

Ricker W.E. Computation and interpretation of biological statistics of fish populations. (Whole issue.) *Bull. Fish. Res. Board Can.* 191:1-382, 1975.
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This compilation and its predecessors have provided a handy exposition of the more important procedures used to estimate recruitment, growth, and mortality in fish populations, with worked examples of all the computations. [The SC⁷ indicates that this paper has been cited in over 410 publications.]

One Hundred Years of Computations

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Biological statistics of fish populations include their abundance, age composition, rate of growth, and mortality rates from fishing and from natural causes. Their scientific study began before the turn of the century, and it had developed a substantial literature by the 1930s when I first had to deal with such problems. However, there was no general treatment available in any Western language. My first step toward meeting this need was a paper dealing with the interpretation of "catch per unit of effort," which had been a serious problem during our campaign to reduce the numbers of squawfish and other consumers of young sockeye salmon in a British Columbia lake.¹

A series of creel censuses and marking experiments on the fishes of small Indiana lakes during the 1940s led to an extended discussion and illustrations of the "mark and recapture" methods of estimating rate of exploitation, population size, and survival rate, published in 1948.² This also contained a treatment of the "catch curve" method of estimating survival rate and related statistics. Both parts of the work were strongly influenced by F.I. Baranov's very original but little-known monograph of 1918,³ which I had laboriously translated from Russian. Some of the illustrations used in 1948 were analyses of data published by others, notably the series of reports on Pacific halibut by W.F. Thompson and colleagues.

This study soon went out of print, but most of it was incorporated into a comprehensive review of the field 10 years later.⁴ During the interval much new material had become available. For example, statisticians had refined the various formulae for estimating survival rate, etc. The "utilized stock" method of A.N. Derzhavin had been reinvented by F.E.J. Fry. Calculations for estimating population size from decline in fishing success had been elaborated by D.R. Delury and P.H. Leslie. Baranov had made a calculation of the rate of fishing that provides maximum sustainable yield in 1918, and in 1945 I outlined a more generally useful procedure. In 1957 a third method was proposed by R.J.H. Beverton and S.J. Holt, which used the asymptotic growth formula originally proposed for fish stocks by S. Brody. In 1954 I had examined the relation of number of recruits to size of the adult stock, which included the "Beverton curve," while for other populations a different curve was proposed by Beverton and Holt. R.F. Saleman had related two levels of mortality among California sardines to the corresponding fishing and natural components. Finally, the "additions and removals" method of Michael Graham had been modified by M.R. Schaefer to give annual estimates of stock size and rate of exploitation.

The fourth and last member of this series of reviews is the 1975 *Bulletin* here cited as a Classic. It contains most of the 1958 material, but the formulae were put into the international notation. Among the new sections are K.R. Allen's method of estimating number of recruits, the effects of size-selective mortality on estimates of growth and optimum rate of fishing, the popular "cohort analysis" or sequential computation of fishing mortality rate and population size, J.A. Gulland's version of the additions and removals method, and an examination of the changes in a stock as rate of fishing first increases and then stabilizes.

Bulletin 191 is still available, in French as well as English, from Ottawa, and a Russian translation has been published in the USSR.

[Editor's note: A recent paper by P.M. Ryan and J.J. Kerekes⁵ discusses fish abundance estimates, citing W.E. Ricker's 1975 *Classic* paper.]

1. Ricker W.E. Relation of "catch per unit effort" to abundance and rate of exploitation. *J. Fish. Res. Board Can.* 5:43-70, 1940. (Cited 30 times since 1945.)
2. ———. Methods of estimating vital statistics of fish populations. (Whole issue.) *Indiana Univ. Publ. Sci. Ser.* 15:1-101, 1948. (Cited 55 times.)
3. Baranov F.I. 1918. [On the question of the biological basis of fisheries.] *Nauchn. Issled. Ikhtiol. Inst.* 1:81-288, 1918. (Cited 60 times since 1945.)
4. Wicker W.E. Handbook of computations for biological statistics of fish populations. (Whole issue.) *Bull. Fish. Res. Board Can.* 119:1-300, 1958. (Cited 80 times.)
5. Ryan P.M. & Kerekes J.J. Correction of relative fish abundance estimates from catch data for variable fishing intensity during lake surveys. *Can. J. Fish. Aquat. Sci.* 46:1022-5, 1989.