STATISTICAL PROBLEMS IN DYNAMICS OF EXPLOITED FISHERIES POPULATIONS

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1. Introduction

The many postwar conferences on allocation of fishing rights on the high seas between various nations and on the conservation of marine resources have focused attention on the dynamics of marine populations and particularly those exploited by man. This interest has brought forth numerous models of various degrees of sophistication pertaining to the dynamics of such populations. The forerunner of these perhaps was the model of Baranov [2]; the most extensive modern study is that due to Beverton and Holt [5]. The emphasis of all of these studies has been in determining the optimum level of exploitation by man, that is, to determine what is the maximum sustainable catch. Since catch is the result of fishing effort, initial population size, growth rate, natural mortality, and certain other parameters, the over-all structure can be examined only if there is information to estimate such parameters. This information comes partly from samples obtained or experiments made by the research biologists and partly from data obtained in connection with the exploitation. In fact, in general it is feasible to study a large population only if it is exploited. Consequently a statistical study of the dynamics of a large population is necessarily based on such information, that is, catch data, effort data, returns of tags from the fishery, and so on.

Such data may be used to estimate the parameters of the various processes that go to make up the total yield and the changes in these parameters in response to manipulations of man. That is, one can attempt to study the structure of the several processes in the small. Alternatively it is possible to consider only the end result of the total catch and try to relate this to changes in effort or other manipulations of man.

Beverton and Holt in the paper cited used the first approach and studied a number of models in detail; however, it was not their aim to give a complete statistical treatment. They have used a number of special methods; some methods suggested have been used uncritically. Often no formulas have been given for variances of the estimates nor confidence intervals for the parameters. It is the aim of this paper, therefore, to formulate some of the statistical problems associated with the dynamics of exploited fish populations, to provide solutions to some of them, and to note problems which are still open.