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BIODIVERSITY ASSESSMENT OF DHAMRA PORT SITE AND SURROUNDING AREAS, ORISSA

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Report commissioned by Greenpeace and prepared by the North Orissa University

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Foreword	4
1 Executive Summary	5
2 Introduction	10
2.1 Study Area	
2.2 Objectives	
2.3 Methodology	
3 Findings	14
3.1 Mammals	
3.2 Avifauna	
3.3 Sea Turtles	
3.4 Snakes	
3.5 Amphibians	
3.6 King Crabs	
3.7 Ichthyofauna	
3.8 Flora	
4 Impacts of Port Construction	29
4.1 On Port Site and Immediate Surroundings	
4.2 On Marine Diversity	
4.3 On Gahirmatha Marine Sanctuary	
5 Recommendations	32
Appendices	33



FOREWORD

The Dhamra port is being projected as one of the largest in India and South Asia by the time it is commissioned. Given its location near the Bhitarkanika National Park and Gahirmatha Marine Sanctuary, there have been concerns raised for almost a decade now on the possible harmful impacts that the port's construction, operation and the ancillary development it spawns, will have on the environment, ecology and wildlife of the region.

Orissa is one of India's richest states in terms of biodiversity. It is also among the least studied and catalogued. There is a severe paucity of reliable base line scientific data of the ecological worth of the region in and around the proposed Dhamra port. Even the Environment Impact Assessment report that has been conducted for the project in 1997 contains insufficient and inaccurate data. Given that the project is being implemented despite this shortage of information, the need was felt for an independent and reputable scientific biodiversity inventory, to provide base line data on the area.

Greenpeace has serious concerns about the massive industrialization planned for Orissa's coastal areas, particularly as such development is proceeding in the absence of reliable data on the environmental and social implications. With this in mind, Greenpeace approached the North Orissa University to conduct a rapid biodiversity assessment or inventorisation of the Dhamra port site and its surrounding areas. The results validate the concern that has been expressed over the possible and probable implications of the project and make it clear that the project cannot go ahead, particularly given the absence of a comprehensive, impartial and scientifically reliable Environment Impact Assessment.



EXECUTIVE SUMMARY

section 1

The state of Orissa has a coastline of 480 km., and one of the most dynamic coastal environments in India due to its location, and physical factors especially its network of large, powerful rivers with their delta and estuarine systems, each with a variety of ecological niches and habitats. The coastline traverses six coastal districts of Orissa, viz. Balasore (80 km.), Bhadrak (50 km.), Kendrapara (68 km.), Jagatsinghpur (67 km.), Puri (155 km.) and Ganjam (60 km.).

This study is concerned with the Dhamra port site in Bhadrak district, near the mouth of the Dhamra river, and surrounding areas. The town of Dhamra is a small business centre with a fishing jetty and trawler base. The proposed port site is nearly 10 km. away from Dhamra town. The port site is located on the mainland, north of the Dhamra River mouth and west of Kanika Sands. The Dhamra river itself is formed by the confluence of the Brahmani and Baitrani rivers. Dhamra discharges to sea through two distinct river channels, a north and a southern channel, which are further separated by an island in the sea named Udabali or Kanika Sands.

The proposed port site is a unique habitat in that it has long stretches of inter-tidal mudflats from the site up till the river mouth. The inter-tidal zone is in some places as wide as two kilometers, and serves as an important breeding ground for king crabs.

The port will be about 13 km. away from the nesting beaches of the Gahirmatha Marine Sanctuary. The port will also lie less than 5 km. from the northern boundary of the Bhitarkanika Sanctuary. The Dhamra port is proposed to be one of the largest deep water ports in India and South Asia, with a total capacity of 83 million tonnes per annum within ten years. It would require the construction and maintenance of a 19 km. long approach channel up to a depth of 18 m. It will be located at approximately 20°50' N and 86°58' E on the Orissa coast of the Bay of Bengal.

Given the size of the port and the broader plans for industrialization of the area following the port's development,



MORE THAN 22 SPECIES OF CRABS
HAVE BEEN IDENTIFIED FROM THE
DHAMRA AREA

concerns have been raised in various quarters about the possible impacts on the environment, biodiversity and wildlife in the surrounding areas, particularly given the site's location in an ecologically sensitive zone on the border of the Bhitarkanika and Gahirmatha Sanctuaries. However, while there has been much public debate and conjecture, there has been hitherto little or no reliable scientific data on which to base claims of potential damage or otherwise.

The rationale for the study arose from the complete paucity of scientific information on the area in question, particularly with regard to its biological values, species found in the area and the overall ecological significance of the area and its surroundings. However, given limited resources, the study could not be as detailed and comprehensive as the Principal Investigators would have liked. It is thus more in the nature of a rapid inventorisation of the area. It is the opinion of the study's authors that given sufficient time and resources, a more thorough study would yield even more significant data in terms of biodiversity and the ecological value of the area.

The rapid biodiversity assessment was conducted from February 10 to March 22, 2007, to gather information about the present diversity of flora and fauna of the area. In order to gather a quick snapshot overview of these aspects, the following were agreed on as key indicators:

1. Documentation of biodiversity of the port site and surrounding areas, including Kanika Sands, via an inventorisation of flora and fauna.
2. Regular monitoring of the fish catch and documentation of other marine creatures like mollusc, crab, and fish diversity over the period of research.
3. Documentation of mangrove species.
4. Collection of primary and secondary information on the movement of sea turtles, dolphins and any other large sea creatures in the offshore area.

The areas surveyed were along the coast from Chandnipal point north to and including the port site, the island of Udabali / Kanika Sands near the river mouth and the offshore waters. The northern most coordinate of the study area was

20°50'07" N and 86°57'47" E and the southern most coordinate was 20°47'08.70" N to 86°57'28.12" E.

Given resource and time constraints and bad weather conditions, rigorous monitoring of the offshore waters was not possible, but certain sightings in offshore waters are indicative and reinforce the need for a more comprehensive study.

KEY FINDINGS

The study has thrown up several animal and plant species that had not yet been reported from the area, or the state. There were even some species that were the first records for mainland India as a whole.

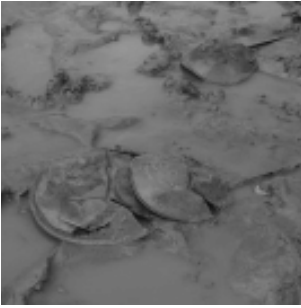
1. Sea Turtles

This part of the Orissa coast is famous for its marine turtle concentrations from November to April. The main nesting beaches at the Gahirmatha Sanctuary are about 13 km. from the port site (straight line distance). This is the largest nesting beach in the world for Olive Ridley Sea Turtles, with between 100,000 to 300,000 turtles nesting there every year. During the course of the study, a total of 2,019 turtle carcasses were recorded along the coast from Chandnipal up to and including the port site itself and on Kanika Sands. While some of these turtles may have been killed in Gahirmatha, it is highly



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TURTLE CARCASSES AT THE PORT SITE



MATING HORSESHOE CRABS IN THE STUDY AREA.
OVER 1,300 TRAPPED HORSESHOE CRABS WERE
RECORDED, INDICATIVE OF THE AREA'S IMPORTANCE
FOR THE SPECIES.

probable that most of the carcasses are of turtles killed in the offshore waters north of the river mouth and north and east of Kanika Sands, that is, off the port site. A survey of the coast further north of the Dhamra port site could possibly yield even more turtle carcasses. Further, anecdotal accounts from local fishermen and researchers confirm that during the months of November to January, mating turtles and turtle movement is common near the river mouth and northeast of Kanika Sands.

2. Horseshoe crabs

The extensive mudflats in and near the port site appear to be important breeding and spawning ground for the king crab or horseshoe crab, recognized globally as a species of great importance and threatened in many parts of its range. Two species are found in Orissa and both were recorded from the study site, *Tachypleus gigas* and *Carcinoscorpius rotundicauda*. This species is one of the oldest on the planet and is often referred to as a 'living fossil'. The blood of horseshoe crabs is blue, which is a result of a high content in copper-based hemocyanin instead of the iron-based hemoglobin found in humans. These bizarre looking animals with a semicircular cephalothorax and a spine-like tail play a very important role in bio-medical research, due to the extraction of Lysate (Limulus Amoebocyte Lysate) from their blood. Lysate is used to test for bacterial endotoxins in pharmaceuticals and for bacterial diseases. The importance of this habitat for horseshoe crabs can be gauged from the fact that the study team recorded a total of 1,315 individuals trapped in fishing gear. Of these, 602 were on Udabali Island and 638 in Sector IV, the port site itself.

3. White-bellied Mangrove snake *Fordonia leucobalia*

This is one of the most significant findings of the study and is only the second record from the Indian mainland, after the Sundarbans. Both colour morphs (olive green and reddish brown) were recorded from the Dhamra area. The study area yielded a significant population of this species. Considering its rarity, this is a very significant finding and an invaluable addition to the Indian herpetological database and also an indication of how much biological wealth yet remains to be discovered in Orissa.

4. Amphibian fauna

From the 14 species of amphibian species recorded during the study, discovery of *Fejervarya cancrivora* and *Euphlyctis hexadactylus* from Dhamra area are especially significant.

The Crab-eating Frog *Fejervarya cancrivora* is an exciting discovery as this species has hitherto only been recorded from the Andaman & Nicobar Islands in India, and in Southeast Asia. This species was recorded by the study team in the mudflats and creeks in the Dhamra area and on the port site itself. It is a brackish water frog, found exclusively in brackish water systems and estuaries.

5. Dolphins

Though marine monitoring was carried out in a very limited manner (nine trips) due to lack of equipment and resources, as well as inclement weather, dolphin sightings were common on all trips to sea, particularly in the waters north of Udabali Island. The dolphin pods observed usually comprised between 5 to 15 animals. Pictures of these dolphins have been sent to experts for identification. According to the Orissa Forest Department, the dolphins recorded from the nearby Gahirmatha Marine Sanctuary are *Sousa chinensis*, *Orcaella brevirostris*, *Stenella attenuata*, *Delphinus delphis* and *Neophocaena phocaenoides* and these same species are believed to occur in the Dhamra region near the river mouth and off the port site.

There is sufficient scientific evidence that the area in question is ecologically significant. Protecting and preserving this area requires certain measures, both on a macro and a micro level. The recommendations have been discussed in more detail on page 32.

Given the results of this short study, Greenpeace is demanding that the area be protected and preserved. This *inter alia* implies that no mega industrial or infrastructural project should come up in, or in the close vicinity of, the study area. This would mean that the mega-port project being executed by TATAs and Larsen & Toubro be dropped immediately and that further measures be taken to protect the area in question.

INTRODUCTION

Orissa is an important maritime state located on the eastern coast of the Indian Peninsula. The coastal zone in Orissa is amongst the most dynamic of India's coastal environments, due to its critical location as well as physical, biological and oceanographic processes. Due to a multitude of large rivers and dynamic estuarine areas, the 480 km. coastline supports a variety of ecological niches and habitats. Orissa's coastline stretches from near Udaypur village bordering West Bengal to the marshy areas bordering Ichhapuram in Andhra Pradesh. The coastline traverses six coastal districts. The major and minor rivers of Orissa, which drain into the Bay of Bengal, are the Subarnarekha, the Budhabalanga, the Brahmani, the Baitarani, the Hansua, the Mahanadi, the Devi, the Kadua, the Kushabhadra, the Rushikulya, and the Bahuda. The coastline of Balasore and Bhadrak district is concave in shape, stretching from Subarnarekha river mouth up to Dhamra river mouth; whereas the central portion of Orissa coast from Dhamra river mouth up to the coastline of Chilika lagoon bulges out with the Bramhani, Baitarani and Mahanadi river systems dominating the geography. From the Pleistocene a sequence of changes have taken place in these deltas through appearance and disappearance of distributaries, channels, lakes, sand bars, tidal flats, beaches and offshore islands (Patnaik *et al*, 2001).

STUDY AREA

Dhamra is approachable from Bhadrak town by road towards Balasore on the NH 5 and 60 km. from Jamjhali (20 km. away from Bhadrak). The small town has developed as a business centre and fishing jetty of the area. The proposed port site is approximately 10 km. away from the Dhamra village. The proposed site for Dhamra port, along the mainland north of the Dhamra River mouth and west of Kanika Sands, is located about 13 km away from the nesting beaches of the Gahirmatha Marine Sanctuary in a straight line. It falls along the extremely important and fragile zone of Northern boundary of Bhitarkanika National Park.

The Brahmani and Baitarani rivers meet and form the Dhamra river, which then flows into the Bay of Bengal, forming an estuary. The area is characterized by alluvial silt

deposits due to regular tidal inundation and high detritus content. The soil consists of clayey loam with sand and a humus layer on top. The mangroves support land accretion, slow down erosion and absorb nitrates and phosphates preventing contamination of shore waters.

The development of this major deep water port facility at Dhamra would require the dredging of a nearly 19 km-long approach channel, aside from land-raising and construction activities on land.

The Dhamra port will be located at approximately 20°50' N and 86°58' E on Bay of Bengal, north of Dhamra river. The Dhamra river is formed after the confluence of river Brahmani and Baitarani. Near the mouth, the river is split for 8 km. of its length by an Island named Kalibhanjadiha. Dhamra discharges its water to the sea through two distinct river channels, a north and a southern channel, which are further separated by an island in the sea called named Udabali or Kanika Sands. River water is discharged primarily from the south channel.

The proposed port at Dhamra envisages:

- Building of 13 berths
- Mechanized loading and unloading
- An entry channel from the North
- The port will be one of the largest on the east coast of India with the ability to handle Cape size vessels (up to 180,000 tonnes)
- The port will require dredging a 19 km. long channel through the sea with a draft of 18 m.

The proposed Dhamra port will come up on an extensive mudflat habitat, which extends from the river mouth northwards. A number of narrow water channels dissect the river bank. The inter-tidal zone is almost 2 km. in some places. This long mudflat is an important habitat for a variety of organisms and an important breeding ground for king crabs or horseshoe crabs. The study area comprises largely of these mudflats, together with scattered mangrove and littoral salt bush-formation. The inter-tidal zones host diverse residential

as well as migratory birds, along with an uncommon assemblage of herpetofauna. The mangrove formation on the Udabali Island is divided into that on the outer and inner estuarine bank, with the pioneer trees *Avicennia alba* and *A. marina*. The flora includes many mangroves, e.g. *Avicennia officinalis*, *Excoecaria agallocha*, *Heritiera fomes*, *Rhizophora mucronata*, and *Heritiera littoralis*. The noteworthy herpetofauna of the area are a variety of brackish water snakes and the brackish water frog species *Fejervarya cancrivora*.

PRIME OBJECTIVES

1. Documentation of biodiversity of the area.
2. Documentation of the mangrove species.
3. Monitoring of the fish catch and documentation of other marine creatures like mollusc and crab species.
4. Status evaluation of the Olive Ridley sea turtles and other mega marine creatures in offshore waters.
5. Collection of secondary information on the movement of sea turtles and other sea creatures in the offshore waters.

METHODOLOGY

A rapid biodiversity assessment was conducted along the Dhamra river mouth area, from February 10 to March 20, 2007, to gather information about the diversity of flora and fauna of the area. The area surveyed was along the coast north of the Dhamra river mouth, the island of Udabali/Kanika Sands near the river mouth and, to a limited extent, the offshore waters. The study can be broadly divided into three parts; viz. onshore study, market survey and offshore study.

The onshore study was carried out by walking along the shore northwards from the Dhamra river mouth (Chandnipal) to the northern edge of the port site, and along the bank of the Udabali Island or Kanika Sands, to document the vegetation, species distribution and other relevant information regarding the marine animals, e.g., documentation of dead animals on the shore. The study was also supported with photo documentation and analysis of water and soil samples from various localities of the area. Animal sightings and their habitat were marked on Google Earth maps.

For convenience the main land is divided into 5 sectors as follows:

Sector I: Defense establishment at Chandnipal to the 1st creek
20°47'08.70" N, 86°57'28.12" E,
20°48'10.04" N, 86°57'53.96" E

Sector II: 1st creek to 2nd creek, north of Sector-I
20°48'10.04" N, 86°57'53.96" E,
20°49'02.34" N, 86°57'58.07" E

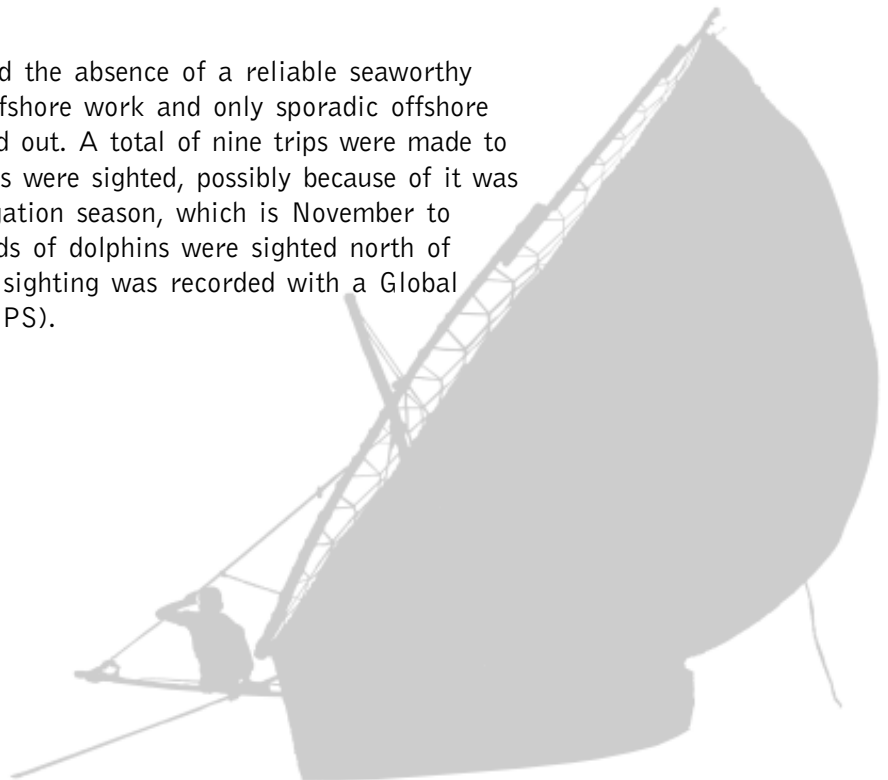
Sector- III: 2nd creek to 3rd creek further north of Sector-II
20°49'02.34" N, 86°57'58.07" E,
20°49'14.97" N, 86°58'02.94" E

Sector- IV: 3rd creek to Balisahi (the starting point)
20°49'14.97" N, 86°58'02.94" E,
20°49'56" N, 86°57'54.76" E

Sector- V: From Balisahi north
20°49'56" N, 86°57'54.76" E,
20°50'07" N, 86°57'47" E

The market survey was aimed at documentation of fish and crab diversity caught by the fishermen of the area in offshore waters.

Inclement weather and the absence of a reliable seaworthy vessel hindered the offshore work and only sporadic offshore monitoring was carried out. A total of nine trips were made to sea. No live sea turtles were sighted, possibly because of it was past the peak congregation season, which is November to January. However, pods of dolphins were sighted north of Udabali Island. Each sighting was recorded with a Global Positioning System (GPS).



FINDINGS

Due to rampant trawling in offshore waters, dead sea creatures such as turtles and dolphins are found along the shore. The onshore study encompassed documentation of such dead animals. During the study it was observed that Dhamra coast and the Udabali Island recorded a significantly high number of dead turtles in Orissa, with thousands of carcasses scattered along the shore from Chandnipal to Kainthakhola and on the Eastern and Northern bank of Udabali Island. Further, very few of the carcasses had been numbered or marked by the Forest Department and so they are probably not being included in the turtle mortality statistics for the year. As Dhamra is not a Protected Area, it is possible that less attention is paid to documenting mortality of turtles and other endangered animals in this area.

During the biodiversity inventory along the mainland from the Dhamra river mouth to the proposed port site and on Udabali Island, several animal and plant species were observed that have thus far not been reported from the area or elsewhere in the state. The study gave an insight into the possible and probable threats to some endangered and lesser known species inhabiting the proposed port area and its immediate surroundings. The significance of the mudflat along the Dhamra river mouth and Kanika Sands was analysed. This is an important breeding and spawning ground for many species of fishes and, significantly, King crabs or Horseshoe crabs. Thousands of Horseshoe crabs were found caught in stake nets in the inter-tidal zone, indicating that the species thrives in this area. Out of the two species of Horseshoe crabs found in Orissa, both *Tachypleus gigas* and *Carcinoscorpius rotundicauda* were recorded by the study team. The study team personally observed thousands of horseshoe crabs caught in the nets, many of which would have died. While they are not a targeted catch, the crabs were not released from the nets either.

The mudflats along the sea shore north of the river mouth were found to be an excellent habitat for several species of snakes and frogs. During the study, an exciting discovery was made of a brackish water snake species, the White-bellied Mangrove

snake *Fordonia leucobalia*. This is the first record of this species from Orissa and from mainland India.

MAMMALS

Dolphins inhabit the Dhamra river mouth and surrounding waters and sightings are very common north of Udabali Island. Pods of dolphins were observed during the offshore study, comprising of five to fifteen animals in each pod. The study team also came across five fresh dolphin carcasses in different localities during the study period. Identification was difficult due to decomposition but photographic identification by experts is being attempted. According to the Orissa Forest Department, the dolphins recorded from the nearby Gahirmatha Marine Sanctuary are *Sousa chinensis*, *Orcaella brevirostris*, *Stenella attenuata*, *Delphinus delphis* and *Neophocaena phocaenoides*, and it is probable that most or all of these species are also found around the Dhamra river mouth. The deep water channel near Udabali appears to be a favoured foraging ground for these marine mammals, at low-tide. Mechanized fishing boats are a threat to the dolphins. The study team recorded five dolphin carcasses on the shore during the study period, three of them on Kanika Sands and the others on the mainland. Locations of the carcasses found are given in the following table.

	Date of observation	Locality
1	11.2.2007	Sector-IV
2	18.2.2007	Udabali
3	18.2.2007	Udabali
4	18.2.2007	Udabali
5	9.3.2007	Sector-I

During the survey live dolphins were sighted at the following locations:

20°50'01.83" N, 86°59'48.72" E

20°51'34.34" N, 87°00'36.56" E

20°51'18.99" N, 87°00'24.80" E

Among terrestrial mammals Jungle cat (*F. chaus*), Palm civet (*Paradoxurus hermaphroditus*), Small Indian Civet (*Vivericula indica*), Jackal *etc.* are common near the port site and in surrounding areas.

The presence of wild boar (*Sus scrofa*) and chital (*Axis axis*) on Kanika Sands is an interesting phenomenon. While the manner in which these animals have arrived on the island is unclear, it is possible that animals that were washed away in floodwaters by the Dhamra, Baitrani and Brahmani rivers managed to swim to the island.

The list of mammals observed is given in Appendix I.

AVIFAUNA

Ninety species of birds, both resident and migratory, were recorded from the study area. Since this was a rapid study over one month, an annual bird count in different seasons will yield a significantly higher bird list. The plentiful availability of food in the extensive mudflats from Chandnipal point to the port site attracts a variety of birds.

Five species of kingfishers: Black-capped Kingfisher, Common Blue Kingfisher, White-throated Kingfisher, Pied Kingfisher and Collared Kingfisher are sighted in the Dhamra area.

The mudflats adjoining the river mouth harboured large numbers of waders, particularly Lesser Sand Plover, Kentish Plover, Little Stint, Curlew, Whimbrels, Sandpiper, Red Shank, Green Shank and Egrets, especially during low tide. Among the raptors Black-shouldered Kite, Black Eagle, Brahminy Kite, Short-toed Serpent Eagle were observed near the estuary during the study period. Egrets like Cattle Egret, Intermediate Egret and Little Egret, Pond Heron, Little Grey Heron etc. are observed. Flocks of Indian Grey Hornbills were also sighted flying over Udabali Island.

The entire list of birds recorded in the study area is given in Appendix II

SEA TURTLES

The Dhamra port site is located about 13 km. away from the Gahirmatha Marine Sanctuary, the largest sea turtle rookery in the world. Hundreds of thousands of sea turtles are attracted every year to the offshore waters of Gahirmatha for mating and nesting. From anecdotal records and reports from the fishing community, congregation and mating pairs of sea

turtles are observed up to 6 km. out to sea from the proposed port site during the peak turtle season. Local people, fishermen and forest department staff confirm turtle movement around the Dhamra river mouth during the peak congregation season (November-January). In 2006, Greenpeace documented mating pairs and lone turtles at the river mouth as well.

This year, the turtle casualty of Dhamra area has exceeded 2,000 until March 20, 2007. While some of these turtles would have been killed in Gahirmatha, many carcasses would be of turtles killed in the offshore waters north of the river mouth and north of Kanika Sands, that is, off the port site. The dead turtle count during February and March at Dhamra is given in the following table. Care was taken to count fresh carcasses and old carcasses and degraded carcasses to estimate death toll during the previous months.

No.	Date	Area	Turtle carcasses		
			Degraded	Fresh	Total
1.	11.02.2007	Sector- I	165	22	187
2.	16.02.2007	Sector-II	97	13	110
3.	15.02.2007	Sector-III	38	4	42
4.	13.02.2007	Sector-IV	254	39	293
5.	22.02.2007	Sector-V	25	3	28
6.	18.02.2007	Udabali	1022	337	1359



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OVER 2,000 DEAD TURTLES WERE RECORDED ON AND NEAR THE PORT SITE. THIS INDICATES THAT TURTLES DO INHABIT THE OFFSHORE WATERS IN LARGE NUMBERS



THE DOG FACED WATER SNAKE, ONE OF SEVERAL SNAKE SPECIES RECORDED FROM THE AREA.

SNAKES

A number of snake species were observed during the study period, which includes brackish water species and marine snake species. Several species of terrestrial snakes were also encountered during the survey. The mudflat of Dhamra bank near its mouth is itself a very good habitat for the brackish water snake species. Among the brackish water snakes, a good population of Dog faced water snake, *Ferdonia Leucobalia*, Glossy Marsh snake and File snake were observed in the small *nallahs* draining to the river. These species of snakes are also regularly caught in the fishing nets near the bank. The checklist of the herpetofauna given in Appendix IV shows the presence of some of the unique and common snakes in the area. The locations where brackish water snake species including the rare *Ferdonia Leucobalia* were recorded is as follows:

- 20°49'14.25" N, 86°58'03.01" E
- 20°49'02.04" N, 86°57'57.51" E
- 20°48'10.37" N, 86°57'53.57" E

Species level description of some brackish water snakes of significance:

Dog Faced Water Snake *Cerebrus Rynchops*

Status: Schedule II of Wildlife (Protection) Act 1972, due to large-scale mortality in fishing nets.

Description: Body thick and stout, strongly-keeled scales. Neck distinct, eyes and nostrils placed high above on head. Body colour grey/ olive or brown with darker cross bars mostly prominent in case of juveniles, belly scales with dark checkered pattern.

Habitat and Natural history: This species is found in crab holes, in intertidal mudflats, mangrove swamps and some times in agricultural fields near estuary areas. These snakes are active during both day and night. Mating or feeding was observed during the day time, and during the night hours the individuals are seen with their heads sticking out from crab holes near the shore line. These snakes are often caught in fishing nets, hence the local

name *Jala-ganthia* in Orissa. Fishing leads to a high mortality rate near the shoreline.

Distribution: India: throughout the Indian coast, including Andaman and Nicobar Islands. Elsewhere: Bangladesh, Pakistan, Srilanka, up to Australia.

White-bellied Mangrove snake *Fordonia leucobalia*

Status: Very little is known about the status of the species. This is only the second record from India and the first photographic record. The species is listed in Schedule IV due to a lack of knowledge of its status. Recorded by the study team in Sector II, III and IV, which includes the port site.

Description: Body thickly built, with round head, neck slightly distinct, eyes with round pupil, tail shorter and prehensile. Body colour reddish-brown, dark lead-gray, olive or greenish, sometimes with small black spots. Belly scales pure white or yellow (two colour-morphs, olive green and reddish brown are observed in Dhamra Estuary).

Habitat and Natural history: Mostly active during evening hours and night, they are usually seen with the anterior part of the body out from the holes near creeks in mudflats. The prehensile tail allows them to cling to the crabs holes and prevent them from being washed out by the tidal flow. In one instance an individual was seen feeding in this position.



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THIS IS ONLY THE SECOND RECORD OF THE WHITE-BELLIED MANGROVE SNAKE *FORDONIA LEUCOBALIA* FROM THE INDIAN MAINLAND

One or many individuals are found in the same hole. They eat fish, frogs and crustaceans. Individuals are inoffensive and not very active, even when handled.

Distribution: India: This is only the second report of the species from mainland India, after the Sundarbans. It has also been reported from the Andaman and Nicobar Islands.

Elsewhere: most of Southeast Asia.

Glossy Marsh Snake *Gerarda Prevostiana*

Status: Uncommon. Common in the study area.

Description: Body cylindrical, neck slightly indistinct, tail short and pointed. Dorsum are uniform gray, brown or olive with pure white or yellow lateral stripes emerging from the lip to the tail tip on both sides. Ventral region is grey in colour with white outer edges.

Habitat and natural history: Inhabits estuaries, mangrove swamps and coastal areas. Sometimes caught in fishing nets near the shore. Feeds on fish, crustaceans, shrimps and marine creatures.

Distribution: India: through out the coastline and tidal rivers. In Orissa, earlier studies confirm its distribution in the Rushikulya river mouth. Elsewhere: Bangladesh, Myanmar, Sri Lanka, Malaysia and Thailand.

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THE GLOSSY MARSH SNAKE
GERARDA PREVOSTIANA, AN
UNCOMMON SPECIES, SEEN
HERE SUBMERGED IN THE MUD



File Snake *Acrochordus Granulatus*

Status: Uncommon. Common in the Dhamra river mouth region.

Description: Body stout, with rough scales, giving its name as file snake. Neck is not distinct, skin loose and highly elastic body. Tail shorter and slightly flattened. Body colour gray with alternate fade cross bands, forming rings. Juveniles brilliantly coloured and bands are prominent, where as adult colouration may change. Grows up to 45 inches long.

Habitat and natural history: Found in mudflats, in the day time seen buried in the mud with a little portion of head out. Active during night time; feeds on fish and other small sea animals. The animal has the capacity to remain submerged in mud for considerable periods.

AMPHIBIAN FAUNA

From the 14 amphibian species recorded during the study, the discovery of *Fejervarya cancrivora* and *Euphlyctis hexadactylus* from Dhamra area are particularly significant. *F. cancrivora* is a brackish water frog, found exclusively in brackish water systems and estuaries. This is the first report from mainland India, with the only previous report being from the Andaman and Nicobar Islands. Elsewhere, it is found in Southeast Asian countries.

Crab-Eating Frog *Fejervarya Cancrivora* (Gravenhorst, 1829)

Habitat and natural history: Found in mudflats, creeks, mangrove swamps and paddy fields near the Dhamra river mouth area including on the mudflats of the port site itself. The individuals were observed living inside crab holes and mostly seen at the openings in the evenings. Most observations were near creeks but the call of the species was also heard further inland from the coast. The name of the species derives from its crab eating habit, though it also feeds on water insects, fishes, molluscs and varieties of small animals.

Distribution: This is the first record from mainland India. Previously reported from the Andaman and Nicobar Islands (Port Blair) (Pillai, 1991). Elsewhere: Philippine Islands, Lesser Sundas east of Flores, Java, Sumatra, Borneo and the Malay Peninsula.

Remark: Dutta's (1984) report of the species from Madhya Pradesh is based on a single specimen available at the FMNH, Chicago and it is suspected that, the specimen belongs to *F. limnocharis* Species Complex.

The list of amphibians recorded in the study area is given in Appendix III and the list of reptilian fauna in Appendix IV.

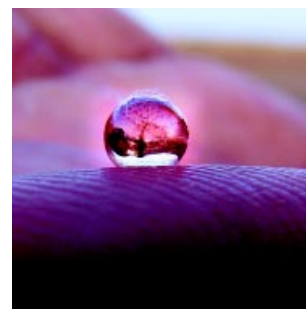
KING CRABS

King crabs are classified under Class Arachnida, Order Xiphosura and family Xiphosuridae. These bizarre looking animals with a semicircular cephalothorax and a spine like tail play an important role in bio-medical research, since the discovery of Lysate (*Limulus Amoebocyte Lysate*) from the blood of these individuals by F. B. Bang in 1956. There are two species of King crabs found in Orissa and both are found along the Dhamra coast. Both species can be distinguished by the presence of triangular caudal spine in case of *Tachypleus gigas* (Muller) and presence of round caudal spine in *Carcinoscorpius rotundicauda* (Latreille). The animals occur in sandy and muddy bottoms from tide line to a depth of 40 meters out to sea. Studies on the breeding behaviour of the animals reveals that during the spring/summer season, King crabs come ashore in large numbers to nest. Breeding pairs of King crabs are observed throughout the year (Chatterji et al, 1992). Females lay their eggs in fine, clean sand at the high water mark during the spring tides. The Dhamra coast offers micro climate and habitat suitable for King Crabs and a large population of the creatures are observed in the area throughout the year.

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MATING HORSESHOE CRABS
TACHYPLEUS GIGAS AT THE
PORT SITE



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KING CRABS CAUGHT IN FISHING NETS AND RESCUED

Date	Locality	Total No.	No. found dead
1 11.2.2007	Sector-IV	273	39
2 14.2. 2007	Sector- III	45	27
3 18.2.2007	Udabali	135	26
4 19.2.2007	Sector- IV	365	44
5 22.3.2007	Sector-I	5	5
6 23.2.2007	Sector- II	25	19
7 27.2.2007	Udabali	467	78

OTHER CRABS

More than 20 species of crabs were collected during the survey period from the Dhamra coast and the fish landing jetty. The collected specimens are being identified with the help of experts.

MARINE SHELLS

Twenty five species of marine shells were identified out of more than 40 species photographed in the field. Brackish water molluscs like Bivalves, Moon shells and Horn shells are abundant in the area. Conches, Tons, Cowries etc. collected during the survey are the result of trawling by-catch.

CORAL

This is potentially a very exciting discovery as there are as yet no confirmed records of corals in the waters along the Orissa coast. This specimen of a hard coral (below) was discovered on the shore near the Chandnival Point by the study team. The process of identifying the species is underway.



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A SPECIES OF HARD CORAL
RECORDED JUST SOUTH OF
THE PORT SITE, NEAR THE
DHAMRA RIVER MOUTH



DOG FISH CAUGHT NEAR THE
DHAMRA RIVER MOUTH

ICHTHYOFAUNA

A market survey was conducted to assess the diversity of marine fish catch along the Dhamra river mouth of Bhadrak district. Fish catch data was collected at regular intervals at the landing jetty and from local fishermen operating trawlers, gill-netters and out-board motors (OBMs) from the Dhamra and Chandnipal fishing jetties. In addition secondary information was also collected from different sources, such as local villagers. Different fish samples were collected from the field and preserved in 4% formalin. For the preservation and identification, the following methods were used.

Collection and Preservations

Fish specimens were collected (see box on page 25 for collection procedure) and preserved intact with all their body parts undamaged and all the fins expanded for taxonomic studies. Collection procedures were followed as described by Jayram (1981). All were preserved in formalin. This solution was made by diluting one part of the concentrated formalin with nine parts of water. The solution was neutralized with five to ten grams of borax per litre. The volume of material to be preserved never exceeded that of the preserving liquid and the specimen was left in this solution for at least for four or five hours for proper fixation.

Fish less than 10 cm (four inches) long were immersed completely in the formalin solution. A narrow cut was made on the abdominal wall a little to one side of the mid-ventral line for fishes of length 10-30 cm. Care was taken to avoid a deep cut or expose the intestines or alimentary canal. Fish longer than 30 cm were injected with 10% formaldehyde in several places and the belly was slit in 2 to 3 places. In the case of fish having a keel, where the abdomen is not rounded, (Clupeoids, Chela etc), the incision was made on the left side of the fish.

All colours, colour patterns, spots, blotches, number and design were carefully noted down as soon as the fishes were caught and when they were fresh for identification. Labels indicating station number, serial number, exact locality of the study area, date and time of collection, name of collector, gear

employed etc., were also recorded at the time of collection. Information on the nature of water, substratum, and extent of vegetation and animal associations were recorded in the field notebook. Preserved fish were wrapped and packed in thin muslin or mulmul cloth for transportation. They were wrapped in formalin-soaked cloth or cotton and kept in plastic bags. For field collection, the materials were taken for bringing the fish samples and other data to the laboratory. The identification process is still ongoing in the North Orissa University Laboratory and the Regional Museum of Natural History, Bhubaneswar.

Results

During this survey, 63 species of fishes are identified. Over 150 species collected from the area are yet to be identified. Fishermen at Dhamra use trawlers, inboard motors (IBM) and country boats (CB). Generally two types of nets are used: the gill net and the trawl net. There are various types of gill nets: Bhasali jal, Manjari jal, Hilsa jal, Tuadi jal and Fasi jal. Trawl nets are of three types: Low opening trawl net, high opening trawl net and mini high opening shrimp-cum fish trawl net. Both gill net and trawl net are available in monofilament nylon and multifilament nylon respectively. Gill nets are used to catch small size fishes, where as trawl nets are used to catch both big and small ones. Mesh size and length of the trawl net is small in comparison to the gill net. Some fish groups were found in both estuarine and marine-water habitats. Their availability in both these habitats is restricted to a particular season, because they migrate from sea to river and from river to sea for feeding and spawning, while others are found either in estuarine or marine areas. November, December, January and February witnessed large fish catches, but towards March, the fish catch drops. Sciaenids and *Metapeneus* catch during November was abundant, and in April the catch of same varieties falls to marginal levels. Sharks are caught mainly in November and December and other species like Polynemids, Mackerel, Black pomfret etc. are not available every month.

The complete list of fish species recorded is in Appendix V.



FISHING, MECHANISED AND TRADITIONAL, IS AN IMPORTANT LIVELIHOOD IN DHAMRA AND SURROUNDING PARTS OF THE COAST

A number of prawn hatcheries along the Dhamra area were surveyed. The increasing numbers may be attributed due to the high market value of tiger prawn. Various types of nets are used to collect tiger prawn spawn. This collection affects the abundance of other fish species as the collection process results in the incidental capture of other fish fry, which are usually discarded and left to die.

Other macro-faunal species in the Dhamra study area

Benthic taxonomical groups maintain a homeostatic mechanism and play a major role as bioindicators of pollution. Based upon their ecological roles in relation to effluents, indicator organisms are categorized as sentinels, detectors, accumulators and exploiters (Joensson et al, 1993) of the ecosystem. Indicator species go a long way in bio-detection of environmental changes. Macro fauna, due to their interactions with sediments, are known to influence the productive potential of the system (Rambabu et al, 1987). Certain macro faunal communities serve as feed items for economically important and edible fin fishes and shell fishes. Further, macro and mega faunal species are now being perceived as reservoirs/ generators of bio-active substances that have applications in modern marine pharmaceuticals. The sedimentary ichthyofauna of the Dhamra estuary, particularly Gobioids, prey on sedimentary macro-faunal elements and benthic diatoms, as shown by an analysis of the gut contents of fish. The future significance of macro faunal research hinges on the generation of knowledge of the utility of macro fauna in aquaculture and aquatic eco-toxicology

AVICENNIA ALBA MANGROVES ON UDABALI ISLAND



PNEUMATOPHORES OF THE
MANGROVE SPECIES AVICINIA ON
UDABALI ISLAND ADJACENT TO
THE PORT SITE



GREENPEACE / P. MOHAPATRA

(Mishra, 2002). The major macro-faunal groups found in Dhamra estuary are Polychaeta, Amphipoda, Isopoda, Macrura, Gastropoda, Anthozoa and Bivalves. Some of the Polychaetes recorded during the study were *Lycastis indica*, *Perineris cultrifera*, *Glycera lancadivae*, *Glycera alba*, *Lumbriconeris latreilli*, *Polydoracarazzia antenatal* and *Sternopsis scutata*.

Flora

The mangrove flora of the Dhamra estuary is represented by 23 species distributed along the mainland north of the river mouth and on Kanika Sands. The river mouth area exhibits a silty shelf, which slopes up in a low gradient to form mudflats in the intertidal zone. Kanika Sands is dominated by tree species like *Avicennia marina*, *Sonneratia alba*, *Avicinia alba* and *Phoenix paludosa* species. The trees attain a height of about 10 meters or more. The mangroves on Kanika Sands provide protection and stabilisation of the inter-tidal landscape from natural calamities and cyclonic floods. They also provide an optimum habitat for some threatened animals and serves as a nursery ground for many fishes, crabs and other animals.

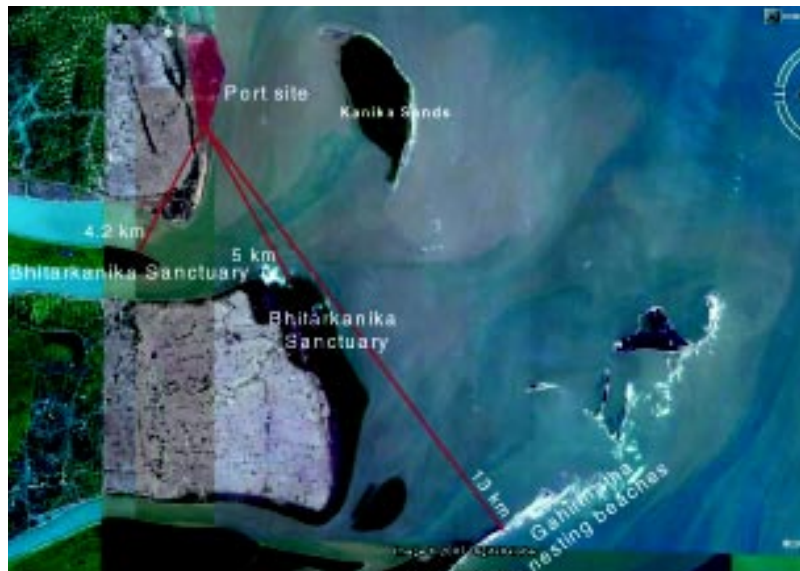
The complete list of flora recorded in the study area is given in Appendix VII.

SESUVIUM PORTULACASTRUM
COVERS LARGE AREAS OF THE
MUDFLATS OF THE PORT SITE

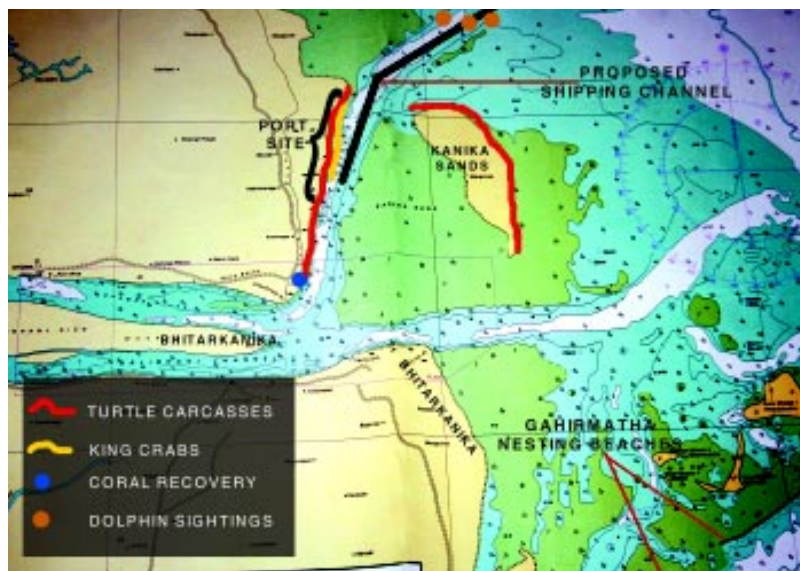


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DISTANCE BETWEEN THE PORT SITE AND THE BHITARKANIKA SANCTUARY AND THE NESTING BEACHES AT GAHIRMATHA RESPECTIVELY



TURTLE CARCASSES (OVER 2,000) RECORDED ON AND NEAR THE PORT SITE, INDICATIVE OF TURTLE PRESENCE IN OFFSHORE WATERS



IMPACTS OF PORT CONSTRUCTION

section 4

The stated purpose of this study was to gather accurate baseline data on the biological diversity of the Dhamra port site and its surroundings. Based on the study team's recordings, and on available details of the port and its planned operations, we can briefly postulate possible and probable impacts on the biodiversity and ecology due to the construction and then operation of the port.

A discussion of these impacts can be broadly divided as below:

A. Impacts on biodiversity of the port site and surroundings

The port construction, from details gathered from the company website and conversations with individuals concerned, involves raising the level of the port site, that is the mudflats, by dumping sand/silt to a height of 10-20 m. The EIA does not mention this since it was prepared for a different port site. If the mudflats were to be smothered in this way, all present life forms in them and that depend on them would be locally wiped out.

This is of particular concern when one considers rare species such as *Fordonia leucobalia*, *F. cancrivora* and the two species of horseshoe crabs that have been recorded in these mudflats. Secondly, the ancillary development that will come up around

THE IMPACT THAT DREDGING, INCREASED TURBIDITY, NOISE LEVELS AND POLLUTION WILL HAVE ON MARINE LIFE, ESPECIALLY TURTLES, NEEDS TO BE ANALYSED



GREENPEACE / SUMER VERMA



MATING TURTLES HAVE BEEN REPORTED FROM THE OFFSHORE WATERS NEAR THE PORT

the port site will have its own impacts on the biodiversity of the area, as land use changes, pollution increases and the natural habitat is altered or destroyed. A thorough in-depth study is needed to gauge these impacts.

B. Impact on marine diversity – turtles, dolphins

Dredging: The offshore waters, north of Kanika Sands, are home to a good dolphin population, as well as being foraging and mating grounds for Olive Ridley turtles. The large amount of dredging that will be required for initial construction as well as recurring maintenance of the 19 km. long and 18 m deep shipping channel, will have impacts on the turbidity of the water and light penetration as well as on the benthic habitat and therefore potential impacts on the entire food chain, including species such as dolphins and turtles. This will affect the primary productivity and will be responsible for the increase in BOD level in these waters. These impacts need to be studied and quantified before any work is done.

Noise levels: Construction will require piling of the site in order to secure a firm foundation, and this will inevitably lead to high ambient noise levels for some time during construction. Port operation and shipping will also create underwater noise, elevated well above background (and almost certainly above noise levels associated with the more limited fishing activities in the port as it currently exists). Turtles are known to be



INDO-PACIFIC BOTTLENOSE DOLPHINS *TURSIOPS ADUNCUS*. IMPACTS FROM THE PORT AND RELATED ACTIVITIES ON THE GAHIRMATHA MARINE SANCTUARY, 15 KM. FROM THE PORT SITE, NEED TO BE THOROUGHLY ANALYSED

sensitive to noise (Samuel, Y., Morreale, S.J., Clark, C.W., Greene, C.H., Richmond, M.E., (2005) '*Underwater low frequency noise in a coastal sea turtle habitat*', Journal of the Acoustical Society of America, 117 (3): Part 1465-1472).

Elevated noise may well deter adults from nesting sites and foraging areas and could also lead to other modified behaviour. In addition, there could be impacts on aquatic fauna. Cetaceans are also known to be affected by increased noise levels due to shipping traffic and the waters off the port site are known to harbour several species of dolphins. These aspects need to be examined in depth.

Pollution: Despite the best efforts, all ports globally, and particularly in Indian conditions, lead to a significant increase in pollution in surrounding waters, by accidental fuel oil leaks, cargo discharges, bilge cleaning and sundry other sources. The area in question is reasonably pristine at the moment due to the presence of only small scale industrial activity. A mega port will alter this scenario radically with impacts on the ecology and the flora and fauna. These impacts need to be quantified and studied before any work starts.

C. Impacts on Gahirmatha Wildlife Sanctuary

Elevated noise levels and pollution described above could impact the waters of the Gahirmatha Sanctuary 10-15 km to the south. In addition, light pollution could also pose a serious threat to nesting behaviour and hatchling survival. The port will be approximately 12-15 km from the nesting beaches. Though this is below the horizon, the glow from artificial lighting does extend over the horizon, as has been experienced with the Paradeep port to the south. The lighting at the Dhamra port and especially from the ancillary development it will spawn would thus pose a very significant threat to nesting and hatching and this needs to be studied in depth.

RECOMMENDATIONS

Despite the study's short duration and limited scope, the key findings are a strong indication that the area is ecologically significant. Based on the findings, this report makes the following recommendations:

1. The area stretching from north of Chandnipal village up to the northern limit of the study area and including Udabali Island be declared an Ecologically Sensitive Area under the Environment Protection Act, 1986. This will not impose restrictions on local inhabitants, but it will ensure protection from polluting industries and large infrastructure projects. The area to the north of the study area also needs to be studied and if required, should be included as part of the Dhamra Ecologically Sensitive Area.
2. A comprehensive study of the *Fordonia leucobalia* population must be undertaken on a priority basis, given that this is as yet only the second confirmed record of the species in the whole of mainland India, and the first photographic record. A similar study of the crab-eating frog *F. cancrivora* is also required, as this is the first record for the species from mainland India.
3. A comprehensive study covering one whole season for terrestrial elements and a minimum of two seasons for turtle and dolphin movement is required to arrive at a more comprehensive picture of the area's importance for these species. The presence of over 2,000 turtle carcasses on and near the port site is a strong indicator that the offshore waters are important turtle habitat.
4. Measures to protect the Horseshoe Crabs *Tachypleus gigas* and *Carcinoscorpius rotundicauda* and their mudflat habitat must be taken, as this is obviously an important habitat for the species.
5. The recovery of coral pieces is a strong indication of the probable presence of offshore coral reefs. This needs to be explored sufficiently, as such reefs could be affected by port construction and operations.
5. Since the area is utilised by the local community, a socio-economic survey on possible livelihood impacts due to the port project needs to be conducted.
6. Pending completion of the studies mentioned above, and their collation into one comprehensive, impartial and scientifically accurate document, there should be no interference with the existing ecology of the port site on the mainland, or with the marine ecology offshore. This would mean that the mega-port project currently being executed by TATAs and Larsen & Toubro be stopped immediately.

APPENDICES

appendices

APPENDIX I

Checklist of the mammalian fauna recorded in the study area

NAME	WPA STATUS
1 Chital <i>Axis axis</i>	Sch. III
2 Jungle cat <i>Felis chaus</i>	Sch. II
3 Jackal <i>Canis aureus</i>	Sch. II
4 Striped hyaena <i>Hyaena hyaena</i>	Sch. III
5 Small Indian civet <i>Viverricula indica</i>	Sch. II
6 Common palm civet <i>Paradoxurus hermaphroditus</i>	Sch. II
7 Ruddy mongoose <i>Herpestes smithii</i>	Sch. II
8 Wild pig <i>Sus scrofa</i>	Sch. III

APPENDIX II

Checklist of avifauna in the study area

NAME	WPA STATUS
1 Asian Koel <i>Eudynamis scolopacea</i>	Not Listed
2 Asian Openbill <i>Anastomus oscitans</i>	Not Listed
3 Asian Paradise Flycatcher <i>Terpsiphone paradisi</i>	Sch. IV
4 Asian Pied Starling <i>Sturnus contra</i>	--
5 Baya Weaver <i>Ploceus philippinus</i>	Sch. IV
6 Black Drongo <i>Dicrurus macrocercus</i>	Sch. IV
7 Black Eagle <i>Ictinaetus malayensis</i>	--
8 Black-hooded Oriole <i>Oriolus xanthornus</i>	Sch. IV
9 Black-rumped Flame Back <i>Dinopium benghalense</i>	--
10 Black-shouldered Kite <i>Elanus caeruleus</i>	--
11 Black-bellied Tern <i>Sterna acuticauda</i>	--
12 Black-capped Kingfisher <i>Halcyon pileata</i>	Sch. IV
13 Common Black-headed Gull <i>Larus ridibundus</i>	Sch. IV
14 Black-headed Ibis <i>Threskiornis melanocephalus</i>	Sch. IV
15 Black-tailed Godwit <i>Limosa limosa</i>	--
16 Blue-tailed Bee-eater <i>Merops philippinus</i>	--
17 Brahminy Starling <i>Sturnus pagodarum</i>	Sch. IV
18 Bronze-winged Jacana <i>Metopidius indicus</i>	Sch. IV
19 Cattle Egret <i>Bubulcus ibis</i>	Sch. IV
20 Chestnut-headed Bee-eater <i>Merops leschenaulti</i>	--
21 Collared Kingfisher <i>Todirhamphus chloris</i>	Sch. IV
22 Common Hawk Cuckoo <i>Hierococcyx varius</i>	Sch. IV
23 Common Iora <i>Aegithina tiphia</i>	Sch. IV
24 Common Kingfisher <i>Alcedo atthis</i>	Sch. IV
25 Common Mynah <i>Acridotheres tristis</i>	Sch. IV
26 Common Redshank <i>Tringa totanus</i>	--
27 Common Sandpiper <i>Tringa hypoleucos</i>	Sch. IV
28 Common Tailor Bird <i>Orthotomus sutorius</i>	--
29 Common Hoopoe <i>Upupa epops</i>	--
30 Common-ringed Plover <i>Charadrius hiaticula</i>	Sch. IV
31 Coppermouth Barbet <i>Megalaima haemocephala</i>	Sch. IV
32 Crested Tree Swift <i>Hemiprocne coronata</i>	Sch. I
33 Dark-necked Tailor Bird <i>Orthotomus atrogularis</i>	--
34 Eurasian Collared Dove <i>Streptopelia decaocto</i>	Sch. IV
35 Eurasian Curlew <i>Numenius arquata</i>	Sch. IV
36 Eurasian Golden Oriole <i>Oriolus oriolus</i>	Sch. IV
37 Eurasian Oystercatcher <i>Haematopus ostralegus</i>	Sch. IV
38 Greater Coucal <i>Centropus sinensis</i>	--

39 Greater Sand Plover <i>Charadrius leschenaultii</i>	Sch. IV
40 Little Green Bee-eater <i>Merops orientalis</i>	--
41 Grey Heron <i>Ardea cinerea</i>	--
42 House Crow <i>Corvus splendens</i>	Sch. V
43 House Sparrow <i>Passer domesticus</i>	--
44 House Swift <i>Apus nipalensis</i>	Sch. I
45 Indian Grey Hornbill <i>Ocyrceros birostris</i>	Sch. I
46 Indian Nightjar <i>Caprimulgus asiaticus</i>	Sch. IV
47 Indian Pond Heron <i>Ardeola grayii</i>	--
48 Indian Robin <i>Saxicoloides fulicata</i>	--
49 Indian Roller <i>Coracias benghalensis</i>	Sch. IV
50 Indian Skimmer <i>Rynchops albigollis</i>	--
51 Intermediate Egret <i>Mesophoyx intermedia</i>	Sch. IV
52 Jungle Babbler <i>Turdoides striatus</i>	Sch. IV
53 Jungle Mynah <i>Acridotheres fuscus</i>	Sch. IV
54 Kentish Plover <i>Charadrius alexandrinus</i>	Sch. IV
55 Large-billed Crow <i>Corvus macrorhynchos</i>	--
56 Lesser Crested Tern <i>Sterna bengalensis</i>	--
57 Lesser Sand Plover <i>Charadrius mongolus</i>	Sch. IV
58 Little Cormorant <i>Phalacrocorax niger</i>	Sch. IV
59 Little Egret <i>Egretta garzetta</i>	Sch. IV
60 Little Grebe <i>Tachybaptus ruficollis</i>	Sch. IV
61 Little Stint <i>Calidris minuta</i>	--
62 Little-ringed Plover <i>Charadrius dubius</i>	Sch. IV
63 Long-toed Stint <i>Calidris subminuta</i>	--
64 Mangrove Pitta <i>Pitta megahyncha</i>	Sch. IV
65 Oriental Magpie Robin <i>Copsychus saularis</i>	--
66 Paddyfield Pipit <i>Anthus rufulus</i>	Sch. IV
67 Purple-rumped Sunbird <i>Nectarinia zeylonica</i>	Sch. IV
68 Purple Sunbird <i>Nectarinia asiatica</i>	Sch. IV
69 Red-vented Bulbul <i>Pycnonotus cafer</i>	Sch. IV
70 Red-wattled Lapwing <i>Vanellus indicus</i>	--
71 River Tern <i>Sterna aurantia</i>	--
72 Rock Pigeon <i>Columba livia</i>	Sch. IV
73 Rose-ringed Parakeet <i>Psittacula krameri</i>	Sch. IV
74 Rufous Treepie <i>Dendrocitta vagabunda</i>	Sch. IV
75 Scaly-breasted Munia <i>Lonchura punctulata</i>	Sch. IV
76 Shikra <i>Accipiter badius</i>	--
77 Short-toed Snake Eagle <i>Circaetus gallicus</i>	--
78 Spotted Dove <i>Streptopelia chinensis</i>	Sch. IV
79 Spotted Owlet <i>Athene brama</i>	Sch. I
80 Temminck's Stint <i>Calidris temminckii</i>	--
81 Whimbrel <i>Numenius phaeopus</i>	--
82 White-bellied Drongo <i>Dicrurus caerulescens</i>	Sch. IV
83 White-breasted Water Hen <i>Amaurornis phoenicurus</i>	--
84 White-rumped Shama <i>Copsychus malabaricus</i>	--
85 White-throated Fantail <i>Rhipidura albigollis</i>	--
86 White-throated Kingfisher <i>Halcyon smyrnensis</i>	Sch. IV
87 White-bellied Sea Eagle <i>Haliaeetus leucogaster</i>	Sch. I
88 Yellow Wagtail <i>Motacilla flava</i>	--
89 Yellow-wattled Lapwing <i>Venellus malabaricus</i>	--

APPENDIX III

Checklist of amphibians of the study area

- 1 Common Indian Toad *Duttaphrynus melanostictus*
- 2 *Bufo fergusonii*
- 3 Crab-eating Frog *Fejervarya cancrivora*
- 4 *Fejervarya sp (Unidentified)*
- 5 Paddy Field Frog *Fejervarya syhadrensis*
- 6 *Fejervarya orissaensis*
- 7 Indian Bull Frog *Hoplobatrachus tigerinus*
- 8 Jerdon's Bull Frog *Hoplobatrachus crassus*
- 9 Skipper Frog *Euphlyctis cyanophlyctis*
- 10 Green Pond Frog *Euphlyctis hexadactylus*

- 11 Ornate Frog *Microhyla ornata*
- 12 Marbled Balloon Frog *Uperodon systoma*
- 13 Painted Frog *Kaloula pulchra*
- 14 Tree Frog *Polypedates maculatus*

APPENDIX IV

Checklist of reptilian fauna of the study area

NAME

- 1 Brook's Gecko *Hemidactylus brookii*
- 2 Marbled Tree Gecko *H. leschenaultii*
- 3 Asian House Gecko *H. frenatus*
- 4 Fan-throated Lizard *Sitana ponticeriana*
- 5 Indian Garden Lizard *Calotes versicolor*
- 6 Indian Chameleon *Chamaeleo zeylanicus*
- 7 Little Indian Skink *Mabuya macularia*
- 8 Common Brahminy Skink *Mabuya carinata*
- 9 Snake Skink *Riopa punctatus*
- 10 Common Indian Monitor *Varanus bengalensis*
- 11 Yellow Monitor lizard *Varanus flavescens*
- 12 Brahminy Worm Snake *Ramphotyphlops braminus*
- 14 Common Sand Boa *Eryx conicus*
- 15 Common Vine snake *Ahaetulla nasutus*
- 16 Common Bronzebacked Tree Snake *Dendrelaphis tristis*
- 17 Indian Rat Snake *Ptyas mucosa mucosa*
- 18 Common Wolf Snake *Lycodon aulicus*
- 19 Common Cat Snake *Boiga trigonatus*
- 20 Checkered Keelback *Xenochrophis piscator*
- 21 Monocellate Cobra *Naja naja*
- 22 Bamboo Pit Viper *Triemeresurus gramineus*

APPENDIX V

Checklist of the identified fishes of Dhamra estuary

FAMILY: SILLAGINIDAE

Sillago panijus (Hamilton-Buchanan)

Sillago sihama (Forsskal)

FAMILY: SYNODIDAE

Saurida undosquamis (Richardson)

FAMILY: NEMIPTERIDAE

Nemipterus japonicus (Bloch)

FAMILY: SPHYRAENIDAE

Sphyraena jello Cuvier

FAMILY: CYANOGLOSSIDAE

Cyanoglossus dubius Day

FAMILY: COILINAE

Setipinna phasa (Hamilton-Buchanan)

FAMILY: HEMIRAMPHIDAE

Hemiramphus unifasciatus

FAMILY: SCATOPHAGIDAE

Scatophagus argus (Linnaeus)

FAMILY: SCOPELIDAE

Harpodon nehereus (Hamilton-Buchanan)

FAMILY: SCOMBRESOCIDAE

Tylosurus choram (Ruppell)

FAMILY: HEMIRAMPHIDAE

Rhynchoramphus malabaricus Collette

FAMILY: KURTIDAE

Kurtis indicus Bloch

FAMILY: POMADASYIDAE

Pomadasyus hasta (Bloch)

FAMILY: EPHIPADAE

Drepane punctata (Linnaeus)

Ephippus orbis (Bloch)

FAMILY: CARCHARINIDAE

Loxodon murorhines Muller & Henle

FAMILY: MURAENESACIDAE
Congresox talabonooides (Bleeker)

FAMILY: PERCIDAE
Lutjanus kasmira (Forsskal)

FAMILY: SERANIDAE
Epinephelus bleekeri (Vaillant & Bocourt)

FAMILY: LUTJANIDAE
Lutjanus johni (Bloch)

FAMILY: POLYNEMIDAE
Polynemus paradeseus Linnaeus
Eleutheronema tetradactylum (Shaw)

FAMILY: MUGILIDAE
Mugil cephalus Linnaeus
Liza vaigiensis (Quoy & Gaimard)

FAMILY: STROMATIDAE
Pampus chinensis (Euphrasen)
P. argenteus (Euphrasen)

FAMILY: ARIIDAE
Arius arius (Hamilton & Buchanan)
A. subrostratus Valenciennes

FAMILY: TRICHIURIDAE
Eupleurogrammus glossodon (Bleeker)
Lepturanctus savala (Cuvier)

FAMILY: TERAPONIDAE
Terapon jarbua (Forsskal)

FAMILY: GERREIDAE
Gerres oyena (Forsskal)

FAMILY: SCIAENIDAE
Otoliths cuvieri Trewavas
Otolithoides biauritus (Cantor)
Daysciaena albida (Cuvier)
Pterotolithus maculatus (Cuvier & Valenciennes)
Johnius macropterus (Bleeker)
J. belangeri (Cuvier)
Panna microdon (Bleeker)
Nibeia chui Trewavas

FAMILY: CARANGIDAE
Megalaspis cordyla (Linnaeus)
Atule mate (Cuvier)
Carangoides malabaricus (Bloch)
Alectis indicus (Ruppell)

FAMILY: SPARIDAE
Argyrops spinifer (Forsskal)

FAMILY: LETHRINIDAE
Lethrinus frenatus

FAMILY: DASYPIDAE
Gymnora japonica (Schlegel)

FAMILY: CLUPEIDAE
Raconda russeliana (Gray)
Ilisha megaloptera (Swainson)
Hilsa ilisha (Hamilton-Buchanan)
Sardinella leiogaster Valenciennes
S. longiceps Valenciennes
S. clupeioides (Bleeker)
S. fimbriata (Valenciennes)
Anodontostoma chacunda (Hamilton-Buchanan)
Pellona ditchela Valenciennes

FAMILY: ENGRAULIDAE
Coilia ramcarati (Hamilton-Buchanan)
C. dussumieri Valenciennes
Thryssa hamiltonii (Gray)
T. malabarica (Bloch)
Setipinna tenuifilis (Valenciennes)

FAMILY: SCORPIONIDAE
Pterois miles

APPENDIX VI

Marine shell species identified

1. *Architectonica laevigata* (Lamarck)
2. *Bursa spionasa* (Lamarck)
3. *Cerithium echinatum* (Lamarck)
4. *Cerithium morus* (Lamarck)
5. *Hemifusus pugilinus* (Born)
6. *Meretrix meretrix* (Linn.)
7. *Murex tribulus* (Linn.)
8. *Natica lineata* (Lamarck)
9. *Natica maculosa* (Lamarck)
10. *Nerita polita* (Linn.)
11. *Placuna placenta* (Linn.)
12. *Potamides cingulatus* (Gmelin)
13. *Pteria brevia lata* (Drunker)
14. *Tonna fasciata* (Bruguiera)
15. *Tonna galea* (Linn.)
16. *Turbo brunneus* (Roding)
17. *Turritella duplicata* (Linn.)
18. *Xenophora solaris* (Linn.)

APPENDIX VII

The floral diversity of the study area

Scientific Name	Type	Family
1 <i>Acanthus ilicifolius</i>	Herb	Acanthaceae
2 <i>Avicennia alba</i>	Tree	Avicenniaceae
3 <i>Avicennia marina</i>	Tree	Avicenniaceae
4 <i>Avicennia officinalis</i>	Tree	Avicenniaceae
5 <i>Brownlowia tersa</i>	Herb	Tiliaceae
6 <i>Bruguiera cylindrica</i>	Tree	Rhizophoraceae
7 <i>Bruguiera parviflora</i>	Tree	Rhizophoraceae
8 <i>Caesalpinia cristata</i>	Creeper	Caesalpiniaceae
9 <i>Clerodendron inerme</i>	Creeper	Verbenaceae
10 <i>Derris scandens</i>	Creeper	Leguminosae
11 <i>Excoecaria agallocha</i>	Tree	Euphorbiaceae
12 <i>Flagellaria indica</i>	Creeper	Flagellariaceae
13 <i>Hibiscus tiliaceus</i>	Herb	Malvaceae
14 <i>Pandanus fascicularis</i>	Herb	Pandanaceae
15 <i>Phoenix paludosa</i>	Tree	Palmae
16 <i>Porteresia coarctata</i>	Grass	Poaceae
17 <i>Rhizophora mucronata</i>	Tree	Rhizophoraceae
18 <i>Salvadora persica</i>	Herb	Salvadoraceae
19 <i>Sesuvium portulacastrum</i>	Herb	Aizoaceae
20 <i>Suaeda maritima</i>	Herb	Chenopodiaceae
21 <i>Suaeda monoica</i>	Herb	Chenopodiaceae
22 <i>Tamarix troupis</i>	Herb	Tamaricaceae
23 <i>Thespesia populnea</i>	Tree	Malvaceae

APPENDIX VIII

Water and soil quality analysis of Dhamra estuary

Place: Dhamra jetty

Water

Water condition: turbid in nature due to churning of littoral sediments by tidal forces

Atmospheric temperature: 20.5

Interstitial water temperature: 20.5

Water temperature: 21.5

pH: 7.0

D.O.: 0.4 ml/lit.

Salinity: 23.1 ppt

Alkalinity: 61.0%

Turbidity: 54.8 NTU

Silicate: trace

Soil

Colour: Dark brown and clayey in nature

pH: 6.0 (Slightly acidic)

Moisture content: 25.58%

OC/OM: 60.7

Place: Kanika Sands / Udabali**Water**

Interstitial water temperature: 30.0

Atmospheric temperature: 37.0

pH: 6.5 (Slightly acidic)

Dissolved Oxygen: 1.96 ml/lit

Salinity: 27.9%

Alkalinity: 400

Phosphate: trace

Turbidity: 461 NTU

Silicate: 15 microgram/ liter

Soil

Soil texture dark brown, fishy smell, equal mixture of clay and silt

Atmospheric temperature: 32.0

Interstitial water temperature: 29.5

Soil temperature: 27.0

pH: 7.0 (Neutral)

Percentage of moisture: 36.5%

Organic matter: 71.1



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We challenge governments to introduce and enforce laws to protect the ocean environment and challenge industry to end its role in ocean destruction.

We support ecologically and socially responsible use of the oceans, including the rights of fishing communities to derive their livelihood from the sea.

We champion responsible scientific research to enhance understanding and appreciation of oceans and their ecosystems.

We are campaigning for the establishment of a global network of fully protected marine reserves to conserve ocean ecosystems and species.

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