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North Atlantic Fishery Management Systems: A Comparison of Management Methods and Resource Trends

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Foreword

The idea of a series of invited papers for publication in the NAFO Journal was first raised by the Standing Committee on Publications of the NAFO Scientific Council in 1985 as one way to enhance the scope of the Journal and to stimulate broader interest in it. The present paper, which documents the development of regulatory systems for North Atlantic fisheries from establishment of the international commissions to the present day, is very much the kind of broad review paper that the Standing Committee had hoped to attract. This paper should be of use not only to scientists but also to fishery administrators and others trying to understand the management of fisheries, how the present juncture was arrived at, and what approaches may hold promise for the future.

September, 1996

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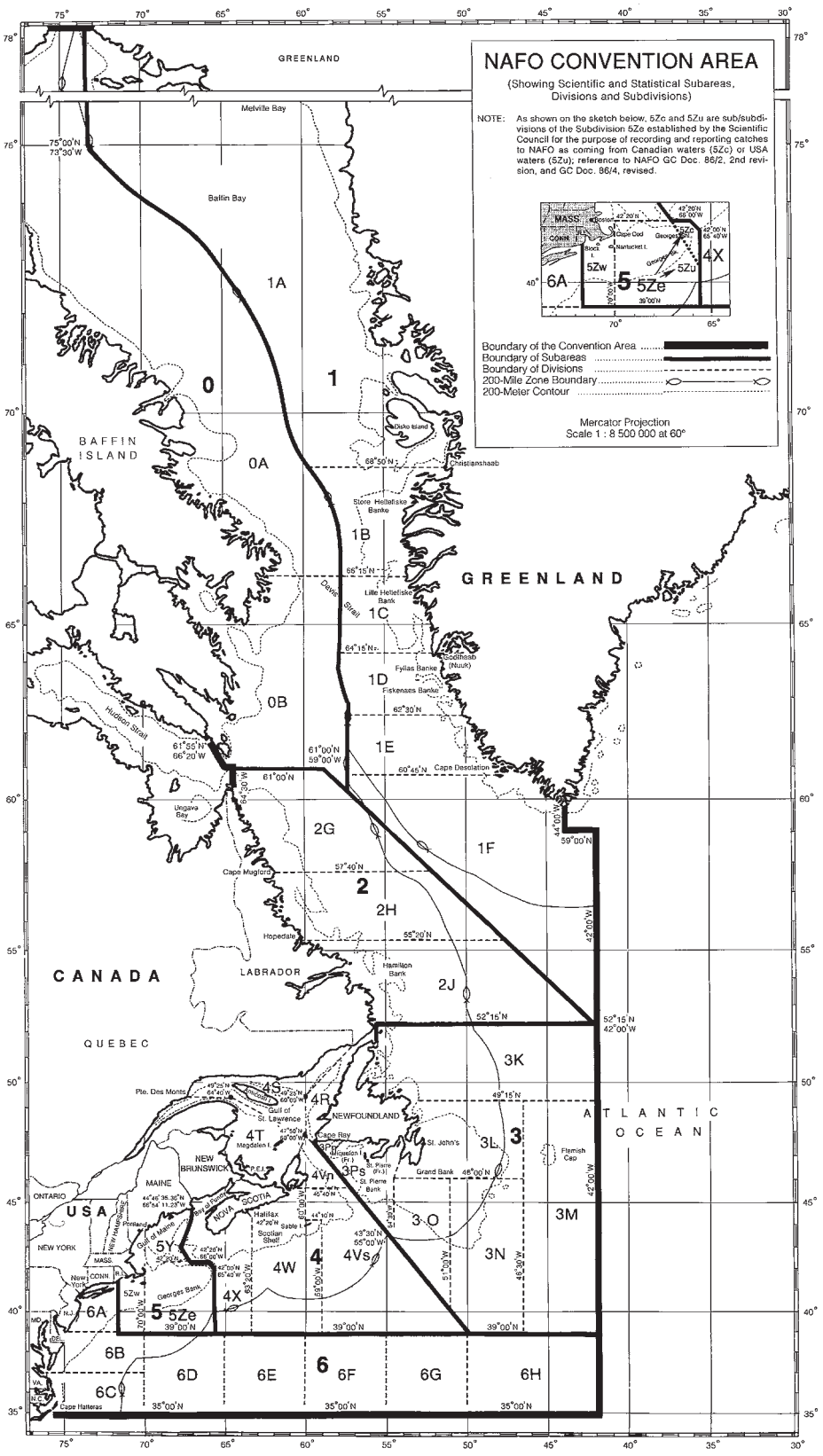
NAFO CONVENTION AREA
(Showing Scientific and Statistical Subareas, Divisions and Subdivisions)
NOTE: As shown on the sketch below, 5Zc and 5Zu are sub/subdivisions of the Subdivision 5Ze established by the Scientific Council for the purpose of recording and reporting catches to NAFO as coming from Canadian waters (5Zc) or USA waters (5Zu); reference to NAFO GC Dec. 86/2, 2nd revision, and GC Dec. 86/4, revised.
Boundary of the Convention Area
Boundary of Subareas
Boundary of Divisions
200-Mile Zone Boundary
200-Meter Contour
Mercator Projection
Scale 1 : 8 500 000 at 60°
GREENLAND
BAFFIN ISLAND
CANADA
LABRADOR
QUEBEC
NEWFOUNDLAND
NEW BRUNSWICK
NOVA SCOTIA
MAINE
ONTARIO
USA
NEW YORK
ATLANTIC OCEAN
Melville Bay
Baffin Bay
Davis Strait
Hudson Strait
Ungava Bay
Gulf of St. Lawrence
Scotian Shelf
Georges Bank
Grand Bank
St. Pierre Bank
Hamilton Bank
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Dedication

This year, Dr A. W. H. Needler celebrates his 90th birthday. It is a great pleasure to mark the occasion by dedicating this review to him in recognition of his immense contribution as scientist, administrator, and diplomat, to the management of North Atlantic fisheries.

R. G. Halliday and A. T. Pinhorn

Contents

Acknowledgements

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North Atlantic Fishery Management Systems: A Comparison of Management Methods and Resource Trends

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Abstract

The administrative and regulatory frameworks used to control fishing in each North Atlantic management regime subsequent to declarations of 200 mile limits are documented, and compared to those of the previous international commissions. The apparent objectives underlying regulatory actions are examined, and trends in stocks of the most important finfish species before and after extensions of jurisdiction are described. The primary elements of these regulatory regimes are then compared. In general, management authorities did not develop coherent policies that reconciled conflicting social and economic aspirations and, as a result, in the 1980s most fleets were overcapitalized, exploitation rates were high for most of the important groundfish stocks, enforcement of regulations was difficult, and non-compliance was a serious problem in many regimes. Most regimes have adopted new regulatory approaches in the 1990s.

Key words: Groundfish, management, North Atlantic, stock

Introduction

Extensions of fisheries jurisdictions to 200 nautical miles in 1977, or about then, by most countries bordering the North Atlantic changed radically the political basis for control of exploitation of marine renewable resources. These jurisdictional extensions put most of the coastal fishing banks within national jurisdictions. Previously, the fish stocks on these banks were in international waters and thus were accessible to everyone. Fisheries were regulated through regional fisheries commissions established under international conventions fairly soon after the Second World War. These commissions, in revised forms, still serve as fora for international management issues, but the geographical area over which they have regulatory authority is much reduced.

The change from international to national management of fisheries provided the opportunity for divergent approaches to be adopted in the many new regulatory zones. The two major international fisheries commissions for the Northeast and Northwest Atlantic, which had many members in common, had developed a fairly standard approach to fishery regulation throughout the North Atlantic. At the time of extensions of jurisdiction coastal nations shared this common heritage. They also had as guidance the consensus developing at the Third United Nations Conference on the Law of the Sea on coastal state authorities and responsibilities with regard to fisheries. Despite this common basis there was, nonetheless, scope for adoption of substantially different objectives and management strategies and of different methods, or tactics, for implementing them.

This paper documents the administrative and regulatory frameworks used to control fishing in each North Atlantic management regime, examines the apparent underlying objectives, and describes concurrent resource trends. Descriptions of the work of the international fisheries commissions prior to extensions of national jurisdiction to 200 miles are followed by comparable descriptions of subsequent domestic management systems and of the new international commissions outside of extended fishing zones. The primary elements of these regulatory regimes are then compared.

The purposes of this review are, firstly, to bring together in a systematic fashion, information on management in all North Atlantic regimes which is often not readily accessible and, secondly, to provide comparisons among regimes of the basic elements of their regulatory systems and resource trends. The review was motivated by a perceived need to counteract ill-informed comparisons among regimes which serve to confuse debate about the most appropriate techniques for regulating fisheries.

There has been a preoccupation in North Atlantic management regimes with what has come to be called conservation, i.e. fish stock management, but, of course, the scope of fishery management is much broader than this and includes, particularly, the economic performance of the industry and the distribution of benefits to meet the objectives of society. There are intimate linkages between conservation, economic and social objectives in that any action taken in the name of one category of objectives has significant implications to the prospects of attaining objectives in the others. Sometimes regulatory actions are taken with multiple purposes in mind, and it is thus not possible to deal exclusively with one aspect of fishery management. This paper is concerned primarily with the regulation of fishing in the context of the overall objectives, explicit or implicit, of management agencies. Its scope includes regulation of participation in the fishery as well as regulation of the amount of fishing and of how fishing is conducted. The actions described are those of fishery managers (administrators) who carry the legal authority and responsibility to regulate fisheries, of biologists who provide the scientific and technical information and advice on which regulatory decisions are largely based, and of enforcement officers who implement managerial decisions through surveillance and apprehension of regulatory offenders. Excluded from consideration, however, are: evaluations of the economic and social effects of management policies; actions taken by management agencies relating to the secondary, fish processing, sector such as product quality or market improvement programmes; and measures taken by government agencies, other that those directly responsible for fisheries management, relating to general economic development, or social support, which result in indirect subsidization of fishing activity.

The comparisons among regimes are limited to the management of finfish species and indeed to the six species which are of greatest overall importance to the finfish fisheries on both sides of the Atlantic; the groundfish, Atlantic cod, haddock and pollock (called saithe in Europe), and the pelagic fish, Atlantic herring, Atlantic mackerel and capelin. Each of these species has stocks in several management regimes and this allows comparisons of the effects of different regulations on stocks of the same species. These six species were at the centre of developments in the

international fisheries in the last 30 years and it was events in these fisheries that provided the primary incentive for extensions of jurisdiction. As a result of their importance, the effects of fishing on the major stocks of these species is relatively well described.

It was decided to restrict comparisons to stocks in the Atlantic proper. Baltic Sea fisheries are not examined although important stocks of cod and herring occur there. These stocks live in unique conditions, particularly of low salinity, and are managed through an international commission specifically for the Baltic Sea (International Baltic Sea Fishery Commission). Stocks in the Skagerrak and Kattegat are also excluded. These are managed under terms of an agreement between Norway, Sweden and the European Union (EU), and a separate account for this special area would introduce an unnecessary complexity.

Conventions and Methodology

References to management regimes and management agencies or authorities may seem clumsy but it is in recognition that not all the political systems of the regimes studied conform to the simple coastal state model. The EU provides a prime example where extensions of jurisdiction were national actions by member nations but where most of the authority to regulate fishing lies with the EU itself. Greenland and the Faroe Islands, however, have authority to regulate fishing in their own zones but responsibility for international relations resides with Denmark. Thus political situations can be complex, and referring to management authorities provides a useful simplification.

The term management institutions is used to describe the organizational framework within which the various players in the management process interrelate. The international commissions are legal institutions, established by treaty to perform prescribed functions in relation to fishery management in a particular geographical area. At a domestic level institutional frameworks can also be recognized that establish the authorities of various parties in the management process.

The conceptual framework for management is discussed in terms of objectives – the broadest statement of a management agency's policy, strategies – the methods used to obtain objectives, and tactics – the mechanisms used to implement strategies (Halliday and Pinhorn, 1985). For example an objective of obtaining optimum yield (OY) from the fishery could be pursued through a strategy of fishing at the biological reference point, $F_{0.1}$, and the tactic used to effect this strategy could be the implementation of a system of catch quotas.

When authority over a maritime zone is extended, fisheries may be only one of the activities over which jurisdiction is claimed. Zones come with a variety of labels such as territorial seas, contiguous zones, exclusive economic zones and fishing zones. The baselines from which these zones are measured may be defined by various criteria. However, for present purposes there is no need to entertain these complications and all zones which confer jurisdiction over fisheries on the claimant are referred to here as "fishing zones".

Fishing limits, and all other distance measurements, are given in nautical miles. Thus, all references in the text to miles should be understood to be nautical miles. A nautical mile is equal to 1.15 statute miles and 1.85 kilometres.

Fish species are referred to by their common names and for the primary species Atlantic cod, Atlantic herring and Atlantic mackerel the "Atlantic" is dropped for the rest of the paper, so cod always means Atlantic cod and so on. A number of other species are also referred to and, to avoid confusion, a list is provided in Appendix Table 1 of common and scientific names for all species referenced.

Catches referred to in the paper are nominal catches. Nominal catch refers to that part of the fish catch removed from the sea which is kept for use either for human consumption or for fish meal. It does not include fish discarded at sea. Nominal catches are recorded as the weight of fish in the round fresh condition, i.e. the weight of the catch as it comes out of the sea before any processing. The weight unit used is metric tons, sometimes referred to as tonnes, and is equal to 1000 kilograms or 2204.6 lbs (avoirdupois). This unit is referred to throughout this paper as "tons" or using the abbreviation "t". The total quantities of fish killed by fishing should be taken into account in fishery management and this would include discards, as most of these are dead when returned to the water. However, this is not possible except in a few specific cases because data on discards are not generally collected.

For ease of reading, use of abbreviations is avoided where practical. Acronyms for international organizations are retained, as are country name abbreviations, those scientific notations which refer to exploitation levels (because there is no alternative), and a few others for which usage has become widespread at least in fisheries circles. A list of all abbreviations which are introduced in the text is provided for reference in Appendix Table 2.

The standard report series produced by management agencies, which contain much of the specific information on regulations, catch statistics, stock status reports, and the like are listed at the beginning of the Reference section by management agency. Citations in the main text of specific documents in these series are restricted to the special cases where a direct quotation is made. The usual citation procedure is used for scientific and other sources.

Information on management systems was obtained from literature sources and supplemented by personal interviews with senior scientists and (in most cases) administrators in each management regime. Draft accounts were then provided to these senior scientists for review, and correction of the facts, regarding their domestic management system.

Many of the stocks included in this account are shared between management zones but, for convenience, all are assigned to one zone or another based on which management regime appeared to have the predominant influence on stock management.

Catch and resource trends were obtained from stock assessment documents produced by international and domestic scientific advisory agencies (Appendix Table 3). Most of the stock assessments used were conducted in 1992 and thus the last year of data in these was 1991. The last year of data used in the actual comparisons in this review is 1988, thus making the comparisons insensitive to the input parameters used in sequential population analyses. Stock assessments were accepted as they stood, the only innovations introduced by the present authors being the joining up of data series from earlier reports with those of the most recent ones, when this was necessary to extend stock parameter estimates back to the 1960s.

The parameters used for each stock are for the fished population. The fished population is defined as those age groups making a significant contribution to the fishery. An age group was judged to be making a significant contribution if it was at least 10% recruited to the fishery. Thus, the estimates relate to that part of the stock that is available to the fishery. In most cases this equates to fish which are age 3 or age 4 and older. In the case of fishing mortality (F), this approach averages the F experienced by young fish which are only partially vulnerable to the gear with the F on older fish which are fully vulnerable, i.e. fully-recruited to the fishery. A weighted averaging method is used, i.e. the F at each age is multiplied by the numbers of fish at each age before summing over age groups and dividing by the total number of fish in the fished population. Thus, variation in the number of recruits has an important influence on the weighted average F. Nonetheless, this is a good F to use for comparing trends over long time series of data or among stocks because it takes into account all the differences resulting from changes or differences in fishing gears or fishing behaviours.

The weighted F described above for illustrating trends is not comparable to the Fs used as biological reference points for management such as F_{max} (Beverton and Holt, 1957) and $F_{0.1}$ (Gulland and Boerema, 1973). The latter are usually the fully-recruited F (Northwest Atlantic) or are representative of the unweighted average F over some selected age range encompassing the last of the partially recruited age groups and the first of the fully recruited age groups (Northeast Atlantic). Thus, the way of calculating reference points varied among stocks and, indeed, sometimes for the same stock over time. Nonetheless, it was necessary to find a way to compare the fishing mortalities estimated to have occurred in the fishery against those targets to determine the effects of regulation. The first step was to decide upon what reference points to use and what the values of those were for each stock. The reference points F_{max} and $F_{0.1}$ were chosen as these were the most widely used and the only ones for which estimates could be located for all stocks (except capelin for which these reference points are not relevant). The source documents for stock assessment data (Appendix Table 3) for the period 1979–88 were searched for estimates of the values of F_{max} and $F_{0.1}$ and those were used for the comparisons. Sometimes several estimates were available for one stock but these were averaged to give a single value. The estimates of fishing mortality in the fishery were then recalculated to express the calculated F on the same basis as the reference F, i.e. averaged over similar age groups in the same way. Those estimates provided the basis for conclusions as to whether the estimated fishing mortalities in the fishery coincided with, or were above or below, the reference levels. This raised the additional complication of deciding what is the same and what is different, a problem that does not lend itself to statistical analysis. Thus, an arbitrary criterion was adopted that estimated values (averaged for 10 year study periods before and after jurisdiction) which lay within 15% of the reference level were considered to be at that level. The 10 year study periods chosen were 1967–76, representing the international commission years, and 1979–88, representing the post-extension of jurisdiction years. This allows a two year transition between the two periods, providing time for new measures, which may have been introduced on extension of jurisdiction, to come into effect. Although this whole procedure is quite crude and arbitrary, the fact of the matter is that most decisions were not difficult to make; mortalities in the fishery usually deviated widely from reference levels.

International Fishery Management: Pre-200 Mile Limits

This section describes the historical development of fishery management in the North Atlantic during the international commission phase prior to 1977. The modern role of international commissions is described later. After a brief historical overview, the present section describes, for the Northeast and Northwest Atlantic commissions, their authorities, organization and scope, the regulatory actions taken and the measures adopted to achieve compliance with these. Resource trends are not described here but chapters below provide illustrations of these from 1960 (where data allowed) for stocks of the primary species associated with each post-1976 jurisdictional zone.

The term "Contracting Parties" is used here to describe those parties that are bound by the terms of a particular international convention (treaty) which establishes an international commission. The use of this general term avoids the need to distinguish between nation states (countries) and other possible members such as groups of states, the EU being a prime example. Although there are a number of legal terms to describe the procedure by which a party signifies its agreement to be bound by a treaty, ratification and accession being the most common in the case of North Atlantic fishery conventions, this is of no practical significance to this study with respect to their rights and obligations under these conventions.

Historical Overview

The first step toward international management of fisheries was the development of a scientific basis for management actions. The inaugural meeting of the International Council for the Exploration of the Sea (ICES) was held in 1902, and concern about the effects of fishing on fish stocks was a primary motivation for its establishment (Went, 1972). The functions of ICES, however, were (and remain) to promote and encourage marine research related to living resources, develop and organize relevant cooperative research programs involving its member countries, and publish or otherwise disseminate the results of research conducted under its auspices. Thus ICES is exclusively a scientific organization and carries no regulatory authority. The original eight members of ICES (Denmark, Finland, Germany, The Netherlands, Norway, Russia, Sweden, United Kingdom (UK)) were northern European states, and early scientific interest concerned adjacent waters. Western North Atlantic states decided to form their own fishery science organization after the First World War. The North American Council on Fishery Investigations was established in 1920, with a membership consisting of Canada, Newfoundland (which had yet to join Canada), and the United States of America (USA) (NACFI, 1932). France joined in 1922. This too was purely a scientific organization but, like ICES, could advise the governments of member states on the technical basis for regulatory actions.

The results of ICES research were first used in support of international conservation actions with the conclusion of the Baltic Convention in 1929, which provided for protection of European plaice and flounder stocks in the Baltic Sea through area and seasonal fishery closures, minimum fish size limits, and requirements to return small fish to the sea. A second international convention in 1932 provided protection of European plaice in the Skagerrak, Kattegat and Sound, again using fish size limits. However, these conventions were of limited scope with regard to species, area and participating states (Tomasevich, 1971). A general convention concluded in 1937 in London, UK, by 10 northern European states, was titled the "International Convention for the Regulation of the Meshes of Fishing Nets and the Size Limits of Fish". It applied from the equator north and from 80°E to 80°W longitude, and minimum mesh and fish size restrictions were specified for most of the important species fished. The 1937 Convention did not legally come into force and was overtaken by the Second World War. Nonetheless, this convention was an important milestone in the development of international regulation of fisheries. The types of regulation proposed were, however, not new as similar regulations were already embodied in various national regulations. Indeed, mesh size and minimum fish size restrictions already had a long history; incorporation into English regulations occurred as early as the 1500s (Burd, 1986).

In anticipation of the end of the Second World War, another conference was convened in London in 1943 to draw up a draft convention for regulation of North Atlantic fisheries. This draft was intended to serve as a basis for a further conference after the war which would conclude a final convention. Unlike the 1937 conference, North American states also participated, although the USA only as an observer. Despite full participation, Canada shared USA doubts that North American interests would be well served by a North Atlantic-wide convention dominated by European states. The meeting was successful in concluding the "Draft Convention relating to the Policing of Fisheries and Measures

for the Protection of Immature Fish". Despite North American reservations it applied to the whole North Atlantic, north of the Tropic of Cancer (23°27'N). Conservation regulations were essentially the same minimum mesh and fish sizes contained in the 1937 Convention.

The follow-up conference after the war was indeed held, again in London, in 1946, and by this stage it was clear that separate solutions to conservation issues in the eastern and western North Atlantic were preferred. The 1946 conference concerned only the eastern North Atlantic east of 42°W and north of 49°N (but excluding the Baltic Sea and Belts). The conference successfully concluded the "Convention for the Regulation of the Meshes of Fishing Nets and the Size Limits of Fish". Similarity to the 1937 Convention extended beyond its title to the measures proposed for minimum mesh sizes and fish sizes, although the minimum levels were set rather higher in some cases. During the conference the UK had pointed out that these measures would not in themselves solve the overfishing problem and proposed a reduction in the total tonnage of the fishing fleets. This, and various alternative measures proposed by other delegations, did not prove acceptable but the Convention provided for creation of a Permanent Commission to consider extensions or alterations to the Convention's provisions. It was seven years before the Convention came into effect and the first meeting of the Permanent Commission was not held until 1953. A number of changes were made to mesh and fish size regulations by the Permanent Commission but no new approaches were adopted to deal with conservation issues.

Dissatisfaction with the limitations of the 1946 Convention resulted in yet another conference being held in London in 1959. The resulting "North-East Atlantic Fisheries Convention", when it entered into force in 1963, established the North-East Atlantic Fisheries Commission (NEAFC) as a successor to the Permanent Commission. Extensions of fisheries jurisdiction in 1977 greatly reduced the relevance of NEAFC and precipitated the withdrawal of many members. A new NEAFC Convention, with provisions appropriate to the new political circumstances, was agreed to and came into effect in 1982. The regulatory authorities and actions of the Permanent Commission and the original NEAFC are discussed below.

The western boundary of NEAFC at 42°W remained the same as that in the 1946 Convention. The southern boundary was extended to the Straits of Gibraltar at 36°N. Again, the Baltic Sea and Belts were excluded. States adjacent to the Baltic recognized the need for cooperation in conservation actions by concluding the "Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts" in 1973 which established the International Baltic Sea Fishery Commission. The regulatory scope of the Baltic Sea commission was wide, including regulation of gear and catching methods, fish size limits, closed areas and seasons, regulation of total catches and amount of fishing effort and their allocation between states and, indeed, "any other measures related to the conservation and rational exploitation of the living marine resources". The Convention applied to waters within national jurisdiction as well as international waters and thus its provisions remained relevant after extensions of jurisdiction. As mentioned in the Introduction, the management of Baltic Sea stocks is not discussed further in this paper.

In the western North Atlantic, meanwhile, action was also taken to establish a regional fisheries commission. At the invitation of the USA, a conference was called in Washington, D.C., in 1949. This resulted in formulation of the "International Convention for the Northwest Atlantic Fisheries", which came into force in 1950. This convention established the International Commission for the Northwest Atlantic Fisheries (ICNAF), and applied to an area the eastern boundary of which was 42°W coincident with the western boundary of the 1946 Convention area and, subsequently, with that of NEAFC. Its southern boundary was at 39°N. This brought all the major international fisheries in the North Atlantic under the regulatory authority of one or other of the fisheries commissions. As was the case with NEAFC, extensions of fisheries jurisdictions in 1977 made inappropriate the provisions of the ICNAF Convention. A new international agreement, the "Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries", was concluded in Ottawa, Canada, in 1978 and ratified in time to come into effect on 1 January 1979. This Convention provided for creation of the Northwest Atlantic Fisheries Organization (NAFO) which, after a transition year, replaced ICNAF. The regulatory authorities and actions of ICNAF are discussed below.

The role of ICES in provision of scientific advice on conservation of eastern North Atlantic fish stocks became entrenched by inclusion in the 1946 Convention of a requirement for the Permanent Commission to consult ICES. This provision was perpetuated in the 1959 Convention establishing NEAFC and this paved the way for ICES to become the authoritative scientific voice regarding fishery management in the eastern North Atlantic. In contrast, the North American Council on Fishery Investigations became defunct with the outbreak of

the Second World War. The scope of ICES interest extended to the western North Atlantic but, when the ICNAF Convention was formulated in 1949, neither Canada nor the USA were members of ICES and were of an independent state of mind. It was decided that ICNAF itself would be responsible for ensuring that appropriate scientific advice was available in support of its regulatory functions in the western North Atlantic, primarily by coordinating the work of national research agencies of member states. ICNAF established a Standing Committee on Research and Statistics (STACRES) for this purpose. The subsequent NAFO Convention explicitly established a Scientific Council with broad responsibilities for promoting international cooperation in fisheries science and for provision of advice both to the NAFO Fisheries Commission and to coastal states. The scope of the NAFO Scientific Council with regard to fisheries research is thus comparable to that of ICES, although the NAFO Scientific Council, unlike ICES, does not enjoy the automony of its own separate international Convention, being subordinate to the NAFO General Council, and operates on a much smaller scale than ICES.

The entire North Atlantic was subdivided into fishing areas (Fig. 1), initially for statistical purposes, by ICES in the northeast and by ICNAF's STACRES in the northwest (Halliday and Pinhorn, 1990; ICES, MS 1982). These statistical units were subsequently used to define management areas when catch controls were introduced by the international commissions, and continue to be used for this purpose by both domestic and international agencies with only minor modifications.

The Permanent Commission and North-East Atlantic Fisheries Commission (NEAFC)

Authority, Organization and Scope. The 1946 "Convention for the Regulation of the Meshes of Fishing Nets and the Size Limits of Fish" did not in itself specify any conservation or other objectives to be obtained through the Convention. The Permanent Commission established under the Convention was charged simply with consideration of whether the provisions of the Convention should be extended or altered. It is clear, however, from the Final Act of the conference which agreed upon this Convention that the purpose was to solve the problems caused by overfishing. The Convention Area extended from the northwest coast of France (48°N) northwards and including the east coast of Greenland (to 42°W) in the west and the western Barents Sea (to 32°E) in the east (Fig. 2).

Contracting Parties were required to give effect to any recommendations for changes in the Convention if these received unanimous approval in the Permanent Commission. There was an immediate challenge by some Contracting Parties to the scope of the Commission's powers based on the legal viewpoint that any recommendations of the Commission could concern only mesh sizes and size limits of fish. This greatly restricted the scope for conservation actions and caused steps to be taken immediately to initiate work on a replacement Convention. However, although the limitations of the Permanent Commission were recognized during its first meetings in 1953, it took until 1959 to agree on a new Convention and it was 1963 before NEAFC came into force.

The North-East Atlantic Fisheries Convention did specify its objective as being "to ensure the conservation of the fish stocks and the rational exploitation of the fisheries of the North-East Atlantic Ocean and adjacent waters". The Convention Area extended north from the southern tip of Spain (36°N). The western boundary was the same as that of the Permanent Commission but the eastern boundary was at 51°E and thus included virtually all of the Barents Sea (Fig. 2). Contracting Parties were required to apply the provisions of the Convention and the Commission's recommendations within their own territorial waters. The Convention Area was divided into three regions. Region 1 encompassed northern waters off eastern Greenland, Iceland, Faroe Islands, northern Norway and the Barents Sea, Region 2 was the North Sea and west of the British Isles, and Region 3 was the waters of the Bay of Biscay and off the Atlantic coasts of Spain and Portugal (Fig. 2). Headquarters of the Commission was specified as London, UK.

The Commission was organized on the basis of committees, one for each of the three geographical regions defined in the Convention. Contracting Parties had the right of representation on a Regional Committee if they had a coastline adjacent to that region or exploited regional fisheries. Contracting Parties which exploited elsewhere a stock which was also exploited in that region could also be represented. The regional committees performed the duties of the Commission with regard to their region and made draft recommendations to the Commission as a whole. The Commission could, however, modify the recommendations of regional committees before forwarding those for action by Contracting Party governments. The Commission could make recommendations on the basis of a two-thirds majority of delegations present and voting.

It was the responsibility of the government of a Contracting Party to establish domestic regulations implementing the Commission's recommendations by the date established by the Commission.

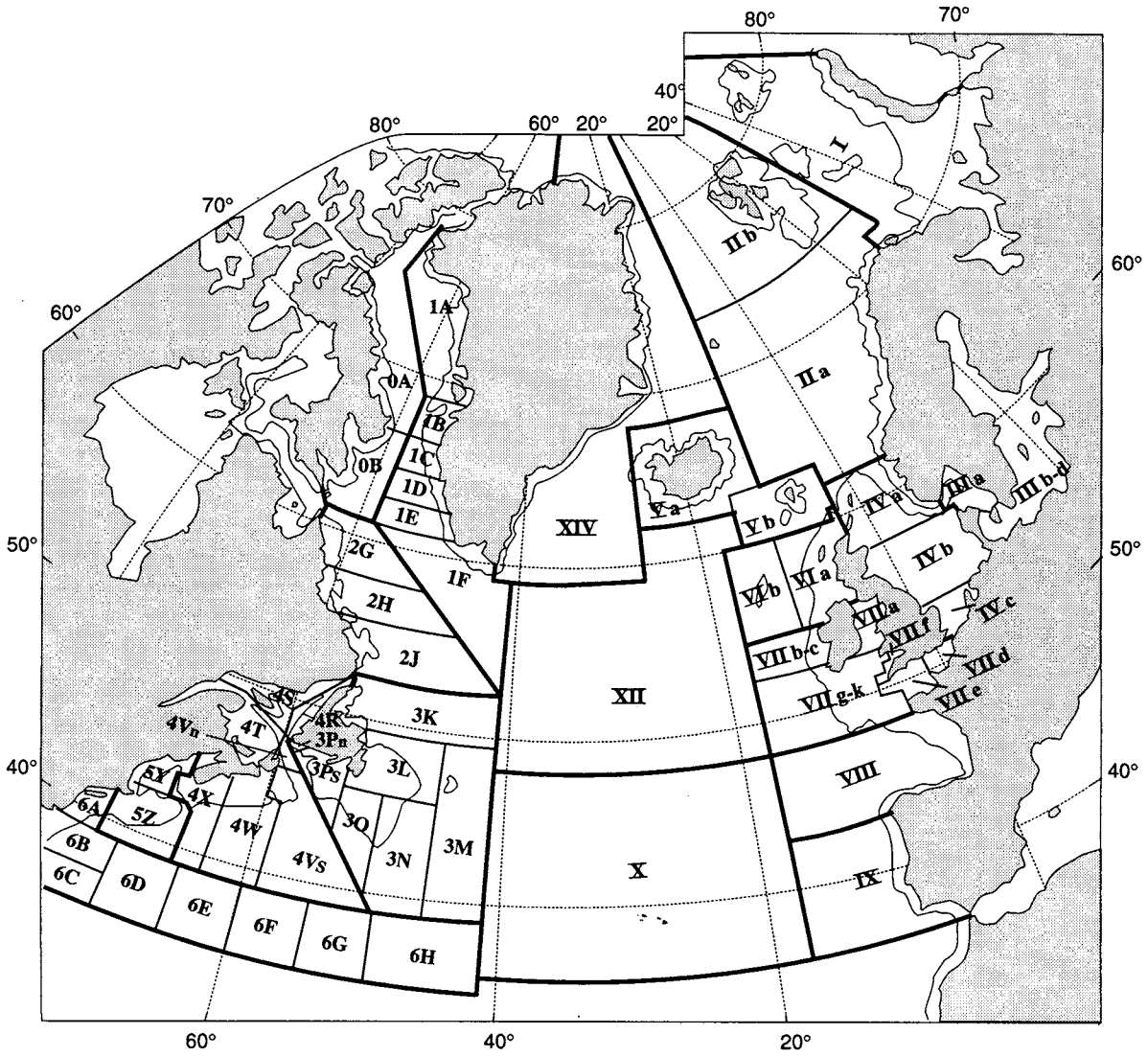

Fig. 1. Statistical Areas defined by ICES and ICNAF for the Northeast and Northwest Atlantic (east and west of 42°W) respectively. (Heavy lines are Subarea and Statistical Area boundaries, light lines are Division and Subdivision boundaries.)

However, a Contracting Party had 90 days within which to lodge an objection to a Commission recommendation and, if it did so, was under no further obligation. Furthermore, once one objection was received, others had a period during which they could also object. If three or more objections were received, the non-objecting Parties were not obligated to implement the recommendation either.

Compliance of vessels with NEAFC regulations was the responsibility of the flag state but the Commission also had the authority to make recommendations for national control measures, and for international control measures on the high seas. This allowed a scheme of joint international enforcement to be established in 1970 under which inspectors from one Contracting Party could inspect at sea, in international waters, vessels of other Parties. Any legal proceedings regarding alleged infractions of NEAFC regulations were, however, a matter for the flag state of the vessel involved.

The primary purpose of NEAFC, as specified in its Convention, was to consider, in the light of the technical information available, what measures were required for the conservation of the fish stocks and for the rational exploitation of the fisheries in the area. With regard to conservation of fish stocks, the

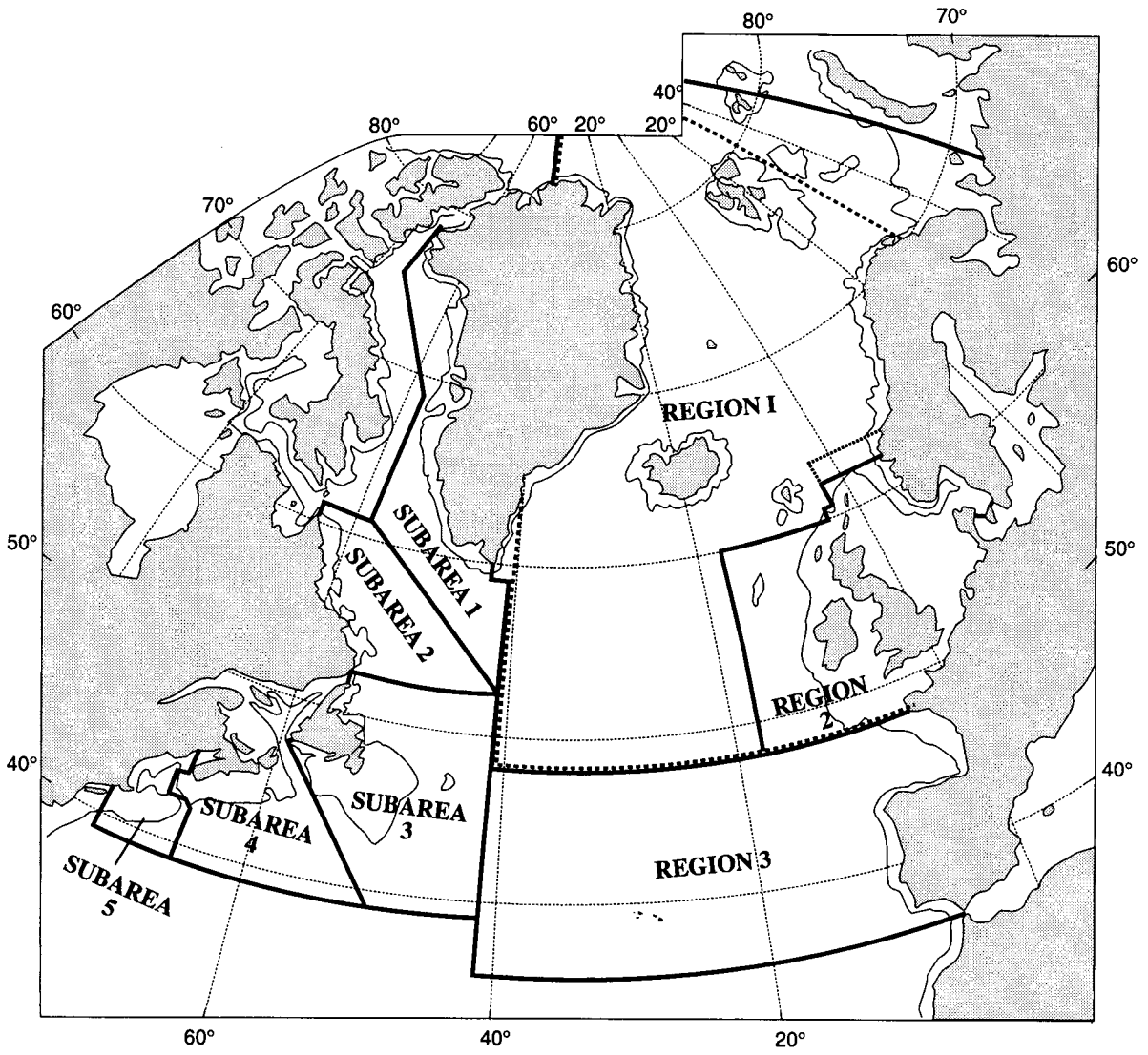

Fig. 2. Convention Areas of North Atlantic fisheries commissions; ICNAF and its Subareas used for administrative and regulatory purposes in the Northwest Atlantic, NEAFC (1959 Convention) in the Northeast Atlantic and its administrative and regulatory Regions (boundary revision of 1970 between Regions 1 and 2 shown by dotted line), and the regulatory area of the Permanent Commission (1946 Convention) (dashed lines).

Commission was also required to seek the scientific advice of ICES, when possible.

The Convention allowed the following regulatory measures to be proposed:

a) regulation of the size of mesh of fishing nets;
b) regulation of the size limits of fish that may be retained aboard vessels, or landed, or exposed or offered for sale;
c) establishment of closed seasons;
d) establishment of closed areas;
e) regulation of fishing gear and appliances, other than regulation of the size of mesh of fishing nets; and
f) measures for the improvement and the increase of marine resources, which could include artificial propagation, the transplantation of organisms and the transplantation of young.

The Convention also allowed for regulation of the amount of total catch, or the amount of fishing effort in any period, or any other conservation measures, to be added to this list, but only on the

basis of a two-thirds majority in the Commission and subsequent acceptance by all Contracting Parties. The Commission agreed in 1970 to add the following regulatory measures to the list of possible actions:

g) regulation of the amount of total catch and its allocation to Contracting Parties in any period; and

h) regulation of the amount of fishing effort and its allocation to Contracting Parties in any period.

However, obtaining the required approvals by the governments of all Contracting Parties proved difficult and NEAFC was not empowered to set TAC or fishing effort regulations until 1974. As a result, a number of international agreements were reached outside the framework of the Commission on catch and effort limitations to deal with pressing conservation issues.

It was clear in 1976 that the jurisdictional extensions planned by coastal states for 1977 made NEAFC an inappropriate vehicle for future negotiations on international management. However, a process initiated by NEAFC in 1976 to prepare a new or amended Convention more suited to the new circumstances was successful in arriving at a new NEAFC convention which came into force in 1982. Although many countries, including all the then EU countries, withdrew from the old NEAFC, the organization continued to function through 1981 until the new NEAFC could take over.

When the Permanent Commission was established in 1953, ICES set up a special Liaison Committee to consider and provide advice on issues relevant to the Commission. This Liaison Committee consisted of the chairmen of relevant ICES committees and a number of co-opted experts in population dynamics. With the change in the political situation in 1977, ICES replaced the Liaison Committee with an Advisory Committee on Fishery Management (ACFM). This committee was constituted mainly of national members nominated by the delegates from ICES member governments and approved by the Council. These members are scientific experts who are expected to serve ICES, not national interests, during their tenure. The ACFM has, in addition, a chairman and the chairmen of ICES fish committees are also members. Many ICES Working Groups determine the status of various stocks and their reports provide the basis for ACFM advice. The role of the ACFM is to give scientific information and advice to fisheries commissions and to ICES member governments, or groups of governments (such as the EU) on such matters on which they may request advice, or on such matters as the Council or the ACFM may consider relevant. The Permanent Commission agreed in 1958 to reimburse ICES for the work undertaken on its behalf and this practice was continued by successor commissions.

Regulatory Actions. *Trawl regulation*s: The 1937 convention required that a mesh size of 105 mm be used in waters off northern Norway and in the Barents Sea, and of 70 mm elsewhere. Exceptions were provided for specific fisheries for pelagic and small bodied fishes and invertebrates, i.e. the regulation was directed at the groundfish fisheries. These measures applied to all trawls, seines or other nets towed at or near the bottom of the sea irrespective of material of construction. The nets were to be measured when wet and with the meshes stretched diagonally in a fore and aft direction, a technique which became the standard in international regulation. Although the convention did not formally come into operation, a number of countries nonetheless implemented national regulations which were more or less in conformity with the agreement.

Forty years later, when jurisdictions were extended, the minimum mesh size allowed in trawl nets (which then included midwater trawls) in the Barents Sea and off Norway, Faroe Islands, Iceland and eastern Greenland had increased to 120 mm (110 mm for seine nets) but in more southern areas, the North Sea and west of the British Isles, remained at 70 mm, and further south had been established at 60 mm. (A chronology of changes is provided in Appendix Table 4.) The principle resistance to a larger mesh size in southern waters came from countries with important fisheries for European sole, a small-bodied species which was well regarded as a food fish and consequently highly valued.

In the 1950s differentials were introduced into mesh size regulations as scientific research showed that selection properties of netting varied with material and method used in netting construction. Great complexities arose with the introduction of synthetic netting materials in the mid-1950s. Manila was adopted as the standard material and the selection properties of all other materials were referenced against it. Thus regulations expressed mesh size for manila netting and defined differentials for other materials which would result in a trawl constructed from them having a size selection equivalent to that of one made from manila. The manila standard continued to be used long after synthetic materials completely replaced natural fibres in netting construction in the early-1960s. The first differential introduced was actually for gear type. It was thought that seine nets selected for larger fish than did trawls using the same mesh size. (Reference to seine nets here means Danish or Scottish seine nets used to catch bottom dwelling

fish.) However, the tests on which this conclusion was based used cotton netting in the seine nets and the differential observed was perhaps a netting material, rather than a gear, effect. There continues to be relatively little information on selection of seine nets. However, much research was conducted on the selection of trawl nets and it was learned that many aspects of net construction affected selection, and the proliferation of synthetic twines made it impractical to measure their diverse selection properties. It also became impractical for enforcement officers to identify in the field the type of synthetic material being used. By the 1970s scientists were advocating dispensing with differentials, a view which was generally welcomed in enforcement circles, but their removal from regulation was gradual and did not start until after 1977.

Mesh size regulations in herring, mackerel and capelin fisheries *per se* were not adopted. However, these species were included in mesh size regulations adopted generally for industrial fisheries, discussed below.

Minimum fish size regulations: In the Northeast Atlantic minimum fish size regulations were consistently used as supplements to mesh size regulations in groundfish trawl fisheries conducted to provide fish for human consumption. These regulations specified the size, in total length, below which fish could not be retained aboard a vessel, landed or sold. No tolerances were provided for any undersized fish. In the 1937 Convention the minimum size for cod and haddock was 24 cm, whereas in the 1946 Convention it was 30 cm for cod and 27 cm for haddock (Appendix Table 5 provides a chronology). In 1963 the Permanent Commission established higher minimum lengths in areas where large mesh nets were specified by regulation. These regulations were carried forward to NEAFC. Size limits were adopted for pollock (saithe) in the mid-1970s, and in this case a tolerance was provided for undersized fish at least for a transition period.

Size limits were adopted in the mid-1970s also for pelagic species. A size limit for mackerel of 30 cm, approximately the size at first maturity, was adopted for the North Sea, Skagerrak and Kattegat, and subsequently extended to the west of Scotland, to reduce catches of immature fish. This regulation applied to the industrial fishery for mackerel only, and by-catches of 20% by weight of undersized fish were allowed. A size limit of 20 cm was established for herring to the west of Scotland, and this was extended to the North Sea and Kattegat. This size corresponded to the size required by the industry for food consumption markets. A by-catch of 10% by weight of undersized herring was allowed.

Rapid development of industrial fisheries in the North Sea and adjacent areas after the Second World War introduced a new dimension to the issue of minimizing the catches of small specimens of species which supported directed human consumption fisheries. The 1946 Convention, which required discard of all undersized fish caught in industrial fisheries, was modified at the time its regulations came into effect in 1954 to allow for retention of up to 10% by-catch, by weight, of undersized fish of controlled species. This provision was carried forward to NEAFC and maintained for the duration of its existence.

Catch controls: As already noted, NEAFC took steps in 1970 to acquire the authority to establish limits on total catches and on fishing effort and to allocate shares to Contracting Parties, but did not receive the necessary approvals until 1974. During the intervening period Contracting Parties were encouraged to enter into conservation agreements on a bilateral or multi-lateral basis. A number of such agreements were reached (Appendix Table 6). The first of these concerned Norwegian spring spawning herring. Iceland, Norway and the Union of Soviet Socialist Republics (USSR) agreed to restrict catches in the 1971–73 period (Anon., 1973). Subsequently, NEAFC prohibited fishing on this stock, although exemptions allowed some fishing to continue in Norwegian coastal waters. An agreement was reached on catch controls for Northeast Arctic cod in 1974 between Norway, UK and the USSR (Anon., 1975a), but regulation was taken over by NEAFC for 1975 and 1976. An agreement was also reached concerning limitation of groundfish catches in the Faroe Islands area, particularly of cod and haddock, and which also established subareas seasonally closed to trawling and placed limits on the gross registered tonnage (GRT) of trawlers fishing in the area (Anon., 1975b). The primary fisheries were conducted by Faroe Islands and the UK but seven countries were parties to the agreement, which came into effect for 1974 and was continued in effect through 1975 and 1976. No need was seen for NEAFC to become involved in catch regulation in the Faroe Islands area.

Prior to acquiring authority to establish catch limitations, NEAFC itself attempted to limit catches indirectly through the use of seasonal closures, or of complete fishery closures, complemented by exemptions which amounted to *de facto* catch allocations. The first such closure was implemented in 1971 for North Sea herring when fishing was prohibited in May and from 20 August to the end of September. Similar regulations were agreed to for 1972 to 1974. North Sea herring was the first stock for which NEAFC established a TAC and national catch allocations, regulations coming into effect for the year 1 July 1974 to 30 June 1975. Prior to these

dates NEAFC had also adopted a prohibition on fishing for Celtic Sea herring, with exemptions equivalent to catch allocations, as well as the already mentioned prohibition on fishing for Norwegian spring spawning herring. With acquisition of authority to establish catch limits directly, NEAFC established such limits for about a dozen stocks for 1975 in addition to those for North Sea and Celtic Sea herring (Appendix Table 6). These included North Sea cod and haddock, and West of Scotland herring as well as the already mentioned regulation of Northeast Arctic cod. Restrictions were also imposed on the catch of mackerel in the industrial fishery in the North Sea, although only during the first half of the year. All of these catch restrictions were extended to 1976 and some new ones added. In particular, catch restrictions on the mackerel industrial fishery were extended to include the west of Scotland, and indirect limitations were placed on the catch of Northeast Arctic haddock by prohibiting directed fishing for haddock once Northeast Arctic cod allocations were taken. The imminence of extensions of jurisdiction and resultant changes in approaches to regulatory issues prevented agreement through NEAFC on catch restrictions for 1977.

Other measures: Although NEAFC acquired authority in 1974 to directly regulate fishing effort, this power was not used. There was occasional use by NEAFC of seasonal and area closures (other than as devices to limit total catches). Two areas in the Bay of Biscay were closed to trawling in 1970–73 to protect small hake, apparently as a more acceptable approach than mesh size regulation. Also closure of the spawning area during the spawning season of herring at the West of Scotland was implemented for 1974 and subsequent years to protect the spawning stock.

One of the biggest regulatory challenges in the Northeast Atlantic arose from the conflicting interests of those engaged in traditional human consumption fisheries and those participating in the industrial fisheries. The focus of these industrial fisheries was NEAFC Region 2, particularly the North Sea, Skagerrak and Kattegat. The industrial fisheries were directed towards small-bodied species which occurred in high densities, giving high-volume catches, and required the use of small mesh nets. Conflicts arose when industrial fisheries were directed towards species which already supported important human consumption fisheries, but also as a result of by-catches of human consumption species in fisheries directed towards other species suitable only for industrial use. These by-catches could include large quantities of small fish, below legal size limits, because of the small mesh nets used.

The original 1946 Convention required all by-catches in small mesh fisheries of undersized fish of protected species, i.e. those for which minimum sizes had been established in the Convention, to be discarded. This apparently created an impractical situation for those countries developing industrial fisheries for herring and sprat, and these Contracting Parties were successful in having the Convention modified in 1954 to allow for 10% by weight of undersized fish in non-human consumption fishery landings (N.B. in landings, not in catches). This provision was carried forward into NEAFC regulations. Steps were taken in 1973 and 1974 to regulate the industrial fishery for mackerel by imposition of a minimum size limit and by prohibition of fishing in the first half of the year, as already mentioned, but these measures related to optimizing yield from the mackerel industrial fishery itself. The prohibition of industrial fishing for herring in 1975 reflected the priority placed on the human consumption fishery at a time of severe resource conservation problems. A series of further restrictions was placed on small mesh fisheries in 1976 involving specific minimum mesh sizes, by-catch limits on protected species of all sizes as well as on undersized fish and application of these to catches on board as well as in landings. Closures of areas to small mesh fishing were also instituted, the most important of which was closure to industrial fishing for Norway pout of an area in the North Sea off the northeast coast of the UK. This last measure did not come into effect, however, as an objection lodged by the primary industrial fishing nation, Denmark, resulted in several other nations also objecting. Several other elements of these regulations did not apply to Denmark, also as a result of Danish objection, which reduced the overall effectiveness of the new regulations.

Surveillance and Compliance. The NEAFC Scheme of Joint Enforcement came into effect in 1970. Not all countries were able to participate in the initial years and Portugal and Ireland were still unable to do so in 1974. Several countries placed reservations on below-deck inspections, the last of which (that of the USSR) was withdrawn in 1974. The scheme allowed inspectors to examine catch, nets or other gear, and any relevant documents, as deemed necessary to verify observance of the Commission's regulations. At the time of the scheme's initiation, NEAFC regulations concerned mesh size and minimum fish size and it was not until 1974 that NEAFC clarified that inspectors were entitled to carry out inspections relating to all the recommendations in force at any time, not only those relating to nets and fish size.

In addition to the international joint enforcement activities, each country had longstanding schemes of regulatory enforcement for their domestic fleets

and, as well, inspected foreign vessels fishing within national fishing limits. According to NEAFC meeting reports, its Standing Committee on Infractions appeared to be generally satisfied with the level of compliance with mesh and fish size regulations in the early-1970s.

Activities under the joint enforcement scheme did, by 1975, give rise to expressions of concern in NEAFC about the level of compliance with regulations, however. Norway drew attention to the fact that its inspectors had detected mesh size violations in 23 of 59 vessels of five nationalities (Underdahl, 1980). Norway also seriously questioned the adequacies of national controls of catches against quotas. However, the published NEAFC reports clearly do not reflect all of the concerns about regulatory compliance. Leigh (1983) for example states "the Soviet and east European fleets --- notoriously disregarded NEAFC recommendations concerning conservation measures". The Commission's own investigations into the accuracy of catch statistics, reported to the 14th annual meeting of July 1976, caused UK and Norwegian delegations to comment that, without improvement in catch reporting, the Commission's quota schemes were in fact all but worthless.

The International Commission for the Northwest Atlantic Fisheries (ICNAF)

Authority, Organization and Scope. The International Convention for the Northwest Atlantic Fisheries which came into force in 1950 was "for the investigation, protection and conservation of the fisheries of the Northwest Atlantic Ocean, in order to make possible the maintenance of a maximum sustained catch from those fisheries". The ICNAF Convention Area extended from western Greenland to New England (Fig. 2) and was divided into five Subareas. At later dates two additional areas were defined for statistical purposes, Statistical Area 0 east of Baffin Island, and Statistical Area 6 off the mid-Atlantic of the USA (Fig. 1). These were not part of the Convention Area, however, and thus ICNAF did not have regulatory authority in these areas. The Convention Area also excluded waters three miles from the coast, the breadth of the Territorial Sea when the convention was negotiated in 1949, in contrast to the eastern North Atlantic where NEAFC authority extended to the coast. The convention required that the seat of the Commission be in North America. Permanent headquarters were established in Halifax–Dartmouth, Nova Scotia, Canada.

The Commission was organized on the basis of Panels, one for each of the five Subareas. Membership of the Commission did not provide automatic representation on Panels. That representation was determined annually on the basis of current substantial exploitation of resources in the Subareas, except that coastal states had automatic membership. As conservation measures were first considered and decided upon in Panels, membership in these was important. The Commission could require reconsideration of regulatory proposals made by Panels but could not prevent their transmittal to the governments of Contracting Parties. Decisions were made by the Commission and its Panels on the basis of a two-thirds majority of the votes of all Contracting Parties. This had the effect of attributing to absentees a negative vote on all proposals. Hence proposals often required a majority of more than two-thirds of those actually present and voting if they were to pass.

Initially, the Convention required that Contracting Parties notify their acceptance of proposals, and proposals came into effect only after four months subsequent to acceptance by all Contracting Parties represented on a Panel. This requirement for action by a substantial number of governments resulted in long delays in proposals taking effect. Thus, the procedure was changed, effective 1969, so that proposals automatically took effect after six months unless an objection was received. Once one objection was received, other Contracting Governments had a period during which they could also object. Nonetheless, if objections remained in the minority, proposals came into effect for the non-objectors.

Compliance of vessels with ICNAF regulations was the responsibility of the flag state. In 1969 ICNAF acquired the authority to make proposals for national and international control measures to ensure that ICNAF regulations were being applied. This allowed a scheme for joint international enforcement to be established in 1971 under which inspectors from one Contracting Party could inspect at sea vessels of other Parties. Nonetheless, prosecution and assessment of penalties for alleged infractions remained the responsibility of the flag state of the vessel involved.

The initial objective of ICNAF was, on the basis of scientific investigations, to make possible the maintenance of the maximum sustained catch (which is the same as the maximum sustainable yield – MSY). This objective was broadened in 1971 by modifying the Convention to one of achieving optimal utilization of the stocks rather than MSY. The Commission, in most cases, continued to aim for MSY as representing optimum utilization in its view. Also, although this amendment broadened the basis for making proposals to include economic and technical considerations, biological considerations remained the primary basis for regulation.

The Convention initially restricted the regulatory measures the Commission could propose to:

a) establishing open and closed seasons;
b) closure to fishing of spawning areas or areas populated by small or immature fish;
c) establishing size limits for any species;
d) prohibiting the use of certain fishing gear and appliances;
e) prescribing an overall catch limit for any species of fish.

The Convention amendment which broadened the objective of management and the basis for proposals in 1971 also provided much greater scope in the nature of regulatory measures which could be proposed. The itemized list was eliminated and replaced by the word "appropriate" in front of "proposals" in the text of the Convention. The primary significance of this was to allow for national allocation of overall (or global) catch quotas which paved the way for acceptance of a comprehensive catch quota control scheme. It also allowed proposals for direct regulation of fishing effort which, although extensively considered, did not receive wide application.

With announcements by coastal states of intentions to extend fisheries jurisdiction in 1977, ICNAF, in 1976, recommended development of a new international framework for cooperation on fisheries management in the Northwest Atlantic. As an interim measure ICNAF proposed to amend its convention to exclude all waters within national fishery limits from the Convention Area, while providing for coastal states to receive scientific advice on management of resources within their zones if they asked for it. Although this amendment did not formally come into force, the Commission functioned effectively on this basis. The new international order was implemented 1 January 1979 when the NAFO convention came into force. The members of ICNAF who had not already withdrawn from the organization were requested by ICNAF to do so effective 31 December 1979. Thus there was an orderly transition between the organizations with an overlap of one year.

The ICNAF convention made provision for the Commission to conduct the scientific research necessary for the support of its work. The Commission chose to obtain the information it required by coordination of the work of national research agencies through its Standing Committee on Research and Statistics, the members of which were scientists employed by Contracting Parties.

Regulatory Actions. *Trawl Regulations*: The ICNAF Commission was established at a time when there was already a recognized need for regulation of haddock fishing on Georges Bank. Trawl mesh size in common use in this fishery was 73 mm and large quantities of fish too small to market were being caught and discarded (Graham, 1952). A minimum mesh size of 114 mm was proposed in 1952 and came into effect in June 1953. Mesh regulation was expanded to include cod and extended to the Scotian Shelf, Gulf of St. Lawrence and the Grand Banks in 1957 (Appendix Table 7). In 1968 trawl regulations were extended to the waters off western Greenland, where a mesh size of 130 mm was established to match that recently established off eastern Greenland by NEAFC, and to Labrador, and a variety of species, particularly flatfish, was included in the regulations. Pollock was included in the 1968 revisions as a regulated species but only off Newfoundland, whereas the main fishery for pollock was further south off Nova Scotia and New England. In the early-1970s, a mesh size of 130 mm was applied in all areas. All ICNAF mesh regulations were specified in manila equivalents from 1957 with equivalents identical to those of NEAFC being adopted in 1968. In southern areas, where small mesh fisheries also occurred, by-catch allowances of mesh regulated species were generally 10% of the catch on board or 5 000 lb. No gear regulations were adopted for pelagic species.

Catch Controls: In the early-1960s, at the same time that ICNAF was formulating the comprehensive trawl regulations which came into force in 1968, the Commission was concerned that those measures would not in themselves be adequate to meet its objectives. A scientific report, prepared on the request of the Commission, advised in 1965 that "there must... be some direct control of the amount of fishing" (Templeman and Gulland, 1965). The first measures to control the amount of fishing, and hence the level of fishing mortality, were agreed to in 1969 for application in 1970. The method chosen was to control the total catch from each stock. Haddock stocks off Southwestern Nova Scotia and New England were the first to be placed under Total Allowable Catch (TAC) controls and, once the Commission acquired the authority to propose national allocation of TACs in 1971, catches from many other stocks were also regulated (Appendix Table 8). By 1974 virtually all stocks subjected to a significant directed fishery were under TAC control.

In Subarea 5 and Statistical Area 6 an overall "second tier" TAC was established in 1974, in addition to single stock "first tier" TACs. This second tier TAC was set at a level below the sum of the first tier TACs to address mixed fishery and by-catch problems and to allow for species interactions (O'Boyle, 1985).

These actions put ICNAF at the forefront among international fisheries commissions worldwide as the first to establish control of overall level of exploitation, to adopt TAC regulations, national allocation of catch possibilities, and, in the case of second tier TACs, the first to attempt multispecies management.

Other Measures: Gear regulations and TAC controls were the primary measures used by ICNAF to regulate exploitation of Convention Area resources. However, minimum fish size, fishing effort, and closed area and season regulations were also adopted.

Minimum fish size regulations were considered to be more effective than mesh size regulations for reducing the catches of small fish in the case of pelagic species. A regulation prohibiting the taking or possession of herring less than 22.7 cm (the regulation specified 9 inches) total length was implemented for Subareas 4 and 5 and Statistical Area 6 in 1972. However, the areas which supported the juvenile herring fisheries which supplied the "sardine" industries of coastal states were exempted. In 1976 the taking or possession of mackerel less than 25 cm total length was prohibited. In the case of both herring and mackerel, by-catch allowances of 10% by weight or 25% by number of undersized fish were provided for. Minimum fish size regulations were not considered necessary for groundfish species.

Area and seasonal closures were used by ICNAF for several purposes; to reduce by-catch problems in small mesh fisheries, to reduce the level of fishing for particular stocks, to protect spawning fish from disturbance, and to reduce interference between fisheries. The most important use was to address by-catch problems, which were most severe off Nova Scotia and to the south. A series of regulations were enacted from 1974 to close increasingly large portions of the shallow water areas on Georges Bank and further south to bottom trawling by large vessels. A large vessel, the definition of which was initially 47.2 m (155 ft) but was gradually reduced to 36.9 m (130 ft), resulted in exclusion of the large distant-water factory trawlers which were the primary vessels used in the high volume small mesh trawl fisheries for herring, mackerel, the hakes and squid. The intention was to protect the species fished with regulation large mesh gear, particularly yellowtail flounder and haddock. In 1977 these area closures were repealed in favour of open window regulations. These regulations defined the areas and seasons when fishing for particular species could take place, i.e. the converse of closed area and season restrictions. A window regulation was adopted also for silver hake, argentine and squid fisheries on the Scotian Shelf from 1977 which restricted these small mesh gear fisheries to deep water along the shelf edge during April to November, again to reduce by-catches of large-mesh regulated species. In both cases, although adoption of windows was negotiated through ICNAF in 1976, these could be looked upon as coastal state regulations, as they applied to areas which came entirely under USA and Canadian jurisdiction in 1977. Closure to fishing of overwintering areas of red and silver hakes off Georges Bank were implemented from 1970, initially as an alternative to TAC control of exploitation level, as there was inadequate scientific knowledge to establish appropriate catch restrictions. Closures of haddock spawning areas during the spawning season were enacted for the same year on Browns Bank off Southwestern Nova Scotia and on Georges Bank and in the Gulf of Maine. These closures were ostensibly to protect against disturbance of mature fish during the spawning act in the hope of improving spawning success, but were part of a package of measures intended to reduce fishing mortality (Halliday, 1988). Finally, capelin fishing off the south-east coast of Newfoundland was not allowed in a band adjacent to the coast from 1975. This was to reduce the interference of the offshore fishery in the ICNAF Convention Area with the inshore migration of capelin, and the cod associated with it, which supported the coastal fisheries (within three miles and hence outside the Convention Area).

Proposals for direct control of fishing effort were abandoned in relation to Subarea 5 and Statistical Area 6 fisheries, because of difficulties in resolving the technical issues involved, in favour of the second tier TAC approach. However, regulation of fishing effort was implemented in 1976 for Subareas 2–4 groundfish fisheries of non-coastal states. This was a simpler regulation than that proposed for the southern areas, although a substantial reduction, 40% of 1973 effort levels, was called for. Effort was measured as days fished and reductions were effected by scaling on the basis of each vessel tonnage class and major gear type category for each Contracting Party in each of five fishing areas. Effort could be reallocated between vessel/gear categories within Contracting Party fleets using agreed conversion factors based on relative catch-per-day fished. Limited transferability between the defined fishing areas was also allowed. This regulation was in effect for only one year, so there is insufficient evidence on which to judge its effectiveness.

Surveillance and Compliance. The ICNAF Scheme for Joint International Enforcement of the

Fishery Regulations, which became operative in 1971, provided for inspectors to examine catches, fishing gear and relevant documents to verify that the Commission's regulations were being observed. There were initial reservations by some countries to below-deck inspections but these were largely removed by 1973, and the scheme was progressively strengthened.

Active participation in at-sea inspection activities was limited, most inspections being conducted by Canada and USA – the coastal states. The lack of authority of inspectors to take direct, immediate, remedial action when apparent infringements of regulations were discovered also limited the effectiveness of the scheme. Attempts were made to rectify this problem by requiring representatives of flag state authorities to be available to receive reports of inspectors on a real-time basis so that immediate action to prevent continuation of violations by their fleets would be possible.

Although the ICNAF enforcement scheme did not provide adequate deterrence to prevent serious violations of its conservation regime, the scheme did prove capable of establishing that disregard for ICNAF regulations was widespread. The USA inspectors discovered that fishermen were often not even aware of the regulations in force for the area in which they were fishing. In addition, USA authorities concluded that most member nations had no effective direct control over their vessels from the time they left port until their return, a situation they characterized as negligent (USA, MS 1976). Violations were by no means restricted to the catch controls which were implemented at the same time as the inspection scheme was instituted. Infractions also involved mesh size regulations which had been in place for many years. Deficiencies found in log record keeping also suggested that the historical record of catch and fishing effort, maintained by ICNAF from the mid-1950s, could not be taken entirely at face value.

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.

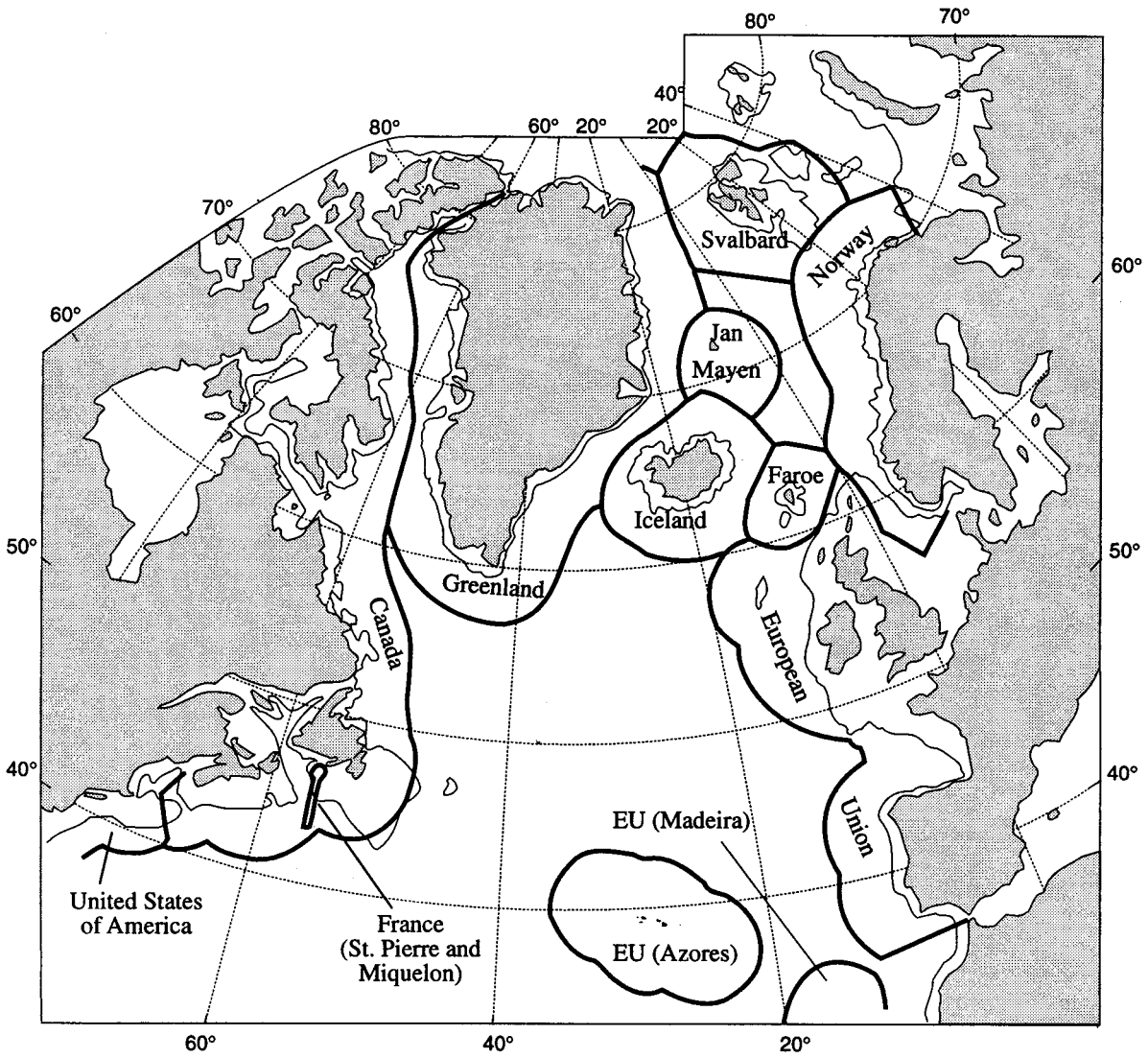

Fig. 3. Fishing zones in the North Atlantic. (Depth contour is 200 m. Zonal boundaries are approximate and not necessarily agreed between parties.)

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

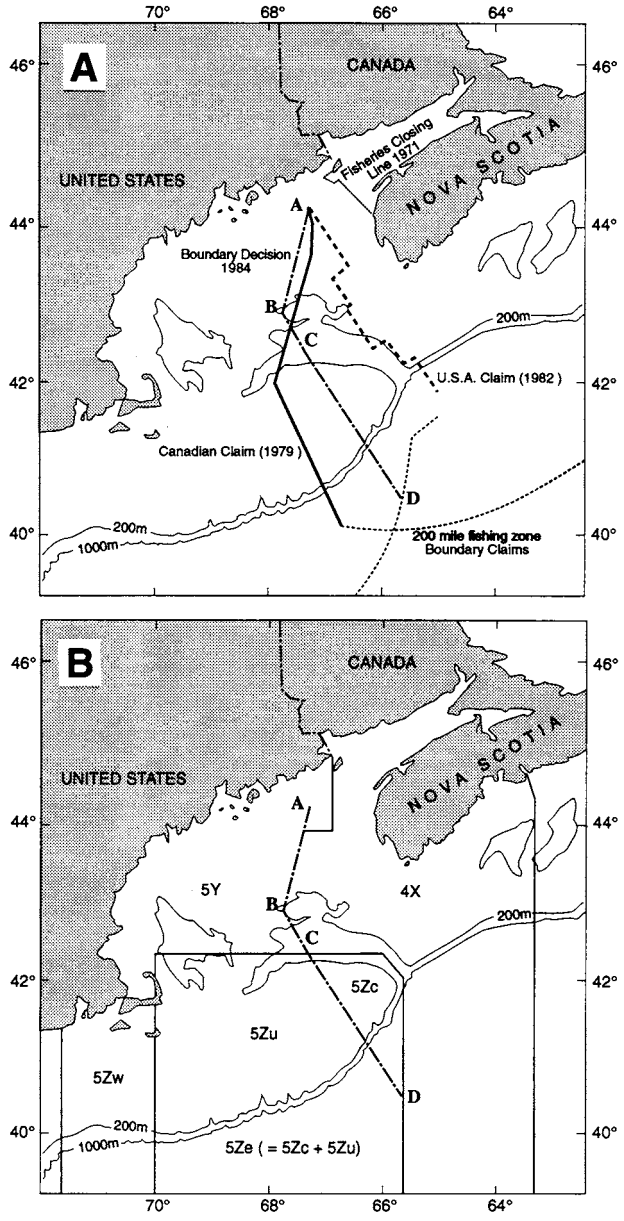

Fig. 4. (**A**) Canadian and USA jurisdiction claims in the Gulf of Maine area put before a Chamber of the International Court of Justice, and the Chamber's binding decision of October 1984 on a jurisdictional boundary (line A–D). Bay of Fundy closing line of 1971 also shown.

(**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

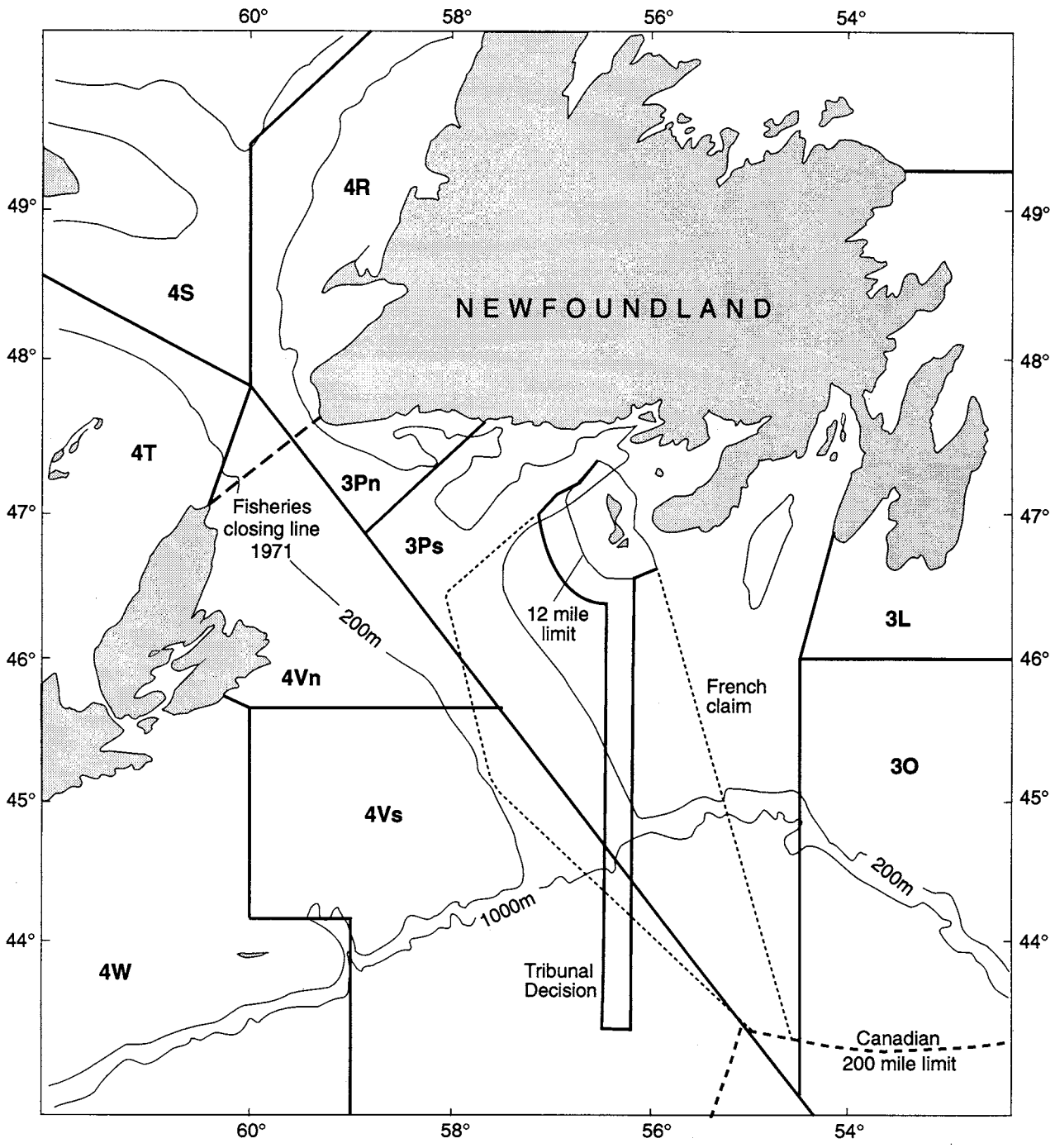

Fig. 5. Canadian and French jurisdictional claims in waters adjacent to St. Pierre and Miquelon put before an international Tribunal, and the Tribunal's binding decision of June 1992 on a jurisdictional boundary. Canada claimed all waters to within 12 miles of St. Pierre and Miquelon. Gulf of St. Lawrence 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 over-capitalization of the 1976–81 period (Schrank, 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 feet 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

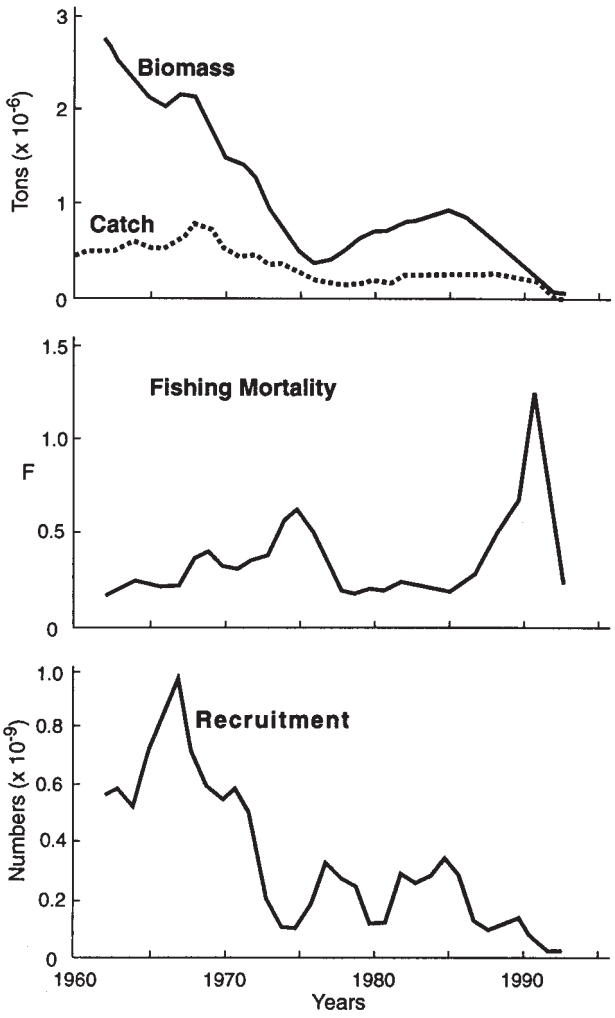

Fig. 6. Labrador–East Newfoundland cod: trends in stock parameters.

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

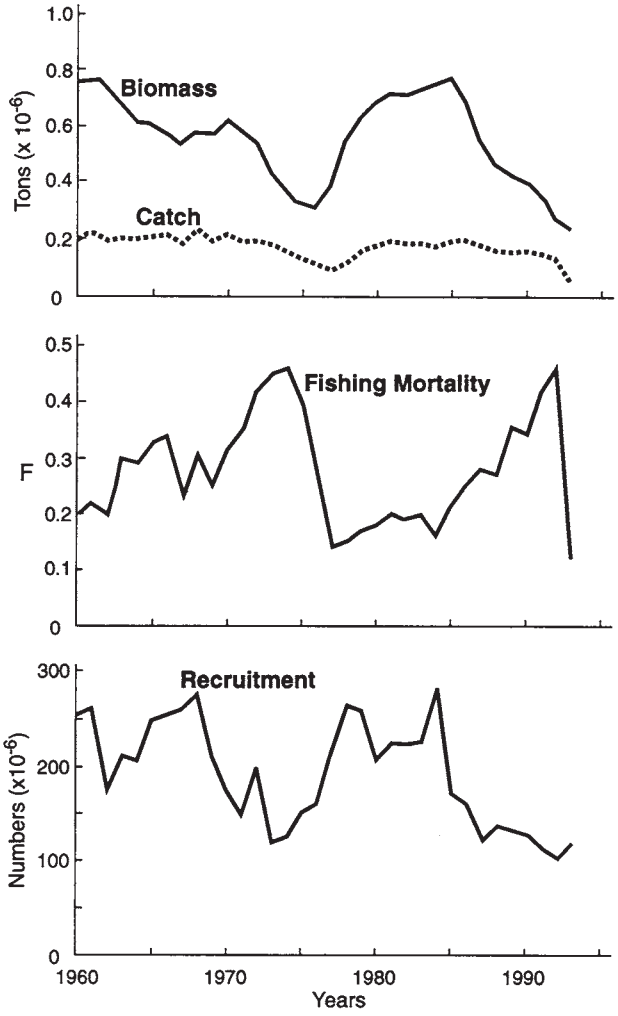

Fig. 7. Other Canadian cod stocks: trends in stock parameters.

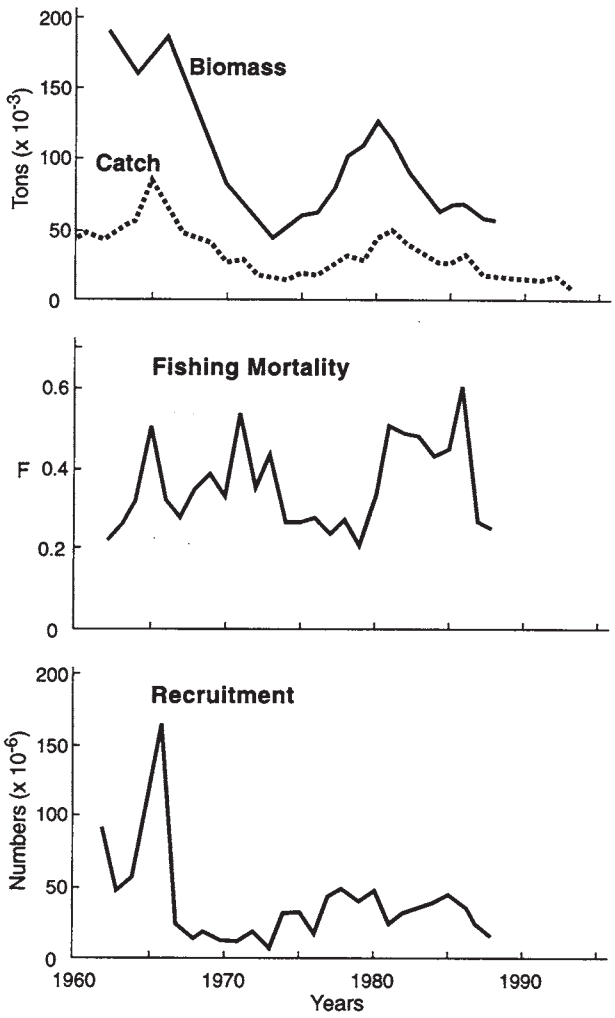

Fig. 8. Canadian haddock: trends in stock parameters.

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

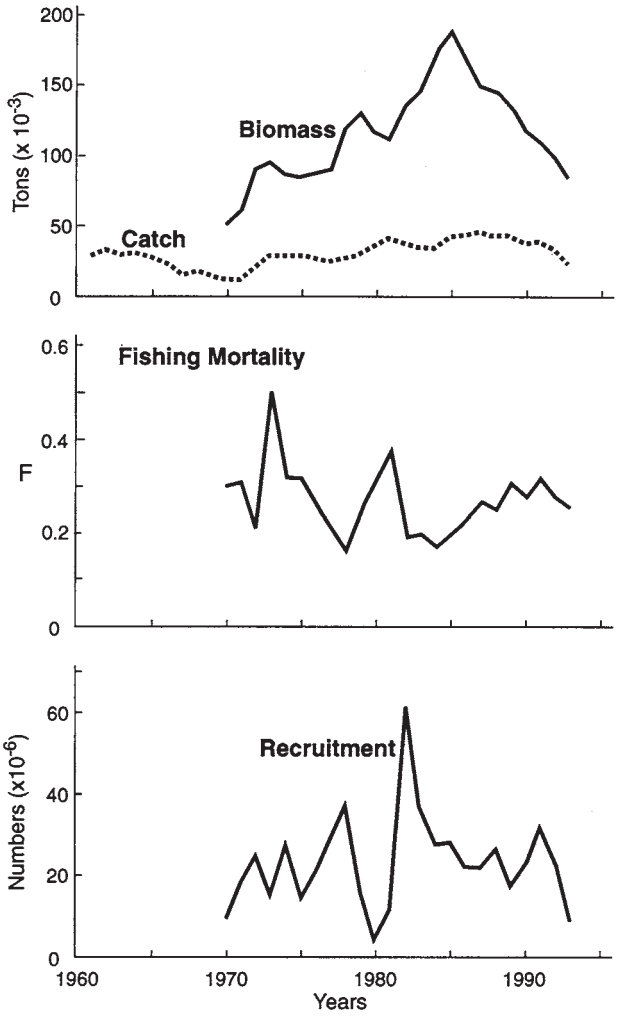

Fig. 9. Canadian pollock: trends in stock parameters.

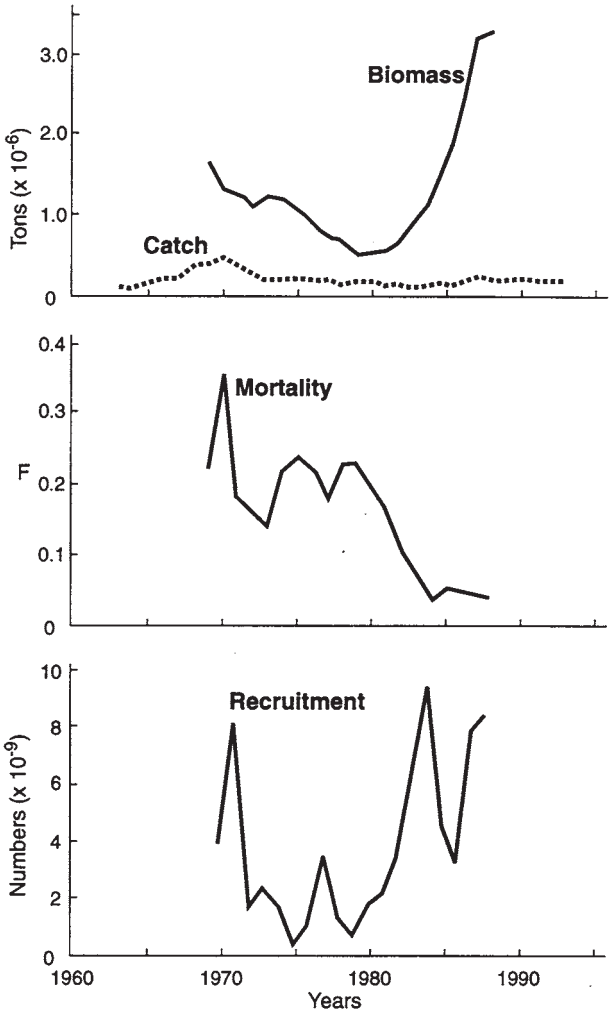

Fig. 10. Canadian herring: trends in stock parameters.

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

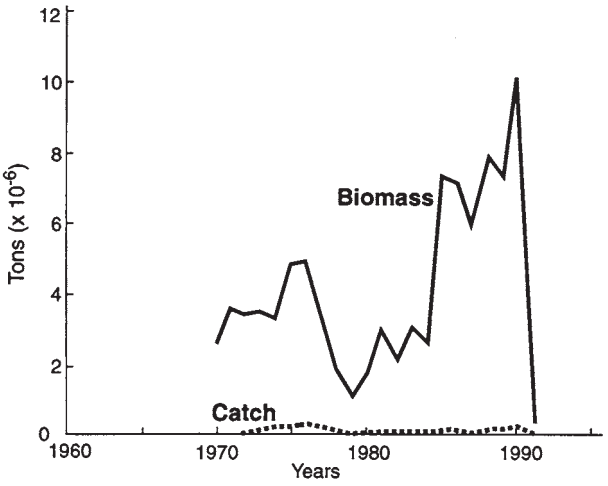

Fig. 11. Canadian capelin: catches and biomass.

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.

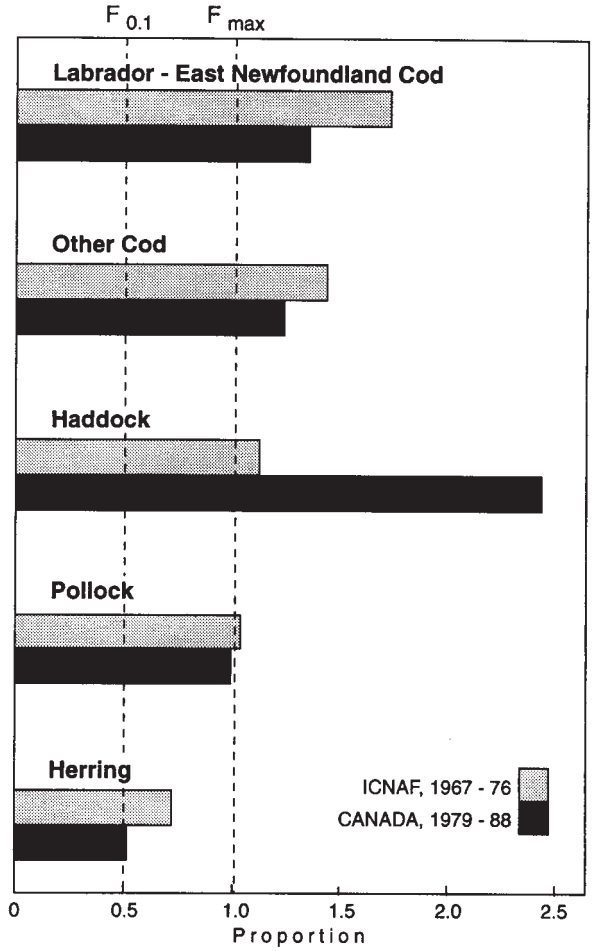

Fig. 12. Canadian stocks: fishing mortality in the ICNAF and Canadian management periods in relation to F_{max} and $F_{0.1}$.

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

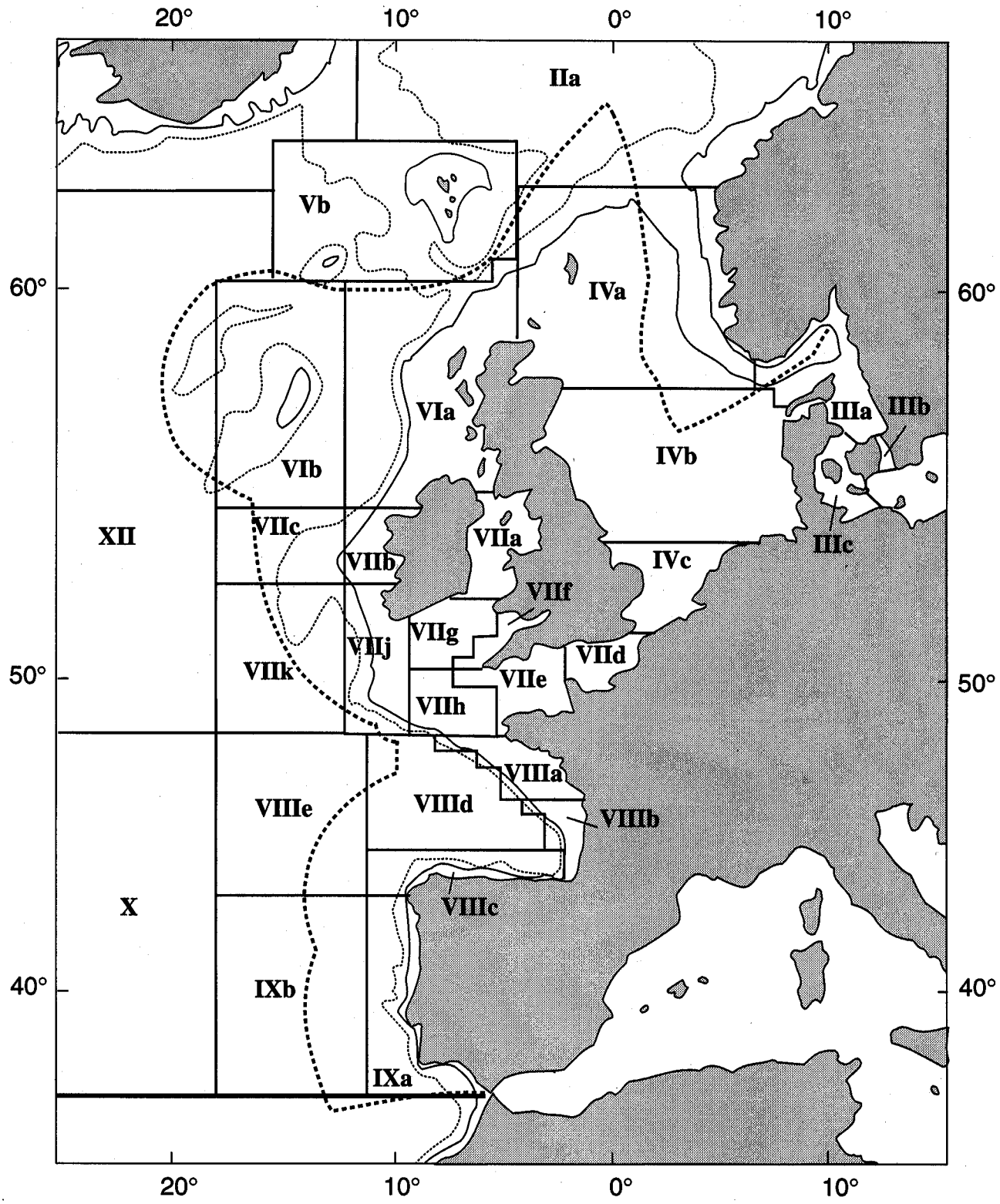

Fig. 13. Outer bounds of jurisdictional claims of EU member states (heavy dashed line) which define EU domestic waters in the Northeast Atlantic, and ICES Statistical Areas. (Depth contours are 200 m – solid line, 1 000 m – fine dashed line.)

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

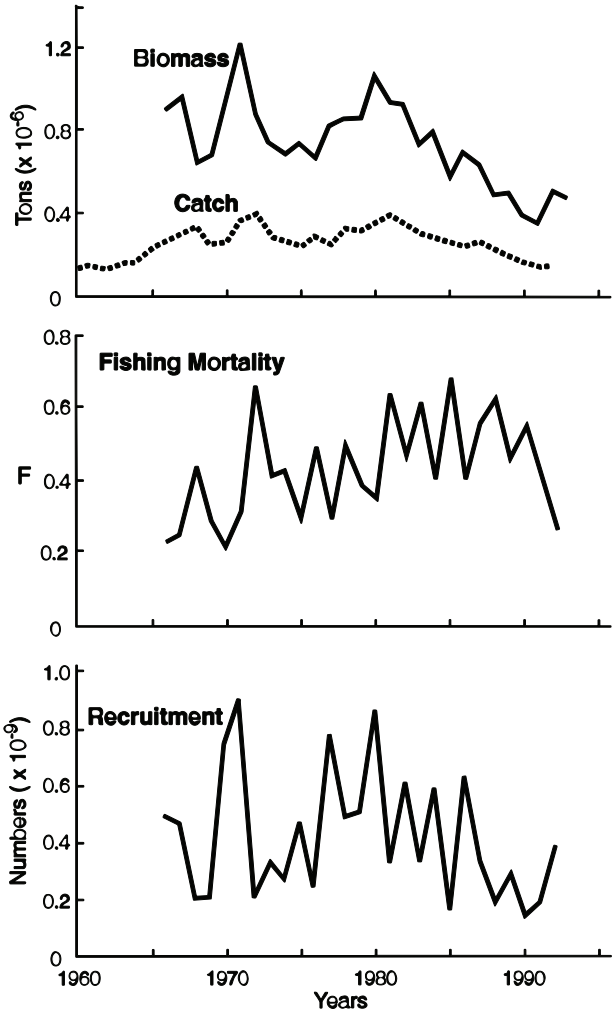

Fig. 14. European Union cod: trends in stock parameters.

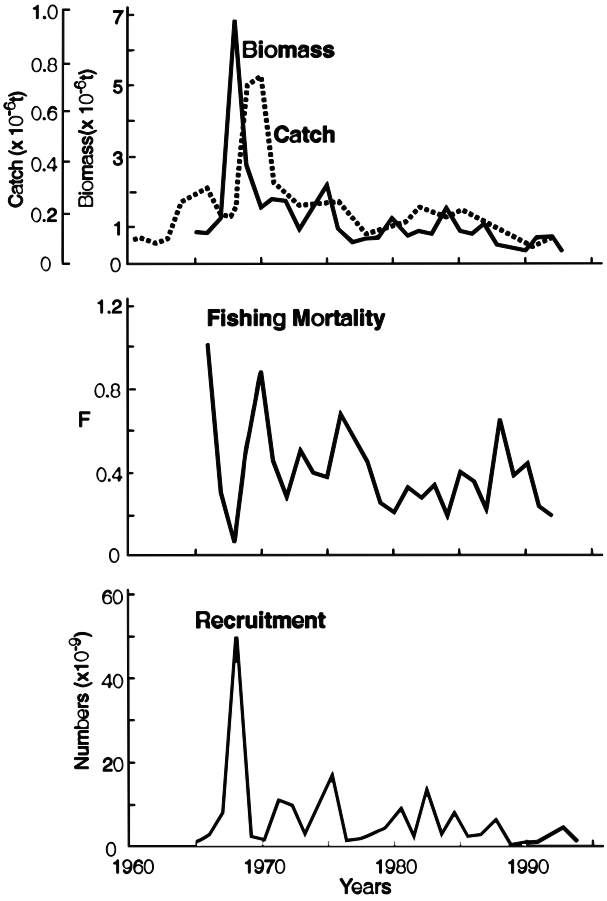

Fig. 15. European Union haddock: trends in stock parameters.

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 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

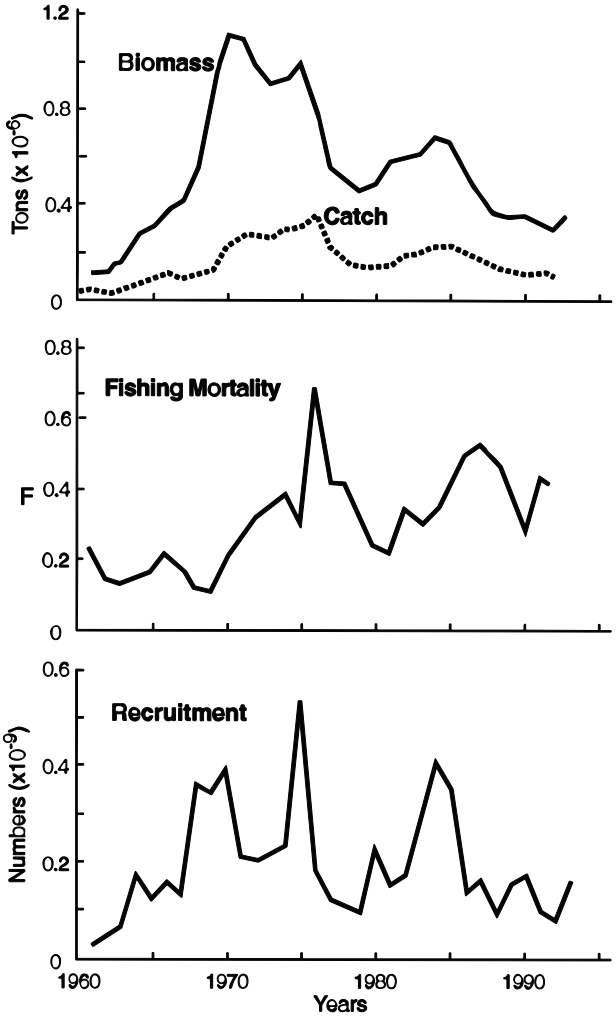

Fig. 16. European Union pollock: trends in stock parameters.

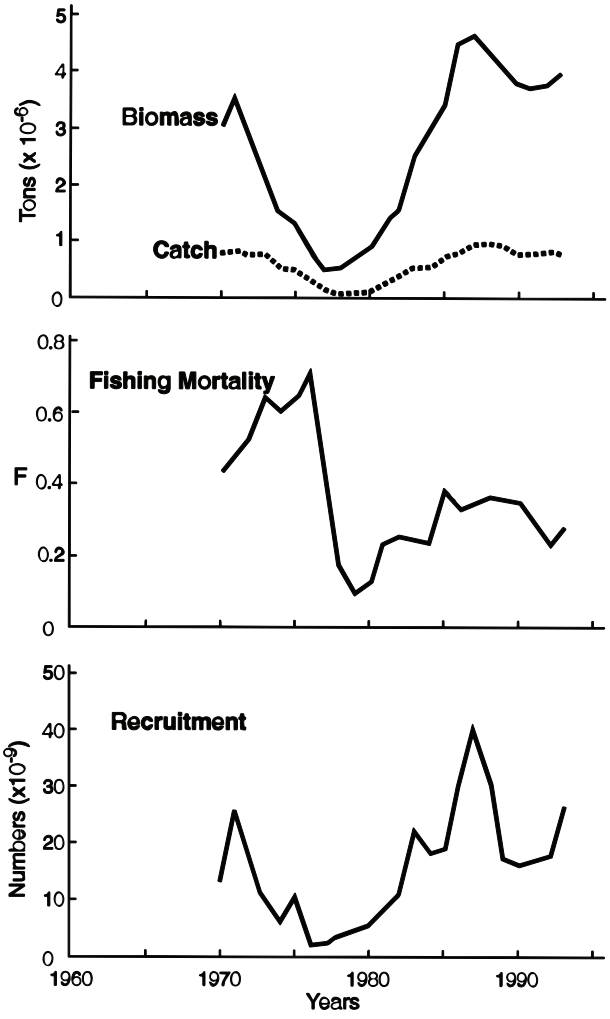

Fig. 17. European Union herring: trends in stock parameters.

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

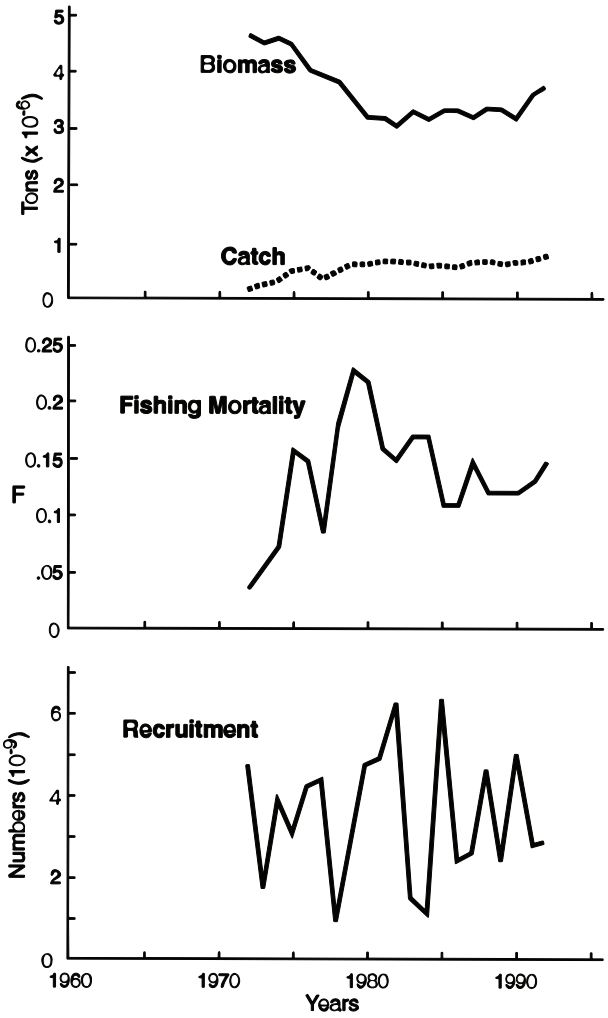

Fig. 18. European Union mackerel: trends in stock parameters.

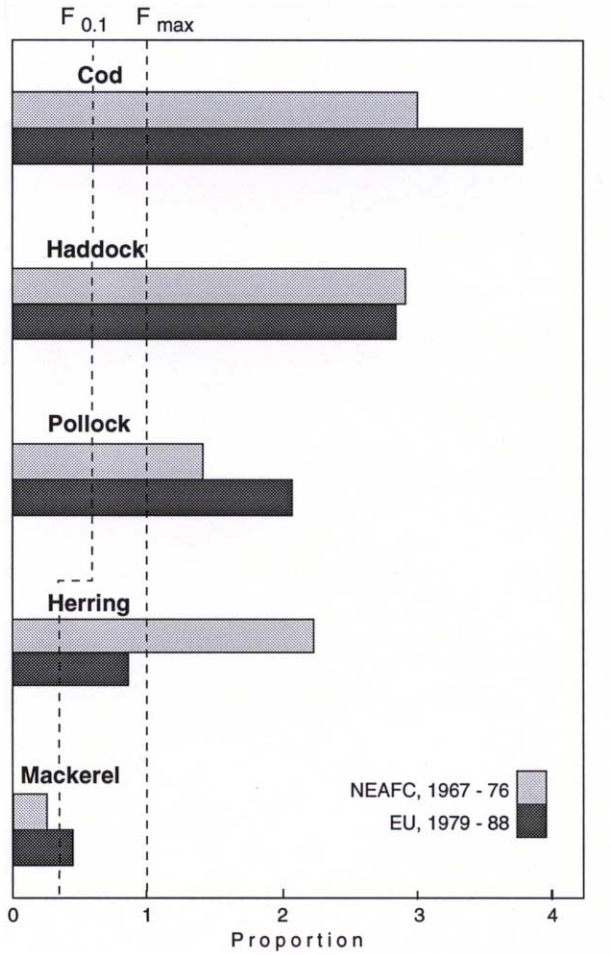

Fig. 19. European Union stocks: fishing mortality in the NEAFC and EU management periods in relation to F_{max} and $F_{0.1}$. (Discontinuity in $F_{0.1}$ line reflects differences in ratios to F_{max}).

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. 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

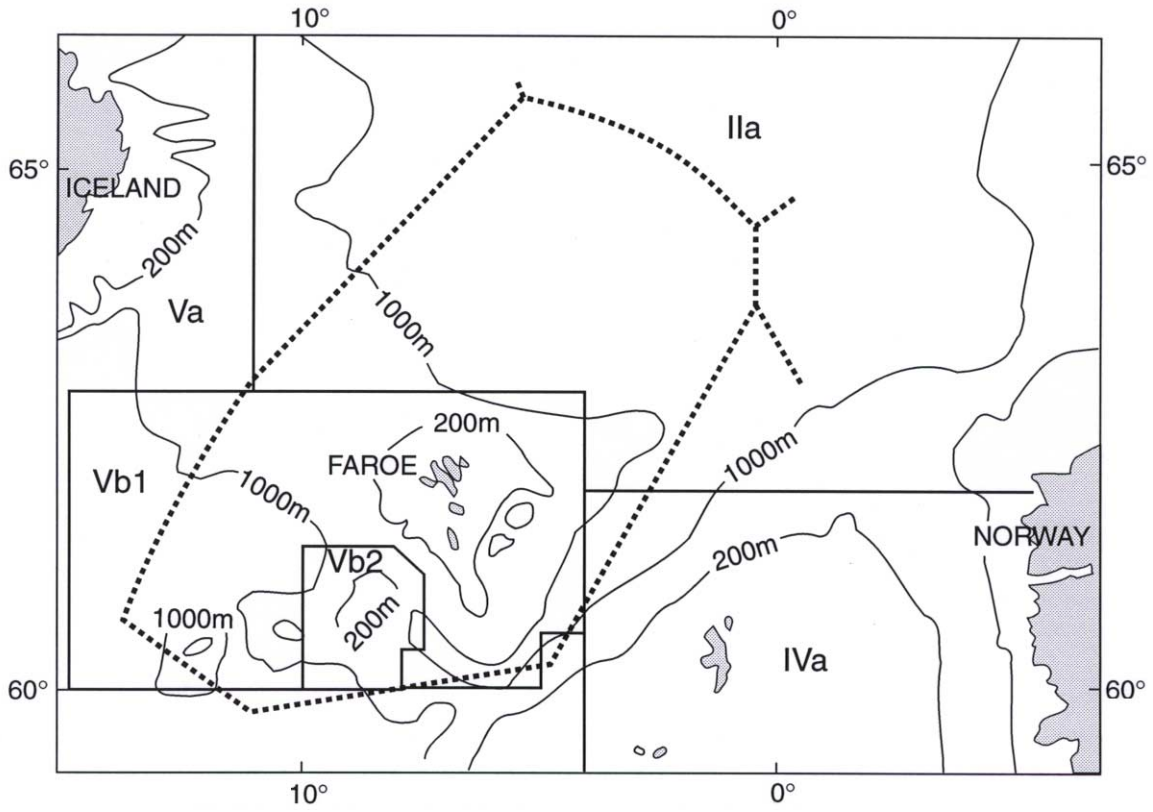

Fig. 20. Danish claim to jurisdiction in waters adjacent to the Faroe Islands, and ICES Statistical Areas.

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 over-riding 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

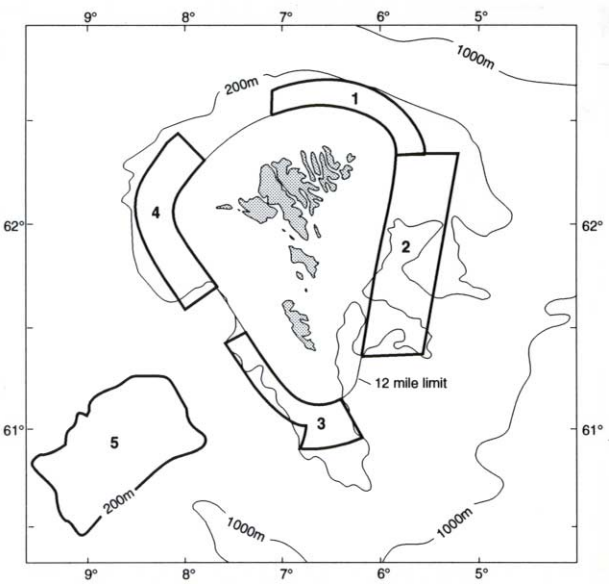

Fig. 21. Areas around the Faroe Islands closed to otter trawling on a seasonal basis in 1974–77 through international agreement.

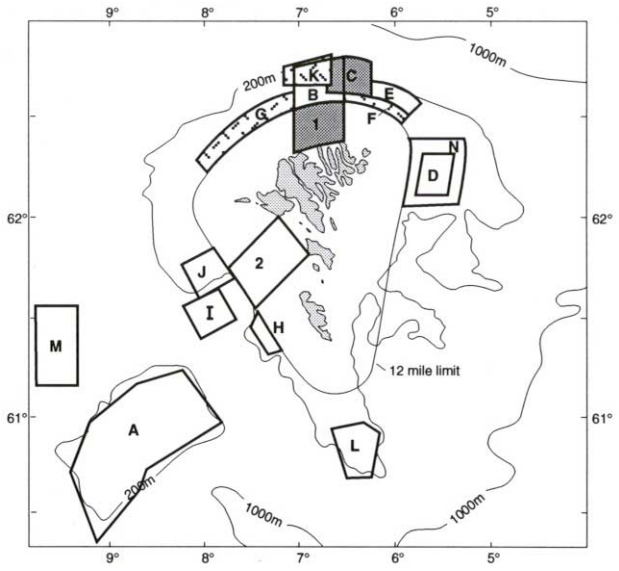

Fig. 22. Areas around the Faroe Islands closed to otter trawling (letter designations) and gillnetting (number designations) on a seasonal basis, through domestic legislation. Trawling prohibited within 12 mile limit (except under special licence) and gillnetting prohibited within four miles of land,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

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.

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

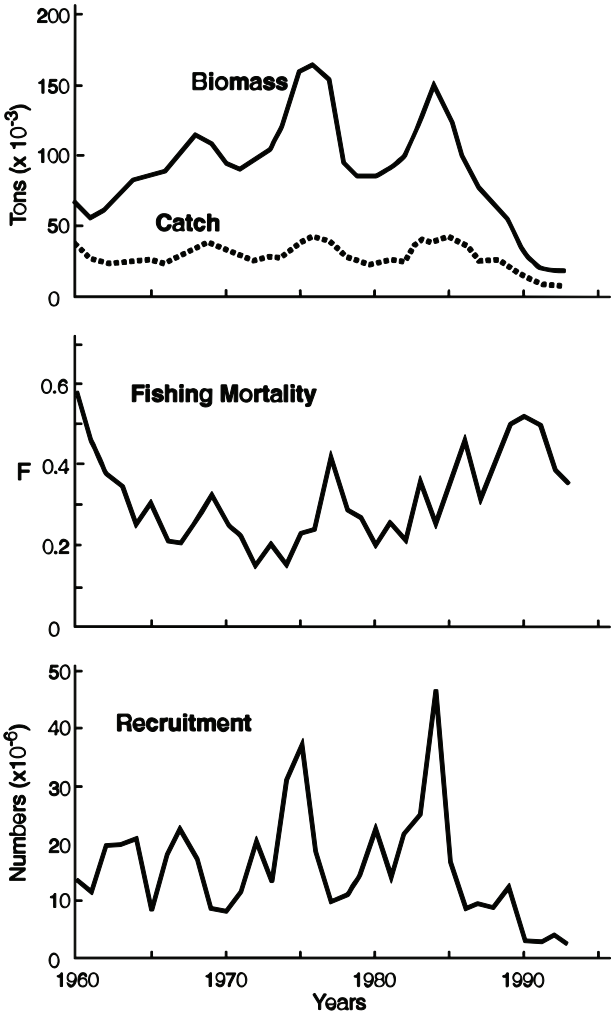

Fig. 23. Faroese cod: trends in stock parameters.

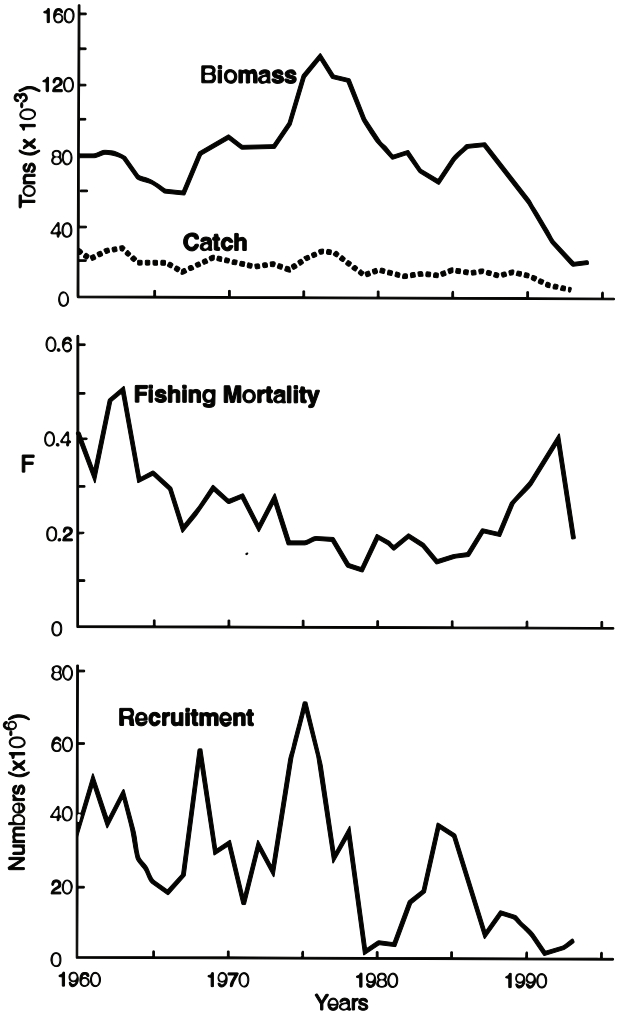

Fig. 24. Faroese haddock: trends in stock parameters.

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

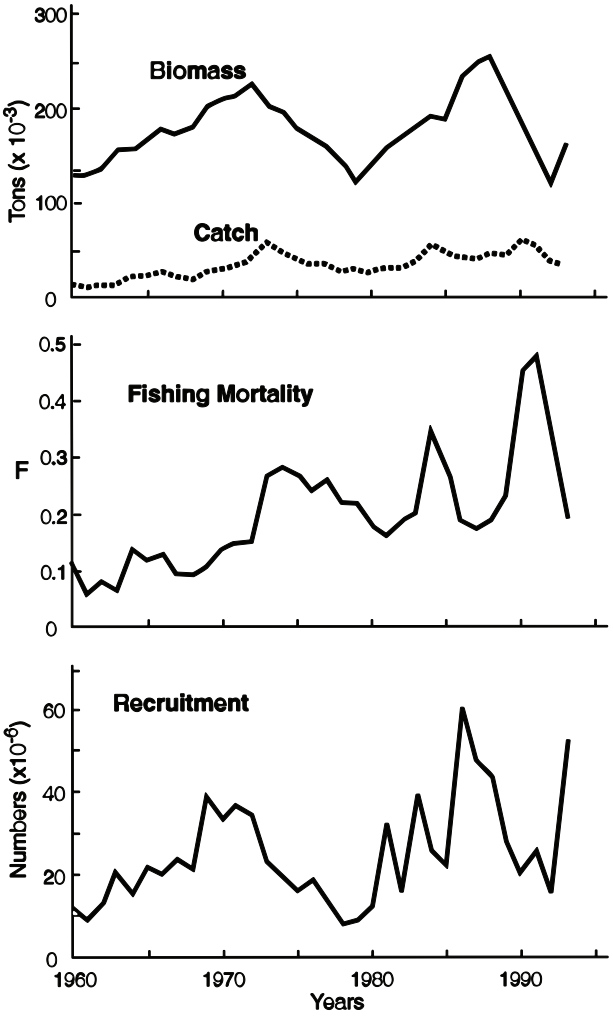

Fig. 25. Faroese pollock: trends in stock parameters.

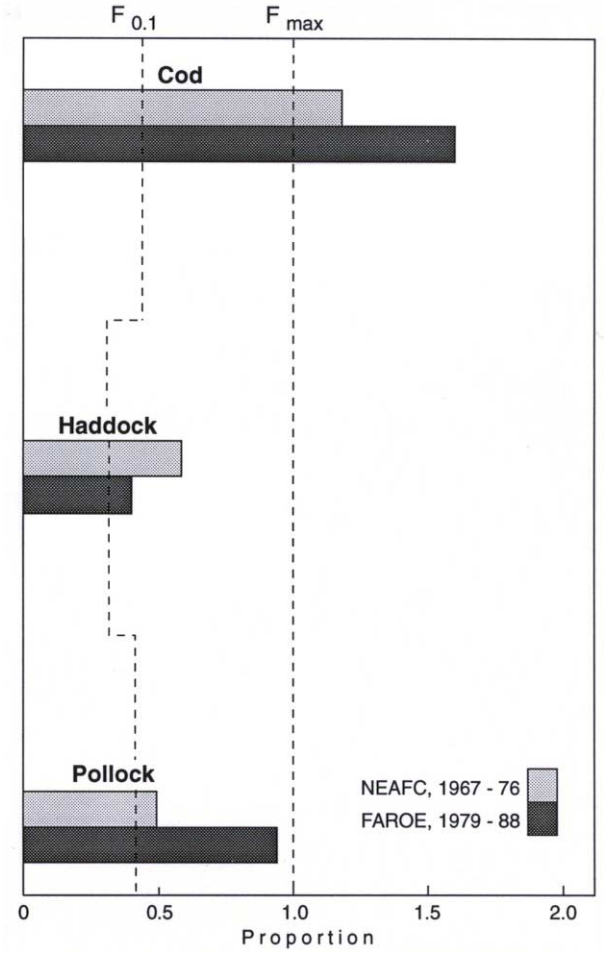

Fig. 26. Faroese stocks: fishing mortality in the NEAFC and Faroese management periods in relation to F_{max} and $F_{0.1}$. (Discontinuities in $F_{0.1}$ line reflect differences in ratios to F_{max}).

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 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

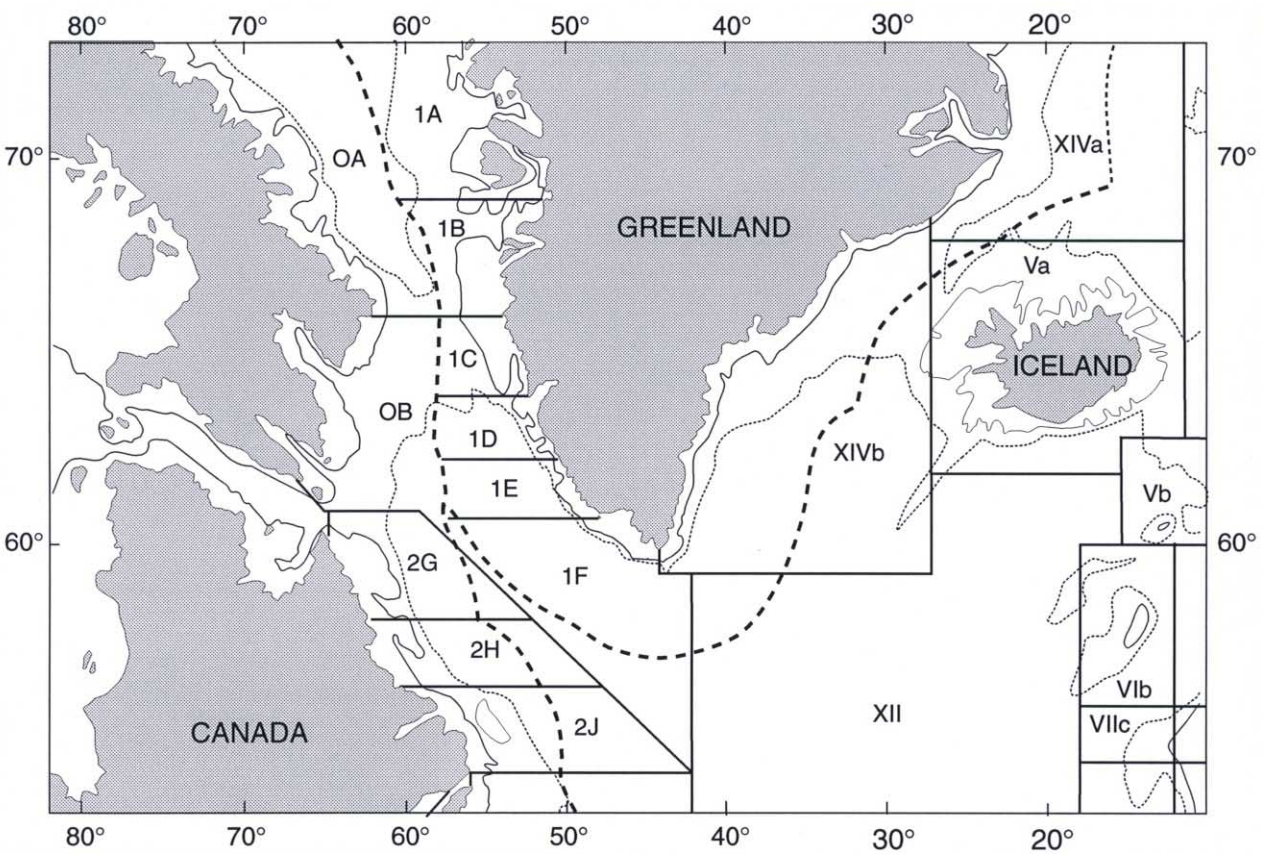

Fig. 27. Danish claim to jurisdiction in waters adjacent to Greenland, except that median line is shown (as lighter dashed line) in disputed area between Greenland and Jan Mayen whereas Denmark claims full 200 mile zone. Statistical Areas also shown.

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 interlinks 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-regium 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

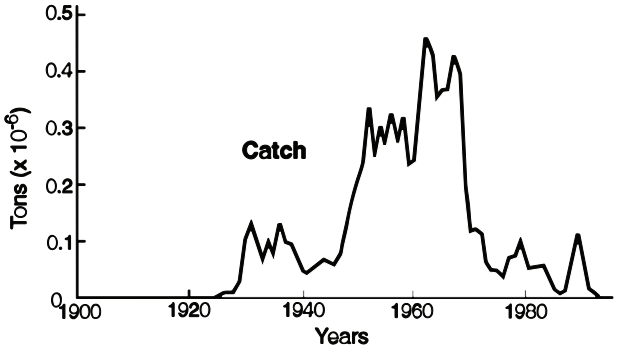

Fig. 28. Catches of cod off western Greenland, 1900–93 (based on Horsted (MS 1994)).

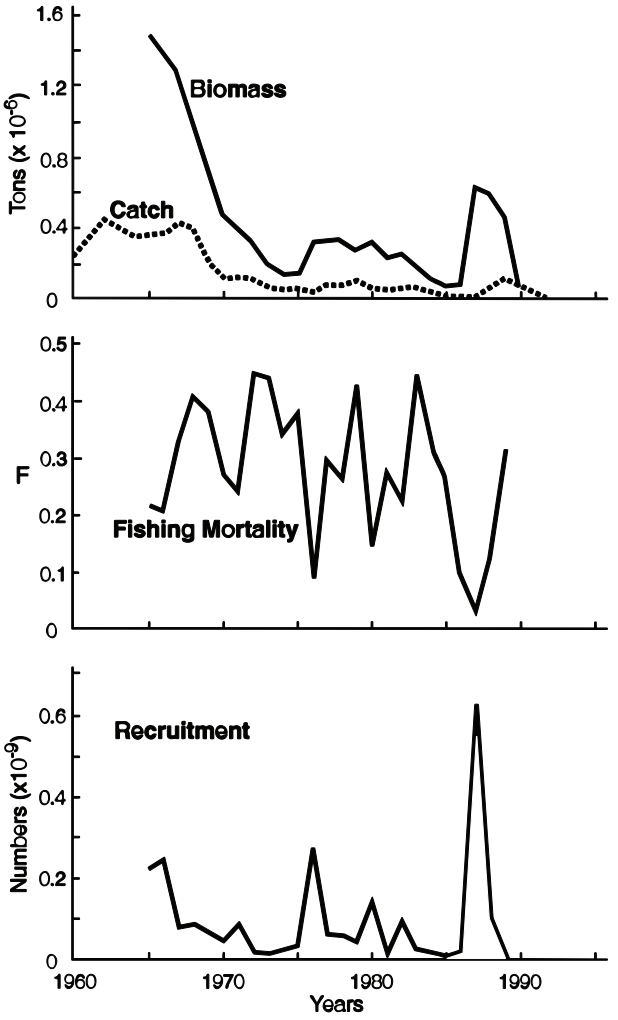

Fig. 29. West Greenland cod: trends in stock parameters.

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.

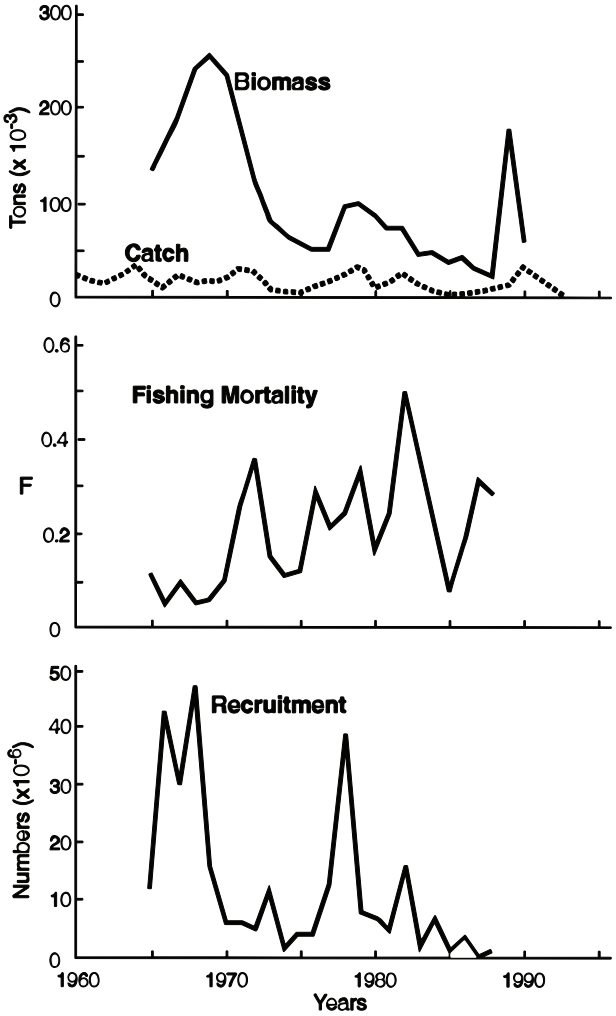

Fig. 30. East Greenland cod: trends in stock parameters.

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

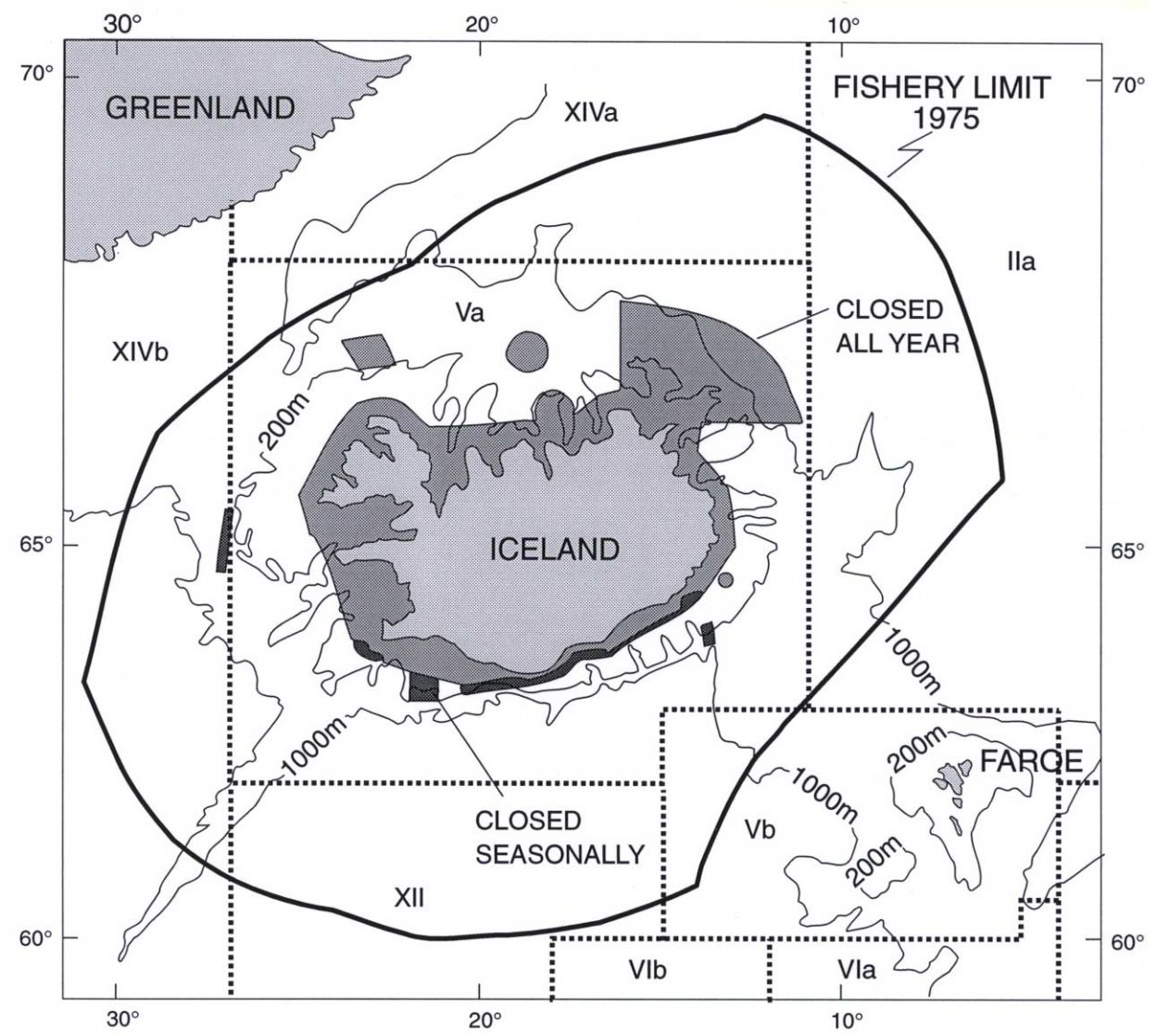

Fig. 31. Jurisdictional boundaries claimed by Iceland in 1975, ICES Statistical Areas, and areas around Iceland closed to trawling by the late-1970s.

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 annunciate 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 (Vilhjálmsson, 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; Skarphédinsson, 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

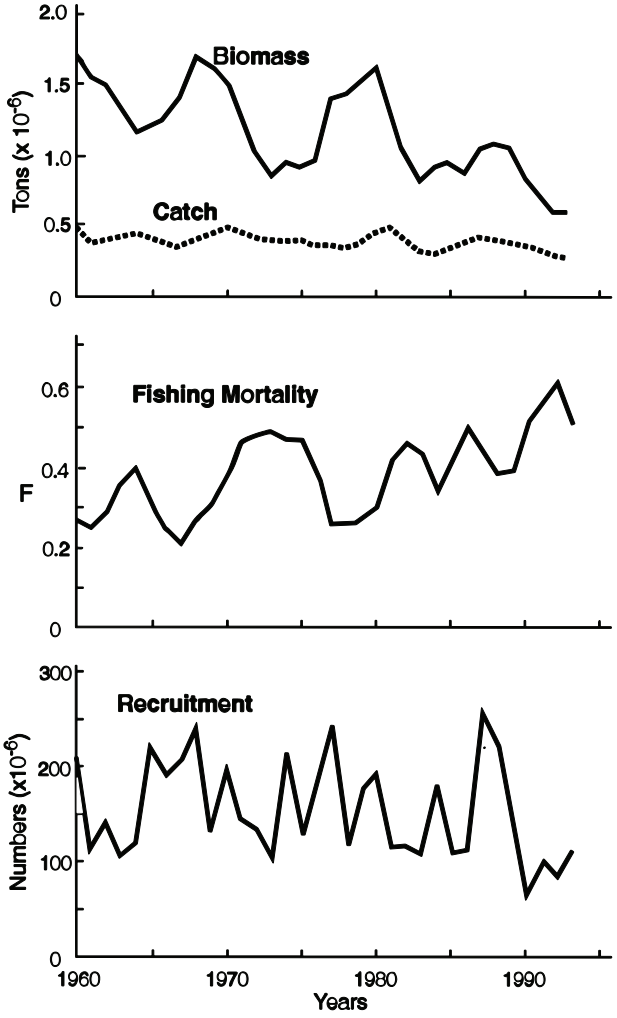

Fig. 32. Icelandic cod: trends in stock parameters.

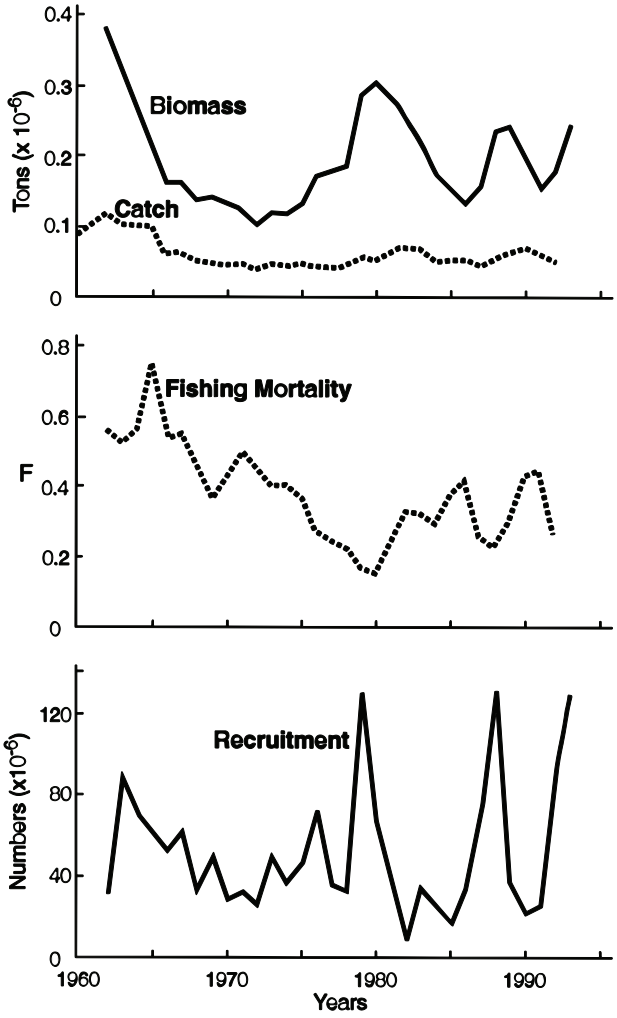

Fig. 33. Icelandic haddock: trends in stock parameters.

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).

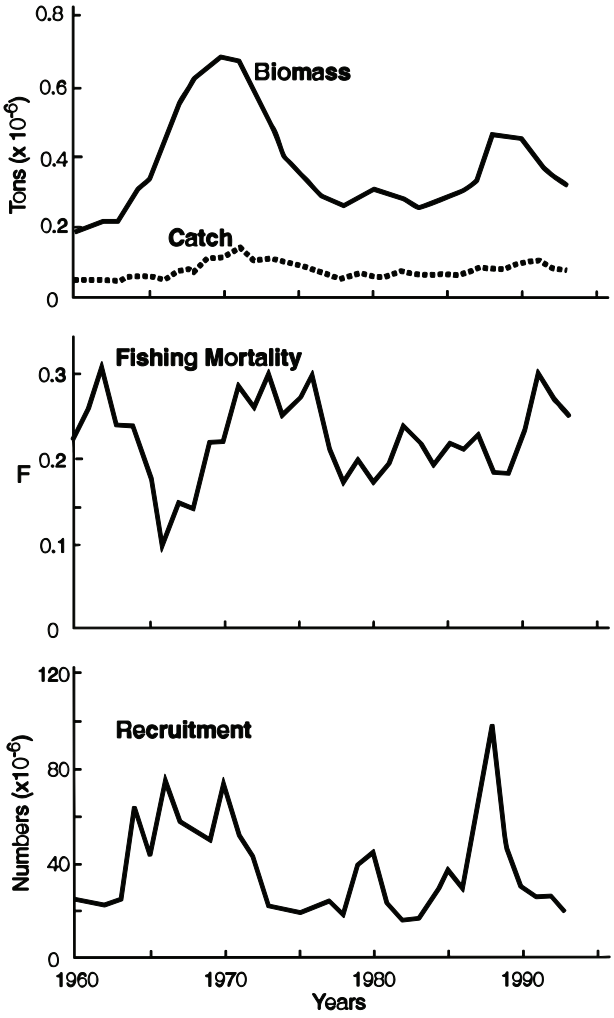

Fig. 34. Icelandic pollock: trends in stock parameters.

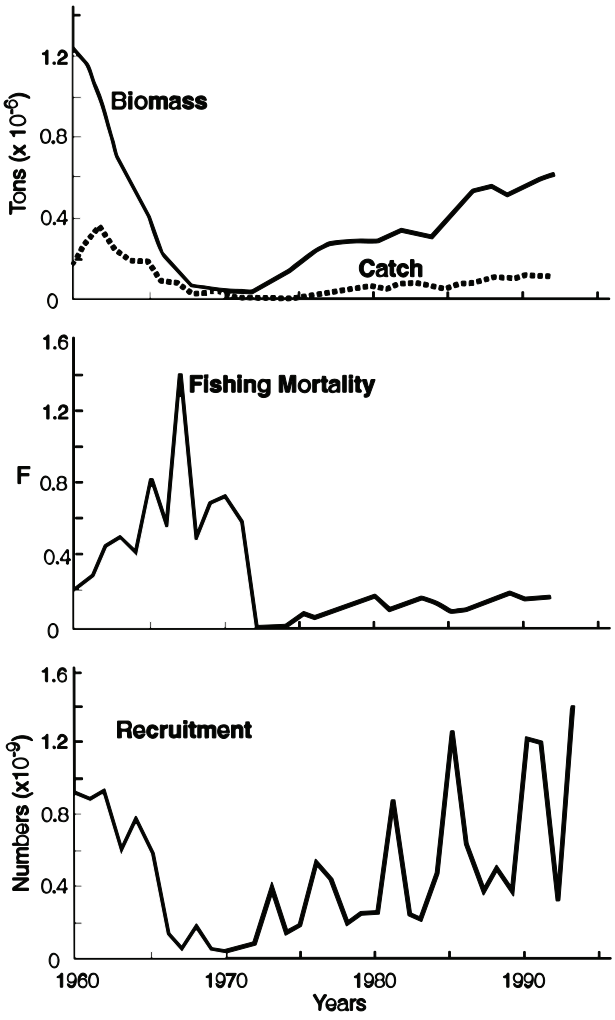

Fig. 35. Icelandic herring: trends in stock parameters.

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

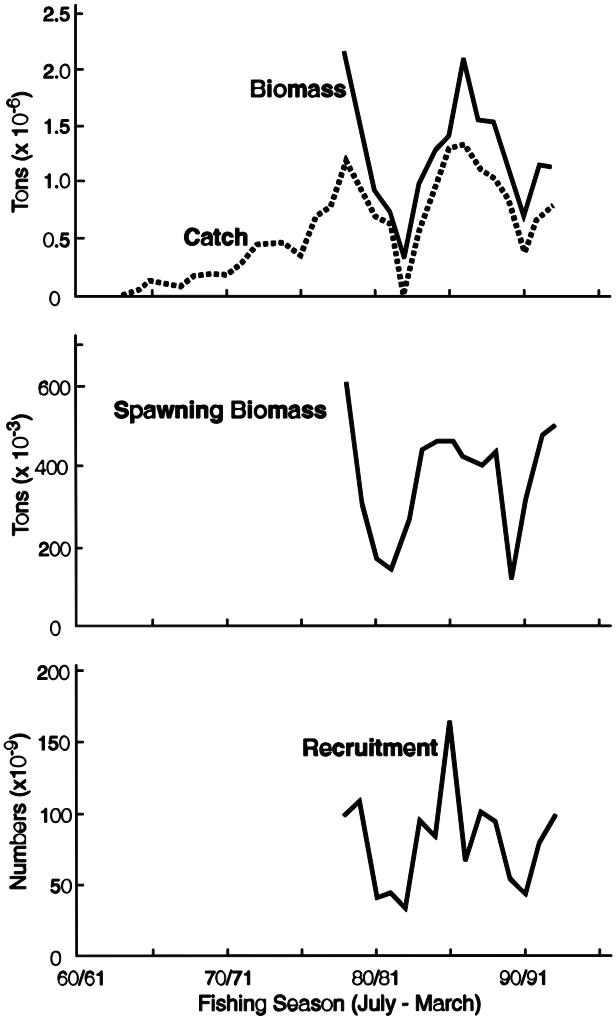

Fig. 36. Icelandic capelin: trends in stock parameters. (Stock biomass and recruitment estimates are for the beginning, and spawning biomass is for the end, of the fishing season.)

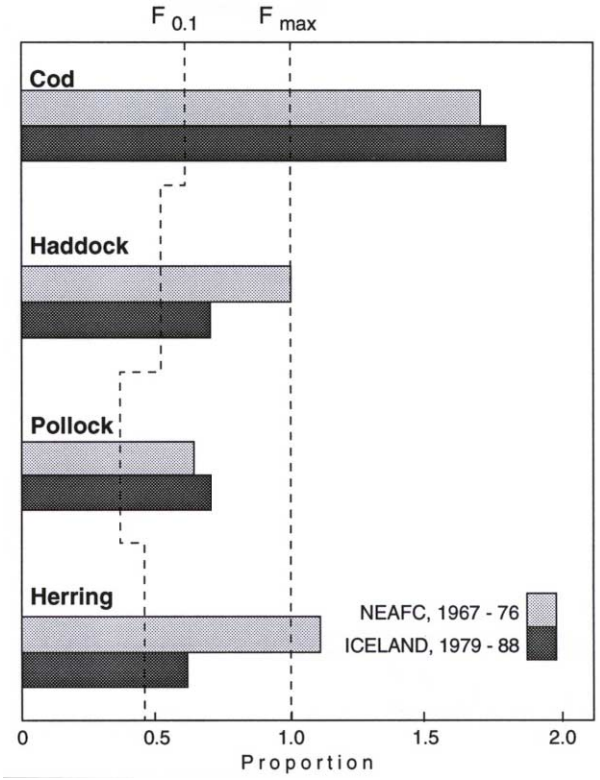

Fig. 37. Icelandic stocks: fishing mortality in the NEAFC and Icelandic management periods in relation to F_{max} and $F_{0.1}$. (Discontinuities in $F_{0.1}$ line reflect differences in ratios to F_{max}).

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 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 Daníelsson 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

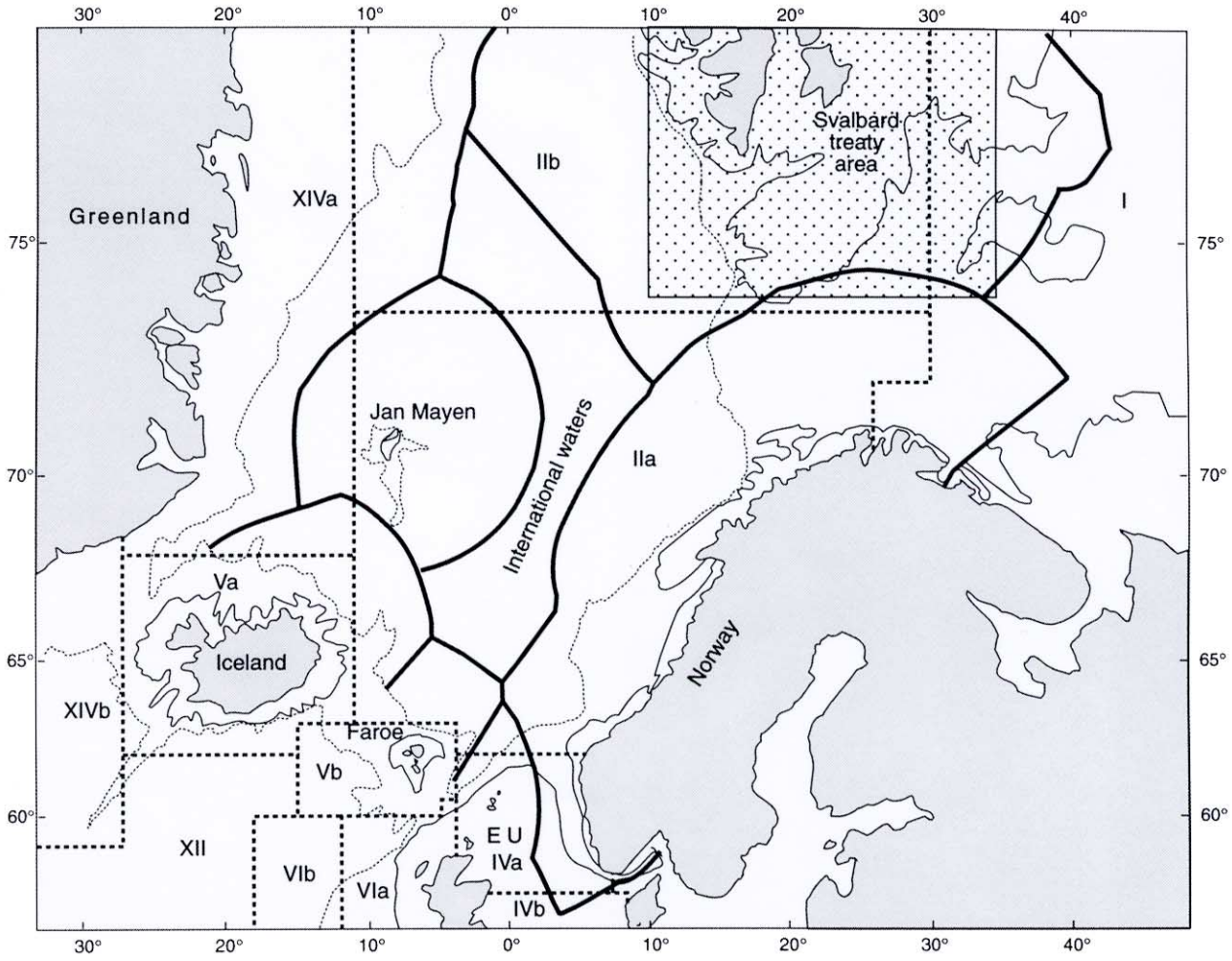

Fig. 38. Norwegian claims to jurisdiction in waters adjacent to the coast of Norway and off Jan Mayen, and to a fishery protection zone around Svalbard. Svalbard Treaty Area and ICES Statistical Areas also shown. (Depth contours are 200 m – solid line, 1 000 m – dashed line.)

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 (Vilhjálmsson, 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

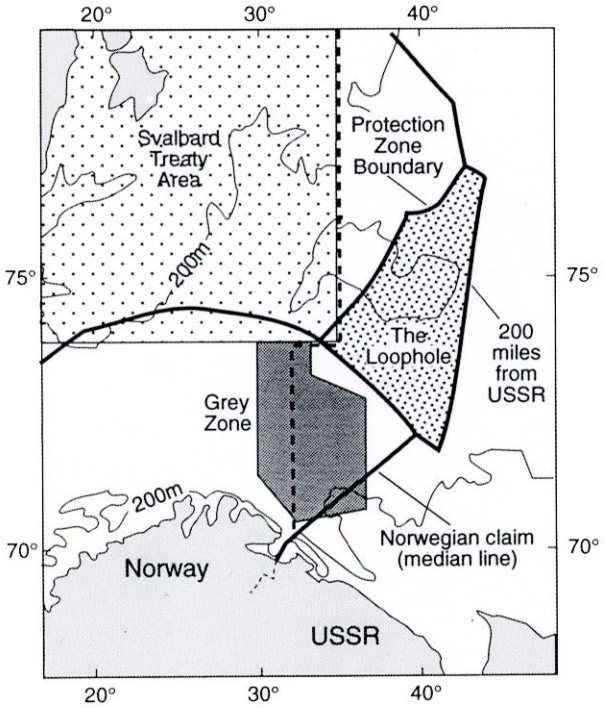

Fig. 39. The political geography of the Barents Sea: the USSR (Russian) sector line claim (dashed line), the Norwegian 200 mile zone claim including a median line boundary with the USSR, the eastern boundary to the 200 mile Svalbard fishery protection zone claimed by Norway, the grey zone of shared Norwegian–USSR 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 development 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 Northeast 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

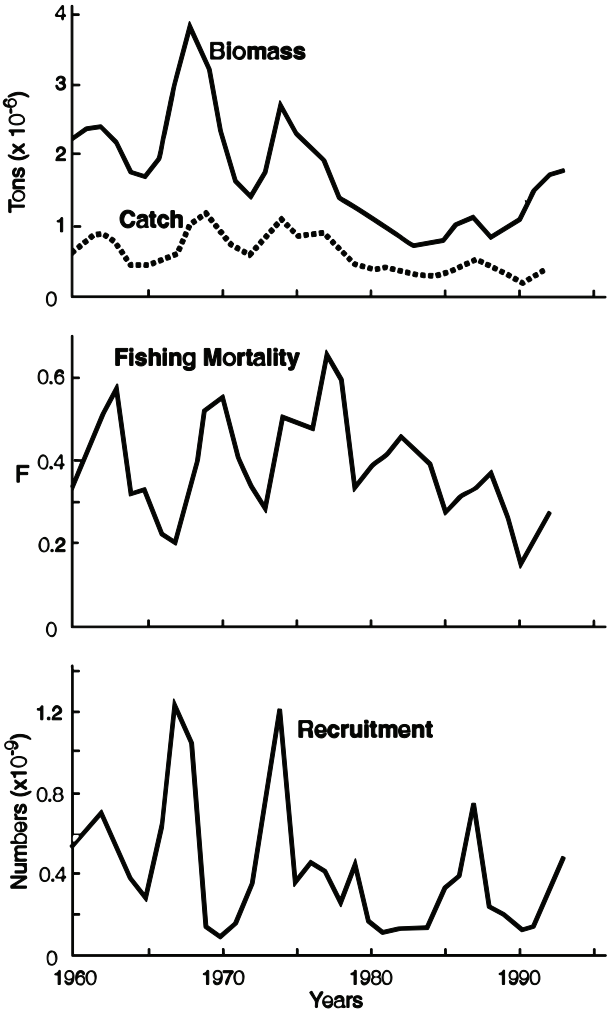

Fig. 40. Norwegian cod: trends in stock parameters.

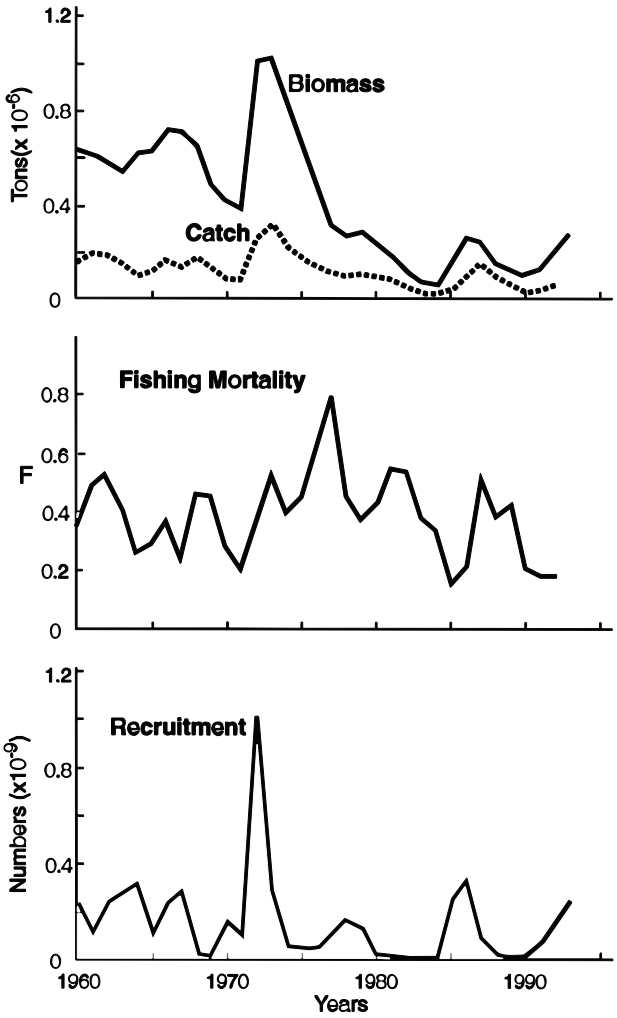

Fig. 41. Norwegian haddock: trends in stock parameters.

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 plaice 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

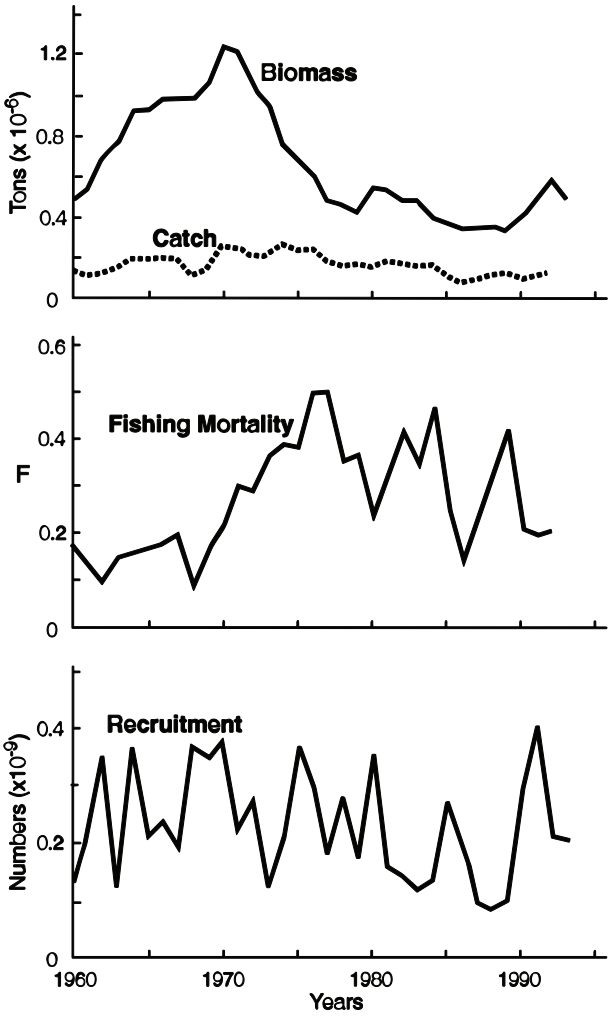

Fig. 42. Norwegian pollock: trends in stock parameters.

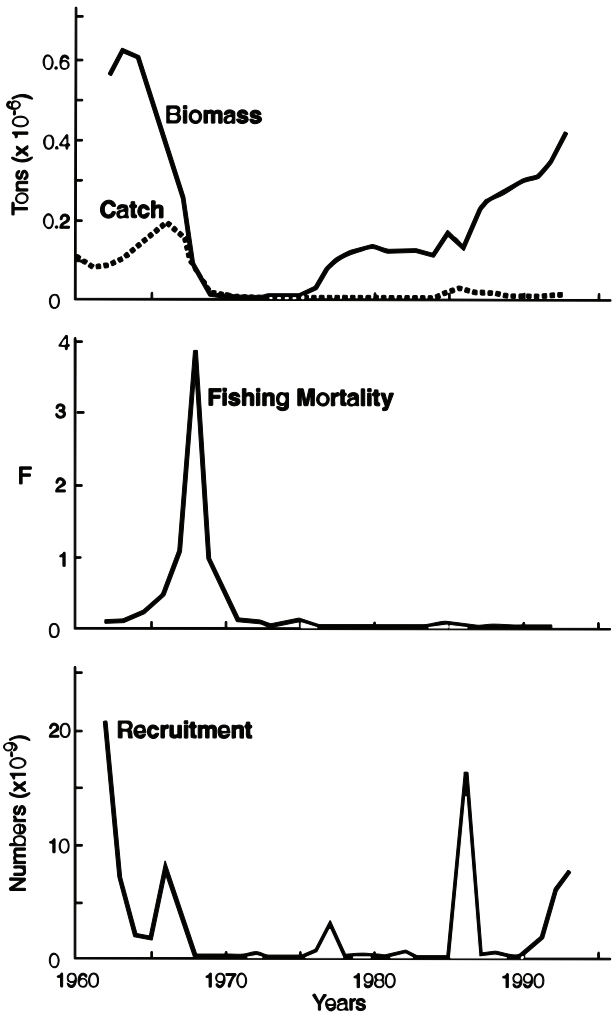

Fig. 43. Norwegian herring: trends in stock parameters.

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 practically 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.

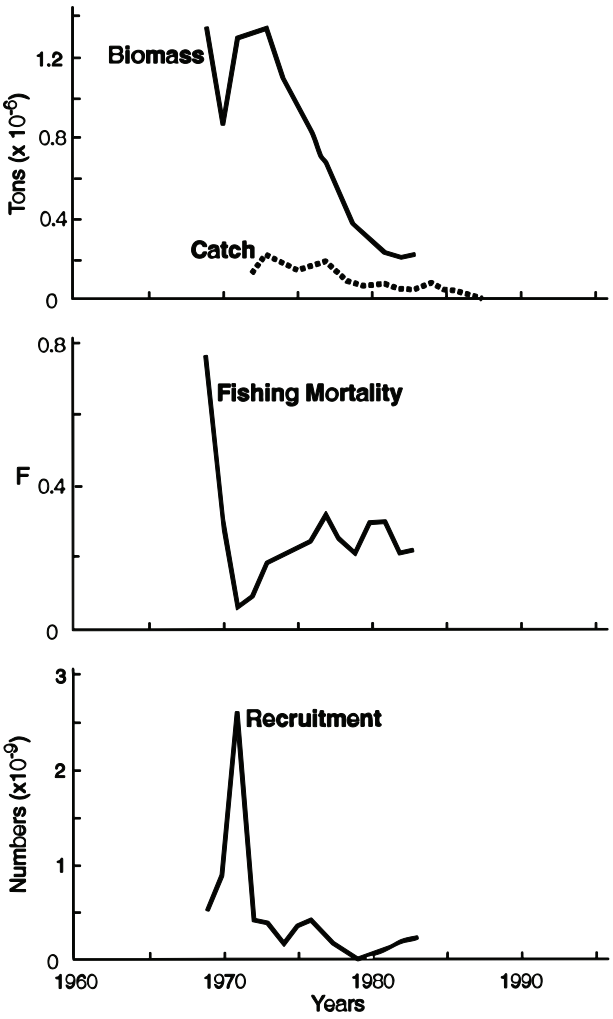

Fig. 44. Norwegian mackerel: trends in stock parameters.

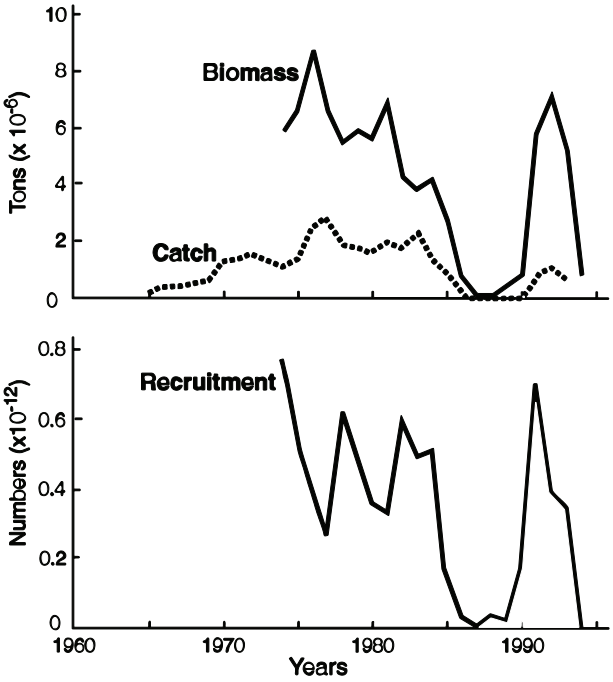

Fig. 45. Norwegian capelin: trends in stock parameters. (Stock biomass and recruitment, calculated for 1 October, assigned to 1 January of following year for plotting purposes.)

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 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 Fs 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).

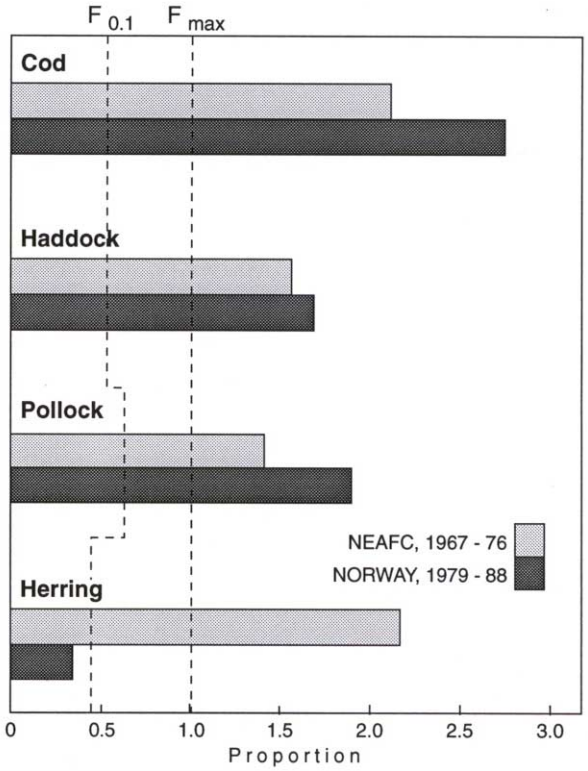

Fig. 46. Norwegian stocks: fishing mortality in the NEAFC and Norwegian management periods in relation to F_{max} and $F_{0.1}$. (Discontinuities in $F_{0.1}$ line reflect differences in ratios to $F_{max.}$)

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 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 Adminstration 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

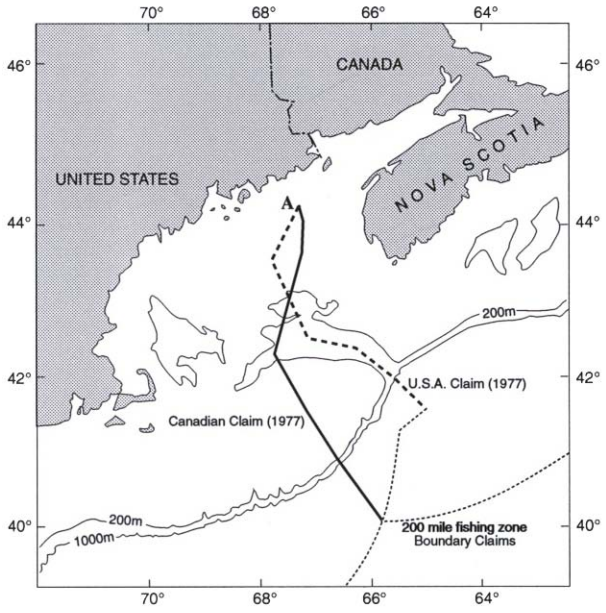

Fig. 47. Jurisdictional boundaries in the Gulf of Maine area claimed by the USA and Canada in 1977. (See Fig. 4A for revised claims of both parties put before a Chamber of the International Court of Justice and for the Chamber's boundary line decision.)

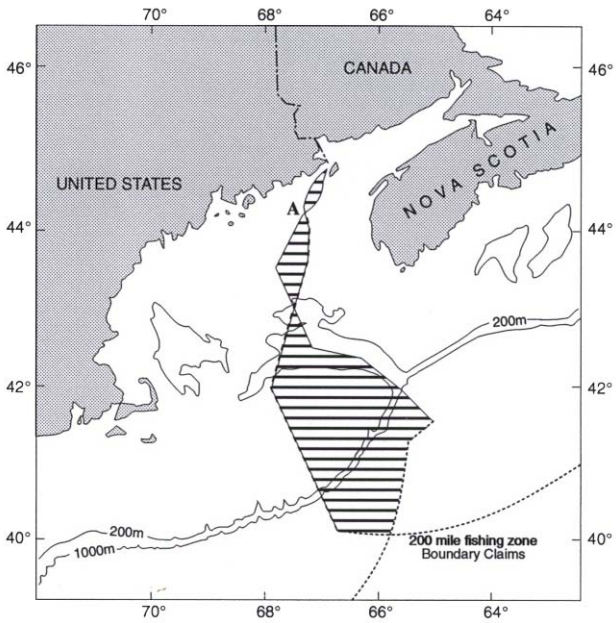

Fig. 48. Those parts of the Gulf of Maine area fished by both the USA and Canada under independent fishing plans, 1979–84 (shaded areas).

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 developed 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 advisors 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 unavoidability 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

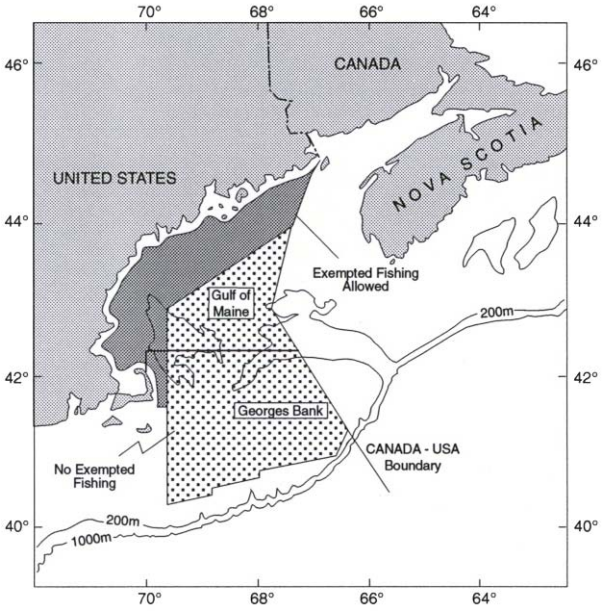

Fig. 49. Regulated large mesh areas off New England, USA, and that part of the Gulf of Maine large mesh area in which small mesh fisheries for certain species were allowed. (Large mesh areas illustrated are those defined by the NEFMC Fishery Management Plan for the Northeast Multi-species Fishery (Amendment 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 by-catches 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

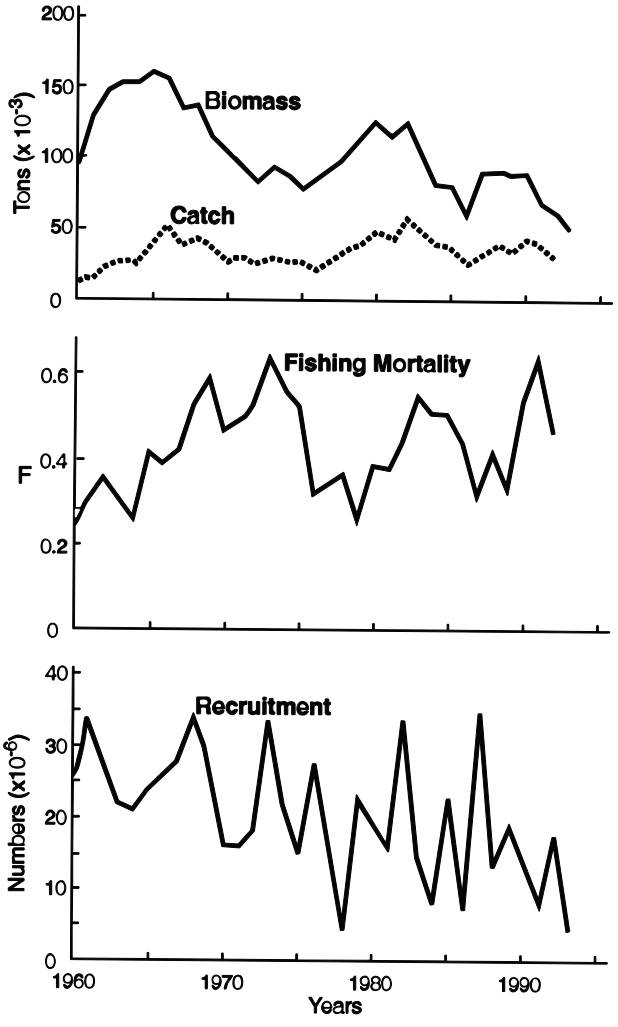

Fig. 50. USA cod: trends in stock parameters.

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-

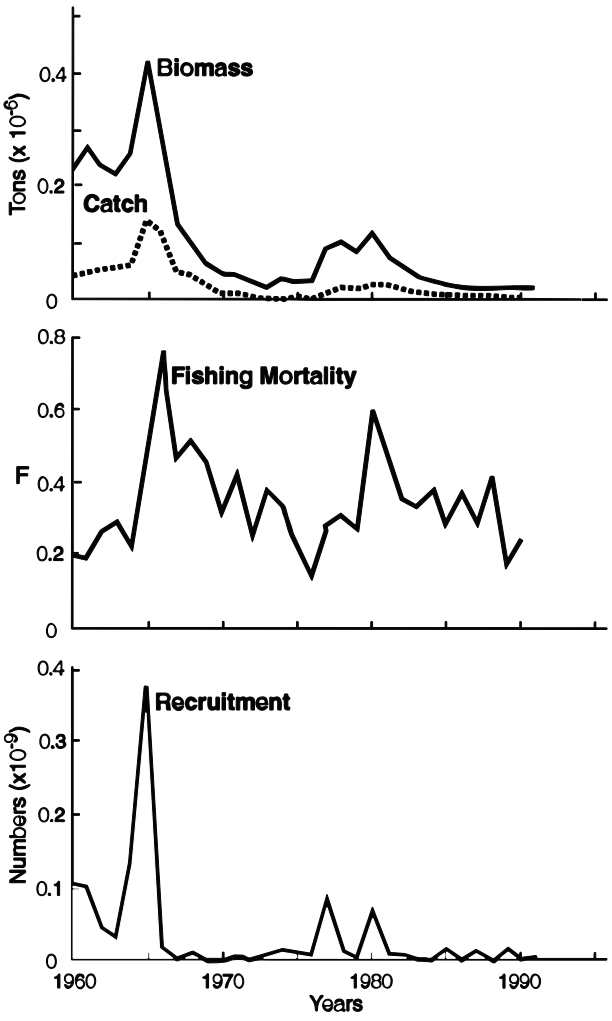

Fig. 51. USA haddock: trends in stock parameters.

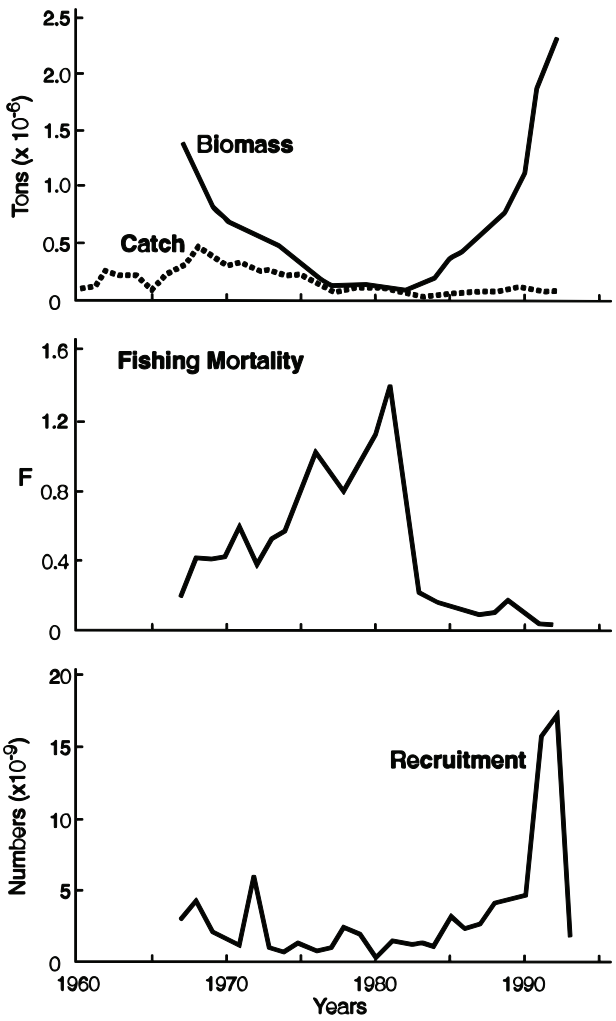

Fig. 52. USA herring: trends in stock parameters.

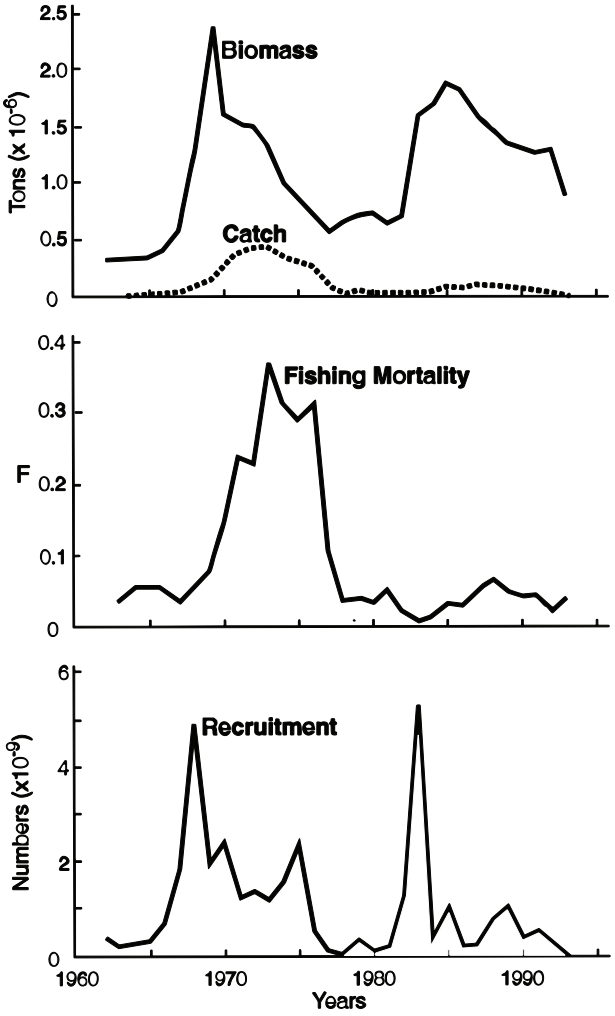

Fig. 53. USA mackerel: trends in stock parameters.

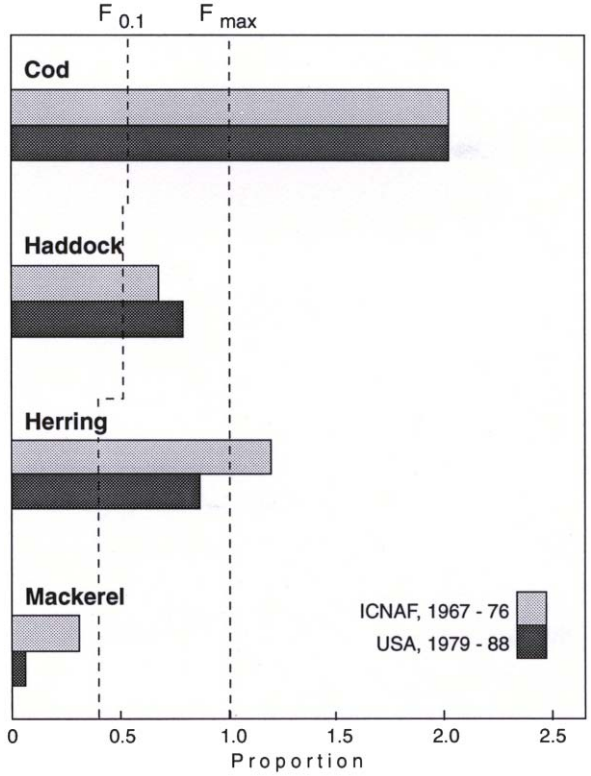

Fig. 54. USA stocks: fishing mortality in the ICNAF and USA management periods in relation to F_{max} and $F_{0.1}$. (Discontinuities in $F_{0.1}$ line reflect differences in ratios to F_{max}.)

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 recreational 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).

International Fishery Management: Post 200-Mile Limits

This Section examines the records of the international fisheries commissions in their new roles, after extensions of coastal state jurisdiction, in conservation of transboundary and high seas fish stocks. The accounts are necessarily unbalanced as the Northwest Atlantic Fisheries Organization was custodian of an area in which there were fisheries of great traditional importance, the management of which proved to be highly controversial in the post-extension period. In contrast the Northeast Atlantic Fisheries Commission was little used and its role in Northeast Atlantic fishery management was thus negligible. The latter organization is dealt with first.

The New Northeast Atlantic Fisheries Commission (NEAFC)

In 1976 it was clear that extensions of fishery jurisdiction were about to place virtually all of the important Northeast Atlantic fisheries under the direct control of coastal nations. Nonetheless, a continuing need for international cooperation in fishery management was recognized among NEAFC members. The 1958 Northeast Atlantic Fisheries Convention was not a suitable vehicle for this in its original form but a working group was established by NEAFC to consider the future for international management of convention area fisheries. A number of NEAFC meetings in 1976 and 1977 resulted in a draft for a new convention being put before a Diplomatic Conference in 1978, but this conference ended in failure. The stumbling block was refusal by eastern European states to accept the EU, as distinct from its member nations, as a party to a new convention. This was a political issue of a general nature rather than one related to fisheries *per se*. However, two years later a change of attitudes allowed agreement to be reached and the "Convention on Future Multilateral Cooperation in the North-East Atlantic Fisheries (North-East Atlantic Fisheries Convention)" was opened for signature in November 1980. The Convention came into force on 17 March 1982, on receipt of the necessary seven ratifications. The UK became the Depository Government for this Convention, as it was for that of 1958. The Convention established the North-East Atlantic Fisheries Commission – the new NEAFC, with headquarters, as for the old NEAFC, in London, UK.

The Convention listed eligible signatories, eliminating the need to specify criteria for membership. By the first annual meeting of the Commission in November 1982 there were seven members: Denmark (on behalf of Faroe Islands), EU, German Democratic Republic (GDR), Iceland, Norway, Sweden and the USSR. Portugal joined in 1983 and Bulgaria, Poland and Spain in 1984. Denmark became the representative of Greenland as well as Faroe Islands with Greenland's withdrawal from the EU in 1985. A decline in membership occurred, numerically, when Spain and Portugal joined the EU in 1986. Similarly, the GDR ceased to be a separate member when unification with FRG in 1990 brought it into the EU. The USSR was replaced by the Russian Federation after 1991. All these members were on the initial list of eligible signatories but other states could join if approved by three-quarters of the Contracting Parties.

Authority, Organization and Scope. The objectives of NEAFC are to promote the conservation and optimum utilization of the living resources of the Northeast Atlantic, and to encourage international cooperation and consultation with respect to these resources. The Convention Area is identical to that of the old NEAFC (Fig. 2) and the Convention applies to all fisheries resources within this area except marine mammals, and sedentary, highly migratory and anadromous species. The Convention Area is not divided into Regions, in contrast to the provisions of the 1958 Convention, and thus there was no need to provide for a geographically based committee structure as was the case for the old NEAFC.

The Commission can adopt recommendations for regulation of fishing in areas beyond coastal state jurisdictions. Recommendations become binding after a certain period unless objections are received. If three or more Contracting Parties object then the measure is not binding on remaining members, unless some of these agree among themselves to be bound by it. When adopting recommendations for its regulatory area the Commission is required to seek consistency with the regulatory actions of Contracting Parties within their exclusive fishing zones, when there is an interrelationship between the stocks involved. The most obvious interrelationship is when the stocks involved are transboundary in their distribution. However, the Convention includes cases of species interactions as well.

The Commission can also adopt recommendations and give advice on fisheries within national jurisdiction if requested to do so by a coastal state. In this case recommendations require a positive vote by the coastal state. Also, the coastal state is

the only Contracting Party which can subsequently object. If it does so, the recommendation is not binding on any party.

The regulatory measures which the Commission can recommend for adoption are essentially the same as those available to the old NEAFC:

- regulation of fishing gear including the mesh size of nets,
- regulation of the size limits of fish which can be retained on board vessels, or landed or exposed or offered for sale,
- establishment of closed seasons and of closed areas,
- improvement and increase of marine resources, e.g. artificial propagation and transplantation,
- regulation of total catch and its allocation to Contracting Parties, and
- regulation of total fishing effort and its allocation to Contracting Parties.

The Commission may recommend (on the same basis as other recommendations) fishery control measures to ensure that the provisions of the Convention are respected and any regulatory agreements are enforced. However, it is up to the Contracting Parties to implement and enforce regulations which have become binding. The Convention requires that Contracting Parties take the measures necessary, including imposition of sanctions for infractions, to control its own fleet.

The Convention establishes ICES as the scientific advisory body to the Commission. An annual financial contribution is made to ICES to defray the costs of providing the Commission with the advice it requires to accomplish its work.

Regulatory Actions. The new Convention made no provision to carry forward the regulations which had come into effect under the old one, and the new Commission decided also that these regulations were not suitable under the changed circumstances. Thus, the new Commission began with a clean slate.

None of the primary species used in this study have stocks which are distributed largely outside national jurisdictions and hence which could be called, for convenience, NEAFC regulatory area stocks. The most important stocks for which NEAFC carries what could be considered the weight of responsibility are blue whiting and oceanic redfish. However, these too are shared with national jurisdictions and, to date, attempts to reach agreements on catch controls have been unsuccessful. In the 1980s, exploitation levels on these stocks were viewed as moderate and this did not encourage urgency in establishing restrictions on catch. However, exploitation of oceanic redfish, in particular, has increased in the 1990s.

The Commission took an interest in the management of Norwegian spring spawning herring, which had an oceanic migration pattern prior to stock collapse about 1970. Subsequent to collapse, the stock remained restricted to Norwegian waters (see Norway section), and the Commission's interest translated into no more than annual appeals to Norway to continue following ICES advice on stock conservation. This situation changed drastically in the 1990s, however, when stock recovery resulted in a resumption of its oceanic migrations. Large catches were taken in 1994 and 1995 in international waters in the Norwegian Sea to the west of the Norwegian zone (see Fig. 38) by a multinational fleet operating without any agreed overall TAC and sharing arrangements. Other resource management issues involving fishing in international waters, such as for cod in the Barents Sea loophole and mackerel in the Norwegian Sea loophole, could also be perceived as coming under the purview of NEAFC. However, management agencies have preferred to pursue bilateral and multilateral accommodations outside of NEAFC.

The Commission's activities in relation to technical measures resulted in regulation of mesh sizes used in fishing for capelin and blue whiting in the regulatory area. Standardization of logbooks was also pursued. Thus, overall, the Commission has not had a significant role to play in management of Northeast Atlantic resources, at least to this juncture.

Northwest Atlantic Fisheries Organization (NAFO)

The announcements in 1976 by Canada and USA of their intentions to extend fisheries jurisdiction to 200 miles in 1977 stimulated an immediate response by the member nations of ICNAF to adapt to the new order. At its meeting of December 1976, ICNAF adopted a resolution recommending fast action to develop new institutional arrangements for cooperation in Northwest Atlantic fishery management. As an interim solution, amendments were made to the ICNAF Convention which excluded waters within national fishing limits and provided for coastal states to receive scientific advice from STACRES of ICNAF if they wanted it. Although these amendments never came into effect the organization functioned as if they had. Canada immediately followed up the ICNAF actions with invitations to attend a conference in Ottawa preparatory to establishment of a new convention for Northwest Atlantic fisheries. This was held in March 1977 and

followed by a second preparatory conference in June and a final diplomatic conference in October. This did not resolve all issues but a further "informal meeting of experts" in May 1978 cleared the way for the Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries to be opened for signature on 24 October 1978. Canada became the Depository Government for the Convention. The Convention came into force on 1 January 1979, having by that time received adherence by more than the required six signatories.

The inaugural meeting of the Northwest Atlantic Fisheries Organization (NAFO) created under the Convention was held in March 1979 and by the beginning of 1980, when ICNAF was dissolved and NAFO took over its full responsibilities, there were 13 members – Bulgaria, Canada, Cuba, Denmark (on behalf of Faroe Islands), EU, GDR, Iceland, Japan, Norway, Poland, Portugal, Romania and USSR. Spain although a longstanding and important participant in the Northwest Atlantic fishery, did not join until August, 1983. When Greenland left the EU at the end of 1984, Denmark became the representative of Greenland, as well as Faroe Islands, in NAFO (thus the number of members of NAFO did not change). With the accession of Spain and Portugal to the EU, these countries withdrew from NAFO at the end of 1986. The GDR withdrew from NAFO at the end of 1990 as a result of reunification with FRG, and hence also became part of the EU. However, membership of the organization was returned to 14 with accession of Estonia, Latvia and Lithuania in 1992 following the breakup of the USSR. The Russian Federation (Russia) continued the membership of the former USSR, also from 1992. The Republic of Korea (South Korea) joined NAFO at the end of 1993, as did the USA at the end of 1995 and France, on behalf of St. Pierre and Miquelon, in August 1996. The headquarters of the organization is in Dartmouth, Nova Scotia, Canada, as was that of ICNAF.

Authority, Organization and Scope. The objective of the NAFO Convention is to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the Convention Area. The Convention Area defined is equivalent to ICNAF's Statistical Area, i.e. it encompasses ICNAF's Subareas 1–5 and also its Statistical Areas 0 and 6 (see Fig. 1). The Convention applies to all fishery resources in this area except cetacean stocks managed by the International Whaling Commission, salmon, tunas and marlins, and sedentary species. That part of the Convention Area which lies outside coastal state fishery jurisdictions is referred to as the Regulatory Area, i.e. the area within which NAFO has the authority to adopt regulatory measures for the fisheries. Most of the continental shelf in the Convention Area lies within the 200 mile zones of coastal states, but Flemish Cap and the southern and eastern edges of Grand Bank lie outside 200 miles and are hence in the Regulatory Area (Fig. 55). Although these are quite small geographical areas they support important fisheries and provide the sole focus of NAFO regulatory attention. The remainder of the Regulatory Area, although extensive, encompasses oceanic waters in which no fisheries which lie within the NAFO mandate have developed to date.

The senior body within the organization is the General Council which has the functions of supervising and coordinating the administration of the organization, and coordinating its external relations. There is a Fisheries Commission charged with providing for the management and conservation of the fishery resources of the Regulatory Area. Whereas all Contracting Parties to the NAFO Convention are members of the General Council, membership of the Fisheries Commission is restricted to those who either currently fish in the Regulatory Area or who provide satisfactory evidence of their intention to do so in the current or following year. There is also

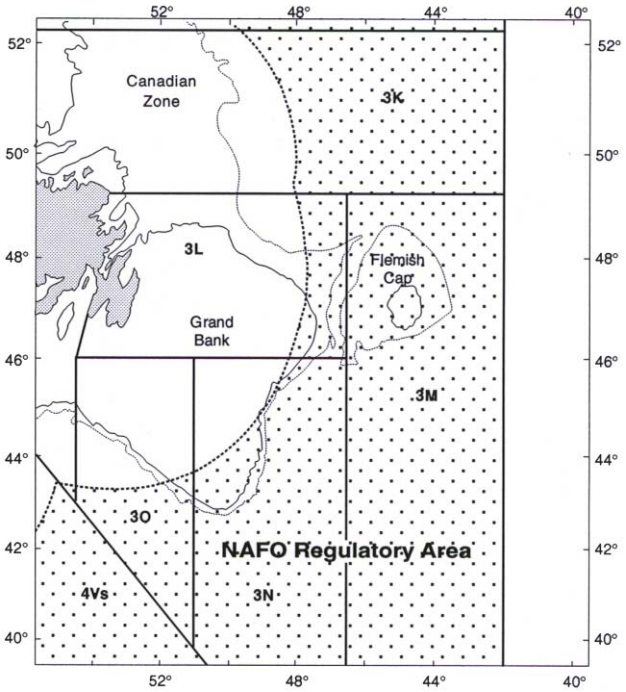

Fig. 55. The NAFO Regulatory Area in the vicinity of Grand Bank and Flemish Cap. (Depth contours are 200 m – solid line, 1 000 m – fine dashed line.)

a Scientific Council responsible for providing advice to the Fisheries Commission, and to coastal states on their request, and for promotion of scientific research, and maintenance of statistics, on the fisheries of the Convention Area. All members of the organization belong to the Scientific Council.

The Fisheries Commission adopts proposals for action by the domestic authorities of Commission members. Once a Commission proposal is transmitted to Contracting Parties, Commission members have 60 days to object before the proposal becomes binding. If an objection is received, other members have further periods for objection. If less than half of the members object, the proposal becomes binding at the end of these periods for those who have not objected. If more than half the members have objected then the remainder are not bound by the regulation unless they themselves decide to be.

Members of NAFO, although responsible for control of their own fleets, are required by the Convention to ensure that their obligations under the Convention are met, in particular by imposition of adequate sanctions for violations. The Convention also allows for adoption of international measures of control and enforcement, and specifically, carried over the ICNAF Scheme of Joint International Enforcement.

The organization faced two serious challenges to its authority, which fell to the General Council to resolve. The first was non-member fishing. The 1982 United Nations Convention on the Law of the Sea makes quite clear the right of all states to fish on the high seas and, as well, their obligations to cooperate in the conservation and management of living resources through regional fisheries organizations. Although the 1982 Convention did not enter into force until the end of 1994, and hence did not present a legal constraint on state behaviour until that time (and then only to those who had acceded to it), it at least reflected the predominant international view of acceptable and responsible behaviour in relation to high seas fishing. The NAFO view was that non-members developing a fishing interest in the Regulatory Area were to be encouraged to join NAFO, the legally established regional management institution, and share equitably the responsibilities and benefits of resource management, a position consistent with the Law of the Sea text.

The organization was immediately faced with a non-member fishing problem when Spain refused to sign the NAFO Convention despite having a substantial fishery presence in the Regulatory Area. The underlying issue was that the large reductions in TACs, particularly those of cod, imposed in the last years of ICNAF had a particularly severe effect on the catch allocations of Spain. The large Spanish fleet was almost solely dependent on cod and was composed primarily of vessels designed for salt cod production which were not readily adaptable to alternative uses. Although NAFO members were successful in encouraging Spanish accession to the Convention in 1983, this alleviated the problem of non-member fishing only temporarily. As early as 1978 Canadian surveillance had reported vessels of Spanish origin fishing under the flags of various Central and South American states. The use of flags of convenience increased and non-member fisheries were initiated by the Republic of Korea and the USA, particularly after 1985. (Some Korean vessels also used flags of convenience.) By 1990, according to Canadian surveillance, more than 40 non-member vessels were taking about 35% of the catch from the Regulatory Area. Non-member fishing clearly had reached a scale which threatened to remove any possibility of NAFO controlling resource exploitation in the area.

The General Council established a Standing Committee on Fishing Activities of Non-Contracting Parties (STACFAC) and, as a result of Committee proposals, NAFO built on previous diplomatic efforts by member governments and the Executive Secretary by making further appeals to non-member governments that had vessels fishing under their flag in the NAFO Area. A decision by the Korean government to withdraw Korean-licensed vessels from the NAFO Area in 1993, and to join NAFO, was a notable success for the diplomatic representations of member governments, particularly Canada, and of NAFO. Little could be achieved regarding flags of convenience, however, as vessels de-registered by one state as a result of NAFO pleas easily found other states ready to provide the registry they required. There was, in fact, little scope for NAFO to deal effectively with the problem. In May 1994 the Canadian government passed amendments to its domestic legislation which empowered Canadian authorities to unilaterally enforce NAFO regulations for transboundary stocks in international waters. This resulted in immediate withdrawal of non-member vessels which were fishing transboundary resources on the Grand Bank, although the retreat was no further than to Flemish Cap to fish stocks which are fully outside of Canadian jurisdiction. However, hope for a fuller and longer term solution lies with implementation of the United Nations agreement on Straddling and Highly Migratory Fish Stocks, opened for signature in December 1995.

The General Council was faced, secondly, with an internal crisis which was an equal or even more serious challenge to its authority. Coincident with accession of Spain and Portugal to the EU, the EU

disputed the Fisheries Commission view of "optimum utilization" (see below) and, beginning with TAC and allocation proposals for 1986, systematically objected to most Fisheries Commission decisions. The EU established much higher allocations for NAFO regulated stocks, through its own domestic regulations, than those proposed for it by the Fisheries Commission. The General Council recognized that this blanket use of the objection procedure was emasculating the organization but proved impotent in dealing with the issue. A Canada–EU fisheries agreement, reached at the end of 1992, included a commitment by the EU to respect all NAFO decisions. This brought at least a respite from this particularly debilitating confrontation.

The scope of the organization's authority to regulate fisheries in the Regulatory Area, the responsibility of the Fisheries Commission, is not constrained by any definition of optimum utilization, or any list of acceptable regulatory measures, embodied in the Convention. It is, however, obliged by the Convention to seek consistency with regulatory measures taken by a coastal state, where there are biological relationships between stocks fished in coastal state and Regulatory Area waters. In practical terms this constraint has applied to stocks for which exploitable concentrations occur on both sides of the Canadian 200 mile limit on Grand Bank. Flemish Cap stocks of cod, redfish and American plaice are recognized as lying entirely within the Regulatory Area. Informal consultations between Canada and ICNAF members in 1978 established a list of seven stocks of shared interest – Grand Bank cod (Div. 3NO), eastern Grand Bank redfish (Div. 3LN), Grand Bank American plaice (Div. 3LNO), yellowtail flounder (Div. 3LNO) and witch flounder (Div. 3NO), Grand Bank capelin (then Div. 3LNO) and *Illex* squid (Subareas 3 and 4). The Fisheries Commission of NAFO inherited this list when it took up its responsibilities in 1980. This list of overlapping stocks was modified in 1982 when Canada proposed, and the Fisheries Commission agreed, to separate the management of capelin on the northern Grand Bank (Div. 3L) from those on the southern Grand Bank (Div. 3NO), as accumulated scientific evidence indicated that these were different stocks. Capelin on the southern Grand Bank continued to be recognized as a shared stock but the northern Grand Bank capelin was accepted as Canadian.

The most serious dispute about the list of shared stocks occurred in 1985 when the EU challenged Canadian authority to manage autonomously the Labrador–East Newfoundland cod (Div. 2J3KL), Greenland halibut (SA2 + Div. 3KL), roundnose grenadier (SA2+3) and northern Grand Bank (Div. 3L) capelin, and proposed that all be considered overlapping (shared) stocks. Earlier in 1985, EU vessels had found concentrations of cod in Div. 3L outside the Canadian zone and caught substantial amounts, evidence that cod of the Labrador–East Newfoundland management unit had a transboundary distribution. The Scientific Council was asked for advice on the distribution of these resources and its report indicated that a small proportion of all these stocks occurred in the Regulatory Area. Canada opposed any change in the list, but nonetheless recognized a practical threat to its interests in Labrador–East Newfoundland cod, the most important stock in the Canadian zone, and the only one of the four for which there was a significant catch, at that time, in the Regulatory Area. Canada argued that the proportion of cod from the Labrador–East Newfoundland management unit that occurred in international waters was so small (estimated at 3–5%) as not to warrant designation of Labrador–East Newfoundland cod as an international stock. Also, the stock was already fully exploited in the Canadian zone. Canada therefore proposed a moratorium on cod fishing in the Regulatory Area portion of Div. 3L for 1986. This was agreed to by the Commission but the EU objected and unilaterally established an EU allocation of Div. 3L cod under domestic regulation. This situation persisted until 1992 when, after Canada had announced a moratorium on all fishing for Labrador–East Newfoundland cod in the Canadian zone in 1992 and 1993 (subsequently extended indefinitely) in recognition of its greatly reduced abundance, the EU agreed with the Fisheries Commission proposal for a moratorium in the Regulatory Area part of Div. 3L for 1993. This agreement came at a time when Canada and the EU were finalizing a bilateral fisheries agreement which provided for EU access to a portion of the Labrador–East Newfoundland cod catch after the moratorium ended and to any surplus catches from other Canadian stocks. While this provided for control of catches from this cod stock, the development of substantial new fisheries in the Regulatory Area by the EU from 1990, particularly for Greenland halibut but with substantial incidental catches of grenadiers, reopened the jurisdictional question for these species.

Agreement on the list of shared stocks was, of course, only a precursor to achievement of "consistency" in regulatory measures between NAFO's Regulatory Area and the Canadian zone. The ICNAF Commission had accepted a revision of its exploitation strategy from F_{max} to $F_{0.1}$ in 1976 (see ICNAF Section) and, in 1977–79, the scientific advice on TAC levels provided by STACRES to the Commission for groundfish stocks used $F_{0.1}$, or equivalent, as the general reference point. Annual requests for advice originated from the Canadian government. These Canadian requests included not

only stocks which lay entirely within the Canadian zone and those which overlapped the 200 mile boundary but also Flemish Cap stocks. When the NAFO Scientific Council and Fisheries Commission took over advisory and management responsibilities from ICNAF in 1980, the ICNAF practice continued, and thus NAFO accepted $F_{0.1}$, *de facto,* as its general management strategy. This met the requirement for consistency in exploitation strategy with that in the adjacent Canadian zone.

The above approach was seriously challenged by the EU from 1985. The EU viewed past practice as Canada imposing its national management strategy on the international fisheries of the Regulatory Area. The EU preferred F_{max} as a management approach to meet the socio-economic needs of its fleet. With regard to TACs for 1986 and subsequent years the EU systematically objected to those for which the Scientific Council did not provide options from which to choose and to these for which the Fisheries Commission had not selected the F_{max} option when the EU considered it feasible to do so.

The Fisheries Commission, in 1985, initiated its own requests for advice from the Scientific Council for management of Regulatory Area and overlapping stocks in 1987, and subsequent years, at the instigation of the EU. These annual requests had "the concurrence of the Coastal State" and hence were joint requests by the Fisheries Commission and Canada to the Scientific Council. The requests asked for TAC options at exploitation rates corresponding to the then current level of F, $F_{0.1}$ and F_{max}. Although the Scientific Council strived to meet these requests, data deficiencies prevented elaboration of options for many of the stocks, i.e. recommendations could be made on precautionary catch levels only, thus providing the EU with continued grounds for objection. In any case, the EU faced implacable opposition from Canada to any move away from an $F_{0.1}$ strategy, particularly for overlapping stocks, thus preventing the Fisheries Commission from adopting TACs at the F_{max} level and providing further grounds for EU objection to virtually all Fishery Commission TAC and allocation proposals.

The sharp EU dissent with NAFO's $F_{0.1}$ management strategy for groundfish coincided with accession of Spain and Portugal to the EU. These accessions presented the EU with the difficult task of accommodating a very large expansion in the EU fleet, and provided motivation for its actions. By the early-1990s, the discrepancy between NAFO allocations and unilateral allocations for the EU had narrowed but nonetheless were still important in 1992. No progress was made in devising agreement on an appropriate NAFO management strategy with regard to groundfish exploitation over the period 1985 to 1992 and this disagreement contributed significantly to NAFO's loss of control over resource exploitation during this period. In the 1992 Canada–EU fisheries agreement referred to above, the parties agreed to support adoption by NAFO of regulations in conformity with Article XI of the Convention; that requiring that the Fisheries Commission "seek to ensure consistency" with coastal state measures for overlapping stocks. Coincidentally, the debate on strategy moved from the merits of $F_{0.1}$ and F_{max} to the need to maximize protection of collapsing stocks. There was agreement on that, and no directed fisheries for transboundary stocks of cod, American plaice, yellowtail and witch flounder on the Grand Banks were allowed in 1994 and subsequent years. This has deferred the question of the appropriate exploitation strategy for these stocks when they recover to more productive levels.

The NAFO management strategy for capelin, the only commercially exploited pelagic species in the Regulatory Area, differed from that for groundfish. Under ICNAF, capelin TACs were precautionary and were fixed at arbitrary levels for the period 1976–78. For 1979, STACRES of ICNAF adopted an arbitrary exploitation rate for capelin of 10% because recruitment at that time was low and STACRES thought exploitation rate should be kept low to protect the spawning stock biomass. However, in the case of the capelin which spawned on the southern Grand Bank the spawning stock was so low that complete closure of Div. 3NO to capelin fishing was advised. These proposals were accepted by the ICNAF Commission in its last year of operation and hence were inherited by NAFO. However, when southern Grand Bank capelin recovered enough to allow a small commercial fishery in 1987 the NAFO Scientific Council adopted the even more conservative strategy of a 5% exploitation rate. No projections of spawning stock size to the fishery year were possible, so the Scientific Council used the stock biomass observed in acoustic surveys, averaged over several years, as a basis for calculating TAC levels corresponding to the target exploitation rate. The 5% rate was maintained for the 1988 fishery but the Scientific Council reverted to 10% for the 1989 fishery as it became more confident of stock recovery. The Fishery Commission accepted the Scientific Council proposed exploitation rate strategy although not all members were satisfied with it and the Scientific Council was asked to reconsider the 10% in relation to the NAFO objective of optimum utilization, and in particular to consider adoption of a minimum spawning biomass target. The Scientific Council re-affirmed in 1991 the importance of retaining a conservative exploitation rate strategy. Although recruitment was at that point

better than when the 10% exploitation rate was originally adopted, it was recommended that this target be retained for other reasons, in particular because capelin is an important prey for cod and also to compensate for the high level of imprecision in estimates of spawning stock size. This did not satisfy the Fisheries Commission because it again asked the Scientific Council to evaluate a minimum spawning biomass strategy and, in addition, a 20% exploitation rate. This debate was effectively deferred by a Scientific Council recommendation for fishery closure in 1993 and acceptance of this by the Fishery Commission, but indicates that there remains some uncertainty in NAFO on the appropriate management strategy for capelin.

Consistency in technical measures between the Regulatory Area and Canadian zone proved as difficult to maintain as consistency in exploitation level strategy, but this was very much a secondary issue. Inconsistency arose in 1982 when Canada dispensed with differentials based on netting material, and proposals that the Commission follow suit were rejected.

The Scientific Council is a coordinating body and, as was the case with ICNAF, all actual data collection and research is conducted by the domestic agencies of Contracting Parties. However, the Scientific Council identified many deficiencies in the statistical and research support provided by Contracting Parties and the Council members apparently carried insufficient authority with their home governments to correct the situation. As a result, a number of attempts were made, through the Fisheries Commission, to extend NAFO's authority in the scientific area. The first initiative was for a scientific observer program on commercial vessels fishing in the Regulatory Area. Proposed by Canada in 1979, and adopted by the Commission, the scheme was implemented in 1980. However, the implementation was through bilateral agreements, extensive coverage was not achieved (maximum of 218 observer days in 1980), and the scheme faded away in the late-1980s. A NAFO Annual Scientific Program, under which Contracting Parties would be bound to conduct the required scientific work, was proposed in the late-1980s but came to no more than members being urged to meet their commitments. In 1992, establishment of a special NAFO scientific research fund was proposed, studied, but not implemented. Thus, NAFO has been unable to extend its authority over scientific data collection and research beyond that of ICNAF.

Regulatory Actions. The TAC and Contracting Party allocation scheme of ICNAF was carried over to NAFO as the preferred method of controlling exploitation level. Trawl regulations of ICNAF were also inherited by NAFO, but none of the ICNAF minimum fish size restrictions or its area/season closures applied to the NAFO Regulatory Area. The Subarea 3 trawl regulations applied to cod, haddock, pollock, white hake, redfish and five species of flatfish, although redfish in Div. 3NOP were exempted. The minimum mesh size was 130 mm manila equivalent with a differential of 120 mm for hemp, polyamide and polyester netting and of 110 mm for seine nets. Canada dispensed with differentials in domestic regulation in 1982 but the Fisheries Commission saw no need for change at that time. However, from 1989, increasing evidence that significant quantities of small American plaice and yellowtail flounder were being caught, followed by similar reports of the capture of small cod, produced a change in view. In 1992, regulations were put into effect restricting the size of fish which could be retained on board to 41 cm fork length and above for cod and 25 cm total length and above for American plaice and yellowtail flounder. In addition, a minimum size for Greenland halibut of 30 cm was adopted at the September 1995 Annual Meeting. Also in 1992, mesh size regulations were revised to include all groundfish species and differentials were dispensed with, the latter taking effect 1 June 1994 (with an exception until January 1997 that nets constructed of the polyamides caprolan, dederon and kapron could continue to be of 120 mm mesh size, i.e. materials used by states which were former republics of the USSR). Furthermore, from 1994 the Grand Bank was established as a large-mesh-only zone, preventing the development of a shrimp fishery there. A shrimp fishery had already developed on Flemish Cap in 1993 and, in that area, use of a separator grate in the trawl codend was made mandatory in order to reduce finfish by-catches, particularly of redfish.

Surveillance and Compliance. The NAFO Convention specifically required that the ICNAF scheme of joint international enforcement be maintained in force and makes provision for new measures of control and enforcement within the Regulatory Area to ensure the application of the Convention and implementation of measures in force under it. The Convention also requires Contracting Parties to take such action as is necessary to make effective the provisions of the Convention, including the imposition of adequate sanctions for violations. The NAFO Fisheries Commission approved a NAFO Scheme of Joint International Enforcement in 1981 which was a rewording of the ICNAF scheme to take account of the change in circumstances but was without change in substance.

Canada was the only active participant in the Joint Enforcement Scheme of ICNAF in the Grand Bank – Flemish Cap area, carrying out regular air

and surface vessel surveillance and boardings for inspection purposes. At the beginning of NAFO, Canada proposed some equitable sharing of the enforcement burden. In response, the USSR put an inspection vessel in the Regulatory Area in 1980 and subsequent years. Other Contracting Parties agreed in principle but failed to establish a continuing inspection presence in the Area.

Aircraft overflights, combined with at-sea boardings, provided Canadian surveillance authorities with sufficient information to detect gross violations of catch allocations on a fleet basis. Immediately after extension of jurisdiction in 1977, Canadian surveillance detected a dramatic increase in fishing activity adjacent to the Canadian zone in Div. 3M. In the last years of ICNAF, 1977–79, surveillance provided strong evidence of overfishing of ICNAF catch allocations, particularly by Spain and Portugal. Canadian surveillance also detected the first Spanish vessels fishing under Central American flags of convenience from 1978. Spain did not joint NAFO immediately and thus, in 1980–83, was not bound by NAFO catch restrictions, but Spain did indicate that it would abide by most other NAFO regulations. However, Canadian surveillance continued to record Spanish fishing practices which were contrary to NAFO requirements such as under-recording of catches (by more than half) and utilization of small mesh trawls, and also established that there was a continued lack of control of Portuguese fleet catches, which greatly exceeded NAFO allocations in a number of cases.

Accession of Spain and Portugal to the EU in 1986 brought the EU into the longstanding and escalating dispute between Canada and Spain. The EU immediately took up with the Fisheries Commission the charges made by Spain against Canada, the primary of which were that the disproportionate attention given to the Spanish fleet by Canadian surveillance amounted to harassment, and that Canada was abusing the provisions of the Joint Enforcement Scheme. The EU proposed in 1986 that the Fisheries Commission replace its Joint Enforcement Scheme by one which was impartial, objective and effective and, to provide incentive, announced its withdrawal from the existing scheme by July 1987. The Commission responded positively and a revised scheme, renamed the Scheme of Joint International Inspection (rather than Enforcement), came into effect in mid-1988. The new scheme added some notification procedures, restricted to some degree the information inspectors could gather, and required inspections, as far as possible, to reflect the ratio of fishing activity of fleets, but it was not fundamentally different from the previous scheme. This process nonetheless contributed to an improvement in Regulatory Area surveillance. The EU withdrawal from the joint scheme in mid-1987 was accompanied by a commitment to have in place a corresponding unilateral scheme. European Union inspectors conducted inspections from two commercial vessels for the balance of 1987 and the EU had an inspection vessel deployed in the Regulatory Area prior to joining the new NAFO scheme in mid-1988. Thereafter deployment of EU inspection vessels in support of the scheme became routine.

The Fisheries Commission was presented with evidence at its September 1990 meeting which made perfectly clear that its regulatory efforts were largely futile as a result of uncontrolled fishing. The chairman of the Scientific Council gave estimates of catches of Flemish Cap cod of 40 000 tons per year in 1988–90, years in which the TAC had been set at zero with agreement of all Commission members. The increased surveillance by Canada, EU and USSR, joined by a Faroese inspection vessel in 1989, left no grounds for doubt as to the existence and scale of the organization's problems. The Commission set about to improve the Inspection Scheme and a number of measures were implemented at the beginning of 1992. A hail system, whereby vessels reported entering and leaving management zones, was perhaps of most immediate importance. However, a pilot NAFO Observer Scheme was also agreed upon for the period January 1993–June 1994 to "monitor a vessel's compliance with NAFO Conservation and Enforcement measures". This Observer Scheme was initially weak, as it was not tied in with the Inspection Scheme, there was no requirement to collect scientific data, and Contracting Parties were to have their own observers on their own vessels and they alone were to receive observer reports. Furthermore, only Contracting Parties expecting to fish in the Regulatory Area for more than 300 days in 1993 were obliged to have observer coverage, and then only at a 10% level. The pilot scheme was extended through 1995, however, and for 1996 there was agreement for 100% coverage, observer reporting of infringements to a NAFO inspection vessel within 24 hours, and availability of observer reports to all parties within 30 days of completion of assignment. Proposals for implementation of an electronic vessel tracking system remain under study.

The failure of NAFO to establish control over exploitation of Regulatory Area stocks has three elements – non-member fishing, unilateral establishment of allocations by Contracting Parties, and illegal over-running of allocations and disregard for other regulations by Contracting Parties. The NAFO surveillance and enforcement measures, can address directly only the last issue of regulatory violations by Contracting Parties. Whether the present round of improvements makes the scheme

sufficiently strong to result in deterrence, rather than simply detection, of illegal behaviour remains to be seen, although adoption of a strong observer program is particularly encouraging. However, the other issues require diplomatic solutions and the will to solve the problem on the part of the Contracting Parties.

Resource Trends. As an organization, NAFO accepted a management strategy of fishing at $F_{0.1}$ as an adequate definition of its objective of optimum resource utilization. This provided for consistency with the Canadian management regime for transboundary stocks, thus meeting Convention obligations. However, the organization faced a number of serious regulatory control problems, and catches for groundfish stocks generally exceeded the levels advised by the Scientific Council as corresponding to an $F_{0.1}$ strategy. These problems would seem to preclude any possibility of management success. Nonetheless, for Grand Bank cod, NAFO appeared to be successful in the early-1980s in maintaining a moderate exploitation level, thus bringing about some stock recovery (Fig. 56). Fishing mortality in 1979–88 averaged about $F_{0.1}$, well below the 1967–76 level of more than twice F_{max}, according to available estimates. However, after the mid-1980s the stock trend reversed, fishing mortality increased and there were reports of an increased dependence on small fish. Transboundary flatfish stocks, the next most important groundfish stocks on Grand Bank, showed similar trends. There are so few data for Flemish Cap stocks that trends cannot be described but there can be no doubt that cod was extremely heavily exploited throughout the NAFO period. The general similarity in trends between the Grand Bank groundfish stocks and those entirely within the adjacent Canadian zone suggests that there was an underlying environmental influence, the adverse effects of which reduced recruitment in the period from the mid-1980s and which in turn reversed the improvements in stock status that occurred after the mid-1970s. However, for all groundfish stocks that are fished in the NAFO Regulatory Area, inadequate data on the level and composition of catches make the estimates of the effects of fishing on these stocks particularly uncertain.

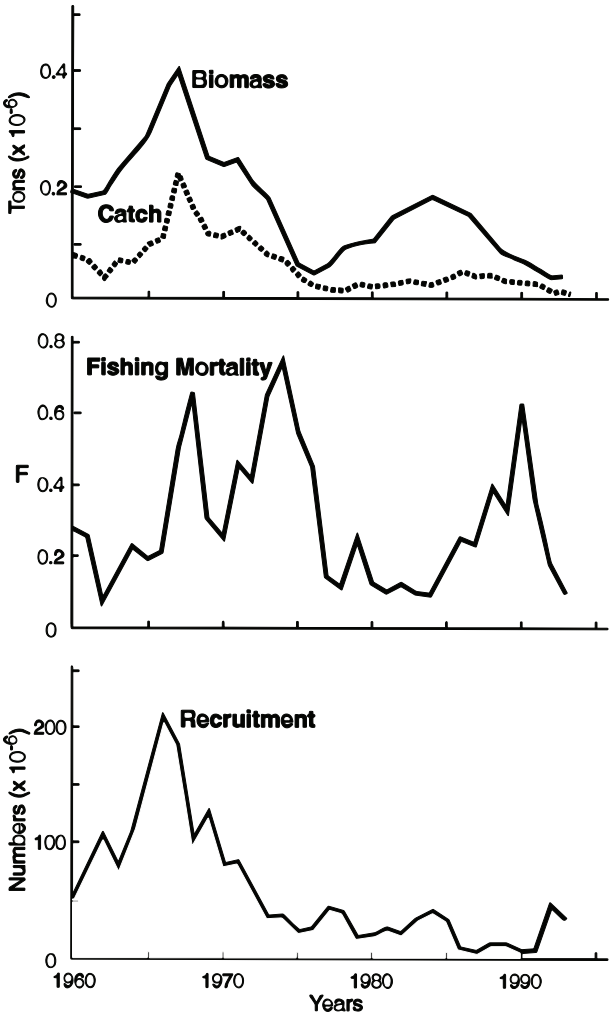

Fig. 56. NAFO cod: trends in stock parameters.

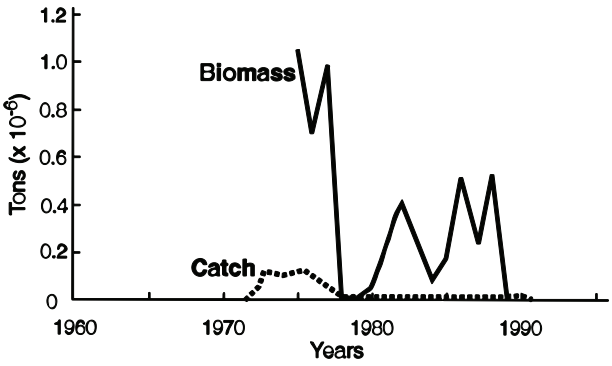

Fig. 57. NAFO capelin: catches and stock biomass.

For the only NAFO pelagic stock, capelin, the exploitation rate target was established by the Scientific Council at an arbitrary rate of 10%, although for most of the NAFO period, the recommended exploitation rate was actually zero because of the low stock size (Fig. 57). This conservative approach reflected the importance of capelin as a forage fish for other species but also the high level of uncertainty in prognosis of potential yields. On those occasions when a fishery was permitted, the exploitation rate appears to have been well below 10%. Thus, in this case the fishery was prosecuted in a manner consistent with the organization's strategy.

Discussion and Conclusions

The section on fishery management in national fishing zones described the actions of regulatory authorities to control fishing activities within the zones created by jurisdictional extensions to 200 miles, their philosophical underpinnings in terms of objectives and strategies, and the changes in stocks and catches which occurred as a result, or in spite of, these actions. The same was then done for the international commissions in regard to high seas fisheries in the post-200 mile era. In the present section, these post-200 mile regimes are compared to each other. The comparisons are organized in a similar way to the accounts of individual management regimes. Firstly, the institutional frameworks for managing fisheries are compared, followed by comparisons of management objectives and of harvesting strategies and tactics. Enforcement and compliance are then discussed, although information is scant and comparison of compliance levels is not possible. Finally, the differences in exploitation level brought about for the stocks of the primary species under the new jurisdictional regimes, compared to the previous international commission era, are summarized.

Institutions

There are substantial variations among management regimes in their institutional framework for devising and implementing fishery regulation programs. These differences could influence the prospect for management efforts to have a satisfactory result. The most common North Atlantic institutional model is that where authority for marine fishery management rests with a ministry of the national government, which then supports a scientific research agency to generate the biological information necessary for decision making, an enforcement agency to ensure implementation of, and compliance with, decisions, and an advisory body of clients which provides domestic fishermen and other interested parties with the opportunity to participate in the decision making process.

When international commissions had authority to propose regulations for coastal fisheries, these commissions made provision for the review and synthesis of scientific results from national laboratories so that all commission members had the benefit of the same advice arrived at by scientific consensus. In the Northeast Atlantic ICES served that purpose and in the Northwest Atlantic ICNAF had its own Standing Committee on Research and Statistics as well as committees of Scientific Advisors to each of its Panels. It is difficult to envision how these commissions could have functioned if each delegation had a separate view of the status of the resources. The commissions were dependent on member governments to implement proposed regulations through domestic laws and to enforce them on their own fleets, although the commissions also achieved some success in implementing joint inspection schemes to improve regulatory compliance. The implementation of 200 mile limits required new international commissions but these retained the same institutional model as their predecessors (although in the case of the new NEAFC no international inspection scheme has yet been required as it has generated almost no regulations). Scientific advice is provided to the new NEAFC by ICES, as it was to its predecessor. In NAFO, a Scientific Council is supported to provide the Fisheries Commission with the advice required.

In the post-200 mile regime the institutional arrangements for management of domestic fisheries were close to the standard model in Canada, Faroe Islands, Iceland, Norway and, from 1985, also Greenland. Centralized decision making resides in the hands of the government Minister responsible for fisheries who maintains consultative mechanisms to gather the views of clients. The EU and USA systems were quite different.

The power to adopt new fishery conservation measures has lain with the EU, rather than its members, from 1979. Thus, it is the EU that has the authority to function as a coastal state with regard to fisheries (Churchill, 1987b). Decision making authority lies with the EU Council which is composed of member governments represented at ministerial level. Thus, fisheries policies and regulations are compromises between the sometimes disparate interests of EU member governments, as determined by a voting procedure. The EU administrative arm, the Commission, is responsible for initiating legislation whereas the input of the fishing industry is largely channelled through member governments and then through ministers to the Council.

The USA management system is formalized in federal law which gives power to regional councils to develop regulatory plans. The bulk of the council members are individuals who are knowledgeable or experienced in fishery management or fishing, while the remainder are state and federal officials. The councils are required to conduct public hearings to ensure that all interested persons have an opportunity to be heard. The role of the federal government, through the Secretary of Commerce, is to

review council plans against the national standards for conservation and management and other legal provisions and either approve them or return them to the council for amendment. The Secretary of Commerce also has various emergency powers to directly implement plans. Prior to implementation, the Secretary is also required to receive comments on the proposed plans and also has the authority to call hearings on them. The USA system thus gives actual participants in the fishing industry a strong, even predominant, influence on management planning.

The EU and USA decision making systems thus differ from those regimes which conform to the "standard model" both in the distribution of decision making power and in the complexity of the mechanisms used for arriving at a decision. Therefore, not only is the nature of decisions affected, so too is the ability to make decisions and the timeframes within which they can be made.

The distribution of enforcement and scientific authorities are also pertinent to regulatory effectiveness. In the countries conforming to the standard model the central agency responsible for fisheries supports an enforcement force, although in all cases these receive some degree of logistical or other support from the armed forces or coast guard. In the EU case, enforcement authority resides with member states and the agency responsible for fishery management, the EU Commission, can only influence enforcement indirectly by evaluating member state enforcement and encouraging improvements. Enforcement responsibility in the USA lies with federal authorities and is shared by the Secretary of Commerce and the Secretary of Transportation, who is responsible for the Coast Guard which does essentially all at sea enforcement. There is no *a priori* reason why any of these arrangements cannot result in effective enforcement of fishery regulations. Nonetheless, there is a greater scope for imbalance between the regulatory aspirations of a management agency and its ability to ensure that its regulations are respected if there is a weak connection between regulators and enforcers. The USA system would appear weakest in this regard. Not only do those determining management plans, i.e. the Regional Councils, have little or no influence over the capabilities of the agencies responsible for enforcement, much of the enforcement authority resides in a government department other than that responsible for fisheries management. The connections in the EU system are also tenuous and enforcement efforts are viewed as unsatisfactory by the EU Commission. According to Holden (1994) many member states, while guarding their authority for enforcement, demonstrate a lack of political commitment to effective control of fishing. In the other (standard model) cases there is also variation in the degree to which enforcement capability resides under the control of the fishery management agency. At one end of the scale, the Canadian Department of Fisheries and Oceans maintains a substantial fleet of dedicated enforcement vessels and contracts commercially for overflight and observer services. Thus armed forces support is not central to enforcement efforts although utilized on occasion. In contrast, Norwegian at-sea surveillance is the responsibility of the Coastal Surveillance Service which is part of the Military High Command. There is greater opportunity to tailor management aspirations to enforcement capabilities or, conversely, to expand enforcement activities to meet management needs, when regulators and enforcers are part of the same management agency. It is, nonetheless, only an opportunity, not necessarily a consequence.

The national scientific laboratories which conducted the research on fish stock dynamics and the effects of fishing continued after the extensions of jurisdiction much as before. The EU did not set-up its own research capability, depending on the already well established national laboratories of member states. The primary changes came in the way scientific results were evaluated and how advice on management options was developed and delivered to regulatory authorities. Years of experience in providing scientific advice to the international commissions convinced scientists of the importance of a committee structure for peer review of research results and the development of a consensus on stock status and yield prospects. This provided a sound mechanism for quality control, a way to develop and use consistent methods in the application of scientific theory and biological knowledge to practical fisheries problems, and a vehicle for documentation of the scientific basis for management which made results available for public scrutiny.

In the Northeast Atlantic, ICES, which functions under its own international convention, was not affected directly by jurisdictional changes. All regional management agencies saw virtue in continuing to use ICES as the vehicle for generating scientific advice for stock management after jurisdictional extensions. Management responsibility for many Northeast Atlantic stocks continued to be shared, of course, and ICES advice provided a common scientific footing on which regulatory agreements between the interested parties could be based. However, ICES advice continued to be sought even for resources entirely within the jurisdiction of each management authority. Indeed, Iceland, which had withdrawn their cod and haddock stocks from ICES consideration at the time of the cod wars, returned there for advice on cod in the early-1990s. The EU maintains its own Scientific, Technical and Economic Committee for Fisheries but this builds on advice received from ICES and does not serve as an alternative to it.

In the Northwest Atlantic, scientific advice was provided by a standing committee of the ICNAF Commission, and this disappeared along with ICNAF as a whole to be replaced by the Scientific Council of NAFO. In addition to its obligation to provide the NAFO Fisheries Commission with all necesary scientific advice, the Scientific Council was given the authority to provide scientific advisory services to coastal states on their request. However, as the USA chose not to join NAFO (until 1995) these services were not available to it, whether it wanted them or not. They were available to Canada and were used quite extensively in the initial years when there was a strong foreign presence in a variety of domestic fisheries. Over time however, usage was reduced to advice for straddling stocks and a very few domestic stocks which were still fished almost exclusively by foreign fleets.

On extension of jurisdiction many stocks in the new Canadian zone were reserved for exploitation by domestic fishermen only and it was decided to establish a domestic science advisory committee, CAFSAC, to assess these stocks and also to provide an advisory vehicle for all other aquatic resources along Canada's Atlantic coast. It was thought that CAFSAC, which was allowed to function with a great deal of autonomy, provided a more effective vehicle for scientific review of these resources than did the NAFO Scientific Council which could not attract the broad scientific participation previously enjoyed by STACRES of ICNAF. However, the decline in groundfish resources in the late-1980s and early-1990s brought CAFSAC under severe criticism, and it was disbanded by the Minister of Fisheries in 1992, and subsequently replaced by stock assessment reviews within regional laboratories organized by science managers, an approach which leaves some doubt about the ability of Canadian scientists to provide the same standard of advisory services as previously.

Each of the USA regional councils is required by law to maintain a scientific and statistical committee to provide scientific information for management plan development. However, that of the New England Regional Council did not function effectively and scientists of the Northeast Fisheries Science Center of the National Marine Fisheries Service felt it necessary to establish their own scientific review (Stock Assessment Workshop) system, starting in 1985, which became more broadly sponsored and developed into a Stock Assessment Review Committee which embodies many of the features of the now defunct Canadian CAFSAC. Despite the use of domestic, rather than international, scientific advisory mechanisms by Canada and the USA, both countries are members of ICES and participate fully in the functions of that organization. Thus, there is a continuous flow of information among the fishery scientists in the North Atlantic and a conformity of standards and procedures.

Domestic and international science advisory agencies have their own strengths and weaknesses, but both can function effectively if they retain their freedom to conduct an open system of peer review and to document publicly the results of their work. Fortunately, these safeguards for collective scientific objectivity are generally (if not universally) appreciated within fisheries bureaucracies.

The fact that it is only natural scientists who maintain such elaborate mechanisms to monitor fisheries and fish stocks and to deliver their end product, scientific advice, to management agencies is a reflection of the predominance of fish stock conservation considerations in fishery management. There appear to be no comparable institutions, maintained by social scientists, directed to promoting the economic and social well-being of the fishing industry. Nor do the scientific institutions described above generally include economic and social research within their mandate, although the USA regional council scientific and statistical committees do have scope to provide economic and social as well as biological information. Also, in 1992, new EU legislation broadened the scope of its advisory committee to include economics, and yet more recently, ICES began to invite economists and sociologists to its annual meetings. The general lack of research coordination and advisory mechanisms in the economic and social fields does not mean of course, that data collection and analysis are not going on within government and other institutions and that the results are not entering into the decision making process. It does indicate, however, that this is not happening in any systematic, organized and consistent way.

Objectives

Other than the statements of purpose of international commissions which are contained in their respective conventions, official statements concerning the objectives of fisheries policy were found for the Canadian, EU, Norwegian and USA management regimes (Table 1). For Faroe Islands, Greenland and Iceland it was necessary to depend on personal communications from government sources and on the conclusions of previous authors, who imputed objectives based on government actions, to reach conclusions about governmental aspirations.

TABLE 1. Objectives of the fisheries management policies of each management regime as stated in international conventions or policy statements of domestic governments when available, or as interpreted in secondary sources (see main text) when official documentation was not available.

Management Regime	Objectives of Fisheries Policy	Notes
old NEAFC	to ensure the conservation of the fish stocks and the rational exploitation of the fisheries	As stated in its convention.
ICNAF	investigation, protection and conservation of the fisheries... in order to make possible the maintenance of a maximum sustained catch (modified December 1971 to: achieve the optimum utilization, defined on the basis of scientific investigations and economic and technical considerations)	As stated in its convention.
Canada	1) best use, as defined by the sum of net social benefits derived from the fisheries and the industries linked to them (also defined in 10 "operational goals" and 20 "precise objectives")	Published statement of Government, 1976.
	2) 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 200 mile zone.	Task Force report accepted by Government, 1982.
European Union	1) 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	Preamble to EU Council legislation on conservation policy, 1983.
	2) 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	Preamble to EU Council legislation on conservation policy, 1992.
Faroe Islands	satisfactory economic performance of the industry	According to officials of the Directorate for Fisheries.
Greenland	to use fisheries as the primary vehicle for economic development	According to non-government sources.
Iceland	– conservation of the fish stocks – restoration of normal profitability in the industry – maintenance, as far as possible, of the current regional and personal distribution of benefits, and – increase of economic rents	According to non-government sources for the groundfish fishery, but could apply to all fisheries. No formal statements of Government policy have been issued but the present interpretation has been confirmed in general by Government officials.
Norway	1) 1. maintain the main features of coastal settlement 2. protect and maintain the fish stocks 3. ensure safe and profitable employment in the fishery industry	Government policy as reported to Parliament, 1977.
	2) 1. improve the real profitability of the fishery, i.e. profitability after deduction of state subsidies 2–4. Same as 1–3 above	Revised Government policy as reported to Parliament 1983.
USA	conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery (National Standard No. 1)	As specified in the Fishery Conservation and Management Act of 1976
	– optimum yield is that which provides the greatest overall benefit to the Nation, with particular reference to food production and recreational opportunities, and which is prescribed as such on the basis of the maximum sustainable yield, as modified by any relevant economic, social or ecological factor	
	– six other National Standards are defined which are ancillary to the first	
New NEAFC	to promote the conservation and optimum utilization of the fishery resources of the Northeast Atlantic area and to encourage international cooperation and consultation with respect to these resources	As stated in its Convention
NAFO	identical to new NEAFC except applicable to the Northwest Atlantic area	As stated in its Convention

Conservation of fish stocks receives a prominent place in most statements of objectives but is, of course, implicit in all, as continued achievement of social and economic objectives requires a successful program of stock conservation. In other words, if the ability of the stocks to maintain a high level of production is undermined by fishing, attaining other long term objectives is compromised. The international commissions saw conservation as a necessary basis for achieving optimum utilization of the stocks. This term adopted by ICNAF, can be considered equivalent to the objective of "rational exploitation" in the old NEAFC convention, to "best use" in Canada's 1976 objectives and "balanced exploitation" in EU, and "optimum yield" in USA, legislation. ICNAF, Canadian, EU and USA objectives make clear that the concept of optimum utilization includes biological, economic and social considerations. Nonetheless, USA legislation uses the biological criterion, maximum sustainable yield, as a foundation for defining optimum yield.

These statements about optimum utilization can, of course, mean anything a management agency wants them to mean. They do convey the idea that the resources are to be fully utilized by the fishing industry to provide economic and social benefits at least to participants in the industry and possibly more broadly to society in general. Canada and Norway, from 1982 and 1983 respectively, adopted more concrete guidance statements about the level of economic performance which the industry was intended to achieve. In Canada's case, economic viability was defined as an ability to survive downturns with only a normal rate of business failure and without government assistance. In Norway, the intention was to improve the real profitability of the industry, i.e. profitability after deduction of state subsidies. Both these countries share broadly similar social objectives, in particular maintaining high employment in the fishery to maintain the viability of settlements in coastal areas, while also ensuring a reasonable level of income. Both jurisdictions recognize that their social and economic objectives are to some extent conflicting and must be balanced.

Although USA regulations provided much the same starting point of optimum yield, the New England Fishery Management Council's thinking evolved in quite a different direction from that of Canadian and Norwegian authorities. This Council's objective became limitation of regulatory interference to the minimum necessary to prevent resources being completely fished out. This could be viewed as a policy with objectives limited strictly to providing minimum resource conservation safeguards.

In the application of EU conservation policy, the economic and social elements translated into preferential catch allocations to support employment and income in coastal regions which were economically disadvantaged or largely dependent on fishing. Other elements of the overall Common Fisheries Policy which related to "structures" and markets clearly also had economic and social motivations. Nonetheless, the preoccupations of the EU during the 1970s and 1980s were the issues of access and of an acceptable system of allocation, at a national level, of catch shares.

These regimes for which official statements of objectives have not been located nonetheless make clear by their actions in most cases that they share, generally, the objectives of Canada and Norway who have documented their intentions more thoroughly. Faroe Islands, Greenland and Iceland, with economies that are heavily dependent on fishing, are obligated to give economic viability of their fisheries a high priority, although Faroe Islands and Greenland have their continuing political association with Denmark as a safeguard in times of adversity, a factor of great importance to the Faroe Islands when its fish stocks declined substantially in the early-1990s. The complete independence of Iceland required particularly rigorous attention to economic efficiency. In Iceland, maintaining the regional distribution of benefits, and hence of community settlement, is also a central element of policy.

As far as can be ascertained then, it appears that a number of post-200 mile management regimes have functioned without benefit of much or anything in the way of "formal" or "official" statements of overall policy objectives. The objectives of those regimes which did make public the intentions underlying their actions on the whole share a generality which allows for wide interpretation. This does not mean that they were necessarily of no value in guiding the actions of the management agencies concerned, but there is no information to suggest that any of these agencies went to the lengths of establishing quantitative targets for other than their stock management objective, and that in itself was not universal. Their economic and social objectives presumably served to give only a general context within which to implement regulatory controls. Thus, it seems fair to say that fisheries in the post-200 mile limit period operated in an impoverished policy environment which was restricted to little more than resource conservation and allocation. The definition of conservation varied greatly among regimes of course, and in some encompassed the concept of obtaining the fullest sustainable advantage from the resource. This meant that social and economic issues were legitimate considerations when imposing regulatory controls on harvesting but nonetheless required that actions be

justifiable in terms of protecting or enhancing resource productivity. The focus of attention, therefore, remained on the strategies and tactics of resource harvesting, as it did in the international commissions.

Harvesting Strategies and Tactics

Maintaining the productivity of fish stocks by controlling the level and pattern of exploitation has been a preoccupation of management. However, controlling the level of catch, for example, will serve the purpose of stock conservation only if it results in fishing mortality being reduced to, or maintained at, an appropriate level. A TAC may be established, without reference to a particular fishing mortality, to create a regulatory basis for equitable catch sharing, i.e. a social purpose, or to limit supply to market demand as an economic motivation, or simply to establish adequate control over fishing, i.e. to close regulatory loopholes. Similarly, the pattern of exploitation may be modified, or limits placed on the amount of capital or labour employed in the fishery, to address various combinations of these purposes. In the following text, all regulatory actions that controlled the level of catch, directly or indirectly, are summarized under "control of exploitation level", whatever their purpose(s). Similarly, all measures that controlled the size or age of fish caught are summarized under "control of exploitation pattern". A third category of regulatory action is also recognized; "spawning closures". There is a widely held belief among fishermen that leaving fish undisturbed by not fishing during spawning will result in improved, or sustained, recruitment. That such closures enhance the success of the spawning act has not received general acceptance among scientists and regulators. However, these latter have seen other values to spawning closures, such as reducing fishing effort. Closures, spawning or otherwise, also have allocative significance. The reasons behind spawning closures are usually poorly documented but, as the concept of the intrinsic conservation value of undisturbed spawning is different from those of controlling level and pattern of exploitation, these spawning closures are summarized separately.

Control of exploitation level: Faroese and USA authorities placed few or no controls on domestic resource exploitation levels (Table 2). As domestic fleet demands on home water resources increased the Faroese found these could, for a number of years, be accommodated by displacement of foreign fleets. It was not until the late-1980s that restrictions were placed on domestic fleet size for economic reasons, and 1994 that TACs were used to limit fishing mortality on particular stocks for conservation purposes. The USA New England Council abandoned control of fishing mortality for groundfish and herring at the beginning of the 1980s, but fishing effort limits for groundfish conservation purposes were introduced in 1994. (The Mid-Atlantic Council maintained management at $F_{0.1}$ for mackerel.) The new NEAFC could be grouped with the Faroe Islands and USA, as blue whiting and oceanic redfish stocks lay within NEAFC responsibilities but remained unregulated. However, exploitation of these resources was low during the study period and this inaction can hardly be used to characterize the organization's regulatory "philosophy".

In the remaining management regimes, regulation of exploitation level was an important element of control measures, and all used TACs as the primary mechanism (Table 2). The EU system of national catch quotas (not fully established until 1984) was essentially for allocative purposes and TAC levels set by the EU Council bore no relation to a particular mortality rate strategy, although the Commission, through its proposals to Council, attempted to stabilize mortality at prevailing levels (Holden, 1994). For most stocks, these levels were above F_{max}. Norwegian and Icelandic approaches were quite similar in that regulatory authorities had a general intention of fishing at about F_{max}, but the importance given to stability of catches and, in the case of Norway to reaching agreement on management of shared stocks, caused mortality to be higher than F_{max} on the most important stocks. Both these countries adopted lower exploitation levels for herring, and for the special case of capelin, most of which die after spawning, target spawning stock size was used as a conservation reference point.

The Canadian management approach was unique both in the extent to which TAC regulations were hinged to a particular biological reference point, and in the fact that this was a low exploitation rate strategy, fishing at $F_{0.1}$. This was seen as addressing economic, as well as conservation, objectives (but ran counter to other measures which promoted high employment in the fishery). This same $F_{0.1}$ strategy had been adopted by ICNAF, albeit under coercion from coastal states, particularly Canada, and was inherited by NAFO. However, unrestricted fishing by non-members of NAFO and unilateral actions by one of its most influential members, the EU, made NAFO adoption of an $F_{0.1}$ strategy nominal, at least from the mid-1980s. Greenland, although not adopting a fixed-F strategy, consistently favoured low exploitation in its management of cod and hence was closest to Canada and NAFO in its strategy. The low exploitation approach of Canada, Greenland and NAFO extended to the capelin fisheries, although in the case of Greenland the fishery has yet to be industrialized and is under a "controlled-development" strategy. Canada and NAFO adopted an arbitrary

TABLE 2. Exploitation level strategies by jurisdictional regime for primary species. General strategy is listed first, then strategies by species when exceptions apply. (SSB – spawning stock biomass target level.)

Jurisdictional Regime	Biological Reference Point	Exploitation Level Strategy	Methods Used to Control Exploitation Level
Pre-1977			
NEAFC	–	Regulated F in 1975–76 only. Intention was to restore stocks to levels giving MSY by first stabilizing F at prevailing high level then reducing F towards F_{max}.	TACs and national allocations from 1975
ICNAF	F_{max}	Regulated F from 1970, comprehensively from 1974. Objectives of maximum sustained catch and, after 1971, optimum utilization were equated with fishing at F_{max}	TACs from 1970 and national allocation from 1972. Second tier TAC in southern area from 1974 to reduce mixed fishery and by-catch problems. Effort regulation in northern area in 1976.
Post-1976			
Canada	$F_{0.1}$	Optimum F for "best use" equated with $F_{0.1}$. For marginal reduction in total catch, reduced required fishing effort significantly, increased catch rates and size of fish in catch for improved economic performance; maintained larger stock size for increased inter-annual catch stability and as a buffer against stock assessment error or enforcement deficiencies; provided for an adequate spawning stock.	Licensing and capacity constraints on replacement vessels-herring purse seiners form 1968, large groundfish vessels from 1973, groundfish vessels less than 65 feet from 1976. TACs and allocations by fleet size category and gear type from 1972 for herring and 1977 for groundfish, boat quotas for herring purse seiners from 1976 – transferability of TAC – shares from 1983 conditional on leaving the fishery, enterprise allocations for large groundfish vessels from 1982 and boat quotas for some groups of under 65 feet groundfish vessels from 1984 - intra-annual quota transferability.
	–	**Capelin**: from 1979, exploitation rate of 10% used for regulation to reflect difficulties in estimating spawning stock size and in recognition of its importance in the food chain.	
EU	–	Regulated catches from 1984. Intention to obtain highest possible catches, while maintaining inter-annual catch stability, pursued by stabilizing F at current level. Recognized possible benefits of reducing F towards F_{max} but reductions in F not implemented.	Fleet capacity controls from 1983, vessel registry form 1989. Fishing effort controls (fleet tie-ups) for cod and haddock fisheries in the North Sea and West of Scotland in 1991–92. General licensing and special permit for effort limitation, from 1995. TACs and national allocations from 1984.
Faroe	–	None until 1989. Then established exploitation rate target, using economic criteria, as the fishing pressure which allows a vessel which is operating normally to obtain an adequate economic return without subsidies	Limited entry licensing and capacity constraints on replacement vessels from 1987. Vessel decommissioning incentives in effect for 1988–91. Closed areas.
	SSB	Targets set for cod and haddock in 1994; to be reached by 1998.	TACs from 1994.
Greenland	–	**Cod**: maintain catches as stable as possible given unstable stock conditions and allow stock rebuilding when opportunities arise. Some TACs set at $F_{0.1}$ or lower but a fixed-F strategy not adopted.	TACS from 1977.
	–	**Capelin**: exploratory development only	
Iceland	–	**Groundfish**: regulated F from 1984. Strategy for cod was to reduce F towards F_{max} and increase spawning biomass towards a target level while maintaining catch stability. For other species, when F did not exceed F_{max}, F kept at F_{max} or below. From 1995/96 season,catch of cod limited to 25% of age 4+ biomass with constraint that TAC is not less than 155 000 tons.	**Groundfish**: Fishing effort controls for cod from 1977. TACs and transferable boat quotas for major species from 1984. TAC-shares transferable conditional on selling vessel leaving the fishery
	$F_{0.1}$	**Herring (summer spawners)**: regulation of F from 1968, at $F_{0.1}$ from 1975.	**Herring (summer spawners)**: TACs from 1968, boat quotas and limited entry from 1975. Boat quotas made transferable in 1979.
	SSB	**Capelin**: from 1983/84 season used target minimum spawning biomass.	**Capelin**. TACs from 1978/79, boat quotas and limited entry from 1981 Boat quotas made partially transferable from 1986. **All Species**. General system of transferable boat quotas from 1988. General system of permanent transferability of TAC shares from 1991.
Norway	F_{max}	**Groundfish**: target exploitation rate of F_{max} provided guidance but phased approach taken and compromises required for shared stocks.	Limited entry licensing from 1972, except traditional gears (small coastal vessels). Vessel decommissioning incentives – for purse seine fleet from 1979, for entire fleet from 1984.
	–	**Herring (spring spawners),and Mackerel (North Sea)**: increase spawning stock.	TACs from 1977 and (non-transferable) boat quotas from 1974.
	SSB	**Capelin**: target minimum spawning biomass.	

TABLE 2. (Continued). Exploitation level strategies by jurisdictional regime for primary species. General strategy is listed first, then strategies by species when exceptions apply. (SSB – spawning stock biomass target level.)

Jurisdictional Regime	Biological Reference Point	Exploitation Level Strategy	Methods Used to Control Exploitation Level
USA	–	Magnuson Act: optimum yield defined as MSY modified by any relevant factor.	
	–	**Groundfish:** for cod about F_{max} and for haddock about $F_{0.1}$ until 1981, thereafter direct controls on F abandoned From 1986, spawning stock size constraints adopted expressed as percentages of maximum spawning potential.	**Groundfish.** TACs from 1977 and allocations by vessel size category, gear type and season form 1978, abandoned after 1981.
			Moratorium on vessel entry and 5 year effort reduction plan introduced in 1994.
	–	**Herring:** increase spawning stock size until 1982, thereafter all regulation abandoned.	**Herring:** TACs in effect for 1979–82, no controls thereafter
	$F_{0.1}$ & SSB	**Mackerel:** increase spawning stock size until 1982, thereafter $F_{0.1}$ if spawning stock remains above a defined minimum level.	**Mackerel:** TACs from 1977
NEAFC	–	None of the primary species except, recently, Norwegian spring spawning herring, occur in regulatory area.	–
ICNAF/ NAFO	$F_{0.1}$	**Groundfish:** $F_{0.1}$ strategy largely adhered to in formal commission regulatory decisions but, after 1985, combined domestic regulatory actions of members resulted in a higher F strategy *de facto*.	TACs and allocations to Contracting Parties from 1977.
	–	**Capelin:** from 1979, exploitation rate of 10% used for regulation to reflect difficulties in estimating spawning stock size and in recognition of its importance in the food chain.	

10% exploitation level for capelin, combined with fishery closures when stock size was low, in contrast to the Norwegian and Icelandic minimum spawning biomass targets.

The general use of TAC regulation reflects its value as a straightforward, readily understood, way to allocate shares of the resource to interested parties, internationally to countries and nationally among vessel size and gear type categories and, increasingly, to individual enterprises or boats. Sometimes boat quotas were not made tradeable, e.g. in Norway, but in most cases some element of tradeability was allowed to provide a necessary flexibility in vessel operation. Tradeability of TAC-shares, i.e. entitlements, as distinct from annual quotas, was less common. Transferability of shares was allowed in the Canadian herring purse seine fleet from 1983 and in the Icelandic groundfish fleet from 1984, but in both cases only upon withdrawal of the selling vessel from the fishery. A full-fledged quasi-property rights system, with relatively unfettered trading of shares, was established only in Iceland and not until 1991. The subdivision of TACs allowed management agencies to pursue a variety of social and economic goals but equity in sharing arrangements among participants was a primary motivation, and the principal criterion for sharing was invariably their historical performance in the fishery. Quota allocation, to the extent that it promoted an orderly approach to harvesting, was also important to maintaining control over the fishery and hence to ensuring that catch limits were respected. The increasing interest in quasi-property rights schemes was by no means entirely motivated by a desire for economic rationalization of fleets. The anticipated economic rationalization was expected to contain the solution to the excess fishing capacity which drives overexploitation. The overexploitation results both from pressures to set too high catch targets and from the difficulty in controlling catches to the levels set, when fleet sizes are much in excess of those required to exploit the available resource.

All domestic management agencies, sooner or later, gave importance to controlling participation in the fishery through licensing, vessel decommissioning, restrictions on vessel size on replacement, fleet size restrictions, direct control of fishing effort, or some combination thereof. These are all methods designed to more directly counter the tendency toward fleet overcapacity inherent in common property fisheries.

Virtually all agencies made exceptions to quota and vessel capacity restrictions for small coastal boats, partly as an element of social policy but also to avoid the practical difficulties of controlling large numbers of small vessels. This typically encouraged expansion of the activities and fishing capabilities of these fleets, and this required that exemptions

be largely or completely eliminated, e.g. in Canada, Faroe Islands, Iceland and Norway.

Despite these many efforts to control fleet composition, in terms of both vessel numbers and vessel and overall fleet size, by almost all management agencies, 15 years after acquiring control of their own fisheries destiny, all recognize fleet overcapacity as an important to extremely serious problem constraining their ability to meet their management objectives. In most jurisdictions, licensing and fleet management were not directly linked to exploitation level targets, and increasingly stringent controls were reactive rather than preemptive. This lacklustre performance of input controls, i.e. of restrictions on investment of labour and capital, resulted in the strong emphasis on output controls, i.e. on catch, and made a market solution based on tradeable TAC-shares an attractive alternative in several jurisdictions, e.g. Iceland, Canada. However, in contrast, the USA made input controls a central element of its management plan in 1994 and the EU is greatly strengthening the input control elements of the CFP because output controls are viewed as not having work at all well.

Control of exploitation pattern: Regulatory measures to reduce the catches of small fish in the groundfish trawl fisheries were essentially the sole preoccupation of the international fisheries commissions in the 1950s and 1960s. Although emphasis was shifted in the 1970s to control of exploitation level, protection of small groundfish was still viewed as important and all post-extension regimes strengthened their regulations in this regard. Indeed, in the initial years of national jurisdiction, Iceland and Faroe Islands made protection of small fish the central element of groundfish conservation strategy. Iceland quickly developed a broader regulatory base, placing increased controls on the level of exploitation. However, the USA took the reverse approach by abandoning controls on exploitation level in the early-1980s in favour of almost exclusive dependence on protection of small fish.

Protection of small specimens of pelagic species has a less extensive history than that for groundfish. The fisheries commissions began introducing regulations to restrict catches of small sizes of pelagic fish only in the early- to mid-1970s just prior to extensions of jurisdiction, although Iceland introduced a minimum fish size in its domestic herring fishery as early as 1966. While the yield-per-recruit argument for protection of young fish is as applicable to pelagic as to demersal fish, there are differences in other aspects of the biology and in the fisheries for the two types of species. In the case of herring, one important difference is that there are commercial products based on small herring, e.g. the Canadian and USA Atlantic coast "sardine", and these may be more valuable than products from adult herring such as fish meal. In other words, the economic yield-per-recruit, as distinct from the physical yield-per-recruit, would in these circumstances favour exploitation of young fish. A further difference is the tendency for pelagic species to show a greater spatial segregation by size than do groundfish. This results in regulation of the temporal and spatial distribution of fishing being a more effective management tool to reduce catches of small pelagic fish than it is for groundfish, and also allows fishermen themselves a greater control over the size of fish they catch. Many pelagic fisheries are directed towards pre-spawning or spawning concentrations, either by regulation or because this is when fishermen have the greatest fishing success (or can obtain the desired product, e.g. herring roe); a circumstance under which few if any small fish will be caught. Moreover, it is more difficult to achieve effective size selection by fishing gears for pelagic species than it is for groundfish. Small mesh is required if meshing problems are to be avoided. The Icelandic purse seine fishery for capelin is a special case, where the difference in size between age 1 fish and the older fish is sufficiently large to allow good escapement of age 1 fish without serious meshing problems (Vilhjálmsson, 1994). Trawl selection for pelagic fish, at commercial catch rates, is poor and most fish which do escape are damaged and likely die (Casey *et al*., 1992; Suuronen, 1995).

The following comparisons of the specific regulations adopted in each regime with regard to minimum mesh and fish sizes is intended as a factual summary only. There is no intention to imply that the regulations should be the same for all regimes. To the contrary, stocks vary in their growth characteristics, the fisheries on them vary in their intensity, and the objectives of management vary among regimes. Thus, "optimum" minimum mesh and fish sizes will vary accordingly, and differences in the regulations among regimes are to be expected. When comparing minimum fish sizes between regimes it is important also to remember that some were in terms of fork length whereas in other cases total length was used. For pelagic species, the conversion between fork and total length is roughly 10%. For groundfish the difference is much less, about 3% for haddock and about the same percentage for pollock, whereas the two length measures are essentially identical for cod.

The primary method of preventing the catch of small groundfish was to specify how fishing gear was to be constructed, with most attention being devoted to controlling the codend mesh size used in mobile gears. Trawl regulations can be complex

but essentially all of the technical specifications for construction are intended to ensure that the net is rigged in a proper way so that, when it is used, size selection by the codend meshes is effective. Among fixed gears, gillnet mesh sizes were usually regulated also. During the study periods used in this paper, all netting was constructed of synthetic materials, although regulations continued to be phrased in terms of manila equivalents until extensions of jurisdiction or later. It is a safe assumption that, differentials or not, nets in use had a mesh size no larger than the smallest allowed, as no ready way was available to enforcement officials for determining the different types of synthetic twines. Most post 200-mile regimes dispensed with differentials based on material. Danish seine nets were classified with otter trawls as a mobile, trawl, gear but were allowed to use smaller mesh than otter trawls in international commission regulations. A differential for Danish seine nets was dispensed with by all post 200-mile regimes, as there were insufficient selection data to justify its retention (but was reintroduced in Norway and Iceland).

In the gadid fisheries of the North Atlantic as a whole, the otter trawl is by far the predominant gear used. Thus, a comparison of minimum mesh size allowed in otter trawls, i.e. the minimum allowed for any material, provides the best standard for comparison of gear regulations among regimes. The otter trawl mesh sizes in effect in 1972 and 1984, the mid-years of the study periods used in this paper, and in 1990, to represent recent years, provide one such set of comparisons (Table 3). All regimes increased the mesh size required after obtaining management authority. The range in mesh size was 70–120 mm in 1972 under international commission regulation whereas by 1984 it was 80–155 mm, and three regimes had implemented further increases by 1990. However, excluding the special case of the EU fisheries in the North Sea and west of the British Isles, the range in mesh sizes among regimes was much less pronounced, in 1972 varying from maximum to minimum by 20 mm and in 1984 and 1990 by 25 mm. The regimes which implemented the largest proportional increases between 1972 and 1984 were Iceland, Faroe Islands and USA at 30%, whereas at Greenland and in the northern Canadian zone and NAFO Regulatory Area the increase was less than 10%.

In the Northeast Atlantic fishery commissions, minimum fish size regulations for groundfish were viewed as useful supplements to mesh size regula-

TABLE 3. Minimum trawl mesh sizes and fish sizes for cod, haddock and pollock, in effect in 1972, 1984 and 1990 in each of the North Atlantic regulatory zones. Mesh sizes cited are the minimum size permitted in otter trawls regardless of material. (Canada/NAFO = NAFO Subareas 0, 2 and 3; Canada–south = NAFO Subareas 4 and 5 [Canadian Part].)

Regulatory Zone	Minimum Mesh Size (mm)			Minimum Fish Size (cm)								
				Cod			Haddock			Pollock		
	1972	1984	1990	1972	1984	1990	1972	1984	1990	1972	1984	1990
Norway (N of 64°)	120	135[1]	135[1]	34	42	47[2]	31	39	44[2]	–	32/40[3]	32/40[3]
European Union	70	80	90	30	30	35	27	27	30	–	30	35
Faroe Islands	100	135	145	34	34	40	31	31	37	–	35	45
Iceland	120	155	155	34	50	50	31	45	45	–	50	50
Greenland	120	130	140	34[4]	40	40	31[4]	31	–	–	35	–
Canada/NAFO	120	130[5]	130[5]	–	–	41[5]	–	–	41[5]	–	–	41[5]
Canada–south	105[6]	130	130	–	–	41	–	–	41	–	–	41
USA	105[6]	140[6]	140	–	43	48	–	43	48	–	–	48

[1] USSR 125 mm mesh may be equivalent to Norwegian 135 mm mesh.
[2] Norway only.
[3] Five Zones – 35–40 cm north of 64°N, 32–35 cm south of 64°N. (30 cm in Skagerrak.)
[4] East Greenland only.
[5] Canadian Zone and Canadian vessels only in NAFO Regulatory Area, NAFO Regulation was 120 mm mesh size, no fish size limits.
[6] Not applicable to pollock.

tions. It was recognized that the two regulations should be consistent with each other so that fishing with regulation mesh size should result in few undersized fish being caught. The benefit of the minimum fish size was that it provided a way to regulate fishermen's behaviour through shore-based inspection of landings, whereas mesh size regulation required expensive and logistically difficult observation of fishermen's practices at sea. Furthermore, fish size regulations provided a control over sizes landed by gears other than trawls. In the Northwest Atlantic, ICNAF depended solely on mesh size regulation to reduce the catch of small groundfish. The post 200-mile regimes in the Northeast Atlantic all retained minimum fish size regulations for groundfish, and increased the regulated sizes from those of NEAFC (Table 3). In the Northwest Atlantic, the USA imposed minimum fish size regulations immediately on extension of jurisdiction. Canada followed suit, but not until 1988, as did NAFO from 1992. Thus, all North Atlantic jurisdictions now have minimum fish size regulations for the primary groundfish. Regulations for pollock lagged those for cod and haddock; NEAFC did not introduce size limits for pollock until 1976 and in the case of the USA it was 1986, reflecting the lesser fishery importance of pollock.

The actual regulated sizes for cod and pollock were quite similar while those for haddock tended to be lower reflecting its lower growth potential (Table 3). By 1990, minimum sizes for cod ranged from 35 cm in EU waters to 50 cm at Iceland. The smallest minimum size for pollock was 30 cm in the Skagerrak (based on tripartite agreement between EU, Norway and Sweden), and the largest was 50 cm at Iceland. For haddock, the smallest size was 30 cm for the North Sea and west of Scotland stocks (EU waters) and the largest was 48 cm in USA waters.

It is doubtful that, in any jurisdiction, the regulated minimum size reflects the actual minimum fish size which can be legally landed because ancillary clauses of the regulations, or enforcement practices, allow for some tolerance. In Norwegian regulation, for example, there are various fisheries for cod, haddock and pollock for which tolerances of 15% by number or 10% by weight of small fish are specified. Tolerances are not specified in Canadian regulation but there are cases where enforcement plans have allowed 15% by weight of small fish in cod fisheries. Small fish caught in excess of these tolerances are required to be discarded at sea by some jurisdictions, e.g. the EU, but in others, e.g. Iceland and Norway and recently Canada, these fish are required to be landed.

Area closures have been used also to protect small groundfish from capture. These fall into two classes, permanent and temporary closures. To provide effective protection, closures must on aggregate encompass most of the area of distribution of small fish for most of the time period that they are available to the fishery. As there is usually a substantial intermixing of small gadids with commercial-sized fish, it is normally difficult to define fixed areas for permanent (seasonal or year-round) closure which do not also cause severe interference with the conduct of normal fishing operations. Furthermore, such geographically-based restrictions usually have greater adverse effects on some fishermen than on others, i.e. they are discriminatory. For these reasons mesh size and fish size regulations are the generally preferred methods of protecting small groundfish.

Permanent closures to protect small fish were prominent features of Icelandic and Faroese groundfish management but the restrictions applied primarily or exclusively to large foreign trawlers, at least initially. Temporary closures more clearly have the singular motivation of protecting small fish. This method was pioneered by Iceland and an almost identical system was adopted by Faroe Islands in the early-1980s, by Norway in 1986 and by Canada in 1993. Based on size composition data from observers aboard commercial vessels, immediate closure was instituted, typically for a week with possibilities for extension, of any area where too many small fish were being caught. The definition of a small fish was not, in the cases of Iceland and the Faroe Islands, the minimum size specified in regulations. It was a size established annually, based on advice from the respective government research laboratories, which depended on the size composition of recruiting year-classes. The percentage of the fish allowed to be under this size was also established by scientists in these two countries. A temporary closure system was also instituted by the USA in 1989 but this did not provide for real-time closure, Regional Council and government consultations being required, and closures were for extended periods of three weeks to six months.

In the Northeast Atlantic, the ban on industrial fishing for herring was of overriding importance in limiting catches of small herring. The EU was the only regime in which trawl mesh size restrictions were adopted for pelagic species and, as noted above, Iceland established mesh size regulation for the capelin purse seine fishery.

Minimum fish size regulations were applied to herring in most jurisdictions and ranged from 20 cm in EU waters to 29 cm off Canada, but there were important exceptions in some cases, such as in Canada where the fishery supplying the sardine industry was exempt. Capelin size limits for the Barents Sea and Icelandic stocks, of 11 cm and 12

cm respectively, were important in protecting age 1 capelin from exploitation, but no size limits were used in management of Northwest Atlantic capelin. Size limits were imposed for all the mackerel stocks, although not for all fisheries, and varied from 20 cm for the western stock to 30 cm for the North Sea in the Northeast Atlantic to about 25 cm in the Northwest Atlantic.

Area closures of various coastal waters established in EU regulation were largely to protect small herring from fishing, and an area was closed off southwest England to safeguard small mackerel. Closure of areas to purse seining by Canada was used to protect small herring when these were particularly vulnerable, e.g. when overwintering in the Bay of Fundy. The real-time closure system in Iceland applied to herring as well as groundfish.

Spawning closures: Seasonal closure of spawning areas has been little used as a regulatory tool. When spawning areas were closed, it was almost invariably as an indirect means of controlling exploitation level rather than to enhance the success of the spawning act *per se*. Spawning area closure was one of the limited arsenal of regulatory measures available to the international commissions and it was used by NEAFC to reduce exploitation of west of Scotland herring in 1974 before the authority to establish TACs was acquired. When TAC control was adopted in 1975, the spawning closure was retained as a supplementary measure, and subsequently became incorporated in EU legislation. In the Northwest Atlantic, ICNAF included closure of spawning areas, along with TACs, in regulation of haddock stocks in 1970, in ICNAF's first venture in control of exploitation level. Proposals for these spawning closures originated from USA fishermen, but were viewed by regulators as supplements to TAC regulation. After extension of jurisdiction, these closures were retained in Canadian and USA regulations.

Norway used spawning ground closures to control spawning escapement of Barents Sea capelin prior to adopting TACs for this purpose, and hence this was intended to control exploitation level, i.e. it was designed to leave enough fish for a successful spawning rather than to allow spawning fish or spawning products to be undisturbed. The purpose of the Icelandic closure of several cod spawning areas is not clear, but the Faroese closure in 1992 of cod spawning grounds was a fishing effort reduction measure to protect the declining cod stock.

Enforcement and Compliance

An enforce-ment program for fishery regulations typically utilizes enforcement officers and data collectors in ports of landing, and aircraft overflights, surveillance vessel patrols and observers aboard commercial fishing vessels, to deter or detect violations on land and at sea respectively. Differences in enforcement methods among North Atlantic regulatory regimes are more in terms of emphasis given to these methods, rather than in the methods themselves. Land-based enforcement is the least expensive but unfortunately, many of the important regulatory controls on fishing require enforcement at sea. Observers are the cheapest at-sea enforcement method, followed by surface craft then aircraft. Each have their strengths and weaknesses.

Observers are unique in their ability to ensure a high level of regulatory compliance but can exert control over the behaviour only of the vessels on which they are aboard and thus a high coverage level is required if compliance at the fleet level is to be reasonably well assured. In special cases, however, such as closure of areas containing undersized fish, conditions on a few vessels can be extrapolated over the whole fleet within a particular area, and thus fleet closures can be effected with a low level of observer coverage. In general, however, a low level of observer coverage, while possibly collecting important scientific information, does little to ensure widespread regulatory compliance. Comprehensive observer coverage of foreign fleets fishing within domestic zones was adopted by both Canada and USA as a primary means of ensuring high regulatory compliance. In Canada the program was extended to give partial coverage of domestic fleets but in special circumstances, when compliance became a contentious, high profile, issue, complete observer coverage of particular domestic fisheries or fleet sectors was instituted. An observer program with only scientific responsibilities was sponsored by NAFO in its initial years, but this came to nothing. In the early-1990s tentative steps were taken by NAFO to establish an enforcement-oriented observer scheme. Thus, observers play a more extensive role in Northwest Atlantic regulatory systems than in those of the Northeast Atlantic, and Canada is unique in its level of utilization of observers for both regulatory and scientific purposes.

Aircraft are most effective in detecting regulatory violations which relate to area of fishing such as patrolling jurisdictional boundaries, closed areas, and detecting unlicensed fishing vessels, because large areas can be covered in short periods. Surface vessels can also perform these tasks but in most cases less effectively. Patrol vessels have the advantage, however, of being able to inspect fishing boats and their gear at sea and have the unique capability to arrest violators (where the legal authority exists of course).

Enforcement which can be done ashore ensures, most importantly, the accurate recording of landed quantities and that sizes of fish in landings

conform to regulation. Fishing gear can also be inspected before departure and on return to see that it conforms to regulations. Unfortunately, this does nothing to ensure that gear is not modified at sea to retain small fish, that the catch is not high-graded at sea by dumping undesirable species, undersized fish or catches over quota limits, or that the fish landed were caught in the proper area. Nonetheless, effective shore-based enforcement can put important limits on the extent to which fishermen can profit from illegal behaviour.

The most important question, of course, is not how enforcement was conducted in each management regime, rather how effective was it in ensuring a high level of compliance with the regulations. Unfortunately, measurements of compliance are extremely scarce. The traditional emphasis in enforcement activities is towards detection of illegal actions and apprehension and prosecution of the culprits. Penalties assessed against the perpetrators of illegal acts by the courts hopefully deter them and others in the fishery from committing such offenses in future. Whether or not this works depends on the balance between the financial gains to be had from illegal fishing on the one hand and the probabilities of being caught and convicted, and on the severity of the penalties assessed, on the other. There are trade-offs among these factors, e.g. if penalties are very severe this may deter illegal activity even if the probability of detection is low. This leaves the question of how to measure compliance. If no illegal activities are detected, does this mean that none occurred or that surveillance was ineffective? If there are lots of convictions, does this mean that surveillance is catching culprits very efficiently or that flaunting regulations is so widespread that culprits cannot be missed and, in reality, that penalties are viewed as no more than a business overhead? These are not questions which can be answered using the standard operational statistics usually collected by enforcement agencies such as days at sea by surveillance vessels, number of violations detected, or percentage of successful prosecutions. They require specific data collections and statistical analysis by appropriately qualified analysts, i.e. it is a research activity and as such has not usually been viewed as being part of enforcement agency mandates. While fishery research laboratories typically employ staff with the qualifications to conduct compliance analysis, it has not usually been viewed as their job and this important issue has fallen between stools. Thus, conclusions about the level of compliance with regulations are usually based on anecdotal reports from informal intelligence networks in the industry. This kind of information can have some serious biases and can mislead a management agency as to what might be an appropriate course of action. Nonetheless, if data are collected from fishermen in an objective and systematic way some useful measures of compliance can result. For example, a professionally-conducted questionnaire survey of fishermen illustrated quite convincingly a high level of regulatory non-compliance by the USA fleet fishing Georges Bank groundfish (Sutinen *et al.*, 1990).

A case where a surveillance agency itself designed an observational program to quantify illegal and unauthorized fishing is that of Canadian actions in the NAFO Regulatory Area under the auspices of the Fisheries Commission's Joint International Inspection Scheme. In the NAFO Regulatory Area there was not only the issue of whether contracting parties were observing agreed catch limits but also that of documenting catches of members who refused to be bound by NAFO regulations and catches of non-members. This presented a statistical estimation problem and required the deployment of surface vessel surveillance and boardings, and air surveillance, to provide valid catch estimates. These estimates, whether fully accepted or not, put a quantitative factual perspective on NAFO's conservation problems which drove the organization's agenda from the mid-1980s.

The NAFO and USA situations appear to be exceptions, however, and an overall assessment of compliance in North Atlantic management regimes is largely a matter of accepting the views of the responsible agencies as the best estimates available. On this basis it appears that the geographically more isolated management regimes of Faroe Islands, Iceland and Greenland have experienced quite a high level of regulatory compliance. Faroese regulations, of course, concerned little more than mesh size and area closure regulations in most of the period considered, but the quality of landing statistics deteriorated with introduction of catch controls in 1994. In Iceland too, compliance became an important issue when tighter constraints were placed on the cod fishery in the last few years. Norway, Canada, EU and USA experienced severe enforcement difficulties in some areas. Under-reporting of landings, of sufficient severity to prejudice effective management of some important resources, was documented in Canada and the EU, and to a lesser extent in Norway. In the USA, catch limits were dropped altogether for groundfish and herring as unworkable. Mesh size regulations were frequently violated in Canada, EU and USA. Minimum fish size regulations, when enforced, resulted in discarding at sea, even when this was illegal as in Norway. Highgrading, the dumping at sea of less valuable or unwanted species or sizes, was alleged to be widespread in Canadian enterprise allocation/boat quota managed fleets, although not quantified. In the case of NAFO, the problems were separable into both legal and illegal non-compliance.

Non-member fishing, and fishing by members who had exempted themselves from official conservation measures, was not illegal but nonetheless represented a non-compliance with serious repercussions for the success of the conservation programme. However, members, even when actually bound by NAFO regulations were also recorded through surveillance as exhibiting a high non-compliance.

It is readily apparent that the information which it is possible to gather, is not at all adequate to quantify the level of compliance with conservation programs. It is nonetheless obvious that most regimes experienced a variety of severe non-compliance problems, and it is safe to say that a failure to meet some conservation objectives resulted from an inability to effectively enforce the management measures adopted.

Resource Trends

Biomass estimates for the stocks in each management regime during the 22 years studied, 1967–88, are summarized by species in Fig. 58–63. All cod stock biomass estimates (Fig. 58) varied by at least a factor or two, i.e. the highest biomass was at least twice the lowest biomass in the period,

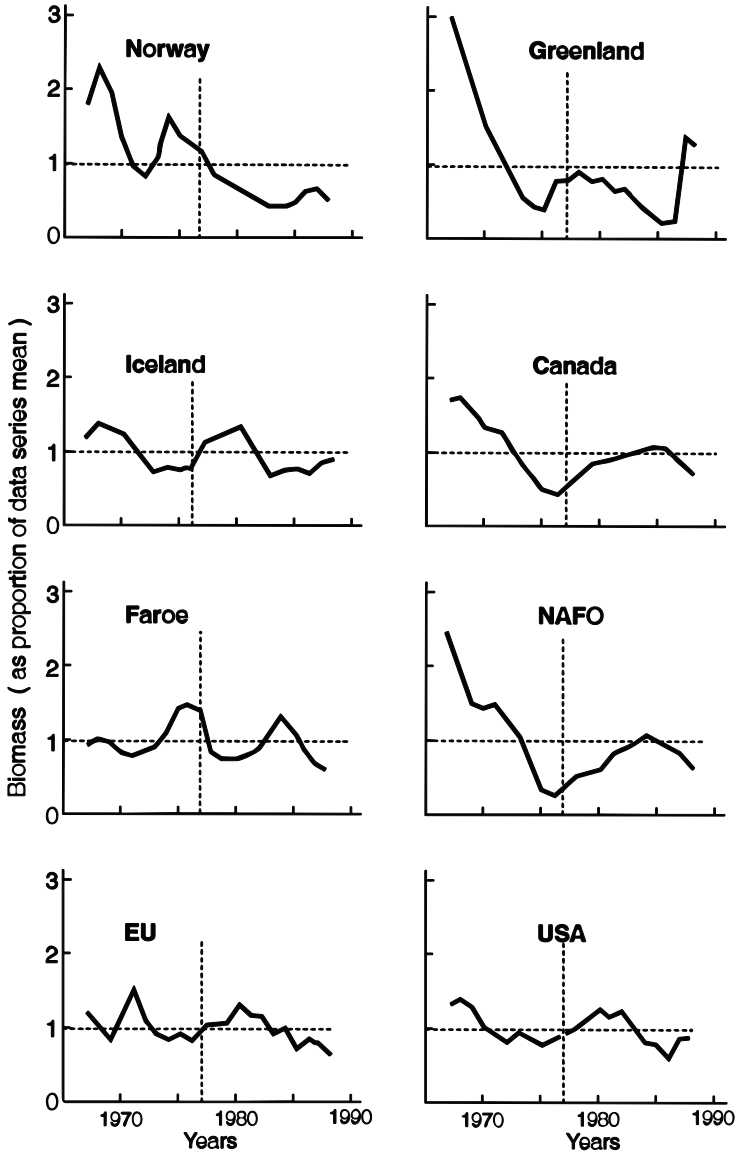

Fig. 58. Cod: biomass trends in North Atlantic stocks, 1967–88. (Break in USA graph indicates a data discontinuity.)

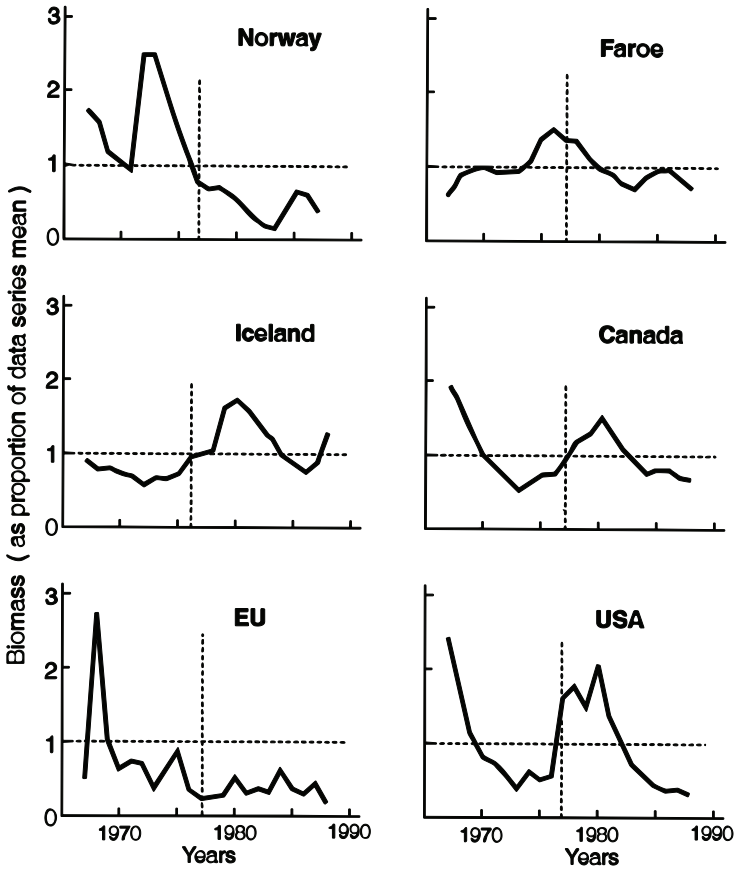

Fig. 59. Haddock: biomass trends in North Atlantic stocks, 1967–88.

and this was true also for haddock (Fig. 59) and pollock (Fig. 60), except for Faroe Islands pollock where the factor was 1.7. The median variation for all groundfish stocks was about 3.5. Biomass of pelagic stocks varied even more, the median factor being about 7.5, and the most extreme values were possibly as great as two orders of magnitude. At the end of the study period, most cod and haddock stock biomass estimates were below the 22 year average, whereas the reverse was true for herring stocks. For the other species, as many stocks were above as below the average by the end of the period. These trends in biomass are largely a function of variation in fishing mortality and in recruitment.

Changes in fishing mortality in each management regime are examined in two ways in Table 4. The change between periods in the fishing mortality of the fished population as a whole is given to indicate whether the population experienced a change in overall mortality. Secondly, the level of fishing mortality in relation to F_{max} is shown. (See section above on Convention and Methodology for explanation of average F calculations.) Capelin is not included in this table because strategic targets were established in terms of spawning stock biomasses and arbitrary exploitation rates rather than standard fishing mortality reference points.

There was a slight overall reduction in the exploitation level of North Atlantic stocks after extension of jurisdiction. Fishing mortality was decreased in almost half of the cases (Table 4). The stocks fished above F_{max} decreased from two-thirds, to less than half, of the total. Mortality decreased in most pelagic stocks, none being fished above F_{max} in the second period. Although fishing mortality decreased in some groundfish stocks, it increased in almost as many, and about 60% continued to be fished above F_{max} in 1979–88, the same percentage as before. Thus, the overall improvement in exploitation level is attributable more or less entirely to more moderate exploitation of herring stocks.

Success in reducing fishing mortality in herring stocks in the Northeast Atlantic in each case required a number of years of more or less complete fishery closure. In the Canadian zone there were fishery closures for some small stock components but the most decisive events were a ban on indus-

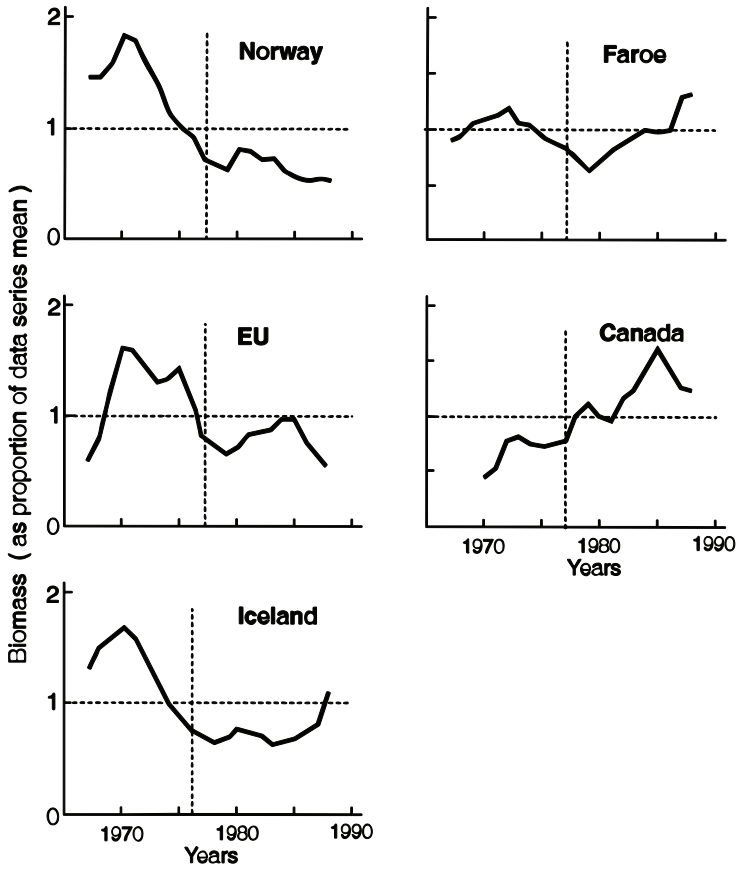

Fig. 60. Pollock: biomass trends in North Atlantic stocks, 1967–88.

trial fishing from the mid-1970s and stringent controls on the activities of purse seine fleets. In USA waters the removal of foreign fleets, which were responsible for almost all offshore fishing for herring, did little immediately to reduce mortality as most remaining stock components were in coastal waters and vulnerable to expanded domestic fishing. However, the economic decline of the sardine industry from the early-1980s resulted in greatly reduced fishing effort, and thus the consequential reduction in fishing mortality was not brought about by any regulatory action. Thus, with the exception of USA herring, success in reducing fishing mortality required Draconian regulatory actions. The accounts in the above section on Management in National Fishery Zones make clear that these actions were taken only when the stocks were on the verge, or in the process, of complete collapse. Fishery closures for groundfish stocks, however, were unheard of until the Canadian closure of the fishery for Labrador–East Newfoundland cod in 1992, again when faced with strong evidence of collapse. This history would suggest that adoption of measures which were adequate to reduce exploitation level proved possible only when a large scale industrial failure was occurring.

Recruitment varied much more in some stocks than others, over the 22 year study period. The difference in size between the largest and smallest year-classes recruiting to a particular stock was a factor of two in the least variable case, and as high as almost 2 000 times in the most variable. Stock biomass does not vary as much as individual year-classes, of course, because typically there are four to seven or eight year-classes which simultaneously make an important contribution to the biomass of the fished stock. Recruitment was averaged over periods of five consecutive years to provide estimates of how much stock biomass might be expected to vary as a function of varying recruitment. The ratio between the highest five year average recruitment and the lowest, in the time series of data for each stock, varied from 1.5 to almost 60 (Fig. 64). Haddock recruitment was the most variable, followed by that of herring, whereas pollock recruitment was the most stable. The median factor for all stocks was about four. Thus, variation in recruitment

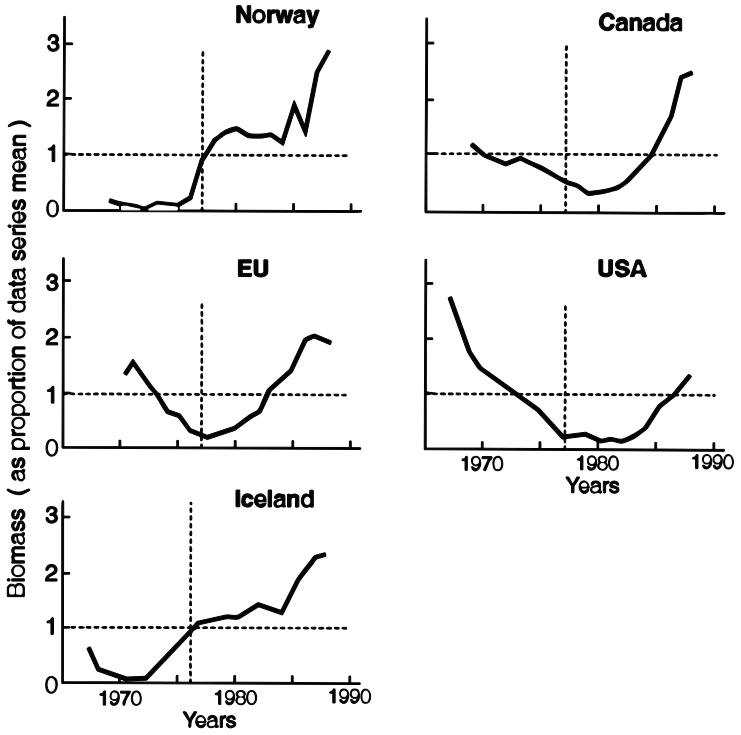

Fig. 61. Herring: biomass trends in North Atlantic stocks, 1967–88.

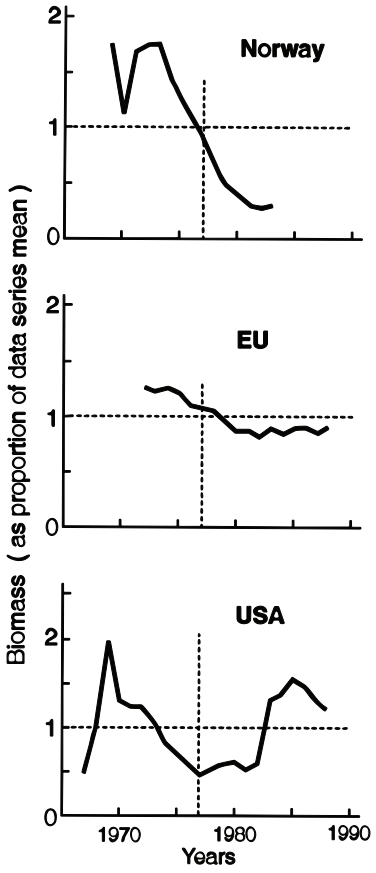

Fig. 62. Mackerel: biomass trends in North Atlantic stocks, 1967–88.

alone was great enough to explain the variation in biomass of most stocks.

In contrast to this large variation in recruitment levels during the study period, it has already been noted that F levels in most stocks did not change greatly after extensions of jurisdiction. Thus, there are relatively few cases where a substantial change in stock biomass could be attributable to a change in fishing mortality. In addition, the changes in F that did occur usually did not result in F being reduced greatly below F_{max} and, as the relationship between fished biomass-per-recruit and F is strongly concave, little response in biomass could be expected. In other words, the greatest changes in biomass-per-recruit in response to changes in F occur when F is relatively low, whereas when F is high, e.g. at F_{max} and above, the change in biomass-per-recruit is relatively small for quite large changes in F (Beverton and Holt, 1957).

This relationship between biomass-per-recruit and F was examined empirically using present data by dividing stocks into three broad categories corresponding to the changes in F experienced between periods. The categories chosen were 1) stocks fished at F_{max} in 1967–76 and at a yet higher level in 1979–88 (eight stocks), 2) stocks fished above F_{max} in both periods but lower in the second (seven stocks), and 3) stocks which, regardless of F in 1967–76, were fished below F_{max} in 1979–88 (eight stocks). Two stocks, pollock at Iceland and

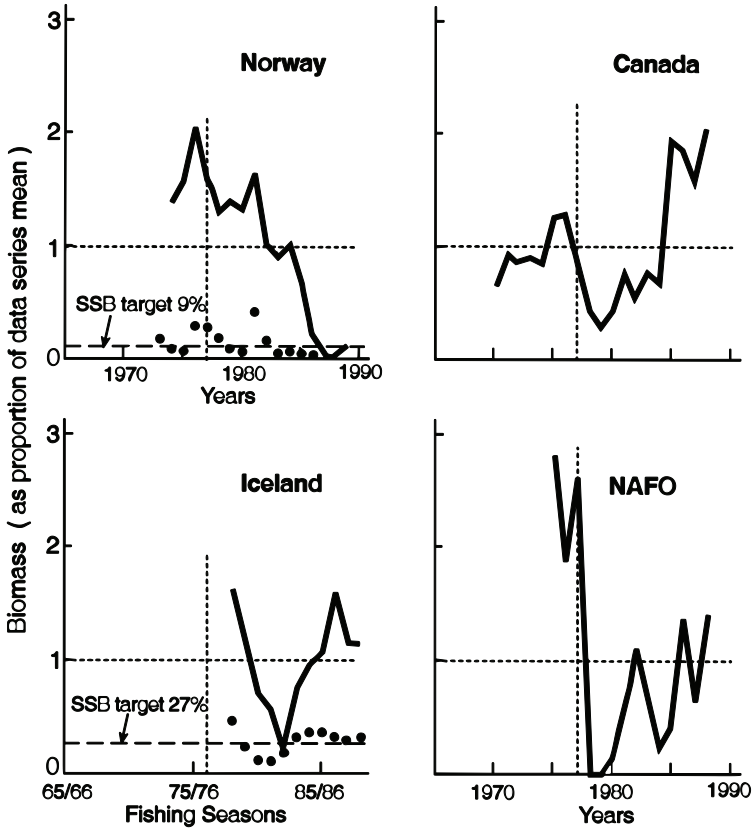

Fig. 63. Capelin: biomass trends in North Atlantic stocks, 1967–88, and spawning stock biomass (circles) in relation to targets for Icelandic and Norwegian stocks (as percentages of mean total stock biomass). (For Iceland, stock biomass is for the beginning, and spawning biomass is for the end, of the fishing season. For Norway, stock biomass calculated for 1 October is assigned to 1 January of following year.)

Faroe Islands, did not experience a change in F which corresponded to one of these categories and were excluded. (Note that, for this comparison, averages of F and recruitment were offset to include 2–4 years earlier and exclude the last 2–4 years of the base periods, as biomass in base periods was more influenced by recruitment and F on these recruits which occurred immediately prior to the base periods than at the end of them.) Changes between periods in F and biomass-per-recruit in the three categories were:

Category	Fishing Morality	Biomass-per-Recruit
1	+45%	-20%
2	-30%	+30%
3	-50%	+100%

As expected, the largest proportional response in biomass-per-recruit occurred when Fs were reduced below F_{max}. It so happens that the stocks in category 3 had an average F close to their average F_{max} value in this first period, and in the second period average F was about their average $F_{0.1}$. This puts a scale on the expected change in biomass-per-recruit if F was reduced from F_{max} to $F_{0.1}$, i.e. an approximate doubling.

General Conclusions

The transition to coastal state management of continental shelf resources could be characterized as an evolution from international management, rather than a revolution. The opportunities presented by the greater level of control over domestic resources (most regimes still shared important resources to some extent) to rationalize the social and economic elements of fishery policy, were not firmly grasped. In several regimes, failure to construct a coherent policy framework that reconciled policy elements has been diagnosed as a major

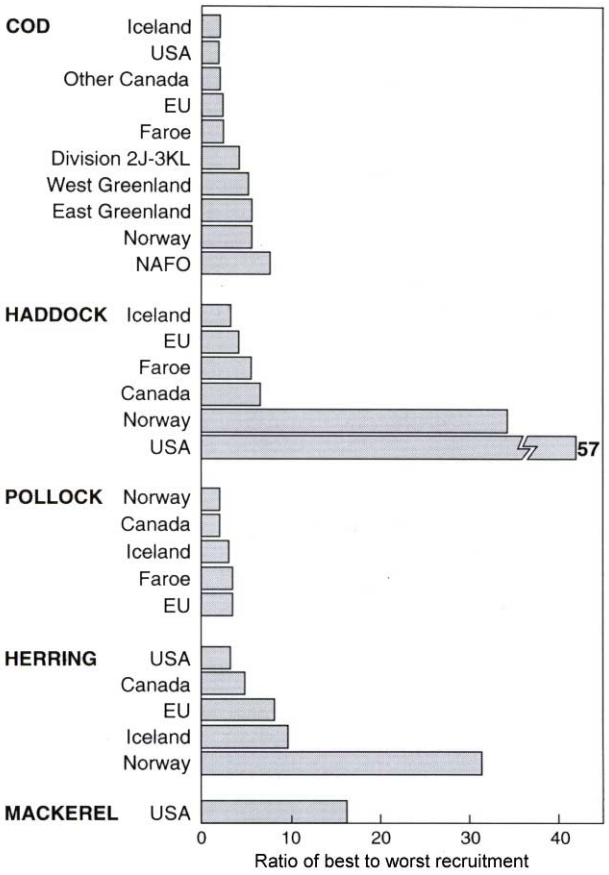

Fig. 64. Variability of recruitment to North Atlantic stocks: the ratio of the number of recruits in the period of five consecutive years when recruitment was highest to that in the five consecutive years when recruitment was lowest, in the 22 years studied.

TABLE 4. Fishing mortality: direction of change between 1967–76 and 1979–88 in fishing mortality for the stocks associated with each management regime (+ indicates an increase, 0 no change and – a reduction) and the relation of fishing mortality to F_{max} in each period (+ indicates F above, 0 at, and - below, reference F). (A stock was classed as 0 if F in the later period was within 15% of that in the earlier period in the first case, and if F was within 15% of the reference F level in the second case.)

Management Regime	Stock	Change between periods in F	F relative to F_{max} in: 1967–76	1979–88
Norway	Cod	0	+	+
	Haddock	0	+	+
	Pollock	0	+	+
	Herring	–	+	–[1]
	Mackerel	...	...	...
Iceland	Cod	0	+	+
	Haddock	–	0	–
	Pollock	0	–	–
	Herring	–	+	–
Faroe Is.	Cod	+	0	+
	Haddock	–	–	–
	Pollock	+	–	0
EU	Cod	+	+	+
	Haddock	–	+	+
	Pollock	+	+	+
	Herring	–	+	0
	Mackerel	+	...	–
Canada	Cod	–	+	+
	Haddock	0	+	+
	Pollock	–	0	0
	Herring	–	–[1]	–[1]
NAFO	Cod	–	+	–[1]
USA	Cod	...	+	+
	Haddock	0	-	-
	Herring	0	+	0
	Mackerel	–	–[1]	–[1]

[1] F at or below $F_{0.1}$.

deficiency in management approach (e.g. Angel *et al.*, 1994; EU, 1991; Hanneson, 1985) and the same criticism can be extended to other regimes. As a consequence, all regimes, 15 years after extensions of jurisdiction, recognize excess capital and labour employed in the fishery as a serious, or critical problem. Fleet overcapacity creates pressures for high exploitation rates, and can make adequate enforcement of regulations prohibitively expensive. Under such circumstances the fishing industry is poorly positioned to withstand adversity, such as a downturn in resource productivity. It is not a situation that is consistent with long-term economic viability of the industry, with stable and adequately renumerated employment for fishermen and other workers in the industry, or with proper protection of the resource base from over-exploitation.

Most regimes are introducing potentially radical reforms to their regulatory systems in the 1990s, subsequent to the study period used here. Iceland has already introduced a comprehensive ITQ system and Canada is moving in that direction. The USA has introduced a fishing effort limitation system for groundfish and the EU has laid the groundwork for effort limitation also. It is too early to judge whether these approaches will put the fisheries on a sounder footing. Much will depend on how well they are implemented and whether adequate control of the behaviour of participants is established. This historical review reveals a tendency to resort to new tools when the results of management are judged unsatisfactory, with relatively little attention being paid as to whether the previous tools were utilized effectively.

References

Standard Report Series

International Agencies

Permanent Commission and NEAFC (old and new): Meeting Reports record decisions and provide summaries of discussions – available from the Secretary, North-East Atlantic Fisheries Commission, Nobel House, 17 Smith Square, London, UK.

ICNAF and NAFO: Annual Proceedings/ Reports, published for all years of ICNAF, for 1979 and 1980 and for 1991+ for NAFO, provide summaries of activities; Meeting Proceedings, published for ICNAF Commission meetings of 1963–79, and for NAFO General Council and Fisheries Commission meetings of 1979 and 1991+, record decisions and provide summaries of discussions; scientific activities of ICNAF recorded in reports of STACRES are published in Redbooks for 1958–79, of NAFO Scientific Council in Reports for 1979+; fisheries statistics for the Northwest Atlantic are published in ICNAF/NAFO Statistical Bulletins for 1951+. All these ICNAF and NAFO publications are available from the Executive Secretary, Northwest Atlantic Fisheries Organization, P. O. Box 638, Dartmouth, Nova Scotia, Canada, B2Y 3Y9. (A summary of meetings and discussions of NAFO in 1979–92 was published in 1993, and compensates to some extent for failure to publish General Council and Fisheries Commission reports during the 1980s.)

ICES: Fisheries statistics for the Northeast Atlantic are published in the ICES Bulletin Statistique des Pêches Maritimes, renamed ICES Fisheries Statistics for Vol. 73 *et seq.*, from 1903 (published 1906); advice of ICES to fisheries commissions is published in the Cooperative Research Report series; – available from ICES, Palaegade 2–4, DK-1261 Copenhagen K, Denmark.

FAO: Fisheries statistics for all major areas of the world are published in the Yearbook of Fishery Statistics: Catches and Landings – available from Distribution and Sales Section (Yearbooks) or the Senior Fisheries Statistician, Fisheries Department (data), FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Domestic Agencies

***Canada*:** Information on the status of fish stocks in the Canadian zone and advice on their management is available in Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Research and Advisory documents respectively, for 1977–92. Annual Reports of CAFSAC, which include all Advisory Documents for the year, were also produced. From 1993, the same information is contained in DFO Atlantic Fisheries Research Documents and Stock Status Reports. These documents are available from the Atlantic Stock Assessment Secretariat, Science Branch, DFO, 200 Kent Street, Ottawa, Ontario, Canada K1A 0E6. The Fisheries Resource Conservation Council (FRCC) publishes its advice to the Minister, DFO, and policy discussion papers, which are available from its secretariat, P. O. Box 2001, Station D, Ottawa, Ontario, Canada K1P 5W3. Annual fishery management plans are usually distributed as miscellaneous publications through regional and headquarters Communications Branches and are available as supplies last.

***European Union*:** The Official Journal of the European Union (OJ): produced by the Office for Official Publications of the European Union, L-1985 Luxembourg. The legislation (L) series contains Council and Commission regulations and decisions. (A second C series contains information and notices.) Regulations are referenced in full as, e.g. Council Regulation (EEC) No. 170/83 of 25 January 1983 but the abbreviation R (EEC)170/83 uniquely identifies this regulation. The date is that on which the legislation was signed. The location of this regulation in the Official Journal Legislative Series is OJ No. L24/1, 27-1-83, i.e. it is in volume 24, starts on page 1, and was published on 27 January 1983. The example used here is the legislation "establishing a Community system for the conservation and management of fishery resources", i.e. the Common Fisheries Policy. The legislation containing the permanent technical measures and the first TACs and allocations are contained in R (EEC) 171/83 and 172/83 respectively.

***Faroe Islands*:** A source of general information on Faroese fisheries is the Fisheries Yearbook (Føroyar) published from R.C. Effersøesgøta 25, Postboks 1378, FR-110 Tórshavn, Faroe Islands.

***Iceland*:** Reports on the state of marine stocks in Icelandic waters and prospects for the next fishing season are published annually by the Marine Research Institute, Reykjavik in the series: Hafrannsóknastofnun Fjölrit (in Icelandic but with English summary and figure and table legends). The same information for most of the important stocks is contained in the reports of the ACFM in the ICES Cooperative Research Report series (in English). Annual statistics on fishery performance

are published in the series: Útvegur (in Icelandic but with English contents list and glossary).

***Norway*:** The Division for International Fisheries Relations of the Ministry of Fisheries, Oslo, publishes annually a pamphlet in English entitled "Quota Regulations in Norwegian Fisheries Zones for (year)". The Institute of Marine Research, Bergen, publishes stock status and prospects reports (in Norwegian) in the Fisken og Havet series. However, stock status and prospects for the major stocks is provided also through the ACFM of ICES and, for these, the same information can be found in ICES Cooperative Research Reports (in English).

***USA*:** Fishery management plan rules and regulations are published in the U.S. Federal Register. The plans themselves and associated supporting documentation, which can be voluminous, are produced by the regional councils. The New England Fisheries Management Council is located at Suntaug Office Park, Saugus, Mass. The Northeast Fisheries Science Center, Woods Hole, Mass. 02543, produces annually a report on the status of fishery resources off the northeastern United States. The latter organization also issues reports of its Stock Assessment Workshops in its Reference Document series.

General References

ANGEL, J. R., D. L. BURKE, R. N. O'BOYLE, F. G. PEACOCK, M. SINCLAIR, and K. C. T. ZWANENBURG. 1994. Report of the workshop on Scotia–Fundy groundfish management from 1977 to 1993. *Can. Tech. Rep. Fish. Aquat. Sci.*, **1979**: 181 p.

ANON. 1973. Agreement between the governments of Iceland, Norway and the Soviet Union on the regulation of the fishing of Atlanto-Scandian herring. *In*: New Directions in the Law of the Sea. S.H. Lay, R. Churchill, and M. Nordquist (eds.). Documents – Volume I. Oceana Publications Inc., New York: 449–450.

1975a. Agreement between the Government of the United Kingdom of Great Britain and Northern Ireland, the Government of the Kingdom of Norway and the Government of the Union of Soviet Socialist Republics on the regulation of the fishing of North-East Arctic (Arcto–Norwegian) cod. *In*: New Directions in the Law of the Sea. R. Churchill, and M. Nordquist (eds.). Documents – Volume IV. Oceana Publications Inc., New York: 175–177.

1975b. Arrangement relating to fisheries in waters surrounding the Faroe Islands. *In*: New Directions in the Law of the Sea. R. Churchill, and M. Nordquist (eds.). Documents – Volume IV. Oceana Publications Inc., New York: 171–174.

1977. Norway. Law No. 1 of January 17, 1975 on trawler-free zones beyond the Norwegian fishery limit (and associated documents). *In*: New Directions in the Law of the Sea. R. Churchill, M. Nordquist, and S.H. Lay (eds.). Documents – Volume V. Oceana Publications Inc., New York: 21–38.

1990. New England groundfish in crisis – again. The Report of the Massachusetts Offshore Groundfish Task Force to the Commissioner, Department of Fisheries, Wildlife and Environmental Law Enforcement, Boston, Mass.

ANTHONY, V. C. 1993. The state of groundfish resources off the northeastern United States. *Fisheries*, **18**(3): 12–17.

ARNASON, R. 1986. Management of the Icelandic demersal fisheries. *Alaska Sea Grant Report*, No. 86-4: 83–101.

1995. The Icelandic fisheries: evolution and management of a fishing industry. Fishing News Books, Oxford, 177 p.

BEVERTON, R. J. H., and S. J. HOLT. 1957. On the dynamics of exploited fish populations. Min. Agr. Fish. and Food, UK, *Fishery Investigations Series II*, **19**, 533 p.

BROCHMANN, B. S. 1984a. Regulation of fishing effort through vessel licences. *FAO Fish. Rep.*, **289**, suppl. 2: 149–151.

1984b. Financial measures to regulate effort. *FAO Fish. Rep.*, **289**, suppl. 2: 167–172.

1985. The economic situation in the Norwegian fisheries 1983. *In*: Adjustments to changes in fisheries law and economics. B.C. Cleveland (ed.). *FAO Fish. Tech. Pap.*, **269**: 81–91.

BURD, A. C. 1986. Why increase mesh sizes? *Lab. Leafl. MAFF Direct. Fish. Res.*, *Lowestoft* (58), 20 p.

BURKE, D. L., and L. BRANDER. 1995. Behind the cod curtain: a perspective on the political economy of the Atlantic groundfish fishery. *Dalhousie Law J.*, **18**: 58–64.

CASEY, J., M. NICHOLSON, and S. WARNES. 1992. Selectivity of square mesh codends on pelagic trawls for Atlantic mackerel (*Scombrus scombrus* L.). *Fish. Res.*, **13**: 267–279.

CHURCHILL, R. R. 1987a. EEC Fisheries Law. Martinus Nijhoff, Dordrecht/Boston/London.

1987b. The EEC's contribution to "state" practice in the field of fisheries. *In*: The UN Convention on the Law of the Sea: Impact and Implementation. R. R. Churchill, and E. D. Brown (eds.). Proceedings, Law of the Sea Institute Nineteenth Annual Conference, University of Hawaii, Honolulu: 557–568.

CHURCHILL, R., and G. ULFSTEIN. 1992. Marine management in disputed areas. The case of the Barents Sea. Routledge, London/New York, 182 p.

DAGENHARDT, H. W. 1985. Maritime affairs – a world handbook: a reference guide to maritime organizations, conventions and disputes and to the international politics of the sea. Longman Group Ltd., Harlow, UK, 385 p.

DANIELSEN, B. 1986. The Faroese fish export and future prospects. *Føroyar '86*: 7–15.

DANIELSSON, Á., and Ó. Ö. KLEMENSSON. 1994. The experience of the ITQ-system in Iceland: the development of the fleet and trade in the quota market. *Irish Fish. Invest. Ser. B* (*Marine*), **42**: 131–138.

DAY, D., and G. HERBERT. 1995. Fisheries violations of an arbitrated maritime boundary: the Gulf of Maine case. *In*: The peaceful management of transboundary resources. G. H. Blake, W. J. Hildesley, M. A. Pratt, R. J. Ridley, and C. H. Schofield (eds.). International Environmental Law and Policy series, Graham and

Trotman/Martinus Nijhoff, Dordrecht/Boston/London: 427–449.

DFO (Department of Fisheries and Oceans Canada) 1993. Charting a new course: towards the fishery of the future. Task Force on Incomes and Adjustment in the Atlantic Fishery. Misc. publ., Cat. No. Fs 23-243/1993, 199 p.

EU (European Union). 1991. Report 1991 from the Commission to the Council and the European Parliament on the Common Fisheries Policy. SEC (91) 2288 final, 90 p + annexes (76 p).

1992. Report on monitoring implementation of the Common Fisheries Policy. Commission of the European Communities. SEC(92) 394 final, 71 p.

EUROFISH REPORT. 1990. Fraud widespread among Norwegians landing abroad. Eurofish Report, Agra Europe (London) Ltd., UK, October 25, 1990, p FS/1.

1992a. Denmark bales out Faroes as fishing slump hits economy. Eurofish Report, Agra Europe (London) Ltd., UK, October 22, 1992, p FS/4.

1992b. Norwegian Government and fishermen strike subsidy deal. Eurofish Report, Agra Europe (London) Ltd., UK, December 21, 1992, p FS/1.

1993. Fisheries fraud rampant in Norway. Eurofish Report. Agra Europe (London) Ltd., UK, June 17, 1993, p. FS/4.

1994. "Black" fish problem in Iceland. Eurofish Report, Agra Europe (London) Ltd., UK, August 4, 1994, p. FS/2.

1995. Icelandic licences withheld for discarding. Eurofish Report, Agra Europe (London) Ltd., UK, June 22, 1995, p. FS/4.

FMS (Fisheries and Marine Service Canada). 1976. Policy for Canada's commercial fisheries. Environment Canada, Ottawa, misc. publ., 70 p + appendices.

GRAHAM, H. W. 1952. Mesh regulations to increase the yield of the Georges Bank haddock fishery. *ICNAF Ann. Rep.*, **2**: 23–33.

GULLAND, J. A., and L. K. BOEREMA. 1973. Scientific advice on catch levels. *Fish. Bull. U.S.*, **71**: 325–335.

GUTTESEN, R. 1992. How did the Faroese fishing industry cope with the new conditions imposed by the 200 nm EEZ? *Ocean and Coast. Man.*, **18**: 339–350.

HACHÉ, J.-E. 1989. Report of the Scotia-Fundy groundfish task force. Department of Fisheries and Oceans, Canada, misc. publ., Cat. No. Fs 23-157/1989E, 86 p.

HALLIDAY, R. G. 1988. Use of seasonal spawning area closures in the management of haddock fisheries in the Northwest Atlantic. *NAFO Sci. Coun. Studies*, **12**: 27–36.

HALLIDAY, R. G., and A. T. PINHORN. 1985. Present management strategies in Canadian Atlantic marine fisheries, their rationale and the historical context in which their usage developed. *In*: Toward the inclusion of fishery interactions in management advice. R. Mahon (ed.). *Can. Tech. Rep. Fish. Aquat. Sci.*, **1347**: 10–33.

1990. The delimitation of fishing areas in the Northwest Atlantic. *J. Northw. Atl. Fish. Sci.*, **10**: 1–51.

HALLIDAY, R. G., J. MCGLADE, R. MOHN, R. N. O'BOYLE, and M. SINCLAIR. 1986. Resource and fishery distributions in the Gulf of Maine Area in relation to the Subarea 4/5 boundary. *NAFO Sci. Coun. Studies*, **10**: 67–92.

HALLIDAY, R. G., F. G. PEACOCK, and D. L. BURKE. 1992. Development of management measures for the groundfish fishery in Atlantic Canada. *Mar. Pol.*, **16**: 411–426.

HAMRE, J. 1991. Interrelation between environmental changes and fluctuating fish populations in the Barents Sea. *In*: Long-term variability of pelagic fish populations and their environment. T. Kawasaki, S. Tanaka, Y. Toba, and A. Taniguchi (eds.). Permagon Press, New York: 259–270.

HAMRE, J., and S. TJELMELAND. MS 1982. Sustainable yield estimates of the Barents Sea capelin stock. *ICES C.M. Doc.*, No. H:45, 24 p.

HANNESSON, R. 1985. Inefficiency through government regulations: the case of Norway's fishery policy. *Mar. Res. Econ.*, ***2***: 115–141.

HART, J. A. 1976. The Anglo-Icelandic cod war of 1972–1973. A case study of a fishery dispute. Institute of International Studies, University of California, Berkeley. Res. Ser. No. 29, 76 p.

HAY, E. 1989. The regime for the exploitation of transboundary marine fisheries resources. Martinus Nijhoff, Dordrecht/Boston/London, 306 p.

HELGASON, T. 1994. The Icelandic quota management system: a description and evaluation. *Irish Fish. Invest. Ser. B* (*Marine*), **42**: 115–125.

HENNEMUTH, R. C., and S. ROCKWELL. 1987. History of conservation and management. *In*: Georges Bank. R. H. Backus (ed.). The MIT Press, Mass., USA: 430–446.

HERBERT, G. J. 1995. Fisheries relations in the Gulf of Maine: implications of an arbitrated maritime boundary. *Mar. Pol.*, **19**: 301–316.

HOLDEN, M.J. 1984. Management of fisheries resources: the experience of the European Economic Community *In*: Experiences in the Management of National Fishing Zones. Organization for Economic Cooperation and Development Documents, Paris: 113–120.

1994. The Common Fisheries Policy: origin, evaluation and future. Fishing News Books, Oxford, 274 p.

HORSTED, S. Å. 1991. Biological advice for and management of some of the major fisheries resources in Greenland waters. *NAFO Sci. Coun. Studies*, **16**: 79–94.

MS 1994. A review with some proposals for amendments of the catch statistics for the cod fisheries in Greenland waters since 1911. *NAFO SCR Doc.*, No. 38, Ser. No. N2407, 33 p.

HOVGÅRD. H., and E. BUCH. 1990. Fluctuations in the cod biomass of the West Greenland sea ecosystem in relation to climate. *In*: Large Marine Ecosystems: patterns, processes and yields. K. Sherman, L. M. Alexander, and B. D. Gold (eds.). *Am. Ass. for the Adv. Sci.*, Publ. No. 90-30S: 36–43.

HOYDAL, K. 1987. A reshuffle of the Faroese fisheries administration. *Føroyar '87*: 49–54.

1988. Control of the fishery in Faroese waters. *Føroyar '88*: 28–33.

ICES. MS 1982. Report of the ad hoc working group on fishing area boundaries. *ICES C.M. Doc.*, No. D:2, 14 p.

1991. Reports of the ICES Advisory Committee on Fishery Management, 1990. *ICES Coop. Res. Rep.*, **173**: 82–83.

JAKOBSEN, T. 1994. Norway-managing its fish resources. *In*: Maximum sustainable yield from fish stocks: a challenge to fishermen and managers. M. Murphy (ed.). Sherkin Island Marine Station, Co. Cork, Ireland: 46–50.

JAKOBSSON, J. 1980. Exploitation of the Icelandic spring- and summer–spawning herring in relation to fisheries management, 1947–1977. *ICES Rapp. Proc.-Verb.*, **177**: 23–42.

1985. Monitoring and management of the Northeast Atlantic herring stocks. *Can. J. Fish. Aquat. Sci.*, **42**(Suppl. 1): 207–221.

JENTOFT. S., and K. H. MIKALSEN. 1987. Government subsidies in Norwegian fisheries: regional development or political favouritism? *Mar. Pol.*, **11**: 217–228.

JÓNASSON, J. B. 1986. Control of demersal fishing: the evolution of the quota system. Iceland–Yearbook of Trade and Industry 1986: 24–25.

JÓNSSON, H. 1982. Friends in conflict: the Anglo-Icelandic cod wars and the Law of the Sea. C. Hurst and Company, London, 240 p.

KIRBY, J. L. 1982. Navigating troubled waters: a new policy for the Atlantic fisheries. Report of the Task Force on Atlantic Fisheries. Supply and Services, Ottawa, 379 p.

KRANIOTIS, P. 1994. The fisheries enforcement agreement between the United States and Canada. *In*: Fisheries Enforcement Issues. Organization for Economic Cooperation and Development Documents, Paris: 45–67.

LEIGH, M. 1983. European integration and the Common Fisheries Policy. Croom-Helm, London, 228 p.

MOHN, R., R. G. HALLIDAY, and C. ANNAND. MS 1990. A review of the cod–haddock–pollock combined quota system for the under 65' mobile gear sector in the western Scotia-Fundy Region. *CAFSAC Res. Doc.*, No. 62, 13 p.

MORTENSEN, K. P. 1995. Fishery and fisheries management in the Faroe Islands. *NAFO News*, **3**: 5–6.

NACFI. 1932. North American Council on Fishery Investigations: Proceedings 1921–1930, No. 1. King's Printer, Ottawa, 56 p.

NORWEGIAN AUTHORITIES. 1993. Individual quota management systems in Norway. *In*: The use of individual quotas in fisheries management. Organization for Economic Cooperation and Development Documents, Paris: 174–184.

OLAFSSON, Á. 1987. The foreign relations of the Faroe Islands. *Føroyar '87*: 33–36.

O'BOYLE, R. N. 1985. A description of the two-tier catch quota system of ICNAF, with commentary on its potential usefulness in current fisheries management on the Scotian Shelf. *In*: Toward the inclusion of fisheries interactions in management advice. R. Mahon (ed.). *Can. Tech. Rep. Fish Aquat. Sci.*, **1347**: 196–200.

PÁLMASON, S.R. 1994. Supervision of the utilization of fishery resources off Iceland. *In*: Fisheries enforcement issues. Organization for Economic Cooperation and Development Documents, Paris: 173–192.

PARSONS, L. S. 1993. Management of marine fisheries in Canada. *Can. Bull. Fish. Aquat. Sci.*, **225**, 784 p.

PAULSEN, T. S. 1987. The Norwegian licensing system. *In*: The regulation of fisheries: legal, economic and social aspects. G. Ulfstein, P. Andersen, and R. Churchill (eds.). Council of Europe Division of Higher Education and Research, Strasbourg: 109–120.

SCHRANK, W.E. 1995. Extended fisheries jurisdiction: origins of the current crisis in Atlantic Canada's fisheries. *Mar. Pol.*, **19**: 285–299.

SISSENWINE, M. P., and J. G. SHEPHARD. 1987. An alternative perspective on recruitment overfishing and biological reference points. *Can. J. Fish. Aquat. Sci.*, **44**: 913–918.

SKARPHÉDINSSON, K. 1993. Fisheries management in Iceland. *In*: Multispecies Fisheries Management. J. R. Nielsen, and T. Helgason (eds.). Nord 1993, **3**: 173–188.

STEPHENSON, R. L. MS 1993. Revised estimates of landings from the 4WX herring fisheries: 1985–1992. *DFO Atl. Fish. Res. Doc.*, No. 74, 13 p.

SUTHERLAND, P. 1994. Canada's alternative management system: individual transferable quotas. *In*: Maximum sustainable yield from fish stocks: a challenge to fishermen and managers. M. Murphy (ed.). Sherkin Island Marine Station, Co. Cork, Ireland: 13–21.

SUTINEN, J. G., and T. M. HENNESSEY. 1986. Enforcement: the neglected element in fishery management, *In*: Natural Resource Economics and Policy Applications. E. Miles, R. Pealy, and R. Stokes (eds.). Univ. of Washington Press, Seattle/ London: 185–213.

SUTINEN, J. G., A. RIESER, and J. R. GAUVIN. 1990. Measuring and explaining noncompliance in federally managed fisheries. *Ocean Dev. and Inter. Law*, **21**: 335–372.

SUURONEN, P. 1995. Conservation of young fish by management of trawl selectivity. *Finnish Fish. Res.*, **15**: 97–116.

SYMMONS, C. R. 1986. The Rockall dispute deepens: an analysis of recent Danish and Icelandic actions. *Inter. and Comp. Law Quart.*, **35**: 344–373.

TEMPLEMAN, W., and J. GULLAND. 1965. Review of possible conservation actions for the ICNAF area. *ICNAF Ann. Proc.*, **15**: 47–56.

THORVIK, T. 1994. Control and enforcement in the Norwegian fisheries. *In*: Fisheries enforcement issues. Organization for Economic Cooperation and Development Documents, Paris: 17–33.

TOMASEVICH, J. 1971. International agreements on conservation of marine resources. Kraus Reprint Co., New York, 297 p. (Original publisher: Food Research Institute, Stanford Univ., California, 1943.)

UNDERDAHL, A. 1980. The politics of international fisheries management: the case of the Northeast Atlantic. Universitetsforlaget, Oslo-Bergen-Tromsø, Norway, 239 p.

USA. MS 1976. Note by US Commissioners on strengthening and improving the Scheme of Joint International Enforcement of the ICNAF fisheries protocols within the Convention Area and Statistical Areas 0 and 6. *ICNAF Comm. Doc.*, No. 2, Ser. No. 3735, 2 p.

VANDERZWAAG, D.L. 1983. The fish feud: the U.S. and Canadian boundary dispute. Lexington Books, Lexington, Mass., 135 p.

VILHJÁLMSSON, H. 1983. Biology, abundance estimates and management of the Icelandic stock of capelin. *Rit Fiskideildar*, **7**(3): 153–181.

1994. The Icelandic capelin stock. *Rit Fiskideildar*, **13**(1), 281 p.

WENT, A. 1972. Seventy years agrowing. A history of the International Council for the Exploration of the Sea, 1902–1972. *ICES Rapp. Proc.-Verb.*, **165**: 252 p.

WISE, M. 1984. The Common Fisheries Policy of the European Community. Methuen, London, 316 p.

ZISKASON, J. 1989. The Faroese fishery regulations must be observed. *Føroyar '89*: 95–99.

Appendix Tables

APPENDIX TABLE 1. List of common names used to refer to species and their corresponding scientific names. (E and W after common names indicate species which occur in commercial concentrations only in the eastern or western North Atlantic respectively.)

Common Name	Scientific Name
Atlantic cod	*Gadus morhua*
Haddock	*Melanogrammus aeglefinus*
Pollock (saithe)	*Pollachius virens*
Atlantic herring	*Clupea harengus*
Atlantic mackerel	*Scomber scombrus*
Capelin	*Mallotus villosus*
Pollack (E)	*Pollachius pollachius*
European hake (E)	*Merluccius merluccius*
Silver hake (W)	*Merluccius bilinearis*
White hake (W)	*Urophycis tenuis*
Red hake (W)	*Urophycis chuss*
Roundnose grenadier	*Corphaenoides rupestris*
Whiting (E)	*Merlangius merlangus*
Blue Whiting (E)	*Micromesistius poutassou*
Norway pout (E)	*Trisopterus esmarki*
Blue ling (E)	*Molva dipterygia*
Atlantic halibut	*Hippoglossus hippoglossus*
Greenland halibut	*Reinhardtius hippoglossoides*
Witch flounder	*Glyptocephalus cynoglossus*
American plaice	*Hippoglossoides platessoides*
European plaice (E)	*Pleuronectes platessa*
European flounder (E)	*Platichthys flesus*
Common sole (E)	*Solea vulgaris*
Lemon sole (E)	*Microstomus kitt*
Yellowtail flounder (W)	*Limanda ferruginea*
Megrims (E)	*Lepidorhombus* spp.
Atlantic argentine	*Argentina silus*
Redfish	*Sebastes* spp.
Wolffish	*Anarhichas* spp.
Anglerfish	Lophiidae
Sand lance	Ammodytidae
Ocean pout (W)	*Macrozoarces americanus*
Tuna	*Thunnus* spp.
Swordfish	*Xiphias gladius*
Jack & Horse mackerels (E)	*Trachurus* spp.
Sprat (E)	*Sprattus sprattus*
Anchovy (E)	*Engraulis encrasicholus*
Atlantic menhaden (W)	*Brevoortia tyrannus*
Atlantic butterfish (W)	*Peprilus triacanthus*
River herring	*Alosa* spp.
Squid (Canadian zone)	*Illex illecebrosus*
Squid (USA zone)	also *Loligo pealei*
Shrimp (northern)	*Pandalus borealis*
Norway lobster (E)	*Nephrops norwegicus*
Sea scallop (W)	*Placopecten magellanicus*

APPENDIX TABLE 2. Abbreviations referred to in this paper.

Abbreviation	Meaning
ACFM	Advisory Committee on Fishery Management of ICES
CAFSAC	Canadian Atlantic Fisheries Scientific Advisory Committee
CFP	Common Fisheries Policy of the EU
DFO	Department of Fisheries and Oceans, Canada
EU	European Union (prior to 1993 called the European (Economic) Community – EC or EEC)
F	Instantaneous rate of Fishing Mortality
$F_{subscript}$	Biological reference points ($F_{0.1}$, F_{max}, etc.)
FAO	Food and Agriculture Organization of the United Nations
FRCC	Fisheries Resource Conservation Council, Canada
FRG	Federal Republic of Germany
GDR	German Democratic Republic
GRT	Gross Registered Tonnage
ICES	International Council for the Exploration of the Sea
ICNAF	International Commission for the Northwest Atlantic Fisheries
IQ	Individual catch Quota, sometimes called boat quota
ITQ	Individual Transferable catch Quota
MFCMA	Magnuson Fishery Conservation and Management Act, USA
MSP	Maximum Spawning Potential (defined as spawning potential of virgin stock in USA legislation)
MSY	Maximum Sustainable Yield
NAFO	Northwest Atlantic Fisheries Organization
NEAFC	Northeast Atlantic Fisheries Commission (Convention)
NEFMC	New England Fishery Management Council, USA
NMFS	National Marine Fisheries Service, USA
OY	Optimum Yield
STACRES	Standing Committee for Research and Statistics, ICNAF
TAC	Total Allowable Catch
UK	United Kingdom of Great Britain and Northern Ireland
USA	United States of America
USSR	Union of Soviet Socialist Republics

APPENDIX TABLE 3. Geographic names for the stocks of the six primary species analyzed in this paper and the statistical areas which define their distribution for stock assessment purposes. Stocks are arranged by the management regime to which they are assigned in this paper (Footnote 1), and sources of stock assessment data are indicated (Footnote 2). The first age used in calculation of stock parameters for the present analysis is given.

Regime/ Species[1]	Geographic Name	Statistical Areas	First Age	Data Source[2]
Norway cod	Northeast Arctic	ICES Subareas I & II	4	a
Norway haddock	Northeast Arctic	ICES Subareas I & II	3	a
Norway pollock	Northeast Arctic	ICES Subareas I & II	2	a
Norway herring	Norwegian spring spawning	Depending on distribution	3	b
Norway mackerel	North Sea	Depending on distribution	2	b
Norway capelin	Barents Sea	ICES Subareas I & II (east)	–[3]	b
EU cod *includes*:	North Sea	ICES Subarea IV	1	b
	West of Scotland	ICES Div. VIa	1	b
	Irish Sea	ICES Div. VIIa	1	b
	English Channel	ICES Div. VIId	1	b
	Celtic Sea	ICES Div. VIIf,g	1	b
EU haddock *includes*:	North Sea	ICES Subarea IV	1	b
	West of Scotland	ICES Div. VIa	1	b
EU pollock *includes*:	North Sea	ICES Subarea IV & Div. IIIa	2	b
	West of Scotland	ICES Subarea VI	2	b
EU herring *includes*:	North Sea	ICES Subarea IV & Div. VIId	1	b

APPENDIX TABLE 3. (Continued). Geographic names for the stocks of the six primary species analyzed in this paper and the statistical areas which define their distribution for stock assessment purposes. Stocks are arranged by the management regime to which they are assigned in this paper (Footnote 1), and sources of stock assessment data are indicated (Footnote 2). The first age used in calculation of stock parameters for the present analysis is given.

Regime/ Species[1]	Geographic Name	Statistical Areas	First Age	Data Source[2]
	West of Scotland	ICES Div. VIa (north)	1	b
	Clyde	ICES Div. VIa (Clyde)	2	c
	West of Ireland	ICES Div. VIa (south) & VII b,c	2	c
	Irish Sea	ICES Div. VIIa	1	b
	Celtic Sea	ICES Div. VIIf,g,j	1	c
EC mackerel	Western	Depending on Distribution	1	a
Faroe cod	–	ICES Div. Vb	2	b
Faroe haddock	–	ICES Div. Vb	2	b
Faroe pollock	–	ICES Div. Vb	3	b
Iceland cod	–	ICES Div. Va	4	d
Iceland haddock	–	ICES Div. Va	3	d
Iceland pollock	–	ICES Div. Va	4	d
Iceland herring *includes*:	spring spawning	ICES Div. Va	1	d
	summer spawning	ICES Div. Va	1	d
Iceland capelin	–	ICES Div. Va & Subarea II (west), XIV	–[3]	a,d
Greenland cod *includes*:	East Greenland	ICES Subarea XIV	5	a*
	West Greenland	NAFO Subarea 1	3	e
Canada cod[4] *includes*:	Labrador–East Newfoundland	NAFO Div. 2J+3KL	4	e
	St. Pierre Bank	NAFO Subdiv. 3Ps	4	f
	Southern Gulf of St. Lawrence	NAFO Subdiv. 4Vn (Jan–Apr) +Div. 4T	4	f
	Eastern Scotian Shelf	NAFO Div. 4VsW	2	f
	Southwestern Nova Scotia	NAFO Div. 4X	3	f
Canada haddock *includes*:	Eastern Scotian Shelf	NAFO Div. 4TVW	3	f
	Southwestern Nova Scotia	NAFO Div. 4X	3	f
Canada pollock	Scotian Shelf	NAFO Div. 4VWX+5Zc	3	f
Canada herring *includes*:	Newfoundland bay stocks	NAFO Div. 3KLPs	2	f
	West Coast of Newfoundland	NAFO Div. 4R	3	f
	Southern Gulf of St. Lawrence	Depending on distribution	–[5]	f
	Southwestern Nova Scotia	NAFO Div. 4WX	1	f
Canada capelin *includes*:	Labrador–Northeast Newfoundland	NAFO Subarea 2 + 3K	–[3]	f
	Northern Grand Bank	NAFO Div. 3L	–[3]	e
NAFO cod	Grand Bank	NAFO Div. 3NO	3	e
NAFO capelin	Southern Grand Bank	NAFO Div. 3NO	–[3]	e
USA cod	Georges Bank	NAFO Div. 5Z + Subarea 6	2	g
USA haddock	Georges Bank	NAFO Div. 5Z + Subarea 6	2	h
USA herring *includes*:	Gulf of Maine	NAFO Div. 5Y	2	h
	Georges Bank	NAFO Div. 5Z	2	h
USA mackerel	Northwest Atlantic	NAFO Subarea 2–6	1	i

[1] "includes" indicates cases where stock assessment results were combined for two or more stocks to give single estimates of parameters for each species in each zone. Catch, biomass and recruitment estimates were summed across stocks. Fishing mortalities were averaged using population numbers as a weighting factor.

[2] Stock assessment data were from the following sources (dates of most recent reports consulted are given, data for early years were obtained from previous reports in same series):

a,b & c) ICES Working Group Reports for 1993, 1992 and 1991 respectively (a* – 1989 ICES WG for stocks of cod at East Greenland)
d) Icelandic Hafrannsóknastofnun Fjölrit No. 29, 1992 (except spring spawning herring from Jakobsson, J. 1980. *ICES Rapp. P.-V. Réun.* **177**: 23–42)
e) NAFO SCR Documents 1992
f) CAFSAC Research Documents 1992
g,h & i) USA Stock Assessment Workshop Reports, 15th, 13th and 12th Workshops respectively. Northeast Fisheries Science Center Reference Documents 93-07, 92-02 and 91-03 respectively.

[3] Capelin biomass estimates are for the sexually maturing component of the stock for Northeast Atlantic stocks and roughly comparable for Northwest Atlantic stocks.

[4] Canada cod "others" – excludes Labrador–East Newfoundland stock.

[5] Age 2 for spring spawners and age 3 for autumn spawners.

APPENDIX TABLE 4. Minimum mesh size regulations in the Northeast Atlantic pertaining to cod, haddock and pollock, established under international conventions to 1976.

Authority	Year in Effect	Area of Application	Gear/Materials Affected	Mesh Size (mm)
1937 Convention	– (Convention did not come into effect)	Northern Norway and Barents Sea (north of 66°N, east of 0°E)	Trawls, seines or other nets towed or hauled at or near the bottom of the sea - of any material, measured wet.	105
		All other waters	Trawls, seines or other nets towed or hauled at or near the bottom of the sea – of any material, measured wet	70
1946 Convention	– (Original provisions did not come into effect)	Northern Norway and Barents Sea (north of 66°N, east of 0°E)	Trawls, seines or other nets towed or hauled at or near the bottom of the sea – of any material, measured wet	110
		Icelandic waters (62°–68°N, 10°-28°W)	Trawls, seines or other nets towed or hauled at or near the bottom of the sea – of any material, measured wet	110
		All other waters	Trawls, seines or other nets towed or hauled at or near the bottom of the sea – of any material, measured wet	80
Permanent Commission (created under 1946 Convention)	1954	Northern Norway, Barents Sea and Icelandic waters (coordinates as above)	Trawls or other nets towed or hauled at or near the bottom of the sea – of any material measured wet, except seine nets	110 [1,2,3]
			Seine nets	100
		All other waters	Trawls or other nets towed or hauled at or near the bottom of the sea – of any material measured wet, except seine nets	75 [1]
			Seine nets	70
Permanent Commission (inherited by NEAFC under 1959 Convention)	1964	Northern Norway, Barents Sea, Icelandic and eastern Greenland waters (north of 66°N from Norwegian coast to 10°W, south to 62°N, west to 28°W, south to 59°N, thence west to 44°W)	Seine nets	100
			Such part of any trawl net as is made of cotton, hemp, polyamide and polyester fibres	110
			Such part of any trawl net as is made of any other material	120
		Other waters	Seine net or such part of any trawl net as is made of single twine and contains no manila or sisal	70
			Such part of any trawl net as is made of double twine and contains no manila or sisal	75
			Such part of any trawl net as is made of manila or sisal	80
NEAFC	1966	NEAFC Region 3 (36°–48°N) (Not part of 1946 Convention Area).	Seine or part of trawl net	60
NEAFC	1967	NEAFC Region 1 except at Faroe Islands (N.B. extends large mesh area south to 62°N from 66°N along Norwegian coast)[4]	Seine net	110 [5]
			Such part of any trawl net as is made of cotton, hemp, polyamide or polyester fibres	120
			Such part of any trawl net as if made of any other material	130
		Faroe Islands (essentially ICES fishing area Vb)	Seine net	95 [6]
			Such part of any trawl net as is made of manila or sisal	100 [6]
			Such part of any trawl net as is made of any other material	95 [6]
		NEAFC Regions 2 and 3		No change

APPENDIX TABLE 4. (Continued). Minimum mesh size regulations in the Northeast Atlantic pertaining to cod, haddock and pollock, established under international conventions to 1976.

Authority	Year in Effect	Area of Application	Gear/Materials Affected	Mesh Size (mm)
	1969	NEAFC Region 3	Seine net, or such part of any trawl net as is made of single twine and contains no manila or sisal	60
			Such part of any trawl net as is made of double twine and contains no manila or sisal	65
			Such part of any trawl net as is made of manila or sisal	70
	1971		Mesh regulations for all areas extended to include midwater trawls	

[1] Agreed in 1955 that "light trawls", i.e. those of single twine and containing no manila or sisal could have a mesh size 5 mm smaller.

[2] Agreed in 1961 that the 5 mm differential for "light trawls" be replaced by a 10 mm differential for trawl nets with codends of cotton, hemp, polyamide or polyester.

[3] Effective 1 January 1963, mesh size in northern Norway and Barents Sea increased to 120 mm.

[4] Agreed in 1970 to move boundary between Regions 1 and 2 from 62°N to 64°N to exempt pollock fishery at 62°–64°N from large mesh regulations.

[5] Effective at Iceland and east Greenland in 1968.

[6] Revised to 110 mm for trawls of manila or sisal and 100 mm for other nets in 1970. Made identical to rest of Region 1 (i.e. 130 mm manila equivalent) in 1974.

APPENDIX TABLE 5. Minimum fish size regulations in the Northeast Atlantic for primary species (cod, haddock, pollock, herring, mackerel and capelin), established under international conventions to 1976. (Fish size is total length.)

Authority	Year in Effect	Species	Size Limit (cm)	Application
1937 Convention	– (Convention did not come into effect)	cod haddock	24 24	Cannot carry on board, land or sell fish of smaller size caught in Convention Area
1946 Convention	1954	cod haddock	30 27	Cannot carry on board, land or sell fish of smaller size caught in the Convention Area
Permanent Commission (created under 1946 Convention)	1954			Exemption: 10% by weight of each industrial landing may consist of undersized fish of species subject to size regulations
	1963	cod haddock	34 31	In waters for which a minimum mesh size of 110 mm applies, i.e. northern waters (see Appendix Table 4)
NEAFC	1964			Size limits of Permanent Commission carried forward to NEAFC Convention Area north of 48°N (the southern limit of 1946 Convention)
	1967			Larger size limits for cod and haddock applicable in northern part of Convention Area extended to the area between 66°N and 62°N off Norway, and thus apply to all of NEAFC Region 1 except at Faroe Islands
	1969			Larger size limits for cod and haddock extended to include Faroe Islands (i.e. to apply to all of Region 1)
	1970			Decided to move boundary between Regions 1 and 2 from 62°N to 64°N
	1974	mackerel	30	Applies to industrial fishery for North Sea stock (ICES Subarea IV + Div. IIIa), tolerance of 20% by weight of undersized mackerel
	1975	herring	20	West of Scotland stock (ICES Div. VIa), tolerance of 10% by weight of undersized herring
	1976	mackerel	30	Extended to West of Scotland (ICES Div. VIa) the regulation applying in IIIa and IV
	1976	herring	20	Applies to human consumption fishery in North Sea (ICES Subarea IV) (and Skagerrak), tolerance of 10% by weight of under sized herring (industrial fishing for herring was banned in 1975)
	1976	pollock	35	Region 1, tolerance of 10% by weight of undersized pollock until December 1977
			30	Region 2, except Skagerrak, tolerance of 10% by weight of undersized pollock until December 1977

APPENDIX TABLE 6. Catch controls in the Northeast Atlantic in the pre-200 mile jurisdiction period.

In Effect	Agreement	Parties
1971–73	Norwegian spring spawning herring - catches restricted to proportions of 1969 levels, decreasing in successive agreements.	Iceland, Norway USSR
1974	Norwegian spring spawning herring – fishing prohibited (except 20% of 1969 catch of small and fat herring could still be taken for human consumption or bait by each Contracting Party).	NEAFC
1975	Norwegian spring spawning herring – prohibition continued and exemptions reduced to 10% of 1969 catch levels.	NEAFC
1976	Norwegian spring spawning herring – prohibition continued and exemptions limited to gillnet catches within national baselines for personal consumption and own use as bait.	NEAFC
1971	North Sea herring (ICES Subarea IV & Div. IIIa) – fishing prohibited in May and from 20 August to 30 September inclusive with allowance during closure for directed fishery catches of 1 000 tons per Contracting Party for human consumption or bait, and by-catch allowance of 10% by weight in other fisheries.	NEAFC
1972	North Sea herring – fishing prohibited from 1 April to 15 June inclusive with allowance during closure for directed fishery catches of 1 250 tons per Contracting Party (Faroe and Denmark treated separately) for human consumption or bait, and by-catch allowance of 10% by weight in other fisheries.	NEAFC
1973	North Sea herring – fishing prohibited from 1 February to 15 June, except that in February and March Contracting Parties could take catches for human consumption and bait equal to the highest catches taken for these purposes in the same months in the years 1969–72. Those benefitting from this provision could take an additional 1 250 tons during the remaining closed period, those who did not could take 2 500 tons, in directed human consumption and bait fisheries. By-catch allowance of 10% by weight in other fisheries.	NEAFC
1974	North Sea herring – 1973 closure regulations extended to also apply in 1974.	NEAFC
1974–75	Celtic Sea herring (ICES Div. VIIg, h and part of VIIa) – fishing prohibited from 1 April 1974 to 31 March 1975 except for exemptions, allocated by Contracting Party, totalling 32 000 tons (equivalent to catch allocations).	NEAFC
1974–76	Demersal stocks at Faroe Islands (ICES Div. Vb) – restricted catches and established specific national catch limits for cod and haddock, and restricted GRT of trawlers fishing in the area; established subareas seasonally closed to trawling.	Belgium, Denmark France, FRG, Norway, Poland, UK
1974	North-East Arctic cod (ICES Subareas I & II) – established specific national catch limits for Contracting Parties and an allowance for others.	Norway, UK, USSR
1975	TACs and national allocations established for the following stocks (for the calendar year 1975 unless otherwise stated): – North Sea herring (1 July 1974–30 June 1975) – Celtic Sea herring (1 April 1975–31 March 1976) – North Sea cod (ICES Subarea IV) – North Sea haddock (ICES Subarea IV) – North Sea whiting (ICES Subarea IV) – North Sea sole (ICES Subarea IV) – North Sea plaice (ICES Subarea IV) – English Channel sole (ICES Div. VIId, e) – English Channel plaice (ICES Div. VIId, e) – Bristol Channel sole (ICES Div. VIIf) – Bristol Channel plaice (ICES Div. VIIf) – Irish Sea sole (ICES Div. VIIa) – Irish Sea plaice (ICES Div. VIIa) – West of Scotland herring (ICES Div. VIa) – Northeast Arctic cod (ICES Subareas I & II) Catch restrictions also imposed on the North Sea (ICES Subarea IV & Div. IIIa) mackerel industrial fishery – catches in January–June period restricted to 2 500–10 000 tons per Contracting Party depending on historical catches during this period.	NEAFC
1976	TACs and allocations established for 1976 for all stocks[1] for which such regulations were established for 1975, with the following addition: – North Sea sprat (ICES Subarea IV) Catch restrictions on mackerel industrial fishery extended to include West of Scotland (ICES Div. VIa) – catches in Div. IIa, IIIa & Subarea IV in January–June period restricted to 2 500–12 000 tons per Contracting Party depending on historical catches during this period. Northeast Arctic haddock (ICES Subareas I & II) directed fishery to cease when Northeast Arctic cod allocations taken.	NEAFC

[1] Objections to North Sea herring regulations for the latter half of 1975 and for 1976 prevented these from coming into effect.

APPENDIX TABLE 7. Minimum mesh size regulations in the Northwest Atlantic pertaining to cod, haddock and pollock, established under ICNAF[1].

Year in Effect	Area of Application	Gear/Materials/Species Affected	Mesh Size (mm)
1953	Subarea 5 (Gulf of Maine and Georges Bank)	Trawl nets of any material, measured wet, when fishing **for haddock** (10% or 5 000 lb. by-catch exemption for small mesh gear). Equivalent dry measurement permitted from 1954.	114
1957	Subarea 3 (Grand Banks)	Trawl nets of manila, measured wet after use or the equivalent size when measured dry before use or when constructed of other materials, when fishing **for cod or haddock** (10% or 5 000 lb. by-catch exemption for small mesh gear).	102
	Subareas 4 and 5 (Gulf of St. Lawrence, Scotian Shelf, Gulf of Maine and Georges Bank)	As for Subarea 3	114
1968	Subarea 1 (West Greenland)	When fishing for **cod, haddock** and five other species: – seine net – such part of any trawl net as is made of cotton, hemp, polyamide or polyester fibres – such part of any trawl net as is made of manila or any other material not mentioned above – (measured wet after use or equivalent when measured dry before use, no by-catch exemptions).	 110 120 130
	Subareas 2–5 (Labrador to Georges Bank)	When fishing for **cod or haddock** (all Subareas), **pollock** (in Subarea 3 only) and up to seven other species: – seine net – such part of any trawl net as is made of cotton, hemp, polyamide or polyester fibres – such part of any trawl net as is made of manila or any other material not mentioned above – (measured wet after use or equivalent when measured dry before use, no exemptions in Subarea 2, exemption for small mesh redfish fishery in Div. NOP of Subarea 3, general small mesh fisheries exemption in Subareas 4 and 5, by-catch exemptions all 10% or 5 000 lb).	 100 105 114
1971[2]	Subareas 2 and 3 (Labrador and Grand Banks)	Mesh size increase only, equivalents remain and exemptions unchanged.	130 manila equivalent
1974	Subareas 4 and 5 (Gulf of St. Lawrence, Scotian Shelf, Gulf of Maine and Georges Bank)	Mesh size increase applies to codend only, other netting can be 114 mm, equivalents remain and exemptions unchanged.	130 manila equivalent

[1] ICNAF Comm. Doc. 79/12, Ser. No. 5441 provides a key to regulations reported in ICNAF Annual Proceedings.
[2] 1972 for Poland, Portugal and Spain, and for Canada in Subarea 3.

APPENDIX TABLE 8. Catch controls in the Northwest Atlantic introduced by ICNAF by species and stock area (defined by ICNAF Divisions and Subdivisions), by year of introduction.

Year in Effect[1]	Subarea 1	Subarea 2	Subarea 3	Subarea 4	Subarea 5
1970				Haddock 4X	Haddock 5
1971					Yellowtail Flounder 5 (E of 69°W) Yellowtail Flounder 5 (W of 69°W) + 6
1972				Haddock 4W Herring 4XWb	Herring 5Y Herring 5Z+6
1973		Cod 2J .....plus	Cod 3KL Cod 3Ps Cod 3NO American plaice 3LNO Yellowtail flounder 3LNO	Cod 4VsW	Cod 5Y Cod 5Z Silver hake 5Y Silver hake 5Ze Silver hake 5ZW + 6 Red hake 5ZW + 6 Other flatfish 5 + 6 Mackerel 5 + 6
				Pollock 4X .....plus	Pollock 5 Redfish 5
1974	Cod 1	Cod 2GH Witch flounder 2J .....plus ..... American plaice 2 .....plus ..... Greenland halibut 2 ....plus..... Redfish 2 .....plus ..... Roundnose grenadier 2 ....plus ..... Capelin 2 .....plus	Cod 3M Witch flounder 3KL Witch flounder 3NO Witch flounder 3Ps American plaice 3K American plaice 3M American plaice 3Ps Greenland halibut 3KL Redfish 3K Redfish 3M Redfish 3LN Redfish 3O Redfish 3P Roundnose grenadier 3 Capelin 3K Capelin 3LNOPs	Cod 4TVn Cod 4Vn (May–Dec) Haddock 4VW[2] Silver hake 4VWX Pollock 4VWX .....plus..... Flatfish 4VWX Redfish 4VWX Argentine 4VWX Herring 4VWa Mackerel 4VWX	2nd Tier TAC 5 + 6 Red hake 5Ze Argentine 5 Other finfish 5 + 6 Pollock 5[3]
1975	Roundnose grenadier 0 + 1		Mackerel 3 ...plus ..... Squid spp. 3 ...plus ..... Capelin 3L[5] Capelin 3NO[5] Capelin 3Ps[5]	Mackerel 4[4] Squid spp. 4 Cod 4X	Squid spp. 5 + 6
1976	Greenland halibut 0 + 1		*Illex* squid 3.....plus	*Illex* squid4[6]	*Illex* squid 5 + 6[7] *Loligo* squid 5 + 6[7]
1977	Shrimp 1				River herring 5 + 6 Butterfish 5 + 6

[1] Not all TACs came into effect at beginning of the year cited. From 1974 onwards various resolutions were adopted to have regulations take effect prior to the date of entry into force under the provisions of the Convention.
[2] Replacing haddock 4W.
[3] Replacing pollock 4X+5.
[4] Replacing mackerel 4VWX.
[5] Replacing capelin 3LNOPs.
[6] Replacing squid spp. 3+4.
[7] Replacing squid spp. 5+6.

APPENDIX TABLE 9. Minimum mesh size regulations pertaining to cod, haddock and pollock in Canadian waters from 1977.

Year in Effect	Area of Application	Ancillary Information	Mesh Size (mm)
–[1]	Newfoundland	Cod trap nets	
		– walls	89
		– leader	177
1977	All	ICNAF trawl regulations retained (See App. Table 7).	130 manila equivalent
1982	All	Differentials for netting material and for seine nets removed. All species included unless specifically exempted.	130
1984	All	Groundfish gillnet mesh size standardized. (Previously varied between 127 mm and 152 mm depending on Province from which fishing occurred.)	140
1991 (March)	Div. 4VsWX+ Subarea 5	Differentials introduced based on type of mesh in codend:	
		– square mesh netting	140
		– diamond mesh netting	155
1991 (July)	Div. 4VsWX+ Subarea 5	– square mesh netting	130
		– diamond mesh netting	145
1994	All	All mesh size regulations revoked; replaced by specifications in annual "conservation harvesting plans" for each fleet sector.	–

[1] The minimum mesh size for netting in cod traps was set at 3 1/2 inches (89 mm) in 1919 or possibly earlier.

APPENDIX TABLE 10. Catch controls established in Canadian Atlantic fishing zones.

Year in Effect	Stocks	Remarks
1972	Herring – Southern Gulf of St. Lawrence	Included Div. 4T and southwest Newfoundland fishing areas
1974	Herring – St. Mary's Bay	Southeast coast of Newfoundland
1974	Herring – Placentia and Fortune Bays	Southeast coast of Newfoundland
1976	Herring – East coast of Newfoundland Cod – West coast of Newfoundland Redfish – Gulf of St. Lawrence	Defined by bays Div. 4RS – 3Pn Div. 4RST
1977	Herring – West coast of Newfoundland American plaice – Southern Gulf of St. Lawrence Witch flounder – Northern Gulf of St. Lawrence	Div. 4R Div. 4T Div. 4RS
1982	Cod – 4X total Greenland halibut – Gulf of St. Lawrence White hake – Southern Gulf of St. Lawrence	Previously only offshore area Div. 4RST Div. 4T
1983	Greenland halibut – Div. 2GH Greenland halibut – Div. 2J3KL	Previously managed as a single unit – Subarea 2 & Div. 3KL
1987	Haddock – Grand Banks Haddock – St. Pierre Bank Pollock – St. Pierre Bank	Div. 3LNO Subdiv. 3Ps Subdiv. 3Ps
1988	Atlantic halibut – Gulf of St. Lawrence Atlantic halibut – Atlantic coast	Div. 4RST Div. 3NOPs + VWX +Subarea 5
1989	Haddock – Southern Gulf of St. Lawrence	Div. 4T added to Div. 4VW management area
1990	Pollock – Div. 4VWX + 5Zc	Redefined management unit to exclude USA waters
1991	(Yellowtail flounder – Georges Bank)	Deregulated
1993	Redfish – Units 1, 2 and 3	Previous management units Div. 4RST, Div. 3P and Div. 4VWX rearranged into Unit 1 – Div. 4RST + Subdiv. 3Pn (Jan–May) + Subdiv. 4Vn (Jan–May), Unit 2 – Subdiv. 3Pn (Jun–Dec) + Subdiv. 4Vn (Jun–Dec) + Subdiv. 3Ps + Subdiv. 4Vs +Div. 4W (statistical areas f g j), Unit 3 – Div. 4W (statistical areas d e h k l) + Div. 4X
1994	Flatfish – Div. 4VW Flatfish – Div. 4X+5Y	Previously managed as a single unit, Div. 4VWX, and included American plaice, yellowtail flounder and witch flounder. Div. 5Y added and winter flounder added in Div. 4X+5Y management area
1995	Witch Flounder – Div. 4RST	Div. 4T added to management area.

APPENDIX TABLE 11. Species and stocks in EU waters[1] subject to TAC regulation in 1992, typical of the period from 1987 subsequent to the accessions of Spain and Portugal. (Council Reg. (EEC) No. 3882/91, OJ No. L367, 31-12-91.)

Species	Stock Areas
Herring	IIIa; IIIb, c, d (EU zone); IIa (EU zone), IVa, b; IVc, VIId; Vb (EU zone), VIa north, VIb; VIa south, VIIb, c; VIa Clyde; VIIa; VIIe, f; VIIg, h, j, k; (10 stocks).
Sprat	IIIa; IIIb, c, d (EU zone); IIa (EU zone), IV (EU zone); VIId, e; (4 stocks).
Anchovy	VIII; IX, X, Morocco; (2 stocks).
Capelin	IIb (1 stock).
Cod	IIb; IIIa Skagerrak; IIIa Kattegat; IIIb, c, d (EU zone); IIa (EU zone), IV; Vb (EU zone), VI, XII, XIV; VIIa; VII b, c, d, e, f, g, h, j, k, VIII, X, Morocco; (8 stocks).
Haddock	IIIa, IIIb, c, d (EU zone); IIa (EU zone), IV; Vb (EU zone), VI, XII, XIV; VII, VIII, IX, X, Morocco; (4 stocks).
Pollock (Saithe)	IIa (EU zone), IIIa, IIIb, c, d (EU zone), IV; Vb (EU zone), VI, XII, XIV; VII, VIII, IX, X, Morocco; (3 stocks).
Pollack	Vb (EU zone), VI, XII, XIV; VII; VIIIa, b; VIIIc; VIIId; VIIIe; IX, X, Morocco; (7 stocks).
Norway pout	IIa (EU zone), IIIa, IV (EU zone); (1 stock).
Blue whiting	IIa (EU zone), IV (EU zone); Vb (EU zone), VI, VII; VIIIa, b, d; VIIIe; VIIIc, IX, X, Morocco; (5 stocks).
Whiting	IIIa; IIa (EU zone), IV; Vb (EU zone), VI, XII, XIV; VIIa; VII b, c, d, e, f, g h, j, k; VIII; IX, X, Morocco; (7 stocks).
Hake	IIIa, IIIb, c, d (EU zone); IIa (EU zone), IV (EU zone); Vb (EU zone), VI, VII, XII, XIV; VIIIa, b, d, e; VIIIc, IX, X, Morroco; (5 stocks).
Jack and horse mackerels	IIa (EU zone), IV (EU zone); Vb (EU zone), VI, VII, VIIIa, b, d, e, XII, XIV; VIIIc, IX; (3 stocks).
Mackerel	IIa (EU zone), IIIa, IIIb, c, d (EU zone), IV; II (excl. EU zone), Vb (EU zone), VI, VII, VIIIa, b, d, e, XII, XIV; VIIIc, IX, X, Morocco; (3 stocks).
European plaice	IIIa Skagerrak; IIIa Kattegat; IIIb, c, d (EU zone); IIa (EU zone), IV; Vb (EU zone), VI, XII, XIV; VIIa; VIIb, c; VIId, e; VIIf, g; VIIh, j, k; VIII, IX, X, Morocco; (11 stocks).
Common sole	IIIa, IIIb, c, d (EU zone); II, IV; Vb (EU zone), VI, XII, XIV; VIIa; VIIb, c; VIId; VIIe; VIIf, g; VIIh, j, k; VIIIa, b; VIIIc, d, e, IX, X, Morocco; (11 stocks).
Megrims	Vb (EU zone), VI, XII, XIV; VII; VIIIa, b, d, e; VIIIc, IX, X, Morocco; (4 stocks).
Anglerfishes	Vb (EU zone), VI, XII, XIV; VII; VIIIa, b, d; VIIIe; VIIIc, IX, X, Morocco; (5 stocks).

[1] Also in Svalbard zone (IIb) for capelin and cod. See Norway section.

APPENDIX TABLE 12. Minimum mesh size regulations pertaining to cod, haddock and pollock in EU waters from 1977 (excluding Skagerrak and Kattegat for which mesh regulations were established under Norway–Sweden–EU agreement).

Year in Effect	Area of Application	Ancillary Information	Mesh Size (mm)[1]
1977		Member governments were expected to retain NEAFC regulations in effect until replaced by EU regulations. Temporary EU regulations also in effect in October 1980–October 1981	
1983[2]	**Region 1**	EU Region 1 is EU waters within NEAFC Region 1 and in NAFO Area off West Greenland (Subarea 1) and off St. Pierre and Miquelon (in Subarea 3)	
	– NAFO Subarea 1, ICES XIV, V	Greenland waters and small parts of ICES V which lie inside EU zone	130
	– other parts of the Region		120
	Region 2	Equates to NEAFC Region 2	
	– Irish Sea	ICES VIIa – single twine nets – double twine nets	 70 75
	– English Channel	ICES VIId,e	75
	– other parts of the Region		80
	Region 3	Equates to NEAFC Region 3	65
1987[3]	**Region 1**	Equates to NEAFC Region 1 (Greenland and St. Pierre and Miquelon waters no longer under EU jurisdiction)	
	– ICES Vb (EU Zone)	Standardized with mesh size to be phased in for Region 2	90
	– other parts of the Region		130
	Region 2		
	– Irish Sea	ICES VIIa (Distinction between single and double twine dropped)	70
	– English Channel	ICES VIId, e	75
	– West of Scotland and Ireland	ICES VI, VIIb, c, f, g, h, j, k	80
	– North Sea	ICES IV, the adjacent part of IIa lying south of 64°N, and a small western part of IIIa	85
	– other parts of the Region		90
	Region 3		65
1989[3,4]	**Region 2**	(Regions 1 and 3 regulations unchanged)	
	– Irish Sea	ICES VIIa	70
	– English Channel and west of Ireland	ICES VI south of 56°N, VII excluding VIIa	80
	– other parts of the Region		90
1992[5]	**Regions 1 and 2**		
	– west of Ireland, Irish Sea and English Channel	ICES VI south of 56°N, VII	80
	– other parts of the Regions	Mesh size specified as diamond mesh, but upper half of the trawl may comprise a section (panel or window) of square mesh netting of 90 mm	100
	Region 3		65

[1] Mesh sizes are irrespective of material of construction in all cases.
[2] Council Reg. (EEC) No. 171/83, OJ No. L24, 27-1-83.
[3] Council Reg. (EEC) No. 3094/86, OJ No. L288, 11-10-86.
[4] Council Reg. (EEC) No. 2968/87, OJ No. L280, 3-10-87.
[5] Council Reg. (EEC) No. 345/92, OJ No. L42, 18-2-92.

APPENDIX TABLE 13. Minimum fish size regulations pertaining to primary species (cod, haddock, pollock, herring, mackerel and capelin) in EU waters from 1977 (excluding Skagerrak and Kattegat for which size regulations were established under Norway–Sweden–EU agreement). (See Appendix Table 12 for definitions of Regions. Fish size is total length.)

Year in Effect	Species	Size Limit (cm)	Ancillary Information
1977			Member governments were expected to retain NEAFC regulations in effect until replaced by EU regulations. Temporary EU regulations also in effect in October 1980–October 1981 which were closely similar to those subsequently introduced in permanent legislation in 1983.
1983[1]			All undersized fish must be immediately discarded at sea (exemptions noted below).
	Cod	34	Region 1, except 40 cm off Greenland and in ICES area V.
		30	Regions 2 and 3, except 45 cm in Irish Sea between October and December. By-catch of cod 30–45 cm of 10% by weight allowed during this period.
	Haddock	31	Region 1
		27	Regions 2 and 3
	Pollock	35	Region 1
		30	Regions 2 and 3
	Herring	20	Regions 1, 2 and 3. By-catches of 10% by weight allowed.
	Mackerel	30	Applicable only to North Sea. By-catches of 15% by weight allowed, reduced to 10% after 1983.
	Capelin	–	
1987[2] (* indicates effective date of 1989)			Discarding requirements and exemptions as in 1983.
	Cod	35	Region 1 (Greenland no longer EU waters).
		35*	Regions 2 and 3. Irish Sea 45 cm provision rescinded after 1987.
	Haddock	30	Region 1
		30*	Regions 2 and 3
	Pollock	35	Regions 1 and 3
		35*	Region 2
	Herring, mackerel and capelin		No change
1992[3]	Mackerel	20	Regions 1, 2 and 3, except North Sea.
		30	North Sea
	Other primary species		No change

[1] Council Regs. (EEC) No. 171/83, OJ No. L24, 27-1-83; No. 2931/83, OJ No. L288, 21-10-83.
[2] Council Regs. (EEC) No. 3094/86, OJ No. L288, 11-10-86; No. 2024/88, OJ No. L179, 9-7-88.
[3] Council Regs. (EEC) No. 345/92, OJ No. L42, 18-2-92.

APPENDIX TABLE 14. Minimum trawl mesh size regulations pertaining to herring, mackerel and capelin in EU waters from 1977 (excluding Skagerrak and Kattegat for which size regulations were established under Norway-Sweden–EU agreement). (See Appendix Table 12 for definitions of Regions.)

Year in Effect	Region	Ancillary Information	Mesh Size (mm)[1]
1977		Member governments were expected to retain NEAFC regulations in effect until replaced by EU regulations. Temporary EU regulations also in effect in October 1980–October 1981 which were identical to those subsequently introduced in permanent legislation in 1983.	
1983[2]	Region 1	herring, mackerel, capelin	16
	Region 2	herring	16 (32 from 1-1-84)
		mackerel – North Sea (Skagerrak and Kattegat)	32
		mackerel – other parts of the Region	16
		capelin	16
	Region 3	herring, mackerel	40
		capelin	–
1992[3]	Regions 1 and 2	herring, mackerel	32
	Region 3	herring, mackerel	40
	All Regions	capelin	–

[1] Mesh sizes are irrespective of material of construction in all cases.
[2] Council Regs. (EEC) No. 171/83, OJ No. L24, 27-1-83; No. 2931/83, OJ No. L288, 21-10-83.
[3] Council Regs. (EEC) No. 345/92, OJ No. L42, 18-2-92; No. 1465/92, OJ No. L155, 6-6-92; No. 3919/92, OJ No. L397, 31-12-92; No. 3676/93, OJ No. 314, 31-12-93; No. 3362/94, OJ No. L363, 31-12-94; No. 1909/95, OJ No. L184, 3-8-95.

APPENDIX TABLE 15. Minimum mesh size regulations for Icelandic waters pertaining to cod, haddock and pollock after 1975. (Mesh sizes are irrespective of material used for construction.)

Year	Fishing Method		Mesh Size (mm)
1976	bottom trawling and Danish seining		135
1977	bottom trawling except for redfish		155
	Danish seining		170
1978	midwater trawling for cod, haddock and pollock		155
1979	Danish seining		155
1978[1]	Cod gillnets	winter	178
		summer	152
1984	Danish seining	Faxaflói Bay	155
		Other Areas	135

[1] Previously 178 mm in winter, 140 mm in summer. Revised to 152 mm all year in 1993.

APPENDIX TABLE 16. Minimum mesh size regulations in the Norwegian zone pertaining to cod, haddock and pollock from 1977 (excluding Skagerrak and Kattegat for which mesh regulations established under Norway–Sweden–EU agreement).

Year in Effect	Area of Application	Ancillary Information	Mesh Size (mm)
1977	All areas	NEAFC regulations were continued in effect (see App. Table 4)	
1981	North of 64°N	Trawls of cotton, hemp, polyamide or polyester	125
		Trawls of any other material	135
		Danish seines	125
	South of 64°N	All nets irrespective of material	90
1983	North of 64°N	Trawls of cotton, hemp, polyamide or polyester	135
		Trawls of any other material	145
		Danish seines	135
	South of 64°N	No change	
1987	North of 64°N	Danish seines of hemp, cotton, polyamide or polyester	125
		Danish seines of any other material	135
		(Trawl nets – no change)	
	South of 64°N	All nets irrespective of material	100

APPENDIX TABLE 17. Minimum fish size regulations pertaining to primary species (cod, haddock, pollock, herring, mackerel and capelin) in the Norwegian zone from 1977 (excluding Skagerrak and Kattegat for which mesh regulations established under Norway–Sweden–EU agreement). (Fish size is total length.)

Year in Effect	Species	Size Limit (cm)	Ancillary Information
1977			NEAFC regulations in effect (see App. Table 5).
1981	Cod	42	NEAFC Region 1. By-catch of 15% by number of undersized cod allowed.
	Haddock	39	NEAFC Region 1. By-catch of 15% by number of undersized haddock allowed.
1983	Pollock	32–40	Size limit varied with latitude, 40 cm in north, 37 cm, 35 cm, 32 cm off southern Norway. By-catch of 10% by weight of undersized pollock allowed in coastal zone.
1990	Cod	47	NEAFC Region 1. By-catch of 15% by number of undersized cod allowed.
	Haddock	44	NEAFC Region 1. By-catch of 15% by number of undersized haddock allowed.
	Cod and Haddock		Size limits in NEAFC Region 2 unchanged from those of NEAFC (30 cm and 27 cm respectively) and thus remained consistent with those of EU until latter increased minimum sizes in 1989.
	Herring		NEAFC limit of 20 cm in human consumption fisheries in North Sea retained, consistent with EU regulations. A minimum size of 25 cm was introduced in 1975 for Norwegian spring–spawning herring. By-catch of 10% by weight of undersized herring allowed.
	Mackerel		NEAFC limit of 30 cm retained but applied to all North Sea catches. This coincided with EU regulation. By-catch of 15% by weight of undersized mackerel allowed. (EU limit reduced to 10% from 1984.)
	Capelin		Size limits were established at 11 cm in Barents Sea in 1978 and at 12 cm for the Jan Mayen zone (consistent with Icelandic regulation). By-catch of 10% by number of undersized capelin allowed. There were no capelin size limits established in NEAFC regulation.
	Prohibition on discard		It is prohibited to discard catches of various fish species including cod, haddock, pollock, herring and mackerel.

APPENDIX TABLE 18. Minimum mesh size regulations pertaining to cod, haddock and pollock in USA waters from 1977. (Data sources: NEFMC management plans and amendments, U.S. Federal Register.)

Year in Effect	Area of Application	Ancillary Information	Mesh size[1] (mm)
1977	Entire zone	Applicable when fishing for cod, haddock, and yellowtail flounder, with trawl nets	
		– codend	130
		– body of net	114
1978	Entire zone	Bottom gillnets	140
1982	Large mesh area – S.W. Gulf of Maine and Georges Bank	Trawl and seine nets	
		– codend (until 31 December 1982)	130
		– codend (from 1 January 1983)	140
		– body of net	114
		Bottom gillnets	140
1986	Large mesh areas – Gulf of Maine and Georges Bank	Trawl and seine nets	
		– codend	140
		– body of net[2]	–
	Large mesh areas, and rest of zone in November–February period	Bottom gillnets	140
1994	Large mesh areas – Gulf of Maine and Georges Bank	Trawl, seine and bottom gillnets	152
	Large mesh areas – Southern New England and Nantucket Lightship ground	Trawl, seine and bottom gillnets	140

[1] Mesh sizes are irrespective of material of construction in all cases.
[2] Codend defined as last 75 meshes of net in 1987 and 140 mm mesh regulation extended to include the whole net effective 1 January 1990.

APPENDIX TABLE 19. Minimum fish size regulations pertaining to cod, haddock and pollock fished commercially in USA waters from 1977. (Fish size is total length. Different conditions applied to recreational fishing. Data sources: NEFMC management plans and amendments, U.S. Federal Register.)

Year in Effect	Species	Size Limit inches (cm)	Ancillary Information
1977	Cod and Haddock	16 (40.6)	By-catch limit of 10% by weight of each species for commercial fishing vessels.
1982	Cod and Haddock	17 (43.2)	No undersized fish could be retained on board, landed or possessed.
1986	Cod, Haddock and Pollock	17 (43.2)	No undersized fish could be landed or possessed.
1987	Cod, Haddock and Pollock	19 (48.3)	No undersized fish could be landed or possessed.

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N O T I C E

What Future for Capture Fisheries

SYMPOSIUM

A Shift in Paradigm: Visioning Sustainable Harvests from the Northwest Atlantic in the Twenty-first Century

Hosted by the Scientific Council of the
Northwest Atlantic Fisheries Organization (NAFO)

10–12 September 1997
St. John's, Newfoundland, Canada

Objectives

1. Present the international profile of NAFO – a model of international collaborative research, management and cooperation.
2. Undertake a visioning exercise of sustainable international fisheries cooperation and management for the twenty-first century.
3. Examine shifts in the traditional capture fisheries and new livelihoods for the coastal community.
4. Produce a book based on the outcome of the symposium – commemorating 500 years of Northwest Atlantic livelihoods based on harvesting the Sea.

The Symposium is built around an opening session with three keynote speakers and five sessions. Each session will have introductory comments from the Chair and a general session discussion.

Opening Session:	**Keynote**	The NAFO model of international collaborative research, management and cooperation.
	Keynote	The framework within which capture fisheries will operate in the future – Development of UNCLOS 1982, Agenda and FAO code of conduct of responsible fishing.
	Keynote	Sustainability – Ecological impact from fisheries – the political environmental issue and how this will affect how capture fisheries will operate in the future.

Session 1 – History of Fishing the Northwest Atlantic

1. History of fisheries in the Northwest Atlantic – the 500 year perspective.
2. The history of fisheries management and the scientific advice – the ICNAF/NAFO history from the end of World War II to the present.

Session 2 – Management Approaches – Caring for the Future Resources

1. Trends in international cooperation in fisheries – monitoring, surveillance and control.
2. Controlling marine fisheries 50 years from now – satellite surveillance or a changed regime – can economy and biology cooperate?

Session 3 – Fisheries Research: Perspectives for the Twenty-first Century

1. What can technology offer the future fisheries scientist – possibilities for obtaining better estimates of fish stock abundance by observations from the sea.
2. What can technology offer the future fisheries scientist – laboratory and aquaria technology – possibilities for obtaining better understanding of the stock structure (eg DNA technology).
3. Where is fisheries science heading – special emphasis on fish stock assessment work.
4. What can information technology and science offer – will we be able to process the mass of data future technology will enable us to collect?
5. Integrating fisheries observations with environmental data – towards a better understanding of the conditions for fish in the sea.

Session 4 – Sustainable Livelihood for the Coastal Community

1. Aquaculture – marine fisheries – will capture fisheries remain competitive?
2. Impact on coastal livelihood from future changes in production and demand for fish.
3. The future for fishery dependent communities – Faroe Islands.
4. The future for fishery dependent communities – fishery dependent regions of the EU – Galicia and other areas.

Session 5 – The Future for Capture Fisheries

1. The future economy of capture fisheries – which sectors will be economically viable?
2. Capture fisheries and the environment issue – implications for the viability of future capture fisheries.
3. The future consumer market for fish – will there be a place for capture fisheries?
4. The capture technology of the future – large trawlers with sea going factories or small vessels of the Coastal State?
5. Development in fish food technology – implications for capture fisheries.

This Symposium is being held in conjunction with 19th Annual Meeting of NAFO and the Cabot 500th Anniversary Celebration in St. John's, Newfoundland. For further information, please contact.

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No. 22 – Miscellaneous papers (6), May 1995, 95 pp.
No. 23 – Miscellaneous papers (5), September 1995, 95 pp.
No. 24 – Symposium papers (12), on Impact of Anomalous Oceanographic Conditions at the Beginning of the 1990s in the Northwest Atlantic on the Distribution and Behaviour of Marine Life, September 1994, 155 pp.
No. 25 – Collection of Papers – Flemish Cap Selected Environmental and Other Papers (5), July 1996, 91 pp.

NAFO Scientific Council Reports

This publication contains reports of Scientific Council Meetings held throughout the year.

1980 – Reports of seven meetings in 1979 and 1980, Published December 1980, 190 pp.
1981 – Reports of four meetings in 1981, Published December 1981, 148 pp.
1982 – Reports of two meetings in 1982, Published December 1982, 110 pp.
1983 – Reports of three meetings in 1983, Published December 1983, 152 pp.
1984 – Reports of three meetings in 1984, Published December 1984, 126 pp.
1985 – Reports of three meetings in 1985, Published December 1985, 146 pp.
1986 – Reports of three meetings in 1986, Published December 1986, 156 pp.
1987 – Reports of three meetings in 1987, Published December 1987, 138 pp.
1988 – Reports of two meetings in 1988, Published December 1988, 150 pp.
1989 – Reports of two meetings in 1989, Published December 1989, 180 pp.
1990 – Reports of two meetings in 1990, Published December 1990, 188 pp.
1991 – Reports of two meetings in 1991, Published December 1991, 164 pp.
1992 – Reports of four meetings in 1992, Published December 1992, 212 pp.
1993 – Reports of three meetings in 1993, Published January 1994, 234 pp.
1994 – Reports of four meetings in 1994, Published January 1995, 234 pp.
1995 – Reports of three meetings in 1995, Published January 1996, 244 pp.

NAFO Statistical Bulletin

This publication replaced ICNAF Statistical Bulletin which terminated with Vol. 28 (revised). The volume numbering continues the series.

Vol. 29 – Fishery statistics for 1979, Originally published July 1981; revised edition published November 1984, 290 pp.
Vol. 30 – Fishery statistics for 1980, Originally published August 1982; revised edition published October 1984, 280 pp.
Vol. 31 – Fishery statistics for 1981, Originally published September 1983; revised edition published March 1985, 276 pp.
Vol. 32 – Fishery statistics for 1982, Published December 1984, 284 pp.
Vol. 33 – Fishery statistics for 1983, Published December 1985, 280 pp.
Vol. 34 – Fishery statistics for 1984, Published December 1986, 304 pp.
Vol. 35 – Fishery statistics for 1985, Published December 1987, 322 pp.
Vol. 36 – Fishery statistics for 1986, Published October 1989, 304 pp.
Vol. 37 – Fishery statistics for 1987, Published April 1990, 295 pp.
Vol. 38 – Fishery statistics for 1988, Published February 1991, 307 pp.
Vol. 39 – Fishery statistics for 1989, Published February 1993, 300 pp.
Vol. 40 – Fishery statistics for 1990, Published February 1994, 309 pp.

NAFO Statistical Bulletin (Continued)

Vol. 41 – Fishery statistics for 1991, Published February 1995, 318 pp.
– Statistical Bulletin Supplementary Issue, 1960–90, (statistics) Published April 1995, 156 pp.
Vol. 42 – Fishery statistics for 1992, Published October 1995, 310 pp.

NAFO List of Fishing Vessels

This triennial publication replaced ICNAF List of Fishing Vessels which terminated with the 1977 list in April 1980.

1980 – List for 1980, Published March 1983, 48 pp.
1983 – List for 1983, Published April 1985, 43 pp.
1986 – List for 1986, Published July 1988, 48 pp.
1989 – List for 1989, Published January 1992, 44 pp.

Inventory of Sampling Data

This publication replaced ICNAF Inventory of Sampling Data 1967–1978 which was completed in 1986.

Inventory of Sampling Data 1979–1984, Published April 1989, 250 pp.
Inventory of Sampling Data 1985–1989, Published March 1993, 265 pp.

NAFO Index of Meeting Documents

This publication contains lists of all documents along with a subject and author index of Scientific Council documents issued during a 5-year period.

1979–84 – Index of Meeting Documents, Published March 1985, 146 pp.
1985–89 – Index of Meeting Documents, Published December 1990, 116 pp.
1990–94 – Index of Meeting Documents, Published November 1995, 139 pp.

A price list for these publications may be obtained upon request. Orders for current and back issues and standing orders for future issues should be forwarded to the Executive Secretary, Northwest Atlantic Fisheries Organization, P. O. Box 638, Dartmouth, Nova Scotia, Canada B2Y 3Y9. Please note, prepayment is required on all orders.