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Evaluation of Fish Catch in Potential Fishing Zones (PFZs) off Veraval Coast, Gujarat

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ABSTRACT: Oceanographic features such as thermal fronts, eddies, gyres, currents and nutrient rich upwelling areas attract certain fish assemblages or affect their distribution. Remote sensing tool can be attempted for optimal harvest of fishery resources as well as to make fishing operation viable through potential fishing zone forecast. Satellite based sea surface temperature (SST) and chlorophyll images were utilized in the present study to locate Potential Fishing Zones (PFZ). Indian National Center for Ocean Information Services (INCOIS) provides satellite-based potential fishing zones (PFZs) forecasts using integration of Ocean Colour derived chlorophyll concentration and Advanced Very High Resolution Radiometer (AVHRR) derived sea surface temperatures (SST). In the present study evaluation of fish catch was carried out during 2017 – 2018 using commercial fishing vessels off Veraval coast at 20 to 50m depth in PFZ demarcated and non-PFZ areas using trawl net. Species-wise CPUE were compared in PFZs and non-PFZs off Veraval Coast. Two to three times higher fish catch was reported from PFZ than non-PFZ regions. Major fish catch observed were Clupeids, Carangids, Scombrids and Ribbon fishes.

Keywords: PFZ, Potential fishing zone, SST, Chlorophyll, CPUE, Veraval coast.

INTRODUCTION

The coastal marine fishery resource play vital role for coastal state in terms of livelihood, food security, employment and foreign exchange through export. In India, fisheries sector provides livelihood to more than 2.8 Crores of people. The fisheries sector in India exhibited growth of 8% per year and contributed about 7.28% of share in Agriculture GDP. The export of marine products stood at 12.9 lakh metric tonnes during 2019-20. In terms of value the fisheries sector contributed Rs 46,663 crores through export in 2019-20. Fish and fish products account for about 17% of agricultural export in India. Pelagic finfishes dominated in the marine fish landings of India, in 2017 contributing 54% of the landings. Indian oil sardine, Mackerel, Ribbon fish, Lesser sardines and Bombay duck contributed almost 60% of the pelagic fish landings (CMFRI, 2018).

Gujarat is consistently leading in the marine fish production among all the maritime states in the country. With rich marine fish diversity and high productivity, the state produced diverse fishery resources. Out of 8,118 km coast line of India, Gujarat state has 1600 km longest coast line of all the maritime states. Out of 0.506 million square kilometers of total continental shelf area, the state of Gujarat has the highest continental shelf area, amounting to about 184,000 square kilometers (Handbook on Fish. Stat., 2020). With such huge resources the estimated marine fish landings from all the maritime states and two union territories in the main land of India for the year 2019 remained 3.56 million tones. After remaining the top contributor in 2018 with 7.8 Lakh tonnes of fish production in 2018, the Gujarat state showed drop of 31000 tonnes (4%) in 2019 compared to previous year and remained second largest contributor of marine fish production with 7.49 Lakh tonnes accounting 21% of national total fish landings (CMFRI 2018, 2019). Gujarat marine fish landings contributed about Rs 12568 crores (21%) in terms of value to the national income. The mechanized sector accounted for 2.98 million tonnes (83%) of the landings followed by motorized 0.56 million tonnes (16%) and non-motorized 0.03 million tonnes (1%) sectors in India (CMFRI, 2019b).

In Gujarat, Veraval, Mangrol, Porbandar, Jafrabad, Amreli and Rajpara contribute about 70% of the total state fish production. Among all the districts, Gir-Somnath contributed about 44% of total state marine fish landings owing the largest Veraval fishing harbour. Assemblage wise marine fish landings of Gujarat during 2017 showed the predominance of the pelagic finfish resources (36%), followed by demersals (30%).

With the application of satellite derived infrared thermal data of AVHRR and chlorophyll concentration by MODIS AQUA provide information on sea surface temperature and ocean color, which can be further used to identify oceanographic features like eddies, meanderings, thermal fronts, nutrient rich upwelling areas in the sea. Variations in ocean conditions play an important role in natural fluctuations of fish stocks and their vulnerability to harvesting. Changes in environmental conditions affect the recruitment, distribution, abundance, and availability of fishery

resources. Access to dynamics of marine environment can be attempted by measurement of sea surface temperature, ocean color, computation of wind-driven ocean transport with the application of satellite remote sensing.

Satellite remote sensing gives synoptic, repetitive large area coverage on spatial and temporal domain (Fig. 2). Thus it has an ability to build a time series data. Spatial averaging instead of point estimation enables in putting the satellite data into numerical models. It is helpful in forecasting fish rich areas (i.e. Potential Fishing Zone) which will reduce the search time for the proper fishing ground thereby reducing total fishing time and expense. It can offer optimum exploitation of our resources with appropriate management laws. Potential Fishing Zone delineation based on the Sea surface temperature has been attempted by many workers (Yamanaka *et al*., 1983; Barbieri *et al.,* 1987; Laurs *et al.,* 1987; Vastanio *et al*., 1992; Reddy *et al.,* 1995; Dwivedi *et al*., 1998; Choudhury *et al.,* 2007; Romeo *et al*., 2011; Tadjuddah *et al.,* 2012). An estimate of primary productivity through chlorophyll detection and fish stock can be attempted with SST and ocean color composite image (Solanki *et al.,* 2005). Satellite information on weather will ensure greater safety for the men out at sea. The present study was carried out to evaluate the fish catch in potential fishing zone (PFZ) and Non-PFZ off Veraval coast, Gir-Somnath district at Saurashtra region.

MATERIALS AND METHODS

The present study was conducted off the Veraval coast of Gujarat. Veraval is the most important fish landing center along the coast of Gujarat in terms of the quantum of fish landing, area of the harbour and number of crafts. The precise geographical coordinates of fishing and other information on time of fishing, depth of the fishing area, catch details, etc., in a structured schedule were collected from the identified identical trawlers operated basing at the Veraval fishing grounds (Lat- 20°51' N Long - 70°12'E) situated in the Gir-Somnath district of Gujarat, India. Experimental commercial fishing carried out during August 2017 to May 2018 at 20 to 50 meter depth off Veraval coast. Fishing ban was observed for the month of June –July 2017. Fishing is prohibited from 1st June to 31st July as per the Marine Fishing Regulation Act. The precise location of fishing ground was approached with Garmin GPS onboard fishing vessel. PFZ Advisory maps (Fig. 1) disseminated by Indian National Center for Ocean Information Services (INCOIS), Hyderabad were utilized for location of fishing ground. During the ban period INCOIS, Hyderabad did not provide potential fishing zone advisories.

The data collection from commercial fishing vessels was restricted to the fishing coordinates (Lat- 20° N Long - 70°'E) as mentioned in potential fishing zone advisories disseminated by INCOIS, Hyderabad.

Location wise catch information in the prescribed schedule for the study on spatio-temporal distribution and catch of commercially important fishes on the waters off Veraval coast were collected. The data collection schedule contained the information such as the latitude and longitude of shooting the net, date, time, depth of the fishing area, trawling speed, latitude and longitude of hauling the net, total catch in the haul etc.

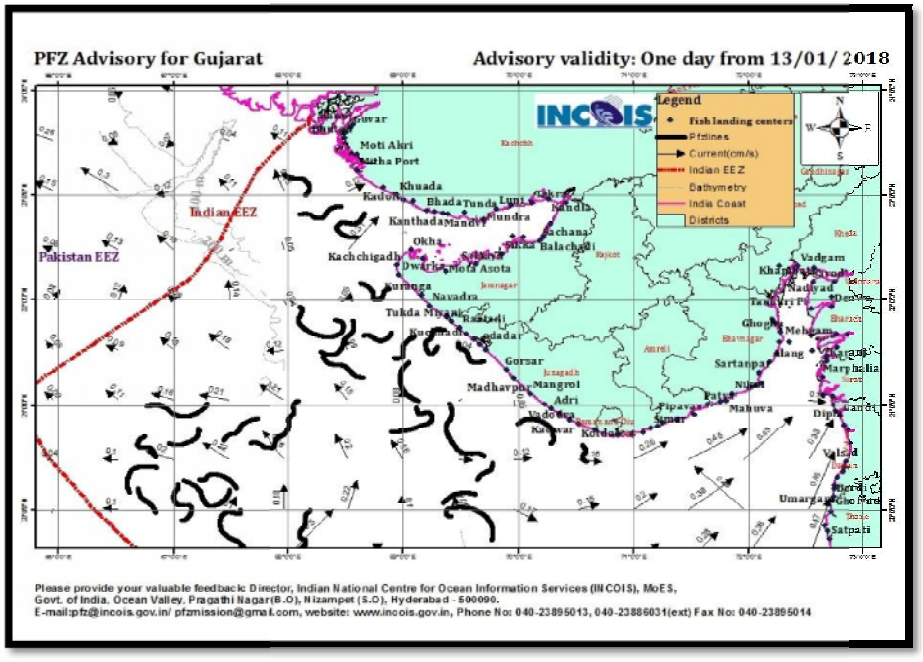


Fig. 1. PFZ Advisory map of Gujarat (Source: INCOIS, Hyderabad).

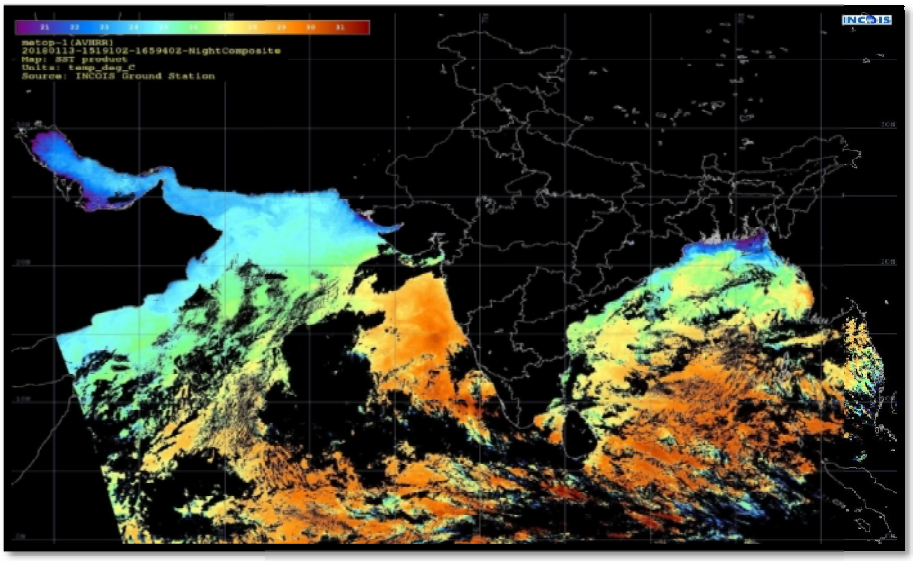


Fig. 2. METOP (AVHRR) SST IMAGE (Source: INCOIS, Hyderabad).

Mackerel

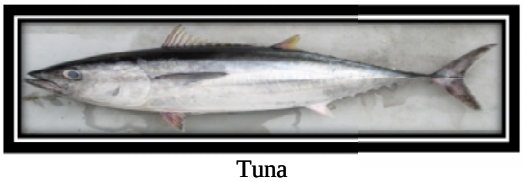
Cat fish

Moon fish

Ribbon fish

Clupeids

Ribbon fish



Tuna

Tenulosa

Fish catch and species observed off Veraval coast.

RESULT AND DISCUSSION

SST and chlorophyll based composite image were utilized for the generation of PFZ advisories. In the present study, total 60 experimental commercial fishing trips were organized to get 180 fish hauls to validate the potential fishing zone (PFZ) forecast disseminated by Indian National Centre for Ocean Information Services, Hyderabad. About 2 to 3 times higher fish catch was recorded in PFZ compared to Non-PFZ. The Non-PFZs are non-notified regions and the randomly selected regions of fishing which are more than 5 nautical miles away from the notified zone. The results of present study confirm to the results of Solanki *et al.* (2001, 2005) who also used NOAA AVHRR derived SST and CHL composite images for delineation of PFZ, off Gujarat Coast. In his studies he used IRS P4 Ocean Colour Monitor (OCM) derived CHL and NOAA AVHRR derived SST for exploring fishery resources. Solanki *et al.*, (2005) reported higher catches of pelagic fish in his studies off Gujarat coast. Similar results were observed in the present studies with higher catches of Clupeids, Scombrids, Carangids and Ribbonfish which dominated in fish catch in PFZ region. Salleh *et al.*, (2012) also demonstrated higher catch in PFZ with the MODIS data off Malasian coast.

Table 1: CPUE in notified and non notified area of Veraval coast.

CPUE (kg/hr)	n	Mean	Median	SD	SEmean	Minimum	Maximum
PFZ	10	52.7	51.5	10.29617	3.255935	36	67
Non-PFZ	10	25.2	25	3.359894	0.733189	21	32

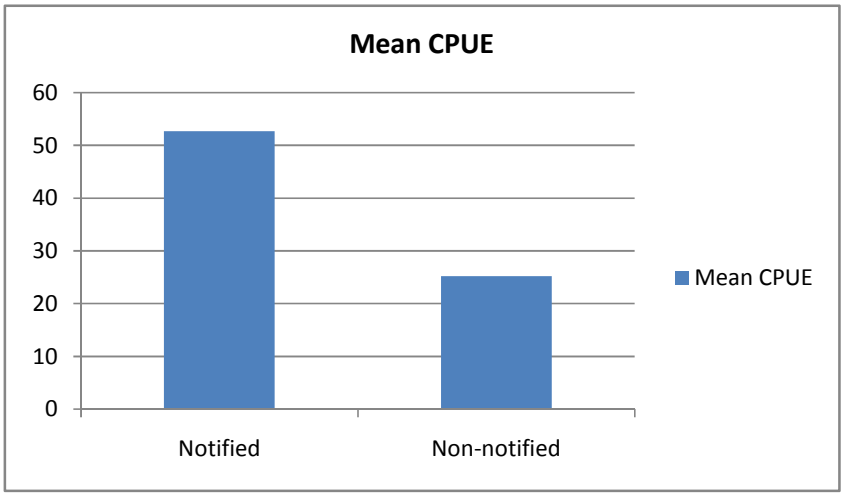


Fig. 3. Mean CPUE (kg/hr) in notified and non-notified zone off Veraval coast.

In the present study, highest mean CPUE of 52.7 kg/hr was reported in notified zone while 25.2 kg/hr in non-notified zone as mentioned in Table 1 and Fig 3. Maximum CPUE 67 kg/hr was noticed in PFZ while minimum CPUE 36 kg/hr observed in notified zone. For non-notified zone highest CPUE was 32 kg/hr while lowest was 21 kg/hr. Similar results were obtained by Solanki *et al*., (2005) with two to three times higher catch rates in PFZ compared to NPFZ. Pillai and Nair (2010) reported 2 to 7 times higher fish catches in pelagic realms in notified zone than non-notified zone along the Kerala coast.

Table 3: Species wise total biomass in PFZ and NPFZ off Veraval coast.

Species group	Total weight PFZ	% in PFZ	Total weight NPFZ	% in NPFZ
Wolf herring	353.01	3.5	123.28	2.7
Lesser sardine	312.67	3.1	86.75	1.9
Bombay duck	110.95	1.1	41.09	0.9
Priacanthid	272.32	2.7	214.6	4.7
Clupeids	1129.63	11.2	196.34	4.3
Sciaenids	292.49	2.9	187.21	4.1
Upenoids	262.24	2.6	173.51	3.8
Mullets	30.26	0.3	59.36	1.3
Barracuda	393.35	3.9	337.88	7.4
Snapper	90.77	0.9	73.06	1.6
Carangids	998.51	9.9	242	5.3
Horse mackerel	544.64	5.4	173.51	3.8
Elasmobranch	131.12	1.3	54.79	1.2
Ribbonfish	726.19	7.2	223.73	4.9
Mackerel	484.13	4.8	155.24	3.4

Seer fish	827.05	8.2	86.75	1.9
Lizard fishes	110.95	1.1	168.94	3.7
Catfishes	484.13	4.8	132.41	2.9
Nemipterids	443.78	4.4	392.68	8.6
Silver bellies	262.24	2.6	219.17	4.8
Terapon	181.55	1.8	242	5.3
Cephalopods	484.13	4.8	328.75	7.2
Tuna	423.61	4.2	95.89	2.1
Misc.	736.28	7.3	557.05	12.2
Total	10086	100	4566	100

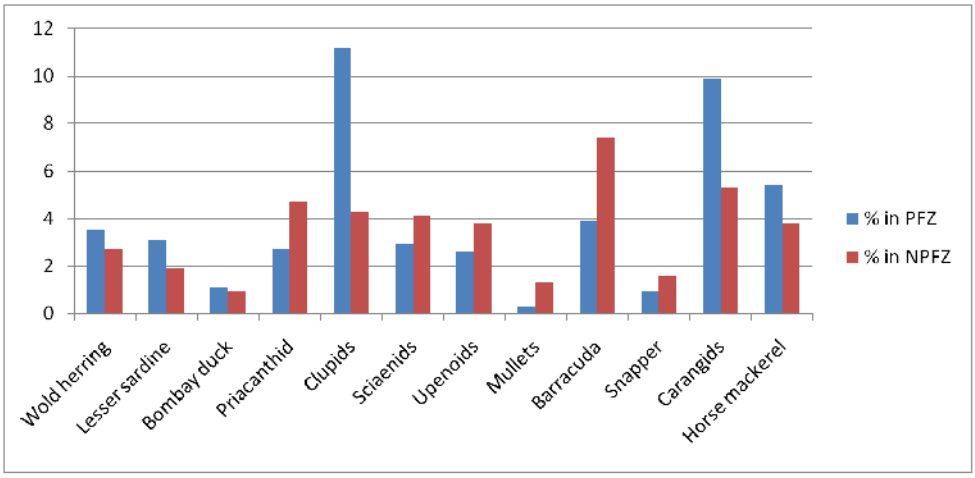


Fig. 4. Species wise fish catch (%) in notified vs non-notified zones off Veraval coast.

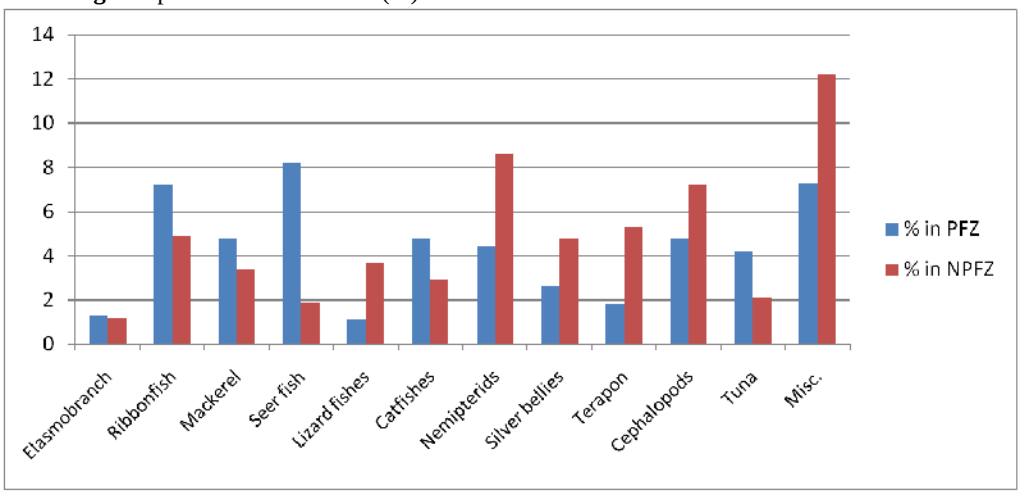


Fig. 5. Species wise fish catch (%) in notified vs non-notified zones off Veraval coast.

Highest biomass in notified zone was of Clupeids, Carangids, Scombridae and Ribbon fish, Horse mackerel and Tuna. Highest biomass observed in non-PFZ was by Nemipterid, Cephalopods, Barracuda, Carangids and Ribbon fish. Species wise fish catch was compared between notified and non-notified zone as depicted in Table 2, Fig. 4 and 5, during the study period. There was significant higher catch was observed for Clupeids, Carangids, Seerfish, Ribbon fish in PFZ than Non-PFZ. Catch of Bombay duck, Elasmobranchs, Lizard fishes, Silverbellies, Terapons and Cephalopods were higher or comparable in Non-PFZ than PFZ area. Hence it indicates that high value fishes can be harvested from PFZ while lower market value fish assemblages are found in non-notified area. Similar results were obtained by Panikkar *et al.,* (1966) ;Choudhury *et al.,* (2007); George *et al.,* (2012) for Sardines, mackerels and other pelagic fish harvest in potential fishing zone with the use of CHL-SST composite image. SST based approach was not successful in the south-west coast of India. Bisht (2002) found significant variation in the fisheries over entire forecast area. Bisht (2002) suggested that strong incidence of solar radiation might inhibit the thermal gradient and recommended incorporation of ocean color data along with sea surface temperature for better results. Bisht (2002) used demersal fishing method using SST based forecast for validation of fish catch. Zamir *et al.,* (2015) examined the association between sea surface temperature (SST) and chlorophyll- a (Chl-a) by using OC3M algorithm across the Arabian Sea, investigating the affiliation between SST and Chl-a

helps in understanding the ocean yields pattern. Composite image of chlorophyll and SST provide good information about oceanographic patterns and gave very good results about getting better catches in PFZs off Gujarat coast (Solanki *et al*., 2001). Chlorophyll image feature along with SST features appeared to be very well defined and contained more information as compared to only SST features.

CONCLUSION

Affinity towards oceanographic features and trophic interactions play important role for distribution and availability of desired fish species in the sea. Fish catch in potential fishing zone remains higher compared to random fishing at sea. Catch composition remained in favour of valued species like Clupeids, Carangids, Trichurus, Scombrids in PFZs, which provide higher returns for the given operation cost of fishing vessel. The fishing methods, price behaviour of marine fish varieties remains main factors for economic performance of fishing operation.

FUTURE SCOPE

Fluctuations of marine fish populations and commercial stocks depend upon the biological features of individual species and the environmental factors. The study of species-specific environmental effect that can establish co-relation of fish aggregation with oceanographic process. Parameters like sea suface surface salinity, wave height, suspended sediments, bathymetry, physiological requirement, food and feeding habit of fish etc. can be taken into consideration in addition to oceanographic parameters SST and chlorophyll for delineation of species specific potential fishing zone.

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Conflict of Interest. Nil.

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