1 Introduction

1.1 Background

Having ocean at three sides of its geographical boundary, India is blessed with over 7500 km long coastline. The shoreline of the country harbors a great diversity of habitats including dense mangroves of Sunderbans, sandy shores of Orissa, coral reefs of Andaman and Nicobar and Lakshadweep, rocky pools of Ratnagiri and the two gulfs of Gujarat. India is the seventh largest marine fishing nation in the world and thirty percent of Indian population is directly dependant on these marine resources.

Gujarat is the western most state of India. Having the longest coastline of 1650 km the state has two gulfs out of three of the country viz. Gulf of Khambhat and Gulf of Kutch. Coastline of Saurashtra has broad continental shelf and hence supports healthy biodiversity compared to the other regions of the state. Gujarat is the leading most state in the development of coastal infrastructure. Government has declared many Special Economic zones (SEZ) in the coastal areas. One of the most important SEZ is established on the coastline of Mundra and is known as Mundra Port Special Economic Zone (MPSEZ) which is located in the Gulf of Kutch. In December 2006 Ministry of Power gave a project to Tata Power Company for establishing a 4000 MW Ultra Mega Power Plant (UMPP) at Tunda – Wandh village of Mandvi Taluka of Kutch district of the Gujarat State. The Company started its work on a massive scale and obtained the early stage environmental clearances and initiated the land acquisition work. The power plant will have five units of 800 MW capacity and will be based on Super Critical Boiler Technology and fully imported coal based.

Fig. 1: Map showing location of CGPL (Mundra village) in the Gulf of Kutch

The project site is situates on the northern boundary of the Gulf (Fig. 1, 2) and it was thus necessary to understand its impact on the coastal and marine ecosystems. Such large scale power units will alter not only the genetic resources of the marine biodiversity but also alter the regular livelihood practices of the coastal population such as fishing. Corporate Social Responsibility (CSR) department consulted Bombay Natural History Society (BNHS) in June 2008 to carry out one year study to benchmark the biodiversity resources so that future impacts of the establishment of the UMPP could be assessed accurately. The study was aimed at generating first hand data which is a prerequisite to design management strategies and to take proactive measure to minimize the ecosystem damage. The study is also aimed at identification of suitable site for mangrove restoration.

1.1 Objectives

i. To document and analyze the coastal and marine biodiversity along the Mandvi-Mundra coast.
ii. To identify the key impact factors on the biodiversity due to the activities related to the CGPL plant.
ii. Identify and benchmark monitoring of benthic species.
v. To develop biodiversity monitoring protocols.
v. To identify appropriate areas and parameters for restoration of affected ecosystem

1.2 Site description

1.2.1 Physical features

The mainland of Kutch has a rocky terrain with two hill ranges running parallel in west –east direction. The belt between the southern hill range – Katrol hill range – and the Gulf of Kutch is dominantly costal alluvial plain lined by mudflats on its south where Mandvi and Mundra are located (Maurya *et al* 2003).

The soils of northern districts of Gujarat especially Kutch and Saurashtra are formed of sheets of deccan lava interspersed with trap dykes. Kutch has good deal of alluvium. Along the coastline saline alluvium is found (Shah, 1978).

Fig. 2: Map showing location of Kotadi and Modhwa creeks with respect to the CGPL plant

The project site is delineated by two creeks, Kotdi creek on its east and Mudhwa creek on its west (Fig. 2).

1.1.1 Climate

The climate in the study area is generally categorized by frequent draught and extreme temperature. It is seasonal and has summer (March – May), monsoon (June – September) and post-monsoon (October – November) and winter (December - February) seasons. The region gets rain from the south-west monsoon, and is very erratic in both, quantity and duration. These climatic conditions have lead to arid lands and high salinity of sea water.

The mean annual temperature varies from 5 °C to 41 °C while humidity ranges from 80 to 90% during monsoon season. The mean annual rainfall of Mundra – Mandavi area is 429 mm – 319 mm (1982 – 2002). The average number of rainy days in a year (calculated over this period) is only 14.

1.1.1 Land use pattern and vegetation

According to the EIA report (2007) the maximum land in an area of 5 km radius surrounding the plant site is under fallow land, followed by marshy land and salt pans, and then agricultural and barren waste land. The forested lands as well as mangroves occupy very less proportion. The total study area has 1.6 % forested area which is mainly scrub vegetation dominated by *Prosopis juliflora*. The nearest reserved forest land is at village Mota Kandagra.

The natural terrestrial vegetation of the study area falls under "VI – B Northern Tropical Forest" Sub type C-I Desert Thorn Forest (Kuchchh, Saurashtra, Gujarat). The forest patches falling under this category have mono-dominant *Prosopis juliflora. Acasia* spp., *Euphorbia* spp., *Zyziphus mauritiana* are also found in these scrubs. The ground cover generally is of *Cassia auriculiformis*, *Zyziphus nummularis* etc.

Mangrove patches are present mostly along the two creeks and cover only 0.05 km^2 area. These are dominated by *Avicennia marina* and show stunted growth. The intertidal mud flats are mostly covered with algae while the upper sandy mudflats have halophytes in abundance. The agricultural crops include cereals like *Pennisetum typhoides, Sorghum bicolor*, and *Triticum vulgare*. The pulses grown in this area are *Arachis hypogaea* and *Vigna radiata*. Also many places around the site are under cultivation of *Phoenix dactylifera, Achrus zapota, Cocos nucifera, Mangifera indica.* Crops like *Ricinus communis, Solanum tabacum* are also common. The study area falls in the semi arid tract of the state in which thorny scrub forests. The vegetation has a very open appearance so that the trees and shrubs are widely spaced. A majority of the vegetation consists of co-dominant, spinous trees and shrubs with drought tolerance. Owing to the distinct seasonality of the climate, the vegetation has two distinct types. The perennial vegetation which is present throughout the year and the annual vegetation which completes lifecycle within the short monsoon season.

Permanent vegetation is xerophytic and consists of trees and shrubs up to 6m tall rarely more. It is characterised by arid vegetation dominated by *Acacia spp., Capparis spp., Prosopis ceneraria, Calotropis procera, Cassia auriculata, Cordia gharaf, Azadirechta indica*. However, large open areas are extensively covered by the naturalized species *Prosopis juliflora* which forms almost impenetrably thickets at the cost of natural vegetation.

Floristic composition of the area thus matches broadly with the secondary, degraded types of the area. Considering the species composition, the vegetation of the project site is closest to the degraded phases of the Tropical Thorn Forest. The classification following Champion and Seth (1968) is as follows:

>Group 6 – Tropical Thorn Forests

>> Sub-group 6B – Northern Tropical Thorn Forests

>>>Type 6B/C1 – Desert Thorn Forests

Champion and Seth (1968) describe Northern Tropical Thorn Forests as similar to the southern form which is an open low forest in which thorny usually hard wooded species predominate, *Acacia* spp. being particularly characteristic. The dominants vary from 4.5-10m in height and tend to be collected in clumps leaving bare ground in between. Regeneration by root suckers is common, notably in *Prosopis* and *Capparis*. Climbers are relatively numerous and also usually exhibit xerophytic adaptations. The woody growth is of all sizes from the trees down to the dwarf shrubs with no differentiation in to storeys. The perennial grasses grow in clumps and tussocks. There is a thin growth of annual grasses after the rains.

A more pertinent classification for the vegetation of this area is found in Puri et al. (1983). It matches It is open formation of shrubs, 6m or less in height with a grass carpet of density varying according to protection. Stunted *Acacia leucophloea, Acacia tortilis, A. nilotica, Prosopis cineraria* are seen intermixed with *Azadirachta indica, Ziziphus spp.* It is mostly invaded by *Prosopis juliflora.* It is a biotically controlled community existing in a severely degraded state. Degraded scrub is the dominant vegetation type throughout the study area. *Zizyphus nummularia* together with *Calotropis procera* are dominant shrubs. Alongwith this *Trianthema portulacastrum, Indigofera sp.* are decumbent herbs. *Salvadora persica* occurs scattered in the scrub growth. *Tribulus terrestris, Cenchrus ciliaris, Aristida spp., Boerrhavia repens, Achyranthes aspera* are dominant.

1.3.4 Fauna

The high faunal diversity in the gulf area owes to the habitat diversity produced by land to sea transitions. The marine as well as coastal biota is very rich which includes corals, sponges, molluscs, crustaceans, fishes, reptiles, birds and mammals. Mundra region of the Gulf is however dominated by mudflats and coral reef or reef associated fauna is absent.

Marine turtles *Chelonia mydas* and *Lepidochelys olivia* breed along the sandy beaches of the Gulf. Species diversity of fishes along the northern Gulf is highest near Kandla followed by Mundra (Nair, 2003). Black-necked Stork a NTspecies breeds in the mangroves along Mundra coast.

1.3.5 Description of the project

The thermal power plant is located at a site near south of Tundawand village in Mundra taluka of Kutch District. This 4000 MW power plant occupies 1242 ha of land at 22 49 48 N and 69 30 58 E. The closest major urban settlement is Mandvi which is 25 km from the site. It is surrounded by other villages like Traghadi, Kandagra and Nana Bhadiya.

The plant will have five units of 800 MW capacity and will require 11-13 million tones of coal which will be imported. It will also require about 14.26 Mm3 /day of water. The only source of water required is nearby sea which is located at 2.5 km from the plant site. Sea water will be taken to the plant through open intake channel, for condenser cooling and also other freshwater requirement. The same water after cooling the condenser will be released back to sea by the outfall channels.

Intake channel

Overall length of the intake channel will be about 6.5 km and is routed through Kotdi creek. The channel will be about 65 m wide.

It is a uniform sandy beach having a very narrow intertidal area of about 30 meters. There is no rocky or muddy substratum towards the shoreline area. There are a few saplings of *Avicennia marina* on the high tidal mudflats which get inundated once a month. Grazing was seen prominent.

Outfall channel

The Outfall channel is 4.9 km long and 100 meter wide. The channel is crossing the Modhwa creek and opens in the open waters of the Gulf of Kutch. The channel will be carrying the saline water having 7^0C higher than the intake channel seawater.

Area of about 102 ha including intake and outfall channels falls into the Mundra SEZ.

1.3.6 Socio-economic features

The shoreline, intertidal area and the open sea adjacent to the outfall channel is rich in fisheries resources including elasmobranch (sharks). Traghadi, Salaya and Modhva have been considered as important fish landing centers. All these centers fall in the impact zone of the outfall channel. More than 50 fishing families are residing adjacent to the proposed outfall channel. However this is a *temporary* settlement and is active only during the fishing seasons i.e. September to May. The local fishermen also hire the labour from all over state for unloading, fishing and fish drying.

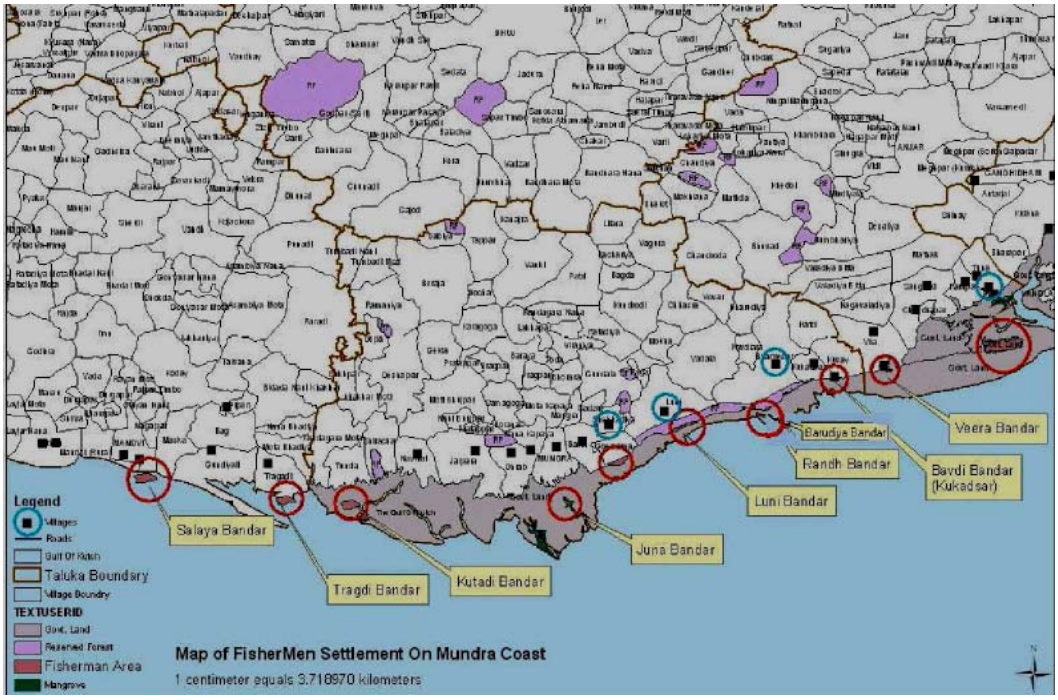

Fig. 3 Map showing fishermen settlement on Mundra coast

1 Methodology

1.1 Characterization of major habitat types

Various factors, especially physiography in combination with tidal cycles gives rise to habitat diversity across the transition from sea to land. Based on the soil type, vegetation and physiognomy these habitats were identified as follows –

I. Coastal saline scrub forests
II. Sand dunes
III. Salt pans
IV. Supra-littoral zone
V. Intertidal mangrove zone
VI. Intertidal open mudflat zone
VII. Open ocean
VIII. Rocky beds

1.2 Sampling

1.2.1 Vegetation

Different sampling techniques were applied for different habitats as well as groups under study (Table 1).

Table 1 Sampling Methods for various habitats and groups

Habitat	Groups	Sampling method	Remarks
Coastal saline scrub forests and sand dunes	Trees, shrubs Herbs	100 m x 10 m transects 1m x 1m nested quadrats	Parallel to the coast line
Salt pans	Halophytes	Observations	Low diversity and density
Supra-littoral zone	Halophytes	1m x 1m quadrats	Randomly placed
Intertidal Mangroves	Mangroves (Trees and saplings)	100 m x 10 m transects 1m x 1m nested quadrats	Parallel to the creeks, mudflat belts
Intertidal open mudflat	Algae	1m x 1m quadrats	Randomly placed
Rocky beds	Algae	1m x 1m quadrats	Randomly placed

The sampling was done on seasonal basis to cover four different seasons, such as summer, monsoon, winter and post winter to cover both vegetation as well as fauna. However, for the vegetation studies post–winter sampling was not considered as the observations did not vary from those of winter sampling.

2.2.2 Fauna

Biased survey

While preparing the biodiversity inventory the methodology selected was biased, by selecting impacted habitat for the study for specific group of animal e.g. surveying sandy beaches to find the evidences of occurrence of sea turtle.

Random Stratified sampling

In statistics, a modification of the random sample is particularly useful when obvious heterogeneity exists in the community, area, etc. to be investigated. In such instances a simple random sample may fail to record sufficient replicates of a particular subcategory, or may do so only very inefficiently, thus preventing a proper statistical monitoring of variability. In a stratified random scheme sample data points are divided into classes (strata) before taking a random sample within each stratum.

(a) Quadrates

Quadrates are the square sampling plots of fixed length and width generally used to study sedentary or slow moving animals. 1x1 meter quadrates were laid to study the biodiversity. This size quadrates provides more accuracy in the turbid water as well as high density species count. It will be based on “Random Stratified Sampling method”

(b)Transects

Transects are mainly of two types, line and belt. Belt transects can be laid by fixing the width and the length. Where as line transects can be laid just by fixing the length of the transect. It is used to measure the occurrence, frequency as well as the diversity of the area.

(c) Other methods

For vertebrates point counts and block counts are frequently used, where as fish by-catch also can be used to analyze the marine biodiversity of the area.

Table 2: Sampling methods for various faunal groups

Type of animals to be studied	Sampling method
Marine invertebrates	Quadrates, transects, by-catch
Fishes	Fish catch
Marine reptiles	Direct sightings, indirect evidences, stranding
Avifauna	Point count, block count, head count
Marine mammals	Direct sightings, stranding

2.3 Community structure and biodiversity analysis

2.3.1 Vegetation

The appropriate sites were selected to represent each of these habitat types listed above except open sea. For each habitat the community structure analysis was carried out. The sampled area and methods were habitat- specific. The parameters studied were frequency, density, IVI and species richness. Frequency indicates number of sampling units in which a given species occurs and thus expresses the distribution or dispersion of various species in a community. It was calculated using the following formula

$$\% \text{ Frequency} = \frac{\text{Number of sampling units in which the species occurred}}{\text{Total number of sampling units studied}} \times 100$$

Density and abundance represent the numerical strength of species in the community.

Density is expressed as the number of individuals of a species per unit area and is calculated as follows

$$\text{Density (number of plants per sample unit)} = \frac{\text{Total number of individuals of a species in all the sample units}}{\text{Total number of sample units studied}}$$

Abundance is expressed as the number of individuals per quadrat of occurrence and is calculated as follows

$$\text{Abundance} = \frac{\text{Total no of individuals of a species}}{\text{Number of quadrats of occurrence of the species}}$$

Relative density, relative frequency, and Importance Value Index (IVI) were calculated from above data. IVI for shrubs and herbs was calculated as,
IVI = Relative frequency + Relative Density

2.3.2 Fauna

Density, frequency, abundance and IVI were studied on the same lines as above.

3 Results

3.1 Characterization of major habitat types

I. Coastal saline scrub forests

These scrubs are supported by relatively firm soil which is saline in nature. It may be classified into two groups, the permanent vegetation occurring throughout the year and temporary vegetation consisting of annuals growing mainly during short rainy seasons.

Prosopis juliflora was the dominant tree species showing stunted growth with very few individuals of *Acacia nilotica* and *Zizyphus nummularia*. The density varied between 3 to 6 individuals per 10 m^2. During the summer and winter seasons the soil is usually devoid of ground vegetation. A very few perennials such as *Aerva javanica*, *Boerhaavia diffusa*, *Heliotropium indicum*, *Launea procumbens*, *Indigofera* spp., *Lotus* sp., grasses and reeds were found throughout the year.

During rainy season, the seasonal ground vegetation is composed of *Citrulus colocynthis*, *Mukia maderaspatana* and various species of grasses.

II. Sand dunes

Sand dunes are extended between scrubs and muddy shorelines and are dominated by grasses. The trailing *Ipomoea prescarpe* was observed spreading over loose sand in many places. The grasses formed small patches intermittently on otherwise barren sand dunes. The grass and allied species include, *Cenchrus biflora*, *Cyperus arenarius*, *C. conglomeritus*, *Dactyloctenium sindicum*, *Leptochloa fusca*, *Fimbristylis cymosa*, *Juncus meritimus*, *Pycreus* spp., *Scirpus tuberosus*, *Sporobolus maderaspatenus*.

III. Salt pans

Saltpans are typical tide water impounded enclosed system adjacent to creek environment. They are characteristically exposed to a wide range of environmental stress and perturbation which manifest mainly through salinity changes. However, saltpans are immature ecosystem as compared with a typical marine system and harbour a high proportion of opportunistic species. Species diversity is directly linked with salinity. Hence the higher the salinity, the lower the species diversity and simpler the structure of the ecosystem.

The abandoned salt pans occupy significantly large area with poor diversity. A few halophytes such as *Suaeda fruticosa*, *S. maritima*, *Sesuvium portulacastrum* were abundant, The other herbaceous species which grow along the bunds include *Cresa critica*, *Aleurops lagopoides*, *Aerva javanica*, *Fagonia cretica*, *Evolvulus nummularius*, *Launea procumbens*, *Lotus* sp., *Trianthema portulacastrum*.

These saltpans serve as feeding grounds for a variety of resident as well as migrant birds.

IV. Supra-littoral zone

The zone represents area in between sandy dunes and the inter-tidal mudflats. The substrate is mainly sandy supporting healthy thickets of halophytes, mostly *Salicornia brachiata*. Also other halophytes including *Suaeda meritima*, *S. fruticosa*, *Sesuvium portulacastrum* were abundant. The grasses found associated with them include *Dactyloctenium sindicum*, *Cynodon dactylon*, *Aleurops lagopoides*.

V. Intertidal mangrove zone

This zone forms one of the important habitats as it harbours several species and provides suitable conditions required for their breeding and feeding. There are two important sites forming this zone in the entire study area; one at the extreme west of the project site along Modhwa Creek and one to the south along Kotdi Creek.

The mangroves of this area as described earlier are dominated by *Avicennia marina* which shows a very stunted growth of max. 2 m. *A. alba* was also seen rarely. The associates like *Salvadora persica* was hardly observed in this zone.

The zone also shows very high density of saplings.

VI. Intertidal open mudflat zone

This zone though looks devoid of any vegetation it is actually inhabited by a few algal species namely, *Cladophora glomerata*, *Enteromorpha intestinalis* and *Ulva sp*. *Enteromorpha intestinalis* forms enormous blooms in this zone changing the physiognomy of the area drastically.

This zone however is rich in faunal diversity with molluscs, flatworms, crabs and is visited by several migrant bird species.

VII. Rocky beds

This habitat is confiding to the southwestern edges of the Mandvi – Mundra coast lines. The only vegetation found were a few species of green and red algae present along the crevices and ditches formed on the rocky substratum. The common species include *Colpomenia sinuosa*, *Corallina officinalis*, *Enteromorpha* sp., *Padina tetrastromatica*, *Sargassum tenerrimum*, *Ulva fasciata*, *Ulva lactuca*.

However, this habitat seems to support a great deal of faunal diversity.

3.2 Community structure analysis

3.2.1 Vegetation

The tree component was represented only by five species in the entire sampled area viz. *Prosopis juliflora*, *Acacia nilotica*, *Zizyphus mauritiana*, *Avicennia marina*, and *A. alba. P. juliflora* showed high density of 170 individuals / ha.

Fig. 4: Map showing intake and outfall channels, different habitats mapped.
(Blue line: intake channel; Orange line: outfall channel; Dark green area: dense mangrove patch; Light green area: sparse mangrove cover; Light blue area: Potential sites for mangrove plantation; Yellow area: sand dunes; Dark yellow area: salt pans; Black area: rocky beds)

At the intertidal mangrove zone along Mudhwa creek *Avecinnia* stand density was 390 individuals/ ha while that along the Kotdi creek was 130 individuals / ha. Both the stands had very high density of saplings (app. 30-70 saplings per 100 m^2).

The study area being a typical marine ecosystem complex is highly heterogenous with several habitats which differ in their physico-chemical parameters and biological composition. The habitats identified during this study too are not comparable and they hardly have species in common (Appendix I). However, species richness was found highest (39 species) in the scrub forest, followed by grass dominated sandy dunes (22) and salt pans (13). One single species was not found occupying more than three habitat types.

Herbaceous communities dominant in the area are either halophytes or grasses. The Important Value Index plotted for herbs across three habitats such as sand dunes, salt pans and supra-littoral zone shows that *Cyperus conglomeratus* was the most dominant species followed by *Cyperus pangorei* and *Paspalum distichum.* However, the gradual slope indicates that overall low dominance and more or less uniform utilization of resources among the species (Fig. 5).

In all twelve species of algae were recorded from intertidal mudflats as well as rocky beds (Appendix I).

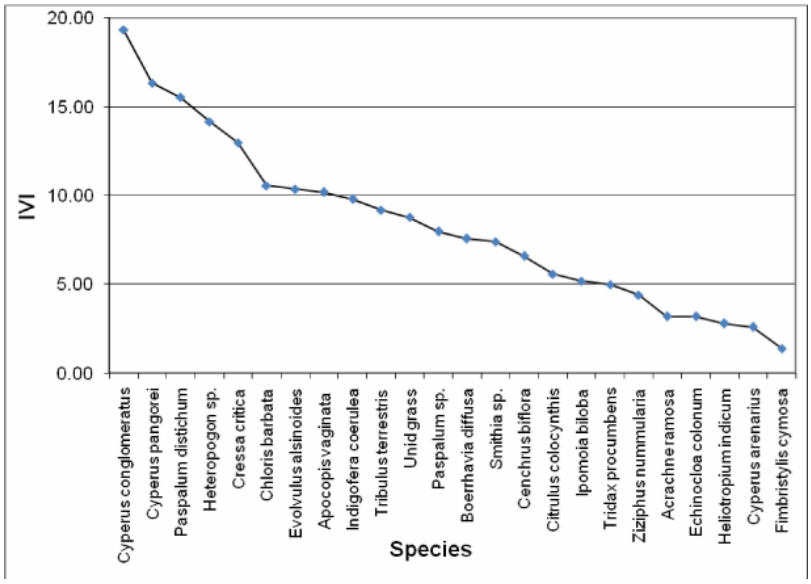

Fig 5: IVI plotted against species sequence for the herbaceous species

3.2.2 Mollusca

Mollusca are one of the most diverse groups of animals on the planet, with at least 1,00,000 living species (and more likely around 200,000). It includes familiar organisms such as sea slugs, octopus, squid, clams, oysters, cowries, cones and chitons. Molluscs are a group of organisms that have soft bodies which typically have a “head” and a “foot” region. Often their bodies are covered by a hard exoskeleton, as in the shells of snails and clams or the plates of chitons. They also have a very long and rich fossil record going back more than 550 million years, making them one of the most common types of organism used by paleontologists to study the history of life.

Marine molluscs occur on a large variety of substrates including rocky shores, coral reefs, mud flats, and sandy beaches. Gastropods and chitons are characteristic of these hard substrates, and bivalves are commonly associated with softer substrates where they burrow into the sediment. However, there are many exceptions: the largest living bivalve, *Tridacna gigas*, lives on coral reefs, and many bivalves (e.g., mussels and oysters) attach themselves to hard substrates. For the marine molluscan population estimation and seasonal variations the intertidal habitat of Modhwa creek was selected. The total inter-tidal area was divided in to six different zones with each zone having 5 quadrats of 1x1 meter size. Three Habitats i.e. Sandy-Muddy, Sandy and Rocky were covered under sampling area.

Diversity

Total 16 species of Gastropods were found in the sampling area (Table 3), however the list of total species encountered is given separately in the annexure. Maximum species were found to be 14 in winter, whereas the lowest species richness was in summer i.e. 10 (Fig. 6). *Trochus niloticus* was found only during the winter of 2008, however it was not found in any other seasons. *Purpura panama* was found only during the monsoon sampling. *Cerithidea cingulata* was found to be dominant throughout the upper intertidal habitats where as *Hemifusus pugilinus* was found dominant in the lower intertidal areas (rocky edge).

Density

Density is one of the most simple analysis factors (the number of individuals per unit area or volume). Highest density of the phylum Mollusca was found to be 4.8 per quadrat where as lowest was 2.1 in summer (Fig. 7). By plotting the graph of phylum density versus the temperature gradient it is evident that the total molluscan density is inversely proportionate to the temperature. The seasonal variation in water temperature was up to 6^{o}C, the highest was recorded during peak summer was 28^{0}C and the lowest was recorded in winter i.e. 22^{0}C which might have decreased the total density of the Gastropod complex to the half of the value i.e. from 4.8 to 2.1 animals per quadrate, which shows a clear indication that the density of gastropods is inversely proportionate to the temperature gradient.

Table 3: Total species within the Quadrates

Sr. No.	Species
1	*Trochus niloticus*
2	*Trochus radiatus*
3	*Cerithium scabridum*
4	*Cerithidea cingulata*
5	*Telescopium telescopium*
6	*Natica picta*
7	*Murex brunneus*
8	*Thais rugosa*
9	*Thais lacera*
10	*Cronia subnodulosa*
11	*Cantharus undosus*
12	*Nassarius distortus*
13	*Pugilina* (*Hemifusus*) *cochlidium*
14	*Turbo brunneus*
15	*Purpura persica*
16	*Babylonia spirata*

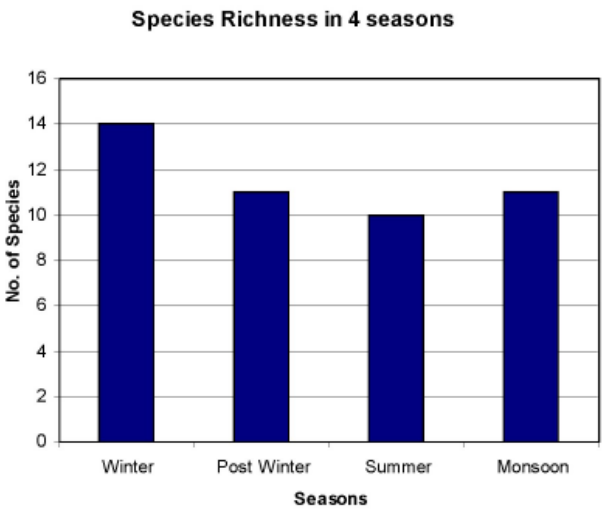

Fig. 6: Molluscan species richness over four seasons

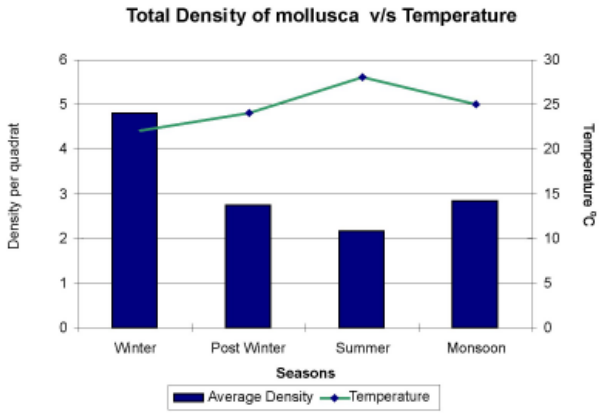

Fig. 7: Molluscan density over four seasons

Relative Abundance

Relative abundance is determined not only by the number of species within a biological community—*i.e.,* species richness—but also by the relative abundance of individuals in that community. Species abundance is the number of individuals per species, and relative abundance refers to the evenness of distribution of individuals among the community.

Results of Relative abundance depict the dominance of the particular species in the given community. Four species viz. *Cerithidea cingulata, Nassarius distortus, Trochus radiatus and Cantharus undosus* were found to be most dominant amongst the all occurring species of gastropods (Fig 8). However, the temperature variation from winter to peak summer was 6^{0}C though the relative abundance of these species was found to be on the higher side compared to the other species and was not much affected and hence is considered as dominant species of the molluscan community throughout the year (Fig. 8-11).

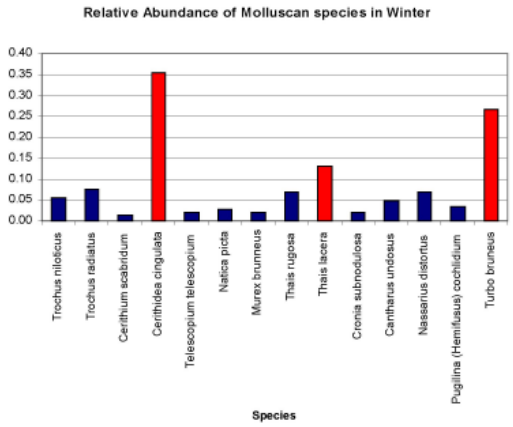

Fig 8: Relative abundance of Molluscan species during winter

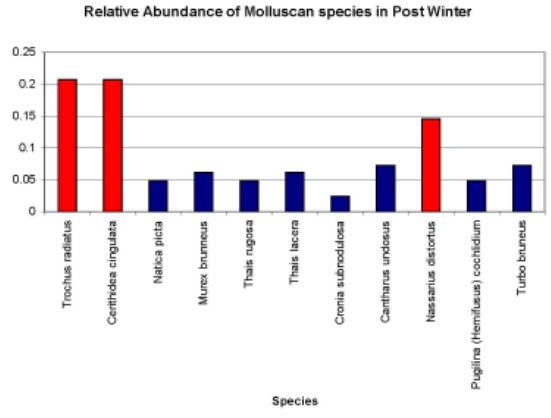

Fig 9: Relative abundance of Molluscan species during post-winter

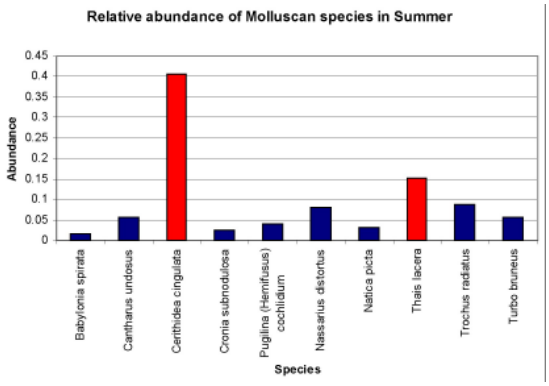

Fig 10: Relative abundance of Molluscan species during summer

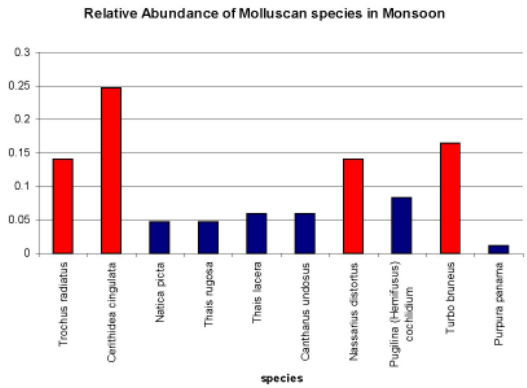

Fig 11: Relative abundance of Molluscan species during monsoon

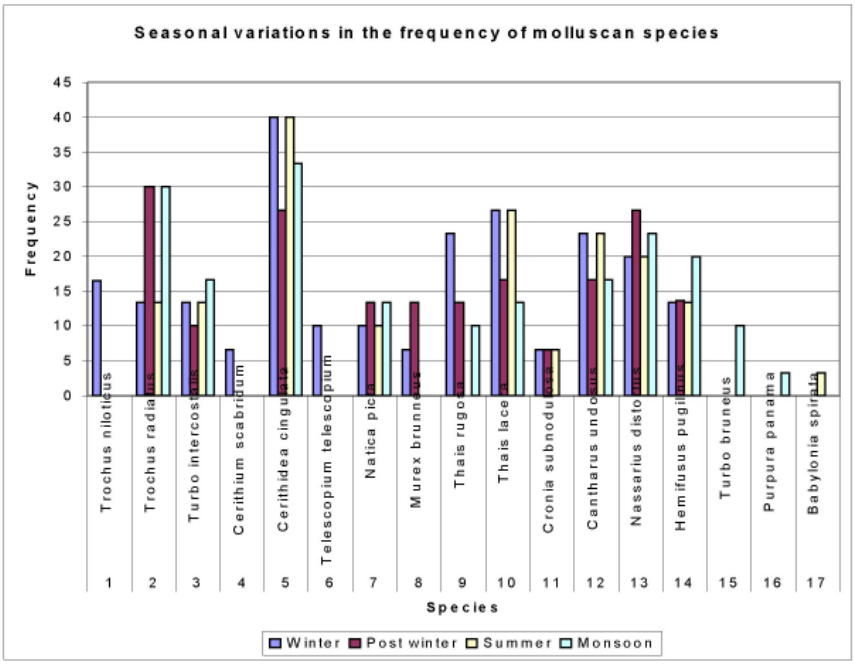

Fig 12: Seasonal variation in the frequency of Molluscan species

Why Monitor mollusca?

Our focus for long term monitoring is on mollusca as these are sedentary species and site specific and do not undertake migration. Thus they will show significant population shift with biotic and abiotic factor fluctuations. This could be easily correlated with increased temp due to warm water release once plant gets operational. Since molluscs are sedentary species, they provide ideal benchmark for future monitoring. There are number of other sedentary species we may choose. But for seasonal monitoring, one need to identify species which can be easily recognizable and yet effective indicators. If we choose birds as monitoring species for e.g., then there are several external factors as well which will influence their population such as draught at nesting areas, hunting on migration route, lack of rainfall etc.

3.2.3 Birds

Shorebirds, also known as waders, undergo amongst the most spectacular feats of migration seen in the animal kingdom, with some species traveling in excess of 20,000 km a year during a life span that may exceed 20 years. Migration enables them to breed in highly productive wetlands at high (Arctic) latitudes of the northern hemisphere during the brief northern summer, and then disperse widely to the south for the rest of the year. The migratory lifestyle of shorebirds is fascinating but it also presents a major conservation problem, the birds rely on sites at destination, and some in-between, at different times of the year. To compound this problem, shorebirds commonly use coastal habitats and congregate at a small number of sites. Their conservation thereby often conflicts with human use of such areas. Major impacts are habitat loss and degradation, hunting and other disturbance, and competition for food.

The Central Asian Flyway (CAF)

The Central Asian Flyway (CAF) has also been referred to as the *Central Asian-Indian Flyway* and the *Central Asian-South Asian Flyway*. It covers a large continental area of Eurasia between the Arctic Ocean and the Indian Ocean and the associated island chains. The CAF comprises several important migration routes of waterbirds, most of which extend from the northernmost breeding grounds in Siberia to the southernmost non-breeding wintering grounds in West Asia, South Asia and the British Indian Ocean Territory.

The CAF range is essentially centred on one of the three major wintering areas of waterfowl in the Old World, namely the Indian subcontinent, the other two being Africa, in territory of the African-Eurasian Flyway (AEWA) to the west, and south-east Asia in the East Asian-Australasian Flyway (EAAF) to the east. These wintering areas are geographically separate, and present entirely different ecological, historical and cultural situations.

The Central Asian Flyway covers at least 279 migratory waterbird populations of 182 species, including 29 globally threatened species and NTspecies that breed, migrate and spend the non-breeding winter period within the region.

Fig 13: Central Asian, East Asian-Australasian and West Pacific migratory bird flyways

India is the core country of the CAF and supports 257 species of water birds. Of these, 81 species are migratory birds of CAF conservation concern, including three critically endangered species, six endangered species and 13 NTspecies. The Ministry of Environment and Forests is the nodal agency for developing strategy and action plans and managing national, regional and international programmes on water birds and wetlands conservation. Implementation of action plans is through the states' environment and forests agencies with complementing activities provided by many academic institutions, NGO-conservation organizations, professional institutions and international agencies. The Bombay Natural History Society is the foremost NGO in India working on water birds and wetlands. India has identified more than 300 potential RAMSAR sites, of which 25 have been implemented. India is notable among CAF countries, with an extensive series of important bird areas and protected areas including bird sanctuaries, wildlife sanctuaries and national parks covering wetlands that provide convenient stopover and wintering areas for migratory birds using the Central Asian Flyway.

As shorebirds are not constrained by international boundaries, their conservation requires that governments cooperate and coordinate conservation efforts, especially the identification and protection of important sites. The identification of important sites requires information on the numbers of birds at sites and the total size of each shorebird population.

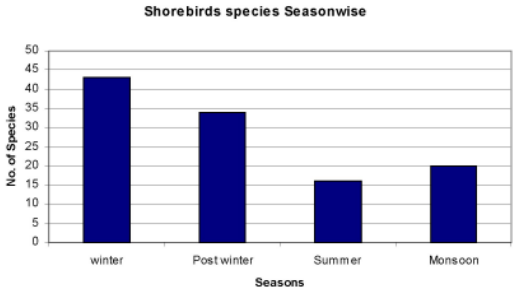

Fig 14: Shore birds species richness over the four seasons

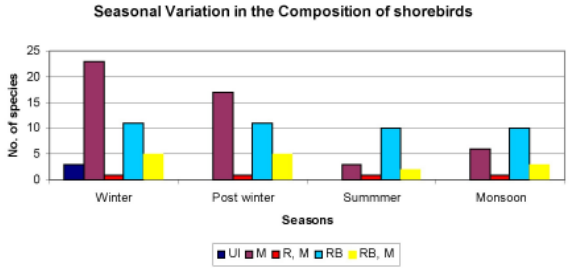

Fig. 15: Graph showing seasonal variation in different categories of Shorebirds

4 Conclusions and Recommendations

Following are the points summarizing the impact posed by various activities-

1) The overall floral diversity of the study area is low, owing mainly to the high biotic disturbances and alterations in the landuse patterns. However, the area is still rich in the faunal diversity pertaining to almost all the groups studied.
2) Intertidal mudflat zone is also important with respect to molluscan diversity, the studies of correlation between algal and molluscan species abundance can be taken up in future**.**
3) Though the seedling and sapling density of mangrove species was found high in both the stands along Mudhwa as well as Kotdi creek, the overall stand is highly disturbed by grazing and saltpan activities operated nearby. Enormous camel grazing affects seedling and sapling establishment in both the areas. This may be one of the major reasons for low establishment of mature trees.
4) According to the amended plan of the outfall channel, this channel has changed its course westward, which passes across the mouth of the Mudhwa creek and the rocky bed towards the west of the project site. This channel will be dredged below ground level. The effluent water probably 7°C warmer than the sea water may affect the saplings of mangrove as well as biota sustaining in this habitat.
5) Some saltpans are seen recently being developed in the supra-littoral zones near Mudhwa creek certainly affecting the mangroves seedling and sapling establishment.

As far as fauna is concerned the study was mainly focused on two major groups viz. Mollusca and Birds to understand the impact of seasonal variations on the community composition. The project period was too short to draw a detailed trend and design a model to understand the impact of seasonal variations on Biodiversity. However, benchmarking biodiversity will be helpful over time to see the change and take appropriate mitigative measures. Though we were able to conclude on the following points; Analysis of community structure is important not only for an understanding of the magnitude of production and energy pathways, but also in evaluating environmental and man-made changes on biota, and further in the management and conservation of the environment (Harkantra, 1985).

1. Impact of Seasonal Variations on Selected Groups:

Mollusca

The counts taken during 4 seasons showed great variation in the species richness as well as the density of Mollusca. Highest species richness was encountered during winter when water temperature was as low as 22^{o}C, whereas lowest richness was found in summer i.e. 10. The density of the molluscan fauna was also highest in winter i.e. 4.8 whereas lowest 2.1 in summer. However the relative abundance of six species found to be high and hence have been identified for long term monitoring to assess the impact of temperature variation on the molluscan community composition. These species can be monitored seasonally and the population ecology can be studied to understand the impact of high variations in the environment and biodiversity resilience. The selected species are as follows.

In future when the plant gets operational and will start releasing water with 7^0C high temperature over that of the sea water through the outfall channel, and with higher temperature regimes, in summer can affect the population of major invertebrates including the mollusca. It requires monitoring in each season. The higher temperature variation is directly proportionate to the salinity rise as the high temperature increase the evaporation rate of the water. Hence, the group of animals, which are prone to decline due to high salinity will be affected adversely.

Sr. No	Species for long term monitoring
1	*Ceritidea cingulata*
2	*Thais rugosa*
3	*Thais lacera*
4	*Cantharus undosus*
5	*Nassarius distortus*
6	*Pugilina* (*Hemifusus*) *cochlidium*

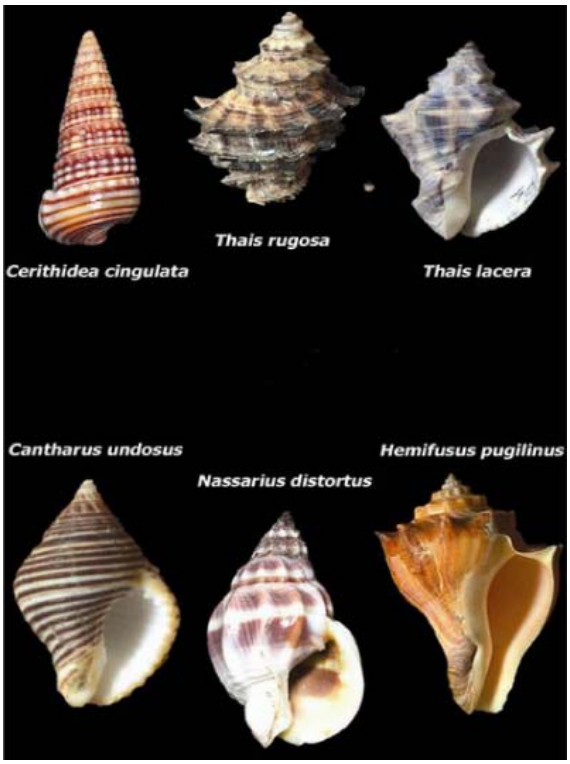

Fig. 16: The molluscan species selected for the long term monitoring programme

Birds

Avifauna of the area was classified in to two major groups i) Terrestrial and ii) Shorebirds. Total 75 species were observed during the project period of which 43 are shorebirds. In all the counts terrestrial birds does not show much variation in the species richness, whereas the shorebirds showed a characteristic trend with the seasonal variations. The diversity shorebirds were 43 in the winter with 23 purely migratory species where only 3 migratory species of birds were observed in summer. During the study out of 43 species of shorebirds, 6 species have been listed under decreasing global population status by IUCN. Where as 5 species are NTand one species Dalmatian Pelican is listed vulnerable. (IUCN Red Data book 2009). Most of the species of shorebirds use existing mangroves for roosting and mudflats and the intertidal areas for the feeding. Black-necked Stork has been found nesting (July 2008 and August 2009) on the mangroves of Modhwa creek near proposed outfall channel.

Table 4: Important shorebird species

Common Name	Scientific Name	IUCN Status
Eurasian Curlew	*Numenius arquata*	NT
Black-tailed Godwit	*Limosa limosa*	NT
Black-headed Ibis	*Threskiornis melanocephalus*	NT
Black-necked Stork	*Ephippiorhynchus asiaticus*	NT
Painted Stork	*Mycteria leucocephala*	NT
Dalmatian Pelican	*Pelecanus crispus*	Vulnerable

1. Impact of outfall channel on sea turtle nesting

There are two endangered species of turtles reported from this area i.e. Green Sea and Olive Ridley. As per (Chaudhary, 2006) the area is an important turtle nesting site of Gujarat. It has been also confirmed by the local fishermen that sea turtles do nest in the area. There are 43 nests within the impact area of the outfall channel. (source: Chaudhary, 2006 Marine turtles of India, study conducted by WII) Turtles belonging to reptile group are cold-blooded animals and are highly sensitive towards temperature variations. The upcoming outfall channel, opening in the Gulf of Kutch will carry 7^0C higher temperature water than the normal sea water. Large quantity of high temperature sea water will impact the breeding ecology of the turtles. The turtles have temperature-dependant sex determination, and rising temperature will alter the sex ratio with an incline towards more female hatchlings. The mortality at the embryonic stage is also high in the raised temperature environments (Pintus K. J. *et al*, 2009).

Transects on various habitats

Sand dunes

Scrub forest dominated by *Prosopis juliflora*

Sandy flats inhabited by halophytes like *Salicarnia brachiata*

Mudflats

Rocky beaches

Salt pans

Mangroves on the west of the proposed outfall channel

Mangroves along Kotdi Creek

Dredging activities before the construction of Intake channel

Excavation activity by the salt pan owners right in the midst of westward mangroves

Enteromorpha sp. blooms in intertidal mudflats

Colpomenia sinuosa

Codium sp.

Trianthema portulacastrum

Fagonia cretica

Launea procumbens

Tribulus terrestris

Evolvulus nummularis

Ipomoea sp

Lotus sp.

Hedyotes sp.

Smithia sensitiva

Indigofera cordifolia

Citrulus colocynthis

Aerva javanica

Aerva javanica

Cressa cretica

Cressa cretica

Suaeda meritima

Salicarnia brachiata

Avicenna marina

Scirpus tuberosus

Pycreus sp. 1

Pycreus sp. 2

Cyperus sp.

Dactyloctenium sindicum

Sporolobus maderaspatenus

Sporolobus maderaspatenus

Aeluropus lagopoides

Leptochloa fusca

Mitrella blanda

Pugilina (Hemifusus) cochlidium

Feather star

Ghost Crab

Eurasian Curlew (Near Threatened)

Crab Plover

Dalmatian Pelican (Vulnerable)

Lesser Flamingos (Near Threatened)

Black-necked Stork
(Near Threatened)

Painted Stork

Star Tortoise

Olive Ridley Turtle (Endangered)

Indian fringe toed lizard

Monitor Lizard

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Appendix I
Distribution of plant species in various habitats identified within the study area

Sr.No.	Species	I	II	III	IV	V	VI	VII	Total
1	*Acacia nilotica*	+	-	-	-	-	-	-	1
2	*Prosopis juliflora*	+	-	-	-	-	-	-	1
3	*Zizyphus mauritiana*	+	-	-	-	-	-	-	1
4	*Avicennia marina*	-	-	-	-	+	-	-	1
5	*A. alba*	-	-	-	-	+	-	-	1
	Shrubs								
6	*Aerva javanica*	+	-	-	-	-	-	-	1
7	*Heliotropium indicum*	+	-	-	-	-	-	-	1
8	*Indigofera coerulea*	+	-	-	-	-	-	-	1
9	*Ipomoia prescarpe*	+	-	-	-	-	-	-	1
10	*Salvadora persica*	-	-	-	+	+	-	-	2
11	*Ziziphus nummularia*	+	-	-	-	-	-	-	1
	Herbs								
12	*Acrachne ramosa*	+	+	-	-	-	-	-	2
13	*Aleurops lagopoides*	+	+	-	-	-	-	-	2
14	*Apocopis vaginata*	+	+	-	-	-	-	-	2
15	*Bergia suffruticosa*	+	-	+	-	-	-	-	2
16	*Boerrhavia diffusa*	+	-	-	-	-	-	-	1
17	*Cenchrus biflora*	+	-	-	-	-	-	-	1
18	*Chloris barbata*	+	+	-	-	-	-	-	2
19	*Citrulus colocynthis*	+	-	-	-	-	-	-	1
20	*Cressa critica*	+	-	-	-	-	-	-	1
21	*Cynodon dactylon*	+	+	-	+	-	-	-	3
22	*Cyperus arenarius*	+	+	-	-	-	-	-	2
23	*Cyperus conglomeratus*	+	+	-	-	-	-	-	2
24	*Cyperus pangorei*	+	+	-	-	-	-	-	2
25	*Dactyloctenium sindicum*	+	+	+	-	-	-	-	3
26	*Leptochloa fusca*	+	+	-	-	-	-	-	2
27	*Echinocloa colonum*	+	+	-	-	-	-	-	2
28	*Evolvulus nummularis*	+	-	-	-	-	-	-	1
29	*Fagonia cretica*	-	-	+	-	-	-	-	1
30	*Fimbristylis cymosa*	+	+	-	-	-	-	-	2
31	*Heteropogon sp.*	+	+	-	-	-	-	-	2
32	*Junchus meritimus*	+	+	-	-	-	-	-	2
33	*Launea procumbens*	+	-	+	-	-	-	-	2
34	*Lotus sp.*	+	-	-	-	-	-	-	1
35	*Mukia maderaspatanus*	+	+	-	-	-	-	-	2
36	*Paspalum distichum*	+	+	-	-	-	-	-	2
37	*Paspalum sp.*	+	+	-	-	-	-	-	2
38	*Salicarnia brachiata*	-	-	+	+	-	-	-	2
39	*Scirpus tuberosus*	+	+	+	-	-	-	-	3
40	*Sesuvium portulacastrum*	-	-	+	-	-	-	-	1
41	*Smithia sp.*	+	-	+	-	-	-	-	2
42	*Sporobolus maderaspatenus*	-	+	+	-	-	-	-	2
43	*Sueda fruticosa*	-	-	+	+	-	-	-	2
44	*Sueda meritima*	-	-	+	+	-	-	-	2
45	*Trianthema portulacastrum*	+	+	+	-	-	-	-	3
46	*Tribulus terrestris*	+	-	+	+	-	-	-	3
47	*Tridax procumbens*	+	+	-	-	-	-	-	2
48	*Urochorda setulosa*	+	+	-	-	-	-	-	2
	Algae								
49	*Caulerpa crassifolia*	-	-	-	-	-	-	+	1
50	*Champia indica*	-	-	-	-	-	-	+	1
51	*Cladophora glomerata*	-	-	-	-	-	+	+	2
52	*Codium sp.*	-	-	-	-	-	-	+	1
53	*Colpomenia sinuosa*	-	-	-	-	-	-	+	1
54	*Corallina officinalis*	-	-	-	-	-	-	+	1
55	*Enteromorpha intestinalis*	-	-	-	-	-	+	+	2
56	*Padina tetrastromatica*	-	-	-	-	-	-	+	1
57	*Sargassum sp.*	-	-	-	-	-	+	+	2
58	*Sargassum tenerrimum*	-	-	-	-	-	+	+	2
59	*Ulva fasciata*	-	-	-	-	-	+	+	2
60	*Ulva lactuca*	-	-	-	-	-	+	+	2
		39	**22**	**13**	**6**	**3**	**6**	**12**	

Annexure 2: Crab species of the Study area

Sr. No.	Scientific Name	Common Name	Edibility
1	*Atergatis integerrimus*	Queen crab	Low
2	*Portunus sanguinolentus*	Three spotted crab	High
3	*Portunus pelagicus*	Neptune crab	High
4	*Matuta planipes*	ghost crab	Low
5	*Menaethius monoceros*	not known	Low
6	*Scylla serrata*	Mud crab	High
7	*Xantho scaberrimus baccalipes*	Custard apple crab	Low
8	*Etisus laevimanus*	not known	Low
9	*Uca annulipes*	fiddler crab	Low
10	*Ocypode platytarsus*	ghost crab	Low
11	*Grapsus albolineatus*	rock crab	Low
12	*Pilumnus vespertilio*	wolf crab	Low
13	*Charybdis variegata*	not known	High
14	*Eriphia smithi*	Calico crab	Low
15	*Doclea rissonii*	not known	Low
16	*Thalamita prymna*	True crab	High

Annexure 3: Prawns of the Study area

Sr. No.	Scientific Name	Common Name	Edibility
1	*Penaeus merguiensis*	Banana Prawn	High
2	*Metapenaeus affinis*	Jinga Prawn	High
3	*Penaeus monodon*	Tiger Prawn	High
4	*Metapenaeus brevicornis*	not known	High
5	*Metapenaeus kutchensis*	Kutchi Prawn (Endemic)	High
6	*Metapenaeus monoceros*	not known	Low
7	*Metapenaeus stebbingi*	not known	High
8	*Parapenaeopsis sculptilis*	Rainbow shrimp	High
9	*Penaeus japonicus*	Kuruma prawn	High
10	*Penaeus semisulcatus*	Green tiger prawn	High

Annexure 4: Dominant Invertebrates of the Study Area

Sr. No.	Phylum	Species	Common name
1	Cnidaria	*Porpita Porpita*	Porpita
2		*Physalia physalis*	Portuguese Man Of War
3		*Polythoa sp.*	Zooanthus
4		*Crambionella tuhlamanni*	Jelly Fish
5	Annelida	*Myzostoma attenuatum*	Polychaete worm
6	Arthropoda	*Lepas anserifera*	Goos neeck Barnacle
7		*Balanus reticulatus*	Acorn Barnacles
8	Echinodermata	*Echinodiscus sp.*	Sand dollar
9		*Astropecten sp.*	Star fish
10		*Ophiocnemus sp.*	Brittle star
11		*Stephanometra sp.*	Feather star

Annexure 4: Reptiles of the Study Area			
Sr. No.	**Group**	**Common Name**	**Scientific Name**
A.	**Turtle**		
1		Turtle Green Sea	*Chelonia mydas*
2		Turtle Olive Readily	*Lepidochelys olivacea*
B.	**Tortoise**		
1		Tortoise Star	*Geochelone elegans*
C.	**Snake**		
1		Viper Saw Scaleda	*Echis carinatus*
2		Viper Russell's	*Daboia russelii*
3		Indian Rat Snake	*Ptyas mucosus*
4		Cobra Bioccelate	*Naja naja*
5		Dog Face Water Snake	*Cerberus rynchops*
6		Glossy Marsh Snake	Gerarda prevostiana
7		Hook Nosed Sea Snake	*Enhydrina schistosa*
8		Bombay sea snake	*Hydrophis mamillaris*
9		Common Small headed sea snake	*Hydrophis gracilis*
10		Yellow Sea Snake	*Hydrophis spiralis*
D.	**Lizard**		
1		Lizard Fan Throated	*Sitana ponticeriana*
2		Indian Fringe Toed Lizard	*Acanthodactylus cantoris*
3		Indian Garden Lizard	*Calotes versicolor*
4		Monitor Lizard	*Varanus bengalensis*

Annexure 5: Mammals of the Study Area		
Sr. No.	**Common Name**	**Scientific Name**
1	Jungle cat	*Felis chaus*
2	Wolf	*Canis lupus*
3	Jackal	*Canis aureus*
4	Small Indian Civet	*Viverricula indica*
5	Common Mangoose	*Herpestes edwardsi*
6	Blue Bull	*Boselaphus tragocamelus*
7	Indian Wild Boar	*Sus scrofa*
8	Pale Hedgehog	*Paraechinus misfopus*
9	Indian Hare	*Lepus nigricollis*
10	Indian Flying Fox	*Pteropus giganteus*
11	Fluvous Fruit Bat	*Rousettus leschenaulti*
12	Indo-Pacific Humpback Dolphin	*Sausa chinensis*

Annexure 6: Avifaunal Diversity				
Sr. No.	**Species**	**Scientific Name**	**Breeding Status**	**IUCN status**
1	Pied Avocet	*Recurvirostra avosetta*	RB, M	LC
2	Jungle Babbler	*Turdoides striatus*	M	LC
3	Blue-tailed Bee-eater	*Merops philippinus*	RB	LC
4	Small Green Bee-eater	*Merops orientalis*	RB,M	LC
5	Red Vented Bulbul	*Pycnonotus cafer*	RB	LC
6	Oriental Honey Buzzard	*Pernis ptilorhyncus*	RB	LC
7	Little Cormorant	*Phalacrocorax niger*	RB	LC
8	House Crow	*Corvus splenddens*	RB	LC
9	Eurasian Curlew	*Numenius arquata*	RB	NT
10	Little Brown Dove	*Streptopelia senegalensis*	RB	LC
11	Spotted Dove	*streptopelia chinensis*	RB,M	LC
12	Black Drongo	*Dicrurus macrocercus*	M	LC
13	Dunlin	*Calidris alpine*	M	LC
14	Large Egret	*Casmerodius albus*	M	LC
15	Western Reef Egret	*Egretta gularis*	M	LC
16	Grey Francolin	*Francolinus pondicerianus*	M	LC
17	Bar-tailed Godwit	*Limosa lapponica*	RB	LC
18	Black Tailed Godwit	*Limosa limosa*	M	NT
19	Common Greenshank	*Tringa nebularia*	M	LC
20	Blackheaded Gull	*Larus ridibundas*	M	NL
21	Brownheaded Gull	*Larus brunnicephalus*	M	LC
22	Heuglin's Gull	*Larus heuglini*	M	NL
23	Yellow-legged Gull	*Larus michahellis*	M	NL
24	Marsh Harrier	*Circus aeruginosus*	RB	LC
25	Montague's Harrier	*Circus pygargus*	M	LC
26	Grey Heron	*Ardea cinerea*	RB,M	LC
27	Pond Heron	*Ardeola grayii*	M	LC
28	Hoopoe Common	*Upupa epops*	RB	LC
29	Black-headed Ibis	*Threskiornis melanocephalus*	M	NT
30	Lesser Kestrel	*Falco tinnunculus*	M	LC
31	Black Shouldered Kite	*Elanus caeruleus*	M	LC
32	Pariah Kite	*Milvus migrans*	M	LC
33	Red Wattled Lapwing	*Vanellus indicus*	R, M	LC
34	Yellow Wattled Lapwing	*Vanellus malarbaricus*	RB, M	LC
35	Crested Lark	*Galerida cristata*	M	LC
36	Common Myna	*Acridotheres tristis*	RB	LC
37	Indian Nightjar	*Caprimulgus asiaticus*	M	LC
38	Eurasian Oystercatcher	*Haematopus ostralegus*	M	LC
39	Dalmatian Pelican	*Pelecanus crispus*	M	Vulnerable A2ce+3ce+4ce

Annexure 6: Avifaunal Diversity (contd.)				
Sr. No.	**Species**	**Scientific Name**	**Breeding Status**	**IUCN status**
40	Great White Pelican	*Pelecanus onocrotalus*	M	LC
41	Crow Pheasant	*Centropus sinenis*	RB	NL
42	Blue Rock Pigeon	*Columba livia*	RB	LC
43	Crab Plover	*Dromas ardeola*	RB	LC
44	Great Stone Plover	*Esacus recurvirostris*	RB	LC
45	Kentish Plover	*Charadrius alexandrinus*	M	LC
46	Lesser Sand Plover	*Charadrius mongolus*	M	LC
47	Little Ringed Plover	*Charadrius dubius*	M	LC
48	Common Quail	*Coturnix coturnix*	R	LC
49	Indian Roller	*Coracias benghalensis*	R,M	LC
50	Ruff	*Philomachus pugnax*	RB	LC
51	Common Sandpiper	*Actitis hypoleucos,*	RB	LC
52	Green Sandpiper	*Tringa ochropus*	RB	LC
53	Marsh Sandpiper	*Tringa stagnatilis*	RB	LC
54	Terek Sandpiper	*Xenus cinereus*	RB	LC
55	Shikra	*Accipiter badius*	RB	LC
56	Bay Backed Shrike	*Linius vittatus*	RB	NL
57	Southern Grey Shrike	*Linius meridionalis*	RB	NL
58	Rufous Backed Shrike	*Linius collurio*	RB	NL
59	Eurasian Spoonbill	*Platalea leucorodia*	RB	LC
60	Rosy Starling	*Sturnus pagodarum*	RB	LC
61	Black-winged Stilt	*Himantopus himantopus*	RB,M	LC
62	Little Stint	*Calidris minuta*	RB	LC
63	Black-necked Stork	*Ephippiorhynchus asiaticus*	M	NT
64	Painted Stork	*Mycteria leucocephala*	M	NT
65	Barn Swallow	*Hirundo rustica*	RB	LC
66	Red-rumped Swallow	*Hirundo daurica*	RB	LC
67	House Swift	*Apus affinis*	RB	LC
68	Caspian Tern	*Sterna caspia*	RB	LC
69	Gull-billed Tern	*Gelochelidon nilcotica*	M	NL
70	Little Tern	*Sterna albifrons*	RB	LC
71	Whiskered Tern	*Chlidonias hybridus*	RB	LC
72	Ruddy Turnstone	*Arenaria interpres*	RB	LC
73	Desert Wheatear	*Oenanthe deserti*	RB	LC
74	Variable Wheatear	*Oenanthe picata*	M	LC
75	Whimbrel	*Numenius phaeopus*	M	LC

LC = Least Concern

NT = Near Threatened

NL = NL

Coastal Biodiversity Assessment and Benchmarking at Coastal Gujarat Power Ltd. (CGPL), Mandvi-Mundra Coast, Gujarat, India

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