

Marine biodiversity of Gulf of Kutch located in North-eastern Arabian Sea

Abstract

Marine biodiversity depends of many factors viz. sediment quality, water quality, tidal waves, tidal amplitude, intertidal zone influence, depth of sea, bottom topography, etc. Here, we have analyzed for these factors to assess the impact on marine biodiversity especially benthos and planktonic organisms. The study of Gulf of Kutch shows that the area is rich in coral reef and benthos; it should not be disturbed in any case for commercial or any other uses.

Keywords: marine biodiversity, arabian sea, gulf of kutch, corals

Special Issue - 2018

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Received: July 13, 2018 | **Published:** August 01, 2018

Introduction

The Gulf of Kutch is opening towards the north-eastern Arabian Sea. The channel depths is varying from 20 m at the head to 60 m in central areas of the outer Gulf. Though water depths of 25 m exist in the broad central portion of Gulf up to a longitude 70° E, the actual fairway is obstructed by the presence of several fish flocks. The high tidal influx covers the low lying area of about 1500 km² comprising networks of creeks and alluvial marshy tidal flats in the interior region. The creek system consists of three main creeks namely Nakti, Kandla and Hansthal and little Gulf of Kutch interconnecting through many other big and small creeks. All along the coast, very few rivers drain into the Gulf of Kutch and they carry only a small quantity of freshwater, except during brief monsoon. The southern shore of the Gulf has abundant islands and inlets covered with mangroves and surrounded by coral reefs. The northern shore is mostly sandy or muddy provoked by several fish flocks.

Physiological conditions

The Gulf has mixed and predominantly semidiurnal type tides with a large diurnal inequality. This is because of complex bathymetry, rough bottom topography and undulation in the shoreline which produce highly non-linear tidal interactions. The tidal waves are entering from the west side and the tidal amplitude increases considerably in the upstream of Vadinar due to shallow inner regions and narrowing cross-section. The tidal elevations (m) are as follows: (Table 1).

Table 1 Tidal elevations (m) in gulf of kutch

Location	MHWS	MHWN	MLWN	MLWS	MSL
Okha	3.47	2.96	1.20	0.41	2.0
Sikka	5.38	4.35	1.74	0.71	3.0
Rozi	5.87	5.40	1.89	1.0	3.6
Kandla	6.66	5.17	1.81	0.78	3.9
Navlakhi	7.21	6.16	2.14	0.78	4.2

MHWS = Mean high water springs; MHWN = Mean high water neaps; MLWN = Mean Low Water Neap; MLWS = Mean low water springs; MSL = Mean Sea level

Over the stretch of the Gulf, the mean spring tidal range increases impressively from 3.47m at Okha to 7.21m at Navlakhi. The phase

lag between Okha and Kandla is 2 h to 2 h 25 min while between Okha and Navlakhi it is 3 h to 3 h 20 min. Due to high tidal ranges in the inner regions, the vast mudflats and coastal low lands which get submerged during high tide are fully exposed during low tide (Figure 1).¹



Figure 1 Map of Gulf of Kutch.

The tidal circulation is principally controlled by the tidal flows and bathymetry though wind effect also conquers to certain magnitude. The surfaces currents are moderate (0.7-1.2 m/s) but increase considerably (2.0-2.5 m/s) in the central portion of the Gulf. The spring currents are 60 to 65 % stronger than the neap streams. The bottom currents are also periodic with a velocity normally 70% of the surface streams.

Water quality

The yearly deviation of water temperature is between 20°C and 30°C, although the localized higher temperature goes upto 35°C which can result in isolated water pools formed in shallow intertidal depressions during low tide. Vertical profiles of temperature and salinity reveal a nearly homogeneous water column with no vertical stratification due to intense tidal-driven turbulence mixing.

The suspended solids (SS) are highly variable, spatially and largely resulted from the dispersion of fine sediment from the bed and the intertidal mudflats due to tidal movements. Obviously, near shore shallow region, invariably sustain higher suspended solids as compared to the central zones. The region between Okha and Sikka has high variable suspended solids (4-308 mg/L) whereas the inner Gulf areas sustain markedly higher suspended solids, even up to

Sampling locations

The sampling locations for marine biodiversity assessment are given in Table 3.

Table 3 sampling locations for marine biodiversity

SNo	Locations	Code	SNo	Locations	Code
1	Okha	MB1	9	Ajad	MB9
2	Dholio Gugar	MB2	10	Bural reef	MB10
3	Dona	MB3	11	Dhani	MB11
4	Boria	MB4	12	Kalumbhar reef	MB12
5	Mangunda	MB5	13	Narara reef	MB13
6	Savaj	MB6	14	Goose reef	MB14
7	Paga	MB7	15	Pirotan island	MB15
8	Manmarudi Langamarudi	MB8	-	-	-

Results and discussion

The Gulf of Kutch flourishes in marine wealth and is considered as one of the biologically richest marine habitat along the west coast of India. The marine flora is highly varied and includes sand dune vegetation, mangroves, sea grasses, macrophytes and phytoplankton. In all 31 species of Chlorophyceae, 33 species of Phaeophyceae and 55 species of Rhodophyceae have been identified with the dominance of Phaeophyceae. The dominant species of sand dune flora are *Euphorbia caducifolia*, *E.neriifolia*, *Aloevera* sp, *Ephedra foliata*, *Urochodra setulosa*, *Sporobolus maderaspatenus*, *Eragrostis unioloides*, *Calotropis procera*, *Fimbristylis* sp, *Indigofera* sp and *Ipomoea pescaprae*. The common sea grasses found growing on the mud flats are *Halophila ovata*, *H.beccarii* and *Zostrea marina*.

The most common marine algal species are *Ulva fasciata*, *U. reticulata*, *Enteromorpha intestinalis*, *Dictyota* sp, *Hypnea musciformis*, *Sargassum tennerimum*, *Silicifolium*, *Gracilaria corticata*, *Cystocera* sp, *Padina tetrastomatica*, *Corallina* sp, *Laurencia* sp, *Caulerpa racemosa*, *Bryopsis* sp, *Turbinaria* sp, *Ectocarpus* sp, *Acanthophora* sp, *Chondria* sp, and *Codium* sp.

The primary production of the water column as assessed from chlorophyll a concentration is generally high in the outer Gulf but decreases in the inner regions. Phytoplankton represents about 31 genera and 41 species. The major phytoplankton genera are *Rhizosolenia*, *Synedra*, *Chaetoceros*, *Navicula*, *Nitzschia*, *Pleurosigma*, *Thalassiothrix*, *Biddulphia*, *Stauroneis*, *Coscinodiscus* and *Skeletonema*. The Gulf also sustains good and variable zooplankton and benthic standing stock with diversity. The primary and secondary trophic levels offer congenial feeding grounds for prawns and fishes in the Gulf.

The intertidal zone of the Gulf of Kutch is rich in biota. Sheltered bays, creeks and mud flats provide ideal sites for mangrove vegetation over an estimated area of about 1066.9 km². The formations are of open scrubby type, with isolated and discontinuous distribution from Kandla-Navlakhi in the northeast to Jodia, Jamnagar, Sikka, Salaya and Okha in the southwest, as also at Pirotan, Positra, Dohlani and Dwarka. Vast stretches of mangroves also exist along the northern shore of the Gulf. The dominant species of mangroves are

Avicennia marina var *acutissima*, *A. officinalis*, *Bruguiera parviflora*, *B. gymnorrhiza*, *Rhizophora mucronata*, *R. apiculata*, *Ageiceros corniculata*, *Ceriops tagal* and *Sonneratia apetata* along with the associated species of *Salicornia brachiata*, *Rosella Montana*, *Suaeda fruticosa*, *Artiplex stocksii* and lichen.

The marine fauna of the Gulf is rich, both in variety and abundance. Sponges having an array of colours are observed, both in the intertidal and subtidal biotopes. The common species of sponge is *Adocia* sp, associated with coral reef fauna. In sandy and silty mud shores, *Tetilla dactyloidea* (Carter) is common.

The most frequently encountered hydrozoans are *Sertularia* sp and *Plumularia* sp. The giant sea-anemone (*Stoichactis giganteum*) is a common sight in the coral ecosystem. Sea anemones, belonging to *Anemonia*, *Bunodactis*, *Paracondylactis*, *Anthopleura* and *Metapeachia*, are wide spread. *Azoantharian*, *Gemmaria* sp, is found forming extensive hexagonal green mats in the coral pools. Another interesting actinarian is the *Cerianthus* sp found in tubes in the soft mud. The Gulf has 42 islands, 34 of which have live corals. Siltation is the main cause affecting the coral growth. The species diversity however is poor with identification of 36 species of Scleractinian and 12 species of soft corals. A number of polychaete worms, both sedentaria and errantia, with the dominant genera of Eurythoe, Terebella, Polynoe, Iphione and Nereis are rather common. Amongst a variety of sipunculid and echiuroid worms, the dominant species are *Dendrostromum* sp, *Asphidosiphon* sp and *Ikadella misakiensis* (*Ikeda*). The intertidal crustacean fauna is very rich and equally diverse with spider crab (*Hyas* sp) and furry crab (*Pillumnus* sp), as specialities.

Amongst the invertebrate component of the marine fauna of the Gulf, the molluscs have the highest representatives. As many as 92 species of bivalves, 55 species of gastropods, 3 species of cephalopods and 2 species each of scaphopods and amphineurans have been reported. The most notable members of the molluscan fauna are octopus, pearl oyster and a variety of chanks, including the sacred chank. *Pinna bicolor*, the bivalve is commonly noticed in the coral reef flat. The echinoderm fauna, represented by 4 classes and 14 genera, have the commonest genera of Palmpsis, Astropecten, Asteria, Temnopleura and Holothuria. The subtidal benthic fauna of the Gulf is dominated by polychaetes, crustaceans, echinoderms, gastropods and bivalves, with an average biomass of 25 g/m².

The Gulf of Kutch has a variety of exploitable species of finfishes and shellfishes. The sciaenids, polynemids, perches, eels, cat-fishes, elasmobranchs and prawns are commercially important groups with an average catch of 1.4 x 10⁵ ton/year. The fishing grounds for Ghol, Karkara, Khaga, Dhoma, Magra and Musi exist in the Gulf. The Gulf region offers plenty of facilities for feeding, breeding and shelter to a variety of birds. In the mangrove forests lining the islands and along the coast, the birds find a near perfect environment. In addition, they are well placed to reach their food supply i.e. the shoals of fish, squids, mud skippers and other animals, during low tide. All along the creeks and around islands, mangrove trees and mudflats are seen crowded with Grey Herons, Pond Herons, Painted Storks, Large and small Egrets, Darters, Cormorants, Flamingos, Lesser Flamingos, etc. during the period of seasonal migration (November-March).¹⁷

The large congregations of uncommon coastal waders such as Bar-tailed Godwit (*Limosa lapponica*), Sanderling (*Calidris alba*), Large Sand Plover (*Charadrius leschenaultii*), Eurasian Curlew (*Numenius*

arquata), Eurasian Oystercatcher (*Haemotopus ostralegus*) and Crab Plover (*Dromas ardeola*) occur only in the Gulf. As per the Bird Life International Red Data List and IUCN 2002 Red Data Book, the MNP is home to several globally threatened species, such as Spot-billed Pelican (*Pelecanus philippensis*), Dalmatian Pelican (*P. crispus*), Greater Spotted Eagle (*Aquila clanga*), Indian Skimmer (*Rhynchops albicollis*), Black-necked Stork (*Ephippiorhynchus asiaticus*) and Pallas's Fishing Eagle (*Paliaeetus leucoryphus*). The Gulf region is also important for marine turtles and sea mammals.¹⁷

Though a detailed systematic survey of biota is lacking, following number of species have been reported: (Table 4)

Table 4 Number of marine species

Flora/fauna	Species (Nos.)
Algae	130
Molluscs	200
Sponges	70
Crabs	30
Corals	36
Birds	200
Fishes	200
Sea mammals	3
Sharks	8
Sea turtles	3
Prawns	27

Because of its high bio-geographical importance and rich flora and fauna, several areas along the southern Gulf are notified under the Marine National Park (16,289 ha.) and the Marine Sanctuary (29,503 ha.) (Figure 2).



Figure 2 Marine sampling.

Table 5 List of intertidal algae of the Gulf

Name	Status*	Name	Status*	Name	Status*
Chlorophyceae		Phaeophyceae		Rhodophyceae	
<i>Boodlea composita</i>	C	<i>Colpomenia sinuosa</i>	C	<i>Acanthophora delilei</i>	C
<i>Bryopsis indica</i>	C	<i>Cystoceira indica</i>	C	<i>A. specifera</i>	R
<i>B. plumose</i>	C	<i>Dictyota atomaria</i>	C	<i>Amphiroa fragilissima</i>	R
<i>B. ramulosa</i>	C	<i>D. bartayrisiana</i>	R	<i>Asparogopsis taxiformis</i>	C
<i>Caulerpa crassifolia</i>	C	<i>D. cervicornis</i>	R	<i>Botroycladia leptapoda</i>	C
<i>C. cupressoides</i>	C	<i>D. ciliolate</i>	C	<i>Calaglossa bombayance</i>	R
<i>C. racemosa</i>	C	<i>D. dichotoma</i>	C	<i>Ceramium sp.</i>	C
<i>C. scalpelliformis</i>	C	<i>D. divaricata</i>	R	<i>Champia indica</i>	C
<i>C. sertularioides</i>	C	<i>Dictyopteris australis</i>	C	<i>Chondria ornata</i>	R
<i>C. taxiformes</i>	C	<i>D. woodwardii</i>	C	<i>C. dasyphylla</i>	R
<i>C. verticillata</i>	C	<i>Ectocarpus sp.</i>	C	<i>Coelarthrum opuntia</i>	C
<i>Chaetomorpha indica</i>	C	<i>Hinskia mitchelle</i>	C	<i>Corallina officinalis</i>	C
<i>Chamaedoris auiriculata</i>	C	<i>Hormophysa triquetra</i>	R	<i>Corynomorpha prismatica</i>	R
<i>Cladophora glomerata</i>	C	<i>Hydroclathrus clathratus</i>	R	<i>Cryptopleur sp.</i>	R
<i>C. prolifera</i>	C	<i>Iyengaria stellata</i>	C	<i>Dasya sp.</i>	R
<i>Codium decorticatum</i>	R	<i>Myriogloea sciurus</i>	R	<i>Desmia hornmanni</i>	R
<i>C. dwarkensis</i>	C	<i>Nemacystus decipiens</i>	R	<i>Gastroclonium iyengaraii</i>	R

Table Continued

Name	Status*	Name	Status*	Name	Status*
<i>C. elongatum</i>	C	<i>Padina gymnospora</i>	R	<i>Galaxaura oblongata</i>	C
<i>Dictyosphaeria cavernosa</i>	C	<i>P. tetrastromatica</i>	C	<i>Gelidiella acerosa</i>	C
<i>Enteromorpha intenstinalis</i>	C	<i>Pocockiella</i> sp.	C	<i>Gelidiospsis gracilis</i>	C
<i>Halideda tuna</i>	C	<i>Rosenvingia intricata</i>	R	<i>Gigartina</i> sp	R
<i>Pseudobryopsis mucronata</i>	R	<i>Sargassum johnstonii</i>	C	<i>Gracilaria corticata</i>	R
<i>Spongomorpha</i> sp.	C	<i>S. tenerrimum</i>	C	<i>G. pygmaea</i>	C
<i>Udoea indica</i>	C	<i>S. plagiophyllum</i>	R	<i>Gastroclonium iyengarii</i>	R
<i>Ulva fasciata</i>	C	<i>S. swartzii</i>	C	<i>Galaxaura oblongata</i>	C
<i>U. lactuca</i>	C	<i>S. wisghtii</i>	R	<i>Gelidiella acerosa</i>	C
<i>U. reticulata</i>	R	<i>Spathoglossum asperum</i>	R	<i>Valonia utricularis</i>	R
<i>Valonia utricularis</i>	R	<i>S. variabile</i>	C	<i>Valloniopsis spachynema</i>	R
<i>Valloniopsis spachynema</i>	R	<i>Gelidiospsis gracilis</i>	C	-	-
<i>Stoechospermum marginatum</i>	C	<i>Gigartina</i> sp	R	-	-
<i>Spathoglossum asperum</i>	R	<i>Gracilaria corticata</i>	R	-	-
<i>S. variabile</i>	C	<i>G. pygmaea</i>	C	-	-
<i>Stoechospermum marginatum</i>	C	<i>G. verrucosa</i>	R	-	-
<i>Turbinaria ornata</i>	R	<i>Grateloupia inica</i>	C	-	-
-	-	<i>G. felicina</i>	R	-	-
-	-	<i>Haloplegma</i> sp.	R	-	-
-	-	<i>Halymenia floresia</i>	R	-	-
-	-	<i>H. porphyroides</i>	C	-	-
-	-	<i>H. venusta</i>	C	-	-
-	-	<i>Helminthocladia clayadosii</i>	C	-	-
-	-	<i>Heterosiphonia muelleri</i>	C	-	-
-	-	<i>Hypnea cervicornis</i>	C	-	-
-	-	<i>H. musciformis</i>	C	-	-
-	-	<i>Hypoglossum spathulatum</i>	R	-	-
-	-	<i>Laurencia papillosa</i>	C	-	-
-	-	<i>L. pedicularioides</i>	C	-	-
-	-	<i>Liagora cerenoides</i>	R	-	-
-	-	<i>Lophocladia lallemandi</i>	R	-	-
-	-	<i>Neurymenia fraxinifolia</i>	R	-	-
-	-	<i>Polysiphonia</i> sp.	C	-	-
-	-	<i>Rhodymenia australis</i>	C	-	-
-	-	<i>R. palmate</i>	C	-	-
-	-	<i>Scinaia indica</i>	C	-	-
-	-	<i>S. furcellata</i>	R	-	-
-	-	<i>Sebdenia polydactyla</i>	C	-	-
-	-	<i>Spyridia alternans</i>	C	-	-
-	-	<i>Soleria robusta</i>	C	-	-

Note: C=Common, R=Rare

Table 6 Distribution of corals in the Gulf

Species/ Location	MB1	MB2	MB3	MB4	MB5	MB6	MB7	MB8	MB9	MB10	MB11	MB12	MB13	MB14	MB15
<i>Esammocora digitata</i>	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>Acropora humilis</i>	-	-	+	+	-	-	+	+	-	-	-	-	-	-	-
<i>A.squamosa</i>	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
<i>Montipora explanata</i>	+	-	+	+	-	+	+	-	+	+	+	+	+	+	+
<i>M.venosa</i>	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-
<i>M.turgescons</i>	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>M.hispida</i>	+	+	-	+	+	-	+	+	+	+	+	-	-	-	+
<i>M.foliosa</i>	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-
<i>M.monasteriata</i>	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-
<i>Coscinaraea monile</i>	+	+	+	+	+	+	+	+	+	-	-	-	-	-	+
<i>Siderastrea savignyana</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pseudosiderastrea tayami</i>	+	-	-	-	-	-	+	+	+	+	+	+	+	+	+
<i>Goniopora planulata</i>	+	+	-	-	+	+	+	-	+	+	-	+	-	-	+
<i>G.minor</i>	-	-	-	+	-	-	+	-	-	-	-	-	-	-	+
<i>G.nigra</i>	+	+	-	+	+	+	+	-	-	+	-	-	-	-	+
<i>Porites leutea</i>	+	+	+	+	-	-	+	-	-	-	-	+	-	-	+
<i>P.lichen</i>	+	-	-	-	-	-	+	-	+	-	-	+	-	+	+
<i>P.compressa</i>	+	+	-	-	-	-	-	-	-	-	-	-	-	-	+
<i>Favia speciosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
<i>F.favus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Favites complanata</i>	+	+	+	+	+	+	+	-	-	+	-	-	-	+	+
<i>F. melicerus</i>	+	-	+	-	-	-	-	-	+	-	-	-	-	+	+
<i>Goniastrea pectinata</i>	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+
<i>Platygyra sinensis</i>	+	+	+	+	-	-	-	-	-	+	-	-	-	+	+
<i>Hydnophora exesa</i>	+	+	+	+	-	-	-	-	-	+	-	-	+	-	+
<i>Plesiastrea versipora</i>	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Leptastrea purpurea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cyphastrea serailia</i>	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+
<i>Symphyllia radian</i>	-	+	-	+	-	+	-	-	+	-	-	-	-	-	-
<i>Acanthastrea simplex</i>	+	+	+	+	-	-	-	-	+	+	-	-	-	-	+
<i>Mycedium elephantotus</i>	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
<i>Paracyathus stokesi</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-
<i>Polycyathus verrilli</i>	+	-	+	-	-	-	+	-	-	-	-	-	-	-	-
<i>Tubastraea aurea</i>	+	+	+	+	+	-	-	-	+	+	-	-	-	-	-
<i>Turbinaria crater</i>	+	+	-	+	-	-	+	-	-	-	-	-	-	-	+
<i>T.peltata</i>	-	+	+	+	+	+	+	-	-	+	-	-	+	+	+

Planktonic and Benthic Habitat

Survey was conducted for the study of planktonic and benthic habitat. Study of biological status of any water body play an important role in assessing the causes of impact on water body and quality of the water. Here the biological parameter considered during EB survey are primary productivity, phytoplankton count, pigment analysis, zooplankton count, availability of benthic organism, fish and other micro habitat (Table 5&6).

In recent years, biodiversity of Marine Park/Marine Sanctuary has been under threat on several scores like extraction of corals and sands by cement industries, increased turbidity of water, oil refineries, chemical industries and mechanized fishing boats. Kumar et al.² have reported 31 species of corals in the Marine National Park. There were two catastrophic and localized bleaching events happened in this region.³⁻⁴ Coral bleaching and associated mortality not only have negative impacts on coral communities, but they also impact fish communities and the human communities that depend on coral reefs and associated fisheries for livelihoods and wellbeing. Bleached corals are likely to have reduced growth rates, decreased reproductive capacity, increased susceptibility to diseases and elevated mortality rates. Nearly everything in a coral-reef ecosystem depends on corals, or on the reef structure in some way. Coral colonies provide a source of food and shelter for countless reef-associated organisms and their health is of critical importance to the ecology of the reef community.

Conclusion

The area in question is rich in marine biodiversity especially Corals and some part of the Gulf has been protected under Marine National Park and Marine Sanctuary in 1980 under the provision of the Wildlife (Protection) Act, 1972 of India. There are many illegal fishing, fish trade, goods transport and many other activities reported from the area in question. The situation is going to worsen due to increase in ship transportation. There is an urgent need to implement the effective ecological management plan to restore the marine biodiversity of the Gulf of Kutch.

Acknowledgements

None.

Conflict of interest

Author declares that he has no conflict of interest.

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