

## 5. BIOTIC STATUS OF THE GULF OF KACHCHH

The fairly good database available with NIO and other sources is sufficient to make a cumulative evaluation on the status of marine flora and fauna of the Gulf at macrolevel. For effective assessment the Gulf can be divided into subsections for comparison and also for identifying the more productive ecologically sensitive zones. The database covers equal number of segments along the southern (Okha, Salaya, Vadinar, Sikka, Bedi and Navlakhi) as well as northern (Kandla, Luni, Mundra, Jakhau, Kharo creek and Kori creek) Gulf. Also the Gulf can be divided horizontally into the outer Gulf and inner Gulf, the former covering Okha to Sikka in the south and the latter from Luni to Kori creek in the north. The inner Gulf includes Bedi and Navlakhi in the south and Kandla in the north. The interior network of creeks consists mainly of Kandla creek, Nakti creek, Sara creek, Phang creek, Chach creek, Chotta Kuttathuki and Hanstal creek.

### 5.1. Southern Gulf

#### Bacteria

TVC is maximum (av.  $1.6 \times 10^3$ /ml) at Okha (Table 5.1.1) with much lower values at Vadinar, Sikka and Bedi (av. 160-278/ml). TC values are the lowest at Okha (av. 12.5/ml) which marginally varied between 14-22/ml at the other segments. As can naturally be expected in sediment TVC and TC are at much higher level as compared to water. TVC in sediment was maximum at Bedi ( $17.48 \times 10^4$ /g dry wt) followed by Vadinar ( $15.21 \times 10^4$ /g dry wt) and the lowest value is at Okha (av.  $10.27 \times 10^4$ /g dry wt). TC values in sediment are relatively high at Vadinar. Levels of coliforms and pathogens indicate low-level contamination off Vadinar, Sikka and Bedi.

#### Mangroves and algae

The southern coast of Gulf has luxuriant growth of algae. Off Okha, *Avicennia marina* is the only species of mangrove found either as dense areas or in degraded patches with three associated halophytes. This area harbours rich algal flora of 59 species. Sikka-Salaya region has extensive growth of mangroves. *Avicennia* stands near Salaya are of scrubby in nature. Though *A. marina* is the dominant species, in some areas four more associated species are found. Intertidal areas around Vadinar harbour a dense mangrove forests constituted mainly by *A. marina*. Narara bet sustains 6 species of mangroves and 4 associated species. A total of 62 species of algae and 3 species of sea grasses are recorded from this region. At Kalubhar Island, the mangrove zone is represented by 6 species, dominant being *A. marina*. There are 3 associated halophytes. The intertidal segment supports 47 species of marine algae and 3 species of sea grasses. Off Sikka 42 species of algae are reported. Mangroves of Sikka are comprised mainly of *A. marina* along with two species of halophytes. At Bedi mangroves are observed either as continuous fringing thick stretches or in large patches. Five species of mangroves are found at Bedi with predominance of *A. marina*. The area supports 4 species of obligate halophytes. Extensive growth of sea weeds occur on the reef of Pirotan Island and the total number of species of marine algae recorded from the area are 44. Beach vegetation of Pirotan Island has 4 species of sand dune flora. Mangroves of Navlakhi region are of the fringing type. There are 4 species of mangroves with the predominance of *Salicornia brachiata*. Two associated species are observed at Navlakhi.

#### Phytoplankton

Average values of phytoplankton pigments, population and generic diversity indicate only marginal variation between surface and bottom (Table 5.1.2 and Figure 5.1.1) and hence average for the water column is considered for comparison. Chlorophyll *a* shows marginally higher concentration at Okha and Bedi (av.  $1.5 \text{ mg/m}^3$ ), followed by Salaya ( $1.4 \text{ mg/m}^3$ ), Sikka ( $1.3 \text{ mg/m}^3$ ), Navlakhi ( $1.2 \text{ mg/m}^3$ ) and Vadinar ( $0.8 \text{ mg/m}^3$ ). Phaeophytin values are lower than chlorophyll *a* at all segments suggesting a delicate balance between the growth and

mortality of algae. Cell count is maximum off Okha (av.  $654.2 \times 10^3/l$ ) followed by Bedi (av.  $118 \times 10^3/l$ ) and Sikka ( $71.7 \times 10^3/l$ ). Generic diversity is fairly high at all segments with comparable values (av. 9-11) except at Navlakhi (av. 17). The total number of genera of phytoplankton recorded at Okha, Vadinar, Sikka, Bedi and Navlakhi are respectively 40, 43, 38, 32 and 17 indicating a rich faunal assemblage at all locations except Navlakhi (Table 3.2.2).

Temporal variation in phytoplankton pigments at different segments along the southern Gulf is shown in the Figure 5.1.2. Peak in chlorophyll *a* concentration is observed either in the morning or evening at Okha, Vadinar and Bedi while at other segments the pattern is irregular. Effect of tide on the level of chlorophyll *a* shows maximum concentration during ebb at Okha, Salaya, Sikka and Bedi while flood period sustained peak in chlorophyll *a* concentration at Salaya, Vadinar and Bedi. On a few occasions phaeophytin show higher values at bottom as compared to chlorophyll *a*.

### **Zooplankton**

It is evident from Table 5.1.3 and Figure 5.1.3 that zooplankton standing stock is low off Okha (av.  $3.4 \text{ ml}/100\text{m}^3$ ) and Vadinar (av.  $4.9 \text{ ml}/100\text{m}^3$ ). Fairly high values are observed off Bedi ( $8.7 \text{ ml}/100 \text{ m}^3$ ) and Sikka ( $11.2 \text{ ml}/100\text{m}^3$ ) with high biomass at Salaya ( $28.8 \text{ ml}/100\text{m}^3$ ) and Navlakhi ( $22.1 \text{ ml}/100 \text{ m}^3$ ). Population density of zooplankton shows a different trend with the highest density off Okha ( $209.3 \times 10^3/100 \text{ m}^3$ ) and with fairly high values off Salaya and Bedi. Moderate values are observed at other segments. Faunal representation is almost consistent at all segments (av. 10-12). Zooplankton faunal groups represented at Okha, Salaya, Vadinar, Sikka, Bedi and Navlakhi are 23, 16, 21, 23, 20 and 18 respectively.

Temporal variation of zooplankton standing stock (Figure 5.1.4) shows that the pattern of diel variation is comparable between biomass and population. Zooplankton biomass is maximum during the early hours like that observed at Okha, Salaya, Vadinar and Bedi. The pattern is irregular at other segments. Tidal variation shows maximum biomass during ebb period except at Sikka and Navlakhi.

### **Benthos**

Intertidal macrobenthic biomass is very high at Vadinar ( $148 \text{ g}/\text{m}^2$ ) and Sikka ( $151 \text{ g}/\text{m}^2$ ) compared to Bedi ( $64.5 \text{ g}/\text{m}^2$ ) and Okha ( $11.7 \text{ g}/\text{m}^2$ ). Population density followed the same pattern like that of biomass (Table 5.1.4 and Figure 5.1.5). Group diversity was maximum at Okha (av. 18) with comparable values for other segments (av. 9-10). Faunal assemblage is maximum at Vadinar (41) followed by Okha (32), Sikka (31) and Bedi (26).

The subtidal macrobenthos at all segments are low as compared to intertidal standing stock except off Okha (Table 5.1.5 and Figure 5.1.6). Subtidal benthic biomass is maximum off Bedi (av.  $44.5 \text{ g}/\text{m}^2$ ) with moderate values off Vadinar and Sikka. Biomass, population density and group diversity of subtidal benthos are low off Salaya and Navlakhi. Group diversity at other segments is fairly high (av. 9-11). Compared to group diversity of intertidal area, subtidal community shows relatively low number of groups except at Okha (av. 42). At Vadinar, Sikka and Bedi the faunal groups present are 28, 25 and 24.

### **Fishery**

Trawl catch rate indicates good potential at Vadinar, Sikka and Bedi with an average catch rate of 41.3, 29.7 and 38.8 kg/h respectively. Catch rate is moderate off Okha and Navlakhi (Table 5.1.6). Species diversity is high at Bedi (av. 44), Vadinar (av. 42) and Sikka (av. 34). Average number of species represented at Okha and Navlakhi are respectively 14 and 24. Catch rate by gill netting is generally low with higher values at Sikka than Navlakhi.

Records of species found at different segments show that the Sikka supports a very wide variety of fishes and prawns, the total being 108. Vadinar and Bedi are also good in sustaining a diverse fishery (74 and 73). Navlakhi has moderate potential (56) while the lowest number is obtained at Okha (23).

### **Corals**

Off Okha, there are 9 major coral reef systems. The Islands adjoining Okha coast harbour 34 species of corals. Salaya has a moderate live coral population with variety and they are under environmental stress due to heavy sedimentation. Sturdy corals like *Goniopora*, *Porites*, *Favia* and *Goniastrea* are common in the area. At Vadinar 29 species of corals are recorded from Narara Bet and 35 species from Kalubhar. At Narara Bet major species observed are *Porites*, *Goniopora* and *Favia*. The live coral colonies are relatively more at Kalubhar as compared to Narara Bet. The corals at Kalubhar are represented mainly by the genera *Favia*, *Favites*, *Porites*, *Goniastrea*, *Goniopora*, *Turbinaria*, etc. Off Sikka, live corals are represented by 24 species of Scleractinians and sturdy corals like *Goniastrea* and *Porites* dominated the area. Records indicate the presence of 22 species of corals at Bedi. The predominant species found in the area are *Goniophora*, *Goniastrea*, *Porites* and *Favia*. Navlakhi region does not have coral reefs as most of the intertidal area is muddy.

From the overall assessment of different segment along the southern Gulf the following inferences can be made. Okha, Vadinar, Sikka and Bedi have rich algal fauna and dense as well as degraded patches of mangroves. Phytoplankton pigments and cell counts are relatively high at Okha, Bedi and Sikka while generic diversity is maximum at Vadinar followed by Okha, Sikka and Bedi. Standing stock of zooplankton in terms of biomass is maximum at Salaya followed by Navlakhi while the population density is maximum at Okha. Zooplankton faunal diversity is high at Okha, Sikka and Vadinar. The stretch Vadinar – Sikka – Bedi support high intertidal macrobenthic biomass and population with a diverse faunal assemblage. Though quantitatively and qualitatively less subtidal macrobenthic population along this stretch is relatively high. Catch rate of fish and their diversity and species diversity of corals are high at Vadinar, Sikka and Bedi. Along the southern coast, the zone between Vadinar and Bedi appears to be more productive followed by Okha. Okha also supports a rich coral community.

### **Northern Gulf Bacteria**

TVC values in water at Kandla are relatively more (av.  $14.1 \times 10^3$ /ml) as compared to Mundra (av.  $7.2 \times 10^3$ /ml) with low values at Luni (av. 194/ml). TC is also low at Luni (av. 7/ml) than that observed at Munda ( $3.3 \times 10^2$ /ml) and Kandla (44/ml). Proportionately high concentration of TVC and TC are found in the sediments of Kandla and Mundra (Table 5.1.1). The presence of faecal coliform and some of the harmful pathogens, though in low numbers, is indicative of low level contamination off Kandla, Luni and Mundra.

### **Algae and mangroves**

In general, the northern shore of the Gulf supports very poor algal diversity. At Kandla there are patch stretches of mangroves predominated by *A. marina* and the flora is contributed by 3 species of mangroves as well as 3 species of obligate halophytes. The intertidal region of Luni has stray mangroves mainly of *A. marina*. At Luni the alga *Enteromorpha* sp. is common with occasional presence of the halophyte *Sueda maritima*. Some of the best mangrove formations along the northern shore of the Gulf are found around Mundra Port. Mangroves are represented by two species with predominance of *A. marina* and 3 obligate halophytes. Jakhau with its extensive mud flats harbour dense mangroves. The dominant mangrove species is *A. marina* associated with 6 other species. Patches of

mangroves are seen towards the interior part of Kharo creek and the species noted is *A. marina*. Kori creek has vast mangrove coverage along east and north shores. *A. marina* dominated the area with 7 associated flora.

### Phytoplankton

Chlorophyll *a* in the water column was maximum at Kori creek ( $2.3 \text{ mg/m}^3$ ) followed by Kharo creek ( $2.1 \text{ mg/m}^3$ ), Mundra ( $2.0 \text{ mg/m}^3$ ) suggesting moderately high primary production potential. The levels of chlorophyll *a* at Kandla, Luni and Jakhau are moderate ( $1.0\text{-}1.4 \text{ mg/m}^3$ ). Phaeophytin values are mostly lower than chlorophyll *a* indicating a healthy condition (Table 5.1.2 and Figure 5.1.1). Phytoplankton population is high at Luni ( $202.7 \times 10^3/l$ ), Mundra  $112 \times 10^3/l$ ) and Jakhau ( $171 \times 10^3/l$ ). Moderate cell counts are observed at Kandla and Kori creek with very low value at Kharo creek. Maximum genera are found at Jakhau (av. 18) and Luni (av. 13). Moderate diversity is observed at other segments with very low value (av. 4) at Kharo creek. Total number of genera recorded at Kandla, Luni, Mundra, Jakhau, Kharo creek and Kori creek are respectively 27, 27, 22, 18, 18 and 28.

It is evident from Figure 5.1.7 that temporal variation in phytoplankton pigments does not indicate regular pattern. In general, ebb period sustains higher concentration of pigments at Mundra and Kori creek. At Kandla and Jakhau the flood period has higher pigments while at Luni tidal difference is not imminent.

### Zooplankton

Biomass of zooplankton is moderately high at the segments between Kandla and Jakhau with moderate value at Kori creek and very low value at Kharo creek (Table 5.1.3). Maximum standing stock is seen at Kandla ( $26.2 \text{ ml}/100\text{m}^3$ ). However, population density is highest at Kharo creek ( $181.2 \times 10^3/100\text{m}^3$ ). Population density at other segments is moderately high except at Jakhau where the population is relatively low. Group diversity is comparable between segments except for the relatively low value at Kharo creek. Total number of groups recorded is more at Kandla, Mundra and Kori creek (20-21), relatively low at Luni and Jakhau (16-18) with the lowest number at Kharo creek (14).

Temporal variation in zooplankton biomass and population show comparable pattern of distribution (Figure 5.1.8). Peak in zooplankton standing stock is the highest during morning or in the evening at Kandla, Mundra, Jakhau and Kori creek. Flood period shows peak in zooplankton standing stock at all segments except at Mundra.

### Macrobenthos

Kharo creek has very rich intertidal benthic biomass (av.  $509.1 \text{ g/m}^2$ ) and population (av.  $59173/\text{m}^2$ ). Kori creek also sustains high intertidal biomass (av.  $42.2 \text{ g/m}^2$ ) with moderate population (av.  $1073/\text{m}^2$ ). Moderate to high standing stock is observed at Luni and Mundra. Kandla and Jakhau support low intertidal standing stock (Table 5.1.4). Number of groups represented is relatively more at Mundra (av. 16) and Luni (av. 13), moderate at Kandla (av. 9) and low at Jakhau to Kori creek (av. 4-6). Total number of groups recorded from different segments shows maximum number at Mundra (28) followed by Kandla (23). Other segments registered 13 to 16 groups except at Kharo creek (6).

Subtidal benthic biomass and population are in general lower at different segments as compared to the values of intertidal data. High subtidal biomass ( $40 \text{ g/m}^2$ ) and standing stock (av.  $14098/\text{m}^2$ ) are observed at Kharo creek (Table 5.1.5). Low to moderate values of biomass are recorded at other segments with very low value at Kandla ( $1.3 \text{ g/m}^2$ ). Subtidal population is relatively high at Luni, Jakhau and Mundra with the lowest values at Kandla and moderate population at Kori creek. Group diversity is relatively high at Luni and Mundra (av.

10-11) while the number is low at other segments (av. 3-5). Number of subtidal macrobenthic groups recorded are 24 at Kandla and Mundra, 18 at Luni, 17 at Jakhau, 13 at Kori creek and 6 at Kharo creek.

### Fishery

Trawl catch is the highest at Jakhau (av. 33.8 kg/h) as shown in Table 5.1.6 followed by Luni/ Kori creek (av. 21.6 kg/h). Catch rate is moderate at Mundra (av. 15.3 kg/h) and Kandla (av. 11.3 kg/h). Species diversity of fish is maximum at Kandla (30) followed by Jakhau, Mundra, Kandla and Kori creek (18-22). Relatively low diversity is seen at Luni (12). Gill nettings at Mundra and Kandla show respective average rates of 7.6 and 4.1 kg/h. Diversity in gill net catch is high at Mundra (34) as compared to Kandla (11).

An evaluation of the different biological parameters is indicative of the production potential of different segments along the northern coast. Mundra, Jakhau and Kori creek support dense mangrove forests. Phytoplankton pigments are high at Kori creek, Kharo creek and Mundra while cell count is high at Luni, Jakhau and Mundra. Generic diversity of phytoplankton is highest at Kori creek, Kandla and Luni. Zooplankton standing stock and group diversity are high at Kandla, Mundra and Kori creek. Kharo creek supports rich intertidal and subtidal macrobenthic standing stock, but group diversity is low. Mundra segment has fairly high intertidal as well as subtidal macrobenthic population with high group diversity. Kori creek is also rich in standing stock of macrobenthos with moderate group diversity. In terms of fish catch Jakhau, Luni and Kori creek predominate over other segments. Species diversity of fish is maximum off Kandla followed by Mundra and Jakhau. Over all, along the northern Gulf, the most productive segment is Mundra followed by Luni and Kandla.

### Comparison between southern and northern Gulf.

Range and average values of different biological parameters for the southern and northern Gulf are given below.

Parameter	Southern Gulf (SG)	Northern Gulf (NG)
<b>Phytoplankton</b>		
Chlorophyll <i>a</i> (mg/m <sup>3</sup> )	0.1-19.1 (1.3)	ND-16.6 (1.7)
Phaeophytin (mg/m <sup>3</sup> )	0.02-15.8 (0.9)	0.01-7.2 (1.0)
Cell count (no x 10 <sup>3</sup> /l)	2-31206 (180.3)	0.04-1789 (94.5)
Total genera (no)	2-22 (12)	2-21 (10)
<b>Zooplankton</b>		
Biomass (ml/100m <sup>3</sup> )	0.02-112.9 (19.9)	0.01-343.5 (14.7)
Population (no x 10 <sup>3</sup> /100m <sup>3</sup> )	0.02-7120 (66.0)	0.01-1230.3 (60.6)
Total groups (no)	3-19 (11)	1-19 (11)
<b>Intertidal benthos</b>		
Biomass (wet wt, g/m <sup>2</sup> )	0-1787.0 (93.8)	0-935.7 (100.9)
Population (no/m <sup>2</sup> )	0-383700 (18588.0)	0-133056 (11658.0)
Total groups (no)	1-22 (12)	0-24 (9)

Subtidal benthos		
Biomass (wet wt, g/m <sup>2</sup> )	0-554.5 (17.8)	0-466.4 (11.7)
Population (no/m <sup>2</sup> )	0-59600 (3418)	0-198400 (5556)
Total groups (no)	1-21 (8)	1-18 (6)
Trawl net catch		
Catch rate (kg/h)	0.4-163.0 (26.3)	0.6-115.2 (20.7)
Total species (no)	7-64 (31)	8-46 (20)
Gill net catch		
Catch rate (kg/h)	0.5-4.2 (2.6)	0.6-11.5 (5.9)
Total species (no)	3-6 (5)	5-34 (22)

Though chlorophyll a value indicates an enhancement at the NG by a factor of 1.3, cell count and total genera at the SG are 1.2 to 2 times higher. Zooplankton standing stock in terms of biomass and population are 1.1 to 1.3 times more at SG as compared to NG. However zooplankton faunal diversity does not indicate any variation. There is marginal variation in intertidal macrobenthic biomass, the NG being more productive. However, intertidal macrobenthic population density and group diversity are 1.3 to 1.6 times higher at SG. Subtidal macrobenthic biomass is higher at SG (1.5 times) while the population density is relatively high at NG (1.6 times). Total faunal groups are more at SG (1.3 times) than at NG. Catch rate of fish shows higher potential as well as species diversity at SG (1.3-1.5 times) as compared to NG. But the gill net catch shows glaring difference in catch rate as well as species diversity at NG (2.3 to 4.4 times) than SG.

The above assessment indicates that among the different parameters compared, about 75% of them show the prevailing higher potential of the SG in comparison with the NG.

## 5.2. Horizontal zonation

The outer Gulf (OG) covers the segments Okha, Salaya, Vadinar and Sikka along the southern shore and Luni, Mundra, Jakhau, Kharo creek and Kori creek along the northern shore. The inner Gulf (IG) encompasses Bedi and Navlakhi covering the south and Kandla in the north.

Data for different biological parameters for OG and IG are given below.

Parameter	Outer Gulf	Inner Gulf
Phytoplankton		
Chlorophyll a (mg/m <sup>3</sup> )	ND-19.1 (1.5)	0.1-5.9 (1.4)
Phaeophytin (mg/m <sup>3</sup> )	0.01-15.8 (0.9)	0.01-12.9 (1.1)
Cell count (no x 10 <sup>3</sup> /l)	0.04-31206 (153.6)	1.8-936 (56.4)
Total genera (no)	2-22 (10)	2-17 (11)
Zooplankton		
Biomass (ml/100m <sup>3</sup> )	0.02-343.5 (12.3)	0.5-163.7 (19.0)
Population (no x 10 <sup>3</sup> /100m <sup>3</sup> )	0.01-7120 (73.5)	0.3-219.6 (32.8)
Total groups (no)	1-19 (11)	5-15 (10)
Intertidal macrobenthos		
Biomass (wet wt, g/m <sup>2</sup> )	0-1787.0 (113.8)	0.02-1259.4 (35.2)
Population (no/m <sup>2</sup> )	0-383700 (16438.0)	0-86864 (6399)

Total groups (no)	0-24 (10)	3-18 (9)
Subtidal macrobenthos		
Biomass (wet wt, g/m <sup>2</sup> )	0-490.3 (14.5)	0-554.5 (15.4)
Population (no/m <sup>2</sup> )	0-198400 (5539)	0-9664 (1332)
Trawl net catch		
Catch rate (kg/h)	0.8-163.0 (24.9)	0.4-139.0 (20.3)
Total species (no)	7-56 (23)	15-63 (33)
Gill net catch		
Catch rate (kg/h)	4.0-11.5 (5.9)	0.5-9.3 (6.1)
Total species (no)	6-34 (20)	3-19 (7)

Most of the phytoplankton parameters show comparable values between OG and IG except for the cell count which is 2.7 times higher at the OG as compared to the IG. Zooplankton biomass is 1.5 times higher at IG while the population density is 2.2 times more at OG. Intertidal macrobenthic standing stock in terms of biomass and population are quite high at the OG by respective factors of 3.2 and 2.6 when compared with the average values of IG. Subtidal macrobenthos are fairly rich at the OG. Population density and faunal diversity of macrobenthos are respectively 4.1 and 2.4 times higher at OG while IG sustains slightly higher biomass of subtidal macrobenthos. In terms of fish catch rate trawling yielded 1.2 times more catch at OG and the gill net catch is 1 time more at IG. Species diversity is higher at IG for trawl catch and the gill net catch is more diverse at the OG.

A general evaluation between the two broad segments of the Gulf suggests that almost 67% of the parameters show higher productivity of the outer Gulf as compared to the inner Gulf.

### 5.3. Creek Systems

In general, bacterial population (TVC and TC) in water are at higher levels (Table 5.3.1) due to moderate human interference. Average values of TVC and TC in creeks vary respectively from 219 to  $2.7 \times 10^4$ /ml and 28 to 69/ml. TC is at low ranges varying from 25-57/ml. Microbial populations in sediment are higher than that of water as settlement of organic carbon on the floor favours the growth of microorganisms.

Chlorophyll *a* in the water column maintains moderate concentration (Table 5.3.2 and Figure 5.3.1) which vary from 1.4 to 1.6 mg/m<sup>3</sup> except at Nakti creek (av. 0.9 mg/m<sup>3</sup>). Phaeophytin values were marginally at higher levels at Nakti creek and other creeks. Phytoplankton cell count is high at Nakti creek ( $664.5 \times 10^3$ /l) and moderate to low at other creeks ( $21.2$  to  $40.2 \times 10^3$ /l). Generic diversity is moderate to high with maximum genera at Kandla creek (26).

Zooplankton standing stock is moderate to high (av. 8.6 to 40.7 ml/100m<sup>3</sup>) at the creek systems with maximum biomass at Chach creek (Table 5.3.3, Figure 5.3.2). Population density between creeks is comparable with moderate density except for the observed high population at Nakti creek ( $89.3 \times 10^3$ /100<sup>3</sup>). Faunal groups found in the area indicate moderate values (av. 7-10).

Intertidal (Table 5.3.4) as well as subtidal (Table 5.3.5) macrobenthic biomass are low in the creek with relatively higher values for population. Faunal diversity is also low, especially at Phang creek and other creeks.

Trawl and gill net catch in general are low at all the creeks except Kandla (av. 6.2 kg/h). Species found in the trawl catch is moderately high at Kandla (av. 22) with low values at other creeks (Table 5.3.6).

Among the five creek systems studied Kandla creek appears to be the most productive creek followed by Nakti creek. In general, the creek systems support moderate levels of phytoplankton and zooplankton with low potential for macrobenthos and fishery.

#### 5.4 Gulf of Kachchh

The prevailing status of different biological parameters of the Gulf based on NIO database is as shown below.

Parameter	Gulf
<b>Phytoplankton</b>	
Chlorophyll <i>a</i> (mg/m <sup>3</sup> )	ND-19.1 (1.6)
Phaeophytin (mg/m <sup>3</sup> )	0.01-15.8 (1.1)
Cell count (no x 10 <sup>3</sup> /l)	0.04-31206 (73.65)
Total genera (no)	2-22 (11)
<b>Zooplankton</b>	
Biomass (wet wt, g/m <sup>2</sup> )	0.01-343.5 (17.3)
Population (no/m <sup>2</sup> )	0.01-7120 (63.3)
Total groups (no)	1-19 (11)
<b>Intertidal macrobenthos</b>	
Biomass (wet wt, g/m <sup>2</sup> )	0-1787.0 (97.4)
Population (no/m <sup>2</sup> )	0-383700 (15123)
Total groups (no)	0-24 (11)
<b>Subtidal macrobenthos</b>	
Biomass (ml/100m <sup>3</sup> )	0-554.5 (14.8)
Population (no x 10 <sup>3</sup> /100m <sup>3</sup> )	0-198400 (4487)
Total groups (no)	1-21 (7)
<b>Trawl net catch</b>	
Catch rate (kg/h)	0.4-163.0 (23.5)
Total species (no)	7-64 (25)
<b>Gill net catch</b>	
Catch rate (kg/h)	0.5-11.5 (4.25)
Total species (no)	3-34 (13)

Overall phytoplankton pigment level and generic diversity are moderate while cell count is high. The area supports high standing stock of zooplankton as well as rich intertidal macrobenthic standing stock. The subtidal macrobenthic biomass and population indicate moderate potential. Trawl catch rate and species diversity are fairly high. Gill net catch rate is moderate.

Compared to the northern Gulf, southern Gulf is more productive and the belt between Okha and Bedi can be considered as a very productive zone. Along the northern segment, Mundra to Kandla is the most productive segment. These highly productive and biodiversified habitats need to be protected through proper conservation measures. When the outer Gulf is productive the inner Gulf including the creek system has only moderate production potential.

The Gulf contributes to the maximum species and biomass of seaweeds for the west coast of India. The area under mangrove forest along the Gujarat coast is 991 km<sup>2</sup> which constitutes 96% of the total mangrove area of the state. Though the mangrove forest of Kachchh and Jamnagar districts formed the major part of mangrove cover in the state, it displays the least diversity the dominant species being *Avicennia marina*. The best-conserved mangroves are the dense forests observed in the Kori creek. A few mangrove species have been reported as vulnerable species. Being a critical habitat, the State Forest Department has under taken mangroves afforestation in Kachchh and Jamnagar districts by plantation of *A. marina*.

The southern coast of Gulf has extensive coral reefs with associated reef flora and fauna. The reefs mostly consist of dead corals and are the most degraded reefs. In areas being referred to as coral reefs or patches, the live corals contribute only 20-30%. Causes for the poor state and low diversity of corals are both natural and anthropogenic. Siltation appears to be the major cause for the mortality and the consequent reduction in species diversity of corals in the Gulf. It has been suggested that some live colonies may occur in deeper waters.

The Gulf abounds in a rich and diverse flora and fauna. Though a detailed systematic survey of the biota of the Gulf is lacking the following number of groups/ species have been reported from the area.

<b>Flora/ Fauna</b>	<b>Species/ Genera/ Groups (no)</b>
Alage	107
Phytoplankton genera	62
Zooplankton groups	34
Intertidal macrobenthic groups	54
Subtidal macrobenthic groups	50
Corals	36
Sponges	70
Molluscs	200
Fishes	196
Prawns	31
Crabs	30
Sharks	8
Sea turtles	3
Reptiles	2
Birds	94
Sea mammals	3