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THE ESTIMATION OF THE SIZE OF FRESHWATER FISH POPULATIONS

1. The general concepts and considerations of the mark-recapture method

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(A series of three papers to be published in 1972)

For a number of management purposes, it may be necessary to obtain estimates of the size of fish populations. Unfortunately, due to the aquatic environment, it is rarely possible to obtain such estimates by means of direct visual counts and thus indirect methods have to be used. The basic concepts of these indirect methods are simple and, provided one is aware of these concepts and the difficulties in implementing them, reliable estimates can be obtained.

However, where a mistake is often made is in attempting too complex a problem before the difficulties have been understood fully; for example, it is highly desirable that experience is obtained of estimating the population size of a pond before attempting a lake. Further, although the principles and basic formulae are simple, the methods and formulae have been developed and refined, and it would be foolhardy to become involved in these more sophisticated techniques before a thorough knowledge of these basic principles has been obtained; a sophisticated formula or technique will not necessarily overcome a bias caused by the failure to observe a basic principle.

This series of three articles explains the principles of two basic methods of estimating the size of freshwater fish populations, some of the problems encountered when employing them, and indicates the means by which the methods have been developed. The two methods discussed are the mark-recapture method and the depletion (or replicate-fishing) method.

Before discussing the methods in detail, it will be useful to consider the parameters governing the size of a fish population. Four factors are important:

(a) recruitment of young fish,
(b) mortality,
(c) emigration of fish from the population, and
(d) immigration of fish to the population.

In enclosed waters, only the first two factors are operable, but over a period of time they can produce great variations in the size of a population. When estimating the size of such a population, it is best to specify the moment of time for which the estimate is valid, and in order to minimise errors caused by changes of population size with time, the process of estimation should be completed as quickly as possible.

The estimation of a fish population of a large water body invariably requires a considerable effort to obtain a reliable estimate and is often beset with practical problems. For example, the movement of fish to and from the population under study would bias the estimate.

In certain circumstances, e.g. a long narrow, shallow lake, it may be possible to obtain an estimate for a large water body by dividing the area up into a number of smaller enclosed areas using stop-nets and to estimate the size of the fish population in each of these small areas. This method is

(This formula produces limits which are symmetrically about the population estimate N; this is only strictly true in certain circumstances dependent on the absolute and relative values of M and R. In an article of this type it is not possible to discuss complex statistical theory but should it be required a discussion of the problem may be found in a review by Cormack (1968). Ricker (1958) suggests a better, though more complex, method of determining the limits. However, for most purposes, the approximate values of the limits given by formula (4) are satisfactory).

From a study of formula (4) it is possible to reveal some important points to be considered when attempting such an estimation. The range of the limits is dependent on the size of the expression within the square root sign; the smaller the expression, the narrower the limits. It can be shown that an increase or decrease in the value of R has a greater influence on the size of the expression than the proportional change in C or M necessary to achieve the change in R. To increase the number of recaptures requires an increase in the size of the sample at the second fishing and/or an increase in the number of marked fish, but the latter increase is more than compensated for by the former and the range of the limits is reduced as a result. Thus to obtain a reliable estimate with narrow confidence limits as many fish as possible should be marked and the second sample should be as large as possible.

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includes chapters by
B. Stott: Marking and tagging
D.S. Robson & H.A. Regier: Estimation of population number and mortality estimates.

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