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CORRECTING DISTANCE BETWEEN ACOUSTIC SURVEY TRACKS

I. L. Kalikhman

All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO)
17 V.Krasnoselskaya, Moscow, USSR

INTRODUCTION

With the help of a mathematical model it was established that on completing each track of an acoustic survey it is expedient to determine the coefficient of variation of a concentration density field along all completed tracks and correct distance between respective tracks. The substantiated algorithm is recommended to be used in carrying out acoustic surveys in fishing areas.

METHOD

Our previous work discussed the task of choosing distance between acoustic survey tracks. With the use of a mathematical model it was shown that it is expedient to determine distance between tracks proceeding from the degree of non-uniformity of the random concentration density field in the area under survey. The formula for calculating distance between tracks (r) is

$$r = \frac{l\sqrt{\delta}}{\nu}$$

where

δ = the allowable relative error of biomass estimate (in fractions of one),
l = the typical size of the area, and
ν = the coefficient of variation of density values[1].

The main obstacle to practical use of the result obtained is the fact that it is impossible to accurately determine the coefficient of variation of density values before a detailed acoustic survey is carried out in the area under investigation. In under-developed fisheries areas this parameter can be estimated by data from a preliminary survey. The tracks of such a survey are few, therefore estimation may be inaccurate. In the traditional areas, where as a rule no preliminary survey is carried out, the data of acoustic surveys made in previous years can be used as initial material for calculating the variation coefficient, though in this case the calculation is even more tentative.

Using an inaccurate value of the variation coefficient leads to a non-optimal choice of track frequency: either the error of biomass estimate is large or time and material expenses are high. To prevent this, it is expedient to operatively correct distance between tracks in carrying out acoustic surveys. The proposed algorithm of the operative correction of track frequency makes it possible to choose distances up to the following track on the basis of the estimation of the degree of non-uniformity of a random concentration density field along all previous tracks. The algorithm is as follows. The first track is made along the periphery of the concentration. On completing each track, the variation coefficient by all completed tracks ν_i is calculated. The following track is made at a distance determined by the formula

$$r_i = \frac{l\sqrt{\delta}}{\nu_i},$$

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The test of the efficiency of the proposed algorithm and the study of its properties were carried out by the method of mathematical simulation with the help of a computer. To achieve this aim the required changes were introduced into the model: distance between different tracks of the survey became variable, the choice of distance being made on the basis of the algorithm proposed.

Nine density fields different in character were simulated, each field corresponding to one of the values of the variation coefficient in the range from 1.5 to 8.7. Acoustic surveys were simulated on each density field in application to four values of the allowable relative error of biomass estimate: 10, 20, 30 and 40%. Thus, 36 simulations of acoustic surveys were carried out. The efficiency of the algorithm was verified in the situation when by the beginning of the survey there were no data on the degree of non-uniformity of the field. It has been found that at the initial stage of the survey due to insufficient data the current value of the variation coefficient can differ from the true one. Similarly distance between the initial tracks differs from the optimal one. However, with the accumulating data verification of the coefficient and track frequency becomes closer to optimum (see Figure 1).

Table 1 shows that in most cases, surveys with correction have one or two tracks more than surveys without correction. From Table 2 it follows that the error of biomass estimate by the results of surveys with correction does not exceed the allowable value in 34 cases out of 36, i.e. the probability is about 95%. Thus, the track frequency can be chosen on the basis of information obtained in the course of an acoustic survey. However, as stated above, in practice, by the beginning of a detailed survey the degree of non-uniformity of the concentration density field is tentatively known. Therefore it is expedient that at the initial stage of the survey, distance between tracks be taken proceeding from an a priori value of the variation coefficient and track frequency be corrected with accumulating data on the non-uniformity of the field.

CONCLUSION

The results obtained confirm the truthfulness of the algorithm of the operative correction of distance between acoustic survey tracks. The algorithm approbated with the help of the mathematical model is recommended to be used in carrying out acoustic surveys in fishing areas.

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Table 1

Coefficient of variation of density values	Number of tracks with allowable error of biomass estimate, %			
	10	20	30	40
1.5	5/7	3/5	3/5	2/4
2.2	7/9	5/7	4/5	3/5
3.1	10/12	7/9	6/7	5/6
3.2	9/10	6/7	5/6	5/5
3.8	11/12	8/9	6/8	5/6
4.5	13/18	9/11	7/9	6/9
5.1	16/18	11/13	9/11	8/8
6.7	17/19	12/13	10/12	8/8
8.7	22/18	15/17	12/10	11/11

In numerator - distance between tracks was not corrected as the variation coefficient is known; in denominator - distance between tracks was corrected as the variation coefficient is unknown.

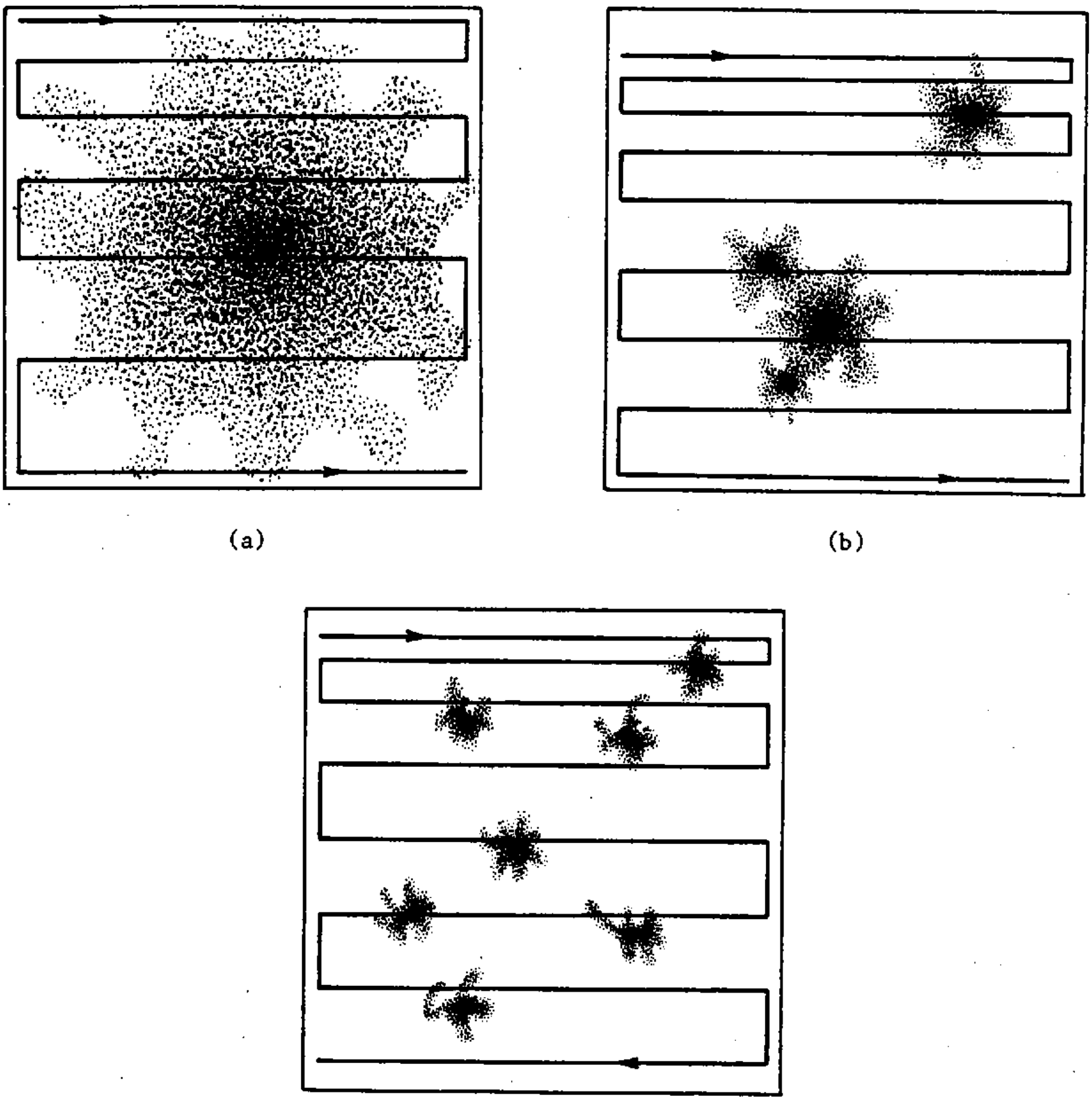
Table 2

Coefficient of variation of density values	Error of biomass estimate with allowable error, %			
	10	20	30	40
1.5	11.5*	14.4	30.0	30.1
2.2	9.6	15.9	20.0	21.3
3.1	2.8	21.3*	27.7	23.8
3.2	3.1	0.0	0.7	1.7
3.8	2.1	8.2	10.7	10.0
4.5	0.8	0.7	12.7	16.7
5.1	3.7	3.1	4.3	23.0
6.7	8.0	18.0	1.5	20.0
8.7	8.6	14.9	12.4	39.5

* The error exceeds the allowable value.

REFERENCE

[1] I. L. Kalikhman, Z. I. Kizner, B. R. Zaripov, W. D. Tesler. Choosing distance between acoustic survey tracks. SC-CAMLR-V/BG/24, 1986. p. 12-164.



(a) (b) (c)

Figure 1 Mathematical models of concentration density fields and the trajectories of acoustic surveys with operative correction of distance between tracks with different values of variation coefficient ν and allowable error of biomass estimate δ: (a) - $\nu = 1.5$, $\delta = 10\%$; (b) - $\nu = 4.5$, $\delta = 30\%$; (c) - $\nu = 5.1$, $\delta = 40\%$. Darker range proportional to density.