Marine fisheries data collection methods in India – an update

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Abstract

The marine fishery data collection in India is accomplished by two methods a). land-based sampling (by Fisheries Departments of State Governments/Union Territories (UT) and the Central Marine Fisheries Research Institute, CMFRI) and b) sea-based exploratory surveys (by Fishery Survey of India, FSI). The CMFRI along with the Fisheries Departments of the coastal States/UTs undertakes regular sampling and estimation of the fish landings from designated landing points throughout the coastline. Besides estimating the fishery landings, studies on biological and socio-economic attributes of fisheries are also carried out by the institute on a regular basis. The Fishery Survey of India (FSI) operates eleven research/survey vessels for collecting the sea truth data on the fish abundance, biology, oceanographic parameters etc. Time series data on landings and effort are used to arrive at estimates on Maximum Sustainable Yield (MSY). For potential yield estimations of highly migratory large pelagics, a proxy of the MSY estimations by Indian Ocean Tuna Commission (IOTC), after incorporating correction factors including productivity and results of fishery independent surveys are used. The methodologies adopted by these different agencies for data collection and reporting are detailed in the present paper.

Introduction

The Republic of India, located between the latitudes 6° 45' and 37° 6' N and longitudes 68° 7' and 97° 25' E, encompasses a total land area of 3.3 million km². The seas around India are part of the northern Indian Ocean, and the west coast of peninsular India boarders eastern Arabian Sea, whereas its east coast boarders western Bay of Bengal. The Indian Exclusive Economic Zone (EEZ) is located between latitude 3°N to 23°40'N and longitude 65°E to 97°E. The EEZ along the west coast covers 0.86 million km², east coast 0.56 million km² and around Andaman and Nicobar Islands covers 0.60 million km². Total coastline of India is 8,118 km and the continental shelf area is 0.57 km². This coastline supports a huge human population, which is dependent on the rich coastal and marine resources. About 4.1 million fisherfolk living in 3,322 fishing villages all along the Indian coasts depends marine fishing and related activities for their food and income. Out of 29 Indian States and 7 Union Territories (UTs), 9 are maritime states (5 in the west coast- Gujarat, Maharashtra, Goa, Karnataka, and Kerala; and 4 in the east coast- Tamil Nadu, Andhra Pradesh, Odisha, and West Bengal) whereas 4 are maritime UTs (2 in the west coast- Daman & Diu and Lakshadweep; and 2 in the east coast- Puducherry and Andaman & Nicobar Islands).

Marine fishing in India is mainly undertaken using small motorised and mechanized crafts. Landings take place almost all along in the coast line throughout the day and sometimes during night. The fishing villages are scattered along the coast line from where fishermen go for fishing and return to a landing centre where the catch will be landed. Total number of fish landing centres is about 1600. All these factors including long coast line, large number of boats, fishers and landing centres, makes the fishery data collection in India highly challenging. However, India has adequate infrastructure and institutional capacity to address these concerns which is endorsed by the IOTC (Moreno, 2012).

Fisheries data collection System

Monitoring and stock assessment of the marine fishery resources are vital for the sustainable management of these commercially important resources. In order to make stock assessments relevant to site-specific fisheries management, it is essential to know the quantum of exploitation from the population, since this affects the ability of stocks to survive and most importantly, to reproduce and replenish. Therefore, catch and effort statistics, along with biological data on fish caught by various gears form the

fundamental basis for effective fisheries management.

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a). Land based sampling (Ref: Srinath *et al.*, 2005)

The CMFRI along with the Fisheries Departments of the coastal States/UTs undertakes regular sampling and estimation of the commercial fish landings from designated landing points throughout the coastlines of mainland India and two island groups, Lakshadweep and Andaman & Nicobar.

A stratified multi-stage random sampling technique is adopted by the CMFRI for the estimation of the fish landings. The coastal States/UTs also adopt the same methodology for this task. The stratification is over both space and time. Over space, each maritime state is divided into several non-overlapping zones on the basis of fishing intensity and geographical considerations. The number of Fish Landing Centres (FLCs) can vary from zone to zone depending on the topography. These zones are further stratified into substrata, on the basis of intensity of fishing in a centre. The stratification over time is by calendar month. One zone and a calendar month are taken as the basis of space-time stratum. If in a zone, there are 20 landing centres, and there are 30 fishing days in a month, there will be 20 x 30 = 600 landing centre days in that zone for that month, which constitute primary stage units (PSU).

A month is divided into 3 groups, each of 10 days. From each group, a cluster of 6 consecutive days are selected systematically with a random start with a sampling interval of ten days: Thus from the first five days of a month, a day is selected randomly, which together with the next 5 consecutive days (6 days in all) form the first cluster. The next 6 days each from the other groups follow systematically. For example, for a particular zone, in a given month, the observation starts from the 4th of the month and continue upto 9th, the next cluster will start from the 14th and the last cluster from 24th. As the days are selected as per the above procedure, three centres are randomly selected for observations over 6 days and each selected centre is observed for two consecutive days.

A landing centre day is divided into 3 periods. One field staff is usually assigned to each zone. The observation is made from 1200 hrs to 1800 hrs on the first day and from 0600 hrs to 1200 hrs on the second day, in a centre. The intervening period of these two days i.e, data collected by enquiry from 1800 hrs of the first day of observation to 0600 hrs of the 2nd day of observation of a landing centre-day is termed as 'night landing'. The 'night landing' obtained by enquiry on the second day covering the period of 1800 hrs of the first day to 0600 hrs of the next day are added to the day landings so as to arrive at the landings for one day (24 hours). Thus in a 10 day period, data from 3 centre-days are sampled and consequently in a month 9 landing centre-days are sampled.

It may not be feasible to record the catches of all boats landed during an observation period, if the number of crafts is large. Samplings of the boats become essential in such a scenario. When the total number of boats landed is 15 or less, the total landings from all the boats are enumerated for catch composition and other particulars. When the total number of boats exceeds 15, the procedure furnished in table 1 is followed to sample the number of

Table1: Procedure followed to determine number of boats to be sampled

Number of units landed	Fraction to be examined
Less than or equal to 15	100%
Between 16 and 19	First 10 and the balance 50 %
Between 20 and 29	1 in 2
Between 30 and 39	1 in 3
Between 40 and 49	1 in 4
Between 50 and 59	1 in 5 and so on

boats.

There is no direct weighing of the catch but estimates are made visually. From the boats, the catches are normally removed in baskets of standard size. The weight of fish contained in these baskets being known (validated periodically), the weight of fish in each boat under observation is estimated. Data on the fishing effort is collected by interviews of fishermen, which is validated from the days out from the landing centres.

From the landings of the observed fishing units, the landings for all the units landed during the observation period are estimated. By adding the quantities landed during the two 6- hours periods and during the night (12-hours) the quantity landed for a day (24-hours) at a centre that is the landings for each centre day included in the sample is estimated. From these, the monthly zonal landings are obtained. From the zonal estimates, district-wise, state-wise and all India landings and corresponding fishing effort are arrived. The corresponding sampling errors are also estimated.

Besides estimating the fishery landings and effort, studies on biological and socio-economic attributes of fisheries are also carried out by the sampling agencies on a regular basis.

b) Sea-based exploratory surveys (by Fishery Survey of India, FSI).

Fishery independent data on the fish abundance, biology, oceanographic parameters etc. of the Indian seas are collected by the FSI by regular survey in the EEZ employing eleven research/survey of the Institute stationed in six base offices of the Institute all along the mainland and Andaman & Nicobar waters. The operational and other details of these vessels are as furnished below (Table 2, Figure 1).

These vessels are used for a). demersal resources survey and research programme along the coasts of India b). survey of oceanic tuna and allied resources in the Indian EEZ c). Pelagic resources surveys in the continental shelf areas using pelagic trawls and drift gillnets and d). Experimental fishing with traps, hand line, purse seining, squid jigging, bottom set longlining, trolling and bottom set vertical long lining.

The major objectives of these surveys are

- Spatio-temporal estimation of abundance indices
- Estimation of biomass of selected species
- Collection of length, weight and other biological data for studying diet, reproduction etc. and estimation of growth and mortality parameters
- Collection of environmental data

For estimation of stock biomass, a stratified random sampling design is adopted. The stratification is based on geographic location, bathymetry and month. The survey activities,

Table 2. Fishery Survey of India (FSI) operational Bases and survey vessels

Name of FSI Base office	Name of vessel	Vessel type	OAL (m)	GRT	BHP
Mumbai	*Matsya Vrushti*	Longliner	37.5	465	1215
	Matsya Nireekshani	Stern trawler	40.5	329.3	2030
Mormugao	*Yellow Fin*	Longliner	35.7	310	800
	Sagarika	Stern trawler	28.8	189	650
Kochi	*Matsya Varshini*	Trawler-cum-purse seiner	36.5	268.8	1160
	Lavanika	Stern trawler	24	151	500
Chennai	*Matsya Drushti*	Longliner	37.5	465	1215
	Samudrika	Stern trawler	28.8	189	650
Visakhapatnam	*Matsya Shikari*	Stern trawler	39.8	352.4	1740
	Matsya Darshini	Trawler-cum-purse seiner	36.5	268.8	1160
Port Blair	*Blue Marlin*	Longliner	35.7	310	800

except oceanic fishery survey is limited to the
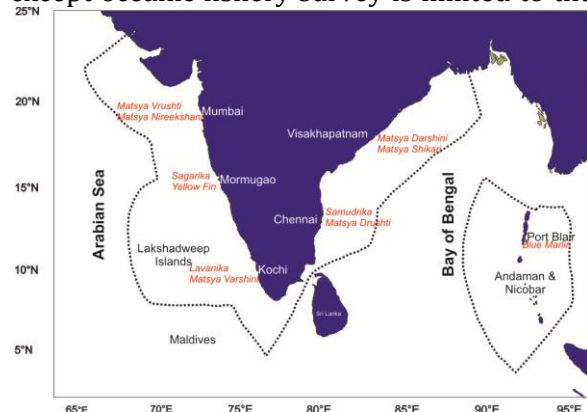
Figure 1 Map showing Indian EEZ and positioning of FSI exploratory vessels

500 m depth contour. Stratification in terms of bathymetry is 20-30m, 30-50 m, 50-100 m, 100-200 m and 200-500 m. The sampling units are demarcated on the basis of one degree latitude and one degree longitude, which is further divided into sub-areas at the level of 6 minutes latitude and 6 minutes longitude. However, the sampling units for survey are selected to stratify the sampling frame into sets of sampling units with more homogeneous properties (same latitude-longitude and depth). The unit sampling area will thus measure 36 sq. nautical miles (123.47 sq. Km). The sampling stations are usually selected so as to ensure that sampling unit is sampled at least once in three months. For oceanic fishery survey, Systematic Statistical Sampling (SSS) is employed in a given area by exploring each 1 degree latitude X 1 degree longitude square at least once in three months. The shore-ward limit for exploration in squares selected was 500m depth contour.

Every month, the survey vessels are deployed for fishing voyages lasting 20 days. At least one Scientist from FSI invariably participates in each voyage, who collects the crucial species-wise data on the catch and effort, length, biology and oceanographic data as per the log sheets designed for this purpose.

Estimation of MSY

The species-wise data on catch, effort and landings, after standardisation are used for estimation of the MSY. The effective CPUE for the species is obtained as the weighted average of the CPUE values with proportion of catch by the gears as the weights. Time series data on catch and standardised effort are used to fit the linear version of Schaefer's logistic surplus production model and the MSY. In cases where the data does not fit well for the linear relationship, the non-linear version of Schaefer's model is followed and a genetic algorithm approach is used to estimate parameters of the model and MSY. Occasionally, Pella–Tomlinson (generalized surplus production) model also is used. Recently, biomass dynamic models in the line of MICE (models of intermediate complexity for ecosystems) (Plaganyi et al., 2014) also are used for the estimations.

The "swept area" method is used for estimating the biomass using the data collected during trawl surveys. On arriving at biomass, MSY is calculated using Gulland's formula for virgin stock and Cadima's formula for exploited stocks.

Since the tunas and other straddling stocks are highly migratory, estimation of national MSY of these stocks cannot be realistic and only regional approaches will give valid estimates. However, the estimation of target yield for these stocks, are of prime importance for fisheries management and development planning. The approximation of the target yield from the Indian EEZ is worked out with reference to the overall potential/production in the Indian Ocean. From the management yield projected for the Indian Ocean, the target yield from the EEZ is apportioned taking into account three factors, *viz.*, primary production, extent of distributional area of the stock and CPUE obtained in fishery independent survey by FSI (John, 2011).

Conclusion

India has a well established fisheries data collection system, both fishery dependent and fishery independent, which is mainly used for policy formulations to ensure the sustainability of the resources in the Indian EEZ.

Acknowledgements

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