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LEARNING FROM HISTORY

Report of the Historical Perspectives Subcommittee

FRCC.96.R.1
July 1996

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EXECUTIVE SUMMARY

"Those who do not learn from the past are condemned to repeat it." *G. Santayana*

This citation guided the discussions of the Historical Perspective subcommittee. Our objective was to examine past stock collapses and subsequent recoveries, where such occurred, to identify lessons which could be used to help guide the choice of future conservation decisions. Our method of work was to review case studies of stocks that have collapsed and rebuilt as well as stocks which did not rebuild. We considered stocks on both sides of the North Atlantic.

The first lesson we learned was one of humility - humans cannot control nature in the manner assumed by standard fisheries models. It is our unanimous conclusion that prudent fisheries management must assume that there is a link between the abundance of spawners and the abundance of their progeny, although we recognize that the overall limits to the productivity of the stocks are set largely through nature's influence on how many fish will reach the adult stock from a given number of eggs produced. Because nature plays such a predominant, unpredictable and potentially devastating role, very cautious target exploitation rates should be set to guard against unexpected periods of low productivity1.

Our second lesson is that human behaviour is very difficult to control, such that despite stated attempts to limit the capacity of our fleets to kill fish, fleet expansion and capacity continued unabated with or without vessel replacement subsidies; so that there are now no natural protection left for the stocks. Even if stocks are very scarce, we can find them and fish them. When the technology was not so efficient, there were areas, periods or weather during which it was not possible to fish and these conditions provided natural refugia for the stocks, possibly preventing prolonged collapses.

The third lesson we learned is that we should match the harvesting capacity of our fleets to the productive capacity of the resources. Nature fixes the parameters within which we operate and it is our duty to estimate these parameters as best as possible while prudently managing the fishing fleets in such a way that humans will not push the resources outside the limits set by nature2.

The forces which led to past mistakes are still in action. It will therefore take considerable efforts to recognize old pitfalls when they will appear under new guise in the future. We conclude from our examination of groundfish and pelagic stocks that in order to protect the fish and the fisheries from the unpredictable potential negative influence of nature it would be prudent to fish at a low fishing mortality rate. In order to rebuild the stocks it will be necessary to keep fishing mortality very low. Once stocks are rebuilt, continued conservation of stocks probably would necessitate that fishing mortality should not exceed the mortality that occurs naturally, on average, in the absence of fishing. For most groundfish and pelagic stocks this would imply that less than 20% of the available fish of commercial sizes would be harvested annually, the percentage for redfish being lower because of a longer maturation period while that for silver hake would be higher. In some cases it may be necessary to maintain fishing mortality below the average natural mortality when stocks are very low, as is presently the case, or when non fishing fish deaths increase because of diseases, predation, climatic or environmental conditions.

The theory of population dynamics generally assumes that fishing mortality is directly proportional to the amount of fishing effort applied by the fishing fleets. Before the Atlantic groundfisheries were closed, the fishing mortality exerted on the stocks was about 4 times higher than the average rate of natural mortality of about 20%. Fishing mortality therefore needs to be reduced by a substantial amount. This is unlikely to be achieved simply by controlling landings because stock assessments clearly show that fishing mortalities have increased during most of the 1980s when Total Allowable Catches (TACs) were intended to control it. It will therefore be necessary to use additional means to decrease fishing mortality. Direct control of the amount of days fished could be useful in the short to medium term, but the most robust and reliable approach is to scale the fishing capacity to the productive capacity of the resource. This problem is often stated as "too many fishermen chasing too few fish".

This formulation artificially limits the possible solutions to reducing the number of fishermen while limiting the technology used could be as or more effective.

1 See comments of Professor Charles in Annex 8

2 On the other hand, nature being chaotic makes it difficult to adjust capacity

It is possible for stocks to rebuild even if fishing mortalities are higher than suggested above, such as occurred with Barents Sea cod in the late 1980s, but this requires climatic and environmental conditions which are very favourable. It would not be prudent to count on such conditions occurring in the current Northwest Atlantic groundfish situation.

INTRODUCTION

In its November 1993 report to the Minister of Fisheries and Oceans, the Fisheries Resource Conservation Council (FRCC), indicated it would create a Historical Perspective Subcommittee. Its rationale was that

> "Many fish stocks throughout the world have exhibited dramatic collapses and recoveries. Investigating these variations may reveal patterns and indicate strategies which could be helpful in understanding how the present state of groundfish stocks in Atlantic Canada developed and, more importantly, identify science and management priorities to assist recovery."

This statement of purpose dictated the method of work of the subcommittee: the case study approach. By reviewing in detail the information available on a number of stocks in different situations, it has been possible to draw conclusions which should have wide application.

We considered at least one stock from each of the ecological regions used by the FRCC in its November 1993 report: Newfoundland Shelf, Scotian Shelf, Gulf of St. Lawrence. Northern (2J3KL) Cod collapsed in the mid-1970's but recovered partially after extension of jurisdiction and subsequently collapsed again. This stock provided an opportunity to assess if it was possible to distinguish and quantify the relative importance of the environment on recruitment, growth and mortality from that of overfishing and on bad fishing practices. Southern Gulf (4T-4Vn (January-April)) Cod also collapsed in the mid-1970's, and recovered after extension of jurisdiction, but it declined to a low level in the early 1990s. It was the main stock from the second ecological region. Eastern Scotian Shelf (4VSW) Cod is from the third ecological region. The rebuilding of this stock after extension of jurisdiction was more rapid than expected while its recent collapse was somewhat precipitous. Multispecies effects (mostly grey seals) and detrimental fishing practices (discarding) are both believed to have played a particularly important role.

Other stocks in the Canadian zone were selected in order to study some particular aspects believed to be important. The role of science and its relationships with fishermen was examined by studying 4T herring while Northern Gulf of St. Lawrence (3Pn4RS) Cod was examined to assess the effects on bad fishing practices. Gulf of St. Lawrence redfish was examined to study the effects of sporadic recruitment on fisheries management approaches. Grand Bank (3LNO) haddock was considered to provide an example of a stock which had collapsed,had shown some initial signs of recovery and then continued failure.

To gain further insights, stocks from outside the Canadian zone were also examined: West Greenland, Icelandic and Barents Sea cod as well as North Sea cod.

The group wants to acknowledge the help of DFO regional staff who made excellent presentations which helped considerably the work of the subcommittee.

LESSONS LEARNED

The first lesson we learned was one of humility: humans cannot control nature in the manner assumed by standard fisheries models.

Nature can affect fish stocks in many ways. It affects where and when fish spawn, how well they survive as eggs, larvae, juveniles and adults and it directs fish in their migration. Fishermen often experience nature's effect on migration routes, but its most profound long term influence is exerted through how it affects the number of young which will survive from the eggs produced in a given year to reach the adult stock. A few examples of how nature exerts its influence are given below.

Our first example deals with the Arcto-Norwegian cod off the coasts of Norway and Russia and its relationship with capelin. The Barents Sea capelin stock collapsed in 1985 and as a result, Norwegian scientists hypothesized that adult cod increased their predation on juvenile cod. The abundance of the 1984-1986 year-classes which appeared very abundant at age 0 in surveys decreased from being above average to smaller than average because of this increased predation by adult cod on juveniles. Combined with high fishing mortality, this lack of recruitment caused the stock to decrease rapidly which led to stringent management measures in 1990 as indicated in the following table.

Year	1987	1988	1989	1990	1991	1992	1993	1994
TAC	560Kt	590Kt	300Kt	160Kt	215Kt	356Kt	500Kt	700Kt
Catch	523Kt	435Kt	332Kt	212Kt	319Kt	513Kt	582Kt	

The cod stock subsequently recovered rather rapidly and this is generally attributed to the strong management measures which have been taken by the Norwegian government. Although there is no doubt that the timing and extent of the management measures helped stock recovery, nature's influence on recruitment and growth also played a major role. One of the measure of recovery of this cod stock is the abundance of the spawning stock biomass and as a result of improved growth, fish have become mature earlier, they have entered the spawning biomass at an earlier age than is normally the case for this stock, therefore artificially increasing the apparent speed of stock rebuilding.

Unit 1 redfish provides another example of nature's influence on recruitment. For this management unit, strong year-classes were produced about every 10 years with very weak, almost non-existent year-classes in between. Therefore there is a high variability in the success of spawning due mostly to nature and not to the abundance of the spawners. For many of the other stocks we have examined, year-classes of below average abundance have been produced even when there were plenty of spawners. The abundance of adult cod in the first half of the 1980s was as high as it had been during the previous 20 years for most Canadian cod stocks, except for northern cod, and the 1983 and 1984 year-classes were nevertheless amongst the weakest ever produced. An example of the opposite effect is offered by haddock on the Grand Banks where strong year-classes were produced in the early 1980s despite extremely low spawning stock biomass.

Based on the above, it could be tempting to conclude that nature is the only factor determining the fate of recruiting year-classes, but this is not the case. There is a point, albeit perhaps at very low spawning stock biomass, where the abundance of recruits is directly influenced by the abundance of their parents. This means that if the abundance of spawners decreases further it will have a direct immediate negative effect on subsequent recruitment. In addition, there is ample evidence from many stocks of various species around the world, that on average, the year-classes produced by large parental abundance are stronger than those produced by low parental stocks. It is therefore our unanimous conclusion that prudent fisheries management <u>must</u> assume that there is a link between the abundance of spawners and the abundance of their progeny3 . We recognize, however, that the overall limits to the productivity of the stocks are set largely through nature's influence on recruitment. This means, as mentioned above, that weak year-classes may be produced even when the abundance of spawners is high and if these conditions persist, the stock will decrease. This is in fact what happened to Canadian cod stocks during most of the 1980s when recruitment appears to have been below average. Combined with very high fishing mortality, the reduce recruitment has resulted in rapid decreases in stock sizes in the early 1990s. One obvious conclusion would be the need to better monitor recruitment.

3 Again, refer to comments of Professor Charles in Annex 8

The observation that nature plays an important role in determining overall stock productivity, does not mean that human actions have no influence. The North Sea cod stock provides a striking example. Recruitment has fluctuated without trends in that stock, and in theory, if fishing mortality had remained stable, this would have resulted in the stock also fluctuating without trend. However, fishing mortality increased steadily and stock abundance shows a definite downward trend.

Haddock on the Grand Banks provides another example. These stocks collapsed as a result of heavy fishing in the 1950s and early 1960s. There remained a very small stock during most of the 1970s, but in the early 1980s, two strong year-classes were produced from these few spawners. If these year-classes had been protected, allowed to grow, mature and reproduce there would have been a possibility of stock rebuilding. But this did not happen. These two year-classes were harvested very quickly as soon as they reached commercial size and the opportunity to rebuild the stocks was wasted.

There are also examples of successful management actions which led to stock recoveries. Immediately after extension of jurisdiction and before the Canadian fleets were renewed, there was a decrease in fishing mortality on eastern Canadian cod stocks. Combined with average or above average recruitment produced immediately before extension of jurisdiction, this decrease in fishing mortality allowed year-classes to grow, mature and reproduce. This resulted in most cod stocks reaching high biomass levels in the early 1980s. Similarly, the southern Gulf of St. Lawrence herring stock in the early 1980s and Unit 1 redfish in the mid 1980s rebuilt after fishing effort and fishing mortality were substantially reduced. These examples show that stocks may recover rapidly when fishing mortality is reduced.

Most of this section has focussed on the effect nature has on recruitment but nature influence all life stages. For example, stock assessments and projection models generally assume that the growth rate of the fish will in the future be the same as in the recent past. This assumption proved to be erroneous for all cod stocks north and east of Halifax on the Canadian east coast in the 1980s when weights at age decreased steadily from one year to the next. Another important factor which is assumed to be constant from one year to the next is the rate at which fish die from natural causes (natural mortality). This is unlikely to be true and it would seem logical that the mortality of prey species would be dependent on the abundance of their predators. Based on this hypothesis, we would expect that species which are normally prey to cod would presently experience a lower mortality from cod predation than when cod biomasses were higher. The current high abundance of shrimp is consistent with this hypothesis.

There are few data available to estimate changes in the natural mortality rate of prey as a result of changes in abundance of a predator, but recently this has been studied for eastern Scotian Shelf cod, one of the stocks we have examined. The grey seal population on Sable Island has increased steadily since the early 1960s and many people suggest that grey seals are the prime reason for the demise of 4VsW cod. They assume that because grey seal abundance increased at a steady rate that the mortality exerted by grey seals must have increased at the same rate. The mathematical model constructed by scientists to estimate the effect of the increased grey seal population on cod shows that, before firm conclusions can be reached, more information is required with respect to the seasonal distribution of grey seals, their diet by area and season and the changes in abundance of other prey over time. Because samples of the seals diet have not been collected during all seasons and in all areas where grey seals are present, it has been necessary to assume that the samples which were available reflect the diet of grey seals during the periods and in the areas where there were no samples. But if in fact the grey seals in a given unsampled season were in areas where there were no cod, then they would not be expected to consume cod at those times. Similarly, if there is an abundance of energy-rich prey such as herring in an area, then it is possible that grey seals would feed less on cod. The results nevertheless indicated that the grey seals probably consumed a larger tonnage of cod than the fishery did in 1992. Since most of the cod consumed by grey seals were less than 45 cm in length, this means that the number of cod consumed by seals was much greater than the numbers landed by the fishery. But it was not possible to reach firm conclusions on how much greater the amount of cod consumed by grey seals was today compared with the 1970s. Some blame for the collapse of this cod stock could be attributed to the seals but it is generally understood that this fishing area was not only subject to heavy fishing pressure but also widescale dumping and discarding. Although not quantified precisely, there were enough reports of this taking place to suggest that the amounts were substantial.

In June 1995, updated harp seal population estimates and their consumption of prey have been published. They indicate that the harp seal population now numbers in the order of 4.8 million animals. For the 2J3KL area, estimates suggest that the consumption of all prey combined has increased from about 1.45 million metric tons in 1981 to about 2.79 million metric tons in 1994. The 1994 diet is estimated to have consisted mostly of Arctic cod (1.2 millions tons) capelin (620,000 t) with Atlantic cod accounting for 88,000t.

The examples reviewed above show that nature has a large influence on many factors affecting fish stocks and especially on the strength of the year-classes that are produced. This means that strong year-classes can be produced even when parental abundance is low such as for the Grand Banks haddock or that recruitment can be low even when parental abundance is high such as was the case for most cod stocks on the Canadian Atlantic coast during the early 1980s. In addition, nature influences the rate of natural mortality and the rate of growth of individual fish as shown for the Arcto-Norwegian (increased growth and maturity in the late 1980s-early 1990s) and Canadian (lower growth during most of the 1980s) cod stocks. We therefore believe that in order to protect the fish and the fisheries from the unpredictable potential negative influence of nature it would be prudent to fish at a low fishing mortality rate. Otherwise, if a string of several weak year-classes is produced when the fishing mortality is high, parental abundance will decrease quickly, decreasing the probability that strong year-classes will be produced, and increasing the risks of stock collapses such as occurred for eastern Canada's cod stocks in the early 1990s.

The second lesson we learned is that human behaviour is very difficult to control.

From the early 1960s to the early 1970s there was a rapid increase in fishing effort by European fleets off the shores of North America. These fleets were using large trawlers as well as factory trawlers. They initially focussed on groundfish species and then on pelagics. Stock assessments at the time indicated that by the early 1970s many stocks were experiencing very high fishing mortality and were being depleted quickly. This depletion of resources off the Canadian and USA shores by foreign fishing fleets led Canada and the USA to extend their jurisdiction over fisheries to 200 miles in 1977.

After Canada extended its jurisdiction to 200 miles in 1977, Canadians believed that their fishing effort could never be as efficient as that of the large fishing fleets which had just been excluded from our zone. At best, the Canadian fleets would exert a small fraction of the effective foreign fishing effort, fishing mortality would be tightly controlled through precise stock assessments and stringent enforcement, and stocks would be rebuilt quickly and permanently.

Stock monitoring programs were designed to provide precise stock assessments which would be used to design fair and efficient management plans to be implemented through tight enforcement of the rules and regulations. These plans were developed bearing in mind that the Canadian fleet was moderately efficient and probably able to apply a fishing mortality corresponding to the then recently established target of removing about 20% of the commercial biomass each year.

Stocks started to rebuild quickly, because fishing mortality had been reduced significantly and strong year-classes which had been produced just prior to 1977 were protected, allowed to grow and mature and they were entering the fisheries. Commercial catch rates increased rapidly and stock assessments were criticized as being too pessimistic, by underestimating the stock sizes. The rapid increases in catch rates fuelled optimism and despite repeated warnings that the domestic fishing capacity which existed in 1977 was sufficient to harvest the catch available from the rebuilt stocks, large investments were made to build new and more powerful and efficient vessels. Old wooden side trawlers were replaced with fiber glass or steel stern trawlers, loaded with the latest electronic equipment to navigate accurately and find the fish efficiently. The foreign harvesting capacity which had exerted the high fishing mortalities causing stock collapses in the early 1970s was rapidly replaced by a domestic one in the early 1980s when the fleets had been renewed.

These vessels needed to be very efficient at catching fish because they were expensive and large loans had to be repaid. As fishing capacity increased, so did the difficulties in controlling the fleets within the TACs. Initially in the late 1970s - early 1980s groundfish mobile gear fleets in Atlantic Canada and Québec were managed according to two fleet categories: vessels less than 100 feet and vessels over 100 feet. Fixed gear were under an allowance system which did not limit their catches. The quotas were set globally for each sector and because of the increasing stock sizes and increasing fishing capacity, they were fished quickly, resulting in some fleets or areas not being able to fish. This led to seasonal, geographical and fleet specific subdivisions of the quotas in order to allow all fleets to share in the resource. Fixed gear which previously were on an allowance system were brought under quotas in the early 1980s. Enterprise allocations were introduced in the offshore mobile sector (EAs) in the early 1980s to slow the race for the fish and allow the companies to rationalize their operations. IQs and ITQs were introduced in the second half of the 1980s in the midshore and inshore mobile gear sector essentially for the same reasons. The end result in the early 1990s is a complex and intricate set of management rules and regulations and fleet categories which proved very difficult to monitor and police with reduced human and financial resources.

All the Canadian cod stocks we have examined have suffered from bad fishing practices: misreporting by species and area in the early to mid 1980s, under-reporting whenever possible, high-grading with the introduction of EAs and I(T)Qs, discarding with the implementation of the minimum landing size, etc.

In the mid-1980s, companies were fishing for markets. Captains were given specific instructions on what species to bring back, and in what quantities, and according to some reports even what sizes. When the load of fish diverted from the instruction, captains and crews were penalized. The only way to stay within the instructions was to high-grade, dump and discard. These bad fishing practices were widespread and not specific to any one company.

In the trap fisheries, discarding occurred also when fish were too small for the markets. The bad fishing practices became tacitly accepted as the way of doing business and they became so entrenched that they continued in 1994 in areas where groundfisheries were open. Over the years, the bad fishing practices have led to a severe deterioration of the quality of the catch data used in stock assessment but also in the historical data base used to make resource allocation decisions. In several of the Canadian stocks we have examined, it is believed that the recorded landings are but a fraction of the quantities of fish that were actually caught.

Many measures have been put in place to try to control bad fishing practices and fishermen themselves want them to stop. But there appears to be a vicious circle whereby the measure intended to protect the resources end up having an opposite effect. The introduction of the minimum size limit in 1988 provides such an example. The minimum fish size was introduced at the request of the fishing industry to minimize the catch of small (juvenile) fish. The new regulation was not accompanied by an effective increase in mesh size or hook size. Therefore the same mix of sizes continued to be caught and undersized fish were simply discarded dead when they could not be sold under the table.

A significant result of the deterioration of the data is that stock assessments became progressively less reliable during the 1980s. Scientists mentioned this problem in the mid-1980s but they nevertheless continued to provide stock assessments and to defend them[4] . It became evident at that time that the target fishing mortality of $F_{0.1}$ had been significantly exceeded since the early 1980s for most stocks. In order to achieve the target, fishing mortality, fishing effort and catches would have to be reduced by substantial amounts. This was considered unrealistic and many in the fishing industry questioned the accuracy of stock assessments - catch rates in the commercial fleets were still increasing or remained high. In addition, it was well known that scientists during their surveys fish mostly where there are no fish and it was not a real surprise that their surveys suggested that stock sizes were not as high as previously thought. The 50% rule was introduced to phase-in the reductions in fishing mortality but recent stock assessments indicate that fishing mortality in fact continued to increase during most of the 1980s. In addition to this “institutionalized” overfishing, scientists realized in the late 1980s, that their previous assessments of the stocks had in fact been optimistic and that they had overestimated the abundance of the stocks consistently - the so called retrospective pattern. The problem still has not been solved and although the increasingly poor quality of the catch data certainly played a major role, it is unlikely to be the only factor.

The bad fishing practices, the “institutionalized” overfishing, the overestimation of stocks by scientists, the poor environmental conditions and the increased abundance of predators all added up to put the stocks in the very precarious situation they were in the early 1990s. Although all the factors are linked, we believe that the damage inflicted on the stocks would have been less if the capacity of the fleets to catch fish had not been so great.

This brings us to our third lesson.

The third lesson we learned is that we should match the harvesting capacity of our fleets to the productive capacity of the resource.

As we mentioned earlier, fishing mortality on groundfish stocks in the late 1980s - early 1990s reached very high values equal to or exceeding those exerted by foreign fleets before extension of jurisdiction. These high fishing mortalities were

4 There were technical difficulties, for example, with the 1986 northern cod assessment

exerted despite many restrictions on where, when and how much the fleets could fish. Therefore, if the fleets were allowed to fish without restrictions, they could exert an even higher level of fishing mortality. From our review of stocks, we believe that it is not possible to monitor precisely either the fish or the fleets and we accept we cannot control recruitment to the stocks. We believe the only reasonable way to prudently harvest the amount of fish that nature provides is to drastically reduce permanently the fishing capacity of our fleets.

One of the objective of the introduction of ITQs and EAs was to reduce fishing capacity. They did achieve a small reduction to an economic equilibrium, but this equilibrium corresponds to fishing mortalities which far exceed that necessary to achieve healthy stocks in the long term. Total Allowable Catches (TACs) have been used in the past to attempt to control fishing mortality, but as current stock assessments clearly show, they have not been effective by themselves - fishing mortalities have increased during most of the 1980s. It will therefore be necessary to use additional means to decrease fishing effort. Direct control of the amount of days fished could be useful in the short to medium term, but fleets would continue to increase their efficiency and they would eventually be able to exert the same fishing mortality in fewer days. The most robust and reliable approach is to periodically scale down the fishing capacity to the productive capacity of the resource.

The fishing mortality on cod stocks in the early 1990s reached $F=0.8$ or more compared with a reasonable fishing mortality, about equal to the average natural mortality, of $F=0.20$. Considering that there is a direct proportionality between fishing effort and fishing mortality, fishing capacity needs to be reduced by at least a factor of 4. This cannot be achieved indirectly, it has to be done directly and decisively.

This overcapacity problem in the Atlantic groundfisheries has often been stated as “too many fishermen chasing too few fish”. This formulation artificially limits the possible solutions to reducing the number of fishermen, while limiting the technology they use could be as or more effective.

Trawlers, especially the modern ones used in the Atlantic zone groundfisheries, are very efficient at finding and catching fish. They exerted by far the largest share of the fishing mortality during the 1980s and 1990s when fisheries were open, and although they were not the only culprit, it is also in this gear sector that the possible damage inflicted by bad fishing practices is the greatest.

CONCLUSION

Many attempts have been made to explain the declines in groundfish stocks and the focus of attention has, more often than not, being on northern cod. The decline of this resource in the 1980s and 1990s has been attributed to a number of factors, including:

- the replacement of foreign effort by the Canadian offshore,
- technological advances which greatly increased fishing capacity,
- overfishing, dumping, discarding small fish, high grading,
- disruption during spawning by trawlers,
- gillnet ghost fishing,
- codtraps killing too many small fish,
- foreign fishing outside 200 miles in 3L,
- the uncontrolled seal population,
- overestimation of biomass and recruitment,
- harsh environmental conditions.

All of those factors no doubt played a role but the debate continues to this day as to the relative importance of each.

After extension of jurisdiction in 1977 we unknowingly erred on the side of optimism. Although we agree that we should not err at all, taking a precautionary approach will help to ensure that if we do err, we will err on the side of caution. We do not think that all the lessons have been learned. Other mistakes will be made and there is a high likelihood that old mistakes will be repeated under the guise of new ones. We are convinced it will require superhuman efforts and extraordinary vigilance to ensure that past mistakes are not repeated. But if fishing capacity is reduced by the proportion indicated above the potential damage which will result from these mistakes will be substantially smaller.

Despite our introductory quotation, we recognize that the forces which led to past mistakes are still in action. It will therefore take considerable efforts to avoid past pitfalls. We conclude from our examination of groundfish and pelagic stocks that the rebuilding and conservation of stocks requires that fishing mortality should not exceed the mortality that occurs naturally in the absence of fishing. For most groundfish and pelagic stocks this would imply that less than 20% of the available fish of commercial sizes would be harvested annually. The value for redfish would be lower, and for silver hake it would be higher.

The only reliable way to ensure that fishing mortality does not reach undesirably high values is to periodically scale down the fishing capacity of the fleets to the productive capacity of the resource.

Although it is possible for stocks to rebuild even if fishing mortalities are higher than suggested above, such as occurred to Barents Sea cod in the late 1980s, this requires conditions which are very favourable. It would not be prudent to count on such conditions occurring in our situation. If our stocks where to bounce back only by chance without solving the fundamental problems of the fishery, then the rebuilding would run the risk of being short lived.

The present collapse of cod stocks in the Northwest Atlantic is worst than the one which occurred in the mid 1970s. At that time, the strong year-classes of cod of 1973 to 1976 were already produced and so to speak in the bank to start the stock recovery of the late 1970s. Presently, however, there are no average or strong year-classes in the bank and it will therefore take longer for the stocks to start rebuilding. In addition, the possible increased predation on small cod as a result of larger seal populations may further slow the rate of recovery. This is unfortunate, but it may afford an opportunity to make the changes required for the fisheries of the future to be sustainable.