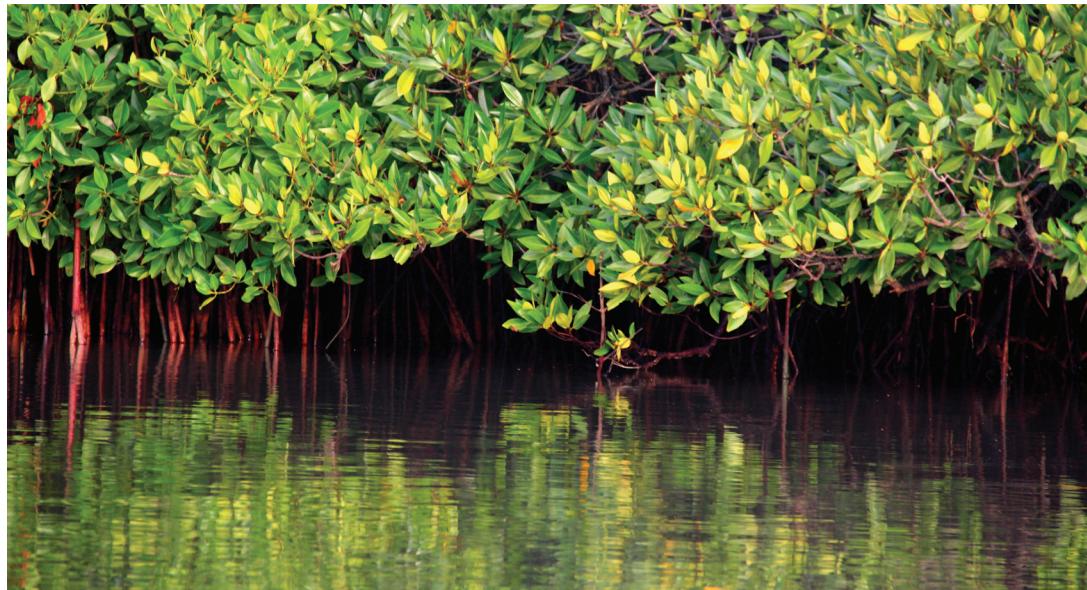


Managing Coastal Marine Biodiversity and Protected Areas

For MPA managers

Module 3

From Landscape to Seascape



भारतीय वन्यजीव संस्थान
Wildlife Institute of India



Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

On behalf of:



Federal Ministry
for the Environment, Nature Conservation,
Building and Nuclear Safety

of the Federal Republic of Germany

Disclaimer:

This Training Module is a part of the training resource material on “Managing coastal marine biodiversity and protected areas” for MPA managers. This training resource material has been developed under the Human Capacity Development component of the GIZ Project –‘Conservation and Sustainable Management of Existing and Potential Coastal and Marine Protected Areas (CMCA)’, under the Indo-German Biodiversity Programme, in partnership with the Ministry of Environment, Forests and Climate Change (MoEFCC) Government of India. The CMCA Project is commissioned by the German Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety (BMUB) with the funds provided under the International Climate Initiative (IKI). The CMCA project is implemented in selected coastal states in India and focuses on capacity development of the key stakeholders in forest, fisheries and media sectors.

This training module is a work in progress. The information has been created and compiled from documented and published references/resources, as cited in the text. While due care has been taken in preparing this document, the publisher, editors, and text contributors assume no responsibility for the authenticity, correctness, sufficiency or completeness of such information or examples.

The contents of this module do not necessarily reflect the views of the GIZ, WII or partners. The participants using this module are encouraged to share their feedback and suggestions for improving this module at neeraj.khera@giz.de.

Table of Contents

3.1 Coastal and marine ecosystems in India	7
3.2 Differences between the terrestrial and coastal and marine ecosystems?	9
3.2.1 Ecological context	11
3.2.2 Socio-economic context	13
3.2.3 Political and security context	14
3.2.4 Key differences between terrestrial and marine ecosystems with respect to environmental and ecological features and the patterns and consequences of human impacts	17
Main Sources	18
Further Resources	19



Summary

This brief but very important module provides an overview of the ecological, socio-economic and political context that make the coastal and marine ecosystem management different from the management of terrestrial ecosystems. The module also summarizes they key ecosystem characteristics of the coastal and marine ecosystems.

Key Messages

- There are several types of coastal ecosystems in India: inland freshwater wetlands, inland brackish water wetlands, estuarine wetlands, coastal mudflats, sand dunes, rocky shores, mangrove forests, coral reefs and other coastal and marine ecosystems.
- There are no discrete boundaries in marine ecosystems as seen on land
- Aquatic environments are richer in nutrients than equivalent terrestrial ecosystems and hence able to support more life
- Habitat destruction in the case of terrestrial ecosystems is widespread whereas it is localized in the case of the marine realm (estuaries, coral reefs etc.)
- Degradation and destruction are ‘visible’ in terrestrial ecosystems whereas they may not be in the case of the marine realm
- Property rights are much more complicated in the coastal environments



3.1 Coastal and marine ecosystems in India

According to the Indian naval hydrographical charts, the mainland coast consists of the following:

- 43 per cent - sandy beaches;
- 11 per cent - rocky coast including cliffs; and 46 per cent - mudflats or marshy coast.

Among the notable coastal features of India are the marshy Rann of Kachchh, in western India, and the alluvial Sundarbans Delta, to the east (which India shares with Bangladesh).

India has two archipelagoes: (1) the Lakshadweep, coral atolls off India's southwestern coast; and (2) the Andaman and Nicobar Islands, a volcanic chain of islands in the Andaman Sea.

According to the Zoological Survey of India¹², the Indian Ocean accounts for:

- 29 per cent of the global ocean area;
- 13 per cent of marine organic carbon synthesis; 10 per cent of capture fisheries;
- 90 per cent of culture fisheries; 30 per cent of coral reefs;
- 10 per cent of the mangroves; and
- it has 246 estuaries draining a hinterland greater than 2,000 sq km, besides coastal lagoons and backwaters.

Being landlocked in the north, and with the largest portion of it lying in the tropics, the Indian Ocean is a region of high biodiversity, with one of the countries in the region, India, rated as being one of the mega-biodiversity centres of the world.

In the current context of international trade and intellectual property regimes, it is important for all of the Indian Ocean countries to understand their marine biodiversity.

The dissimilarities between the west and east coasts of India are remarkable. The west coast is generally exposed, with heavy surf and rocky shores and headlands, whereas the east coast is generally shelving, with beaches, lagoons, deltas and marshes. The west coast is a region of intense upwelling, associated with the southwest monsoon (May–September), whereas the east coast

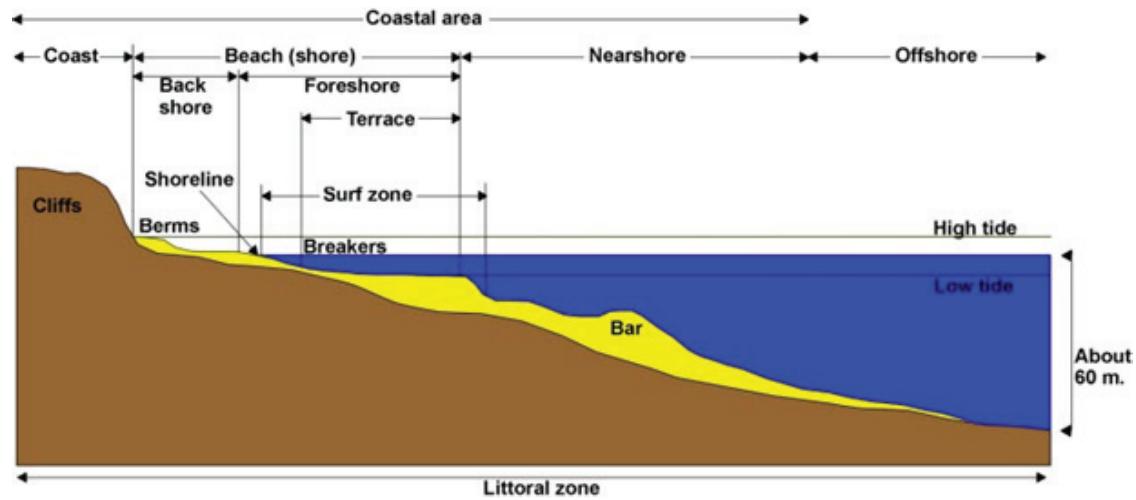
experiences only a weak upwelling, associated with the northeast monsoon (October–January), resulting in marked differences in hydrographic regimes, productivity patterns and qualitative and quantitative composition of fisheries.

All the islands on the east coast are continental islands, whereas the major island formations in the west coast are oceanic atolls.

According to the Zoological Survey of India¹³, the current inventory of coastal and marine biodiversity of India indicates that a total of 17,795 species from the faunal and floral communities have been reported from the seas around India.

The data reveal that India contributes 6.75 per cent to the global marine biodiversity.

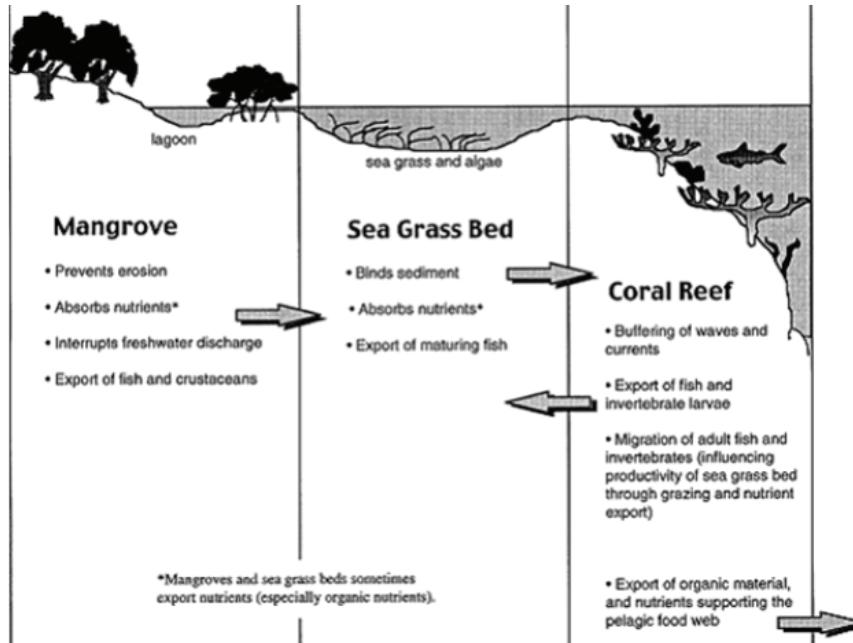
India is one among 12 mega-biodiversity countries and 25 biodiversity hotspots of the richest and highly endangered eco-regions of the world.



3.2 Differences between the terrestrial and coastal and marine ecosystems?

Marine and terrestrial ecosystems are different with respect to the aquatic medium in which all marine organisms exist. Water unites, land divides – there are no discrete boundaries in marine ecosystems as seen on land. Populations in the marine realm have been found to be genetically more homogenous and therefore, effective population sizes are larger. Dispersal and response to local events such as pollution or rising temperatures elicits faster response in the case of marine organisms.

Degradation and destruction are ‘visible’ in terrestrial ecosystems whereas they may not be in the case of the marine realm. Only relatively recently property rights have been introduced in the



marine realm (till now considered largely open-access) whereas they are well entrenched on land. Defining borders and patrolling them is much easier on land than on water.

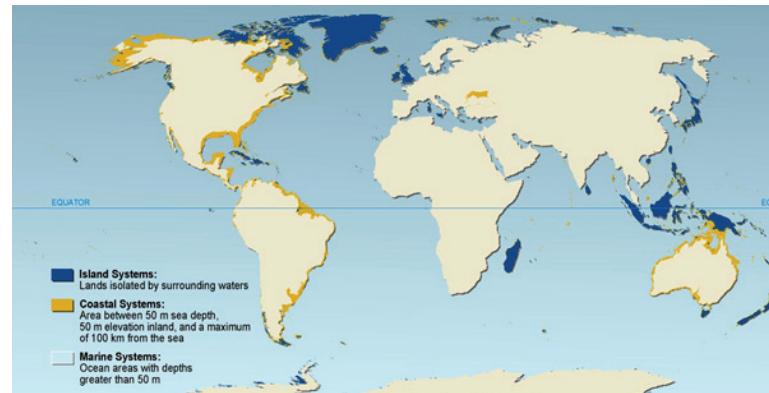
According to Convention on Biological Diversity (CBD) Aichi Target 11, protected areas should be integrated into the wider landscape and seascape, and relevant sectors, bearing in mind the importance of complementarity and spatial configuration. Here landscape refers broadly to terrestrial ecosystems whereas seascapes refer to marine ecosystems. Wider landscape and seascape includes the array of land and water uses, management practices, policies and contexts that have an impact within and beyond protected areas, and that limit or enhance protected area connectivity and the maintenance of biodiversity. The methods of managing terrestrial ecosystems cannot be directly applied to marine ecosystems because of a number of causes. These can be examined under the following broad contexts:

3.2.1 Ecological context

The fundamental difference between marine and terrestrial areas is the aquatic medium in which all marine organisms live. Water being denser than air (800 times), organisms may be neutrally buoyant, have specialised floatation devices (e.g. swim bladder of fish) or have surface area to volume ratio to increase buoyancy. The buoyancy of water offsets the effect of gravity which is why the largest animal on earth is a whale, an inhabitant of the marine realm. Terrestrial plants such as trees have to invest large resources in support structures (e.g. wood) whereas aquatic plants invest in fewer resources for support.

Plants, primarily the multicellular flowering forms, are the dominant primary producers on land, releasing oxygen through the process of photosynthesis. On land, plants are mostly sessile, rooted to the ground for their lifetime. In the marine realm, the microscopic unicellular phytoplankton are the dominant primary producers. These drift along with winds and waves, forming blooms where conditions (especially availability of nutrients) are favourable. Thus, on land, the ecosystems can be described as being more internally controlled by the dominant organisms (trees) whereas the organisms of the marine realm are subject to the physics of the surrounding medium, water.

Figure 1:



source: <http://ocean.si.edu/ocean-videos/mosaic-ocean-habitats-video-national-geographic-and-census-marine-life>

Marine systems are highly dynamic, tightly connected through a network of surface and deep-water currents whose stratifications are broken by upwelling that create vertical and horizontal heterogeneity. Consequently, the wide range of physical, chemical and geological variations that are found in the sea have given rise to a complex of marine habitats that range from highly productive near-shore ecosystems to the ocean deeps that are inhabited only by specialised organisms.

Aquatic environments are richer in nutrients than equivalent terrestrial ecosystems and hence able to support more life. However, while light and oxygen can be limiting factors in the aquatic environment, they are seldom so on land. The aquatic realm is relatively more stable than the terrestrial realm with smaller fluctuations in temperature and other variables. Since they live in water, aquatic organisms are seldom exposed to desiccation while terrestrial organisms are often exposed to desiccation. This is important considering the fact a large proportion of an organism's body is made up of water.

Perhaps the most important ecological point that needs to be considered in managing marine ecosystems is that terrestrial ecosystems have discrete boundaries while in the case of marine ecosystems, the boundaries are relatively open; which is why it may be said that while the sea unites, land divides. This issue of boundaries

is important in the context of migration of organisms and in the dispersal of organisms in various life stages. This has probably resulted in relatively lower genetic variation between populations and therefore larger effective population sizes. Apart from migration in search of food, marine organisms migrate as the local conditions change; the rate of response to environmental variability is much faster in the case of marine ecosystems compared to terrestrial ecosystems. The boundary issue is also relevant with respect to habitat fragmentation – the sensitivity to habitat fragmentation is much lower in the case of marine ecosystems.

Watch this documentary:

Mangroves: Guardians of the Coast

Guardians of our Coast showcases the fascinating web of life that surrounds these tidal forests. The movie highlights the unique collaboration between governments, regional and local institutions, NGOs and local communities, in efforts to save these vulnerable ecosystems and restore them to their former glory.

<https://www.youtube.com/watch?v=4SY7X9zdZ-U>

There is also a difference in the rate and importance of anthropogenic pressures. Habitat destruction in the case of terrestrial ecosystems is widespread whereas it is localised in the case of the marine realm (estuaries, coral reefs etc.). More importantly, in the case of terrestrial ecosystems, habitat destruction is ‘visible’ as in the cutting down of trees in a forest whereas while bottom trawling may devastate the benthic habitat of marine ecosystems, it may not be visible unless someone dives in the area as humans do not live in water and therefore cannot be aware of change in habitat.

3.2.2 Socio-economic context

PROPERTY RIGHTS AND OWNERSHIP:

In the socio-economics context, the different kinds of property rights become relevant in understanding the difference between marine and terrestrial ecosystems. On land, property rights are reasonably clear: private, public (state) and common property. In contrast, coastal waters and many coastal spaces such as beaches have always been considered open access which means that restricting natural resource based activities such as fishing, sea- weed collection and shell collection can be difficult as it will affect thousands of livelihoods.

At the international level, it was only after the United Nations Convention on the Law of the Sea (UNCLOS) that nations have acted to establish ownership of the seabed and overlying waters by the declaration of territorial waters and Exclusive Economic Zone (EEZ). While the onus of conservation of living marine resources in the EEZ vests with the coastal state, Section 2 of Part VII of UNCLOS broadly states that states should cooperate with one another in the conservation and management of living marine resources in the high seas. Most recently (2011), the Global Environment Facility (GEF) project on Areas Beyond National Jurisdiction (ABNJ) was developed to promote efficient and sustainable management of fisheries resources and biodiversity conservation in the ABNJ, considered as the world’s last global commons.

More than a third of the world’s population lives in coastal areas and small islands that make up just over 4 per cent of earth’s total land area. Fisheries and fish products provide direct employment to 38 million people. Coastal tourism is one of the fastest growing sectors of global tourism and

provides employment for many people generating local incomes. 90 per cent of world trade is through sea shipping.

FOOD CHAIN:

Marine ecosystems have been important as providers of food for millennia, especially for those living in coastal areas. While the proportion of farmed food with respect to wild-caught food is very high in the case of terrestrial ecosystems, it is capture fisheries that dominate production from the marine environment. In terrestrial environments, it is primary producers and herbivores, the first two levels in a food chain/web that are farmed and consumed, whereas in the case of food from the sea, it is the carnivores or organisms at higher levels in the food chain that are harvested and consumed. Depletion at the higher trophic levels can have a cascading effect on the food chain and food web. This can be considered as the second relevant point of difference between marine and terrestrial ecosystems from a socio-economics context.

3.2.3 Political and security context

Land borders are geographical features such as rivers, seas, mountains and other formations that present natural obstacles to communication and transport. Existing political borders are often a formalisation of these historical, natural obstacles. While some borders (between countries) are open and completely unguarded (e.g. inter-state borders within the Schengen area in Europe), most borders between countries are fully or partially controlled and may be crossed legally only at designated check points. Deliberate (human) movement of plants and animals across borders may be prohibited (in the case of endangered species) and is otherwise usually restricted with quarantine requirements. However, migratory movement of plants or animals (in which a significant proportion of the members of the entire population or any geographically separate part of the population cyclically and predictably crosses one or more national jurisdictional boundaries) is historically unrestricted and also the subject of the Convention on Migratory Species.

With respect to maritime boundaries, under UNCLOS, a coastal state is entitled to a territorial sea not exceeding 12 nautical miles measured from its baselines. Within its territorial sea, the coastal state exercises sovereignty, including over its resources. Subject to the provisions of the convention,

ships of all states enjoy the right of innocent passage through the territorial sea. The convention also grants a coastal state the right to establish a contiguous zone not extending beyond 24 nautical miles from the baselines. Within its contiguous zone, the coastal state may exercise the control necessary to prevent and punish infringement of customs, fiscal, immigration or sanitary laws and regulations that have occurred within its territory or territorial waters and to control, in specified circumstances, the trafficking of archaeological and historical objects.

In addition, a coastal state may establish an exclusive economic zone not extending beyond 200 nautical miles from its baselines, where the coastal state has sovereign rights for, inter alia, marine scientific research and protection and preservation of the marine environment. When two or more coastal states share a sea or ocean, usually bilateral/ multilateral treaties are executed to resolve border disputes.



On land, hunting in border areas can be controlled: hunters chasing their prey may be stopped by clearly demarcated natural or artificial borders which allow their prey to move away but clearly indicate the limit of human movement. On the other hand, fishing may involve chasing fish even across maritime borders as there may not be visible indicators of such borders and the fish are swimming underwater, out of sight. Similarly, since a reserve demarcated in the ocean realm, unlike that demarcated on land, may not have visible boundaries, hence, trespass (human) may happen.

Thus, there is considerable difference in costs in demarcating and monitoring in terrestrial and marine systems in terms of their borders. It is easier to fix boundaries of terrestrial systems and ensure their visibility by, for example, using fences and monitor them by patrolling. In contrast, it is much more difficult to demarcate boundaries of marine ecosystems and make the boundaries visible. The costs of patrolling seas/ocean and enforcing regulations are higher than that for terrestrial ecosystems.



3.2.4 Key differences between terrestrial and marine ecosystems with respect to environmental and ecological features and the patterns and consequences of human impacts

Feature	Terrestrial ecosystems	Marine ecosystems
Environmental		
Prevalence of aquatic medium	less	greater
Dimensions of species distribution	two-dimensional	three-dimensional
Scale of chemical and material transport	smaller	greater
"Openness" of local environment (i.e., rates of import and export)	less	greater
Ecological		
Phyletic diversity (α and β)	less	greater
Life-history traits		
Per capita fecundity of invertebrates and small vertebrates	lower	higher
Per capita fecundity of mammals	low	low
Difference in dispersal between life stages	less	greater
Importance of pollination syndromes	great	minimal
Rate of response to environmental variability	lower	faster
Sensitivity to large-scale environmental variability	lower	higher
Population structure		
Spatial scale of propagule transport	smaller	greater
Spatial structure of populations	less open	more open
Reliance on external sources of recruitment	lower	higher
Likelihood of local self replenishment	high	low
Sensitivity to habitat fragmentation	greater	less
Sensitivity to smaller scale perturbations	greater	less
Temporal response to large-scale events	slower (centuries)	higher (decades)
Trophic		
Lateral transport of energy	low (few planktivores)	high (many planktivores)
Turnover of primary producers	slow (many perennials)	high (few perennials)
Reliance of carnivores on external input of prey	lower	higher
Prey populations influenced by external input of predators	lower	higher
Pronounced ontogenetic shifts of vertebrates	rare	very common
Genetic		
Effective population size	smaller	larger
Spatial scale of gene flow	smaller	larger
Interpopulation genetic diversity	higher	lower
Types and relative importance of contemporary human threats		
Habitat destruction	widespread	spatially focused (e.g., estuaries, coral reefs)
Loss of biogenic habitat structure	widespread (e.g., deforestation)	spatially focused (e.g., estuaries, coral reefs)
Trophic levels threatened or exploited	lower (primary producers)	higher (predators)
Degree of domestication	higher	lower

Main Sources

- Khera, N. (2013). Sustainable Management of Marine and Coastal Protected Areas: Taking an Inclusive Approach Technologies and their applications in sustainable use and conservation of coastal and marine protected areas in India. In Sivakumar, K. (Ed.) Coastal and Marine Protected Areas in India: Challenges and Way Forward, ENVIS Bulletin: Wildlife & Protected Areas. Vol. 15 Wildlife Institute of India, Dehradun-248001, India. 264-273 pp
- Millennium Ecosystem Assessment (MEA). 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.
- NCSCM. 2012. Lagoons, Lives, Livelihoods. Editors: Purvaja Ramachandran, Ahana Lakshmi and Ramesh Ramachandran. Special publication for the 11th meeting of the Conference of Parties, Convention on Biological Diversity, Hyderabad, India. <http://www.ncscm.res.in/cms/more/pdf/ncscmpublications/COP11%20BOOK%20Final.pdf>
- NCSCM report/SAC. 2011. National Wetland Atlas. SAC/EPSA/ABHG/NWIA/ATLAS/34/2011. Space Applications Centre (ISRO), Ahmedabad, India, 310p.
- Parikh et al (2012). The Economics of Ecosystems and Biodiversity-India. Initial Assessment and Scoping Report. Working Document. MoEF publication.
- UNEP regional seas information series, Technical analysis for policymakers on issues related to protection of the marine and coastal environment <http://www.unep.org/regionalseas/publications/series/unep-rsp-info-series.pdf>
- Venkatrama, K., (2005). Costal and marine biodiversity of India. Retrieved on 5th September, 2015 from [http://nopr.niscair.res.in/bitstream/123456789/1544/1/IJMS%2034\(1\)%2057-75.pdf](http://nopr.niscair.res.in/bitstream/123456789/1544/1/IJMS%2034(1)%2057-75.pdf)

Further Resources

- BBC Human Planet ep 1 of 8 Oceans pt 14 HD nature documentary <http://www.youtube.com/watch?v=Mugl3av42Bk>
- A Photographic journey through Ocean biodiversity <http://ocean.nationalgeographic.com/ocean/photos/starfish/>
- The Structures and Adaptations to Marine Living - MarineBio.org". MarineBio Conservation Society. Web. Accessed 7:12 AM 10/2/2015. <<http://marinebio.org/oceans/structures-adaptations/>>
- Coastal Zones of India. http://envfor.nic.in/sites/default/files/Coastal_Zones_of_India.pdf | SAC ISRo 2011

20

