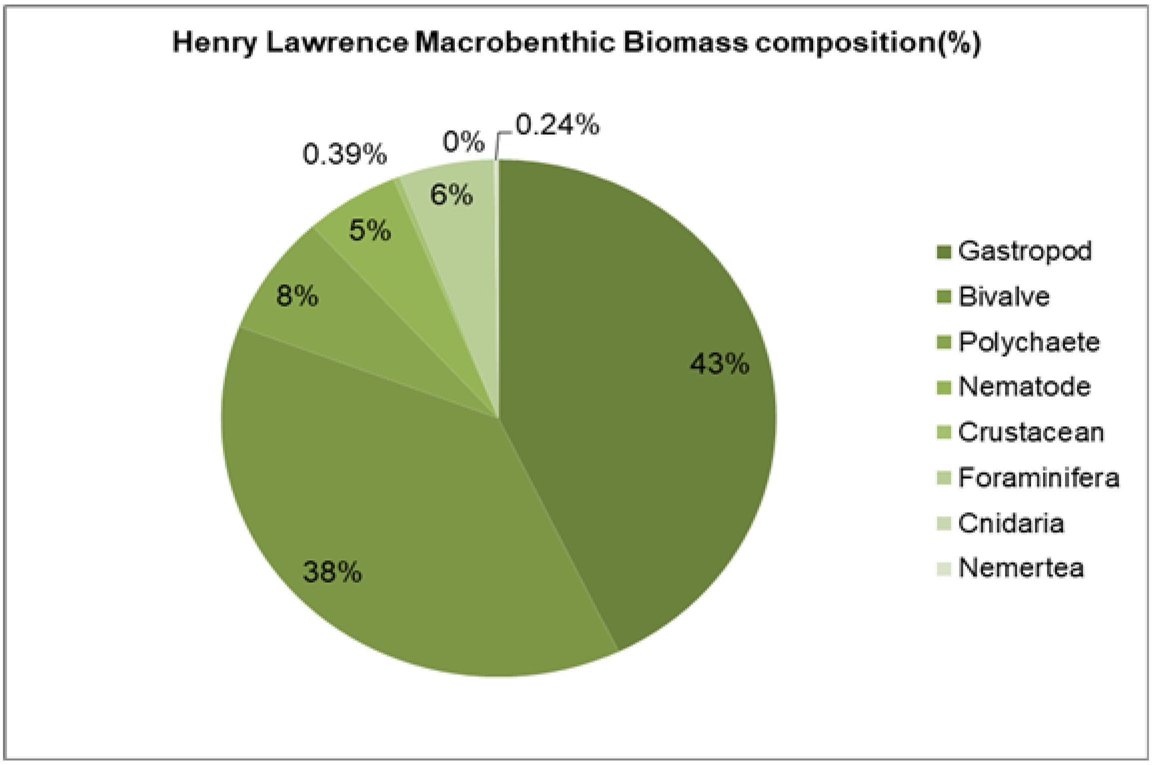


Figure 5.29: Percentage biomass of various benthic taxonomic groups in Henry Lawrence, Andaman Islands

Shaheed Dweep Island

Total 9 quadrats {4 transect} were laid. The seagrass composition in the area was dominated by *Halodule ovalis*, *Thalasia Hempirchii* and *Halophila pinifolia.* Total 9 samples constituted of 7 groups but only 5 samples individual and biomass count has been done. Hence the found groups are viz. Gastropod (17.16%; 0-300 individual/m², N=9; Avg 161.3; SE±57.2), Bivalve (9.17%; 0-225 indi/m², N=9; Avg 86.11; SE±27.64), Polychaete (31%; 0-900 indi/m², N=9 ; Avg 297.2 indi/m²; SE± 94), Nematode (29.3%; 25-525 indi./m², N=9; Avg 58; SE±30), Crustacean (6.2%; 0-275 indi./m², N=9; Avg 58; SE±30) , Foraminifera (3.9 %; 0-150 indi,/m², N=9; Avg 36.1; SE±18.8) and Nemertea (2.66%; 0-225 indi,/m², N=9; Avg 25; SE±26.5).

Here Polychaete community (31%) is dominant, the biomass of Bivalve (62.5%) is highest in Shaheed Dweep Island.

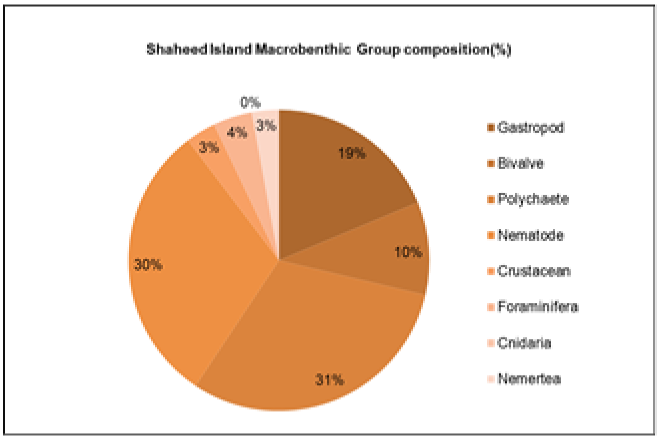


Figure 5.30: Percentage abundance of various benthic taxonomic groups in Shaheed Island, Andaman

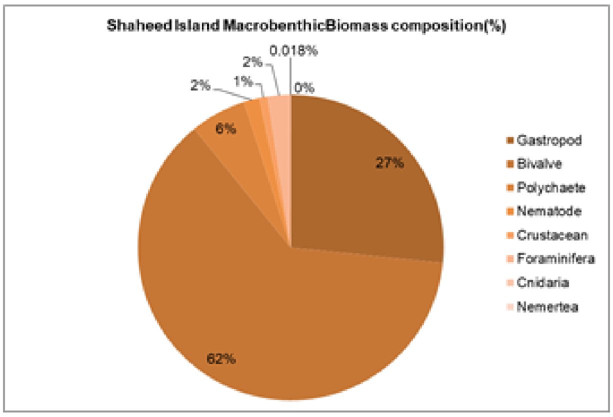


Figure 5.31: Percentage abundance of the biomass of various benthic taxonomic groups in Shaheed Dweep Island, Andaman

Table 5.4: Distribution of macrobenthic faunal group in the Andaman Islands [GS-Gastropod, BV- Bivalve, PL-Polychaetes, NM-Nematode, CR-Crustacean, FM-Foraminifera, CN-Cnidaria, NT- Nemertea, UN- Unknown]

Sample ID	GS	BV	PL	NM	CR	FM	CN	NT	UN
ING 1.1	-	+	-	+	+	-	-	-	-
ING 1.6	+	+	+	-	-	+	-	-	+
ING 1.11	+	+	-	-	-	+	-	-	+
ING 2.1	+	+	-	+	+	-	-	-	+
ING 2.11	+	-	+	+	+	-	-	-	+
ING 3.1	+	+	-	+	+	-	-	-	+
ING 3.6	+	+	+	+	+	-	-	-	-
ING 3.11	+	+	+	+	-	-	+	-	+
JT 1.6	+	+	+	+	+	-	-	-	-
JT 1.11	+	+	-	+	-	-	-		+
JT 2.1	-	+	+	+	+	-	-	+	+
JT 2.6	-	+	+	+	-	-	-	-	+
JT 2.11	+	+	+	+	+	-	-	-	+
LX 1.1	-	-	+	+	+	-	-	-	+
LX 2.1	-	+	+	+	-	-	-	+	-
LX 2.6	+	+	+	+	-	-	-	-	-
BHA 1.1	+	+	+	+	+	-	-	-	-
BHA 1.6	+	+	+	+	+	+	-	-	-
BHA 1.11	+	-	+	+	+	-	-	-	-
BHA 2.1	+	+	+	+	+	+	-	-	-
BHA 2.6	+	+	+	+	+	-	-	-	+
BHA 2.11	+	+	-	+	+	+	-	-	-
IMD1.1	+	+	+	+	-	-	-	-	+
IMD 1.6	+	+	+	+	-	+	-	-	+
IMD3.6	+	+	+	+	-	+	-	-	+
IMD1.11	+	+	+	+	-	-	-	-	+
IMD 3.1	+	+	+	+	+	+	-	-	+
IMD2.6	+	+	+	+	+	-	-	-	+
IMD 2.1	+	+	+	+	+	+	-	+	-
IMD 3.11	+	+	+	-	+	+	-	-	+

Figure 5.32: Seagrass associated Macrobenthic fauna: 1) Sipuncula 2) Acantholaimus Sp. (Nematode) 3) Laevidentalium sps. 4) Pyrinidae (Anachis Sp.) 5) Neritidae 6) Sipuncula 7) Mactra Sp. (Bivalve) 8) Clavatulidae (Gastropod) 9) Fissurellidae (Gastropod)

5.1.6. Mapping Seagrass distribution using satellite imageries

Introduction

Space-borne technologies like Remote sensing (RS) and Geographic information system (GIS) are actively used for underwater mapping using moderate and high-resolution satellite products with high efficiency. High-resolution satellite images can be processed to study the distribution of seagrass beds and detect the dugong feeding trails (Mizuno *et al*., 2017). The primary and secondary range distribution of Dugongs in the Indo-Pacific region is shown in Figure 1. Primary sites are areas where dugongs are frequently reported, and secondary sites are areas where a single dugong or a calf is occasionally reported.

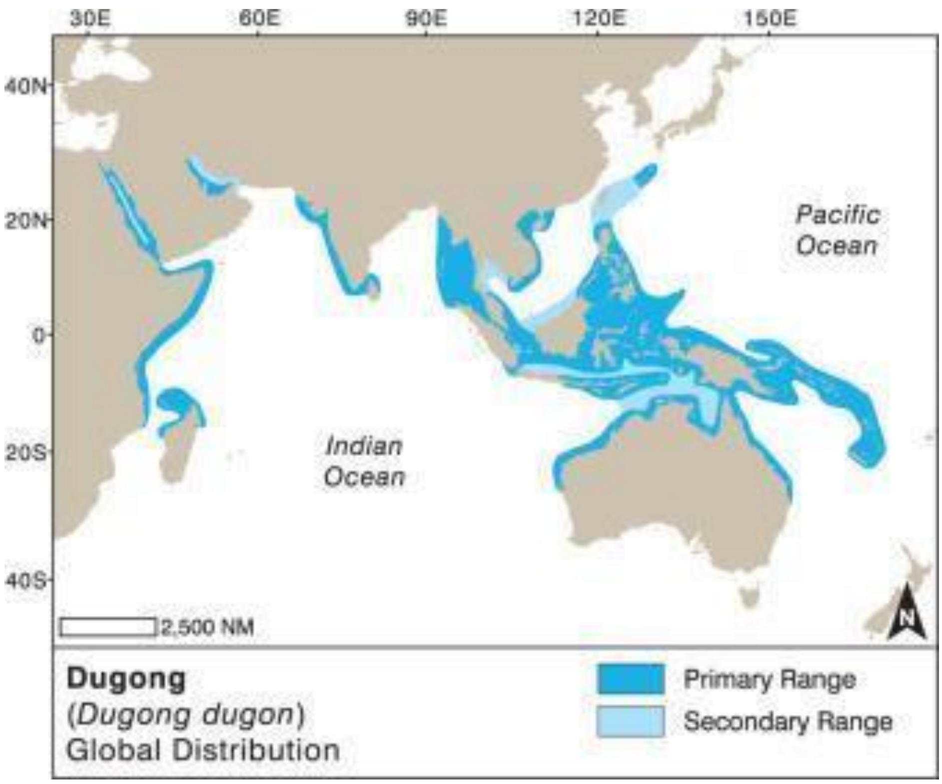


Figure 5. 33: Primary and secondary range distributions of Dugong in the Indo-Pacific region. Source (Jefferson et al., 2015)

Objective

To map seagrass distribution using machine learning algorithms on Google Earth Engine (GEE) from high-resolution satellite images.

Study Area

1. Parts of Andaman group of Islands
2. Palk Bay, Tamil Nadu
3. Gulf of Kutch, Gujarat

Datasets

European Space Agency (ESA) provides a high-resolution data repository of the Sentinel-2 image series. The products are being extensively used for land monitoring and climate change activities. It also supports the assessment of biogeophysical parameters such as Leaf Area Index (LAI), Leaf Chlorophyll Content (LCC), and Leaf Cover (LC). This research aims to classify Sentinel-2 multi-temporal series data at 10m resolution for the period of Apr 2015 to Apr 2020 to analyze the seagrass beds in the study area. Sentinel-2 Level 1C (Top-of-Atmosphere reflectance) and Sentinel-2 Level 2A (Bottom of Atmosphere reflectance) will be used for further analysis. Google Earth Engine has a free data repository of Sentinel 2 data for public access and can be easily extracted using Earth Engine API. Table 5.3 specifies the metadata with bands description of Sentinel-2 data product.

Table 5.5: Metadata for Sentinel-2 product

METADATA	
Satellite	Sentinel-2
Sensor	Multispectral Instrument (MSI)
Bands	Band 1 Aerosol (443.9 nm-S2A/ 442.3 nm-S2B) Band 2 Blue (496.6 nm-S2A/ 492.1 nm-S2B) Band 3 Green (560 nm-S2A/ 559 nm-S2B) Band 4 Red (664.5 nm-S2A/ 665 nm-S2B) Band 8 NIR (835.1 nm-S2A/ 833 nm-S2B) Band 11 Shortwave Infrared 1 (1613.7 nm-S2A/ 1610.4 nm-S2B) Band 12 Shortwave Infrared 2 (2202.4nm-S2A/ 2185.7 nm-S2B)
Spatial Resolution	10 m
Temporal Resolution	5 days at equator with twin satellites (Sentinel 2A and Sentinel 2B) under cloud-free conditions
Date of capture	Apr 2015 – …...

Methodology

The overall methodology is briefly described in Figure 5.26, where the whole process is executed in GEE using JavaScript. Certain parts of statistical processing will be performed on R programming. Also, using very high-resolution spectral profiling, an attempt would be made to detect dugongs.

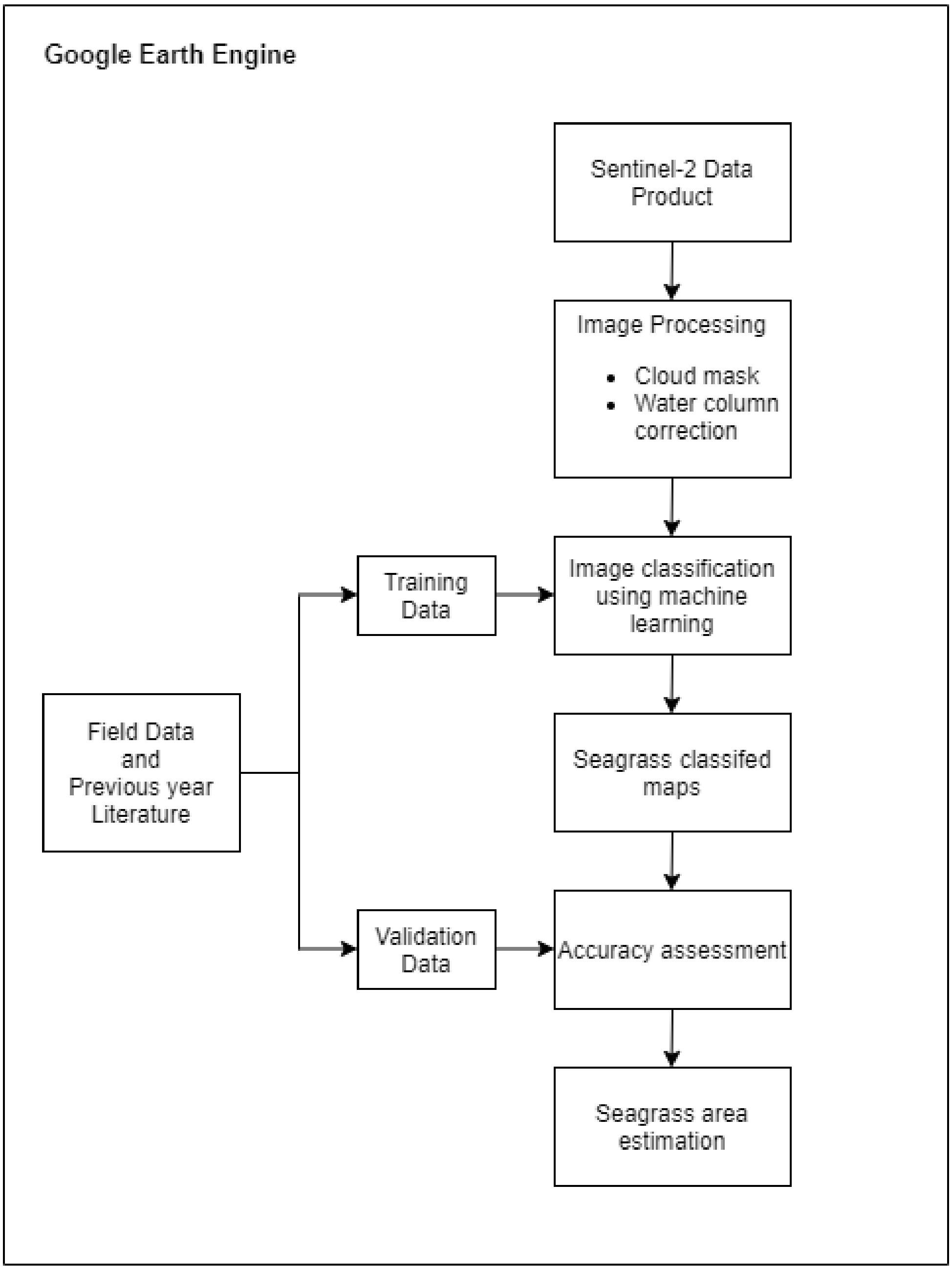


Figure 5.34: Overall methodology

Results

Seagrass classification is performed using the pixel-based image classification method. GEE in-built machine learning classifier, Random Forest (RF), is tested for different sites. The RF model was analyzed on Sentinel-2 surface reflectance level-2 product, an atmospherically corrected data providing radiometrically and geometrically corrected cloud-free images for all the study sites. Temporal data for April 2015 to date satellite images are used for different sites depending upon the low tide and cloud cover. The field data acquired for Andaman & Nicobar Island was from 2018 to 2021. The data was segregated into four classes as seagrass, sand rubble, water, and mixed pixels. Andaman & Nicobar Islands support a rich underwater habitat, including various seagrass species and coral reefs. These habitats were observed to exist in diverse cultures, as shown in Figure 5.35, Figure 5.36, and Figure 5.37. Also, the Palk Bay in Tamil Nadu consists of a dense patch of seagrass. The field data obtained from Palk Bay is from 2018-2019. Based on seagrass percentage cover, the satellite image is classified into four classes: dense seagrass, sparse seagrass, sand, and water, as shown in Figure 5.38. Whereas in the low tide regions of the Gulf of Kutch, Gujarat, only two classes were observed, namely seagrass and non-seagrass. The seagrass classification for Gujarat is shown in Figure 5.39.

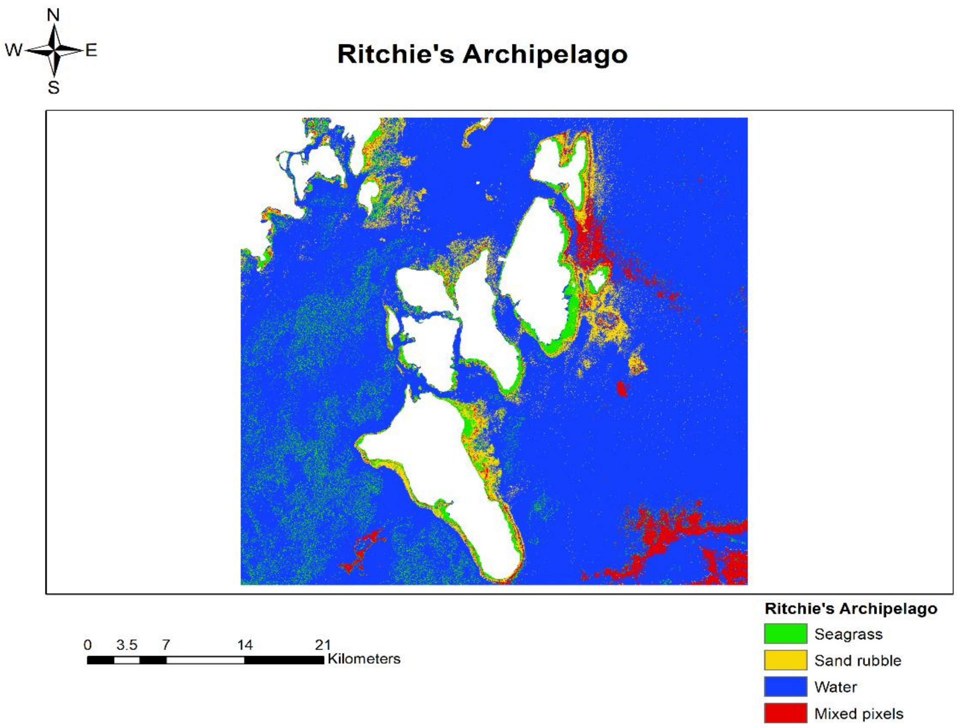


Figure 5.35: Seagrass classification for Ritchie's Archipelago, Andaman Nicobar Island

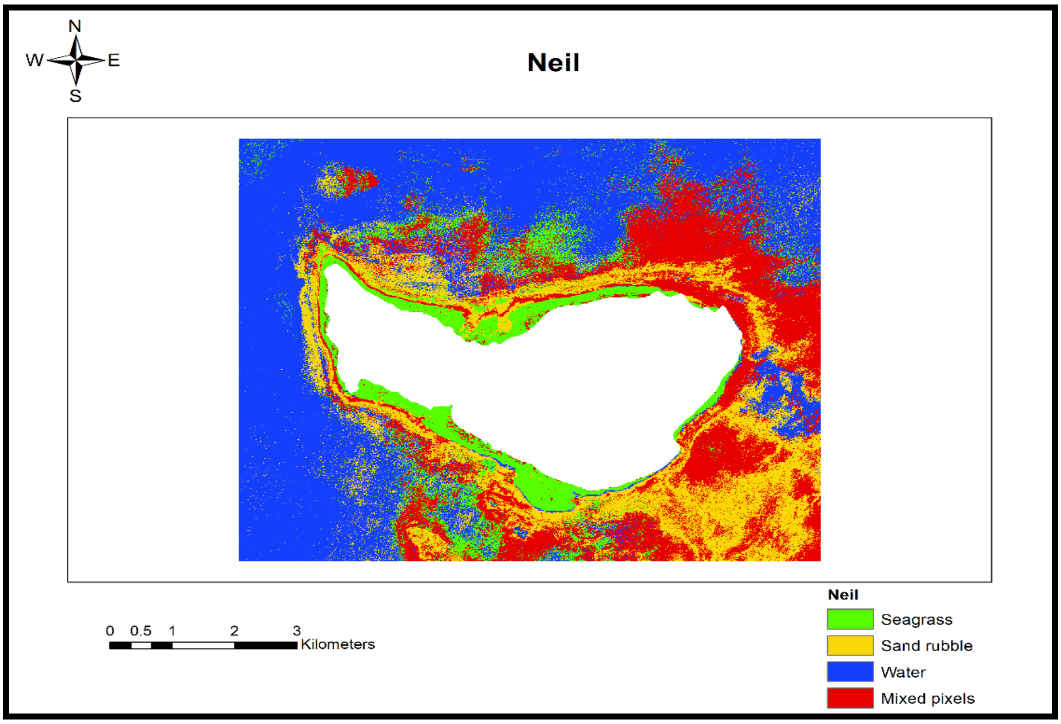


Figure 5.36: Seagrass classification for Neil Island, Andaman, and the Nicobar Islands

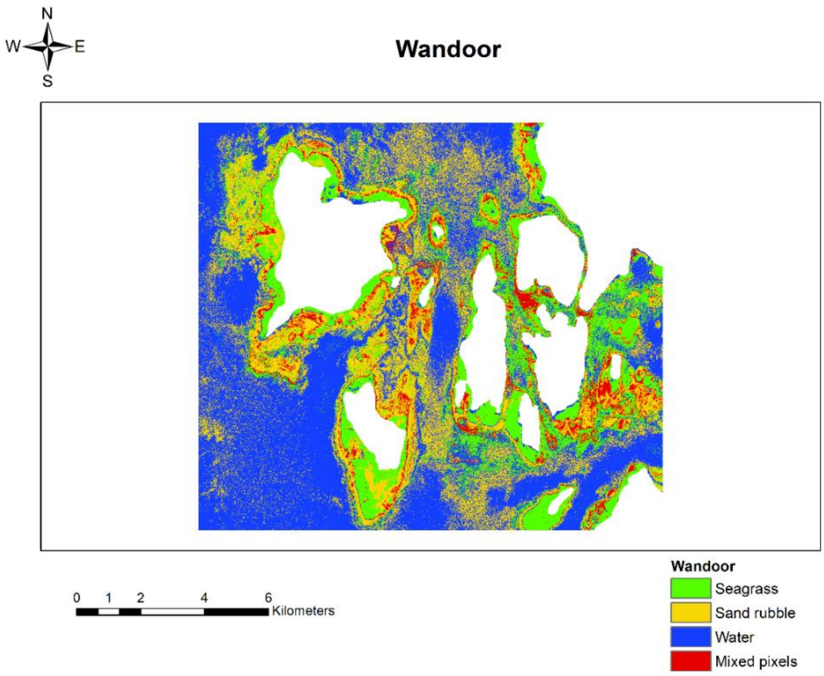


Figure 5.37: Seagrass classification for Wandoor, Andaman, and the Nicobar Islands

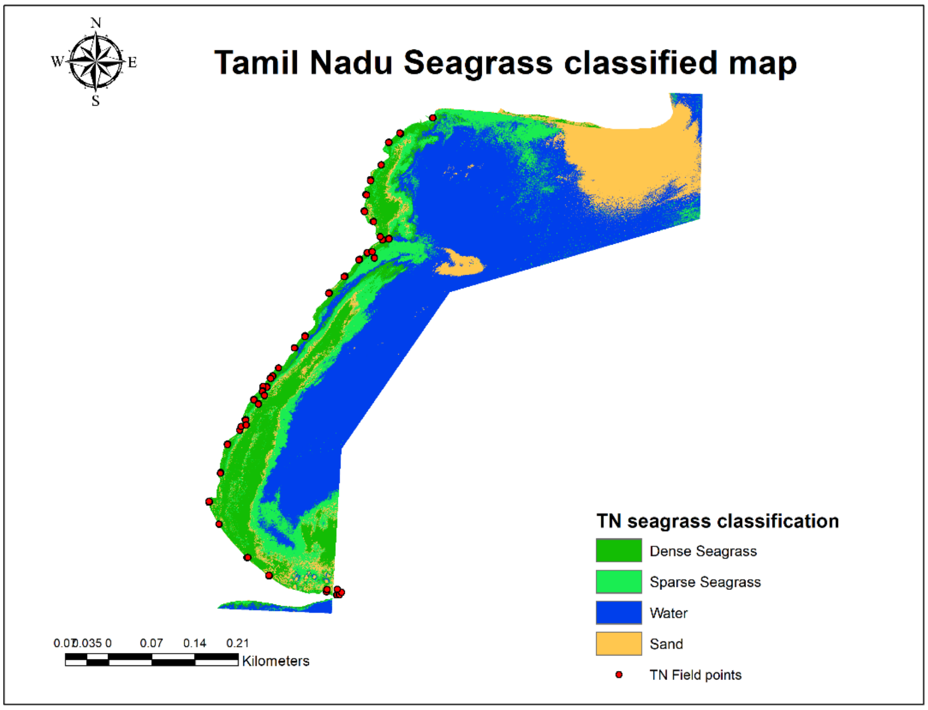


Figure 5.38: Seagrass classification for Palk Bay, Tamil Nadu

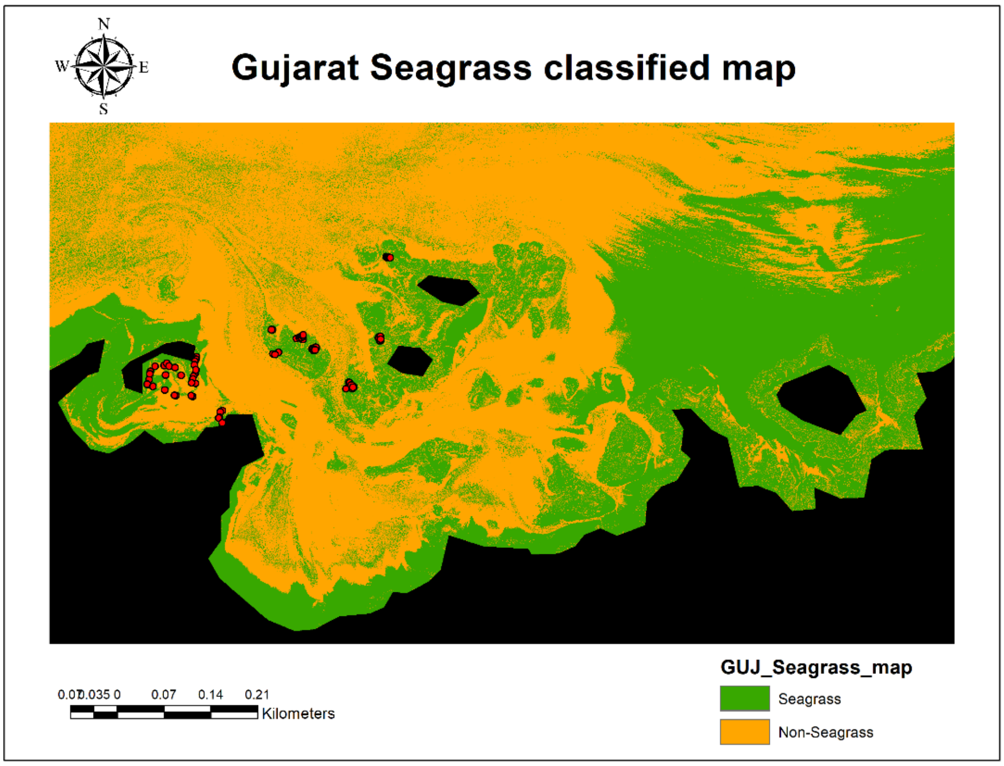


Figure 5.39: Seagrass classification for Gulf of Kutch, Gujarat

5.1.7 Study of Dugong population in Indian sea waters using microsatellite and mitochondrial markers

Introduction

Conservation is best done when we get a snapshot of the species population structure in the past and the present. This gives us how time, any anthropological or natural event has affected the population to a recent structure.

Microsatellites are short tandemly arrayed di-, tri-, or tetranucleotide repeat sequences with repeat size of 1–6 bp repeated several times flanked by regions of nonrepetitive unique DNA sequences, which are distributed throughout the genomes of most eukaryotic species (Tautz, 1989). The very high levels of variability associated with microsatellites, speed of processing, and the potential to isolate a large number of loci provide a marker system capable of detecting differences among closely related populations of a species (Muneer, 2009). Free of natural selection pressure, short size range, uninterrupted stretches of identical repeat units, and the high proportion of polymorphisms are some of the properties that make microsatellites ideal genetic markers for conservation genetics and population structure analysis by giving an insight into understanding mutational processes (Abdul-Muneer, 2014).

The control region of the mitochondrial DNA (mtDNA) due to its elevated mutation rate, lack of recombination, and maternal inheritance serves as a biomarker in phylogenetic studies and ancestry. Mitochondrial DNA (mtDNA) has strictly maternal inheritance, meaning mtDNA haplotypes should be shared by all individuals within a maternal family line, hence giving a picture of ancient gene flow.

Method

Microsatellite markers were used for the amplification of dugong nuclear DNA. The reactions were performed in panels consisting of four different microsatellite markers of varied amplicon size and labeling dye. Details of the primers are mentioned in Table 5.6. The samples were amplified panel-wise.

Table 5.6: Panels used for microsatellite analysis along with the primers used, their annealing temperature, and corresponding dyes.

SN.	Panels	Primers	Dye	Temperature
1	Panel_1	Ddu B01	Fam	58
2		Ddu C05	Pet	58
3		Ddu B02	Ned	58
4		Ddu E04	Vic	58
5	Panel_2	Ddu G12	Fam	58
6		Ddu D08	Pet	58
7		Ddu C11	Ned	58
8		Ddu G11	Vic	58
9	Panel_3	Ddu E09	Fam	58
10		Ddu F07	Pet	58
11		Ddu H02	Ned	58
12		Ddu C09	Vic	58
13	Panel_4	Tma A02	Fam	54
14		Tma E08	Pet	54
15		Tma A09	Ned	54
16		Tma A04	Vic	54

Microsatellite markers were amplified using Qiagen Hotstart master mix (Qiagen Inc., Hilden, Germany) and genotyped in ABI 3500XL Genetic Analyzer (Applied Biosystems, California, United States). Allele sizes for each locus were scored manually using GENEMARKER v2.6.7 (SOFTGENETICS INC., USA).

The mitochondrial DNA (mtDNA) control region was amplified using a universal mammalian primer- A24 (Kocher et al., 1989) and dugong-specific primers A58, A77, and A80 (Blair, et *al.*, 1997). The amplified PCR products were cleaned using Exonuclease-Shrimp Alkaline Phosphatase (Exo-SAP) mixture (New England Biolabs, Ipswich, Massachusetts) and sequenced bidirectionally using BigDye v3.1 Terminator kit in ABI 3500XL Genetic Analyzer (Applied Biosystems, California, United States).

Analysis

The alleles were manually called therefore any error in calling these microsatellite loci was checked in GIMLET v1.3.3 (Valière, 2002). All the calls with a frequency of less than ten percent were recalled. The microsatellite data thus generated was used to look for the genetic variability in the four-sampling site by implementing a Bayesian iterative algorithm using the software STRUCTURE v2.3.4. (Porras-Hurtado, *et al.,* 2013).

The mitochondrial DNA fragment of dugongs generated was aligned with already submitted sequences of Dugongs (Srinivas *et al*., 2019) in MEGA v.7 (Kumar, S., 2016) and cleaned for further analysis. We looked for common haplotypes in DnaSP v5.10(Librado, *et al*., 2005) and determine if there was any structuring between the Dugong sequences obtained from various field sites using Bayesian Analysis for Population Structure (BAPS) v6.2 (Corander *et al.,* 2007). A haplotype network, using PopArt v1.7 (Leigh, *et al*., 2015), containing all the haplotypes was made to get a picture of the variability amongst the population.

Results

Out of the 44 dugong samples that we acquired we have generated microsatellite data for 37 individuals and mitochondrial data for all 44 individuals. Both the data are being analyzed for deeper demographic understanding. Here we talk about some basic analysis that gives a baseline outlook.

The mitochondrial analysis showed there are 10 distinct haplotypes with one to 10 base-pair differences between the sequences. This variability was spread out across the population i.e., the haplotypes were found in most of the sampling sites (Figure 5.40)

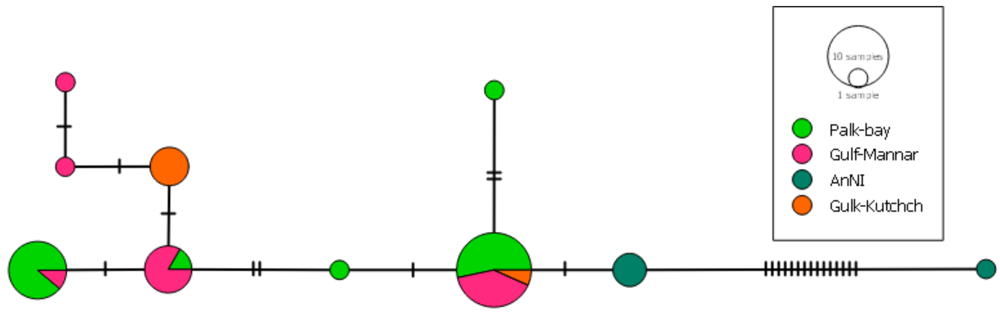


Figure 5.40: Each circle depicts a haplotype and the colors within show the places it is shared in. The dashes depict the number of base-pair differences between each haplotype

The Bayesian Analysis for Population Structure (BAPS) using mitochondrial gene showed that there are two distinct maternal lineages in the Indian dugong population again shared between the four sites (Figure 5.41).

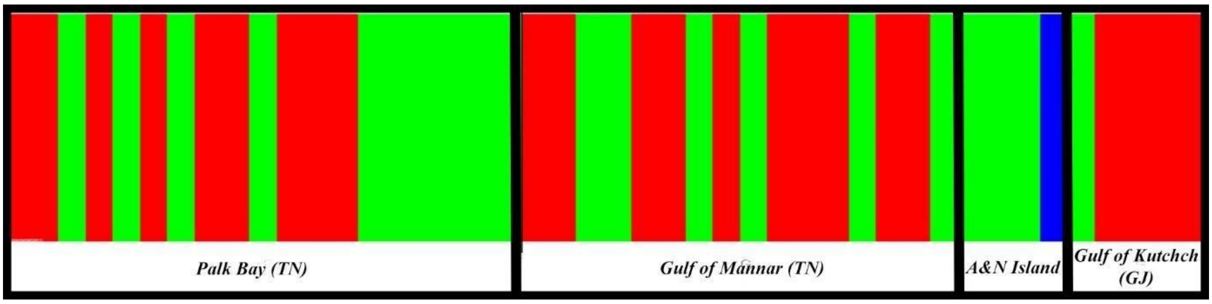


Figure 5.41: The BAPS analysis showed two maternal lineages, depicted by different colors, shared between all the sampling sites

In either of the analysis above, it appears like Andaman & Nicobar Islands appears to have a distinct line apart from the aforementioned two, however, the samples acquired from the place is relatively less to speculate anything.

The population structure analysis using microsatellites brings out a similar picture for recent times, where there is no segregation in populations from the sites. It can be said that the populations are intermixing however further analysis on the same needs to be done. Such a result can also be a result of loci not being efficient in picking up the distinction (Figure 5.42).

Figure 5.42: Structure population genetic analysis depicts there is no distinction in population and the variability is equally distributed across the sampling sites. The bars show the probability of an individual being in each lineage which in this case ranges between 40-60 percent (Srinivas *et al.*, unpublished data)

Both mitochondrial and microsatellite analysis points towards populations mixing and being connected. For a deeper understanding and a precise picture, we need to look into migration rates, any bottleneck event, and inbreeding signatures to comment about how well the populations are connected with each other. However, the baseline analysis does point towards the importance of conserving sea-grass patches between these sampling sites since they play a major role in sustaining the dugong habitat.

5.1.8 Assessing environmental contaminants from critical Dugong habitats of India

Pollution is one of the significant threats to the marine ecosystem (Evans, 2003). Small cetaceans cannot metabolize persistent organochlorines, so they are at greater risk from environmental contaminants. (Tanabe *et al.*, 1988). Baseline information of heavy metal detection and Organochlorine residues was obtained from Ganges river dolphin's blubber, muscle, kidney, and liver tissues from India (Kannan *et al.*, 1993). The residual pattern of PCBs, DTTs, HCHs, HCB, aldrin, dieldrin, heptachlor, heptachlor epoxide, and chlordane is in the Ganges River dolphins were also assessed (Kannan *et al*., 1994). For the first time, organochlorine (OC) pesticides, polychlorinated biphenyls (PCBs), and polybrominated diphenyl ethers (PBDEs) concentration detection were performed in tissues of Irrawaddy dolphins collected from Chilika Lake, India (Kannan *et al.*, 2005). A similar concentration of organochlorines and DDT, HCH, and PCBs was found in the blubber samples of Spinner dolphins, Bottlenose dolphins, and Humpback dolphins from the Bay of Bengal, India. (Tanabe *et al.,* 1993, Karuppiah *et al*., 2005). These previous studies in freshwater and marine mammals have shown us that pollutants are biomagnified and indicate a chain of bioaccumulation and biomagnification in marine and freshwater ecosystems. There is a dearth of information about the pollutant toxicity in marine mammals of India.

This study was the first to determine the trace metal concentrations in dugongs and elucidate the status of essential and toxic metal accumulations in the tissue samples. Twenty-eight tissue samples were collected from the 19 Dugong strandings from Palk Bay and Gulf of Mannar, Tamil Nadu. Out of these, blubber samples were collected from 10 individuals whereas, both blubber and liver samples were collected from the remainder of the nine individuals. Detailed necropsies were performed, depending on the state of decay of the animal. Collected samples were then wrapped in aluminum foil, labeled, and stored in an icebox during transportation and later stored at -20°C until further analysis. The samples were digested in a high-performance microwave digestion system (Milestone ETHOS UP™). 13 elements, i.e., Mg, Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Cd, Hg, and Pb, were analyzed by subjecting the samples to ICP-MS (ICP- QQQ Agilent 8900 in Helium (He) mode). Mercury Standards of 1,5,10 ppb concentrations and multi-element standards of 10, 50,100 ppb concentrations from Agilent technology were used.

Out of 13 Elements analyzed, 12 elements and their concentrations were detected in the ICP MS from 28 dugong tissue samples. They are Magnesium (316.617 ppb), Aluminum (21.150 ppb), Chromium (1.541 ppb), Manganese (1.959 ppb), Iron (245.682 ppb), Cobalt (230.308 ppb), Nickel (7.253 ppb), Copper (30.371 ppb), Zinc (294.379 ppb), Arsenic (0.073 ppb), Cadmium (9.632 ppb), Mercury (0.221 ppb). These concentrations appear to be potentially valuable indicators of the level of trace metals accumulated in the marine environment: according to their position in the trophic network, their life span, and their biological half-time of elimination of pollutants. This indicates that these animals accumulate high levels of metals. Although metals generally occur at low concentrations in the oceans, marine organisms' bioaccumulate trace elements with a significant increase of metal burdens through the food chain, especially toxic elements such as Hg and Cd potentially constitute a toxicological risk for the species.

These factors indicate unique potential exposures to environmental contaminants and biotoxins that warrant more significant research. Long-term monitoring of persistent contaminants in accessible dugong populations has the potential to offer essential insights into the changing quality of such environments in the face of climate change and ongoing habitat degradation. Considering that Dugongs are usually exposed to a mixture of different pollutants whose effects may be synergistic and challenging to assess, these conclusions must not lead to an underestimation of the toxicological risk of other trace metals and persistent pollutants. Further studies are needed in the marine ecosystems to understand the processes involved which have led to such accumulation of pollutants at the topmost trophic level. Studies targeting the lower trophic levels and the substrate will allow us to understand how these pollutants are transferred from the source to the apex trophic level. There is a significant opportunity to apply other technological advances in ecotoxicology to the study of dugongs.

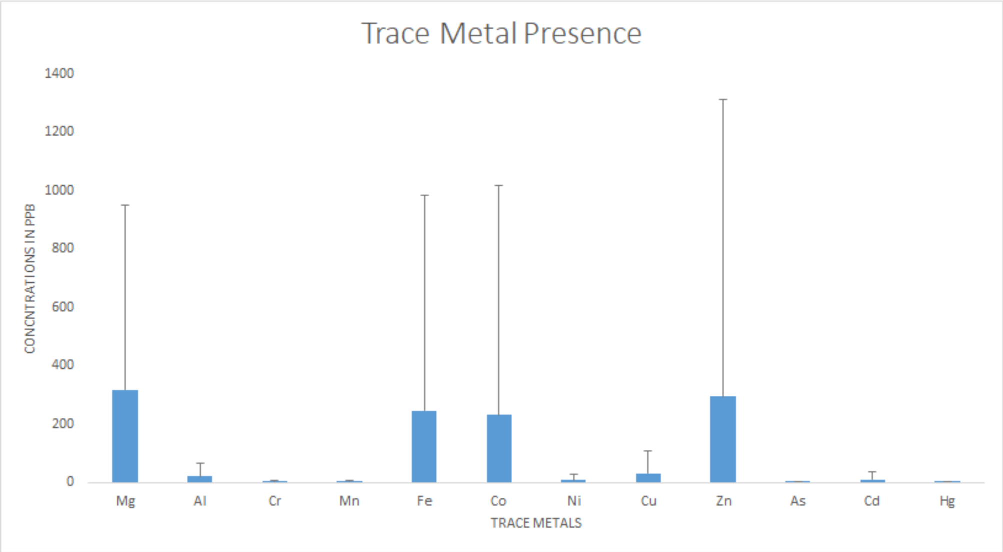


Figure 5.43: Concentration of trace metals found in tissue samples of Dugong

6.1 Outreach and awareness- 2020-2021

Under the project's mandate, several field activities are being conducted at the 3 field sites viz. Andaman & Nicobar Islands, Gulf of Mannar & Palk Bay (Tamil Nadu) and Gulf of Kutch (Gujarat). The field activities are classified under three broad heads: Research & Monitoring, Participatory Management of Dugong and Seagrass Habitats and Capacity Building Activities. These activities have been conducted simultaneously at all the three field sites in coordination with respective State Forest Departments, local communities and other stakeholders (Figure 6.1). The total reach of this awareness campaign was about 3500.Total 11 stakeholders were targated consisting maximum locals n=1629, college students n=991 and school children n=447, coast guard n=116, Fishermen n=81, Forest officials n=72, Navy= 54, NGOs, divers and Fishery department n= 13.

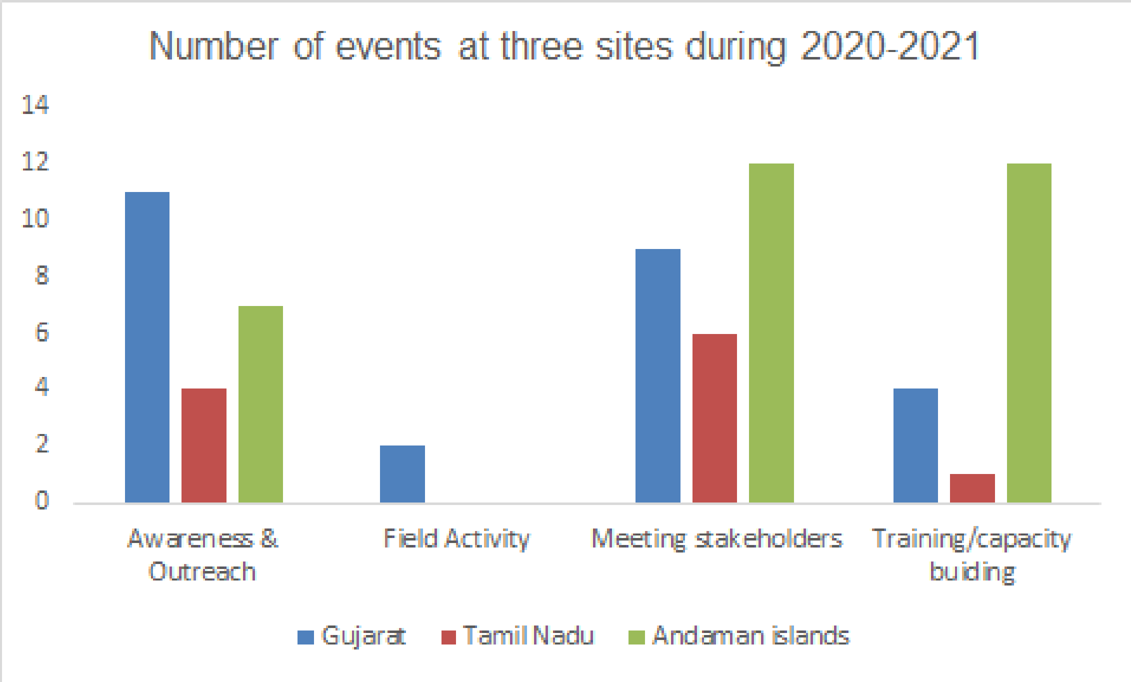


Figure 6.1: Field outreach activities conducted under the Dugong Recovery program at three field sites

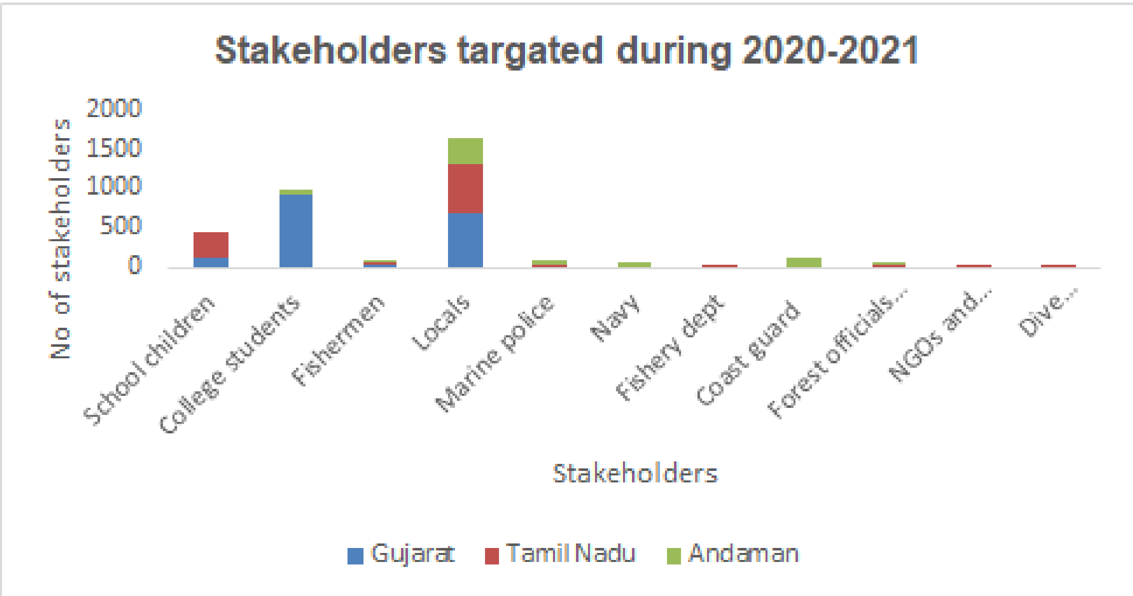


Figure 6.2: Stakeholders targeted during 2020-2021

6.2 Dugong Scholarship Programme 2020-2021

Under the project's outreach and awareness component, a unique participatory program, the Dugong Scholarship Scheme was initiated to engage local fisherfolk communities at the grass-root level. This program targets school-going children of local communities (most of them are fisherfolk) and provides them with a scholarship of Rs. 500 / month for two years to support their education. Through this program, we have identified a total of 73 school students at Tamil Nadu, Gujarat, and Andaman & Nicobar Islands, through a competitive written examination followed by several participatory programs conducted at schools to raise awareness about Dugong and seagrass conservation. The students selected through the process have been identified as *Dugong Ambassadors* and have become part of an extensive *Dugong Volunteer Network,* alternatively known as *Friends of Dugong* network. This multi-pronged strategy involves school children in Dugong conservation awareness activities and integrates their families as part of the wider network of forest department frontline staff, divers, tourist boat operators, and coastal village communities. This network provides us with information on dugong sightings/stranding and participates in outreach events to generate awareness in the areas of Dugong occurrence.

A total of 153 students were selected under this program in Phase-I starting from July 2017-18. Out of these 153 students, 57 were from Andaman & Nicobar Islands, 53 were from Tamil Nadu, and 40 students were selected from Gujarat field sites.

Under phase-II, 100 more students from Tamil Nadu and 46 students from Andaman & Nicobar Islands, and 22 students from Gujarat have been selected as Dugong Ambassadors in 2018- 2019.

Under Phase III, a total of 100 students from Tamil Nadu, 86 students from Andaman and Nicobar Island, and 79 students from Gujarat have been selected as Dugong Ambassadors in 2019-2020.

Under Phase IV, a total of 100 students from Tamil Nadu, 80 students from Andaman and Nicobar Island, and 66 students from Gujarat have been continued as Dugong Ambassadors in 2020-2021. Students from the 6th to 12th standard of age group 11-18 were selected and 246 students were selected through competitive examination. Due to the Pandemic, we couldn't conduct any offline examination for this phase. In Tamil Nadu, 70 girls, 30 boys, Andaman and Nicobar Island 44 girls, and 36 boys and in Gujrat 44 girls and 22 boys were selected. In Tamil Nadu and the Andaman Islands, 6 dropouts were confirmed. In Gujarat, 14 dropouts were observed. The dropout numbers were less compared to the last phase in Gujarat.

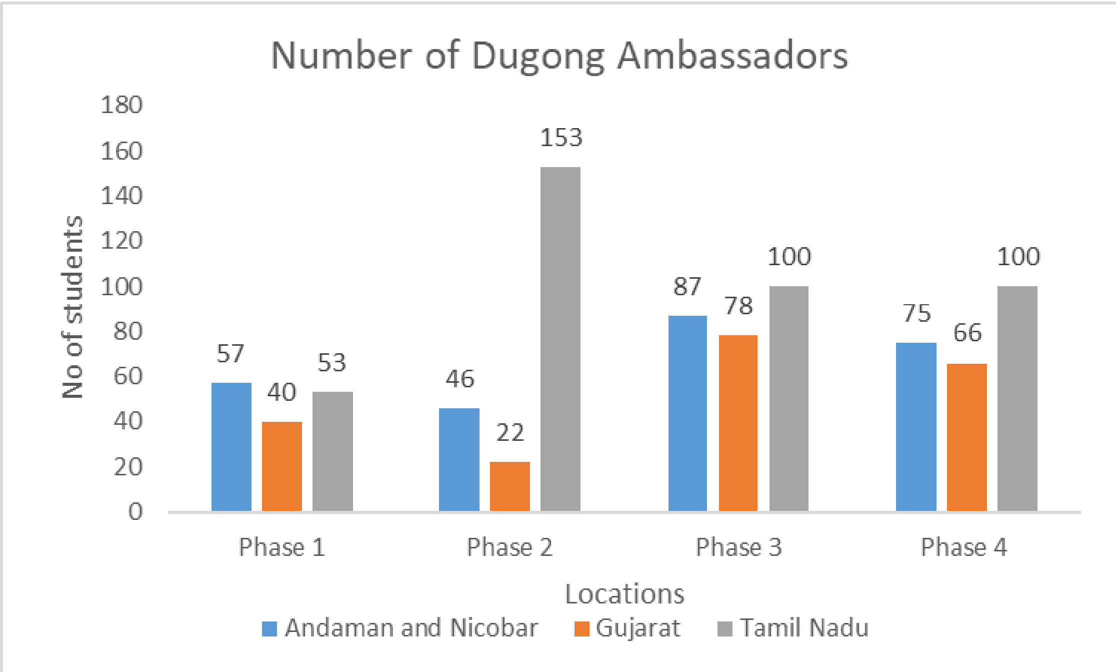


Figure 6.3: Dugong ambassadors phase-wise

6.3 WORLD DUGONG DAY CELEBRATION

Dugong, a globally vulnerable and uncelebrated species, was dedicated to a day '**World Dugong Day**' for the first time in India on 28th May 2021. An initiative by the Wildlife Institute of India to spread awareness about the importance and status of the species throughout the country. The species is protected under Schedule 1 of the Wild (Life) protection Act, 1972, India has signed a non-legally binding Memorandums of Understanding (MoU) with CMS on the conservation and management of Dugongs and their habitats in India on 28th May 2008.

To commemorate Dugong Day, a month-long social media campaign was organized from 28th April 2021 to 28th May 2021**.** The event aimed to educate the general public about Dugongs, their habitat, life cycle, distribution, and the current status of the species in the country. The event was organized in collaboration with ENVIS resource partner "Wildlife and protected area", and was channelized through different platforms like the WII website, Facebook, Twitter, and Instagram. Daily two-three infographics about Dugongs and their habitats, stakeholders, project achievements were posted on all the social media platforms.

The event included an online quiz and photography competition for all the people around the world. The quiz competition was organized online for global reach. The link for the quiz was made available from midnight of 27th May 2021 and was closed at midnight of 28th May 2021. A total of 284 people participated in the quiz competition and were awarded the quiz

participation certificate. 210 people participated in the slogan competition and 86 participated in the online photography competition. The winners of the competition were awarded winning certificates along with dugong souvenirs. The total reach of this month-long campaign was around 34,355 over Facebook, 629 people over Twitter, and 1416 people over Instagram from people across Florida, Costa Rica, Indonesia, and Japan across the globe.

A live talk show was showcased on Facebook and Youtube live of the official account of Wildlife Institute of India.

Apart from these presentations at national and global forums, talks were given at various meetings and consultations conducted under the outreach and capacity building initiatives. These talks targeted stakeholders ranging from the scientific community as well as locals.

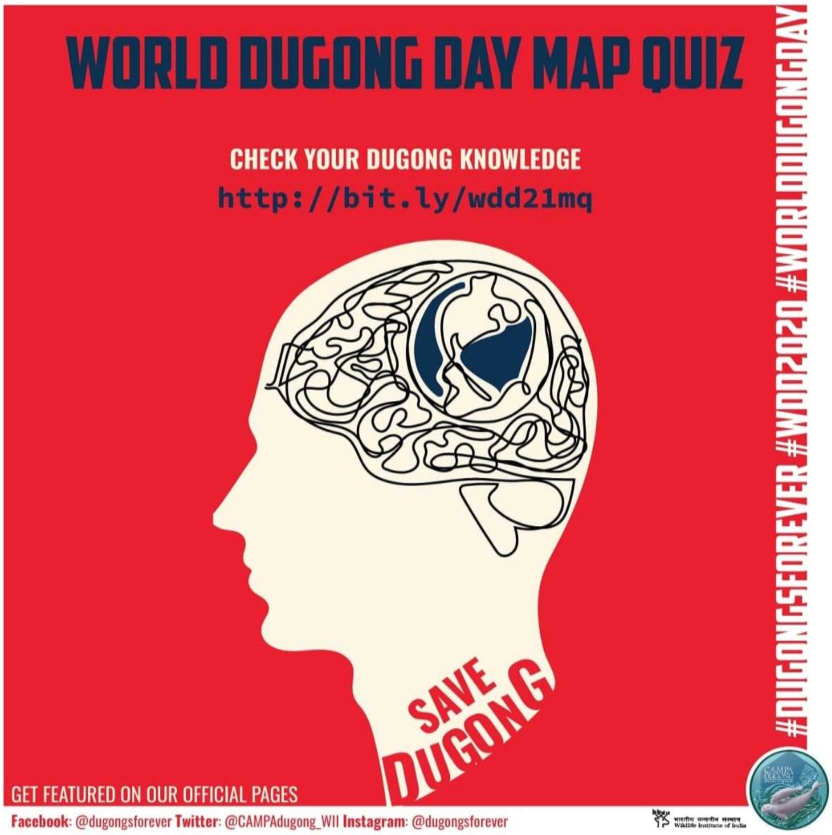


Figure 6.4: Quiz Competition flyer for World Dugong Day

Figure 6.5: Flyer for Online Photography competition

Figure 6.6: Webinar series: A dive into the world of Dugong by Chinmaya Ghanekar

Figure 6.7: Webinar series: Reviving gentle giants of the sea by Dr. Anant Pande

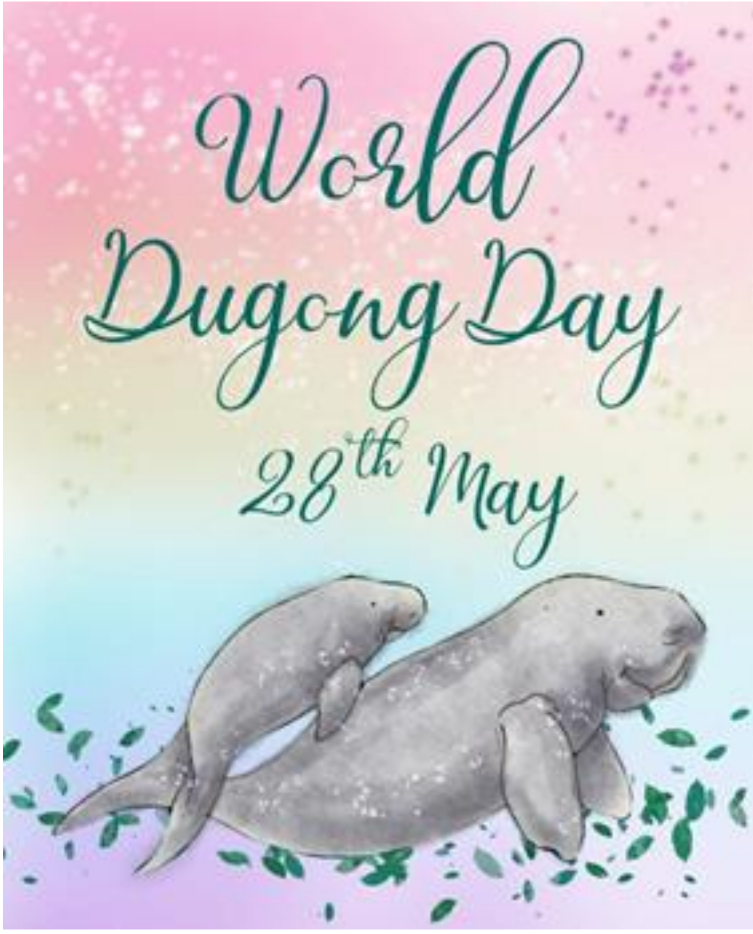
Figure 6.8: Flyer for World Dugong Day live talk session

Figure 6.9: Certificate for winners of the competition held on World Dugong Day

The insights of Dugong Day celebration - World Dugong Day 2021

Day 1 (28 April 2021)

30 days to go! Given the circumstances, we are going to observe #worlddugongday virtually, in the safety of our homes this year. Stay tuned for exciting online events to follow in the coming days.

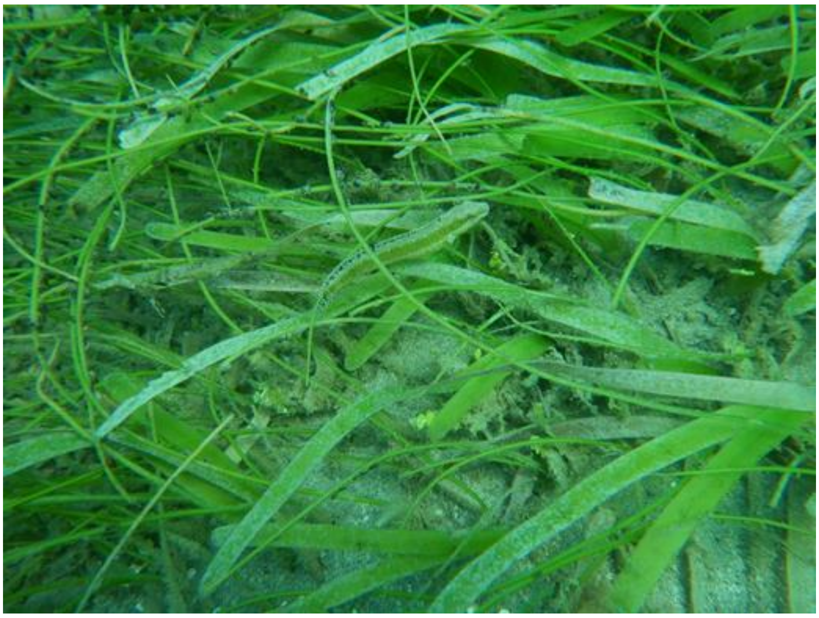


Day 2 (29 April 2021)

Hello there! Choose your greens from the best gardens of the sea, for dinner tonight.

Day 3 (30 April 2021)

#Seagrass meadows, forage for #dugongs, act as #fish refugia as well. Can you find the fish here?



Day 4 (1 May 2021)

Photography competition Categories: 1. Underwater marine biodiversity 2. Threats to marine environment Deadline: 20th May 2021 till 23:59 hours. Winners to be announced on 28th

May 2021

Day 5 (3 May 2021)

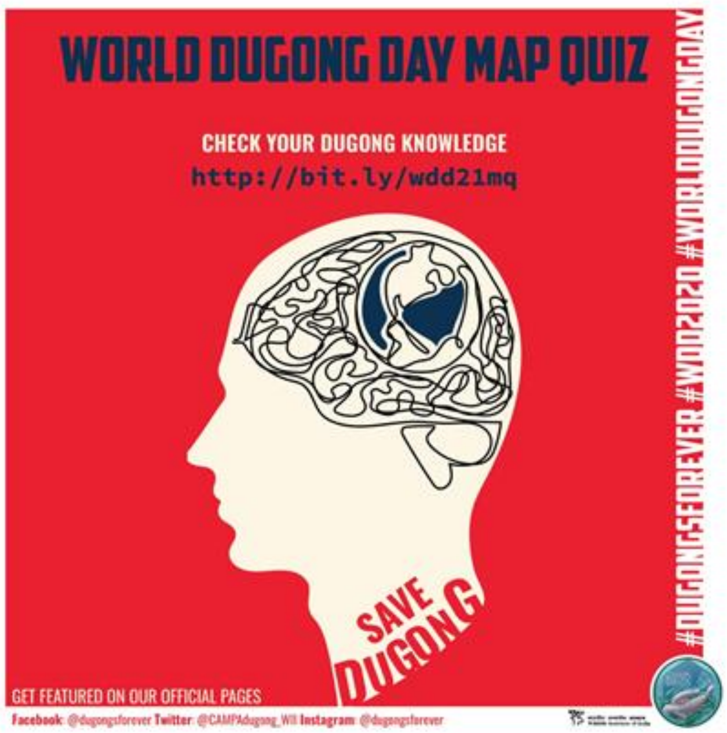
Did you know #dugongs can feed on up to 40 kilos of #seagrasses like this Halophila? Such binge eaters!

Day 6 (4 May 2021)

Introducing a new logo for CAMPA Dugong Recovery Programme.

Day 7 (5 May 2021)

Wanna know more about the Dugongs world? Take this map quiz to navigate there...



Day 8 (6 May 2021)

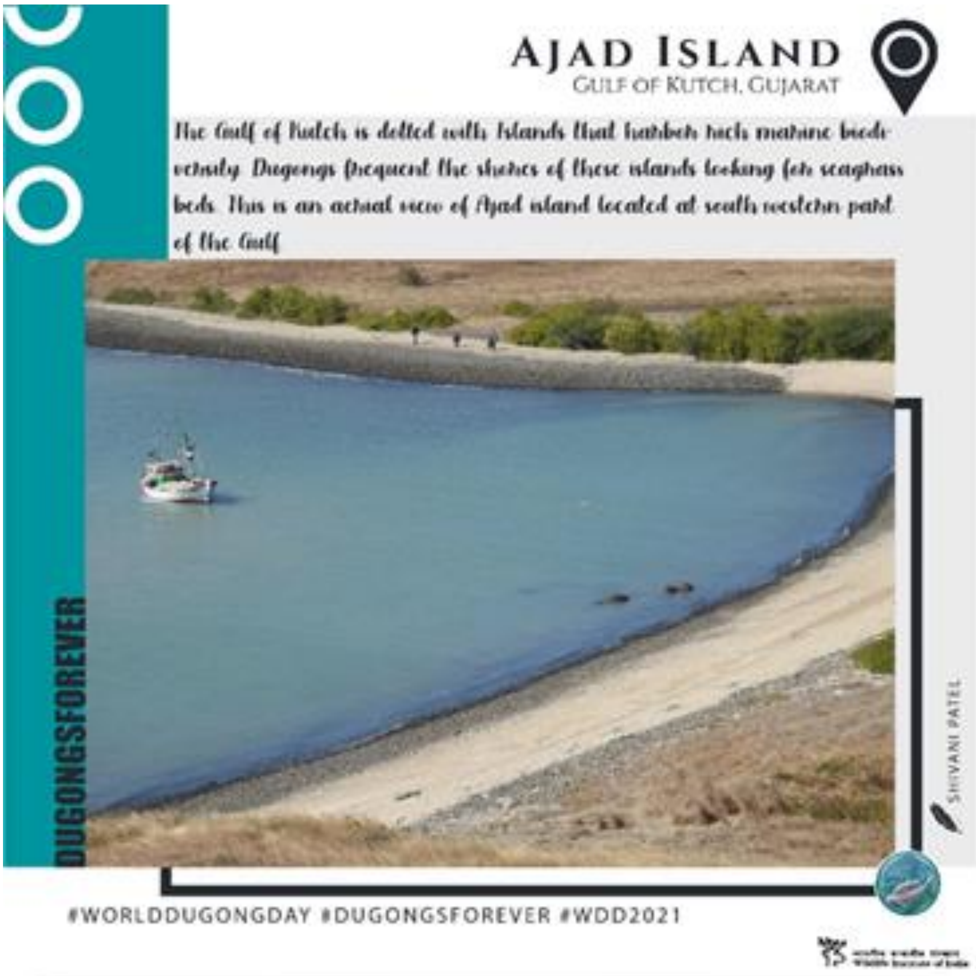
Behind the scenes of the amazing information, we get about #Dugong habitats...

Day 9 (7 May 2021)

"Midsea meals" - a behind the scene episode of fieldwork!

Day 10 (8 May 2021)

Gulf of Kutch... The home of Dugongs on the West Coast of India!

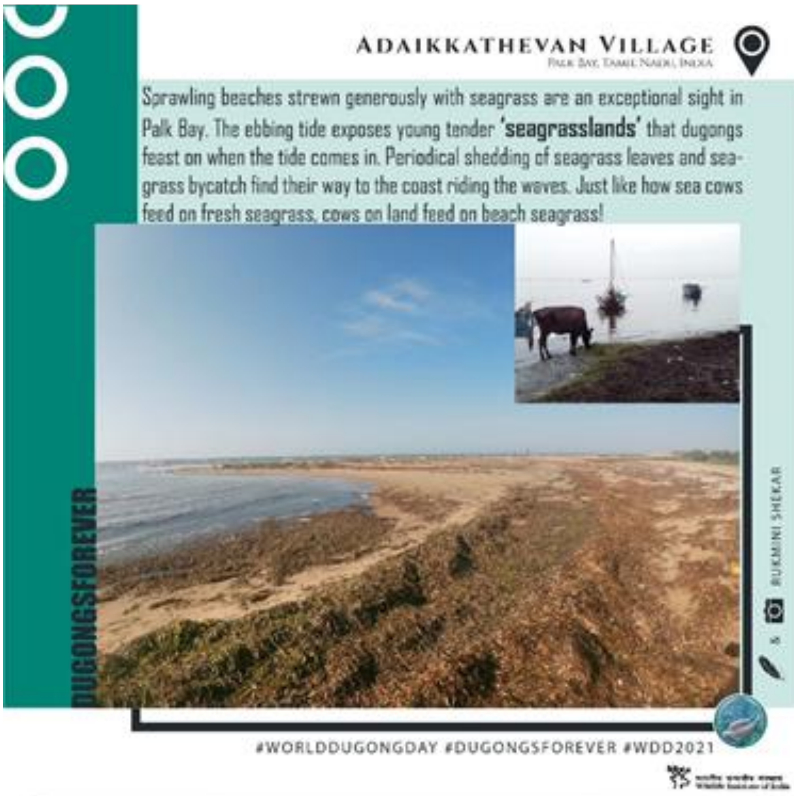


Day 11 (9 May 2021)

Happy Mother's Day...

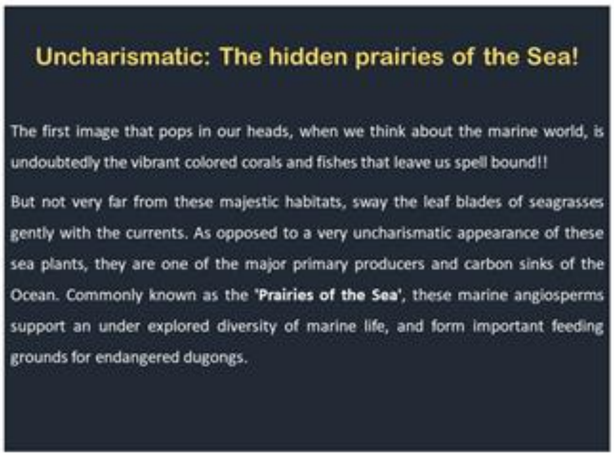
Day 12 (10 May 2021)

Sea Grasslands of Tamil Nadu... Grazing grounds for both land and sea cows!



Day 13 (11 May 2021)

Uncharismatic: The hidden prairies of the sea...



Day 14 (12 May 2021)

Divided by genes, United by curiosity...

Day 15 (13 May 2021)

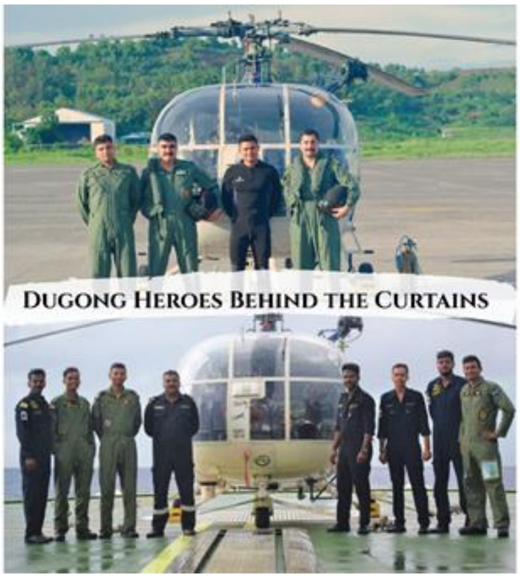
Have you seen the little beauties in Dugong's Garden?

Day 16 (14 May 2021)

Eid Mubarak! Illustration by Vabesh Tripura

Day 17 (15 May 2021)

Meet the #Dugongheroes

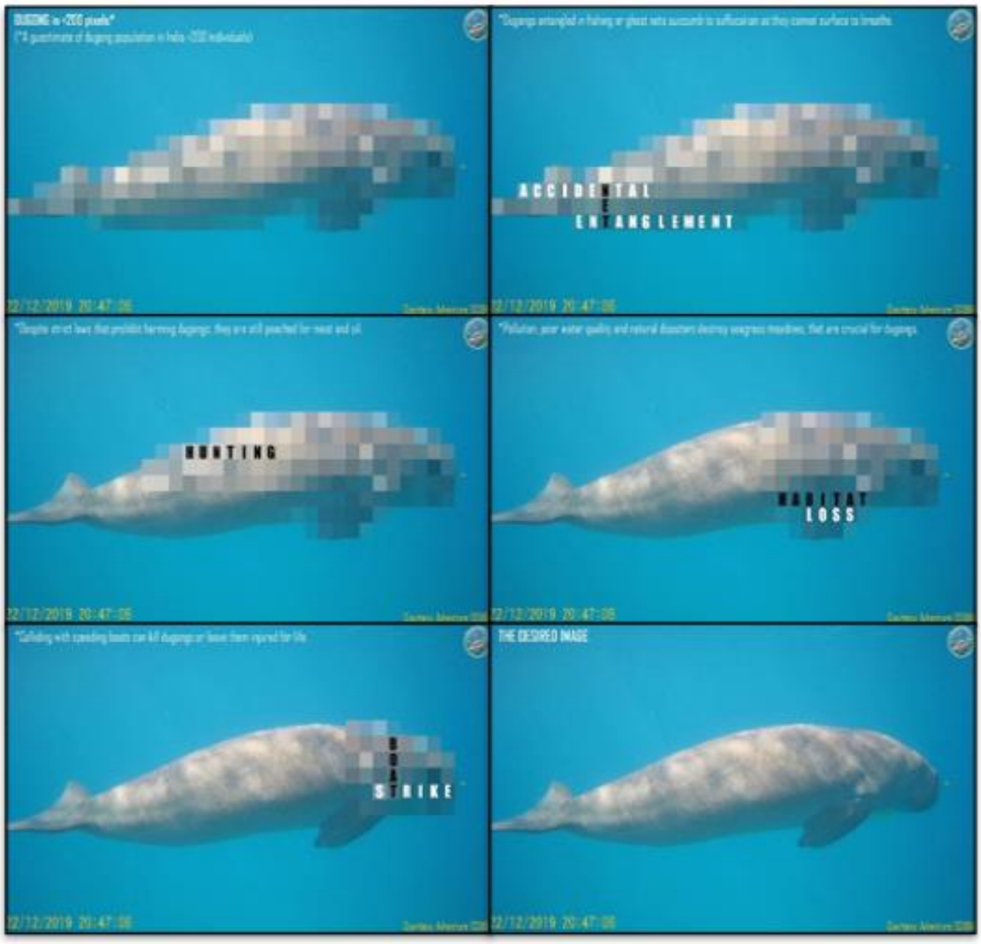


Day 18 (16 May 2021)

Maritime hangover phases off to the field realities... A trapped story from Andaman by Swapnali!

Day 18 (16 May 2021)

Swipe out the wrongs…



Day 19 (18 May 2021)

Meet our Dugong savior...

Day 19 (18 May 2021)

Marine biodiversity monitoring training by SCUBA diving for State Forest Department, Coastal Security Group, Fisheries Department, fishers, who act as Dugong Volunteers. So far 35 participants have been trained in Tamil Nadu.

Dugong Ambassadors... shaping the new generation for biodiversity conservation!

Day 20 (19 May 2021)

Not all heroes wear capes... Some wear lab coats!

Webinar announcement

Meet our Dugong Hero... Junus Babbar!

Day 21 (20 May 2021)

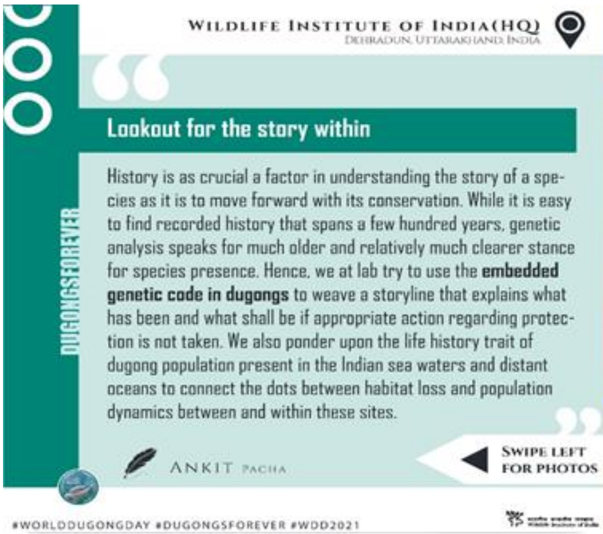
Join us for the talk series 'Rise again... Endangered Chronicles' on Facebook live!

Day 22 (21 May 2021)

From darkness to light, the unknowns take a flight,

With a step towards protection, they gallop into recognition!

Using ATGC to connect A(andaman) T(amilnadu) G(ujarat) via C(sea)!



Day 23 (22 May 2021)

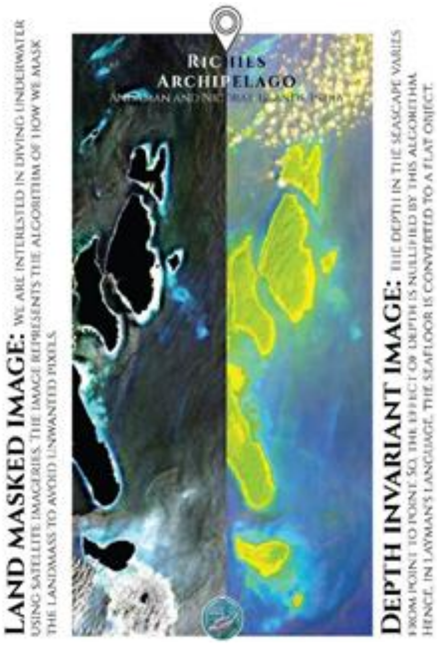
Becoming one! #InternationalDayForBiologicalDiversity

Webinar: A dive into the world of Dugong

Day 24 (23 May 2021)

Meet our Dugong Hero... Lt. CDR Vivek Tamilmani!

In SEArch of "Where"…

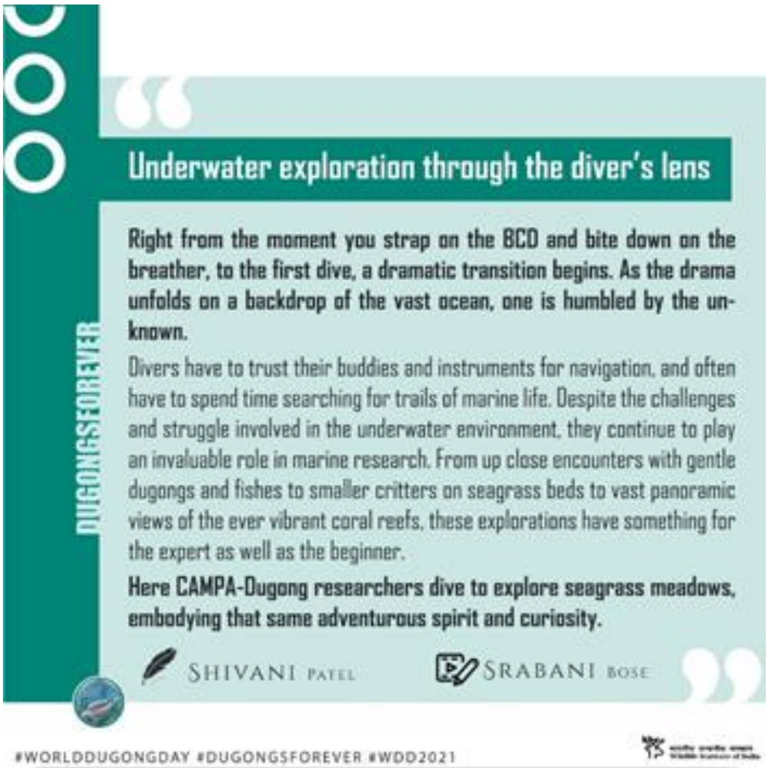


Day 25 (24 May 2021)

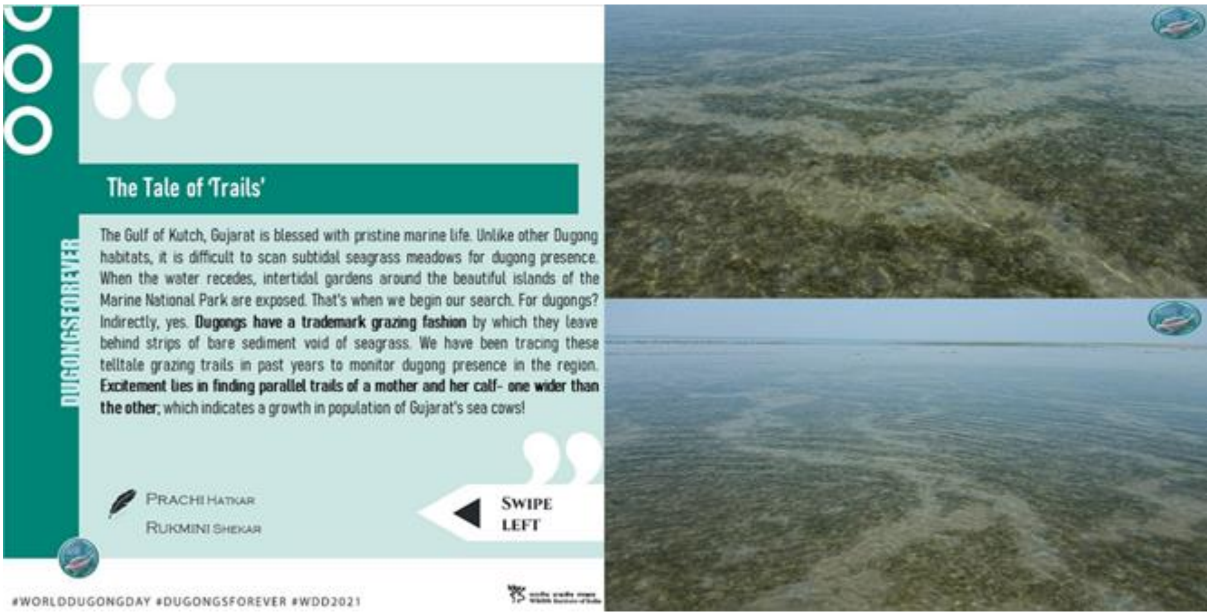
Let's hear about #dugongs from @AnantPande28! Do join the @ecosupportpl YouTube channel on 26th May at 1800 Hrs IST!

Day 26 (25 May 2021)

It's more than a quest, it's a venture of understanding life!



The Tale of 'Trails'!



Meet our Dugong Hero Mr. Murugesan...

Day 27 (26 May 2021)

Meet our #dugong hero Ajay Kumar…

Securing the present, for conserving the future!

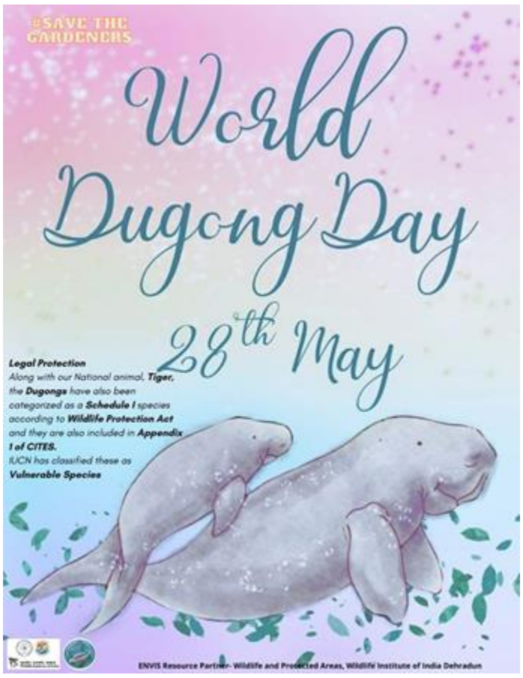
Appreciating the uber-cool, enthusiastic bunch of #citizenscientist! The #Scuba Divers!

Meet our #dugong hero Mr. Chandra Sekhar…

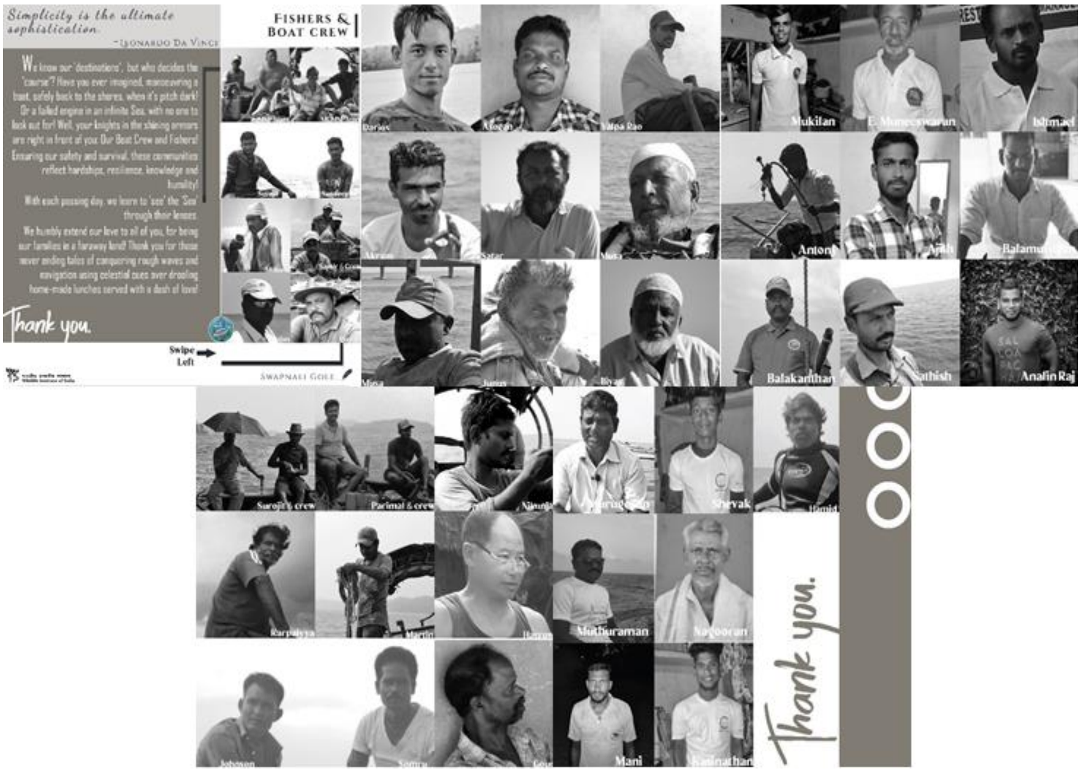
Meet our #dugong hero Mr. Senthil Murugan...

Day 28 (28 May 2021)

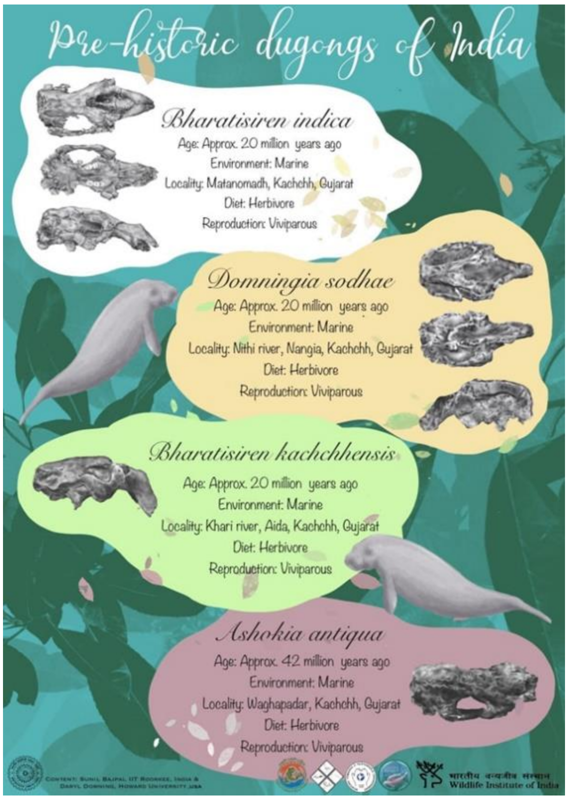
Happy World #Dugong day!!



'People of the Sea', and our lifeline while at work! The Fishers and boat crew



On #worlddugongday, Meet the #dugongs of Ancient #India!



#Dugong is one of the endangered marine animals. To conserve the declining population of dugongs, #MoEFCC constituted a ‘Task Force for Conservation of Dugongs’. On

#WorldDugongDay spread awareness to #SaveDugongs, from its extinction.

KADAL OSAI FM 90.4

By KADAL OSAI FM 90.4

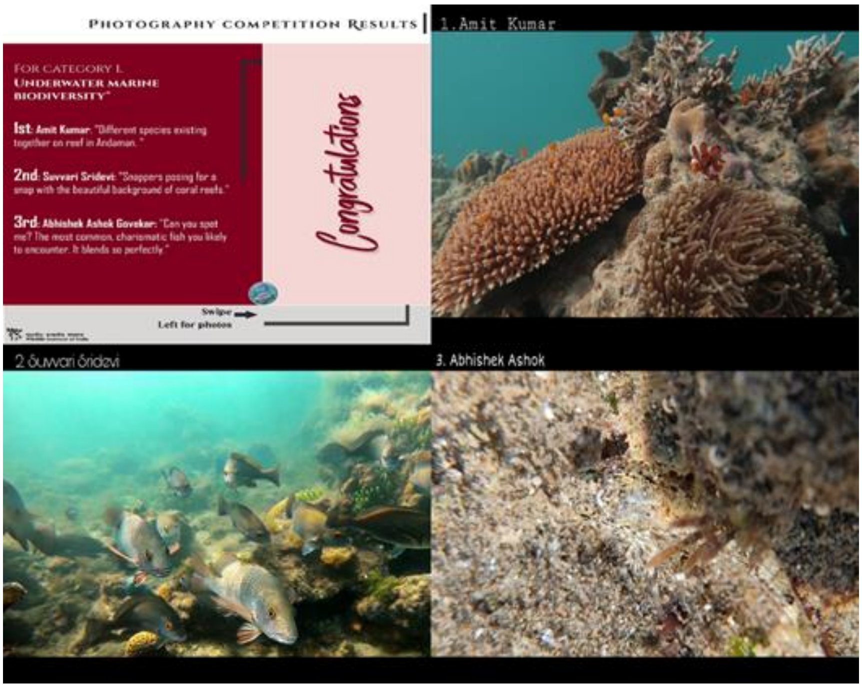
THE WORLD'S FIRST COMMUNITY RADIO STATION FOR FISHERMEN AT PAMBAN ISLAND | RAMESWARAM

Link of the Radio Program:

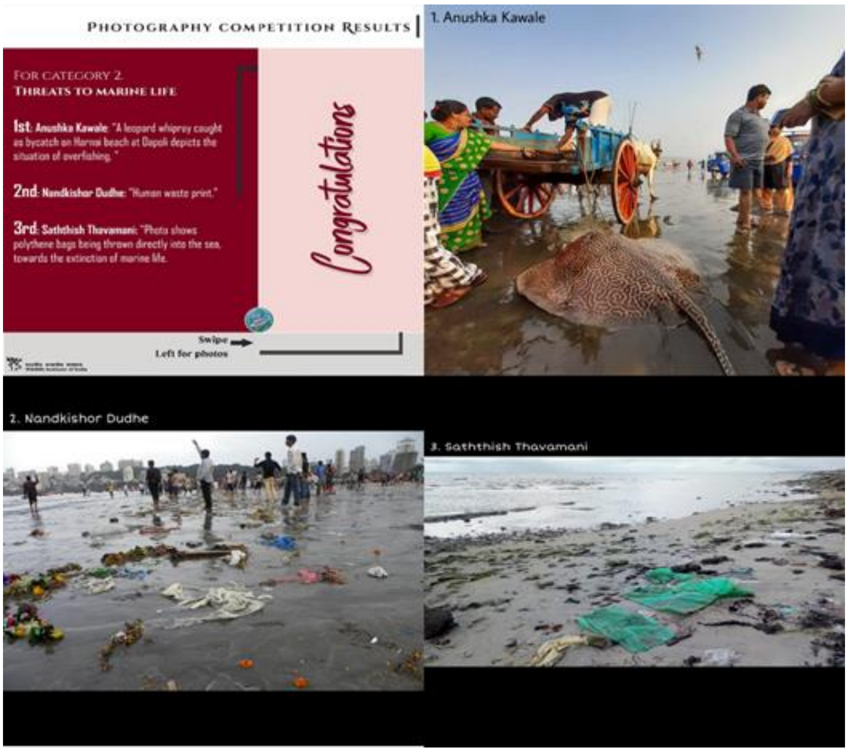
https://anchor.fm/kadal-osai-fm-904/episodes/PART-01--WILDLIFE-IINSTITUTE-OF-INDIA-------K-e9475g?fbclid=IwAR1qwr68_7cDLetNFVPRcvd36X2mn-fHNZk38TZWa1Rguq381GAL

Here are the winners of the online Photography competition

Category 1



Category 2



6.4 Webinar series on Marine Mammal Conservation in India: Status, challenges, and opportunities (12- 14 Oct 2020)

The aim of conducting webinar was to address marine mammal conservation issues and scope of the research opportunities also to create awareness among the young researchers, provide a platform for spreading knowledge on current research conducted on marine mammals, to provide them a platform for exchanging ideas, identifying opportunities for future research on marine mammal conservation in India. The participants got the opportunity to interact with eminent scientists working for marine mammal conservation on the national and international levels. This webinar series was conducted online keeping the adhering norms to reduce to impact of COVID-19 as this provided us an opportunity to conduct an online seminar as open access for students and early career researchers, so they could avail the information provided by our eminent speakers at the comfort of their home, reducing the risk. The Wildlife Institute of India with MoEFCC's ENVIS Resource Partner "Wildlife & Protected Areas", Wildlife Institute of India, conducted this national webinar series for 3 days from 12th October 2020 to 14th October 2020. The webinar was broadcasted on social media platforms such as Facebook and YouTube channels. The registration was open to students of academia. The live session was also broadcasted on the homepage of the Wildlife Institute of India's website.

Figure 6.8: Flyer of the webinar series

Figure 6.9: Technical Session 1 Day 1 (12th October 2020)

Figure 6.10: Technical Session 2 Day 2 (13th October 2020)

Figure 6.11: Day 3 - Panel Discussion on marine mammal conservation in India: Perspective from India 14th October 2020

6.5 Celebration of 16th Annual Endangered Species Day on May 21st, 2021

Every year on the third Friday in May, thousands of people around the world participate in Endangered Species Day by celebrating, learning about, and taking action to protect threatened and endangered species. Wildlife refuges, zoos, aquariums, gardens, schools, libraries, museums, community groups, nonprofits, and individuals hold special programs or events for people of all ages. Due to the global coronavirus crisis, the programs organized for Endangered Species Day 2021 were primarily online talk series events.

Figure 6.12: Event flyer for online talk series

Join us for the talk series 'Rise Again... Endangered Chronicles' on Facebook live!

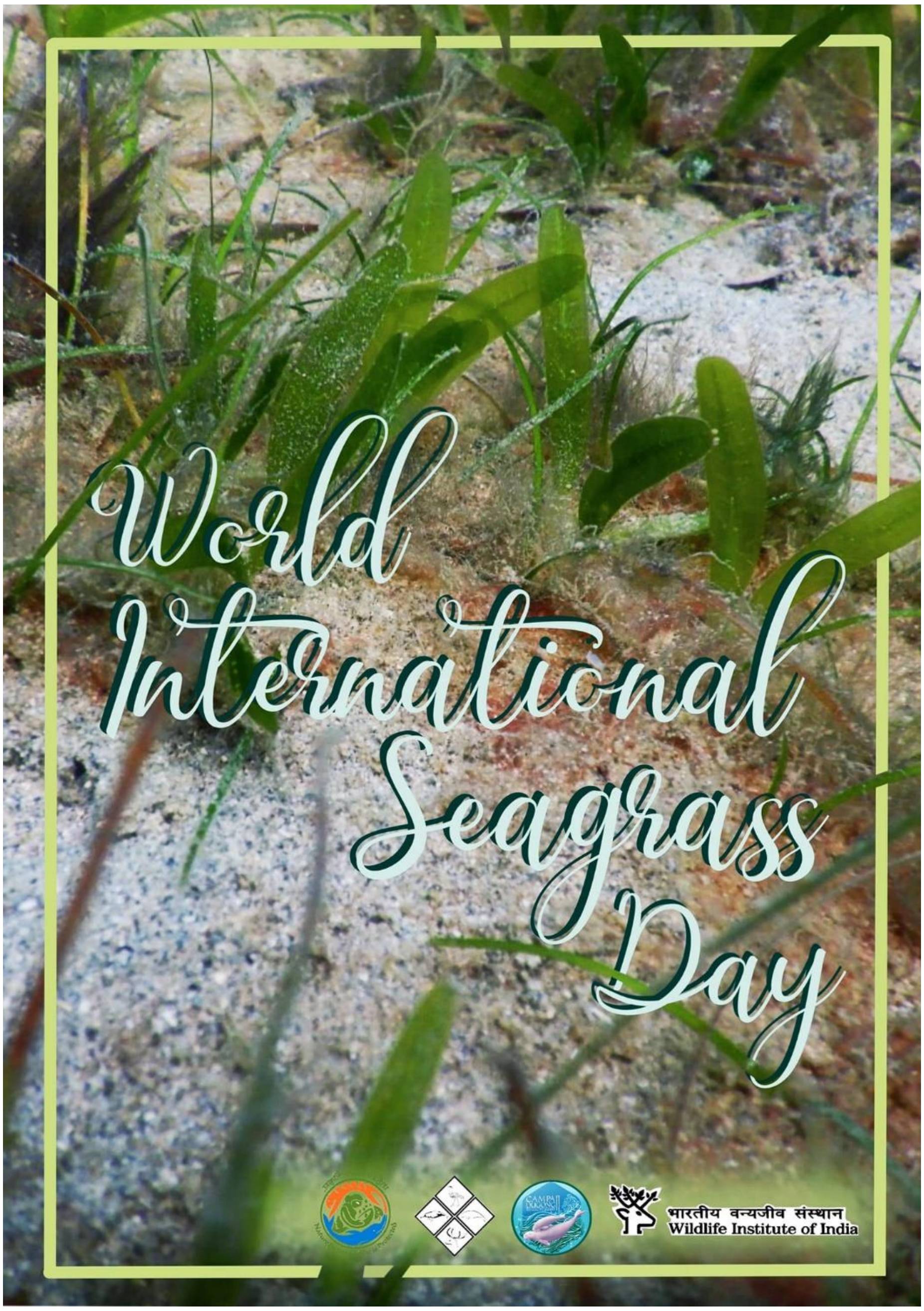
Figure 6.13: Flyer for endangered species day talk series - introductions of topics

6.6 Celebration of becoming one! #International day for Biological Diversity

The United Nations has proclaimed May 22 the International Day for Biological Diversity (IDB) to increase understanding and awareness of biodiversity issues.

6.7 Celebration of World International Seagrass Day on 1st March 2021

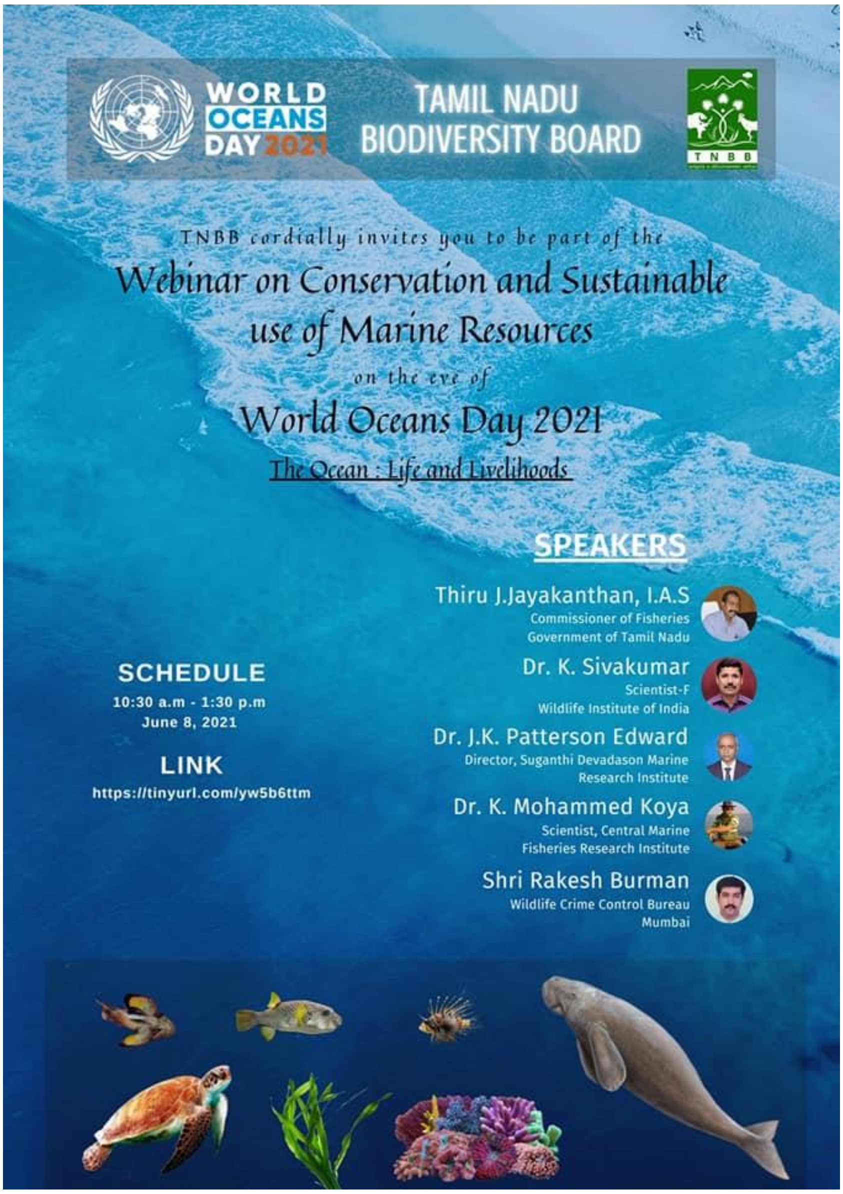
Over the years, it appears that March has become "Seagrass Awareness Month" in many parts of the world, and Project Seagrass is leading calls for the UN to officially recognize **March 1st** as the International Day for the Conservation of Seagrass Meadows, World Seagrass Day.



6.8 Celebration of World ocean day 2021: The ocean: life and livelihood

"The Ocean: Life and Livelihoods" is the theme for World Oceans Day 2021, as well as a declaration of intentions that launches a decade of challenges to achieve the Sustainable Development Goal 14, "Conserve and sustainably use the oceans, seas, and marine resources", by 2030.

Link for registration: https://tinyurl.com/yw5b6ttm



Tamil Nadu Biodiversity Board

World Oceans Day – June 8th 2021

"The Ocean : Life and Livelihoods"

Webinar on Conservation and Sustainable use of Marine Resources

Date : June 8th 2021

Schedule : 10:30 a.m – 1:30 p.m

Link : https://tinyurl.com/yw5b6ttm

PROGRAM SCHEDULE

SPEAKER	ADDRESS	TIMING
Ms Mita Banerjee IFS APCCF and Member Secretary Tamil Nadu Biodiversity Board	Introduction and setting the context	10 mins
Thiru J.Jayakanthan, I.A.S Commissioner of Fisheries Government of Tamil Nadu	Policy and programmes of Fisheries Department for marine based livelihoods	15 mins
Dr. K. Sivakumar Scientist-F Wildlife Institute of India	Coastal & marine biodiversity of Tamil Nadu	30 mins
Dr. J.K. Patterson Edward Director, Suganthi Devadason Marine Research Institute	Protection and Conservation of the Marine Wealth of Gulf of Mannar and Palk bay, India: An Imperative for Sustainable Livelihood	40 mins
Dr. K. Mohammed Koya Scientist, Central Marine Fisheries Research Institute	Indigenous seaweed farming - a climate smart enterprise for inhabitants of vulnerable coral atoll reef in Lakshadweep	30 mins
Shri Rakesh Burman Wildlife Crime Control Bureau Mumbai	Illegal trade in marine species with special reference to Export Import policy	30 mins
Q & A and Conclusion		25 mins

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Annexure I Media reports and Coverage

વિજ્ઞાન દિવસ અંતર્ગત ઓ. એન. પી પ્રાયમરી સ્કૂલ મા વિદ્યાર્થીઓ માટે અવેરનેસ પ્રોગ્રામ નું આયોજન

દેવભુમી દ્વારકા તા.૨૭/૦૨/૨૦૨૧,

વિજ્ઞાન દિવસ અંતર્ગત ઓ. એન. પી પ્રાયમરી સ્કૂલ મા વિદ્યાર્થીઓ માટે અવેરનેસ પ્રોગ્રામ નું આયોજન થયું હતું, જેમાં પક્ષી, પર્યાવરણ, પ્લાસ્ટિક, દરિયાઈ ગાય વગેરે જેવા વિષયો ઉપર સમજાવવા મા આવ્યું હતું. અને ઓફલાઈન વેબિનાર નું આયોજન કર્યું હતું. જેમાં શાળા ના શિક્ષિકા પૂજાબેન દવે એ પણ વિજ્ઞાન વિશે મહત્વ નું વિસ્તૃત માર્ગદર્શન આપ્યું હતું, આચાર્ય શ્રી જાડેજા સર એ વિજ્ઞાન ની વિશેષતા સમજાવી હતી. , ભારતીય વન્ય જીવન સંસ્થાન માંથી પ્રાચી બેન અને રોનક ભાઈ પણ આવેલ હતા.

રીપોટર:– વીતલ પીસાવાડીયા

ઓખામાં દરિયાઈ ગાયના રક્ષણ માટે તાલીમ

કચ્છમાં દરિયાઈ ગાય એટલે કે ડુગોંગના સંરક્ષણ માટે કામ કરતી વાઇલ્ડલાઇફ ઇન્સ્ટિટ્યૂટ ઈન્ડિયાની ગુજરાતની ટીમે દરિયાની અંદર ગુજરાત ઓખા મરીન પોલીસ સ્ટેશનના પીએસઆઈ આર. એમ. મુંધવાના માર્ગદર્શન હેઠળ એક કાર્યક્રમનું આયોજન કર્યું હતું. આ કાર્યક્રમમાં મરીન કમાન્ડો હાજર રહ્યા હતા. તેમને દરિયાઇ સસ્તન પ્રાણી જોવા અને નોંધ કરવા માટે તાલીમ આપવામાં આવી હતી. સાથે સાથે દરિયાઇ ગાયની નોંધણી કરવા માટે નોંધપોથીનું વિતરણ પણ કર્યું હતું.

વિજ્ઞાન દિવસ અંતર્ગત ઓ. એન. પી પ્રાયમરી સ્કૂલ મા વિદ્યાર્થીઓ માટે અવેરનેસ પ્રોગ્રામ નું આયોજન થયું હતું, જેમાં પક્ષી, પર્યાવરણ, પ્લાસ્ટિક, દરિયાઈ ગાય વગેરે જેવા વિષયો ઉપર સમજાવવા મા આવ્યું હતું. અને ઓફલાઈન વેબિનાર નું આયોજન કર્યું હતું. જેમાં શાળા ના શિક્ષિકા પૂજાબેન દવે એ પણ વિજ્ઞાન વિશે મહત્વ નું વિસ્તૃત માર્ગદર્શન આપ્યું હતું , આચાર્ય શ્રી જાડેજા સર એ વિજ્ઞાન ની વિશેષતા સમજાવી હતી. , ભારતીય વન્ય જીવન સંસ્થાન માંથી પ્રાચી બેન અને રોનક ભાઈ પણ આવેલ હતા.

દેવભૂમિ દ્વારકા થી વિતલ પિસાવાડિયા

ગુજરાતમાં સમુદ્રી ગાય સંરક્ષણ અંગે વેબિનાર

ઓખાઃ વાઇલ્ડ લાઇફ ઇન્સ્ટિટ્યુટ ઓફ ઇન્ડિયા અને જામનગરની ડી. કે.વી. આર્ટ્સ એન્ડ સાયન્સ કોલેજ દ્વારા સમુદ્રી ગાય માટે જાગૃતિ લાવવાના પ્રયાસરૂપે કચ્છના અખાતમાં ગુજરાતના ડુગોંગ્સ અને તેમનાં નિવાસસ્થાનનું સંરક્ષણ વિષય પર રાજ્ય કક્ષાના વેબિનારનું આયોજન કરાયું હતું.

ગુજરાતમાં ઓછા જાણીતા દરિયાઈ સસ્તન પ્રાણી દરિયાઈ ગાયના સંરક્ષણના પ્રશ્ને જાગૃતિ લાવવાના ઉદેશથી આયોજિત કાર્યક્રમમાં વૈજ્ઞાનિક સમુદાય અને મહત્ત્વાકાંક્ષી સંશોધનકારો અને સંરક્ષણવાદીઓ વચ્ચેના વિચારો અને જ્ઞાનની આપ લે માટે ઇન્ટરેક્ટિવ પ્લેટફોર્મ બનાવવામાં આવ્યું હતું. વેબિનારના ઉદ્‌ઘાટન સત્રમાં ડીકેવી આર્ટ્સ એન્ડ સાયન્સ કોલેજના પ્રા. ડો. ઘનશ્યામ જાદવ અને વાઇલ્ડલાઇફ ઇન્સ્ટિટ્યુટ ઓફ ઇન્ડિયાના પ્રાચી હટકરે માર્ગદર્શન આપ્યું હતું. શિવાની પટેલે ડ્યુગોંગ્સ સંરક્ષણ અંગે વાત કરી હતી. કેમ્પા ડ્યુગોંગ પ્રોજેક્ટ રજૂ થયો હતો. સમુદ્રી ઘાસના આવાસ અને તેનાથી સંકળાયેલ પ્રાણી સૃષ્ટિની વિવિધતા પર ભાર મુકાયો હતો. વેબિનારને રાજ્યભરના ૮૦૦ જેટલા સહભાગીનો મોટો પ્રતિસાદ મળ્યો હતો. દરેક સહભાગીને ઇ - પ્રમાણપત્ર આપવામાં આવ્યું. આભારવિધિ જીવવિજ્ઞાન વિભાગના વડા ડો.અન્વથી ઉપાધ્યાયે કરી હતી.

Gujarat:

આજરોજ ઓખા ખાતે 8-જૂન -વર્ડ઼ ઓસિયન ડે એટલે કે વિશ્વ સમુદ્રી દિવસ ની ઉજવણી કરવામાં આવી હતી. જેમાં ઓખા નાં નગરપાલિકા નાં શિક્ષિકા પુજા બેન દવે કે જેઓ શિક્ષણ ક્ષેત્રે હંમેશા અગ્રેસર રહી ને, વિદ્યાર્થીઓ ને આગળ વધારે છે એમણે અને એમના વિદ્યાર્થીઓ એ સારી એવી જહેમત ઉઠાવી હતી.

ઓખામાં દરિયાઈ ગાય બચાવો અભિયાનમાં જોડાયેલા વિદ્યાર્થીઓએ 'વિશ્વ મહાસાગર દિવસ' ની કરી ખાસ રીતે ઉજવણી
૮-જૂન, ૨૦૨૦- સોમવાર

ભારતીય વન્યજીવન સંસ્થાન ના વળતર વનીકરણ ફંડ મેનેજમેન્ટ અને પ્લાનિંગ ઓથોરિટી ના એક પ્રોજેક્ટ "ભારતમાં ડુગોંગ્સ અને તેમના રહેઠાણોની પુનઃ પ્રાપ્તિ - એક સંકલિત સહભાગી અભિગમ" માં કાર્યરત પ્રાચી બેન હિતકર અને સમીહા પઠાણ, ઓખા નાં શિક્ષિકા પૂજાબેન દ્વારા 'વિશ્વ મહાસાગર દિવસ' વિશિષ્ટ રીતે ઉજવાયો જેમાં પ્રોજેક્ટ દ્વારા ચુંટાયેલ નગરપાલિકા સંચાલિત ઓખા પ્રાથમિક શાળાના 'ડુગોંગ સ્વયંસેવક' વિદ્યાર્થીઓ અને તેઓ નાં શિક્ષિકા પૂજા દવે અને ઓ એ દરિયા કાંઠાનાં વિસ્તારોમાંથી પ્લાસ્ટિક અને દુષિત કચરાની સફાઈ કરી હતી. આ કાર્યક્રમ સોશિયલ ડિસ્ટન્સ નું પાલન કરતા થયો હતો.

પ્લાસ્ટિક ખાસ કરીને દરિયાઇ ગાય સાથે દરેક સમુદ્રી જીવોને નુકશાન પહોંચાડે છે. તૃણાહારી સસ્તન પ્રાણી દરિયાઇ ગાય સમુદ્રી જીવ છે, જેની પ્રજાતી ભયના આરે આવીને ઉભી છે. તેનો વસવાટ સૌથી વધુ પ્લાસ્ટિક કચરાથી પ્રદુષિત થઈ રહ્યો છે.
વિશ્વ મહાસાગરનો દિવસ ૮ મી જૂને વાર્ષિક ધોરણે યોજાય છે. આ દિવસ વિવિધ પ્રકારે ચિહ્નિત થયેલ છે, જેમાં નવી ઝુંબેશ અને પહેલ શરૂ કરવી, બીચ ક્લિનઅપ્સ, શૈક્ષણિક અને સંરક્ષણ ક્રિયા કાર્યક્રમો શામેલ છે.
યુવાનો વધુને વધુ મહત્વની ભૂમિકા ભજવી રહ્યા છે. ભારતીય વન્યજીવ સંસ્થા ના ડુગોંગ પ્રોજેક્ટ રિસર્ચસે "પ્લાસ્ટિક ફ્રી સમુદ્ર" ની કામગીરીમાં મદદરૂપ સૌ સ્વયં સેવક અને હિસ્સેદારો નો આભાર વ્યક્ત કર્યો હતો.

ઓખામાં દરિયાઈ ગાય બચાવો અભીયાનમાં જોડાયેલ વિદ્યાર્થીઓનું સન્માન કરાયું

ઓખા : ભારતીય વન્ય જીવન સંસ્થાન દ્વારા શ્રી સર્વોદય મહિલા મંડળ ઓખા માં ઓખા ના શિક્ષિકા ખુજાબજેન દવે તથા પ્રાચીબેન ની અથાગ મહેનત થી તેમજ મહિલામંડળ પ્રમુખ ડો.પુષ્પા બેનના પ્રોત્સાહન થી બાળકો ની સુશુપ્ત શકિતઓ ની ખીલવણી સાથે આબેહૂબ રીતે ઉજવાયો હતો. અમે ઓનલાઈન ચિત્ર સ્પર્ધા, નિબંધ સ્પર્ધા અને પ્રશ્નોત્તરી ની સ્પર્ધા રાખેલી હતી. અને વન્યજીવન સંસ્થાન દ્વારા વિદ્યાર્થીઓ ને ઈનામ આપવામાં આવ્યા હતા. આજે દરિયાઈ ગાય ને બચાવવા માટે ભારતીય વન્ય જીવન સંસ્થાન દ્વારા વિશ્વસ્તરીય જાગૃતી ફેલાઈ રહી છે ત્યારે, અમે દરિયાઈ ગાય દિવસ ની વિશિષ્ટ રીતે ઉજવણી કરી. દરિયાઈ ગાય તૃણાહારી સમુદ્રી સસ્તન દરિયાઈ જીવ છે. તે ઉષ્ણ–ઉપઉષ્ણ કટિબંધ માં રહે છે. પેસિફિક મહાસાગર મા પૂર્વિય આફ્રિકા થી ઓસ્ટ્રેલિયા ના સમુદ્રી વિસ્તાર માં જોવા મળે છે . ખાસ કરી ને દરિયાઈ ગાય ભારત માં મનાર ના અખાત અને પાલ્ક ની ખાડી માં જોવા મળે છે. દરિયાઈ ગાય કુળ નું એકમાત્ર જીવંત ઉદાહરણ છે, જેની પ્રજાતી ભય ના આરે આવી ને ઉભી છે, જયારે શિક્ષિકા પૂજાબેન દવે એ દરેક વિદ્યાર્થીઓ માં આ વિશે ઉત્સાહ જગાડ્યો હતો. આ અભિયાનમાં ભાગ લીધેલ દરેક વિદ્યાર્થીને ભારતીય વન્યજીવન સંસ્થાન દ્વારા ટી–શર્ટ અને કેપ આપવામાં આવી હતી તથા ડો. પુષ્પાબેન સોમૈયા દ્વારા ઈનામો આપી પ્રોત્સાહીત કરવામાં આવેલ.

આજરોજ ઓખા ખાતે 8-જૂન -વર્લ્ડ ઓસિયન ડે એટલે કે વિશ્વ સમુદ્રી દિવસ ની ઉજવણી કરવામાં આવી હતી. જેમાં ઓખા નાં નગરપાલિકા નાં શિક્ષિકા પુજા બેન દવે કે જેઓ શિક્ષણ ક્ષેત્રે હંમેશા અગ્રેસર રહી ને, વિદ્યાર્થીઓ ને આગળ વધારે છે એમણે અને એમના વિદ્યાર્થીઓ એ સારી એવી જહેમત ઉઠાવી હતી.

ઓખામાં દરિયાઈ ગાય બચાવો અભિયાનમાં જોડાયેલા વિદ્યાર્થીઓએ 'વિશ્વ મહાસાગર દિવસ' ની કરી ખાસ રીતે ઉજવણી
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ભારતીય વન્યજીવન સંસ્થાન ના વળતર વનીકરણ ફંડ મેનેજમેન્ટ અને પ્લાનિંગ ઓથોરિટી ના એક પ્રોજેક્ટ "ભારતમાં ડુગોંગ્સ અને તેમના રહેઠાણોની પુનઃ પ્રાપ્તિ - એક સંકલિત સહભાગી અભિગમ" માં કાર્યરત પ્રાચી બેન હિતકર અને સમીહા પઠાણ, ઓખા નાં શિક્ષિકા પૂજાબેન દ્વારા 'વિશ્વ મહાસાગર દિવસ' વિશિષ્ટ રીતે ઉજવાયો જેમાં પ્રોજેક્ટ દ્વારા ચુંટાયેલ નગરપાલિકા સંચાલિત ઓખા પ્રાથમિક શાળાના 'ડુગોંગ સ્વયંસેવક' વિદ્યાર્થીઓ અને તેઓ નાં શિક્ષિકા પૂજા દવે અને ઓ એ દરિયા કાંઠાનાં વિસ્તારોમાંથી પ્લાસ્ટિક અને દુષિત કચરાની સફાઈ કરી હતી. આ કાર્યક્રમ સોશિયલ ડિસ્ટન્સ નું પાલન કરતા થયો હતો.

પ્લાસ્ટિક ખાસ કરીને દરિયાઇ ગાય સાથે દરેક સમુદ્રી જીવોને નુકશાન પહોંચાડે છે. તૃણાહારી સસ્તન પ્રાણી દરિયાઇ ગાય સમુદ્રી જીવ છે, જેની પ્રજાતી ભયના આરે આવીને ઉભી છે. તેનો વસવાટ સૌથી વધુ પ્લાસ્ટિક કચરાથી પ્રદુષિત થઈ રહ્યો છે.
વિશ્વ મહાસાગરનો દિવસ ૮ મી જૂને વાર્ષિક ધોરણે યોજાય છે. આ દિવસ વિવિધ પ્રકારે ચિહ્નિત થયેલ છે, જેમાં નવી ઝુંબેશ અને પહેલ શરૂ કરવી, બીચ ક્લિનઅપ્સ, શૈક્ષણિક અને સંરક્ષણ ક્રિયા કાર્યક્રમો શામેલ છે.
યુવાનો વધુને વધુ મહત્વની ભૂમિકા ભજવી રહ્યા છે. ભારતીય વન્યજીવ સંસ્થા ના ડુગોંગ પ્રોજેક્ટ રિસર્ચસે "પ્લાસ્ટિક ફ્રી સમુદ્ર" ની કામગીરીમાં મદદરૂપ સૌ સ્વયં સેવક અને હિસ્સેદારો નો આભાર વ્યક્ત કર્યો હતો.

આજરોજ ઓખા ખાતે 8-જૂન -વર્લ્ડ ઓસિયન ડે એટલે કે વિશ્વ સમુદ્રી દિવસ ની ઉજવણી કરવામાં આવી હતી. જેમાં ઓખા નાં નગરપાલિકા નાં શિક્ષિકા પુજા બેન દવે કે જેઓ શિક્ષણ ક્ષેત્રે હંમેશા અગ્રેસર રહી ને, વિદ્યાર્થીઓ ને આગળ વધારે છે એમણે અને એમના વિદ્યાર્થીઓ એ સારી એવી જહેમત ઉઠાવી હતી.

ઓખામાં દરિયાઈ ગાય બચાવો અભિયાનમાં જોડાયેલા વિદ્યાર્થીઓએ 'વિશ્વ મહાસાગર દિવસ' ની કરી ખાસ રીતે ઉજવણી
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પ્લાસ્ટિક ખાસ કરીને દરિયાઇ ગાય સાથે દરેક સમુદ્રી જીવોને નુકશાન પહોંચાડે છે. તૃણાહારી સસ્તન પ્રાણી દરિયાઇ ગાય સમુદ્રી જીવ છે, જેની પ્રજાતી ભયના આરે આવીને ઉભી છે. તેનો વસવાટ સૌથી વધુ પ્લાસ્ટિક કચરાથી પ્રદુષિત થઈ રહ્યો છે.
વિશ્વ મહાસાગરનો દિવસ ૮ મી જૂને વાર્ષિક ધોરણે યોજાય છે. આ દિવસ વિવિધ પ્રકારે ચિહ્નિત થયેલ છે, જેમાં નવી ઝુંબેશ અને પહેલ શરૂ કરવી, બીચ ક્લિનઅપ્સ, શૈક્ષણિક અને સંરક્ષણ ક્રિયા કાર્યક્રમો શામેલ છે.
યુવાનો વધુને વધુ મહત્વની ભૂમિકા ભજવી રહ્યા છે. ભારતીય વન્યજીવ સંસ્થા ના ડુગોંગ પ્રોજેક્ટ રિસર્ચસે "પ્લાસ્ટિક ફ્રી સમુદ્ર" ની કામગીરીમાં મદદરૂપ સૌ સ્વયં સેવક અને હિસ્સેદારો નો આભાર વ્યક્ત કર્યો હતો.::
રિપોર્ટર વિતલ પીસાવાડિયા

આજે વિશ્વ મહાસાગર દિવસ નિમિતે ઓખા ખાતે ચાંદનીબેન કોટેચા અને પ્રિતીબેન ચાવડા દ્વારા ચાલતુ ઈકો ક્લબ ના બાળકો એ દરીયા કિનારે પડેલો કચરો એકત્રિત કર્યો હતો અને સાથે સાથે બાળકો ને આ કુદરતી સંપતિ નુ મહત્વ સમજાવ્યુ હતુ

When Dugong Meets the Islanders: A Republic Day to Remember!

Denis Giles – 27 January 2021

Port Blair, Jan 27: On the auspicious occasion of the 72nd Republic Day of India, the CAMPA_Dugong team of the Wildlife Institute of India (WII) took their dugong awareness program, a step ahead. This time neither the stakeholders were chosen, nor did the program happened in a close knit setup with limited participants, as the dugong researchers took it by the Sea! And which place would have been ideal, other than the Flag Point at Marina Park-Port Blair, where our tri-color proudly sways with the wind!

Andaman:

IIT Roorkee researchers discover new fossils that show India was home to a variety of sea cows millions of years ago

IIT Roorkee researchers have discovered new fossils that show India was home to a variety of sea cows millions of years ago.

India Today Web Desk
New Delhi
May 31, 2021 UPDATED: May 31, 2021 15:13 IST

IIT Roorkee researchers have discovered new fossils that show India was home to a variety of sea cows millions of years ago. (Representative image of a sea cow)

Listen to this article now

-03:06 x1

IIT Roorkee researchers have discovered new fossils that show India was home to a variety of sea cows millions of years ago. Sea cows, or Dugongs, are an endangered species of herbivorous marine mammals, which feed on seagrass in shallow coastal waters.

Sea cows at danger of extinction

Although protected in India under the Wild (Life) Protection Act, 1972, these rare animals are fighting for survival in the Indian waters including the Gulf of Kutch, the Gulf of Mannar and Palk Bay (Tamil Nadu), and the Andaman and Nicobar Islands.

There is a serious danger of these sea cows becoming extinct if concerted efforts are not made

SPECIES

India was home to a variety of sea cows millions of years ago

Findings of fossil discoveries by IIT Roorkee faculty

SHARE ARTICLE A- A+

Poster released on the occasion of World Dugong Day on May 28

School Web Desk

Roorkee, May 30

Sea cows, or Dugongs, are an endangered species of herbivorous marine mammals, which feed on seagrass in shallow coastal waters. Although protected in India under the Wild (Life) Protection Act, 1972, these rare animals are fighting for survival in the Indian waters including the Gulf of Kutch, the Gulf of Mannar & Palk Bay (Tamil Nadu), and the Andaman & Nicobar Islands.

There is a serious danger of these sea cows becoming extinct if concerted efforts are not made for their conservation.

The World Dugong Day is celebrated every year on May 28 to create awareness about this growing threat to sea cows by human activities such as the destruction and modification of dugong habitats, rampant illegal fishing activities, pollution, vessel strikes, unsustainable hunting or poaching, and unplanned tourism.

Annexure-II

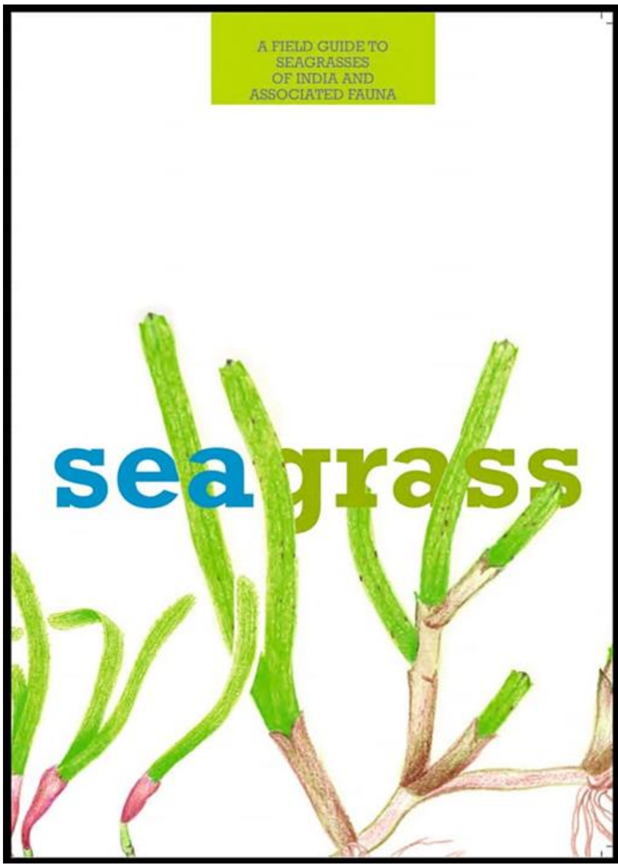
Outreach materials and Publications

Seagrasses of India poster

CAMPA Dugong Project new logo

Dugong Souvenir design

A field guide to Seagrasses of India and associated fauna



A FIELD GUIDE TO
SEAGRASSES
OF INDIA AND ASSOCIATED FAUNA

A Field Guide to Seagrasses of India and Associated Fauna

Printed in India, 2021

The contents of the manual may be freely used for non-commercial purposes with due acknowledgement.

Disclaimer
The information presented in the manual are of authors and do not represent the views of the institution.

The manual is also available online at https://wii.gov.in/dugong_publications

WII website link: http://wii.gov.in/

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Authors
Dr. K Sivakumar
Dr. J A Johnson
Dr. Anant Pande
Sohom Seal

Illustrations
Vabesh Tripura
Sohom Seal

Other contributors
Chinmaya Ghanekar
Himani Saini
Sumit Prajapati
Sagar Rajpurkar
Shivani Patel
Sharad Bayyana

Contact
ksivakumar@wii.gov.in
dugongforever@gmail.com

@CAMPAdugong_WII
@dugongsforever
@dugongsforever

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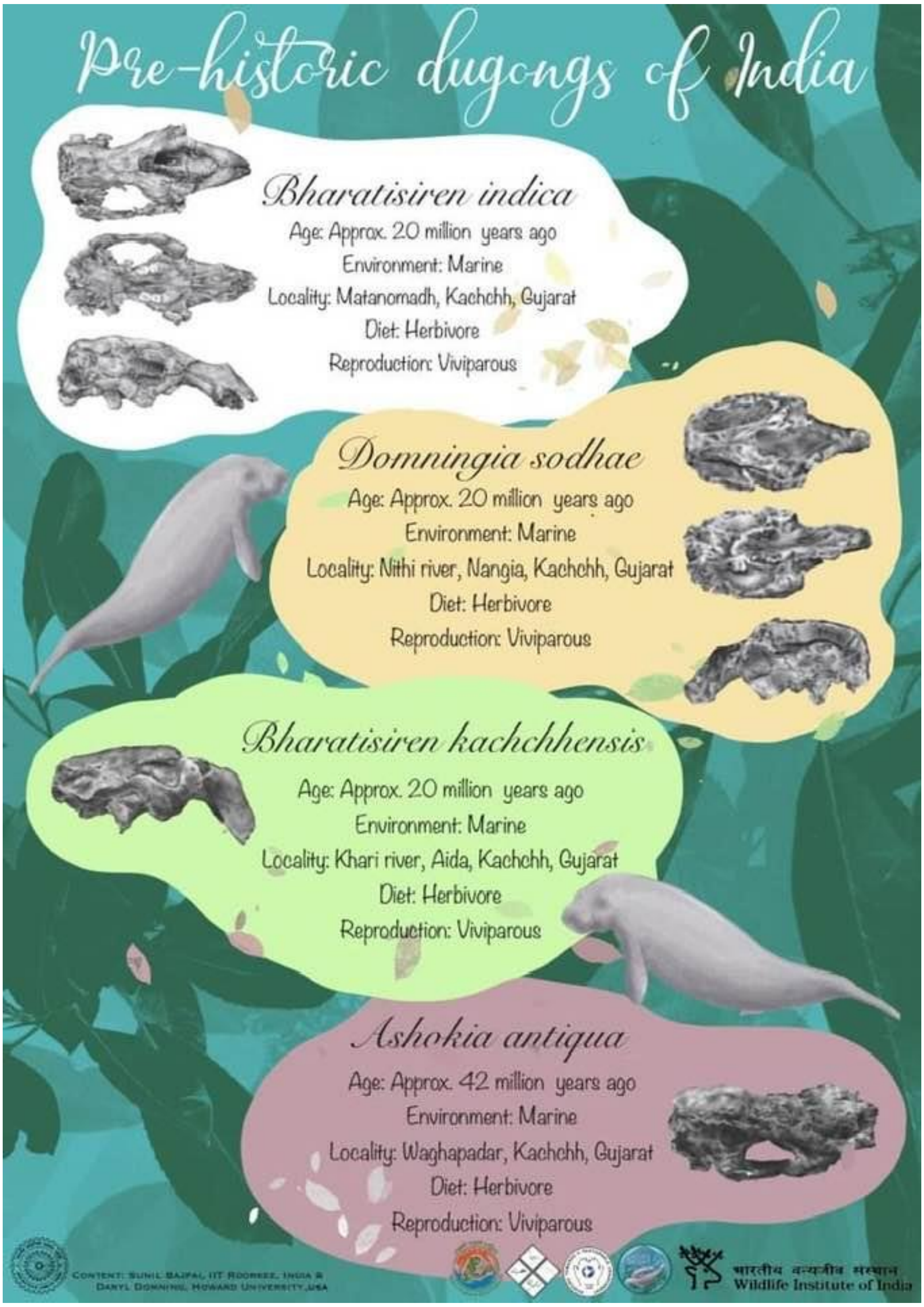
Pande, A., Seal, S., Tripura, V., Johnson, J.A., Sivakumar, K. (2021). *A field guide to seagrasses of India and associated fauna.* Wildlife Institute of India, Dehradun, Ministry of Environment, Forest and Climate Change, Government of India.

Project Citation
CAMPA-Recovery of dugong and their habitats in India: an integrated participatory approach (2021). *A field guide to seagrasses of India and associated fauna.* Wildlife Institute of India, Dehradun, Ministry of Environment, Forest and Climate Change, Government of India.

ISBN : 81-85496-55-2

Prehistoric dugongs of India Poster

Ancient India had four species of dugongs, God's own cows in the Kutch regions of Gujarat, the highest anywhere in the world. Reflects the richest marine biodiversity of India during the prehistoric periods.



<u>Annexure III</u>

Dugong ambassadors list

1: Dugong Ambassadors of Tamil Nadu

Sl. No.	Photo	Name	Gender	Standard	School
1		S. Deebika	Female	11^{th}	Govt. Girls Hr. Sec. School, Adiramapattinam
2		S. Prathana	Female	9^{th}	Govt. Girls Hr. Sec. School, Adiramapattinam
3		P. Kamali	Female	11^{th}	Govt. Girls Hr. Sec. School, Adiramapattinam
4		N. Nageshwari	Female	11^{th}	Govt. Hr. Sec. School, Rajamadam
5		E. Nasrin Banu	Female	11^{th}	Govt. Hr. Sec. School, Mallipattinam
6		B. Mohamed Paisul	Male	11^{th}	Govt. Hr. Sec. School, Mallipattinam
7		J. Aseera	Female	9^{th}	Govt. Hr. Sec. School, Mallipattinam
8		S. Shabhurrusha	Female	9^{th}	Govt. High School, Sethuma Chathiram

Sl. No.	Photo	Name	Gender	Standard	School
9		M. Sarumathi	Female	9th	Govt. High School, Sethuma Chathiram
10		B. Riyana	Female	9th	Govt. High School, Sethuma Chathiram
11		P. Pavithra	Female	9th	Govt. High School, Pudutheru
12		K. Sundareswari	Female	11th	Govt. Hr. Sec. School, Kattumavadi
13		P. Karthika	Female	11th	Govt. Hr. Sec. School, Kattumavadi
14		M.Kaviyarasan	Male	11th	Govt. Boys Hr. Sec. School, Manamelkudi
15		B. Chitralakshmi	Female	11th	Govt. Girls Hr. Sec. School, Manamelkudi
16		M. Aruna Devi	Female	11th	Govt. Girls Hr. Sec. School, Manamelkudi
17		C. Sugitha	Female	9th	Govt. Hr. Sec. School, Jagathapattinam
18		R. Thaslima Banu	Female	11th	Govt. Hr. Sec. School, Kottaipattinam

Sl. No.	Photo	Name	Gender	Standard	School
19		R. Nanthini	Female	11th	Govt. Hr. Sec. School, Gopalapattinam
20		M. Murugeswari	Female	11th	Govt. Hr. Sec. School, Mimisal
21		R. Saminathan	Male	11th	Govt. Hr. Sec. School, Mimisal
22		U. Pavithra	Female	9th	Govt. High School, Vattanam
23		S. Megaran Beevi	Female	9th	Govt. Hr. Sec. School, S. P. Pattinam
24		G. Munishwaran	Male	11th	S. M. Govt. Hr. Sec. School, Thondi
25		R. Kerishtoper	Male	9th	S. M. Govt. Hr. Sec. School, Thondi
26		M. Malaiyarasi	Female	11th	Govt. Girls Hr. Sec. School, Thondi
27		V. Bagampriyal	Female	9th	Govt. Girls Hr. Sec. School, Thondi
28		B. Nagasoundarya	Female	9th	Govt. High School, Nambuthalai

Sl. No.	Photo	Name	Gender	Standard	School
29		M. Manotha	Female	9^{th}	Govt. High School, Nambuthalai
30		K. Kavinesh Kumar	Male	9^{th}	Amala Annai Hr. Sec. School, Karangkadu
31		S. Sandosh	Male	9^{th}	Amala Annai Hr. Sec. School, Karangkadu
32		S. Sivaranjani	Female	11^{th}	Amala Annai Hr. Sec. School, Karangkadu
33		T. Vimalthasan	Male	11^{th}	Govt. Hr. Sec. School, Uppoor
34		M. Achitha	Female	11^{th}	Govt. Hr. Sec. School, Uppoor
35		S. Dhivya	Female	11^{th}	Govt. Hr. Sec. School, Uppoor
36		K. Kali Karthika	Female	9^{th}	Govt. Hr. Sec. School, Tiruppalaikudi
37		N. Durkka	Female	9^{th}	Govt. Hr. Sec. School, Tiruppalaikudi
38		S. Bowmiya Begam	Female	9^{th}	Govt. Hr. Sec. School, Tiruppalaikudi

Sl. No.	Photo	Name	Gender	Standard	School
39		S. Logesh Raj	Male	9^{th}	Govt. High School, Sambai
40		S. Karthigadevi	Female	9^{th}	Govt. Hr. Sec. School, Devipattinam
41		N. Jeyapratha	Female	11^{th}	Mohamedia Hr. Sec. School, Chittar Kottai
42		K. Savithiri	Female	11^{th}	Mohamedia Hr. Sec. School, Chittar Kottai
43		N. Gowtham	Male	9^{th}	Govt. High School, Palanivalasai
44		K. Ritheesh	Male	9^{th}	Arabi Oliyullah High School, Puduvalasai
45		G. Vijaya	Female	11^{th}	Govt. Girls Hr. Sec. School, Panaikulam
46		P. Kaviya	Female	9^{th}	Govt. Girls Hr. Sec. School, Panaikulam
47		B. Vikram	Male	11^{th}	Bahrurdin Govt. Boys High School, Panaikulam
48		K. Viji	Female	11^{th}	Govt. Hr. Sec. School, Alagankulam

Sl. No.	Photo	Name	Gender	Standard	School
49		B. Umeshvithya	Female	11^{th}	Govt. Hr. Sec. School, Alagankulam
50		R. Sheeba	Female	9^{th}	Govt. Hr. Sec. School, Uchipulli
51		M. Jansi	Female	9^{th}	Govt. Hr. Sec. School, Uchipulli
52		V. Santhiya	Female	9^{th}	Govt. Hr. Sec. School, Uchipulli
53		U. Udayabrunda	Female	9^{th}	Govt. Hr. Sec. School, Irumeni
54		M. Harris Jayaraj	Male	9^{th}	Govt. Hr. Sec. School, Irumeni
55		S. Al Shiba Fathima	Female	9^{th}	Govt. Hr. Sec. School, Vedalai
56		S. Tharshika	Female	9^{th}	Govt. Hr. Sec. School, Vedalai
57		S. Afritha Banu	Female	11^{th}	Govt. Hr. Sec. School, Vedalai
58		J. Banu Priya	Female	11^{th}	Govt. Hr. Sec. School, Vedalai

Sl. No.	Photo	Name	Gender	Standard	School
59		A. Babyrani	Female	11th	Govt. Hr. Sec. School, Vedalai
60		R. Asmiya	Female	11th	Govt. Hr. Sec. School, Mandapam Camp
61		A. Farsiya Fathima	Female	9th	Govt. Girls Hr. Sec. School, Mandapam
62		N. Durga	Female	9th	Govt. Girls Hr. Sec. School, Mandapam
63		M. Arrahilthifa	Female	9th	Govt. Girls Hr. Sec. School, Mandapam
64		A. R. Harimathi	Female	11th	Govt. Girls Hr. Sec. School, Mandapam
65		J. Jerolin Santhiya	Female	11th	Govt. Hr. Sec. School, Pamban
66		M. Abirami	Female	11th	Govt. Hr. Sec. School, Thangachimadam
67		A. Mariya Renipa	Female	11th	Govt. Hr. Sec. School, Thangachimadam
68		S. Jemil	Female	9th	Govt. Hr. Sec. School, Thangachimadam

Sl. No.	Photo	Name	Gender	Standard	School
69		M. Anthony Benosh	Male	9^{th}	Punitha Yagappar Hr. Sec. School, Thangachimadam
70		L. Zionraj	Male	9^{th}	Punitha Yagappar Hr. Sec. School, Thangachimadam
71		S. Sahaya Sweetlin	Female	11^{th}	Punitha Yagappar Hr. Sec. School, Thangachimadam
72		M. Ageciya Nilodika	Female	9^{th}	Punitha Yagappar Hr. Sec. School, Thangachimadam
73		S. Babu	Male	9^{th}	Govt. Hr. Sec. School, Rameswaram
74		T. Palanimurugan	Male	9^{th}	Govt. Hr. Sec. School, Rameswaram
75		M. Thavamurugan	Male	11^{th}	Govt. Hr. Sec. School, Rameswaram
76		I. M. Ramkumar	Male	9^{th}	Govt. Hr. Sec. School, Rameswaram
77		A. Arul Ebineesh	Male	11^{th}	Govt. Hr. Sec. School, Rameswaram
78		N. John Pethuro	Male	9^{th}	Govt. Hr. Sec. School, Rameswaram

Sl. No.	Photo	Name	Gender	Standard	School
79		P. Rathish Kumar	Male	9^{th}	Govt. High School, Karaiyur
80		N. Nambu Priyadharshini	Female	9^{th}	Govt. High School, Karaiyur
81		S. Thurgesh Raja	Male	9^{th}	Govt. Hr. Sec. School, Pudumadam
82		M. Jaheedeen	Male	9^{th}	Govt. Hr. Sec. School, Pudumadam
83		A. Nasrin Begam	Female	9^{th}	Govt. Girls Hr. Sec. School, Pudumadam
84		K. Jeya	Female	9^{th}	Govt. High School, Thamaraikulam
85		S. Mohammedu Shihar	Male	9^{th}	Govt. Hr. Sec. School, Periyapattinam
86		S. Jaisha	Female	9^{th}	Govt. Hr. Sec. School, Periyapattinam
87		M. Saktheeswaran	Male	9^{th}	Govt. high School, Kalimankundu
88		R. Jeya Surya	Male	9^{th}	Govt. Hr. Sec. School, Thinaikulam

Sl. No.	Photo	Name	Gender	Standard	School
89		M. Muthu Kumar	Male	9th	Govt. Hr. Sec. School, Thirupullani
90		S. Segu Bakurudeen	Male	9th	Mahdhoomia Hr. Sec. School, Kilakarai
91		Y. Anthony Akshab	Male	9th	Islamiah High School, Kilakarai
92		A. Mohana Soundhari	Female	9th	Hameediah Girls Hr. Sec. School, Kilakarai
93		K. Kaviya	Female	11th	Hameediah Girls Hr. Sec. School, Kilakarai
94		R. Mugesh Kunnan	Male	9th	Hameediah Boys Hr. Sec. School, Kilakarai
95		M. Vinitha	Female	9th	Govt. Hr. Sec. School, Ervadi
96		C. Panu Priya	Female	11th	Govt. Hr. Sec. School, Ervadi
97		M. Nandini	Female	11th	Govt. Hr. Sec. School, Ervadi
98		G. Durga Devi	Female	11th	Govt. Hr. Sec. School, Ervadi

SN	Photo	Name	Gender	Standard	School
99		N. Thilochana	Female	11^{th}	. Hr. Govt Sec. School, Ervadi
100		P. Iswarya	Female		Govt. Hr. Sec. School, Ervadi

Table no. 3 Dugong Ambassador of Andaman & Nicobar Island

SN	Photo	Name	Gender	Standard	School
1		Snigdha Sikder	Female	11^{th}	Govt. Sr. Sec School Havelock-3
2		Seema Chowdhury	Female	12^{th}	Govt. Sr. Sec School Havelock-3
3		G. Shiva	Male	12^{th}	Govt. Sr. Sec School Havelock-3
4		Abhijeet Mazumder	Male	12^{th}	Govt. Sr. Sec School Havelock-3
5		M. Neha	Female	First year graduation	Govt. Sr. Sec School Havelock-3
6		Abhay Halder	Male	11th	Govt. Sr. Sec School Havelock-3
7		Chanchal Sarkar	Male	12^{th}	Govt. Sr. Sec School Havelock-3
8		Rohit Sammaddar	Male	12^{th}	Govt. Sr. Sec School Havelock-3

SN	Photo	Name	Gender	Standard	School
9		Ashit Halder	Male	12^{th}	Govt. Sr. Sec School Havelock-3
10		Rohit Mondal	Male	12^{th}	Govt. Sr. Sec School Havelock-3
11		Ranjeet Mondal	Male	12^{th}	Govt. Sr. Sec School Havelock-3
12		Payal Bala	Female	12^{th}	Govt. Sr. Sec School Havelock-3
13		Tanushree Mondal	Female	12^{th}	Govt. Sr. Sec School Havelock-3
14		Srishti Gharami	Female	12^{th}	Govt. Sr. Sec School Havelock-3
15		Nibedita Mondal	Female	11^{th}	Govt. Sr. Sec School Havelock-3
16		Sunita Roy	Female	10^{th}	Govt. Sr. Sec School Havelock-3
17		Deepti Mondal	Female	12^{th}	Govt. Sr. Sec School Havelock-3

SN	Photo	Name	Gender	Standard	School
18		Rupsha Biswas	Female	First year graduation	Govt. Sr. Sec School Havelock-3

Table 2: Dugong Ambassadors Gulf of Kutch of Gujarat

SN	Photo	Name	Gender	Standard	School
1		Payal Jasrajbha Manek	Female	10^{th}	RMSA Government Highschool Vasai
2		Paruben Devubha Manek	Female	10^{th}	RMSA Government Highschool Vasai
3		Namrata Madhav Rathod	Female	10^{th}	RMSA Government Highschool Vasai
4		Thaim Ashmabanu Sulemanbhai	Female	11^{th}	PVM Girls HighSchool and Higher Secondary School

SN	Photo	Name	Gender	Standard	School
5		Manek Bharti Gagabha	Female	11th	PVM Girls HighSchool and Higher Secondary School
6		Mahinur Jusabbhai Karar	Female	12th	PVM Girls HighSchool and Higher Secondary School
7		Simran Firojkhan Khatak	Female	12th	PVM Girls HighSchool and Higher Secondary School
8		Shaniyabanu Ajimbhai Malek	Female	10th	PVM Girls HighSchool and Higher Secondary School
9		Roshan Khamisha Bhikhalani	Female	11th	PVM Girls HighSchool and Higher Secondary School
10		Shabari Salim shaikh Bismillah	Female	10th	PVM Girls HighSchool and Higher Secondary School
11		Vaghela Indrakumar	Male	9th	Shree Karmayog Highschool

SN	Photo	Name	Gender	Standard	School
12		Rinuben Rameshbhai Chauhan	Male	9^{th}	Shree Karmayog Highschool
13		Kinjal P Chanpa	Male	9^{th}	Shree Karmayog Highschool
14		Arti Lakhabhai Vaghela	Female	10^{th}	Shree Karmayog Highschool
15		Baraiya Hiteshbhai Pragna	Female	8^{th}	Shree Dwarka Taluka School 1
16		Arjan Jiva Chauhan	Male	8^{th}	Shree Varvala Wadi Primary School
17		Arjunbhai Jivabhai Chauhan	Male	8^{th}	Shree Varvala Wadi Primary School
18		Shantiben Pratapbhai Vaghela	Female	8^{h}	Shree Varvala Primary School
19		Payal Vaghela	Female	8^{th}	Shree Varvala Primary School

SN	Photo	Name	Gender	Standard	School
20		Varshibhai Vaghela	Male	8^{th}	Shree Varvala Primary School
21		Karan Kanabhai Chauhan	Male	7^{th}	Shree Varvala Wadi Primary School
22		Lakhman Vaghela	Male	8^{th}	Shree Varvala Primary School
23		Mamta Mavjibhai Chauhan	Female	7^{th}	Shree Varvala Wadi Primary School
24		Nagita Bhikhubhai Vaghela	Female	7^{th}	Shree Varvala Wadi Primary School
25		Sumaribai Parmar	Female	7^{th}	Shree Varvala Primary School
26		Ramabhai Ajunbhai Chauhan	Male	7^{th}	Shree Varvala Primary School
27		Abbas Faruk Bolim	Male	7^{th}	Nagar Palika Sanchalit Okha Primary School
28		Jigar Balubhai Dhayani	Male	8^{th}	Nagar Palika Sanchalit Okha Primary School

SN	Photo	Name	Gender	Standard	School
29		Saniya Sap	Female	8th	Nagar Palika Sanchalit Okha Primary School
30		Rayazada Muskan Munaf	Female	9th	Nagar Palika Sanchalit Okha Primary School
31		Rafik Adam Bandri	Male	8th	Nagar Palika Sanchalit Okha Primary School
32		Ayub Junus Bandri	Male	8th	Nagar Palika Sanchalit Okha Primary School
33		Aksha Aasif Chauhan	Female	9th	Nagar Palika Sanchalit Okha Primary School
34		Komalaben Harjibhai Gohel	Female	9th	Nagar Palika Sanchalit Okha Primary School
35		Shirinbanu Rafikbhai Betara	Female	9th	Nagar Palika Sanchalit Okha Primary School
36		Ashraf Rajha Betara	Male	9th	Nagar Palika Sanchalit Okha Primary School

SN	Photo	Name	Gender	Standard	School
37		Komal Kamalan Mrugesh	Female	9th	Nagar Palika Sanchalit Okha Primary School
38		Bolim Aezaz	Male	9th	Nagar Palika Sanchalit Okha Primary School
39		Sodha Riyaz	Male	9th	Nagar Palika Sanchalit Okha Primary School
40		Ravina Vijaybhai Parmar	Female	9th	Shree Varvala Primary School
41		Ravina Vaghela	Female	7th	Shree Varvala Primary School
42		Jasmin Harun Bloch	Female	8th	Shree Varvala Primary School
43		Manek Gani Sorathiya	Female	8th	Shree Varvala Primary School
44		Krupali Anilbhai Tavdi	Female	7th	Shree Varvala Primary School

SN	Photo	Name	Gender	Standard	School
45		Divya Rupadiya	Female	7th	Shree Varvala Primary School
46		Julekhbanu Janibhai Pateliya	Female	7th	Shree Rupen Bandar Primary School
47		Mantasa Gafur Beladiya	Female	7th	Shree Rupen Bandar Primary School
48		Sumera Juma Thaiyam	Female	7th	Shree Rupen Bandar Primary School
49		Hina Hanif Bhesaliya	Female	7th	Shree Rupen Bandar Primary School
50		Nazmin Kasambhai Bhesaliya	Female	7th	Shree Rupen Bandar Primary School
51		Sanvovar Jusubhai Mer	Female	8th	Shree Rupen Bandar Primary School

SN	Photo	Name	Gender	Standard	School
52		Sabnam Shabirbhai Ishbani	Female	7^{th}	Shree Rupen Bandar Primary School
53		Nurjaha Yunus Pateliya	Female	7^{th}	Shree Rupen Bandar Primary School
54		Sharifan Munasha Jalali	Female	8^{th}	Shree Rupen Bandar Primary School
55		Sanambanu Rafikbhai Betai	Female	7^{th}	Shree Rupen Bandar Primary School
56		Subhaniya Rijavan	Male	10^{th}	Shri Swaminarayan Highschool
57		Vadha Latif	Male	10^{th}	Shri Swaminarayan Highschool
58		Jagatiya Mohamad Mohyunudin	Male	10^{th}	Shri Swaminarayan Highschool
59		Sap Navaz Jumabhai	Male	12^{th}	Mithapur HighSchool and Higher Secondary School

SN	Photo	Name	Gender	Standard	School
60		Kureshi Ashiyabanu Sattarbhai	Female	10th	Mithapur HighSchool and Higher Secondary School
61		Chaki Sahid	Male	11th	Mithapur HighSchool and Higher Secondary School
62		Chaki Tasneem Mahammad bhai	Female	11th	Mithapur HighSchool and Higher Secondary School
63		Kaushar Shabir Kureshi	Female	10th	Okha Grampanchayat HighSchool and Higher Secondary School
64		Kasta Mansi Harishbhai	Female	12th	Okha Grampanchayat HighSchool and Higher Secondary School
65		Sodha Satar Idrushbhai	Male	10th	Okha Grampanchayat HighSchool and Higher Secondary School
66		Amjad Gudhani	Male	10th	Okha Grampanchayat HighSchool

RECOVERY OF DUGONGS AND THEIR HABITATS IN INDIA AN INTEGRATED PARTICIPATORY APPROACH			
RECEIPT & PAYMENT			
FOR THE PERIOD OF 01 APRIL 2020 TO 31 MARCH 2021			
RECEIPT	**AMOUNT (In Rs.)**	**PAYMENT**	**AMOUNT (In Rs.)**
Opening Balance	20951896.32	Manpower Engagement	7823042.00
Grant Received	16036000.00	Capacity Building & Awareness	1689034.00
Advance for Expenses	1508696.00	Research Monitoring Species and Habitat	6394416.00
Bank Interest	504351.00	Participatory Management	1110500.00
		Marine Mammal Rescue and Rehab	521511.00
		Refund of Interest to MoEF & CC	65526.00
		Total Expenditure	**17604029.00**
		Outstanding :	
		Forest Advance	1304410.00
		Tour Advance	305000.00
		Balance as on 31.03.2021 A/C No. 55294	**19787504.32**
Grand Total	**39000943.32**	**Grand Total**	**39000943.32**

सत्यमेव जयते

प्रकृतिः रक्षति रक्षिता

Nature Protects if She is Protected

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

CAMPA DUGONG Recovery Programme

FOREST DEPARTMENT GOVT. OF GUJARAT

Tamil Nadu Forest Department

ANDAMAN & NICOBAR ISLANDS FORESTS ANF

सत्यमेव जयते

शं नो वरुणः

भारतीय तटरक्षक

वयम् रक्षामः