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Items 10 and 11 of the provisional agenda

INTERNATIONAL TECHNICAL CONFERENCE ON THE CONSERVATION OF THE LIVING RESOURCES OF THE SEA

Item 10: Types of scientific information required for a fishery conservation programme

and

Item 11: Types of conservation measures applicable in a conservation programme

In accordance with the advice of experts consulted by the Secretary-General, technical papers on certain items of the provisional agenda were invited from a number of authorities. The Secretary-General has the honour to communicate the following paper by Dr. Michael Graham, Director of Fishery Research of the United Kingdom Ministry of Agriculture and Fisheries.

A FIRST APPROXIMATION TO A MODERN THEORY OF FISHING

by

Michael Graham

I. INTRODUCTION

1. In 1930, Meek published a diagram on the relationships of growth and mortality to age in a stock of fish and almost simultaneously others developed the same line of thought, which was indeed Petersen's (1894) and Baranov's (1918). The new work of the 1930's contained a new lesson, namely, that the possibility had arrived of continually controlling the yield of a fishery by controlling the rate of fishing. Any difficulty thus became one not of uncontrollable fish but of unco-operative men.

2. The new theory, with much evidence bearing on it, has been worked out in detail by Beverton and Holt, whose main equation was quoted by Graham (1952) and whose book is in the press. Parrish and Jones (1953) have already used some of Beverton and Holt's methods, which are mentioned by Schaefer in his background paper for the present conference.[1/] Dr. Schaefer has very ably and elegantly expounded the whole subject. He has been courteous enough to send me an advance copy of his paper. After reading it, I thought that perhaps there might also be some use for a short paper with an arithmetical example, which a reader could easily follow through himself. I have found that such examples do help some people to understand what the fishery scientists from 1930 onwards have meant. Such a paper can be written shortly, provided we are content with a first approximation. There is no reason to despise the first approximation, because it is sufficient to demonstrate the main lesson, and none of the many deeper studies have, in fact, disturbed it.

II. MORTALITY AND AVERAGE AGE

3. Death fosters youth. At school, I was told that in the Middle Ages a forty-year old European would be a senior among his fellows, because death by violence or disease was more common in a man's lifetime then than in modern times. Although I have since learnt to be uncertain about the Middle Ages, I do not doubt the explanation, which is confirmed by actuarial algebra and practice: a high rate of mortality goes with a low average age, and *vice versa*.

1/ See A/CONF.10/L.1.

4. Man, nowadays, generally succeeds in avoiding death by being eaten, which is the usual fate of other members of the organic world. Most fish can be eaten by many kinds of animals, and sometimes by parasites or other organisms of disease. If, however, one agent of death becomes so active as to claim more fish than die by all other agencies put together, then that agent has control of the average age of the stock of fish.

5. Until man attains that relation to the fish, the example given in this paper does not apply. Instead, Huxley's Dictum[1/] is the appropriate guide: let the fisherman be free.

6. The theory of fishing therefore begins thus: When the rate of fishing effectively governs the average age of a stock of fish....

III. EXAMPLE

7. Having agreed that the rate of fishing could control the average age, let us consider that 20 fish represent a stock - which might really number 200 millions - with young fish coming in and old ones dying or being caught, but the level yet remaining the same, just as, in even a swift stream, a pool can retain the same level. In this case, which is quite realistic for hard-fished stocks, we suppose that a rate of fishing of 0.80 holds the stock level, that is, the average annual catch is 80 per cent of the average stock. The resulting age census might be as follows, with average weights of fish also shown.

Age	I	II	III	IV	V	VI	VII	Total
No.	6	4	3	3	2	1	1	20
Av. wt. (kgs.)	0.17	1	2	3	5	7	9	
Wt. of Stock (kgs.)	1	4	6	9	10	7	9	46

The catch would be 0.8 x 20 fish, of an average weight of 46/20 kgs., which is 0.8 of 46 kgs., namely 36.8 kgs.

1/ See the author's paper A/CONF.10/L.2.

8. Now, let us suppose that a rate of 0.70 would allow the census to alter to the following steady level:

Age	I	II	III	IV	V	VI	VII	VIII	Total
No.	6	5	4	4	3	2	1	1	26

then, using the same average weights, and one extra for the oldest fish, we would have:

Wt. of Stock	1	5	8	12	15	14	9	10	74

and the new catch would be 0.7 x 74 or 51.8 kgs. That is a gain in yield, and shows how fishing <u>less</u> can catch a <u>greater</u> weight.

9. If one looks closely at that comparison, one can see that the gain is not automatic. The lower fishing rate, which allows greater survival to form a heavier stock, also takes less of that stock, and the gain cannot continue indefinitely. For example it is difficult to conceive of a 1 per cent rate of fishing giving a high annual catch; and a 0 per cent rate certainly could not.

IV. CONCLUSION

10. In order that the arithmetic in the example might be followed easily, I have used convenient imaginary data. Here, however, are real values for some North Sea species: (from Beverton and Holt, MS, for a fishery using a trawl mesh 70 mm. on the gauge):

	Plaice				Haddock				Cod			
Rate of Fishing	0.70	0.50	0.30	0.20	0.70	0.50	0.30	0.20	0.70	0.50	0.30	0.20
Relative Yield	196	212	217	197	134	137	125	112	1030	1440	2100	2450

Those figures are not first, but close, approximations, using, as best we can, all the information that we have. First approximations would, however, be sufficient to illustrate the modern theory, which might be put into words such as these: <u>When the rate of fishing effectively governs the average age of a stock of fish, then varying the rate of fishing would control the yield of the fishery</u>.

11. Great benefits of several kinds are therefore obtainable, if the rate of fishing can be controlled, especially when, as often is the case, an intermediate rate of fishing gives the best results.

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