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1 INTRODUCTION

The Seventh ICES Dialogue Meeting was held on 28 November 1989 in the Strand Palace Hotel, London. It was co-sponsored by ICES, the North-East Atlantic Fisheries Commission (NEAFC) and the International Baltic Sea Fishery Commission (IBSFC). The main theme of the meeting concerned the biological, economic and social considerations in determining the objectives of fishery management, taking into account the management of shared stocks.

The aim of all Dialogue Meetings has been to promote communication among three groups of people concerned with fisheries management, namely 1) fishery scientists, 2) national and international administrators and 3) members of the fishing industry. Each group was well represented making a balanced discussion possible. Of the approximately 110 participants (from 14 countries), 28% were scientists, 37% were administrators and 35% represented the industry. A list of participants is given in Appendix 1. The meeting was conducted in English but simultaneous interpretation into English, French and Spanish was provided by the Commission of the European Community.

The meeting was chaired by Mr Jakob Jakobsson, President of ICES. Four speakers representing fisheries science, economics, administration and the fishing industry presented papers and led the discussion. The speakers were Dr John Shepherd (MAFF Fisheries Laboratory, Lowestoft), Professor Rögvaldur Hannesson (Norwegian School of Economics and Business Administration, Bergen), Mr Michael Holden (Commission of the European Communities, Brussels) and Mr John Goodlad (Shetland Fishermen's Association, Lerwick). The ICES General Secretary and Statistician acted as rapporteurs. The meeting comprised two sessions, one on Stability and the other on Objectives, with each beginning with presentations from the speakers and ending with open discussion.

Copies of all the papers prepared by the speakers had been circulated to participants prior to the meeting. Copies of reports of the ICES Advisory Committee on Fishery Management (ACFM) for 1989 were available at the meeting together with samples of 1989 ICES assessment working group reports. A list of technical terms and their definitions, which was available at the meeting, is given in Appendix 2.

2 OPENING

The Chairman opened the meeting at 10:00 hrs. After welcoming participants, he continued as follows:

"The first Dialogue Meeting was convened in 1980. At that time it was felt that the exchange of views between scientists, administrators and the fishing industry, which had taken place at the annual meetings of the "old" NEAFC, and which continued to take place in the International Baltic Sea Fishery Commission, had been very necessary. With the changed role of NEAFC, a new forum was badly needed in order to make it possible for scientists, administrators and fishermen to discuss important topics of fishery management, and this resulted in the Dialogue Meetings."
The theme of this meeting is "Biological, economic, and social considerations in determining the objectives of fisheries management, taking into account the management of shared stocks". This has been split into two topics, stability and objectives, and these are similar to two of those discussed at the Sixth Dialogue Meeting. What is new at this meeting is that we are not only discussing this from the biological, industrial and administration points of view, but we have added a new dimension, that of economics.

The Chairman pointed out that this was the first Dialogue Meeting to have been held in conjunction with the "new" NEAFC and then gave the floor to the President of NEAFC, Dr W. Ranke, who welcomed participants and then continued as follows:

"It was the wish of NEAFC to have this Dialogue Meeting on the eve of our annual Commission meeting. There are links between ICES and NEAFC. Under the present Law of the Sea conditions with 200 nm zones, it is the main function of the "new" NEAFC to protect and manage stocks in the international waters (beyond 200 nm) and stocks which straddle the 200 nm zones of contracting parties and international waters. NEAFC relies on ICES for scientific information and advice. The meeting which starts tomorrow will be faced with problems of protection and rational utilisation of the "oceanic-type" redfish stock of the Northeast Atlantic and of the Northern blue whiting. If the Atlanto-Scandinian herring stock appears again in international waters, NEAFC will in the future be faced with regulating this fishery.

I am sure that this Dialogue Meeting will provide us with suggestions and new ideas on how best to manage the resources which NEAFC is responsible for. I wish us all a successful meeting."

3 STABILITY

The Chairman introduced the four main speakers and said that the session on Stability would start with each speaker giving a presentation.

3.1 Fishing Industry Perspective - Mr J.H. Goodlad

"From time to time, the argument has been advanced that, since stability in fisheries management will distort market forces, it is an undesirable objective. It has been argued that the fishing industry is the same as any other form of economic activity where unregulated market forces will eventually result in the most efficient and economic means of production. In this respect, fish stocks should not be regarded as anything other than a resource which can be exploited in order to generate revenue. It, therefore, follows that overfishing in itself is not particularly harmful since, if a stock is overfished, the price of fish will tend to increase so as to compensate for reduced catches. In addition, the overfishing of particular stocks may very well encourage further technological innovations which will lead to the exploitation of new species and new fishing grounds using different types of fishing vessels and fishing gear. In the same way it is argued that the fish processing industry will also adapt to change in a similar way by producing new fish products and devel-
oping new markets. As a result, instability should not be regarded as a problem but rather as the natural order which will provide the necessary incentives for continued technological innovation and improvements in efficiency for the fishing industry as a whole.

Fortunately, this "hands off" argument regarding the question of stability in fisheries management does not have many adherents. The principle flaw in this argument is, of course, the fact that the continued overfishing of any stock may eventually result in stock collapse - a situation whereby there is no economic benefit accruing to anyone from what would otherwise have been a renewable resource. There have been many examples of overfishing and resultant stock collapse with devastating consequences for the fishing industry. The overexploitation of the Atlanto-Scandian and North Sea herring stocks are recent examples of a situation where continued instability eventually resulted in a complete closure of these fisheries.

The bitter experience of the closure of these and other fisheries, together with the realisation that most fish stocks in the North Atlantic are now overexploited, has lead to a greater demand for stability from the fishing industry. As the fishing industry becomes more technologically advanced, with increased capital investment costs, so does the need for stability become more and more essential. In order to convince any lending institution that a loan of several million pounds can be repaid over a specified period of time, a fisherman needs to be able to predict future catch possibilities with some level of accuracy. Given that the repayment of an investment in a new fishing vessel is usually scheduled to take place over at least ten years, it is absolutely essential that fishermen can predict catch possibilities over the next decade. In a similar way, fish processors must be able to estimate the raw material supply situation over a period of several years before investing in plant and equipment to process particular fish products for specific markets. Stability is not only vital for the fish catching and fish processing industries, but is also essential for the continued economic viability of the various ancillary service industries such as boat building and marine engineering. In the fishing industry there are enough imponderables (such as the world price of fish and fish products, variable interest rates, the weather and fickle consumer demand) without having the additional uncertainty of widely varying catch possibilities. A degree of stability in estimating catch opportunities is, therefore, absolutely essential in order that investors may correctly assess investment opportunities in the fishing industry.

Despite the obvious economic necessity of reasonably stable annual catches, the fishing industry appears to be faced with increasing instability in catch opportunities. While there are many examples of instability in annual fish quotas, perhaps the most appropriate example is that of North Sea haddock. Since the Common Fisheries Policy was signed in 1983, the total allowable catch (TAC) for North Sea haddock (which is shared between the EEC and Norway) has been subject to major fluctuations culminating in the dramatic reduction in the 1989 TAC.
The white fish industry in the United Kingdom, and especially in Scotland, is extremely dependent on the haddock fishery. That the North Sea haddock quota should have been reduced to only 68,000 tonnes during the current year (which is a reduction of over 60% from the 1988 TAC) has lead to disbelief and frustration amongst fishermen and fish processors. In no year since the Common Fisheries Policy was signed has the haddock quota ever been exceeded. In other words, the fishing industry has only caught the quantity of North Sea haddock which was recommended by the scientists and administrators. In spite of this, the TAC was slashed by over 60% in one year. The fishing industry simply cannot understand why this should have happened.

The dramatic fluctuation in the North Sea haddock TAC is a classic example of the instability in catch opportunities which the fishing industry desperately needs to avoid. In order to remain economically viable, the fishing industry requires a degree of stability in annual catch opportunities. Stability is not only desirable, it is essential for the future of the fishing industry. Despite this, the fishing industry appears to being asked to operate in an increasingly uncertain and unstable environment.

Perhaps the other speakers can explain why the desirable and essential objective of stability appears so difficult to achieve.

3.2 Fisheries Biology Perspective - Dr J.G. Shepherd

"Everybody agrees that stability in fisheries would be a good thing. Fish processors would like constant supplies, and the fishermen would like constant catches (or possibly constant earnings) so that they can plan their investments in new boats, and not get caught out on the loan repayments. The administrators would like the same TACs from year to year so that they can just use last year’s deal again this year, without re-negotiating everything, and the scientists would like the stocks to stay put for a while so that they have a better chance of figuring out what is really going on.

Unfortunately, nobody has told the fish what they are supposed to do, and most of the stocks in the North Atlantic fluctuate enormously, mostly because the number of young fish recruiting to the stocks each year is very variable indeed. This is because only a tiny fraction of one percent of the eggs spawned each year survive the first year of life. Any slight change in that enormous death rate means a big change in the final numbers of survivors. The fluctuations are believed to be due to subtle changes in the weather and currents at certain times of the year. They do not
seem to have much to do with how many bigger fish there are to produce the little ones, or indeed to eat them up. They certainly are not due to anything very obvious, or someone would have figured it out long ago. There are still a lot of people trying to find out what causes these fluctuations, but do not hold your breath while you are waiting for the answer.

You can see the sort of thing which happens in Figure 1. This shows the number of young haddock recruiting to the North Sea stock from 1960 up to 1987. The number varies wildly from year to year; quite often it is more than double, or less than half, the average, and every now and then there is a real ringer - the enormous 1967 year class, for example, or the tiny one of 1987 - the smallest on record, the one that has led to the scarcity of haddock in the North Sea right now. Haddock stocks often exhibit more variation than most other stocks, but the North-East Arctic cod provides another example (Figure 2). Here there are also big fluctuations in recruitment, but they seem to be a bit more systematic. The number of young fish seems to go in cycles, with a period of 6 or 7 years. We do not know the reasons for this cyclic behaviour, but it certainly seems to be there. In both cases, there also seem to be some long-term changes, with good recruitment before 1975, and not so good since then.

Now, what are the consequences of these variations of recruitment?

First, they mean that the stock size varies - and if the death rate of the fish is high, so that there are few older fish, then the stock size may vary a lot. This is just like putting money in the bank; if you pay in highly variable amounts each month, but take out and spend half of what is there every month, you would not expect your total balance to stay constant. If, on the other hand, you only take out 10% each month, you will accumulate something like a year's worth of money. And with a nice big balance like that, you would not notice the effects of the variability of the monthly amounts nearly so much.

Exactly the same is true for fish stocks - except that fish usually take a few years to grow up and join the fishable stock, so there is a time lag involved.

Figure 3 shows what the fishable stock of haddock would have been with a moderate death rate from fishing of 30% per year over the period 1960-1989, based on the recruitment figures you saw before. You can see that it varies quite a lot - not so much as the recruitment, because even with this death rate there are still several year classes contributing to the stock at any time. But it is a long way from being constant.

With a lower death rate, you would have a much bigger stock, and much smaller fluctuations. If you really wanted maximum stability for the stock, the best you could achieve, with no fishing at all, so that deaths are due to natural causes only, is shown in Figure 4.
**North Sea Haddock**

Figure 1 North Sea Haddock recruitment (thousand million at age 0) for 1960-1988.

**North-East Arctic Cod**

Figure 2 North-East Arctic cod recruitment (millions at age 3) for 1946-1988.
Figure 3 Stock biomass (t x 10^{-4}) of North Sea haddock if fishing had removed 30% per year (F = 0.4) during the last 30 years.

Figure 4 A comparison of the stock biomass of North Sea haddock (t x 10^{-4}) assuming an exploitation rate of 30% (F = 0; crosses) during the last 30 years.
It is still quite variable over long periods, though the year-to-year fluctuations are quite small - and that is with no fishing. The first picture for a 30% death rate is closer to the real situation - in fact recently the death rate has been even higher than that, near 70%, and the effect on the stock is shown in Figure 5. The fluctuations are severe, and the stock crashes to very small levels in bad years - just because the death rate is so high.

Well - so what if the stock size does fluctuate? That is tough for the fish, but should we care? Unfortunately, yes, for demersal (bottom-living) fish at any rate. The fisherman's catch rate, in boxes per tow or whatever, is roughly proportional to the stock size. So a variable stock means variable catch rates, and that means variable earnings, with good years and bad years - a situation with which any fisherman will be only too familiar. This was always the situation, long before TACs were implemented under the Common Fisheries Policy, and it will stay that way.

Let us see what this means for catches and TACs. Figure 6 shows what the catch would have been over the last 30 years if we had fished at the current very high rate for the whole time. This is also what the TACs would have been if we had had them that far back, assuming we had adopted a constant effort strategy. You can see that it is very much boom and bust, with big variations from one year to the next. With a fairly low level of fishing, taking 30% of the stock each year, the TACs would be as shown in Figure 7 - lower in the boom years (when there could well be marketing problems anyway), a bit better in the bad years (though you cannot buck the long-term trend for long), but not crashing up and down nearly so violently.

Unfortunately, that level of fishing corresponds to a massive 70% cut in fishing effort, and would be very difficult and very painful to achieve, even if spread over many years. More realistically, we can see what would happen with a 40% cut in effort - still painful, but probably achievable over two or three years, given the will to do it. This would lead to TACs like those of Figure 8. Here the good years are a bit better, and the bad ones no worse. It is a useful improvement on the present position, anyway, even though this year would still be the worst on record. Two really poor year classes in a row is still enough to cause a lot of trouble. At the end of the day, everything still depends on the recruitment, and that is something we still cannot forecast before it happens, let alone control. We can only observe it in our surveys as soon as we can, and base our forecasts and advice on those estimates.

This is the main cause of varying catches, and varying TACs. It is not due to mistakes by scientists, or cock-ups by politicians - though there are a few of those, of course. The main cause is simply mother nature, aided and abetted by all of us - scientists, politicians, administrators, and fishermen - because between us we have let the fishing pressure get too high, and made the situation worse.
Figure 5  A comparison of the stock biomass of North Sea haddock ($t \times 10^{-3}$) assuming an exploitation rate of 70% ($F = 1.2$; triangles) with that assuming no fishing at all ($F = 0$; crosses) during the last 30 years.

Figure 6 Yield ($t \times 10^{-4}$) of North Sea haddock during the last thirty years if the exploitation rate had been constant at 70% per year ($F = 1.2$).
Figure 7 Yield ($t \times 10^{-4}$) of North Sea haddock during the last thirty years if the exploitation rate had been constant at 30% per year ($F = 0.4$).

Figure 8 Yield ($t \times 10^{-4}$) of North Sea haddock during the last thirty years if the exploitation rate had been constant at 50% per year ($F = 0.7$).
Well - suppose we could get the fishing pressure down a bit. That would reduce the fluctuations, but they would still be there - still big enough to give us TACs that varied up and down by something like 30% or 40% each year, even if fishing effort were held constant. Do you want catches that are more stable than that from year to year? If so, there are only two ways - reduce the fishing pressure even further - and that means fewer fishermen and fewer boats - and keep it that way, or vary the fishing effort, with short seasons or fewer trips in one year and more in the next. That is certainly possible, but be warned - the changes of effort needed are big - even bigger than the variations of catch if you keep the fishing effort constant. And you will be fishing flat out to try to take the quotas in a bad year, and forced to tie up in port when the stock is high and the fishing is good. That is what constant catches and constant TACs mean in reality. If you really want that, the managers can arrange it - but I do not really think you do. I think you want constant catches and constant effort - and you cannot have that. It is not on offer: not because the scientists and politicians and managers do not care, but because mother nature does not work that way.

In fact, we have recently done some fancy sums in collaboration with some control engineers at Oxford University, to see what you would have to do if you really wanted to minimise variations of both catch and effort at the same time. The answer is pretty obvious when you think about it. If the stock is in good shape, with low fishing pressure, you can reduce fishing effort when you get good recruitment, and still get better catches. When recruitment is poor, you have to increase the fishing effort to try to keep the catches up, in an attempt to 'fill in the troughs' in the bad years. That means you let the stock take the strain - you fish it down even further when it is depressed. That is obviously a pretty dangerous strategy, and in fact is only viable when the fishing pressure is low. When it is high - and it is very high for most stocks in the Northeast Atlantic - it turns out that the best you can do is to keep fishing effort constant, and hope for the best. And that is pretty much the basis on which most TACs have been set for the last few years. If we could get the fishing pressure down - especially on young immature fish - by a significant amount, something like a 30% reduction as a minimum, then we would have more room for manoeuvre. Until then, there is no point in trying to be clever - we just have to try to reduce fishing effort, ride with the natural fluctuations, and hope for the best. If we have to ride this roller-coaster, we should at least make sure we have got the brakes on."

3.3 Fisheries Administration Perspective

"The demand for stability by the fishing industry is of very recent origin. It has arisen only since it was possible to predict catch possibilities. In the past, catches fluctuated from one year to the next (Table 1) but, because it was not possible to make catch predictions, these fluctuations were accepted as one of the hazards of fishing. Now that it is possible to make catch

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1 The views expressed in this paper are those of the author. They represent the view of “an administrator” in the context of the Seventh ICES Dialogue Meeting.
predictions, fishermen expect stable catch possibilities which are seen as essential for long-term planning. Administrators are continually confronted with the demand from the fishing industry for "stability". It is considered "unacceptable" that catches should fluctuate markedly from one year to the next.

<table>
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<tr>
<th>Year</th>
<th>Plaice</th>
<th>Sole</th>
<th>Haddock</th>
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<tbody>
<tr>
<td>1974</td>
<td>-13</td>
<td>-7</td>
<td>+4</td>
</tr>
<tr>
<td>1975</td>
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<tr>
<td>1976</td>
<td>-1</td>
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<td>1978</td>
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<td>+16</td>
<td>+8</td>
<td>-5</td>
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<tr>
<td>1980</td>
<td>-6</td>
<td>+39</td>
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<td>-6</td>
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</tr>
<tr>
<td>1982</td>
<td>+18</td>
<td>+45</td>
<td>+31</td>
</tr>
<tr>
<td>1983</td>
<td>-9</td>
<td>-7</td>
<td>-6</td>
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The irony of the present situation is that the general basis now for fixing TACs is to obtain stability, stability of fishing effort. But with fluctuating recruitment and heavily overexploited stocks, this automatically generates fluctuating TACs. As this is the element with which the fishing industry expresses its extreme dissatisfaction, it is the problem of fluctuating catches which is considered in this paper.

In order to start a dialogue about stability, it is essential that both administrators and the fishing industry understand the basic dynamics of the resources on which fishing depends. These were discussed at the last, Sixth Dialogue Meeting, but that we are discussing the same topic at this Seventh Dialogue Meeting shows that there still exists a lack of understanding. However, I hope that Dr Shepherd's paper has now made clear the message which is that year-to-year fluctuations in catch possibilities are "not due to mistakes by scientists or cock-up by politicians" (or administrators, for that matter), but that "the main cause is simply mother nature". Variation in fisheries is something which is unavoidable. As Dr Shepherd explains, we can take actions which will minimise these naturally-induced variations. But we can also take actions which will maximise it. Unfortunately we always seem to do the latter.

The critical problem facing fisheries management today in the Northeast Atlantic and the Baltic Sea is that almost all the fish stocks are overfished, many of them heavily overfished. If we want stability, then, as Dr Shepherd shows, we need to fish less. This almost certainly means earning less money today in the expectation of earning more tomorrow. However, the fisherman has
financially to survive today in order to be fishing tomorrow. Faced with the problem of paying off the capital costs of a modern up-to-date vessel plus interest charges - and banks require that these payments are made "today" and not "tomorrow" - plus meeting running costs as well as making sufficient profit to cover wages and depreciation, every fisherman wants the maximum income today.

This results in a ratchet effect. When the scientific advice permits a TAC to be increased, the fishing industry invariably exerts pressure for the highest possible TAC to be fixed. Stability is not mentioned in these circumstances.

On the contrary, when the scientific advice is that a TAC should be fixed at a lower level than the previous year, stability is invoked and every effort made to make the reduction as small as possible. Within the EC, it is often argued that the reduction in any TAC from one year to the next should not be bigger than 10%.

In this situation, a frequent outcome of the negotiations which take place is that a TAC is fixed which is impossible to catch. With no limit on fishing, the stock becomes more heavily exploited and, unless there is good recruitment, the catch possibilities advised for the next year are even lower and the vicious circle becomes even more vicious.

If recruitment is good, the TAC is fixed at the maximum level which corresponds with the latest high level of the fishing mortality rate, not with the lower rate which previously existed. Fishing rates always increase. Instability always gets worse.

How do we break this vicious circle? As Dr Shepherd shows, fishing effort, particularly on juvenile fish, must be reduced.

In theory, reducing fishing effort on juvenile fish is simple; we simply increase the mesh size. In practice, this is administratively very difficult. Most fisheries, particularly those for bottom-living species, catch several species and the mesh size is a compromise. So, in the North Sea, we should be using mesh sizes of 140-150 mm for cod and plaice. But fishermen are unable to catch only cod and plaice and no other species. Consequently, 90 mm is the standard minimum mesh size in the EC sector of the North Sea because we also need to catch haddock and whiting which form a very important part of the catches. When fishing for sole, it is permitted to use an even smaller mesh size, 80 mm from 1 April to 31 December. It is necessary to have a minimum percentage of sole in the landings to meet the definition of "fishing for sole", but because sole is so valuable, this is only 15%.

However, even when regulations exist, they are often circumvented either illegally or legally. Enforcement at sea is expensive and, therefore, the rate of inspection is low. As the probability of getting caught is low and the short-term economic benefit to be

\footnote{This approach appears to be a perverse interpretation of earlier advice of ACFM that fishing mortality rates on overexploited stocks should be reduced by 10% a year until $F_{\text{max}}$ was achieved.}
gained high in comparison with any fines incurred, fishermen use illegal measures if they consider that the economic necessities described earlier justify their use. However, the benefits are short term and contribute to the absence of stability.

Additionally, there are a large number of gear developments which have occurred and which have resulted in a much larger proportion of juvenile fish being retained. Legislation, at least in the EC, has yet to catch up with these developments. Not only is it difficult to legislate in this area because it means drafting legislation which describes fishing gear in a legally enforceable manner, a difficult administrative problem, but each fisherman sees his particular gear construction as essential to his method of catching fish and, therefore, applies political pressure for its use to be permitted. As already noted, if all these hurdles are overcome, the legislation still has to be enforced to be effective.

However, should this be primarily an administrative problem? Every fisherman must be aware when he is discarding large quantities of juvenile fish that he is in a much better position than any administrator to know what he should do to stop catching them. The fishing industry should take its responsibilities in this area. Some fishermen do, by using mesh sizes much larger than those specified in the legislation. Unfortunately, they are in a minority.

Concerning reducing fishing effort in general, if there were fewer fishing vessels, fishing effort should be less; it is necessary to qualify this because if the remaining vessels become more efficient, fishing effort will remain the same or increase. Within the EC, phased reductions in the fleets are being implemented, but the pace of reduction is slow. This is not surprising, because reductions in fleet size have serious social and economic consequences for the ports and all those dependent upon fishing, especially as fishing is often centered in regions which are socially deprived and in which there are few, if any, alternative forms of employment.

It was essentially because these problems could not be resolved - and in the period before the general extension of fishery limits to 200 miles, it was impossible practically to limit fishing effort - that the system of TACs was developed. It is worth remembering, because it seems to have been forgotten, that the objective of TACs is to limit fishing effort indirectly. Their basis is that, if the scientists have enough information about the stock, they can predict catches which correspond to different rates of fishing mortality. So, turning the equations around, if a TAC is agreed which corresponds with a certain rate of fishing, and the TAC is enforced, that rate of fishing will be achieved.

The key phrase in this is "and the TAC is enforced". Administratively, there are many ways of enforcing the TAC. It is possible simply to allow all fishermen to fish until the TAC is exhausted and then stop fishing until 1 January next year. When the TAC will be fully caught will depend upon whether the TAC was designed to reduce fishing effort a lot, only a little, or not at all. If it was designed to reduce it a lot, the TAC will be exhausted early in the year. This is disastrous for catchers and
processors alike. To avoid this, administrative measures are often taken to limit catches by boat or by number of crew members or to limit the number of days which each vessel may fish each year.

However, for the economic reasons described earlier, fishermen are becoming less and less willing to accept limitations on their freedom to catch fish. "The fish are there, why am I not allowed to catch them?" is an increasingly common cry. To allow it means to allow unrestricted fishing. Unrestricted fishing means instability.

Dr Shepherd indicates that we have got ourselves into such a serious crisis that we have no alternative but to "ride the natural fluctuations and hope for the best". He may be correct, but this appears to be a counsel of despair, because if we get the worst, such as, for example, the collapse of the North Sea stock of haddock, it will not be possible to recover it by prohibiting fishing as for North Sea herring because so much haddock will inevitably be caught when fishing for other species. Is one way out to try to use above-average year classes to rebuild the stock, in other words, when the level of recruitment would permit an increase in TAC, not to increase it? Experience suggests that it is unlikely to work, but the alternative sequence of events is potentially so disastrous that it may be worth trying. Of course, this would mean accepting not to catch the fish "because they are there" or "high-grading", keeping only the largest and most valuable fish, discarding the rest.

However, not all the stocks in the Northeast Atlantic are overexploited. One of these is the stock of Northern blue whiting whose management is of particular interest to NEAFC because it is highly migratory, part of the stock occurring in international waters where NEAFC has responsibility for management.

Paradoxically for this stock, it seems that we may generate instability by following the scientific advice. The advice given by ICES for this stock for 1989 was that ACFM prefers that the fishing mortality rate should be reduced to the F0.1 level, "the reason being that, at present levels of fishing mortality, it is expected that the spawning stock will decrease as a result of relatively low recruitment levels. This trend is not likely to be reversed until stronger year classes recruit to the stock. The recommended level of fishing mortality for 1989 is based on the need to prevent a rapid decrease in spawning stock if recruitment continues at its recent level".

Implicit in this advice appears to be the assumption of a stock and recruitment relationship. Yet, as Dr Shepherd notes, nobody has yet found out what causes fluctuations in recruitment, and there is certainly no evidence that they are related to the size of the spawning stock, especially when this is very large; the spawning stock biomass of the Northern blue whiting stock is currently four million tonnes!
The information given for this stock by ACFM in its report for 1988, reproduced as Figure 9 of this paper, shows that if ICES continues to advise $F_{0.1}$ as the management objective in future years and their advice were followed, variability in catches from this stock would be guaranteed.

Figure 9 shows that recruitment to the stock has varied by a factor of eight over the period 1979-1987 and that the size of the spawning stock biomass lags behind recruitment by about nine years. The present decline in stock size reflects a fall in recruitment since 1970, but the 1982 and 1983 year classes are very large so it can be expected that catch possibilities will start to increase within the next few years. If an $F_{0.1}$ management objective were followed, the possible TAC would increase, probably quite considerably. The 1984-1987 year classes have been comparatively small, so this increase in catch possibilities in 1991-1993 would be followed by a subsequent decrease. As it can confidently be expected that the "ratchet effect" described earlier would operate, TACs, if agreed, would be fixed higher than those corresponding with $F_{0.1}$, the stock would become overexploited and a cycle of overexploitation with its associated instability initiated.

Using the data on yield per recruit and average recruitment given by ICES, it is possible to calculate the average long-term catch for a reasonable rate of fishing; it is around 800,000 t, depending upon the actual rate chosen. But, as we are concerned with the principle, the actual figure is not important. If 800,000 t, or whatever the TAC selected, were fixed as the TAC for 5 years, the fishing mortality rate would fluctuate inversely with recruitment. Fishing is mainly by pelagic trawling and catches of other species are uncommon, so there would be few complications in carrying out a directed fishery which could be stopped once the TAC had been caught. The stock is very large, six million tonnes, of which 4 million tonnes consist of mature fish, so the risks of this strategy are minimal. "If recruitment continues at its recent level", as ACFM pessimistically assumes for the basis of its advice, it would still be possible to revise the long-term TAC to a lower level before too much damage were done to the stock. Whether that chance would be taken is, of course, another question.

As an administrator I would ask, is this not a case "where you let the stock take the strain", to use Dr Shepherd's phrase?

Administrators cannot bring about stability. Their role is to help develop policy. At the end of the day, it is the politicians who take the decisions. To a large extent, these decisions will reflect the views of the fishing industry. If the industry wants stability then it must decide what sacrifices it is prepared to make to obtain stability or, rather, greater stability than we experience at present. If the answer is "no sacrifice at all", then we shall experience even greater instability than we have done to date. Or perhaps I should rephrase that and say that we shall eventually obtain total stability, the total stability of no fishing whatsoever because one or more stocks have collapsed and fishing on them has had to be prohibited. Remember North Sea herring!
Figure 9  Stock summary plots for Northern blue whiting (Figure 6.2.1 in 1988 ACFM report).

FISH STOCK SUMMARY
STOCK: Blue Whiting - Northern Area
19-10-1988

Trends in yield and fishing mortality (F)

Yield  ---- F

Trends in spawning stock biomass (SSB) and recruitment (R)

SSB  ---- R

Recruitment at age 0 (no. in millions)

Recruitment year class, SSB year
Figure 9 cont'd

FISH STOCK SUMMARY
STOCK: Blue Whiting – Northern Area
19–10–1988

Long-term yield and spawning stock biomass

Short-term yield and spawning stock biomass

Average fishing mortality (ages 4-8, u)

Yield per recruit (kg)

SSB per recruit (kg) at 1 January

Average fishing mortality (ages 4-8, u)

Yield in 1989 ('000 tonnes)

Yield in 1990 ('000 tonnes)

SSB in 1990 ('000 tonnes) at 1 January
3.4 Fisheries Economics Perspective - Prof. R. Hannesson

"The previous speakers have explained various aspects of the stability of annual catch quotas, why they might be desirable, and whether they are at all possible to achieve. In this presentation, I will be concerned with the economic aspects of stable TACs. Would stable TACs improve the profitability of the fishing industry? Could the answer possibly depend on the particular circumstances in each fishery?

To focus on the main issues, let us compare two stylized TAC strategies:

**Strategy 1:** The TAC is always a constant proportion of the fishable stock.

**Strategy 2:** The TAC is constant from year to year and equal to the average catch otherwise obtained under strategy 1.

The first strategy is equivalent to setting the TAC on the basis of a constant fishing mortality, as seems to be the basic philosophy behind the advice that ICES currently provides.

Let us now compare the profitability of these two strategies. In order to do so, we must specify the relationship between catch and fishing effort. We shall look at two specific cases:

A: The catch is proportional to the size of the exploited stock.

B: The catch per unit of effort is proportional to the size of the exploited stock.

Both of these assumptions are quite special but useful, I believe, to put things in perspective. Assumption A is probably not too far off the mark for pelagic fish such as capelin or herring, while assumption B is frequently made for demersal stocks.

Figure 10 compares the profitability of the two TAC strategies when the catch is proportional to fishing effort and independent of the stock. The curves show the revenue and cost of catching a certain fraction of the stock, and the profit of this policy. The shape of these curves is quite crucial for the argument to follow. The revenue curve will typically be shaped this way if the price of fish falls as more fish are landed, but will be linear if the price of fish is independent of the amount caught. The shape of the cost curve implies that the cost per unit of effort rises as more effort is applied, but it would be linear if the cost per unit of effort is constant. The profit curve shows the difference between revenue and cost, and it would be linear and upward sloping if the revenue and cost curves are both linear and the revenue exceeds the cost.

Suppose that the stock can be large or small, with equal probability. If we always catch a given fraction of the stock, the catch will also be either large or small. These catch levels are shown by Y2 and Y1 in the figure. The average, or expected, catch is half way in between, at the point EY. The profit obtained in each case can be read off the profit curve at the points A and B,
but the average or expected profit is given by the point on the straight line between these points directly above EY.

Now suppose that the catch is stabilized at the level equal to the average catch. The profit of this stable catch would clearly be greater than the average profit of the variable catch, as the profit curve lies above the straight line between the points A and B. Only if the cost and revenue curves were linear, and hence the profit curve linear as well, would stable and unstable catches provide the same profit on the average.

Let us now look at assumption B, when the catch per unit of effort is proportional to the size of the exploited stock.

The catch will then vary in proportion to the size of the fish stock and the effort applied, as in Equation (1):

\[(1) \ Y = ZS,\]

where \(Y\) is catch, \(S\) is the stock, and \(Z\) is fishing effort. The effort is, for convenience, defined as the proportion fished from the stock.

In this case, it is not possible to stabilize both catch and fishing effort simultaneously, unless the size of the fish stock itself happens to be stable as well. If we maintain a stable catch, then the effort needed to take it will vary inversely with the stock. If, on the other hand, we always take a constant proportion of the stock, then the effort will be stable while the catch will vary with the stock.

We can use Equation (1) to define precisely the two TAC strategies mentioned at the beginning. This is done in Equations (2) and (3):

**Strategy 1:**

\[(2a) \ Y = Z^*S\]
\[(2b) \ EY = Z^*ES\]

**Strategy 2:**

\[(3a) \ Y^* = EY\]
\[(3b) \ Z = Y^*/S\]
\[(3c) \ EZ = Y^*E(1/S)\].

The asterisks indicate that the variable is kept constant.

The meaning of these equations is as follows. Equation (2a) tells us that if we always take a constant proportion of the stock, then the catch will be equal to that proportion multiplied by the actual size of the stock. Equation (2b) then tells us that the average (expected) catch will be equal to the constant proportion that is taken from the stock multiplied by the average (expected) size of the stock.
Moving to Strategy 2, Equation (3a) tells us that the constant catch is, by assumption, equal to the average catch taken under Strategy 1. Equation (3b) shows that the effort we then need to apply is equal to the constant catch divided by the actual size of the stock. Equation (3c) tells us that the average (expected) effort that we must apply under this strategy is equal to the constant catch multiplied by the average (expected) value of the inverted size of the stock.

We can use these equations to derive a result that will prove useful later, namely that the constant effort applied under Strategy 1 is less than the average effort applied under Strategy 2. Since $1/S$ is a convex function, $E(1/S) > 1/ES$, and hence $EZ > Z$. This is illustrated in Figure 11 for two stock levels, $S_1$ and $S_2$, that can occur with equal probability.

Now let us compare the profitability of the two strategies. The average annual profit of the two strategies is given by Equations (4) and (5):

**Strategy 1:**

\[ EP_1 = ER(Y) - C(Z)^* \]

**Strategy 2:**

\[ EP_2 = R(Y^*) - EC(Z) \]

Because the fixed TAC, or $Y^*$, is equal to the average catch in Strategy 1 [by Equation (2a)], it is likely that the revenue in Strategy 2 will be greater than the average revenue in Strategy 1, by the same argument as used in connection with Figure 10. This by itself will make Strategy 2, constant TAC, more profitable than Strategy 1.

This result may be reversed when we consider the cost, because the average annual cost of taking a constant catch will be greater than the annual cost of catching a constant fraction of the stock with fixed effort. There are two reasons for this. First, the cost of effort is likely to rise progressively. This makes the average cost of variable effort higher than the constant cost of a fixed effort that is equal to the average effort. Secondly, the average effort needed to take the constant catch is greater than the fixed effort needed to take a fixed proportion of the stock, as demonstrated above.

It is time now to summarize the results so far. What we have seen is that the constant TAC strategy gives the highest profit when the catch per unit of effort is constant and independent of the stock. In this case we are in the fortunate circumstance to be able to stabilize both catch and effort at the same time.

When, on the other hand, the catch per unit of effort depends on the size of the stock, the result is less clear. In this case, stability of catches means instability of fishing effort and vice versa. Which kind of stability is to be preferred is a matter for careful calculation. The best TAC policy might in fact mean stabilization of neither, but some instability of both.
Figure 10  Cost (C), revenue (R) and profit (H) as functions of exploitation rate (x) in terms of fraction of stock caught, assuming catch is proportional to fishing effort and independent of stock size.

Figure 11  Relationship between stock size (S) and its reciprocal (E represents expected values). For further explanation see text.
How much of a difference might it make which of the two TAC strategies were followed? In order to gain some insights into this, I have simulated a stylized model of the North-East Arctic cod. The fluctuations in the stock were generated by letting the recruitment to the stock follow a regular 8-year cycle generated by a sinus curve. I then searched for the fixed fishing mortality and fixed annual catch that maximized the average annual profit over one recruitment cycle, after the stock had settled down to a dynamic equilibrium. The figures in Table 2 show the average annual profit of these two strategies under various assumptions about price of fish and cost of effort. In all these cases, it is assumed that fishing mortality is proportional to effort.

TABLE 2
Arcto-Norwegian cod
Annual profit of TAC strategies under various assumptions
(′000 metric tonnes)

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Constant F</th>
<th>Constant TAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Constant price of fish and constant unit cost of effort</td>
<td>341.1</td>
<td>334.5</td>
</tr>
<tr>
<td>2. Price depends on catch, constant unit cost of effort</td>
<td>329.0</td>
<td>334.5</td>
</tr>
<tr>
<td>3. Price depends on catch, unit cost of effort depends on effort</td>
<td>329.0</td>
<td>323.0</td>
</tr>
<tr>
<td>4. Constant price of fish, costless effort</td>
<td>1,013.0</td>
<td>1,018.0</td>
</tr>
</tbody>
</table>

For a detailed discussion, see R. Hannesson and S.I. Steinshamn: "How to set catch quotas: constant effort or constant catch?", forthcoming in the Journal of Environmental Economics and Management.

The difference between the two strategies in terms of profitability is not very great, and agrees fully with the theoretical results above. In the first case, the price of fish and cost of effort are constant. Both strategies would then be equally profitable, if it were not so that the average effort needed to take the constant TAC is greater than the effort needed to take the variable TAC and hence more costly. In the second case, the price of fish falls as landings increase, which makes a constant TAC more profitable. In the third case, the cost per unit of effort increases as effort is increased beyond a certain point, and the result is reversed.

The fourth case merits a special comment. Here the cost is zero, so the figures represent the maximum average annual quantity that could be taken from the stock. It turns out that a constant TAC would be slightly greater than the average catch produced by a
constant effort and fishing mortality. This is similar to a re­
result once obtained by Pope\(^1\), who demonstrated that varying the 
fishing mortality in a stock with variable recruitment could pro­
duce a larger average catch than a constant fishing mortality 
would do.

What about the feasibility of the constant TAC strategy? Would it 
be at all possible, in the face of the substantial fluctuations 
in recruitment? In most of the simulations that I did, the fish­
ing mortality turned out to be quite low, typically of the order 
of 0.1. This means that the standing stock is quite large and 
composed of many year classes of a substantial size. This evens 
out the fluctuations in recruitment. I kept special track of the 
spawning stock, which one might fear would suffer from a constant 
TAC policy. After all, a constant TAC policy means that the stock 
is being fished most intensively when it is at its lowest. The 
simulations showed that the minimum spawning stock was not much 
less under the constant TAC policy than under a constant fishing 
mortality policy; there were even cases in which the reverse was 
true.

How valid are these results with respect to other fish stocks in 
the Northeast Atlantic? Many of these stocks are also multi-year 
class stocks characterized by fluctuating recruitment. For some 
stocks at least, these fluctuations seem to be considerably 
smaller than the case is for the North-East Arctic cod. A stable 
TAC policy is even more likely to be feasible if the fluctuations 
in the stock are small, but the possible advantage of this policy 
also becomes less. My attention has been drawn to the management 
of the Icelandic herring stock. This management is, to some ex­
tent, similar to a stable TAC policy. Between 1979 and 1985, the 
catches from this stock fluctuated between 40,000 and 60,000 
tonnes, and the fishing mortality was moderate, or of the order 
of 0.2 - 0.3. This made it possible to rebuild the stock, and the 
catches have now been increased to 90,000 tonnes per year.

As a final conclusion, I will say that the profitability of the 
fishing industry does not seem to depend critically on the stab­
ility of catches. The difference, in terms of profit, between 
letting the catches vary with the stock and taking a constant 
catch is not very great. One way of interpreting this, however, 
is to say that the cost of stabilizing catches, if that is de­
sired in itself, is not very high. There are, of course, valid 
arguments for such stability, even if the lack of it does not 
show up in profit figures. On the other hand, we must recognize 
that stability of catches is likely to mean destabilizing the 
operations of the fishing fleet. It is, therefore, not entirely 
clear where the argument for stability for its own sake really 
leads."

\(^{1}\)Pope, J.G. 1973. An investigation into the effects of variable 
rates of the exploitation of fishery resources. Mathematical 
Theory of the Dynamics of Biological Populations (Eds. M.S 
3.5 Discussion

The Chairman opened the floor for discussion.

Dr J. Gulland (Imperial College, London) pointed out that, unlike money in a bank (the analogy used by Dr Shepherd), fish can waste away if left alone because of natural mortality. On the other hand, if fishing mortality is reduced on young fish, the catch foregone could be exceeded by increased yields in later years because young fish grow quickly; in the bank analogy this would be equivalent to a good interest rate. He also took up a point made by Mr Holden concerning fishermen always looking for higher TACs, even when stocks are known to be overfished. This is inevitable as long as management plans are made only for one year ahead; if plans were agreed for longer periods, the industry may take a different stance.

Mr W. Hay (Scottish Fishermen's Federation) said that his organisation has never argued to have TACs increased. When he asked scientists why it was proposed to increase the North Sea haddock TAC in 1988, he was told that the stock was in good shape. The following year there was a TAC cut of over 60%. It was the scientists who "argued the TAC up", not the industry.

Dr Shepherd agreed with Dr Gulland with regard to leaving small fish in the sea when recruitment is strong, so as to obtain better yields in later years. This should be done now for North Sea sole which is experiencing very good recruitment, although it will be a difficult decision. In reply to Mr W. Hay, he said that scientists had no way of predicting for the haddock stock that there would be three poor year classes in a row.

Dr P. Hillis (Fisheries Research Centre, Dublin) suggested that individual transferable quotas would provide a much improved means of managing by TACs because it would dispense with the "race for fish" and allow fishermen to take their catches when it best suited them.

Mr A. Holm (Directorate of Fisheries, Bergen) questioned whether fishermen really would prefer a constant catch management regime when they would have to vary their effort from year to year, although he accepted that processors would. It would be hazardous to let an over-exploited stock "take the strain", and anyway Prof. Hannesson had shown, at least for North-East Arctic cod, that profitability would not improve with a constant catch policy.

Mr J. West (Scottish Pelagic Fishermen's Association) made a plea for more input from fishermen to be provided for in the assessment and management process. He believed that scientists tend to be isolated from the "real world" in which fishermen work and more input from the industry could be helpful to the scientists.

The Chairman pointed out that one of the purposes of the Dialogue Meeting is to promote communication and bridge the gap between scientists and the industry.
Dr R. Boddeke (Netherlands Institute for Fishery Investigations) stated his belief that discarding is the real problem for North Sea haddock. Discarding of plaice and sole in the North Sea has been reduced greatly and these two stocks are at present in good shape. With some imagination, discarding of haddock could also be greatly reduced.

Dr D. MacLennan (Marine Laboratory, Aberdeen) said that scientific assessments are only as good as the data going into them. Some of the data on discards, industrial by-catches and recruitment are very unreliable and are a source of errors in the analyses. Only when this situation improves, and the cooperation of fishermen is essential here, will the predictions be more accurate.

Mr J. Urbieta (Fed. de Cofradias de Pescadores de Guipuzcoa, Spain) urged that discarding should be stopped and means should be found to utilise fish which are now thrown away.

Mr Holm contrasted management regulations in Norwegian and EC waters concerning catches of undersize fish. Norwegian regulations deal with illegal catches (and discarding is banned), whereas EC regulations are concerned with illegal landings (undersize fish must be discarded, but fishing can continue in the area).

Mr W. Hay said that the effect of discarding can be over-emphasised. The North-East Arctic cod fishery has been conducted with 135 mm mesh and a ban on discarding and still the stock has declined seriously. What has gone wrong?

Mr Holm replied that discarding is not the whole problem, but it still makes sense to tackle it.

Mr B. van der Meer (Netherlands Institute for Fishery Investigations) proposed as an alternative conservation measure to close some areas to all fishing and allow free fishing elsewhere.

Mr K. Hoydal (Director of Fisheries, Faroe Islands) stated that, in his view, there is no global solution to fisheries management which can be applied everywhere. At the Faroe Islands, many technical measures have been tried, and more have been discussed, but these alone are not enough. TAC management has been ruled out on economic grounds because tying up vessels for part of the year is very inefficient. Now the policy is to reduce the fishing fleet by 30%; this is not easy, but he believes that it is the common sense approach.

Mr Holden agreed with Mr Hay that things have not changed very much in the last five years, and this is a great disappointment. He believed that the discard problem is peripheral; the real problem is one of over-capacity. But there is very strong opposition to reducing fleet sizes. Capacities have been reduced in the coal and steel industries in Europe, but not so far in the fishing industry. He would welcome suggestions from the industry as to how this could be implemented.
Mr W. Hay said he agreed that the capacity should be reduced as in the coal and steel industries, but where is the money going to come from for scrapping grants and redundancies? Also, with large fluctuations in stock size, the ideal capacity is not known with any certainty.

Dr Boddeke returned to the question of reducing discards. He recognised that the problem is more difficult to solve for haddock than for plaice, but he believed that modifications to gear design and the introduction of closed areas could help solve the problem.

Dr MacLennan disagreed. He saw no practical solution to the problem for haddock. An increase in mesh size would be unacceptable to the industry. The most important thing for the haddock is to reduce fishing mortality overall; scientists have been saying for years that it is too high. If it is reduced, the size composition in the stock will change in favour of larger fish, and this in turn will reduce the discard problem.

Prof. N. Daan (Netherlands Institute for Fisheries Investigations) pointed out that the question of instability is being over-emphasised because many of the fisheries are mixed species fisheries. What is important to a fisherman is the catch of several species combined. The consequence of this is that the constant TAC option is not available because it is not possible to catch only haddock, for example. All that can be done is to regulate effort and adjust the TACs accordingly, otherwise the regulations will bring about discarding.

Mr J. Maddock (Irish Fishermen's Organisation) stressed the need for fishermen's leaders to tell young aspiring fishermen that the catch possibilities are very limited and to encourage fishermen to diversify into under-exploited stocks.

4 OBJECTIVES

4.1 Fisheries Economics Perspective - Prof. R. Hannesson

"In this presentation, I shall review briefly the objectives of fisheries management as they look from the economic perspective. Furthermore, I shall explain why fisheries management is needed in order to attain these objectives. Let me start by presenting a well-known figure (Figure 12). In the upper part of this figure, the revenue and cost of a fishery are shown, as well as the maximum long-term profit. I do not want to postulate right away, however, that we should try to attain this maximum long-term profit. Some apparently take offense at the idea of maximizing profits, and furthermore this objective may not have an intuitive appeal in the socio-economic context. I, therefore, propose an indirect route towards justifying maximum long-term profit as a worthy goal of socio-economic management.

Given the relations shown in the figure, what kind of situation would prevail in an unmanaged fishery? The horizontal axes in the figure show the level of effort in the fishery. Let us suppose, for simplicity, that the effort is measured in number of boats. How many boats would take part in the fishery? In the lower part
Figure 12 Conventional bio-economic model relating cost and revenue to fishing effort.
of Figure 12, one of the downward sloping lines shows the long-term revenue per boat, while the horizontal line shows the cost per boat, including both short- and long-term costs. As long as the revenue per boat is greater than the cost per boat, it will be profitable to invest in new boats. The incentives to invest in additional boats will not disappear until the revenue per boat has become equal to the cost per boat. This happens when the number of boats has reached the level $E_{eq}$.

In real life, the actual number of boats may easily expand beyond this level and stay there for a while, because many people may invest in new boats simultaneously, only to discover that their expectations did not come true. They may nevertheless stay in the fishery for quite a while, even if their boats are unprofitable in the long term, because the short-term cost is much less than the long-term cost. As the figure is drawn, the equilibrium number of boats in the fishery is beyond the maximum sustainable yield level. The catch that these boats bring ashore could in fact be taken by a much smaller number. This indicates that there is something basically wrong with unfettered competition in this case. Some people seem to have a hard time understanding this. The reason for this is probably that free enterprise and free competition have provided impressive gains in many spheres of economic activity. However, it should not be overlooked that competition can sometimes be destructive. One of the Icelandic sagas tells of an old viking who intended to spread his silver over the ground at the annual Council Meeting to watch those present fight for the spoils. This was to be his last enjoyment in life. The situation in a free access fishery is not unlike this, with everyone fighting for the largest possible share of a limited amount of fish.

The thing that is wrong with the free access fishery is that one of the basic conditions that must be satisfied if free competition is to yield a good result is not satisfied. This condition is that all resources must be traded at a price that reflects their scarcity. Resources that carry no price will be used as if they were unlimited. This is why we need fisheries management.

But what, then, should be the objective of management? Consider the cost of an additional boat. This cost consists of crewmen’s salary, expenses for fishing gear, fuel and miscellaneous items, amortization of boats, and interest on invested capital. All these items reflect the value that these resources could produce if used otherwise. They may not do so exactly; real world economies are not that perfect, but they do so to some extent and could in principle be corrected and made to do so. I shall, in the name of simplicity, assume that the cost per boat does reflect the value that capital, manpower, and various other inputs could produce if used otherwise.

How much of these resources should be used in the fishery? What needs to be looked at is the value that an additional boat generates in the fishery. We should invest in fishing boats up to the point where the value generated by an additional boat is equal to the cost of that boat. This occurs when the net revenue that an additional boat provides (marginal revenue) is equal to its cost (the marginal cost), at the level $E_0$ in Figure 12.
Now we can see why maximization of long-term profit makes sense. In fact, when the marginal revenue is equal to the marginal cost, the long-term profit happens to be maximized. I want to emphasize that the long-term profit is maximized as a consequence of achieving the best possible use of our productive resources, but not because of any inherent value of that profit as such. If there were somebody, a firm or an individual, who owned the fish and could sell fishing licences of some kind, that owner would be able to retrieve this profit through the licence fees. In so doing, he would in fact put a correct price on the resource itself. Among those few who got the licences, competition would be healthy, as the necessary condition for a constructive competition would now be fulfilled, namely that all scarce resources, including the fish, should be priced.

Who, then, will get the profit that will emerge in a fishery which is optimally managed along these lines? This depends on how the fishing effort is limited. If fishermen are given fishing licences or fishing quotas for free, the first generation of fishermen will get this profit. When the first generation fishermen leave the fishery, they will be able to sell their quotas or licences to those who enter the fishery, much like a retiring farmer sells his farm. The second and later generations of fishermen get nothing, the only beneficiaries are those who get their rights for free. Alternatively, the state may sell or put a tax on the fishing rights. The government would then get some, and possibly all, of the profit. It is commonplace in some other natural resource industries to tax such profits that exceed the normal costs of extraction. The prime example is the petroleum industry, which is heavily taxed in all petroleum-producing countries.

Up to now I have been talking about maximizing long-term profits. This is slightly misleading. We are not only concerned with things that take place some time in the future, after fish stocks have reached some optimal level, but with processes which take place over time and in the end will bring us to a long-term optimum. The appropriate concept to use under those circumstances is the maximization of present value of profits. This raises some important questions that I wish to address specifically.

Maximizing the present value of profits introduces the concept of discounting future values. This makes a difference, because temporary but unsustainable catches can be justified against some loss in long-term catches. This means that fish stocks should be somewhat more intensively exploited than if we only take long-term yields into account. We would need an infinite discount rate, however, to justify the overexploitation of an unregulated fishery. Nevertheless, for slow-growing stocks like whales, a moderate discount rate could make a tremendous difference and even point towards optimal extinction. It goes without saying that such irreversible consequences need to be evaluated in a broader perspective than provided by maximizing the discounted value of profits.

Often the long-term adjustment of the fishing industry will involve a reduction in effort, that is, fewer boats and less people employed. It should be emphasized that the adjustment to the long-term goal is very likely to be a gradual one. People who are
employed in the fishing industry are not easily transferred elsewhere, not in the short term at any rate. This means in effect that the cost of labour in the fishing industry is zero. That again means that more people should be employed in the fishing industry than we would think, if we took the incomes of fishermen as the true opportunity cost of their labour. It needs to be kept in mind, however, that only under extreme circumstances of endemic unemployment could this be a long-term solution as well. Otherwise one would have to prevent young people, who are entering the labour market, from acquiring specific skills that are useful only in the fishing industry and to establish themselves as fishermen, until the number of fishermen has fallen to the long-term optimal level.

Under no circumstances should the number of people employed in the fishing industry be maintained at a higher level than implied by a zero cost of their labour. Doing otherwise is akin to solving the unemployment problem by having people digging useless holes in the ground, only worse. While digging useless holes in the ground is relatively innocuous, the overfishing of fish stocks can have disastrous consequences.

A similar argument can be made about the gradual phasing out of excessive boats. Even if the present number of boats in a fishery is excessive, given that their marginal revenue is less than the full cost of a new boat, this need not be so once we take only short-term costs into account. The appropriate short-term cost to use is the value that the boat could produce, if it were used otherwise, including sold out of the fishery. This value could be very low, if there are few alternative fisheries and no second-hand market for boats. It may, therefore, be justifiable to let such boats continue fishing until they wear out, but they should not be replaced.

In conclusion, I wish once again to stress the need for management. This need is pressing, and it is not easy to see that other institutions than government bodies could undertake this role; private ownership of fish stocks is not, I think, a practical solution, even if harvesting rights can be partitioned out and made a private property in various ways. At the same time, I think we must recognize that most governments have failed miserably in rising to this challenge. With a few exceptions, they have at best been content with protecting the fish stocks in a biological sense, but most often with measures that are wasteful and have perpetuated excessive capacity in the fishing industry. In my view, this represents a terrible waste of opportunity, because the new law of the sea offers an excellent opportunity to manage the fisheries in an economically meaningful way. We have got the TAC mechanism in place and, to the extent it is effective, it protects the fish. What we need is a mechanism to allocate the TAC in such a way that it is taken at the lowest possible cost and yields the highest possible revenue. One such mechanism is individual transferable quotas, but it would take us too far to discuss that idea at this point."
4.2 Fisheries Biology Perspective - Dr J.G. Shepherd

"Stability is one possible objective for fisheries management, and as we have seen, it is going to be pretty difficult to achieve. But there are lots of other possible objectives, and it is worth seeing what they all mean when we come to think about management.

First, of course, comes money. The profitability of a fishing trip depends on how much you catch, and that depends on how many fish there are in the sea. We can calculate how many fish there will be of fishable size, from a year class of a given size, for various levels of total fishing pressure, and this is shown in Figure 13.

Not surprisingly, the stock size goes down as the fishing pressure goes up. The fish are killed off quicker, so they are not around so long. That means we have a simple answer. If you want to maximise the profitability of fishing, you should reduce the total amount of fishing to the lowest possible level. That means the last fisherman has no competitors - so he does fine!

But it is pretty obvious that that is not a sensible objective. Why should one man stay in business making fat profits when the rest are forced out? The supply of fish to the market from that last boat would be pretty small too. There is another possible objective - fish supplies. How should we maximise those? We can calculate that too - that is shown in Figure 14.

As you increase fishing effort from zero, at first the catches go up in proportion. But pretty soon you get to a state of diminishing returns - the curve starts to level off. And pretty soon after that, it does level off, so you get no more fish from the increased effort. You are just sharing out the same catch between more boats. If you still increase fishing effort beyond this point, you actually get less fish from increased effort. Not just diminishing returns - we have all heard about those - these are negative returns. So, if you want maximum fish yield, you only want moderate fishing pressure. In practice, you do not usually want the fishing mortality to be more than about double the natural mortality (typically about 20% per year). This level of fishing, that would give a maximum yield from a given level of recruitment, is described by a number called $F_{\text{max}}$ that you will often see in the tables of catch options that ICES working groups and ACFM provide. It is a possible target level for management, but by no means the only one. In fact, the curve is often quite flat-topped, so you get more-or-less the same yield over a wide range of fishing effort. That means there is no point in fishing very hard.

However, increased fishing effort means increased costs - more boats, more men, more fuel. Obviously, when you start getting negative returns (reduced gross earnings) in total, you have gone too far. But if you take account of the costs, it is obvious you should stop increasing fishing effort before you reach that point. With the help of a friendly economist, you can calculate that too. The point of maximum economic yield (MEY) always corresponds to less fishing effort than maximum landings or maximum earnings. How much less depends on the balance of costs and earn-
North Sea Haddock
Spawning Biomass per Recruit

Figure 13 Spawning stock biomass per recruit (kg) for North Sea haddock in relation to fishing mortality (effort).

North Sea Haddock
Yield per Recruit

Figure 14 Yield per recruit (kg) for North Sea haddock in relation to fishing mortality (effort).
ings. If you cannot find a friendly economist (quite likely these days), you can calculate something called $F_{0.1}$ which is a substitute for MEY. It is quite popular as an objective of management in some parts of the world (e.g., Canada), and invariably corresponds to low values of fishing mortality: usually roughly equal to the level of natural mortality, and certainly less than $F_{\text{max}}$.

From the point of view of an individual fisherman, however, this is not the main point. He usually cares about his own profits, not those of fishermen as a whole. At a low total level of fishing mortality, his profitability would probably be very high. In fact, an individual fisherman may still be fishing profitably when the fishing pressure is way above this MEY (or $F_{0.1}$) level. It may indeed still be high when fishing pressure is way above the level for maximum total earnings, and well into the region of negative returns.

This happens, and this is why fishing pressure has increased on so many stocks, and continues to increase while the scientists continue to say that it is much too high. In an unregulated fishery, this means that more and more fishermen fish harder and harder, and drive the stock down to the point where fishing becomes unprofitable, and the stock may collapse. This is the 'tragedy of the commons' applied to the sea, and it has been repeated over and over again all around the world. It is not that anyone is doing anything wrong or unreasonable. It is just the natural effect of market forces operating. For many industries, the operation of market forces leads to many benefits, and is generally a good thing. But unrestrained market forces cause serious problems for fisheries, because these are based on a finite, and fragile, renewable resource. The combination of unrestrained market forces and the basic biological facts of life is almost invariably disastrous in this case. This natural interplay between the biological and economic facts of life has indeed led us to the present position, that most fisheries in the Northeast Atlantic (not just cod and haddock in the North Sea) are fished at levels of intensity way above those indicated by the $F_{\text{max}}$ and $F_{0.1}$ reference points, with yields less than the maximum obtainable, and stock sizes only a fraction of what they could be.

What about the fragility of the resource? Fish stocks do collapse. North Sea herring, Atlanto-Scandian herring, North Sea mackerel, Georges Bank haddock .... the list is quite long, even close to home. So sustainability of fish stocks, and the catches they can yield, is another potential objective for management. The processes leading to stock collapse are poorly understood. The big natural fluctuations correspond to excessive noise, and we have trouble finding the signal in amongst that noise. We know that zero stock means zero recruitment, but usually have difficulty deciding just how low a stock has to be driven before the risk of recruitment failure becomes serious. But there is no doubt that in most cases, to be reasonably sure of sustainability means aiming for a fishing mortality that is quite low - certainly no more than another reference point called $F_{\text{med}}$. Above that level of fishing mortality the risks of collapse start getting serious - higher than 50:50 in the long run. Below it, collapse should not be too much of a worry, though nothing can be guaranteed in the natural world.
Finally, what about employment? In the last decade, unemployment has been a serious problem throughout Europe and North America, and creating jobs has often been an over-riding objective. For fisheries, this means increased fishing effort, obviously. It is a pity that this is the opposite of most of the other things I have considered.

To summarise, there are two possible objectives that would argue for high fishing effort: employment, and individual earnings in the short term. All the other possible objectives we have mentioned – maximum total landings, maximum total earnings, high stability, sustainability (low risk of collapse), profitability, high stock size – all these indicate low, or at most very moderate, levels of fishing effort. There is a genuine conflict, and the whole question is very complicated, and it really does not help to pretend that there is a simple answer. There is not. Somebody, somewhere, has to figure out which of these objectives is most important. Then we can try to manage in the appropriate way. We really need a constructive dialogue between fishermen, scientists and managers, and up to now that has been pretty difficult to achieve.

Before leaving the subject of objectives – what about discarding of small fish? I am sure everyone realises that catching, killing and discarding young fish is very bad for the stock, and for the future of the fisheries that depend on it. It is a particularly serious problem for the North Sea haddock stock too. Just how serious can be seen from Figure 15, which shows how much extra yield could be obtained (upper line) if it were possible to eliminate the extra deaths of young fish entirely. One could almost double the yield at present levels of fishing intensity. Figure 16 shows the effect on the spawning stock size. This does not look so impressive at first sight, but it does still represent almost a doubling of the present depressed stock size, for the same level of recruitment. Of course, it would be very difficult to eliminate discards entirely, but there is no doubt that a lot could be done by using more appropriate fishing gear, and avoiding times and places where the young fish congregate. A major reduction of discards would be the single most rapidly effective conservation measure that could be applied for this stock.

There is one other thing which is often misunderstood that ought to be mentioned. Suppose we accept that fishing effort ought to be reduced, say by 30% as a minimum, to increase the stock size, improve profitability and stability and so on. For how long does the effort have to be kept down before it can be increased again? There is an unpleasant answer to this question: the answer is, for ever. If the effort is kept down for a few years, the benefits should begin to appear. The fisheries will become more profitable, and everyone will want to increase his effort, maybe get another boat, or one for his son. But if this is allowed to happen, the effort will increase, and after a couple of years things will be back where they started. The uncomfortable truth is that maintaining healthy fish stocks means permanent restriction of fishing effort, to a level less than market forces would allow. It is not just one spoonful of bitter medicine that has to be swallowed. It is more like a rigorous diet that has to be followed for the rest of your life. Thomas Jefferson said that the price of liberty is eternal vigilance. For fisheries, we could
**North Sea Haddock**

Yield per Recruit

![Graph showing yield per recruit for North Sea haddock in relation to fishing mortality (effort) for the current situation (lower line) and if fish currently discarded were allowed to survive (upper line).]

**Figure 15** Yield per recruit (kg) for North Sea haddock in relation to fishing mortality (effort) for the current situation (lower line) and if fish currently discarded were allowed to survive (upper line)

**North Sea Haddock**

Spawning Biomass per Recruit

![Graph showing spawning stock biomass per recruit for North Sea haddock in relation to fishing mortality (effort) for the current situation (lower line) and if fish currently discarded were allowed to survive (upper line).]

**Figure 16** Spawning stock biomass per recruit (kg) for North Sea haddock in relation to fishing mortality (effort) for the current situation (lower line) and if fish currently discarded were allowed to survive (upper line)
say that the price of profitability is eternal regulation. That may be an unwelcome conclusion, but I am afraid it seems to be true."

4.3 Fisheries Administration Perspective\(^1\) - Mr M. Holden

"Historical Background

To someone outside fisheries, one of the most surprising features must be the absence of a specific statement of management objectives. So far as is known, amongst the contracting parties of ICES, Canada alone has a specific management objective, that of managing stocks at the fishing rate corresponding to the reference point \(F_{0.1}\).

The reasons for this are historical. Fisheries management was started because the stocks were overfished. They were overfished because there were no limitations upon fishing in international waters. Governments were prepared to take only those measures which they considered absolutely necessary and which did not conflict with national policies, such as maintaining employment and ensuring a supply of food. In some countries, the fishing fleet formed a reserve of trained seamen and vessels which could immediately be used in time of war. Even when international fisheries commissions were established, they were unable to set objectives because the contracting parties would not agree to take measures which impinged upon their national policies.

The type of scientific advice which was available in the 1950-1960s reinforced this situation. The only assessments which could be made were of the yield-per-recruit type showing the relative change in total catch which could be obtained by altering either the mesh size or the amount of fishing. Altering the amount of fishing would have required agreements on the size of the national fleets, which was politically impossible at that time as it would have conflicted with national policies. Additionally, it was confidently expected by the scientific community that fisheries could be managed by increasing minimum mesh sizes as fishing effort increased. This was to prove an illusion. In the time it took to agree to any change, the fishing effort had made the new mesh size totally inadequate. The illusion received its deathblow when the stock of North Sea herring collapsed.

Because the yield-per-recruit curve illustrates relative changes in yield, the reference point adopted was automatically that at which the maximum yield per recruit was obtained, \(F_{\text{max}}\) or \(F_{\text{msy}}\), which became tacitly accepted as the objective of fisheries management. It was also an emotionally and politically acceptable objective because it implied obtaining the greatest possible catch, thus making the best use of the fish resources as a source of food. However, there was no agreement that \(F_{\text{max}}\) or, later, \(F_{0.1}\) should be the objective.

\(^1\)The views expressed in this paper are those of the author. They represent the view of "an administrator" in the context of the Seventh ICES Dialogue Meeting.
Because fishing effort could not be regulated, the fact that it was too much fishing effort which was causing all the problems became increasingly ignored. Minimum mesh sizes, minimum landing sizes and similar technical measures came to be considered as "conservation measures". They were, in effect, only palliative measures to minimise the adverse consequences of too much fishing effort. The key conservation measure was, and still is, in reality, fishing effort or, rather, its control.

The present situation is that most of the stocks are still over-exploited, in many cases, severely overexploited. Fishing capacity is far in excess of that needed to meet any objective which might be considered "optimal". As a result, governments and the EC are faced with conflicting pressures. On the one hand, they need to implement management measures which will prevent the stocks becoming further overexploited while at the same time they need to respect the democratic process by responding to the pressures from the fishing industry. Paradoxically, the industry recognizes that management measures are essential, but frequently resists their adoption because it considers that it cannot accept their short-term adverse financial consequences. Thus, the conflict between biological, economic, and social considerations prevents specific objectives from being agreed. The status quo, unsatisfactory though it is, is allowed to continue, essentially because of the adverse short-term economic consequences of trying to reach a better situation. This attitude is not helped by the fact that there is no guarantee that the "better situation" will be reached, or that the individual fisherman will still be in the industry when it is. The advent of 200 mile fishery limits should have simplified the situation, but the existence of jointly managed stocks has meant that the problem of conflicting national policies still exists. The result is that negotiations between the joint managers are still based essentially upon biological criteria. This occurs in bilateral negotiations and in the fisheries commissions such as NEAF and IBSFC.

Even where the possibility theoretically exists to set specific objectives, this does not occur. For example, the EC has competence for fisheries and could set specific objectives. But because the Member States have different objectives, the Council of Ministers has agreed only on the very general objectives specified in Article 1 of Council Regulation (EEC) No. 170/83 of 25 January 1983 establishing a Community system for the conservation and management of fishery resources which gives as the objectives of that system, "the protection of fishing grounds, the conservation of the biological resources of the area and their balanced exploitation on a lasting basis and in appropriate economic and social conditions".

Objectives

What should be the objectives of fisheries management? Firstly, it is necessary to clarify one point by saying what is not the objective. The objective of fishery management is not the preser-
vation of the fish stocks in order to have a lot of fish in the sea — the "marine aquarium" concept. This idea is very widespread partly because this idea is implied by the word "conservation". It would be better if this term were not used at all in the context of fisheries management.

This interpretation has been strengthened since ACFM decided to give advice on management of fish stocks "within safe biological limits". In order to interpret this term, advice is usually now given in terms of the prediction for the evolution of the spawning stock biomass. Implicit in this approach is that there is a relationship between spawning stock biomass and subsequent recruitment, a relationship which has yet to be established for any stock, although of course, when the spawning stock biomass is zero, recruitment is zero.

This attitude has evolved as the result of what happened to the stocks of North Sea herring and mackerel. It has had unfortunate consequences because it leads some authorities and fishermen to the conclusion that management (= conservation) measures are not necessary until a stock is "menaced", that is, the spawning stock biomass reduced to a very low level. For any rationally-managed stock, it is very improbable, on the basis of existing scientific evidence, that the size of the spawning stock biomass would ever fall below the level at which average recruitment would be too low to maintain the stock.

What then should be the objectives of fisheries management? This question does not have a unique answer because a single objective does not exist. Each manager will have his own set of objectives. The set of objectives selected will combine several elements, such as the economic return, total catches, employment and catch rates. But the weight given to each of these elements will depend upon the overall objective of the manager. The important point is that it is not possible to maximise all the elements at the same time. For example, it is not possible to manage fisheries in order to obtain maximum economic benefit and maximum employment because the latter implies a high level of fishing or a labour intensive inefficient fishery, which in turn means that the economic return will be low.

To take a familiar example, the concept of $F_{0.1}$ is a compromise. At $F_{0.1}$, the average long-term total catch will be less than the average long-term maximum total catch, and the economic return will be higher than that which would be obtained at $F_{\text{max}}$ but usually less than the maximum possible. However, $F_{0.1}$ says nothing about how the rate of fishing mortality to which it corresponds is to be generated. The concept was based on the theory that fleet capacity should be reduced to the arbitrary level defined by $F_{0.1}$ in order to increase economic benefits. But it could be generated by having a large fleet, and therefore high employment, but using that fleet inefficiently, thus dissipating the intended economic benefits. This is, perhaps, an unrealistic example, but it is used to demonstrate both the variety and complexity of objectives. It also demonstrates the need to have clearly-defined objectives in which all the interactions between the different elements have been taken into account.
Having established a set of objectives, it is essential to decide the measures by which they are to be achieved and to implement them. The two processes combined constitute management.

Unfortunately, "fisheries management" is a much misused term which is applied more to the setting of objectives than to their implementation, although the former is useless without the latter. For example, there is no point in fixing a certain fishing mortality rate as the management objective and then fixing a total allowable catch which corresponds with that rate if a coherent set of measures is not implemented to ensure that the total allowable catch is not exceeded. These measures, of course, include effective enforcement.

To summarize, because specific objectives do not exist, effective fisheries management cannot exist. Assuming that we do want to agree a set of objectives, how do we achieve it, taking account of the diversity of views within the fishing industry?

4.4 Fishing Industry Perspective - Mr J.H. Goodlad

"The management of fisheries is undertaken to achieve a variety of policy objectives. These policy objectives can be quite different depending on one's perspective. For example, a marine biologist would normally prefer to manage fisheries according to the concept of maximum sustainable yield, while a fisheries economist would usually choose the concept of maximum economic yield. In contrast, politicians might often prefer to maintain high employment levels within the fishing industry regardless of the long-term economic or biological consequences of such a policy. In any open democracy, the inevitable policy objective adopted by governments will be a compromise reflecting these and other policy options.

In considering preferred policy objectives for fisheries management, the industry perspective has often been limited to political lobbying at a very late stage. This is unfortunate because the fisheries sector, representing the people whose incomes ultimately depend on which fisheries management measures are adopted and how successful these measures are, is in a unique position to provide practical advice on policy objectives.

Previous speakers have explained the reasons why the policy objective of stability is extremely difficult, if not ultimately impossible, to achieve. The fishing industry recognises this problem. However, notwithstanding the difficulties, or impossibilities, of achieving predictable catch opportunities for an indefinite period, we must nevertheless try to improve the current situation of total uncertainty and gross instability which is characterising more and more fisheries.

Previous speakers have clearly explained how excessive fishing effort exacerbates the "natural variability" from catch quotas, thereby leading to the very unstable situation we now have in many fisheries. It, therefore, follows that, in order to "stabilize fisheries management", a reduction in fishing effort is required. The ideal situation would be a reduction in fleet size to a level which would, fishing with normal efficiency in a normal
year, just manage to take the TAC by the year end. Even if the fishing fleet could be reduced to this ideal level, it must be accepted that there will still be some fluctuations in TACs. It must also be recognised by the fishing industry that the price of greater stability is that, whenever there is an exceptionally good year class, it should not be fished to its maximum possible level, so that a buffer stock is created which will, in time, help even out future fluctuations. In this way, future TAC fluctuations should be much less excessive and unstable than at present.

In summary, therefore, while it is accepted that absolute annual catch stability can never be achieved, it is clear that a reduction in fishing effort would reduce extreme variability in catch opportunities and result in the much more stable management of fisheries.

Up to this point, there is little disagreement - stocks are overfished, and in order to achieve greater stability in future catch levels, fishing effort needs to be reduced. The problem is by how much, and by what method, and by whom. This is of course the political problem which needs to be tackled urgently. This raises the extremely difficult question of whether politicians should legislate in order to create the most economic fishery (i.e., a very profitable fishery for only a few fishermen) or to try to temper this economic aim with the social objective of keeping as many fishermen employed (at lower income levels) as possible. In addition to this, there is also the very important question of the regional implications of fleet reduction and what effect a reduction in fleet size may have on fragile rural communities which have very few alternative employment opportunities.

Implications of Reduction in Fishing Effort

The implications of reducing fishing effort can, therefore, be considered in terms of the social, economic, and regional dimensions.

a) Social Implications

The inevitable consequence of reduced fishing effort will be fewer boats manned by less fishermen. The political dilemma is how to choose between those fishermen who are to have a future in the fishing industry and those fishermen who can no longer be employed.

This decision should not be imposed on the fishing industry. Instead, the fishing industry should be encouraged to allow this decision to be made by each individual fisherman by means of offering a financial incentive for those fishermen prepared to scrap their vessels. The European Community has attempted to provide such incentives through the current Structural Regulation (No. 4028/86). By providing financial assistance, the Community hopes that each Member State will be encouraged to reduce its fleet size in line with objectives laid down within its Multi Annual Guidance Programme (MAGP). The MAGP targets are medium term and will be reviewed in 1992. While the level of uptake of these decommissioning schemes has varied within the European Community, the policy of planned
intervention appears to be gradually succeeding in reducing the size of the European fleet. Similar schemes have been introduced in the past in other areas (e.g., Norway) with similar success. Without a planned scheme of fleet reduction, it is clear that fishing effort will not reduce by itself.

b) **Economic Benefits**

At the same time as encouraging the reduction in fishing effort by a system of financial incentive, the fact that the economic prospects for those remaining in the fishing industry will be much more secure should be emphasised. Following the reduction in fishing effort, more stable catch opportunities should be available thereby permitting better long-term planning. A reduced fleet fishing more stable annual quotas will result in a much more profitable fishing industry.

This should be self-evident, but needs to be emphasised so that potential investors do not assume that a decommissioning scheme and fleet reduction are symptomatic of the demise of the fishing industry. The point is that a reduction in fishing effort is the medicine needed to ensure the future well-being of the fishing industry.

c) **Regional Aspect**

Fishing is one of the few industries which can be economically viable on the periphery of Europe. The fishing industry is, therefore, a very important tool of regional economic development within the European Community. It is vitally important that any EC policy to reduce fishing effort must ensure that the particular social and economic conditions of the many fragile rural communities dependent on the fishing industry (e.g., western Ireland, Azores, Shetland) are fully taken into account. This has to some extent been recognised with regard to the rates of financial assistance awarded to "sensitive regions" for vessel building and modernisation under the Structural Regulation (No. 4028/86). This policy of differential assistance for "sensitive regions" must, however, be complemented by a similar approach regarding the application of future MA6P targets on a regional, as opposed to a national, basis.

4.5 **Discussion**

Dr Gulland made the observation that the further away fisheries are from capital cities, the better they are managed! He said that decisions about overall levels of fishing mortality should be made centrally, but how the catches are to be allocated amongst sectors should be decided locally by the industry. For most stocks, large reductions in fishing mortality should be agreed internationally and then local communities should decide which vessels should be scrapped or tied up.

Mr Holden said that this is precisely what happens at present where national quotas are allocated to sectors, but it has failed to reduce fishing mortality. What is required is a forum where scientists, administrators, economists and industry representa-
tives can try to reach agreement on common objectives and how to achieve them. Also, managing mixed species fisheries by TACs is a real problem. Would it be possible to control effort directly?

Dr Hillis stated that he believed that it is possible to reduce fishing effort using individual transferable quotas by reducing fishing time, but not the numbers of vessels, and still maintain profitability. This is because catch rates increase and running costs are reduced.

Mr West opposed the concept of individual transferable quotas because he believes that they will all be bought up by large businesses resulting in the destruction of fishing communities. He also opposed the introduction of more areas closed to fishing because he did not believe that the present boxes are working. Concerning a forum to discuss fleet reduction, he said that this would be pointless unless compensatory funds were made available.

Prof. Hannesson responded on the subject of individual transferable quotas. He believed that they represent a painless and equitable way of achieving fleet reductions because people have the option of giving up fishing and receiving compensation for it. There are two major cases where individual transferable quotas would not work; one is in mixed species fisheries and the other is in fisheries which are difficult to monitor. However, there are probably a great many fisheries (including EC ones) where the system would work well.

Mr Urbieta stated that the optimal fishing method should be decided for each species, and the other methods should be reduced first.

Mr Goodlad expressed complete agreement with this. A large reduction in overall vessel tonnage, as proposed in the Multi-Annual Guidance Programme, is a very crude way of reducing fishing effort. It is not sensible to apply the same reduction to all fisheries, some fisheries will need greater reductions, some may even justify expansion.

Mr T. Hay (Scottish Whitefish Producers Association) said that there is a wide consensus within the fishing industry of the need for conservation. The problem is that very few of the scientists and administrators really know the industry well; virtually none have backgrounds in the industry. There are too many people interfering with the industry; fishermen should look after the management themselves.

Mr Holden said that he did not believe that there would be general support for a "hands off" approach to management. He saw it as disappointing that there were so few positive suggestions, especially from the industry, as to how the management mechanism can be improved.

Mr R. Banks (National Federation of Fishermen's Organisation) suggested that the membership of ACFM and STCF is somewhat incestuous. Why are there no economists or, more importantly, industry representatives on STCF?
Mr Holden said that, as far as possible, efforts were made to keep the membership of STCF different from that of ACFM, but the pool of suitable scientists made available by national authorities is limited and there will inevitably be some overlap. There are, in fact, some economists on STCF. It is true that there are no industry representatives, but the industry is represented on the Consultative Committee for Fisheries and it may well be possible to organise a joint session of that Committee and STCF.

Mr N.A. Nielsen (Danmarks Fiskeri- og Havundersøgelser) said that there is general agreement that fishing effort needs to be reduced, but the problem is agreeing how it should be reduced. As he saw it, the first requirement is for the scientists and economists to make it much more apparent which fleets would gain and which would be losers given various different management regimes. This is something that STCF is at present working on.

Mr Goodlad restated his view that the industry should have more say in management. He was totally opposed to Mr T. Hay's "hands off" approach which would inevitably lead to stock collapse.

Mr R. Allen (Scottish Fishermen's Federation) wanted to counter some of the criticism of the industry for being negative. He believed that the Scottish industry was being very positive and had recently made some radical proposals for fleet reduction. He agreed with Mr Goodlad that the industry should have more direct input to the decision-making process. In the EC, the industry really only had a few days each year to make an input before TACs were agreed. He also believed that the EC Consultative Committee for Fisheries was not really listened to by the Commission.

Mr M. Lochrin (Irish Fish Producers' Organisation) believed that the implementation of policy at a national level is best undertaken by people in the industry, perhaps by a semi-state body to which powers are devolved.

Dr Boddeke proposed reducing the number of fishing days allowed as a first step. Such restrictions have been introduced in the Netherlands and have been surprisingly well accepted by the industry, which can then plan its fishing operations for the year. In the long run, this will lead to a reduction in fleet size as vessels are scrapped.

Dr Gulland said that there are lots of ways to reduce fishing effort and capacity, but the only successful ones are those that cost money. Paying fishermen to get out of the business has successfully reduced fleet size in New Zealand, Australia and Alaska.

Mr Peder Andersen (Danish Ministry of Fisheries) expressed his support for Mr Nielsen's proposal that before any change is made in a management regime, an analysis of the effect on each fleet be undertaken. This has been tried in Denmark on a small scale in conjunction with the industry and it has made for easier decision making.
The Chairman asked the Chairman of ACFM, Mr B. Vaske, to summarise the day's proceedings. His summary was as follows:

"The Seventh Dialogue Meeting focussed on stability in fisheries and the objectives of fishery management. We had very valuable contributions from the four main speakers and based on these, there was an interesting discussion and useful exchange of views.

We had an excellent presentation from the scientific perspective which clearly showed how difficult stability is to achieve, simply because of the large fluctuations in recruitment which most fish stocks experience. Maximum stability in catches is found at very low fishing intensity when several year classes contribute to the fishery. Unfortunately, we are exploiting most fish stocks in the Northeast Atlantic at a very high level, and these fisheries are based on very few year classes. With large fluctuations in recruitment, this means that catches are very unstable and it also makes it very difficult to make accurate catch forecasts. North Sea cod and haddock are examples of this.

North Sea haddock has been mentioned a lot today because of its disastrous state. I would like to make it clear that scientists are not blaming the industry for this situation. It was clearly explained that this is basically due to failure in recruitment. I would like to underline the need for close cooperation between the industry and scientists as was stressed in the first session; we as scientists need accurate information from the fisheries to provide reliable stock assessments and it is then our duty to communicate the results back to the industry.

I would like to point out here that medium and long-term predictions are very unreliable. On occasions in the past, we have provided medium-term predictions in response to requests, but we have had some bad experiences with this, for example with North-East Arctic cod.

The speaker representing the administrator's point of view suggested having a fixed TAC for a number of years for a lightly exploited stock such as the Northern blue whiting. That can be done, but it will probably mean choosing a low level of catches. It will also mean that fishing mortality will have to vary from year to year. It is not possible to have constant catches and constant effort at the same time. Real stability is not possible, but reducing fishing mortality helps and it is the scientists' duty to try to minimise fluctuations in TACs.

I will turn now to the session on objectives. A variety of objectives are used by scientists, for example reference fishing mortality levels and target spawning stock sizes. There is no single objective which can be applied to all stocks. When ACFM is framing its advice, it takes into account the present state of the stock. The general policy is to reduce fishing mortality to one of the biological reference points. In some cases, a very large reduction in fishing mortality is required, maybe 50-60%, and in such cases, ACFM needs to be realistic (and make some concessions towards stability) and so generally recommends stepwise annual reductions of 20% per year."
This advice goes to the managers who then face the problems we have heard a lot about during this session. A reduction in fishing effort requires a reduction in fleet capacity or in fishing days. This seems to be extremely difficult to achieve and little progress has been made in recent years. However, the discussion today has given us plenty of food for thought. A forum has been proposed to discuss the question, and we have heard several pleas to have more input from the industry in the decision-making process.

We had some debate on individual transferable quotas as a means of managing fisheries and achieving reductions in fishing effort. I am no expert in this area, but it is my impression that this scheme requires further evaluation.

Finally, as Chairman of ACFM, I would like to make a comment about the work we are doing within ICES. The national laboratories are collecting the data from the commercial fisheries and from surveys. There are about 25 assessment working groups which scrutinise the data very well and make assessments and catch forecasts for 70-80 stocks each year. ACFM then reviews these analyses and provides advice to managers. There are some cases when the advice is not very accurate, but in general, I believe that the system works well and in most cases, our customers are satisfied with the advice ACFM provides on behalf of ICES."

6 CLOSE OF MEETING

The Chairman thanked the speakers, the organisers and all the participants for their contributions to the meeting and the lively debate. He said that a meeting such as the Dialogue Meeting cannot be expected to produce miracles, but it should help to make people aware of the views of those in other sectors. The most useful aspect could be when the participants dissipate the impressions they have received here back in their own countries.

The meeting was closed at 17:25 hrs.
APPENDIX 1

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APPENDIX 2

DEFINITION OF SOME TECHNICAL TERMS

Catch per unit effort: The catch taken for each unit of fishing effort.

Exploitation pattern: Distribution of the fishing mortality rate for each of the age groups in the stock.

F_{high}: The fishing mortality rate above which the historical data on stock recruitment suggest that there is a very serious risk of the stock collapsing.

Fishing effort: Any measure of the activity of fishing vessels; for example, hours travelling, number of hooks fished, kilometers of gill nets.

Fishing mortality rate (F): Expresses the relative quantity of fish dying from being caught. Mathematically, it is the negative of the natural logarithm of the proportion S of fish surviving fishing in a year: \( F = -\ln S \) or \( S = e^{-F} \). For example, \( F = 0.6 \) means that \( e^{-0.6} = 0.45 \) or 45% of the fish survive or \((100 - 45) = 55\% \) of the fish are dying each year from being caught. Another example: \( F = 0.2 \) means that \((1 - e^{-0.2}) = 18\% \) die from fishing.

F_{max}: The fishing mortality rate at which they MSY will be taken, based on the relationship between yield per recruit and fishing mortality rate.

F_{med}: The fishing mortality rate at which the historical data on stock-recruitment suggest that the stock should be sustainable.

F_{msy}: The level of fishing effort at which the MSY would be taken.

F_{0.1}: The fishing mortality rate at which the slope of the yield-per-recruit curve is one-tenth of the slope at its origin. \( F_{0.1} \) is always less than \( F_{max} \); the catch is only slightly less than at \( F_{max} \), but the implied reduction in the fishing mortality rate is much greater; therefore, catch per unit effort is higher with consequent economic benefits; \( F_{0.1} \) is, therefore, essentially an economic concept. However, for those stocks for which \( F_{max} \) occurs at a very high value of the fishing mortality rate or at an infinite value, \( F_{0.1} \) is used as a biological reference point.
Maximum sustainable yield (MSY): The maximum long-term average annual catch which can be taken from a stock under the present exploitation pattern.

Natural mortality rate (M): Expresses, similar to the fishing mortality rate, the relative quantity of fish dying from natural causes (predation, disease, etc.)

Recruitment: The process by which fish enter the fishery (e.g., growing large enough to be retained by the fishing gear and/or migrating from nursery areas where there is no fishing to areas where fishing takes place).

Recruits: The number of young fish entering the fishery each year.

Spawning stock biomass (SSB): For each stock, the biomass (total weight in the sea) of mature fish (those capable of reproducing).

Stock biomass: For each stock, the weight of all fish in the sea (usually of the age groups which can be caught in the fishery (exploitable biomass)).

Stock-recruitment: The relationship between the number of recruits which enter the fishery each year and the spawning stock biomass which produced those recruits.

Yield per recruit: The long-term average yield in weight in the catch for each recruit entering the fishery for a given exploitation pattern. The average yield per recruit multiplied by the number of recruits (if known) gives the total yield.