CHAPTER 5

SUMMARY AND CONCLUSIONS

This chapter carries a summary of the entire work presented in the thesis and the future scope.

CHAPTER 5 - SUMMARY AND CONCLUSIONS

5.1. Salient features of the research findings

This thesis mainly concentrates satellite data analysis for the observations of oceanographic events/features, their relevance to the fishery resources accumulation/distribution, interpretation of satellite derived SST and chlorophyll images for identification of potential fishing zones, fishing operation data analysis, interpretation of fish catch results with reference to the oceanographic features derived from satellite data, ecological perspective with respect to the spcies variability and habitat, modeling of zooplankton using remotely sensed chlorophyll concentration and SST.

The study area was off Gujarat coast, North West Coast of India. NOAA AVHRR data have been used to compute SST using multi channel sea surface temperature (MCSST) approach. IRS P4 OCM data were used for chlorophyll concentration. A long wave length approach was used for atmospheric correction Modified OC-2 algorithm was applied to atmospherically corrected radiance to compute chlorophyll concentration. The integration of both physical and biological (CC and SST) variables was carried out The features were delineated on both sensors' images This allowed understanding the patterns of variability in the oceanographic features The fish catch was procured from Fishery Survey of India. Fishing operation data were analyzed and plotted on composite images The fish catch results were co-related with the patterns of variability in oceanic

features to understand the relevance of fishery resources habitat and their percent distribution in PFZs and other areas.

Oceanographic events like upwelling was observed in the images of NOAA AVHRR derived SST images. The cool water along the coast indicated coastal upwelling Thermal data is most important tool for identification of upwelling. The signatures of upwelled cooled water first appeared in SST images. Upwelling along Gujarat coast was monitored during September-October, 1995 Upwelled cool water enhances the primary production in the euphotic zones, which can be sensed by ocean colour sensors The upwelling areas are most important areas for fishing due to enhance production for prolong period. The signatures of different stages of upwelling was studied. The first phase known as initiation phase is known to have deep low oxygenated water. Fishes avoid staying in low oxygenated areas and trying to be away. During stabilization phase the water of upwelling areas start maturing In the maturation phase fishes are likely to aggregate in upwelling areas due to enhanced production, which in tern enhances the secondary production. Eddies in the study area were monitored using OCM chlorophyll images. Two types of eddies were observed during the winter months. The cyclonic eddies were with high chlorophyll concentration indicating the high production due to the movement of deeper water in euphotic zone. Anti-cyclonic eddies were found with low chlorophyll concentration in the center. They occupied around100x100 Km areas with low chlorophyll concentration, called biological deserts in the oceans Eddies were persisted for a month. The cyclonic eddies are conducive of fish aggregation due to high bio-mass production. Oceanic fronts with the high chlorophyll concentration were observed with

different shapes and sizes were observed. Different patterns of variability in oceanic fronts were observed.

The synergistic analysis of chlorophyll concentration and SST was carried out to understand the relevance between two variables derived from the satellite The thermal features and ocean colour features were compared. The inverse relation was observed between the two variables i.e. chlorophyll and SST. The ocean colour features were found co-incised with thermal boundaries. This indicates that biological and physical processes are closely coupled. The fish catch data were plotted on both sensors' images It was observed that high fish catch was in the vicinity of oceanic feature representing the enhanced production.

The integration of chlorophyll and SST were carried out to generate composite images representing the both variables. Some of the features were founded matching at some locations. This indicates that biological and physical processes are closely couple at these locations Normalized fish catch points were plotted on the composite images. It was observed that the high CPUE containing points were found in the vicinity of matching features. Matching features show the enhanced production in ocean colour image and the at same time status of nutrient water supply in the area, which is indicated by low temperature. These studies helped for identification of PFZs. The different types of features, their shape, size and gradient, persistence have been taken in account for selection for PFZs Image interpretation keys for identification of PFZs have been discussed in detail. About 70% of observation catch points were well match with identified PFZs.

Habitat of fishery resources and their link with satellite derived PFZs was studied based on the patterns of variability in fish catch and their habitat i e.

pelagic, columnar and demersal in the identifies PFZs and other areas. Fishing operation results indicated the mix catch of species belong to different habitats, i.e. pelagic, demersal and column. The food and feeding habitats play a key role in the distribution of resources. Congregation of food in different habitats at surface, column and sea bed controls the distribution of fish population. The production and congregation of food resources at surface and subsurface can be easily detected by ocean colour sensor as it has capability to look into the sea. The ocean color sensor can detect the radiation back-scattered from one attenuation depth in the water column. This helps to locate sites of enhanced production available as food to the resources in the habitat zones. Habitat of fishery resources also depends on physiologically suitable environment. Satellite derived sea surface temperature (SST) partially explain the environmental suitability to fish with reference to their physiology. Fishery resources of benthic zone depend on the food resources available on sea floor, detritus material, vertically migrated plankton and other marine living resources Majorities of the species contributed in PFZs are primary, secondary or tertiary consumers feeding on different stages of life cycle of prey except herbivorous like sardines and mackerels.

Per cent contribution of fishery resources in identifies PFZs and other areas were compared. The per cent contribution of pelagic and column resources are more in the PFZs as compared to seasonal mean of entire area during the fishing season This proves the capability of satellite sensors to visualize the production over a large area. Comparatively the contribution of the demersal resources in the catches is lower in PFZs The limitation of satellite sensor to visualize the marine resources at bottom is reflected as the catfish catches were found to be higher due

to the muddy bottom. The exploration of demersal resources through remote sensing is based on the inter-link between the surface/column production of biomass with distribution of detritus material and living resources at the sea floor. This can further be linked with vertical migration of biomass and movement of the demersal resources towards the upper layers of the column in search of food, causing variation in the local ecosystem at different trophic levels, which supports benthic biomass.

Wind driven surface circulation is most important for the distribution and accumulation of fishery resources as well as phytoplankton. They have impacts on the eggs and juveniles of fishes. The mortality rate depends on the wind driven circulation Hence there is need to incorporate satellite scattrometer derived wind speed and direction to understand the shift the oceanographic features. This will also help in predicting the shift of feature and hence will allow prolong fishing activity in predicted PFZs.

Copepod egg production rate was modeled using remotely sensed chlorophyll concentration and SST. The in-situ observations for zooplankton population in the study areas was carried out using Multiple Plankton Net during February 2003 from on board Sagar Sampada. The results indicated that copepods contributed around 68% Sub surface production was found high at some locations, where sub surface chlorophyll maxima was observed. The modeled copepod egg production rate and in-situ copepod populations were found significantly related.

5.2. Future scope

Fishes depend on the multiple variables for there accumulation Some parameters are linked to each other. There is need to integrate parameter like chlorophyll, SST, MLD, current, bottom topopography, bathymetry, secondary production etc. per weightage based on importance of each parameter Geographic Information System (GIS) is tool, where such parameters can be integrated as per ranks and weight. GIS would also help in construction of fishery Information system.

Secondary production computation is one the important area where remotely sensed derived chlorophyll concentration, primary productivity and SST can be utilized The proper modeling on this line with validation through in-situ observations would be very useful for stock assessment of fishery resources in the Sea

It is clear that there will be expansion of interest and activity regarding expert system implementations in fishery science. These systems combine the knowledge based reasoning methods of expert systems with formal methods of decision analysis The future knowledge based systems in fisheries will be integrated with data base management, simulation models, prediction systems, management information system and planning systems. It is conceivable that in the future, fishing activities and fishery management will be largely integrated Telemetry from monitoring buoys and remote sensing service centers will be utilized tactically by the fishermen and for the strategic planning by the fishery managers In this scenario, simulation model run by the manager to provide

resource assessment information, while the fishermen will attempt to optimize the capture activity within the constraints provided by the manager Over all advantages of knowledge based system are such that progress in their development and implementation seems inevitable. Plant and Stone (1991) describe in detail an integrated decision support system for agriculture, which provides a dramatic view of the future of such systems Such systems are also expected in future for fisheries management purposes