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MANAGMENT OF CANADIAN COD STOCKS

by

A.W. May, R.G. Halliday, R. Wells and E. Dunne

Department of Fisheries and Oceans, Canada

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Historical Overview

(a) ICNAF management to 1973

Management jurisdiction over what are now the Canadian cod stocks lay with ICNAF until December 31, 1976. ICNAF regulatory actions set the pattern for subsequent Canadian management.

In the late 1950's, ICNAF was preoccupied with the adoption of mesh size regulations as the primary regulatory tool. However, the Standing Committee on Research and Statistics (STACRES) established a Working Group on Fishery Assessment to provide the scientific basis for mesh regulations and wisely retained this organizational entity as an Assessments Subcommittee. This Subcommittee was soon warning the Commission that further regulatory measures were required to check the rapid expansion of fishing effort in the ICNAF Area (e.g. ICNAF Redbook 1964, Part I). As a result the Commission asked for a review of "the various kinds of action which might be taken by the Commission for the purpose of maintaining the stocks of fish in the Convention Area at a level at which they can provide maximum sustained yields" (ICNAF Annual Proceedings Vol. 14, p. 18, 1964). The conclusion of the review by Templeman and Gulland (ICNAF Annual Proceedings Vol. 15, pp 47-56, 1965) was that there must "be some direct control of the amount of fishing. All methods of doing this raise difficulties, but that presenting least difficulties is by means of catch quotas. There must be separate quotas for each stock of fish, e.g. for cod at West Greenland, and preferably be allocated separately to each section of the industry." The Commission agreed that setting of catch quotas seemed to be the most feasible system of regulation but foresaw serious scientific and particularly, economic, difficulties and recommended study of the economic implications (op. cit. p 25-26).

ICNAF established a Working Group on Joint Biological and Economic Assessment of Conservation Actions, in conjunction with FAO, NEAFC and OECD, the report of which (ICNAF Annual Proceedings Vol. 17, pp 48-84, 1968) was presented to the 17th Annual Meeting of the Commission in 1967. In response the Commission established a Standing Committee on Regulatory Measures (STACREM) to advise "on the economic and administrative aspect of the problems of introducing regulatory measures" and also charged STACRES with answering a variety of scientific questions on establishment of catch quota control (op. cit. p 21-22).

The dialogue between STACRES, STACREM and the Commission continued over a number of years during which STACREM increasingly focused on the principles of national allocation of catch quotas. In 1969 the Commission adopted a protocol for revision of Articles VII and VIII of the Convention which provided greater flexibility in the types of fisheries regulatory measures which the Commission could propose. Whereas, initially, the Convention allowed, on the basis of scientific investigations, recommendations on closed areas and seasons, fish size limits, prohibitions of gear and overall catch limits, to achieve the maximum sustained catch, the amendment allowed "--appropriate proposals, for joint action by Contracting Governments, designed to achieve the optimum utilization of the stocks--" on the basis of scientific investigations and economic and technical considerations (authors' emphasis). This amendment giving the Commission

much greater freedom of action and, in particular, the authority to propose national allocation of catch quotas, came into effect on 15 December 1971. This new authority was utilized in February 1972 with agreement on catch quotas and national allocations for herring in Subareas 4 and 5.

Herring, however, was not the first species for which catch quotas were set by ICNAF. The collapse of the Georges Bank haddock fishery in the late 1960's resulted in the Commission agreeing to global catch quotas for haddock in Division 4X and in Subarea 5 at its 1969 meeting, the quotas to apply for the years 1970 and 1971. At its 1970 meeting the Commission adopted global catch quota regulations for two yellowtail stocks in Subarea 5 (for 1971) and, at its 1971 meeting adopted a global catch quota for haddock in Division 4W (for 1972).

With the entry into force of the amendment to Article VIII, the rapid action on herring conservation measures at the First Special Meeting of the Commission in February 1972 was followed with extensive action at the Annual Meeting in June 1972 to control fishing on groundfish stocks, 17 species/stock catch quotas being set most of which were allocated on a national basis. Six of these 17 were for cod stocks. By the 1973 Annual meeting, the Commission had brought almost all of the major stocks in the Convention Area under catch quota control.

So far cod has been mentioned only in passing. However, it was, primarily, events in the cod fisheries that stimulated concern over the buildup of fishing effort in the early 1960's and which started the process which led to the adoption of comprehensive catch quota control with national allocations as the primary management tool for control of exploitation rate for stocks in the Northwest Atlantic. The steady progress of the 15 member countries, through study and debate, toward a major achievement in fisheries regulation is, in many ways, commendable particularly in contrast to the progress of other international fisheries commissions. However, the progress was rather too slow for the cod. During the 10 years from recognition of the problem to effective action, fishing effort continued to build-up. However, cod catches peaked at 1.4 million tons in 1968 and had declined to 0.9 million tons by 1972, the year before the introduction of catch quota control (Table 3).

(b) ICNAF Management 1973-76

The ICNAF Commission's objective, embodied in the Convention, was to achieve the maximum sustained catch and, although this was modified to achievement of optimum yield in 1971, optimum was interpreted as maximum. STACRES advice to the Commission on catch quota levels used F_{max} or F_{MSY} (depending on the population dynamics model used) as reference points to achieve that objective.

After two years of widespread application of catch quota control (1973 and 1974), and for some stocks a longer period, STACRES advice in 1975 was for continuing decreases in TAC's for many major stocks in 1976. Concerned that the catch quota scheme was not being effective in reversing stock declines, Canada proposed (at the 1975 Annual Meeting) that total allowable catches (TAC's) for some stocks should be reduced below the level recommended by STACRES (i.e. below F_{max}). Although not agreed to,

discussions on six stocks, including four cod stocks in Subareas 3 and 4, were deferred to a special meeting in the autumn of 1975 and STACRES was asked to "--re-examine the potential effects of a range of levels of exploitation lower than that associated with the MSY, with a view to promoting greater stability of stock sizes and catches,--".

At the Seventh Special Meeting of the Commission in September 1975, STACRES advised that "--in view of the possible adverse consequences of setting the fishing mortality rate too high in cases where there is doubt about its adequacy, a more restrictive management system than that based on the F_{max} level of fishing mortality rate would be justified--" the management system might comprise either, or a combination of, the following elements: (i) fixing the fishing mortality rate at a level somewhat lower than F_{max}, i.e., the $F_{0.1}$ level, -- and (ii) setting a target spawning stock size which would serve to minimize the risks of stock depletion and recruitment failure--" STACRES also pointed out that it had already used $F_{0.1}$ as the basis for advice to the Commission on the TAC's for some stocks having relatively high values of F_{max} (i.e. with flat-topped yield-per-recruit curves). Indeed, the concept of $F_{0.1}$ had been introduced to STACRES in 1972 by Gulland and Boerema (ICNAF Res. Doc. 72/26, Serial No. 2717 - Scientific advice on catch levels) and explained to the Commission (ICNAF Redbook 1972, Part I, pp 41-42). However, at the September 1975 meeting STACRES also revised downwards the TAC's associated with F_{max} for the six stocks referred to it from the June 1975 meeting based on revised assessments of their status. Faced with large reductions in TAC's even at F_{max}, the Commission could not face the additional reductions implied by moving to $F_{0.1}$ and set the TAC's at the F_{max} level for 1976. (Cod in Subdivision 3Ps was a trivial exception where the TAC of 47,500 mt was set 500 mt below the F_{max} level).

Between the September 1975 meeting of STACRES and its Annual Meeting in 1976, two other reports had been produced which largely agreed with the conclusions of its September meeting - the ICES Report of the ad hoc Meeting on the Provision of Advice on the Biological Basis for Fisheries Management (C.M. 1976/Gen: 3) and the FAO Advisory Committee on Marine Resources Research (FAO Fisheries Report No. 142, Suppl.1). With the weight of internal scientific opinion behind them, STACRES took the matter into its own hands and, in presenting the work of its Assessments Subcommittee to the Commission in 1976 stated "--the Subcommittee decided that its advice on TACs for 1977 should be based on management objectives different from those associated with F_{max} or F_{MSY}. Several reasons for managing stocks at a level of fishing mortality less than that giving F_{max} or F_{MSY} were pointed out:

a) Errors associated with TACs can be large, and losses from over-exploiting a stock are likely to be much greater than any losses due to under-exploitation.

b) Fishing at higher levels of fishing mortality reduced the number of age-groups in the stock with the result that the fisheries (and the calculated TACs) are heavily dependent on recruiting age-groups. This increases the probability of error in the TACs.

c) Although it may be too early to fully assess the effects of regulations in recent years based on F_{max}, it is evident in many cases that the stocks are continuing to decline.

A single management objective to cover all stocks was not proposed, but it was decided that advice on TACs for 1977 would in general be recommended with the aim of achieving $F_{0.1}$ rather than F_{max}, or to control fishing effort at a level less than that associated with F_{MSY}--".

The Commission was faced, for each stock, with only one TAC figure associated with fishing at $F_{0.1}$ and they accepted it. The extent to which this represented agreement among the member nations that this was a more appropriate management strategy is hard to discern. Agreement may have been heavily influenced by the fact that STACRES had the support of an influential Coastal State, Canada, on the eve of her extension of jurisdiction. (The announcement by Canada that fisheries jurisdiction would be extended to 200 miles was made just before the 1976 ICNAF Annual Meeting). Canadian support was based on economic reasons e.g. increased catch rates, larger fish, lower processing costs, as well as the conservation reasons given by STACRES.

Canada also took another major initiative during the last years of ICNAF - institution of fishing effort control for groundfish in Subareas 2-4. The Canadian proposal was introduced at the 1975 Annual Meeting of the Commission and called for a reduction in fishing effort by 40% from 1973 on groundfish stocks in Subareas 2, 3 and 4 for 1976. The proposal received intense debate at the Seventh and Eighth Special Meetings in September 1975 and January 1976 and was implemented for 1976 by agreement at the meeting of that January. The proposal received many modifications before implementation and, in any case, excluded reductions in effort for Coastal States. Thus, the expected overall impact in terms of reduction in fishing effort was substantially less than 40% from the 1973 level. The actual impact has not been evaluated.

Prior to the Canadian proposal, the USA had tried in vain to introduce effort control for the Subarea 5 and Statistical Area 6 fisheries. The success of the Canadian proposal lay in its relative simplicity. STACRES evaluation of the Canadian proposal and its advice to the Commission were contained in a half page of text and one figure showing catch, effort and catch rate from 1961 to 1973 (ICNAF Redbook 1975, pp 56-57) in contrast to the voluminous technical evaluations of USA proposals. The report pointed out that the catch in 1973 was similar in quantity to that of the early 1960's but that fishing effort had doubled and stock abundance declined by one-half and that these general relationships suggested that a significant reduction in fishing effort would not reduce the total catch in the long-term. The Canadian proposal was for proportional reduction by area and country vessel tonnage class while allowing limited transfer among area and also among tonnage classes within country, the latter based on simple conversion factors based on relative catch per day fished of the tonnage classes involved. This could be easily understood by decision makers with non-technical backgrounds.

Two other actions by ICNAF in September 1975, although apparently of minor import, are worthy of note. The Commission adopted a resolution requiring provision of monthly fishing effort statistics within 30 days of the month the effort was expended. A second resolution originated from the Standing Committee on International Control (STACTIC) requiring each country to register its vessels which planned to fish in the ICNAF Area and each such vessel to carry a registration document which would specify the Subareas and species for which it was registered to fish. Changes in plans required an endorsement to the registration.

Again there has been little mention of cod specifically in this section. However, again, events in the cod fisheries largely influenced the Commission's actions by their very dominance in the groundfish fisheries in ICNAF Subareas 2-4.

(c) Canadian Management, The Transition

The transition to Canadian management on 1 January 1977 was smooth as Canada accepted the framework constructed under ICNAF. The TAC's agreed through ICNAF for 1977 were based on fishing at $F_{0.1}$ or on a more conservative basis to promote stock rebuilding and Canada has maintained this management strategy through 1980. All nations fishing the new Canadian zone were familiar with, and had accepted, this strategy in the ICNAF context.

Control of foreign fishing in the Canadian zone included prior agreement on annual fishing plans and licencing of days on ground on an individual vessel basis, as well as national catch allocations on a stock basis. Weekly reporting of catch and effort on a vessel basis also became a requirement. Control continues to be by a dual system on catch and fishing effort and the development of any major imbalance between utilization of the two allocations provides a warning of errors in estimates of stock status. Again, ICNAF actions on fishing effort control, vessel registration and effort reporting familiarized countries with these kinds of procedures and controls and had already caused them to take many of the domestic actions required to exert sufficient control over their fleets which would allow them to comply with Canadian regulations.

A more detailed description of Canadian management follows which emphasizes economic objectives rather than the more general objectives of developing control of exploitation patterns in international fisheries at some moderate level. The Appendix contains tabular information on the historical levels of groundfish catches in the Canadian zone with emphasis on cod, and Canadian expectations of trends in the immediate future (to 1985).

Current Management of Candian Cod Stocks

Resource declines in the mid-70's, coupled with increased harvesting costs, brought the Canadian fishing industry to a crisis in economic terms. The very existence of hundreds of coastal communities, dependent totally on the fisheries, was threatened. These events gave particular impetus to the Canadian extension of fisheries jurisdiction on January 1, 1977. Since that time a primary objective of Canadian fisheries policy has been

improvement in the viability of the fishing enterprise. In resource management terms this has been translated to increasing biomass as a major objective in order to achieve increased catch rates, larger fish and less year to year variability. All Canadian groundfish stocks are now managed at or below the $F_{0.1}$ level. Catch rates have improved dramatically (for some elements of the fleet about 50% from 1976-79).

Catch restrictions have been accompanied by widespread effort restrictions achieved through limited entry, and development of licencing policies (including restrictions on replacement vessels) in all fisheries. These measures have been instituted at substantial short-term social and economic cost, and have been accompanied by extensive controversy and unusual strains on bureaucratic systems, both scientific and regulatory, not to mention political courage.

In addition to catch quotas, all Canadian cod fisheries are subject to some degree of licencing control. Entry to all domestic cod and groundfish fisheries, except for coastal Labrador residents, has been frozen.

The domestic licence controls are designed to accomplish two purposes. The more immediate or short-term objective is to prevent excessive build-up of fishing effort as fish stocks are being restored - the pressure to enter as the rebuilding takes place is enormous. The second and longer term aim is to provide for a better matching of fishing effort and available resources or allowable catches. This is intended to create more viable fishing operations by preventing fleets from developing more catching capacity than is justified by, or required to take, expected harvest levels. We are really talking about economic criteria which have become more and more significant in Canadian fishery management programs in recent years.

In addition to the general licencing controls, all Canadian cod and other groundfish fisheries are subject to an annual groundfish fishing plan developed in the context of a 5-year resource forecast. These annual plans have been a part of the Canadian Atlantic fishing scene since 1976. A variety of direct management measures are employed in these plans including:

- sub-allocations of quotas amongst fleet segments based on size, horsepower, gear types, etc.;
- fishing seasons (for some species);
- closed areas (for some species);
- trip month or period catch limits;
- by catch provisions or restrictions;
- daily catch reporting and provision of log-book records.

These annual plans are an additional attempt to match available resource to existing catching capacity on a yearly basis. A variety of objectives are aimed for; the more significant of which are:

1) Allocation of fishery resources on the basis of satisfactory balance between economic efficiency and the dependence of the fleets involved.

2) Coordination of the deployment of mobile fishing fleets over the fishing grounds and the operating season.

3) Provision for the withdrawal of excessive catching capacity in congested fleet segments and in areas of low productivity and for the best possible mix of fleet units.

4) Utilization of the fishery resources over the calendar year to the degree possible.

With such combinations of management measures and objectives coupled with existing capacity and available quotas, it is not surprising that the annual fishing plan becomes very complex. In 1980, thirty-eight separate groundfish quotas are subject to this plan, including 12 cod quotas. The 1980 plan's provision for the 4Vn (January-April) + 4T and 4VsW cod quotas are good examples of the detailed measures that are applied.

"Cod - 4Vn (January - April) 4T

Total Allowable Catch	54,000 MT
4Vn (January - April)	
Quota to France	8,540 "
Fixed gear allowance	300 "
Mobile gear under 65 ft. quota	300 "
Mobile gear over 65 ft. quota	9,100 "
Mobile gear less than 1050 b.h.p.	4,550 "
Mobile gear greater than 1050 b.h.p.	4,550 "
4T (January - December)	
Fixed gear allowance	9,000 "
Mobile gear under 100' quota	26,760 "
Jan. 1 - Oct. 31	24,760 "
Nov. 1 - Dec. 31	2,000 "

Cod - 4VsW

Total Allowable Catch	45,000 "
Canadian quota	43,850 "
Fixed gear allowance	6,000 "
Mobile gear less than 65' quota	7,000 "

The offshore mobile gear quota of 30,850 MT will be divided equally between vessels less than 1050 b.h.p. and vessels greater than 1050 b.h.p., and each segment will have a yearly quota of 15,425 MT. It will be managed as follows:

* Mobile gear less than 1050 b.h.p. (March 1)	8,000 MT
Mobile gear greater than 1050 b.h.p. (March 15)	8,000 MT

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* Subject to review based on ice conditions in the Gulf and Sydney Bight.

Until the directed fishery opens, cod in 4VsW will be fished as a 20% by-catch, all cod caught in this manner will be deducted from the respective spring quotas.

When these quotas have been reached, directed fishery will be closed and the fishery will be managed on a 20% by-catch until 2,000 MT has been caught when the fishery will revert to a standard by-catch of 1,500 Kg and 10%.

On October 15, the directed codfish will resume with the remaining quota allocation for vessels greater than 1050 b.h.p. and those less than 1050 b.h.p. All vessels will be limited to catches of 300,000 lbs. per months (managed by Industry).

Once the total yearly offshore quota of 30,850 MT is about to be reached, the directed fishery will be closed and it will be managed on the standard by-catch of 1,500 Kg and 10%.

Whitehead Hole closure will remain in effect".

It might be noted the management measures for haddock quotas in 4VWX + 5 are even more complex.

The purpose of these annual plans is to match annual available quotas to existing fishing capacity and to share resources among fleet sections on an equitable basis. The licencing control measures are intended to bring fishing effort more in line with available resources over the longer term.

The Canadian Atlantic groundfish trawler fleet over 65 ft. has been subject to entry control since 1973. As of that time no additional unrestricted groundfish trawling licences were available. Only licences issued at that point remained valid. There are provisions for replacement of licenced vessels, but Ministerial approval is first required. There are two types of replacement allowances in present guidelines. Otter trawl vessels may be approved for replacement on a one-for-one basis with the new vessel not exceeding 125 per cent of the length of the replaced vessel. Replacement may also be approved for a single vessel at 80 per cent of the combined length of two or more replaced vessels. These replacement guidelines are intended to control addition of fishing capacity and to limit excess capital investment.

A further measure of control has recently been placed on otter trawl vessels over 100 ft. Such vessels with unrestricted groundfish licences may not be equipped to fillet traditional groundfish at sea. Freezing capacity is permitted for round or dressed traditional species and for non-traditional species. As well, no such vessels are permitted to exceed 200 ft. LOA. The purpose of these additional controls is to protect employment on shore and to control application of fishing methods that are of dubious value to Canada's traditional groundfish fisheries and current fisheries economy.

Since the adoption of these licencing measures in 1973, replacements for only 14 unrestricted otter trawl vessels over 100 ft. have been acquired. All have been replaced on an one-for-one basis. At present, 19 approvals

for active vessels and for vessels removed (lost) since 1976 are in effect. One of these is on the basis of two-for-one. It appears, however, that it will be several years before all replacement vessels under these approvals actually enter the fisheries. High capital costs and financing requirements are causing vessel owners to develop replacement plans with considerable caution.

While otter trawling by vessels over 65 ft. was placed under licence limitation in 1973, similar measures for other groundfish fleet segments and gear types were adopted over the next seven years as well. The sequence of events is as follows:

- June, 1976 - Licences for otter trawls by vessels under 65 ft. were limited.
- November, 1978 - A moratorium placed on entry to groundfish fishing by vessels under 65 ft. in all of sub-area 4 and 3P.
- June, 1979 - Moratorium relaxed to allow entry by vessels using baited gear only.
- March, 1980 - Complete freeze placed on entry of inshore groundfish vessels anywhere on Atlantic Coast.
- May, 1980 - Limitation placed on issuing of otter trawl licences to under 65 ft. vessels in 2 + 3KL.
- June, 1980 - A complete freeze placed on issuing of personal commercial fishing licences.

The most recent actions (1980) were taken to stem the tremendous influx of persons and vessels to segments of the inshore (under 65 ft.) fisheries that were previously left open. These are primarily cod fisheries which is the major inshore activity in most of the Atlantic area. Further development of licencing measures for these fisheries is now under way and application will begin in 1981. A major thrust in this area will be a system of issuing classified licences to both control total numbers and to give those most dependent on the resource greater opportunity to earn a satisfactory level of income.

As mentioned at the beginning, foreign vessels fishing for national quota allocations are required to obtain Canadian fishing licences. This is to place an additional control on fishing beyond that provided by catch quotas.

Under this Canadian system licences are approved after National allocations have been decided and expected catch rates for various species established. Countries receiving quota allocations submit fishing plans showing the number of vessels by size and type that are desired. In the final analysis, fishing licences are granted for specified vessels and for a fixed number of fishing days per vessel. In this way, the number of vessels and fishing days licenced is related to the fishing effort required to take each country's quota allocation.

While this system of determining and authorizing foreign fishing licences is primarily a resource protection measure, it can also have eventual economic benefits for foreign fleets. As all nations fishing in the Canadian zone are subject to the same controls, the incentive (and the opportunity) to deploy excessive catching effort is removed. When national fleets are restructured, more economically efficient operations will arise insofar as this licencing system reduces the necessity to compete between and within fleets.

The experiment we are conducting is only three years old and it is too soon to draw many conclusions let alone to be pedantic about them. We use the term "experiment" as an admission that, although we are confident that our policies will put our fisheries on a more rational, stable and economic basis, we cannot quantify precisely its full impact on future resource yields.

Appendix

Nominal catches of groundfish in NAFO (formerly ICNAF) Subareas 2, 3 and 4 in the period 1960-1979

NAFO Subareas 2, 3 and 4 extend along the east coast of Canada including the Gulf of St. Lawrence. In this area nominal catches of groundfish, as defined by NAFO, were fairly stable in the early 1960's at about 1.4 million MT, reached a peak in 1968 at about 2.0 million MT and declined to about 0.8 million MT in 1977 (Table 1). The provisional nominal catch in 1979 is about 0.9 million MT. The decline in nominal catch was greatest in Subarea 2.

Cod was the largest single component of groundfish nominal catches in each of the three subareas in the 1960's and 1970's (Table 2). Over the whole of the two decades, cod accounted for about 60% of the total groundfish catch in the three subareas combined.

Nominal catches of cod from NAFO Subareas 2, 3 and 4 increased from about 0.9 million MT in the early 1960's to about 1.4 million MT in 1968, (Table 3). The subsequent decline continued until 1977 and levelled off in 1978 at about 0.4 million MT. The provisional nominal catch in 1979 is about 0.47 million MT.

There were increases in catch from 1978 to 1979 in all stocks except those of NAFO Division 2GH and 3M. From the stock in Division 2GH, catches since 1973 have been below 10 thousand MT and in 1979 were about 2 thousand MT. The highest reported catch, that in 1966 was 94 thousand MT. In winter and spring, when large concentrations are usually found, weather and ice conditions are often quite severe. The catch of 29 thousand MT in 1979 from Div. 3M was at about the average level over the 20-year period (the 1980 TAC is 13,000 tons).

Catches from the resident stock in Div. 4Vn, fished in May-December as well as from the stock in Div. 4X appear to have stabilized in the last few years close to the average level.

Catches in 1979 from the stocks in Division 2J 3KL and Division 3NO are much below the average level.

Catches from the stock in Subdivision 3Ps have averaged about 33 thousand MT since 1975, as compared with the 20-year average catch of 54 thousand MT.

Catches from the two Gulf of St. Lawrence cod stocks in 1979 were at about the 20-year average level. The catch from the western Gulf stock, that of Division 4T and Subdivision 4Vn (winter), more than doubled from 1977 to 1979. On the Scotian Shelf, the catch from the stock of Division 4W and Subdivision 4Vs has increased from 10 thousand MT to 40 thousand MT from 1977 to 1979.

TABLE 1

Total groundfish nominal catches (000 t) in NAFO Subareas 2, 3 and 4 in the period 1960-1979

Year	Subarea 2	3	4	Total
1960	279	692	391	1362
1961	296	674	375	1345
1962	265	592	397	1254
1963	223	522	557	1302
1964	245	751	517	1513
1965	376	716	536	1628
1966	365	711	502	1578
1967	327	1002	410	1739
1968	482	1012	512	2006
1969	437	821	493	1751
1970	237	805	653	1695
1971	242	821	631	1694
1972	198	842	561	1601
1973	96	755	787	1638
1974	163	685	497	1345
1975	134	551	498	1183
1976	78	491	414	983
1977	77	427	305	809
1978	60	404	359	823
1979	55	450	400	905

TABLE 2

Average annual nominal catches (000 t) of groundfish by major species groups in Subareas 2, 3 and 4 in the 1960's and 1970's

Species Group	Subarea 2		Subarea 3		Subarea 4		Subarea 2,3,4	
	1960-69	1970-79	1960-69	1970-79	1960-69	1970-79	1960-69	1970-79
Cod	297	96	539	368	219	185	1054	649
Haddock	+	+	25	3	54	24	79	26
Redfish	22	11	83	92	72	90	178	193
Am. Plaice	+	1	41	66	14	22	55	89
G. Halibut	1	10	9	19	+	3	10	32
Other Flounder	3	2	31	47	27	21	61	70
Silver Hake	-	-	+	+	33	116	33	116
Pollock	+	+	2	1	26	22	28	23
R.N. Grenadiers	+	10	5	16	-	-	5	26
Other Groundfish	7	2	14	11	25	29	46	43
Total Groundfish	330	134	749	623	469	510	1548	1267
% Cod	90	72	72	59	47	36	68	51

Note: Totals may reflect rounding errors.

TABLE 3

Nominal catches of cod from the various stocks in NAFO Subareas 2, 3 and 4

Year	2GH	2J3KL	3M	3NO	3Ps	4RS+3Pn	4T+4Vn (Jan-Apr)	4VsW	4VN (May-Dec.)	4X	Total
1960	8,413	468,976	12,381	79,677	77,775	95,148	67,252	49,893	4,556	13,728	877,799
1961	4,295	502,297	20,703	72,724	86,210	101,194	65,931	66,465	4,157	13,695	937,671
1962	4,934	506,999	16,174	34,984	50,921	91,682	67,074	65,810	8,627	15,877	863,082
1963	4,014	499,904	38,216	69,742	50,051	76,151	70,202	68,297	7,687	17,817	902,081
1964	9,161	603,585	47,819	64,461	53,956	85,562	60,547	63,284	10,646	25,766	1,024,787
1965	54,929	552,654	60,313	99,187	51,400	69,698	63,027	70,988	11,999	26,914	1,061,109
1966	94,189	522,307	33,834	108,919	65,749	65,085	54,851	68,170	9,873	30,899	1,053,876
1967	56,110	610,535	42,163	226,784	62,393	79,312	41,314	54,163	7,627	32,462	1,212,863
1968	84,148	807,470	40,385	165,512	77,217	89,671	46,551	80,442	7,052	36,546	1,433,994
1969	60,571	748,433	31,845	117,705	63,103	71,140	47,512	50,165	9,447	32,760	1,232,681
1970	17,787	516,213	26,529	111,561	76,161	106,736	66,601	61,775	9,894	22,302	1,015,559
1971	12,643	432,496	33,692	126,296	63,967	84,310	57,215	54,263	10,631	23,378	898,891
1972	13,690	458,170	57,691	103,374	44,325	58,237	67,733	61,645	9,171	22,381	896,417
1973	279	354,509	22,900	80,429	52,641	66,489	50,635	54,093	5,748	22,224	709,965
1974	4,070	372,650	24,938	73,389	46,712	66,428	48,747	43,741	5,984	21,171	707,830
1975	6,959	287,508	22,375	44,174	35,373	60,215	42,471	32,517	3,998	21,091	566,681
1976	5,929	214,220	22,266	24,283	37,133	76,981	33,415	24,407	5,957	16,657	461,248
1977	3,658	172,720	27,019	17,604	32,245	73,566	22,219	10,390	7,921	22,833	390,175
1978	4,858	138,559	33,231	14,718	27,221	78,506	37,892	25,405	5,549	23,638	389,577
1979	2,130	171,752	29,170	27,941	32,946	80,062	52,318	40,029	6,674	28,386	471,948
Average	22,639	447,098	32,209	83,173	54,375	78,809	53,175	52,297	7,660	23,476	854,912

Projected catches and population biomasses for the major cod stocks in Subareas 2, 3 and 4.

For the projections shown in Table 4, constant partial recruitment rate and constant weights-at-age were used for 1980 and thereafter. Constant recruitment values corresponding to the long term average for the various stocks were assumed after 1980 or 1981 depending upon availability of recruitment estimates from research vessel surveys. All of these parameters are variable, and reflect environmental factors, fishing strategy and biological interactions such as density dependent growth. Note that projections for one stock (4T + 4Vn [J.A.]) have been conducted incorporating density-dependent growth. These, naturally, project lower future stock sizes and potential yields than the fixed parameter projections given here. The projections are therefore merely indicative of trends. Fishing mortality in 1981 and thereafter was assumed at the $F_{0.1}$ level.

The projections show substantial increases in catch except for the eastern Gulf of St. Lawrence stock (4RS 3Pn) and the Flemish Cap stock (3M). In the former case, the stock has been fished for some years at a fishing mortality level less than F_{max} and includes a number of strong year-classes. On the Flemish Cap, on the other hand, the stock has been exploited at a fishing mortality level higher than F_{max} and at present apparently no strong year-classes are included.

TABLE 4

Projections of population biomasses (000 MT) for the major cod stocks in Subareas 2, 3 and 4

Year	2J3KL	3M	3NO	3Ps	4RS3Pn	4T+4Vn(J-A)	4W+4Vs
1979	1,600	69	204	186	462	378	273
1980	1,800	75	220	204	504	454	309
1981	1,900	89	257	248	565	507	337
1982	2,200	110	284	271	597	549	362
1983	2,500	134	303	285	610	569	391
1984	2,700	166	324	305	607	572	417
1985	2,900	187	347	313	597	569	434
Age Range	4+	3+	3+	3+	4+	3+	2+
Average Recruitment ($X\ 10^{-6}$)	500	27	40	54	100	70	85

TABLE 5

Projections of catch (000 MT) for the major cod stocks in Subareas 2, 3 and 4

1979	150	28	27	29	86	50	40
1980	180	13	26	28	75	54	45
1981	250	7	30	33	76	60	49
1982	280	11	32	37	87	72	49
1983	300	15	33	40	93	79	52
1984	320	20	34	44	94	80	57
1985	350	24	34	46	93	80	59

TABLE 6

Catch of groundfish per day fished in Subareas 2, 3 and 4
by Canadian otter trawlers of tonnage classes 4 and 5 combined

YEAR	Subarea 2	3	4
1960		12.5	10.8
1961		14.4	11.5
1962		11.9	11.0
1963		10.4	10.4
1964		11.0	11.0
1965		12.5	11.0
1966		12.9	10.8
1967		11.9	9.5
1968	16.7	11.3	10.7
1969		10.7	10.8
1970		11.2	10.2
1971		10.5	9.1
1972		10.2	9.9
1973		10.2	8.9
1974		8.3	8.5
1975		8.2	8.1
1976		7.9	8.9
1977	9.6	8.5	9.6
1978	17.5	9.6	11.9
1979	16.4	11.2	10.8

TABLE 7

Catch per hour fished for major cod stocks in Subareas 2, 3 and 4. These catch rates are based on various effort standards and are therefore not directly comparable.

Year	2GH	2J3KL	3M	3NO	3Ps	3Pn,4Rs	(Jan-Apr.) 4T+4VN	4VsW
1960	3.66	1.79	2.74	1.21	0.61	1.32	0.14	1.30
1961	5.43	1.83	3.37	1.28	0.67	1.74	0.31	1.52
1962	4.37	1.92	1.53	1.28	0.60	1.58	0.23	1.35
1963	2.22	2.02	1.89	2.03	0.67	2.04	0.25	1.56
1964	4.20	1.94	1.31	1.61	0.81	1.95	0.23	1.55
1965	2.75	1.65	1.51	1.18	0.85	1.73	0.24	1.62
1966	1.95	1.79	1.36	1.73	0.90	1.61	0.15	1.65
1967	1.53	1.85	1.53	1.92	0.68	1.32	0.22	1.67
1968	1.20	1.86	1.92	1.40	0.92	1.62	0.23	2.38
1969	1.13	1.58	1.98	1.13	0.89	1.45	0.25	1.70
1970	.98	1.39	1.09	1.22	0.76	1.42	0.26	1.53
1971	.70	1.16	1.28	1.19	0.67	1.08	0.26	1.25
1972	.61	1.04	1.35	1.05	0.58	1.19	0.28	0.90
1973	(.005)	0.92	0.87	0.81	0.49	0.91	0.17	0.81
1974	-	1.04	1.25	0.68	0.36	1.02	0.09	0.51
1975	1.07	0.93	0.97	0.61	0.39	0.86	0.20	0.29
1976	.88	0.89	0.77	0.93	0.52	0.95	0.15	0.47
1977	1.58	0.54	0.59	0.44	0.44	1.02	0.19	0.95*
1978	.71	0.48	0.76	0.30	0.58	1.03	0.25	0.78*
1979	.72	1.00	0.40	1.00	0.65	1.28	0.68	1.43*

* Adjusted to the catch rate standard available up to 1976 by the conversion of research vessel data.