The Managed Commercial Annihilation of Northern Cod

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INTRODUCTION

IN THE FALL of 1986, we were asked by NIFA (the Newfoundland Inshore Fisheries Association) to review the paper entitled "An examination of factors affecting catch in the inshore cod fishery of Labrador and eastern Newfoundland" (Lear et al. 1986), which attempted to assess the importance of various environmental factors that had led to the poor inshore fishery in 1985. We concluded that the basic assumption of a fishable stock of 1,250,000 metric tons was not justified and that there was a strong inverse correlation between recent offshore landings and the inshore catches. As a result a study was made of the recent (in 1986) assessments of the northern cod stock. This study concluded that the assessments had overestimated the size of the stock with the result that fishing mortality had been underestimated (Keats, Steele and Green 1986). These findings were communicated to the federal Minister of Fisheries in December and representations were subsequently made to the Task Group on the Inshore Fishery (Alverson 1987) and the Northern Cod Review Panel (Harris 1990).

These representations were completely ignored and the commercial fishery for northern cod has now been shut down and a moratorium declared. One of the world's greatest sustainable protein resources that should be able to sustain annual landings of more than 400,000 metric tons has been allowed to decline to virtual oblivion.

The present paper reviews how this ecological and economic catastrophe has occurred, with the hope that *if* the stock is allowed to recover again, past mistakes will not be repeated.

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THE MORATORIUM

A moratorium, one dictionary tells us, is a period of obligatory delay. Why is it necessary and what happens during it? And what happens when it is over?

On July 2, 1992, John C. Crosbie, Minister of Canada's Department of Fisheries and Oceans (DFO), appeared at a press conference in St. John's, where he announced the government's decision to impose a moratorium on the Canadian — chiefly Newfoundland — exploitation of the northern cod stock. Federal fisheries managers took a radical step, one ostensibly designed to restore a fishery long in decline despite their management efforts.

Provincial government officials publicly predicted that the moratorium would have a severe impact on employment, the provincial economy and the well-being of outport fishing communities. It was suggested that 19,000 fishers and plant workers would be directly affected, and perhaps 20,000 others — a total of 39,000 jobs, mainly in Newfoundland but also in Quebec — would be either lost or harmed in an economy already desperate for employment. Cabot Martin, President of NIFA, described the situation as one of "total failure of one of Canada's great natural resources." Various observers spoke of the moratorium as a cultural catastrophe; Newfoundland, it was said, would lose its small outport way of life and its distinctive culture. Comparisons were drawn between the moratorium and the community resettlement program of the 1960s, another purported cultural catastrophe recalled as having been forced upon Newfoundland's people.

Crosbie, perhaps forgetting for the moment that the fishery, Newfoundland, and its distinctiveness are symbolically *one* in the thinking of many if not most Newfoundlanders, may initially have attempted to diminish the magnitude of the moratorium's human impacts. He observed that Newfoundland's fishery "generates 6% of the value of all goods and services produced in the province." He went on to note that "hundreds of communities ... are dependent on the fishery." But his remarks were taken to imply that the actual loss and consequences would be trivial.

This quantification sparked a minor but rancorous debate. Some took the minister's side, while others, like Tom Best, President of the Petty Harbour Fishing Cooperative, and MHA John Efford, Head of United Fisherpersons of Newfoundland and Labrador, argued that in fact the fishery contributed directly and indirectly to 70% or more of the provincial gross domestic product.

When the moratorium was announced it was linked with a fisheries "adjustment" package, which Crosbie held to be "a necessary response to an ecological crisis of unprecedented scope." The announcement sketched measures for an initial or emergency ten week plan. The complete package would assist fishers and other directly affected industry workers to, among other things, either keep some economic footing until the fishery was reopened,

voluntarily retire, or retrain for work in other industries — with the expectation that many so retrained would leave fishing permanently. Licenses would be retired, and the government would assist vessel owners and fish processing plants.

Many workers displaced by changing conditions in other sectors, e.g. forestry, agriculture, and mining, watched what the federal government was doing in the Atlantic fishing industry. They naturally wondered why the federal government had not offered them similar special aid packages beyond the established "safety net" of Unemployment Insurance (UI). The federal and provincial government answer is that Ottawa has retained the exclusive right to manage marine fishery resources off Newfoundland. It does not have similar jurisdiction in other resource industries. Some find this action discriminatory despite this rationale.

In Newfoundland the perilous condition of the northern cod stock was widely appreciated. Yet news of the moratorium fell like a thunderclap. Fishers and fish plant processing workers, together with their union leaders, immediately expressed strong negative reaction to the terms of the announcement. In seven days their government would bar them from their livelihoods and well-being. Careers, families, homes and mortgages, businesses and entire communities were suddenly in grave danger.

The immediate special focus of their wrath was the weekly wage proposed to sustain fishers and plant workers during the short initial transitional period until a more firm plan would be in place. To many, the preliminary scheme seemed inadequate and insulting. Speculating that it was keyed to the lowest income level under UI guidelines, Richard Cashin, President of the Fishermen, Food and Allied Workers union (FFAW) held it to be simply unacceptable. Further, declaring the moratorium decision arbitrary, he proposed that fishers respond with civil disobedience: "The only way to funnel our energies [in opposition] is to go [on] fishing!"

Heeding the criticism, the federal minister agreed to reexamine the adjustment program and to discuss the situation with the federal cabinet.

His comments about his future action seemed a measured statement of determination to press for an increase in the sums even at risk of personally resigning should he fail. Taken as a display of loyalty to Newfoundland and its fishery, perhaps this somewhat defused the heated atmosphere. In the event, the adjustment payment figures were increased, most fishers affected ceased fishing, and Crosbie remained Minister of Fisheries and Oceans. Like oil on troubled waters, the injection of federal funds may have calmed many tempers and silenced many voices.

On the Canadian mainland, however, the plight of Newfoundland's labor force — fishers and fish plant workers in particular — became a major media topic for a time. There was a flurry of letters to editors in support of

Newfoundland workers, and criticism of federal government handling of the situation. The federal leadership, already wounded politically by a weak national economy in recession, high unemployment, and an unending constitutional crisis and debate, now faced another problem of major regional importance.

The long-standing clamor for an explanation for the northern cod decline was renewed. A litany of familiar scapegoats was repeated: growing harp seal herds, ice and cold water, disappearance of caplin, foreign overfishing, domestic overfishing and, of course, federal mismanagement. The moratorium, a conservation action intended to solve a major resource problem, itself became a further political crisis. Highly paid DFO personnel were seen to be scrambling, struggling to establish what seemed like jury-rigged arrangements necessitated by the moratorium and the human crisis it exacerbated. As a result, DFO's leadership was further discredited for its inept handling of another management decision — the moratorium.

On the sidelines, observers, like the authors of this paper, wonder how the proposed plan was arrived at, although reasons for imposing the moratorium were clear enough. There was grudging acceptance at the inshore fisheries level that the moratorium was necessary and that strong protective action was long overdue on the federal government's part. But some fishers, especially those with heavy financial investments in new boats and gear, wondered why their government had not warned them that such a drastic action was being considered and how they would be able to survive their personal financial crises.

DFO's moratorium shocked many inshore fishermen, especially after they had lobbied for several years for greater total allowable catch (TAC) reductions in the face of contrary government management decisions. Other fishermen felt that they had been misled; had they been given some indication that the moratorium was in the offing, they would not have continued to invest in boats and gear. Some suspected that federal authorities were deliberately managing the inshore fishery in such a way as to push their way of life into oblivion.

By 1992, however, the northern cod stock had been overfished to commercial extinction and other stocks were in danger, the fishing industry was over-capitalized in vessels and processing plants, its labor force had suddenly lost its economic base, and the future was highly uncertain for thousands of Newfoundlanders. Hundreds of communities and enterprises, and perhaps a way of life that many believe is crucial to Newfoundland's social and cultural distinctiveness, seemed in jeopardy.

The Newfoundland fishery and Newfoundland society are at a precipice. How did this happen in an era of modern fisheries management? Much of the answer lies in the history of DFO procedures and management decisions. The following discussion deals with key elements of this scientific and management

history, provides an outline of how DFO's management and decision-making process is organized for the creation of its annual Atlantic Groundfish Management Plans, and presents our conclusions, together with compelling questions raised by this crisis and the moratorium.

LANDINGS OF NORTHERN COD (2J3KL) AND THEIR VARIATIONS

Estimated historical landings of northern cod, compiled from various sources are shown in Figure 1. Until the 1950s catches were not apportioned to division, so the early figures have been estimated as the portion of the total Newfoundland landings that are considered to have been of northern cod. Although the International Commission for the Northwest Atlantic Fisheries (ICNAF) was established in 1950, the collection of separate statistics for catches of inshore and offshore northern cod landings began only in 1958.

Between 1804 and 1947 Newfoundland catches of northern cod increased linearly from about 75,000 to 200,000 metric tons (Figure 1). This gradual increase was probably related to an increase in effort related to the increase in population during this period. Changing technology such as the introduction of the cod trap in the 1860s and the long-trawl in the 1880s seems to have had little effect on the landings.

Yearly fluctuations in landings in this period amounted to 35,000 metric tons above and below the regression line and seem to have been related mainly to economic conditions such as the price collapse in the 1890s, the Depression of the 1930s, and variations in demand associated with the two world wars. The effect, if any, of environmental conditions such as water temperatures during the fishing seasons or during the spawning seasons was obscured by economic or other unknown factors.

From 1948 onwards, Newfoundland catches of northern cod declined. A combination of factors may explain the decline in the early 1950s: decreased effort because of demand for other species such as haddock, the availability to fishermen of alternate sources of employment, or a natural fluctuation in the stock size. With the increase in offshore catches of cod by foreign vessels to a maximum of 709,000 metric tons in 1968, inshore catches continued to drop. They fell to 35,000 metric tons in 1974, the smallest catch since 1804.

The fact that such large offshore catches were possible in the 1960s indicates that the earlier Newfoundland catches of northern cod of up to 200,000 metric tons were well below the sustainable yield. However, the massive offshore catches between 1959 and 1973 depressed the stock size, with the result that inshore catches fell to their minimum in 1974.

Offshore catches plummeted after 1968. Catch restrictions (TACs) were imposed in 1973, but not until 1977 and the adoption of extended jurisdiction to 200 miles were the TACs reduced to the level of the actual catch.

There was an initial period of euphoria and optimism about the future of

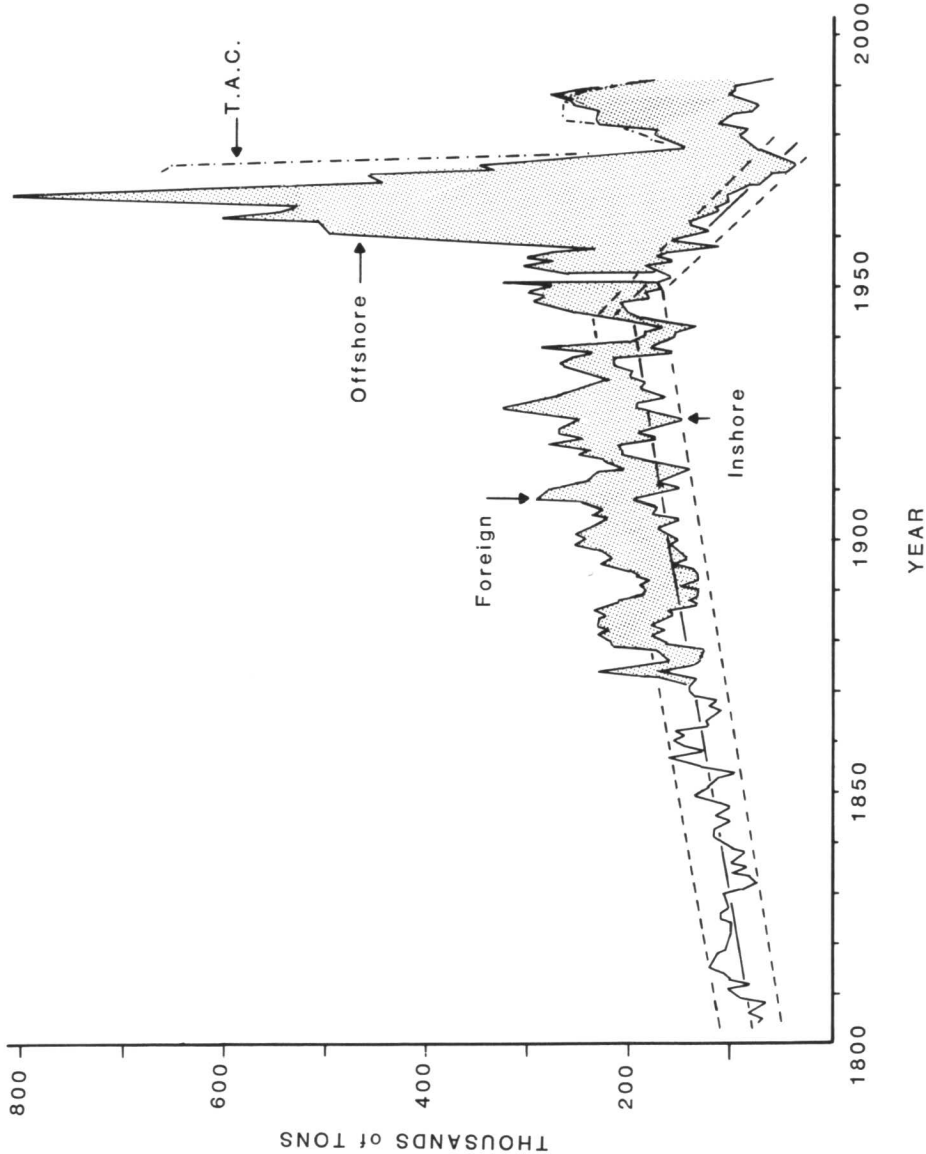
T.A.C.
Offshore
Foreign
Inshore
THOUSANDS of TONS
800
600
400
200
1800
1850
1900
1950
2000
YEAR

Figure 1

Canadian fisheries following the establishment of the 200 mile fisheries management zone in 1977. The industry moved anxiously, with government encouragement, to expand its catching and processing capacity to take advantage of the preferential fishing privileges granted the coastal state, and to prevent expansion of foreign fishing in the new zone to take fish judged to be surplus to Canadian needs and capacity to harvest. If anything, the fear was that stocks would recover after about ten years and there would be so much fish that the real problem might be in marketing it.

Inshore catches increased to 115,000 metric tons in 1982, but declined subsequently. Offshore catches, now by Canadian vessels, increased from 57,000 metric tons in 1978 to 180,000 metric tons in 1987, but were subsequently reduced in stages to the current zero.

The relation between the size of the stock and the size of catches has been consistently downplayed over the years. Until catches from the North Sea were observed to increase following the cessation of fishing during World War I, overfishing in the sea was generally thought to be impossible. Even today, after many cases of overfishing have been documented, the myth persists that fishing does not affect the abundance of fish. Instead, declining catches are most often blamed on the environment (water temperature, pollution, etc.) or predation by whales, seals or birds. It must be recognized, however, that fishing will reduce the number of fish and that fish can only be caught once. Morever, as far as management is concerned, fishing effort is the only factor that can be effectively controlled and regulated.

History of fisheries management in the northwest Atlantic since 1949, with particular reference to northern cod

The historical facts are presented and are followed by our comments in parentheses. Figures 1 and 2, which document historical trends in fishing mortality and the biomass of the spawning stock (seven years old or older; i.e., 7+) northern cod, should also be referred to.

1949

Signing of International Convention for the Atlantic Fisheries "to make possible the maintenance of maximum sustained catch."

(The application of the ecological theory of the growth of populations to fisheries by Michael Graham [1939] led to the idea that populations could be exploited to obtain the maximum sustained yield [MSY]. Although possible in theory according to the Graham-Schaefer Model, in which the population [stock] is maintained at the size at which it grows fastest and catches [yield] are the excess [surplus production], the practical difficulties in achieving such a target led to its later abandonment.)

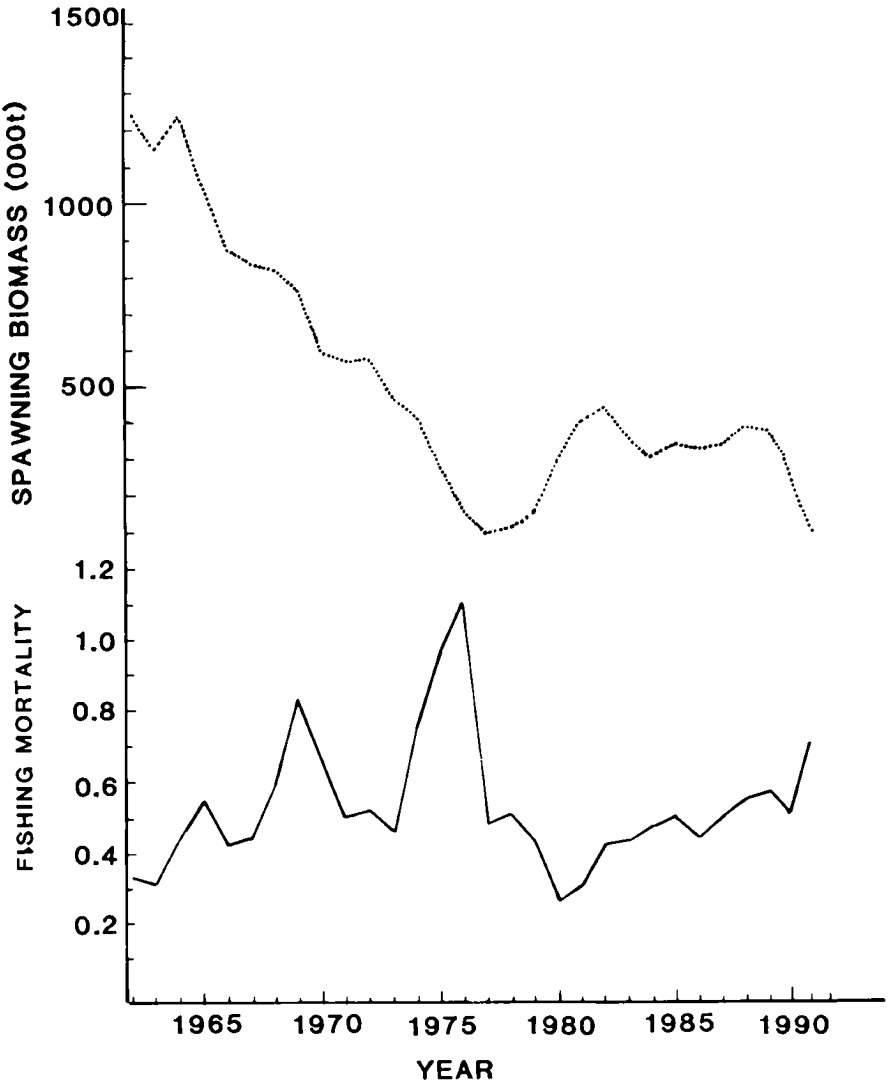
1500
1000
500
SPAWNING BIOMASS (000t)
1.2
1.0
0.8
0.6
0.4
0.2
FISHING MORTALITY
1965
1970
1975
1980
1985
1990
YEAR

Figure 2

1950

International Commission for Northwest Atlantic Fisheries (ICNAF) is established to coordinate the collection of catch statistics, to conduct research, and to manage multi-nation fisheries.

(The expansion of otter trawling in the northwest Atlantic by various countries following World War II made it necessary to have compilations of the total landings by all countries. Research was devoted to coordinating basic biological studies. Fish stocks were to be managed for maximum sustained catch, although only the New England stocks were perceived to be at risk through overfishing.)

1957

The Beverton-Holt (Dynamic Pool, Yield per Recruit, Analytic) Model was developed for fisheries research. This model provided an estimate of yields from a stock at various fishing mortalities (F).

(This equilibrium model uses estimates of factors such as growth, recruitment and mortality to calculate how the stock will respond. Since only catches can be directly measured, yields are related to rates of change or coefficients of growth, natural mortality [M] and fishing mortality [F] rather than the actual number of deaths, etc. If the coefficients are multiplied by the size of the stock in numbers or weight [biomass] the actual values can be determined. The model is simplified by assuming that natural mortality, which is very difficult to measure, is constant and is given a "reasonable value," usually 0.2. The model is further simplified by assuming constant recruitment. If this is done, the catch or yield from a single year class throughout the period from when it is recruited to the fishery until it finally disappears is equal to the average catch from the whole stock each year. Thus yields can be estimated from a single year class as it ages and passes through the fishery. Since the individual is a recruit entering the fishery, the latter is commonly known as yield per recruit. The total yield can be calculated if the total recruitment is known. Given these assumptions and appropriate estimates of weight at age, it is possible to calculate yields for various fishing mortality rates [F] for a year class as it moves through the fishery.

As fishing rates increase from zero, yield increases rapidly to a maximum and then decreases slowly, since yield depends on the interaction between numbers caught and their average weight. Thus this model provides estimates of yields for various values of F. The fishing mortality providing the largest yield is known as F_{max} or maximum yield per recruit. If recruitment does not vary with stock size $F_{max} = F_{msy}$, but if there is a correlation between stock size and recruitment F_{max} will be greater than F_{msy}.

This model demonstrates that, as fishing increases, more and more fish are caught, but an increasing proportion are new recruits and the average size of

the catch decreases. This is known as "growth overfishing." A marked decrease in the average size of the fish caught with time will indicate overfishing even if nothing else is known about the state of the stock. The model will also readily demonstrate the effects of varying the age at recruitment. For example, increasing the age at recruitment by using larger meshed gear will result in fewer fish being caught but a larger total weight [biomass].

This model was quickly adopted by fisheries management and remains in use today. The only significant changes have been in the choice of a target fishing mortality [F]. Initially this was usually F_{max} on the assumption that $F_{max} = F_{msy}$. However, it was soon realized that because of the low curvature of the yield curve the health of the stock could be adversely affected if the estimated F_{max} was too high, but the yield would not differ very much. Moreover, it does not make economic sense to fish this intensively, since better economic returns can be obtained at a lower fishing rate [F_{mey} or F_{opt}].

Increased concerns about the conservation of fish stocks led to the development of the concept of $F_{0.1}$. This was described by Gulland and Boerema in 1973. $F_{0.1}$ was adopted as a target for fisheries management by Canada in 1977. Although developed for conservation, $F_{0.1}$ is defined in economic terms as "the level of fishing mortality at which the increase in yield obtained by adding one more unit of fishing effort is 10% of the increase in yield to be obtained by adding one unit of effort to a lightly exploited stock." As such, it is quite arbitrary and could just as easily have been $F_{0.09}$ or $F_{0.11}$. $F_{0.1}$ is more conservative than F_{max}, F_{msy} or F_{mey} and could be expected to result in more older and larger fish in the catches and a more stable fishery, less dependent on newly recruited small fish. In practice, however, as will be documented below, actual values of F for northern cod have invariably exceeded the target $F_{0.1}$ with predictable catastrophic consequences. It should be noted that $F_{0.1}$ was not accepted as a suitable target F in Europe and thus has not been applied to the stocks outside the 200 mile limit that, since 1977, have been managed by the Northwest Atlantic Fisheries Organization [NAFO].)

1954

ICNAF introduced increased mesh sizes for otter trawls to allow the escape of small fish and to increase yields.

1961

Winter-spring foreign fishery for spawning cod in the offshore waters of divisions 2J3KL (northern cod) begins to increase. Offshore catches rise to a peak of 709,000 metric tons in 1968. Inshore catches of northern cod decline to a minimum in 1974.

1969

ICNAF establishes its first catch quotas (TAC) based on estimated maximum sustainable yields (MSY).

(Actual catches were much less than the TAC in this and subsequent years. Beginning a pattern that persists to the present, the failure to obtain the TAC was ascribed by ICNAF to environmental conditions rather than a reduced abundance of cod.)

1971

Based on scientific investigations and economic and technical considerations, the goal of management is stated by ICNAF to be to achieve optimum utilization of fish stocks.

(Although not defined explicitly, this is the first instance in which economic considerations were included in management planning.)

1972

Different values of F that might be adopted are discussed by ICNAF. These include $F_{0.1}$ which is described and defined in economic terms. The TAC for northern cod is set at 650,000 metric tons, using a fishing mortality (F_{max}) equal to 0.35.

1973

TACs are allocated to particular countries.

1974

Atlantic Offshore Groundfish Advisory Committee (OGAC) is formed by the federal government to receive industry reactions to fishery management proposals.

1976

An economic crisis in the fishery, in part due to overfishing, leads to a new approach to fisheries management and development by the Canadian government. This approach was to provide a guide for rebuilding Canada's commercial fisheries over the next ten years. "The guiding principle in fishery management no longer would be the maximization of the crop sustainable over time but the best use of society's resources. 'Best use' is defined by the sum of net social benefits (personal income, occupational opportunity, consumer satisfaction and so on) derived from the fisheries and the industries linked to them" (Federal Fisheries Minister Romeo LeBlanc 1976).

(This policy statement marks the end of MSY as a management strategy

and the adoption of a policy based on the achievement of long term socio-economic goals. Unfortunately, as documented below, these goals were completely lost sight of by the managers in subsequent years, and management became preoccupied with the catches [TACs] set for the following year and how they were to be divided up.)

1977

Canada extends jurisdiction to 200 miles.

(There have been persistent rumors to the effect that the boundary at least as it applied to the Grand Banks was a mistake, in that 200m was interpreted as 200 miles rather than as a depth of 200 meters. If so, it was a costly error, since the latter designation would have placed the boundary at the edge of the continental shelf and incorporated both the "Nose" and "Tail" of the banks. These areas, however, remained outside Canadian jurisdiction, with the fish to be managed by ICNAF and later by NAFO.)

"Since January 1, 1977 a primary objective of Canadian fisheries policy has been improvement in the viability of the fishing enterprise" (May et al. 1981).

(This statement by key federal fisheries bureaucrats reiterates the policy adopted in 1976.)

Advice on the management of Canadian stocks is now to be provided by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC). Beyond 200 miles and for transboundary stocks, such as those extending to the Nose and Tail of the Grand Banks, management advice was still provided by ICNAF.

The first management plan for northern cod (1977) was prepared in 1976 by ICNAF rather than CAFSAC.

(This set the pattern for all subsequent management plans.)

Because of depletion due to overfishing, the stock of northern cod was to be rebuilt. The target was to be a spawning biomass of 1.5 million metric tons (range 1.2-1.8 million metric tons). This spawning biomass was the amount estimated by ICNAF to be necessary to achieve a level of egg production such that the number of eggs spawned would not limit subsequent recruitment to the fishery. In other words, recruitment overfishing would be prevented. To reach this target, the TAC was set below the maximum sustainable yield as determined by F_{max}. The new reference point was $F_{0.1}$ This target fishing mortality rate was estimated to be equal to 0.2, well below the F_{max} of 0.35. Using $F_{0.1}$ the TAC for 1977 was set at 160,000 metric tons.

(Considering its importance as a management target for northern cod, the target size of the spawning stock biomass [1.5 million tons] has received very little study. However, DFO has expressed conflicting views as to the utility of spawning stock biomass as a management target and it has gradually diminished

in importance in management considerations.)

Based on its projections of the rate of rebuilding of the northern cod stock, DFO forecast a TAC of 402,000 tons by 1985.

(These and other overly optimistic projections, which were never realized, led to the rapid expansion of the Canadian fishing industry. In 1977, Canadian offshore landings of northern cod were small. In the expectation of landings comparable to those of the 1960s, expansion of the Canadian industry [inshore, offshore, and processing plants] was mandated to utilize the expected bonanza of fish.)

1979

January 1 — NAFO is created to supersede ICNAF.

A Northern Cod Seminar in Corner Brook discusses catch projections of 350-400,000 metric tons expected to be made by 1985, and how these catches might be made and processed.

"To provide for more rapid rebuilding of the stock and to allow recovery of the inshore fishery" (Pinhorn 1979), the target fishing mortality rate was reduced to 0.165. This is less than the $F_{0.1}$ level. The TAC was set at 135,000 metric tons.

Atlantic Groundfish Advisory Committee (AGAC) supersedes OGAC.

Doucet (1979) uses a projected catch of 350,000 metric tons for 1985 in preparing a strategy for the management of northern cod and evaluating alternatives for its harvesting.

DFO reduces its projected TAC for 1985 to 365,000 metric tons. The reduction is blamed on poor recruitment.

December 31 — ICNAF is disbanded.

1980

The development plan proposed by the government of Newfoundland and Labrador accepts the predicted doubling of the catch of northern cod by 1985 and recommends that the inshore fishery should catch 85% of the total (Government of Newfoundland and Labrador 1980).

Atlantic Coast Groundfish Trawler Study uses a projected 35% increase in groundfish resources, primarily cod, as a basis for projecting replacements of offshore trawlers.

1981

Projected landings for 1985 were estimated to be 250,000 metric tons for the inshore and 150,000 metric tons for the offshore.

Newfoundland Oceans Research and Development Corporation (NORDCO 1981) produces an extensive and detailed review of the history and potential for

harvesting northern cod entitled *It were well to live off fish.*

(While this study provides a valuable account of the fishery for northern cod, in retrospect its uncritical acceptance of fisheries management procedures was unfortunate.)

In *Policy for Canada's Atlantic fisheries in the 1980's: A discussion paper* (LeBlanc 1981), the government of Canada reaffirms the "best use" policy and the use of $F_{0.1}$ as a reference point. It rejects management for a minimum spawning biomass since "for no fish stock has it thus far been possible to define this critical spawning biomass." It also recommends more long term research, sector management and a greater involvement of fishermen in management decisions.

(Despite the assertion about the difficulties in determining the size of the critical spawning biomass, it continued to remain an important consideration in fisheries management for some time [see below]. Few of the latter recommendations were followed.)

May et al. (1981) project a biomass of 2,900,000 metric tons and a TAC of 350,000 metric tons for 1985.

DFO forecasts a TAC of 310,000 metric tons for 1985. The reduction from previous predictions is again based on poor recruitment.

(Since the spawning biomass had not yet recovered, below average recruitment and a failure to achieve projected TACs should have been expected.)

1982

Enterprise allocations based on past catches were introduced to the offshore fishery for northern cod.

An economic crisis in the fishery led to the formation of a Task Force on Atlantic Fisheries, chaired by Michael Kirby. The task force accepted catch projections of 380-400,000 metric tons of northern cod to be made by 1987. The suggested inshore allowance would be as follows:

July 13 — A press release suggests 200,000 metric tons would be available for inshore vessels.

Oct. 12 — Memorandum reduces the allowance to 150,000 metric tons.

December — Final report (Kirby 1982) recommends an inshore allowance of 145,000 metric tons.

(The Kirby Report apparently originates the concept of an allowance rather than a TAC for the inshore fishery. An allowance of 200,000 metric tons would be comparable to historical landings by the inshore fishery, so the decrease of 55,000 metric tons [22%] in the allowance in five months is difficult to understand. Later it was reduced to 115,000 metric tons, but even this low amount was never landed.)

1984

The target fishing mortality rate for northern cod was increased to $F_{0.1}$. The reason as stated in the "Resource Prospects for Canada's Atlantic Fisheries" (1985) is as follows: "Since the spawning biomass in the 1983 assessment was projected to reach the range of the target spawning biomass established by ICNAF in 1978 (1.2-1.8 million metric tons) at the beginning of 1985 even by fishing at $F_{0.1}$, the TAC for 1984 was set at the $F_{0.1}$ level (266,000 metric tons)."

(Note that 1.2 million metric tons was not the original reference point. Even this lower target had not yet been reached in 1992. Subsequent events have shown that this was the key decision affecting the recovery of northern cod [see Figure 2]. It was shortly to be followed by declining stocks and reduced landings, first in the inshore and subsequently offshore. The underlying reason for the decision is highly suspect, since a spawning stock biomass of 1.2 million metric tons was not the original target but only its lower range. Even this had not yet been reached but was expected in the subsequent year. In the event, even 1.2 million metric tons was never reached and is now farther away than ever. Nevertheless, the fishing rate was not reduced again. It is worth emphasizing that since 1984 the northern cod stock has been deliberately managed at a level below that originally considered necessary to ensure that recruitment was not limited by stock size. The underlying problem has been that the stock size of northern cod was consistently overestimated, with the result that the actual fishing mortalities resulting from the TACs have been much higher than the projected fishing mortalities.

Unfortunately, it appears that the Minister of Fisheries and Oceans believed that the stock was being managed at the conservative $F_{0.1}$ level when the actual F was two or three times that level. The effect on the stock has been catastrophic.)

1985

DFO reduced its 1985 catch forecast to 266,000 metric tons. The reduction is again blamed on poor year classes.

(Thus the forecast made in 1977 for 1985 landings erred by 136,000 metric tons [34%]. This was to be expected, given the small size of the spawning stock biomass.)

1986

June — A reexamination of the target spawning biomass of northern cod by Rice and Evans (1986) concluded that the original 1977 ICNAF spawning biomass target was too high and should have been only 0.85-1.3 million metric tons. However, they also concluded that the stock had reached only 0.5 million

metric tons by 1984 for the reason that "there is a stock recruit relation in this stock" and that with F = .35 the stock does not grow. They recommended that "the stock be allowed to rebuild to a spawning biomass of at least 1.3 mmt."

(This seems to be the only DFO study of the target spawning biomass for rebuilding northern cod. Although it provides a clear analysis of why the stock had failed to rebuild at projected rates, its conclusions have been largely ignored. Since actual fishing mortality rates have averaged 0.5 when the target was 0.2 or less and it was concluded the stock would not grow with F = 0.35 the failure of the stock to rebuild should have been expected. The stock recruit relation and the importance of the size of the spawning stock biomass for rebuilding were subsequently repudiated by one of the authors [see below].)

NAFO accepted the reduced target range of spawning stock biomass for northern cod suggested by Rice and Evans.

(The justification for this decrease of almost 500,000 metric tons in the target is debatable. Estimates of the critical spawning biomass are usually based on unfished stocks, which in the case of northern cod would certainly have included old, large fish that would have produced a large number of eggs. The numbers of such large cod are difficult to estimate accurately but prudence suggests caution. Note also that only a range of spawning stocks is given, of which the lower limit of 850,000 metric tons seems likely to become the target, if previous experience is a guide. Even these lower levels are much higher than the actual spawning stock biomass of 0.5 million metric tons estimated by Rice and Evans for 1984.)

August — Concern by fishermen over low inshore catches of northern cod resulted in a study by DFO of the factors affecting the inshore cod fishery. On the assumption that the estimated fishable biomass should be sufficient to sustain a successful inshore fishery, it was suggested that the failure of the inshore fishery was due to environmental causes such as water temperature, abundance of food offshore, etc. (Lear et al. 1986).

(The implicit assumption of an adequate biomass was unjustified according to some of DFO's own estimations and should have been validated before such a study as this was undertaken.)

November — Owing to the failure of the inshore fishery, CAFSAC reviewed the status and the management of northern cod. Despite concluding that "catch levels advised have been higher than they should have been," they found no basis upon which to disagree with the assessment of the status of the stock.

(This is an amazing statement, since if catch levels were too high, the size of the stock must have been overestimated.)

December — The 1987 Atlantic Groundfish Management Plan includes as the rule for setting the TAC: "If the stock assessment provides evidence of levels of spawning stock biomass likely to endanger recruitment, fishing effort

(and thus fishing mortality) in the coming year [should] be reduced to allow immediate growth in the spawning stock biomass."

(Despite this clear statement of procedure, which appears in all subsequent management plans, and despite the fact that the spawning stock of northern cod was known not to have reached any of the targets used for stock rebuilding, projected fishing mortality remained at $F_{0.1}$. It was also known that actual fishing mortalities exceeded $F_{0.1}$ by a significant amount.)

NIFA commissioned a review of the status of the northern cod stock (Keats, Steele and Green 1986). This concluded that actual catch rates (F) were much higher than those which had been projected and that the stock size had been overestimated. It was also argued that the commercial catch rates used to calibrate the assessments could remain high in the face of declining abundance if fishing efficiency increased, and that research vessel surveys provided a superior measure of abundance.

(These assertions were disputed by DFO, but have subsequently been supported by others.)

Representations made to the Minister of Fisheries and Oceans by NIFA resulted in offshore fishing effort being dispersed more evenly throughout 2J3KL and observers being placed on offshore vessels to estimate the amount of discarded small fish, but the offshore allocation was reduced only by 10,000 metric tons to 256,000 metric tons for 1987.

(The relatively small changes that took place did not address the serious nature of the overfishing problem. Unfortunately, it was not realized that the Minister believed that the stock was being managed at the $F_{0.1}$ reference level when the actual F was so much higher.)

1987

July — Continued concern over low inshore catches of northern cod resulted in the formation of a Task Group on the Newfoundland Inshore Fishery (Chairman D.L. Alverson).

CAFSAC concluded the northern cod stock was growing steadily.

The task group (Alverson 1987) concluded that the northern cod stock was rebuilding, but at a slower rate than projected by CAFSAC. It recommended that the 1988 TAC not be higher than that of 1987 (256,000 metric tons).

CAFSAC's advice on the management of northern cod was that the 1988 catch at $F_{0.1}$ would be 293,000 metric tons. The TAC was set at 266,000 metric tons (the 1986 level) in the management plan in what was described by the federal government as a "judgement call."

(It is astonishing that at this late date DFO was still advising TACs based on projected $F_{0.1}$s when it had been repeatedly documented that actual fishing mortalities had greatly exceeded the projected fishing mortality. Great emphasis was placed in all these deliberations on the fact that the stock was rebuilding

and not in imminent danger of collapse. However, the failures to achieve projected rates of increase or the target critical spawning stock biomass were not discussed.)

DFO forecasts a TAC of 266,000 metric tons in 1988. This is predicted to rise to 358,000 metric tons in 1993 (range 260-492,000 metric tons). The low inshore catches of recent years were blamed on water temperatures, caplin distribution and the amount of fishing effort.

(Again, the failures to rebuild the stock so as to achieve the TACs previously forecast are not addressed.)

1988

January — The Natural Sciences and Engineering Research Council (NSERC), Fishery Products International (FPI), and National Sea Products jointly sponsor a chair in fisheries oceanography at Memorial University.

DFO concluded that the northern cod stock continued to grow, that the fishable (4+) biomass was 1.5 million metric tons in 1986, and that projected catches would be 245-477,000 metric tons in 1991, 254-471,000 metric tons in 1992 and 260-492,000 metric tons in 1993. Difficulties in the inshore fishery were ascribed to environmental factors.

(Failure to achieve the previously projected landings, the target spawning biomass, and the fact that fishing mortalities have exceeded the projected $F_{0.1}$ reference level are not discussed.)

December — The Atlantic Groundfish Management Plan gives a TAC of 266,000 metric tons for 1989. However, the stock assessment for 1989 was delayed until January, 1989.

1989

The advice on management of northern cod when offered was in the form of four options — 125,000, 133,000, 200,000 and 233,000 metric tons. Reassessment of the data by CAFSAC indicated that the actual F value in 1988 was .44 and that catches since 1981 had resulted in fishing mortalities more than double the $F_{0.1}$ target. Since the catch of 258,000 metric tons in 1988 produced a fishing mortality "over double the $F_{0.1}$ level, fishing at $F_{0.1}$ in 1989, and hence reducing the effort by over half, would generate a catch of 125,000 tons."

(It should be emphasized that if the TAC was to be 125,000 metric tons this would be the first time that the target fishing mortality would agree with the actual mortality. It would also be the first time that the fishing mortality would be set at the actual $F_{0.1}$ level, even though this reference level had been DFO's stated policy since 1977. While much was subsequently made of the fact that a TAC of 125,000 metric tons was not the advice given to the managers, but rather

one of the four separate scenarios, the fact is that 125,000 metric tons would be the TAC in accordance with $F_{0.1}$ which has been the stated policy since 1977.)

February — The TAC for 1989, however, was set by the Minister at 235,000 metric tons in order not to disrupt the industry.

(This was at least twice the $F_{0.1}$ reference level and in contradiction to stated policy.)

To explain the reasons for the differences between current and earlier scientific advice, a Northern Cod Review Panel (Chairman L. Harris) was established. The panel held public hearings and conducted a review of the stock assessment methods employed since 1977.

May — The Northern Cod Review Panel released an interim report. This concluded that fishing mortalities had been too high and should be reduced in stages to the $F_{0.1}$ level, and that the current TAC should be 190,000 metric tons.

July — A Senior Task Force of DFO officials (Ken Stein Chairman) is established to provide analysis and proposals to deal with the reduced landings in the Atlantic fishery in 1990.

October 15 — John Crosbie, federal Minister of International Trade, is quoted in the St. John's *Evening Telegram* as stating that "from 1982 to 1989 the actual TACs were in line with or lower than the TAC advice given by scientists using the management tool $F_{0.1}$ while the actual catch was below the actual TACs and the TAC advice. Why the problem?"

(As documented repeatedly, while the scientific advice was provided for a proposed $F_{0.1}$ level of fishing mortality, the actual catches have resulted in fish mortalities that have been two to three times the $F_{0.1}$. This information was documented by DFO and presented to the Minister, Tom Siddon, by NIFA in December, 1986. The "problem" has been that DFO has not followed its own policy.)

November — NIFA filed an action in court to require an environmental impact assessment of the northern cod stock and an interim injunction to stop offshore trawlers from fishing between January and May on the spawning stock. They argued that the "quota policies resulted in overfishing of the northern cod resource by Canadian offshore trawler fleets, and the use of otter trawls on the spawning grounds has potentially harmful effects on the spawning process and therefore on the long term viability of the Northern cod resource leading to the commercial extinction of the resource."

1990

January — CAFSAC advised that the TAC for fishing at $F_{0.1}$ would be 125,000 metric tons. The TAC was set at 197,000 metric tons.

(DFO continued to ignore its own policy of fishing at $F_{0.1}$.)

February — Final Report of the Northern Cod Review Panel (Harris 1990) is released. It recommends that a TAC be set at 190,000 metric tons and

that the F should be reduced from its present value to the $F_{0.1}$ level in stages to allow the stock to recover. The Minister of Fisheries and Oceans accepted in principle most of the recommendations contained in the report but rejected the suggested TAC and the reduction in F.

(This report provides a very detailed analysis of the recent history of the northern cod fishery and its management. However, the explanation offered for the sharp change in advice between 1988 and 1989 is incorrect. A more precise analysis based on a longer time series of data and using better statistical methods was not necessary since the basic information that clearly showed the problem was available as early as 1986. In 1989 advice was provided for the actual $F_{0.1}$ level (TAC = 125,000 metric tons) whereas previously it had been based on a projected $F_{0.1}$ level which had no basis in reality.)

Spring — CAFSAC advises that the TAC for $F_{0.1}$ should be reduced to 100,000 metric tons.

April — The application by NIFA is denied since the evidence does not lead to a conclusion of irreparable harm.

In his brief to the court, Rice effectively refuted his earlier conclusion that spawning stock and recruitment were correlated, stating "that the apparently strong relationship between level of recruitment and level of spawning biomass is highly dependent on the recruitment estimates from the year-classes produced in the early 1960's. Without these earlier (less reliable and less accurate) values referred to (above), recruitment appears to vary substantially, with spawning biomass influencing recruitment weakly."

(It is not proper procedure to pick and choose data in any analysis, and in this case removal of all the early values when both stock size and recruitment were high substantially reduced the correlation between the two. In recent years both stock size and recruitment have been low so there is little correlation between the relatively small variations of each.)

May — AGAC concluded that the size of the northern cod had been overestimated. The 3+ biomass of fishable stock was estimated to 900,000 metric tons rather than 1.2 million metric tons and the 1983 and 1984 year classes were much weaker than previously thought.

(It is worth noting that the fishable biomass now includes three year old cod, whereas it previously included only fish four years old and older [4+]).

Northern Cod Program is announced; $40 million will be spent over five years on twenty-five projects to learn more about the basic biology and environment of northern cod as a response to recommendations of the Harris Panel.

(The necessity of such a crash program on cod biology underscores the decline in biological studies on cod and other groundfish that had occurred in recent years.)

October — The Dunne task force report (Dunne 1990) on the implementation of the recommendations in the Harris report is released. This report frankly acknowledged that policy positions developed for the management of northern cod in the early 1980s "gradually eroded, so that by the latter half of the 1980's the policy basis for management of this stock was very unclear." To a large extent this report perpetuates the short term management procedure since it provides only "minimum starting points for a renewed management policy for 2J3KL cod in terms of biological, ecological and socio-economic goals." It recommends multiyear TACs to reduce fishing to the $F_{0.1}$ level over a period of time and to rebuild the spawning stock biomass to 450,000 metric tons in 1994 and 650,000 metric tons in 2000.

(It is disappointing that this report provides only minimum starting points for a renewed management policy. There is no discussion whatsoever of what the long term goals for the stock and the fishery might be. Has a target spawning biomass been abandoned even if it continues to appear in the Groundfish Management Plans? Will the stock be allowed to recover so that the TAC can reach 400,000 metric tons, or will it be maintained at only 100,000 or 200,000 metric tons?)

December — The management plan sets TACs for three years. These will be 190,000 metric tons in 1991, 185,000 metric tons in 1992 and 180,000 metric tons in 1993. The inshore allocation will be 115,000 metric tons.

(These catches would still exceed those at the $F_{0.1}$ level by a considerable amount.)

1991

July — CAFSAC advised that the fishable biomass of northern cod is one million tons and that this "implies that the $F_{0.1}$ (degree of mortality that will sustain a population) target may almost be reached in 1993."

(In view of the fact that the policy since 1977 has been to fish at $F_{0.1}$ and that the Minister of Fisheries and Oceans believed that $F_{0.1}$ was being followed, this is an astonishing admission. Moreover, $F_{0.1}$ is not the degree of mortality that will "sustain a population," but a more conservative mortality.)

December — CAFSAC advised that the multi-year management should be maintained and the TAC for 1992 should be 185,000 metric tons.

1992

February — CAFSAC advised that the spawning stock biomass was only 130,000 metric tons compared to the previous estimate of 300,000 metric tons. It further advised that "the 1992 catches for the first half of the year should be restricted to the lowest level possible, in the order of 25,000 metric tons, that is about 50% of the catches during the first half of 1991."

(These estimates were so perplexing to CAFSAC that they apparently believed the missing fish might come back — "the preliminary assessment assigns to the fishery the disappearance of older cod when the reason could be either a decrease in availability or an increase in non-fishing mortality; if older cod do re-appear, it would indicate that there was an availability problem in 1991, but if they do not re-appear it would confirm a real decrease in abundance.")

As a result of this advice the Minister of Fisheries and Oceans reduced the TAC to 120,000 metric tons and ended the harvest of cod offshore by Canadian otter trawlers.

June — Upon the request of Canada NAFO reviewed the status of northern cod as presented by CAFSAC. NAFO concurred with the conclusion that the stock was currently at or near the lowest level observed and recommended that it would be wise to consider the $F_{0.1}$ catch to be 50,000 metric tons, the lowest range of $F_{0.1}$ values. It was noted that the 1992 catch (to the end of May) was estimated to be about 25,000 metric tons.

July 3 — CAFSAC advised that "because of reduced catch rates, the presence of small fish and reduced allocations, there has been no Canadian directed offshore cod fishery after February." Both CAFSAC and NAFO concluded that the commercial series could not be used as an index of stock size because of various changes in efficiency. "The number of cod aged six and older caught in 1991 was amongst the lowest in the time series, suggesting very low abundance. Age seven and older biomass, taken as an approximation to spawning stock biomass is between 48 and 108 thousand tonne, amongst the lowest values observed."

CAFSAC further advised that "prudence dictates that the lowest estimate of stock size be used to provide advice, resulting in 1992 $F_{0.1}$ catches of about 50,000 metric tons. However, quantitative projections are not necessary to advise that the 1992 catches be kept the lowest possible. Prospects for stock building are not optimistic. The entire stock is now essentially composed of the 1986 and 1987 year-classes which may be followed by four weak year-classes. Fisheries in the next four years would depend heavily on the 1986 and 1987 year-classes and would exploit them before they have made their full contribution to the spawning stock." The decline in abundance of the older fish was ascribed to an apparent increase in natural mortality due to environmental factors.

(As before, the increase in fishing mortality since 1980 is not considered as a cause of stock decline. To explain the recent decline, it is argued that the exploitation rate is normally correlated with fishing effort and therefore the reduced effort in 1991 could not have resulted in increased fishing mortality. However, if the stock size is very low, an increase in fishing mortality could be consistent with a decrease in effort. There is less incentive to fish, but the

fishing that does take place could remove a disproportionately large amount of the stock if it was efficient. Having rationalized the effects of fishing, the uncertain effects of environmental factors are discussed extensively as probable causes of stock decline.)

As a result of the advice, the Minister of Fisheries and Oceans, John Crosbie, announced a two year moratorium on the commercial fishery for northern cod. This was based on: 1) the current size of the spawning stock, and the fact that the 1986 and 1987 year classes which make up almost the entire spawning stock needed for stock re-building would likely be harvested in large numbers in 1992 or 1993 and diminish the breeding stock; 2) the advised TAC at $F_{0.1}$ — only 50,000 metric tons. Since about 25,000 had already been taken, only 25,000 would be left for the inshore fishery. This would not be commercially viable.

The decline in the stock is blamed on three main factors: 1) overestimation of the stock, leading to the setting of TACs that were too high; 2) foreign overfishing; 3) devastating ecological factors.

(There is evident confusion about when the recent decline in abundance of northern cod took place. CAFSAC stated that there was already a very low abundance in 1991, whereas its subsequent studies and the Minister of Fisheries and Oceans seem to believe the decline took place during 1991.

The reasons offered for the recent decline are of varying merit. The effects of ecological factors are unmeasurable, dubious at best, and have now reached the status of myth. Foreign fishing since 1977 has been confined to the small area outside the 200 mile limit, so that overfishing there cannot be held responsible for the catastrophe that has overtaken northern cod. It is recognized, however, that when the stock is low, overfishing outside the 200 mile limit becomes much more significant. However, foreign overfishing cannot be considered the primary cause of the decline and now serves only as one among several scapegoats.

The primary cause of the decline has been the overestimation of the stock, leading to the setting of TACs that were too high. The federal government, through the Minister of Fisheries and Oceans, has exercised exclusive management of northern cod since 1977, and must therefore take responsibility for the catastrophe that has taken place.)

THE DECISION-MAKING PROCESS

From the outside, fisheries management decision-making resembles a "black box"; i.e., it is difficult to see what is going on inside it, how things work, and how decisions come out.

As indicated above, the northern cod stock decline that triggered the moratorium has been a matter of increasing concern, particularly among inshore fishers and related interests. Their protests figured in DFO's establishment of the

Alverson Task Group on Inshore Fisheries and the Harris Review Panel.

Opposition to DFO management's thinking also included the unsuccessful legal action to establish that DFO Fishery Management Plans should be subject to impact assessment reviews. This concern from the inshore fisheries level, which has been reinforced by the provincial fisheries authorities, merits more explanation.

In 1986 Newfoundland inshore fishing interests — the fishermen, plant workers, and small plant operators — banded together and organized NIFA. They took issue with the direction of federal fisheries northern cod stock management decisions and policy as expressed in DFO Management Plans, particularly for Atlantic groundfish. They found that the Plans contradicted their view of expressed federal policy and endangered their well-being, and they concluded that the views and concerns of the inshore fishery sector were not taken seriously in the consultative process that leads to Atlantic Groundfish Management Plans.

These findings led NIFA to commission an independent scientific study of the status of the northern cod stock by a team of Memorial University biologists (Keats, Steele and Green 1986). Their report raised doubts about aspects of the scientific methods and the wisdom of the advised size of the TAC. Other questions were aired, in public meetings and media reports, about the federal fisheries stock assessments and scientific advice. In 1987 these circumstances led federal Fisheries Minister Tom Siddon to establish the already mentioned Task Group on Newfoundland Inshore Fisheries. The Task Group was composed of international experts with wide knowledge of contemporary fisheries stock assessment. It submitted its findings in November, 1987 (Alverson 1987). The Alverson Report, as it is called, simultaneously complimented DFO's scientists for their research accomplishments and urged more caution in their predictions. The latter finding reinforced DFO's critics. But the tenor of the report seems to have encouraged DFO scientists and managers to believe that problems were not as serious as they seemed to their critics. The report was not widely distributed.

However, in February, 1988, DFO's Newfoundland regional office published "The Science of Cod," in *Fo'c'sle*, a booklet series targetted at fishermen and the general public. The booklet is based upon information supplied by Fisheries and Oceans (Newfoundland), although it was written by a freelance writer. It includes an introductory statement from the Newfoundland Region's Director General, in which he interprets the importance of the Task Group's findings, and justifies and explains the Department's scientific research effort in the interests of the industry. He says:

> It is reassuring that the conclusions of the Task Group and CAFSAC about northern cod are quite similar with respect to the present stock size and the causes for the decline in the inshore fishery since 1982. The credibility of DFO scientific advice

> was not questioned. The northern cod stock continues to increase, but perhaps not as fast as projected several years ago. The Task Group therefore recommended a cautious approach to managing the stock to protect the inshore fishery. The Minister has accepted this recommendation and set the 1988 TAC 27,000 tons below the calculated $F_{0.1}$ level.

Provincial government fisheries department officials, however, argued that this 1988 TAC was unacceptable, because retrospective assessment indicated that the TAC had been too high for the past ten years. It was also contrary to the advice of the Task Group.

Why did DFO authorities feel it necessary to commission the Task Group on Newfoundland's Inshore Fisheries and, later, "The Science of Cod" booklet? These events suggest 1) how non-governmental pressure groups like NIFA increasingly intervene in and affect the fisheries management planning process at both the domestic and international level since Canada extended its jurisdiction to 200 miles in 1977, and 2) that the information written by federal fisheries authorities is prepared primarily for scientists and administrators. It is not written for use by the fishing industry. DFO resource and industry studies have not aimed at those whose livelihoods depend directly upon sound stock management and fisheries industrial development and who may wish to intervene effectively in discussions leading up to decisions.

NIFA felt that the biological and social kinds of information and factors used to shape management decisions, and the stages through which they are taken, should be described for their non-scientist membership. The following discussion attempts to sketch how the fisheries management system is organized to make decisions over the calendar year and, briefly, some of the social considerations, viewpoints and concerns about the management of the northern cod stock (2J3KL) at work in this process, especially concerning allocation.

Canada's fisheries management and administration occur within a distinct legal framework. The British North America Act (1867) gives Parliament exclusive legislative authority over seacoast and inland fisheries. Section 34 of the Fisheries Act grants broad authority to federal fishery administration for "the proper management and control of the seacoast and inland fisheries." The federal minister of fisheries, at his absolute discretion, may issue or cancel fishery licenses, and thereby limit entry into fisheries and prescribe levels of effort. Further, the Coastal Protection Act effectively gives the federal minister the power "to regulate foreign fishing vessels within any Canadian fishing zone in accordance with pertinent laws and treaties. Licenses may be issued, suspended, or cancelled." Other acts grant the minister additional authority. In sum, the federal fisheries minister and his subordinates have wide discretionary powers, which are frequently exercised outside existing regulations through policy directives and the interpretation of regulations (Hennessey and LeBlanc

1987).

Provincial governments have authority over the licensing, number, and location of processing plants. The two governments and various agencies participate in jointly-funded fishery development programs, such as construction of shore facilities, vessel upgrading, gear replacement, and loan funds.

The division of authority over fishery-related matters between the federal and provincial governments makes consultation between them essential. Since 1977, when Canada extended its fisheries jurisdiction, consultation has become increasingly structured and formal. Its effectiveness depends greatly upon the state of the industry's own organization and preparation to participate. When the industry lacks agreement about particular issues, the federal government also frequently resorts to informal consultation.

Fishery management decisions are also influenced by policy guidelines, that is, by government's general goals. Policy relates to what we hope to accomplish for our society by managing the fisheries. The sum of fisheries management decisions for the northern cod in NAFO area 2J3KL, and to some extent government policy itself, is expressed in annual Fishery Management Plans, and particularly the Atlantic Groundfish Management Plan. The latter Plan also lists "Basic Principles" that are to guide stock allocation and quota decisions.

The Atlantic Groundfish Management Plan results from an annual process of consultation and decision-making. During March federal fisheries scientific units are normally busy analyzing stock assessment information in preparation for the May meeting of CAFSAC, which provides advice to federal authorities on stocks totally within Canada's 200 mile exclusive fishery management zone. (CAFSAC's original terms of reference require that its management advice take into account "economic objectives," but until recently its scientists appear to have limited their assessments and advice to biological considerations. It seems there has been no suitable forum for interaction between biologists and experts in socio-economic fields. Their training and other considerations did not encourage biologists to broaden their expertise or to include socio-economic factors in their assessments.)

In March as well, DFO normally conducts bilateral discussions with foreign fishing nations on allocations within the 200 mile zone.

CAFSAC provides scientific advice to DFO's Atlantic Directors General on the management of groundfish and other stocks in Canada's exclusive fisheries zone, and for "transboundary stocks" on the Nose and Tail of the Grand Banks. CAFSAC is also the forum for setting the requirements for all fisheries biological data to be gathered for scientific assessment and monitoring both domestic and foreign fisheries. Its membership includes DFO scientists from the three Atlantic regional DFO units. And its activities are organized around the activities of six

sub-committees. These include the Groundfish sub-committee, which is responsible for the northern cod.

CAFSAC also provides scientific information and participates in the Scientific Council discussions of NAFO, and Canada is represented on NAFO's Fisheries Commission, which is responsible for management and conservation of the fishery resources of the NAFO regulatory area (whether or not individual NAFO members abide by its Commission's recommended quotas).

Canada's federal fisheries authorities have also established advisory committees for consultation about fishery matters with the industry and provincial governments. This consultation involves all Atlantic area species. From the Newfoundland provincial government standpoint, however, groundfish are the most important of those species.

Some 300 local fishing committees are only nominally involved in the advisory process, although they set local fishing season limits, regulate annual draws for fishing berths, resolve gear conflicts, and arrange applications to government programs in aid of the fishery. These committees vary greatly in their effectiveness. Some rarely meet or keep records; others meet regularly, keep minutes, and vigilantly pursue their management interests. Government representation occurs at committee meetings as required.

Federal fisheries management consults more regularly by way of several formal advisory committees. At the lowest level are Working Group Committees (or Advisory Committees), like the Groundfish Advisory Committee. In 1988 the Newfoundland Region had six such committees, each chaired by a senior DFO official. Other members include fishermen (from various community committees), together with union, provincial government, and industry participants (though not from the offshore sector). Although at times primarily advisory-informational on DFO's part, these committees do permit dialogue about fishery issues among all parties.

AGAC meetings are the next formal advisory level. The federal Assistant Deputy Minister for Atlantic fisheries chairs AGAC meetings, which occur about four times annually. All matters concerning groundfish management within the 200 mile zone (e.g. the TAC, quotas, licensing, policy, etc.) are open for discussion at these meetings. But the meetings are large and include participants from both federal and provincial governments in the Atlantic region, and from NIFA, the unions, industry, and other bodies. The topics discussed cover stocks and other important topics from harvesting to markets.

DFO's Draft Fishery Management Plan is usually presented for discussion at the Fall AGAC meeting. Discussions frequently become heated, and not all issues (e.g., the application of Basic Principles and the appropriateness of proposed quotas) are resolved.

AGAC proceedings, recommendations, and unresolved issues are carried to the next formal advisory level, the Federal-Provincial Atlantic Fisheries

Committee. These meetings are chaired by DFO's Deputy Minister of Fisheries and include Atlantic Provincial Deputy and Assistant Deputy Ministers of Fisheries.

Issues still unresolved go to the last and highest advisory level, the Atlantic Committee of Fisheries Ministers, where the federal Minister participates directly. Meetings occur about five times annually, and are confidential. Once again, DFO is the primary initiator and manager of these discussions. It sets the agenda, although provincial input is invited.

DFO officials thought its approach to managing its fisheries quite sensible, perhaps even sensitive, on the surface. Canadian fisheries managers have gradually developed this approach in preference to other possibilities, especially the Regional Management Council system, established in 1976 in the U.S. That system occurs in a highly litigious society, and is often dismissed as "too political." It is certainly carried on in a rather public way; public reviews and impact assessments of proposed management plans are standard operating procedure. We are unable to say that it is better or worse.

In general, the Canadian process permits and requires frequent give and take among all parties over Fishery Management Plans. Effective participation in this process requires having the facts and figures straight and being well organized to form and express arguments and positions with strength and clarity. But the scientific and informational arsenal available to the participants in these consultative discussions always favors DFO. For example, until 1992 Newfoundland's provincial fisheries department had but one fisheries biologist on its regular staff to advise on all stock matters. More recently, the provincial government has created a Resource Division responsible for stock assessment advice. It is hoped that its present staff of two biologists will expand in the future.

Effective participation also requires a balance of authority among stakeholders when decisions are made. That balance does not exist under the present Fisheries Act. Moreover, the organizational structure designed to enable a productive exchange of views and information between fishers and well-intentioned scientists has failed in important ways. Only DFO scientists and managers have ultimate authority, and they control the information requisite to management planning. Fishers can only talk. To compound their weakness, other key stakeholders, in particular the industry, unions and the Newfoundland Department of Fisheries, have failed to develop the scientific wherewithal that would enable them to evaluate the scientific advice of DFO. Had they done so, they might have better used their opportunities to participate in consultative exchanges and to lobby for changes. The basis for this failure invites a separate inquiry.

These are among the factors behind the Newfoundland government's persistent call for the establishment of a new, joint fisheries management

scheme (Government of Newfoundland and Labrador 1991). In 1992 some Newfoundland authorities were optimistic that such a new regime is not far away. Our perception is that joint management is unlikely. However, DFO has indicated that plans for a new organizational structure may be tabled in the near future.

SCIENTISTS IN THE "BLACK BOX"

The history and structure of fisheries management that have led to the northern cod stock crisis and moratorium as outlined above leave us with many questions. We know things went awry with DFO's science. When they did, those most affected were unwilling or unable to challenge or check the course of management, in part because of the way authority and decision-making are organized to create fisheries management plans. Until recently, however, DFO's science and its scientific community were somewhat of a sacrosanct "black box," about which the general public knew very little. However, that community is a human, social and cultural enterprise, with its processes and interactions engaged in science for fisheries management. As such, it is material worthy of study by social scientists. We feel compelled to ask: what might there be about this community of scientists, its organization and culture, that may have influenced its operations?

We are fortunate to have some independent answers to this question. DFO managers in Newfoundland permitted Alan C. Finlayson, a social scientist studying at Memorial University, to interview its personnel about their experience and thinking concerning northern cod stock assessments from 1977 to 1990 (Finlayson 1991). His findings are reported in a detailed and thoughtful M.A. thesis, soon to be published. At risk of oversimplification, it may suffice to note and comment on several of Finlayson's key findings:

1) Managers were strongly committed "to the idea of a rebuilt, rationally managed northern cod stock."

2) Because of errors and uncertainties inherent in stock assessments, which permitted a high degree of "interpretative flexibility," annual stock assessments and resource projections resulted in "assessments that are better understood as expressions of pre-existing commitments and expectations rather than useful descriptions of natural reality."

3) The inshore fishery's challenge to DFO's stock assessments and projections, and DFO's resistance to it, were really "a crisis in epistemological legitimacy and institutional authority."

(In other words, there was a crisis in the legitimacy of contending ways of knowing, and it was based in part upon notions of less vs. more scientifically "correct" stature.)

4) DFO's scientists were somewhat divided among themselves, by the contradiction inherent in their formal mandate — to serve fisheries management

— as opposed to the long-established professional reward/promotion system. In consequence, the Science Branch persistently failed "to produce knowledge of practical utility to its mandated clients; the State and the commercial fishery."

(DFO fisheries scientists' career advancement is based heavily upon their meeting long-established professional standards: i.e., the publication of primary fisheries science articles. This standard applied in the days of the old Fisheries Research Board of Canada, until federal fisheries scientists were brought under more direct administrative control shortly before and following establishment of the 200 mile management zone in 1977.

In their annual Program Reviews, it is postulated that federal fisheries scientists will publish their findings in the primary journals. These now have a wide international readership. This to some extent compels writing for a general audience, since papers on parochial subjects such as northern cod may be of little interest to an "international" journal. As a result, the basic biological studies have not been done or published. For example, the average number of papers on cod in the *Journal of the Fisheries Research Board of Canada* and its successor the *Canadian Journal of Fisheries and Aquatic Sciences* decreased from 10.3 per year in the 1960s to 2.0 in the early 1980s. Yet such studies are generally of greater relevance to Newfoundland and Canadian regional fishing interests. The information gaps were noted by the Harris Review Panel and as a result the Northern Cod Program was established.

In this situation, DFO fisheries scientists face a basic conflict that concerns what they should do. Should publication be the basis of their success in the system? Or should it be how well they manage the fisheries they are responsible for?)

5) Fisheries science is imbedded in, dependent upon and subservient to the state.

(When DFO science fails, or is perceived to fail, it impugns both the dignity and, perhaps worse in view of the division of powers mandated by the Fisheries Act, the authority of the state itself. Hence it may be to the advantage of the state to maintain "black box" government science. But it would always be suspect. Likewise, to be convincing its virtue must be seen and not merely declared.)

At the same time that DFO's managers were speaking of the the "Northern Cod: [as] A Fisheries Success Story" (Department of Fisheries and Oceans 1980), the eminent fisheries scholar James A. Crutchfield painted a rather dark picture of fisheries management prowess in an address before an audience of Australian fisheries managers in Canberra:

> Given all the time and all the splendid research that has gone into expanding our knowledge of the sea, its living resources, and the technical problems of harvesting them, the results are remarkably disappointing. The number of programmes that have actually succeeded in checking depletion of ocean fish

> stocks can be counted on the fingers of one hand. And those that have protected stocks while providing some real improvement in earning, stability of employment, and ability to withstand the usual economic jolts to which fisheries are subject, can be counted by someone with no hands at all (1982: 9).

A decade later fisheries management remains experimental, with techniques that manage relationships between people and the living marine resources they build their lives around. Like any experimental science with serious implications for human lives, what fisheries scientists do and what managers and politicians decide should be matters open to close public scrutiny, if not more direct public involvement and direction. The management system outlined in this discussion is still a black box into which light enters with difficulty, but there are some signs that it is becoming more open in response to external pressure. Perhaps the wisdom of increased openness will become deeply imbedded in the thinking and institutions of DFO managers. It remains to be seen if this will happen.

MORATORIUM: ITS PUBLIC CONSEQUENCES AND UNCERTAIN AFTERMATH — THE DARK HOLE OF POLICY MAKING

The northern cod moratorium means different things to many people. For the optimistic, it is an opportunity, nay, necessity. The hope is that those most concerned will seriously examine what kind of a social and economic world we might construct for our fishing communities and industry in the future. A number of recommendations, some already tabled in various task force reports, that bear upon the northern cod crisis and Newfoundland and Atlantic fisheries generally, are already available. Others will follow shortly. Evaluation and application of these recommendations constitute formidable challenges to Newfoundland society and DFO managers alike. Unless an aggressive effort is made to face these challenges, and soon, we risk another cycle of resource, community, and social destruction.

Various observers have suggested that, in consequence of the stock crisis and moratorium, things cannot be as they were, ever again. But this catastrophist rhetoric is not wholly true. There are choices to be made. Newfoundland's way of life and culture have been changing for some time in response to a wide range of forces. For example, the Kirby Commission did result in the reorganization of the Canadian Atlantic fisheries industry. Change is evident in population demographics (smaller families, increasing proportion of aged in our communities, increasing urbanization, etc.) and in changing values and lifestyles. Likewise, important changes have occurred in the technical expertise of the inshore and offshore fishing industries.

Despite these changes, a strong sense of community, separate identity, and historical and cultural continuity and distinctiveness endures. In the inshore

fishing community especially, a heritage of environmental and marine life lore continues to be transmitted. Newfoundland will not be Ontario, and the fishery may continue to form the backbone of the economy and society since it involves such a large proportion of the population.

But we cannot escape the responsibility to ensure that Newfoundlanders have the opportunity for work that earns them the self-respect that is essential to a sense of well-being and confidence. One need only talk with young people to appreciate the demoralizing burden of uncertainty they presently carry about their future.

There is also an important cautionary lesson in these facts. We have an opportunity to restore, rebuild and preserve a renewable resource that has sustained many of Newfoundland's communities and resulted in a unique lifestyle. It is necessary to discuss and plan for the level to which the stock will be rebuilt, and at the same time determine how the stock will be harvested, and by whom. Otherwise, projections about how many fishers and communities might be supported in a sustainable fishing industry are unwarranted.

It is already apparent that government, unionists and other interested parties see the moratorium as an opportunity to trim and shape the fishing labor force and capital investment so as to produce a smaller, specialized fishing industry. That jobs, firms and communities will be lost is understood.

But neither the end of the moratorium nor the shape of the fishery afterward is preordained; they are subject to choice. What is needed therefore is an open discussion in the province to determine the directions that will be taken in the future.

Conclusions

1) The history of the scientific advice provided for northern cod offers an example of poor science. Science proceeds by generating hypotheses and then doing experiments to test them. If the experimental results do not confirm an hypothesis, then it has to be abandoned and new ones generated that can be tested in their turn. In the case of northern cod, projections (hypotheses) were made of the rate of rebuilding the cod stock when certain fishing mortalities were applied to the stock. However, when the stock failed to rebuild at the expected rate the hypothesis was not examined to determine why, or abandoned; instead a variety of other factors such as low water temperatures or caplin availability ("devastating ecological factors") were invoked to rationalize the failure. The projected numbers were taken to be real and therefore the fish must exist somewhere. At the same time, the projected fishing mortality was also accepted as real even when landings showed that the actual fishing mortality was two to three times higher.

2) CAFSAC's responsibility to provide scientific advice is so heavy that it has been made a collective rather than an individual responsibility. Peer review

of the science, however, evidently consists of in-house discussions. The problem is that if everyone is responsible then no one is responsible. As a result there has been little or no open, independent, critical discussion of the merits of the science. Provision should be made to allow independent (i.e., non DFO) reviews of the assessments and the scientific advice by all stakeholders who have an interest in the management of the resource.

3) It is apparent that the policies enunciated by DFO and expressed in the Groundfish Management Plans have been only words on paper to be ignored or disregarded at will. Although fishing at $F_{0.1}$ or less has been the declared policy since 1977, this policy was never actually followed. Yet even before the moratorium, the hope was expressed that fishing might get down to the $F_{0.1}$ level in 1993. Although the Alantic Groundfish Management Plans state that fishing should be reduced to prevent recruitment overfishing, the spawning stock of northern cod was never allowed to rebuild to any of the targets that were deemed necessary. Moreover, a target spawning biomass has no longer been specified in recent management decisions, and it is unclear if one exists at the present time.

4) There appears to have been confusion within DFO between the scientific advisors and the managers. Although it had been documented in 1986 that actual fishing mortalities were two to three times the $F_{0.1}$ level, the Minister has apparently believed until recently that the fishery was being managed at the $F_{0.1}$ level.

5) Long term socio-economic goals for the management of the fishery have to be proposed, discussed and decided on. Will the stock be allowed to recover so that the TAC will be 100,000, 200,000, 300,000 or 400,000 metric tons? How rapidly should the stock be rebuilt? How large a spawning stock biomass is required so that recruitment is not limited? New long term management plans which are recognized as experiments must be developed, tested by fishing and continually reexamined. If they are found wanting, new plans should be developed and then tested in turn. Such long term management goals should never be ignored or forgotten.

6) When the goals for rebuilding the stock have been decided, then there should be a similar open discussion of how the stock is to be harvested. Will the inshore allowance of 115,000 metric tons be maintained? Should the offshore trawling of spawning concentrations continue? These and many other questions have to be posed and given adequate discussion before decisions are made.

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