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30 Application of remote sensing techniques for locating pelagic fish concentrations along the Kerala coast (SW coast of India) - work done and future prospects

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ABSTRACT

Intensive validation programme on Potential Fishing Zone forecasts carried out by the MARSIS, Central Marine Fisheries Research Institute, Cochin, at 17 selected fish landing centres along the Kerala coast between November 1995 and May 1996 revealed a positive relationship between PFZ and occurence/abundance of commercially important pelagic fishes. An attempt is made to identify possible reasons for the above, based on results of oceanographic investigations undertaken in the area and also taking into consideration fish behaviour in relation to environment based on past data. Future plans for evolving a suitable prediction system for commercially important pelagic fishes in the coastal waters of the mainland and skipjack fishery in the Lakshadweep islands based on PFZ forecasts are also discussed in view of its importance to the artisanal and small mechanised sector fishermen for reducing the searching time and thereby effecting an overall reduction in the cost of fishing.

Introduction

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 mortality and production.

As a premier nodal institute for marine fisheries research and related biological oceanographic investigations, the Central Marine Fisheries Research Institute (CMFRI) under Indian Council of Agricultural Research, has been

actively collaborating with the Department of Space and the Department of Ocean Development, Govt. of India,in the National Project On "Ocean Related Remote Sensing Programme"

The Marine Satellite Information Service (MARSIS) Programme was initiated by the Department of Ocean Development and is being co-ordinated by the National Remote Sensing Agency/Department of Space, as the nodal agency. The other participating agencies are, Space Application Centre (SAC), Ahmedabad, National Institute of Oceanography (NIO) Goa, Centre for Mathematical Modelling and Computer Simulation (C-MMACS), Bangalore, Orissa State Remote Sensing Application Centre (ORSAC), Bhubaneshwar, Institute for Ocean Management (IOM), Madras and Central Marine Fisheries Research Institute (CMFRI), Cochin. MARSIS has the overall objective of developing operational remote sensing capabilities for extraction of coastal zone and oceanic parameters and providing data to down stream users. Models are to be developed for simulation and prediction of oceanic processes. During the first phase of the programme, which was completed in March 1993, operational products of sea surface temperature (SST) data sets, Potential Fishing Zone (PFZ) advisories and coastal maps of Kerala and Tamil Nadu states have been generated and disseminated. Effective sea truth data was collected through ship cruises and drifting and moored buoys. The above mentioned MARSIS Centres were implemented and made operational during the first phase. In the second phase, which is under progress, to be completed in March 1997, operational services such as SST maps and PFZ advisories have been further strengthened.

The total marine fish landing in India was provisionally estimated at 2.36 million tons during 1994 (CMFRI, Annual Report, 1994-95). An increase of 3.5% (80,000 t) over 1993 was observed. Pelagic groups contributed 46.7% and demersal 53.3%. Though there was an increase of about 80,000 t in landings during 1994 compared to previous year, the catches of oil sardine, whitebait and mackerel decreased by 49,000 t, 12,000 t and 45,000 t respectively. The total landings along the SW coast of India has shown a decline of 60,000 t during 1994 over those of 1993. Major contributors to the decline were oil sardine, whitebait and mackerel.

The above mentioned figures clearly show the large scale fluctuations observed in the occurence and abundance of selected pelagic fishes along the SW coast of India.

Potential Fishing Zone (PFZ) forecasts and validation

Studies conducted both within the country and abroad have revealed that sea water temperature, dissolved oxygen content, salinity, phytoplankton and zooplankton concentrations play an important role in the distribution and abundance of fishery resources, especially the pelagic resources.

Monitoring these parameters in space and time is 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 oceanic parameters such as sea surface temperature and phytoplankton pigment at sea surface from satellites is found ideal as it provides high repetitivity and large spatial coverage. Timely forecasts of Potential Fishing Zones based on sea surface temparature or sea surface phytoplankton pigment concentration can help in minimising the searching time for fish shoals especially among artisanal fishing sector thereby bringing down the overall coast of fishing operations.

PFZ advisories are being generated by the National Remote Sensing Agency, Hyderabad, twice a week to over 160 centres all along the Indian coast. Validation campaign are regularly undertaken to enhance the accuracy, format and dissemination aspects. PFZ awareness/training programmes are regularly conducted at various fish landing centres. Institutions such as CMFRI, FSI and ORSAC and State Fisheries Departments are being associated for validation. The CMFRI has taken up a special programme for the intensive collection of marine fish catch data on exploited fishery resources in relation to PFZ forecasts. Marine fish landing data pertaining to a total of 1300 landing centres distributed in the various maritime states and Union Territories distributed is being collected systematically through a network of over 120 trained survey personnel attached to the Institute's headquarters at Cochin and 12 Regional/Research Centres.

Even though the dissemination of PFZ forecasts to groups of the active fishermen and obtaining feedback from the same groups was taken up on a priority basis since the beginning of 1993, especially along the Kerala Coast, the response was comparatively poor mainly because of the fact that, the fishermen were not convinced about the usefulness of the information provided to them through the PFZ forecasts.

Since 1995, the MARSIS Centre at CMFRI, Cochin, organised an intensive dissemination and feedback data collection programme at 17 selected landing centres along the Kerala coast, between November, 1995 and May, 1996, the period during which PFZ forecasts were given out by NRSA. The forecasts received were translated into the local language and passed on to the active fishermen. Arrangements were made through the local daily, "Malayala Manorama" to bring out this information twice a week, immediately on receipt of the forecast from NRSA. A blackboard of suitable size was installed at the Cochin Fisheries Harbour wherein the salient features of each forecast was given in writing in simple local language. The information was also broadcast through the AIR services at Cochin the same evening.

Seventeen fish landing centres such as Kottekkunnu, Kannur, Thalassery, Cowayi, Perimba, Chombala, Quilandy, Puthiappa, Vellayil, Beypore, Nattika, Azhikode, Cochin, Valanjavazhi, Ambalapuzha, Needakara / Shaktikulangara and Vizhinjam were selected for the compaign mainly based on the positive response received from active fishermen groups operating from these centres. The location of the above mentioned centres is given in Fig. 1

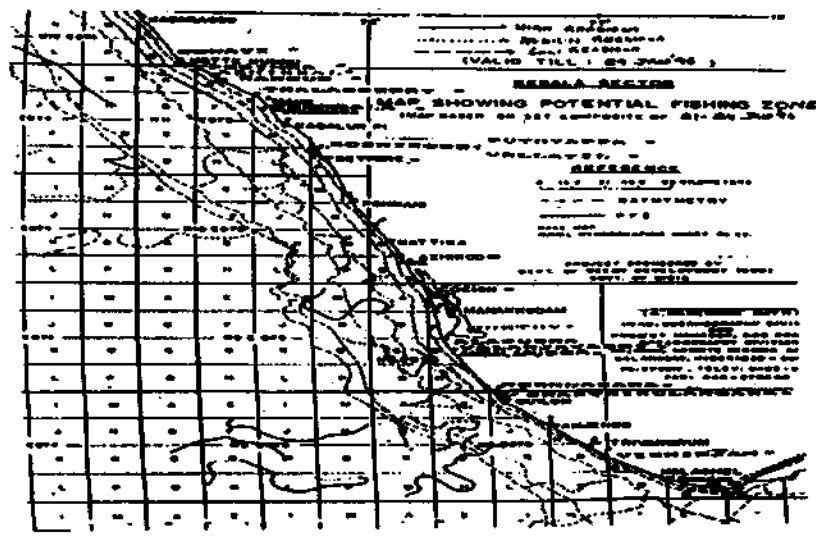

FIG.1.-MAP SHOWING LOCATION OF LANDING CENTRES MONITORED IN THE PRESENT STUDY ALONG THE KERALA COAST

The feedback information with details of craft, fishing methodology adopted, fishing gear employed, fishing effort expended, haulwise fish catch, specieswise fish catch, location of fishing activity along with depth, distance from the coast and bearing were collected from the same group of fishermen on their return from fishing activity.

Detailed analysis and processing of the basic data was undertaken at the MARSIS Centre against individual PFZ forecast and the validation results were passed on to NRSA immediately.

Results of PFZ validation

It is well known that, the adaptation of fish to the surrounding marine environment is controlled by various physicochemical and biological parameters. Fishes are known to react to changes in environmental conditions and migrate to areas where favourable conditions of sea water temperature, dissolved oxygen levels and salinity exist. Availability of food is an important factor which controls fish occurence, abundance and migration. Sea surface temperature is the most easily observed environmental parameter and is quite often correlated with availability of fish, especially pelagic fishes. Fluctuations in SST result from changes occuring in other factors such as upwelling, eddies etc. Squire (1982), found that many oceanic pelagic species concentrate at current boundaries especially in areas with sharp horizontal temperature gradient. Laurs *et al.* (1984) found higher catch rates in the vicinity of temperature fronts sometimes extending upto 100 km offshore from the boundaries of the front.

The European Commission Fisheries Report published by the Nansen Centre (Pettersson, 1989) provides an excellent review of the successful use of satellite - based observations in fisheries applications. Fiuza (1990) has discussed the application of satellite remote - sensing to fisheries. In Portugal the SATOCEAN project has since 1989 been providing operational service to the portuguese tuna and swordfish fishermen (Santos and Fiuza, 1992), wherein, fishermen are provided with charts with location of thermal fronts and isotherms derived from AVHRR data.

The salient results of PFZ validation undertaken by CMFRI, MARSIS Centre at the above-mentioned 17 landing centres along the Kerala coast between November 1995 and May 1996 are given below.

a) Positive relationship between PFZ resulting from comparatively high gradients of SST (2°c & above) and fishable concentrations of commercially important fishes were found only in respect of pelagic and column fishing activities such as purse seining, gill - netting and trolling especially during the period November 95 to January 96. In the case of bottom trawling activity, the relationship was found to be negligible or nil during the same period.

For purse seine fishing, the average fish catch / boats varied between 4,480 and 3,200 kg for PFZ and non-PFZ respectively at Cochin Fisheries Harbour landing centre during the month of November 95, when the maximum number of purse - seine boats were operating off Cochin. In the case of gill-net fishing,the same varied between 480 and 187 kg for the same month (Figs. 2 & 3).

In the case of bottom trawling, PFZ was showing a lesser quantity when compared to non-PFZ during the same month (Fig. 4.).

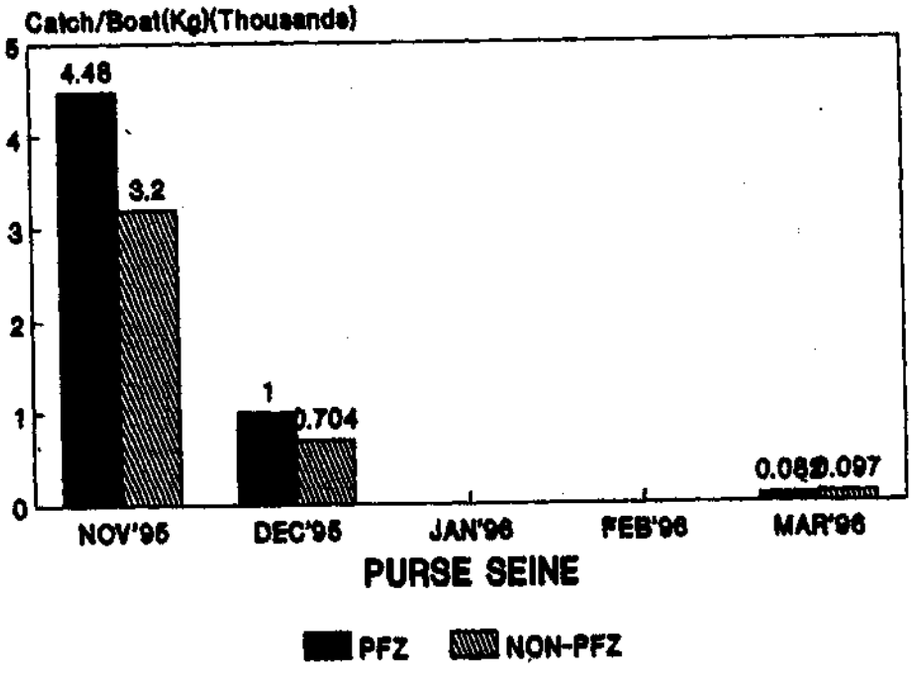

FIG.2.-PFZ VALIDATION, COCHIN FISHERIES HARBOUR

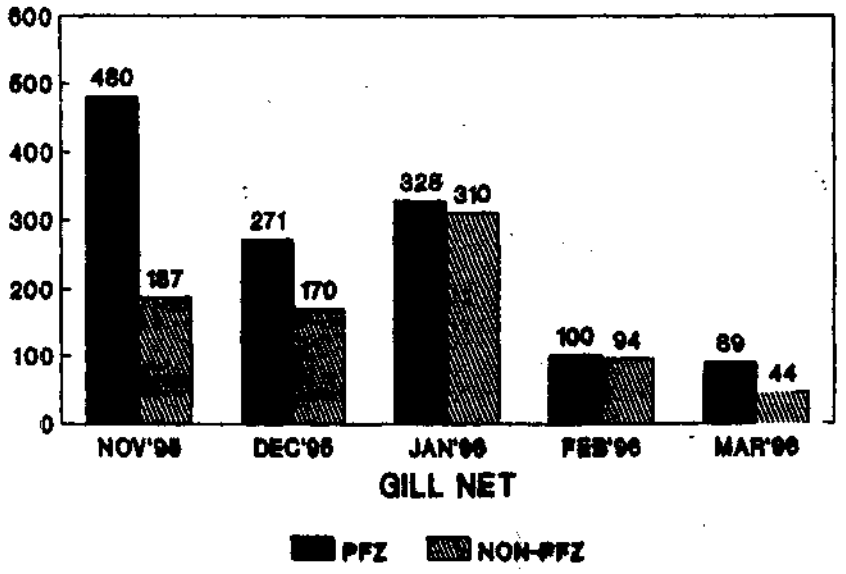

FIG.3.-PFZ VALIDATION, COCHIN FISHERIES HARBOUR

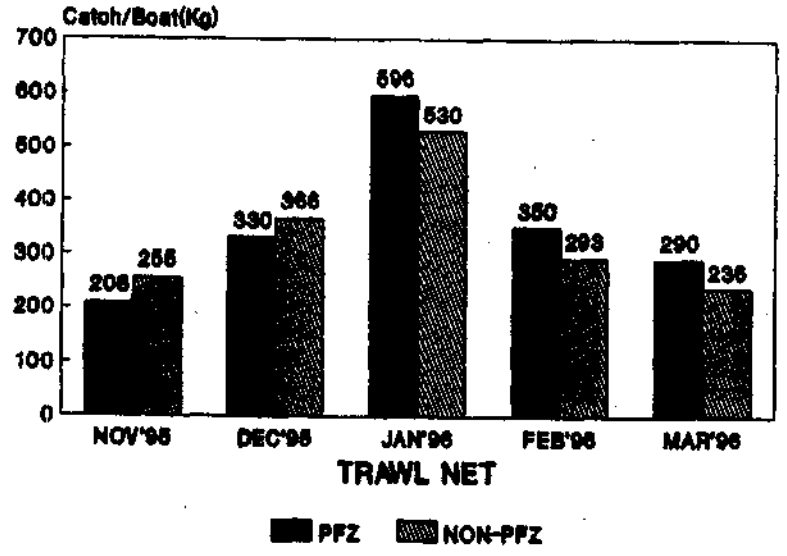

FIG.4.-PFZ VALIDATION, COCHIN FISHERIES HARBOUR

Comparisin of catches obtained for PFZ and non-PFZ employing different fishing methodologies for the months November 95 to March 1996 is given in Fig.5.A. to 5.E.

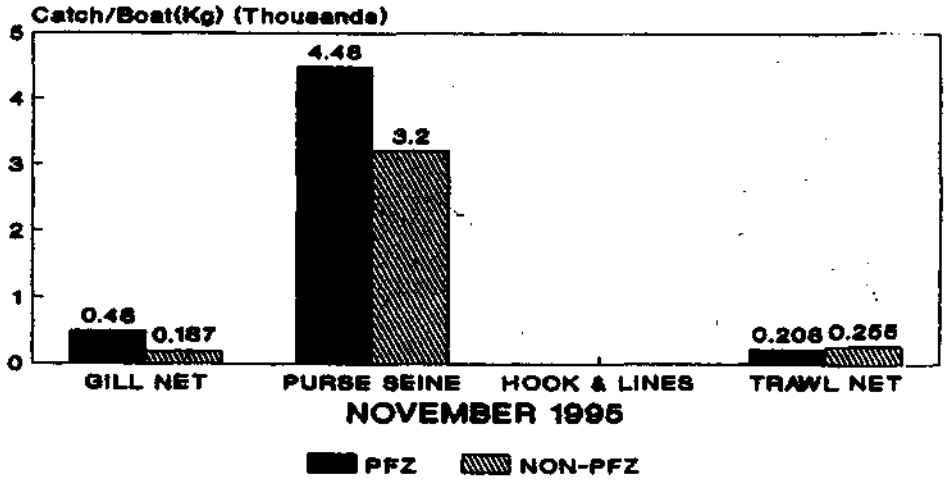

FIG.5.A.-PFZ VALIDATION, COCHIN FISHERIES HARBOUR

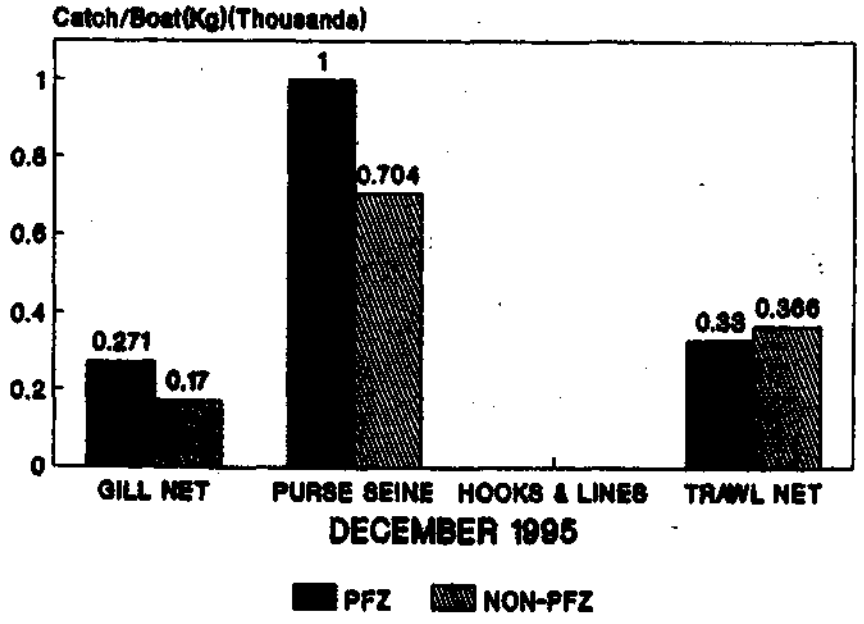

FIG.5.B.-PFZ VALIDATION, COCHIN FISHERIES HARBOUR

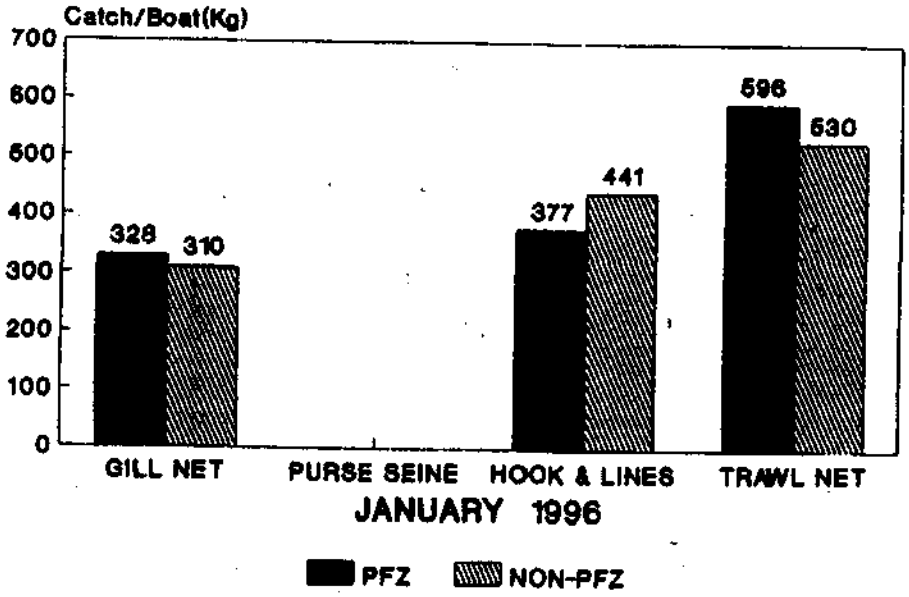

FIG.5.C-PFZ VALIDATION, COCHIN FISHERIES HARBOUR

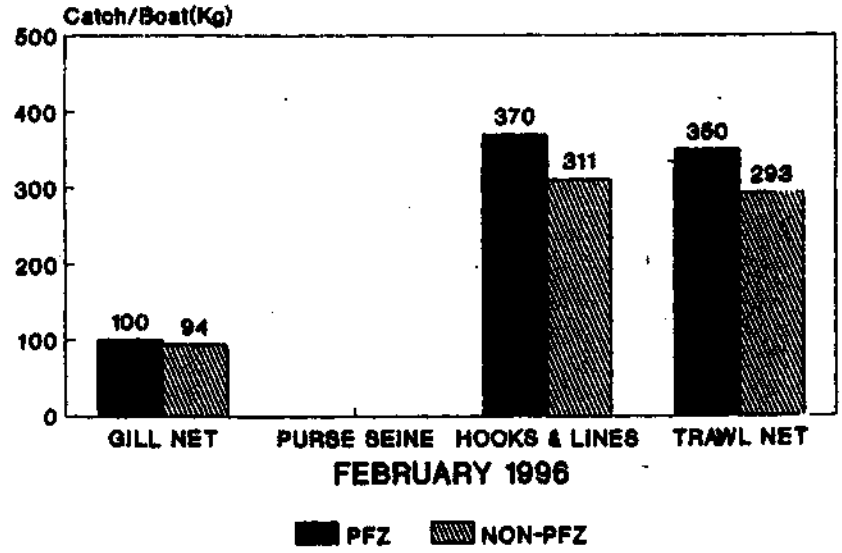

FIG.5.D.-PFZ VALIDATION, COCHIN FISHERIES HARBOUR

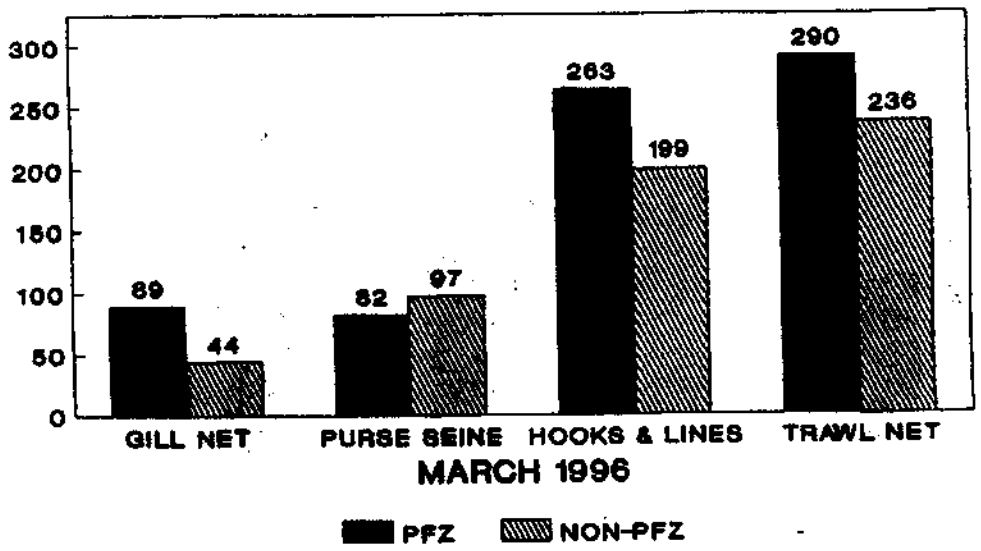

FIG.5.E.-PFZ VALIDATION, COCHIN FISHERIES HARBOUR

Details regarding the duration of individual PFZ forecast, total number of boats monitored, fishing activity in PFZ and non-PFZ, average fish catch / boat in PFZ and non-PFZ, fishing methodology adopted / fishing gear employed and catch composition are given in Table I.

Table 1: Results of the validation of PFZ forecasts carried out by MARSIS Centre of CMFRI, Cochin

Forecast	Total no.of Boats Monitored		Average fish catch/Boat		Fishing Gear	Fish Catch
Date	PFZ	non-PFZ	PFZ	non-PFZ		
21-24 Nov '95 Cochin	1	26	480	187	GN	Tuna, Seer Fish
21-24 Nov '95 Cochin	5	9	4480	32000	PS	Tuna, Seer Fish
21-24 Nov '95 Cochin	6	18	208	255	BT	Prawn, Sep IA Sharks,
2-4 Dec '95 Cochin	1	13	800	348	BT	Carangids, *Nemipterus*

6-7 Dec'95 Cochin	1	3	150	236	GN	Seerfish
6-7 Dec'95 Quilandy	1	8	110	89	RS	Sardines
6-7 Dec'95 Chombala	3	5	112	105	RS	Sardines
6-7 Dec'95 Kannur	3	18	100	81	RS	Sardines
5-6 Jan'95 Cochin	9	13	697	613	BT	*Nemipterus* *Priacanthus* Perches
5-6 Jan'96 Cochin	10	6	422	475	HL	Perches
10-12 Jan'96 Cochin	8	16	353	306	GN	Tuna,Seerfish
10-12 Jan'96 Cochin	2	8	375	462	HL	Perches
10-12 Jan'96 Cochin	5	28	539	573	BT	*Nemipterus* *Saurida*
13-15 Jan'96 Cochin	6	1	216	450	BT	*Nemipterus*
24-25 Jan'96 Cochin	18	3	352	316	Troll	Seerfish Tuna
24-25 Jan'96 Cochin	6	14	495	365	BT	*Nemipterus* *Decapterus* *Saurida*
3-5 Feb'96 Beypore	2	14	415	353	BT	*Nemipterus* *Decapterus*
6-9 Feb'96 Azhikal	2	25	132	101	BT	*Decapterus* *Nemipterus*
13-15 Feb'96 Beypore	3	22	380	311	BT	*Decapterus* *Nemipterus*

13-16 Feb'96 Cochin	2	30	310	312	HL	Perches
13-16 Feb'96 Cochin	5	8	100	94	GN	Seerfish, Tuna
13-16 Feb'96 Cochin	3	31	590	371	BT	*Nemipterus Decapterus*
6-8 Mar '96 Cochin	2	5	705	386	BT	*Nemipterus Sepia*,Prawns
13-15 Mar'96 Cochin	5	12	101	68	GN	Tuna,Seerfish
13-15 Mar'96 Cochin	6	9	325	228	HL	*Epinephelus Pristi-Pomoides*
13-15 Mar'96 Cochin	4	23	411	228	BT	*Nemipterus Decapterus*
12-13 Mar'96 VFH	3	6	41	33	HL	Perches, Tuna
14-15 Mar'96 Neendakara	18	7	563	311	BT	*Nemipterus* Anchovies
27-29 Mar'96 Cochin	1	14	30	24	GN	Seerfish, Tuna
27-29 Mar'96 Cochin	5	4	82	97	PS	Mackerel
27-29 Mar'96 Cochin	5	8	190	166	HL	*Pristipo-moides*, Kalava
27-29 Mar'96 Cochin	16	15	208	198	BT	*Decapterus Nemipterus* Squids, Prawns

VFH= Vizhinjam Fisheries Harbour

27-29 Mar'96	25	11	418	323	BT	*Decapterus*

Neendakara						*Saurida* Anchovies
27-29 Mar'96 Neendakara	8	3	98	101	HL	Seerfish Tuna,Perches
30-31 Mar'96 Valanjavazhi	4	4	114	84	MT	*Decapterus* *Stoliphores*
01 APR'96 Thottapalli	--	4	--	143	HL	Sharks Mackerel
01 Apr'96 Chethy	3	5	80	93	RS	*Decapterus*
01 Apr'96 Thottapalli	1	3	85	112	DN	Mackerel Seerfish.
5-6 Apr'96 Beypore	5	15	214	192	BT	*Nemipterus* Flatfish
8 Apr'96 Chombala	6	3	213	150	GN RS	Mackerel *Decapterus*
8 Apr'96 Quilandy	3	5	113	90	DN	*Decapterus* *Stoliphores*

GN : Gill net,PS : Purse Seine, DN : Drift Net,
BT : Bottom Trawling, MT : Minitrawl, RS : Ring Seine,
HL : Hooks & Lines

Between the end of February and May '96, with the coastal waters getting heated up to greater vertical extent caused by summer heating and with the disappearance of high gradients of SST from the area under study, many of the commercially important pelagic shoaling fishes like oil sardine (*Sardinella longuiceps*), mackerel (*Rastrelliger kanaqurta*) 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. Sloggett *et al.* (1995) observed that, demersal (Bottom living) 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.

b) The seatruth data collected through the cruises of FORV *Sagar Sampada* during different seasons in the area under study clearly revealed factors which contributed towards the formation of high gradients of SST (2°c or more) characteristics of the months, November '95, December '95 and January '96,along the Kerala coast. The presence of comparatively strong surface currents caused by the prevailing NE monsoon (winter monsoon) in the SE Arabian sea which carried comparatively warmer equatorial waters towards northern latitudes would have resulted in comparatively high thermal gradients in the area under study. The SST in this area during November '95-January '96 is comparatively low resulting mainly out of winter cooling. When comparatively warmer waters were carried northward through the winter monsoon circulation, it resulted in strong temperature gradients at surface levels in the SE Arabian Sea. This is especially so in the island territories of Maldives and Lakshadweep.

The northerly current became weak and slowly died out during January - February resulting in medium as well as low thermal gradients in the locality between February and May. Exceptions were mostly found on the windward side of oceanic islands (Maldives and Lakshadweep) where the divergence would have resulted in the formation of comparatively high gradients of temperature. This is clearly revealed from the maps of potential fishing zones brought out by NRSA between November and May, the period during which the cloud cover was comparatively minimum.

c) Seasonal varitions are characteristic of the thermocline in the eastern Arabian Sea and western Bay of Bengal bordering the Indian subcontinent. In the southeastern Arabian Sea the top of the thermocline is deepest between November and April (80-130m) and shallowest between July and September (10-30 m). During the southwest monsoon season in areas of strong upwelling activity, the thermocline reaches the very surface.

Considering the presence of a well defined seasonal thermocline which exhibits a periodic up and down movement, the correlation of SST with occurence/abundance of pelagic fish is possible within a reasonable limit. Correlating SST with the occurence/abundance of demersal fish should be attempted with caution since many of the commercially important demersal fish are known to be stenothermal, not capable of tolerating wide variations in sea water temperature. They are also known to habitate ecosystems below the seasonal thermocline.

Future prospects:

A. The MARSIS Centre of CMFRI is planning to continue the PFZ validation programme by extending the activity to more fish landing centres along the Kerala coast during the next PFZ forecast season commencing from November 1996 to obtain confirmatory evidence on observations made above. Arrangements are also made for the collection of seatruth data in the area under study during pre-monsoon, southwest monsoon and post-monsoon seasons.

B. The centre also proposes to evolve a prediction system for Skipjack tuna (*Katsuwonus pelamis)* Fishery in the Lakshadweep islands based on PFZ forecasts brought out by NRSA by organising a regular feedback from the active fishermen of the islands through the Directorate of Fisheries, Lakshadweep. Skipjack tuna fishery, being pelagic in nature, mainly employing a single fishing methodology, viz., tuna pole and line fishing, is expected to give better correlation with PFZ forecasts generated out of SST imageries. Moreover, the fishing activity is aimed at harvesting a single species *Katsuwonus pelamis.*

C. In due course, through the IRS-P3 and P4 satellites it would become possible to obtain chlorophyll distribution at sea surface which in turn can be correlated with the occurence / abundance of pelagic herbivores like oil sardine (*Sardinella longiceps*) in space and time along with SST data. The MARSIS Centre of CMFRI is fully involved in the above mentioned activities through close collaboration with Space Application Centre, Ahmedabad and National Remote Sensing Agency, Hyderabad.

Evolving a suitable prediction system for the commercially important pelagic fisheries in the coastal waters of the Indian subcontinent and the island territories based on PFZ forecasts will greatly help the artisanal and small mechanised sector fishermen to reduce the searching time for fish shoals and thereby effecting an overall reduction in the cost of fishing operations.

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