

Fisheries Science and Management in the North Atlantic

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Abstract

Institutionalised fishery management in the North Atlantic dates at least 100 years. The structure, processes and roles of major interested parties involved in fishery science and management (i.e., international entities: ICCAT, ICES, NEAFC, NAMMCO, NASCO, NAFO, EU, and Norway, Iceland, The Faroe Islands, Greenland, Canada, and the USA) and how they are linked are described. The deterioration of fishery statistics as a result of the imposition of management measures without the implementation of adequate monitoring, control and surveillance programs is almost universal. Strength and weaknesses of the various components in each fishery management processes are identified and discussed, with particular emphasis on the consequences of the single species approach generally used and for the involvement of interested parties. Improved arrangements for the provision of management advice are suggested.

Introduction

Fishery management activities have grown considerably in the North Atlantic over the last 50 years. After the Second World War, several fishery management arrangements were created for offshore, large vessels, distant water fisheries. With the large scale extension of Exclusive Economic Zone to 200 nautical miles in the mid to late 1970s, fishery management activities grew considerably and became applied to almost all fisheries, including small scale operations.

The organisation and processes of fishery management are described based, as far as possible, on up-to-date information available on the web sites of the various bodies involved. The discussion identifies some strengths and weaknesses of the various processes and institutions examined (see also Alder et al. this volume).

Northeast Atlantic

The main administrative separation in the Atlantic ocean is at 42° W, just eastward of the Flemish Cap. At 59° N, the boundary moves westward to 44° W to the southernmost tip of Greenland. There is a similarly jagged boundary in the Barents Sea where the main boundary is at 30° E, ex-

cept from 72° N where it moves westward to 26° E to the northern tip of Norway. The Northeastern Atlantic extends to 36° N, while the Northwestern Atlantic extends to 35° N (note that this definition of the North Atlantic is slightly different from that of the Sea Around Us project (see Pauly et al. 2000)).

ICES

The International Council for the Exploration of the Sea (ICES) is an intergovernmental organisation created in 1902. There are nineteen member country as of the year 2000: Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Latvia, Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweden, United Kingdom and, United States. Observer status has been granted to Australia (i.e., its Commonwealth Scientific Industrial and Research Organisation), South Africa (Sea Fisheries Institute), Greece (Institute of Marine Biology of Crete) and World Wide Fund for Nature (WWF). ICES currently operates under the terms of its 1964 Convention.

ICES is a multifaceted organisation. To many, it is a scientific organisation with almost half of the close to 80 meetings to be held in 1999-2000 being primarily of a scientific nature. To others, it is mostly an advisory organisation with its two main advisory committees, the Advisory Committee on the Marine Environment (ACME) and the Advisory Committee on Fishery Management (ACFM) and their associated Working Groups. ICES is a forum for the exchange of information and ideas on the sea and its living resources, and for the promotion and coordination of marine research by scientists within its member countries. "Since the 1970s, a major area of ICES work as an intergovernmental marine science organisation is to provide information and advice to Member Country governments and international regulatory commissions (including the European Commission) for the protection of the marine environment and for fisheries conservation. This advice is peer-reviewed by the Advisory Committee on Fishery Management (ACFM) and the Advisory Committee on the Marine Environment (ACME) before passing on" (<http://www.ices.dk>).

ICES being an intergovernmental organisation, most participants in its working groups, study groups and advisory meetings leading to the provision of fishery management advice are members of government fishery research institutes.

ICES currently provides traditional fishery management advice, mostly in the form of advice on Total Allowable catches (TAC), but also advice on

technical measures (mesh size, closed areas and seasons, etc.) through its Advisory Committee on Fishery Management. ACFM relies on sixteen assessment working or study groups. Half of the assessment groups are area-based, i.e., including most species that occur in a given area, e.g. the Arctic Fisheries working group, and half are species oriented, e.g., the Mackerel, Horse Mackerel, Sardine and Anchovy Working Groups.

Somewhere between 170 and 200 scientists participate each year in the assessment meetings. The *Pandalus* assessment WG in 1999 had only three participants (chairperson included), the largest number was for the joint EIFAC/ICES (European Inland Fishery Advisory Committee) Working Group on Eels where 41 scientists from 27 countries attended. The heaviest workload was arguably that of the northern shelf demersal assessment working group, whose 8 participants had to provide information or assessment on no less than 14 stocks.

At its annual meeting in 2000, ICES created an Advisory Committee on Ecosystems (ACE). It “is ICES official body for the provision of scientific advice and information on the status and outlook for marine ecosystems and on the exploitation of living marine resources in an ecosystem context. ACE provides a focus for advice that integrates consideration of the marine environment and fisheries in an ecosystem context, such as the ecosystem effects of fishing.” The Advisory Committee on Ecosystems will hold its first meeting in August 2001 (<http://www.ices.dk/committe/ace/ace.htm>). The creation of the Advisory Committee on Ecosystems shows that ICES recognise the need for an ecosystem approach.

In addition to the Advisory Committee on Ecosystems, ICES also created at its 2000 Annual Meeting, a Management Committee for the Advisory Process to interact with Partner Commissions and other clients, route the request for advice to the appropriate Committee, ensure adequate expert participation to review the questions at hand and co-ordinate the preparation and delivery of advice, among other things. The existence of two advisory committees (ACME and ACFM) was already an impediment to the provision of consistent integrated advice. It is doubtful that the creation of a third advisory committee (ACE) will simplify matters, decrease the workload, increase the quality of background analyses, etc. However, ACE might help focus research on the ecosystem effects of fishing.

NEAFC

“The origins of the North East Atlantic Fisheries

Commission lie in an organisation known as the Permanent Commission which was founded in 1953. The Permanent Commission was formed under the 1946 Convention for the Regulation of Meshes of Fishing Nets and the Size Limits of Fish. However, by the early 1960s it was considered that the Commission needed a wider range of powers to regulate for the effects of the technological advances in fishing methods. In 1963 the North East Atlantic Fisheries Commission (NEAFC) was formed under the North East Atlantic Fisheries Convention to succeed the Permanent Commission. In addition to the powers of the Permanent Commission, NEAFC could also establish closed fishing areas and seasons, and regulate catch and fishing effort.” (<http://www.neafc.org/index.htm>)

“The present NEAFC Convention entered into force in 1982 and there are currently six contracting parties: The European Community, Denmark (on behalf of the Faroe Islands and Greenland), Iceland, Norway, Poland and the Russian Federation.

NEAFC acts as a forum for the commissioning and dissemination of scientific advice on the state of fish stocks in the northeast Atlantic. The Advisory Committee on Fisheries Management of ICES supplies NEAFC with scientific advice and, on the basis of this advice, NEAFC establishes conservation and management measures. At present [1998] the main stocks to be regulated by NEAFC are Atlanto-scandian herring and oceanic redfish. However, the number of regulated stocks is likely to increase in the near future.”

The role of NEAFC progressively diminished in the late 1970s and most of the 1980s as a result of coastal states extending their EEZs to 200 nautical miles. However, the rebuilding of the Atlanto-Scandian herring at the end of the 1980s, the development of fisheries for oceanic redfish and blue whiting, as well as the expansion of the mackerel fishery outside of national EEZs have provided a focus for the revival of NEAFC who now has a permanent secretariat.

NAMMCO

“NAMMCO - the North Atlantic Marine Mammal Commission - is an international body for cooperation on the conservation, management and study of marine mammals in the North Atlantic. The NAMMCO Agreement, which was signed in Nuuk, Greenland, on 9 April 1992 by Norway, Iceland, Greenland and the Faroe Islands, focuses on modern approaches to the study of the marine ecosystem as a whole, and to understanding bet-

ter the role of marine mammals in this system. NAMMCO provides a mechanism for cooperation on conservation and management for all species of cetaceans (whales and dolphins) and pinnipeds (seals and walrus) in the region, many of which have not before been covered by such an international agreement.” (<http://www.nammco.no>) Canada, Denmark (on behalf of the Faroe Islands and Greenland), Russia, and Japan normally send observers to NAMMCO meetings.

NAMMCO is hosted by the University of Tromsø, in Tromsø, Norway. NAMMCO has a Council, a Management Committee and a Scientific Committee. It was created to overcome the inability of the International Whaling Commission (IWC) to provide scientific and management advice for the harvesting of marine mammals.

National management (Within EEZ)

Iceland

Iceland’s economy depends heavily on fisheries, with around 80% of the commodity exports in Iceland or 50% of the foreign exchange earnings originating from fishery products. The fishery’s total direct and indirect contribution to the Gross Domestic Product (GDP) is estimated to be as high as 45% (Arnason 1995).

Six government bodies are directly involved in fishery management in Iceland: The Ministry of Fisheries, the Directorate of Fisheries, the Marine Research Institute, the Icelandic Fisheries Laboratories, the Icelandic Coast Guard, and the Ministry of Foreign Affairs.

“The Ministry of Fisheries is responsible for management of fisheries in Iceland and the implementation of legislation, and issues regulations to this effect. Its duties are general administration, long-term planning and relations with other fisheries institutions at the international level. The Minister of Fisheries is responsible for the annual TAC decisions.” (<http://brunnur.stjr.is/interpro/sjavarutv/english.nsf/pages/front>).

The Directorate of Fisheries is a Government institution under the ultimate responsibility of the Minister of Fisheries. The Directorate is responsible for [...the] implementation of all laws and regulations covering fisheries management, administration of fishing activities and imposition of special fines for illegal catches. Enforcement of the laws regarding the handling and inspection of marine products. Collection, processing and publication of data relating to fisheries management,

marine research and all relevant statistics on fishing and processing.” (<http://www.hafro.is/dirfish/dirfish/mandate.html>).

The Marine Research Institute provides fishery management advice to the Minister of Fisheries, either directly or through the Advisory Committee on Fishery Management of the International Council for the Exploration of the Sea (ICES) (<http://www.hafro.is/hafro/intro.html>).

“The Icelandic Fisheries Laboratories is a research institution in the field of foodstuffs, with specialisation in marine resources and products. The role of IFL is to increase the competitiveness of its customers through research, services and dissemination of information. IFL emphasises high quality in all operations. In carrying out this role, the laboratories may work independently or in co-operation with other parties such as universities, institutions and enterprises.” (<http://www.rfisk.is/general/aboutifl.htm>).

The Icelandic Coast Guard is responsible for monitoring, control and surveillance of the fishing activities while the Ministry of Foreign Affairs is responsible for international agreements.

In 1973, Iceland had implemented effort controls in its fisheries. By 1983, it was clear that the effort controls had not limited fishing mortality and the cod stock was in decline. Individual transferable quotas (ITQs) were introduced in 1984 with the objectives of limiting the total catch and increasing efficiency through rationalisation of the fleets. The ITQ system underwent several adjustments to rectify shortcomings and unintended negative side-effects. The quota represent a share of the Total Allowable Catch (TAC) of all regulated species, and the quotas can be sold and bought without restrictions between licensed fishing vessels registered in Iceland.

The ITQ system and the associated TAC decision are the cornerstone of Iceland’s fisheries management, but there are a number of other measures including:

- A tonne-for-tonne withdrawal of fishing capacity when a new vessel is introduced into the fleet;
- Control on fishing gear e.g. minimum mesh sizes;
- Trawl bans in large coastal spawning and nursery areas;
- Sorting grids in shrimp fishing to limit the catches of juvenile fish;
- Extensive provision for temporary closures of fishing areas to protect spawning fish from all fishing;
- Provisions giving the Marine Research Institute the authority to close fishing areas temporarily without prior notice if the proportion of small fish in the

catch exceeds certain limits.

These measures, however, were insufficient to protect the cod stock and the agreed TAC consistently exceeded the catches advised either nationally or through ICES from 1987 to 1996. Over this period, catches decreased from 392 000t in 1987 to 169 000t in 1995. Extensive simulation work and consultation with interested parties were held nationally and in 1997 a catch rule whereby the TAC is automatically set at 25% of the stock biomass was implemented. Although this appeared to have resulted in stock recovery (ICES 1999), and a stock size in the order of one million tonnes, very recent developments (as of July 2001) suggest that cod biomass and the extent of the recovery may have been overestimated.

According to Runolfsson and Arnason (1996 and hag.hi.is/~bthru/iceitq1.html), for ITQ species, most landings are accounted for. Although there are some violations of the various regulations, these are considered negligible.

Norway

Norway prides itself with one of the most effective fishery management systems in the world. Contrary to Canada whose management was unsuccessful at protecting their Northern cod, Norway's quick reaction in decreasing the agreed TAC (from 560 000t in 1987 to 451 000t in 1988, 300 000t in 1989 and 160 000t in 1990), the fishing activity of the fleets, and strict surveillance of fishing activity combined with favourable environmental conditions allowed the Northeast Arctic cod to successfully rebuild in the 1990s. Unfortunately, this stock rebuilding was short lived, and by 1997, TACs again had to be reduced substantially.

We have not found a concise description of how fishery management works in Norway, but apparently, the organisation is very similar to that described for Iceland. However, "eighty per cent of Norwegian fisheries is harvesting stocks shared with other countries, Russia and the EU being the most important" (OECD 1997). Therefore, most Norwegian TAC decisions are the result of bilateral international negotiations, and contrary to the Icelandic Minister of fisheries who has authority over such issues, the Norwegian Minister can only decide on the mandate for the Norwegian delegation to the international negotiations. This is normally based on discussions involving interested parties, including scientists and the industry. However, "The internal distribution of the national quotas are determined by the Ministry of Fisheries, on the basis of recommendations from

an advisory board, representing different sectors of the industry, and other relevant organisations. Considerations of conservation and distributive aspects are the main background for the national distribution of the national share of the agreed TAC. While local interests play an important part in this process, local fishery administration is restricted to advisory activities. The management system is based on a number of laws, the important being the Salt Water Fisheries Act. On the basis of this law a number of measures controlling the fisheries are left to the discretion of the Ministry of Fisheries in Oslo, and the Directorate of Fisheries in Bergen. These two bodies have the power to decide upon – partly on a day-to-day basis – a number of management measures. The control of the implementation of the management decisions is made by the National Control Board and the Coast Guard. The latter inspects both Norwegian and foreign vessels in Norwegian fishing areas. The coastal guard also surveys activities in international waters. Non-compliance with regulation in Norwegian waters are punished by fines and withdrawals of licences. [...] On the basis of the Salt Water [Fisheries] Act, the Ministry of Fisheries and the Directorate of Fisheries have at their disposal a wide variety of management instruments – fishing permits, quotas, gear regulations (mesh size), by-catch regulations, minimum fish size, time and area closures, etc. Considerations on resource conservation, efficiency and distribution are the background for the use of these instruments (OECD 1997).

European Union member countries

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom are presently members of the European Union (EU). Their fisheries are managed under the EU Common Fishery Policy (CFP).

OECD (1997, p. 43) provides a succinct and useful description of the EU Common Fishery Policy: "The Common Fisheries Policy (CFP) of the European Union is based on the Treaty of Rome signed in 1957. Article 39 specifies the general objectives: a) to increase productivity; b) to improve fishing communities standards of living; and c) to stabilise markets, supply and prices to the benefit of the consumers. More recently the Treaty of the European Union (the Maastricht Treaty) has inserted Article 130R which requires that environmental impacts be taken into account in all community policies. The environmental aspects therefore also have to be taken into account in the implementation of the CFP.

The CFP covers markets, structures (including fleets), the management of external resources fished in the EEZ of the Member States ('Community waters'), and access to 'external' resources located in international waters or in the waters of third countries.

The structural policy was originally designed to assist the modernisation of the fishing fleets and to improve the processing and marketing sectors. In recent years the reduction of overcapacity of the fishing fleet has, however, been given increasingly higher priority.

Policy on the conservation and management of resources is the cornerstone of the CFP. Technical measures (mesh sizes, minimum landing sizes, closed areas, etc.), have always played an important role. Before 1983 decisions were taken within the framework of international agreements on the management of the fish resources. In 1983 the first framework regulation supplementing a 1976 Community agreement was adopted to regulate access by fishing vessels to Community waters. Based on this regulation, decisions are taken annually on technical measures and on limitation of catches (Total Allowable Catches or TACs) and on their allocation among Member States according to the Principle of Relative Stability, i.e., by the use of fixed allocation keys. This principle is of crucial importance to the smooth operation of the CFP. It leaves to each Member State a broad margin of freedom to decide how to exploit the allocated fishing opportunities."

"The Common Fishery Policy in its present form was adopted in 1983 for a 20 year period, to last to the end of 2002. The review of the CFP in 1992 resulted in a new basic regulation (Reg. 3760/92). This revision provides the framework at the EU level:

- For complementing output controls (TACs) with input controls (restriction on effort);
- For establishing a better integration between management of resources and measures to restructure the fleet;
- For multi-annual decisions on the exploitation of resources;
- For reinforced inspection and monitoring of the fisheries.

Effort constraints on vessel capacity and restrictions on the number of days at sea have for demersal fisheries been implemented according to this regulation since 1 January 1996 (OECD 1997, p. 44)."

Three different bodies are involved in the EU decision-making process. "The Commission has the

right of initiative, i.e., of making proposals to the Council. In most cases the European Parliament must be consulted, but the final decision is made by the Council. [...] Whereas TACs are decided and allocated between Member States at the EU level, further allocations of quotas and other fishing rights between individual fishers or groups of fishers (e.g. Producer Organisations) are decided at a Member State level. Also the responsibility for implementation and control remain the competence of the Member State (OECD 1997, p. 44)".

Producer organisations (POs) are present in every EU country, but their role vary from country to country. They are in fact organised groups of fishers who "are given legal responsibility to ensure that fishing is carried out 'along rational lines' and conditions for sale are improved. They may also be charged with ensuring the proper management of catch quotas. To be recognised, POs are to be 'sufficiently active economically' and the economic area covered is to be of 'sufficient importance'. EC start up grants (under FIFG) encourage the formation of POs although uptake has varied considerably between the Members States. In the UK there are 20 POs, compared to 31 in Germany and only three in Greece (Coffey 1999, p. 30)."

"All POs throughout Europe are now involved, to a greater or lesser extent, in the implementation and administration of the EU marketing regulations. Some POs have become involved in related activities such as the establishment of quality control systems, the marketing of fish and the establishment of fish processing plants. It is only within the UK, however, that POs have come to play a central role in fisheries management. This new role for POs was recognised in 1993 when the EU marketing regulation was amended to allow POs, at the discretion of member states, to manage national catch quotas. With this change in the relevant regulation, the EU has clearly signalled its approval of fisheries management by the PO sector. It will therefore be interesting to see if other member states follow the UK approach and develop fisheries management systems based on PO participation. [...] In terms of fish quotas it is estimated the PO sector manages over 95 percent of all quotas (Goodlad 1999 p. 6)."

As indicated above, there is considerable scope for variability in the way that the national allocations are distributed and/or managed within any given EU country. ITQs are explicitly used in The Netherlands and in Belgium in the flatfish fisheries and in Portugal for distant water cod and red-fish fisheries and for hake in national waters in

1993 and 1994 (OECD 1997), and to a certain degree in the UK. “The system of UK fisheries management is firmly based on quota allocations and is therefore a classic resource based management system. The development of the SQ [sector quotas] system, and especially the recent introduction of FQAs [fixed quota allocation], has resulted in fish quotas being bought, sold and leased. Although there is no legal title to UK fish quotas, increasing numbers of fishermen are prepared to invest in an administrative system which actually confers most of the advantages of an ITQ system. For many people the UK system of fisheries management is virtually a system of ITQs by another name (Goodlad 1999, p. 19).” Generally speaking, the national systems are designed more to ensure that the national allocations will be actually taken (OECD 1997) than to ensure protection and conservation of the resources.

Technical measures such as spatial and seasonal restrictions, controls on gear type and size, as well as on fish sizes are an integral part of the Common Fishery Policy, and they are also used widely by individual Member States.

Monitoring Control and Surveillance had long been a shortcoming of the CFP and horror stories about ‘blackfish’ are widespread. In 1994, additional measures were introduced: “The monitoring and control system is designed to ensure the legality of activities on board fishing vessels, as well as during landing, selling, storing, transporting and importing fish. It also aims to ensure that effective sanctions are applied wherever legislation is breached. Unlike many of the CFP’s provisions, it applies to the activities of all EC fishing vessels, and all activities in the territory or under the sovereignty of Member States. Member States retain responsibility for enforcement, but there is also an EC inspectorate to oversee their activities and ensure some parity between national enforcement approaches.” (Coffey 1999, p. 42).

The Faroe Islands

The Faroe Islands belong to the Kingdom of Denmark but are not part of the European Union. The Faroese economy, like that of Iceland, is highly dependent on fisheries. Despite its small size and population (about 50 000 inhabitants), the Faroe Islands had a significant distant water fishing fleet in the 1960s and 1970s. With the widespread extension of fisheries jurisdiction during the second half of the 1970s, much of that fleet had therefore to search fishing opportunities in the Faroese EEZ.

The Faroe Islands is one of the few western juris-

diction where input controls, in terms of fishing days, is one of the principal means of regulating fisheries. As with most other fishery management processes, other tools, including gear, time and area restrictions are used.

For most of the 1980s and the first of the 1990s, the main fishery management measure was by technical measures (mostly closed areas and seasons) and by limiting investment. “In 1987 a system of fishing licences was introduced. The demersal fishery at the Faroe Islands has been regulated by technical measures (minimum mesh sizes and closed areas). In order to protect juveniles and young fish, fishing is temporarily prohibited in areas where the number of small cod, haddock and saithe exceeds 30% in the catches; after 1-2 weeks the areas are again opened for fishing. A reduction of effort has been attempted through banning of new licences and buy-back of licences.

A new quota system, based on individual quotas, was introduced in 1994. The fishing year started on 1 September and ended on 31 August the following year. The aim of the quota system was, through restrictive TAC’s for the period 1994–1998, to increase the SSB’s of Faroe Plateau cod and haddock to 52 000 t and 40 000 t, respectively. The TAC for saithe was set higher than recommended scientifically. It should be noted that cod, haddock and saithe are caught in a mixed fishery and any management measure should account for this. Species under the quota system were Faroe Plateau cod, haddock, saithe, redfish and Faroe Bank cod. (see also Zeller and Freire 2001).

The catch quota management system introduced in the Faroese fisheries in 1994 was met with considerable criticism and resulted in discarding and in misreportings of substantial portions of the catches. Reorganisation of enforcement and control did not solve the problems. As a result of the dissatisfaction with the catch quota management system, the Faroese Parliament discontinued the system as from 31 May 1996. In close cooperation with the fishing industry, the Faroese government has developed a new system based on within fleet category individual transferable effort quotas in days. The new system entered into force on 1 June 1996. The fishing year from 1 September to 31 August, as introduced under the catch quota system, has been maintained.

The individual transferable effort quotas apply to:

- 1) The longliners less than 100 GRT, the jiggers, and the single trawlers less than 400 HP;
- 2) The pair trawlers; and

3) The longliners greater than 100 GRT.

The single trawlers greater than 400 HP do not have effort limitations, but they are not allowed to fish within the 12 nautical mile limit and the areas closed to them, as well as to the pair trawlers, have increased in area and time. Their catch of cod and haddock is limited by maximum by-catch allocation. The single trawlers less than 400 HP are given special licences to fish inside 12 nautical miles with a by-catch allocation of 30% cod and 10% haddock. In addition, they are obliged to use sorting devices in their trawls. One fishing day by longliners less than 100 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners less than 100 GRT could therefore double their allocation by converting to jiggling.” (ICES 2000)

There are also other geographical restrictions to limit fishing mortality such as not allowing trawlers to fish inside the 12 nautical mile limit, and allowing only longliners less than 100 GRT and jiggers less than 100 GRT to fish in the near-shore areas.

The effort quotas are transferable within fleet categories (e.g. between various sizes of longliners) but not between fleets (e.g. from longliners to trawlers).

Fishery management advice for the commercially most important stocks is provided directly by the Faroese Fisheries Research Laboratories but the assessment and analyses are reviewed by the North Western Working Group of ICES and the ACFM does provide advice which normally guides national advice.

Greenland

Greenland, like the Faroe Islands, belongs to the Kingdom of Denmark without being a member of the European Union. Greenland is governed by a Home Rule administration since 1979. Foreign affairs and justice are still under the Danish authorities, but it has been agreed with the Danish government that Greenland must be consulted on all matters of relevance to Greenland. Fishery management is under the responsibility of the Ministry of Industry, but fishery research is in the Ministry of Health and the environment (<http://www.gh.gl/>).

Greenland in fact straddles the Northeast and Northwest Atlantic boundary (mostly at 42° West, except at 59° N when it moves to 44° W) and therefore must be heavily involved in both the ICES and the NAFO fora through which stock as-

sessments and fishery management advice for the most commercially important species are reviewed.

The domestic fisheries are relatively underdeveloped except for shrimp and Greenland halibut. Fishing activities in Greenland’s waters have decreased substantially with the decrease in cod biomass, but there is considerable fishing activities in are Sub Area XIV, mostly for redfish.

Northwest Atlantic

The Northwest Atlantic witnessed rapid development in fishery science and in fishery management during the 1950s to the early 1970s through the work of the International Commission for Northwest Atlantic Fisheries (ICNAF) the predecessor of NAFO.

NAFO

ICNAF ceased to exist shortly after Canada (1977) and the USA (1976) extended their EEZ to 200 nautical miles. It was replaced in 1977 by the Northwest Atlantic Fisheries Organisation whose Convention applies to all fishery resources of the Convention Area, i.e., outside of the Canadian and US EEZs. The following species are excluded from NAFO: salmon, tunas and marlins, cetacean populations managed by the International Whaling Commission or any successor organization, and sedentary species of the Continental Shelf, i.e., organisms which, at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil. (Article I.4, NAFO Convention)

NAFO has a General Council for co-ordinating and administrative functions, a Fisheries Commission for conservation and fishery management decisions, and a Scientific Council to provide scientific advice for fishery management.

As of September 1999, Bulgaria, Canada, Cuba, Denmark (representing the Faroe Islands), Estonia, European Union (EU), France (Saint Pierre et Miquelon), Iceland, Japan, Republic of Korea, Latvia, Lithuania, Norway, Poland, Romania, Russian Federation; Ukraine, and the United States of America are member of NAFO. Before joining the EU in 1986, Portugal and Spain were also member of NAFO.

Most of the traditional groundfish fisheries in the NAFO area have been severely curtailed, except for Greenland halibut, and northern shrimp. The yellowtail flounder stock has recovered after being closed in the mid 1990s.

National management (within EEZ)

The fishery management processes described below for Canada and the United States of America are for their East Coasts. There may be slight differences in their West Coasts processes.

Greenland

The situation for Greenland is briefly described above in the section on the Northeast Atlantic.

Canada

In Canada, the Minister of Fisheries and Oceans (DFO) has almost exclusive powers in fisheries management, except for fish processing where the provincial governments also have responsibilities. All fishery management activities related to resource conservation and allocation, including stock assessment, licensing, monitoring, control and surveillance are solely assigned to the DFO. In the past, the inspection of fishery products for health and safety standards was also part of DFO's mandate but a Canadian Food Inspection Agency began operation in 1997-98 for both fishery and agriculture products.

DFO is geographically divided in six administrative regions (Newfoundland, Maritimes, Gulf (of St. Lawrence), Laurentian, Central and Arctic, Pacific). Aside from the Canadian Coast Guard, previously with the Department of Transport Canada, DFO has three main operational branches (Science – 1203 person-years (PY), Fisheries Management – 1488 PY, Oceans – 503 PY), and a policy group (DFO 1999). Each administrative region is lead by a Regional Director General, and normally, each would have a Regional director for Science, one for Fishery Management, one for the Coast Guard and one for Oceans.

For many years DFO had a virtual monopoly on fishery science, but with the collapse of the groundfish stocks in the early 1990s, the Fisheries Resource Conservation Council (FRCC) has been created in 1993 to advise the DFO Minister on Conservation measures for groundfish (the FRCC also provided advice on lobster conservation measures in 1995) based largely on stock assessments provided by DFO's science branch, but taking into account comments gathered through large scale consultations of fishing communities. Subsequently, a Pacific Fisheries Resource Conservation Council (PFRCC) was created to advise on Pacific salmon.

Prior to the groundfish collapse, few non-DFO scientists participated in the assessment process.

However, since the collapse, the process has become considerably more transparent, partly in an effort to increase the credibility of, but also to increase the quality of the data used in the assessment. Fishers have co-authored stock assessment documents and some are actively involved in the peer-review meetings.

USA

The fishery management system in the USA has been designed to provide checks and balances between the various interested parties. Ultimate responsibility rests with the Commerce Secretary who is responsible for the National Oceanic and Atmospheric Administration (NOAA) to which the National Marine Fisheries Service (NMFS) belongs, but fishery management plans are developed by the Regional Fishery Management Council (New England and Mid-Atlantic in the area under interest). The Regional Fishery Management Councils have some research staff, but depend heavily on NMFS for scientific advice. "The councils membership is a balance of commercial and recreational fishermen, marine scientists and state and federal fisheries managers, who combine their knowledge to prepare Fishery Management Plans (FMPs) for stocks of finfish, shellfish and crustaceans. In developing these FMPs, the Councils use the most recent scientific assessments of the ecosystems involved with special consideration of the requirements of marine mammals, sea turtles and other protected resources. The FMPs are prepared through a planning process that includes the public comments provided by fishers and other persons concerned with the management of these resources. (<http://www.nmfs.gov/councils/>)." The fishery management plans are developed by the councils, but must be approved by the Secretary of Commerce.

"Groundfish resources in the Northeast occur in mixed-species aggregations, resulting in significant bycatch interactions among fisheries directed to particular target species or species groups. Management is complex because of these interactions. [...] The principal regulatory measures currently in place for the major New England groundfish stocks are allowable days at sea for fishing coupled with closed areas, trip limits (for cod and haddock), and target total allowable catch corresponding to target fishing mortality rates. (Anderson et al. 1999)"

In the North Eastern USA, the Stock Assessment Review Committee process is open to participation by fishers and other interested parties. The final recommendations are discussed at widely-

advertised public meetings. The assessments are done by individuals or by small groups, generally involving NMFS scientists often with input from others. States have started some surveys and do employ their own scientists.

Until the mid 1990s, the New England Fishery Management Council did not appear overly pre-occupied with science and conservation. After an initial recovery of the stocks in the late 1970s following extension of jurisdiction, stocks rapidly declined and remained low. Highly restrictive fishery management measures in terms of number of days fished and area closures were introduced in the mid and late 1990s with some positive signs for cod, haddock and yellowtail on Georges Bank (NMFS 1999).

Highly migratory species

ICCAT

“The International Commission for the Conservation of Atlantic Tunas is an inter-governmental fishery organization responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and adjacent seas. The organization was established in 1969, at a Conference of Plenipotentiaries, which prepared and adopted the “International Convention for the Conservation of Atlantic Tunas,” signed in Rio de Janeiro, Brazil, in 1966. The Convention is open for signature, or may be adhered to, by any Government which is a Member of the United Nations or of any specialized agency of the United Nations. Instruments of ratification, approval, or adherence may be deposited with the Director-General of the Food and Agriculture Organization of the United Nations (FAO), and membership is effective on the date of such deposit. The official languages are English, French and Spanish.” (<http://www.iccat.es/wiccat.htm>). “Currently, there are 28 contracting parties: Angola, Brazil, Canada, Cap Verde, Côte d’Ivoire, Croatia, European Union, France (Dependent Territories), Gabon, Ghana, Equatorial Guinea, Japan, Korea, Libya, Morocco, Namibia, Panama, People’s Republic of China, Republic of Guinea, Russia, S. Tome & Principe, South Africa, Trinidad & Tobago, Tunisia, United Kingdom (Overseas Territories), United States of America, Uruguay, Venezuela” (<http://www.iccat.es/iccat2.html>).

“The Commission currently has the following Standing Committees: on Finance and Administration (STACFAD), on Research and Statistics (SCRS), and on Conservation and Management Measures. There is also a Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (PWG). [...] The Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (PWG) was specifically established to review compliance, by non-contracting parties, of the regulatory measures recommended by the Commission. (<http://www.iccat.es/wiccat.htm>).”

“About 30 species are of direct concern to ICCAT: Atlantic bluefin (*Thunnus thynnus*), yellowfin (*Thunnus albacares*), albacore (*Thunnus alalunga*) and bigeye tuna (*Thunnus obesus*); swordfish (*Xiphias gladius*); billfishes such as white marlin (*Tetrapturus albidus*), blue marlin (*Makaira nigricans*), sailfish (*Istiophorus albicans*) and spearfish (*Tetrapturus pfluegeri*); mackerels such as spotted Spanish mackerel (*Scomberomorus maculatus*) and king mackerel (*Scomberomorus cavalla*); and, small tunas like skipjack (*Katsuwonus pelamis*), black skipjack (*Euthynnus alletteratus*), frigate tuna (*Auxis thazard*), and Atlantic bonito (*Sarda sarda*).

Through the Convention, it is established that ICCAT is the only fisheries organization that can undertake the range of work required for the study and management of tunas and tuna-like fishes in the Atlantic. Such studies include research on biometry, ecology, and oceanography, with a principal focus on the effects of fishing on population abundance. The Commission's work requires the collection and analysis of statistical information relative to current conditions and trends of the fishery resources in the Convention area. The Commission also undertakes work in the compilation of data for other fish species that are caught during tuna fishing (i.e., bycatch, principally sharks) in the Convention area, and which are not investigated by another international fishery organization.” (<http://www.iccat.es/iccat2.html>).

NASCO

“The North Atlantic Salmon Conservation Organization (NASCO) is an international organization established under the Convention for the Conservation of Salmon in the North Atlantic Ocean which entered into force on 1 October 1983. The objective of the Organization is to contribute through consultation and cooperation to the conservation, restoration, enhancement and rational management of salmon stocks subject to the Convention taking into account the best scientific evidence available to it. The Convention applies to the salmon stocks which migrate beyond areas of fisheries jurisdiction of coastal States of the Atlantic Ocean north of 36°N latitude throughout their migratory range.

Contracting Parties: Canada, Denmark (in respect of the Faroe Islands and Greenland), European Union, Iceland, Norway, Russian Federation, United States of America. Twenty-five Non-Government Organizations (NGOs) have observer status to NASCO. Inter-Governmental Organizations and media representatives may also attend NASCO meetings.” (http://www.nasco.org.uk/html/about_nasco.html).

NASCO receives scientific advice for the management of salmon fisheries from ICES through ACFM.

Discussion

The fishery management processes examined share several similarities. They are all science-based with essentially the same functions, implemented through a similar sequence of steps: the fishery management process starts with the provision of scientific advice, interested parties are consulted on the advice, the fishery management agency makes a decision, a management plan is developed, and fishing takes place under monitoring, control and surveillance. Everywhere, there is an implied objective to protect the resources and the environment they depend on, but generally explicit protection of the environment is only beginning to be incorporated in fishery management. Fishery science is considered highly important in all jurisdictions and it is usually dominated by biologists. The need to incorporate social sciences in fishery management has long been recognised, and attempts have been made to attract social scientists in the process, but the day to day provision of fishery management advice remains firmly grounded in the biological stock assessment science with little room for social science and/or economics. Yet, fishery management is about managing the activities of human beings, not those of the fish (Maguire, et al. 1995). In addition, fisheries science has become reduced to stock assessment science for advisory purpose, with little consideration given to multispecies interactions or ecosystem considerations.

Beyond those functional similarities, however, there are structural differences. For example, Iceland and Norway can be considered to be at one end of the structural spectrum with responsibilities for the various fishery management functions distributed across several ministries, departments and agencies providing a system of checks and balance dear to the drafters of the American Constitution. At the other end, Canada is concentrating almost all the powers in a single department, under a single minister. While such a concentration of powers in a single department can have definite advantages in terms of efficiency and consistency of action, it has drawbacks in terms of transparency and it has been argued that fishery science in Canada would be better served by being independent from the agency making decisions on quotas and allocations (Hutchings et al. 1997). This reasoning can easily be extended and it can be argued that the agency allocating the resource should be independent of the one implementing

the monitoring, control and surveillance. The USA, not surprisingly, also has a system of checks and balances with the Regional Fishery Management Councils drafting the management plans in a transparent and open process where all interested parties can have the possibility of being involved if they so wish. On paper, the USA arguably has one of the best fishery management processes. In practice, the system is bureaucratic and it can be slow to react.

The scientific advisory processes also share several similarities in terms of tools, products and organisation. In North America, the tendency is for a single individual to have assessment responsibility for the technical analyses of one or several stocks. There is a similar tendency in ICES, mostly to increase efficiency, but the multinational nature of the ICES WG sometimes make it impractical. In most cases the final assessments are done by the WG. In all the fora reviewed, the assessments are subjected to a detailed examination through a peer review process.

Considerable effort and energy is spent discussing the reliability of the input catch and effort data, but the assessments are always finalised, regardless of the (lack of) reliability of input data. In the early 1990s, the statistics on landings were believed to be so unreliable as a result of large scale misreporting and discarding because of restrictive TACs, that ICES concluded that lack of reliability of the basic statistics was jeopardising its ability to provide advice. The ICES General Secretary of the time wrote to national fishery authorities, alerting them of this situation and implying that there was a real possibility ICES would not be able to provide fishery management advice if the situation did not improve. Very little changed in terms of data availability, and ICES nevertheless continued to provide advice twice a year. Admittedly, however, programs to estimate discards, funded by the European Commission, have been initiated in several countries. These should fill and important gap, but these studies do not address the issue of over quota landings.

The peer-review process is time-consuming, it concerns itself mostly with the details of individual assessments, and it rarely rejects assessments that have been accepted in the past, even if new information cast doubts on the reliability of input data. This stems from the view that some advice, even if it is based on faulty data (and assumption) is better than no advice. The process cannot be described as 'independent' peer review as there is considerable inbreeding. The US NMFS has recognised this problem and it has developed a special project to enhance peer review by obtaining

the services of independent experts they remunerate to review specific documents and participate in certain stock assessment reviews (<http://www.rsmas.miami.edu/info/cimas-announce.html>). The influence of these independent experts may be limited by the format of the process they participate in: generally the invited expert is one independent voice amongst the other 15 to 20 who have been involved in these assessments in the past. The formulation of advice normally also falls in the so-called peer review process. In cases where the technical experts have an in-depth knowledge of the fisheries issues, they may indeed be the best qualified to formulate the advice, but this is progressively less and less the case. With recent developments in assessment methodology, partly motivated by the unavailability or unreliability of information on stock status, the assessment processes have become dominated by 'number crunchers.' More time is now spent on trying to develop analyses that are scientifically defensible, rather than try understand what is happening or has happened in the fisheries. This means that most advisory processes have lost their intelligence (*sensu* understanding) of the fishing scene.

The reduction of fishery science to stock assessment science for advisory purpose is an unfortunate development. Fishers and fishery management agencies, traditionally the main clients of fishery management advice, know that the data on landings are faulty, and they know stock assessment scientists use these data in the assessments. This makes it very difficult for them to have any faith in the results. In, addition, the majority of fishers believe in multispecies interactions: they witness them daily in their fishing operations. The fact that fishery scientists openly admit not taking multispecies considerations into account add to the lack of credibility of stock assessment and the derived management advice.

There are an increasing number of constituencies interested in fisheries science and fisheries management, including environmental non-governmental organisations, academic research institutions, industry researchers etc. Current advisory processes do not lend themselves easily to incorporating these newly interested parties.

Current wisdom in traditional fishery management circles is that limiting the catch removed from a population is the best means of ensuring its sustainability. This wisdom has been derived from large volume single-species fisheries, or multispecies fisheries with a relatively small number of species involved such as in the North Sea with cod, haddock, and whiting. This belief,

over the years, has led to an elaborate system to set TACs on all species in all areas even when the information was insufficient to provide reliable advice. But a TAC being needed, and based on the above mentioned view that any advice is better than no advice, advice was provided, and TACs have been set. This problem continues to exist despite the fact that large scale misreporting is known to have occurred (Coffey 1999), including over-reporting for the purpose of artificially increasing the value of fishing licences (Goodlad 1999). This problem, mentioned above, greatly reduces the credibility of the scientific advice (Coffey 1999).

Insufficient monitoring, control and surveillance, given restrictive TACs, have resulted in the aforementioned large scale misreporting. TAC management to be effective in protecting resources, implies that TACs are properly set and enforced, neither of which is believed to be happening. In most EU countries, there are numerous reports to national parliaments, TV and other media indicating that the actual landings are substantially higher than those reported, and add up to totals higher than the TACs. There is therefore a direct link between the type of management measures applied, the investment in monitoring, control and surveillance and the quality of the data that are available to evaluate the success of fishery management. Most ICES assessment Working Group reports give unallocated landings which can easily reach 50% or more of the official landings. As an example, a herring stock with estimated average landings in the order of 40,000t for 1981 to 2000 shows, for 1984, unallocated landings of 16,500t (catches that were not reported) and area-misreporting of minus 19,000t (catches caught from another stock but reported for the one in question). Values for unallocated and area-misreported catches vary considerably from one year to the next indicating that the fisheries respond very quickly to changing regulations. There is reason to believe that misreporting of landings is a smaller problem in those TAC-managed fisheries in North America where dock-side monitoring has been implemented, but there is no reason to expect discarding and high-grading to be a lesser problem. The reliability of catch data therefore remains a problem there as well. It might be possible to temporarily relieve the symptoms of the illness affecting the current fishery management system by investing more in monitoring, control and surveillance. It is doubtful that such increased investments would be cost-effective, however, and they are unlikely to provide more than temporary relief. Drastic changes in the roles and responsibilities of the

various interested parties are required in order to cure the system.

TACs appear a satisfactory means of allocating the resources amongst the various participants. However, as a resource conservation tool, the stock assessments and the implementation of the TACs are insufficiently precise to guarantee the protection of the resources unless very low fishing mortalities were used as targets. (Note that low fishing mortalities reduce even further the precision of stock assessments). In addition to these shortcomings current fishery management has been unable to adequately take into account the multispecies nature of many fisheries and the ecosystem impacts of fishing.

Conclusion

Considerable investments have been and continue to be made to manage North Atlantic fisheries. Yet, despite these substantial investments, the fishery management processes, including scientific advice, can hardly be described as successful, particularly for the important cod fisheries that have been the backbone of demersal fisheries in the North Atlantic. The collapse of the Northern cod off Newfoundland in the early 1990s was not predicted by scientists, it caught management authorities by surprise, and a collapse of such magnitude was not considered possible before it occurred. In the eastern Atlantic, the Northeast Arctic cod, fished mostly by Norway and Russia, provides another example. The spawning stock biomass increased rapidly from about 120 000t in the late 1980s to close to 900 000t in 1992. The increase was attributed to the stringent management measures adopted, but increased growth and maturity also played a large role. The spawning stock biomass has since decreased to 250 000t in 2000, considerably below the 500 000t threshold below which management action should be taken. Fishing mortality was notably decreased only in 1991 and 1992 and current values are not sustainable. Both North Sea and Icelandic cod recently joined the list of cod stocks in imminent danger of collapse.

Countless person-hours are invested in doing stock assessments, peer-reviewing them and using them to formulate management advice. These assessments are, in the greatest majority of cases, as good and reliable as can be expected given the data available. But, at the end of the day, it may be the wrong science to do.

Bauer (2000, p. 19-20) discussing the use of mathematics and statistics in an essay titled *Disregard of Reality* dealing with development economics makes several points that are directly

relevant to fishery science. He states (p. 19) that the use of mathematics and statistics “has led to unwarranted concentration [...] on variables tractable to formal analysis. As a corollary it has led to the neglect of influences which, even when highly pertinent, are not amenable to such treatment. Similarly, it has encouraged confusion between the significant, on the one hand, and the quantifiable (often only spuriously quantifiable), on the other. It has contributed to the neglect of background conditions and historical processes where they are indispensable for understanding.” Bauer’s statements that “the acceptance of quantitative methods as the most respectable procedure has permitted the burgeoning of incompetent or inappropriate econometric studies, including those based on seriously flawed data” describes the situation for many stock assessments where landing statistics are unreliable. His observation that “studies based on direct observation or detailed examination of slices of history are apt to be dismissed as anecdotal, unscholarly, or unscientific, even if they are informative” also applies to fisheries science in the North Atlantic.

Fishery management has not been universally unsuccessful. Smaller scale fisheries, such as the crustacean fisheries in Eastern Canada have remained very profitable with healthy resource bases. In those fisheries, common sense has not been entirely taken over by quantitative methods. The biological basis for management, particularly for shrimp and snow crab has continued to be investigated with the objective of understanding, not only on quantifying.

Although the theory and some tools are available to apply a multispecies approach, fishery management in the North Atlantic and the scientific advice it uses remains largely single species. This does nothing to improve the credibility of the scientific advice because receivers of the advice, and particularly fishermen, are fully aware that species interact and influence each other.

Fishery management has neglected the influence of the environment. It would benefit from a more humble evaluation of what it can reasonably expect to be achievable, recognising the large role of oceanographic and hydrographic variability. Fishery management should formally and explicitly incorporate the social, economic and environmental components of fishery management in addition the presently dominating stock assessment component. This should help put back the fishermen as one of the component of the ecosystem whose functions fishery management is trying to protect.

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