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New directions in fishery research

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The Fishes of the Gulf of Maine, by Bigelow and Schroeder, published two years ago, brings up to date a work that has been an American ichthyological classic for 30 years. It sums up our knowledge about every species of the northwest Atlantic that regularly occurs in the oceanic bight from Nantucket Shoals and Cape Cod eastward to about 65° W. longitude and including the Bay of Fundy. When read in comparison with the 1924 edition, it measures the progress which biologists have been making in their studies of fishes in this area. In bringing together the work of three generations, it marks where we are now, and serves as a basis on which to consider the question of where to go from here. In the following paragraphs, I propose to examine some facets of this question from the viewpoint of fishery research.

In general, the ichthyological fauna of the North Atlantic is now fairly well known; at least the species which are of actual or potential commercial interest are well known. This does not mean that taxonomy is finished in the Gulf of Maine (or anywhere else for that matter) leaving only the routine job of keeping the bottles on the museum shelves properly labelled and filled with alcohol. What has been done so far is to lay the foundation on which the taxonomy of the future must be built; for there remains the enormously important and difficult work of clarifying conceptions of the sub-populational structure of the species. This is not of " mere academic interest ", as people who are unsympathetic to this line of research sometimes scornfully assert. Fishery investigators have everywhere shown it to be a fundamental necessity; for sub-populations often differ enough from each other in many ways—in rates of growth and mortality, in fecundity, in migratory habits, and in various other biological characteristics, that these segments of species must be studied, fished and regulated as distinct entities.

No matter how distinct they may be genetically, however, they are exceedingly difficult to define, for body proportions and meristic counts vary widely within sub-populations; they overlap broadly between populations; and they are affected by the continually varying conditions of the environment, particularly temperature. Because of the consequent limitations in the usefulness of anatomical features, other means of identifying sub-populations are being sought in the fields of biochemistry, serology, parasitology, and experimental marking. Whatever methods be used for analysing sub-populations, it is necessary to systematically sample large quantities of fish throughout the range of each species under study. In the northwest Atlantic, this laborious and costly work has hardly begun. So far, it has necessarily been concentrated on only the species of greatest commercial importance, namely haddock, cod and red-fish; and even these few species have been studied intensely only over a part of their total distributions. Thus, the study of sub-populations of these must continue, while that of all the other species still lies ahead.

The Fishes of the Gulf of Maine is full of information that is best classed as Natural History. There is much more of this than could be assembled for other parts of North

America, since history is longer and the facilities for keeping records go back further there; universities and museums are more ancient, great fisheries and fishery researches have been longer established, and there has been more opportunity to observe the habits of fishes and to record the vagaries of fisheries there than in other sections of the country. Thus over the course of over 300 years there has accumulated a great store of knowledge about western north Atlantic fishes—about the characteristics of their environment, their seasons and places of spawning, the structure of their eggs and larvae, their food habits, routes of migrations, anomalies of occurrences, and many other matters relating to normal patterns of life history and to the deviations therefrom.

Natural History has been unappreciated for a long time, and is now at last again coming into its own, though perhaps under a different label. During the 1920's and 1930's the extraordinary growth of new fisheries such as for haddock in New England, for sardines in California, and for shrimp in the Gulf of Mexico, aroused concern for the future productivity of those natural resources that were being subjected to unprecedented exploitation. It was logical that these fisheries should be regulated as promptly as possible in order to safeguard them from extermination, and that to be effective, the regulations must be based on scientific information. It transpired from preliminary inquiries that a special kind of information was required which in fact did not exist. Although there was a large store of facts, none of it was suitable for calculating estimates of the sizes and ages at most profitable capture. Under the impetus of the demands of the time, therefore, biologists whose interests might otherwise have been natural history took up the study of fishery biology. At first they were preoccupied with determining the effect of fishing on the abundance and productivity of populations of fish. For this they paid the bulk of their attention to founding useful systems of commercial statistics and to the analysis of the quantities, sizes and ages of fish caught in relation to the amount of effort required in the catching. They tended to limit biological studies to those features of life history required for scientific regulation, i.e. rates of growth, death and replacement.

Fishery research might have remained so for a much longer time had it been proved unequivocally that fishing alone causes depletion, which can always be corrected simply by controlling the catch. However, one of the principal results of studies over the past 30 years has been to bring out that, although fishing certainly does affect the abundance of fishes, so also do events which happen in the ever changing environment. Long period trends in climate and hydrography, for example, affect distribution and abundance of all species, whether they are fished or not; and they affect different species in different ways. Thus there is continuous change in the numerical interrelations among the many species inhabiting an environment, perhaps with some kind of pattern of oscillations which has yet to be deciphered.

Fishery researchers had first thought to speed their progress towards practical results by limiting the scope of their studies to the species of greatest importance and to the problems of greatest urgency. Every study about those species, however, has made it more evident that they can not be understood out of context from the intricate system of their biological environment composed by their predators (including man), their competitors and their prey. So it is that fishery researchers have been finding it necessary to rediscover natural history (now called ecology), and to enlarge the scope of their programmes in order to establish a proper balance between studies

of fisheries and of fishes. The average fishery programme of today is neither a one-man nor a one-agency enterprise. It generally involves the collaboration of several institutions, sometimes of several nations, and the participation of many scientists having among them a wide variety of disciplines and talents.

Most fishery investigations begin with the tacit hope that a solution to what had looked like a clear-cut problem will be reached, and the work concluded in five or six years. Of course this never happens. Research about the effect of varying exploitation upon irregularly oscillating populations of fishery organisms can not be concluded for all time any more than can research about any other constantly changing natural phenomena. In this connection, it might be helpful in our thinking to alter our concept of the dimensions of time from years to generations. The time required for a brood of fishes to reproduce itself (i.e. a generation) varies from one species to another, but commonly runs about three to eight years. To formulate dependable principles about fishes, it is necessary to follow many generations. Most fishery problems also involve human affairs. Those that concern us now will probably be much more acute a generation hence (i.e. 30 years from now) when people will be more numerous and their food needs consequently greater.

Thus the new directions in fishery research are towards greater comprehensiveness —the whole of species with all their sub-populations; the whole of environments with all their component species. This takes up again the tradition established far back in the past, which is behind books like *Fishes of the Gulf of Maine*, and promises to carry it forward to further enrich human knowledge about the sea.

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