03 Monitoring and Quantifying Marine Fish Landings in India: Survey Design, Sampling and Estimation followed by CMFRI

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Sampling Design

Fishing has been a traditional occupation of a section of people all over the world from time immemorial. In India, the fisheries sector contributes significantly towards strengthening nutritional security, income, employment, foreign exchange earnings and livelihood opportunities. These facts established the fisheries sector as an important enterprise of Indian economy. During the last six decades, Indian fisheries had made tremendous progress, with the annual fish production increasing from 0.52 million tonnes in 1950 to 3.78 million tonnes in 2013. India has a coast line of about 8129 km. Landings take place almost all along in the coast line throughout the day and sometimes during night. According to the marine fisheries census 2010, there are 3288 fishing villages scattered along the coast line from where fishermen go for fishing and return to a landing centre which may be distinct from the fishing village. There are 1511 landing centres scattered along the coastline of the main land. Under these conditions collection of statistics by complete enumeration would involve a very large number of enumerators and a huge sum of money apart from the time involved in collection of data. In this situation a feasible solution for obtaining marine fish landings is the adoption of a suitable sampling technique for the collection of fish landing data. The sampling design adopted by the Central Marine Fisheries Research Institute (CMFRI) to estimate resource-wise/region-wise landings is based on stratified multi-stage random sampling technique, in this, the stratification is over space and time. Over space, each maritime state is divided into suitable, non-overlapping zones on the basis of fishing intensity and geographical considerations (Fig. 1).

The number of centres may be different from zone to zone. These zones have been further stratified into substrata, on the basis of intensity of fishing. Each zone is regarded as a stratum in space. The stratification over time is by calendar month. A zone and a calendar month constitute a space-time stratum. If in a zone, there are 10 landing centres and there are 30 fishing days in the month; we get 10 x 30 = 300 landing centre days which constitute the primary stage units (PSU). The fishing boats that land on a landing centre day forms the second stage units (SSU). The introduction of space–time stratification in the sampling methodology becomes necessary as the fish population is supposed to vary with respect to both space and time. The stratification is intended to reduce the
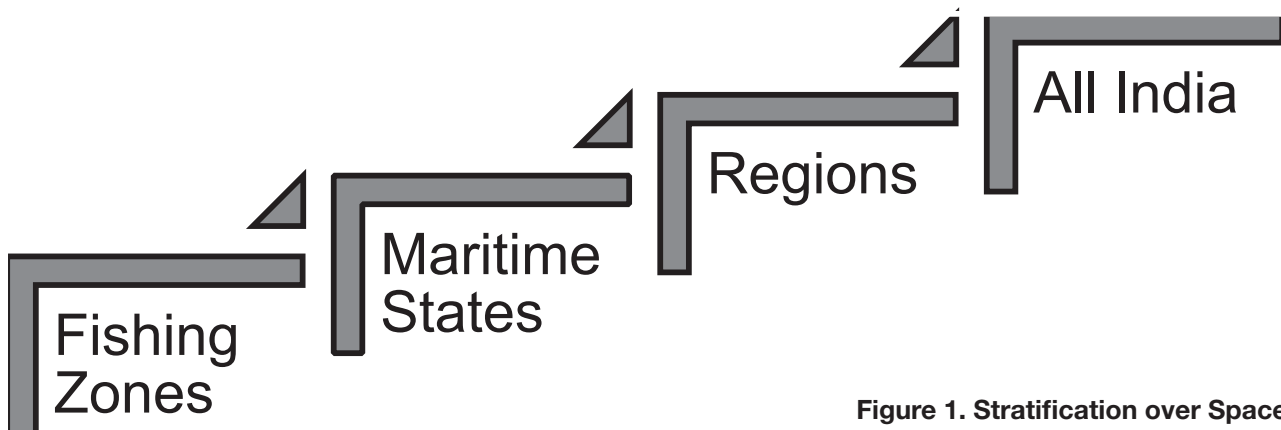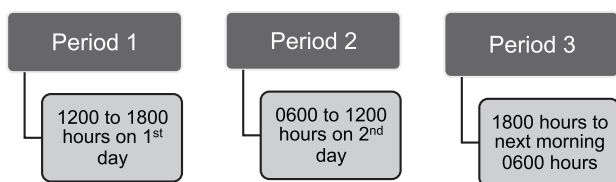

**Figure 1. Stratification over Space**

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variance in the sample estimates. The fish landings are found to vary considerably among the landing centres in a multi-centre zone, especially in different seasons and hence a zone is further stratified as major, minor and very minor centres etc. The centres in which either mechanised boats or 100 or more non-mechanised/motorised boats are operating are considered as major centres. Similarly other strata are defined based on the number and type of fishing boats operating.

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. From this, three clusters of two consecutive days are formed. For example, for a given zone, in a given month, from the five days if the date (day) selected at random is 4, then the clusters formed from the first 10 day group are (4, 5), (6, 7) and (8, 9). In the remaining ten day groups, the clusters are systematically selected with an interval of 10 days. For example, in the above case, the cluster of days for observation in the remaining groups are (14, 15), (16, 17), (18, 19); (24, 25), (26, 27) and (28, 29). Normally, in a month 9 clusters of two days each can be obtained. From among the total number of landing centres in a zone, 9 centres are selected with replacement and allotted to the 9 cluster days selected as described earlier. These 9 days are evenly distributed among the strata in case of multi-centre zones. A landing centre day which is the PSU is the 24 hour duration from noon of the first day to the noon of the following day.

A landing centre day has been divided into 3 periods as given in the infographic. One field staff is usually provided to each zone. A field staff starts data collection from period 1 on each selected landing centre day. The enumerator will be present throughout the periods 1 and 2 at the centres. The data on landings during period 3 (night landings) is usually collected from the landing centre by enquiry on the following day morning. The sum of the observations on the 3 periods contribute the data for one landing centre day (24hrs). Thus

Period 1	Period 2	Period 3
1200 to 1800 hours on 1st day	0600 to 1200 hours on 2nd day	1800 hours to next morning 0600 hours

in a 10 day period, data from 3 centre-days are sampled and consequently in a month 9 landing centre-days are sampled.
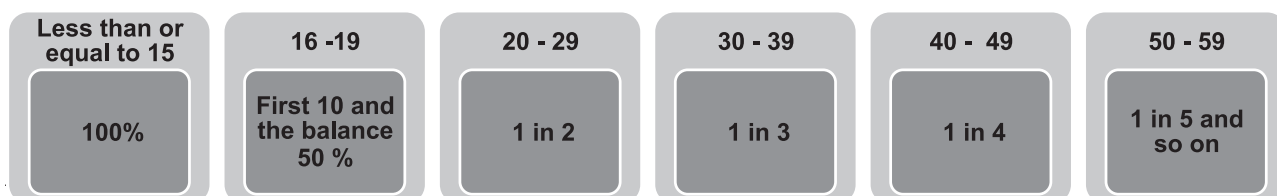
It may not be feasible to record the catches of all boats landed during an observation period, if the number of crafts is large. A sampling of the crafts become essential. When the total number of boats landed is 15 or less, the total landings from all the boats are enumerated for catch composition and other particulars. When the total number of boats exceeds 15, the following procedure is followed to sample the number of boats.

From the boats, the catches are normally removed in baskets of standard volume. The weight of fish contained in these baskets being known, the total weight of the fish in each boat under observation has been obtained. The procedures of selection of the landing centre days and the boats landed on the selected day for single centre zones are the same as in the case of a stratum in a multi-centre zone. 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- hour's 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 are arrived. The corresponding sampling errors are also estimated. The estimation procedure is detailed in Srinath et.al. (2005).

Administration of the Survey

The survey staff is given 10-12 weeks training course immediately after recruitment and is posted to the survey centres. Each survey centre each centre is provided with literature connected with the identification of fish, a reference collection of local fish species, crustaceans and molluscs, field notebooks and registers. The programme of work for the following month is carefully designed by the staff of Fishery Resources Assessment Division at the CMFRI headquarters. Generally one field staff is allotted to each zone to collect the fish landings data. At the end of every month, the survey staff receives the programme of work for the next month by post, that includes the names of landing centres to be observed and details such as dates and time for observations at each landing centre. The field staff are instructed to send the data collected during every month to reach the Institute's headquarters at least by the end of first week of the subsequent month.

Surprise inspections are carried out by the supervisory staff of the Institute and the enumerators are inspected while at work in the field and their field notebooks and diaries are scrutinised. The estimated zonal landings are always

Less than or equal to 15	16 -19	20 - 29	30 - 39	40 - 49	50 - 59
100%	First 10 and the balance 50 %	1 in 2	1 in 3	1 in 4	1 in 5 and so on

compared with the previous year's survey figures, and if any variation which cannot be explained is observed, the technique of interpenetrating sub-samples is adopted to detect observational errors. Observational errors are rarely encountered and when confirmed, the field staff is either called back to the headquarters for giving intensive training or he is replaced. Zonal workshops are held periodically to review the progress of work and update the sampling frame and to impart refresher courses to the field staff. Non-response occurs when the regular field staff is not available to observe the centre-day included in the sample. Usually, arrangements are made at the Headquarters/Research/Regional Centre to minimise the non-response.

In the existing sampling methodology, the interest is to estimate gear-wise, species-wise landings for the state in a month, fishing effort according to different types of fishing boats and also in terms of man hours. The analysis is carried out at CMFRI headquarters. Before the data is processed for analysis it will be ensured that the data collection is made as per the approved schedule, by checking the appropriate proforma. The responsibilities and functions of staff at the headquarters are data coding, estimation and database management. The data analysis is computerised and estimates are made using the software developed by the Fishery Resources Assessment Division of the Institute. The processed data are again counter- checked for errors. When discrepancies are detected, the estimation procedure is scrutinised in detail.

Suggested reading

M. Srinath, Somy Kuriakose and K.G. Mini, 2005. Methodology for the Estimation of Marine Fish Landings in India, CMFRI Special Publication No. 86, p.57