Summary
and
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About 40% of the world’s population residing within 100 km of the coastline. The major portions of coastal regions, particularly from the tropic, are characterized by ecological sensitive fragile ecosystems such as seagrass, corals, seaweeds, mangroves, obligate halophytic and sand dunes, essentially because they represent the interface between the land and the sea. Goa with about 105 km long coastline has limited resources of ecological sensitive marine habitats.

Mangroves form one of these major habitats, sustaining various types of fauna and flora of socioeconomic values. The physical structure of fishes and invertebrates is greatly influenced by mangroves. These habitats support small scale fisheries and produce nearly one million tones of fin fishes, mollusks, crabs and shrimps. Oysters form edible and economically feasible source of commercial importance. Mangrove forests along with its ambient environment are conducive for oyster and their larval settlement.

This study would be of a great help in detecting the changes in mangrove ecosystems of Goa in the last decade, as well as its present situation and distribution. This would also aid in monitoring and management of mangrove resources. The investigations would greatly help in understanding the environmental characteristics and productivity of the oyster beds associated with the mangrove ecosystems, and to
evaluate their potential bioindication ability for trace metals pollution in these habitats.

In view of the above points, the change in land use pattern in mangrove regions from the state, during last three decades, have been evaluated, using remote sensing and GIS techniques. The oyster beds associated with the mangrove environment form selected localities, have been investigated for a period of twelve months from August 2005 to July 2006. Data generated during present studies revealed an increase of approximately 22% in mangrove area in the state from 1997 to 2006, suggesting better status of the habitat compared to the other regions along the west coast of India. Although ground truth data confirmed new formations and rehabilitation of mangroves, loss of habitats has also been observed in a number of localities. Recently, mangrove habitats have been subjected to tremendous pressures from increased anthropogenic activities, particularly land conversion, grazing and habitat fragmentation. The state of Goa, being a tourist destination, is intensively pressurized from economical activities, leading to deterioration of coastal habitats, particularly mangrove and sand dunes.

Hydrological parameters influencing mangroves showed marked spatial and temporal variations. Monsoon season plays a vital role in influencing mangrove environment. Cloud cover, precipitation as well as strong wind during monsoon decrease the summer high temperature and increasing relative humidity in the range of 83% - 86%. Fresh water runoff reduces
temperature and salinity, and enriches the habitat with nutrients, POC and DO during rainy period (June – September).

The study of oyster beds in the mangrove habitats from Goa revealed that these beds are subjected to severe exploitation. Unmanaged removal of oyster ultimately leads in declining the natural population. Approximately 64 – 84% of the oyster beds, studied presently, have been damaged. *Crassostrea madrasensis* and *C. gryphoides*, though form the communities constituents, the former dominate the beds. *Crassostrea madrasensis* species was not reported earlier from Goa, and hence present investigation report the same for the first time.

The results revealed lower values of percentage edibility (PE) during the post-monsoon season, whereas higher values were observed in both species during pre-monsoon season. *Crassostrea madrasensis* produced better edible biomass compared to the same by *C. gryphoides*. However, both species showed comparatively higher condition index (CI) values in the pre-monsoon season, and lower values during post-monsoon season. The correlation between values of PE and CI in *C. madrasensis* was found to be highly significant at the 1% level. The allometric results revealed that the increase in total weight and meat (wet) weight are mostly dependent on the increase of the shell length. However, the increase in the total weight coincided with the increase in the flesh wet weight, indicating that contribution of soft tissue to the total weight was highly significant ($r = 0.7615$).
Molluscs including bivalves and oysters form a low-cost subsistence food of the coastal people, especially for the fishing communities. The nutritive value in molluscs is influenced by the various ecological and environmental parameters in ambience. Annual variations in water contents of oyster could be attributed to the salinity concentrations in the water column. The water contents of *C. madrasensis* was negatively correlated with the water salinity (r= -0.3675 & -0.13074). Higher values of proteins and lipids in the oyster's tissue have been found during monsoon season when salinity in ambience remains to very low. Therefore, the rich contents of proteins and lipids in oyster tissue could be attributed to the higher concentrations of food availability in ambience during monsoon. Both parameters found to be positively correlated with POC concentration in the water column. Negative correlation was found between water contents and lipids. Carbohydrates in the tissue of *C. madrasensis* ranged from 1.52% to 4.19%, with lower values during post-monsoon season, which increased during pre-monsoon and monsoon seasons.

*Crasostrea madrasensis* were reported to have higher caloric values during monsoon season. These values were positively correlated to major biochemical constituents. It was noticed that carbohydrates, proteins and lipids in *C. madrasensis* were significantly influenced by the conditions of ambient environment such as quantity of food availability, temperature and salinity. The optimum time for harvesting oyster population found to be during pre-monsoon season between February and May, when Cl, PE and the caloric values, remain higher. Regulation
on oyster exploitation was felt for the sustainable development of oyster fisheries, which is presently lacking in the state.

Certain bivalve species have been reported to be of a great ecological importance, and serve as an indicator or a flag species, for monitoring the environmental quality by analyzing trace metals in their tissue. The hinterland and the coastal waters from Goa estuaries are intensively used for mining of manganese and iron ores and their transportation, respectively, for the last four decades. The major mangrove formations from the state exist along this Mandovi-Zuari and Cumbarjua canal estuarine complex. The estuaries also receive discharge of waste water arising from anthropogenic and industrial activities. The attempts have been made to evaluate the concentrations of selected trace metals from water, major mangrove flora and its associated oyster *C. madrasensis*, and to find its bioindicating ability for trace metal pollution.

Insignificant correlations were found between metal concentrations in *C. madrasensis* in the ambient waters and the mangrove species. The insignificant relations between metal values in oyster tissue and ambience could be attributed to the metal bioaccumulation kinetics in oysters, which may be slow relative to short-term fluctuations in metal concentrations in the surroundings. Therefore, metal concentrations in oyster at any particular times may not exactly reflect the quantum of metal in ambiance at the same time. Since oyster possesses ability to accumulate high concentrations of metals, it might be harmful to the animal as well as to its consumers including human being. Therefore, it
is essential that concentration of metal pollutants should be kept under continuous observations to ensure the acceptable limits. The present findings revealed that the *C. madrasensis* may not serve as an efficient indicator of metal pollution. Therefore, it is suggested that the indication ability of this species for different trace metals need to be evaluated further to draw the firm conclusion on its suitability as bioindicator.

Mangrove habitats subjected to various anthropogenic threats by over exploitation, particularly reclamation of these areas for residential, commercial, industrial and agricultural purposes. Conservation of these habitats meant for the maintaining of their rich biodiversity, germplasm, sustainability of utilization of fishery, forestry and other products and protection of coastal areas from fiery effects of tidal waves and cyclones. Management of natural oyster beds is important to insure the long-term sustainable yield. Shell planting and regulated harvesting practices, based on sound biological data, will enable the mangrove's oyster resources to continue contributing to the well being of the people that depend on this resource for part of their livelihood.