

Management in National Fishery Zones

Introduction

Extensions of maritime jurisdictions to 200 miles in the late-1970s radically changed the political map with regard to regulatory authority over fisheries. This new map is also an evolving one as jurisdictional claims are revised and boundary disputes resolved. An overview of the present situation (Fig. 3) follows, as introduction to more extensive accounts in the subsections on each national fishing zone.

The Northwest Atlantic jurisdictional map looks simple in comparison to that for the Northeast Atlantic (Fig. 3). Most of the Northwest Atlantic continental shelf now lies within Canadian or USA jurisdictions. The shelf off western Greenland in the north and the area south of Newfoundland adjacent to the French islands of St. Pierre and Miquelon are exceptions. The southern and eastern edges of the Grand Bank and all of Flemish Cap are important continental shelf fishing areas adjacent to the Canadian zone, the fisheries in which remain under international jurisdiction through NAFO. In contrast there is a much greater number of national zones in the Northeast Atlantic, but the EU fishery policy of equal access to fishing grounds for EU fishermen results in the combined zones of EU members being treated as a unit for purposes of fishery regulation. Thus the EU zone, from inclusion of Spain and Portugal in 1986, encompasses all of the Atlantic seaboard of Europe as far north as the north of Scotland and includes the western and southern parts of the North Sea. (The EU fisheries policy applies also to the fishing zones around Madeira and the Azores.) The North Sea is shared jurisdictionally with Norway. Norway also shares the Barents Sea with Russia, has jurisdiction of a zone around the islands of Jan Mayen in the Norwegian Sea, and has established a fishery protection zone around Svalbard off its north coast. Iceland and Faroe Islands each have jurisdictional zones which encompass all of their adjacent continental shelves, but boundaries with other zones still have some important implications for management of fisheries. Greenland waters, part of the EU zone in the late-1970s, have been under the control of Greenlandic authorities since 1985. While all of the continental shelf in the Northeast Atlantic (except in part of the Barents Sea) is enclosed within national jurisdictions, there are species with oceanic or partly oceanic distributions which are of commercial importance. Thus, control of fishing in the areas of international waters in the Barents and Norwegian seas and to the south of Iceland and west of the

UK, which lie within the NEAFC regulatory area, cannot be ignored by adjacent national authorities if their fishery interests are to be fully protected.

In the following subsections, the management regimes discussed are those of Canada and the USA in the Northwest Atlantic, the EU, Norway, Faroe Islands and Iceland in the Northeast Atlantic, and Greenland which has links both to east and west. The islands of St. Pierre and Miquelon are not treated separately but are discussed in conjunction with Canada. The regimes are ordered alphabetically. The accounts first review the history of jurisdictional changes, boundary disputes, their resolution, and their effect on fishery management. Institutional arrangements for discharging the regulatory responsibilities of the management authority for fisheries are then described, followed by outlines of management objectives and strategies adopted, regulatory actions taken, surveillance procedures and any assessments of compliance with the regulatory system which are available. Trends in stock parameters – catch, population biomass, recruitment and fishing mortality – after extension of jurisdiction are then compared with those in the prior period of management by international commission.

Canada

Fishing Limits. Canada's fishing limit was extended from three to 12 miles in 1964, but of much greater significance was the enactment in 1971 of exclusive fishing zones which enclosed the Bay of Fundy (Fig. 4) and the entire Gulf of St. Lawrence (Fig. 5). The Gulf of St. Lawrence in particular is a large sea area, and in 1970 supported fisheries yielding almost 500 000 tons, about 15% of the Northwest Atlantic catch. Most of this catch was taken by Canadian vessels but there were important foreign fisheries in the area, particularly those of France, Portugal and Spain for cod. Canada negotiated fishery agreements with Denmark, France, Norway, Portugal, Spain and the UK, which resulted in their phase-out from Canadian fishing zones between 1972 and 1978 except in the case of France. Vessels of metropolitan France retained fishing rights to 1986 and those of St. Pierre and Miquelon retained rights in perpetuity for coastal boats and for as many as 10 trawlers no larger than 50 m. Canada had an existing agreement with the USA on reciprocal fishing privileges, thus USA fishermen were not affected. The 1971 jurisdictional extension by Canada was motivated by the need for resource conservation, although the benefits of exclusive harvesting rights were also recognized.

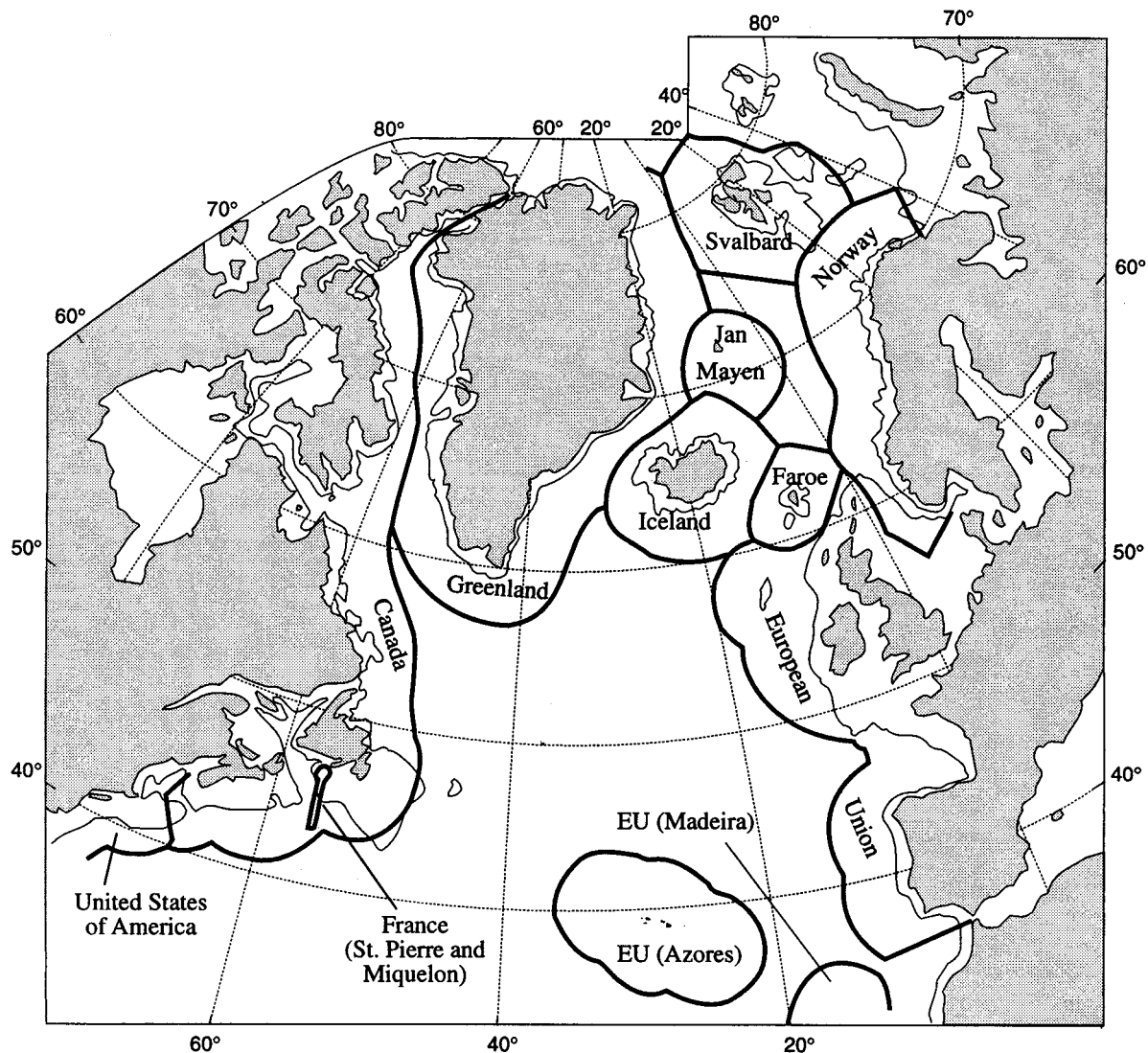


Fig. 3. Fishing zones in the North Atlantic. (Depth contour is 200 m. Zonal boundaries are approximate and not necessarily agreed between parties.)

The Canadian 200 mile zone became effective in January 1977. The transition was initially a smooth one as Canada had prepared the way by negotiating bilateral fishery agreements with the countries having significant fisheries in the area to be claimed by Canada, and also as a result of Canadian adoption of a regulatory regime which was consistent with that of ICNAF which it was replacing. Furthermore, Canada had negotiated through ICNAF in 1976, the TACs and other regulations for 1977 corresponding to Canadian management strategies. The bilateral agreements provided assurances of access to Canadian resource surpluses in exchange for recognition of the 200 mile limit and cooperation in the management of

adjacent and overlapping stocks and also of salmon on the high seas. Extension of jurisdiction left boundaries with neighbouring coastal states to be resolved. Further bilateral agreements on resource conservation and sharing with neighbouring coastal states provided for orderly conduct of the fisheries, in the initial years. However, each of these agreements quickly foundered. International agreements coordinated through ICNAF and NAFO for management of stocks transboundary between Canadian and international waters also proved less than satisfactory from a Canadian viewpoint.

Canada and Denmark had reached agreement on a common continental shelf boundary in the

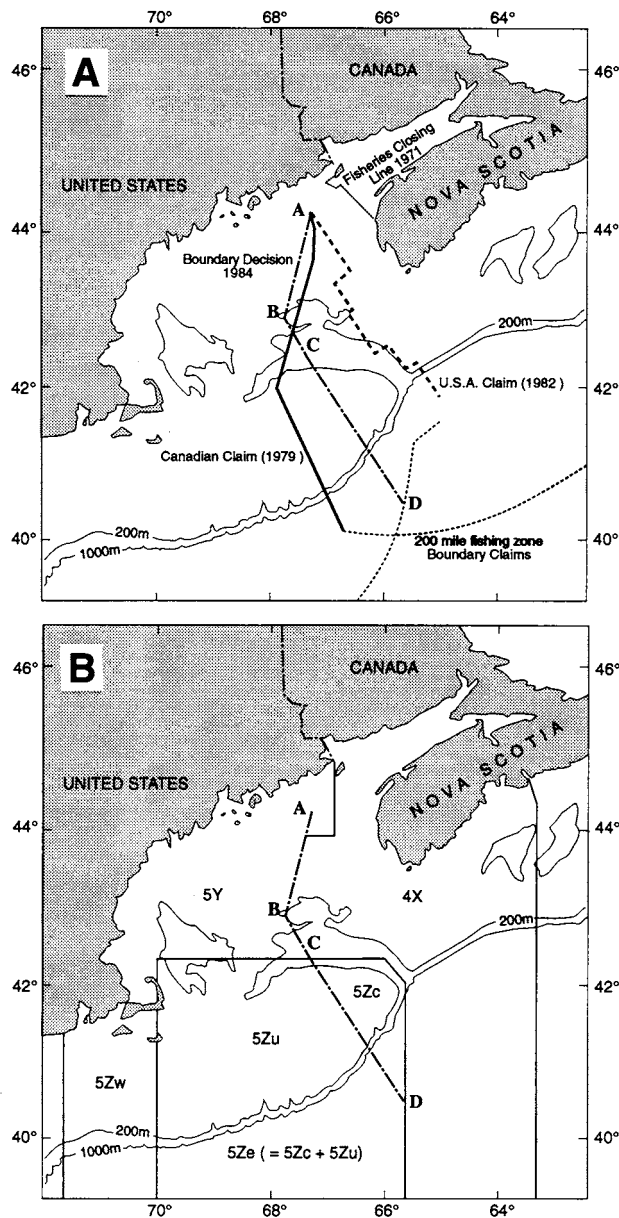


Fig. 4. (A) Canadian and USA jurisdiction claims in the Gulf of Maine area put before a Chamber of the International Court of Justice, and the Chamber's binding decision of October 1984 on a jurisdictional boundary (line A-D). Bay of Fundy closing line of 1971 also shown.

(B) The statistical grid in the Gulf of Maine area as modified by NAFO in 1986 to incorporate part of the international boundary into the line dividing Div. 4X and Div. 5Y. No formal boundary changes were made in Subdiv. 5Ze but reporting of fishery statistics as coming from Canadian (5Zc) or from USA (5Zu) waters was required.

Davis Strait – Baffin Bay area between Canada and Greenland in 1973, and there was no disagreement when fishery zone boundaries were declared because claims were consistent with the continental shelf boundary. Fishery agreements were reached in 1978–80 between Canada and the EU (which at that time had regulatory authority for the Greenlandic fishing zone) on exploitation of shared stocks of shrimp, roundnose grenadier and Greenland halibut in Davis Strait. However, this cooperation ended in 1981 as a result of a difference in views on TAC levels for shrimp and also over EU insistence on linking this agreement with other Canada–EU issues in more southern waters (Parsons, 1993). Management of shared stocks has since been pursued independently in Canadian and Greenlandic zones.

Canadian and USA claims overlapped extensively in the Gulf of Maine, particularly on the northeastern part of Georges Bank (Fig. 4). An interim agreement controlled fisheries in 1977 at catch levels agreed within ICNAF in 1976, but broke down in 1978. A long-term fisheries agreement was negotiated in 1979 but not ratified by the USA. As a result the jurisdictional issue was referred to a chamber of the International Court of Justice in The Hague. The Chamber's decision, rendered in October 1984, resolved the boundary question by rewarding the northeast corner of Georges Bank to Canada and the remainder to the USA (Fig. 4). However, this did not lead to cooperation with regard to conservation regulations, although there are important resources which are shared by the two nations, particularly Georges Bank cod, haddock and herring stocks.

The jurisdictional claims of France around St. Pierre and Miquelon, beyond a 12 mile territorial sea, were overlapped entirely by the Canadian claim (Fig. 5). The fishing area primarily in dispute was that of St. Pierre Bank. Agreements were reached on catch limits for cod, the species of primary interest to the two parties in the disputed zone, in 1977 to 1982 but thereafter a unilateral approach was taken by France which greatly increased exploitation of St. Pierre Bank cod. This action introduced a period of intense dispute and a progressive deterioration of fisheries relations between the two parties. Agreements were reached in March 1989, one of which referred the boundary dispute to adjudication by an international tribunal and another which established catch quotas for the interim period. The Tribunal rendered its decision

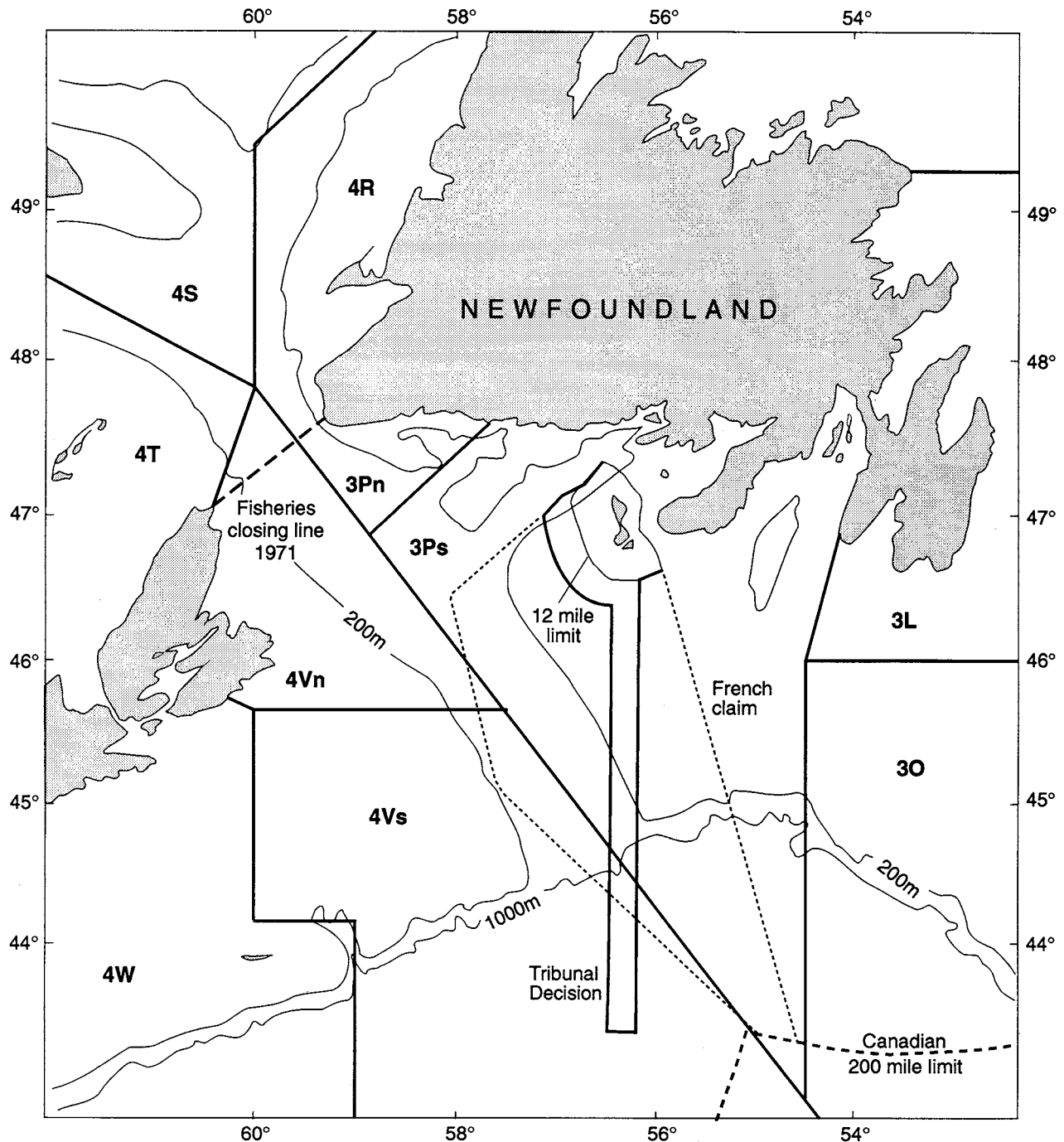


Fig. 5. Canadian and French jurisdictional claims in waters adjacent to St. Pierre and Miquelon put before an international Tribunal, and the Tribunal's binding decision of June 1992 on a jurisdictional boundary. Canada claimed all waters to within 12 miles of St. Pierre and Miquelon. Gulf of St. Lawrence fisheries closing line of 1971 also shown.

in June 1992 which gave France a 24 mile zone southwest of St. Pierre and Miquelon and an approximately 10 mile wide corridor running due south of the islands for a distance of 200 miles (Fig.

5). Subsequent negotiations on conservation of shared resources in the St. Pierre Bank area led to agreement in 1994 on cooperative arrangements for a 10-year period.

The continental shelf extends outside Canada's 200 mile zone at the southern and eastern limits of the Grand Bank – the "tail" and "nose" of the bank respectively – and at Flemish Cap east of the Grand Bank (Fig. 3). These have traditionally been important fishing areas. While Flemish Cap resources are largely isolated from those of the Grand Banks, i.e. belong to separate stocks, the resources inside and outside the Canadian zone on the Grand Banks largely belong to the same stocks. In the years immediately following 1977 the management of these transboundary stocks jointly by Canada and ICNAF, then NAFO, proceeded on a cooperative basis, although increased participation in ICNAF/NAFO Regulatory Area fisheries by non-members of these organizations, and inadequate control of fishing by members, to some degree prejudiced these efforts. Beginning in 1985, the EU challenged the prevailing approach within NAFO of setting TAC levels for transboundary stocks at the $F_{0.1}$ level, consistent with the Canadian management strategy inside its 200 mile zone. This raised a serious problem of inconsistency in NAFO and Canadian approaches which resulted in substantial increases in exploitation. This issue is dealt with in more detail below in the section that provides an account of NAFO management.

Management Institutions. In Canada, legislative authority for marine and inland fisheries lies entirely with the federal government and this power is exercised by its Department of Fisheries and Oceans (DFO). However, provincial governments are involved in various aspects of fisheries development such as processing plant licensing and provision of loans for vessel construction. Federal departments other than DFO have also been involved in provision of financial aid for fisheries support and development.

The federal government, through DFO, maintains a bureaucracy which is concerned with all functions of fisheries management and development including biological and other research, management planning and enforcement of fisheries regulations. Management planning involves extensive consultations with representatives of the fishing industry through a complex committee structure. The first of these consultative committees was the Atlantic Herring Management Committee established in 1972, followed by the Offshore Groundfish Advisory Committee, which became the Atlantic Groundfish Advisory Committee, in 1974. By the 1980s the advisory function was served by a plethora of species, or species group, committees established primarily on the geographical basis of DFO administrative regions. Decisions on management actions are made by the federal minister responsible for

fisheries, usually in consultation with provincial counterparts and other federal ministers depending on the issues involved and their importance. Proposals for ministerial actions were, through 1992, brought forward by the DFO bureaucracy, but in 1993 a Fisheries Resource Conservation Council (FRCC) was established by the Minister to provide recommendations on conservation measures. In the initial year, 1993, the FRCC concerned itself only with groundfish management but it is intended that it systematically expand its role to cover other species groups. The FRCC is composed of members of the fishing industry and non-government scientists, and reports directly to the Minister, although its advice is public. When the FRCC was formed, the previous Atlantic Groundfish Advisory Committee was disbanded and its consultative role with industry was taken over by the FRCC. As the scope of the FRCC expands it would appear likely that it replace other such groups. The Minister, of course, remains responsible for establishment of overall fisheries policy.

Fisheries research is conducted almost exclusively by DFO, laboratories presently being supported in each of three Atlantic regions. Prior to extension of jurisdiction, however, there was little in the way of domestic demand for scientific advice and the products of this research were directed very largely to the scientific committee of ICNAF for application in its international regulatory program. Implementation of the 200 mile zone did, of course, greatly increase domestic requirements for scientific advice and in response DFO scientists established the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC). This was necessary, due to a decentralized organization, to provide co-ordination and consistency in approaches among regions but equally importantly to provide a forum for peer review of scientific analyses and to provide a focus for documentation of the scientific basis for management actions. Although controlled by the DFO scientific establishment, its scientific deliberations were open to outside scientists, including foreign scientists, on an invitational basis. This committee was disbanded by the Minister at the end of 1992 on formation of the FRCC. Although DFO scientists remained responsible for producing assessments of stock status, the FRCC was charged with reviewing these and the data on which they were based, and advising the Minister on research and stock assessment priorities and methodologies. This change appears to have been motivated by dissatisfaction with the reliability of stock assessments and with DFO science priority setting, particularly the emphasis on short-term rather than longer-term stock projection. Ad hoc arrangements for stock assessment review and generation of advice on stock status were made within DFO for

1993, and in 1994 a new, largely intra-regional, peer review mechanism was implemented, the effectiveness of which is yet to be established.

Canadian authorities received scientific advice from CAFSAC mainly for stocks which lay entirely within the Canadian zone. Those stocks for which there remained a significant level of foreign fishing were referred to the NAFO Scientific Council for advice, particularly in the initial years after 1977. These became fewer as foreign fishing within the zone declined, but advice on silver hake is still requested from the Scientific Council. As a matter of practicality, advice on stocks overlapping the Canadian zone-NAFO Regulatory Area boundary continues to be requested from the NAFO Scientific Council. Advice for stocks which occur in both Greenlandic and Canadian waters has also consistently been requested from the NAFO Scientific Council by both coastal states. In the years immediately after extensions of jurisdiction, scientific advice on the stocks in the Canada-USA disputed area was harmonized through ad hoc scientific discussions because the USA was not a member of NAFO. After a few years, however, the continuing lack of coordination between management actions of the two parties made this unnecessary. Scientific advice for St. Pierre Bank cod was at times requested from the NAFO Scientific Council and at others was the subject of *ad hoc* bilateral consultations depending on political circumstances.

Responsibility for enforcement of regulations rests with DFO and is discharged through a corps of land-based and at-sea surveillance personnel. A fleet of ships is maintained by DFO for at-sea surveillance. In addition, a policy of multi-tasking the armed forces has made available air force planes and naval vessels, including the occasional submarine, for fisheries patrols. Air surveillance has recently been conducted by private company aircraft through contract with DFO. An important decision was made in 1978 to establish an at-sea observer program with both surveillance and scientific functions. Initially, observer coverage was restricted to foreign vessels fishing in the Canadian zone. Coverage of these vessels was 50–75% of days-on-ground in the early-1980s and was increased to 100% from 1987. Increasingly, observers were placed on domestic vessels, particularly large groundfish trawlers. At first, this domestic vessel coverage focused on specific problem situations but the trend was towards more general coverage, including placing of observers on some small groundfish vessels under 20 m (65 feet). However, with some high-priority exceptions, coverage levels of domestic fleets was low.

Management Objectives and Strategies. A fundamental review of marine fisheries management policy was conducted by DFO in the early-1970s, when the fishing industry was in crisis as a result of declining catch rates and a weak market for groundfish products (Parsons, 1993), and a comprehensive statement of policy was published in 1976 (FMS, 1976). A "guiding principle" (in present parlance, an overall objective) of the policy was "best use" of fish resources, to be defined by the sum of net social benefits derived from the fisheries and associated industries. A large number of secondary objectives were used to define best use. The exploitation strategies which were consistent with a best use objective were not defined in the policy. However, contemporaneously with development of this policy, Canada was promoting, successfully, the adoption of an $F_{0.1}$ exploitation strategy within ICNAF as a replacement for F_{max} . In the absence of any social and economic analyses which could be used to define optimum yield, $F_{0.1}$ became the standard reference point for setting levels of harvest for Canadian fish stocks.

Annual TACs were used to control the level of exploitation of fish stocks in Canadian waters, thus maintaining continuity with ICNAF regulation. Initially, stringent catch controls were required to encourage stock rehabilitation, and annual fishing plans were developed that suballocated TACs to interest groups, defined by vessel length and gear used (and in some instances by vessel horsepower). These fishing plans also coordinated the deployment of mobile fishing fleets over the fishing grounds, and over the operating season, to promote full utilization both of fleets and of fish resources. Inshore fleets, which came over time to be defined as boats under 20 m (65 ft) in length, were given preferential catch opportunities, as a matter of social policy, through a system of allowances. Allowances were non-binding quantities, subtracted from TACs, to cover the expected catches of these inshore fleets, the remainder of the TAC then being available for allocation as binding quotas to offshore fleets.

Another important element of Canadian management strategy was to balance catching capacity of fleets to available resources. Limited-entry licensing, first introduced in 1967 for the Atlantic coast lobster fishery, was extended to the herring purse-seine fleet in 1971, to large groundfish trawlers in 1973, and to groundfish boats less than 20 m (65 ft) in 1976. Licensing policies not only restricted the number of licences but also placed controls on the size of vessel replacements. However, in the case of inshore groundfish boats (<20 m) licensing controls initially allowed fleet

expansion, again as an element of policy. By the early-1980s, however, it was necessary to impose strict controls on inshore groundfish fleet capacity, to dispense with catch allowances in favour of binding quotas, and to introduce a sector management policy which restricted the area of operation of inshore boats to sectors adjacent to home ports.

The general economic recession of the early-1980s threatened the financial viability of some of the largest fishing companies, resulting in another large-scale government intervention in the industry and the commissioning by the government in 1982 of an independent Task Force on Atlantic Fisheries. The report of this task force (Kirby, 1982) proposed new objectives which were accepted by the government and subsequently guided DFO policy. These were, in order of priority, 1) economic viability of the fishing industry on an ongoing basis, 2) maximization of employment at reasonable income levels, and 3) Canadianization of the fishery within the Canadian zone. The fish resources, at this juncture, were at a fairly high level of abundance and the task force did not address conservation objectives or strategies. The $F_{0.1}$ strategy, limited entry, and the annual planning process remained as central elements of harvesting sector management, but increasingly, individual quota shares assigned to specific boats (IQs, or ITQs when shares are transferable) or fishing enterprises (called enterprise allocations) replaced global allocations to fleet sectors defined on the basis of vessel size and gear type, as recommended by the Task Force. Some schemes involved elements of transferability between quota holders, but none involving full and free transferability of individual quota shares have yet been implemented. The first utilization of IQs actually predated the Task Force by a number of years; they were introduced for the Bay of Fundy herring purse seine fleet in 1976. Enterprise allocations for the offshore groundfish trawler fleets were introduced on a trial basis for 1982, also in advance of the Task Force recommendations.

The rapid decline in the early-1990s of most cod stocks, and those of a number of other groundfish species, required that a large number of fisheries be closed. This separated thousands of fishermen from their primary or sole source of livelihood and required that government financial support of unprecedented scale be provided to avoid extremes of social hardship. Another Task Force was established in 1992 to review and recommend actions "on incomes and adjustment in the Atlantic fishery". This represented the first major study specifically directed at social policy for the fishery. This Task Force was requested to advise on how to

ensure stable, adequate incomes for those whose employment was sustainable by the fishery and on how to provide alternatives for those displaced. The Task Force report (DFO, 1993) recognized that the "adjustment" required was a reduction in groundfish harvesting and processing capacity of about 40 to 50% and proposed creation of "fishing industry renewal boards" to implement a reduction policy. The need for clear policy objectives that give explicit priority to ecological and commercial sustainability was also stressed, and a warning was issued against an exclusive preoccupation with conservation. The effect of these proposals, and the many specific recommendations of the Task Force, on government policy will require the passage of more time to determine.

Canada provides foreign access to stocks which are surplus to Canadian needs, in accordance with Article 62 of the 1982 United Nations Convention on the Law of the Sea. Canada also granted access to non-surplus stocks, on occasion, in exchange for various forms of cooperation, but foreign allocations of non-surplus stocks was terminated in 1986. Overall control of foreign fishing in Canadian waters is through catch allocations. Although the number of days on ground is licensed, this is an administrative procedure only and does not serve to limit fishing effort.

Regulatory Actions. Canada retained the ICNAF trawl regulations for the groundfish fisheries until 1982 when differentials based on net materials, and for seine nets, were dispensed with (Appendix Table 9). This resulted in an increase in mesh size to 130 mm as trawlers had previously been able to use 120 mm mesh and seiners 110 mm. The primary motivation for this change was to simplify enforcement. In contrast to the ICNAF regulations which specified the species and areas to which the minimum mesh size applied, the new Canadian regulations applied to all species and parts of the Canadian zone unless specific exemptions were given. Thus, pollock came under mesh regulation for the first time in the Scotian Shelf-Gulf of Maine area, where the fishery mainly occurred. In March 1991, a further increase in mesh size was imposed in the southwestern part of the zone. This raised minimum mesh size in traditional diamond mesh netting (where netting bars are hung at 45° to the water flow) to 155 mm and introduced a differential for square mesh netting (where netting bars are at 90° to the water flow) for which the minimum was set at 140 mm. The short-term effects on catch rates of such a substantial mesh size increase were, however, more severe than the industry was prepared to accept, and a reduction to 145 mm diamond and 130 mm square mesh was announced in July of the same year. The original increase in

mesh size was introduced because consultations between DFO and fishermen in the Region affected showed substantial support for an increase in the size of fish caught and landed (Haché, 1989). Mesh size in cod traps, fished almost exclusively along the Newfoundland coast, and in groundfish gillnets was also regulated throughout the post-extension of jurisdiction period, and longline hook size restrictions were introduced in the southwestern part of the zone in 1995. From 1994, reference to specific mesh and hook sizes, and also to minimum fish sizes (see below), for groundfish were removed from regulations. These are now embodied in "conservation harvesting plans", negotiated annually between DFO and each fleet component. This provides great flexibility to modify gear and fish size restrictions to suit prevailing circumstances.

Reliance solely on mesh size regulations to control the size range of groundfish subject to fishing was modified by the introduction of minimum fish size regulations in 1988. Thereafter, it became illegal to catch or retain or have on board a vessel cod, haddock and pollock of less than 41 cm total length. In 1991 this minimum size was raised to 43 cm when fishing in the southwestern part of the zone, coincident with the increase in mesh size for that area. A minimum size was also adopted for Atlantic halibut in 1988 at 81 cm total length. Fish caught in cod traps were exempted from all these minimum size limits. However, these minimum fish size regulations are unlikely to have had a significant effect on the size of fish caught or landed, at least initially, as no procedures were established for their enforcement. When undersized fish by-catch allowances were set for cod fisheries in the Gulf of St. Lawrence in 1991, these were sufficiently lax that a large proportion of the numbers of fish removed from the stock could still be of undersized fish. A firmer approach was adopted for 1993 for all Canadian waters using the Icelandic concept of real-time area closures. Specific fishing grounds were closed for specified periods to particular fleet sectors when their fleet catch in a single day exceeded 15% of undersized fish by number, as estimated by at-sea observers. It was, however, made legal to retain all undersized fish actually caught, to avoid wastage.

The ICNAF technical regulations for pelagic fish, which consisted only of minimum fish size regulations, were strengthened by Canada but no new elements were added. The minimum fish size limit on mackerel was retained, although modified to 25 cm fork length, rather than total length, in 1986, which equated to an increase of about 10%. The ICNAF herring size regulation of 22.7 cm total length was discarded in 1977 in favour of a 26.5 cm fork length regulation (about 29 cm total length).

However, this regulation applied only in areas north and east of the north-central Scotian Shelf. Thus the fishing areas which traditionally supplied the sardine (small herring) industry remained exempt, but development of fishing for small herring in new areas was prevented. In the case of both herring and mackerel, gillnet catches were exempted from the fish size regulations, and by-catch allowances were reduced to 10% by number, from the ICNAF 10% by weight or 25% by number.

Other than the innovation of real-time short term closure of specified fishing grounds to protect undersized fish (at least temporarily), there was little use of closed area and season regulations for conservation purposes other than those established under ICNAF. Permanent closure of an area on the eastern Scotian Shelf was instituted in 1987 to protect juvenile (ages 0–3) haddock, initially from capture by otter trawling but from 1993 from capture by all gears. Some herring spawning beds were closed to otter trawling and purse seining to protect the spawn from disturbance. The ICNAF haddock seasonal spawning area closures off southwestern Nova Scotia and on Georges Bank from 1970, and the window on the Scotian Shelf to minimize by-catches in the small mesh gear fisheries for silver hake, squid and argentine, adopted by ICNAF for 1977, were continued in Canadian regulation, with some spatial and seasonal adjustments. The capelin closure off southeast Newfoundland was dropped, as elimination of offshore fishing made it unnecessary. There are many other seasonal area closures in Canadian fishery regulations for both pelagic and groundfish species but virtually all relate to direct gear conflict or indirect allocation issues.

Catch controls established by ICNAF applied to virtually all the major fisheries in the area claimed by Canada in 1977. Canadian authorities retained and enhanced these TAC controls as the primary measure for regulation of exploitation levels. Some TAC regulations had been adopted by Canada in the early-1970s for herring stocks within its Gulf of St. Lawrence and 12 mile coastal fishing zone around Newfoundland (Appendix Table 10) and TACs had been in effect for southern Gulf of St. Lawrence cod under ICNAF from 1974, but the primary extension of catch controls to Gulf of St. Lawrence waters occurred in 1976–77 in preparation for the post-200 mile limit regime.

An exploitation strategy of $F_{0.1}$ is generally a low level of exploitation. Establishing and enforcing TACs at such a conservative level is difficult if there is a large fleet which requires much greater fishing opportunities to cover loan payments on vessels and provide adequate incomes to captains and

crew. Overcapacity was recognized in the Canadian herring purse seine fleet, and the number of licences was frozen, prior to extension of jurisdiction. The herring fishery had been essentially domesticated before 1977, and the 200 mile limit did not present new catching opportunities. Individual vessel quotas to purse seiners, introduced in 1976, were made transferable, on retirement of the selling vessel, in 1983, with some resultant reduction in fleet size.

In the case of groundfish, the crisis of 1974–76 stimulated the introduction of limited entry licensing but the primary concern was to constrain investment in large offshore trawlers, as the number of inshore vessels was in decline (Parsons, 1993). Extension of jurisdiction created high expectations for greater catches and encouraged the view that greater catching capacity was required to replace the fishing effort of foreign fleets. In actuality, the target fishing mortality of $F_{0.1}$ was substantially below the levels of F prevailing prior to 1977 on resources traditionally harvested by the Canadian fleet. The fisheries administration, aware that the domestic groundfish fleet was already close to the capacity required to exploit the resource at this lower $F_{0.1}$ level, was successful in preventing a substantial expansion of the large trawler fleet. However, the capabilities of the inshore fleet to expand under the favourable conditions of continued availability of new licences, substantial subsidies for boat construction, and no catch limitations, was badly underestimated. By the time these incentives were removed in the early-1980s, there was already a serious overcapacity in the catching sector (Halliday *et al.*, 1992). In the 1980s, management efforts focused on how to contain this capacity so that TACs were not exceeded. This involved adoption of various indirect controls on fishing effort, such as trip limits on catches of inshore boats and seasonal closures, but direct controls on fishing effort were not imposed. Increasingly, ITQ schemes were adopted for some species and areas for particular fleet components as a way to control the utilization of fleet capacity by bringing market forces to bear. However, caution on the parts of both industry and government has limited the extent of transferability under these schemes (Sutherland, 1994). The severity of the groundfish industry crisis of the 1990s can be traced to the fleet overcapitalization of the 1976–81 period (Schrunk, 1995).

Surveillance and Compliance. Foreign vessels licensed to fish in the Canadian zone were required to carry observers on request. Observer coverage was consistently high and from 1987 onwards was essentially 100%. This, combined with aircraft and surface surveillance, is thought to have resulted in

a high level of regulatory compliance. A different problem is presented by unlicensed vessels which may transgress zonal boundaries. In the Canadian context this is most likely to occur in two areas where foreign vessels are fishing in immediately adjacent waters, i.e. on Georges Bank and the Grand Bank. Transgressions of the Georges Bank boundary by U.S. vessels were common in the 1980s, the primary attraction being the sea scallop stock on the Canadian side of the bank, managed autonomously by Canada. This illegal activity had allocative significance and was of a scale sufficient to adversely affect fisheries relations between Canada and the USA until a fisheries enforcement agreement was signed in 1990 (Day and Herbert, 1995; Herbert, 1995; Kraniotis, 1994). The important finfish resources, however, are transboundary in distribution on both Georges and Grand banks and thus, from a conservation viewpoint, precisely where the fish are taken is of less significance than is the total quantity taken from the stock overall. Uncontrolled fishing of transboundary stocks in waters outside of Canadian jurisdiction has presented by far the more important threat to conservation (see USA account below and the Section regarding NAFO management).

The level of regulatory compliance by domestic vessels is more difficult to evaluate as hard information is scarce. Observer coverage on groundfish vessels was low, except for the large trawler fleet fishing for Labrador-East Newfoundland cod which had 100% coverage after 1986. Enterprise allocations for companies owning fleets of large trawlers, and trip limits for smaller vessels, led to high-grading and to dumping of unwanted species, although dumping of fish at sea is illegal under Canadian fishery regulations. The greater range of large vessels opened up opportunities for misreporting the stock area from which fish were captured whereas smaller vessels, which can avail themselves of the many small harbours along the coast, had greater opportunities for misreporting or non-reporting of quantities landed and for providing erroneous species designations. There are some important cases where reliability of statistics from the domestic fleet has been raised by scientists as a primary limitation to the advisory process. Groundfish stocks off southwestern Nova Scotia and on Georges Bank are cases where there is reason to believe that official catch statistics for under 65 foot boats, which dominate the fishery, represented no more than two-thirds of actual catches (Angel *et al.*, 1994; Mohn *et al.*, MS 1990). Also, Bay of Fundy herring purse seiners are believed to have reported no more than half to three-quarters of their catches against IQs in the 1980s (which follows a long tradition of under-reporting by this fleet) (Stephenson, MS 1993). The level of compliance

with mesh regulations is not known but a large body of anecdotal evidence suggests that they were regularly flouted, and groundfish minimum fish sizes were generally ignored.

Resource Trends. The cod stocks of the Northwest Atlantic have been divided into twelve units for management purposes. Of these, seven management units are managed autonomously by Canada; northern Labrador cod, Labrador – East Newfoundland cod (although this has been challenged in NAFO – see NAFO Management Section), northern and southern Gulf of St. Lawrence cod, Sydney Bight summer cod, eastern Scotian Shelf cod, and southwestern Nova Scotia cod. St. Pierre Bank cod, although shared with France, is included here with Canadian stocks. However, Flemish Cap cod, which is restricted to the NAFO Regulatory Area, and the overlapping Grand Bank cod are treated under the NAFO section. Also, for Gulf of Maine cod, which is autonomous to the USA zone, and the transboundary Georges Bank cod, trends are described in the USA section. The assignment of transboundary stocks to particular management regimes was based on a judgement as to which regime had the predominant influence on stock trends. This is debatable in the case of St. Pierre Bank cod and it is classed under the Canadian regime largely as a convenience. In the cases of Grand Bank and Georges Bank cod, the agency which allowed the highest de facto exploitation rate was chosen. This is not a comment on resource distributions in relation to boundaries or on appropriate catch allocations between interested parties. It is simply a judgement about which agency, in the post extension of jurisdiction period, may have had the greater influence in determining the overall exploitation level.

In the case of Canadian cod stocks, then, there are eight, and five of the largest have had analytical assessments conducted on them which allow trends in catch, stock biomass, fishing mortality and recruitment to be described over the time period used in this paper. The two smallest, northern Labrador and Sydney Bight summer cod, can be ignored and the time series of data for the northern Gulf of St. Lawrence stock is too short for present purposes. By far the largest of the stocks is that off Labrador and East Newfoundland (Div. 2J+3KL), locally known as "Northern cod". In recognition of its overriding importance to the Canadian groundfish fishery, indices for this stock are illustrated separately (Fig. 6). The other four stocks, which all had very similar trends, are combined for illustration (Fig. 7). The general pattern for cod stocks is one of decreasing abundance in the 1960s – early-1970s, a subsequent increase, but a decline again in the late-1980s and the 1990s. Fishing

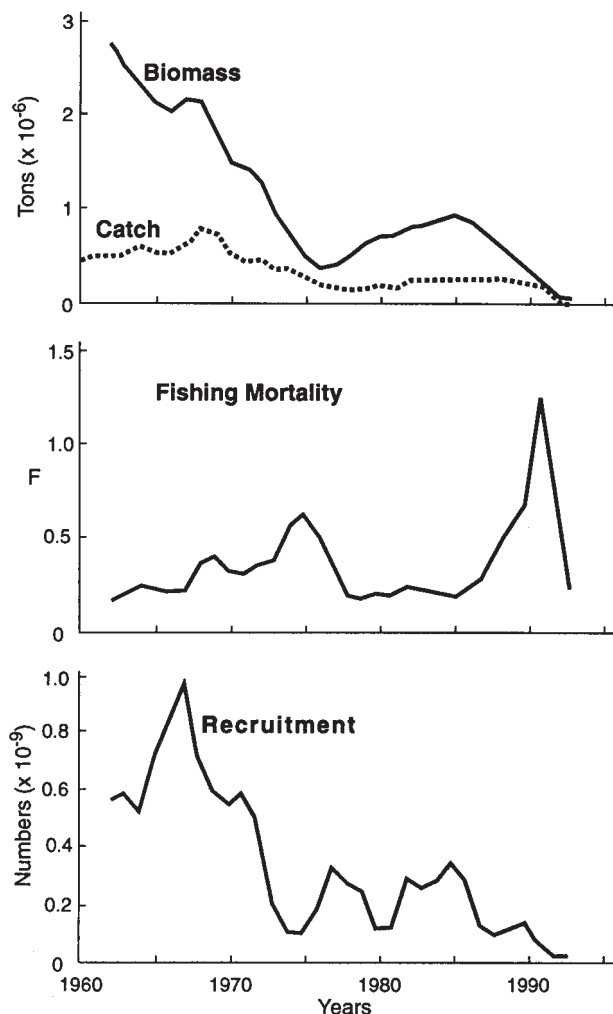


Fig. 6. Labrador–East Newfoundland cod: trends in stock parameters.

mortality trends were the inverse of those for biomass and, for Div. 2J+3KL cod, recruitment was much lower subsequent to the 1960s.

Haddock stocks on Grand Bank and St. Pierre Bank once supported large fisheries but these have been unimportant since the early-1960s. Most catches were subsequently from Scotian Shelf stocks, divided into eastern and western management areas, which are in the Canadian zone, and from Gulf of Maine and Georges Bank stocks. Although the Georges Bank stock is transboundary, it is treated in the USA section. Trends for Scotian Shelf haddock (Fig. 8) were similar to those for Div. 2J+3KL cod.

Although there are a substantial number of pollock spawning components on the Scotian Shelf

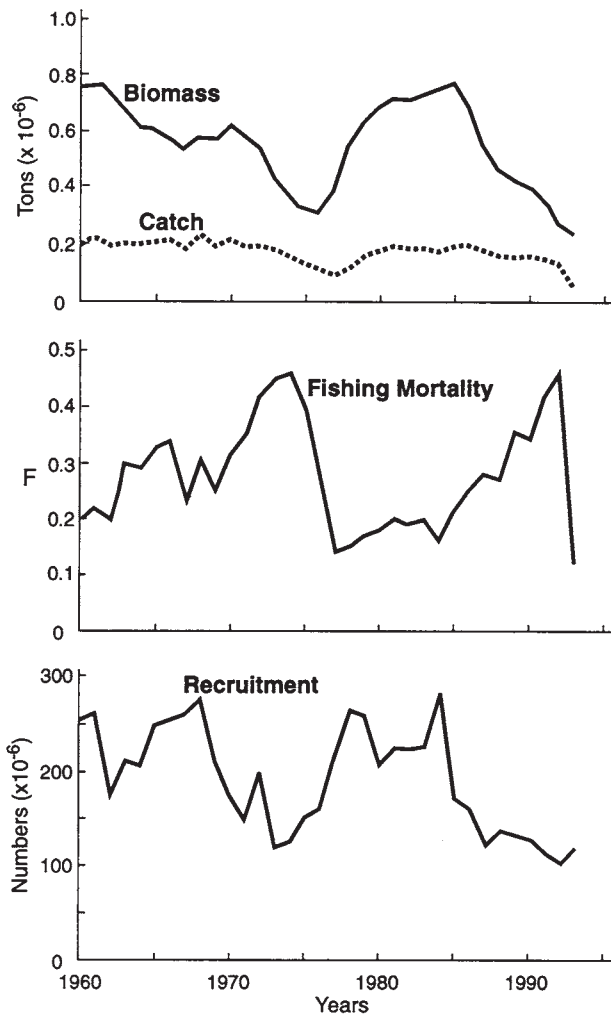


Fig. 7. Other Canadian cod stocks: trends in stock parameters.

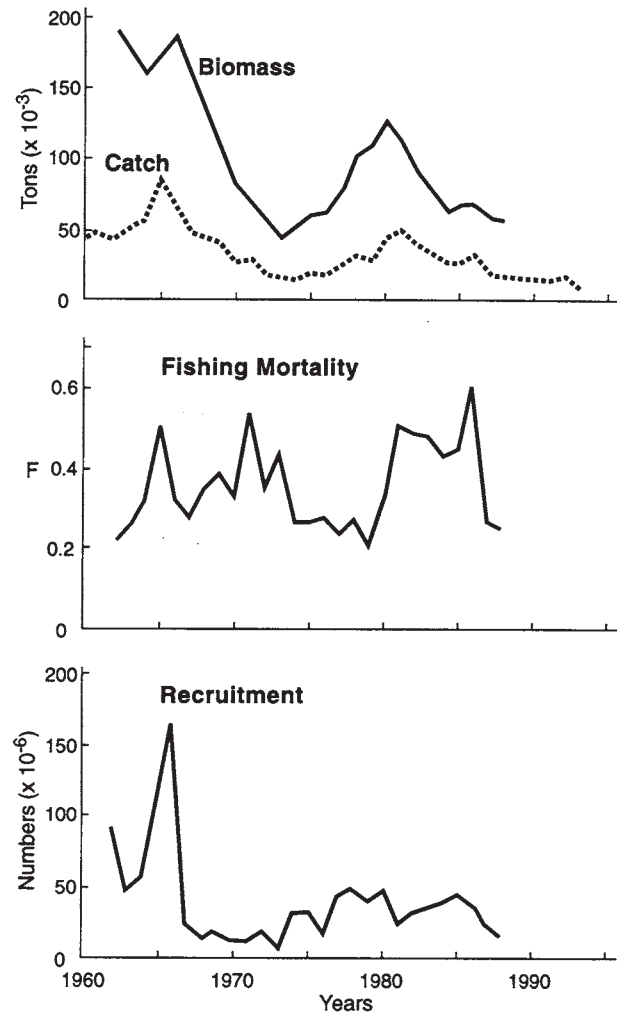


Fig. 8. Canadian haddock: trends in stock parameters.

and Gulf of Maine there is a lot of mixing among them. Under the ICNAF regime, and for a number of years after extension of jurisdiction, all pollock in these areas were assessed as a single unit. However, after 1976 catch restrictions were applied only in the Canadian zone, and the USA fishery was unregulated. It was subsequently decided that it was practical to manage the fishery in the Canadian zone separately from that in USA waters, as Canadian tagging experiments suggested that emigration to USA waters from Canadian stock components was not high. Thus, from 1990, pollock on the Scotian Shelf and the Canadian portion of Georges Bank were assessed and regulated as a unit. The size of the Canadian pollock stock increased greatly from 1970 (the earliest year in the available estimates) until the early-1990s (Fig. 9).

There are a great many herring spawning components in the area from Newfoundland to the Gulf of Maine. Stock assessments are conducted for these in a number of areas, i.e. in various Newfoundland bays, off the west coast of Newfoundland, in the southern Gulf of St. Lawrence and off southwestern Nova Scotia, and these in aggregate provide a description of overall stock trends in the Canadian zone. Georges Bank herring are transboundary, and there is also mixing of juvenile herring in the Gulf of Maine and western Bay of Fundy, but Subarea 5 herring are included in the USA section. Canadian herring stocks declined from the late-1960s but there was an increase subsequent to 1980, apparently to a level well above that of the late-1960s (Fig. 10). It has not been possible to conduct analytical

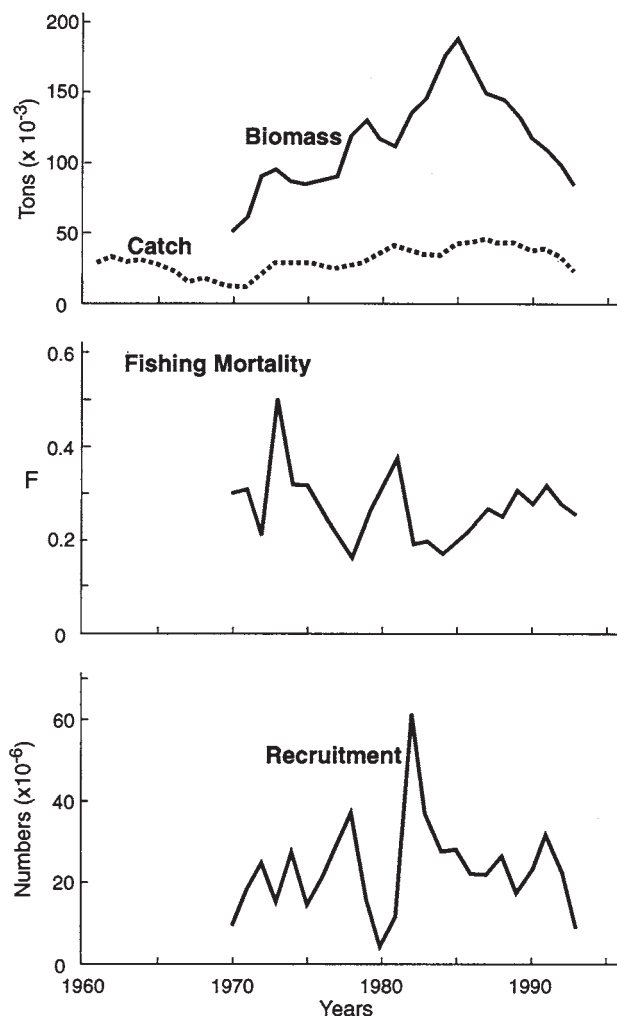


Fig. 9. Canadian pollock: trends in stock parameters.

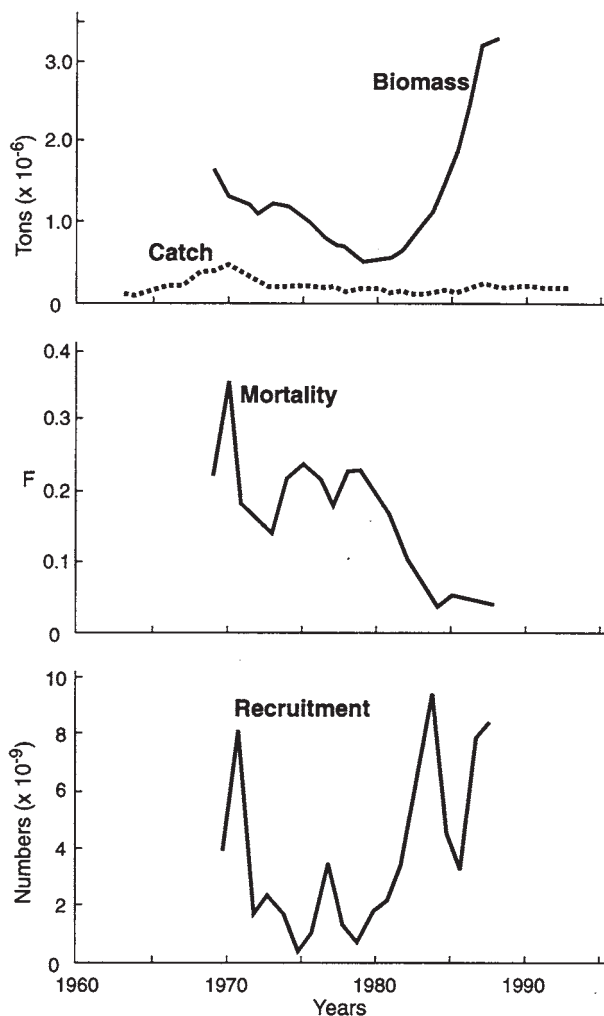


Fig. 10. Canadian herring: trends in stock parameters.

assessments for all of the important stocks in recent years because of degradation of data quality, thus the estimates of stock indices for the late-1980s should be taken as no more than indicative of an overall recovery of herring populations from the depressed levels of the late-1970s – early-1980s.

There are northern and southern spawning components in the Northwest Atlantic mackerel stock, the northern component spawning predominantly in the Gulf of St. Lawrence. However, both components overwinter primarily in USA waters and, as all Northwest Atlantic mackerel are assessed as a single unit, this transboundary resource is dealt with under the USA regime.

Five management units have been defined for capelin in the Northwest Atlantic, one of which, the southern Grand Bank capelin, is transboundary and managed jointly with NAFO. The largest Canadian

stocks are those off Labrador–northeast Newfoundland and on northern Grand Bank, and the abundance of these is monitored through acoustic surveys and commercial fishery catch rates. (However, the autonomous jurisdictional status of northern Grand Bank capelin has been challenged – see NAFO Management Section) The remaining stocks, separated into management units on St. Pierre Bank and in the Gulf of St. Lawrence, are relatively small. Their abundance trends are not monitored but precautionary TACs are applied. While there are many difficulties in obtaining abundance estimates for capelin, and the time series of estimates in Fig. 11 should not be interpreted in great detail, several things are clear nonetheless. Abundance of capelin off Labrador and east Newfoundland was high in 1971–77 and 1985–90 with much lower abundance in the intervening period and also apparently after 1990. Stock size estimates may not be in scale between

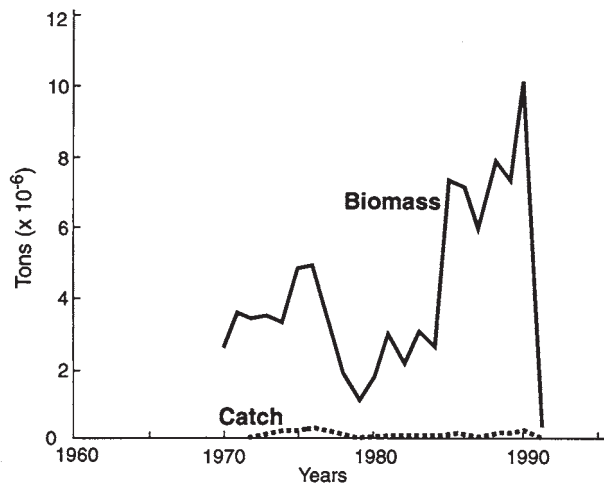


Fig. 11. Canadian capelin: catches and biomass.

high abundance periods but indicate that there was undoubtedly a very large amount of capelin present at those times. In contrast, catches have been small, and stock fluctuations have resulted very largely from natural causes.

The first catch controls and other measures introduced by ICNAF for all major haddock stocks in 1970–72 were intended to keep catches as low as possible to promote stock recovery. Regulation of the cod stocks at the F_{max} level was introduced in 1973–74 and for pollock in 1974. Regulation of herring by ICNAF and Canada began in 1972 with $F_{0.1}$ as the primary reference point. Canadian regulation from 1977 aimed at fishing mortalities at $F_{0.1}$ or lower for all these stocks. Canada was successful in reducing fishing mortality for cod stocks in 1979–88 below levels prevailing in ICNAF times, 1967–76 (Fig. 12). However, the $F_{0.1}$ target was not reached and fishing mortalities were still somewhat above F_{max} . For pollock, fishing mortality was about F_{max} in both periods, and for herring stocks fishing mortality was maintained at about the $F_{0.1}$ level. Haddock stocks appear to have been more heavily fished under Canadian jurisdiction, well above F_{max} . The actual level, as shown in Fig. 12, is uncertain because there were technical problems in ageing the fish during this latter period, but fishing mortality was no doubt high. For capelin, however, the intention to keep exploitation rate very low was clearly met, as catches were negligible in relation to stock biomass. Thus, in the 1980s, Canada did not meet its central strategic objective of fishing groundfish stocks at $F_{0.1}$, but appears to have realized its regulatory intentions for pelagic fish stocks.

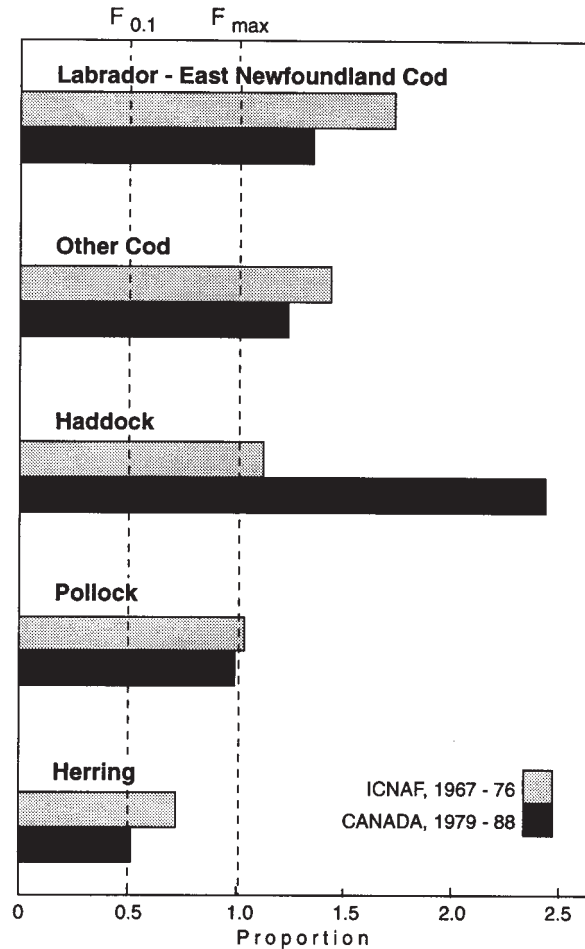


Fig. 12. Canadian stocks: fishing mortality in the ICNAF and Canadian management periods in relation to F_{max} and $F_{0.1}$.

Canada's difficulties in meeting its strategic targets for groundfish resource conservation can be in large part attributed to a failure to balance fleet capacity with resource availability through the licensing and vessel replacement policies adopted. No targets were ever established under these policies which could be used as guidelines in judging what constituted an appropriate balance, and against which statistics on the number of fishermen, or on fleet capacity, could be compared. As late as 1993, the Task Force on Incomes and Adjustment in the Atlantic Fishery (DFO, 1993) concluded that the provisions then existing could not control the number of vessels or fishermen entering the industry, nor could they limit the actual harvesting power brought to bear on the resource. In broader terms, an emphasis on maximizing employment in the fishery has prejudiced attainment of the conservation

and other objectives by encouraging greater demands for catch possibilities than the resource can provide (Angel *et al.*, 1994; Burke and Brander, 1995).

The European Union

The European Economic Community was established in 1957. As its aspirations broadened, its representatives came to refer to it simply as the European Community (or to refer collectively to the European Communities, as there are others for coal and steel and for atomic energy). Ratification of the Maastricht Treaty on European Union in 1993 resulted in a change in name to the European Union and this name is used throughout the present paper, for simplicity, in reference to events prior to, as well as after, 1993. There were initially six members – Belgium, France, Italy, Luxembourg, The Netherlands, and the Federal Republic of Germany (FRG). Denmark, Iceland, and the UK joined in 1973, Greece in 1981, Portugal and Spain in 1986, and Austria, Finland and Sweden in 1995, bringing total membership to 15. When Denmark joined the EU in 1973, Greenland was an integral part of Denmark and thus also acquired EU membership. However, Greenland subsequently achieved home rule and withdrew. It has managed its own fishing zone since 1985. Thus, management in Greenlandic waters is treated in a separate section. The Faroe Islands, although also Danish, already had a substantial degree of self-government in 1973 at the time of Danish accession to the EU treaty. Although Faroe Islands had the option to join, the home rule government decided against it. Another special case of some importance to fisheries management in the Northwest Atlantic is that of the French islands of St. Pierre and Miquelon situated adjacent to the south coast of Newfoundland. In the period 1975–86, these islands had the status of an overseas department of France, hence were French territory and were subject to EU fisheries law. They subsequently reverted to a Collectivité territoriale, placing fisheries in adjacent waters under French national, rather than EU, jurisdiction. The fisheries management issues which concern St. Pierre and Miquelon have already been discussed under Canada.

The EU members with a significant interest in North Atlantic fisheries and management policy in the post-extension of jurisdiction period were, until 1986, Belgium, Denmark (excluding Faroe Islands), France, FRG, Ireland, The Netherlands and the UK. Greece and Italy did not have significant fisheries in the North Atlantic (and Luxembourg is landlocked). In 1986, accession of Portugal and Spain increased the number of interested countries to nine. The unification of East and West Germany in 1990 further increased the importance of EU fisheries. Among new entrants in 1995, Austria is

also landlocked, and the marine fisheries of Finland and Sweden do not extend beyond the Baltic Sea, or the Skagerrak and Kattegat, respectively, to any important extent.

Fishing Limits. Until the late-1950s most European nations claimed exclusive fisheries jurisdictions of three miles. By the early-1970s most claimed some degree of jurisdiction over fisheries in a 12 mile coastal zone. By 1975, Iceland had extended its jurisdiction to 200 miles and progress at the Third United Nations Conference on the Law of the Sea had cleared the way for other North Atlantic states to plan a similar extension. In particular, Canada, Norway and the USA in 1975–76 made clear their intentions to declare 200 mile zones effective in 1977. A number of EU countries had important distant water fisheries in the waters to be claimed by these countries and it was obvious that major disruption of EU fisheries was inevitable. The member states of the EU decided, therefore, that they too would claim 200 mile zones (or median line boundaries), around their North Sea and Atlantic coasts. These various claims became effective in 1977–78. (Portugal and Spain extended their jurisdictions to 200 miles also, in 1977 and 1978, respectively.) The outer bounds of jurisdictional claims of EU members, which define domestic waters in the Northeast Atlantic within which EU fisheries policies apply, are illustrated in Fig. 13.

Extensions of jurisdiction by Northeast Atlantic countries resulted in a great many conflicting claims and a large number of boundaries between national zones remain in dispute. However, the equal access provision of EU fisheries policy greatly reduced the relevance to fisheries of boundaries between zones of member countries. Also, the EU negotiated fishery agreements with third parties which included reciprocal access agreements and, when necessary, included provisions for management of shared stocks. These agreements prevented boundary issues becoming important in the contexts of resource management and the orderly conduct of fishing. A number of resources which occur in the EU zone have distributions which extend also into international waters. Furthermore, the UK claim to a 200 mile limit around Rockall, off the west coast of Scotland, has been challenged (Symmons, 1986). However, these circumstances did not raise important obstacles to management in the study period (but see also the Section on the new NEAFC).

Management Institutions. The authority for management of fisheries in EU waters resides in the political and administrative bodies of the EU rather than with individual member states. From 1970, when the first EU regulations for fisheries were

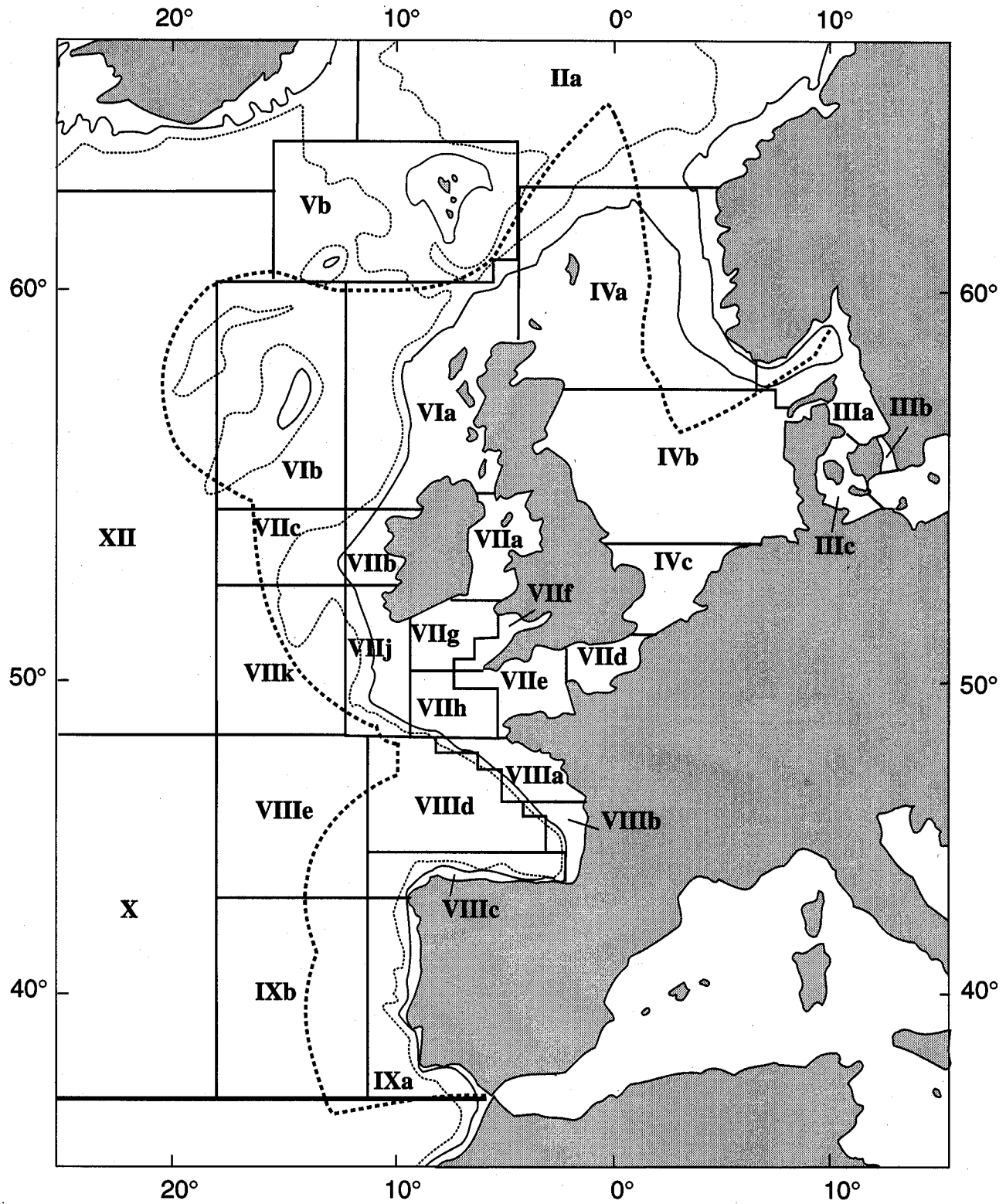


Fig. 13. Outer bounds of jurisdictional claims of EU member states (heavy dashed line) which define EU domestic waters in the Northeast Atlantic, and ICES Statistical Areas. (Depth contours are 200 m – solid line, 1 000 m – fine dashed line.)

established, there was a gradual transfer of the legal authority to regulate fisheries from member states to the EU. After 1978, the power to adopt fishery conservation measures belonged fully to the EU; member states had no power of their own (Churchill, 1987a). They could, however, retain national measures in force as of that time and modify these to deal with changing circumstances, but such modifications could not embody any new conservation initiatives. Thus, with regard to fisheries, the EU can be regarded as a single coastal state (Churchill, 1987b).

Fisheries policy in the EU is dealt with primarily by two of its institutions, the Commission, which is the EU's administrative arm, and the Council of Ministers, which is its legislative body composed of ministers of the governments of member states. The composition of the Council of Ministers varies depending on subject matter. Fisheries issues are normally dealt with by the Council meetings attended by the minister responsible for fisheries in each member state government. The European Parliament has an advisory role in some fisheries matters. Fisheries legislation is initiated through Commission proposals. Those proposals accepted by the Council become EU law. (When proposals are not accepted, it is for the Commission to bring forward modified versions.) The legal and political functioning of the EU with regard to fisheries is thoroughly described by Churchill (1987a) and Holden (1994).

Within the European Commission, a Directorate-General for Fisheries is responsible for fisheries matters. This Directorate-General was formed in 1976 in response to the emergence of fisheries as an important issue for the EU. The Commission established several external advisory groups, the most important of which, from the viewpoint of conservation, was The Scientific and Technical Committee for Fisheries which was established in 1979 to advise on the biological status of fish stocks and the technical aspects of their exploitation. A requirement to maintain this committee was subsequently incorporated into regulation in 1983. Its scope was broadened in 1992 to include economic issues and thus it is now called the Scientific, Technical and Economic Committee for Fisheries.

The EU depends primarily on ICES for biological advice on the status of fish stocks and for projections of future yields. The Commission's scientific committee tailors and amplifies ICES advice to meet Commission needs. Duplication of effort is avoided as much as possible. However, the new Scientific, Technical and Economic Committee has the scope and membership to deal with a

broader range of technical issues than does ICES, particularly the economic implications of regulatory actions. The members of the EU scientific committee serve as individuals, not as national representatives. Appointments are made by the committee's secretary, who is a Commission civil servant, from lists of national nominees. The Committee functions on a democratic and independent basis. It can establish its own agenda, in addition to accepting an agenda from the secretary on behalf of the Commission.

After extensions of jurisdiction, there was a need to establish new lines of communication between fishery scientists and managers to replace those previously provided by NEAFC. ICES took the initiative by establishing a series of dialogue meetings with its clients, starting in 1980. As a result of these meetings ICES reformulated its advice to meet the expressed needs of the EU Commission. The dialogue led to a formal agreement between the two parties in 1986 under which the EU makes annual financial contributions to ICES. In return, ICES became obligated to provide advice on specific issues requested by the Commission. The agreement also allowed for a closer association between the ACFM of ICES and the Commission, which resulted in the Commission being able to have a scientific observer in attendance at ACFM meetings in 1987 and subsequent years.

The authority and responsibility for surveillance and enforcement of regulations lies with member states and not with the EU itself. However, the Council adopted regulations in 1982 which required member states to establish mechanisms for ensuring compliance with EU conservation measures. A particularly important element of these regulations was establishment of an EU inspection scheme to oversee the work of national authorities. The Commission, on the basis of reports from EU inspectors, can require member states to conduct an administrative enquiry into perceived "irregularities". Inspections by the EU began in 1984 with seven inspectors. By the end of 1984, 12 inspectors were employed and by 1989 the number was 18; two from each Atlantic coastal member state.

Management Objectives and Strategies. The Common Fisheries Policy (CFP) is the sum of a number of specific policies which address regulation of, or approaches for dealing with, various fisheries issues. A markets policy provides a system of market support, an external fisheries policy sets the framework within which the EU negotiates fishery agreements with third parties, a structural policy is concerned primarily with fleet development, and a conservation policy controls

harvesting activities. The conservation policy is supported by legislation controlling the quantities and distribution of catches, establishing technical measures (i.e. minimum mesh sizes, minimum fish sizes, area closures, etc.), and providing for fishery control and enforcement of regulations. The structural policy, which dates from 1970, initially provided subsidies for fleet development but progressively became a vehicle for fleet capacity reduction and hence an adjunct to conservation policy.

The initial conservation policy had the general objectives:

"to ensure the protection of fishing grounds, the conservation of the biological resources of the sea and their balanced exploitation on a lasting basis and in appropriate economic and social conditions" (Council Regulation (EEC) No. 170/83, Article 1).

A revision to the conservation policy in 1992 resulted in this statement of objectives being replaced by:

"As concerns the exploitation activities the general objectives of the common fisheries policy shall be to protect and conserve available and accessible living marine aquatic resources, and to provide for rational and responsible exploitation on a sustainable basis, in appropriate economic and social conditions for the sector, taking account of its implications for the marine ecosystem, and in particular taking account of the needs of both producers and consumers" (Council Regulation (EEC) 3760/92, Article 2).

This very general guidance left the Commission with scope to decide on the more specific objectives on which its regulatory proposals to the Council would be based. Commission actions to the mid-1980s were interpreted by Churchill (1987a) as embodying the following objectives:

- A.1. in the medium and long-term, to optimize exploitation of the living resources in Community waters, taking into account economic constraints,
- A.2. in the short-term –
 - a) to take measures which will ensure the continuation of each stock as a commercially viable resource,
 - b) to decrease the fishing effort on over-exploited stocks in order to ensure yields which are stable from year to year and,
 - c) to ensure the highest possible catches from the stocks consistent with a) and b) and taking into account the inter-relationships among stocks,

- B. to maintain as far as possible the level of employment and income in coastal regions that are economically disadvantaged or largely dependent on fishing activities, and
- C. to adapt Community fishing fleets to catch potential.

With regard to A.1. above, the Commission accepted the ICES strategy of maintaining or rebuilding spawning stocks, and proposed closure of fisheries on stocks which were in danger of, or had suffered, a recruitment failure. For A.2., also consistent with ICES, the Commission proposed exploitation at F_{max} for other stocks by reducing fishing mortality by 10% each year for stocks exploited above F_{max} (Holden, 1984). However, the Council did not find acceptable the Commission's proposals for reductions in catches, although these were required to bring about reductions in fishing mortality. The Commission modified its initial stance in 1982 to one of achieving a stabilization of the fisheries at the existing level of fishing mortality, but the Council did not adopt any particular exploitation level strategy; the primary value of TACs was as a mechanism for allocation of catch shares.

The objective of maintaining employment and income in disadvantaged areas and in those largely dependent on fishing activities (objective B above) stemmed from a Council resolution in the Hague in 1976 which established guidelines for policy development in the new, extended jurisdiction, era. It was implemented by providing, in TAC legislation for 1982 and subsequent years, preferential catch allocations to particular member countries based on whether that country, or part of it, fit the definition of being particularly dependent on fishing, or disadvantaged. Greenland, Ireland and the northern UK received this designation.

With regard to objective C, the EU addressed the issue of adapting fishing fleets to the available catch opportunities, as an element of its structural policy. A Council regulation of 1983 on restructuring and modernizing fleets made provision for financial aid to those member states which produced plans that sought a satisfactory balance between fishing capacity and available stocks. Also in 1983 the Council made provision for reimbursement of member states which introduced programs for scrapping and for temporary lay-up of vessels, and passed regulations providing financial support for fisheries diversification through exploratory fishing voyages and establishment of joint ventures. A revised policy was introduced in 1986, which incorporated all the elements of structural policy in one regulation, with the same objective of developing a fleet in equilibrium with resources. This policy was valid for 10 years but was divided into two periods, 1986–91 and 1992–96. Under it,

member countries were required to submit plans for fleet structural changes consistent with conservation regulations.

The EU was not faced with disposition of resource surpluses as a policy issue. Thus, countries which had been fishing in waters which became the EU zone in 1977, but which were not in a position to offer reciprocal access arrangements, were excluded from EU waters. In bilateral agreements with Norway and Sweden the issue of shared stocks was an important one, and the three states also reached a tri-partite agreement making provision for joint management of shared stocks in the Skagerrak. The EU – Norway agreement was of particular importance, providing a framework for joint management of shared stocks in the North Sea which are of major economic importance to both parties. Central to the agreement are "ownership shares" based on the "zonal attachment" of shared stocks. The defined level of "attachment" of stocks to the zones of each state had a basis in biology and in particular to the proportion of the stocks of catchable size which are found in each zone. However, the shares were not derived by any specific formula. The initial agreement recognized North Sea cod, haddock, whiting and plaice, and North Sea and Skagerrak pollock and mackerel as joint stocks. Other stocks, although occurring in both zones, were treated as autonomous for management purposes, e.g. sprat and Norway pout, and in the case of the western mackerel stock it was agreed to differ; the EU considering it to be autonomous whereas Norway considered it to be shared. The recovery of North Sea herring required that this stock be brought under the agreement. An ad hoc agreement was reached on a TAC and allocations for 1986. A working group was set up to define zonal attachment of herring stocks and an agreement was subsequently reached which provided for variable shares as a function of spawning stock biomass.

Ownership shares in the framework agreement did not correspond either to historical fishing patterns or the current level of interest in fishing joint stocks. However, these shares provided the basis for annual negotiations on catch allocations. Negotiations on allocations involve the trading of harvesting rights using a "cod unit" as currency. The equivalencies between species were based on relative market values during a period in the early-1970s. While the agreement provided a basis for resolution of sharing issues, it did not establish criteria for setting the level of TAC and there was a conflict of objectives between the two parties, Norway preferring TACs to be established at the F_{max} level. Also, while there was provision for reciprocal access to the other party's waters for

harvesting of allocations, technical measures were not standardized between zones, e.g. there were differences in mesh size and in discarding regulations, which created practical difficulties for fishermen and resulted in enforcement problems.

Regulatory Actions. The first elements of the Common Fisheries Policy adopted in 1970 made provision for conservation actions by the EU within the national fishing zones of member states (Wise, 1984). However, at that time, prior to extensions of fishery jurisdiction to 200 miles, the multi-national, high-seas, nature of the important regional fisheries dictated that international action through NEAFC offered the only practical solution to the most critical Northeast Atlantic conservation problems. Anticipating adverse effects on members from the worldwide trend towards 200 mile fishing limits, the EU Council, at a meeting in the Hague in October 1976, produced what came to be called the "Hague Resolutions" which established guidelines for future development of a new fisheries policy. In addition to agreeing to extend jurisdictions to 200 miles, and authorizing the Commission to conduct international negotiations on fisheries matters on behalf of EU members, these resolutions also affirmed the EU as the single body for adoption of conservation measures. However, pending agreement on an EU regulatory system, the Hague Resolutions permitted individual members to take measures protective of the resources within their zones (provided that these were non-discriminatory with regard to other EU states and that the approval of the Commission was sought before the measures were applied).

Catch Controls: It proved possible in 1977–78, based on a complex of measures by the EU and by the UK national government, to ban herring fishing in the North Sea and to the west of Scotland and to impose greater restrictions on by-catches in industrial fisheries (Wise, 1984). Nonetheless, it was not until 1984 that the EU was able to implement a TAC and national quota system which was legally in effect during the period of fishing. Agreement on a system had been achieved in January 1983, but the actual regulations applied to the 1992 fishing year (and regulations for the 1993 fishing year were similarly too late). The importance of the January 1983 agreement, however, was in the success it represented in reaching agreement on catch allocation keys for each stock and on acceptance of a principle of "relative stability" of fishing activities for each member state (Holden, 1994).

Whereas NEAFC, by 1976, had succeeded in recommending TACs for 16 stocks of marine finfish involving eight species in what became EU waters, the first EU TACs for 1982 encompassed 82 stocks of 22 marine finfish species. The driving force for a

comprehensive EC scheme was the requirement for a full share-out of resources, rather than conservation needs (Holden, 1994). Subsequent changes to the TAC regime were made primarily to take account of the changes in status of Greenland and St. Pierre and Miquelon in 1985–86 which resulted in deletion of the species and stocks in these areas. However, in 1987 the plan was extended to include the waters off Spain and Portugal after their accession in 1986 and this resulted in both the addition of new stocks and the extension of the management areas of stocks already in the plan. Modifications, other than those brought about by changes in jurisdiction, included the addition of three species (and hence 12 stocks); anglerfish, megrims, and the pollack (a close relative of the pollock (*saithe*)). Various stock boundaries were modified also, but changes on the whole were few. By the early-1990s, the TAC plan contained provisions for 94 stocks of marine finfish from 18 species (Appendix Table 11).

Trawl and Minimum Fish Size Regulations: It was in January 1983 also that the Council was able to adopt a comprehensive set of technical measures of indefinite duration. These permanent technical measures bore strong similarities to those adopted by NEAFC some years earlier. However, mesh size regulations dispensed with differentials in relation to gear type, netting materials and net construction (with a minor exception in the Irish Sea fishery), but introduced greater geographical subdivision. This resulted in some increases in the required mesh size for cod, haddock and pollock, e.g. from 70 to 75 mm to 80 mm in the North Sea and west of Scotland (Appendix Table 12). Groundfish fisheries in the EU zone present fairly extreme examples of the mixed-fishery problem and this has made for severe difficulties in deciding upon optimum mesh size regulations. Exemptions for certain gears/species, particularly for the common sole and whiting fisheries, allowed the mesh size in the North Sea and West of Scotland, the primary cod, haddock and pollock fishing areas, to be gradually increased to 100 mm by 1992. In more southern and western areas of Region 2, mesh size was standardized at 80 mm. Minimum fish size regulations adopted in 1983 were essentially identical to those of NEAFC, although those for Region 2 were extended to Region 3 (Appendix Table 13). Significant increases in minimum size for cod, haddock and pollock were introduced in 1989, coincident with mesh size increases, and minimum sizes were standardized throughout the EU zone at 30 cm for haddock and 35 cm for cod and pollock.

By 1983 the ban on herring fishing in the North Sea and off the west of Scotland had been lifted, but EU regulation continued the prohibition on

industrial fishing first established under NEAFC regulation. Minimum trawl mesh sizes of 32 mm in Region 2 and 40 mm in Region 3 were imposed on the herring food fishery in 1983–84, which codified into regulation the mesh size typically used, and mesh size for herring and mackerel throughout Regions 1 and 2 was standardized at 32 mm from 1992 (Appendix Table 14). Industrial fisheries for other species continued to be regulated at a 16 mm mesh size. The EU minimum fish size regulations of 1983 continued the NEAFC restriction on possession of herring under 20 cm (Appendix Table 13). The NEAFC size limit for mackerel of 30 cm was retained in the North Sea and not applied by the EU to the western stock, but in 1992 a 20 cm limit was established for this stock. Capelin do not occur in commercial quantities in the EU zone (although this was not so when Greenland and St. Pierre and Miquelon were under EU regulation).

Essentially all of the important fisheries for the six primary species in the EU zone occur in Region 2, with only mackerel being taken in significant quantities in Region 3. Region 1, which was redefined in EU legislation to include all of Greenland and St. Pierre and Miquelon, was otherwise largely outside the EU zone. When the status of these islands changed in the mid-1980s, and the surrounding waters no longer came under EU jurisdiction, technical regulations for Region 1 did no more than close a potential misreporting loophole.

Other Measures: Area and seasonal fishery closures were important secondary measures in EU management plans, primarily for reduction of catches of small fish, particularly of herring, in various coastal waters. Another closed area was established for mackerel off southwestern England, and several areas were closed to redfish fishing off Greenland while it was still part of the EU. A closure was instituted off the Danish coast from 1987 to 1992 to protect juvenile cod (although trawlers using a mesh size of 100 mm or greater were exempted) and, more recently, seasonal closed areas were used to protect juveniles of other groundfish species. The herring spawning area closure off the west of Scotland, first instituted by NEAFC, was continued in EU legislation. The Norway pout box northeast of Scotland, which had been sustained by the UK as an autonomous measure, was adopted by the EU also. This could be viewed as another measure to reduce the catch of small fish, in this case haddock and whiting, but it also established a balance between the competing interests of industrial and food fisheries. Despite their fairly extensive use, area closures were not popular, as they were viewed as being discriminatory. Fishermen who traditionally used an area suffered

losses, on its closure, for the benefit of fishermen who fished the same resource elsewhere.

The Council regulation of 1983 on restructuring of fleets introduced the concept of management of fleets to target levels consistent with resource availability. All states had plans approved by the Commission which aimed at maintaining fleet capacity at 1982/83 levels through to 1986. However, this program proved ineffective with only two member states meeting their targets, while the total fleet tonnage increased.

More stringent controls were introduced with the new policy in 1986. Multi-annual guidance plans established schedules for reductions in capacity over the five years which constituted phase one of policy implementation. The reductions in overall fleet capacity were established through negotiations at 2% in horsepower and 3% in GRT below the levels in 1983, by 1991. The actual reductions required were, of course, greater as capacity was above 1983 levels at the time the plan was implemented. The results of the 1986–91 phase of the program were viewed as, at best, a limited success. Several countries ended the period with a recorded fleet capacity which was actually greater than at the start and it is thought that, where reductions were recorded, most were achieved through removal of inactive vessels (Holden, 1994). A further deficiency in the program stemmed from its failure to include most inshore vessels. Nonetheless, the first phase provided a vehicle for establishment and testing of capacity control mechanisms.

However, the objective of balancing capacity with resources required substantial fleet reductions in the second, 1992–96, phase. A group of scientific experts was established under the Commission's scientific committee to identify where imbalances lay and to provide a basis for quantifying the required reductions. The 1990 report of this group indicated that an average cut of at least 40% should be envisaged in fleet capacity throughout the EU. Proposals for such large fleet reductions naturally led to prolonged negotiations, requiring adoption of interim measures for 1992, but leading to agreement of reductions in fishing effort over the 1993–96 period of 20% for fleets using bottom trawls to fish for demersal species, of 15% for those using beam trawls and dredges for benthic stocks, and no reduction for other fleets. The reductions in effort by the end of 1996 could be achieved by a combination of fleet capacity reduction and fishing effort restrictions through vessel tie-ups (first introduced for vessels fishing cod and haddock in the North Sea and west of Scotland in 1990). An EU vessel registry was established, which recorded vessel characteristics and fishing activity, to alleviate accounting problems with earlier plans.

A Union-wide vessel licensing scheme came into effect at the beginning of 1995, as required under the revised CFP of 1992. This established a minimum set of information to be included in licences, which were to be issued by member states (various member states already maintained domestic licensing systems). In addition to this general licensing scheme, the Council made provision for issuance of special fishing permits, again by member state authorities, to control the fishing activities of specific vessels by time, area and fishery. Permits provided a vehicle for effort control measures for western waters (ICES areas VI–X and south) brought into effect for 1996 when, according to their terms of accession to the EU, Spain and Portugal obtained access to these areas on an equal footing with other member states. While the objective of the specific measures adopted for western waters was to prevent fishing effort increasing as a result of the changed legal circumstances, a mechanism was created which allowed for the management of fishing effort at target levels for specific fisheries.

Surveillance and Compliance. The EU regulations on enforcement adopted in 1982 and as subsequently amended, required member states to establish monitoring procedures, in particular to establish a logbook system for all vessels over 10 m in length and to verify the accuracy of logbook reports, to establish a system which would ensure complete recording of landings, and to inspect vessels to ensure compliance with regulations. Members were also required to prosecute or take administrative action when a violation was detected, to notify the Commission of landings against quotas, and to provisionally close national fisheries when quotas were caught. Official closures were the prerogative of the Commission. The Commission was given authority to verify compliance with these regulations thus allowing appointment of Commission inspectors.

Commission inspectors reported in June 1986, after two and a half years of the EU inspection scheme, that breaches of regulatory measures were frequent and in some cases were so widespread that they endangered conservation. Five states did not have a system which allowed them to record catches accurately, four were not in a position to satisfactorily prohibit fishing once quotas were caught, and many had made little or insufficient effort to enforce technical measures. Inspectors were also successful in detecting specific violations such as systematic falsification of landings data. The Commission, in 1991, still considered the surveillance and enforcement facilities of member states inadequate. A report on available facilities (EU, 1992) concluded that about double the number of port-based inspectors were required, and at-sea

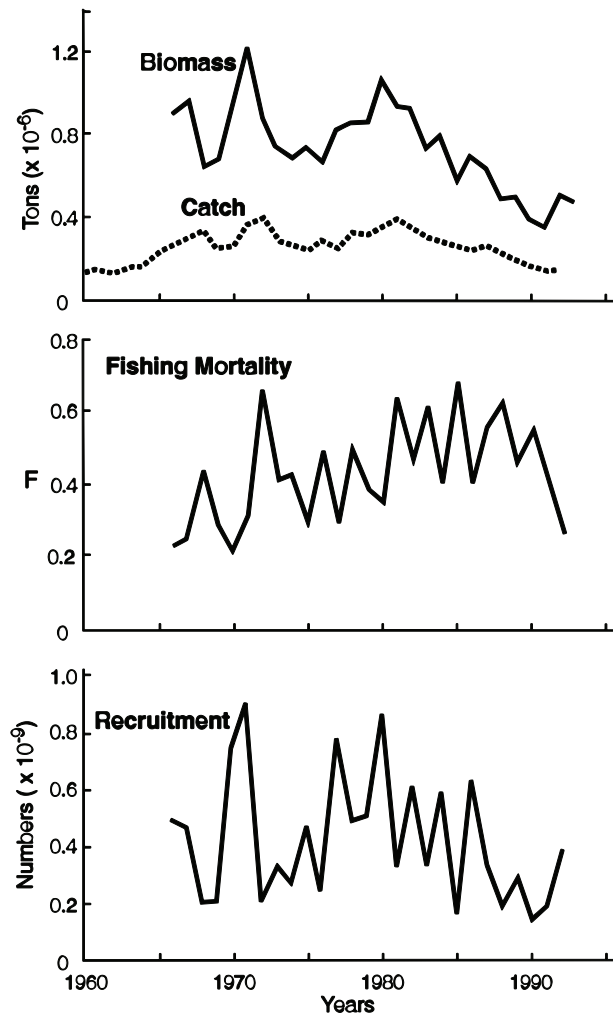


Fig. 14. European Union cod: trends in stock parameters.

inspections and aerial surveillance required substantial increases, although deficiencies varied greatly among members. This shortfall in resources available for surveillance resulted in a number of enforcement problems such as lack of enforcement of minimum mesh and fish size regulations and deficiencies in landings reports. There were also indications of falsification of landings data in some member states. This led the Commission to propose further strengthening of EU control over member state enforcement efforts. However, member states consistently resisted the acquisition by the Commission of enforcement powers. In a revision of fishery control legislation in 1993, however, provision was made for Commission inspectors to make port visits without notice to national authorities, whereas previously one month's notice was required, and for pilot projects on real-time

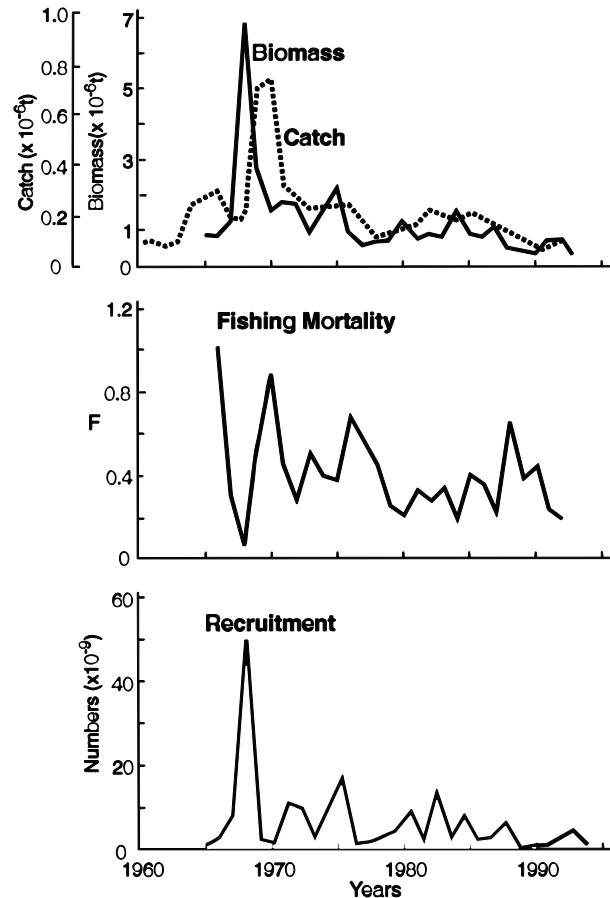


Fig. 15. European Union haddock: trends in stock parameters.

positional monitoring of fishing vessels through use of satellites or other means.

Deficiencies in catch data for particular stocks in EU waters were frequently identified by the ACFM of ICES and, on occasion, these were sufficiently severe to prevent calculation of stock size and provision of specific advice on TAC levels. However, in 1990, the ACFM made a radical departure from its previous approach by advising that any TAC set for groundfish stocks (cod, haddock, whiting and pollock) in the North Sea would not produce the reduction in fishing mortality that was necessary, i.e. that TAC regulation was proving ineffective for conservation purposes (ICES, 1991). It pointed out that, although management agencies had established TACs close to recommended levels and reported landings agreed with TAC levels set, fishing effort was not reduced and actual catches (rather than reported landings) exceeded recommended levels. Excess catches were discarded, were reported as other species or as

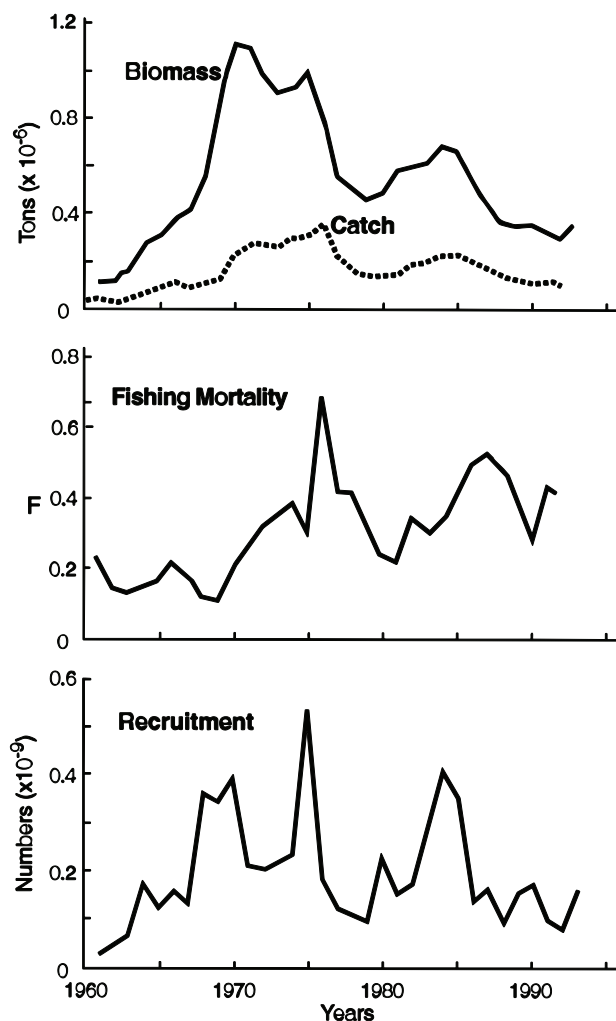


Fig. 16. European Union pollock: trends in stock parameters.

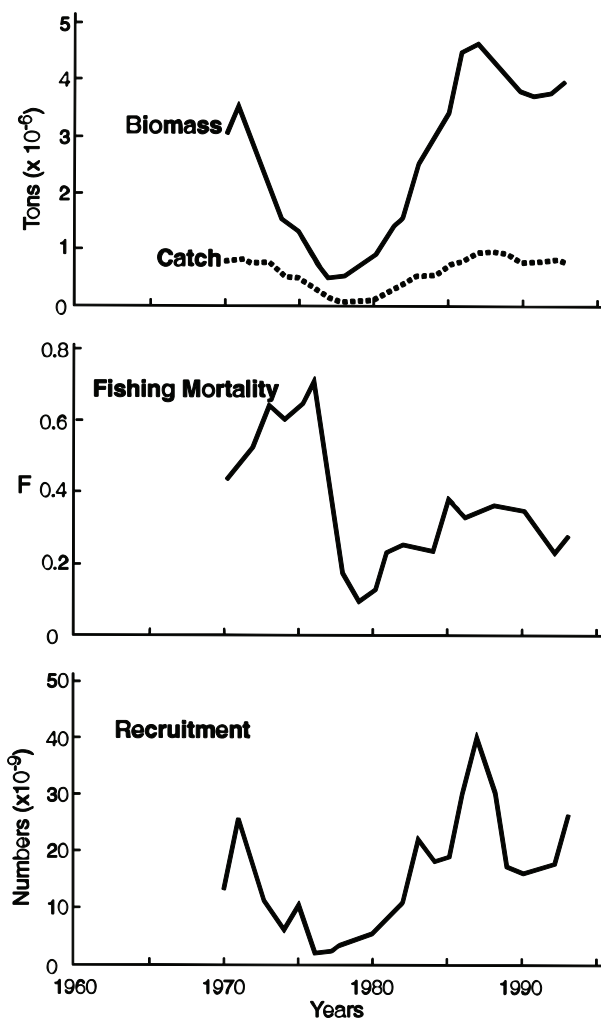


Fig. 17. European Union herring: trends in stock parameters.

coming from other areas, or were not reported at all. The ACFM proposal was that fishing effort be directly regulated, not the resultant landings.

Overall, Commission officials have not viewed control and enforcement in EU waters as being effective. Legislation concerning conservation measures is complex making it difficult to understand and implement, and resources for enforcement have been inadequate. Some member states are viewed as having a lack of political commitment to effective control. The probability of apprehension for illegal fishing is low and penalties tend to be inadequate to act as a deterrent (Holden, 1994).

Resource Trends. The EU shares North Sea cod, the largest cod stock in its zone, with Norway but this is treated as an EU stock here as the EU

has the predominant share and hence greatest influence on exploitation levels. There is also a number of entirely EU cod stocks of some importance to the west and south of the UK and Ireland. As with cod, the largest haddock stock in the EU zone, that in the North Sea, is shared with Norway but the fishery is dominated by the EU and it is treated here as an EU stock. There is also a substantial haddock stock off the west of Scotland which is completely in EU waters. Haddock also occur off the southwest coast of the UK and Ireland but these stocks are small. The large North Sea-Skagerrak stock of pollock is shared between Norway and the EU almost equally but, arbitrarily, it is treated here as an EU stock. Another important, but smaller, stock occurs entirely in EU waters off the west of Scotland. Pollock also occur off the southwest of the UK and Ireland. The largest herring stock occurs in the North Sea. While shared with

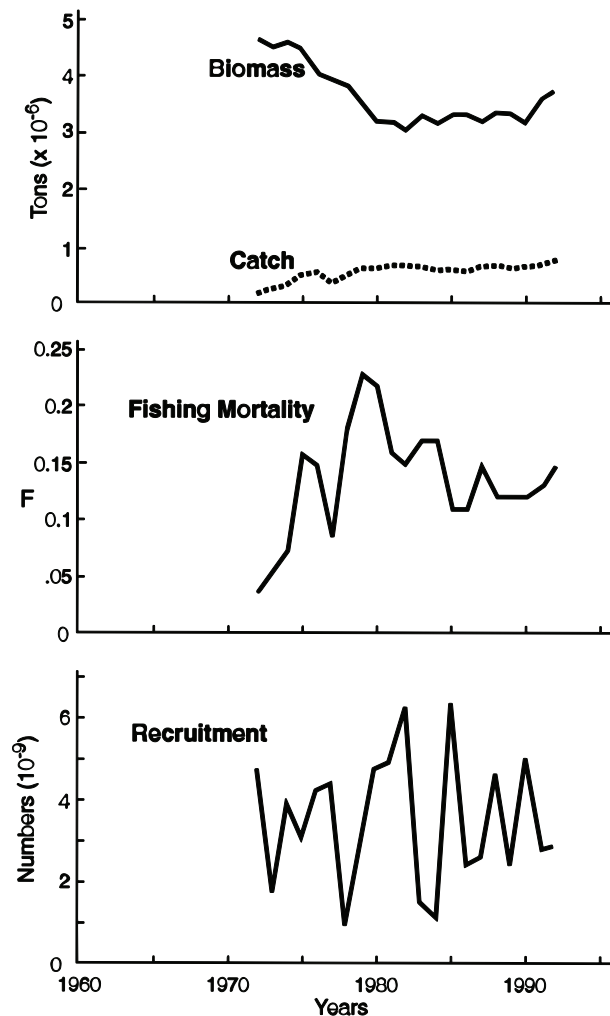


Fig. 18. European Union mackerel: trends in stock parameters.

Norway, the EU has the predominant share of the resource. There is also a large stock to the west of Scotland and a number of less significant stocks to the southwest of the UK and around Ireland. The western stock of mackerel occurs in EU waters along the west coasts of the UK and Ireland and the EU has claimed authority for its management. It also occurs in Norwegian waters in the northern North Sea and in the Norwegian Sea, in the Faroe Islands zone and in international waters, and in recent years an increasing proportion of the catch has occurred in these more northern waters. However, it is treated here as an EU managed stock in reflection of the predominant EC influence during the period analyzed. In contrast, the North Sea mackerel stock is recognized as shared, but the predominant share is held by Norway and it is treated as a Norwegian stock. Mackerel also occur in the Bay of Biscay and off the Iberian Peninsula.

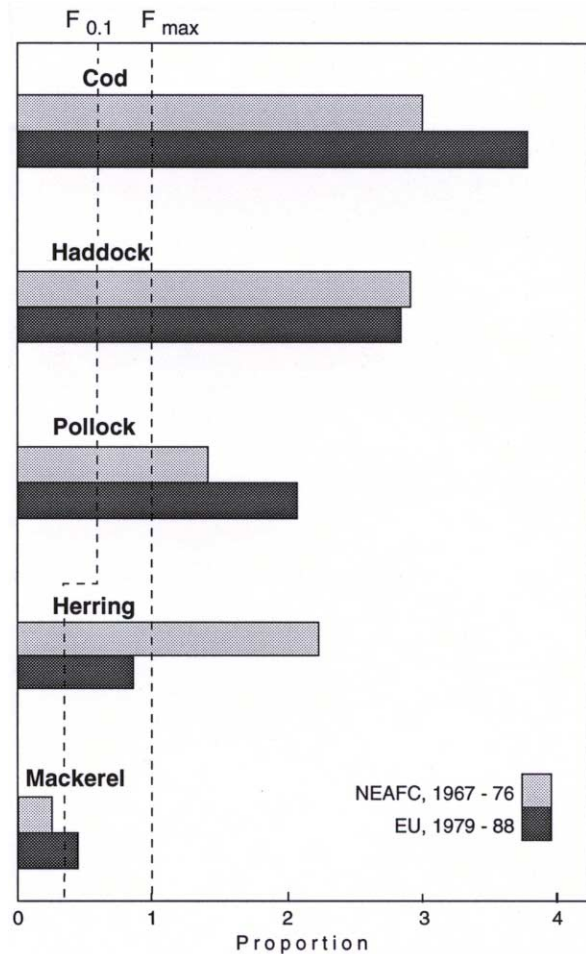


Fig. 19. European Union stocks: fishing mortality in the NEAFC and EU management periods in relation to F_{max} and $F_{0.1}$. (Discontinuity in $F_{0.1}$ line reflects differences in ratios to F_{max}).

Trends in these stocks of the primary species are illustrated in Fig. 14–18.

It was a NEAFC intention, as an initial step, to stabilize exploitation rates of Northeast Atlantic resources and its first action in this regard was taken in 1971 (with establishment of seasonal closures for North Sea herring). However, a general system of TAC regulation was not agreed to until 1975, and NEAFC recommendations are unlikely to have greatly affected the level of fishing. The TAC controls established by the EU were comprehensively implemented only for the last five years of the post-200 mile study period used here (1979–88) and, even in these years, the purpose of TACs was essentially allocative. This resulted in fishing mortalities for groundfish stocks well above F_{max} and as high as or higher than prior to the period of EU management (Fig. 19). The closure of the herring

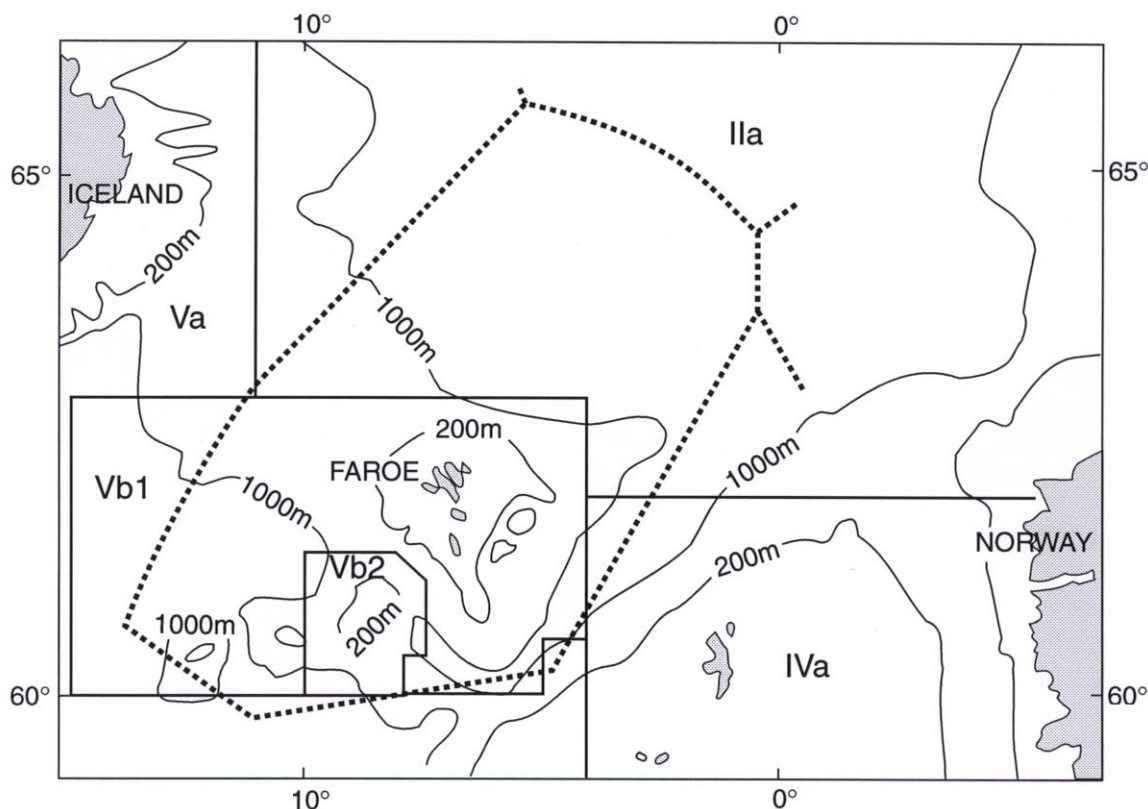


Fig. 20. Danish claim to jurisdiction in waters adjacent to the Faroe Islands, and ICES Statistical Areas.

fisheries did, however, greatly reduce fishing mortality in the late-1970s and early-1980s. By the late-1980s, fishing mortality was again reaching quite high levels but, averaged over the period 1979–88, did not exceed F_{max} . Fully-recruited fishing mortality estimates for mackerel are available only for the post-extension period at which time fishing mortality approximated the $F_{0.1}$ level.

The Faroe Islands

The Faroe Islands obtained a large degree of self-government in 1948, although they remained part of the Kingdom of Denmark and the Danish government retained responsibility for foreign policy. When Denmark joined the EU in 1973, the terms of accession provided for Faroe Islands to also become part of the EU at any time up to the end of 1975. However, the Faroese parliament decided in January 1974 not to join. Thus, it is the Faroese government which has responsibility for fisheries regulation in Faroese waters. The economy of the islands is almost entirely dependent on fishing.

Fishing Limits. The fishing limits around Faroe Islands were set at three miles from the coast in

1901, in accordance with the provisions of the North Sea Fisheries Convention of 1882, to which Denmark was a signatory. Denmark declared a 12 mile limit, from straight baselines, around the Faroe Islands in 1961 and a 200 mile zone effective from March 1977. In fact, the jurisdictional claim of 1977 in large part did not extend to 200 miles, boundaries being constrained to the northwest by Iceland, to the southeast by the UK (and hence the EU in the context of fisheries) and to the east by Norway (Fig. 20). Only to the north-east was the boundary not constrained by the claim of a neighbouring state. There are "grey zones" where the Faroese claim overlaps with those of the UK and Iceland but these are small and do not generate significant conflicts in a fishery management context, and the boundary between Faroe Islands and Norway was agreed to in 1979 (Dagenhardt, 1985).

The Faroese 200 mile fishing zone boundaries corresponded well with the boundaries recognized for the fish stocks of most importance to Faroese coastal, or "home water", fishermen; the Faroese cod, haddock and pollock stocks occur entirely within the Faroese fishing zone. Thus, management of these stocks lies completely in Faroese hands. Some resources of secondary importance are

shared. Redfish and Greenland halibut stocks in ICES Statistical Areas V and XIV are recognized as being shared with Iceland and Greenland. Also, blue ling distribution extends over the Faroe Islands – EU boundary. Blue whiting and Norwegian spring spawning herring are shared on a multi-national basis, as well as occurring in international waters. The distribution of the western mackerel stock also extends into Faroese waters in some periods.

Management Institutions. The Faroese government has responsibility for fishery regulation in home waters and shares responsibility with Denmark for international fisheries negotiations and trade (Olafsson, 1987). However, it was not until 1986 that a fisheries directorate was formed to provide a centralized administration for fisheries and a focus for policy formulation (Hoydal, 1987). The government's Fisheries Research Institute, which conducts biological research and fisheries development, became part of this directorate. In addition, the fishing industry supports a Fisheries Council which advises government on social and economic issues and aspects of policy. The fisheries directorate is responsible for enforcement through its Inspection and Rescue Service which was first formed in 1976, and at-sea surveillance is supported by patrol vessels and helicopters (Ziskason, 1989). Naval vessels from the Danish naval station at Faroe Islands also support fisheries enforcement.

Faroese authorities receive scientific advice on the major fish stocks in their zone through ICES. A 1988 agreement between Denmark, on behalf of Faroese and Greenlandic home governments, and ICES formalized arrangements through which ICES was required, in return for a financial contribution, to meet requests for advice and to allow a representative (for both home governments) to participate as an observer on the ACFM of ICES.

Management Objectives and Strategies. Prior to extension of jurisdiction to 200 miles, the Faroese fishing industry was heavily dependent on middle and distant water fisheries, only about 15% of catch tonnages being taken in home waters. The home water fishery was prosecuted almost exclusively by hook and line vessels of less than 50 GRT. In the early-1970s, about 70% of the catch around Faroe Islands was taken by non-Faroese, mainly UK, vessels.

The first objective of the Faroese government after obtaining home rule in 1948 was to reserve as much of local waters and fish stocks as possible for domestic fleets and it pressured the Danish government, which remained responsible for external affairs, for jurisdictional extensions (Guttesen, 1992). An international arrangement

relating to fisheries in waters surrounding the Faroe Islands was subsequently negotiated between Denmark and six other countries (Anon., 1975a). This arrangement, which was in effect in 1974–77, recognized both the conservation needs of cod and haddock stocks in the area and the need for preferential access to these resources by Faroese vessels given the exceptional dependence of the Faroese economy on fisheries. The measures introduced in this arrangement included catch limits by country, seasonal closure of specified areas to trawl fishing, and a freeze on the size of trawlers which could be used in these areas at other times of the year. In addition to these provisions, NEAFC regulations on minimum trawl mesh size and minimum fish sizes were also in effect for Faroese waters when jurisdiction was extended in 1977.

Faroese authorities took a pragmatic approach to fisheries management in their new zone, the overriding consideration being the satisfactory economic performance of the industry. The initial view was that technical measures, particularly closed area and mesh size regulations for protection of spawning grounds and juvenile fish, would provide adequate protection for the fish stocks. No specific biological reference points, such as $F_{0.1}$ or F_{max} , were chosen as resource exploitation rate targets in relation to either conservation or economic objectives. Closed areas were also extensively used to avoid gear conflicts.

The coincidental extensions of jurisdiction by North Atlantic states in 1977 necessitated major adjustments in the Faroese fishery because of its heavy dependence on middle and distant water grounds. However, Faroe Islands was able to compensate for loss or limitations of access to these grounds by displacing foreign fishermen in Faroese home waters (Danielsen, 1986). In addition to redeployment of some of the existing fleet to home waters, a fleet of mid-sized groundfish trawlers was developed, and by 1980 the Faroese stocks of cod, haddock and pollock were exploited almost exclusively by domestic vessels. By the late-1980s about 50% of Faroese catches originated from home waters in contrast to 15% in the early-1970s. Nonetheless, Faroese fishing in the zones of other nations remained of importance to the Faroese industry. Agreements were negotiated for reciprocal access to EU, Norwegian, USSR and GDR waters, and for unilateral access to Icelandic and Canadian zones. However, these were purely catch allocation arrangements.

The status of Faroese cod and pollock stocks deteriorated in the 1980s (see below) and, despite increases in fleet size, catches stopped increasing. The industry had been the recipient of heavy

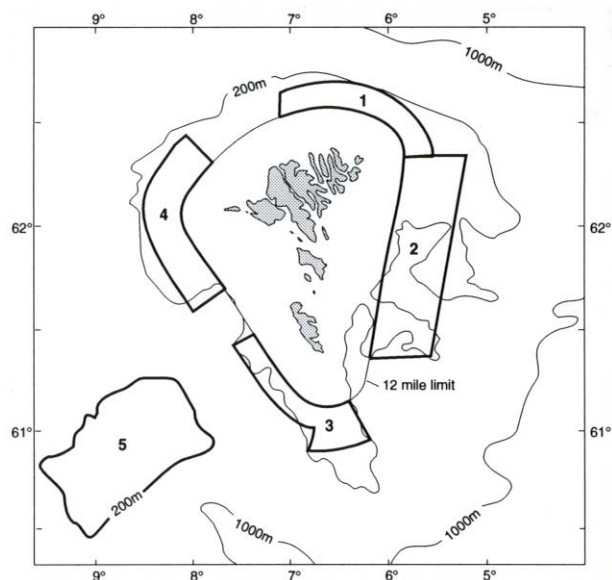


Fig. 21. Areas around the Faroe Islands closed to otter trawling on a seasonal basis in 1974-77 through international agreement.

government subsidies for some years and it became clear that the objective of satisfactory economic performance was not being met (Guttesen, 1992). New policy initiatives followed establishment of the fisheries directorate in 1986. It was recognized that control of the fishing capacity of the fleet was necessary if economic performance was to be improved, and a vessel licensing system was introduced in 1987 and financial incentives for decommissioning of vessels were also introduced (Hoydal, 1988). A revised approach was implemented for the period 1990-92 which included a new decommissioning scheme, withdrawal of licences on bankruptcy, and a phased reduction of subsidies. Its objective was to keep fishing pressure on Faroese stocks at a level allowing a vessel which is operating normally to obtain an adequate economic return without subsidies. However, this decommissioning scheme proved unattractive to vessel owners, as had the initial one, and was abandoned in 1991. In 1992 the home-waters fleet was still operating with a substantial overcapacity. Catches from home waters, and in total, had been decreasing steadily after 1988 and towards the end of 1992 the islands were placed under the administration of the Danish government which was required also to provide substantial financial support (Eurofish Report, 1992a). A catch quota system was finally introduced in 1994 (Mortensen, 1995). Its aim is to rebuild cod and haddock spawning stocks to target levels of 52 000 tons and 40 000 tons, respectively, by 1998.

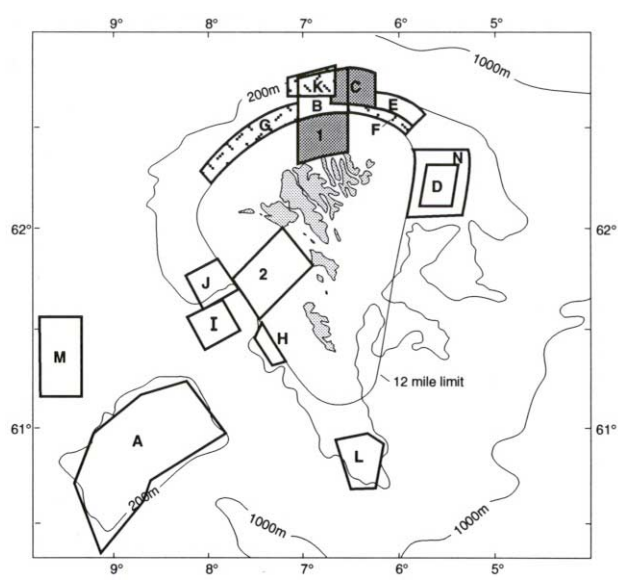


Fig. 22. Areas around the Faroe Islands closed to otter trawling (letter designations) and gillnetting (number designations) on a seasonal basis, through domestic legislation. Trawling prohibited within 12 mile limit (except under special licence) and gillnetting prohibited within four miles of land, all year, also. (Areas closed varied over time, the example illustrated being applicable in or about 1989.)

Regulatory Actions. Regulation of harvesting in Faroese waters depended almost exclusively on trawl mesh size regulation and seasonal area closures for the first 10 years after extension of jurisdiction in 1977. A precedent had been set in the 1974-77 agreement for use of catch limitations for control of exploitation levels. However, catch controls were viewed as economically inefficient and when the need for control of exploitation levels in domestic fisheries was recognized in the mid-1980s, regulation of fleet capacity was the favoured method.

The NEAFC minimum trawl mesh size in effect in 1977 was 130 mm manila equivalent (which equated to 120 mm for most trawl materials), with Danish seiners being allowed to use 110 mm. Faroese authorities dispensed with differentials for both netting material and seine nets and adopted a larger minimum mesh size of 125 mm in 1978 (Hoydal, Nordic-Atl. Coop., pers. comm.). Mesh size was increased to 135 mm in 1984 and again in 1989, to 155 mm. While this last mesh size proved satisfactory for cod, there was a substantial immediate reduction in catch rates of pollock. Haddock already had a low availability to trawling as a result of area closures. The adverse effects on pollock fishing necessitated a roll-back in the mesh size to 145 mm as of June 1990. (There were various exemptions from these regulations to permit

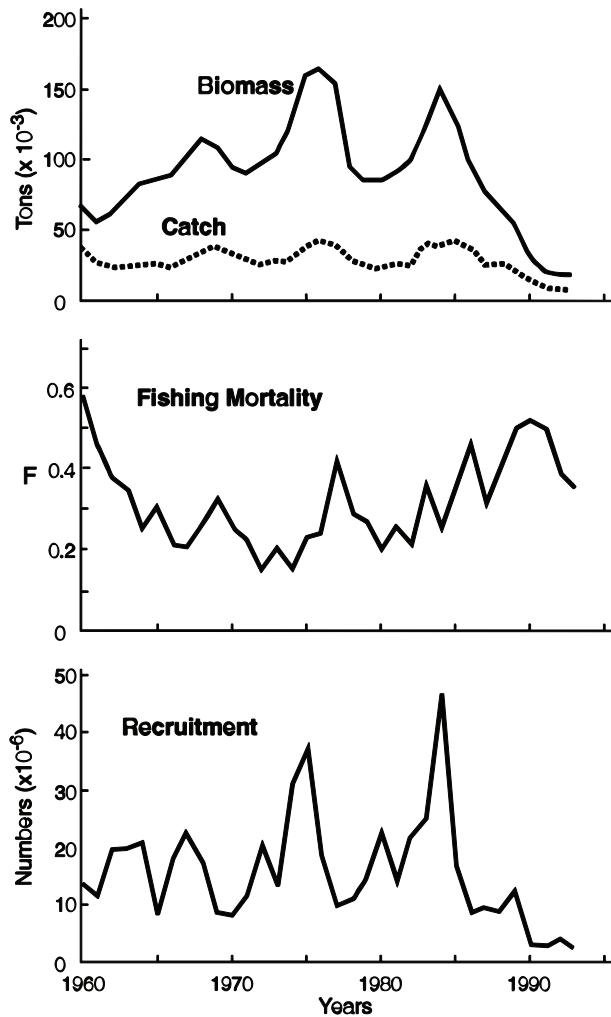


Fig. 23. Faroese cod: trends in stock parameters.

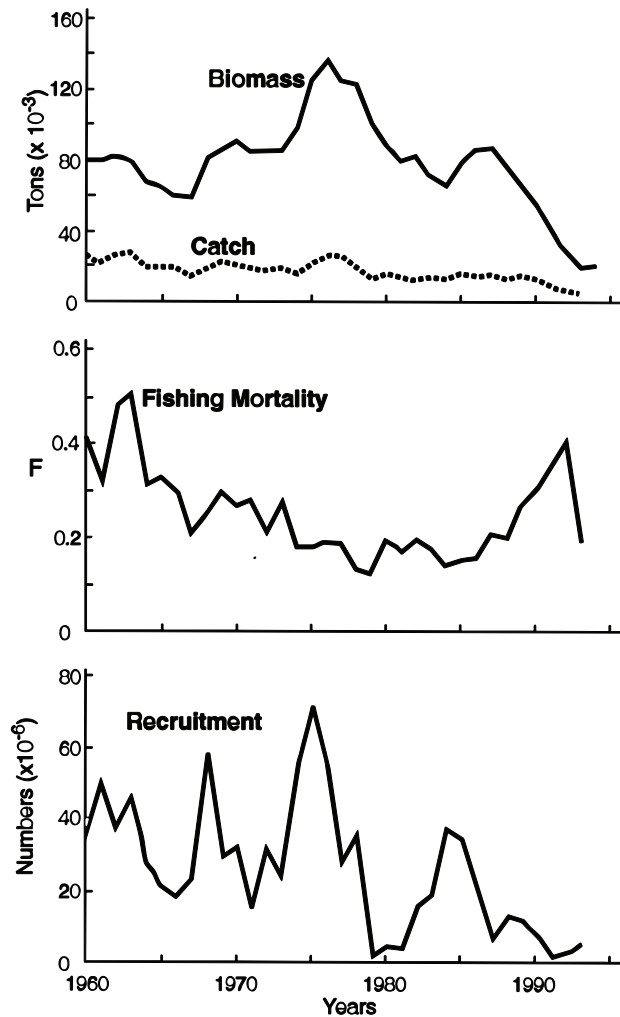


Fig. 24. Faroese haddock: trends in stock parameters.

directed fishing for smaller-bodied species.) Gillnets used for cod fishing were required to have a mesh size of 180 mm and when used for pollock meshes had to be at least 150 mm but not greater than 165 mm.

The NEAFC minimum fish sizes, in effect for 1977 for cod (34 cm), haddock (31 cm), pollock (35 cm), and various other species, were retained in Faroese regulation without change until the mesh size increase of 1989, when minimum sizes were raised to 40 cm for cod, 37 cm for haddock and 45 cm for pollock. Emphasis was placed on area closures, both permanent and temporary, to direct fishing away from areas containing small fish.

Closure of areas on a seasonal, or year-round, basis had several purposes. Initially, protection of small fish from capture, and reduction of conflicts between fixed and mobile gear, were the primary

motivations for closing areas to trawling. More recently, protection of spawning stocks has been an important factor motivating seasonal closure of areas to all gears. The 1974–77 international agreement closed to trawling the 12 mile zone throughout the year and five additional areas for periods of one to six months. In combination these areas encompassed much of the fishing banks shallower than 200 m (Fig. 21). After 1977, these closures evolved in number, size and duration, tending to become smaller but more numerous (Fig. 22). In addition to these “permanent” closures defined in regulation, a system of temporary closures, comparable to that used by Iceland (see below), was instituted in the early-1980s as an additional way to protect young fish. Areas in which catches contained more than an established percentage of fish below a certain size were closed for one week after which they automatically reopened. If the small fish remained in the area after

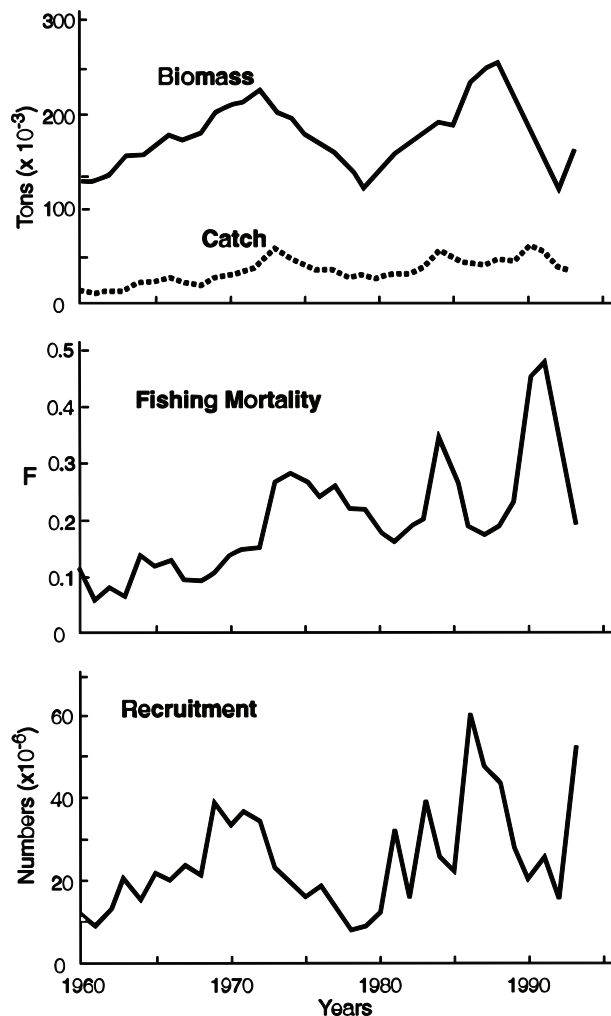


Fig. 25. Faroeese pollock: trends in stock parameters.

the one week closure they were again subject to fishing, which limited the effectiveness of this measure. However, in 1992, the rules were modified to allow closures to be maintained until concentrations of small fish dispersed, which may have increased the usefulness of these closures. The size of fish to be protected, and the percentage allowed in catches, are established periodically by biologists based on expected abundance of young fish on the grounds. Closures specifically to protect cod on their spawning grounds were instituted in 1992, reflecting serious concern about the decline in abundance of the spawning stock. As cod are highly aggregated at this period, the closures, by reducing fleet operating efficiency, were expected to reduce annual fishing mortality.

Under the vessel licensing scheme, which applied to vessels over 20 GRT when first introduced in 1987 and to vessels over 5 GRT from

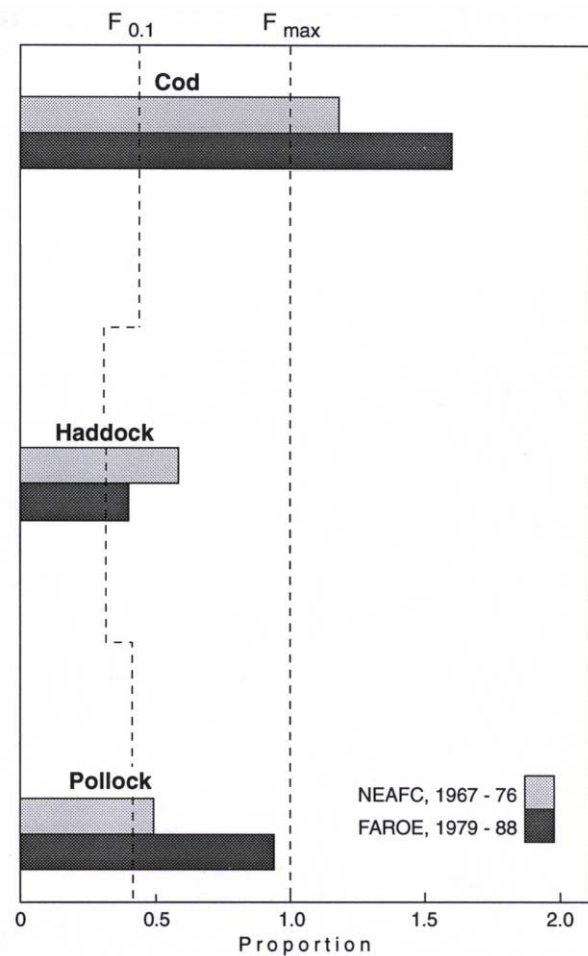


Fig. 26. Faroese stocks: fishing mortality in the NEAFC and Faroese management periods in relation to F_{max} and $F_{0.1}$. (Discontinuities in $F_{0.1}$ line reflect differences in ratios to F_{max}).

1989, no new entrants were allowed and replacement vessels were restricted to 90% of the fishing capacity of the vessel(s) being replaced. Vessel fishing capacities were calculated by a complex formula incorporating external dimensions, horsepower and carrying capacity. Concurrent decommissioning schemes offered financial payments for scrapping vessels but these efforts to encourage fleet reductions were undermined by extensive subsidy schemes to support vessel operations. Targets set for fleet capacity reduction of approximately 35% were not the result of specific analyses which related fleet size to resource exploitation rates. These targets did, however, recognize that moderate exploitation rates, by maintaining resource abundance, and hence satisfactory commercial catch rates and adequate fish supplies, were a prerequisite for the economic viability of vessel operations. However, capacity reduction targets were not met under these schemes.

Surveillance and Compliance. Faroese authorities are of the view that compliance with regulations was high until the introduction of TACs in 1994 encouraged discarding and misreporting (Mortensen, 1995). Dumping of small fish and violations of closed areas were issues prior to this, but heavy fines on conviction proved to be a significant deterrent.

Resource Trends. Of the six primary species, separate stocks of cod, haddock and pollock occur in Faroese waters and can be managed autonomously by domestic authorities. Trends in these stocks are illustrated in Fig. 23–25.

Although Faroese authorities set no exploitation rate targets as a basis for their management actions, maintaining the economic performance of the industry implied moderate rates of exploitation. The multinational agreement of 1974–77, rather than NEAFC, provided control over fishery expansion and, in fact, fishing mortality was moderate during this period. After 1977, reduction of foreign access was enough to keep exploitation moderate, at least until domestic fleet expansion created an overall overcapacity situation. Fishing mortality of cod increased steadily in the 1980s and that on pollock also tended to increase, and as a result averaged about F_{max} for pollock but above that for cod (Fig. 26). In contrast, fishing mortality on haddock was reduced after 1977, averaging close to $F_{0.1}$.

Greenland

Fishing Limits. Denmark declared an extension of fishing limits around Greenland from three to 12 miles in 1961, and to 200 miles off southern Greenland in January 1977. Fishing boundaries off northern Greenland, north of 75°N on the west coast and 67°N on the east coast, were established in June 1980. In actuality, along much of western Greenland and off southeast Greenland equidistant boundaries are shared with Canada and Iceland, respectively (Fig. 27), and the claims of these countries have not resulted in disputes relevant to fisheries. Off eastern Greenland, the claims of Denmark and of Norway (with regard to Jan Mayen) overlap considerably and this dispute has been referred to the International Court of Justice in The Hague.

In the period since implementation of the 200 mile limit the northern shrimp supported the most important fishery in Greenlandic waters. Of the six primary species considered here, there are significant, commercially exploitable, stocks only of cod and capelin. Haddock, pollock and mackerel do not occur off Greenland in commercial quantities and herring support only a small local fishery in southern Greenland.

Many of the stocks in Greenlandic waters can be characterized as transboundary. The valuable western Greenland shrimp, along with Greenland halibut and roundnose grenadier, are to some degree shared with Canada, while shrimp, Greenland halibut and redfish off eastern Greenland are shared with Iceland. There are intimate connections between cod stocks at Greenland and Iceland, and the capelin which occur seasonally off eastern Greenland are recognized as belonging to the Icelandic stock. As far as is known, however, the as yet lightly exploited capelin occurring along the west coast are of substantial abundance and are distributed entirely within the 200 mile zone.

Management Institutions. Greenland became an integral part of the Kingdom of Denmark in 1953. Thus, when Denmark joined the EU in 1973, Greenland automatically joined as well. However, Greenlanders on the whole favoured administrative autonomy and were unhappy to be part of the EU. They were successful in obtaining home rule from the Danish government in 1979 and subsequently negotiated withdrawal from the EU as of the beginning of 1985.

Prior to 1977 the major fisheries off Greenland fell under the auspices of two international fisheries commissions. The convention areas of NEAFC and ICNAF met at Cape Farewell on the southern tip of Greenland. The primary fishery during this international phase was for cod off western Greenland; thus the activities of ICNAF were the more pertinent to Greenland fisheries.

After extension of jurisdiction to 200 miles, the EU was responsible for management of fisheries in Greenlandic waters. However, the failure of the EU to establish regulations allowed Denmark to maintain the regulatory regime in place and to adopt new regulations as long as the prior approval of the EU Commission was obtained (see above under EU). The first effective imposition of EU regulation did not occur until 1983–84 and by this time negotiations for Greenland's withdrawal from the EU were well underway. Thus national management actions, initially through the Danish ministry responsible for Greenland and after 1978 by the Home Rule government, had a substantial influence on management of fisheries in Greenland's waters. The EU influence came primarily through negotiation of foreign allocation arrangements until responsibility for international fisheries matters reverted to Denmark in 1985.

Responsibility for conducting research on fishery resources off Greenland was discharged by a scientific laboratory in Copenhagen established specifically for this purpose in 1946. In 1989 this laboratory was transferred to the authority of the Greenland government and thereafter reported to

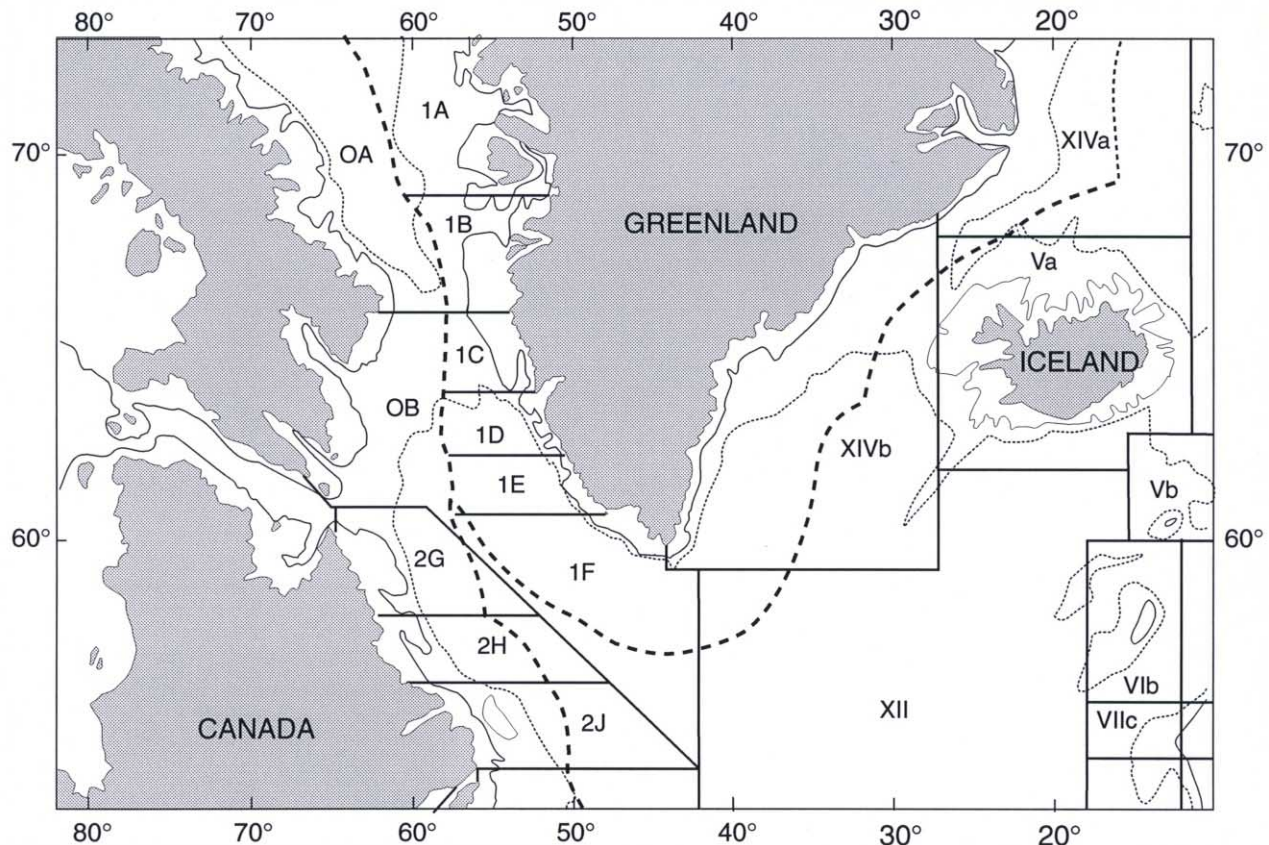


Fig. 27. Danish claim to jurisdiction in waters adjacent to Greenland, except that median line is shown (as lighter dashed line) in disputed area between Greenland and Jan Mayen whereas Denmark claims full 200 mile zone. Statistical Areas also shown.

the minister in that government with responsibility for fisheries. The laboratory itself relocated to Greenland, officially, in 1993 but a section of it is expected to remain in Denmark for some years.

The Danish/Greenlandic authorities and the EU continued to use the international scientific advisory agencies for advice on management of Greenlandic fishery resources after 1977. Although issues off eastern Greenland continued to be considered primarily in ICES and matters off western Greenland by the scientific committees of ICNAF and subsequently NAFO, there was a gradual rationalization of scientific responsibilities. When a shrimp fishery developed off eastern Greenland in the late-1970s, advice on shrimp management off both coasts was consolidated within the NAFO Scientific Council. Conversely, as the migratory component of the Greenland cod populations, and hence the inter-links with the Icelandic stock, became relatively more important, ICES took responsibility for assessment of all cod at Greenland from 1992.

Greenland established an enforcement agency, the Greenland Fisheries Licence Control, when authority to manage fisheries was acquired from the EU in 1985. This agency maintains an at-sea observer system and sets reporting requirements for foreign and domestic vessels. The Danish navy, which maintains a base in Greenland, enforces fishery regulations pertaining to foreign vessels in the Greenlandic zone through patrols and at-sea inspections.

Management Objectives and Strategies.

Greenland's economy is largely dependent on the fisheries, thus fishing is viewed as the primary vehicle for economic development. Shrimp fishing expanded greatly in the 1970s at the same time as the cod fishery off western Greenland collapsed and is now by far the most important resource for the Greenland fisheries. Cod remained second in importance until 1992, when Greenland halibut came to support the major groundfish fishery.

Management of the exploitation level in the western Greenland cod fishery was initiated through ICNAF in 1974 when TAC regulation was introduced, and was continued by Danish, EU and Greenlandic administrations. By the time catch limits were introduced, the stock had already collapsed from a size in the 1960s which yielded over 300 000 tons annually to a stock yielding less than 100 000 tons. Thus, management considerations concerned maintaining or increasing spawning stock size and stock rebuilding. The intended strategy was to fish lightly the occasional good year-classes which recruited to the fishery, and thus to allow these to contribute to stock rebuilding while also deriving some social and economic benefits from them by exploiting them at a low level over a number of years. In some years TACs were set at, or even below, the $F_{0.1}$ level but no fixed-F strategy was adopted (Horsted, 1991).

The cod fishery off eastern Greenland was much smaller historically than that off western Greenland. Catch restrictions were first introduced by the EU for 1982–84 (although only legally binding for 1984) and were subsequently maintained by Greenland. Stock size off eastern Greenland is much influenced by immigration from western Greenland and by emigration to Iceland, thus yield-per-recruit considerations do not apply. Management strategy has centered on maintaining an adequate spawning stock off eastern Greenland.

In the late-1980s, the distribution of cod off the west coast of Greenland became increasingly restricted to the south and there was a large-scale movement of the abundant 1984 year-class to eastern Greenland. The TACs for the two areas were amalgamated in 1990 to allow the fleets freedom to fish allocations wherever the fish were to be found. By 1991 it was evident that the 1984 year-class had, in substantial part, moved out of the Greenland area, presumably to Iceland, reflecting the complexity of establishing a suitable management strategy for cod in Greenlandic waters.

Development of a capelin fishery is likely to require high volume removals for industrial uses. However, the ecological importance of capelin as a food fish is also recognized. Management policy for capelin off western Greenland is to provide for a controlled expansion of fishing to ensure that biological knowledge for rational management increases in step with exploitation pressure. The specific strategy adopted from 1985 was to prohibit fishing for capelin outside three miles from coastal baselines, except on the basis of experimental permits which would provide for government control. In the coastal zone within three miles, the traditional aboriginal fisheries remain unregulated.

No large scale fishery has yet developed off western Greenland. Off eastern Greenland, the occurrence of Icelandic capelin is sporadic and Iceland has the predominant influence on management strategy.

Although Greenland shares a number of stocks with adjacent states, little emphasis has been placed on developing international conservation arrangements for these resources. Arrangements were made for joint management of shared resources in NAFO Subareas 0 and 1, most importantly shrimp, as part of an overall fisheries agreement between Canada and the EU in the late-1970s, but these terminated after 1980 as a result of disagreement over objectives. Off eastern Greenland there is international agreement only for management of Icelandic capelin; a 1989 tripartite agreement between Denmark, Iceland and Norway established catch shares, and an arrangement for TAC setting. Although initially for a three year period only, this agreement was renewed until 1994 and again thereafter with little change. An earlier agreement between the EU, Iceland and Norway banned fishing for Icelandic capelin in 1982, but this was a one year arrangement only.

On withdrawal from the EU, a comprehensive fisheries agreement was reached between the two parties which gave EU vessels extensive access to Greenlandic waters in exchange for financial compensation and trade concessions. The agreement establishes fixed allocation tonnages for the EU and gives the EU preferential access to any additional catch possibilities which are surplus to Greenland's needs. The preferential status of the EU in Greenlandic waters is, therefore, an important element of management policy, but it does not explicitly concern conservation issues.

Regulatory Actions. Prior to extension of jurisdiction in 1977, TACs were established through ICNAF for several species off western Greenland. A TAC was placed on Subarea 1 cod in 1974, on Subareas 0 and 1 roundnose grenadier in 1975, and on Greenland halibut in these Subareas in 1976. A TAC for shrimp in Subareas 0 and 1 was agreed to in ICNAF for application in national zones in 1977. There was no history of TAC regulation for stocks off eastern Greenland through NEAFC.

In the inter-region between jurisdictional extension and EU regulatory action, Denmark largely retained the TAC controls established under ICNAF. In 1978–79, TACs were not set for cod off western Greenland but fishing was restricted to Greenlandic vessels only with allowances for by-catches of other fleets. However, catch limits were reimposed for 1980. Under the EU Common Fisheries Policy, TACs were established in the

period 1982–84 for cod (separate TACs for east and west coasts), Greenland halibut, redfish, Atlantic halibut, sand eel and shrimp, and for wolffish off western Greenland and capelin off eastern Greenland. As for other areas under EU jurisdiction, the 1982 and 1983 regulations were not legally implemented until after the fishing season. On withdrawal of Greenland from the EU in 1985, TAC regulations were retained and control of fishing for capelin off western Greenland was added.

Control of trawl mesh size used in the groundfish fishery has also been a central element of regulation in Greenlandic waters. The first mesh regulations introduced for the Northeast Atlantic by the Permanent Commission in 1954 applied also off eastern Greenland. Subsequent NEAFC regulations included waters off eastern Greenland in a large mesh area in 1964 and in 1967 revised the mesh size to 130 mm manila equivalent. The 1967 NEAFC action stimulated ICNAF, which had been attempting for some years to implement a minimum mesh size of 114 mm, to introduce a regulation identical to that of NEAFC off western Greenland in 1968. Thus, at the extension of jurisdiction in 1977, the mesh regulations were already consistent throughout Greenlandic waters at 130 mm, with differentials of 120 mm for trawls made of cotton, hemp, polyamide and polyester and of 110 mm for seine nets. The EU technical regulations established in 1983 dispensed with the differentials, with all nets being regulated to 130 mm. Under Greenlandic regulation the minimum mesh size was raised to 140 mm in 1985.

The Permanent Commission also established minimum fish size regulations in 1954 which were applicable to waters off the east coast of Greenland. For cod, the only species relevant in the present context, the initial size of 30 cm was revised to 34 cm in 1964 (when large mesh regulations were extended to this area) at which it remained thereafter. No minimum sizes were established by ICNAF for fisheries off the west coast. Greenlandic domestic regulation established a minimum landed size of cod of 42 cm in 1970 which was subsequently revised to 40 cm in 1973. This may have had some general significance once the cod fishery off western Greenland became predominantly Greenlandic after 1977. The EU technical regulations of 1983 and subsequent Greenlandic regulations retained 40 cm as the minimum size for cod at Greenland.

Area closures have not been used to any important extent for conservation purposes in Greenland waters except for redfish off eastern Greenland, where closures were initiated in EU regulation and maintained by Greenlandic authorities.

Although licensing was introduced for offshore boats (>80 GRT) in 1978 for shrimp fishing, 1979 for cod fishing, and subsequently for other species, this was for administrative purposes and did not represent a control on fleet size or activity. Catches of inshore boats were not restricted, i.e. an allowance system analogous to the Canadian approach was adopted, fishing by large boats only being under restrictive overall fleet quotas. Recognition that the offshore shrimp fleet was overcapitalized stimulated introduction of a transferable catch quota scheme in 1991 which resulted in a halving of that fleet over five years. A capacity limitation system was introduced for inshore shrimp boats in 1991 also, but catches continued to expand in the absence of direct limits on catch quantities. Capacity restrictions have not yet been introduced for the groundfish fleet.

Surveillance and Compliance. In the initial years of Danish control, 1977–83, a substantial amount of unauthorized cod fishing by third parties occurred in Greenland waters. The NAFO Scientific Council and ICES estimated unreported cod catches totalling almost 200 000 tons in the period 1977–80. Two-thirds of this was from NAFO Subarea 1. In 1981–83, a further 30 000 tons was estimated to have been taken in east coast fisheries, in addition to catches recorded in official statistics. However, discrepancies detected in later years were minor. In the Greenland domestic cod fishery, allocations were usually established which allowed vessels to operate during their normal season, except in 1986–87 when trawlers and pound-net fishermen (in large part) were closed out of the fishery. Thus, there are no reports of serious enforcement problems with domestic catch regulations for cod.

Resource Trends. The cod stocks off western Greenland have, in general, been of greater commercial importance than those off eastern Greenland. However, occurrence of cod off western Greenland has been periodic. In the 19th century, cod occurred there in commercial quantities only in the 1820s and the late-1840s, and were essentially absent thereafter until the 1920s some 70 years later. Commercial fishing expanded rapidly after the Second World War and annual yields of cod from off western Greenland consistently exceeded 300 000 tons in the 1950s and 1960s. The fishery collapsed by about 1970 and thereafter fluctuated around a much lower level of about 50 000 tons (Fig. 28). The increase in cod stocks off Greenland's west coast in the 1920s corresponded with the occurrence of warmer climatic conditions and the decrease at the end of the 1960s coincided with climatic deterioration (Hovgård and Buch, 1990). Drift of eggs and larvae

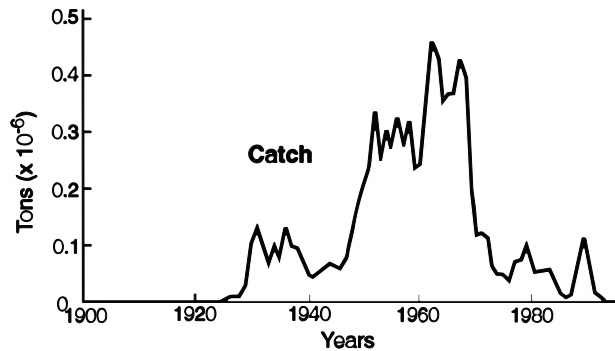


Fig. 28. Catches of cod off western Greenland, 1900–93 (based on Horsted (MS 1994)).

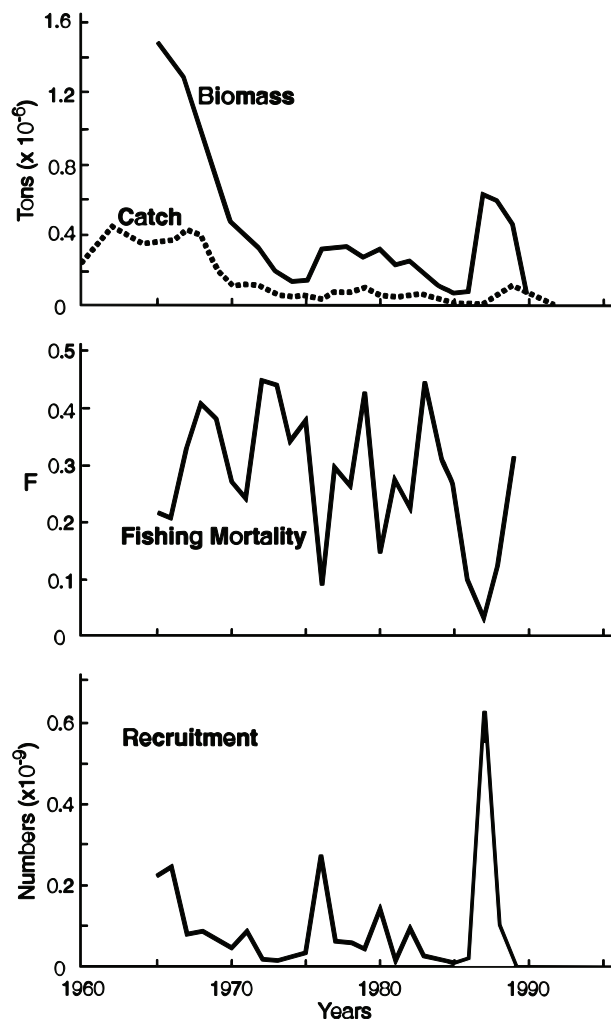


Fig. 29. West Greenland cod: trends in stock parameters.

of Icelandic cod to Greenland in some years is well documented and this has provided a mechanism for colonization of Greenland waters by cod, and for periodic replenishment of Greenlandic stocks. Local spawning stocks became established off both coasts of Greenland and in some western Greenland fjords, although their contribution to local production is uncertain. Also some, apparently high, proportion of the cod originating from Iceland, migrate back to Iceland on maturation and thereafter remain in Icelandic waters. The stock situation is, therefore, very complex.

The objectives of TAC controls on exploitation level of cod off western Greenland from 1974 were to maintain or increase local spawning stocks and rebuild the population size through a strategy of moderate or low exploitation. In fact, estimates of F changed little as a result of TAC regulation, fluctuating around $F = 0.3$ on age 3+ fish (Fig. 29).

Changes in stock size off eastern Greenland have a similar pattern to those off western Greenland (Fig. 30). Off the east coast cod are older before making a significant contribution to the fishery than off the west coast, age 5 rather than age 3, thus the trends off eastern Greenland are displaced by two years. Fishing mortality off eastern Greenland increased after 1970 and fluctuated around $F = 0.2$ on age 5+ fish thereafter.

In the period after the extension of jurisdiction, the cod stocks at Greenland benefitted from recruitment of only two large year-classes (spawned in 1973 and 1984) and these are documented as originating at Iceland rather than being of local production. The larger year-class of 1984 had by 1991 in large part emigrated back to Iceland and this frustrated Greenlandic efforts to rebuild local spawning populations. In addition there were other changes, including a southward regression of cod distribution along the west coast and a very substantial reduction in size-at-age of cod off western Greenland, which have contributed to management difficulties. It seems quite clear that fishery effects are very much secondary to environmental effects in determining the overall status of cod at Greenland and that the rebuilding of local populations likely must await a return to more suitable oceanographic conditions. In the interim a revised perception of the cod population at Greenland as essentially a component of the Icelandic stock presents some new questions about the management objectives and strategies that it would be best to adopt.

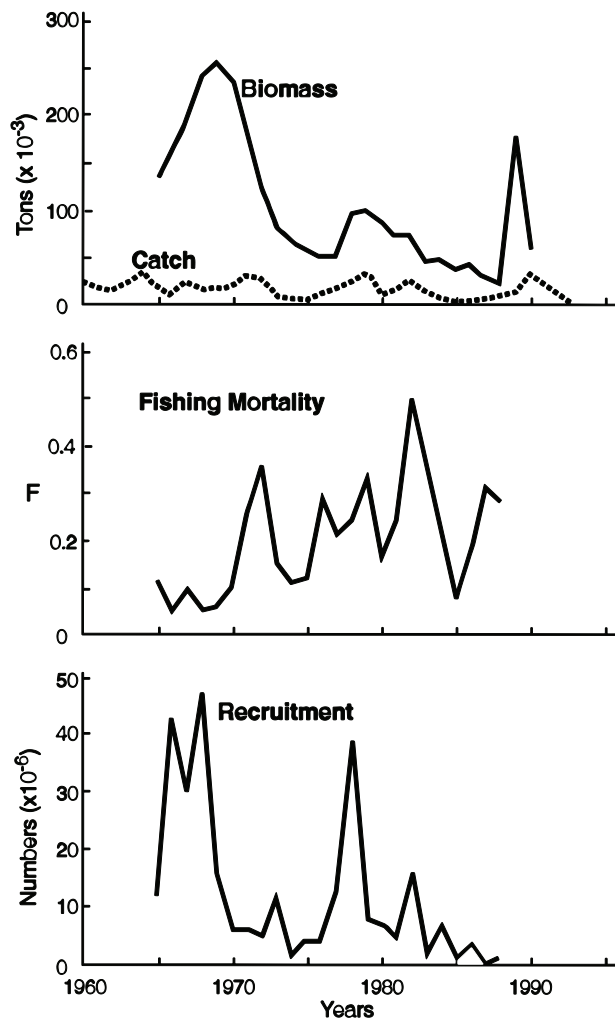


Fig. 30. East Greenland cod: trends in stock parameters.

ICELAND

Fishing Limits. Fishing has long been the mainstay of the Icelandic economy, and protection of resources on the continental shelf and their preservation for Iceland's fishermen have been central to Icelandic government policy. The Icelandic parliament passed a law on the conservation of continental shelf fisheries in 1948, soon after Iceland achieved independence from Denmark, which made clear the government's view that jurisdictional extension to the edge of the continental shelf was necessary for protection of marine resources off Iceland. A subsequent series of extensions to fishing limits established Iceland as the leading advocate of extended jurisdiction in the North Atlantic. It also precipitated a series of crises in diplomatic relations with distant water fishing nations which fished around Iceland, particularly the UK, which developed in severity to

the stage of physical conflicts on the fishing grounds known as "the cod wars" (Hart, 1976; Jónsson, 1982).

The chronology of jurisdictional extensions began in 1949 when the UK was informed of Icelandic abrogation of a 1901 agreement between Denmark and the UK under which Denmark had established a three mile limit around Iceland. In 1950 Iceland declared its regulatory authority over all the bays on Iceland's north coast, and a four mile zone contiguous to them, and closed these areas to otter trawling and Danish seine-netting by Icelandic as well as foreign nationals (although UK vessels were exempted until termination of the 1901 agreement, which required a two year notice, in 1951). This four mile zone was instituted around the rest of the Icelandic coast in 1952 and all otter trawling and Danish seining was prohibited in this area also. The limits within which Iceland claimed fishery jurisdiction were extended from four to 12 miles in 1958, then to 50 miles in 1972 and 200 miles in 1975. Despite stiff opposition, Iceland was able to sustain its claims while conceding to various phase-out agreements. The UK fishery in Icelandic waters terminated by agreement in 1976 and FRG fishing ended in 1977. Agreements with Belgium, Faroe Islands and Norway allowed for continued small scale fishing in Icelandic waters.

The Icelandic claim to a 200 mile zone (Fig. 31) was in fact constrained to the southeast and to the west by proximity of the Faroe Islands and Greenland, respectively. The equidistant boundaries claimed by Denmark in respect of Faroe Islands and Greenland in 1977 and those claimed earlier by Iceland, while not coincident, were close and differences have not yet proved to be obstacles in a fisheries management context. A slight overlap also with the fishery zone claimed by the UK was of little practical fishery significance. To the north, Iceland and Jan Mayen are separated by less than 400 miles. However, an agreement between Iceland and Norway in 1980 sustained Iceland's original 200 mile claim in waters between Iceland and Jan Mayen.

The stocks of primary groundfish species, cod, haddock and pollock, in Icelandic waters have been managed autonomously. The Icelandic cod stock sometimes supplies spawning products to Greenland waters depending on current patterns and is consequentially augmented by migrants returning from Greenland waters as mature fish. There is also some degree of intermixing on occasion among large pollock of the Norwegian, Faroe Islands and Icelandic stocks. However, the biological information available supports the view that it is indeed practical to manage the primary

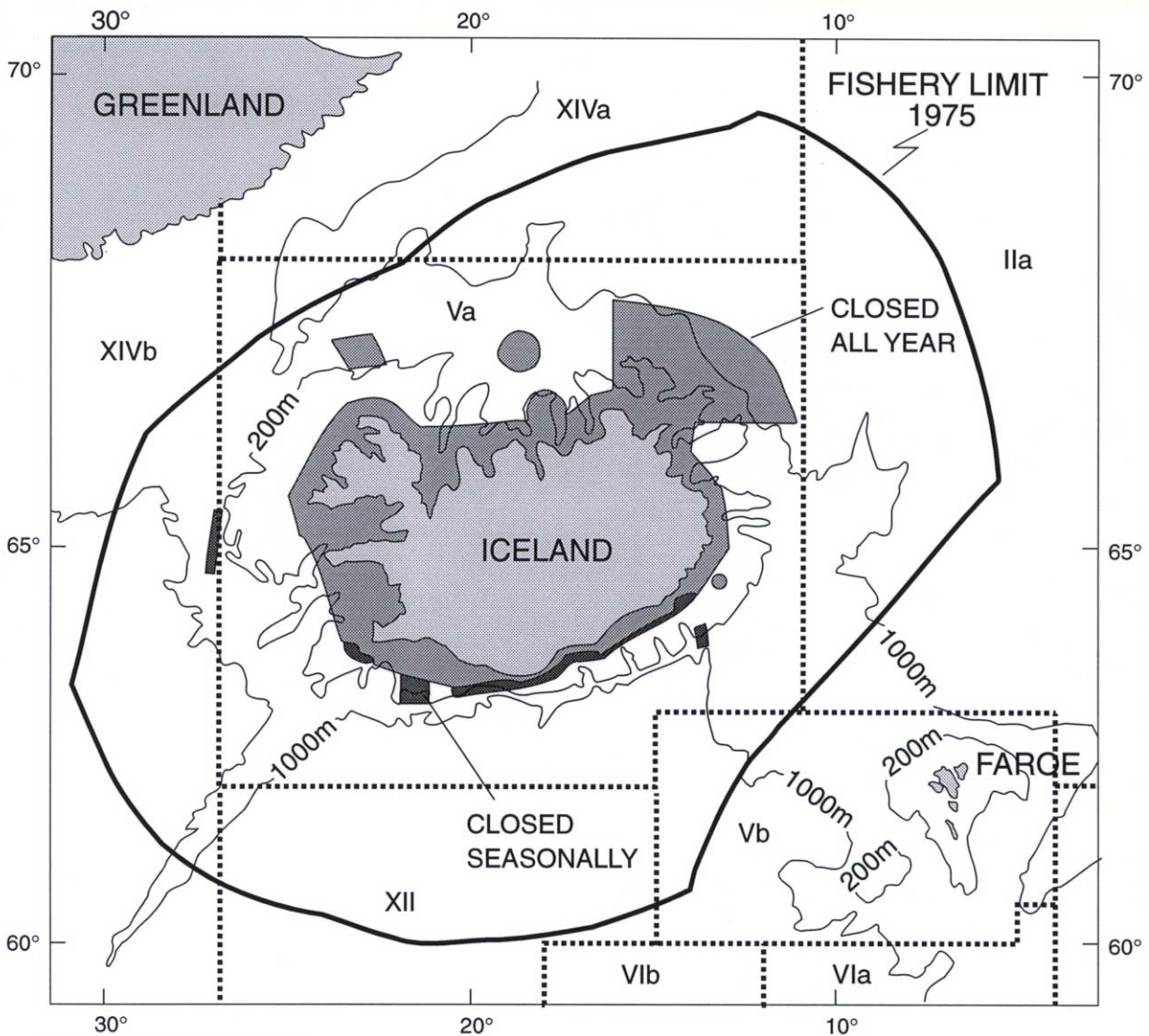


Fig. 31. Jurisdictional boundaries claimed by Iceland in 1975, ICES Statistical Areas, and areas around Iceland closed to trawling by the late-1970s.

groundfish populations at Iceland as independent units. Redfish and Greenland halibut stocks are recognized as shared with Greenland and Faroe Islands, and redfish stocks also extend into international waters.

Herring and capelin stocks occur off Iceland but mackerel is not present in commercial quantities. Two stocks of herring have been recognized in Icelandic waters, spring-spawners and summer-spawners, but the spring-spawning stock collapsed in the late-1960s and the fishery has since depended on the summer-spawning stock. Norwegian spring-spawning herring also occurred in feeding and overwintering concentrations off

north and east Iceland until a stock collapse, again in the late-1960s. No international arrangements were necessary for management of Norwegian spring-spawning herring as, after the collapse, the residual stock was very largely restricted to Norwegian waters. However, with increased abundance in recent years, the stock has re-undertaken its oceanic migrations and occurred again in Icelandic waters in 1994 (see below under Norway). Capelin supported the most important Icelandic pelagic fish fishery after the collapse of the spring spawning herring stocks. The initiation of a Norwegian capelin fishery off Jan Mayen in 1978 and documentation through surveys and tagging that these fish were a summer feeding

component of the Icelandic stock, stimulated discussions between Iceland and Norway which resulted in the 1980 agreement already mentioned. This agreement not only resolved the boundary issue between Iceland and Jan Mayen but also set up a joint fisheries commission and a method for establishment of TACs and national allocations for capelin (Hay, 1989). A new agreement in 1989 included Greenland in the management process for capelin because significant fishing opportunities occurred off East Greenland during summer feeding migrations in some years. Thus, the importance of capelin to the Icelandic fishery resulted in strong emphasis being placed on international conservation agreements. Blue whiting occur in Icelandic, as well as in Norwegian, Faroese, EU and international, waters but no conservation agreements have yet been reached.

Management Institutions. The Icelandic government's responsibility for management of fisheries is discharged through a Minister for Fisheries. A Directorate of Fisheries was formed within the Ministry of Fisheries in 1992 with specific responsibilities to administer the conduct of the fisheries including enforcement of regulations. This Directorate employs inspectors (23 in 1993) who monitor adherence to regulations both at sea aboard commercial vessels and ashore. At-sea surveillance is otherwise the responsibility of the Coast Guard and is its primary duty. Surveillance is conducted using surface vessels and aircraft. Weighout of fish on landing is supervised by inspectors accredited by the Ministry. The Fisheries Association of Iceland, a fishing industry organization, also has delegated responsibilities to collect statistics mainly from the processing sector (Pálmason, 1994).

Scientific research is conducted by a Marine Research Institute supported through the Ministry. This institute is responsible for providing biological advice on fisheries management to the government. Icelandic scientists participate in ICES and ICES has been used as a mechanism for analysis of stock status for many of the stocks around Iceland. Cod, by far the most important species for the domestic fishing industry, and haddock have been exceptions. This policy decision of "cod war" days was reversed in 1992 when Icelandic cod (but not haddock) were again discussed within ICES. The transboundary Denmark Strait shrimp provide a further exception, scientific advice on their stock status being provided by the NAFO Scientific Council.

Management Objectives and Strategies. The groundfish fishery is by far the most important for Iceland, generating 75–80% of the total catch value. Cod is the predominant species, alone accounting

for roughly half of the value of all species. Pelagic fish, herring and capelin, although caught in high volume, account for only about 15% of value (although in the early- and mid-1960s herring were substantially more important). The overriding dependence of the Icelandic economy on the fisheries has thus made the conservation of cod, and protection of Icelandic interests in the cod fishery, the driving forces of national policy and international relations. The series of jurisdictional extensions, particularly the initial ones to four and to 12 miles in the 1950s, appear to have been primarily motivated by a desire to protect nursery areas for conservation of cod. The extensions of boundaries in the 1970s to 50 then to 200 miles could also be justified by the Icelandic government on the basis of conservation, given the failure of NEAFC to institute any controls on the international fishery around Iceland other than on mesh size and minimum fish size. Protection of the Icelandic economy by reservation of continental shelf fish resources for Icelandic use was clearly the other fundamental objective of jurisdictional extension (Jónsson, 1982).

When extension of jurisdiction placed groundfish resources under Icelandic control, however, initial actions were limited to strengthened measures to protect small fish, i.e. minimum fish and mesh size regulations and closure of areas to trawling and Danish seining. A system of real-time temporary closure of areas found to contain undersized fish was developed for groundfish in 1976. The government began adopting guidance catch levels for cod from 1978 based on advice from the Marine Research Institute and attempted to manage fleet activities through a system of effort controls so that cod catches were constrained and effort was diverted to other, less heavily exploited species. However, in the absence of entry controls the fleet expanded making effort control increasingly unsatisfactory, and the approach was abandoned for a system of TACs and individual vessel quotas for the major groundfish species in 1984. The subsequent trend in management was towards a comprehensive transferable catch quota system.

The adoption of TAC and IQ management for groundfish indicated a recognition that explicit management of exploitation level was a prerequisite if the dual goals of resource conservation and economic viability of the industry were to be met. Although the government did not announce the specific objectives behind this radical departure from previous strategies, one interpretation of objectives has been given by Arnason (1986) as:

1. conservation of the demersal fish stocks,

2. restoration of normal profitability in the industry,
3. maintenance, as far as possible, of the current regional and personal distribution of benefits, and
4. increase in economic rents.

A senior official of the Ministry of Fisheries gave much the same statement of policy although in different words (Jónasson, 1986):

1. to control total catch sizes,
2. to keep costs down and increase earnings through improving the treatment of the catch, and
3. to promote regional employment by spreading fishing more evenly round the country as a whole.

Objective 3 in both lists reflected a long-standing general policy of the Icelandic government to preserve the regional distribution of settlement. The important departure from previous approaches was the recognition by government of the need to take a direct interest in the economic performance of the groundfish industry which was central to national economic welfare. Nonetheless, conservation continued to be ranked first.

Regulatory authorities did not define specific criteria which would guide their decision making with regard to conservation. The Marine Research Institute nonetheless used a number of biological reference points in recommending catch options. The cod stock was heavily exploited when TAC controls were introduced and thus advice was necessarily framed in terms of reductions in fishing mortality and towards increase in spawning stock size. A spawning biomass of 5–600 000 tons was adopted as a target and the initial mortality target was F_{\max} although Icelandic scientists consider that targets below F_{\max} , possibly as low as $F_{0.1}$, merit consideration. However, fishing below F_{\max} has not been a practical consideration to date. A further element of the strategy was to use recruitment of strong year-classes as an opportunity to increase stock size by keeping catches on these year-classes down. Scientific recommendations on catch options served as a basis for wide consultations between fishery managers and an industry which greatly values catch stability. Resulting TACs were consistently higher than the catch levels advised on a purely scientific basis. Haddock and pollock (and other important groundfish) stocks are also under TAC regulation and similar procedures are applied to determining allowable catch levels although the specific criteria vary with circumstances. The historically low level of the cod stock in the early-1990s caused the government to adopt a firm strategy, beginning with the 1995/96 fishing season, of limiting catch to 25% of the age

4 and older stock biomass (but with a minimum catch level of 155 000 tons).

The development of management systems for pelagic fish species also evolved as minimal responses to fishery crisis rather than from an interventionist approach. The collapse of the herring stocks in the 1960s brought the introduction of minimum fish size regulations, seasonal fishery closures, then TACs and finally, in the early-1970s, more or less complete fishery closure (Jakobsson, 1980, 1985). Recovery of the summer spawning stock (spring spawners did not recover) allowed the fishery to be reopened in 1975. At that time TACs were reintroduced along with a boat quota system for the purse seine fleet, and an exploitation level strategy of fishing at $F_{0.1}$ was adopted. Minimum fish size regulations were retained and supplemented by a system of temporary closures of areas containing small fish managed through an at-sea observer program. Permanent seasonal closures were also used but these had the objective of regulating catch quality.

Capelin catches increased greatly in the 1970s when purse seine effort diverted from the collapsed herring stocks to the capelin stock. Minimum mesh size and fish size regulations and seasonal closures were introduced in the mid-1970s to protect juvenile capelin. Although TACs were introduced from the 1979/80 fishery through bilateral agreements with Norway these were essentially sharing arrangements rather than conservation measures. Boat quotas were introduced for the Icelandic fleet in 1980. Biologically based exploitation level management was introduced after stock collapse required complete fishery closure for the 1982/83 season. Subsequently, harvests were limited to the tonnage surplus to that which provided for a spawning stock biomass of 400 000 tons. This target level for spawning stock biomass was essentially arbitrary but was judged adequate to protect against recruitment overfishing and also gave some recognition to the importance of capelin as a forage species, particularly for cod and Greenland halibut (Vilhjálmsen, 1983, 1994).

In the case of both herring and capelin, boat quotas were made increasingly transferable. Progressive standardization with other fisheries culminated in a uniform system of completely transferable boat quotas for all fisheries from 1991.

Regulatory Actions. During the period of the international cod fishery around Iceland, implementation of area closures to mobile gears for protection of spawning and juvenile fish was the preoccupation of Icelandic authorities. Through a series of jurisdictional extensions and consequent

negotiations with foreign governments, virtually all areas within 12 miles of the coast and some additional large areas, particularly off the northeast coast, were closed to trawling. Most of these areas were closed year-round, ostensibly for the protection of juvenile fish, whereas some were seasonal closures primarily for protection of spawning fish (Fig. 31). The latter were implemented largely at the instigation of fishermen rather than scientists. These closures, of course, also had allocative implications, preserving coastal grounds for smaller fixed gear vessels.

From 1976, when the groundfish fishery was under exclusive Icelandic control, emphasis was placed on real time fishery closures to prevent the capture of small fish. Iceland appears to have been the first country to establish a system of temporary area closures, based on an at-sea observer system, for protection of young fish. This system allowed immediate closure of areas when the catch was observed to contain more than a set percentage of fish under a certain size. The critical sizes, and the maximum percentages of undersized fish allowed, were established annually by the Marine Research Institute based on expected size composition of the catches and it was the Marine Research Institute which had the authority to order closures. These closures were valid for seven days and could be extended if necessary.

Protection of small cod, haddock and pollock was strengthened also by increases in bottom trawl mesh size to 135 mm (regardless of material) in 1976, and to 155 mm in 1977, from the previous NEAFC level of 130 mm manila equivalent (Appendix Table 15). Other gears (midwater trawls, Danish seines and gillnets) were also regulated to large mesh sizes with various compromises to allow efficient capture of other species as well.

Minimum fish sizes were also increased greatly in 1977 to 50 cm for cod and pollock (from the NEAFC levels of 34 cm and 35 cm, respectively) and to 45 cm for haddock (from 31 cm), to keep regulations for minimum fish sizes and mesh sizes consistent with each other. These minimum fish sizes were set by regulation and are not to be confused with those established under the system of temporary area closures. Their intention was nonetheless the same, i.e. protection of young fish, but their applicability was at time of landing. Prior to 1984, it was required that all catches be landed but undersized fish were confiscated. This encouraged discarding of undersized fish at sea. When quotas were established in 1984, undersized fish were not confiscated and not counted against quotas. This, in turn, encouraged an increase in landings of undersized fish. Thus, in 1987, all

undersized fish were included in quotas but this again encouraged the original problem of discarding at sea (highgrading). Finally, only one third of the undersized fish landed were counted against quotas, provided that no more than 10% of the catch was of undersized fish, and this appeared to provide a motivational balance which maximized the conservation value of the regulation.

Regulations designed to control catches were first implemented in 1978 when limits were placed on the number of days each vessel could fish for cod. This system was in place for six years but, as there were no controls on entry to the fishery, the fleet grew and the number of days each vessel could fish for cod decreased with adverse repercussions for economic performance of the fleet. A positive feature of this system was that fishing effort was diverted to other groundfish species but, by the early-1980s, these other species were approaching full exploitation while the catch of cod remained well above levels recommended by the Marine Research Institute. A sharp, and unpredicted, drop in cod catches in 1982–83, and the resultant economic adversity, stimulated the introduction of a direct catch control system.

The catch controls introduced in 1984 set TACs for seven groundfish species, cod, haddock, pollock, redfish, Greenland halibut, wolffish and European plaice, and allocated individual boat quotas based on historical performance. This system was renewed for 1985 but only the first five of the above species were included. (European plaice were re-included from 1991.) There were further renewals of the boat quota system for two years and then for a further three years until, in 1991, a new plan was introduced which was of indefinite duration thus making TAC shares permanent assets of vessel owners.

Some provisions of the initial boat quota schemes proved to work against attainment of the implied objectives of ensuring stock conservation while at the same time improving the economic performance of the overall fishery. One of these was the exclusion of small boats, initially those under 12 GRT and then under 10 GRT, from the IQ scheme. As there was no limitation on entry of boats to the fleet the small boat sector rapidly expanded. Boats of 6–12 GRT were brought into the scheme in 1988. However, by 1991 it was necessary to limit entry to boats already in the fishery in 1990 and to incorporate all boats into the catch quota scheme. Nonetheless, boats under 6 GRT fishing with handlines retained the option of fishing for a limited number of days, rather than accepting catch quotas, at least for a further three years.

For those boats included in the IQ scheme there were also provisions which did not encourage the hoped for rationalization of capital investment. Only 50% of the catch of longline boats in November to February was counted against vessel quotas. This exemption, introduced in 1984 and continued under the 1991 scheme, was designed to support regional employment during the winter. In general, the short term nature of the first boat quota regulations caused boat owners to retain, or even increase, their fishing capacity as protection against a future change in policy direction. A fishing effort option (permissible days at sea), introduced initially to accommodate those boats disadvantaged by the historical catch basis for boat quota allocations, but subsequently extended to all boats, provided one mechanism to expand fishing activities. Vessel replacement rules were also not sufficiently restrictive, at first, to prevent replacement by vessels of greater fishing power. Tightening of replacement rules resulted in each new vessel being restricted to a volume no greater than that of the vessel (or vessels) replaced. Also, the 1991 scheme eliminated the effort option and introduced TAC share allocations of indeterminate duration. Furthermore, although annual quotas were freely tradeable from the beginning of the IQ system in 1984, transferability of TAC shares was possible only in conjunction with permanent retirement of a vessel from the fishery. In 1991 shares became more or less freely transferable between vessels, either in part or in whole, and this, along with the comprehensive scope of the 1991 plan, was expected to provide the conditions necessary to promote a much fuller rationalization of fishery investment (Arnason, 1986, 1995; Skarphéðinsson, 1993).

A minimum fish size for herring of 23 cm was introduced in 1966 and a closed season, from March 1 to May 15 was imposed in 1967. In 1968 the minimum size was increased to 25 cm, the closed season extended to August 15, and TACs were introduced. In 1969 the closed season was again extended to include February to August, but these various measures did not stem decline of the herring stocks and a ban on all herring fishing, except for drift netting, was imposed from the beginning of February 1972. This was almost a complete fishery closure because no vessels had used drift nets since 1960, although this method of fishing was reactivated during the purse seine closure. The ban was replaced by reintroduction of TAC regulation in 1975. The purse seiners' catch share was divided into individual boat quotas and reserved for smaller boats, as the larger purse seiners had catch possibilities in the capelin and North Sea herring fisheries. Minimum fish size was increased to 27 cm in 1975 and real time closure of areas containing

small fish was instituted in 1976. Also a closed season of about nine months resulted in the catch being taken in the autumn when the fish are in prime condition. Boat quotas were made transferable, with few restrictions, in 1979 and the herring system became part of the general boat quota system introduced in 1988, and subsequently modified in 1991.

Exploitation of capelin for meal and oil production began in the mid-1960s as a winter fishery on spawning and prespawning fish. When the fishery expanded into summer and autumn months on the feeding grounds north of Iceland in the mid-1970s, measures were taken to prevent the capture of small fish less than age 2. In 1975 a minimum fish size of 12 cm, and an accompanying minimum purse seine mesh size of 19.6 mm, were introduced. Mesh size was increased in 1981 to 21 mm to improve escapement of the I-group capelin. Spring and summer seasonal fishery, or area, closures were also used to avoid capture of small capelin.

Acoustic abundance surveys for capelin were established in 1978 (at the time TAC controls were initiated) to provide estimates of stock biomass. However, for the first few seasons, TACs were established at the beginning of the fishing season in July whereas reliable abundance estimates did not become available until the following autumn and winter. By this time, much of the TAC had been harvested and it proved difficult or impossible to make adequate adjustments to TACs late in the season. Furthermore, TAC levels were established by Icelandic/Norwegian agreement and no controls on catch were in place for Greenland waters, which was then under EU jurisdiction. As a result, landings exceeded biologically recommended levels by large amounts in the first three seasons for which TACs were in effect, and spawning stock escapements were below the guideline of 400 000 tons adopted in 1980. Prognosis of poor recruitment for the 1982/83 fishing season necessitated complete fishery closure. (Agreement was reached with the EU to also prevent fishing in Greenland waters that year.) The fishery was reopened the next season but a new procedure was adopted which set low provisional TACs subject to upward adjustment when acoustic survey abundance estimates became available. This greatly improved the ability to limit landings so that the spawning stock target was met. Capelin boat quotas became transferable in 1986 and, as with herring, became part of the general boat quota system introduced in 1988 and modified in 1991.

Surveillance and Compliance. There is believed to have been a high level of compliance with Icelandic fishery regulations. Vessels are

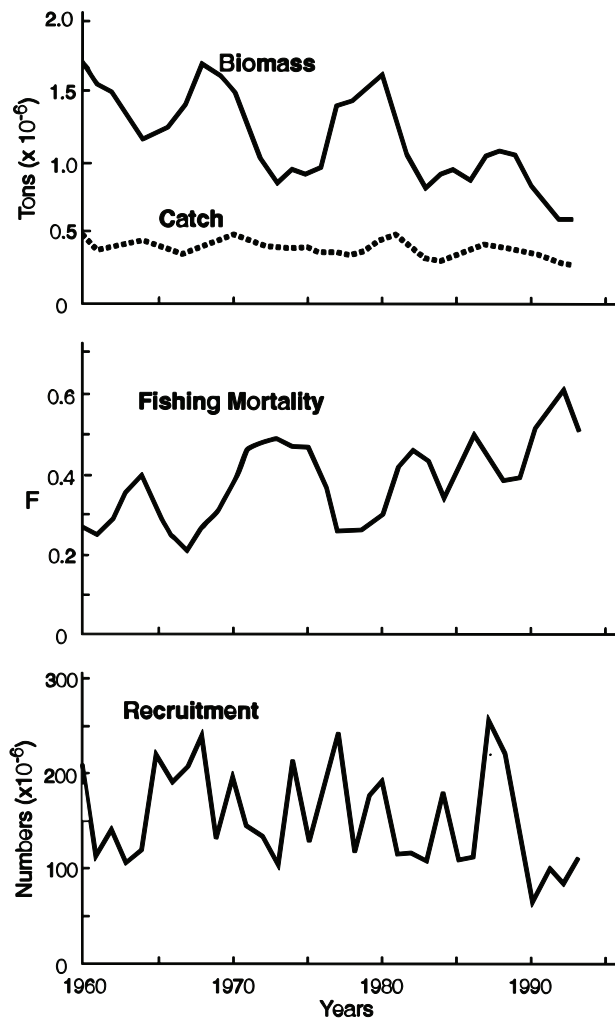


Fig. 32. Icelandic cod: trends in stock parameters.

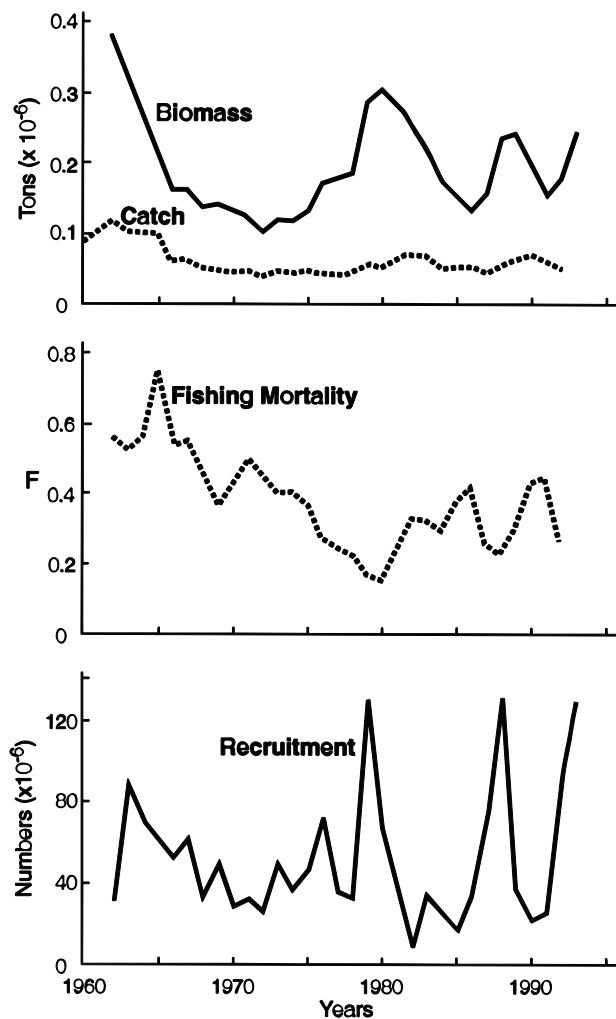


Fig. 33. Icelandic haddock: trends in stock parameters.

allowed to carry only one mesh size at a time which facilitates control. There is, perhaps most importantly, widespread support among fishermen for the mesh regulations which are in place.

There are multiple checks on the quantities of fish landed. There are public officials in each port to record landings and records are available on sales, purchases and on plant production. As 99% of the landings are exported, export records also provide a check on quantities landed. Vessels can land fish directly in foreign ports but inspectors are employed at these locations to check validity of reports. As a result, fishery managers have a high confidence in landings statistics.

Discarding of fish at sea is not permitted but there is evidence that less valuable components of

the catch in terms of species and sizes are discarded to maximize the value of vessel quotas. A government commission, reporting in 1993, concluded that groundfish discards ranged from 1% to 6% of total catch weight depending on gear and vessel type, and that there had been no detectable increase in discards since the introduction of the vessel quota system (Arnason, 1995). Thus it is thought by the fisheries ministry that discarding, at least to this juncture, was a minor problem.

Subsequent to this government commission report, however, particularly restrictive TAC levels for cod may have put into jeopardy these high levels of regulatory compliance. In particular, there are reports of unreported landings and of landings misspecified as to species (Eurofish Report, 1994), and of discarding (Eurofish Report, 1995).

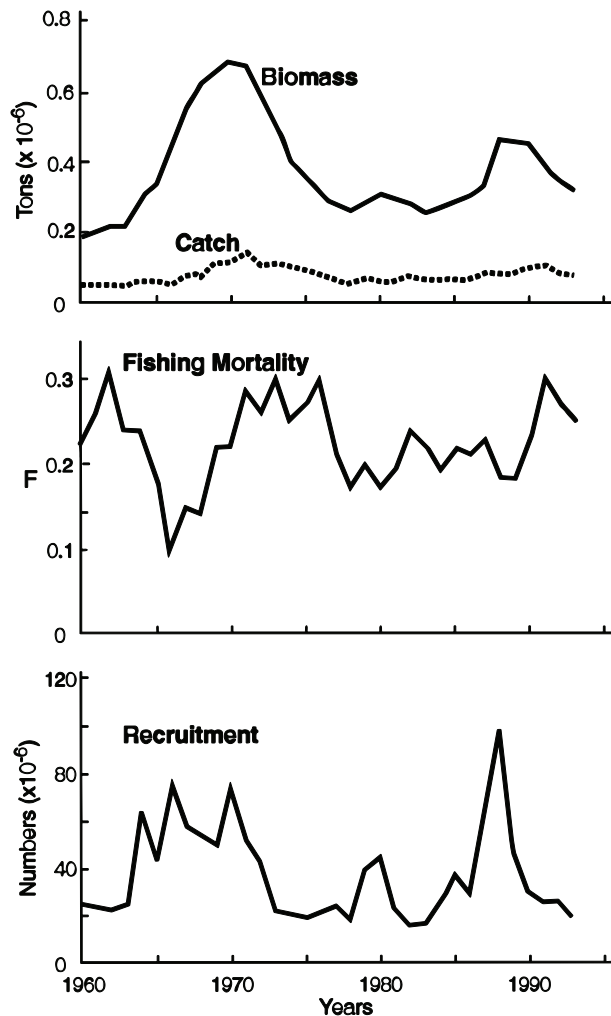


Fig. 34. Icelandic pollock: trends in stock parameters.

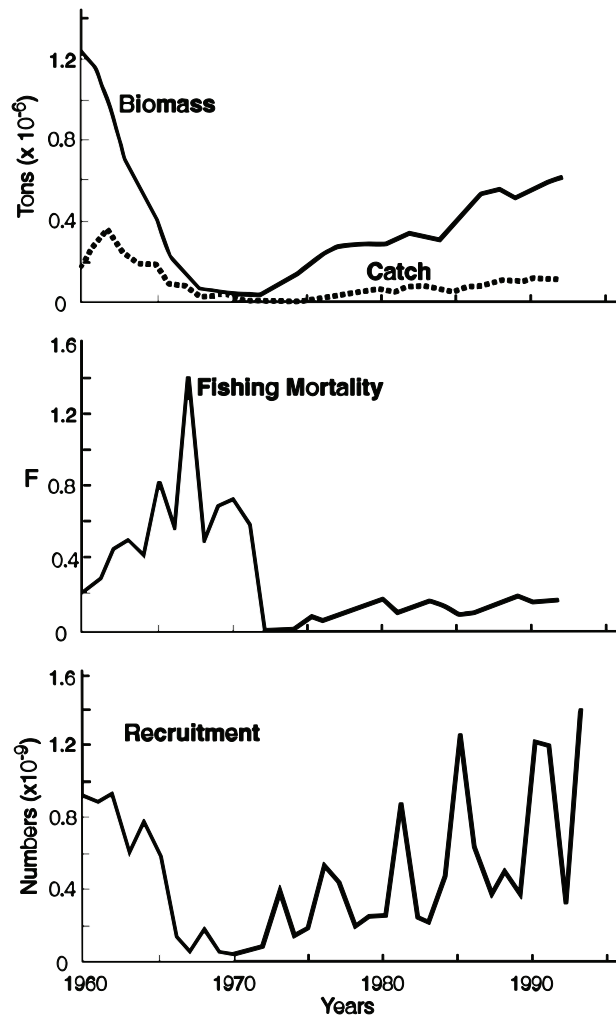


Fig. 35. Icelandic herring: trends in stock parameters.

Resource Trends. Trends in the stocks of the primary species in Icelandic waters are illustrated in Fig. 32 to 36. For the most important species, cod, fishing mortality declined precipitously on extension of jurisdiction but rose steadily thereafter, to the highest levels recorded, in the late-1980s to early-1990s. On average in the 1979–88 period, F was about as high as it was prior to the 200 mile limit, and in both cases was well above F_{\max} (Fig. 37). Spawning stock biomass remained at about half the target level in the 1980s and early-1990s, and the fishable stock in most recent years has been the lowest recorded.

In contrast to cod, haddock mortality was lower, on average, after the mid-1970s, between F_{\max} and $F_{0.1}$ (Fig. 37). Pollock continued to be fished at a moderate level, between F_{\max} and $F_{0.1}$ (Fig. 37). The fisheries for both species remained stable under domestic regulation.

In combination, the two Icelandic herring stocks had a biomass of over 1.2 million tons in 1960. This was reduced to about 25 000 tons in the early-1970s but rebuilt during the 1970s and 1980s to 750 000 tons, composed entirely of summer spawners (Fig. 35). Peak catches, in 1962, were about 370 000 tons whereas catches recovered to 100 000 tons by 1990. Fishing mortality was very high in the late-1960s and early-1970s but was kept low, close to $F_{0.1}$, after the fishery reopened in 1975 (Fig. 37).

The level of capelin spawning escapement was below the 400 000 tons target level in 1980 to 1983, i.e. at the end of 1979/80 to 1982/83 seasons (Fig. 36). Subsequent to the fishery closure of 1982–83 and imposition of more stringent control of catches, spawning stocks at or above the target level are thought to have been achieved in 1984 to 1989. The spawning stock was below the target in 1990 and 1991 but above it again in 1992. Recruitment (at

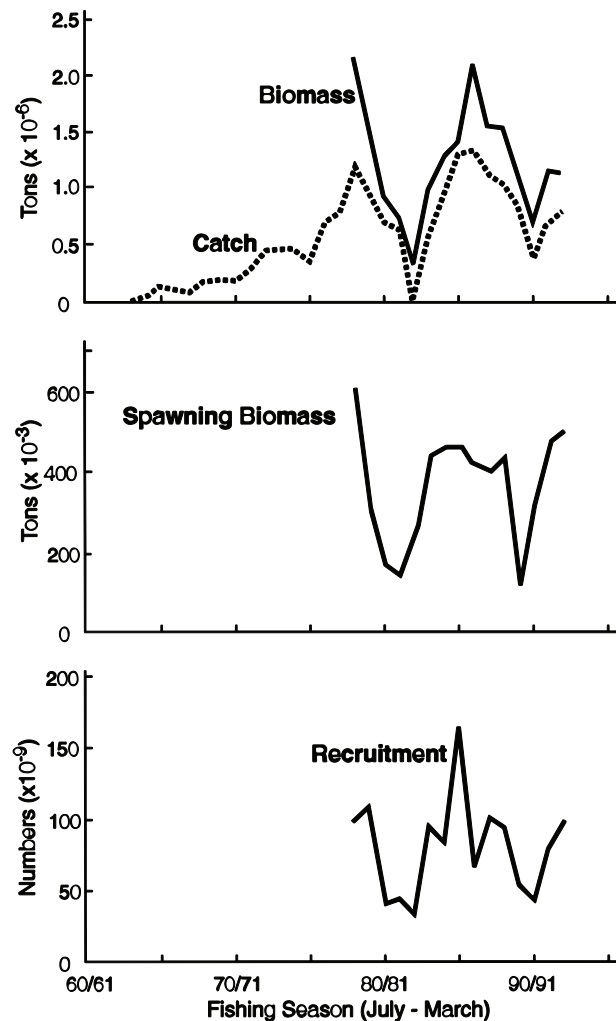


Fig. 36. Icelandic capelin: trends in stock parameters. (Stock biomass and recruitment estimates are for the beginning, and spawning biomass is for the end, of the fishing season.)

age 2) was poor in 1980/81 to 1982/83 seasons, causing the great decline in fishable biomass observed, and was poor again in 1989/90 and 1990/91 and again greatly reduced stock size, particularly in the latter season. Catches were, of course, highly variable, ranging from zero in 1982/83 to 1.3 million tons in 1984/85 and 1985/86, as is to be expected in fisheries managed for a target spawning escapement.

In a comprehensive analysis of the economic effects of fishery management actions, unique among North Atlantic management systems, Arnason (1995) concludes that the introduction of ITQs in the pelagic fisheries produced substantial increases in economic efficiency. Even in the groundfish fishery, in which many exceptions were

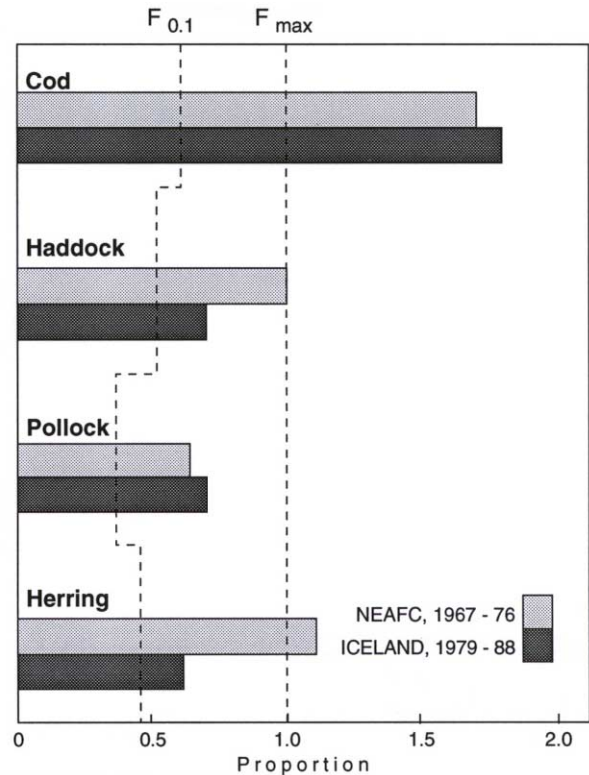


Fig. 37. Icelandic stocks: fishing mortality in the NEAFC and Icelandic management periods in relation to F_{max} and $F_{0.1}$. (Discontinuities in $F_{0.1}$ line reflect differences in ratios to F_{max}).

allowed and constraints imposed on the operation of the ITQ system, there are strong indications that significant net economic benefits were produced by the fishery. Furthermore, the regional distribution of groundfish quota holdings remained stable although with a slight tendency for redistribution toward more remote areas, and hence, to date, the results of the ITQ system have been consistent with the government objective on regional distribution of benefits. Other, more brief, descriptions of the effects of the ITQ system are provided by Danielsson and Klemensson (1994) and Helgason (1994).

Norway

Fishing Limits. Issues of fisheries jurisdiction concern not only mainland Norway and its adjacent coastal islands but also the islands of Jan Mayen and Svalbard over which Norway acquired sovereignty in the 1920s (Fig. 38). Jan Mayen lies at approximately 71°N 9°E in the Norwegian Sea 450–500 miles from the Norwegian west coast. Svalbard is a group of islands 350–400 miles north of Norway.

The importance placed by Norway on protection of coastal fisheries, which are a mainstay of coastal communities, particularly in the north, caused it to be among the leaders in jurisdictional claims over coastal waters. For many years Norway claimed a 4 mile zone (one Scandinavian league), rather than the conventional 3 miles, until establishing a 12 mile zone in 1961. The European Fisheries Convention of 1964, although it accepted the concept of a 12 mile fishing zone, was rejected by Norway because of its provision requiring recognition of historical fishing activities by other signatories in the 6–12 mile zone. Also, the equal success principle in the EU Common Fisheries Policy was a major stumbling block during Norwegian negotiations to join the EU in 1972. Despite the offer of a 10 year derogation of this principle, it proved a key factor in the Norwegian referendum vote against entry to the EU. Soon afterwards, Norway established seasonal "no trawling zones" outside of 12 miles from its coast as a further protective measure for coastal fisheries (Anon., 1977). This was declared an interim measure pending establishment of a 50 mile exclusive zone. However, Norway claimed a 200 mile zone effective January 1977 (Fig. 38). Maintenance of domestic control over fisheries policy was again an important factor in rejection of EU membership in a second referendum in 1994.

Off southern Norway, in the North Sea and the Skagerrak, fishing zone boundaries with neighbouring states, Sweden, Denmark (metropolitan and Faroe Islands) and UK, were resolved based on continental shelf boundary agreements. Off northern Norway, however, resolution of a maritime boundary with the USSR proved intractable. The USSR, when it claimed a 200 mile fishing zone in the Barents Sea in 1977, used as the western boundary a meridian which had served as the western boundary to a previous claim to jurisdiction of an Arctic "sector". This differed substantially from the equidistant line proposed by Norway. As a practical solution a "grey zone" was established in 1978 (Churchill and Ulfstein, 1992; Hay, 1989), pending resolution of the boundary issue, which covered most of the contested area between boundary claims, but also areas which lay within the uncontested zones of both parties (Fig. 39). Within this grey zone, each party has jurisdiction over its own fleet and may, within a joint framework, licence fishing by third parties.

The Treaty of Paris of 1920 regarding Svalbard placed under Norwegian sovereignty all islands in the area between 10° and 35°E and 74° and 81°N. However, all 40 or so signatories to this treaty enjoy equal rights of economic enterprise, including fishing, on these islands and in their territorial

waters. Norway declared territorial waters to be 4 miles wide in 1971. It is the Norwegian view that the rights of signatories do not apply to the continental shelf and waters outside the territorial sea but this claim is not accepted by other signatories and has been specifically rejected by the USSR. In face of this opposition, Norway established a 200 mile "fishery protection zone" around Svalbard in June 1977 as an interim solution which allowed it to implement fishery management measures. The protection zone differs from an exclusive fishing zone in the requirement to treat all signatories of the Svalbard Treaty equitably. While the USSR did not recognize this protection zone, practical arrangement between Norway and the USSR for orderly fishing in the zone proved to be possible. Similarly, the EU, although it establishes its own autonomous TACs for the zone to maintain its position on legalities, establishes catch levels by mutual agreement with Norway. Norwegian authority in the Svalbard zone has been directly challenged through unregulated fishing by other parties, most recently by trawlers from Iceland (which did not become a signatory to the 1920 treaty until 1994). In 1994 this resulted in at-sea confrontations, with Norwegian patrol vessels cutting trawl warps, reminiscent of the Icelandic "cod wars" with the UK. The ambiguity about regulatory authority in the Svalbard zone is a source of uncertainty about the effectiveness of conservation efforts.

The various jurisdictional claims made by Norway and the USSR did not include the waters of the Barents Sea in their entirety. An approximately triangular area between Bear Island and Novaya Zemlya remained unclaimed (Fig. 39). This was not expected to create difficulties in the control of exploitation of Barents Sea stocks. However, in the early-1990s French and Greenlandic vessels, and subsequently Icelandic and other trawlers, found it sufficiently attractive to fish for cod in this "loophole". The political importance given to this uncontrolled fishing suggests that it is viewed as a significant threat to the success of Norwegian and (now) Russian conservation efforts in the Barents Sea.

Norway and Iceland concluded an agreement on a fishing zone boundary between Jan Mayen and Iceland in 1980. Although Jan Mayen and Iceland are less than 400 miles apart the agreement recognized the full extent of Iceland's previous 200 mile claim. Norwegian declaration immediately thereafter of an extended fishery zone around Jan Mayen, precipitated Danish proclamation of a 200 mile limit off east Greenland, north of 67°N. (Greenland's more southern limits were established in 1977.) The dispute created by these overlapping claims was referred to the International Court of Justice in the

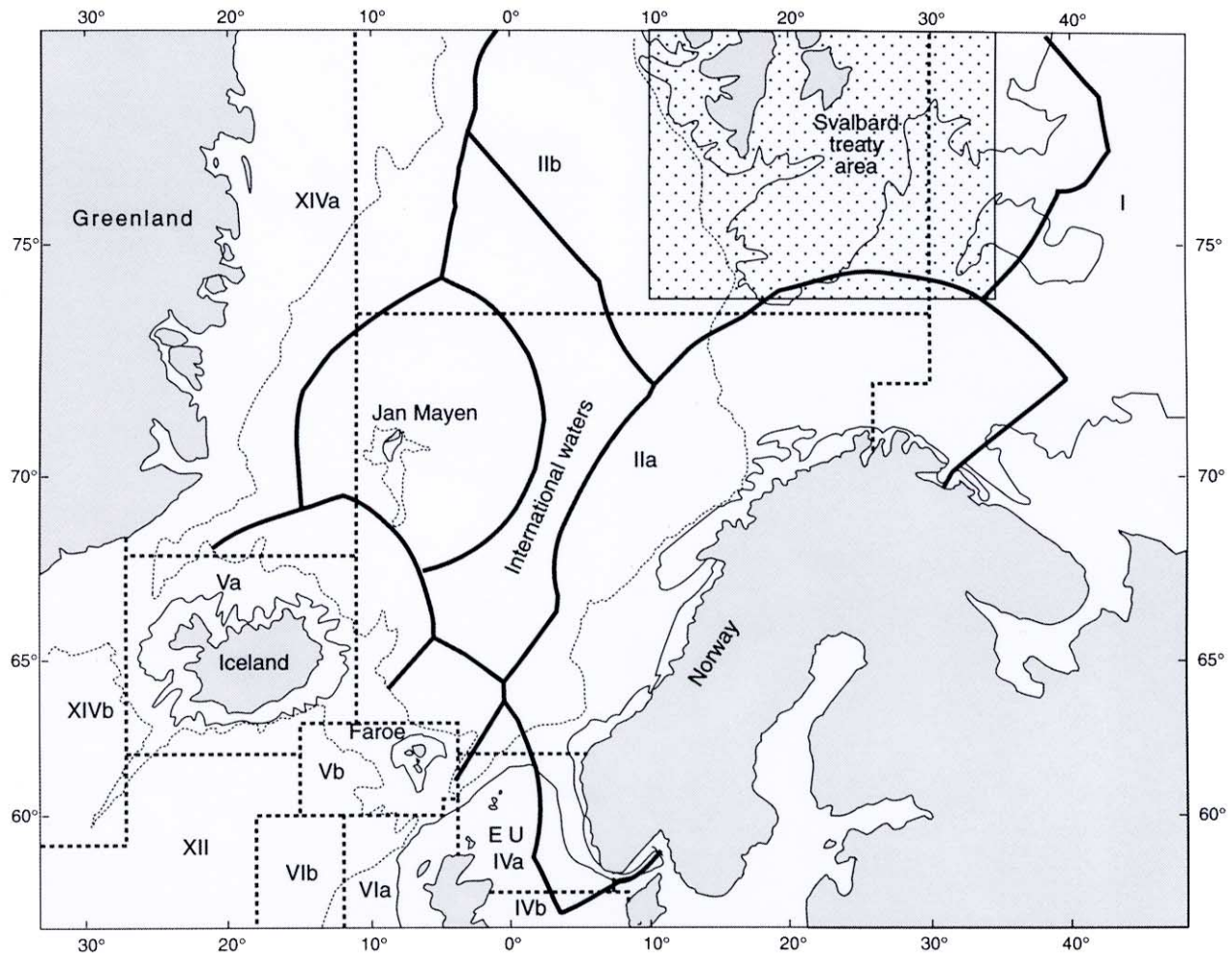


Fig. 38. Norwegian claims to jurisdiction in waters adjacent to the coast of Norway and off Jan Mayen, and to a fishery protection zone around Svalbard. Svalbard Treaty Area and ICES Statistical Areas also shown. (Depth contours are 200 m – solid line, 1 000 m – dashed line.)

Hague. The boundary agreement between Norway and Iceland also set up a fisheries commission and a method for establishment of TACs and national allocations for capelin. The latter was the issue of immediate practical importance. The discovery by the Norwegian purse seine fleet of commercial quantities of capelin off Jan Mayen and the recognition that these were summer migrants belonging to the Icelandic stock, rather than being of local production, immediately predated these diplomatic activities (Vilhjálmsen, 1994).

Extension of jurisdiction did not give Norway exclusive jurisdiction over many of the finfish stocks on which its fishing industry depended, and boundary resolutions were thus important in facilitating resource conservation and sharing arrangements. However, it was the establishment of satisfactory fisheries agreements with neighbouring states which was crucial to Norwegian fishing interests.

The most important of these were with the USSR with regard to Barents Sea stocks and with the EU for the North Sea and Skagerrak stocks. Cooperation between Norway and the USSR in imposing catch limitations for Northeast Arctic cod began with the agreement between these countries and the UK for 1974 (Anon., 1975a). This was followed by an Intergovernmental Agreement between Norway and the USSR on cooperation in fisheries in 1975 which established the Mixed Soviet-Norwegian Fisheries Commission. A further agreement in 1976 provided for reciprocal access in 12–200 mile zones, and the subsequent grey zone agreement circumvented the problems associated with failure to resolve a common boundary. Thus, mechanisms were in place for bilateral agreement on TACs and sharing arrangements for Barents Sea stocks from the time of jurisdictional extensions. Indeed, sharing arrangements for Northeast Arctic cod and haddock were established prior to extended jurisdictions, based on

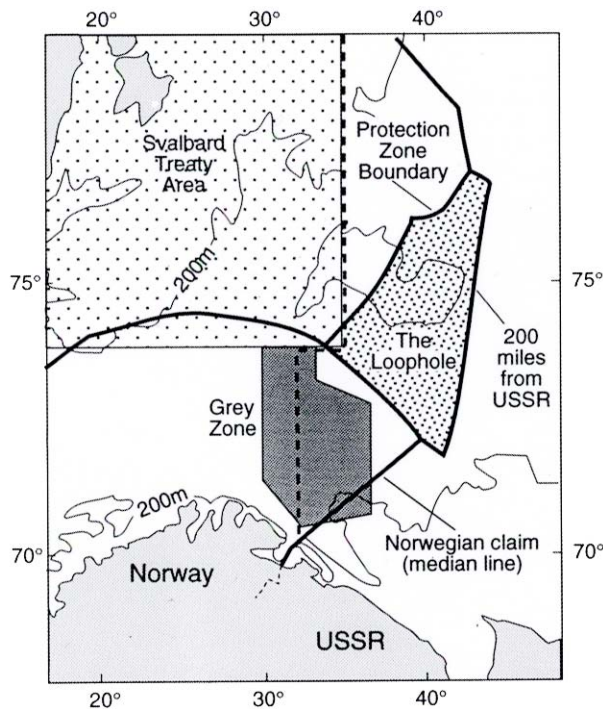


Fig. 39. The political geography of the Barents Sea: the USSR (Russian) sector line claim (dashed line), the Norwegian 200 mile zone claim including a median line boundary with the USSR, the eastern boundary to the 200 mile Svalbard fishery protection zone claimed by Norway, the grey zone of shared Norwegian-USSR jurisdiction, and the loophole – an area which lies outside 200 miles from all adjacent territories.

historical fishing activities and without consideration of resource distributions in relation to zonal claims. Norwegian negotiations with the EU on a fisheries agreement were concluded in 1977 but did not come into force until 1981 due to conflicts internal to the EU. Nonetheless, a succession of temporary agreements was used to implement the necessary measures in the interim. The Norway-EU framework agreement identified shared stocks and the extent of their "zonal attachments" as the basis of ownership shares. Thus, this agreement provided a basis from 1977 for establishment of TACs and agreement on shares of joint North Sea stocks. Other agreements containing provisions for fish stock conservation, as well as for reciprocal fishing, include that concerning Jan Mayen-Icelandic waters already mentioned, and a tripartite agreement between Norway-EU-Sweden for Skagerrak and Kattegat stocks.

Management Institutions. Responsibility for fisheries management lies with the Norwegian Ministry of Fisheries and this authority is exercised by

the Minister of Fisheries. The ministry maintains a Fisheries Directorate for management planning, regulation and development, and an Institute of Marine Research in Bergen for biological research. Shore-based enforcement of regulations is conducted by officers of the Fisheries Directorate. However, at-sea surveillance and enforcement in the Norwegian zone is the responsibility of the Coast Guard which is organizationally part of the Ministry of Defence. Sales organizations, which are owned and operated by the fishermen, also play an important role in the collection of fishery statistics in close cooperation with the Directorate of Fisheries (Thorvik, 1994). An Institute of Fisheries Technology Research, an autonomous institution established in 1973 and funded jointly by government, universities and business, conducted research on fishing gear and methods (as well as vessel and marine engineering, food processing and economics). A reorganization of responsibilities placed the fishing gear and methods division under the Institute of Marine Research.

A Committee on Fisheries Management provides the institutional framework for consultations between the authorities and the fishing industry. This committee is chaired by the Director of the Fisheries Directorate and membership on it includes representatives of different sectors of the industry as well as of administrative bodies concerned with management questions. Recommendations from the committee are taken into account by the Minister in his decisions. Fisheries issues which involve international relations are subject to consultations with other ministries and government departments which have an interest in international matters.

Norway continues to use ICES as the source of biological advice for fisheries management. Scientists from the Institute of Marine Research had long contributed to the ICES advisory process for stocks of interest to the Norwegian fishing industry, this advice being directed to NEAFC prior to extended jurisdiction. As most of the major finfish resources are shared, international cooperation among scientists is essential to the determination of stock status, and ICES provided a well established forum for thorough peer review and development of scientific consensus. Prior agreement on scientific advice facilitates bilateral negotiations on TACs and allocations. This advice is, of course, also available as a basis for domestic decisions. The director of the Institute of Marine Research is a member of the Committee on Fisheries Management.

Management Objectives and Strategies. The Norwegian government announced a long-term plan for fisheries in 1977 with three main goals: 1) to maintain the main features of coastal settlement, 2)

to protect and maintain fish resources, and 3) to ensure safe and profitable employment in the fishing industry. A revision to management objectives in 1983 added, as objective 1, improvement in the real profitability of the fishery, i.e. profitability after deduction of state subsidies. The original three goals were retained.

The strategies pursued by Norway to protect and maintain fish stocks were in general consistent with proposals by the ACFM of ICES that the spawning stock was to be maintained at, or built up to, a level which would provide, on average, satisfactory levels of recruitment and, within that constraint, the exploitation level and exploitation pattern aimed at were those which maximized yield, although a phased approach was taken to major adjustments (downward) in exploitation level to minimize disruption of fishing activities. This translated, for demersal stocks, into a strategy of aiming for F_{\max} on the yield-per-recruit curve. For the Barents Sea capelin stock the strategy was to harvest all of the maturing stock surplus to a target level of spawning biomass of 500 000 tons in 1970–82 and 400 000 tons thereafter (Hamre and Tjelmeland, MS 1982). The 400 000 tons target was seen as an optimal, rather than a minimum, level and was based on an observed relationship between stock size and recruitment. The Norwegian spring spawning herring stock collapsed prior to Norwegian extension of jurisdiction and, throughout the period from 1977, management strategy was to rebuild the spawning stock toward previous levels in the hope of restoring the stock to its previous high productivity. A minimum spawning stock biomass of 2.5 million tons provided a guideline for gauging stock recovery. However, the possibility for ongoing yields was not totally discounted in favour of potentially much higher future yields and a coastal fishery was allowed in most years (Hannesson, 1985). Similarly, the North Sea mackerel stock declined greatly in the late-1970s and from 1980 stock rebuilding was the primary management concern but, nonetheless, as with herring, a fishery was permitted. The high proportion of stocks shared between Norway and its neighbours required compromise solutions where strategies of interested parties differed.

Collapse of the fishery for Norwegian spring spawning herring at the end of the 1960s left Norway with a severe overcapacity problem in its purse seine fleet. This was at least part of the motivation for introduction of a comprehensive licensing system in 1972. This system allowed licensing for particular fisheries in order to restrict participation, although vessels using traditional gears, essentially small coastal vessels, were exempted. While licensing could prevent the worsening of existing overcapacity problems and conceivably prevent devel-

opment of new ones, it did not provide a mechanism for reduction in capacity to match resource availability. For the latter purpose, a vessel decommissioning scheme was introduced in 1979 for the purse seine fleet. It was necessary to extend this to the entire Norwegian fishing fleet by 1984. Initial targets for the decommissioning scheme, through which the government paid for scrapping of vessels, were reductions in both purse seine and trawler fleets of about 25%. Fleet size targets were not based on intercalibration of fleet catching capability and resource exploitation rate; the programme was driven largely by economic and social considerations. Nonetheless, there was also a recognition that fleet overcapacity exacerbated problems of controlling exploitation level through catch quotas. Thus, one objective of licensing was to provide a crude control over fishing effort in particular fisheries and hence to serve a conservation purpose (Brochmann, 1984a, 1984b, 1985; Paulsen, 1987).

Government objectives gave a strong emphasis to social policy which was effected by a longstanding strategy of industry subsidization, particularly through price support. Subsidies greatly increased in the early-1980s to the point where they were contributing about 50% of net income of the industry and, while fishermen's incomes were keeping pace with these in other industries as a result, price support was found to maintain participation and stimulate investment in the industry despite existence of fleet overcapacity and decline in real profitability (Hannesson, 1985, Jentoft and Mikalsen, 1987). This made resource conservation more difficult by generating pressures for increased fishing opportunities. It was this which stimulated parliament to put profitability into the revised objectives of 1983 (Brochmann, 1985). Price subsidies were greatly reduced in the early-1990s (Eurofish Report, 1992b).

Regulatory Actions. Norway retained NEAFC minimum mesh size regulations in effect after extension of jurisdiction. Norway considered it important to increase the age at first capture of North-east Arctic cod, but agreement with the USSR was viewed as essential as this was a shared stock. Such an agreement was reached for 1981 which raised mesh size to 135 mm from 130 mm (manila equivalent) (Appendix Table 16). This was too small an increase in Norwegian eyes and, being unable to convince USSR authorities to go further, unilaterally raised mesh size again in 1983 to 145 mm (manila equivalent). The disagreement in part reflected technical uncertainties about the selection properties of the netting materials used by the fleets of the two countries but an underlying issue was that cod in the USSR zone were mainly juveniles and

hence smaller than in the Norwegian zone and a mesh increase by the USSR fleet would have benefitted Norwegian more than USSR fishermen. Differentials for Danish seine nets were dispensed with in 1981 but reintroduced in modified form in 1987 (Appendix Table 16) based on new selection data which showed seines of polyamide had a higher selection factor than trawls of the same material.

In the North Sea groundfish fisheries, NEAFC regulations had allowed nets with meshes as small as 70 mm to be used, depending on material and net construction. Norway dispensed with differentials for this area (as did the EU which shared these stocks) and established a mesh size of 90 mm from 1981. Mesh size was further increased to 100 mm from 1987, resulting in Norwegian mesh sizes for these stocks being rather higher than those of the EU for most of the extension of jurisdiction period. (See EU section regarding the complexities faced by the EU in mesh regulation for North Sea fisheries as a result of the mixture of species fished.)

Minimum fish size regulations of NEAFC for cod and haddock in the North Sea were not changed by Norway but those for Northeast Arctic cod and haddock were increased in 1981, and again in 1990, for an overall increase from 34 to 47 cm for cod and 31 to 44 cm for haddock (Appendix Table 17). Pollock size limits were increased in 1983 from those of NEAFC with introduction of varied limits, decreasing from 40 cm in the north to 32 cm off southern Norway.

For pelagic species, minimum fish size regulations were given modest importance in Norwegian regulation but mesh size regulations were not changed from those of NEAFC which required the use of 16 mm mesh in trawls and Danish seines when fishing for pelagic or industrial species. A minimum size for herring of the Norwegian spring spawning stock of 20 cm was imposed for 1970–72. Although replaced by catch quotas for small herring in 1973–74, a minimum size was again imposed for 1975 at 25 cm. The NEAFC minimum size for North Sea herring of 20 cm in the human consumption fishery was retained by Norway after jurisdictional extension. (Norway prohibited industrial fishing for Norwegian spring spawning herring from 1971.) For mackerel, the 30 cm NEAFC minimum size for the industrial fishery was also retained. Minimum fish size regulations were also employed (in conjunction with the USSR) to prevent the capture of age 1 capelin from the Barents Sea stock (minimum size = 11 cm) and also at Jan Mayen (minimum size = 12 cm, consistent with Icelandic regulation).

Norwegian regulations provided for some tolerances in the amount of undersized fish in catches which varied with species and area, usually between 10% and 15% by either weight or number. In a major departure from NEAFC regulations, discarding of cod, haddock, pollock, herring and mackerel (and several other species) caught in the Norwegian zone was prohibited. Fish of these species caught in excess of small fish allowances were required to be landed and counted against catch allocations. Upon sale, proceeds from these fish did not accrue to the offending vessel but to the fishermen's sales organization (Norwegian Authorities, 1993).

Another important innovation was the introduction in 1986 of a system, similar to that used in Iceland, of real-time closures of areas containing large quantities of small cod, haddock or pollock. Areas were closed when more than 15% of the catch was below the minimum size. Chartered vessels and observers aboard commercial vessels were used to identify areas for closure through a special Surveillance Service. Institution of closures was decided upon by a working group comprised of one representative of the Institute of Marine Research and two from the Directorate of Fisheries (Thorvik, 1994).

Most of the important North Sea stocks (including cod, haddock, herring and mackerel), as well as Norwegian spring spawning herring and Northeast Arctic cod had been placed under TAC controls by NEAFC prior to Norwegian extension of jurisdiction. Norway continued the use of catch controls as the primary basis for control of exploitation level of fish stocks within its new zone. Norwegian Sea pollock, redfish and Greenland halibut stocks are distributed almost exclusively within the Norwegian and Svalbard zones and are viewed by Norway as falling entirely within its control. From 1977, TACs were established for these stocks essentially as a basis for defining surpluses, as Norwegian domestic catches were below resource potential and were left unrestricted. Subsequently, only Atlantic argentine was brought under TAC regulation within the Norwegian zone, that occurring in 1983.

Agreements through the Soviet–Norwegian Fisheries Commission continued TAC controls on Northeast Arctic cod and, beginning in 1977, also initiated TAC controls for Northeast Arctic haddock. In 1976, fishing for haddock was required to cease when cod quotas were reached, as a result of NEAFC regulation. This was intended to provide some control of catch as haddock were taken largely as by-catch in the cod fishery. Similarly, allocations from 1977 and subsequent TACs were intended to cover unavoidable by-catches while providing an obligation to restrain catches to levels

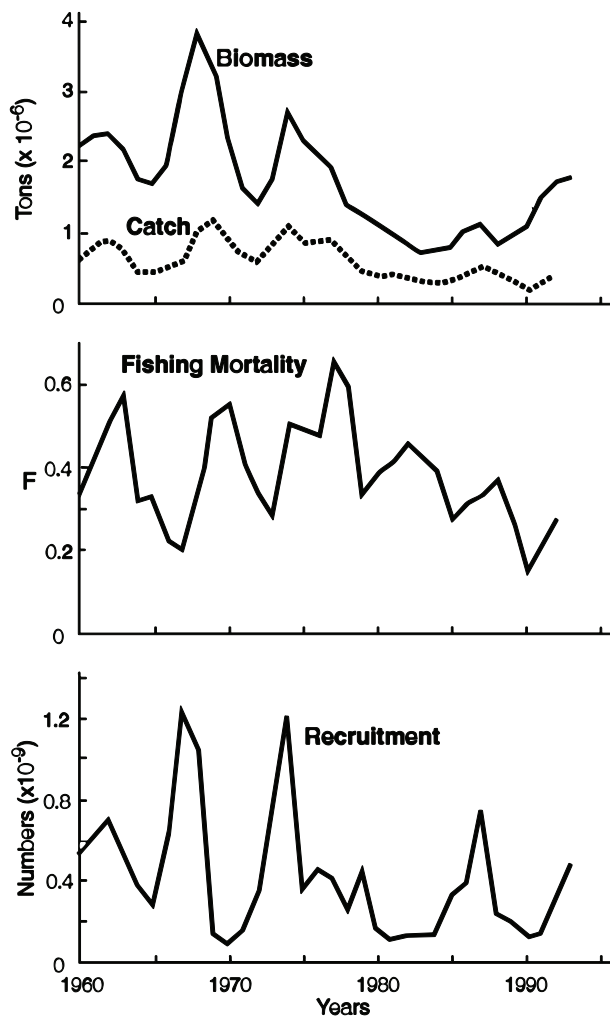


Fig. 40. Norwegian cod: trends in stock parameters.

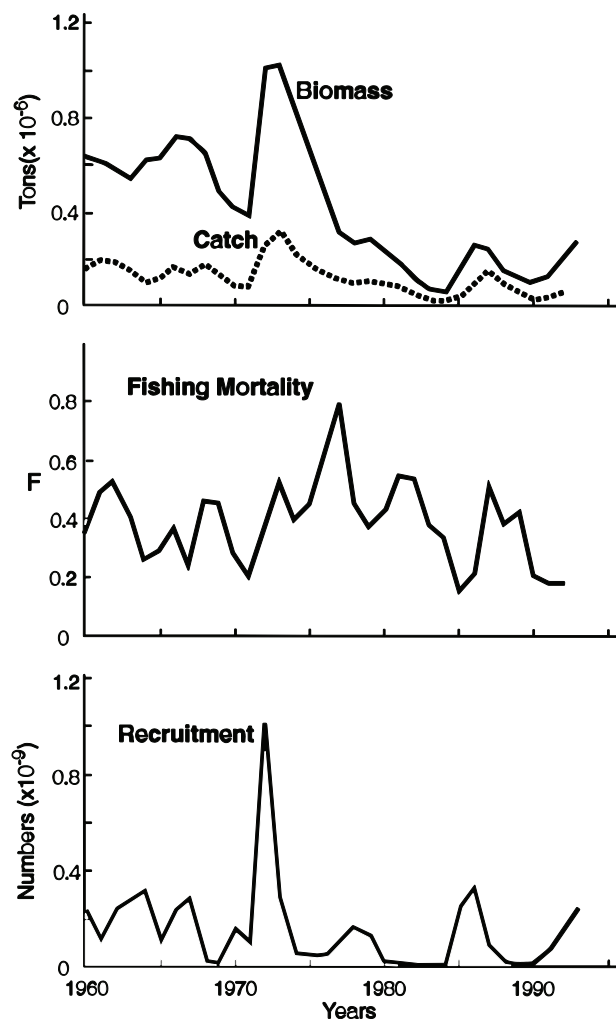


Fig. 41. Norwegian haddock: trends in stock parameters.

consistent with protection of haddock stock productivity. Development of the Barents Sea capelin fishery in the late-1960s and early-1970s was largely by Norway and domestic controls, consisting of area and seasonal closures, were placed on the fishery in some years to allow adequate spawning escapement and prevent capture of small fish. The USSR fishery became significant by the mid-1970s and thus coordination between the two countries in conservation measures became necessary. Overall catch limits and national allocations for Barents Sea capelin were imposed beginning in 1979.

Agreement was reached with the EU in 1977 on TACs and allocations for North Sea stocks in 1978. Cod, haddock, whiting and plaice stocks, which had previously been regulated by NEAFC TACs, were included in the Norway-EU agreement. Neither the Norwegian share nor fishery interest in these stocks was high (zonal attachments varied from 7% for pla-

ice to 23% for cod). However, North Sea pollock was made subject to TAC agreement for the first time, a stock of substantial interest to Norway (zonal attachment 52%). The North Sea mackerel stock, the industrial fishery for which had been regulated by NEAFC, was also included. Although no entitlements were defined for North Sea mackerel, Norway had a predominant fishery interest in this stock. However, the western mackerel stock, considered by Norway to be another joint stock but viewed by the EU as theirs, was not agreed upon. As a result both parties autonomously establish TACs for this stock within their own zones, the 62°N line being used in Norwegian regulation to distinguish the management areas. Early in 1977, Norway and the EU agreed to a complete ban on fishing for North Sea herring and this continued through 1980. Gradual stock recovery allowed TACs to be established from 1981 to 1983 through joint agreement, but no agreement could be reached on TAC levels for 1984 or

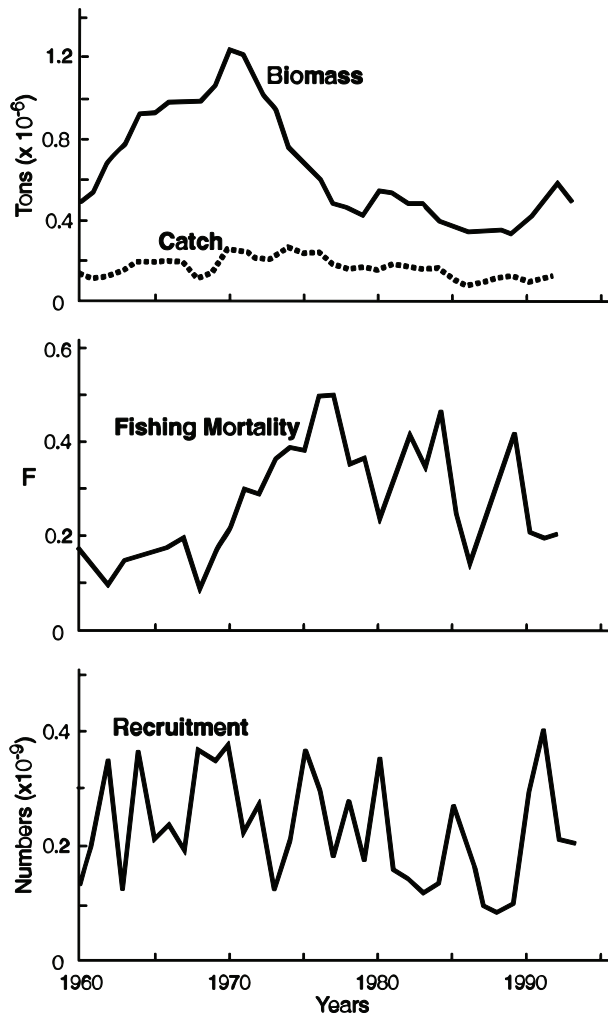


Fig. 42. Norwegian pollock: trends in stock parameters.

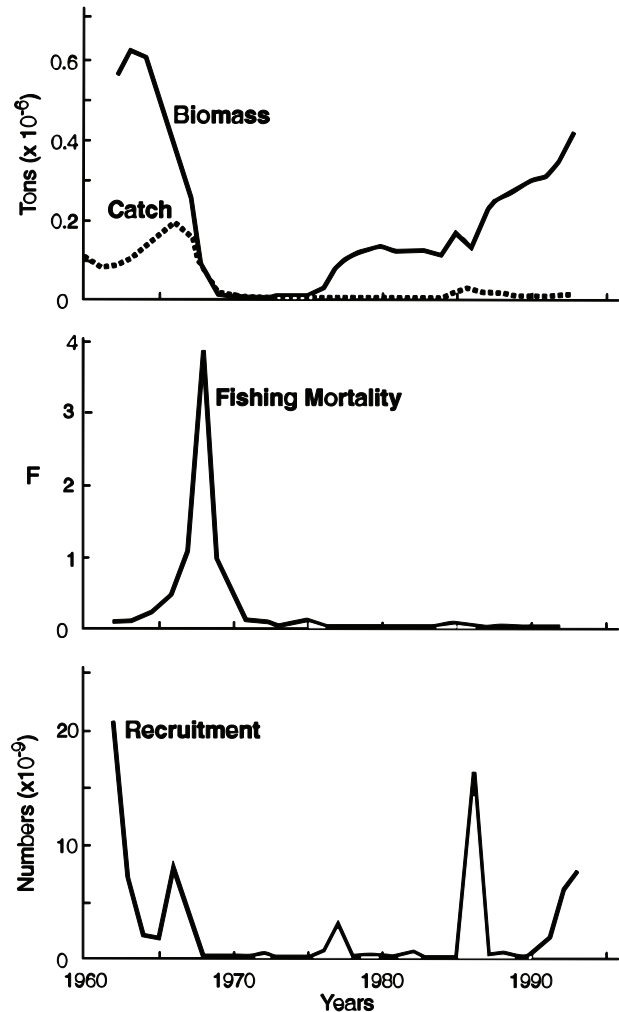


Fig. 43. Norwegian herring: trends in stock parameters.

1985 and each party established its own regulations. For 1986 an *ad hoc* TAC agreement was reached while a joint working group considered the zonal attachment of herring which would provide a formula for future sharing arrangements. This formula, which established Norwegian shares at 25–32% depending on the size of the spawning biomass, provided the basis of agreement for 1987 and subsequent years.

Control of fishing was facilitated by vessel licence limitations in major fisheries, combined with decommissioning schemes, and by allocation of catch quotas to individual boats. However, ITQs were not adopted as a mechanism to promote reduction of fleet catching capacity, and no direct regulation of the amount of fishing effort exerted in particular fisheries was employed. Small coastal vessels were generally exempted from licensing and

catch controls, not only for administrative practicality but as a feature of social policy. However, expanding catching capabilities of this sector required imposition of constraints. In the cod fishery off Northern Norway, for example, limits were imposed from 1982 on the days when fishing was allowed and on the maximum annual catch of any vessel. By 1990 it was found necessary to impose individual boat quotas on this coastal fleet except for the very smallest boats.

Area closures, other than those instituted to restrict the capture of small fish, did not feature prominently in Norwegian management. Prior to TAC regulation, spawning ground closures were used to control spawning escapement of Barents Sea capelin. Permanent trawler-free zones, and flexible closures of fishing grounds, were persistent regulatory features but these served primarily to reduce gear conflicts.

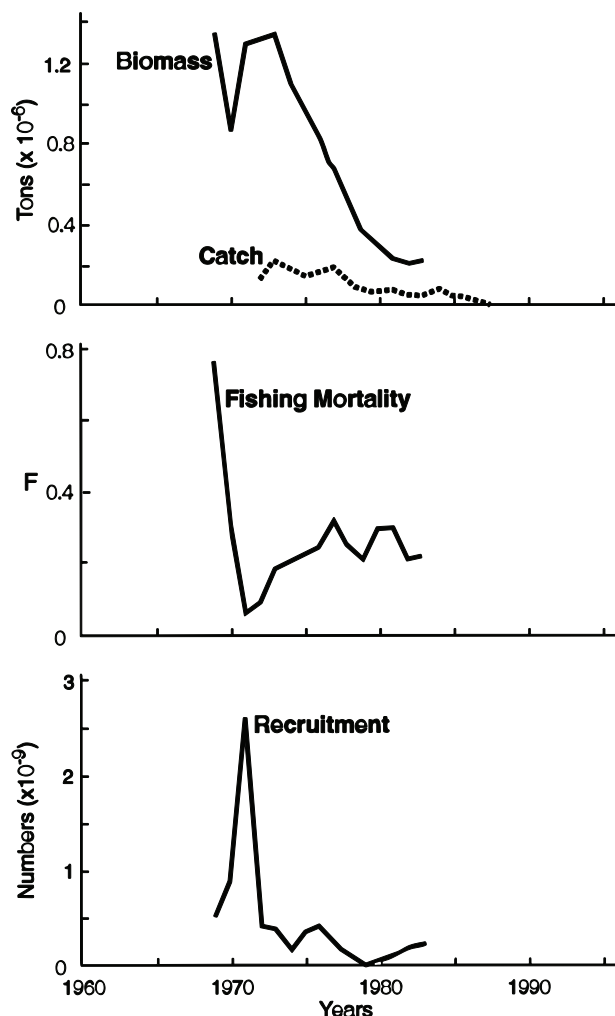


Fig. 44. Norwegian mackerel: trends in stock parameters.

Surveillance and Compliance. The complex distribution of stocks among jurisdictional zones places Norway in an unenviable position with regard to enforcement issues. Some stocks occur in part in international waters, and the legality of the Svalbard protection zone has not received international recognition, constraining Norwegian actions. Also, the extent of resource sharing with adjacent national jurisdictions makes the effectiveness of fishery control in these neighbouring zones as important to Norwegian interests as is enforcement effectiveness in Norwegian domestic waters.

While Norwegian control of the Svalbard zone was consistently challenged during the study period, 1979–88, diplomatic efforts appear to have prevented third party fishing becoming a serious impediment to control of exploitation levels. Nonetheless, the more recent challenges to Norwegian authority off Svalbard by Icelandic and other flag

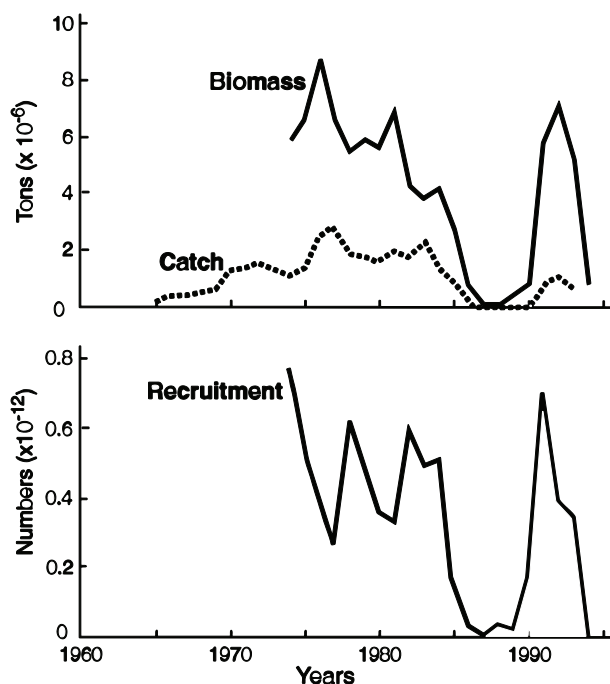


Fig. 45. Norwegian capelin: trends in stock parameters. (Stock biomass and recruitment, calculated for 1 October, assigned to 1 January of following year for plotting purposes.)

vessels, and their utilization of the high seas "loophole" in the Barents Sea, represent a significant threat to conservation programs.

There were persistent, but apparently unsubstantiated, claims by Norwegian fishermen of USSR overfishing of its quotas of joint stocks in its own zone. Be that as it may, the collapse of the USSR had a negative effect on regulatory control of what became Russian waters, according to Norwegian authorities (Thorvik, 1994). Norwegian estimates of overfishing of Northeast Arctic cod by Russian, Faroese and domestic vessels was more than 100 000 tons in 1992, 25–50% of the TAC set (Jakobsen, 1994). Problems of EU overfishing of joint North Sea stocks in the late-1970s to early-1980s were firmly based, however, and stemmed from difficulties internal to the EU in establishing control legislation (see above under EU). Furthermore, serious statistical deficiencies for many stocks in the North Sea are well documented in ICES reports.

In domestic fisheries, discarding/high-grading proved difficult to prevent and it became necessary to put observers aboard some vessels in particularly problematic fisheries, e.g. the mackerel purse seine fishery (Norwegian Authorities, 1993). Misreporting of area of capture also arose as

a problem, particularly for mackerel between North Sea and western stocks. Underreporting of landed quantities and misreporting of species have been noted as serious problems, at least in some areas in the 1990s (Eurofish Report, 1993). Also, direct landing of catches by Norwegian vessels in foreign ports caused some landings to go unreported (Eurofish Report, 1990).

Resource Trends. Trends in the stocks of the primary species in Norwegian waters are illustrated in Fig. 40–45. The most striking features of the groundfish trends are the continuing high levels of fishing mortality, and the declines in stock sizes, after extensions of jurisdiction. Average F_s in both study periods were above F_{max} , particularly for cod (Fig. 46).

The Norwegian spring spawning herring stock showed the first signs of recovery in the mid-1980s from its spectacular collapse about 1970 (Fig. 43). The 1983 year-class, and then those of 1989 and subsequent years, were strong, and the minimum target spawning biomass of 2.5 million tons was exceeded in the mid-1990s. The large increase in stock size resulted in readoption of the Barents Sea as a nursery area and the open ocean of the Norwegian Sea as a summer feeding area. Thus, its management has again acquired international dimensions. Fishing mortality in 1979–88 was reduced to well below $F_{0.1}$ (Fig. 46), although still substantially above the recommended level of ACFM of ICES (of zero).

In summer months there is substantial mixing between the western mackerel stock and the North Sea stock in the North Sea and Skagerrak, and also to some extent off the west of Scotland, so it is difficult to separate out catches from the North Sea stock *per se*. As a result, trends in the North Sea stock are not well estimated. Catches were high in the late-1960s when Norwegian purse seiners began directing their attention to this stock. In the North Sea, Skagerrak and Kattegat in 1967 over 900 000 tons were taken, the larger proportion of which was derived from the North Sea stock. As a result of poor recruitment throughout the 1970s and 1980s the stock biomass declined drastically in the 1970s and did not recover (Fig. 44). Estimated catches from the stock declined from 226 000 tons in 1973 to 10 000 tons or less after 1986. Fishing mortality was moderate in the 1970s but is thought to have risen to high levels in the late-1980s as the stock became very small. Clearly, a management strategy of rebuilding the North Sea mackerel stock has so far failed.

Barents Sea capelin sustained high catches throughout the 1970s and early-1980s, but rapid

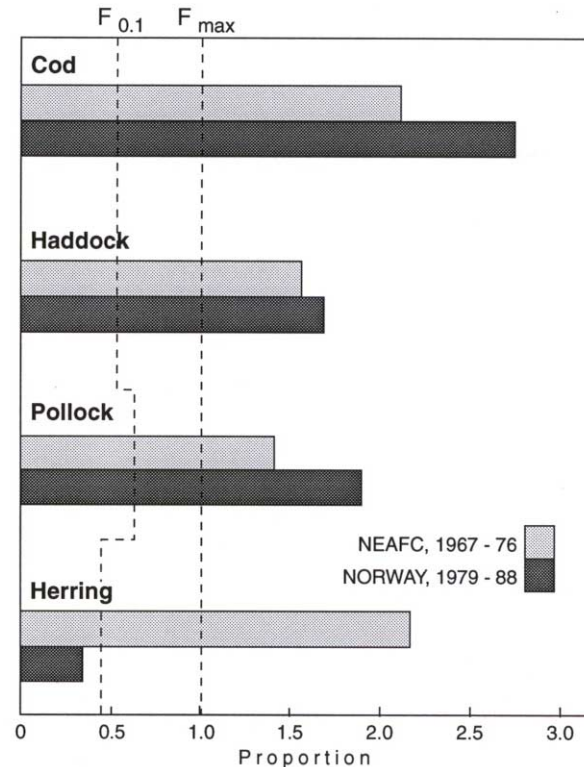


Fig. 46. Norwegian stocks: fishing mortality in the NEAFC and Norwegian management periods in relation to F_{max} and $F_{0.1}$. (Discontinuities in $F_{0.1}$ line reflect differences in ratios to F_{max} .)

collapse in the mid-1980s required fishery closure in 1986 (Fig. 45). The fishery was reopened in 1991. From the institution of TAC controls in 1979, the target spawning stock biomass was met in only about two years (prior to stock recovery in the early-1990s). Nonetheless, recruitment failure was not attributed to low spawning stock size but to the combined effects of predation of 0-group capelin by herring and of older capelin by cod (Hamre, 1991).

The United States of America

This account is restricted to the sea area off the northeastern USA, north of Cape Hatteras at 35°N. Indeed, the primary groundfish considered here, and the herring, are mainly fished north of 39°N in NAFO Subarea 5. The mackerel fishery extends to more southern waters. Capelin do not occur in the USA zone.

Fishing Limits. In 1966, the USA established a nine mile fishing zone contiguous with the long-established three mile territorial sea, bringing the total width of the fishery zone to 12 nautical miles

from established baselines. A 200 mile fishery conservation zone was proclaimed under the Fishery Conservation and Management Act of 1976 and became effective in March 1977.

The original three mile territorial sea off each coastal state is state territory and fishery jurisdiction in these waters lies with the state level of government. (Although the territorial sea was extended to 12 miles at the end of 1988 this did not affect the limit of state jurisdiction.) Neither the state nor federal level of government had legal jurisdiction over domestic vessels engaged in high seas fishing, i.e. outside of three miles, until extension of jurisdiction in 1977 when the zone between three and 200 miles came under federal control. Thus, there was little scope to take domestic regulatory initiatives prior to that date. Nonetheless, the federal government did have the authority to implement measures required under international agreements, such as ICNAF regulations (Hennemuth and Rockwell, 1987).

Off the northeastern USA, the 200 mile zone claimed in 1977 was in conflict with that claimed by Canada, creating a large disputed zone encompassing the northeast part of Georges Bank (Fig. 47). The area in dispute was of central importance to the regional fisheries for groundfish and sea scallops (Halliday *et al.*, 1986). Negotiations between the two parties on establishment of a framework agreement for management of regional fisheries was successful in producing a treaty for ratification, but the agreement was rejected by the U.S. President (VanderZwaag, 1983). The fishery agreement would have circumvented the obstacles to coordination of fishery management created by the conflicting boundary claims. Subsequent to the treaty's rejection the boundary issue could not be avoided and the two parties agreed to refer the dispute to a Chamber of the International Court of Justice in The Hague. The Chamber ruled in October 1984 on a boundary which lay intermediate to the two claims (Fig. 4 – note that the claims put before the Chamber by both parties were revised from those made in 1977). The decision of the Court concerned the boundary in the primary offshore fishing areas in the Gulf of Maine and on Georges Bank; boundaries in coastal waters and off the continental shelf remain unresolved. In the first year of extended jurisdictions, 1977, Canada and the USA fished under a provisional fishery conservation agreement which implemented the provisions agreed to within ICNAF but subsequent negotiations to extend this interim agreement, pending conclusion of a more permanent agreement, also failed. Both nations thereafter fished the disputed zone (Fig. 48) under their independent fishing plans. Although the 1984 boundary bisected the fishing areas for a number

of important stocks, no formal negotiations occurred on a conservation agreement. Haddock, and probably cod, stocks on Georges Bank are transboundary in distribution, as is the Georges Bank herring stock. Coastal herring stocks also appear to be shared to some extent. Mackerel conduct extensive migrations between Canadian and USA zones. Pollock has a complex stock structure. While there is some intermixing of pollock between the two zones, Canadian scientists, at least, tend towards the view that pollock could be satisfactorily managed on the basis of jurisdictional zones.

Management Institutions. The Fishery Conservation and Management Act of 1976 gave the federal government authority over marine fisheries between coastal state waters and 200 miles from March 1977, and established the institutional framework for fishery management within this zone. (The act was subsequently renamed the Magnuson Fishery Conservation and Management Act: MFCMA.) The primary federal authority under this act is exercised by the Secretary of Commerce through the National Marine Fisheries Service (NMFS), which is an agency of the National Oceanic and Atmospheric Administration within the Department of Commerce. The Department of State is responsible for the international aspects of fishery management, e.g. foreign fishing agreements, and the Coast Guard, which is part of the Department of Transportation, is charged with at-sea surveillance and enforcement. These same federal agencies were responsible for similar functions in implementation of international conservation actions agreed within ICNAF prior to 1977.

A completely new element to the institutional framework, the Regional Fishery Management Council, was introduced through the MFCMA. Two Councils are relevant in the present context, the most important being the New England Fishery Management Council (NEFMC). This Council encompasses the states of Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut. To the south, the Mid-Atlantic Council comprises the states from New York to Virginia inclusive. Most of the primary species examined here, cod, haddock, pollock and herring lie off the New England states and only mackerel, with its more southern distribution, falls under the authority of the Mid-Atlantic Council. The primary purpose of the regional Councils is to prepare fishery management plans for the fisheries within their geographical area of authority and to submit these to the Secretary of Commerce for approval.

The New England Council has 17 voting members, 11 of whom are appointed, for three year terms, by the Secretary of Commerce based on lists of qualified individuals submitted by the Governor

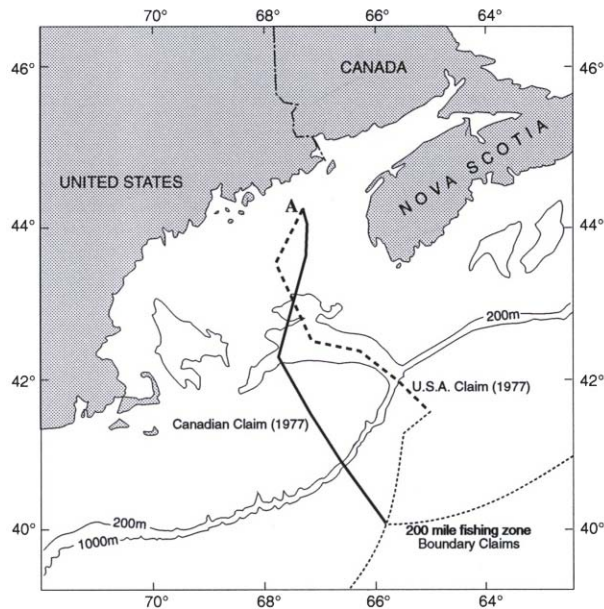


Fig. 47. Jurisdictional boundaries in the Gulf of Maine area claimed by the USA and Canada in 1977. (See Fig. 4A for revised claims of both parties put before a Chamber of the International Court of Justice and for the Chamber's boundary line decision.)

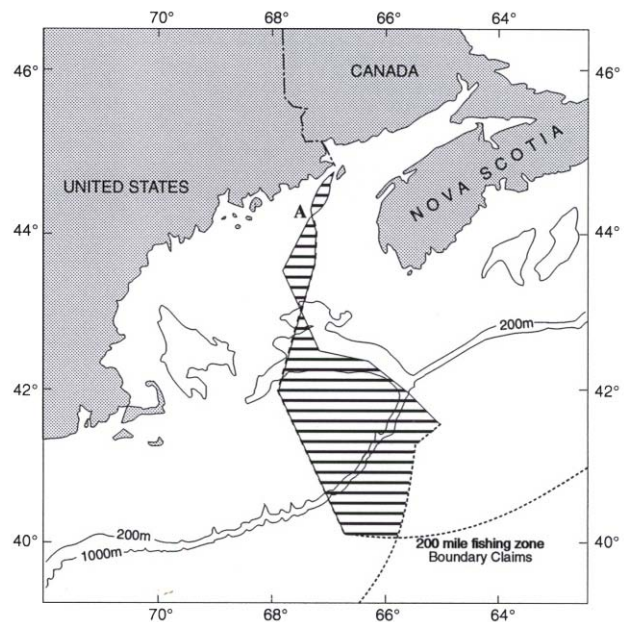


Fig. 48. Those parts of the Gulf of Maine area fished by both the USA and Canada under independent fishing plans, 1979–84 (shaded areas).

of each member state, and six are appointed by virtue of the positions they hold in state and federal governments. These latter include the regional director of NMFS and the principal official with marine fishery management responsibility and expertise in each state. There are also four non-voting members, the regional director of the Fish and Wildlife Service (Department of Interior), the district commander of the Coast Guard, a representative of the State Department, and the executive director of the Atlantic States Marine Fisheries Commission. (This last is an inter-state organization created in 1942 to study and advise members on cooperative actions, but is without regulatory authority.) The Mid-Atlantic Council is similarly constituted (as are all eight regional councils) but has 19 voting members, reflecting the different number of states involved. All decisions of regional councils are by majority vote of members present and voting.

Councils may appoint an executive director and such other administrative staff which the Secretary of Commerce agrees are necessary to perform its functions. Each Council is also required to establish and maintain a scientific and statistical committee to assist in the development, collection and evaluation of statistical, biological, economic, social and other scientific information relevant to the Council's work. The New England Council devel-

oped a strong technical capability within its own staff and its scientific and statistical committee has come to play a minor role advising on research needs and budget priorities.

Councils can determine their own organization and operating procedures. The New England Council uses a system of oversight committees which take responsibility for development and oversight of management plans for particular species or species groups. Each oversight committee is comprised of five Council members and a variable number of advisers. These advisers are appointed from an advisory panel established by the Council under a provision of the MFCMA. The oversight committees relevant here are those for demersal finfish and for herring.

It is the responsibility of the Secretary of Commerce to review plans received from Councils in relation to the requirements of the MFCMA and other laws, and to approve them or send them back for amendment. The Secretary also has the authority to establish preliminary management plans and emergency regulations under certain circumstances.

A prominent element of the institutional arrangements under the MFCMA is extensive public input to management planning. Public hearings must be held by Councils to allow all interested persons an opportunity to be heard. The Secretary must also

publish proposed plans and regulations, receive written comments on them, and if considered necessary hold a public hearing.

The MFCMA requires the Secretary of Commerce to initiate and maintain a comprehensive programme of fisheries research, so that the objectives of the act can be achieved. This was, in fact, a reaffirmation of the central role played by the National Marine Fisheries Service, and its predecessors, in marine fisheries research. Each NMFS region has a research arm. In New England the Northeast Fisheries Science Center, composed of several laboratories, conducts basic and applied research to develop a better understanding of marine resources in the Northwest Atlantic sector of the USA zone, and to provide advice on options for resource utilization and conservation. Prior to extension of jurisdiction, research results were directed to the scientific committee of ICNAF, and advice on management was formulated within that committee. Under the MFCMA, no formal mechanism was provided for peer review of scientific analysis and formulation of management advice. The New England Council's scientific and statistical committee did not prove to be a suitable vehicle and, as the USA had resigned from ICNAF at the end of 1976 and did not join the successor organization, NAFO, until 1995, the scientific committees of these bodies could not be used for this purpose. *Ad hoc* arrangements for peer review in initial years developed, from 1985, into a series of Center sponsored Stock Assessment Workshops. Subsequently, these workshops were managed under a partnership between the Center, the Northeast Regional Office of NMFS, the New England and Mid-Atlantic Fishery Management Councils, and the ASMFC, through a Stock Assessment Review Committee. Participants include representatives from various federal and state agencies and the Management Councils as well as staff of the Northeast Fisheries Science Center. Academic and private institutions may also be represented and attendance by Canadian scientific experts is sponsored on occasion. The Committee produces advisory reports on stock status for the advice of fishery managers.

The Secretary of Commerce is responsible for implementation of approved plans, but enforcement responsibility is shared with the Coast Guard, which is the primary USA maritime law enforcement agency. Generally, special agents of the NMFS conduct dockside enforcement while the Coast Guard performs at-sea surveillance.

Management Objectives and Strategies. The MFCMA embodies a set of "national standards" for fishery conservation and management which must be met, in the eyes of the Secretary of Commerce,

for a Council management plan to receive approval. Conservation and management measures:

- shall prevent overfishing while achieving on a continuing basis, the optimum yield from each fishery,
- shall be based on the best scientific information available,
- shall manage individual stocks as units throughout their range, and interrelated stocks as a unit or in close coordination, as far as this is practicable,
- shall not discriminate between residents of different states,
- shall promote efficiency in the utilization of fishery resources,
- shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches, and
- shall, where practicable, minimize costs and avoid unnecessary duplication.

Optimum yield is defined as the amount of fish a) which will provide the greatest overall benefit to the nation, with particular reference to food production and recreational opportunities, and b) which is prescribed as such on the basis of maximum sustainable yield, as modified by any relevant economic, social, or ecological factor.

The Act requires that each Council produce a fishery management plan with respect to each fishery within its geographical area of authority. The plan must contain a comprehensive description of the fishery concerned, a diagnosis of its condition, a prognosis of its future status, definition of MSY and OY, an assessment of the capability of the USA fleet to harvest OY and hence of the surplus available for harvest by foreign nations, and the regulatory measures necessary to control fishing in order to achieve OY. The information required from the fishery with regard to catches, fishing effort and area of capture, is also specified.

The Secretary of Commerce, in reviewing management plans, must ascertain that they conform to the national standards, these other provisions of the MFCMA, and also "any other applicable law". There are a substantial number of other laws which are relevant to the planning process, primarily those concerned with environmental and budgetary implications of management plans. Thus environmental assessments and cost/benefit analyses must accompany management plans.

The MFCMA embodies a policy of providing access to foreign vessels to catch fish surplus to USA harvest levels, in conformity with the 1982 Law of the Sea Convention. However, it is an expressed

purpose of the act to encourage the development of domestic fisheries for stocks which are underutilized, or not utilized, by USA fishermen.

The MFCMA, in its national standards and other provisions, thus provides a primary objective of preventing overfishing and thus allowing the optimum yield to be extracted from each fishery on a continuing basis. The underlying strategy is to aim for the maximum sustainable yield unless there are reasons to expect that a modified strategy would provide greater overall benefits to the nation.

When the MFCMA came into effect, all the directed fisheries off the northeast coast of the USA were under regulations agreed to through ICNAF in 1976 as transitional arrangements. Catch controls were in place which were intended to minimize exploitation of depressed stocks and for others to control exploitation at a moderate level at, or close to, the newly adopted ICNAF target of $F_{0.1}$. Actions by USA authorities in the initial years of extended jurisdiction can be characterized as being in general conformity with the ICNAF approach. For mackerel, enhancement of recreational fishing was an important objective and a low exploitation strategy was maintained, i.e. fishing at $F_{0.1}$, although this was modified by adoption of a minimum spawning stock target as an overriding element of conservation strategy. In the case of herring, however, all controls on exploitation were abandoned as unworkable in 1982. Control of exploitation level of groundfish was dropped, also in that year, in favour of strengthened controls on exploitation pattern. This new strategy of minimum regulation subsequently remained central to groundfish management; optimum yield was defined as that which resulted from this approach. Controls on exploitation pattern were considered adequate for conservation purposes, i.e. to prevent overfishing. Definitions of overfishing were adopted in 1986 legislation in terms of minimum acceptable levels of spawning potential for particular stocks. If it was demonstrated that such a biological reference point was not being met, additional measures to restrict fishing mortality were to be considered. Limitation of entry to the fishery, control of fishing effort, restriction of fleet capacity, and introduction of quasi-property rights such as ITQs, were all rigorously opposed by USA fishing interests. Resort to court of law by private conservation groups was required in the early-1990s to force the NEFMC to give serious consideration to some limitations on fishing effort and fleet size in the groundfish fishery to restore cod, haddock and yellowtail stocks from an overfished condition. As a result, fishing effort controls and a moratorium on entry were imposed from 1994. The evolution of these strategies is described in more detail under the following chronology of regulatory actions.

Regulatory Actions. The tools provided by the MFCMA for regulatory control of fisheries are as follows:

1. permits may be required, and fees paid, to fish in the fishery conservation zone,
2. zones and periods can be designated where fishing is prohibited, restricted, or permitted only by particular types of vessels or with specific types and quantities of gear,
3. TACs and catch quotas can be established,
4. types and quantities of fishing gear, of fishing vessels and of equipment carried on vessels, including devices to facilitate enforcement such as position locators, can be controlled,
5. relevant fishery conservation and management measures of adjacent states can be incorporated in plans,
6. a limited access system can be established, and
7. such other measures and restrictions considered necessary can be prescribed.

This list includes all the traditionally used management measures and appears to leave the door open for adoption of any innovative approaches.

Groundfish: For some years prior to extension of jurisdiction to 200 miles, USA fishermen were subject to the regulatory controls imposed through ICNAF on the groundfish fisheries in Subareas 5 and 6. These comprised TACs and national catch allocations for all stocks subject to directed fisheries, including second tier quotas, minimum trawl mesh size regulation and other restrictions on net construction, and haddock spawning area closures during the spawning season.

The USA, as well as Canada, used ICNAF in 1976 to establish a framework of regulation for 1977. For the primary groundfish species, cod, haddock and pollock, and also for redfish and flatfish, TACs were reserved exclusively for the two coastal states, and national allocations between Canada and USA were agreed upon before 200 mile limits were implemented. Third party allocations were limited to red hake and silver hake stocks, and fishing for these was restricted to defined spatial and temporal windows within the USA zone. Although the boundary between Canadian and USA zones in Subarea 5 was in dispute, maintenance of the ICNAF agreements and regulations was confirmed through an interim reciprocal fishing agreement.

The first USA plan for groundfish species, the Fishery Management Plan for Atlantic Groundfish,

formulated by the New England Council, became effective in March 1977. This plan established catch quotas consistent with ICNAF and bilateral agreements, although for the three species cod, haddock and yellowtail flounder only. It also maintained the ICNAF minimum codend mesh size regulation of 130 mm for codend meshes, and 114 mm for the body of the net, for these species, but differentials were eliminated (Appendix Table 18). The seasonal haddock spawning area closures of ICNAF were also retained. An innovation was the introduction of a minimum fish size for cod and haddock of 40.6 cm (Appendix Table 19). A limit on by-catches of undersized fish of each species was set at 10% by weight of the catch on board. A 1978 amendment established a minimum mesh size for bottom gillnets of 140 mm.

The management plan quickly ran into difficulties as a result of a marked improvement in the status of cod and haddock stocks in 1977 and investment in new fleet capacity. In combination, these factors resulted in rapid catching up of quotas and required increasing subdivision of quotas among fleet categories, defined by boat size and gear type, and seasons, and upward adjustments to TACs. Measures were also adopted to slow down catch rates by limiting quantities which could be landed on a per-trip or weekly basis. Although permits to fish were required, these were not used to limit access to the resource or restrict fishing effort. The increasing complexity of the plan and difficulties in its enforcement brought this plan into widespread disrepute, and it was replaced by a second plan in March 1982 which dispensed with catch quota controls.

Deficiencies of the first plan were attributed in substantial part to its failure to identify objectives. Initially the implied objective of the plan was restoration of depleted stocks but, with rapid stock increases, the policy vacuum provided a poor footing for strategic planning. First TACs for cod and haddock (and also yellowtail flounder) were implemented at the levels agreed in ICNAF. For haddock, the TAC was set to allow the greatest opportunity for stock recovery that was possible, given the unavailability of by-catches in a mixed fishery. The TAC for Gulf of Maine cod was set at the F_{\max} level, whereas that for Georges Bank cod was set between $F_{0.1}$ and F_{\max} . Although they were above the new ICNAF target of $F_{0.1}$, these cod TACs still represented substantial reductions from previous catch levels. Subsequent decisions on TAC levels were complicated by uncertainties about stock status as a result of discarding and misreporting. In the case of cod stocks, OY came to be defined as the long-term potential catch (MSY) level, whereas for haddock the plan was approximately consistent with

fishing at $F_{0.1}$. The failure of Canada and the USA to agree on a cooperative basis for management of Georges Bank transboundary stocks was also a significant complicating factor.

The Interim Fishery Management Plan for Atlantic Groundfish implemented in March 1982 was intended as a stop-gap measure until a more comprehensive plan could be developed. As with the first plan, the Interim Plan only concerned cod, haddock and yellowtail flounder. The objectives of this plan were to acquire reliable data on normal fishing patterns of the industry, and on the biological attributes of stocks, by deregulation of fishing while providing minimal safeguards for stock conservation. Objectives included enhancement of spawning activities and reduction of the risk of recruitment overfishing in comparison to the situation expected to prevail under total deregulation. No controls were placed on catch or fishing effort and, while permits to fish were still required, there was no limitation to participation. Optimum yield was defined as the amount of fish actually harvested by USA fishermen in accordance with measures in the plan. Conservation objectives were addressed through mesh size, fish size and spawning area closure regulations. Emphasis was placed on improved data collection from the industry. A large mesh area was defined, which included the western Gulf of Maine and Georges Bank west to Cape Cod (at 70°W), where only large mesh nets could be used. Nonetheless, exemptions could be obtained to conduct small mesh fisheries in this area under restrictive conditions. Large mesh was defined as 130 mm, as in the previous plan, for 1982. After 1982, the mesh size increased to 140 mm. As before, these were codend mesh sizes; mesh in the body of the net could still be as small as 114 mm. Minimum mesh size for gillnets was retained at 140 mm. Minimum fish sizes were also increased for cod and haddock caught commercially to 43.2 cm (and instituted for yellowtail flounder). Minimum size restrictions were also imposed on recreational catches of cod and haddock. It became illegal to retain on board any undersized fish, i.e. the 10% by weight by-catch allowance was eliminated. The previous seasonal closures of haddock spawning areas were retained with minor modifications.

In September 1986 the Interim Plan was replaced by the Fishery Management Plan for the Northeast Multispecies Fishery. The objectives of this plan (termed "basic goals") were:

- "1) to allow the multi-species fishery to operate with minimum regulatory intervention, and
- 2) to adopt initial measures to prevent stocks from reaching minimum abundance levels, defined as those levels below which there

is an unacceptably high risk of recruitment failure".

The management strategies (called objectives in the plan) were:

" – to control fishing mortality on juveniles (primarily) and on adults (secondarily) of selected finfish stocks within the management unit for the purpose of maintaining sufficient spawning potential so that year-classes replace themselves in the stock on a long-term average basis; and to similarly reduce fishing mortality for the purpose of rebuilding those stocks where it has been demonstrated that the spawning potential of the stock is insufficient to maintain a viable fishery resource; and further to promote the collection of data and information on the nature, behaviour and activity of the multi-species fishery, and on the effectiveness of the management program."

The plan categorized stocks into those requiring specific regulatory efforts to achieve stock rebuilding (Georges Bank haddock and Gulf of Maine redfish), those requiring actions to achieve or maintain an acceptable level of spawning potential (cod, haddock and various flounders in the Gulf of Maine, cod, yellowtail and other flounders on Georges Bank, yellowtail and other flounders in Southern New England), and those which required no specific regulatory action at that time. This categorization required that an "acceptable level" of spawning potential be defined for each stock (Sissenwine and Shephard, 1987). The Council adopted the level of 20% of maximum spawning potential (MSP) as an acceptable level in general, but for the specific cases of Georges Bank haddock 30% MSP was chosen and for Gulf of Maine redfish the "largest feasible value". MSP was taken as the potential egg production of a virgin (unfished) stock. Optimum yield from the multispecies fishery was defined as "that level of yield which results on an annual basis from implementation of the management program over time", and was thus more or less identical to OY in the Interim Plan.

The Multispecies Plan contained regulatory measures directed toward conservation of 10 species, cod, haddock, pollock, white hake, redfish, and five flatfish species, and placed restrictions on a variety of small mesh trawl fisheries for other species to control by-catch mortality of the 10 "multispecies finfish". Silver hake, red hake and ocean pout were subsequently added as principal species under the plan. Regulation of fishing again depended exclusively on minimum fish size and mesh size limits and on closed areas.

The provisions of the Multispecies Plan were modified in a series of four amendments prior to 1994, when significant new elements were introduced. The most important provisions concerning cod, haddock and pollock over the period 1986–93 were as follows. Two large mesh areas were created which encompassed all of the Gulf of Maine and most of Georges Bank (Fig. 49) and, as a result, the minimum mesh size of 140 mm, established under the previous Interim Plan, applied to a substantially larger area. The Georges Bank large mesh area was subsequently extended west, south of Cape Cod, to protect juvenile cod during December to March. An important exemption to the mesh regulations was provided in coastal waters of the Gulf of Maine which allowed small mesh fisheries for certain species in particular seasons, although under increasingly stringent conditions. The minimum fish size regulation (of 43.2 cm) for cod and haddock was extended to pollock in 1986, and the minimum size for all three species was increased to 48.3 cm in 1987. Seasonal closures of haddock spawning areas were retained. The season was extended to include February and reopening was kept at the end of May, but with provision to open earlier if haddock spawning was complete. A temporary area closure system to protect concentrations of small or spawning fish introduced a new element to the plan from 1990. This provided that, on the recommendation of the Multispecies Committee of NEFMC, the Regional Director of NMFS could close small areas for three weeks to six months to some or all gears, or could specify the mesh sizes to be used, or catches to be taken, within the specified area. While these closures could be instituted much faster than was possible through plan amendment, consultation and public notification requirements prevented the real-time response embodied in the Icelandic-type temporary closure system. A particularly significant innovation in the Multispecies Plan was creation of a Technical Monitoring Group, attached to the NEFMC, to monitor the fishery, report on the status of resources, and on the operation of the multispecies fishery in relation to the achievement of plan objectives. This group, composed of six scientists and fishery analysts from the New England and Mid-Atlantic councils and the NMFS, could recommend changes to the plan.

The amendments to the Council's Multispecies Plan were responses to initial criticisms by the Secretary of Commerce that the plan did not adequately address conservation requirements, and to subsequent evaluations of the plan. The Council's own Technical Monitoring Group reported in 1988 that the overall management system had not been very effective. The underlying premises of the plan concerning the willingness of fishermen to comply with

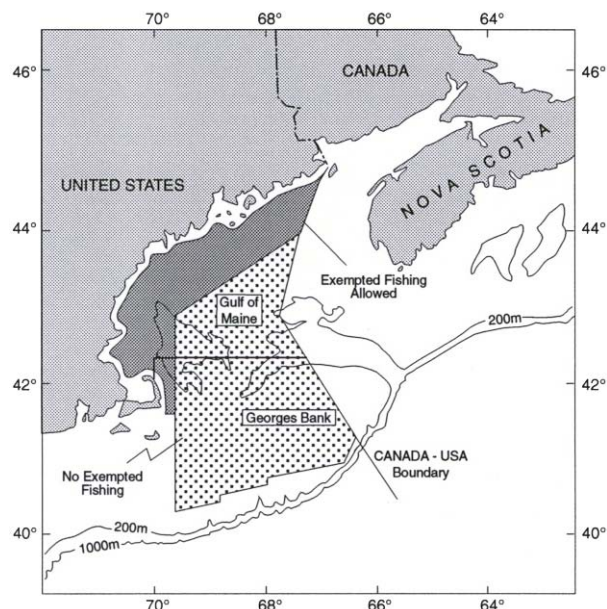


Fig. 49. Regulated large mesh areas off New England, USA, and that part of the Gulf of Maine large mesh area in which small mesh fisheries for certain species were allowed. (Large mesh areas illustrated are those defined by the NEFMC Fishery Management Plan for the Northeast Multi-species Fishery (Amendment No. 1, 1987). Coastal boundary of Gulf of Maine large mesh area is seaward boundary of state territorial waters.)

its regulations, and the ability of government agencies to enforce these, had proven invalid. However, even if there had been full compliance, the regulatory measures in the plan were not adequate to result in spawning stock biomasses of cod, haddock and yellowtail above the minimum target levels. Measures to control fishing mortality were recommended, including catch or effort restrictions. Another working group, the Massachusetts Offshore Groundfish Task Force, concluded in late-1990 that the plan had failed "because short-term economic considerations were allowed to prevail" (Anon., 1990). This group recommended a management goal of recovery of groundfish stocks to pre-1960 levels in five to 10 years, that direct regulation of fishing mortality through catch quotas be reestablished, and that consideration be given to limited entry, fleet size reduction, and ITQs. In 1991, the NMFS and Secretary of Commerce were sued by the Conservation Law Foundation and Massachusetts Audubon Society for failing to prevent overfishing of cod, haddock and yellowtail. A court settlement required the Council to amend the plan in such a way as to eliminate the overfished condition of cod and yellowtail stocks in five years and haddock stocks in 10 years.

A radical change in management strategy was required for the Council to meet the requirements placed upon it by the court. This came in the form of a moratorium on entry to the fishery, and of a fishing effort reduction, in amendment No. 5 to the multispecies plan introduced in 1994. The moratorium was based on a vessel permit system under which vessels could be upgraded or replaced within rules which allowed an increase of no more than 20% in horsepower and 10% in length, GRT and net tonnage (over initially registered characteristics), but otherwise permits were not transferable and were retired permanently if not renewed. The fishing effort reduction program, which applied only to vessels greater than 45 feet (13.7 m), came in two options. The first provided a days-at-sea allocation and required reductions from it of 10% per year for a total of 50% over five years. The second required a progressively greater number of days, in blocks of 20 days or more, out of the multispecies fishery (either tied up or occupied in another fishery) from 80 days in the first year to 233 days in year six. Hook and line vessels which fished no more than 4 500 hooks per day, and gillnet vessels, were exempted from effort reductions (although the latter faced reductions in order to reduce marine mammal by-catches). It became mandatory to maintain and submit fishing log records, to accept at-sea observers and, for vessels fishing under the days-at-sea restriction, to install an electronic vessel tracking system. The previous elements of the plan were retained and in some cases, particularly mesh size regulations, strengthened. Minimum mesh size in the Gulf of Maine/Georges Bank area, where cod, haddock and pollock are primarily caught, was raised to 152 mm, and a Southern New England area was introduced in which 140 mm mesh was required.

Consultations between Canadian and USA management authorities resulted in agreement to strengthen protection of the Georges Bank haddock stock, which had reached a very low level by the end of 1993. In the USA case, this amounted to extension of the Georges Bank haddock spawning area closure spatially and temporally, imposition of strict possession limits for haddock of 500 lb (227 kg) for vessels fishing elsewhere until at least the end of June, a ban on pair trawling and of transfer of fish between vessels. Most of these measures were subsequently incorporated into Amendment No. 5 to the Multispecies Plan. The particular significance of this event is in the cooperation exhibited between Canadian and USA authorities in implementing consistent conservation measures for a transboundary stock. Previous cooperation had been restricted to boundary enforcement issues (Kraniotis, 1994).

Herring: Under ICNAF, TACs were established for Gulf of Maine and Georges Bank herring stocks, and a minimum size limit of 22.7 cm total length was imposed, from 1972. The minimum size limit did not apply within territorial waters where the historical juvenile fishery occurred, but was intended to restrict offshore fishing to adult concentrations. For 1977, ICNAF introduced the window concept which defined a spatial and temporal box within which non-coastal state fishing for herring could occur. This proved of little import however, as decline of Gulf of Maine stocks and the collapse of the Georges Bank stock left no surplus for foreign fishing after extension of jurisdiction in March 1977.

The New England Council implemented a Fishery Management Plan for Atlantic Herring in December 1978. Catch quotas were established, on the basis of a July–June fishing year, for USA domestic fisheries on Gulf of Maine, and Georges Bank and south herring, of ages 3 and older. Catches in territorial waters of the State of Maine were excluded, however, although age 3+ fish were taken in conjunction with juvenile catches. Juvenile fisheries were not regulated. A plan amendment in March 1980 increased quotas, modified management boundaries and eliminated the exemption for catches of age 3+ herring within Maine territorial waters. However, a succession of strong year-classes, entering these coastal fisheries in the late-1970s and early-1980s, provided for a substantial increase in catches, and large quota overruns occurred. Domestic USA herring fisheries occurred in substantial part in state territorial waters. Difficulties in coordinating regulatory controls among states and with federal authorities caused the NMFS to propose abandonment of the Council management plan. The plan was officially withdrawn in January 1983. The ICNAF minimum size limit was not carried forward into USA regulation.

Herring management was left to state agencies after failure of the federal plan. The states of Maine, New Hampshire, Massachusetts, and Rhode Island did agree, in 1983, to an interstate management plan which instituted fishery closures in state waters during spawning periods. In 1994, these regulations were subsumed within a broader management plan for state waters, agreed to through the Atlantic States Marine Fisheries Commission, which defined overfishing in the context of spawning potential. As for groundfish, an acceptable level was taken to be 20% of MSP. A preliminary management plan for herring in the adjacent federal waters, complementary to that of the Atlantic States Marine Fisheries Commission, was instituted by federal authorities in 1995. The stimulus for these 1994–95 plans was the need to determine OY and thus the

level of catches, surplus to domestic requirements, that could be allocated under joint venture processing agreements with foreign interests. The plans impose no restrictions on fishing activity, other than spawning closures.

Mackerel: Although there are two components to the Northwest Atlantic mackerel stock, a northern and southern, which in summer months occur primarily in Canadian and USA waters respectively, most mackerel of both components over-winter off New England. The international fishery of the early-1970s developed most strongly on these over-wintering concentrations. Catch controls for the mackerel fishery were initiated by ICNAF for 1973, and by 1977 a single TAC was being set for all mackerel in the Northwest Atlantic, although this was partitioned to control the distribution of catch between northern and southern areas (off Canada and the USA respectively). A size limit of 25 cm total length was implemented in 1976, and windows were defined for non-coastal state mackerel fishing in Subareas 5 + 6 in 1977.

The quota agreement in ICNAF for 1977 established substantial foreign allocations of mackerel in the new USA zone. The Secretary of Commerce initiated a Preliminary Fishery Management Plan for 1977 to establish an OY and foreign fishery allocations consistent with the commitments made in ICNAF. However, the mackerel stock had been declining substantially under ICNAF management and, for 1978 and 1979, OYs were established which allowed only for normal USA catch levels and bycatches in foreign fisheries. Mackerel was the responsibility of the Mid-Atlantic Fishery Management Council and this Council developed a Fishery Management Plan for the Atlantic Mackerel Fishery of the Northwest Atlantic Ocean which was implemented in February 1980. This plan, which established a rather higher TAC which allowed reinstatement of a low level of foreign fishing, was replaced in September 1983 by a combined Fishery Management Plan for the Atlantic Mackerel, Squid, and Butterfish Fisheries. Under the 1983 plan, OY and catch allocations became contingent on the level of spawning stock biomass. The OY was defined as the catch at $F_{0.1}$, unless this resulted in spawning stock biomass falling below the level, based on a stock-recruitment relationship, which was associated with production of good year-classes (defined for most of the period as 600 000 tons). In addition to protecting resource productivity, this strategy recognised the need to keep the total stock size at a fairly high level to protect the viability of recreational mackerel fishing which accounted for a significant proportion of the USA catch. The ICNAF minimum fish size regulation was not carried forward into USA regulation.

Surveillance and Compliance. The MFCMA requires the NMFS and the Coast Guard to enforce the provisions of the Act, in cooperation with other federal and state agencies if necessary. The Coast Guard provides at-sea surveillance from ships and aircraft, whereas the NMFS concentrates on shore-based enforcement. State enforcement agencies also play a role in enforcement of state regulations. Council management plans have applied to all USA waters. Full application of the plans thus required the cooperation of state governments to implement, and enforce, complementary legislation applicable to the territorial waters in which they exercise jurisdiction.

Foreign fishing was not permitted for cod, haddock, pollock or herring, but was for mackerel and for hakes and squids. The restrictive window system promoted enforcement effectiveness and USA observers were deployed on foreign vessels. Coverage was about 20–25% in the late-1970s and early-1980s, but a 1980 amendment to the MFCMA required this be increased to 100%.

Enforcement of regulations on the domestic fleet proved to be an intractable problem. In the initial years failure to integrate state and federal regulations left wide loopholes for circumvention of Council regulatory measures. This compounded the already difficult task of establishing and enforcing catch quota controls at a time when low catch limits were required to encourage stock recovery. Problems were exacerbated by a substantial expansion in fleet capacity. There was little acceptance among industry that catch controls provided a satisfactory solution to management requirements or, indeed, that direct control of fishing mortality was necessary, and as a result the New England Council abandoned them for both groundfish and herring in 1982. Catch controls were retained for mackerel in the Mid-Atlantic Council Plan but this resource was lightly exploited and allocations to domestic fishermen were not restrictive.

Groundfish management after 1982 was based on a policy of minimum interference in the fishery while providing some safeguards for resource productivity. The Council anticipated that, as this was the plan fishermen appeared to want, there would be a willingness to comply with the new regulations, and also that enforcement agencies had the ability to enforce them. However, evaluations of management plan effectiveness concluded that Council's expectations were not being met. These conclusions were supported by a study which found that groundfish regulations for the Georges Bank area were frequently violated by a quarter to a half of all fishermen, with illegal mesh being used on almost all trips, and closed areas being violated on about one third of trips by these fishermen (Sutinen and

Hennessey, 1986; Sutinen *et al.*, 1990). Violation rates were lower in other areas. The 1988 report of the Council's Technical Monitoring Group also identified abuse of the small mesh exempted fisheries program as a significant problem for groundfish conservation, juveniles of regulated species being landed or discarded in significant amounts. The Technical Monitoring Group pointed out that there were few incentives for fishermen to comply with regulations. There were inadequate resources for enforcement, and the plan contained regulations which were difficult to enforce and provided ready loopholes for evasion, so the risk of detection was low. There were long delays in prosecution and fines, if assessed, were low, whereas the economic benefits from regulatory violation was significant.

Resource Trends. Georges Bank cod and haddock stocks, Gulf of Maine and Georges Bank

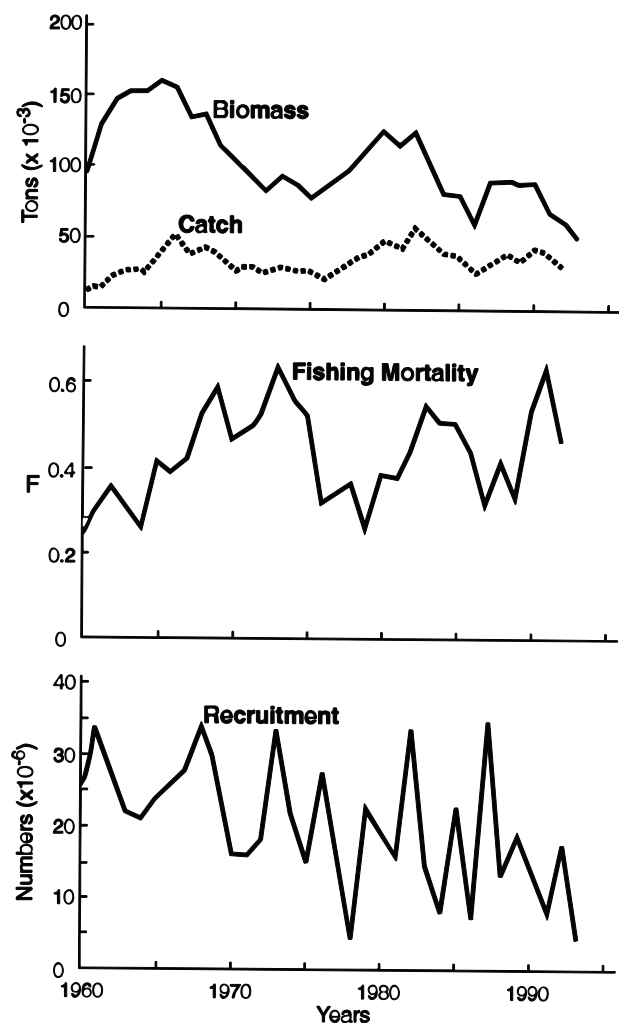


Fig. 50. USA cod: trends in stock parameters.

herring, and Northwest Atlantic mackerel, are all transboundary in distribution, and stock trends (Fig. 50–53) reflect the results of Canadian, as well as USA, management actions. Crucial to the course of events, however, were USA rejections of the 1979 draft fisheries agreement between the two countries and of Canadian overtures to discuss cooperation on management of transboundary stocks after the 1984 boundary settlement. The USA preference for unilateral management, and for minimum regulatory interference, justify assigning to the USA the predominant influence on resource trends.

Georges Bank cod was exploited just as heavily after extension of jurisdiction as before, over twice the F_{\max} level (Fig. 54). Haddock exploitation was apparently at a more moderate level, between F_{\max} and $F_{0.1}$, in both periods (Fig. 54), but stock rebuilding required much lower fishing mortality levels as

recruitment was extremely low throughout most of the period from 1965 (Fig. 51).

There were virtually no herring remaining on Georges Bank by the time of extension of jurisdiction and the area presented no opportunities for fishing herring until stock recovery began in the late-1980s. Coastal herring stocks experienced exploitation rates as high and higher in 1977–82 as they had prior to 1977. Perversely, fishing mortality declined to low levels in these coastal stocks immediately after all management restrictions were removed, reflecting a reduction in demand for herring. The combined trends for herring stocks are shown in Fig. 52. Fishing mortality over the whole 1979–88 study period decreased from that in 1967–76 but, nonetheless, the average equalled the F_{\max} level (Fig. 54). The mackerel fishery in the ICNAF period was prosecuted predominantly by distant-

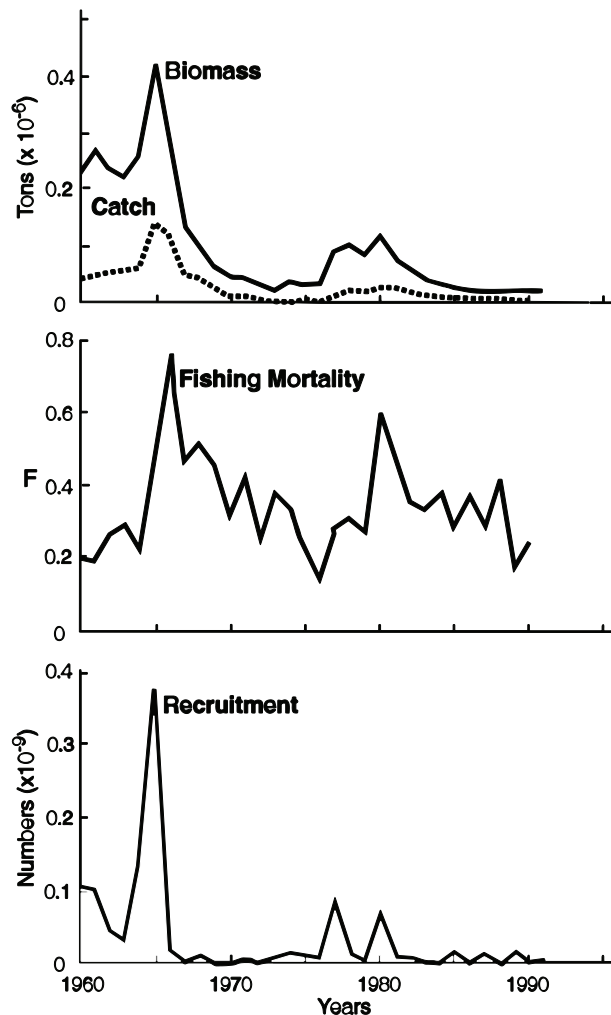


Fig. 51. USA haddock: trends in stock parameters.

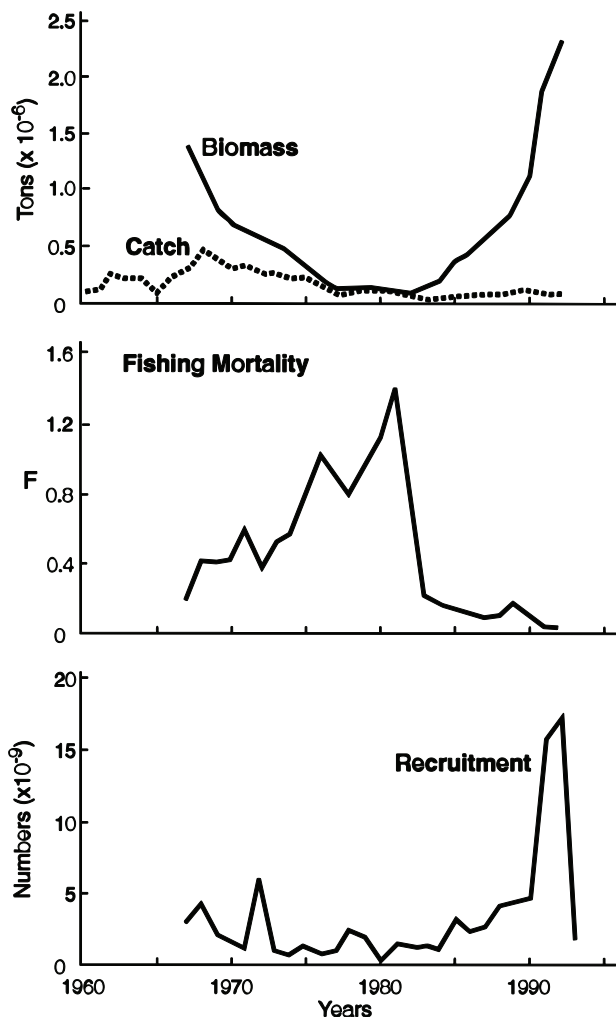


Fig. 52. USA herring: trends in stock parameters.

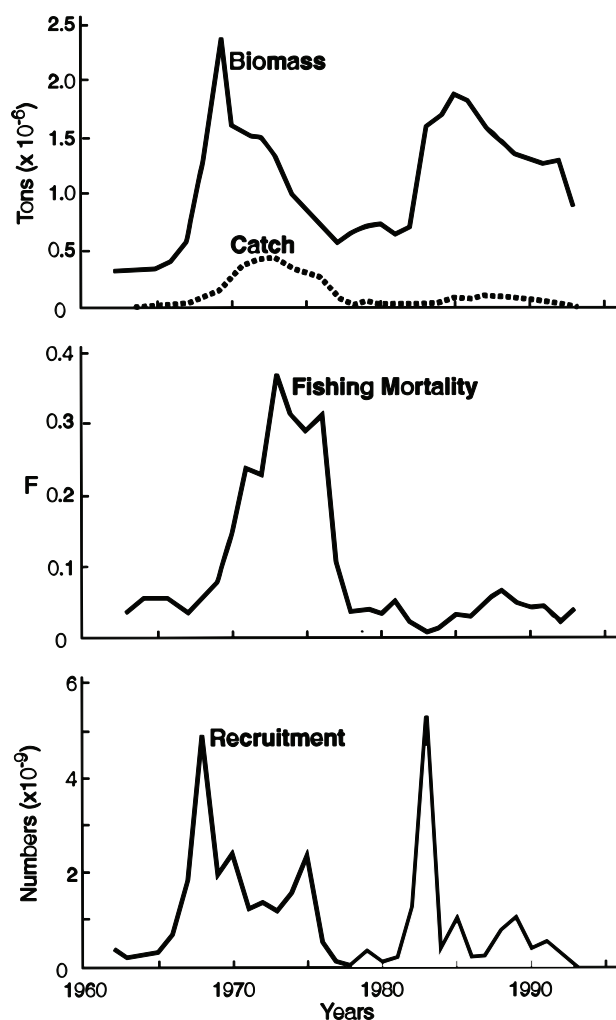


Fig. 53. USA mackerel: trends in stock parameters.

water fleets and severe restrictions on foreign fishing protected the stocks during the low recruitment period immediately after 1977, and allowed stock rebuilding thereafter under an $F_{0.1}$ management strategy (Fig. 53). Fishing mortality appears to have been below $F_{0.1}$ prior to 1977 and very low thereafter (Fig. 54).

The low demand for mackerel in the domestic commercial sector made it straightforward to implement conservative management plans and to meet the objective of enhancing the important recre-

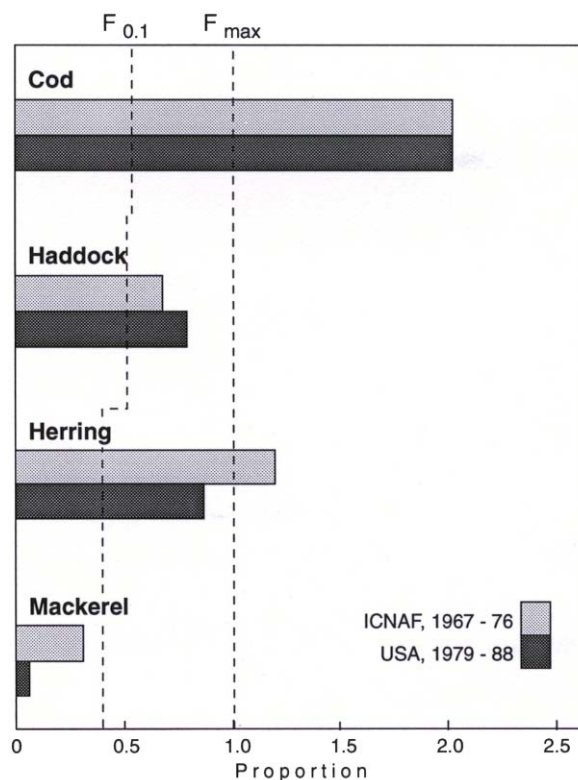


Fig. 54. USA stocks: fishing mortality in the ICNAF and USA management periods in relation to F_{max} and $F_{0.1}$. (Discontinuities in $F_{0.1}$ line reflect differences in ratios to F_{max} .)

ational fishery. For herring, reduced domestic demand from the early-1980s (and a moratorium on herring fishing by Canada on its side of Georges Bank) allowed stock recovery in the absence of U.S. management plans. In the case of groundfish, the objective of OY could not fail to be met, as it was defined as the catch resulting from the plan. However, the New England Council was forced to abandon its minimum intervention strategy in 1994 and to introduce fishing effort controls to counter the build-up of fleet capacity after 1977. As the Council's Technical Monitoring Group concluded, the regulatory measures in groundfish plans were not adequate for the Council's objectives to be met, and fishing mortality on cod and haddock in the early-1990s was well above levels which could be considered as consistent with Council objectives (Anthony, 1993).