CHAPTER 2:
STUDY SITE - NARARA REEF

Location

Consideration for current study

Geography and Hydrography

Sub-sites and field visits

Reef morphology and habitat characterization

2.1 LOCATION:

Narara reef (Latitude 22°25.8'N to 22°28.3'N and Longitude 69°42.1'E to 69°40.7'E), an integral part of India's first Marine Protected Area the Marine National Park, is situated in Gulf of Kachchh (GoK) on the coast running along Jamnagar district of Gujarat state. It is near to Vadinar village of Jam-Khambhaliya taluka (Plate: 2.1 a). The reef is also popular as *Narara Tapu* or *Narara Bet* or *Narara* only. It is one of the few reef formations in GoK formed contiguous to mainland hence the reef is accessible by motorway. The reef area is about 55 km away from Jamnagar city and can be approached from Jamnagar-Dwarka State Highway No. SH-25 via Jhankhar Patiya and Vadinar village, the nearest coastal village is about 8 km away from the reef area.

Narara reef is critically located on the southern coast of GoK. The reef area is surrounded by small to large reefs of Marine National Park and Sanctuary (MNP & S). Kalubhar Island, the largest island of MNP & S, is situated on the western side of Narara reef. This island has rich patches of mangroves and also harbors good corals (Nair, 2002). A narrow creek in-between separates Narara and Kalubhar. Goose reef, Sri reef and intertidal area of Sikka village are situated on the eastern side of Narara reef. All the three locations have coralline area and possess live coral formation. Eastern expansion of Narara reef is separated from Sikka intertidal by vast Sikka creek.

Narara is one of the famous tourist attractions of MNP & S, the location is also popular for Nature Education Camps organized by MNP & S annually to generate awareness on marine life among the school children of adjoining areas.

2.2 CONSIDERATION FOR CURRENT STUDY:

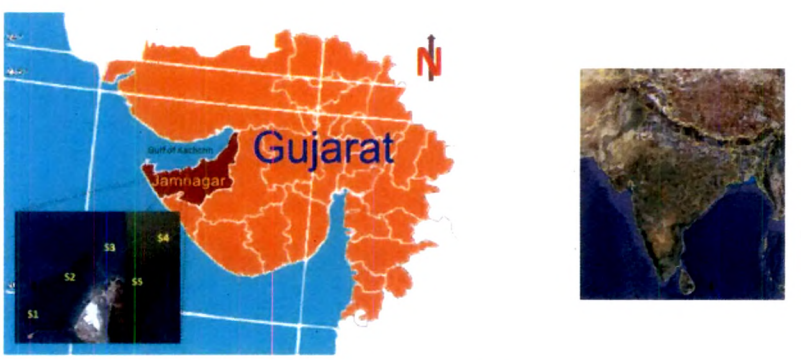
Before the various areas along the southern coast of GoK were notified as Marine Protected Area by Government of Gujarat in early 1980s, many areas were exploited for coralline sand by M/s Digvijay Cement factory located at Sikka. Narara reef was also among the severely affected coralline areas due to indiscriminate excavation of sand from intertidal area, with sand small to moderate size boulders were also exploited (Patel, 1985b; Singh *et al.*, 2004). This mining rendered Narara reef almost dead. The

giant petroleum refineries like Reliance Petroleum Ltd. (RPL) and ESSAR Oil Ltd. (EOL) at Moti-Khavdi and Jam-Khambhaliya respectively have preferred area around Narara reef for establishment of oil hubs, Single Buoy Moorings (SBM) and jetties. There are total 09 SBMs operational in this region, 1 off Narara bet (EOL), 2 off Vadinar (IOC) and 6 off Sikka (5 RPL and 1 BORL). All these have contributed to the increased traffic of Very Large Crude Carriers (VLCC) around this point, making this area prone to the oil spillages. In year 1999 a small scale crude spillages were observed washed ashore on Narara (Singh *et al.*, 2004). Apart from refineries many other major industries like M/s Digvijay Cement factory and Thermal Power Station at Sikka, production unit of Gujarat State Fertilizer Corporation (GSFC) at Moti-Khavdi, Singach Salt works at Singach (near Vadinar), Crude Oil Terminal of Indian Oil Corporation and sub-sea pipeline of Bharat-Oman Petroleum at Vadinar and Kandla Port Trust (KPT) complex off Vadinar have been setup in nearby vicinity (Plate: 2.1 b). The presence of such giant industries has made the location of the Narara reef critical in terms of any possible environmental catastrophes. In recent past, two pipelines were laid across the intertidal area of Narara to cater the supply need of oil industry and refinery.

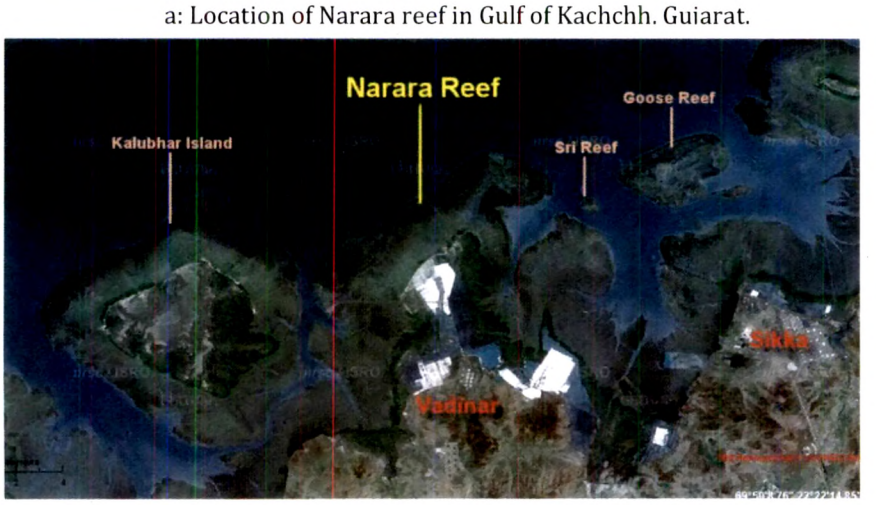
Further, as mentioned above, continuity of this reef area with mainland put it on preference of tourists who want to visit reefs located on remote islands e.g. Pirotan but cannot visit due to excess cost of boat hiring and unfavorable tide timings. Therefore, majority of tourists turn to Narara as second best, near and easily approachable place to experience marine life. As per Dixit *et al.*, (2010), mean values calculated for year 2004 to 2008 depicts that Narara received 29.79% of tourists compared to 61.97% for Pirotan (Fig. 2.1).

However, going through literature and preliminary survey revealed the fact that in spite of all above mentioned pressures, this reef area holds good coral diversity and has potential to regain its past glory if supported with in-depth understanding of ecology of this area leading to the better conservation practice aided with reef rehabilitation.

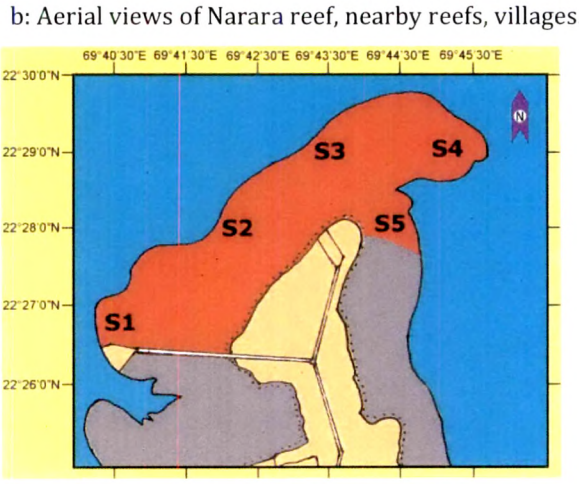
Plate: 2.1



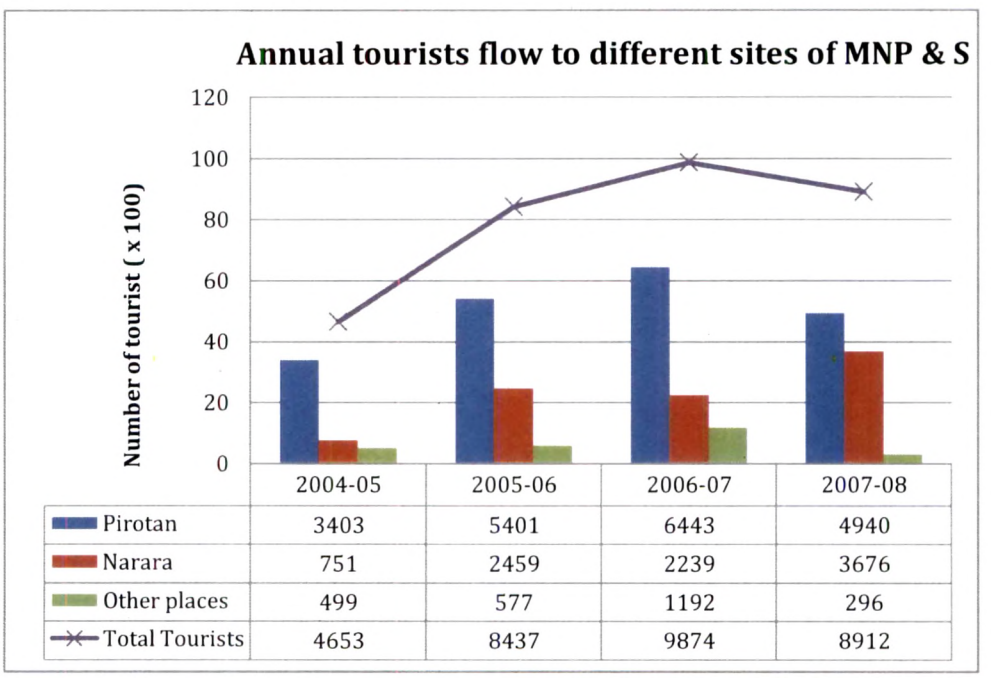
a: Location of Narara reef in Gulf of Kachchh. Guiarat.



b: Aerial views of Narara reef, nearby reefs, villages.



c: Sub-site wise zonation of Narara reef.



	2004-05	2005-06	2006-07	2007-08
Pirotan	3403	5401	6443	4940
Narara	751	2459	2239	3676
Other places	499	577	1192	296
Total Tourists	4653	8437	9874	8912

Fig. 2.1: Number of tourists visiting MNP & S areas.

2.3 Geography and Hydrography:

The Narara reef is expanded facing northwest direction. The area of Narara reef is approximately 3084.88 ha out of which 792.36 ha is notified as Marine National Park whereas remaining area falls under Marine Sanctuary and other reserve forest categories (MNP & S office records). This reef is located in the mid of GoK and hence it receives tidal front with phase lag of approx. 02 hours and 30 minutes from Okha, the mouth of the Gulf. Here the tidal amplitude is almost 4.85 m during spring tides and 2.65 m during neap tides (Fig. 2.2). Therefore, during normal tides the intertidal area get exposed ranging from 1.5km to maximum of about 5km. Whereas, during spring tides intertidal area remains exposed for the longest time with maximum relief. Entire reef area including high tidal mudflats gets submerged during each tide cycle.

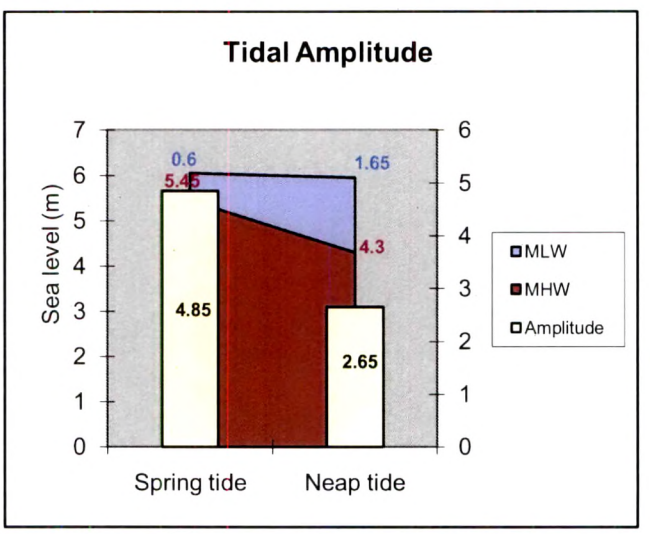


Fig. 2.2: Status of tides at Narara.

2.4 SUB-SITES AND FIELD VISITS:

The Narara reef intertidal area was divided in to five sub-sites i.e. S1, S2, S3, S4 and S5 for habitat characterization study, biodiversity assessment and seawater sample collection to assess prevailing physico-chemical environment (Plate: 2.1 c). Each sub-site was defined considering spatial relief between sub-sites, each of the sub-sites receives different wave action because of difference in directions and surrounding geographical features (Plate: 2.2 a, b). Such a division helped to compare spatial variation for study parameters.

The reef area was visited over the period of 02 years and 09 months i.e. May 2007 to January 2010 to achieve objectives set forth for this study. Total 23 field visits involving 82 days were conducted. The majority of field visits were planned 4-5 days following full moon or new moon to get the daytime low tides. The intertidal extent of Narara reef is huge so it was only possible to explore single sub-site during daytime low tide (approx 4 hours) out of two low tides in a day. Low tides in early morning and late evening were not preferred to avoid any error in observations due to lower visibility. Thus it was necessary to visit the reef area 4 days consequently in a month to cover 4 sub-sites. The sub-site S1 was explored less frequent compared to the other

sub-sites as it was near to the industrial establishment and it was difficult to get entry from the jetty area because of security reasons.

Daytime negative tides occurring once or twice in year were preferred for biodiversity surveys as during those tides maximum of intertidal area exposes so biota remaining submerged otherwise can also be surveyed.

2.5 REEF MORPHOLOGY AND HABITAT CHARACTERIZATION:

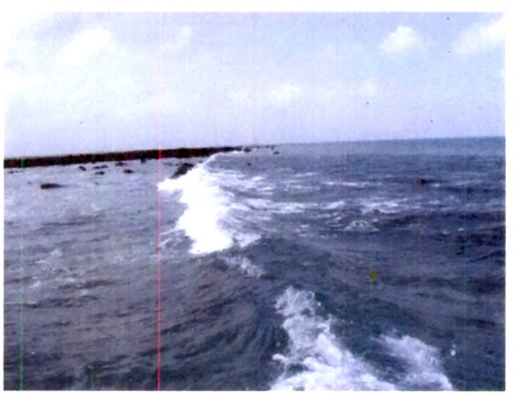
The coral reefs in GoK are mainly of fringing type. However, rather growing continuously, they are formed in scattered patches along the islands/mainland. The typical reef morphology of GoK reefs includes reef flat, lagoons (tide pools), reef crest and outer reef slope.

Narara, fringing reef, is largely a dead reef with distinctively diverse macro-habitats. The reef has vast mudflats along the HTL followed by reef flat. The intertidal live coral formations occur mainly within knee deep tidal pools/lagoons located between reef flat and reef crest (Plate: 2.2 c). This can be attributed to near to twice the difference in the spring and neap tidal amplitudes. Therefore, the area near to low tide line remains inundated during entire lunar cycle. However, during this study small sized recruits were also recorded sparsely dispersed over the reef flat. The Narara reef was analyzed for habitat composition during current study.

2.5.1 METHODOLOGY:

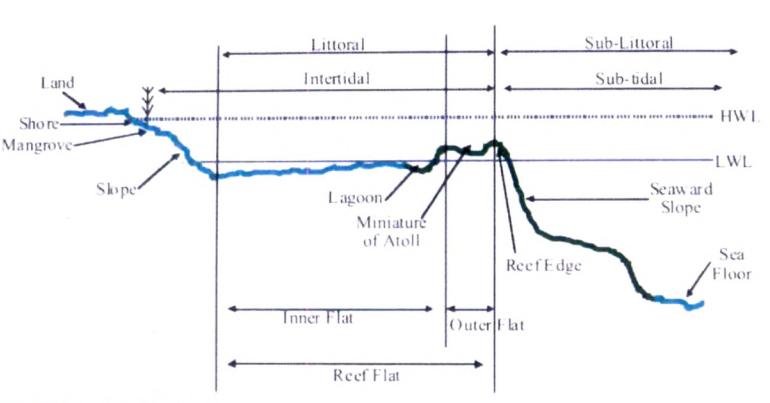
The reef area was surveyed for substratum/habitat characterization by Line Transect (LT) method during ebb tides. Each sub-site was subjected to 3 LTs of 300m perpendicular to reef edge. Transects were placed parallel to each other with approximately 200m distance. While following each transect, at every 10m of distance $1m^2$ quadrate was placed and appropriate readings were noted down in the field diary.

Plate: 2.2



a: Wave action received by sub-sites S2, S3 and S4.

b: Sub-site S5 with no prominent waves.



c: Cross section of Narara reef (Dixit et al., 2010).

2.5.2 RESULTS:

SUB-SITE S1:

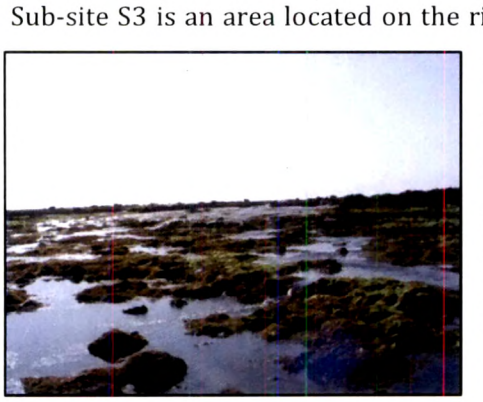
Sub-site S1 is located near Kandla Port Trust Offshore Oil Terminal (KPT-OOT). This sub-site receives less intense waves as it is protected by Kalubhar Island on the western side. This sub-site was recorded with second highest live coral cover (27.27%) among all the sub-sites, the fair percent of dead reef and sand cover suggested that this sub-site may be influenced by nearby port infrastructure (Fig. 2.3).

SUB-SITE S2:

Sub-site S2 is located around 2.5 km away from KPT jetty on the northern side. This sub-site faces open gulf, hence, it is affected by moderate waves. Here the substratum was found to be dominated by sand particles (42.42%) followed by dead reef/coral boulders (21.21%). However, presence of large sized coral colonies of *Porites sp.* put the sub-site on first rank (33.33%) for live coral cover among all the sub-sites (Fig. 2.3).

SUB-SITE S3:

Sub-site S3 is an area located on the right to the IOC sub-sea pipeline. This sub-site is also affected by waves. As this area is easily approachable, it is frequented by the tourists visiting Narara. A knee deep intertidal lagoon is present on the shoreward side of reef crest. Major coral formation was found within the lagoon. Substratum was recorded 49.9%



covered with sand followed by dead reef (28.7%), whereas, live coral cover was recorded 9.09%. No mud deposit was observed on this area (Fig. 2.3).

SUB-SITE S4:

Sub-site S4 is the farthest sub-site from the HTL. It is located in the north direction and

receives waves same as sub-sites S2 and S3. Being the farthest sub-site, hardly any tourists visit this area except occasional visits by fishermen. Substratum of this area was dominated by Sand (40.3%), followed by live coral cover (25.53%) and dead reef (19.01%). (Fig. 2.3)

SUB-SITE S5:

Sub-site S5 is facing Sikka creek on the eastern side. It is protected by creek waters and

not affected by waves. Further it is separated from sub-site S4 by a notch. The substratum of this area is predominated by mud deposition over dead reef. Sand was recorded 37.87% followed by Mud (30.3%) and dead reef (22.72%). Because of heavy mud deposition, the least live coral cover (3.03%) was recorded here (Fig. 2.3).

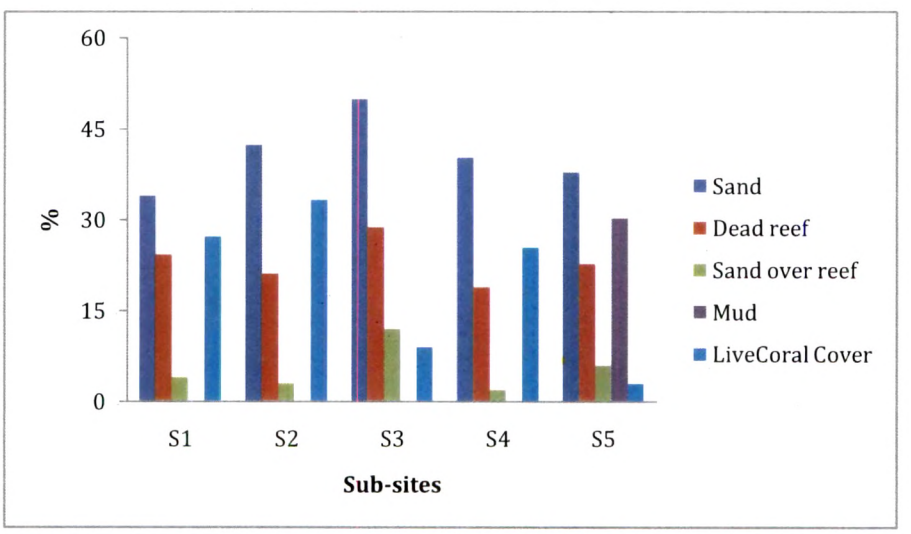


Fig. 2.3: Substratum characteristic of sub-sites of Narara Reef.