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BIODIVERSITY STUDY FOR THE PROPOSED BURROW PIT REGION IN ARABIAN SEA WITHREFERENCE TO DEVELOPMENT OF VADHAVAN PORT, PALGHAR, MAHARASHTRA

Project Technical Report

Submitted to:

Jawaharlal Nehru Port Authority, Mumbai

Zoological Survey of India

(Ministry of Environment, Forests and Climate Change)Western Regional Centre,

Akurdi, Ravet Road, Pune – 411044

October 2023

General Terms and Conditions:

1. Proposal submitted by ZSI to M/s JNPA for undertaking "BIODIVERSITY STUDYFOR THE PROPOSED BURROW PIT REGION IN ARABIAN SEA WITHREFERNCE TO DEVELOPEMNT OF VADHAVAN PORT, PALGHAR, MAHARASHTRA" is solely in the interest of M/s JNPA.

2. The report on the "BIODIVERSITY STUDY FOR THE PROPOSED BURROW PIT REGION IN ARABIAN SEA WITH REFERNCE TO DEVELOPEMNT OF VADHAVAN PORT, PALGHAR, MAHARASHTRA" to be submitted by ZSI to M/s JNPA is not binding on the part of the Government of India / State Government/ Forest Department / Fisheries Department / Port Authority or other competent department to issue the NoC/Environmental Clearance of the said project. Also, there is no legal binding on the result of the report by ZSI.

3. There is no financial involvement from Zoological Survey of India, Kolkata for theproposed study, neither there is no consultancy charges levied by ZSI for carrying out the study.

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Acknowledgements

CONTENTS

PREAMBLE

The Arabian coast at Vadhvan towards the north of Mumbai is a new proposed port about 10 Km from the National Railway grid and about 35-40 Km from National Highway 8. As informed, The Jawaharlal Nehru Port Authority (JNPA) has been entrusted to develop the Vadhvan Port along with the participation of Govt. of Maharashtra and Maharashtra Maritime Board. The port will be developed based on Landlord Port, and will be developed as a Greenfield Port and deep draughtPort to cater to large container, bulk and crude vessels as well for handling all cargos. The Ministry of Environment, Forests and Climate Change, Government of India has issued the Terms of Reference (ToR) for prior Environmental Clearance for the project in April 2022, and accordingly, all the studies as per the ToR have been completed. The Dahanu Taluka Environment Protection Authority (DTEPA) has granted JNPA permission to establish and develop the Vadhavan port in the Dahanu Taluka on 31st July 2023.

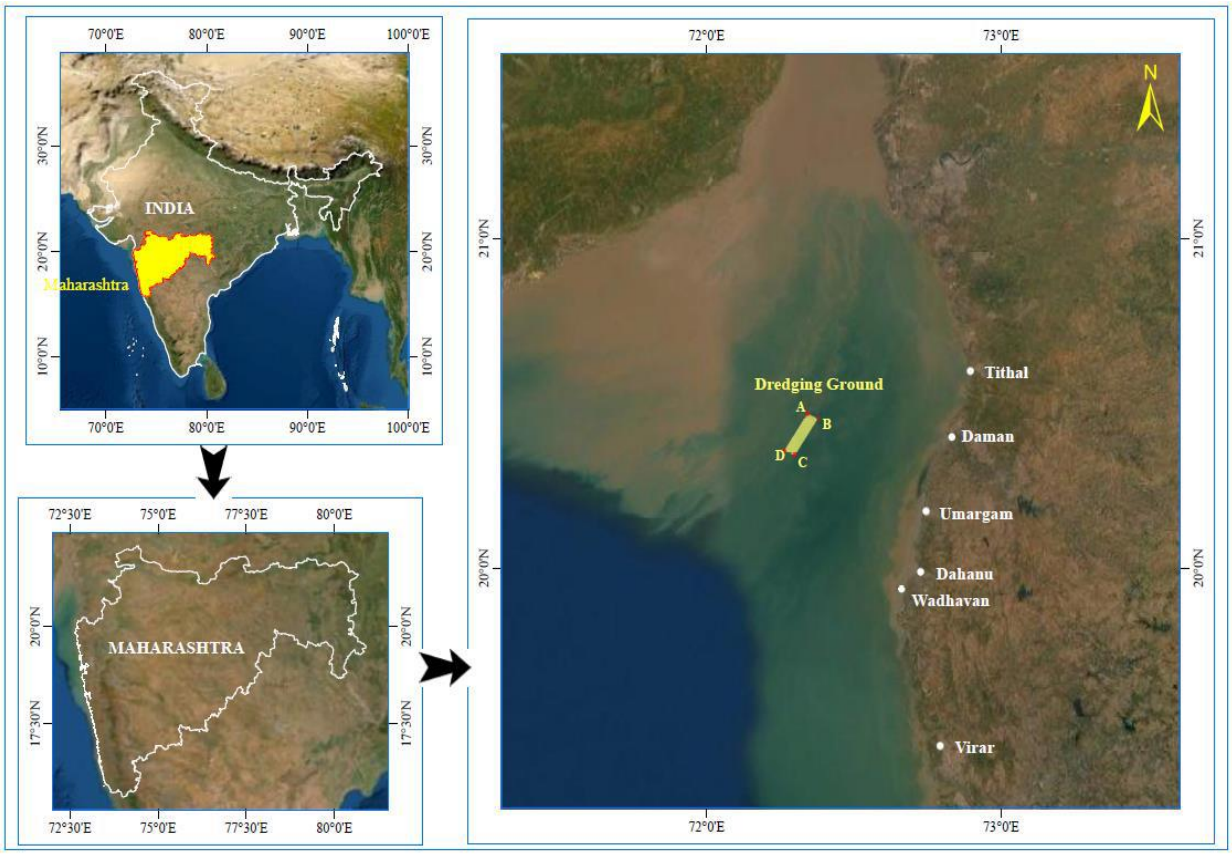
The basic infrastructure of the port e.g., breakwater, dredging, offshore/ nearshore reclamation & shore protection bund, rail and road linkages, power, water lines and common infrastructure and services will be developed by the project proponent. Further, the fill material for reclamation of offshore in Dahanu will be sourced from Daman off Coast and for which sea sand which is considered to be most environmentally sustainable proposed to be used. The EAC, taking into account the submission made by the project proponent has recommended the proposal. However, the Appraisal Committee has suggested the Zoological Survey of India to study the biodiversity at Daman Offshore area (proposed burrow pit), from where the sand to be extracted for port construction

purpose. The Zoological Survey of India was also advised to monitor the offshore marine mammal movement and fish aggregation sites if any, along with the study on the biodiversity in the proposed burrow pit in the Arabian sea, off Daman coast.

The M/s JNPA has identified a burrow pit at around 50-65 km into the Arabian sea from the proposed Vadhavan port for obtaining sand for creating reclaimed land at the proposed Vadhavan port. Marine sand will be dredged using Trailing Suction Hopper Dredger (TSHD) and the sand will be transported and dumped at the reclamation location. For the development of Greenfield Port at Vadhavan by the Jawaharlal Nehru Port Trust (JNPT), the Project proponent placed the proposal before the EAC of Govt. of India, MoEFCC and has submitted the revised Feasibility Report with modified Master Plan and change in source of material for reclamation from offshore sand borrow pits. The amount of the reclamation in the proposal is 200 M cum and the reclamation and land filling of 1,473 ha. of land would be carried out by murrum filling/earth which required 86.88 M cum. However, considering the substantial amount of reclamation requirement, it is proposed to extract the fill material through marine borrow pit as against the earth filling burrow from land location and in view of the ecological sensitivity of the region, the change of location was proposed to burrow the material from offshore in the Arabian sea, off the coast of Daman.

PROJECT AREA

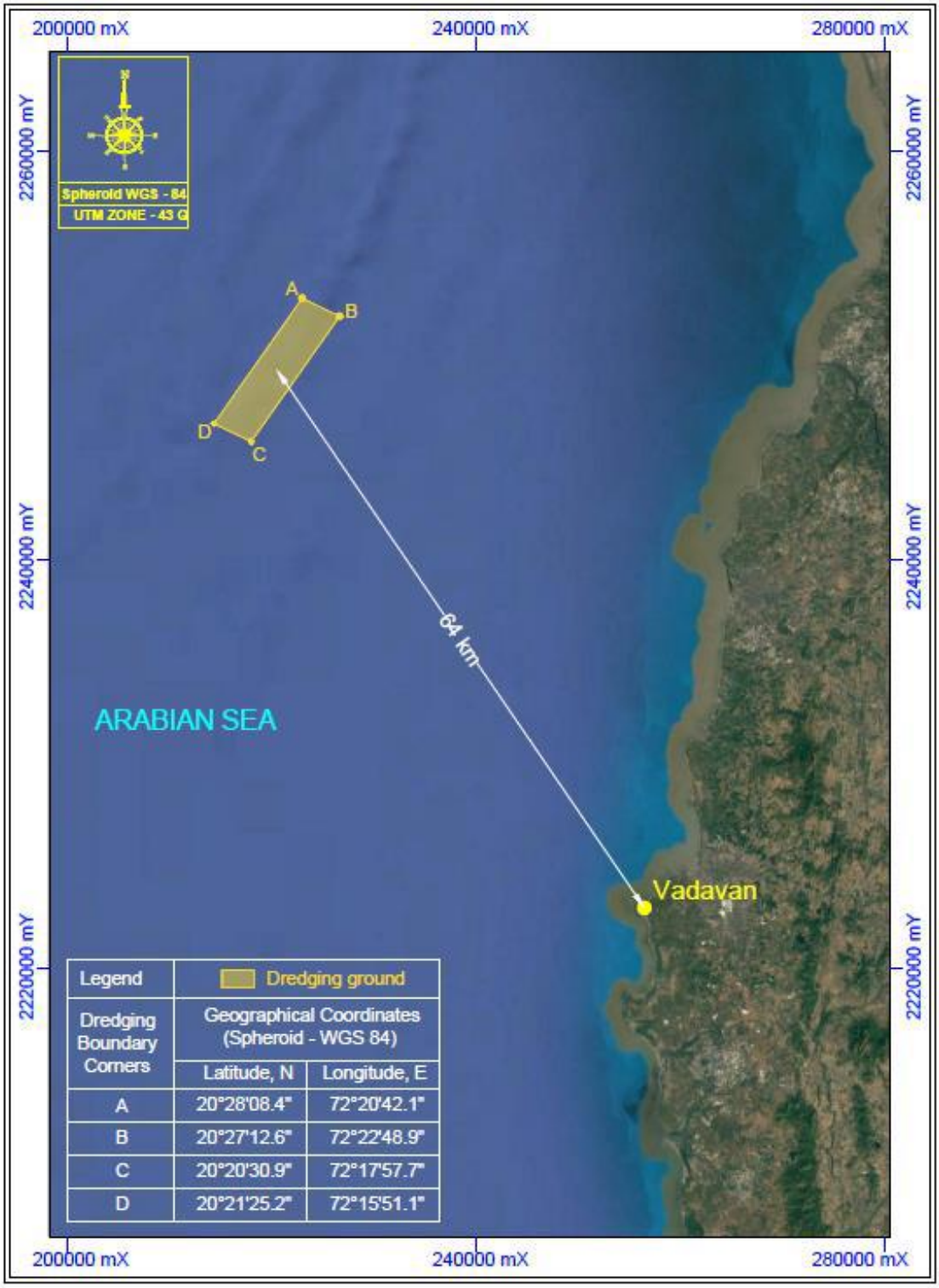
Location of Marine Borrow Pit for Sand Mining



Source: Google Earth; IIT, Madras study

The locations of offshore area is in the northern side of proposed port where sandy bed is available. The marine borrow pit was identified in the offshore of the Daman coast about 50 km from the proposed port site at a depth varying from 20 m to 25 m. The proposed area falls under Exclusive Economic Zone (EEZ) of India and it stretches from the outer limit of the territorial sea (12 nautical miles from the baseline) out to 200 nautical miles from the coast. The dredging quantity expected from the project is 200 x 106 m^3 and generally consists of sandy silt. Marine sand will be dredged using dredging equipment and the sand will be transported by sea route and dumped at the reclamation location within protected bunds. The Ministry of Mines, Government of India is the owner of the area and No Objection Certificate and permit has already been issued for such

activities by MoM as per Offshore Areas Mineral Concession Rules, 2006, for a period of 3-5 years of dredging.



Satellite imagery of Project Location

Source: Google Earth; IIT, Madras study

In this context, the M/s Jawaharlal Nehru Port Authority (JNPA) contacted the Zoological Survey of India, Western Regional Centre, Pune for carrying out a biodiversity study of the burrow pit region covering monsoon and winter seasons (considering the sand flats are active breeding areas for fishes and other sand burrowing fauna) as well as two seasons additional baseline data with specific focus on marine mammals movement and fish aggregation site if any with special focus on offshore sand mining area and port reclamation areas. Accordingly, a project proposal was submitted to M/s JNPA and approved by the Competent Authority at JNPA to carry out the work and submit a technical report to place before the EAC of MoEFCC, Govt. of India.

OBJECTIVES

The objectives of the study are as below.

i. Biodiversity study for the burrow pit region for two seasons.

ii. Collection of baseline data with specific focus on marine mammal movement and fish aggregationsites with special focus on offshore sand mining areas and port reclamation areas.

iii. Suggest conservation and management strategies for biodiversity for burrow pit region andoffshore sand mining area and port reclamation areas.

STUDY AREA:

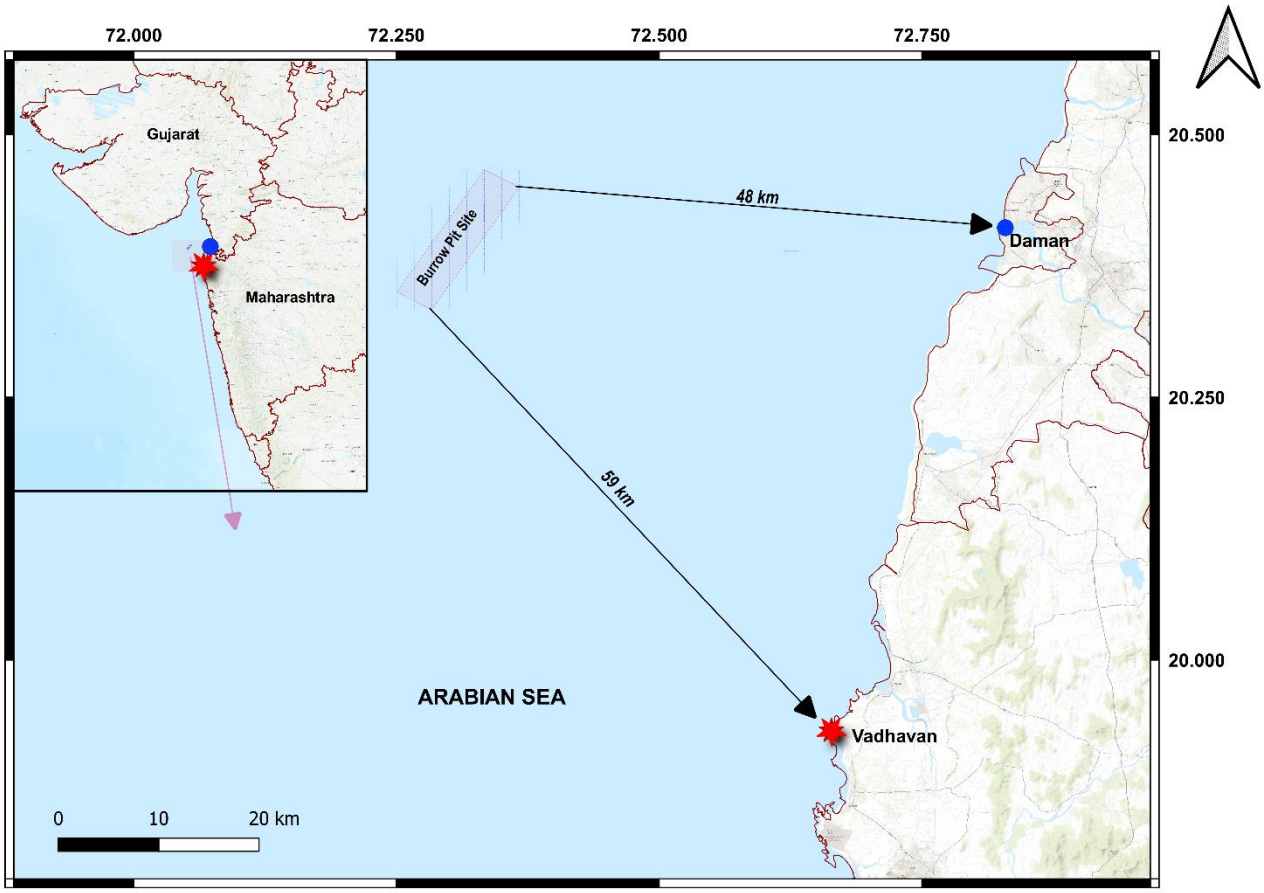
Location of Vadhavan Port site (Google Earth, JNPA)

Proposed Burrow Pit Location for Vadhavan Port site in Arabian Sea (Google Earth, JNPA)

METHODOLOGY

Field work in the burrow pit region offshore sand mining area in the Arabian Sea (location as shown in the map above) was initiated from August 2023 and monitoring to be carried out for two seasons upto to March 2025. Information based on secondary sources collated and collected from fisherfolks and other stakeholders using the area for fishing and other purpose. Published and unpublished literature were consulted for background information on the faunal diversity documentation conducted by research organizations/ institutions/ individuals from the study area.

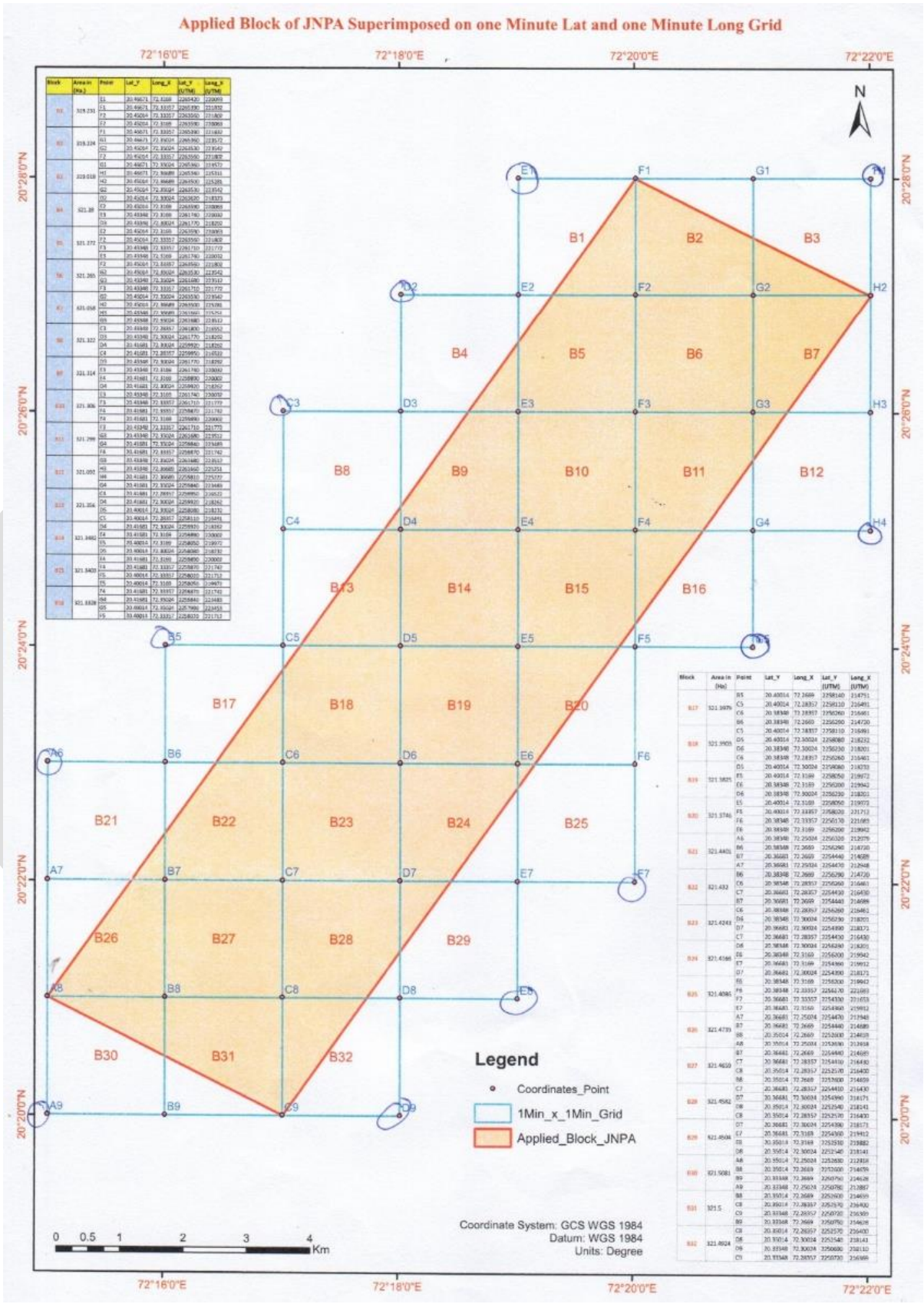
Two surveys conducted from 6th to 10th September 2023 and from 30th September 2023 to 8th September 2023. For biodiversity study of the burrow pit region and offshore sand mining area, faunal sample collections were carried out using onboard multidisciplinary cruise. Medium Speed Demersal Trawl (commercial bottom trawling) was used for the offshore study and fishing operations was carried out for biodiversity profile of the pelagic and benthic environment at the proposed site. A rectangular grid was made covering the entire area (as shown in the map) and plotted on the GPS for covering north to south and west to west and vice versa. At total of 25 stations were plotted within the grid for effectively covering the area. These collection stations were fixed using the navigation chart. The geographic locations of all the sampling areas (start and end position of the trawler) were taken with Global Positioning System (GPS). Other parameters, such as start and end times of trawls and depth of the trawl, state of the sea, weather condition were recorded. Tows at 3.5 – 4.5 knots conducted and the duration of the operation was standardized to one hour, so that there are no entanglement related casualties of any marine turtles or marine mammals, if any caught during the operation, at the site.



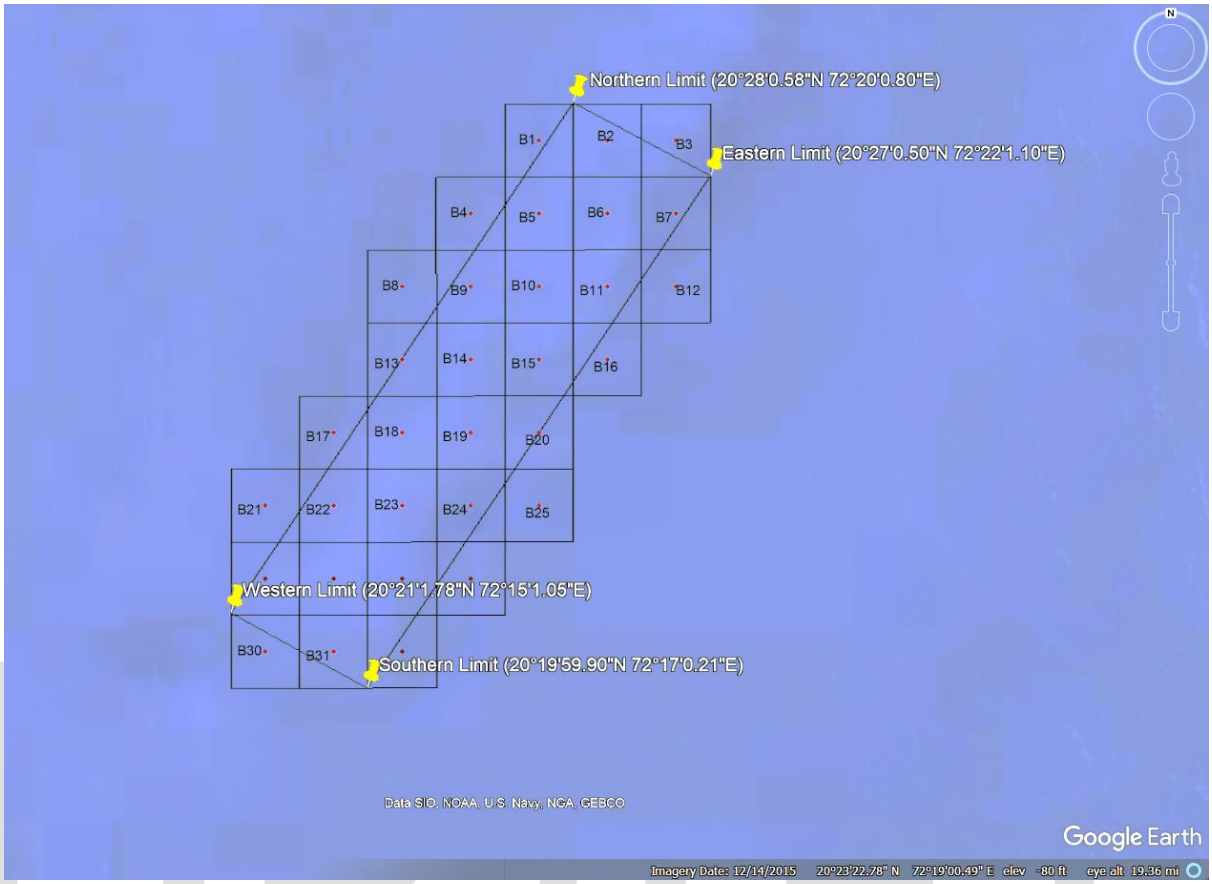
Burrow pit location showing location of port and Daman

Table 1. Details of dredging ground

Location	Geographical Coordinates	
Latitude (N)	Longitude (E)	
A	20°28'08.39"	72°20'42.09"
B	20°27'12.58"	72°22'48.85"
C	20°20'30.87"	72°17'57.66"
D	20°21'25.23"	72°15'51.09"



Applied block of JNPA where dredging proposed (source: JNPA)



Grid designed for carrying out field surveys by ZSI (source: Googlearth)

Table 2. Habitat characteristics (Trawling in the Grid)

Date	Trawl No.	Starting location	Ending location	Apprx. Depth	Bottom feature	Fishing practice
03.10.2023	1	20.42113°N, 72.37343°E	20.43747°N, 72.38538°E	20-22 m	Sandy, muddy	No fishing in the project area, however mechanised boats seen in the periphery at deeper depths.
03.10.2023	2	20.43802°N, 72.38603°E	20.43783°N, 72.40233°E	20-22 m	Sandy, muddy	-do-
04.10.2023	3	20.32582°N, 72.28431°E	20.35170°N, 72.25058°E	20-22 m	Sandy, muddy	-do-
04.10.2023	4	20.39582°N, 72.26431°E	20.35170°N, 72.25058°E	20-22 m	Sandy, muddy	-do-
05.10.2023	5	20.39058°N, 72.35020°E	20.36232°N, 72.35598°E	20-22 m	Sandy, muddy	-do-
05.10.2023	6	20.42448°N, 72.33333°E	20.43421°N, 72.42438°E	20-25 m	Sandy, muddy	-do-
06.10.2023	7	20.32639°N, 72.28333°E	20.35139°N, 72.25000°E	20-22 m	Sandy, muddy	-do-
06.10.2023	8	20.32639°N,	20.35139°N,	20-22 m	Sandy, muddy	-do-

		72.28333°E	72.25000°E			
07.10.2023	9	20.39623°N, 72.42503°E	20.42500°N, 72.41667°E	25-30 m	Sandy, muddy	-do-
07.10.2023	10	20.43333°N, 72.41667°E	20.42517°N, 72.45500°E	25-30 m	Sandy, muddy	-do-

Representative samples of all fauna captured from the trawl nets were collected and preserved using Formalin / Rectified Spirit at the collection location itself and later brought to the laboratory of ZSI for identification and other examinations purpose. Allsamples collected are part of the National Zoological Collections of ZSI and registered properly. The collected samples were identified using standard literature on faunal taxonomy.

Data collection

During the period of survey, a total of 10 trawling effort were made in which fishing was done both in the pelagic and benthic substratum. On-board information collected consisted of date, depth of shooting and hauling of net (5-44 m), geolocation of fishing operation, time of shooting and hauling of net, net type, mesh size (cod end), total catch (kg), total discard (kg) and number of hauls. During analysis, all collected materials including fishes in the sample were identified up to species level. Number of the fishes in the sample and their length weight measurements were recorded. Marine organisms ranging from sponge, crustacea, Mollusca, echinoderms to fishes including sharks were documented from the fishing efforts.

The details of fauna collected from fish trawl is provided in Table xxx.

ZSI Survey Team Off-Daman for data collections

ZSI Survey Team Off-Daman for data collections

ZSI Survey Team Off-Daman for data collections

Survey Team at fish landing site of Dholai Port to collect the fishes data samples

Survey Team Off-Daman for data collections

Trawler Boat 'Balaji Prasanna' on which the survey and data collections made

RESULTS:

Biodiversity of Proposed Burrow Pit - Faunal composition

Fish: A total of 16 fish species belonging to 16 genera, 13 families and 11 orders were caught by 10 hauls of single-day trawlers. In total, Finfishes (10 species), elasmobranch (six species), shrimps (four species), lobster (one species), crabs (11 species), cephalopods (two species) and other shellfishes (14 species of mollusca) comprised the trawl catch.

Family-wise species richness of fish assemblages revealed that the family Synodontidae were dominant followed by Sciaenidae, Engraulidae, Gobiidae and Carcharhinidae. Finfishes from the trawl catches of the Burrow pit were mainly composed of 13 families constituting of 62 to 94% of the total catch. Synodontidae formed 22-76% followed by Sciaenidae (2-22%), Engraulidae (4-17%), Carcharhinidae (1%) and the rest by other families. The non-commercial catch comprises 3 species of Jellyfishes and one species Squilla and two shrimp species and two crab species which constituted about 7-58% of the trawl

catches. Among the catches, Harpadon nehereus contributed maximum catch with size ranges 5.5- 58 cm SL. About 68% of catch *Harpadon nehereus* shows mature individuals with ripe ovaries and few trawls caught 2-3% juveniles with size ranges 5.5 to 7.5 cm SL. This indicates the habitat is a nursery and breeding ground for Bombay-duck. Spadenose shark Scoliodon laticaudus is a common species of small sized shark in the trawler and dolnet fishery along the west cost of India, especillay Mumbai and Gujarat area. A large number of juveniles and mature adults animals in the trawling catches were enumerated. The shark gut shows the presence of Bombay-duck juveniles indicates that the area may be used as feeding grounds for Spadenose shark, which is having high withstanding ability against intensive fishing pressure.

Crustacea:

Mantis shrimp: There are four species of Mantis Shrimp i.e. *Clorida bombayensis* (Chhapgar & Sane, 1967), *Erugosquilla hesperia* (Manning, 1968), *Harpiosquilla harpax* (de Haan, 1844) and *Miyakella nepa* (Latreille in Latreille, Le Peletier, Serville & Guérin, 1828) recorded from west coast of India. Mantis shrimp being non-edible, are neglected group although forms a major portion of the catches, mostly while trawl fishing. They, however, received certain amount of significance in recent years since they started forming good raw material for the production of fish meal, poultry feed and manure, fetching fairly good price. Nevertheles, there were no targeted fishing of mantis shrimp recorded during the surveys.

Prawns/Shrimps: There are atleast 35 species of Decapod Prawns/Shrimps documented from the eastern Arabian sea, belonging to 17 genus and five families. However, among them, five species of shrimps (*Metapenaeus*

monoceros (Fabricius, 1798), *Metapenaeus affinis* (H. Milne Edwards, 1837) *Metapenaeus brevicornis* (H. Milne Edwards, 1837), *Parapenaeus indicus* Crosnier, 1986 and *Parapenaeopsis stylifera* (H.Milne Edwards, 1837) are caught for commercial fishing purpose.

Lobster: There are five species of Lobsters namely *Panulirus polyphagus* (Herbst, 1793), *Biarctus sordidus* (Stimpson, 1860), *Thenus orientalis* (Lund, 1793), *Allogalathea elegans* (Adams, 1847) and *Trapezionida spinulifera* (Miers, 1884) have been documented from the eastern Arabian sea. However, only one species i.e. Spiny Lobster *Panulirus polyphagus* is fished in commercial quantities. The targeted fishing for the species in and around Daman is restricted 5-20 km from the coast and at a verying depth of 20-50 m.

Crabs: Among the decapod crabs, there are 70 species reported from eastern Arabian sea, of which predominantly there are mangrove associated intertidal species. However, several species of crabs are also known to occur in the deeper waters and during the surveys, 11 species of crabs, belonging to eight genera with three families have been recorded of which *Charybdis* (*Charybdis*) *hellerii* (A. Milne-Edwards, 1867), *Charybdis* (*Charybdis*) *lucifer* (Fabricius, 1798), *Portunus sanguinolentus* (Herbst, 1783)*, Portunus segnis* (Forskål, 1775)*,* and *Thalamita crenata* (Latreille, 1829) are known to be commercially exploited. However, crabs are caught in the fishing nets as incidental catch and there is no target fishing for crabs known in the area.

Mollusca: A total of 34 species of mollusca of which 18 species of bivalves belonging to seven families and 17 genus as well as 16 species of gastropods with 11 families and 16 genus have been reported from the project locations.

During the fishing operation, four bivalves, eight gastropods and two species of cephalopods (one species of Cuttlefish and one species of Loligo) have been documented.

Echinodermata: A total of 11 species of Echinoderms have been reported with nine families and 10 genus among which three are starfish, one feather star, two sea urchin and five brittle starfish known to occur in the area. However, during the trawling operation, no species encountered during the fishing operations. Nevertheless, considering the sandy-muddy bottom, their occurrence in the burrow pit site is possible.

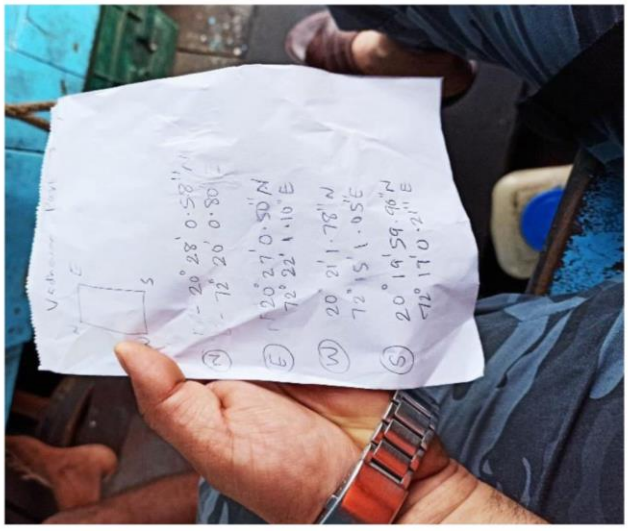
Avian fauna A total of 16 species of birds belonging to 16 genera under eight families and five orders were observed during the offshore surveys. The list is represented by winter migrants including 4 pelagic bird species viz. Arctic Skua or Parasitic Jaeger *Stercorarius parasiticus* (Linnaeus, 1758), Wilson's Storm Petrel *Oceanites oceanicus* (Kuhl, 1820), Bridled Tern *Onychoprion anaethetus* (Scopoli, 1786) and the Common Tern *Sterna hirundo* Linnaeus 1758. Out of 16 species, two species – Gull-billed tern Gelochelidon nilotica (Gmelin, JF, 1789) and Indian Swiftlet *Aerodramus unicolor* (Jerdon, 1840) are categorized in the Schedule- I of the Indian Wildlife Protection Act (2022 amendment) and all the species are listed in the Least concern category of the IUCN Redlist. During the visit to the burrow pit area, three species of birds i.e. Common Tern, Bridled Tern and the Arctic Skua observed very frequently.

M.V. Balaji Prasanna Boat Jetty Site, Daman Port

Boat Jetty Site, Daman Port

Shifting of ZSI team from small boat to Trawler

Approaching the burrow pit site by navigating through GPS



Coordinates for the Survey site in the burrow pit

Boat Crew members releasing the fishing net

Boat crew members hauling the fishing net

Fishing net having collections from the sea

Collections from the fishing net

Segregation of specimens from the collections

ZSI Team noting the data for the sample collected

ZSI team segregating the specimens collected

ZSI Team members weighing the collection

Catch data noting of the sample collected

Crew member segregated specimens

Segregated specimens of fishes and shellfish

Team members inspecting the specimens

Team member inspecting the specimens

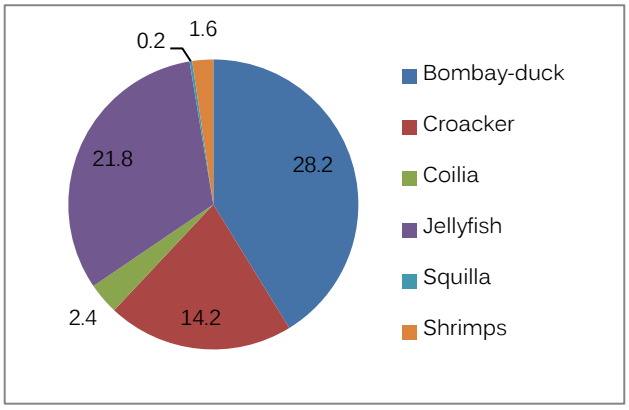
Details of faunal components caughts during offshore surveys conducted in the proposed burrow pit area off Daman in Arabian Sea

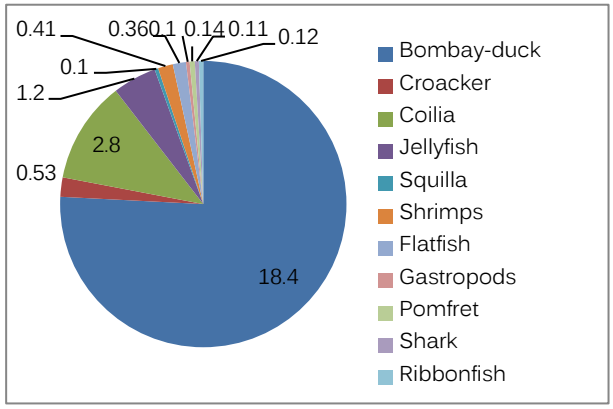
Date	Trawl No.	Apprx. Depth	Groupwise catch (Kg)
03.10.2023	1	20-22 m	Bombay-duck - 28.2 Croacker - 14.2 Coilia - 2.4 Jellyfish - 21.8 Squilla - 0.2 Shrimps - 1.6
03.10.2023	2	20-22 m	Bombay-duck - 18.4 Croacker - 0.53 Coilia - 2.8 Jellyfish - 1.2 Squilla - 0.1 Shrimps - 0.41 Flatfish - 0.36 Gastropods - 0.1 Pomfret - 0.14 Shark- 0.11 Ribbonfish - 0.12
04.10.2023	3	20-22 m	Bombay-duck - 13.21 Coilia - 1.26 Shrimp - 0.92 Crab - 0.83
04.10.2023	4	20-22 m	Bombay-duck - 67.1 Croacker -11.85 Coilia - 8.8 Jellyfish - 42.6 Squilla - 0.1 Shrimps - 2.47 Flatfish - 3.3 Gastropods - 0.1 Pomfret - 1.65 Shark- 0.78 Ribbonfish - 3.85 Crab - 0.55 Juvenile fishes - 2.75
05.10.2023	5	20-22 m	Jellyfish - 134 Bombay-duck - 82.5 Coilia - 14.85 Croacker - 1023 Shrimps - 13.2
05.10.2023	6	20-25 m	Jellyfish - 134

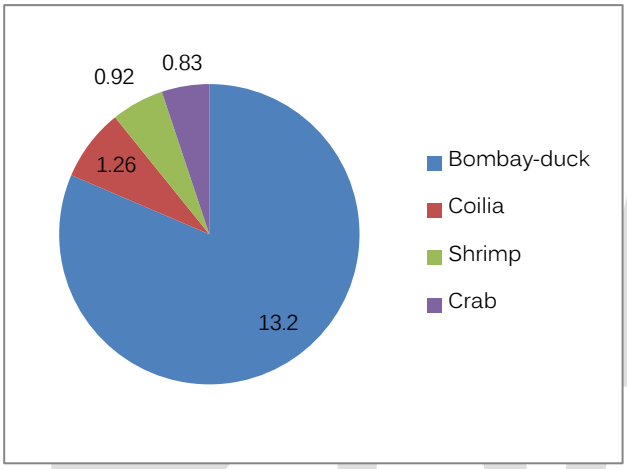
			Bombay-duck - 82.5 Coilia - 14.85 Croacker - 1023 Shrimps - 13.2
06.10.2023	7	20-22 m	Bombay-duck - 3.2 Coilia - 2.5 Shark - 0.1 Rays - 2.3 Shrimps - 1.1 Croacker -3.1 Pomfret - 0.42 Flatfish -0.32 Juveniles - 1.3
06.10.2023	8	20-22 m	Bombay-duck - 6 Coilia - 0.96 Shrimps - 0.75 Croacker -0.5 Pomfret - 1.1 Jellyfish - 0.5 Juveniles - 0.5
07.10.2023	9	25-30 m	Catch not enemurated
07.10.2023	10	25-30 m	Catch not enemurated

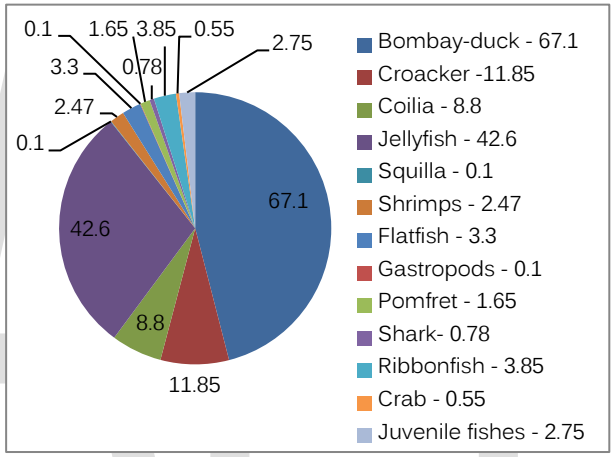
Other than the above, there are atleast three species of sea turtles (Olive ridley, Hawkshill and Green turtles), eight species of seasnakes and 16 species of marine mammals are reported to inhabit in the eastern Arabian sea. During trawling opration, a pod of 5-8 Chinese White Dolphins *Sousa chinensis* seen in the study area but the sighting was only for few minutes on three occasions on separate dates. Hence, marine mammals may be visiting the project area occasionally as there are reports of 11 species of marine mammals in the eastern west coast of India. All the aboves species of turtles, seasnakes an mammals are protected under the Wildlife (Protection) Act, Amended 2022 of Government of India and are also migratory species known for their upward and download migrations in the Arabian sea and to the Indian Ocean.

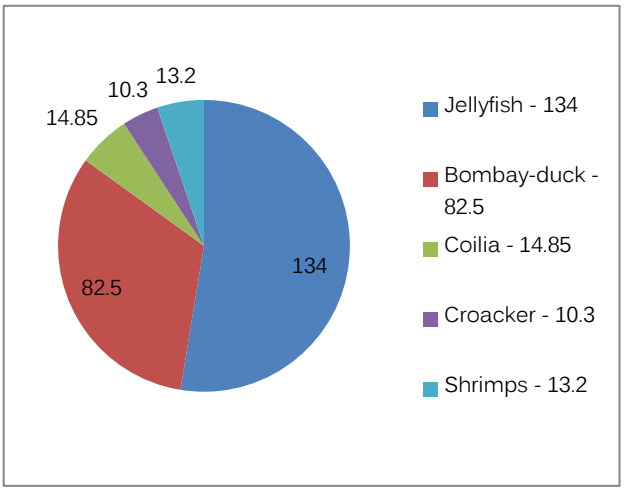
Catch composition from offshore surveys and fishing conducted in the proposed burrow pit area off Daman in Arabian Sea

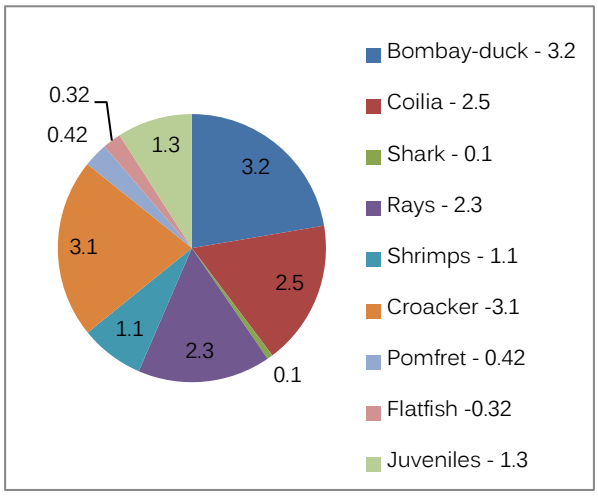


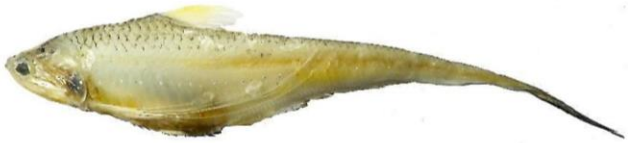












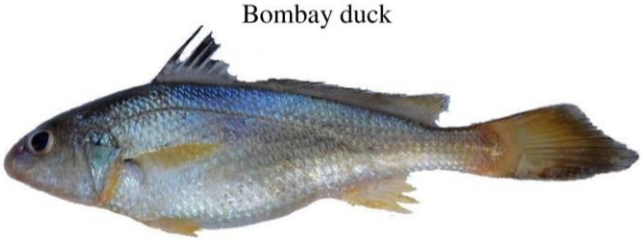
Coilia dussumieri Valenciennes, 1848
Goldspotted grenadier anchovy

Pampus cinereus (Bloch, 1795)
Grey pomfret

Thryssa hamiltonii Gray, 1835
Hamilton's thryssa

Harpadon nehereus (Hamilton, 1822)
Bombay duck

Lepturacanthus savala (Cuvier, 1829)
Savalai hairtail



Johnius carouna (Cuvier, 1830)
Caroun croaker

Cynoglossus arel (Bloch & Schneider, 1801)
Largescale tonguesole

Scoliodon laticaudus Müller & Henle, 1838
Spadenose shark

Chiloscyllium arabicum Gubanov, 1980
Arabian carpetshark

Trypauchen vagina
(Bloch & Schneider, 1801)

Rhynchobatus laevis (Bloch & Schneider, 1801)
Smoothnose wedgefish

Uroconger lepturus (Richardson, 1845)
Slender conger

Common marine crabs (Crustacea: Decapoda) of Daman coast

Tumidodromia dormia **(Linnaeus, 1763) (Dromiidae)**

Ashtoret lunaris **(Forskål, 1775) (Matutidae)**

Matuta victor **(Fabricius, 1781) (Matutidae)**

Schizophrys aspera **(H. Milne Edwards, 1831) (Majidae)**

Enoplolambrus pransor **(Herbst, 1796) (Parthenopidae)**

Halimede tyche **(Herbst, 1801) (Galenidae)**

Charybdis **(*Charybdis*)** ***feriata*** **(Linnaeus, 1758) (Portunidae)**

Charybdis **(*Charybdis*)** ***goaensis*** **Padate *et al.*, 2010 (Portunidae)**

Common marine crabs (Crustacea: Decapoda) of Daman coast

***Charybdis* (*Charybdis*) *hellerii* (A. Milne-Edwards, 1867) (Portunidae)**

***Charybdis* (*Charybdis*) *lucifer* (Fabricius, 1798) (Portunidae)**

***Thalamita crenata* (Latreille, 1829) (Portunidae)**

***Portunus segnis* (Forskål, 1775) (Portunidae)**

***Portunus sanguinolentus* (Herbst, 1783) (Portunidae)**

Other marine crustaceans of Daman coast

Metapenaeus lysianassa **(De Man, 1888)**
(Decapoda: Penaeidae)

Mierspenaeopsis hardwickii **(Miers, 1878)**
(Decapoda: Penaeidae)

Mierspenaeopsis sculptilis **(Heller, 1862)**
(Decapoda: Penaeidae)

Parapenaeus longipes **Alcock, 1905**
(Decapoda: Penaeidae)

Panulirus polyphagus
(Herbst, 1793)
(Decapoda: Palinuridae)

Harpiosquilla harpax **(de Haan, 1844)**
(Stomatopoda: Squillidae)

Oratosquillina interrupta
(Kemp, 1911)
(Stomatopoda: Squillidae)

Common marine molluscs of Daman coast

Turritella duplicata **(Linnaeus, 1758)**
(Gastropoda: Turritellidae)

Tibia curta **(G. B. Sowerby II, 1842)**
(Gastropoda: Littorinimorpha: Rostellariidae)

Neverita didyma **(Röding, 1798)**
(Gastropoda: Littorinimorpha: Naticidae)

Paratectonatica tigrina **(Röding, 1798)**
(Gastropoda: Littorinimorpha: Naticidae)

Bufonaria echinata **(Link, 1807)**
(Gastropoda: Littorinimorpha: Bursidae)

Gyrineum natator **(Röding, 1798)**
(Gastropoda: Littorinimorpha: Cymatiidae)

Common marine molluscs of Daman coast

Babylonia spirata **(Linnaeus, 1758)**
(Gastropoda: Neogastropoda: Babyloniidae)

Nassaria acuminata **(Reeve, 1844)**
(Gastropoda: Neogastropoda: Nassariidae)

Cantharus spiralis **Gray, 1839**
(Gastropoda: Neogastropoda: Pisaniidae)

Indothais lacera **(Born, 1778)**
(Gastropoda: Neogastropoda: Muricidae)

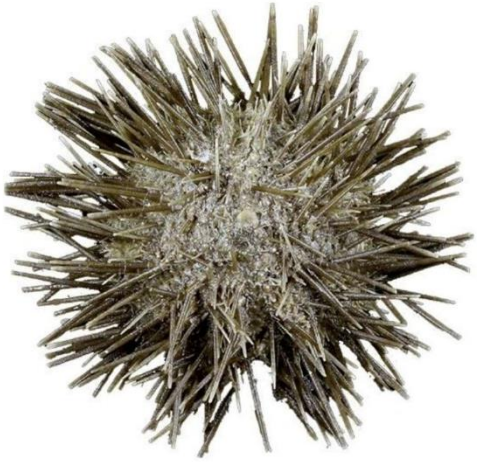
Turricula tornata fulminata **(Kiener, 1839)**
(Gastropoda: Neogastropoda: Clavatulidae)

Murex tribulus **Linnaeus, 1758**
(Gastropoda: Neogastropoda: Muricidae)

Common echinoderms of Daman coast

Aquilonastra burtoni **(Gray, 1840)**
(Asteroidea: Asterinidae)

Astropecten indicus **Döderlein, 1888**
(Asteroidea: Astropectinidae)



Temnopleurus toreumaticus **(Leske, 1778)**
(Echinoidea: Temnopleuridae)

Some of the bird species observed during the Pelagic survey off the coast of Daman

Pastor roseus **(Linnaeus, 1758)**

Larus fuscus **Linnaeus, 1758**

Emberiza buchanani **Blyth, 1845**

Stercorarius parasiticus **(Linnaeus, 1758)**

Saxicola maurus **(Pallas, 1773)**

Onychoprion anaethetus **(Scopoli, 1786)**

Sterna hirundo **Linnaeus 1758**

Marine Mammals (Dolphins) sighted in vicity of the proposed Burrow Pit, Off Daman Coast, Arabian Sea

The project location seemed to be a soft bottom habitat and water was too murky with sandy, muddy subtratum. During the survey, major catch while trawling in the the proposed burrow pit site was Bombay-duck (*Harpadon nehereus*) fish including that of juveniles and therefore, it is presumed to be fishing site for the species, where they may be feeding and breeding. September to January is reported to be more productive, adults predominant over juveniles during fishing along the upper west coast of India. Traditional stationary bag net (dol net), Gill-nets, boat seine and trawls are used for fishing. During the surveys, on an average 10 fishing boats were observed in the vicinity of the study site and these were actively fishing, may be targeting for such fish species in the area.

DISCUSSION

A total of 51 marine species that comprised finfishes, elasmobranch, shrimps, lobster, crabs, cephalopods, stomatopods and other shellfishes were documented by 10 hauls of day trawlers operated off Daman coast and within the proposed burrow pit. Biodiversity in terms of number of species was in the depth range of 20-30 m and poor representation of the faunal groups indicate that the area in not rich or productive. In general, the most common species of fish found in the project location was Bombay-duck (*Harpadon nehereus*). Therefore, the propose burrow pit area is unlikely to be a major fishing ground for commercially viable fishes and shellfishes and in terms of capture fisheries in the Arabian Sea, it is not an important fishing area.

IMPACT ASSESSMENT

Impact on fisheries both in Maharashtra and Daman

The borrow pit is located in deep waters at a depth of 20-25 m which is ~50 km from the Daman coast, where there is no/ minimum fishing activity as

most of the fishing in Daman is carried out in the nearshore waters and targeted at Lobster species *viz*. *Panulirus homarus* and *Panulirus polyphagus*. As such, there that no traditional fishing reported to be carried out in the proposed dredging area. The common marine fishing practices in the region are by set bagnets (SBN) called as '*dol* net and by *'gillnets'* . The fishermen of Daman are reported to use mechanized vessel for deeper water fishing with purse seine mostly targeted pelagic fishes like oil sardine, Indian mackerel, large carangids, Clupeids, Perches, Ribon fish and Pomfrets, occasionally for Seerfish, Tunnies and Crustaceans.

Although the proposed burrow pit area is not a potential fishing ground for such species or other commercially viable fishes, however, the proposed burrow pit being located off Daman and around the project location, there are active fishing grounds, are likely to impact the fishing practices and livelihood of fisherfolks, as this area is reported to be ease fishing area for the fisherfolks of north Maharashra coast and Daman. Therefore, during the sand mining and dredging period, there is likely to be loss of common area and loss of fishing area, although temporary in nature. Further, there will be loss of income and with the decreased fishing areas, there will be chances of increasing conflicts over fishing space. Simultaneously, due to loss of fishing time and increased operating cost (fuel) to reach far fishing grounds and return, there will be economic compression on the fisherfolk depending on this area for fishing as their livelihood. These aspect need to be considered by the proponent for sustainable and alternate ways to compensate.

The environmental impacts of dredging are mainly confined to a radius of a few hundred metres or may even remain restricted to the dredging area. The

main physical impacts of dredging activities relate to removal of sedimentary material, alteration of bottom topography and re-deposition of sediment, both in the directly affected zone and in neighboring areas. Changes in the physicochemical characteristics of the sediment, especially granulometric composition and organic content, cause marked initial alterations in populations (Lopez-Jamar and Mejuto 1988), and may subsequently change the community composition (McCall 1977; Bonsdorff 1983; van Dalfsen et al. 2000). Direct short-term effects of dredging on macrofauna communities are usually a fall in the number of taxa, abundance and biomass (Newell et al. 1998). The capacity of the system to re-establish is very variable and depends, among other factors, on the community type of the affected and nearby areas, on local hydrological and sedimentological conditions (van Dalfsen *et* al. 2000), on the season when dredging is carried out, on its intensity and penetration into the substrate (Kaiser and Spencer, 1996; Pranovi et al. 1998), on the lifecycles and feeding strategies of the species (Lopez-Jamar and Mejuto 1988), and on settlement of larvae and immigration of mobile species (Hall, 1994; Defeo, 1996). The initial recovery is usually rapid and involves opportunistic species, but it may take six months to five years or more for a community to reach “maturity” (Desprez, 2000). Most studies demonstrated a first phase of recolonization of the substrate by opportunistic species, with an initial rise in abundance in the defaunated area after dredging and with low densities later in the presence of other species (McCall, 1977; Lopez-Jamar *et* al. 1995).

There are only few case studies, however in the context of dredging and its impact of marine biota. However, it is to cite here that the Chilika lake, which is largest lagoon of Asia, due to siltation from land drainage getting affected on its depth and salinity and for which dredging is being regularly and aquatic

diversity are reported to have been increasing after dredging of the lagoon. Also, there are Irrawaddy Dolphins (*Orcaella brevirostris*) in the dredging areas and are reported to have no disturbances to them due to the mining of sand and dredging operations and continue to occupying the habitats before and after dredging of sands (Chilika Development Authority, 2002-2012; ZSI study, 2018). Nevertheless, the level of dredging and the quantity of dredged materials may be much lesser than from the burrow pit proposed in the Arabian Sea.

To avoid impacts of dredging on the marine fauna including macrobenthos, certain aspects must be taken into consideration. The type of dredging employed can affect the time course of recolonization. Because most of the macrobenthos lives in the top 30 cm of the sediment, the number of animals removed is directly related to the surface area of extraction (van Dalfsen et al. 2000). Pranovi *et* al. (1998) demonstrated that, with dredging that penetrates only 7-13 cm into the sediment, the fauna can recover after 15 days, but if the penetration is 20 cm, recovery does not start until after 60 days, depending on whether the organisms live on the surface of the sediment or in deeper zones. Therefore, in the present case, the proposed dredging depth may determine the recovery of faunal composition of the area.

The seasonal timing of dredging activities is crucial as their impacts can be minimal or disastrous depending on time. Therefore, periods related to reproduction or larval recruitment (usually monsoon) should be avoided. The least harmful season will usually be the late winter months and early summer.

From ecological and biological point of view, it is naturally expected that biomass will remain reduced, as the fine material will be disturbed (Kenny and

Rees, 1996). Several authors (Desprez, 2000; van der Veer *et* al., 1985; Desprez, 2000; Van Dalfsen *et* al., 2001) have shown that an increase in the sand extraction has been frequently reported and associated with a change in the type of marinelife recolonizing the area. Similarly, where sediments are more heterogeneous and contain pebbles and gravel, biological interactions are likely to play an important role in community formation (Seiderer and Newell, 1999; Van Dalfsen et al., 2001; Newell *et* al., 1999; Newell and Seiderer, 2003). According to these authors, coarser sediments can support a wider variety of species, including those that are epilithic. They are also convinced that it is not surprising that marine fauna shows a stronger relationship with sediment composition in sand-dominated deposits. The same authors then examined recovery rates of benthic communities at a wide range of dredging sites and found that recruitment success was mainly controlled by the ability of sediments to settle after dredging was completed.

According to Hitchcock & Drucker, 1996; Gubbay, 2003), during actual dredging, very fine sand dispersed by dredging and high turbidity is caused by a high content of fine sediments and/or organic particles. These high turbidity levels (or high levels of suspended sediment) can be harmful to fauna due to shading (blocking of sunlight) and burial by suspended sediments released from dredging (Dankers, 2002). This effect only occurs when the turbidity level is significantly higher than the natural variations in turbidity and sedimentation in the area. Filter feeding species appear to be more sensitive than deposit feeders, and larval forms being more sensitive than adults. Many of the species are able to burrow back to the surface following burial (Newell *et* al. 1998). It is observed that sand extraction activity may inadvertently create an abundance of food in the form of damaged animals such as bivalves or crustaceans and that this may

temporarily increase the number of fish and marine mammals present in the area (Rozenmeijer, 1999).

In general, recent studies of filter feeders that live in coastal waters show that they are highly adaptable in their response to increased turbidity such as can be induced by storms, dredging or sediment disposal, and can maintain their feeding activity over a wide range of phytoplankton concentrations and inorganic particulate loads (numerous authors quoted in Newell *et* al. 1998).

The extraction of sea sand has an impact on the flora and fauna of the seabed and that such dredging in the benthic (seabed) zone destroys organisms, habitats and ecosystems and profoundly affects the composition of biodiversity, generally leading to a net decline in the biomass and abundance of fauna or a change in species composition. In contrast, sand dredging could be beneficial for the fishery because most fishermen believe that sand removal in very specific areas of the complex would improve fish reproduction (Djihouessi *et* al., 2017). Nevertheless, further in-depth studies required to be done to examine the environmental impacts of dredging to help decision-makers manage the balance between dredging.

The impact of dredging and mining activities can influence areas outside the immediate boundaries of site, affecting communities differentially. This can be brought about by lateral transport of some of the material by various means *viz*. spillage, current transport etc. In recent years, greater consideration has been given towards identifying mitigation measures to reduce the impact of sand extraction which are translated into appropriate authorized limit. To ensure that such authorization is effective in minimizing environmental disturbance and that

predictions regarding the extent and significance of effects are sound, a monitoring programme warranted for the area. Monitoring is required to document both pre and post-extraction conditions at the project site and to determine whether unacceptable impacts are occurring, or if conditions that could lead to an unacceptable impact are developing, within and in the vicinity of site. Monitoring will also be appropriate to determine whether authorization is being properly implemented, and to improve the basis on which future dredging applications are assessed by improving knowledge of field effects.

The impact due to dredging and sand mining on biodiversity of the area are broadly as below.

Impact 1: The effect of increased turbidity levels on primary production

Increased SS levels will possibly have a moderate negative impact on localised (dredging site) primary production over the short term. This will have the effect of a chain reaction with regards to the foodweb, but based on the small area of the site in relation to eastern Arabian Sea, any impact can be considered to be of LOW significance.

Impact 2: The effect of increased turbidity levels on the fish community

It is possible that aspects such as breeding, hatching rates, larval survival, feeding and escape responses may be affected by the turbidity levels. The absence of rare or endangered endemic fish species in the vicinity of the disposal site, means that impacts that may occur would be moderate, localised, short term and of LOW significance.

MITIGATION AND MANAGEMENT

Measures to minimize the impact on dredging / sand mining during operational phases

There are no practical mitigating measures which could be implemented to impact levels at the dredging / sand mining site. However, at the outset, there should be a comprehensive Environmental Management Plan (EMP) in place both during the operation phase for the dredging / sand mining activities in the proposed burrow pit.

The following recommendations to minimize and mitigate the impacts.

(1) Dredging of immediate offshore bottoms as well as shallow estuarine habitats

Dredging activities in proposed burrow pit area during the sand extraction phase will apparently destroy the seabed. There are few studies on the effects of dredging that can be attributed entirely to dredging activities in isolation. However, avoidance of breeding season for fishes and shellfishes will be beneficial, and minimizes large-scale losses of species, as will minimizing dredging-related sedimentation around feeding and breeding as well as sensitive habitats used by marine fauna. Also to minimize the impact on benthic biodiversity of the area, it is suggested that dredging activities may be conducting mostly during high tide of 4-6 hours window.

(2) Pollution Control

Serenity of the dredging area to be maintained and it should be totally free from solid waste and any other form pollutants emanating through vessel movement as well as onshore, offshore operations. The Environmental Management Plan should empathetically cover this aspect while designing for

the construction and even during operation of the sand mining activities.

(3) Temporary halting of dredging / sand mining activities

During the dredging / sand mining activities, it is suggested to halt to the possible extent especially during monsoon which is active breeding and spawning period for many marine organisms. Activities as far as possible to be avoided during night hours which will pave a movement of turtles, dolphins and other nocturnal fauna may be using this shallow area their feeding, breeding and roosting.

(4) Reduction of underwater noise pollution

The main sources of underwater noise pollution are shipping, dredging, and seismic surveying. Measures to reduce the noise from shipping vessels include modifying propellers and/or hulls and performing regular maintenance, vibrationally isolating machinery, implementing ship speed restrictions and incentivizing the use of fewer, larger vessels etc. These measures should be the part of the approval process while allowing the ship to enter into the burrow pit exaction area.

As per the recent study of Indian Institute of Technology, Madras for the proposed burrow pit, as the marine burrow pit location far away from the coastal region approximately 50 km to 60 km with high tidal range and associated strong currents, the concentration of the sediment plume gets weakened immediately during the dredging activity. The model simulation shows that the turbid plume does not reach the shore.

Based on the above scenarios, it can be observed that, the plume

trajectory of the dredged sediment does not move towards the coast, and they appear not to cause any impact on the shore and the marine environment. Therefore, the impact should be temporarily in nature during the dredging and sand mining operation and also restricted to biodiversity of proposed burrow pit area, which is expected to recovered within six month to five years period.

RECOMMENDATIONS

On the thorough scrutiny of the project facilities, baseline data collected on the faunal diversity of the proposed burrow pit in the Arabian Sea off Daman coast, and also, positively considering the envisaged benefits of the proposed project (The Vadhavan has a natural draft of ~20 m and has Port has potential to be among the Top 10 Container Ports in the World. The Vadhavan Port will add container capacity of 15 Million to ~23.2 Million TEUs. It will reduce logistic cost and provide hinterland connectivity through Mumbai Delhi western railway line at a distance of 12 km and Natioanl Road Grid NH-8 is about ~33.6 km), Marine Borrow Pit for Sand Mining from the proposed site off Daman in the Arabian Sea are recommended in view of the following reasons.

1. The proposed activity is the only environmentally feasible proposal as huge amount of sand required for reclamation location offshore in Dahanu within protected bunds and use of sea sand is most environmentally sustainable.

2. The proposal is for making burrow pit in Arabian sea for dredging/ sand mining for the development of the port, the environmental impact is presumed to be temporary in nature and naturally be restored and marine creatures will adopt to the location as soon as the dredging and mining activities are completed.

3. There is no significant nesting / breeding grounds and roosting ground for any endemic or threatened marine species including turtles, dolphins, pelagic or shorebird and fishes etc. reported and or observed in the proposed project areas. Nevertheless, there may be stray movement of turtles and dolphins as are they are reported in the eastern Arabian sea. As these animals are highly mobile, translocation of the habitat may be a feasible solution, if encountered during dredging and sand mining operations and they can be relocated to safe and suitable places. Also, although the proposed site falls under the migratory route of the birds, since there is no land mass for roosting/ resting of birds transit during their flying close to the proposed burrow pit, the impact on migratory birds very unlikely.

4. The assessment of the present study revealed out the environmental impact through the proposed project that coule be recorded and which can be managed sustainably to restore the pristine ecosystem though proper conservatory measures.

5. It is suggested that second year of operational phase of the project, baseline data on the status of faunal communities may be collected which will be helpful to assess the environment in the project site.

6. A state-of-art research Institutes/ laboratory should be developed in the proposed project area with the consultation with expert scientists to monitor the ecosystem with greater emphasis on breeding grounds for fishes and shellfishes, their health and population status.

7. Suggested mitigation measures should be followed rigorously in order to safeguard the marine life as well as their feeding, breeding and migratory path and future survival.

8. The suggested environmental management plans may be strictly followed.

References