

## EXAMINATION OF THE EFFICACIES OF SOME SAMPLING PROCEDURES IN THE ESTIMATION OF FISH LANDINGS

The lower region of the Hooghly-Matlah estuarine system is characterized by the presence of a number of fish landing points or centres from where the assembled fish are transported to markets for sale and which between them receive practically the entire produce from this region, except for some quantity in winter which are first dried close to the fishing grounds before being directly despatched to the marketing centres. At present the daily landings at each of the landing centres are enumerated for all the days of the month, requiring a high number of standard man-days. It was therefore thought appropriate to investigate the possibilities of introducing sampling in this region and with this end in view the efficacies of 3 different sampling procedures, S. R. S. ( simple random sampling without replacement ), Sy. S. ( systematic sampling ) and Str. S. ( stratified sampling ) were compared. All the 3 sampling procedures provide unbiased estimates of the population mean or total\* and hence they may be discriminated by comparing the variance of the estimates provided by them with same sample-size. The daily landing records were used to draw the samples under the different procedures. Data of 2 months ( November, 1964 and June, 1966 ) for Namkhana centre and 1 month ( May, 1967 ) for Raidighi centre were considered for analysis. In case of stratified sampling 2 sorts of stratification were considered : (i) weeks as strata and (ii) fortnights as strata. The first 28 days were taken of a month and the 3 types of samples were drawn. For the full month, S. R. S. and systematic sampling only were considered and compared. The variance-values of the estimates given in Table I. Refer to the true sampling variance of the sample-mean. For S. R. S. and Str. S., the population values of the variance per unit for the whole population and within different strata ( obtained by calculating the same from all the daily landings constituting the population ) have been utilized in deriving the required sampling variances. For systematic samples, the variance was calculated from the means of all possible systematic samples that could be formed with a given gap. Hence the variances of the estimates given here are free from sampling fluctuation. It is felt that conclusions which are relevant to this type of problem are better not drawn on the basis of variance estimates based on a few isolated samples, in view of the nature of variability of the material. As already noted, when the gap used in forming systematic samples is not an exact divisor of the population size, the sample mean is slightly biased as an estimator of the population-mean. In Table I, the

\*There is some bias, usually small, in case of systematic sampling when the population number is not an exact multiple of the gap used.

TABLE I

Variance of sample means

Type of sample	Number of days (sample size)											
	5	6	7	8	9	10	11	12	13	14	15	16
Systematic			(For the 1st 28 days)									
	66926.76		89123.46			123737.82				27751.99		
	(66952.20)					(123937.23)						
S. R. S.		265493.92	217222.30	181018.58		130333.38		96543.24		72407.43		54305.57
Stratified :												
Weekly strata				108715.92				57981.82				32614.78
Fortnightly strata		214164.70		146021.39		105135.40		77878.07		58408.56		43806.41
			(For complete 30 days)									
Systematic	184342.77	69403.36				98801.15					17988.17	
S. R. S.	315812.33	252649.86	207533.82	173696.78		126324.93	109098.80				63162.47	55267.16
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Systematic			(For the 1st 28 days)									
	20722.42-		27296.70			17198.33				4450.80		
	(20727.16)					(17208.98)						
S. R. S.		232992.73	190630.42	158858.68		114378.25		84724.63		63543.47		47657.60
Stratified :												
Weekly strata				57935.82				30899.10				17380.75
Fortnightly strata		240063.35		163679.56		117849.28		87295.77		65471.82		49103.87
			(For complete 30 days)									
Systematic	45505.65	26423.80				17287.81					1843.27	
S. R. S.	285887.18	228709.75	187868.72	157237.95		114354.87		85766.16		65345.64		50030.26
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Systematic			(For the 1st 28 days)									
	802.79		209.79			97.58				57.60		
	(803.47)					(97.67)						
S. R. S.		849.73	695.24	579.36		417.14		308.99		231.75		173.81
Stratified :												
Weekly strata				398.80				212.69				119.64
Fortnightly strata		851.00		580.23		417.76		309.46		232.09		174.07
			(For complete 31 days)									
Systematic			858.36	385.31				434.37				31.69
			(858.36)	(385.78)				(435.23)				
S. R. S.		1092.46	898.94	753.80		550.60	476.71				279.67	245.80

1.1 Namkhana,  
November 19641.2 Namkhana, June  
19661.3 Raidighi, May  
1967

bracketed values given in such cases refer to the mean square errors about the population-mean. The difference between the variance and the mean square error in each case shows that the bias is small. Some interesting features revealed by the study are given below :

#### **Namkhana ( November, 1964 )**

For 28 days generally it is found that systematic sampling has yielded an estimate with much lower variance than S. R. S. In case of sample-size of about 10, the variances are about the same. Stratified sampling has also given estimates with lower variance than random sampling, weekly stratification being more efficient between the 2. Systematic sampling at sizes 5-6 and 14 has given variances of about one-third and one-half compared to fortnightly stratified sampling of the same sizes. The variance at size 14 for systematic sampling is lower even than variance at size 16 of weekly stratified sampling. Fortnightly stratification is seen here to be slightly superior to S. R. S.

For complete 30 days also, systematic sampling is seen to yield estimates with much lower variance compared to S. R. S. at all comparable sizes. In fact a systematic sample of size 6 appears to be only slightly less efficient than a S. R. S. of size 15.

#### **Namkhana ( June, 1966 )**

For the first 28 days systematic samples were found to give estimates with lower variance than S. R. S. or stratified R. S., at any sample-size. Weekly stratified sampling is more efficient than S. R. S. or fortnightly stratified sampling while S. R. S. is seen to be superior to fortnightly stratified sampling. In this case, the variance of the estimate under systematic sampling with size 10 is about the same as that in the case of weekly stratified sampling with size 16.

For all the 30 days, systematic sampling is highly superior to S. R. S. In fact the variance of estimate with size 5 under systematic sampling is lower than that with size 16 under S. R. S.

#### **Raidighi ( May, 1967 )**

Corroboration of the above features is obtained here also. Systematic sampling is again seen to be the most efficient amongst the 3 procedures in yielding estimates with smallest variance. Next comes weekly stratified sampling. S. R. S. and fortnightly stratified sampling appear to be at par.

It can be concluded from this study that for estimation of landings at assembly centres in the Hooghly-Matlah estuary, or in similar situations elsewhere, systematics ampling is superior to the other 2 types of sampling from the point of view efficiency of the estimate. Further, systematic sampling has definite practical advantage of operation over simple random sampling due to the constant periodicity of observation. Weekly stratified

sampling is superior to S. R. S. and fortnightly stratified sampling, the last 2 being more or less at par regarding efficiency.

In the present case the variances of systematic samples have decreased with sample size in all cases, except for sizes 7 and (9, 10) in case of November, 1964 and for size 7 in case of June, 1966, both relating to Namkhana. However, the relevant variances are all less than those corresponding to S. R. S. The fact that systematic sampling is more precise than S. R. S. in this case shows that variance within the systematic samples is larger than the population variance as a whole (Cochran<sup>1</sup>). Such peculiar nature of the variability of fish landings has been noted by other workers also. In the case of marine fish landings of India, Sukhatme *et al.*<sup>2</sup> found the variability to be such as to make systematic sampling within a day better than S. R. S., for estimation of either the daily catch or the daily number of boats landings at a centre.

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Central Inland Fisheries Research Institute,  
Barrackpore, West Bengal.

P. DATTA  
K. ALAGARAJA  
P. M. MITRA  
G. C. LAHA

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