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On the Canadian proposal to restrict fishing effort

by

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The Canadian proposal is based on 2 papers (Pinhorn 1975; Halliday and Doubleday, 1975) which suggest that the stock of total groundfish (excluding silver hake) in sub-areas 2, 3 and 4 is over-exploited. Schaefer models have been used and in the southern regions the argument depends upon a 4% increase in efficiency each year during a period of 20 years, which is a total increase of 80% between 1954 and 1973; in detail the linear approximation of catch-per-effort has been improved with the 4% annual increase in efficiency. From the 2 papers it is concluded that effort should be reduced by 40% in each national fleet independently. This approach raises the following questions:-

1. SHOULD THE STOCKS OF DIFFERENT SPECIES BE LUMPED AS TOTAL GROUNDFISH?

In the Schaefer model, fishing reduces stock linearly from a maximum by the ratio of fishing mortality to the rate of natural increase. If the stocks are lumped we assume that the rates of natural increase are common or if they are not, that there are interactions between the stocks that effectively render them common. If no interaction exists, the rates of natural increase should be the same; otherwise a component of unnecessary variance is introduced.

At the recent ICES symposium at Aarhus on "Changes in the stocks of fish in the North Sea during the sixties", there was much discussion on whether the notable gadoid outburst in the North Sea was generated by the decline in the herring stocks. If there is biological interaction between different species, it is perhaps equally likely between pelagic and demersal species as within the latter group. Hence it would be interesting to see the total groundfish model extended to include not only Silver hake, but the pelagic stocks as well.

2. IS THE ARGUMENT FROM INCREASED EFFICIENCY VALID?

Schaefer assumed that the relationship of catch-per-effort on effort was linear, which may be reasonable over a limited range in fishing effort. It is however a

curvilinear relationship; if effort were increased by an efficiency factor, the component of curvilinearity is decreased and an improved fit would be obtained necessarily. Hence, independent evidence of the considerable increase in efficiency is desirable.

3. IS THE STOCK OF COD IN SUB-AREAS 2 AND 3 OVER-EXPLOITED?

The cod stock is traditionally the most important stock in the ICNAF area. If it is over-exploited the stock is well beyond the MEY (Maximum Economic Yield), but much more important there is a distinct danger of recruitment failure due to heavy fishing. Because the first 2 questions raise doubts about the Canadian thesis, independent evidence of the over-exploitation of the cod stock is needed.

4. WHAT IS OVER-EXPLOITATION?

To raise such a question in a well established Commission may appear impertinent, but with the development of fisheries science, the phrase "maximum sustainable yield" (MSY) has acquired slightly different meanings. "Over-exploitation" is any fishing beyond the maximum however defined or determined, and is not, for example, the reduction in catch/effort as a particularly good yearclass is fished out. There are 3 ways in which the MSY is established:-

a. determine the maximum yield vs fishing mortality from a yield-per-recruit curve. It has the advantage that the full power of cohort analysis can be used and the disadvantage that the danger of recruitment failure due to heavy fishing is ignored.

b. Determine the maximum yield vs fishing intensity from a Schaefer scatter. It has the advantage of simplicity and the disadvantage of high variability. Indeed the data sometimes yield little confidence that the maximum lies where it is supposed to.

c. Determine the maximum yield vs stock from a stock/recruitment relationship. Although 2 methods have been developed for the Arcto-Norwegian cod stock (Cushing, 1973; Garrod, 1973), the basic stock/recruitment relationships have not yet been established for the ICNAF stocks. It is likely that, in fecund species at least, such maxima are found at higher stock levels than those derived from yield-per-recruit curves.

The real danger when using present methods based on the yield-per-recruit curve is that of recruitment failure under the pressure of heavy fishing. There is an urgent need to establish a stock constraint at which recruitment failure is thought to be unlikely.

5. IS EFFORT REGULATION DESIRABLE?

At the Overfishing Convention in 1946, Michael Graham said that effort regulation (by licence) was the best form available primarily because it provided a stable basis within which fishing industries could work. However, since that time, the fleets have become much more mobile and the possibility of stable effort on a given stock may no longer exist.

To the present system of ICNAF regulations, the Canadians propose to add an effort restriction. In cohort analysis, catch quota and fishing mortality are well related because variance due to recruitment is excluded; in the Schaefer model an equally good relationship between catch (or catch-per-effort) and fishing mortality is impossible because the variance due to recruitment is included. A reliable relationship between the 2 systems is probably unlikely and therefore they appear to be incompatible. There are further difficulties; first, if effort is reduced, catch-per-effort will not "retrace" the Schaefer plot of the original expanding fishery because of non-equilibrium effects that are well established in the early stages of the development of any fishery. Secondly, different countries will use their catch and effort restraints in different ways and the incompatibility between them may well introduce biases in the data series. It is likely that the combination of catch and effort regulation will make subsequent scientific analysis very difficult to handle.

The following papers attempt to answer these questions.

QUESTION 1: ON THE GROUPING OF STOCKS

Pope and Harris show that biological interactions may occur between pilchard and anchovy and that an optional ratio might be established although we do not know whether it would be stable. Management regimes that depend on biological interactions might be devised in the future, but those interactions might have to be estimated independently. Pope also shows that if interaction is low, total yield approximates to the sum of individual yields.

Pope shows that there is no evidence of biological interaction between cod and redfish and concludes that individual catch quotas should be adequate.

Horwood assumes a mixed fishery (with no biological interaction) which takes catches in proportion to the abundances of the 2 species. The combined MSY is not necessarily obtained and the mechanics of the Schaefer method change their character, sometimes drastically.

One of the reasons why stocks are grouped is because a catch quota on a by-catch in a mixed fishery may be exhausted before that on the directed catch. From the 3 papers presented here, it can be seen that the science is not developed far enough to

allow quotas to be lumped with confidence. Perhaps in the interim, attention should be directed to the problem of managing species quotas in a mixed fishery in different ways, for example, which is the most sensitive quota? or can the quota be seasonally delayed?

QUESTION 3 : ON THE EXPLOITATION OF THE COD

Pope has used the same catch-per-effort data as Pinhorn for the cod stock and has shown with a Schaefer scatter that it has probably been over-exploited since 1970 and that it was still so in 1973. The important point is that the case is made on the single stock without the use of an efficiency factor.

QUESTION 4 : ON EXPLOITATION

Garrod recommends using the MSY from the yield-per-recruit with a stock constraint [illegible] in order to prevent recruitment being reduced by fishing. The same end can be achieved with a Schaefer scatter, if it is good enough - with the disadvantage that the vital population parameters remain unrevealed.

QUESTION 5 : ON EFFORT REGULATION

Garrod rehearses a number of arguments on the effects of errors in sampling and in procedure on catch and effort regulation and concludes that regulation by catch quota is preferable.

DISCUSSION

The Canadian proposal arises from 3 distinct management problems, that of mixed fisheries, that of recruitment failure under the pressure of fishing and that of the reliability of records.

With a preliminary and perhaps superficial examination of the problems of lumping species within a single quota, individual species quotas appear preferable. This does not mean that species quotas should not be added; if the stocks are relatively secure, an overall quota summed for a group, with a limited overlap in quantity might be a reasonable solution.

The dependence of recruitment on parent stock is the most difficult from the management point of view. Only recently has it been obvious that the very variability of recruitment may mask the decline in yearclass strength that we wish to avoid. Despite its disadvantages, the Schaefer model does provide a safeguard against this dangerous condition. However, the Garrod stock constraint probably provides an equally good safeguard, which allows us to exploit the scientific power of the yield per recruit model and cohort analysis to the fullest degree.

Records of catch, of quota taken, of effort expended or of fish discarded at sea may be variable, unreliable or wrong. Such problems lie in the fields of data collection and enforcement monitoring. The collection of statistics has to be controlled nationally and for obvious reasons internationally; not only should they

be of as high quality as possible, BUT THEY MUST BE SEEN TO BE CORRECT, or the whole basis of quota regulations falls. Similarly if quotas are grossly exceeded or indeed exceeded at all, the enforcement system must be improved to prevent such infractions. Such problems are not solved by adding effort control to catch quota regulations, which makes the science needlessly complex; it is indeed dangerous because fisheries science is not a strong and confident one like physics. Such problems can only be solved in the statistical offices and in the enforcement procedures.

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