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On Fishing Intensity

by

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Fundamental tenets of the fishery theory were formulated by Prof. F.I.Baranov in his work "On biological bases of the fishing industry" (1918). However, considering the ideal case of an isolated water body where fishery is developing with invariable intensity during a long period of time, he did not approach the solution of the problem in a simple manner. On the contrary, assuming that "there is no place in such a reservoir for epidemics, sharp fluctuations in hydrographical factors, etc. and similar phenomena, which could cause accidental changes in the composition of a fish population", he stressed by this the importance and significance of the variable factors to the theory of stock and fishing. On the other hand, at that time it was expedient and justified from a methodical point of view to ignore the variable factors related to stock and fishery. Although these factors are rather essential, they involve some unnecessary complications.

Such factors are dealt with individually in the process of theory deliberation by introducing appropriate amendments and alterations into equations which characterize main regularities of the process under examination. Obviously, due to this fact, Prof. Baranov wrote in the preface to his above-cited work: "We do not concentrate our attention on a general question concerning the utilization of productivity of a water body and on the conditions of equilibrium of certain groups of its dwellers. The solution of this problem would ensure a sound basis for all economic calculations, but it requires the knowledge of a number of quantitative relationships which are not yet studied at all". At the time of Prof. Baranov's work, very few data on the growth rate of fish (relation between age and length, age and weight, etc.) as well as on fish distribution in time and space had been collected. The scientist did not possess the necessary data on the intensity and selectivity of fishing either. It applied even to the main commercial species.

At present the state of affairs has changed radically, a great deal of materials has been collected, which may serve as a basis for precise calculations. Theoretical methods of assessment of relative fish abundance on the basis of catch fluctuations and some other typical signs were given sufficient development. Recently in the USSR on the basis of cibernetic principles, the scientists have advanced closely to the establishment of general regularities in the formation of organic and non-organic resources of the seas and oceans.

Finally, with the aid of hydro-acoustic devices and underwater photography the Soviet scientists have made quite successful attempts to evaluate the magnitude of a fish stock, which periodically forms dense schools within the areas being their habitat.

All this enables us to make now more detailed analyses of fish stocks and fishing than previously. We have no intention of considering here this problem from all aspects, we will rather concentrate our attention on a single problem concerning the fishing intensity, which is of great importance from our point of view. As is known, the fishing intensity comprises the concept of fish catching intensity and intensity of fishing operations. Fishing intensity is the ratio between the catch taken within a certain period of time (C) and the total available abundance of species fished (A) within the limits of an exploited area. Unfortunately, so far no common definition for fishing intensity has been worked out. One interpretes this term as the ratio between the area fished to the total area of fish habitat, the other defines the fishing intensity as a number of fishing vessels and gear engaged in the fishing operations and so on. In recent years "fishing intensity" is replaced by the meaning of "fishing effort". But, there is no uniformity in the assessment of this value either.

So, for example, it is practice in the Soviet Union "to understand the unit of fishing effort" as a catch per hour trawled", whereas in the other countries it is a"catch per day fished", "catch per one horsepower of the vessel's engine", or "catch per one ton of the vessel's displacement" and so on. A lack of uniformity in the determination of such an important factor like fishing intensity creates many obstacles in the analysis of the effect of fishing on the fish stock and impedes the solution of the questions related to fishing regularities. In this report we shall try to consider briefly the meaning of fishing intensity conformably to trawling. Obviously, it should be reasonable for practical purposes to characterize the intensity of trawling operations as the ratio between the catch taken within a certain period of time to the amount of water filtered through the trawl during the same time, i.e.,

$$i = \frac{C}{S \cdot V \cdot T}$$

where i = intensity of fishing operations
C = catch
S = square of the trawl opening (horizontal opening x vertical opening)
V = trawling velocity
T = duration of fishing operations.

In this formula the catch value characterizes the interrelation between the fish and the trawl. The quantity of water filtered per unit of time depends on the size of the trawl and the towing speed. Time- (duration of trawling) indicates the organization of labour and fishing operations. Hence, fishing intensity is the ratio of catch to fishing effort.

However, this definition is not sufficient from a theoretical point of view, since live objects are involved in catching operations. Expenditures of fishing effort per catch unit depend considerably, in this case, on the behaviour of the species fished. Therefore, the trawling intensity may be expressed as follows:-

$$i = f(\delta, \gamma, K_3, t);$$

where i = intensity of fishing operations
δ = density of fish concentrations
γ = criterion of the trawl's catchability
K_3 = selectivity factor representing the relation between the quantity of fish escaped and the quantity of fish caught in the trawl
t = duration of trawling.

At present, it is possible to determine approximately the density of fish congregation in the vicinity of the trawl with the aid of hydro-acoustic apparatus.

The trawl selectivity is also being considerably studied now, and the above-mentioned factor of selectivity can also be determined to a desirable degree of accuracy. Furthermore, the duration of trawling is known.

γ = is a value resulting from the interaction between fish and trawl; it has not so far been sufficiently studied as to allow an expression in terms of measurements.

This value depends on the biological condition of the fish as well as on the trawl design and the conditions of trawling. By means of modern underwater observations it is possible to assess rather approximately (of course, its mean value) its value in relation to the main types of trawls.

Consequently, observations in relation to cod and herring carried out in the USSR with the aid of the sub-marine "Severjanka" and other methods, showed that -γ- depends chiefly on transparency of the water, sizes of the trawl's opening and towing speed, i.e. on lighting and the volume of water filtered through the trawl.

As to fish behaviour in relation to trawl, it is almost constant all year round as far as cod is concerned.

By the sight of the trawl, the cod gets a little scared and tries to move ahead the trawl along the way of its dragging. On the contrary, the herring's reaction to trawl changes greatly during the different fishing seasons. During the cold season the herring is not so active and like the cod has no intention of moving away from the trawl, while in the warm season it is scared by the trawl and tries to escape it, but is apt to notice it only at a short distance (particularly when herring keeps by schools). In future investigations the behaviour of the herring will be studied more thoroughly. But it is clear at present, that if fishing is being analyzed according to seasons, the value δ can be regarded as a mean factor indicating the quantity of fish escaped from the area swept.

The question of the effect of lighting is considered in detail by K. G. Konstantinov in his report to this meeting. The report instructively shows that certain regularities in fish behaviour and lighting of water layers exist. The knowledge of these phenomena would help us to determine a relation between lighting and trawl catch ability.

Thus, it is expedient from a theoretical point of view and practically possible to assess the trawling intensity straight on the basis of the trawl's catching ability, i.e., in relation to the peculiarities of the behaviour of the species fished.

References

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