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On the management of a capelin fishery

by
Øyvind Ulltang
Institute of Marine Research, Bergen, Norway

Introduction

Very little is known about stock size and sustainable yield of the capelin stocks in the Newfoundland - Labrador area. Therefore some background information on the capelin fishery in the Barents Sea and the experiences gained there might be useful for the discussion of principles for regulation of the developing capelin fishery in the ICNAF area.

This paper is intended as a provisional basis for discussions within the ICNAF Assessment Subcommittee and gives a summary of the history of the capelin fishery in the Barents Sea, of the national Norwegian regulations of this fishery and of the methods used in stock assessment. Further information on these topics is found in papers and reports listed at the end of the paper, particularly in the paper by DRAGESUND, GJØSÆTER and MONSTAD (1973).

The experiences from the Barents Sea are used as a basis for a brief discussion of the management of a capelin stock, taking into account the possible effects of the capelin fishery on other species such as cod.

It should be stressed, however, that the differences between the Barents Sea and the Newfoundland - Labrador area are so great that only cautious comparisons can be made.

The capelin fishery in the Barents Sea

The annual yield of the Norwegian capelin fishery in the Barents Sea has increased gradually from below 100 000 metric tons in the 1950-es

to a level of 1.2 - 1.5 million tons in 1970 - 1973. At present the Barents Sea capelin is the most important resource for the Norwegian purse seine fleet. It is apparent from the history of the fishery that stock strength has fluctuated widely (OLSEN 1965, 1968, DRAGESUND, GJØSÆTER and MONSTAD 1973). Most of the catch has been taken during winter and spring when the mature capelin enter coastal waters to spawn, but since 1968 a summer fishery for capelin has developed on the feeding grounds in the Barents Sea. The catches of Barents Sea capelin in 1952 - 1973 are shown in Fig.1. The steady increase of the total catch since 1965 is correlated with a significantly increased fishing effort, but for a large part the increased catches also may be attributed to a raise in stock size (DRAGESUND, GJØSÆTER and MONSTAD 1973).

The increased effort has caused great attention to the management the fishery in Norway. Minimum size limit and closed areas have been used as means to rectrict the summer fishery to 3 years old and older capelin, i.e. to capelin which will spawn the next winter season. The purpose has been to utilize the growth potential of the young fish. Yield per recruit studies have shown that the yield may be increased considerably by protecting 2 years old and younger capelin (DRAGESUND, MONSTAD and ULLTANG, 1973). In 1973 a quota was introduced for the summer fishery (about 200 000 tons), and in 1974 a quota of about 700 000 tons was set for the winter fishery. In the winter seasons of 1972, 1973 and 1974 spawning areas were closed during the spawning periods.

Estimates of stock size of Barents Sea capelin are available but their precision is probably not very high. They have, however, been of decisive importance for the management of the fishery. Knowledge of the relationship between stock size and recruitment is very limited, but no sign of reduced recruitment due to fishing has been observed so far. Catch quotas for the summer fishery in 1973 and the winter fishery in 1974 were introduced because the 1970 year-class, the main component of the spawning stock in 1974, was known to be relatively small compared to the yearclasses which made the spawning stocks in 1970 - 1973. The 1971 and 1972 year-classes seems to be abundant, and the relatively low production in 1970 was probably caused by environmental factors and not by a too small spawning stock (DRAGESUND, GJØSÆTER and MONSTAD 1973).

VPA-analysis or similar methods are not applicable in stock assessment because of the special biology of capelin. Acoustic surveys in the Barents Sea in summer and autumn now are the main source of data for estimating the size of the spawning stock the next winter season and the relative strength of the younger year-class. At this time 0- and 1-

group capelin are distributed farther south than the older capelin and this separation makes it possible to get the first indication of year-class strength at the 0- and 1-group stage by acoustic surveys.

The acoustic estimates have gradually been improved not only by improvements in the hydroacoustic method but also by the experience accumulated from year to year about the distribution of the capelin at different times of the year.

In addition to acoustic surveys tagging experiments and egg and larvae surveys have been made in order to estimate the spawning stock. It has not yet been possible to put confidence limits on these latter estimates. They may be subject to rather large errors. However, together with the catch statistics and the more subjective observation of the abundance of capelin through the fishing season they have given indications of the order of magnitude of the stock and of changes from year to year. These indications have been useful in judging whether the acoustic estimates were completely out or at about the correct level.

The experience from the Barents Sea shows that it takes several years to get an acoustic estimate of a stock distributed over such a wide area wich is useful for management purposes. With heavy restrictions in the form of catch quotas on a new capelin fishery the number of years needed to assess the stock will increase.

The relationship between capelin and other fish stocks and its consequences for the management of the capelin fishery

In the ICNAF discussions of capelin regulations some consern has been expressed about the effects of a high exploitation of capelin on other fish stocks, especially on the stocks of cod which has capelin as an important food item. No systematic Norwegian investigations have been carried out in the Barents Sea to study such relationships, but some more general comments may be given on the relation between cod and capelin from knowledge about the geographical distribution of capelin and cod through the year and some observations of stomac content in cod.

To some degree cod feed on capelin through most of theyear. Capelin is particularly important for the cod in winter and spring when mature capelin enter coastal waters to spawn. In summer adult cod feed more on other organisms but in late autumn the capelin again becomes of great importance. Young cod feed on capelin more even through the whole year. On an annual basis capelin is the ~~basis~~ major food item both for young and adult cod.

In earlier periods when a substantial stock of Atlanto-Scandian herring still existed in the area cod fed on herring at about the same or at an even higher degree than on capelin through long periods of the year (ZETSEPIN and PETROVA, 1939 [1964]).

No effect has been observed of the capelin fishery on the stock of Arctic cod in the Barents Sea. The cod stock has been at a low level the last years, but this is a result of a high exploitation rate on cod and weak year-classes in 1965 - 1969. The stock is now increasing as a result of the strong 1970 year-class.

Despite the fact that capelin is an important food item for cod no serious effects of the capelin fishery on the cod stock could actually be expected. The main capelin fishery is based on prespawning and spawning congregations and nearly all capelin die after spawning. This means that the fishery takes the capelin away from the cod only for a short period. The capelin fishery therefore can have an adverse effect on the cod stock only if the recruitment of capelin is reduced as a result of a too low escapement for spawning. If mainly prespawning and spawning capelin are exploited the same principle therefore will apply both if the aim is to maximise the yield of the capelin stock regarded as a separate unit or if it is to regulate the fishery for capelin in such a way that no serious effects are expected for cod: the capelin fishery should be regulated is such a way that recruitment is n ot seriously affected. One is back to the old problem of the management of a separate stock, the stock/recruitment relationship.

Above the possible consequences fishing on capelin will have for the cod stocks are discussed. One should, however, also ask what effects the exploitation of cod has on the capelin stocks. If cod is feeding on capelin and the cod stock decreases as a result of exploitation by man, then some surplus production of capelin may be available for fishing.

No estimates have been made of the quantity of capelin consumed annually by other fish stocks in the Barents Sea. For the Newfoundland-Labrador area the annual consumption of capelin is estimated to between 2.2 and 3.7 million tons (CAMPBELL and WINTERS 1973) of which cod take between 1.5 and 3.0 million tons and the seal populations about 0.5 million tons. As pointed out by CAMPBELL and WINTERS (1973), the cod stocks were probably at a substantially higher level in the mid-1950-es, and the harp seal population at that time was about twice the current size. A substantial amount of surpluss production of capelin therefore may have been released by the decline in stock abundance of its major predators. Further reasoning along such lines could give an estimate of the amount of surplus production of capelin available for fishing. There are, however, several complicating

factors. Not only the stocks of capelin and its major predators have changed. Multispecies model may be a help in taking proper account of such factors and regulate the fisheries in a more rational way in the future, but until further studies have been undertaken in this field one has to use the one-species model and make allowances for our present knowledge about relationships between species in our estimates of sustainable yield. The estimate of annual consumption of capelin by its major predators in the Newfoundland - Labrador area and the changes in the predator stocks through the last two or three decades indicates that the TAC of the capelin stock should be substantially higher than the present quota.

Discussion and conclusions

Within ICNAF there is a general agreement that the capelin fishery should be managed by a quota system. At present the MSY of the capelin stocks in the area is not known. The advise on the size of the quota therefore must be based on other critera. One possibility is to try to make an estimate of the probable range of the MSY. This range certainly will be rather wide and the next problem therefore is to choose the level where the quota should be set within this range.

A rough estimate of the range of the MSY could be based on:

(i) Consideration of the annual consumption of capelin by its major predators and the changes in the predator stocks through the last decades.

(ii) Direct observations of capelin in the area, i.e. observations on geographical distribution from acoustic and other surveys and experiences from the capelin fishery.

The consequences both of a too low and a too high quota should be considered when the level of the quota within the range of the MSY is chosen.

Too low quotas of course will give an immediate loss in yield. But there are other consequences: Heavy restrictions on the fishery may increase the number of years needed to get a reasonable precise estimate of the stock. The same problems in giving advise on the quota therefore will recur and the loss in yield will be repeated if the safe low quota is chosen all the time.

Too high quotas, i.e. quotas greater than MSY, in the long run will have serious consequences both for the capelin stock and probably also for some of its predators. How serious the consequences will be depends on how far beyond the MSY the quota is, how many years a too

high quota is agreed on and the way the capelin is exploited. If mostly mature capelin is caught and the stock is overexploited for one year only the result will be one single weak year-class, but if also young capelin is heavily exploited or if the stock is overexploited for several years the adverse effects would be much more serious.

In order to finally get an estimate of stock size it seems necessary to carry out hydroacoustic surveys. A considerable amount of research effort will be needed. One cannot hope to get an estimate with reasonable precission at once such surveys are started. The estimates will improve gradually as more knowledge about the distribution of capelin is accumulated from the surveys and from the fishery and when more experience in the hydroacoustic method itself has been gained.

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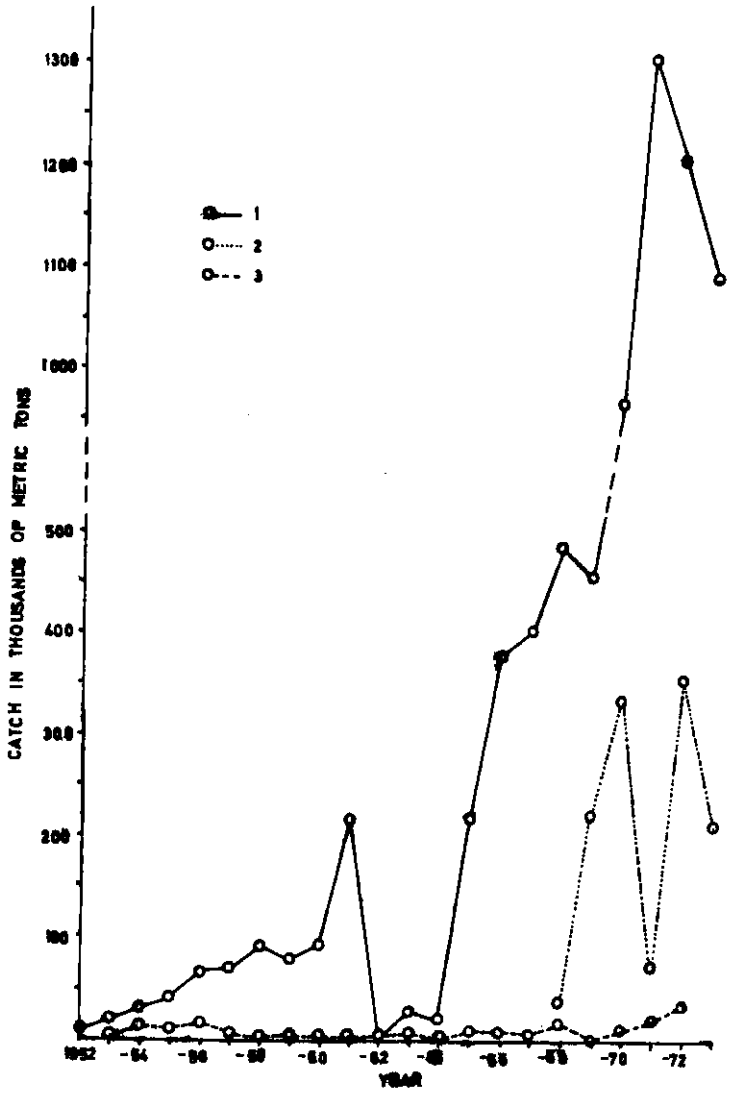

Fig. 1. Catches of Barents Sea capelin in 1952-1973. 1) Norwegian winter fishery, 2) Norwegian summer fishery, 3) Soviet winter- and summer fishery.