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A Rational Survey Method for Evaluation of Trawl Fishing Ground

by

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Abstract

The paper presents a method by which the optimum number of hauls for an area can be estimated when the desired precision for estimating fish abundance is given. This method is applied to an area along the east coast Gulf of Thailand. The area was divided into three subareas according to the various features of fishing conditions. Subarea-I contains 13 blocks and is located in the southernmost part of the area; subarea-II comprises 17 blocks in the northernmost part and extends eastwards in the form of a rectangle. The remaining 31 blocks are contained in the subarea-III which occupy the intermediate and off-shore regions of the two subareas. The superiority of trawl fishing ground is in the order of the subareas II, I and III. If an error of 20% can be tolerated for the estimate of fish abundance, sixty hauls are necessary for subareas I and III, while thirty hauls are sufficient for subarea-II.

Introduction

In an unexploited area evaluation of trawl fishing ground is usually made by an estimation of fish abundance from a limited number of experimental trawls. It may be unavoidable in a preliminary survey that the result is accompanied with some degree of statistical inaccuracy. However, when the area is trawled repeatedly for more detailed survey, careful consideration should be made on planning the research programme.

Generally, even when trawling is repeatedly carried out in the same fishing ground, large variation of catch can still be encountered; and when the sample in a locality is too small, the data are often unreliable for quantitative analysis. In actual experimental trawls, however, it is not easy to obtain a large enough sample per unit area especially when it is also necessary to collect data covering as wide an area as possible. To achieve the dual objectives simultaneously for every cruise would be a problem if research facilities were limited. This paper, therefore, attempts to settle the difficulty by compromising between statistical accuracy and available facilities.

The present problem should be reduced to finding the least necessary number of hauls for each locality in the area when certain tolerance limits for the estimate of fish abundance are given. When each locality is trawled by the necessary number of hauls thus determined, fish abundance in the respective loalities could be estimated with the same degree of accuracy.

Background

Since 1970 regular research trips have been made by the research vessel CHANGI in the South China Sea and its adjacent waters. Between 1970 and 1971, most of the research cruises to the South China Sea were concentrated in the area along the east coast of the Malay Peninsula extending from waters off the Gulf of Thailand to the vicinity of Singapore. For the purpose of the present exercise only the data collected by research cruises specially designed to cover as wide an area as possible are considered.

Evaluation of optimum number of hauls

A total of 286 hauls was made in this relatively wide area east of the Malay Peninsula. It contained 61 blocks, each of which is 30 nautical miles square. Basing on the values of mean catch, coefficient of variation, total number of hauls, and the number of trips visited in each block, the area was divided into three subareas. When subdividing the area, precaution was taken so that these blocks in each subarea were spatially continuous and the above values in each block were not greatly different from those within the subarea. As shown in Fig. 1, subarea-I contains 13 blocks and is located along the east coast of the Malay Peninsula; subarea-II comprises 17 blocks which extend eastwards in the shape of a rectangle; the remaining 31 blocks are contained in the subarea-III. Of the 286 hauls, 116 were made in subarea I, 76 in subarea II and 94 in subarea III. The number of hauls per unit block ranged from 3 to 18, 3 to 10, and 1 to 8 for the subareas I, II and III respectively.

The frequency distributions of catch per haul for the respective subareas were compared. Their distribution patterns were those of the Polya-Eggenberger[1)] model and these are shown in Fig. 2 together with the expected ones from the model. The statistics $\bar{x}$ and $\hat{k}$ necessary for the further mathematical procedure were calculated for the respective subareas. The arithmetic means of cath $\bar{x}$'s for the subareas I, II and III were 3.84, 4.96 and 2.19 respectively. These $\bar{x}$'s are given in a converted unit, and could be reconverted into the original unit in kg. by multiplying with the value by 50. The values of $\hat{k}$ were calculated by the method of maximum likelihood, and were2.93, 10.39, and 8.51 for the subareas I, II and III respectively. The goodness-of-fit by the chi-square test showed that agreement of the respective observed distributions with the P.E. model was accepted at the 95% probability level. When the P.E. model is suitable for the sample, an index of the precision D of the estimate of fish abundance is given by the following expression (Elliott, 1971):

$$D^2 = \frac{t^2}{n}\left(\frac{1}{\bar{x}} + \frac{1}{\hat{k}}\right) \qquad (1)$$

where t is found in Student's t-distribution. By the substitution of the values $\bar{x}$ and $\hat{k}$ into the above equation and with the aid of a table of t-distribution, D can be numerically expressed as a function of the number of hauls n at the desired confidence limits of t. The results, calculated at 95% confidence limits, for the respective subareas are shown as an example in Table 1.

As shown in the table, when the desired tolerance limits are given to be D = 0.2, sixty hauls are necessary for the subareas I and III, while thirty hauls are enough for the subarea-II. Considering the present research facilities and statistical accuracy, the above number of hauls may be optimum.

Conclusion

The area to the east of the Malay Peninsula is roughly divided into three subareas, and superiority of trawl fishing ground is in the order of the subareas II, I and III. When an error of 20% can be tolerated for the estimate of fish abundance, the least necessary number of hauls was calculated to the respective localities in the area. The number of hauls was different from locality to locality and a total of about 150 hauls is reqauired to cover the whole area.

When a more detailed survey is necessary for these localities, we could take precautions about the optimum number of hauls for the respective localities. By repeating the survey based on such a plan, the spatial and seasonal characteristics on the trawl fishing condition could perhaps be clarified.

Reference

Elliott, J. M. 1971. Some methods for the statistical analysis of samples of benthic invertebrates, *Freshwater Biol. Assoc.*, Scient. Pub. No. 25, 126–131.

Table 1. D at 95% confidence limits

n	3	5	10	20	30	50
$D_{I}^{2)}$	1.93	0.96	0.55	0.36	0.28	0.21
D_{II}	1.35	0.67	0.39	0.25	0.20	0.15
D_{III}	1.88	0.94	0.54	0.35	0.28	0.21

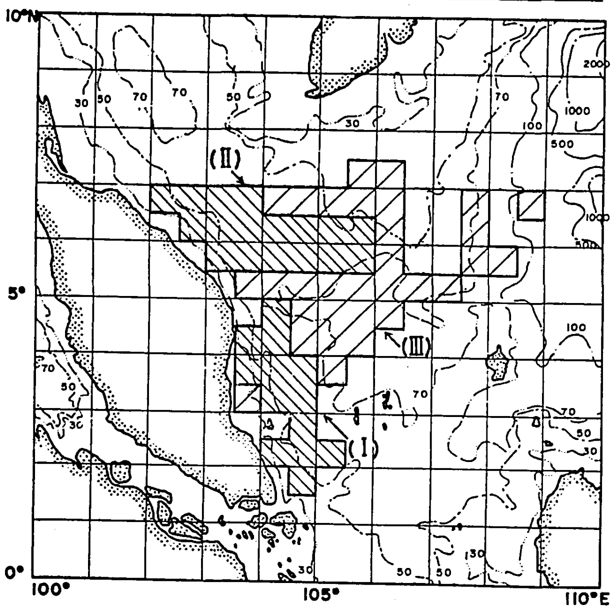

Fig. 1 Experimentary trawled area along east coast of Malay Peninsula. Depth is shown in meter.

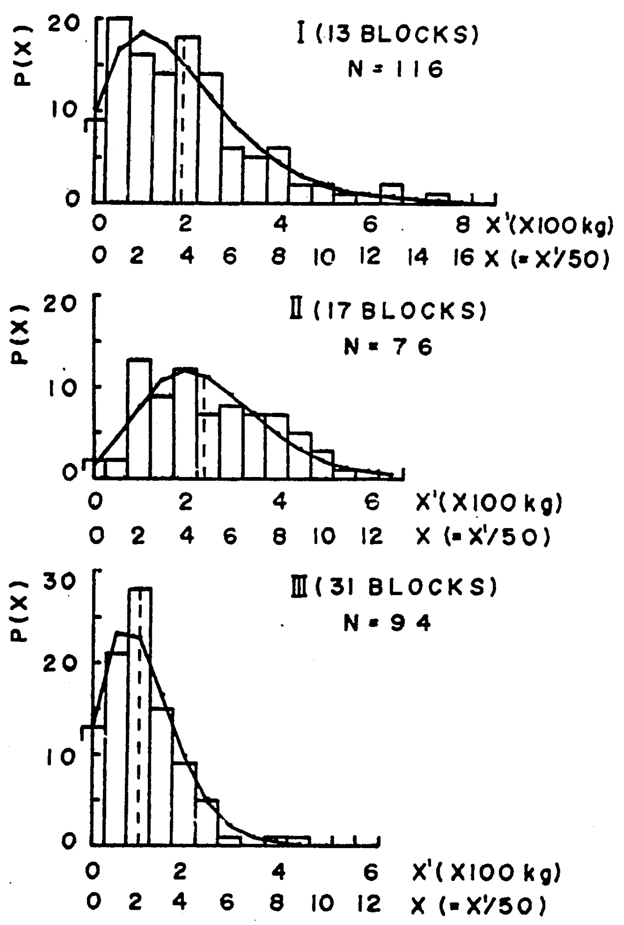

Fig. 2 Observed and expected frequencies plotted against catch per haul. Data from three subareas off east coast of Malay Peninsula.