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Validation of Potential Fishing Zone (PFZ) Advisories (2006 – 2007)

By

Srinivasa Kumar, Nagaraja Kumar, Padmaja, Naga Swetha, Shailesh Nayak

&

V. Narayana Pillai, K. Gopala Reddy, S. Subramanian, N.C. Anil Kumar, P. Nammalwar Rajan, U. H. Mane, K. V. Radhakrishnan, P. Kumar

Indian National Centre for Ocean Information Services
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Srinivasa Kumar, Nagaraja Kumar, Padmaja, Naga Swetha, Shailesh Nayak & U. H. Mane, S. Subramanian, K. V. Radhakrishnan, V. Narayana Pillai, N.C. Anil Kumar, P. Nammalwar Rajan, K. Gopala Reddy, P. Kumar

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11. Abstract (Maximum 100 words):

The Potential Fishing Zone (PFZ) Advisories are being generated and disseminated by Indian National Centre for Ocean Information Services (INCOIS). The methodology used for generation of these advisories and the scientific basis behind the identification of the PFZ locations was described. With a view to validate these PFZ Advisories and to assess the potential benefits to the fishing community, INCOIS had undertaken PFZ validation experiments at various places under the leadership of fishery experts. Simultaneous fishing operations have been conducted within the PFZ Areas and outside PFZ Areas using identical vessels. The quantitative results of the experiments were described.

12. Keywords: **SST, Chlorophyll, PFZ Advisories, Validation, Fishing, Fishing zones**

13. Security classification: **Unrestricted**

Table of Contents

1. Background

The Ministry of Earth Sciences, Government of India has formulated a programme to provide the fishing community with credible advisories on Potential Fishing Zones (PFZ). The concerted efforts of scientists from Earth Sciences, Space and Fishery science in collaboration with the coastal states have resulted in a unique service of potential fishing zone (PFZ) advisories. PFZ Advisories mission became a matured operational application of satellite remote sensing for providing timely and reliable advisories to fishermen. This mission became part of the "Common Minimum Programme (CMP)" of the Government of India. These advisories are generated by using satellite data of the entire coastline of the country in a Mission mode with active participation of all stakeholders.

The Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, autonomous body of the Ministry of Earth Sciences (MoES) is the responsible agency for the generation and dissemination of PFZ Advisories. This is the only short-term forecast available to the fishing community of the country.

2. Fishery/ Fishing Scenario in the Country: The details are given in Table 1.

Table 1: Fishery Statistics of the Coastal States and Union Territories (Source: Fisheries Statistics, Dept. of Animal Husbandry & Dairying, Min. of Agriculture,Govt. of India, 1999)

	Coast line (kms)	Continental Shelf (*000 Sq. Km)	Fishing Villages	Active Fishermen	Fish landing Centres / Ports (Harbours)	Boats operating (Mechanized/ Motorized/ Traditional Crafts)
Gujarat	1,600	184	851	NA	286/ 41	11,372/ 5,391/ 9,222
Maharashtra	720	112	395	25,286	184/ 50	8,899/ 286/ 10,256
Goa	104	10	72	30,225	88/ 07	1,092/ 1,100/ 1,094
Karnataka	300	27	221	NA	29/ 08	2,866/ 3,452/ 19,292
Kerala	590	40	222	1,90,483	226/ 08	4,206/ 17,362/ 28,456
Tamilnadu	1,076	41	556	2,08,250	362/ NA	13,164/ 26,601
Andhra Pradesh	974	33	508	2,40,000	508/ 04	8,642/ 4,164/ 53,853
Orissa	480	26	329	86,312	63/ 04	1,276/ 2,640/ 10,993
West Bengal	158	17	652	NA	47/ NA	3,362/ 270/ 4,850
Andaman & Nicobar Islands	1,912	35	45	NA	57/ NA	230/ 160/ 1,180
Lakshadweep Islands	132	4	10	NA	11/ NA	478/ 306/ 594
Daman and Diu	27		31	NA	7/ NA	805/ 350/ 252
Pondicherry	45	1	45	NA	28/ NA	560/ 505/ 7,297

3. Methodology for Generation of PFZ Advisories

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 the surrounding environmental conditions and migrate to areas where favorable environmental conditions in terms of seawater temperature, salinity, dissolved oxygen levels etc., exist. Availability of food is an important factor which control their occurrence, abundance and migrations in the sea. Sea Surface Temperature (SST) is the most easily observed environmental parameter and is quite often correlated with the availability of fish, especially pelagic fish. Many pelagic species are known to concentrate at current boundaries especially in areas with sharp horizontal temperature gradients. Usually, chlorophyll and SST

images are expected to reveal common gradients due to inverse correlation between these two parameters. *(Solanki, et al, 2005).*

Monitoring the above mentioned 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 impossible. Indirect methods of monitoring selected parameters such as SST and phytoplankton pigments (Chlorophyll-a) at sea surface from satellites is found very ideal as it provides high repetivity and large special coverage. The methodology discussed on integration of Chlorophyll and SST images by *Dwivedi & co-workers* has been adopted.

Integrated PFZ (IPFZ) Advisories are generated using SST and Chlorophyll Imagery derived from NOAA-AVHRR (USA) and IRS P4-OCM (India) data. The features such as oceanic fronts, meandering patterns, eddies, rings, up-welling areas (Table 2) are identified from these satellite images in near real time and translated as advisories in terms of latitude, longitude and depth of the shelf at such locations as well as angle, direction and distance from the landing centres/light houses. These IPFZ advisories prepared in English, Hindi and other local languages (Gujarati, Marathi, Kannada, Malayalam, Tamil, Telugu, Oriya and Bengali) and local measurement units are disseminated thrice a week, i.e. every Monday, Wednesday and Friday through various dissemination modes.

Table 2: Relevance of oceanographic features to fishery resource
(Source: H.U. Solanki, et al, 2003)

Sl. No.	Feature Type	Definition/ Morphology description	Relevance to fishery resource
1.	Oceanic Fronts (colour and thermal)	Fronts are the boundaries between two water masses with different properties They can be easily detected as breaks in the ocean colour (chlorophyll concentration) or SST of water masses on an image.	High chlorophyll is indicator of biomass production. Hence, resource sustained for longer period. The chances of development of local eco system are greater, which enables benthos exploration. Higher SST gradient is an indicator of upwelled water from deeper layer. Hence, the water with greater nutrient concentration would be available in euphotic zone, which enables enhanced production. Restrict movement in species that prefer particulate temperature ranges.
2.	Mushroom shaped features	The feature appears mushroom shaped on an image.	Form an enclosed pocket. Periphery is important. Sometimes rings form inside the feature, which may be productive. Form due to wind driven current.
3.	Coastal Upwelling	Easily detected in thermal imagery. Appear as different bands of thermal gradients in the images.	Indicates the nutrient rich water transported from bottom to surface. Form in different phases like initiation phase, stabilization phase and maturation phase. Initiation phase should be avoided for fishing due to low oxygen water. In the maturation phase a well developed ecosystem forms, should be exploited.
4.	Meandering pattern of	A turn or winding of current that may be	They cover a large area. So, even if feature shift the potential area may not shift totally. This

	features	detached from the main stream. Easily detected through the curvatures in the image.	also helps in delayed fishing. Large concentrations of phytoplankton are available as compared to linear features. An enclosed pocket is formed, hence confining the resources. Sometimes rings are formed, which are productive and important for resource exploration.
5.	Eddies	A current of water often on the side of the main current, especially one moving in a circle. Easy to monitor in space and time.	Rotating water masses cause deep mixing hence nutrient enrichment occurs leading to high production. Persistence for relatively longer duration. The visual predictors like tunas prefer periphery of eddies and streamers.
6.	Rings	Rings of derivative of meanders and eddies. Easy to identify on an image.	Rings are productive and already localised developed eco systems. These features ensure secondary and tertiary production.
7.	Plume front	Plumes form mostly in the coast area near river mouths as well as at discharge points of effluent.	Coastward side should be avoided because of the turbidity; generally fish avoid turbid water due to visibility and blocking of gills. Seaward side may be explored for resources. Sediment images may be checked before suggesting the PFZs.
8.	Shelf Break Front	Formed due to bathymetry at shelf and slope depth gradient.	If it is a high depth gradient it will appear many times at same location. Persist for longer periods. Supporting ecosystem. Not suitable for bottom trawling.
9.	Diverging fronts	Water flows in a different direction from the centre due to diverging current.	The process enriches the nutrient supply, which supports the enhanced production.
10.	Converging fronts	Two or more fronts converge at one point.	Causes mechanical aggregation of resources and plankton, centre may be more productive. Can be used for resource exploration.

4. Dissemination of PFZ Advisories:

Multi-lingual IPFZ advisories are being generated and disseminated during the non-ban and non-monsoon period to the entire fishermen community situated all over the entire coast of India and Islands under 12 sectors, viz. Gujarat, Maharashtra, Goa & Karnataka, kerala, South Tamilnadu, North Tamilnadu, South Andhra Pradesh, North Andhra Pradesh, Orissa & West Bengal, Andaman Islands, Nicobar Islands and Lakshadweep Islands. The modes of dissemination and the number of users are given in Table 3.

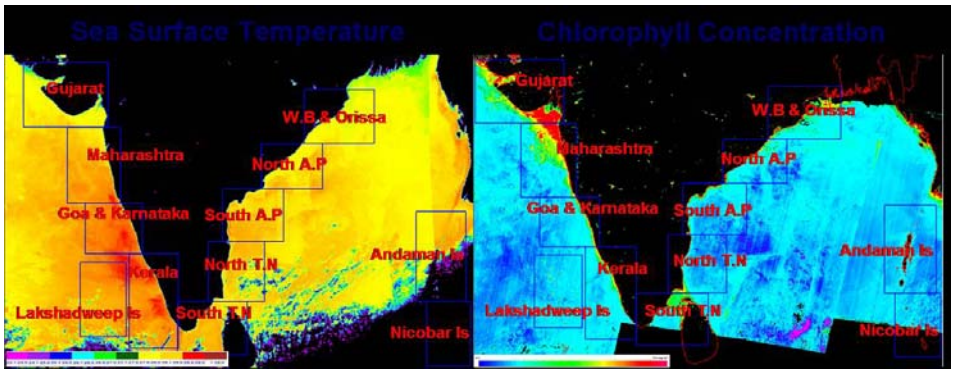
Table 3: Dissemination Modes and the Number of Users

Mode of Dissemination	Number of Users
Telephone / Fax	200
Electronic Display Boards (23 No.)	NA
Email	124
Website (PFZ Text)	4018
Website (Web-GIS)	285
Doordarshan (DD-Saptagiri)	NA
News Paper (Eenadu)	NA
Information kiosk (Brahmavar, Karnataka)	3,000

Fig 1: Modes of Dissemination

PFZ advisories along with SST and Chlorophyll images, (Fig 2) vector coverage and text information have been also made available through INCOIS web-site to the user community. PFZ advisories in both map and text forms are e-mailed to about 124 registered users located along the coast of India. PFZ advisories were also disseminated through Telugu daily newspaper (coastal district editions of AP) and Doordarshan Kendra of Andhra Pradesh (DD Saptagiri).

Fig 2: SST and Chlorophyll Images overlaid with 12 PFZ Sectors



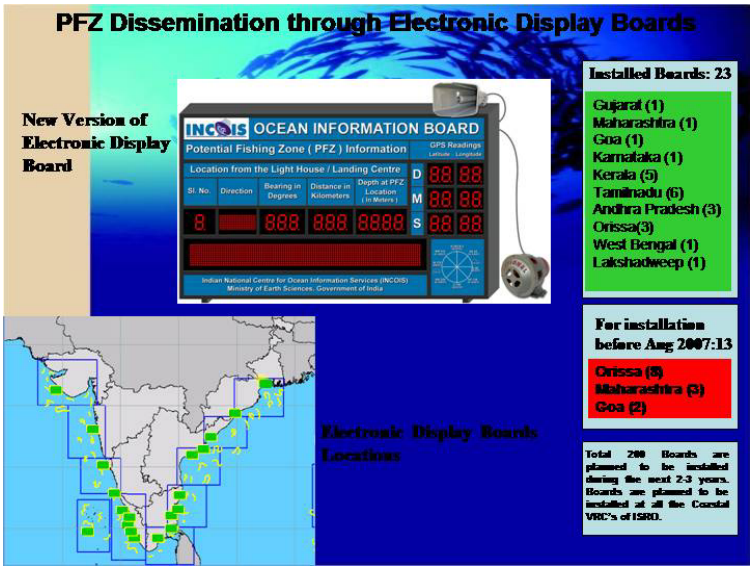
Electronic Display Boards (EDB)

To improve the coverage, advances in Information and Communication Technology have been adapted. Installations of Electronic Display Boards (EDB) at major fishing harbours have made significant impact in the delivery chain. PFZ advisories are being transmitted through 23 such Electronic Display Boards have been installed all over the coastal states of India and Islands at the locations provided in the Table 4.

Table 4: Locations of Electronic Display Boards

State	Location of the boards		Total Installed (Planned)
	Installed	Planned	
Gujarat	Veraval		01
Maharashtra	Ratnagiri,	Harne Paj, Deogad, Malvan	01 (03)
Goa	Panjim,	Cutbona,Vasco	01 (02)
Karnataka	Malpe		01
Kerala	Vypeen, Neendakara, Munambam, Beypore and Srayakkad		05
Tamilnadu	Royapuram, Thengaithittu, Veerampattinam, Nagapattinam, Thangachimadam, Cuddalore		06
Andhra Pradesh	Machilipatnam, Kakinada, Visakhapatnam		03
Orissa	Gopalpur, Balaramgadi, New Golabandha,	Bahabalpur, Chudamani, Kharanasi, Talachuan, Paradeep, Astaranga, Penthakotta, Arjipalli	03 (08)
West Bengal	Diamond Harbour		01
Lakshadweep Islands	Agatti		01
		Total	**23 (13)**

Fig 3: Location details of Electronic Display Boards



The forecast is being updated thrice a week directly from Indian National Centre for Ocean Information Services (INCOIS) and about 1000-3000 fishermen from each fishing harbour

use this information for their fishing activities. The new version of these boards is equipped with voice communication, siren and alert system for alerting the coastal states during disasters and Tsunami warnings. These boards use the GSM Communication technology for transfer of data remotely from INCOIS.

5. User Interaction Workshops:

Frequent and intense interactions at the fishing harbours between scientists and fishing community ensure improved awareness and effective use of these advisories. Parallel affirmation and feedback are integral to this mission for which necessary institutional mechanisms are in place.

As part of creation of user awareness programmes and workshops, conducted User Interaction Workshops in major fishing harbours.

Table 5: List of Awareness Campaigns organized

Area	Number of Campaigns	Fish Landing Centers & date of campaign
Maharashtra (Ratnagiri District)	06 group discussions/ campaigns with fishermen associations and fisheries department officials.	Harnai Paj (04/05/06), Dabhol (05/05/06), Sakhri Natye Coop. Society (06.05.06), Ratnagiri (07/05/06), Malvan (03/12/06), Deogad (03/12/06)
Goa	07 Group Discussions have been held with the owners of boat and members of boat owners association.	Cutbona (15/06/06, 26/06/06, 12/12/06 and 02/03/07), Vasco & Malim (16/06/06 and 13/12/06),
Karnataka	NIL	NIL
Kerala	PI of the project has organized / participated in the awareness campaigns organized in Kerala (12) and in Goa (06)	Vizhinjam (04/04/06), Cannore (21/06/06), Neendakara (02/09/06), Beypore (06/09/06), Shakthikulangara (09/09/06), Cannore (08/12/06), Mariyanad (02/12/06), Pozhiyoor (22/12/06), Anchuthengu (20/02/07), Vettoor (20/02/07), Valiyathura (23/02/07), and Kolachal (24/02/07)
Tamilnadu	04 Awareness campaigns	Kasimedu (13/02/07), Neelangarai (14/02/07), Thiruvanmiyur (17/02/07) and Ennore (02/03/07)
Andhra Pradesh	01 User-interaction meet with 200 fishermen and 30 PFZ Awareness/ field campaigns.	Visakhapatnam (29/09/06), Gilakaladindi, Giripuram and Satravapalem villages around Machilipatnam and Visakhapatnam (Dec 06 to Mar 07)
Orissa	07 Awareness Campaigns with Fishing officials and Trawler/boat owners.	Chandipur/Balaramgadi (02/01/07, 15/03/07, 17/03/07, 29/03/07 and 30/03/07), Bahabalpur (16/03/07), Dhamra (12/03/07)

6. Validation Experiments

With a view to validate the Potential Fishing Zone Advisories being generated and disseminated by INCOIS and to assess the potential benefits to the fishing community, INCOIS had undertaken PFZ validation projects, since 2002, at various places under the leadership of fishery experts affiliated to leading research organisations/universities.

Table 6: List of Projects under taken at Various Institutes/Organization

Sl. No.	Title of the Project	Principal Investigator/Institution	Date of Commencement
1.	To develop a scientific approach for in situ validation and demonstration of Potential Fishing Zones (PFZ) off Mangalore Coast	Prof. K.V. Radhakrishnan, College of Fisheries, Mangalore	February 2002
2.	Dissemination of PFZ information to Fisher Folk of Ratnagiri and collecting feedback information from the Users *	Prof. U.H. Mane, Dr Baba Saheb Ambedkar Marathwada University	March 2002
3.	Validation of PFZ Advisories brought out by INCOIS among Artisanal and small mechanised sector fishermen along Kerala Coast to compare the advantages derived for different types of Fishing Operations/Targeted Species	Dr. V.N.Pillai, Regional Centre-NIO, Kochi	June 2003
4.	Validation of Potential Fishing Zone (PFZ) Advisories along Goa Coast with an attempt to study the possible advantages of PFZ Advisories for different types of fishing activities	Dr. S. Subramanian, ICAR Complex, Goa	April 2004
5.	Validation of Potential Fishing Zone (PFZ) Advisories along the Coast of South & North Andhra Pradesh and to assess their potential benefits (Machilipatnam & Visakhapatnam)	Dr. K. Gopala Reddy, Andhra University, Visakhapatnam	September 2004
6.	Validation of PFZ Advisories along Chennai Coast with an attempt to study its possible utility for increasing the CPUE/Reducing the searching time for shoaling fishes	Dr. P. Nammalawar, Institute for Ocean Management, Anna University, Chennai	August 2006
7.	Validation of PFZ Advisories along South West Kerala/Tamilnadu (Anjengo	Dr. N.C. Anil Kumar, Kerala State Remote	August 2006

	to Kolachal) with an attempt to study its possible utility for increasing the CPUE/Reducing the searching time for shoaling fishes	Sensing and Environment Centre, Thiruvananthapuram, Kerala	
8.	Satellite derived Potential Fishing Zone (PFZ) Advisories dissemination and validation along Orissa Coast	Dr. P. Kumar, Orissa Remote Sensing Application Centre, Bhubaneswar, Orissa	November 2006
9.	PFZ Validation following uniform methodology of INCOIS at Diamondharbour, Kakadwip and Fresherganj Fishing Harbour, West Bengal	Prof. Sugata Hazra, School of Oceanographic Studies, Jadavpur University, Kolkatta, West Bengal	July 2007

7. Objectives of the Validation Projects:

7.1 Primary Objectives

- To collect concurrent and quantitative feedback on the total catch (species-wise) obtained in the notified and non-notified areas from the fishing boats operating in the region in a common format. Also an analysis should be made on the reliability of forecast.

7.2 Secondary Objectives

- Data Collection on Oceanographic/Biological Parameters
    - Physical Oceanographic data could be obtained from alternate sources viz. by coordinating the cruises of other research vessels in the area, etc.
    - Length Frequency Analysis
    - Gut Content Analysis to study the food and feeding habits as well as Prey-Predator relationships.

8. Methodology adopted for validation of PFZ Advisories:

- To conduct validation exercises by hiring a commercial fishing vessel, in order to obtain concurrent and quantitative feedback on the total catch (species-wise) obtained in the notified and non-notified areas. A representative could be sent onboard the hired vessel.
- Collect feedback data in a common feedback format (Annexure I) for carrying out further quantitative and qualitative analysis.
- To carry out downstream dissemination of PFZ advisories to the fisher-folk on a regular basis and to increase the awareness among the fishing community by conducting group discussions/ awareness campaigns.
- Estimation of the benefits of PFZ advisories by means of calculating the reduction in searching time, saving of fuel and CPUE and generation of Reports.

9. Statistics of Dissemination of PFZ Advisories

The below charts provides the statistics about the number of forecasts provided to each sector of the country. There is a maximum of 13 forecasts in the month of November 2006 for Gujarat Sector. No forecast was given for East Coast sectors during April 15, 2006 to May 31, 2006 and for West Coast sectors during June 15, 2006 to August 10, 2006 due to ban imposed on Marine Fishing by Government of India. The PFZ Advisories generation and dissemination has been resumed from October 17, 2006 onwards. The state and month-wise Statistics of the forecasts is given in the Fig 5. The cloud cover is a major issue for most of the states due to which there was a large variation in the number of forecasts issued.

Fig 4: Total number of forecasts for each Sector

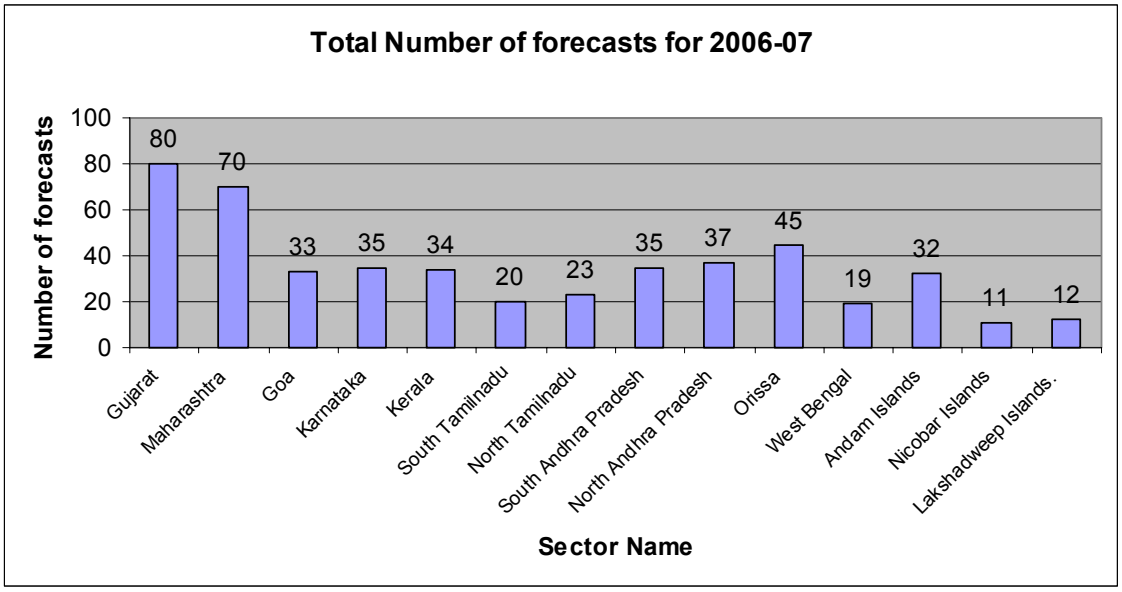
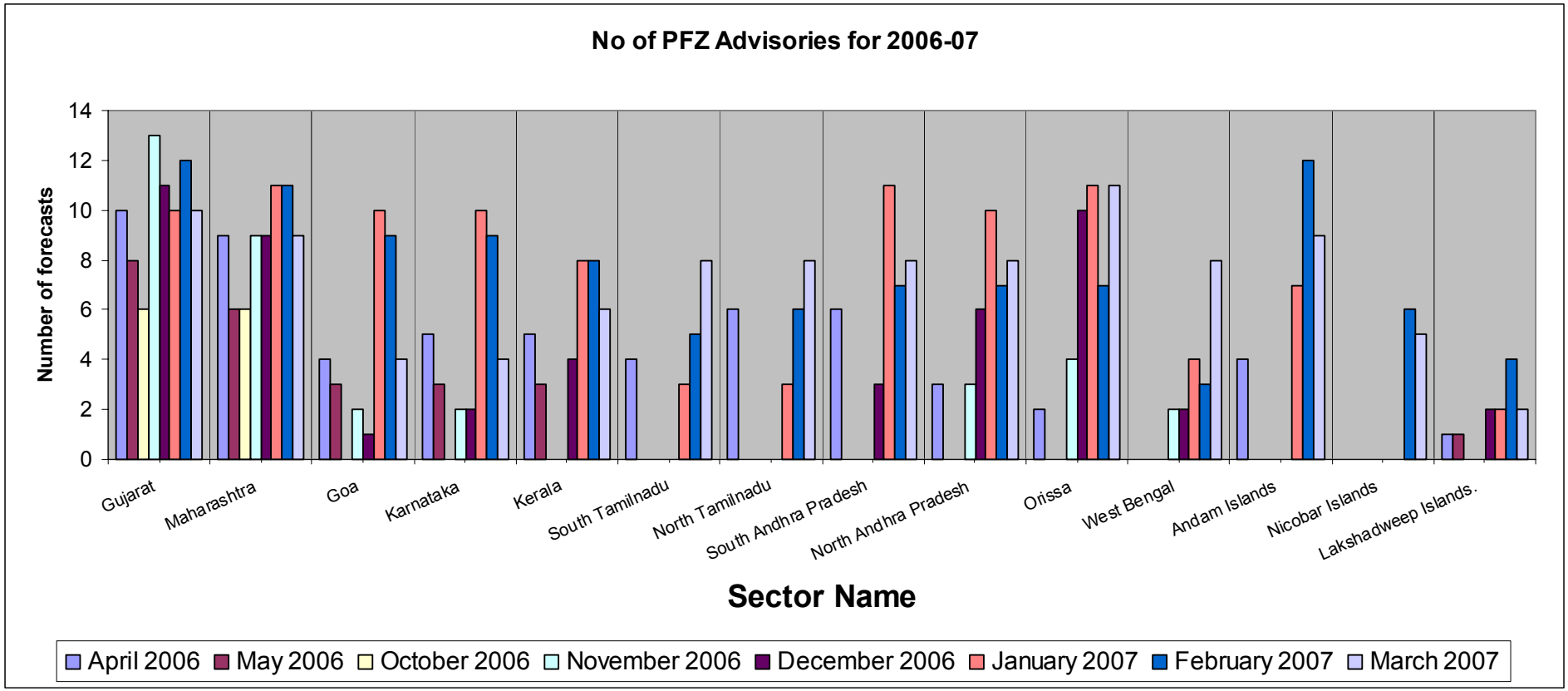


Fig 5: State and month-wise Statistics of forecasts issued



10. Validation Experiments Conducted

Month wise statistics of the number of advisories validated in each sector and the number of simultaneous observations/ experiments conducted within PFZ and outside the PFZ Areas employing identical vessels were provided in the Table 7

Table 7: List of Validation Experiments conducted

Month/ Year	Total No. of PFZ Advisories based on Chlorophyll / SST		Total No. of Fish Landing Centers visited	Total No. of fishing vessels from which feedback on PFZ is gathered	Total No. of simultaneous observations made within and outside PFZ employing identical vessels
	Received	Validated			
1	2	3	4	5	6
Maharashtra					
Apr 06	08	08	02	30	30
May 06	03	03	01	06	06
Nov 06	08	08	01	06	06
Dec 06	07	07			
Jan 07	07	07			
Feb 07	08	08			
Goa					
Apr 06	02	01	03	06	01
May06	01	01	03	06	01
Nov 06	01	01	03	06	01
Dec 06	02	02	03	08	01
Jan 07	05	05	03	23	03
Mar 07	01	01	03	06	01
Karnataka					
Nov 06	01	01	02		01
Dec 06	01	01	02		01
Feb 07	06	06	02		03
Mar 07	01	01	02		01
Northern Kerala					
Apr 06	01	01	37	88	01
May 06	02	02	22	91	01
Dec 06	04	03	14	104	01
Jan 07	07	07	16	98	01
Feb 07	07	07	20	91	01
Southern Kerala					
Dec 06	01	01	03	14 (05—outside PFZ)	
Jan 07	04	04	05	25 (12)	01
Feb 07	03	03	05	26 (17)	01
Mar 07	04	04	05	45 (18)	04
Tamilnadu					
Jan 07	03	01	07		
Feb 07	04	03	09	18	
Mar 07	08	07	27	17	
Andhra Pradesh - Machilipatnam					
Dec 06	02	01	05	04	
Jan 07	07	01	05	14	
Feb 07	06	04	05	09	01
Mar 07	01		05		
Andhra Pradesh - Visakhapatnam					

Dec 06	03		03		
Jan 07	06	02	03	02	
Feb 07	05	02	03	02	01
Mar 07	02	01	03	01	

Table 8: Status of submission of Feedbacks, Gut content analysis and LFA results

	Quantitative Feedback in INCOIS format	Gut Content Analysis	Length Frequency Analysis	Data on Oceanographic/ Biological Parameters
Maharashtra	NA	A	A	NA
Goa	NA	A	A	NA
Karnataka	NA	A	A	NA
Northern Kerala	07	A	NA	NA
Southern Kerala	02	A	A	NA
Tamilnadu	02	NA	A*	NA
Andhra Pradesh	32	A	A	A
Orissa	NA	NA	NA	NA

* Only two species details are provided and the remaining details are pertaining to Length Frequency data of major fish species caught along the Chennai Coast.

11. Results of Validation Experiments

Some of the results (both the CPUE achieved and the quantitative results) of the simultaneous fishing operations conducted within PFZ and outside PFZ Areas were given below.

Table 9: State-wise average CPUE in Notified and Non-notified Areas

State	Average CPUE (Kg)	
	Notified (PFZ) Area	Non-notified (Non-PFZ) Area
Maharashtra	202	133
Karnataka	41	35
Goa	5,588	2,794
Kerala	5480	1210
Tamilnadu	NA	NA
Andhra Pradesh	24	10
Orissa	96	57.5

Fig 6: SST based PFZ Forecast issued on December 12, 2006

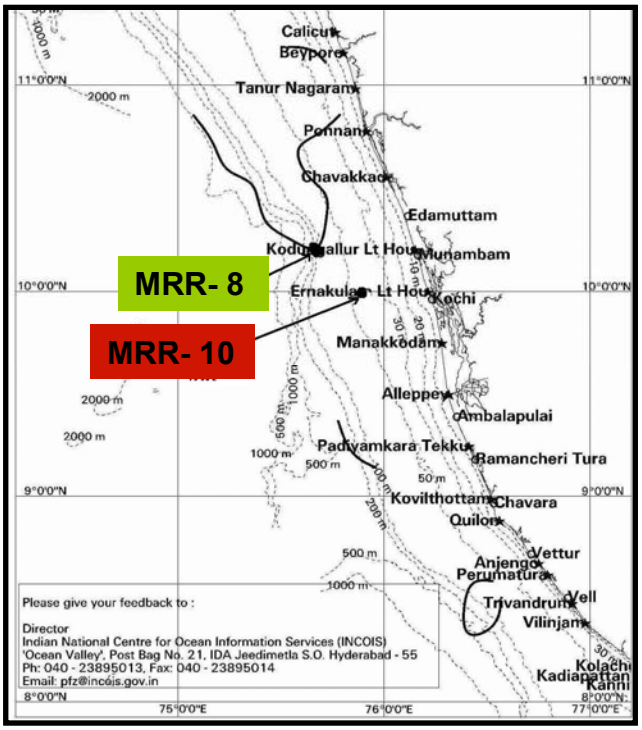


Table 10: Quantitative Results of the Simultaneous fishing operations made Using Fig 6

Date of Fishing: December 16, 2006

Details (Experiment in Kerala)	PFZ	Non PFZ
Name of the Boat	MRR-8	MRR-10
Type of Boat	Mech. Ring Seine	Mech. Ring Seine
Duration of Total Trip	9 Hrs 30 Min	7 Hrs 15 Min
Number of fishing hours	01	01
Number of Hauls	01	01
Number of Fishermen Engaged	37	36
Total Catch (Kgs)	7200	1800
Major Species Caught	Carangids	Carangids
Approximate cost of total catch (Rs) (@ 50 Rs /Kg)	3, 60, 000	90, 000
Total Expenditure in Fishing Operation (Rs)	77, 600 (Fuel: 5, 400) (Wage:72, 000)	21, 440 (Fuel: 3, 240) (Wage:9, 000)
Net Profit	2, 82, 400	68, 560

Fig 7: SST based PFZ Forecast issued on January 22, 2007

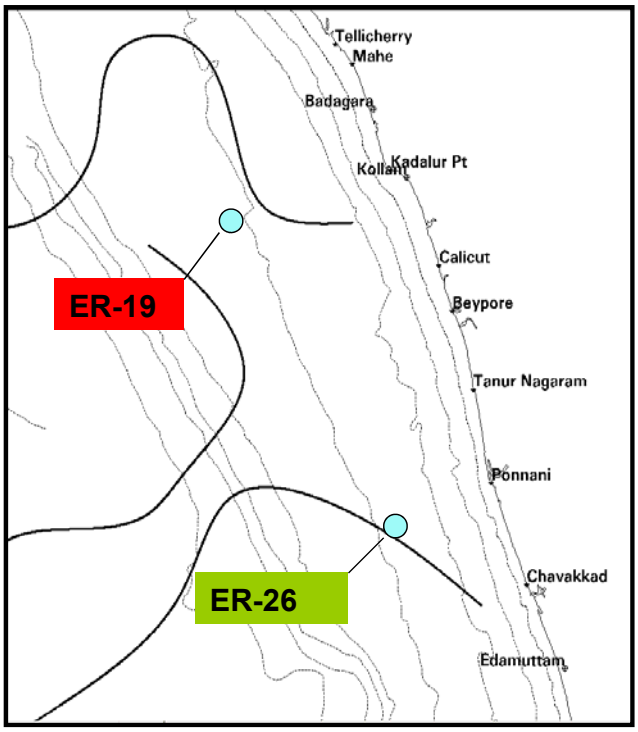


Table 11: Quantitative Results of the Simultaneous fishing operations made using Fig 7

Date of Fishing: January 24, 2007

Details (Experiment in Kerala)	PFZ	Non PFZ
Name of the Boat	ER - 26	ER - 19
Type of Boat	Mech. Ring Seine	Mech. Ring Seine
Duration of Total Trip	11 Hrs	11 Hrs
Number of fishing hours	01	01
Number of Hauls	01	01
Number of Fishermen Engaged	37	35
Total Catch (Kgs)	4100	850
Major Species Caught	Kera	Kera
Approximate cost of total catch (Rs) (@ 50 Rs /Kg)	2,46,000	51,000
Total Expenditure in Fishing Operation (Rs)	1,28,960 (Fuel: 5,760) (Wage:1,23,000)	30,740 (Fuel: 5,040) (Wage:25,500)
Net Profit	1,17,040	20,260

Fig 8: SST based PFZ Forecast issued on February 23, 2007

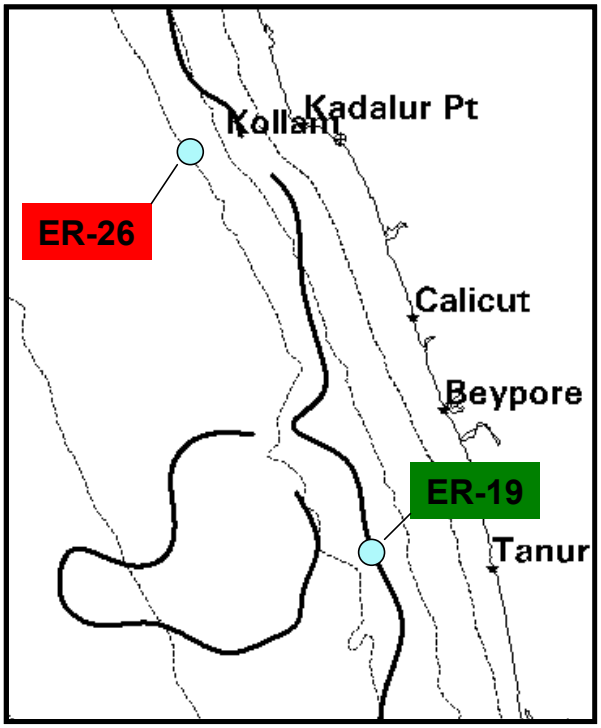


Table 12: Quantitative Results of the Simultaneous fishing operations made using Fig 8

Date of Fishing: February 24, 2007

Details (Experiment in Kerala)	PFZ	Non PFZ
Name of the Boat	ER - 19	ER - 26
Type of Boat	Mech. Ring Seine	Mech. Ring Seine
Duration of Total Trip	10 Hrs	10 Hrs
Number of fishing hours	01	01
Number of Hauls	01	01
Number of Fishermen Engaged	33	30
Total Catch (Kgs)	3800	700
Major Species Caught	Kera	Kera
Approximate cost of total catch (Rs) (@ 50 Rs /Kg)	1,90,000	35,000
Total Expenditure in Fishing Operation (Rs)	99,820 (Fuel: 4320) (Wage:95,000)	23,040 (Fuel: 5,040) (Wage:17,500)
Net Profit	90,180	11,960

Fig 9: SST based PFZ Forecast issued on March 21, 2007

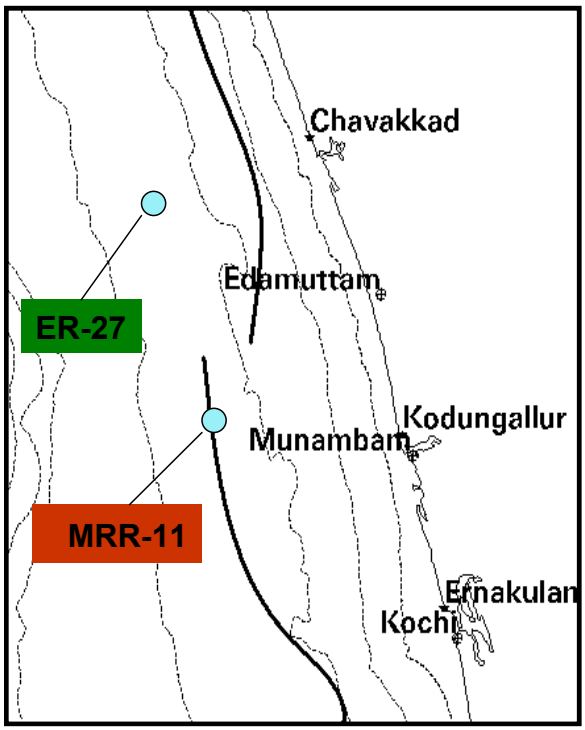


Table 13: Quantitative Results of the Simultaneous fishing operations made using Fig 9

Date of Fishing: March 22, 2007

Details (Experiment in Kerala)	PFZ	Non PFZ
Name of the Boat	MRR-11	ER-27
Type of Boat	Mech. Ring Seine	Mech. Ring Seine
Duration of Total Trip	5 Hrs	5 Hrs
Number of fishing hours	01	01
Number of Hauls	01	01
Number of Fishermen Engaged	30	32
Total Catch (Kgs)	1800	700
Major Species Caught	Indian Mackerel	Indian Mackerel
Approximate cost of total catch (Rs) (@ 45 Rs /Kg)	81,000	31,500
Total Expenditure in Fishing Operation (Rs)	46,100 (Fuel: 5, 040) (Wage:40,500)	21, 700 (Fuel:5, 400) (Wage:15, 750)
Net Profit	34,900	9,800

Fig 10: SST based PFZ Forecast issued on April 08, 2006

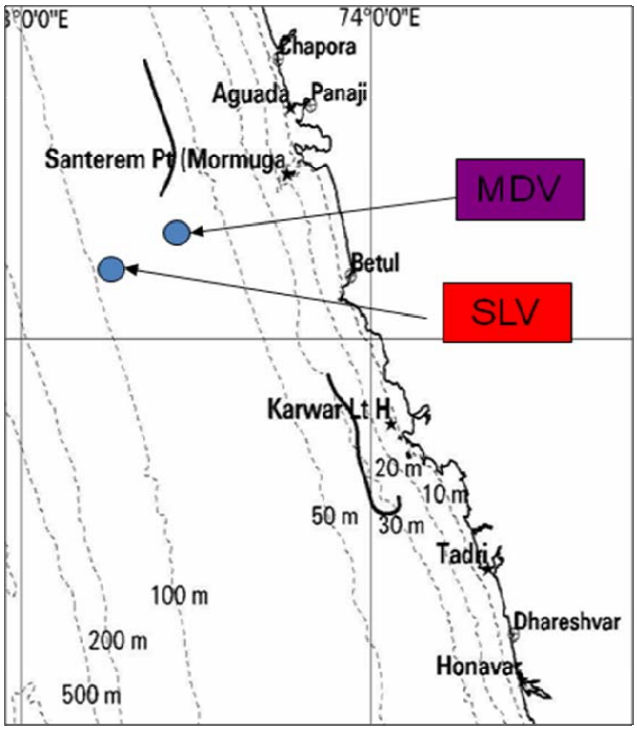


Table 14: Quantitative Results of the Simultaneous fishing operations made using Fig 10

Date of Fishing: April 10, 2006

Details (Experiment in Goa)	PFZ	Non PFZ
Name of the Boat	MDV	SLV
Type of Boat	Purse Seiner	Purse Seiner
Duration of Total Trip	24 Hrs	24 Hrs
Number of fishing hours	02	01
Number of Hauls	02	01
Number of Fishermen Engaged	23	23
Total Catch (Kgs)	12,193	4,000
Major Species Caught	Coastal Tuna	Pomfrets
Approximate cost of total catch (Rs)	12,00,000	6,00,000
Total Expenditure in Fishing Operation (Rs)	36,000 (Fuel: 10,000) (Wage:20,000) (Other: 6,000)	26,050 (Fuel:9,000) (Wage:15,000) (Other: 2,400)
Net Profit	11,64,000	5,73,950

Table 15: Gut content and Length Frequency Analysis of major species caught in PFZ areas of Kerala and Andhra Pradesh

Landing Centre	Species	Gut content	Average length (cm)	Average weight (gm)
Mariyanadu, Kerala	Rastrelliger sp.	Copepod, Coscinodiscus, Radiolaria	23.0	140
	Decapterus sp.	Small fishes, Copepods	17.30	46.5
	Sardinella sp.	Fragilaria sp. Coscinodiscus, Triceralium	21.0	87
Anjengo, Kerala	Rastrelliger sp.	Copepod, Crustacean larvae	22.5	175
	Decapterus sp.	Copepod, Small fishes	20	110
	Katsuwonus	Copepod, Crustacean larvae	27.5	475
Valiathura, Kerala	Katsuwonus sp.	Copepod, Small fishes	29	445
	Rastrelliger sp.	Coscinodiscus, Copepod	20	177
Vizhinjam, Kerala	Rastrelliger sp.	Copepod, Crustacean larvae	16.5	160
	Decapterus sp.	Small fishes, Copepod	21	120
	Katsuwonus sp.	Crustaceans, Copepod, Small fishes	26.5	400
Mariyanadu, Kerala	Decapterus sp.	Copepod, Small fishes	20.0	115
Vizhinijam, Kerala	Rastrelliger sp.	Copepod, Fish larvae, Crustacean larvae	19.0	200
	Decapterus sp.	Copepod, Small fishes	16.8	40
	Auxis sp.	Small fishes	27.5	270
Mariyanadu, Kerala	Rastrelliger sp.	Small fishes, Crustacean larvae	28.0	240
	Decapterus sp.	Fish larvae	17.0	40
Anjengo, Kerala	Rastrelliger sp.	Coscinodisum	17.5	190
	Decapterus sp.	Copepod, fish larvae	15.0	30
	Sardinella sp.		18.0	35
Machilipatnam, Andhra Pradesh	Lutjanus sp. (Snappers)	Portunid crabs, Squilla, vertebrae of Juvenile fish	8	6.2
	Stolephorus sp. (Anchovy)	Juvenile prawns, acetes shrimp and post larvae of prawns	6	0.9
	Drepane sp. (sickle fish)	Parts of siphonophore colony, detritus, organic matter and completely digested material	4.8	2.8

	Trichiurus sp. (Ribbon fish)	Empty	23.5	3.2
Kakinada, Andhra Pradesh	Lutjanus sp. (Snappers)	Squilla, semi digested fish, Post larvae of shrimp, portunid crabs, Mollusc egg ribbons, parts of ophiothrix, fish and penile.	6.65	1.4
	Saurida sp. (Lizard fish)	Squilla, crustacean larvae, fish vertebrae	9.5	4.9
	Stolephorus sp. (Anchovy)	Gastropod larvae, Juvenile prawns, mysis & post larvae of penaeids, Adult lucifers and mysids	5	0.4
	Fistularaia sp. (flute mouths)	Crustacean larvae, Juveniles of prawn & fish, Mollusc shell parts, dentalium and Nereid larva.	16.25	1.5
Pudimedaka, Andhra Pradesh	Saurida sp. (Lizard fish)	Squilla	10	2.8
	Dussumieria sp. (sardines)	Juveniles of squilla, amphipods, Mysids, Crustacean larvae and alima larvae of squilla, phytoplankton.	6	1.9
	Johnius sp. (Croaker)	Crustacean larvae and Mysis & Post larvae of penaeids	8	1.1
	Drepane sp. (sickle fish	Copepods and cladocerans	6.5	2.3
	Kathala sp. (Croaker)	Crabs, Juveniles of penaeid and appendages of crustaceans.	6.25	1.1
	Secutor sp. (pony fish)	Empty	4.9	0.6
Visakhapatnam to Machilipatnam	Parastomatus sp. (Pomfret)	Completely digested matter, appendages of crustaceans	26.25	6.4
	Drepane sp. (Sickle fish)	Semi-digested food material with the remnants of crabs, zooplankton like Hyperia and Penile.	29	3.8
	Upeneus sp. (Goat fish)	Crustacean larvae, Suilla, semi-digested decapods (portunid crabs), Shrimp, fish juveniles, Amphipods, Post-larvae of penaeid prawns, remains fish (Vertebrae and eyeballs), Sagitella, Chaetognath and mysids.	8	1.1
	Rastralliger Kanagurta (Mackerel)	Phytoplankton (diatoms such as chaetoceras, fragillaria, Thalassionema, Skeletonema) and	7	

		zooplankton belonging to varied groups crustaceans being the major portion.		
	Secutor sp. (Pony fish)	Organic matter, mollusk shell remains, mytillopsis.	3	1.2
	Andonostoma sp. (Shads)	Partially digested matter, Zooplankton dominant (copepods, Lucifier).	15	2.3
	Stolephorus sp. (Anchovy)	Crustacean larvae, copepods, post-larvae of penaied prawns and acetes shrimp (30% of the examined guts were found empty)	4	1.1
	Triciurus sp. (Ribbon fish)	Crustaceans (acetes, squilla), Juveniles of fish (Stelephorus, Sardinella, Leiognathus, Dussumieria), crab larvae, megalopa larvae, young ones of Sepia, Zoea larvae. Lucifier, Alima larvae of stomatopods, Amphipods, Copepods and Nematode worms.	40	1.8
	Sphyraena sp. (Baracuda)	Partially digested juvenile fish, crustaceans, copepods.	14	2.6

12. Conclusions

1. PFZ advisories generated from satellite retrieved SST and Chlorophyll were found more beneficial to artisanal, motorised and small mechanised sector fishermen engaged in pelagic fishing activities such as ring seining, gill netting etc., thereby reducing the searching time which in turn result in the saving of valuable fuel oil and also human effort.
2. Reduction in searching time was found to be 60-70% for oil sardine shoals in ring seining with 30-40% reduction reported for mackerel, anchovy, tuna and carangid shoals in ring seining operations.
3. From the quantitative results of the fishing operations done by identical vessels simultaneously within and outside PFZ area, it was concluded that the average income received by vessels operated in the PFZ areas were considerably higher than vessels operated in non PFZ areas. Fishing expenses were also comparatively less for vessels which operated within PFZ.
4. The catch within the PFZ area gave more CPUE and net profit compared to the results of operations in the non PFZ areas.
5. In PFZ Areas, commercially importance species are more abundant and supports richer fishes compared to the non-PFZ Areas.
6. Fishing operations undertaken on or closer to dates on which related SST/chlorophyll imageries have been received yielded positive results. When the gap increases the yield within PFZ is likely to come down unless the features remain more or less in the same location as revealed by the succeeding satellite imagery.
7. The Gut content analysis of Rastregiller and Decapterus species revealed predominant presence of Copepod. Crustacean larvae and other small fishes were also seen in the Rastregiller where as some small fishes were seen in Decapterus species.

13. References:

1. *Solanki, et al, IJRS Vol. 26, No. 10, 20 May 2005, 2029–2034*
2. *Dwivedi, et al, IJMS Vol. 34(4), December 2005, pp.430-440*
3. H.U. Solanki, R.M. Dwivedi, S. R. Nayak, et al, IJRS, 2003, VOL. 24, NO. 18, 3691–3699

Annexure I

Indian National Centre for Ocean Information Services (INCOIS)
Potential Fishing Zone Advisories - Feedback Form

FISHING PERIOD:

Name of the Landing Station/ Fishing Base	Date of Fishing	Time of Departure	Time of Arrival

VESSEL/BOAT & NET DETAILS:

Name of the Vessel	Type of Boat (Mech /Non.Mech)	Length of Boat	Type of Net

PFZ FORECAST DETAILS:

Location as per PFZ Forecast		Validity Date	Forecast Received on
Latitude/Longitude	Angle, Degrees, Distance and Depth		

ACTUAL LOCATION OF FISHING:

Latitude	Longitude	Distance from the Landing Centre (Km.)	Direction from the landing centre	Depth at the Location (meters)

FISHING OPERATION DETAILS:

Number of fishing Hours	Number of Hauls	Engaged Number of Fishermen	Number of Fishing Boats

CATCH DETAILS:

TOTAL (Kg.)		Name of Major Species					
		a)	b)	c)	d)	e)	f)
Haul I Duration Hr							
Haul II Duration Hr							
Haul III Duration Hr							
Total Catch							
CPUE							

STATUS OF THE CATCH:
(Give √ Mark)

Bumper	Normal	Below Normal

EXPENDITURE:

Total Expenditure in Fishing Operation (Rs.)	Fuel (Rs.)	Wages (Rs.)	Other Expenses (If Any) (Rs.)	Approximate cost of total Catch

WEATHER CONDITION:

State of Sea	State of Sky	Wind Direction

Oceanographic Parameters: **Hauling Site**

	HAUL I	HAUL II	HAUL III

• Sea Surface Temperature (deg C)
• Secchi disk depth (m)
• Ocean Color (visual)
• Plankton Volume
• Chlorophyll concentration (ug/litre)
• Dissolved nutrients (ug-atm/lit.)
  o Nitrate
  o Nitrite
  o Ammonia
  o Silicate
  o Phosphate			

DETAILS OF LENGTH FREQUENCY ANALYSIS OF MAJOR SPECIES:

DETAILS OF GUT CONTENT ANALYSIS OF MAJOR SPECIES:

Signature of Analyst with Date

Signature of the Scientist-In-Charge with Date

Note: This form should be sent to INCOIS within a week after each forecast through email to pfz@incois.gov.in or to Fax: 040-2389 5001.