Management of Scombroid Fisheries

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Application of satellite data for marine fishery forecasting

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ABSTRACT

The sharing of the pelagic and demersal common property fishery resources of the coastal waters has created considerable tensions, law and order problems and conflicts among various fishing sectors in the recent past. Fishes are known to react to changes in environmental conditions and migrate to areas where favourable conditions in terms of seawater temperature, dissolved oxygen and salinity exist. Monitoring of these parameters in space and time is time consuming and prohibitively expensive. Indirect method of monitoring selected parameters such as sea surface temperature and phytoplankton pigments is found very ideal in view of its high repetivity and spatial coverage. Short term fishery forecasts based on satellite imageries can help in minimizing the searching time for shoaling fishes by artisanal and small mechanised sector fishermen which in turn can result in the saving of valuable human effort and also fuel for the mechanised/motorized vessels, thereby bringing down the overall cost of fishing operations.

INTRODUCTION

The last few decades' fisheries research together with the technological advancement in the harvest and post-harvest areas have accelerated the process of transformation of a traditional subsistence oriented marine fisheries into a market oriented multi -crore industrial sector with considerable strength and capabilities in essential infrastructures. With the result the marine fish production has made great leaps through successive stages, first with a change from natural to synthetic fibres in fishing gear fabrication and a concurrent introduction of mechanised trawlers in the fifties, second with the introduction of mass harvesting gear the purse seine along the southwest coast in the eighties immediately followed by the introduction of motorisation (outboard) of country crafts. With the subsequent proliferation of innovative gears the yield reached around 2.4 million t. This production remains almost static in the nineties, probably waiting for another technological breakthrough in the harvesting sector.

Although the achievements were tremendous, slowly but gradually this common property was stressed and led to overharvest of at least a few easily vulnerable and target species and degradation of some of the fish habitats perhaps even to the extent of denudation, by the unbridled human greed. Ultimately the sustainability of many of the resources harvested from the coastal areas was jeopardised by the incessant fishing pressure coupled with the impacts of pollution and other anthropogenic causes. This situation is closely similar to the global marine fisheries scenario wherein 70% of the

fish stocks are either fully exploited, overfished, depleted or slowly recovering.

Thus today's challenging problem in this sector is to sustain the coastal production through appropriate region/area/resource specific regulatory management and enhance production through technological inputs in mariculture and expansion of fishing to hitherto little or unexploited areas of the oceanic realm for which, new concepts and policies are inevitable.

Diversity in Indian fisheries

The characteristic tropical species diversity is rich in Indian marine fisheries. There are nearly 1,570 species of finfishes and about 1,000 species of shellfishes known from our seas. The abundance of these stocks vary from region to region. Our capture fisheries progressively increased from about 0.6 million t in 1950 to 2.67 million t in 1998, showing an average annual growth of 6.4% over this period. However the annual growth rate declined from 6.5% during 1950-'60 to 2.3% during 1960-'70, increased to 4.3% during 1970-'80 and to 4.8% during 1980-'90 and declined to 4% during 1990-'98. This fall in growth rate is reflected well in the annual catch attaining optimum levels in the inshore fishing grounds extending up to about 50m depth covering an area of approximately 1,80,000 sq.km. Currently 1.91 lakh nonmechanised craft (including 32,000 motorised craft), 47,000 small mechanised craft and 180 large fishing vessels are operating in the Indian EEZ which is in excess of the optimum by 55%, 60% and 81% respectively. The contribution from the mechanised sector to the total catch is 67%, motorised 20% and nonmechanised 13%. This fleet capacity warrants imposition of responsible fishing practices and proper codes of conduct for sustainable growth in this sector.

Strategic issues and challenges

The sharing of the pelagic and demersal common property fishery resources of the continental shelf waters has created in the recent past considerable tensions and conflicts among various fishing sectors. Information insufficiency on resources and lack of proper resource management advice are sighted as drawbacks. There is need to find solutions for the sustainable long term economic utilisation of the resources by maintaining the exploited fish stock through proper regulatory measures controlling fishery dependent factors such as access and efforts expended while ensuring biological productivity. The socio-economic, environmental and concomitant issues also need to be studied.

Fishery forecasts

Lack of a firm grip on the physico-chemical properties of the coastal waters and their influence on the marine biota is a deterrent to resource modelling and forecasting. The significance of major hydro-meteorological

phenomena such as monsoon, upwelling currents and drifts in relation to passive and active migratory behaviour of species, the significance of an extensive oxygen minimum layer in the Arabian Sea on the diurnally and vertically migrating mesopelagics, the mechanism that triggers the phytoplankton blooms etc. are being explored in-depth by various agencies.

It is well known that the adaptation of fish to the surrounding marine environment is controlled by various physico-chemical and biological factors. Fishes are known to react to changes in environmental conditions and migrate to areas where favourable environmental conditions in terms of sea water temperature, dissolved oxygen levels and salinity conditions exist. Availability of food is an important factor which control their occurrence, abundance and migrations in the sea. Sea surface temperature is the most easily observed environmental parameter and is quite often correlated with the availability of fish, especially pelagic fish. Changes in sea surface temperature (SST) result out of changes occuring in the direction/velocity of both horizontal and vertical circulation processes in the sea. Many pelagic species concentrate at current boundaries especially in areas with sharp horizontal temperature gradients. The European Commission Fisheries Report published by the Nansen Centre provide an excellent review of the successful use of Satellite based observations in fisheries application. In Portugal the SATOCEAN Project since 1989 has been providing operational service to the Portuguese tuna and swordfish fishermen wherein they are provided with charts indicating location of thermal fronts and isotherms derived from NOAA - AVHRR data. Tropical marine fisheries are essentially multispecies and multigear in their characteristics. Tropical fish stocks are distinctly different from their temperate counterparts in their behaviour, migration, food and feeding habits, reproduction, recruitment, growth and mortality. Table 1 shows the estimated annual landings of selected pelagic fishes around the Indian subcontinent during the period from 1989 to 1999. It clearly shows the large-scale fluctuations observed in the landings of selected pelagic fishes around the Indian subcontinent.

Studies conducted by different agencies both within the country and abroad revealed that sea water temperature, dissolved oxygen levels, salinity, phytoplankton and zooplankton concentrations play an important role in controlling the distribution and abundance of fishery resources, especially pelagic. Monitoring these parameters in space and time is time consuming and prohibitively expensive and a real time picture of any one of these parameters or a combination of the above becomes almost an impossibility. Indirect method of monitoring selected parameters such as Sea Surface Temperature and phytoplankton pigments (Chlorophyll - *a*) at sea surface from satellites is found very ideal as it provides high repetivity and large spatial coverage.

Potential Fishing Zone advisories

Since sea surface temperature (SST) is one of the parameters which can be easily measured, the SST derived from the NOAA satellite AVHRR imageries are being utilised for the prediction of Potential Fishing Zones (PFZ) in the sea. Timely forecasts of PFZ based on SST or sea surface chlorophyll concentrations can help in minimising the searching time for shoaling fishes by artisanal and small mechanised sector fishermen which in turn can result in the saving of valuable human effort and also fuel for the mechanised/motorised vessels, thereby bringing down the overall cost of fishing operations.

SST - based PFZ advisories (short-term forecasts) are generated by the National Remote Sensing Agency, Hyderabad twice a week between November and May (cloud free months) to over 160 centres all along the Indian coast since 1990. Validation campaigns were regularly undertaken to enhance the accuracy, format and dissemination aspects. PFZ awareness/ training programmes were regularly conducted at major fish landing centres in Kerala, Andhra Pradesh, Orissa and Minicoy Island. The CMFRI has taken up special programmes for the intensive collection of marine fish landing data on exploited fishery resources in relation to PFZ forecasts both along the Kerala coast and Minicoy Island since 1993. The CMFRI organised an intensive dissemination and feedback data collection programme based on PFZ advisories generated by NRSA since 1995 at 17 selected landing centres along Kerala coast and around Minicoy Island based on the positive response received from active fishermen groups operating from these centres. The feedback information was collected from the same group on their return from fishing activity.

The results indicated the following:

1. Positive relationship between PFZ resulting out of comparatively high gradients of SST (2°C and above) and fishable concentrations of commercially important fishes was found only in respect of pelagic and column fishing activities such as purse seining, gill netting, trolling, and tuna pole and line fishing (around Minicoy Island). In the case of bottom trawling activity, the relationship was found to be negligible or nil during the same period.

2. For purse seine fishing, the average fish catch/boat varied between 4,480 kg and 3,200 kg for PFZ and non-PFZ respectively off Cochin during the month of November, when maximum number of purse seine boats were operating off Cochin. In the case of gill net fishing, the same varied between 480 kg and 187 kg for the same month. For tuna pole and line fishing for skpjack tuna around Minicoy Island the average catch/boat varied between 83 kg and 28 kg for PFZ and non-PFZ areas respectively.

3. An average increase in catches of 40% for purse seining and 260% for gill netting was observed in the PFZ along Kerala coast. Around Minicoy Island, an average increase of 300% in skipjack tuna catches for pole and line fishing activity was observed in the Potential Fishing Zones.

4. Between end of February and May, with the coastal waters getting heated up to greater vertical extent due to the summer many of the commercially important pelagic shoaling fishes like oil sardine (*Sardinella longiceps*), mackerel (*Rastrelliger kanagurta*) and tunas remained in comparatively deeper waters thereby getting themselves caught in bottom trawling gear which cannot be interpreted as any kind of relationship between sea surface temperature and demersal fish. However, demersal fish are equally likely to thrive at zones of high pelagic production since their benthic food resources are directly enhanced by the high primary production in the euphotic zone.

Improved PFZ advisories - future prospects

With the commissioning of OCEANSAT it has become possible to obtain real time satellite pictures of ocean colour, which provides information on chlorophyll - *a* distribution at surface levels both in the Arabian Sea and Bay of Bengal. The CMFRI in collaboration with the Space Application Centre, Ahmedabad, Fishery Survey of India and National Institute of Oceanography has initiated steps for the effective utilisation of the ocean colour monitor data along with SST for bringing out improved PFZ advisories which would indicate possible areas of concentration of herbivores like oil sardine which shows large scale changes in their occurrence / abundance in space and time.

Considering large scale fluctuations observed in the availability of fishable concentrations of some of the commercially important pelagic / column fishes like oil sardine, mackerel, tunas, Bombay duck and white bait from year to year and the high cost of fuel and human effort, it is very important that the searching time for the above mentioned pelagic shoaling fishes is reduced to maximum possible extent. This is especially so in the case of small mechanised sector and artisanal sector especially the Island fishermen engaged in tuna pole and line fishing activity.

Being a short term fishery forecast the PFZ advisories have to reach the active fishermen by the quickest possible means. The acceptance/adoption of the technology would, certainly to a large extent, depend on the usefulness of the information for the enduser, to be proved in terms of higher fish catches and also an overall reduction in searching time and resultant saving in the cost of fishing operations.

Table 1. Estimated annual landings (t) of selected pelagic fishes in India during the period 1989 - '99

Fish/year	1989	1990	19991	1992	1993	1994	1995	1996	1997	1998	1999
Oil sardine	278877	260995	176887	104062	95385	46814	56633	110346	223879	203909	240978
Indian mackerel	291077	184402	113675	135034	251146	205866	176830	275677	223937	177172	209741
Ribbonfishes	65256	74301	95428	111271	91671	112787	74043	126905	169647	113883	124548
Seerfishes	40984	29841	37408	43109	41729	41025	45912	37394	37537	54871	45228
E.affinis	26402	32659	17624	23391	19197	15705	15447	14778	23425	18609	22753
Auxis spp.	7462	6947	5407	7895	3976	12463	4867	11119	10564	9249	8276
K.pelamis	5664	5012	4967	833	8761	1086	796	1225	1888	1249	1841
T.tonggol	984	951	3727	2487	4324	4953	5787	64263	5322	5722	9121
Other tunas	4718	6491	4523	8666	7698	3162	10892	9535	5267	4855	6536
Bombayduck	120193	131095	136442	122273	97727	109307	88106	85767	103115	122803	91853
Horse mackerel	12454	22120	19203	19545	16074	24698	21021	17652	18771	25439	32693