Statistical Survey and Fish Catch Data Collection by ICAR-Central Marine Fisheries Research Institute

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The fisheries sector in India, contributes significantly towards strengthening nutritional

security, income, employment, foreign exchange earnings and livelihood opportunities for millions of people. With a coastline of over 8000 km, an exclusive economic zone of over 2 million square kilometers is home to a diverse range of marine life. Marine fish production in India grew from 0.05 million tonnes in 1950 to the highest recorded 3.94 million tonnes in 2012. The estimate of marine fish landings in India for 2023 was 3.53 million tonnes.



The marine fisheries of India is characterized by open access, multi-species and multigear fishery. The enormous diversity of species, use of various fishing gears for harvesting, the dynamic marine environment and the widely scattered landing locations make fisheries management extremely challenging in tropical nations like India. As the demands on fisheries resources become greater, the complexity of fisheries management challenges increases and we will be facing escalating needs for good fisheries monitoring data. More than a thousand species have been observed in the taxa that are fished around the Indian coast in recent years. Reliable data on recent and past catches are essential for assessing the current status of fisheries and maintaining sustainable harvest levels to stop the fish population from depleting over time.

Fish landings take place at various locations along the Indian coastline in all seasons at all hours of the day and night. The fishery resources are exploited through a variety of gears employing mechanized, motorized and non-motorized crafts. Complete enumeration of the catches or the use of a log sheet system are impractical for the multi-species and multi-gear fisheries prevailing in India and the most effective method for gathering data is using a good and scientifically supported sample design.

CMFRI has routinely monitored the harvest of the nation's varied marine fishery resources by using a scientific data collection and estimation system from all around

the Indian coast to provide management measures to maintain sustainable resource harvest levels. After conducting a series of pilot surveys, ICAR-CMFRI and the Indian Agricultural Statistics Research Institute devised the stratified multistage random sampling design (SMRSD), which was deployed nationwide in 1961 except in Lakshadweep and the Andaman Nicobar Islands. Over time, the sampling process has been adjusted to keep up with the evolving marine fisheries scenario. The selected methodology, based on space-time stratification, is an effective tool for getting accurate fishery data that is both practically and theoretically tailored to the unique circumstances that exist in the nation.

Marine fish landings in India are estimated from the sampling of commercial landings. In SMRSD, the stratification is done over space and time to collect and estimate species-wise/region-wise landings. Over space, each maritime state is divided into suitable, non-overlapping fishing zones. These fishing zones consist of different fish landing centres and the quantity of fish landed in each of the places varies. A calendar month is considered as a stratum over time, and each zone is considered as a stratum over space. Thus, a space-time strata are composed of a zone and a calendar month.

In a zone, the landing centres are again grouped into sub- strata on the basis of fishing

intensity, type of fishing craft, fishing method employed, number of fishing crafts operated and other geographical considerations. The number of landing centres may differ between zones. Certain major fishing harbours and landing centres with relatively high intensity of fishing activity are



categorized as single centre zones, which have exclusive and thorough coverage.

The stratification over time is a calendar month. For observation purpose, a month is

divided into 3 groups, each of 10 days. From the first five days of a month, a day is selected at random, and the next 5 consecutive days are automatically selected. Thus, three clusters of two consecutive days are formed.

Time strata	Days in a month									
1	1	2	3	4	5	6	7	8	9	10
2	11	12	13	14	15	16	17	18	19	20
3	21	22	23	24	25	26	27	28	29	30

For example, for a given zone, in a given month, from the first five days if the date (day)

selected at random is 4, then three clusters of two days (4, 5), (6, 7) and (8, 9) are formed from the first ten-day group. In the remaining ten-day groups, the clusters are systematically selected with an interval of 10 days and the cluster of observation days in the remaining groups are (14, 15), (16, 17), (18, 19) (24, 25), (26, 27) and (28, 29). Thus nine clusters of two days each will occur in a month. From the total number of landing centres in the given zone, 9 centres are selected with replacement and allotted to the 9 cluster days. In case of single centre zones, the data collection will be repeated in all cluster days. In other zones, landing centres are selected from the substrata with replacement. Thus, in a month 9 landing centre days are observed in a zone. If in a zone, there are 20 landing centres, there will be 20 x 30 = 600 landing centre days in that zone for that month of 30 days. One zone and a calendar month is a space-time stratum and primary stage sampling unit is a combination of landing centre and a selected day.

Further, as per the sampling method, a landing centre day is divided into three periods. On the chosen landing centre day, data collection begins with period 1 (1200 hrs to 1800 hrs) on the first day and ends with period 2 (0600 hrs to 1200 hrs on the second day). The field observer will be present at the centres throughout periods 1 and 2. For the intervening period of these two days, ie, period 3, the information on landings from 1800 hrs of the first day of



observation to 0600 hrs of the 2nd day of observation -night landings- are collected by enquiry. The `night landing' obtained by enquiry are added to the day landings so as to arrive at the landings for 24 hour period (landing centre day). Thus a landing centre day lasts for 24 hours, starting at noon on the first day and ending at noon on the following day.

The second stage units are fishing crafts landed on a selected landing centre. Recording the species-byspecies catches of every fishing craft landed during an observation period might not be feasible if the number of crafts landed are more. It becomes necessary to take a sample from the different types of crafts landed. When the total number of boats landed is 15 or less, the landings from all the boats are enumerated for species-wise catch and other particulars. When the total number of boats exceeds 15, the following procedure is followed to sample the number of boats.

The field observer must arrive at the landing centre prior to the start of the observation period in order to inquire locally about the number of fishing crafts that have left for fishing and the number of crafts that are anticipated to land during the observation period. The number of units

Number of boats landed	Fraction to be observed
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

for observation must be determined using this information.

Depending on the fraction of selection, choose a number from the random number table. Check all the other numbers systematically at intervals appropriate to the fraction. As soon as the fishing unit for corresponding to the selected number lands, the field observer should record all information from that craft. Usually, standard volume baskets are used to remove the catches from the boats. The weight of fish contained in these baskets being known, the weight of different species of fish in each boat under observation is obtained. Along with the specieswise landings, fishing gear details, fishing effort in terms of trip duration, manpower and fishing location and price should be recorded.

The species wise landings for each craft-gear combination are estimated from the observed boats during each period of observation. The monthly estimates for each zone are obtained by pooling this information for different landing centre days in different strata. The estimates of district-wise, state-wise, region-wise and all India landings are also computed from these estimates. The detailed procedure on estimation of landings and their standard error are given in Srinath et al. (2005) (available online at http://eprints.cmfri.org.in/4053/).

Data collection is usually performed by CMFRI field observers, who receive training on species identification and data collection techniques as soon as they are appointed. They receive monthly schedules for data collection, carefully designed at the headquarters, which include the landing centre to be visited, the date and the period of observation.

Advances in information and communication technology have opened up new possibilities for data collection. ICAR-CMFRI developed a web-based application software Fish Catch Survey and Analysis (FCSA), along with the hardware and network

support needed to enable online data collection from the landing centres. The web application prototype speeds up the process of collecting, analyzing, and estimating marine fish landings along the Indian coast allowing real-time tracking of the system's dynamic performance. Mini et al. 2023 provide a detailed explanation of FCSA (https://doi.org/10.1016/j.fishres.2023.106821).

Each observer is provided with an electronic tablet with login id/username. They can login and download the work program for the month. Using the web application software for online data entry, they can directly record the information from landings centres and can transmit the information to the server. The data processing is carried out at the institute's National Marine Fishery Resources Data Centre (NMFDC). The Centre maintains the database, which has been generated through field data collection over decades following the SMRSD at ICAR-CMFRI. The species-wise, gear-wise, month-wise and region-wise database is used largely to aid fisheries management by national and international organizations.

