THE ANALYSIS OF DATA OF HARE POPULATION
SURVEYED UNDER THE BUFFON'S NEEDLE MODEL

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SUMMARY

A new method of estimating the population size of hare has been presented. This method is based on the application of Buffon's needle problem. The half-circle model is effectively used instead of a line (needle). The field survey data are obtained under the guidance of this model and the goodness of fit of the model is discussed. The coincidence of the estimation by this model with that by the usual method [1,2] has been confirmed.

1. Introduction

The idea of Buffon's needle model was suggested by B. Metérn for the estimation of the size of an animal population [5]. A new model has been presented [4], in which the half-circle model instead of a needle (line) model is assumed. In the present paper, the author discusses the applicability of the method for the actual field survey of hare population, using the data analysis of a pre-test in Hokkaido, north part of Japan.

2. Method

The theory of estimation used in this paper has been published in [4] which is not described here.

The number n of crossing points of hare tracks with the flight line of a helicopter is observed, flying over straight L km (See Fig. 1). The unbiased estimate $\hat{N}$ of total size in $2hL$ km² is obtained by $\hat{N} = n/p$ on the half-circle model of a track, where $p = 2l/\pi h$, $2l$ is a mean running length of tracks in one night

Fig. 1

and the condition $h > 2l/\pi$ is necessary. If we try a survey on J flight lines, the estimate of the density of hares is given by $\hat{N}/J \cdot 2hL$, disregarding the number of hares ingoing and outgoing near the boundaries, which is recognized to be negligible if J , L and $\hat{N}$ are large.

3. Survey

The survey was done over about 50,000 hectares in a south-west part of Hokkaido in March, 1980. A helicopter flies at an absolute altitude 60m with the velocity 120km/hour. It flies on a straight lines ($L = 27\text{km}$ or 15km) as shown in Fig. 2.

Fig. 2

We obtained two estimates, one being by N-S flight and another by E-W flight. The counting of tracks was done on the films taken by systematic sampling of equal interval. The accuracy of absolute altitude was checked by the film reading of a definite distance (10m) on the ground. From this, a film of size 35mm covered 45.7m in average length on the ground.

4. Data Analysis

We have the data in the following table in case of $2l = 1.5\text{km}$ [4] which is observed as the mean value in the past data in Hokkaido.

	E-W direction	S-N direction	mean
number of film L	316	309	-
mean of tracks on a film	0.1487	0.1230	-
standard deviation between tracks on a film	0.5626	0.4455	-
estimation $\hat{N}$	1687	1310	1499
density/hectare	0.0341	0.0282	0.0312
precision under 95% confidence level $2 \cdot (\sigma_{\hat{N}} / \hat{N})^*$	0.43	0.42	0.31

* $\sigma_{\hat{N}}^2$ is the variance of estimate $\hat{N}$ and

$$\sigma_{\hat{N}} / \hat{N} = \sqrt{\frac{V^2}{L} + \frac{1-p}{\hat{n}}}$$

where V is a coefficient of variation of the number of tracks on a film and $\hat{n}$ is total observed number of tracks divided by the sampling ratio. The first term is due to the sampling variance on the number of film shots and the second term is on the estimation by Buffon's probability model.

The estimated density by the usual method INTGEP and COC or RST method [2, 3] is 0.0346 in the case of $2l = 1.5\text{km}$. This estimate 0.0346 is not so different from the estimate 0.0312 by the present method (see table) taking into consideration the variance of that estimate. The applicability of the present method may be recognized to be verified.

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