Fisheries Resource Conservation Council

Towards Recovered and Sustainable Groundfish Fisheries in Eastern Canada

A report to the Minister of Fisheries and Oceans

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Fisheries Resource Conservation Council
P.O. Box 2001
Station D
Ottawa, ON
K1P 5W3

Internet: www.frcc-ccrh.ca
E-mail: info@frcc-ccrh.ca

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Table of contents

Executive Summary

This report is in response to a request from the Minister of Fisheries and Oceans Canada (DFO, the Department) that the Fisheries Resource Conservation Council (FRCC, the Council) develop a long-term strategic approach to the sustainability of eastern Canadian groundfish fisheries and the conservation of the resource. In carrying out its mandate, the Council was to consider the conditions necessary for long-term success in the groundfish fisheries (with an emphasis on cod) and the requirements to meet them, and to provide advice on moving forward.

The Council was helped in its task by observations and suggestions from participants at its 27 consultation meetings and a workshop held to seek additional guidance on topics specific to the precautionary approach. The Council also received and reviewed 26 written briefs from organizations and individuals and engaged in frequent and extensive discussions with DFO biologists and fisheries managers.

The current status of groundfish stocks is highly variable. Almost 20 years after the severe stock declines of the early 1990s, very few stocks are healthy and productive. Most are at low abundance. Some are showing signs of recovery, others remain stagnant, and a few are in decline. To help understand the background to this sad state, the Council has provided a brief history of the groundfish fisheries of eastern Canada, and discussed the various reasons that have been proposed to explain the declines and slow recovery.

To help the process of stock recovery, the Council supports the application of the precautionary approach to the management of groundfish stocks. The Department has recently accelerated the preparation of harvest strategy frameworks, and recovery plans for stocks that require them. The Council applauds this work, and encourages the Department to move swiftly towards completing these tasks for species/stocks that must meet eco-certification standards in the next two years. The Council has learned that the purpose, costs and potential benefits of the precautionary approach are not well understood by many in the industry, and feels that there must be greater collaboration and increased consultation on this topic.

Additional aids to recovery include ensuring that fisheries for forage species do not compromise the food requirements of cod and other groundfish, and that fishing practices and other ocean activities do not harm the habitat of groundfish.

The aids to stock recovery discussed above involve doing what we can to avoid harming the groundfish stocks. The Council believes, however, that a “do no harm and wait” approach is insufficient to allow the recovery of many of the groundfish stocks. The Council and many in industry have been saying for years that predation on groundfish by seals has been the major cause of the high level of natural mortality that is the dominant reason for non-recovery in many groundfish stocks. The Council feels that the Department should proceed as soon as possible with targeted grey seal removals of sufficient magnitude and duration in a specific area (the southern Gulf of St. Lawrence) to test the hypothesis that predation by grey seals is the major factor preventing recovery of groundfish stocks in that area.

Recovery of groundfish stocks is an essential element in the rebuilding of groundfish fisheries, but there is much that should be done to improve management and governance. The process will be aided by successful implementation of the Department’s Sustainable Fisheries Framework, including policies such as harvest strategy frameworks and tools such as Integrated Fisheries Management Plans. Successful implementation will require enhanced collaboration and consultation with industry and others with an interest in groundfish. Much of the work can be accomplished within groundfish advisory committees. These should be reactivated in areas where they no longer operate. Shared stewardship and co-management, in an atmosphere that is open, transparent and accountable, will help to improve the level of trust and respect between industry and the regulator. The Council is concerned that the top-down, prescriptive nature of the *Species at Risk Act* will largely remove industry from participation in management of the resource, and will counter initiatives towards stewardship and co-management. Governance and management will also be considerably aided by modernization of the *Fisheries Act*.

The Department can assist industry to become more economically viable. For example, it can formulate policies that help the industry to self-rationalize. It can also implement, in a timely fashion, various policies, such as those regarding sustainability, that will help industry meet market standards for eco-certification and traceability.

The Council found its task to be complex and broad. This is reflected in the high number of recommendations. The Council believes that these will assist the Department in its efforts to promote the recovery of groundfish stocks and the rebuilding of fisheries based on those stocks. This rebuilding will require sustainable fishing practices, economically viable enterprises and the production of quality, high value products that find acceptance in global markets. The rebuilding of groundfish fisheries will support coastal communities throughout eastern Canada.

1 Introduction

1.1 Mandate and approach

On January 19, 2010, the Honourable Gail Shea, then Minister of Fisheries and Oceans Canada (DFO, the Department), asked the Fisheries Resource Conservation Council (FRCC, the Council) to develop a long-term strategic approach to the sustainability of the Atlantic groundfish fisheries and the conservation of the resource. In carrying out its mandate, the Council was to consider the conditions necessary for long-term success in groundfish fisheries (with an emphasis on cod) and the requirements to meet them. The Council's work was to be guided by DFO's Sustainable Fisheries Framework.

The Council began by meeting with DFO staff involved with groundfish science and management as well as departmental staff responsible for the Sustainable Fisheries Framework. In April and May 2010, the Council held 25 public consultations with stakeholders in the Atlantic Provinces, Québec and Nunavut (collectively referred to hereinafter as eastern Canada) and an additional two meetings with Aboriginal peoples representatives. In January 2011, the Council held a workshop to seek additional guidance on specific topics related to the Precautionary Approach. The Council also received 26 briefs from persons and/or organizations interested in the groundfish industry.

1.2 Terms of reference

Context

The health and status of Canada's Atlantic groundfish stocks are highly varied. Some are healthy; some have been depressed but show signs of rebuilding, while others are still stagnating or decreasing. As well, recent indications that some non-groundfish species may be on a downturn is leading to heightened expectations that groundfish populations will soon recover, with attendant pressure to resume harvests. Further, the abundance of certain groundfish species, currently under moratorium, is making it increasingly challenging, in some cases, to have directed fisheries for certain species without large bycatch of the moratorium species.

Given these challenges, the Department could benefit from advice in respect of conditions and considerations (status of stock rebuilding, governance and management regimes, etc.) for a recovered Atlantic Canadian groundfish fishery, with an emphasis on cod. Very broadly, key conditions for the long-term success of commercial fisheries include:

- sustainable use of fish resources and non-adverse impacts on other species and ecosystems;
- effective and efficient governance and management regimes;
- economically sustainable enterprises and
- ability to meet existing and emerging market demands.

The circumstances and conditions for a successful, sustainable and enduring groundfish fishery must be considered within the context of the new Department's Sustainable Fisheries Framework. The Sustainable Fisheries Framework, associated policies and new Integrated Fishery Management Plan template provide a strategic policy framework for rebuilding depleted stocks and managing fisheries in a sustainable manner while factoring in ecosystem considerations. For example, the Fishery Decision-making Framework Incorporating the Precautionary Approach provides guidance on rebuilding plans and the requirements for reopening fisheries on recovered stocks that respects the requirements of a precautionary approach.

Scope and purpose of the assignment

Guided by the Sustainable Fisheries Framework, the FRCC will consider the conditions necessary for long-term success in the groundfish fisheries (with an emphasis on cod), the requirements to meet them, and provide advice on moving forward. Taking into account the status of stock rebuilding, existing fleet structures and existing infrastructure, as well as possible market and cost implications, provide the Minister with possible scenarios that would inform optimal harvesting strategies for rebuilding groundfish/cod fisheries.

2 History

This section provides a short introduction to the general biology (natural history) of groundfish and an overview of the stock structure used for the management of groundfish in eastern Canada. It then provides a narrative of changes and events in the groundfish fishery and its management, and concludes with historic changes in groundfish landings.

2.1 Natural history of groundfish

The term "groundfish" is applied to a diverse group of fish that live on, in, or close to the bottom. They may also be called "demersal fish", in contrast to "pelagic fish" that live some distance from the bottom in the open water column. The distinction between demersal and pelagic is not always clear, as some species such as Atlantic cod may at times move far off the bottom and some, such as redfish, live pelagically but often not far from the bottom.

Here we focus on those marine species of eastern Canada that grow sufficiently large to be of commercial interest. Many species of groundfish, such as most sculpins, rocklings and eelpouts, are too small to be taken in quantity by commercial gear.

The major commercially-important groundfish species belong to just two taxonomic groups (Appendix 1). The cod-like family (Gadidae) includes Atlantic cod (hereinafter cod), haddock and pollock. The flatfish family (Pleuronectidae) includes Atlantic halibut, Greenland halibut (turbot), American plaice and yellowtail flounder. Other groundfish for which there are or were fisheries include thorny skate, cusk, grenadiers, silver hake, white hake, wolffish, redfish, lumpfish and monkfish.

Groundfish may be found in shallow water close to shore or as deep as 1500 m or more on the continental slope. Some species such as American plaice tend not to migrate very much, whereas others such as Atlantic cod may undertake extensive seasonal migrations.

Most groundfish tend to release large numbers of eggs into the water column, where the eggs and larvae drift in the currents. Juveniles tend to remain pelagic for awhile and then settle to the bottom. The demersal juveniles sometimes occur in shallow, coastal "nursery areas". There is much variability in life cycles, and indeed some species differ from this general pattern. For example, redfish incubate their eggs and release larvae into the water column. Wolffish produce relatively few and large eggs, which they extrude into a demersal nest.

The productivity of each species depends on the rate at which it produces young (recruitment), the rate at which it puts on weight (somatic growth), and the rate at which it dies (mortality). There is much variability among species. Some species, such as haddock and redfish, produce strong year-classes only occasionally, often with many weak year-classes in between, whereas other species, such as American plaice, tend to produce steadier but unspectacular recruitment. Growth in the cool waters of eastern Canada tends to be slow, although again there is much variation. Redfish grow particularly slowly. Natural death rates also vary, with some species, notably redfish, having low mortality rates and hence long life spans of several decades.

Average environmental conditions may vary considerably over the distribution range of each species, and this may result in considerable variability in productivity from one area to another. For example, cod off Labrador historically grew much more slowly than cod on southwestern Grand Bank and Georges Bank. Each group of cod historically had a characteristic range of size and age that was presumably an adaptation to its local environment. In the early 1960s, cod caught off central Labrador tended to have a maximum length of about 60 cm, whereas those taken on the southern Grand Bank had a maximum length of 120 cm.

Fishing reduces life expectancy. As a consequence, the age structure, and usually the size structure, of a fished population will be shorter than that of an unfished population. This shortening or truncation can be seen in the history of all cod stocks in eastern Canada. Most stocks currently have a severely truncated age structure. For example, catches of northern cod in the 1960s included fish older than age 20, but in recent years there have been very few fish older than age 10.

Groundfish feed on a great variety of prey. Even within a group of similar-looking species, there may be considerable differences in feeding behaviour. For example, within the cod-like species, haddock tend to feed mainly on small, bottom-dwelling animals, but will take small fish when they are locally abundant. Pollock tend to feed pelagically on fish. Atlantic cod tend to have a broader diet, feeding on both bottom-dwelling species such as crabs and pelagic species such as krill and small pelagic fish. Among the flatfish, some

species, such as yellowtail flounder and winter flounder, have small mouths and tend to feed on small, bottom-dwelling animals. Others, such as Atlantic halibut and Greenland halibut, have relatively large mouths, and tend to feed on fish and squid. Redfish feed mainly on pelagic crustaceans (such as krill) and small fish. Wolffish feed on bottom-dwelling animals such as sea urchins and molluscs (whelks, mussels, clams).

Most species of groundfish change their diets as they grow, and this is especially true for species that can grow to a relatively large size. For example, small cod tend to feed on small crustaceans, medium-sized cod feed on larger crustaceans and small fish, and large cod feed on crabs and medium-sized fish. Although each species of groundfish has a preferred type of prey and feeding behaviour, its diet may vary seasonally and geographically to take advantage of prey that are locally abundant.

The predators of groundfish change as the fish progress through their life cycles. Eggs and larvae are eaten by a wide variety of pelagic animals, including jellyfish, crustaceans (e.g. copepods and krill) and small fish. Juvenile groundfish are eaten by larger groundfish, and indeed some species, such as cod, Greenland halibut and silver hake, are cannibalistic. The largest groundfish may have relatively few predators, but some large cod are killed by seals that bite only their bellies to remove the energy-rich liver.

2.2 Distribution and stock structure

Commercially important groundfish are distributed throughout the waters off eastern Canada, from Georges Bank in the south to Davis Strait and Baffin Bay in the north (Figure 1). The number of species is highest in the south, and the tendency for one species to dominate increases towards the north.

Some discussions of the management of large marine ecosystems have identified the Northeast U.S. Continental Shelf, the Scotian Shelf and the Newfoundland Shelf as candidate areas for management, with boundaries at the Fundian Channel (dividing Georges Bank from the Scotian Shelf) and the Laurentian Channel (dividing Nova Scotia and the southern Gulf of St. Lawrence from Newfoundland and the northern Gulf). However, studies of catches in research bottom-trawl surveys from Cape Hatteras (North Carolina) to Cape Chidley (northern tip of Labrador) found that the Fundian and Laurentian channels are not important distribution boundaries for species of groundfish. The same study did report that depth is a major factor in species distribution.

Many groundfish species have broad distributions, and scientists and managers have used various biological characteristics to divide most species into stocks for purposes of fisheries management. When one looks at the stock structure of the various species (Appendix 2), one finds that there tend to be groups of stocks associated with the Labrador and Northeast Newfoundland Shelves (2G-3K), Grand Bank (3LNO), southern Newfoundland (3Ps), the Gulf of St. Lawrence (4RST), and the Scotian Shelf (4VWX). Many of the stocks in the Gulf of St. Lawrence migrate in winter out of the Gulf to the Cabot Strait (between Nova Scotia and Newfoundland) and beyond, causing some difficulties in management.

Deepwater species, such as Greenland halibut and grenadiers, tend to be broadly distributed at depths where there are relatively few physical boundaries to distribution and where temperature at depth changes only gradually. These species are generally differentiated into few stocks. In contrast, the biology of species that are distributed mainly on the continental shelf tends to reflect regional differences in depth and temperature, and such species are generally divided into a greater number of stocks. The species with the highest number of stocks is cod, for which ten stocks are recognized within or overlapping Canada's 200 nautical mile (nm) fishing zone (Figure 1). There is an eleventh cod stock on Flemish Cap (3M), completely outside Canada's zone. Scientific data indicate that cod do not cross Flemish Pass (between Flemish Cap and Grand Bank), and that cod on Flemish Cap are isolated and biologically distinct from other cod stocks in the area.

2.3 The groundfish fishery

First Nations peoples utilized a variety of marine species, including mammals, shallow-water invertebrates (such as mussels, lobsters, and crabs), and a variety of fish, particularly those that ascended rivers and streams to spawn (salmon, shad, smelt and Arctic char). However, most groundfish species would have been relatively inaccessible or not accessible at all.

Large-scale exploitation of groundfish started in the late 15th century, following the discovery by Europeans of large quantities of cod, a species that could be preserved by salting and carried back to Europe. Much of the

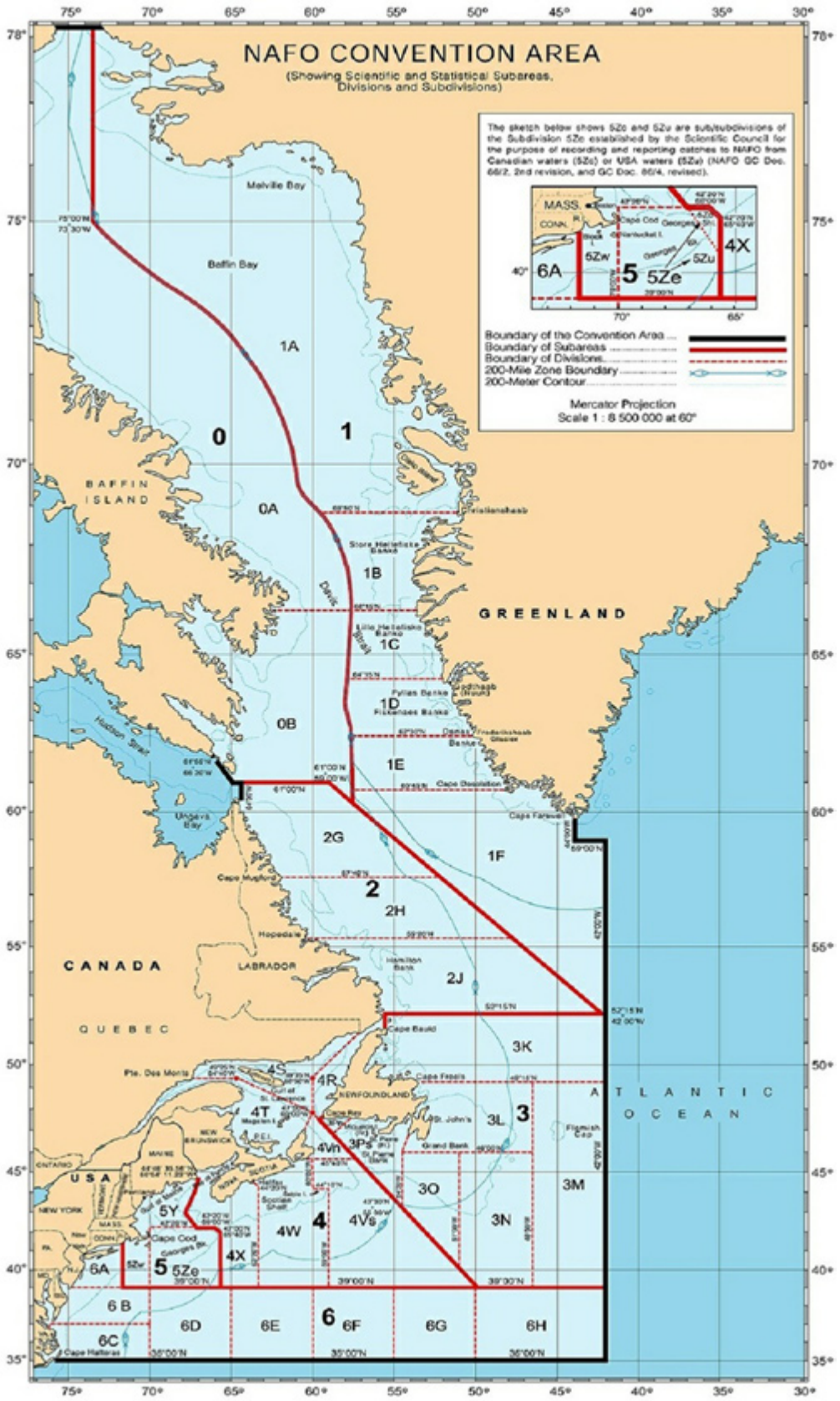


Figure 1. Map showing the major physiographic features of the waters off eastern Canada; the boundaries of the subareas, divisions and subdivisions used for fisheries management; and the outer boundary of Canada's 200 nautical mile fishing zone.

early settlement of what is now eastern Canada tended to be close to good, shallow-water cod-fishing grounds.

The cod fishery was initially prosecuted with hook and line, which could be used only in shallow water near shore and on offshore banks. Over time, the fishing pressure gradually increased as the number of fishermen and boats increased and technology was improved. The rate of technological change increased in the 19th and 20th centuries with the development of longlines (bultows) and cod traps, the introduction of gasoline engines, the development of synthetic gillnets and hydraulic net haulers, and the invention of otter trawling, first side-trawling and then stern-trawling. Other aids included improved navigational methods and fish finders. Whereas the early fishery was limited to shallow water predominantly in summer, the fishery evolved to the point where most stocks could be exploited throughout their depth range and in all seasons.

There is evidence that some coastal stocks were showing signs of local depletion as early as the late 19th century. However, declines became more widespread and severe following the huge increase in catches by distant-water fleets of stern trawlers, including factory freezer trawlers, that arrived from Europe in the late 1950s and 1960s.

The earliest concerted international attempts at regulating fishing came with the creation in 1950 of the International Commission for the Northwest Atlantic Fisheries (ICNAF). At first, conservation measures were aimed at reducing the catches of small fish, and included increases in trawl mesh sizes and the introduction of regulations regarding minimum fish size in landings. Emphasis shifted during the 1970s to the control of exploitation rate by limitations on total allowable catch (TAC). The earliest TACs were ineffective, since they proved to have been set much too high. Most stocks had suffered large reductions in overall biomass and average fish size by the mid-1970s, when Canada and many other coastal states announced their intentions to declare fisheries jurisdictions to 200 nm.

The declaration by Canada of an Exclusive Fishing Zone, which took effect in 1977, transferred control of the fisheries on most of the continental shelf to Canada, but there were areas on Grand Bank that were beyond the 200 nm limit (the “Nose” in the northeast and the “Tail” in the south). The Flemish Cap was entirely outside the 200 nm limit. The removal of foreign fishing from most of the area and adoption by Canada of a conservative reference level of fishing mortality (F0.1) for setting TACs gave rise to an expectation of stock recoveries and large increases in catches. There followed a large and rapid expansion in catching and processing capacity. This included an increase in the number of stern trawlers, which soon replaced foreign trawlers on many of the best offshore fishing grounds.

The Exclusive Fishing Zone required a change in regulatory structure. ICNAF was gradually wound down during 1977-1978. It was replaced in 1979 by the Northwest Atlantic Fisheries Organization (NAFO), which managed stocks overlapping or outside Canada’s 200 nm zone. For stocks within its 200 nm zone, Canada in 1977 created the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) to provide scientific advice. Senior officials within DFO recommended TACs and other management measures to the Minister, who retained absolute discretion and power in these matters. For groundfish stocks, industry did have input to the process through the Atlantic Groundfish Advisory Committee (AGAC).

For a number of years after establishment of the 200 nm zone, the expectation of recovering stocks and increased opportunity seemed to be realized. CAFSAC reported that stocks were increasing and advised larger TACs consistent with the management strategy. The fishery was revitalized, although not without some economic adjustments along the way, notably the reorganization of large companies in the early 1980s.

There was also an evolution in management practices. The fisheries had come under a limited-entry licensing system before extension of jurisdiction, but this had limited success in curbing overcapacity and overinvestment during the late 1970s and early 1980s. Conflicts over access to the common pool of resource intensified and were addressed by formally apportioning the available resource among fleet sectors. Enterprise Allocations (EAs) were introduced to the offshore (large vessel) sector in 1982-1983. Subsequently, the number of fleet sectors that have come under Individual Quotas (IQs) or Individual Transferable Quotas (ITQs) has gradually increased.

By the mid-1980s there were some signs that many stocks may not have been increasing to the extent reported by CAFSAC. For example, small boat fishermen along the coast of Labrador and eastern Newfoundland were saying that the northern (2J3KL) cod stock, the largest single groundfish stock in eastern Canada, was in decline. In 1988-1989, CAFSAC revised downward its assessment of the status of

northern cod. While it reported that the stock had increased considerably since the late 1970s and was not in decline, the stock level was much lower than indicated in the 1987 assessment. CAFSAC advised that the TAC for 1989 should be cut to less than half that of the previous year if the fishing mortality strategy were to be followed. The TAC was not substantially reduced, contributing to an increase in fishing mortality.

Although such a large and sudden change in scientific perception did not occur for any other stock, overestimation of stock size was chronic within assessments. In retrospect, most groundfish stocks had been fished more intensively than intended throughout the 1980s.

During the latter half of the 1980s, northern cod remained the stock of greatest concern. DFO contracted two independent reviews of the status of northern cod; the Task Group on Newfoundland Inshore Fisheries (Alverson report, 1987) and the Northern Cod Review Panel (Harris report, 1990). Both noted numerous uncertainties regarding the biology and assessment of the stock. Most of the problems had already been recognized and reported by CAFSAC. Neither review panel reached the conclusion that the stock was in substantially worse shape than indicated by the most recent CAFSAC assessment. However, immediately after release of the Harris report, the survey indices for northern cod declined rapidly and severely. By the spring of 1992 the northern cod was understood to be at a low level and declining rapidly, without a clear understanding of why. A moratorium on directed fishing of northern cod was announced on July 2 of that year. Meanwhile, other stocks had continued to decline, and many were closed to directed fishing in 1993 or 1994. The southern Grand Bank cod stock, which was managed by NAFO, was also closed in 1994.

Subsequent to the collapse and closure of most of the cod stocks and many stocks of other species of groundfish in the early 1990s, there were numerous studies and analyses of what had happened. Not surprisingly, most focused on northern cod. The literature, both popular and academic (scientific, economic and social), is voluminous, contradictory and contentious. Although there have been many calls for a Royal Commission or Judicial Inquiry to determine the cause of the collapses, there has been no single authoritative review.

The collapse of northern cod was viewed by some as a failure of the system that was providing scientific and management advice. Both CAFSAC and AGAC were dissolved in 1992. For the provision of scientific information, there evolved a new system of local-level Regional Advisory Process (RAP) meetings, which were to include not only assessment scientists but also other scientists who could provide information on relevant matters such as fish biology, oceanography, and the impacts of predators and prey. They also included people from industry and academia who could help interpret data and provide their own views on the status of the stocks. The information from the groundfish assessment meetings (which did not include TAC advice) was made public and presented during open consultations conducted by the Fisheries Resource Conservation Council (FRCC), an arms-length advisory group created in 1993. The FRCC was mandated to review the formal assessments and other information brought to its attention, and to make recommendations to the Minister regarding TACs and other management measures. In formulating its TAC advice, the FRCC was to take into account not only information regarding stock status but also economic and social considerations.

To provide assistance to industry during the period of declining TACs and closures, the Government of Canada created a series of programs that were intended to provide income support, retire boats and licences, and encourage people to leave the industry. These programs, which cost more than $4 billion between 1990 and 1998, did provide income support, indeed far more than expected. They also contributed to a substantial (roughly one-third) reduction in the Atlantic fleet and the number of registered fishermen, but for the most part the boats that were retired were small and the licences that were retired had been held by people who had not been very active. The programs are generally considered to have had relatively little impact on fishing power and the number of people who were seriously interested in the fishery. Indeed, in some areas fishing power increased considerably as fishermen moved to larger, more powerful boats with greater technological sophistication to take advantage of opportunities in the expanding shellfish fisheries.

During the 4-5 years between the initiation of moratoria and the sunset of the biggest support program (The Atlantic Groundfish Strategy, TAGS), there were signs of improvement in the status of some cod stocks, most notably the 3Ps stock off the south coast of Newfoundland. There were strong demands from harvesters for reopening of directed fisheries, and in 1997 the FRCC recommended the reopening of the 3Ps stock and the northern Gulf of St. Lawrence (3Pn4RS) stock, followed in 1998 by recommendations for

reopening of the southern Gulf of St. Lawrence (4TVn) stock and the inshore of the northern (2J3KL) stock. The latter three stocks subsequently declined and were closed by DFO in 2003. However, in the spring of 2004 the FRCC recommended that small participatory fisheries be reinstated for the two cod stocks in the Gulf of St. Lawrence, in part to support a continued involvement by harvesters in the determination of resource availability. In response, the Department reopened these two stocks to small directed fisheries.

The spring 2004 recommendations regarding management of groundfish in the Gulf of St. Lawrence were the last recommendations that the FRCC made regarding quotas for groundfish stocks. From that time, the FRCC has concentrated on its renewed mandate, which has been to provide strategic conservation overviews and frameworks for species or species groups.

Fish harvesters along the east coast of Newfoundland soon demanded a reopening of directed fisheries in the inshore portion of the northern cod stock area, and in 2006 DFO consented to an inshore "stewardship fishery", which has remained open. Meanwhile, the cod stock in the southern Gulf of St. Lawrence continued to decline following its reopening in 2004, and it was closed to directed fishing once again in 2009. Figure 2 illustrates the history of closures for each of the cod stocks.

The moratoria that were imposed on most stocks of cod and many stocks of other groundfish in 1992-1994 were severe measures intended to promote recovery of the stocks. However, the closure of directed fisheries ended the flow of information on stock status and fish biology from the fishery itself. Following a recommendation from the FRCC, sentinel surveys were established whereby data on relative fish density and fish distribution and biology were obtained from limited fishing conducted by a small number of fishermen using commercial gears within a scientific protocol. The monitoring of many of the fisheries that were not closed was increased by expansion of the at-sea observer program and introduction and expansion of the Dockside Monitoring Program (DMP) and the Vessel Monitoring System (VMS). Although severe reduction in fishing mortality and maintenance of monitoring (of both stock status and fish removals) are essential ingredients of any recovery strategy, formal recovery plans were not put into place.

During the latter half of the 1990s and early 2000s, there was substantial progress towards international agreements on sustainable fishing, including the definition and application of precautionary approaches to fisheries management. Within Canada, the *Oceans Act* of 1997 provided for the development and implementation of a national oceans management strategy based on the principles of sustainable development, integrated management and the

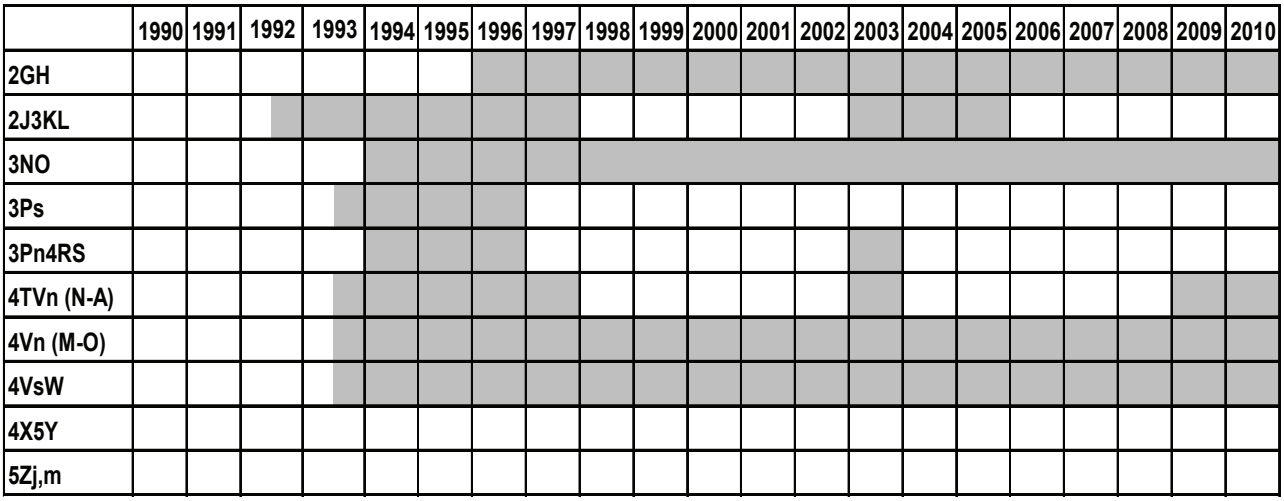


Figure 2. Cod stock closures. Years during which each of the ten stocks of cod in eastern Canada was open to directed commercial fishing are shown in white and years during which each was closed are shown in grey. The 2GH stock was not formally closed until 1996, but it had declined long before then; reported landings were less than 1000 t during 1985-1990 and nil during 1991-1995. For the 2J3KL stock, directed fisheries during 1998-2002 and 2006-2010 were restricted to the inshore. The 4Vn area appears in the name of two stocks. In general, catches in 4Vn during November to April are assigned to the 4T stock and catches during May to October are assigned to the resident 4Vn stock. The 4X5Y and 5Zj,m stocks were not closed at any time during the 1990s or 2000s.

precautionary principle. The Oceans Strategy statement of 2002 also emphasized an ecosystem approach to ocean management, including the management of fisheries. Specific progress towards implementation of the precautionary approach for groundfish stocks in eastern Canada included the establishment in 2002 of limit reference points (LRPs) for the two Gulf of St. Lawrence cod stocks and the exploration of the range of an LRP for northern cod. The status of each of these stocks relative to its LRP was assessed for the first time at an assessment meeting in 2003. A general harvest strategy framework compliant with the precautionary approach was formulated early in 2004 and published in 2006. "A fishery decision-making framework incorporating the Precautionary Approach" was published online by DFO in 2009. This framework is often referred to simply as "the PA".

Following the second closure of northern cod and the two Gulf of St. Lawrence cod stocks in 2003, a Canada - Newfoundland and Labrador Action Team for Cod Recovery (often referred to as the Cod Action Team or CAT) was established to develop a stock rebuilding and long-term management strategy for the four cod stocks adjacent to Newfoundland and Labrador. Action Teams were soon established as well between the federal government and Quebec and between the federal government and the Maritime provinces. The CAT process advanced furthest for the two cod stocks in the Gulf of St. Lawrence. In conjunction with the reopening of fisheries on both of those stocks in 2004, a shared stewardship approach was set up to establish rebuilding plans, implement precautionary management and define decision-making frameworks. However, fish harvesters were critical of several aspects of the process. Draft TAC decision rules were developed for each of the two stocks in early 2005, but were not fully endorsed and were not used for TAC determination in 2005 and 2006. In addition, science review in 2006 found that the draft TAC decision rules for both stocks were not fully compliant with the precautionary approach.

The NL CAT initiated a public consultation process, which included a two-day workshop in early 2005 attended by about 100 participants from government, industry, Aboriginal groups, development associations, academia, and the other two Action teams. There was no concensus regarding targets and time frames for stock recovery, but there was a broad consensus that there should be some level of fishing even at very low stock levels. In its final report later in 2005 the NL CAT provided neither recovery targets nor timeframes for recovery. It simply recommended development of a risk management approach, which would involve the determination of reference points and the development of decision rules and associated management actions. An excellent opportunity for advancing harvest control rules, and recovery plans for those cod stocks that might require them, was allowed to pass. Little concrete action occurred during the next 5 years.

Support for harvest strategy frameworks increased towards the end of the first decade of the 2000s with the rise of eco-labelling, such as that promoted by the Marine Stewardship Council. It became increasingly clear that markets would be lost unless it could be demonstrated that stocks were being harvested sustainably, and in most cases this required that fisheries management be consistent with the precautionary approach.

Assessments of the status of cod and other groundfish species have generally been conducted by government scientists, with formal participation by industry and academia since the mid-1990s. In the latter half of the 1990s, the status of cod came to the attention of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an independent committee of wildlife experts and scientists created in 1977 to assess the risk that species of wildlife might become extinct or extirpated. COSEWIC assessed the status of cod in 1998, 2003 and 2010. In its 2010 assessment, COSEWIC identified six populations or designatable units. Four of these, which encompass all ten stocks identified for fisheries management, were designated as endangered.

Cod is not the only groundfish species to have been assessed by COSEWIC. Other species that have received designations include winter skate, spiny dogfish, cusk, roundnose grenadier, roughhead grenadier, deepwater redfish, Acadian redfish, American plaice and three species of wolffish. With passage of the *Species at Risk Act* (SARA) in 2002, designations by COSEWIC are considered recommendations for the legal listing of wildlife species at risk. To date, only the three species of wolffish have been placed on the SARA Schedule 1 (List of Wildlife Species at Risk).

As this present report is being written, DFO is progressing through the various steps required to respond to the COSEWIC designations for cod and other species, as required by SARA. As part of its extended consultation process, DFO has conducted recovery potential assessments (RPAs) for several species, including roundnose grenadier, American plaice, cod and redfish.

DFO is also moving towards implementation of harvest strategy frameworks for all cod stocks. Determination of limit reference points for those cod stocks that did not have them was completed in late 2010. The creation of rebuilding plans is underway for some cod stocks.

2.4 Groundfish landings

During the 1980s, groundfish accounted for 63% by weight of Canadian landings of fish (including shellfish) from waters off eastern Canada (Figure 3). The 1990s saw a severe and rapid decline in groundfish landings and a steady increase in shellfish landings. During the first decade of the 2000s, groundfish accounted for just 16% of the landings.

Cod has historically dominated the groundfish catch (Figure 4 top panel). During the 1980s, cod represented 62% of Canadian groundfish landings, but during the first decade of the 2000s it represented just 23% (and just 4% of total fish landings). In recent years, groundfish landings have comprised a variety of species (Figure 4 bottom panel), with the major landings coming from cod, Greenland halibut (in the north and east and in the Gulf of St. Lawrence), haddock, pollock, white hake and silver hake (all in the southwest), smaller flatfish (mainly yellowtail flounder on Grand Bank), and redfish.

The decline in landings of groundfish, and cod in particular, is even more dramatic than noted above. Total landings were much higher if one looks back to the 1960s and the landings by countries other than Canada are included. (As an example of the large landings by non-Canadian fleets, the total landings of northern cod are shown in Appendix 3. During the period prior to declaration of the 200 nm limit, non-Canadian fleets took more than 50% of annual reported landings of northern cod, with the percentage rising to greater than 80% during 1967-1975 and peaking at 90% in 1974.)

Total annual landings of cod from eastern Canadian waters peaked at over 1.2 million t in 1968-1969 but declined to an average of 556,000 t during the 1980s and just 35,000 t during the first decade of the 2000s (Figure 5 top panel). The contribution of northern cod (2GH plus 2J3KL) declined from about 65% during 1968-1969 to an average of 42% during the 1980s.

Following the initiation of moratoria on directed fishing in the early 1990s, landings of cod came primarily from 4X5Y (Figure 5 bottom panel). After the reopening of four of the cod stocks in 1997-1998, the highest landings came from 3Ps, but with moderate contributions from inshore 2J3KL, 3Pn4RS, 4TVn(N-A), 4X5Y, and 5Zjm.

Historic landings from each of the ten cod stocks are shown in Appendix 4.

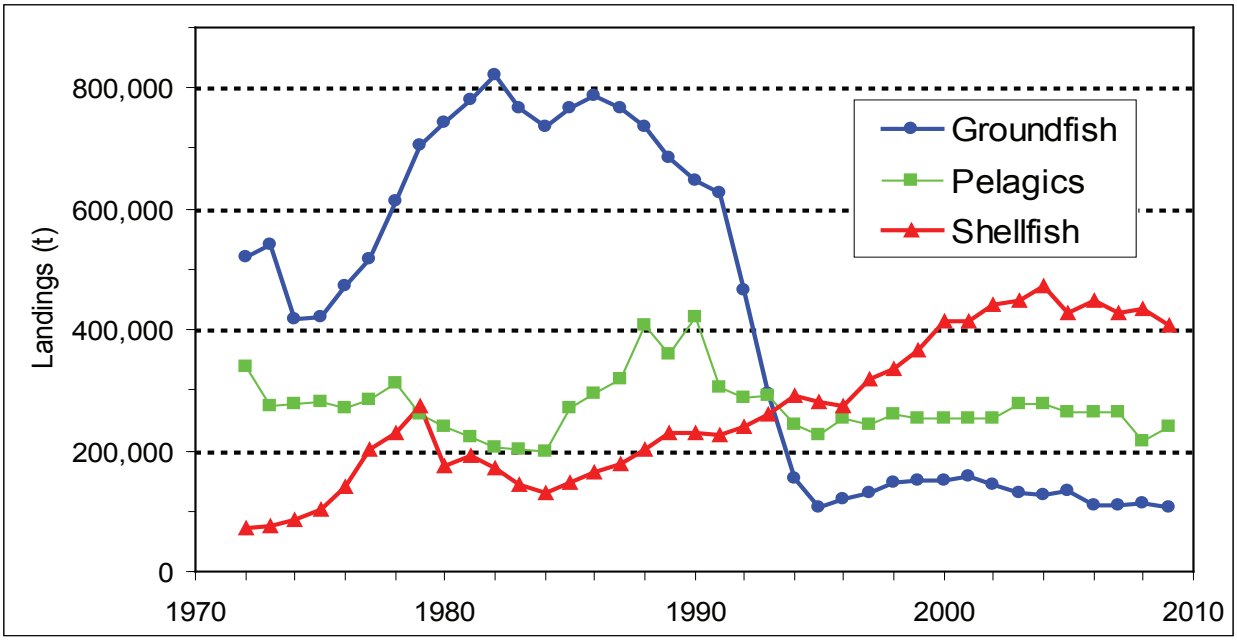


Figure 3. Canadian landings (in tonnes) of marine fish from eastern Canadian waters by major species groups, 1972-2009. (Data from Fisheries and Oceans, Statistical Services, Ottawa)

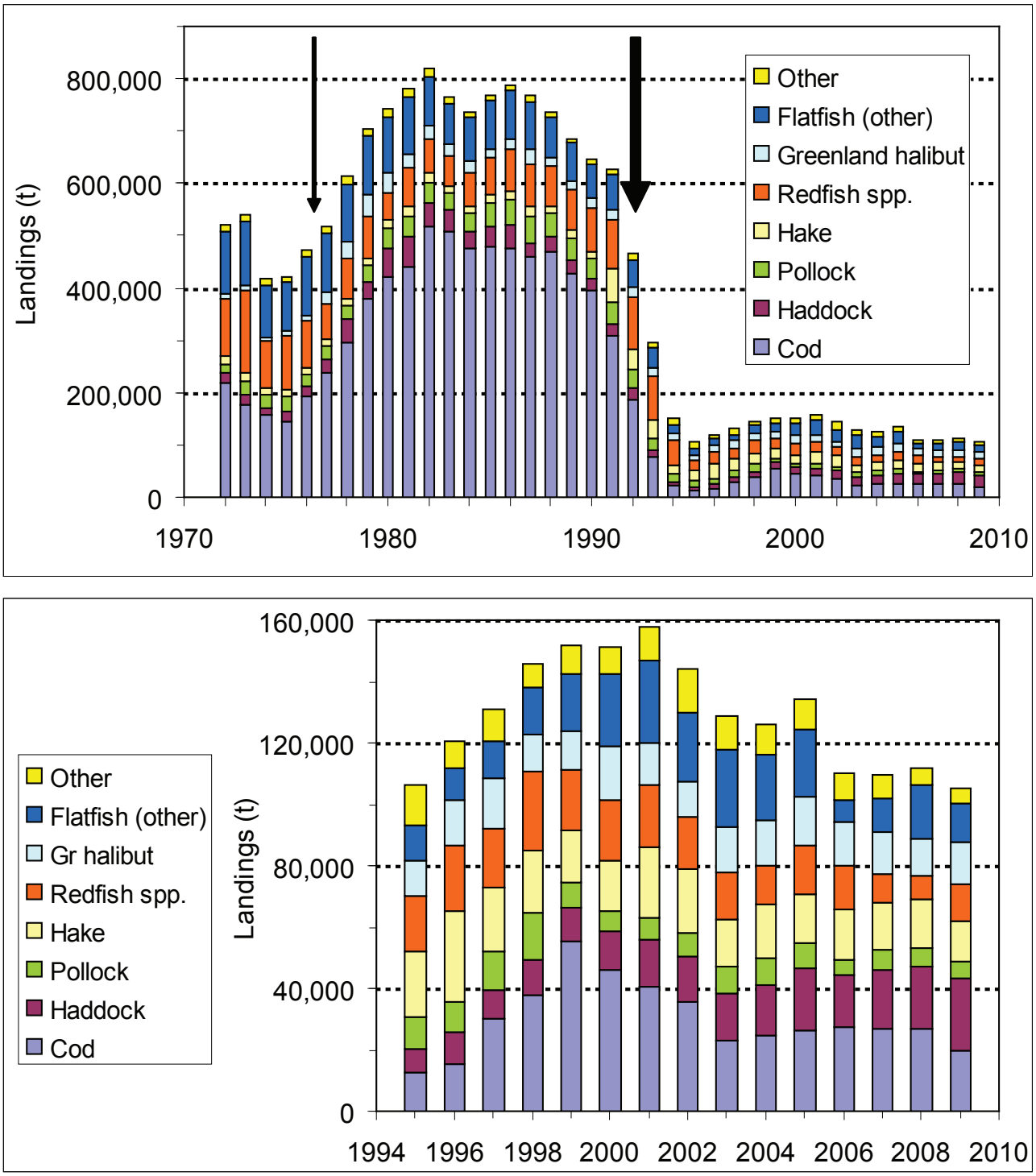


Figure 4. Canadian landings (in tonnes) of groundfish from eastern Canadian waters. The top panel shows landings by major species or species group during 1972-2009. The light vertical arrow indicates 1977, the first year under the 200 nm fisheries limit. The heavy vertical arrow indicates 1992, the year when northern cod was closed to directed fishing. Many other stocks were closed during the next 2 years. The bottom panel shows the same landings data for years 1995-2009, with the landings scale expanded. (Data from Fisheries and Oceans, Statistical Services, Ottawa)

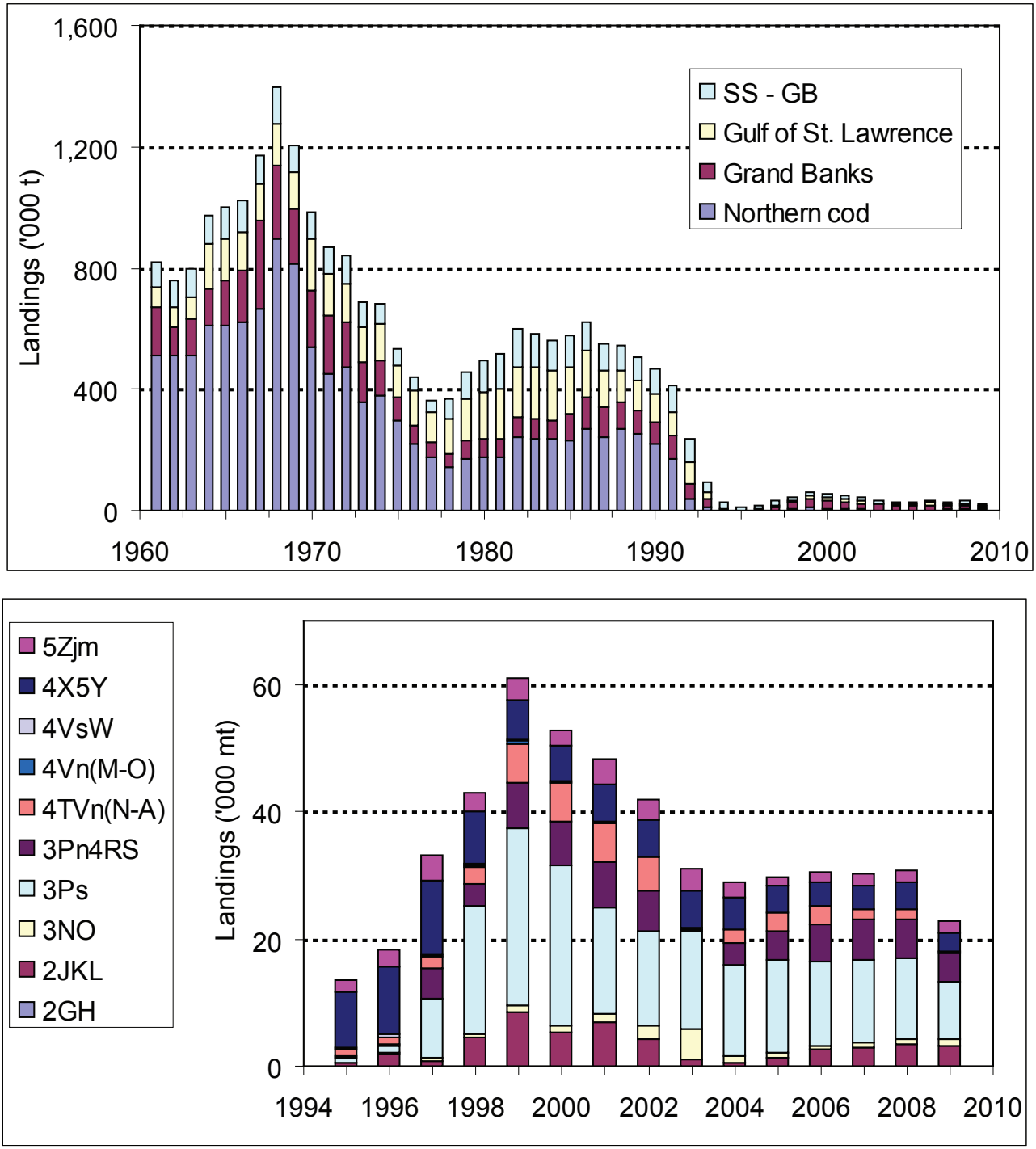


Figure 5. Landings of cod (in thousands of tonnes) from eastern Canadian waters by Canadian fleets and non-Canadian fleets combined.The top panel shows landings during 1961-2009 by large geographical area. Stocks included in each area are as follows: Northern cod (2GH, 2J3KL); Grand Banks (3NO, 3Ps); Gulf of St. Lawrence (3Pn4RS, 4TVn(N-A)); SS - GB (Scotian Shelf to Georges Bank; 4Vn(M-O), 4VsW, 4X5Y, 5Zjm). The bottom panel shows cod landings by stock during 1995-2009, with the landings scale expanded. (Data compiled from documents produced by the Canadian Science Advisory Secretariat (CSAS), the Northwest Atlantic Fisheries Organization (NAFO), and the Transboundary Resources Assessment Committee (TRAC).)

3 Status of Groundfish Stocks

This section will provide a very short summary of historic trends and current status of groundfish stocks, with emphasis on cod. Although the collapse of northern cod is well known and frequently cited as a prime example of the consequences of bad fishery science and management, there is little appreciation for the fact that many species/stocks did not decline as severely as northern cod, and that some are currently productive and supporting commercial fisheries. We focus on biomass, but there are other indicators of status or well-being, such as geographic distribution, age and size structure, size-at-age and condition (weight at length). Note as well that we focus on total biomass. The biomass of mature fish (spawning stock biomass, or SSB) is considered to be an important factor influencing the level of recruitment, and for this reason SSB is generally the focus of attention in harvest strategy frameworks. However, in many geographic areas the cod are maturing at younger ages and smaller sizes than in the past, so changes in total biomass may be more useful than SSB for showing changes in stock size.

We also attempt a short summary of the causes of the stock declines and reasons why recovery has been slow in some cases. This is a difficult task. Although much has been written about the causes of the cod collapse and the subsequent slow or nil recovery, there is no generally accepted understanding about what has happened and why. The Scotia-Fundy region of DFO held a workshop in 1993 to identify the degree to which management objectives had been met and to identify the causes that prevented attainment of those objectives that had not been met. The groundfish industry would have benefited from similar reviews in other Regions and an Atlantic-wide synthesis.

3.1 Stock trends and current status

The simplest measure of the history of a stock comes from landings. However, landings may not be a good reflection of stock size, because the proportion of the stock taken in the fishery may vary over time. Scientists have developed mathematical models (sequential population analysis, SPA) to reconstruct the history of the stock in terms of numbers and weight (biomass). These models use catch statistics, sampling of the catch for size and age composition, and indices of abundance or biomass. The indices may be derived from the fishery, such as catch per unit of effort in trawl fisheries, or may be independent of the fishery, such as bottom-trawl or acoustic surveys conducted by research agencies or fishing enterprises operating according to a scientific protocol.

The change in biomass of each of the ten cod stocks is shown in Appendix 5. For those stocks whose biomass estimates go back well before extension of fisheries jurisdiction (1977), one can see a decline through the late 1960s and 1970s associated with severe overfishing, much of which was attributable to the increase in landings by non-Canadian trawler fleets (see Appendix 3). Following extension of jurisdiction, most stocks increased until at least the mid-1980s. A notable exception is the cod off northern and central Labrador (2GH), which was historically considered part of the northern cod stock, but was designated a separate stock in part because it failed to recover following the overfishing of the 1960s-1970s. For that stock there has never been an analytical assessment (SPA) and DFO surveys of the whole stock area have been too infrequent to demonstrate a trend.

The historic trends in cod stocks from southern Labrador to eastern Nova Scotia (2J3KL to 4VsW) were similar to one another. Those stocks experienced a decline in the 1960s-1970s as noted above, a (partial) recovery that started in the mid-1970s and extended to about the mid-1980s, and a second and deeper decline in the late 1980s and early 1990s. Although all these stocks were closed to directed fishing in the early 1990s, their recoveries have generally been less than anticipated. Only the southern Newfoundland stock (3Ps) rebounded quickly. It was reopened to directed fishing in 1997 and has remained open, but was in decline until very recently. The northern cod stock (2J3KL) has been more productive in the inshore than in the offshore, although there has been some improvement in the offshore in recent years. The two stocks in the Gulf of St. Lawrence (3Pn4RS and 4TVn (N-A)) recovered a little, but small directed fisheries during most years since 1997 or 1998 contributed to a reversal of the gains. Fisheries on stocks on the southern Grand Bank (3NO), on the eastern Scotian Shelf (4VsW) and in Sydney Bight (4Vn(M-O)) have remained under moratoria. The 3NO and 4VsW stocks have shown some recent increase.

Fisheries on the two cod stocks in the most southwesterly portion of eastern Canada were never placed under moratorium. However, both stocks have declined severely since the early 1990s. The

stock in southwestern Nova Scotia (4X5Y) has been declining fairly steadily since about 1980. The stock on northeastern Georges Bank (5Zjm) remained moderately high until about 1990, but then declined rapidly to a low level, at which it remains.

Cod is not the only groundfish to have declined. Stocks of many other species declined severely and directed fishing was stopped on many of these stocks in the early 1990s. Stocks that remain under moratorium include 3LNO American plaice, 4TVW haddock, Unit 1 redfish and 4T white hake. However, some stocks, most notably 3LNO yellowtail flounder, have recovered sufficiently that directed fishing is permitted once again.

There are also some stocks that were never closed to directed fishing. Silver hake on the Scotian Shelf (4VWX) remains under a directed fishery, although in recent years its biomass has been near the lowest levels in the time series. The three major stocks of Greenland halibut have also continued under directed fisheries, but whereas the stock off Nunavut [0+1A(offshore)+1B-F] is considered to be healthy, the biomass of the stock from Labrador to Grand Bank (2+3KLMNO) is near its historical minimum and the biomass of the stock in the Gulf of St. Lawrence (4RST) is in decline. Atlantic halibut is doing well. The abundance of the stock in the Gulf of St. Lawrence (4RST) is steadily increasing but is still well below the level in the first half of the 20th century. The abundance of the stock outside the Gulf (3NOPs4VWX5Zc) is also steadily increasing and the stock is assessed as being healthy.

The fact that some species/stocks are open to directed fishing while others in the same area are closed has resulted in serious problems of managing bycatch. This is particularly acute where the stock that is closed is the one that historically supported the larger catch. As examples, we note that directed fishing for Greenland halibut on the shelf off eastern Newfoundland is not allowed because of cod bycatch, and directed fishing for yellowtail flounder on Grand Bank is at times curtailed or moved because of American plaice bycatch. In some areas, a stock is open for fishing but the quota is so low that the species is taken largely as bycatch in a fishery directed largely at another species. An example is the use of much of the cod quota in 4X5Y as bycatch in the haddock fishery. There are also instances of fisheries being closed because of bycatch of a species that has a quota that fishermen think is too low. An example is the closure of lumpfish and Greenland halibut fisheries in the northern Gulf of St. Lawrence because of high levels of catch of Atlantic halibut.

There are many concerns about the quality of catch data. Prior to the early 1990s, sequential population analysis (SPA) was used to assess the status of most of the larger groundfish stocks, including all stocks of cod except the one off northern and central Labrador (2GH). Such modeling has been discontinued for several stocks for a variety of reasons, but it is disturbing to note that an important reason given for the 3Ps cod stock is lack of confidence in catch data. Science advisory reports also speak of a lack of confidence in the commmercial catch data for northern cod. For several cod stocks, there are also no direct measures of the landings taken in recreational fisheries. Furthermore, in the northern cod recreational fishery there is good evidence of highgrading.

Even if catch data are not used to model a stock, it remains essential that all fish killed be identified and recorded so that the impact upon the resource can be measured. Concerns about fish deaths that are not recorded are particularly acute for Atlantic halibut in the northern Gulf of St. Lawrence, where many of the undersize (< 81 cm) fish that are caught as bycatch in nets and returned to the water probably die and are unaccounted for.

DFO has committed to recording all catches, and yet shortfalls remain apparent in many fisheries.

The FRCC recommends that all fish killed during all commercial, recreational, scientific, food, social and ceremonial fishing operations be recorded and reported.

For most groundfish stocks that are not entirely coastal in distribution, DFO bottom-trawl surveys provide the only or longest-running fishery-independent index of abundance/biomass. These indices provide information essential for management of fisheries, either directly or as inputs to population modeling. The surveys also provide data necessary for assessment of the status of groundfish as required under the *Species at Risk Act*, including some species that are not formally assessed for fisheries management. In a broader sense, the surveys constitute a major source of information on status and trends in the ecosystems of eastern Canada.

The FRCC recommends:

- **that DFO ensure that there is at least one reliable fishery-independent index of abundance/biomass for every groundfish stock.**

- **that DFO ensure that it has sufficient trawler capacity in its own fleet to continue, and in some areas to expand, its multispecies bottom-trawl surveys. Should DFO surveys be replaced by industry surveys, those industry surveys should be comparable in extent and design.**
- **that DFO ensure that there are sufficient qualified personnel for conducting surveys, archiving and analyzing the data that are collected, and reporting results of analyses to assessment meetings and to industry and others who have an interest in the conservation and exploitation of groundfish.**

3.2 Why did stocks decline/collapse?

When a stock declines, the weight of fish lost from the stock by fishery removals and natural causes is greater than the weight gained by the addition of young fish (recruitment) and somatic (body) growth. To understand the reason for stock declines, we have to identify and measure the changes that may have occurred in each of these processes.

Many scientists, journalists and commentators have stated that the reason that stocks of cod and other groundfish off eastern Canada collapsed was that fishery removals were too high. If indeed removals were too high, it will be helpful to understand why. For example, management goals may not have been precautionary (especially in earlier years), scientific assessments may have overestimated stock size, management plans may have specified quotas in excess of scientific advice, and fish harvesters may have killed fish in excess of that specified in management plans. The latter possibility includes reported overruns, non-reported landings, and discards. We shall very briefly review the contribution of these factors to the decline of groundfish in eastern Canada, but recognize that the role of each of these factors has not been thoroughly investigated for most stocks.

When Canada announced its intention to extend its fisheries zone to 200 nm, it said it would fish conservatively (at or below F0.1) to promote recovery of stocks. For almost a decade, things seemed to be progressing well. In general, scientific advice was in accordance with the conservative harvest control rule, TACs were at or below the scientific advice, and reported catch did not exceed the TACs. However, it gradually became apparent that the scientific assessments were chronically underestimating fishing mortality. The advised TACs were too high, causing stock growth to be slower than thought. In addition, the levels of unreporting and discarding were high, especially in the early to mid-1980s. Towards the end of the 1980s, the assessments of some stocks indicated that those stocks were declining, and sometimes quotas were set above scientific advice to help meet economic and social needs. This contributed to a further rise in fishing mortality.

The big question is why fishing mortality apparently increased so quickly in so many groundfish stocks at about the same time (latter half of the 1980s and particularly the early 1990s). Was it solely because of the reasons just noted, or was there also something happening in the physical environment?

For the area from the eastern Scotian Shelf northward, the environment had gradually cooled from highs in the 1960s, with notably cold years in the early 1970s and mid-1980s. The early 1990s were particularly severe, with very low temperatures and extensive ice coverage. Somatic growth rate declined in many stocks, and this in itself contributed considerably to the declines in biomass. In addition, recruitment tended to be low in some stocks.

A huge source of uncertainty in stock assessments is the level of natural mortality (the rate at which fish die due to natural causes). If the actual level is higher than that which is assumed, then TACs may be set too high, with a consequent and unintended increase in fishing mortality. In retrospect, there is good evidence that natural mortality increased in many stocks in the late 1980s. For example, heightened natural mortality was eventually incorporated into formal assessments of three cod stocks (northern and southern Gulf of St. Lawrence and the eastern Scotian Shelf) and the American plaice stock on Grand Bank. The cause of heightened natural mortality may be difficult to discern. Indeed, it may be difficult to determine whether an apparent increase in natural mortality has actually been due to natural mortality or to some other change, such as an increase in the rate of discarding.

An increase in natural mortality has been attributed, for some stocks, to an increase in predation by seals. There is also evidence that fish in some areas died because the physical conditions (volume of very cold water or extent and duration of ice cover) limited access to prey, resulting in low energy reserves and death.

While the declines in many groundfish stocks have been attributed to overly intensive directed fishing, it is

important to note that there were also severe declines in some species that were not subjected to directed fishing and even in some species, such as northern wolffish, that were of no commercial value.

It has been claimed by some that the declines of these other species were due to excessive bycatch that was either under-reported or discarded. An example of a stock that declined to a much greater extent than can be explained by reported catch is American plaice off Labrador and northeastern Newfoundland (2+3K). Arguments have been advanced both for and against the idea that the severe decline of that stock was due to large unreported catches.

In summary, there are many factors that probably contributed to the declines of groundfish stocks. Removals appear to have been too high for many stocks. The reasons include scientific underestimation of fishing mortality, assignment of TACs in excess of scientific advice (particularly during the late 1980s and the early 1990s) and removals by harvesters in excess of quotas. It also appears that environmental cooling contributed to declines in somatic growth and recruitment, and that some fish died because of increasing predation and declining availability of food. The relative importance of these factors undoubtedly varied among stocks.

3.3 Why has recovery been slow?

The cessation of fishing was expected to halt stock declines and promote recoveries. Elsewhere in the world, such severe restrictions have generally had the desired effect. Why has this not been the case for many groundfish stocks in eastern Canada?

First, it must be recognized that a few stocks did recover well. To some extent, these were stocks that had not declined to the same degree as some others. Cod off the south coast of Newfoundland (3Ps) and yellowtail flounder on Grand Bank (3LNO) are examples.

For some stocks, such as the two cod stocks in the Gulf of St. Lawrence, there is evidence that reopened fisheries, although small compared to those that existed in the 1980s, have been sufficiently large to crop off gains that have been made. Even for stocks that were not reopened, such as cod on the southern Grand Bank (3NO), bycatches of cod in fisheries directed at other species have been sufficiently large to retard recovery.

The major problem, however, is that many stocks have experienced low productivity. This includes low recruitment, low somatic growth and high natural mortality. The relative importance of each of these varies among stocks.

The dominant factor preventing recovery of many stocks is high natural mortality, particularly of adults. This is the case, for example, for both cod stocks in the Gulf of St. Lawrence, and until recently it was also the case for northern cod, especially in the offshore. Predation by seals is thought by many to be an important contributor to such high natural mortality.

Low somatic growth rate has been identified as important for some stocks, notably haddock on the eastern Scotian Shelf (4X), but also cod in the southern Gulf of St. Lawrence (4TVn).

Poor recruitment is a very important factor for many stocks. For some of these stocks, poor recruitment is not unexpected, since the biomass of spawners (SSB) is low, but recruitment in many cases is even lower than might be anticipated for the size of the spawner biomass. The causative factor(s) could operate at the parent stage, the egg and larval stage, or the juvenile stage. For example, a relatively low proportion of large fish in the parent stock might contribute to the quality of eggs being low or the eggs not being released into the water at the right time or place. Factors operating at the egg and larval stage might include unusually high predation by invertebrates or planktivorous fish, or inadequate or insufficient prey for larvae. Factors operating at the juvenile stage might include inadequate quantities of prey or increased predation (such as by seals).

As noted in the History section, DFO has conducted recovery potential assessments (RPAs) for several species of groundfish, notably roundnose grenadier, cod, American plaice and redfish. Many of the reports of these assessments will be available on the website of the Canadian Science Advisory Secretariat (CSAS) by the time the present document is presented to the Minister. Readers are encouraged to consult these documents for discussion and analyses of factors currently limiting population recovery.

4 What the Council Heard at Consultations

In the spring of 2010, the Council held open consultations to hear from all those with an interest in the groundfish fisheries of eastern Canada. At each meeting, the Council described its current mandate, and asked for views on issues relating to the sustainability of groundfish fisheries, including:

Conservation issues

- Ecosystem and habitat considerations
- Social and economic factors
- Governance and management

The Council visited 25 communities in Atlantic Canada, Québec and Nunavut, and held an additional 2 meetings with representative of Aboriginal peoples. Total attendance was approximately 248.

In March 2010, prior to the start of the FRCC consultations, representatives of industry, participating in a meeting of the Gulf Groundfish Advisory Committee, called for a boycott of the FRCC consultations. They felt that until action was taken to significantly reduce the number of grey seals in the Gulf of St. Lawrence, as had been recommended in earlier FRCC reports, more studies and other actions would be pointless. Their position was that no recovery of groundfish, particularly cod, can occur with the current level of seal predation. While the boycott undoubtedly affected attendance, many people did come along and express their concerns about seals. The question most often directed to the FRCC was: "why are we saving groundfish for seals?" With a few notable exceptions, the overwhelming belief among harvesters is that stocks cannot recover until seal numbers are reduced substantially.

A common issue was the need for rationalization. Part of this was the suggestion that incomes and future prospects were not high enough to encourage young people to enter the fishery at either the harvesting level or the processing level. In fact, it was felt that the fishery could not viably support the current number of licensed operations.

There is a perception among inshore harvesters that DFO policy is biased against the inshore fishery in that the current realities faced by inshore fishermen are not being considered. Harvesters expressed concerns related to the cost of operating in today's fishery and felt that in many cases it was unrealistic to assume that returns from the groundfish fishery, now or in the foreseeable future, could cover operational costs and at the same time provide for a reasonable economic return. Much of the groundfish fleet is struggling with the high cost of vessels, fuel, safety and training requirements, gear, equipment to ensure quality, wharfage, fees and monitoring,

It was felt by some that the reasons for which they had originally started to fish no longer applied. The ability to exercise one's choice in occupation and to be one's own boss, and the desire to maintain a family or community tradition and provide well for one's family, were now being jeopardized by many factors. These included resource uncertainty and increased operational costs, including those associated with meeting sustainability requirements for the marketplace, such as traceability and monitoring. For many, particularly those who were in the fishery before such additional requirements became necessary, these elements complicated if not contradicted why they chose to fish in the first place.

Views on the status of groundfish stocks varied considerably. In some areas, groundfish stocks were felt to be improving, while in others they were poor or declining. In some areas, participants felt that stocks were in better shape than indicated in scientific reports.

Some participants suggested that shellfish were more lucrative and would decline if groundfish returned. Some thought it would be better if groundfish did not recover.

Many participants felt that forage species, particularly capelin, were declining but some felt there were as many as ever, but that they were further offshore.

The Council heard a variety of opinions on the value of certain gear types. Many felt that mobile gear had more potential to cause harm to groundfish recovery than passive gear, whereas others felt that gillnets had selectivity and quality issues.

When bycatch was mentioned, it was with respect to two concerns; in some circumstances bycatch created limitations on the target fishery whereas in other circumstances too much bycatch of non-targeted groundfish was being taken in gear types other than the one favoured by the speaker.

Some non-industry presentations called for more areas to be closed to fishing while many in the industry doubted the value of closed areas other than in special cases, such as the protection of sponges and corals.

Many industry participants felt that their access to the groundfish decision-making process had decreased since 2004 with the cessation of the consultations that had been held by the FRCC. Most felt that the current consultation process was not adequate. A few thought that a lack of cohesiveness in industry made the current model unworkable. Most industry representatives do not feel empowered to recommend specific actions.

Some participants felt that fishery science was doing a good job with existing resources but most felt cutbacks had impaired research capabilities. Many stated that they would have more trust in data, other than log books, that they had a hand in collecting.

Participants in areas that currently have a groundfish fishery expressed optimism that, with more emphasis on quality, more collaboration with science, and changes to meet eco-labelling criteria, a prosperous future was attainable.

However, in many areas the groundfish fishery was either non-existent or a small add-on to a more lucrative shellfish fishery. Participants in such areas were discouraged, felt deserted by science and management, and saw little hope. Many stakeholders had withdrawn from the advisory process as all they saw were cuts and restrictions. In these areas the notions of eco-labelling and precautionary approach seemed irrelevant with respect to groundfish.

In the two consultations with representatives of Aboriginal peoples, a strong call for science-based decisions was heard. Aboriginal peoples are relatively new to the current groundfish fishery and are still being informed on governance aspects of the fishery. They look to the fishery to provide much-needed income for their communities. They feel groundfish stocks must improve significantly in order for them to exercise their constitutional right to fish. Nunavut stakeholders see an opportunity to develop the fishery in a sustainable manner, but are concerned with current environmental changes that impair their ability to fish in traditional ways.

There was acknowledgment on the part of some industry participants that the industry was undergoing change. Many of these changes were a result of an increased emphasis on societal goals related to sustainability.

There was little discussion about implementing the Precautionary Approach (PA) or sustainability criteria. Neither DFO nor harvester organizations seem to have adequately communicated to industry the idea of the PA and the implications of its implementation. The fact that there was little mention of the PA by participants during consultations led the Council to organize a workshop in Halifax in January 2011. The goal was to gain information from industry on how implementing the PA in groundfish fisheries could encourage stock recovery and sustainable harvest levels.

In the workshop, the Council heard concern that fisheries without a PA would not qualify for eco-certification and as a result risked losing market opportunities. There was recognition that the PA will be a challenge to implement for some harvesters and groundfish stocks. Concern was expressed for fisheries which would need to be closed due to currently low stock levels. For stocks in the critical zone, continued fishing mortality would imply a longer timeframe for rebuilding. Reaching agreement on decision rules would be difficult, particularly if stocks continued to decline. Rebuilding plans would need to consider bycatch in other fisheries, promote measures to increase age and size structure and reduce controllable mortality. A majority of workshop participants felt the workshop was valuable for them as it increased their understanding of the PA.

On a very positive note, the FRCC was encouraged by the passion for fishing groundfish and the desire to fish again, even by those whose fishery has been closed for many years.

5 Ecosystem Considerations

The concept of the ecosystem is now so well established that it permeates many aspects of human endeavour on land and sea. Essential to the ecosystem concept is that 'man' is a part of, not apart from nature; that connections between organisms and their environments are structured such that any whole is more than the sum of its parts. Food webs, flows of energy and materials, bio-physical and social-biological processes are now recognized to be as important as the distributions and abundances of species populations in predicting the capacity of ecosystems to provide essential goods and services. It is thus virtually impossible to understand fish populations or to manage fisheries without considering factors that are external to the interaction between the fish population and the industry that exploits it. Some of those factors, such as marine environmental effects on the recruitment and growth of fish, have been recognized for at least a century. But efforts to incorporate them formally into scientific and management models have met with limited success. More recently, the set of potentially important external considerations has been extended to include essential fish habitat, forage species, non-human predators, climate change, human cultures, politics and markets. Evolving management paradigms attempt to formalize and integrate these ecosystem factors, which were dealt with intuitively or ignored in the past. (Examples of holistic approaches to the management of fish resources appear to have arisen long ago in island ecosystems of Oceania). Multi-species management, integrated management and ecosystem-based management are progressively more inclusive stages in the modern evolution of fisheries management beyond the single stock fishery.

5.1 Ecosystem-based approaches to fisheries science and management

Ecosystem-based approaches to the management of fisheries attempt to incorporate and balance (integrate) all four components of sustainable development (ecological, social-cultural, economic and institutional) in making decisions about access, exploitation and conservation of these renewable resources in the context of the ecosystems that sustain them. Through fishing activities, marine ecosystems include human societies that derive goods and services. One source summarized it this way to a Council member:

> *"The socio-cultural system, including the economy, exists in a dynamic balance with the ecosystem in which social-cultural and economic activities depend upon ecological goods and services, while at the same time our actions transform the state of the ecosystem as a result of the demands we place on it."*

In this context the fishery is not to be managed independently, but as a nested component within a coordinated effort to manage all human interactions with the other components of the ecosystem. Management actions are integrated at the level of a large marine ecosystem, such as the Gulf of St. Lawrence, not only at the level of a resource or a vocation.

The modern ecosystem approach to fisheries science and management has been developing in many jurisdictions along multiple fronts for more than twenty years. While not yet a mature management science, ecosystem-based management (EBM) has universally accepted principles, a growing body of best practice guides, and some robust indicators of effectiveness. According to the Department, EBM:

- is holistic and cross-disciplinary, including the whole system, not just a few parts;
- is based on the best knowledge available;
- incorporates the precautionary principle and approach;
- is applied within the broader context of Integrated Management;
- is a phased implementation process, nationally developed and regionally implemented;
- employs techniques of area-based management, such as protected areas;
- uses objectives-based management directed towards verifiable outcomes;
- is built upon adaptive management processes.

Such a broad ambit of consideration places large demands for information gathering and processing on scientists and managers. These can never be met by attempting to measure and calculate all the components and processes of a fished marine ecosystem. Similarly, management cannot optimize every objective of management, nor can it be customized for every sector of the community of resource users. Ecosystem-based

approaches therefore employ a variety of shortcuts and indicators to identify management units and measure the effectiveness of management in data poor environments for outcomes that balance many needs. They are not replacements for population-based management of established, high-value fisheries that can be afforded the advantage of stock-specific surveys, fishery-specific monitoring, and numerical modeling.

Marine ecosystem-based management has developed along two related tracks in the Canadian context: ecosystem approaches to fishery management (EAFM) and multiple use zoning of large ocean management areas (LOMAs). The first track is the older, more familiar management of fisheries, updated and highlighted by the Department in its Sustainable Fisheries Framework. The focus is the incremental incorporation of ecosystem considerations into stock assessments, bycatch policies, habitat protection, Integrated Fishery Management Plans, and the "Fishery Decision-making Framework Incorporating the Precautionary Approach". The second track derives from additional responsibilities assumed by the Department upon passage of the *Oceans Act* (1997). The focus is the preservation of biodiversity (both species and benthic ecosystem types), the maintenance of marine water quality, and the conservation of secondary productivity while permitting the generation of wealth from the cautious use of marine resources. The tools are comprehensive ocean mapping, spatial zoning of human uses, and networks of marine protected areas, with strong elements of broad community consultation and co-management arrangements. While the first track has received more investment by DFO, perhaps because it is the more pragmatic, both may be required to achieve the desired goals for rebuilding the groundfish fisheries.

The linkage between these two ecosystem approaches has been tenuous, as they have evolved under different legislation in rather different 'silos' within the Department. The economies and advantages of improving the linkage are now becoming apparent as ecosystem approaches to fisheries management increasingly seek to consider cumulative effects of all human activities in marine ecosystems, not just the effects of fishing on the target stock. Ecosystem approaches demand synoptic data on ocean climate regimes, benthic habitat distributions and trophic relationships amongst forage, target and predator species derived from marine ecosystem mapping, modeling and prediction. As importantly, the necessity of formally embedding human behaviours, incentives, societies and cultures in decision-making processes stretches the need for scientific input beyond the natural sciences to the social and management sciences. An avenue of integration could be to cross-appoint science and management staff between the various Branches within the Department at local, regional and national facilities.

The FRCC recommends that DFO create the environment and incentives for better integration of initiatives towards ecosystem-based management of ocean and coastal zones and ecosystem approaches to the management of fisheries.

5.2 Operationalizing ecosystem approaches

An ecosystems approach to marine management views a fishery (humans hunting fish prey) as a sub-system of ecological governance in which the optimization of fishery production is one part of a broader optimization of marine ecosystem goods and services derived from multiple, often competing, ocean values and uses.

A common example of an ecosystem approach, whether it be intended to achieve broad marine management goals or objectives specific to fisheries management, is the marine fishery reserve, or closed area. These reserves have identifiable and enforceable boundaries placed around ocean space known or predicted to have environmental, habitat and biotic attributes with potential for high fish production. There are no clear demonstrations of net benefits associated with the spillover of groundfish from marine reserves in eastern Canada and there have been few concentrated efforts made to measure such benefits.

Other examples of ecosystem approaches to fisheries management include recent policies initiated by the Department on the precautionary approach, managing impacts of fisheries on sensitive benthic areas and forage species. A number of these policies have been operationalized domestically to protect important habitat and support biodiversity. These include Marine Protected Areas (MPAs) and coral closures within Canada's economic zone as well as internationally agreed closures of Vulnerable Marine Ecosystems (VMEs) to protect corals, sponges and seamounts in the Northwest Atlantic Fisheries Organization (NAFO) regulatory area.

There are currently five MPAs in eastern Canada: the Musquash Estuary, The Gully, Eastport, Gilbert Bay and Basin Head. Developments are underway to consider the establishment of additional MPAs and

are at the proposed "area of interest" stage. One such area, within the Laurentian Channel, is intended to protect coral, and may also protect known mating grounds for migrating porbeagle sharks. Coral closures already in place in eastern Canada include a portion of the Northeast Channel, the Stone Fence, the Narwhal Coral Closed Area, and the 2G /OB Fishing Industry Voluntary Closure. A closed area around Emerald Basin has been proposed for the protection of rare glass sponges.

Measures adopted by NAFO in 2007-2009 to protect corals, sponges and sensitive benthic areas in general have resulted in the closure to all bottom fishing in Division 3O of 14,000 square km, the implementation of 11 closures with a combined area of 4,630 square km in Division 3LMN, and the closure of 6 seamount areas. In addition, encounter thresholds have been established to reduce NAFO fisheries impacts on corals and sponges.

The Council notes that the collaborative approach undertaken by the Department with ocean users to propose areas of interest, establish closures and MPAs, has for the most part been a constructive means of building broad support to protect sensitive benthic areas.

5.3 Applications of the ecosystem approach to management of groundfish fisheries

The Council has increasingly recognized the added value of ecosystem approaches to the assessment of groundfish resources and the management of their fisheries, compared to approaches predicated solely on tracking the biomass of individual sub-populations in a management area, and its mortality attributable to fishing. Recommendations to expand and integrate the natural, social and management sciences with the policies and practices of the Department have been more frequent during the past decade. The Council has previously recommended the adoption of ecosystem-based approaches to the management of the eastern Canadian fisheries for lobster and herring, detailing the objectives and actions required to achieve it.

The current context differs in that the management goal is rebuilding collapsed stocks rather than conservation of status quo fish production. Acknowledging the diversity, complexity and practical unpredictability of the many designated stocks of groundfish and their fisheries in eastern Canada, the Council emphasizes the urgent need for advancement of practical ecosystem approaches to fisheries science and management that encourage natural processes of stock recovery within the current ocean production regime. The urgency is amplified by:

- low resilience of most of these stocks, as demonstrated by failures to recover after almost two decades of greatly reduced fishing mortality;
- reduction in the capacities of the Department and industry, in the absence of active fisheries, to identify and measure the factors that suppress stock recovery, and to track all the populations with sufficient precision to evaluate the effectiveness of management interventions;
- demographic and economic wasting of the commercial groundfish fisheries post collapse, compounded by market factors beyond the control of industry or government;
- accelerating, poorly predicted effects of climate change on the patterns and pace of ocean productivity and food web structure;
- low levels of collaborative trust and respect between many sectors of the groundfish industry and the Department.

The ecosystem approach as understood by Council applies both to the assembly of information that supports good management decision-making (often referred to simply as "science"), and to the targets, units and processes of management intervention (often referred to simply as the "fishing industry" and the "regulator"). In both the science and management aspects it requires a broadening of horizons to include areas, agents and processes as being internal rather than external to the domains of the objects of greatest interest (i.e. recovering stocks and the fishing industry).

The following examples reflect the incremental implementation of the ecosystem approach in strategies for the recovery of groundfish stocks and management of their fisheries.

5.3.1 Environmental factors and processes

Physical and chemical properties of the environment affect groundfish species at all their life stages, and also affect those plants and animals with which each species interacts as competitor, predator or prey. Rapidly accelerating rates of change in the variability, intensity

and frequency of ocean weather events associated with local manifestation of global climate change are recognized by the Council as the environmental factor of overarching concern for the rebuilding of depleted fish stocks. The urgency is highlighted by a nagging suspicion that some poorly documented and understood change in the Northwest Atlantic ocean production regime compounded the catastrophic mortality experienced by a majority of groundfish stocks of eastern Canada during the late 1980s and early 1990s.

The FRCC recommends that new metrics, models and predictions of changing marine environments, and uncertainties in recruitment, growth and mortality associated with environmental factors and processes, be more rigorously incorporated into determinations and projections of the status of groundfish stocks.

5.3.2 Forage species

The availability of sufficient prey of high quality is important to the recovery and continuing high productivity of cod and other species of groundfish. The most important prey for cod of medium to large size are relatively small fish that often occur in high densities, either pelagically in overwintering and feeding schools or demersally on their spawning grounds. In eastern Canadian waters, important prey species for cod and other groundfish include herring, capelin, sand lance and gaspereau. Various species of invertebrates, such as shrimp, krill and squid, may also be important. Such species are often referred to collectively as forage species.

DFO has a "Policy on New Fisheries for Forage Species". The preamble to the policy states: "Some forage species, such as herring and capelin, have been targets of sustainable and economically viable fisheries in Canada for many decades, without causing undue alteration of ecosystem components and processes. … New fisheries on forage species present new challenges to ensuring sustainability of fisheries. Not only must target species of the fisheries be conserved, and bycatch be controlled, but the fisheries must not threaten the conservation of other species which depend on the forage species for food."

Despite the assertion in the paragraph above, the Council is concerned that fisheries for herring and capelin may indeed be having an impact on the abundance and well being of cod. For example, scientific assessments and interveners at the FRCC consultation meetings have noted the apparent low level of abundance of capelin off southern Labrador and eastern Newfoundland, and have stated that the insufficient supply of capelin may be hindering the recovery of northern (2J3KL) cod.

The importance of capelin to northern cod has long been recognized in management practice. As noted in the report of the Canada-NL Action Team for Cod Recovery, Canada decided not to have a reduction fishery for capelin. In the late 1970s, the TAC for capelin was set at a conservative exploitation rate of 10% due to poor recruitment. The rationale for maintaining this approach was expanded in 1982 when concern was expressed over the effect that the capelin fishery might have on cod and other predators. Difficulties with assessing the abundance of capelin arose during the 1990s and these problems, combined with declines in funding levels, resulted in termination of the major survey designed to assess capelin abundance/biomass.

Fisheries for capelin continue in the northern cod area off southern Labrador and eastern Newfoundland. The Council acknowledges the value of such fisheries to the coastal communities of the area. However, there are no reliable estimates of current spawning biomass for the capelin stocks, so the impact of current catches on spawning biomass cannot be evaluated. Furthermore, there is no explicit allowance for the feeding requirements of cod and other predators in the capelin Integrated Fisheries Management Plan (IFMP). Such explicit allowance should be factored into the harvest strategy framework for capelin, but such a framework has not yet been developed.

The Council believes that capelin and other forage species that are currently harvested (such as herring, mackerel, gaspereau, shrimp and squid) should be subject to policy very similar to that enunciated in the policy on new fisheries for forage species. This would include requirements not only for (i) minimization of the risk of changes to species' abundances that are difficult or impossible to reverse and (ii) maintenance of full reproductive potential (including genetic diversity and geographic population structure), but also (iii) maintenance of ecological relationships, such as predator-prey.

The FRCC recommends that DFO extend major elements of its "Policy on New Fisheries for Forage Species" to those forage species that are currently being harvested, especially capelin and herring.

The Council notes that some stocks of small pelagic fish are harvested even though there is no reliable index of stock size. For some of those stocks, incidental catches in DFO bottom-trawl surveys have been used to provide an index of relative abundance/biomass. The Council is of the opinion that incidental catches in bottom-trawls may provide some indication of the distribution of small pelagic fish. However, such incidental catches would generally not provide a reliable basis for monitoring abundance/biomass because the magnitude of individual catches may depend more on the vertical distribution of the fish than on their abundance or density.

The FRCC recommends that DFO and industry ensure the provision of sufficient scientific information and advice to support the management of fisheries for forage species. Each stock should have at least one reliable index of stock size.

The FRCC recommends that DFO consider the merits of managing forage species according to a target escapement strategy that would take into account the food requirements of cod and other groundfish.

5.3.3 Predators

The Council recognizes that an emerging strategy for ecosystem-based management of fisheries is to structure the entire suite of fishing mortalities so as to maintain a balanced harvest; one that attempts to retain the relative biomass ratios in the trophic levels comprising a diverse and resilient marine food web within a given ecosystem. While it is recognized that the benchmark for such a strategy is difficult to determine in food webs and ecosystems that have undergone regime shifts, the concept of fishing to maintain key predator-prey ratios within historic bounds is judged to be a valid objective of ecosystem-based management for rebuilding groundfish populations.

The Council's analysis of this example and the recommendations that flow from it are detailed in the following Chapter on seals.

5.3.4 Additional elements of ecosystem-based management

A related set of examples summarizes other elements of ecosystem-based management that can contribute positively to the recovery of groundfish fisheries. They recognize the multiple roles of humans as top predators and competitors in marine food webs; modifiers of marine environments and habitats through direct (e.g. fishing gear) and indirect (e.g. pollution) impacts; social animals; economic agents; stewards and managers.

- Inclusion of bycatch as a critical control on the capacity of depleted stocks to recover.
- Protection of critical marine habitats for various life stages of recovering stocks through controls of the use of physically destructive fishing gear and the closure to certain types of fishing of marine habitat areas. The Department has a "Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas". It differentiates between historically fished and frontier areas of seabed, and employs an ecological risk analysis framework to guide management measures such as gear restrictions and area closures based on mapping of seabed sensitivity and intensity of use by fishing gear. The policy is well grounded in the precautionary principle and the principles of ecosystem-based management. It explicitly recognizes threats to both target species and non-target (e.g. forage) species associated with habitat damage.
- Recognition and modeling of ecological connectivity. The distributions of recovering groundfish populations in space relative to the distributions of their habitats (spatial ecology), and their connectedness to one another by the physically and biologically mediated flows of migrating adults, juveniles, larvae, and genes (metapopulation dynamics).
- Elaboration of the ethical, social, cultural and economic stimulators and controls of the behaviour of individuals and institutions in the fishing industry (socio-economics).

5.4 Science for ecosystem approaches to groundfish fisheries management

Ecosystem-based fisheries management requires fishery science that goes beyond tracking the dynamics of an exploited fish population and the mortality associated with fishing. The essential elements of ecosystem-based fishery science are explicitly mandated in codes of practice adopted by international (e.g. the Food and Agriculture Organization of the United Nations) and national agencies (e.g. the National Marine Fisheries Service of the U.S.A.). Some elements

summarized from the 2005 Strategy for the Recovery and Management of Cod Stocks in Newfoundland and Labrador, and the 2007 Ecosystem Science Framework, highlight the key objectives of the ecosystem approach that are endorsed by the Council:

1. Develop flexible risk assessment tools to cope with ever-present scientific uncertainty.
2. Evaluate performance of ecosystem indicators to maximize the cost-to-benefit ratio of adaptive management.
3. Generate rule-based management systems based on these tools and indicators to implement the Sustainable Fisheries Framework.
4. Formalize ecological regime shifts to identify the management implications of climate variability, and relate changes in stock and ecosystem productivity to help adapt to ecosystem regime shifts.
5. Specify the recovery potential of depleted populations to integrate knowledge of changes in stock productivity with policies and management practices that contribute to stock rebuilding.
6. Identify key structural and functional components of ecosystems that matter most to management objectives. Practical and consistent identification of predators and prey, habitat features, community structures and ecological processes of resilience inform decision-makers of properties that enable sustainable use of aquatic resources.
7. Use spatial information from natural and social sciences to structure diverse databases that focus on localized issues and link all relevant information to area-based management tools such as multiple-use zoning and marine protected areas.
8. Set clear management goals and employ both experimental and comparative methods to evaluate progress and effectiveness of ecosystem approaches.

Ecosystem approaches are explicitly deemed to be essential by communities, scientists, agencies and governments worldwide, including many in Canada (see, for example, the reports of the Cod Action Teams). Although the Council acknowledges that to operationalize ecosystem-based approaches to the management of groundfish fisheries poses significant challenges for science, government and society, it recognizes that doing so is key to supporting their recovery.

The FRCC recommends that ecosystem science, including ocean environment prediction, food web models, and decision-support tools linking social and ecological priorities, be more fully incorporated into stock rebuilding and Integrated Fisheries Management Plans.

5.5 Conclusion

Understanding the potential of ecosystem-based approaches elsewhere leads the Council to consider their immediate application to the rebuilding of groundfish fisheries in eastern Canada. The most obvious is the use of comparative analyses of marine ecosystems and controlled interventions to resolve uncertainty about management outcomes in the complex relationships among groundfish, their significant natural predators, the prey species they share, and the range of marine production systems they inhabit. Most of the information required to compare fished ecosystems and design experiments in adaptive management is already available from fisheries, oceanographic, and ecological science and local knowledge. There is now the challenge of assembling and viewing it as a set of ecosystem indicators that can be predicted to respond to a managed change in a potentially controlling factor. In many marine ecosystems of eastern Canada, the cessation of commercial fishing for groundfish represents such a managed change. Although the action was not designed or treated as an experiment in ecosystem-based management, changes in abundance and biomass of most species taken in research trawls is routinely recorded, so there is information on many species other than those targeted by fisheries. Analyses of these data have already demonstrated profound change in the structure of the food web on the Scotian Shelf, begging the question of whether damaged ecosystems must be recovered before individual stocks rebuild. Of the latter, a small minority of more than fifty groundfish stocks across eastern Canada are currently in a healthy state or showing clear evidence of regrowth.

Based on these results, an ecosystem-based approach to adaptive management requires that managed change in another factor be trialed. Currently, the best candidate parameter for manipulation is predation pressure, because of the exceptionally high natural mortality rates present in the absence of significant fishing mortality.

In an ecosystem-based approach, the abundance of the most effective predator would be manipulated within a few, well-bounded marine ecosystems (and not in a few others), for which key parameters of the food web and physical-chemical environment could be measured with sufficient precision to determine whether they confounded the effect of the predator manipulation. This is essentially the approach that has been proposed for the targeted removal of grey seals from the southern Gulf of St. Lawrence, following an exhaustive analysis of existing spatial data to refine the hypotheses and experimental design.

6 Seals

The roles played by harp and grey seals, and to a lesser extent hooded seals, in the failure of most eastern Canadian groundfish stocks to recover since the collapses and closures of the early 1990s, was the dominant topic of concern expressed to Council throughout its consultations (see Section 4). Three departmental science or management meetings related to this topic were held during the period of this assignment, in all of which some Council members observed or participated. Thus, a great deal of information and opinion was made available to Council in this endeavour. Given the abundance of reviews and synopses, the Council does not reiterate the history of seal hunting, management and science. Rather, it summarizes previous FRCC conclusions in the context of groundfish, highlights the current opportunity for action, and provides concrete advice for research and management now.

Much of the Council's study and deliberation centred on what, if anything, could and should be done about seals by the Department so as to enhance the rebuilding of groundfish stocks and fisheries. The question is relevant to virtually every other aspect considered in this report. Scientific understanding of the relationship between seal predators and their groundfish prey must be developed in the context of the large marine ecosystems of eastern Canada because of the many other biotic and environmental factors that affect the outcomes of the interaction. Management decisions about interventions in seal population processes must be ecosystem-based because of the many other roles that seals play in marine food webs and human economies, and because extensive and intensive reductions in seal numbers are called for. The precautionary principle is relevant not only because of the great uncertainty about impacts down food webs associated with the removal of top predators, but also because some of the groundfish species have been listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered or threatened in portions of the eastern Canadian marine ecosystems, and seals have eclipsed humans as a major cause of mortality in some stocks of these fish. Socio-economic considerations must be taken into account because of the complex ethical problems associated with the hunting of sentient marine mammals, the logistic challenges to large interventions in marine mammal populations, and the market implications for all Canadian fisheries.

6.1 Current context

6.1.1. Harp and grey seal abundance at historically high levels

Seals have been evolutionarily and ecologically significant predators in eastern Canadian marine and coastal ecosystems for millions of years. Their rights of place are unequivocal, but we do not yet understand the significance of their contributions to the stability and resilience of these ecosystems. The severe depletions of harp seals by hunting during the eighteenth and nineteenth centuries have largely been recovered since the historical lows around 1860 when the market for seal oil reached a peak. Severe depredation of seal populations continued sporadically well into the twentieth century as the market shifted to pelts. Reliable stock assessments available from about 1950 show a more recent low in harp seal abundance of about 1.5 million animals in 1972, shortly after harvest quotas were introduced. From that time, the population has increased rapidly to reach about 9.1 million at present. The situation is similar for the grey seal population centred on Sable Island, which increased more than 10–fold during the past 30 years to reach about 350,000 animals at present. Large increases in grey seal populations have occurred in the Gulf of St. Lawrence as well, although to a lesser extent.

The reasons for these increases in seal abundance and distribution are not known precisely, but marked declines in hunting mortality since the 1970s are part of the story. The anti-sealing lobby served to greatly reduce market demand for harp seals, and hence hunting mortality (including that for harp and ringed seals by Aboriginal hunters) since about1982. The depression of market demand for seal products compounded the relative ineffectiveness of bounty programs introduced for grey seals since 1967. The effect of reduced hunting mortality on seal populations and their ecology has been confounded by massive changes in populations of seal predators, competitors and forage species associated with fisheries and their management. The most notable changes are those associated with grey seals, and with the collapse of the eastern Canadian groundfish fisheries. The direct and indirect effects of ecological factors such as prey availability, predation and ice cover have not been evaluated quantitatively for most of the main seal herds of eastern Canada. Changes in the production regimes and structure of ocean food webs on the Grand Banks, Scotian Shelf and in the Gulf of St. Lawrence may also

be implicated. The recent increases in the size of seal populations, coupled with changes in marine climate and production regimes, translate into range expansions, such that grey seal foraging and colony formation are increasingly common in areas such as southwestern Nova Scotia and the northeastern Gulf of St. Lawrence. (These range expansions were repeatedly described by participants at the Council's consultations.)

6.1.2 Seals compete directly and indirectly with humans for groundfish

Seals are highly efficient and adaptive predators on a very wide range of prey items in Canadian waters. They are known by fishermen to be aggressive hunters and competitors for fish, and have shown a steady increase in interaction and interference with the fishing industry. They regularly move tens to hundreds of kilometres (grey seals) or even hundreds to thousands of kilometres (harp and hooded seals) during their annual cycles of feeding and breeding. Grey seals can establish new rookeries within a decade. The degree to which their hunting activities impose ecologically significant mortality on demersal fish populations has been the subject of intense analysis for decades, reaching a climax for grey seal science at the Zonal Advisory Process (ZAP) meeting in October 2010.

Data on gut contents and biochemical analyses, as well as direct observation, demonstrate that seals hunt, kill and eat many species of groundfish in stocks that are currently below their limit reference points. Circumstantial data and numerical model results indicate that predation by grey seals is the most likely explanation for historically high levels of natural and total mortality measured in at least three species of groundfish, including cod, in the southern Gulf of St. Lawrence. The impact of grey seal predation on populations of groundfish in the Scotian Shelf ecosystem is more equivocal in the science community, with different research groups producing widely disparate estimates of groundfish consumption by the same seal populations.

In the highly disputed case of the Eastern Scotian Shelf (4VsW) cod stock, the rate of predation mortality predicted from the most conservative estimates of consumption by approximately 300,000 grey seals on Sable Island is an order of magnitude greater than the total fishing mortality from scientific sampling and bycatch. Seal-induced mortality is calculated to range from 2% to 22% of the total annual mortality in a cod stock of approximately 45,000 t. This constitutes 0.6% to 13% of the current biomass (an average loss of 3,060 t, or 5.4 million fish per year). Most (78 - 90%) of the very high total mortality rate experienced by this stock has not been attributed to any specific factor.

Most recent studies of the impact of seals on recovery of stocks of groundfish, especially cod, have focused on grey seals. However, fishermen have for years expressed concern about the impact of harp and hooded seals on the recovery of the northern cod stock off southern Labrador and eastern Newfoundland (2J3KL) and the cod stock in the northern Gulf of St. Lawrence (3Pn4RS). Scientific assessments of northern cod from the late 1990s to the middle of the first decade of the 2000s reported that the stock was experiencing a high rate of natural mortality, and stated that "predation by seals has been an important source of mortality of cod since the start of the moratorium" or "predation by harp seals … may be preventing the recovery of the cod stock". However, on-going modeling suggests that predation by harp seals is not a significant direct factor in the lack of cod recovery to date. That model does indicate, however, that low availability of capelin may be an important factor in the slow recovery of the cod, and there has been a suggestion that harp seals may be influencing cod indirectly by preying on capelin. The relative importance of biotic and environmental factors has yet to be resolved in this case. With regard to the cod stock in the northern Gulf of St. Lawrence, the 2010 stock assessment stated that natural mortality has increased over the last few years, and an increase in consumption of cod by seals is a possible cause.

6.1.3 Reductions of seal predation mortality have potential to facilitate groundfish recovery

Arguments that seal predation acts to inhibit or prevent the rebuilding of groundfish populations in eastern Canada come from several sources. The body of evidence comprises the collective observations of thousands of fishermen, historical analyses of causes of natural mortality in groundfish populations, model predictions of the response of groundfish stocks to reduced seal predation, and outcomes of seal culls elsewhere. The models and assumptions have been extended to estimate the number of grey seals that would have to be removed from the foraging population in order to reduce natural mortality sufficiently to permit an increase in groundfish population growth rates that could lead to stock recovery. The greatest level of scientific consensus exists for grey seals preying on cod, winter skate and white hake in the southern Gulf of St. Lawrence. It has been estimated,

under a specific set of assumptions, that the number of grey seals foraging in the southern Gulf would have to be reduced by 70%, to approximately 31,000 animals, in order to reduce the natural mortality of cod to a level sufficiently low to allow for a measureable increase in the southern Gulf (4TVn) cod stock. This translates to an initial removal of approximately 73,000 seals from the southern Gulf of St. Lawrence.

The initial reduction would have to be undertaken within a year or two for the experimental effect to be unequivocal. Furthermore, the reduced mortality rate (and hence the maximum number of foraging grey seals) would have to be maintained for at least five years before a measureable increase in cod biomass could be detected. That is, after the large initial removal of seals, it would be necessary to continue to remove seals each year for the duration of the experiment. These ongoing removals would include the estimated annual production of recruits through reproduction by the resident population plus any immigrants from areas outside of the southern Gulf. It follows that the total number of grey seals removed from the southern Gulf over the course of the experiment may be twice as high as the initial removal.

Similar modeling of grey seal and cod populations on the Eastern Scotian Shelf is less conclusive in predictions of the outcomes of management interventions. Some models require a minimum 30% reduction in seal abundance before increases in groundfish biomass could occur, while others demonstrate no measureable effect of any proportional reduction. The major causes of these discrepancies between simple predator-prey models using the same data on cod and seal abundance are the assumptions about the composition of seal diets and the manner in which seals respond to changes in availability of cod and other prey (the seals' functional feeding response). It appears that the grey seal-groundfish interaction on the Eastern Scotian Shelf is more complex and less well understood than that in the southern Gulf of St. Lawrence, despite the very large concentration of seals on Sable Island.

Because groundfish and seal populations do not interact in isolation within the marine ecosystems of eastern Canada, it is likely that large experimental reductions in seal abundance will produce unexpected effects on other species. Food web models indicate that seal predation constitutes a major flow of energy from populations of many different prey species to this top predator. Retrospective analyses argue strongly for prey switching as the benthic regime shifted from dominance by demersal fish production to benthic invertebrate production over the past 20 years, but the role of seals in these regime shifts remains unclear. At their current, primitive state of development, these ecosystem models suffer from great uncertainty about diets, and cannot predict changes in specific populations of groundfish, pelagic fish or invertebrates. Experimental manipulations of seal abundance, properly monitored, offer opportunities to improve the realism, precision and usefulness of ecosystem models of the outcomes of seal management practices.

Scientific understanding of data on seal abundance, distribution and consumption of groundfish are reinforced and extended by a large body of local ecological knowledge, much of it from fishermen and fish processors working at sea and near shore. The frequency, intensity, and nature of interactions between seals and fishermen are escalating. Seals are seen foraging and hauling out in locations where they have not been seen in living memory. Seals are more aggressive in their pursuit of groundfish in fishing gear, and are observed to reduce the catchability of some species when they are in the area where fishing gear is deployed. Direct observations of predation on groundfish, including belly-biting of large fish, are increasingly reported. Market resistance, extensions in processing time and discarding of fish fillets due to increasing parasite loads are imposing cost escalations in areas where seal-born parasites were rare or unknown even a decade ago. As the density and distribution of seals expand, the economic viability of fisheries on those few groundfish stocks showing signs of recovery is compromised. Thus, seals constitute a complex external factor that exerts both direct and indirect effects in the ecosystems of groundfish.

The centre of grey seal abundance is Sable Island on the Eastern Scotian Shelf, where population numbers have reached the point that density-dependent limitation is becoming a factor. The ecological and historical significance of this offshore island and the current change in governance imposes serious constraints on its consideration as a logistically feasible site for grey seal population control.

On the balance of substantial evidence currently available to it, the Council concludes that predation by grey seals is the most likely cause of the high natural mortality that is inhibiting the recovery of groundfish populations in the southern Gulf of St. Lawrence. It is still not clear whether seal predation is the most likely factor preventing recovery of other collapsed groundfish stocks. But it is apparent that well-

controlled experimental reductions of seal numbers in specific areas, backed up by careful monitoring of groundfish population responses, are required to resolve untested scientific hypotheses about the effect of seals on groundfish population recovery, and to inform possible options for the control of seal predation. Given the comprehensive, albeit still equivocal, scientific data available, the collective knowledge of the fishing community, and the desperate status of most groundfish stocks and fisheries, the Council argues for experimental interventions in certain seal populations. This conclusion is consistent with a steady stream of advice from the FRCC since 1993.

6.2 Previous FRCC conclusions and recommendations

Over the past 18 years, the Council has heard a steady, consistent and increasingly urgent message from all manner of fishing interests that predation by rapidly growing populations of harp and grey seals is preventing the recovery of groundfish stocks. Throughout that period, the Council has progressively explored the evidence and consistently recommended research and management actions. In no fewer than twelve reports and communications, the Council concluded that seal predation is a significant factor in groundfish conservation. It provided increasingly specific advice on ways and means of determining the magnitudes of predation mortality, and of reducing and controlling seal abundance so as to determine whether such interventions would encourage the recovery of groundfish stocks. The situation in the Gulf of St. Lawrence was often highlighted as critical. This concern reached a peak at the Council's community consultations, when many of the meetings were partially or totally boycotted as a protest against the Department's inaction on industry calls to control seal populations. A brief summary of the Council's conclusions and recommendations on seals over the years is provided in Appendix 6.

On June 16, 2009, the Minister of Fisheries and Oceans announced a number of management measures for the Gulf of St. Lawrence. Among these was direction to the Department to ensure the targeted removal of grey seals. A backgrounder to the announcement indicated that, according to the Department's most recent peer-reviewed scientific assessment, the impact of seal predation on southern Gulf cod appears to be a significant component of the very high mortality rates of cod in the southern Gulf. Based on these findings, the Department has been directed to ensure the targeted removal of grey seals preying on cod in the southern Gulf, as part of its conservation approach. To date, there has been no action.

6.3 Recommendations

6.3.1 Precautionary and Adaptive management through experimental manipulations at the ecosystem level

The dire condition of most eastern Canadian groundfish populations calls for a particular invocation of the precautionary principle. In this application, the absence of scientific certainty that seal predation is maintaining groundfish populations at levels below their limit reference points (LRPs) should not preclude cautious action by decision makers to mitigate such serious or irreversible harm. In this unusual context, cautious action means highly controlled reductions of seal abundance such that the target seal species population remains well above its LRP (i.e. in the cautious zone), but well below levels that inhibit the recovery of the groundfish stock at risk.

Recognizing the value of a demonstrated proof that seal predation is preventing the recovery of groundfish stocks, the Council fully supports both the scientific justification and the practical logic of the proposed experimental reduction of grey seal abundance in the southern Gulf of St. Lawrence. The action is recommended in the context of adaptive management. That approach to fisheries management, itself a tenet of the precautionary principle, deals with uncertainty in decision-making by undertaking management "experiments" carefully designed and monitored to determine what "works". Future decisions are systematically informed by the series of "trials and errors" and "trials and successes".

The scale of the proposed experiment is well-matched to those of co-occurring groundfish populations, such that a measurable effect can be detected if the prediction is correct. Experiments at smaller scales are unlikely to yield unequivocal or generalized results. The monitoring program must be maintained over the full five years of the manipulation at a precision no less than that of the research vessel surveys. Indeed, it is highly desirable to measure the densities of seals, groundfish and forage species at an even finer spatial and temporal resolution using fishery-independent and dependent

methods. Changes in seal and groundfish distribution and abundance should be mapped, and the movement of seals and groundfish tracked using electronic tagging technologies. It is best that the experiment be conducted and monitored by a multidisciplinary team of researchers from government, academia and industry, so that the results of this high profile exercise are as comprehensively transparent, defensible and shared as possible.

The FRCC recommends that effort start immediately on an experimental reduction of grey seals in the southern Gulf of St. Lawrence to maintain the number of seals foraging in that area at less than 31,000 animals, and that comprehensive monitoring of the effect on groundfish and ecosystem parameters be continued for a time sufficient to definitively test the effect on groundfish population processes and parameters in that area.

The results of this experiment will inform decisions about appropriate actions in other ecosystems of eastern Canada experiencing rapidly expanding populations of seals. It would also be wise to consider and formalize strategies for future actions flowing from different possible outcomes of the seal depletion experiment.

6.3.2 Targeted research

New evidence that predation by grey seals has prevented the rebuilding of some groundfish stocks provides the basis for immediate and substantial collaborative actions to reduce seal abundance sufficient to reduce natural mortality to levels that can permit population rebuilding, and limit the spread of fish parasites that threaten the stocks and the industry. While the evidence is compelling for one area, it is not conclusive for other areas where grey seals forage, nor does it provide management direction for determining the effects of harp and hooded seals. Evidence from observations of historical and geographical trends in food web structure, and from models of forage-groundfish-seal interactions, are necessary before firm decisions can be made about experimental interventions in other ecosystems.

The FRCC recommends that a set of scientific meetings (workshops and ZAPs) be convened to extend and explore hypotheses about whether reductions of seals (grey, harp and hooded) would enable or enhance the recovery of groundfish stocks on the western Scotian Shelf, in the northern Gulf of St. Lawrence and on the shelf off Labrador and eastern Newfoundland.

These meetings should draw on a broad base of expertise (national and international) and incorporate workshop components dealing with practical policy, management and implementation elements required to test the hypotheses at appropriate scales.

The grey seal ZAP of October 2010 identified many gaps in knowledge that inhibited the translation from scientific model to support for management decisions. Future advisory processes will be better informed if research designed to address those knowledge gaps is intensified.

The FRCC recommends the funding of a targeted research effort designed to provide key missing information on seal diets, functional responses to prey availability, foraging ranges, behaviours and efficiencies, and methods of population control.

The field research should be incorporated where possible into ecosystem-scale experimental reductions of seal numbers, such as that proposed for the southern Gulf of St. Lawrence.

6.3.3 Strategic removal zones

The effect of seals on groundfish fisheries is not limited to elevated levels of natural mortality. Seals challenge the processing and marketing aspects of the fishery by serving as a vector of parasites that greatly increase costs and severely compromise the quality and value of seafood products. As grey seal populations continue to grow, the species continues to expand its range, resulting in the establishment of new colonies to the south and north. These range expansions are most effectively stymied in the early stages.

The FRCC recommends that strategic removals of grey seals be undertaken in specified areas so as to limit the expansion of the foraging, parasitism and colonization ranges into new regions.

6.4 Reducing seal abundance through a sustainable harvesting industry

The Council recognizes that an adaptive management approach to seal population reduction is incremental and time consuming compared with the eastern Canada-wide removals that are called for by a large majority of the groundfishing community. Scientific uncertainties and societal sensitivities surround the

killing and discarding of animals solely to reduce their competition with humans for shared natural resources. Seal control programs elsewhere, such as in the Barents Sea, are relatively small. In eastern Canada, we have seal populations at the peak of the exponential phase, so the reductions calculated to be necessary to produce a positive effect on groundfish recovery are very large. In addition, we are subject to intense international scrutiny that has the potential to put established markets for Canadian seafood products at serious risk.

The non-trivial question of how to practically remove tens of thousands of seals from a large, sub-boreal marine ecosystem at the rate and magnitude required for adaptive management experiments is now the critical path. The question has been addressed in some detail from several perspectives here and elsewhere. Of the options proposed, considerations of ethics, social good, public perception, economics and international markets lead to the conclusion that an efficient seal harvest is the most desirable option, and one that could be maintained indefinitely. This approach is consistent with emerging best practice of ecosystem approaches to the management of fisheries, including the balanced harvesting in marine food webs. In highly concentrated sub-populations of seals (such as on Sable Island), the possibility of contraceptive inoculation of female seals is an option worthy of further consideration as an alternative population control.

Council argues that the most ecologically, socially and economically desirable option to maintain reduced grey seal abundances over the long terms at which fish stock recoveries occur is by means of a targeted commercial hunt in restricted areas, that includes adult seals as well as juveniles. This goal poses challenges for hunting capacity, technology, harvest logistics, processing capacity, capital investment and market development. The recent efforts of the Minister to open new markets for seal meat; the existing, if weak, markets for fat, oil, bones and pelts; and niche markets for nutraceuticals, medical tissues, arts and crafts, have the potential to address the market issues. The other challenges must also be dealt with in a coordinated effort.

The explicit commitment of the Department to a science-based reduction of seal population size provides a significant opportunity for public investment in the re-development of a vital sealing industry that targets grey seals as well as the other, traditionally hunted species. Should the results of the first seal reduction experiment lead to further exercises in the adaptive management of the seal-groundfish interaction, the existence of an established industry with capacity to grow in an adaptive manner would re-double the savings and benefits to the people of Canada, while greatly reducing the costs associated with occasional mass removals. The Council recognizes that an effective sealing industry will take several years to rebuild. In the short term of the initial experiment, large numbers of seals must be killed even in the absence of commercial gain. The respectful course of action is to use this as an opportunity to develop harvest methods and commercial products as rapidly as possible.

There exists an established and legitimate vocation of commercial seal hunting in Canada. It is in danger of extinction as a livelihood because of recent closures of markets, climate-related changes in sea ice conditions, and effective negative publicity. A cadre of fishermen capable and willing to hunt seals still exists, and there is capacity to train more, drawn mainly from the ranks of core fishermen who often depend on multiple fisheries to make a living. Aboriginal peoples have a special relationship with marine mammals and much to teach about the respectful killing and full utilization of seals. Now is the time to encourage the sealing industry to develop a business plan for the emerging seal reduction program that builds capacity and efficiency in all aspects, from humane killing, to community economic development, to international shipping of seal products.

7 The Precautionary Approach

Over the past two decades, the Government of Canada has recognized the need to consider uncertainty and risk in science-based decision-making. Government commitments to international agreements and changes in domestic science and fisheries related laws and policies have been instrumental in introducing the precautionary approach (PA) to resource management in Canada.

In 2009, Fisheries and Oceans Canada (DFO) produced "A fishery decision-making framework incorporating the Precautionary Approach". (In this section, the terms fishery decision-making framework, harvest strategy framework, PA framework, and framework are used interchangeably). The framework is a key component of the DFO Sustainable Fisheries Policy for Canadian Fisheries. Over the next few years, DFO Regions will be developing and implementing decision-making frameworks for fish stocks, including rebuilding plans for those stocks in need. Incorporating the PA into Atlantic Canadian fisheries management is an important element of the FRCC advice to rebuild groundfish stocks.

In 2003 and 2004, cooperative efforts by DFO and fishing industry representatives were initiated to develop management plans for rebuilding cod stocks. Unfortunately, the plans developed were not PA compliant. It is widely recognized that a decision-making framework incorporating the PA, accepted by stakeholders, is essential in developing optimal harvesting strategies for rebuilding groundfish and ensuring long-term sustainability. With the rise of eco-labeling such as Marine Stewardship Council (MSC), it is clear that markets will be lost unless it can be demonstrated that stocks are being harvested sustainably. As part of stakeholder consultations, the Council held a workshop to discuss aspects of the PA including recovery strategies and industry adjustment. The workshop provided the Council with stakeholder guidance on how the PA could be implemented and promoted a shared understanding of the policy.

There are several recent examples of PA frameworks underway for domestic fish stocks and NAFO stocks. The PA framework for northern shrimp is already in place and the development of management frameworks for 4X cod, 3LNO American plaice and 3NO cod are in the early stages. These examples may have some value as a guide in the development of PA frameworks for other groundfish stocks.

7.1 What is the precautionary approach?

The precautionary approach (PA) is about being cautious when scientific information on the state of a stock is uncertain, unreliable or inadequate, and not using the absence of adequate scientific information as a reason to postpone or fail to take management action to avoid serious harm to the resource. In a more general sense, management according to the precautionary approach exercises prudent foresight to avoid unacceptable or undesirable situations. The term "PA" is often used, at least in eastern Canada, as a shorthand for the general harvest strategy framework developed by Canada to be compliant with the precautionary approach.

In a fisheries context, the goal of the PA is to reduce the risk of serious or irreversible harm to a stock. For a fish stock, serious harm could be caused by impaired productivity, which itself might be due to a change in one or more of the stock's biological characteristics, such as a lowered rate of production of young fish (recruitment), reduced body (somatic) growth, increased natural mortality or lowered age or size at maturity. Serious harm might also be due to a reduction in geographic distribution, loss of spawning groups, or reduction in the range of ages or sizes in the stock. In the management of Canadian groundfish fisheries, primary attention is given to the size of the parent stock because of the importance of the number and size of the spawners to the production of young fish.

The generalized harvest strategy framework adopted by Canada for implementing the PA is shown in Figure 6.

Along the bottom of the figure is information regarding the status (or size) of the stock. This might be the total weight of all spawners in the stock, often referred to as the spawning stock biomass (SSB). Because the goal of the PA is to reduce the risk of serious harm, we may wish (for example) to identify a SSB below which recruitment (the number of young produced each year) tends to be consistently poor. The stock size at which this occurs is called the limit reference point (LRP). When the SSB is below the LRP, the stock is considered to be in the critical zone. To reduce the risk that the stock will fall into the critical zone, another reference point (the upper stock reference, USR) is set at a higher level of stock status. This point is set far enough above

the LRP that stock declines can be recognized and corrective measures taken to reduce the risk of the stock declining into the critical zone. The range between the LRP and the USR is called the cautious zone. The area above the USR is called the healthy zone.

There are many factors that may affect stock status, but the major one over which we have control is fishing. The proportion of the stock killed by fishing is called the removal rate. This is shown on the left side of the figure. In the general framework shown here, the removal rate changes depending on stock status. When the stock is within the healthy zone, the removal rate may be set at, but no higher than, some maximum level that is considered appropriate for the stock. This is called the removal reference. If the stock size falls into the cautious zone, the removal rate is lowered to promote a return to the healthy zone. If the stock size continues to decline, the removal rate also continues to decline. If the stock size falls into the critical zone, then conservation becomes the first priority. The removal rate should be kept at the lowest level possible to prevent further decline and promote stock growth. There should be no tolerance for preventable decline.

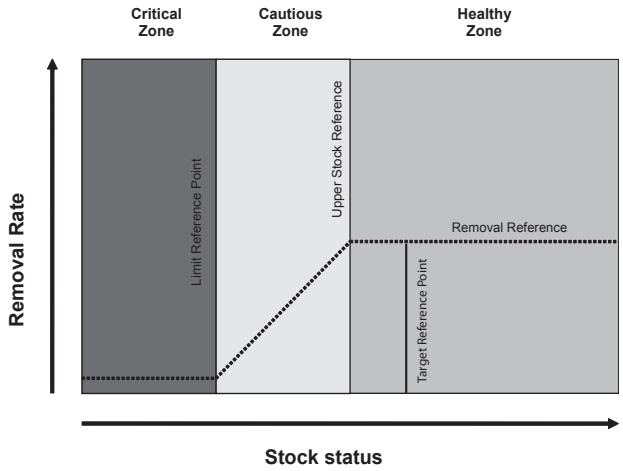


Figure 6. Generalized harvest strategy framework adopted by Canada

The framework described above could be extended to include a target reference point, which might be defined on the basis of economic or social objectives. The target reference point could be set at the upper stock reference but it would usually be set higher into the healthy zone. A target reference point is a required element under the United Nations Fish Stocks Agreement (UNFSA) and in the guidance on the application of the PA provided by the Food and Agriculture Organization of the United Nations (FAO). A target reference point is also required for eco-certification standards such as those of the Marine Stewardship Council.

Pre-agreed harvest decision rules (HDRs) and management actions for each stock are essential elements of the harvest rate strategy. The pre-agreed HDRs and management actions should respond to changes in stock status in relation to the reference points and be designed to achieve the desired outcome by affecting the removal rate. For example, if the stock biomass is in the cautious zone and increasing, the harvest rate could be scaled to match the increase in biomass or a lower harvest rate to promote faster stock growth.

An important aspect of this decision framework is the treatment of uncertainty and risk when estimating stock status, reference points, and in making and implementing management decisions. In the framework, the management of this risk is expressed by the identification and position of reference points, the changing severity of management actions that are chosen as stock status changes and the tolerance for stock declines. Decision rules developed for a fishery should reflect these general principles. For example, if the risk of stock decline is 75 to 95%, the risk would be considered high. If the risk is 5% to 25%, the risk would be considered low. Management actions would aim to be consistent with the level of risk tolerance.

7.2 Why the precautionary approach?

Conceptually, the precautionary approach is the practical application of the precautionary principle, which is found in many international instruments and in Canadian domestic legislation. The focus of international and domestic developments in the PA over the past two decades has provided a substantial buttress to the implementation of precaution in Canadian fish management decision making.

Internationally, the Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries, concluded in 1995, promotes the PA widely in the conservation, management and utilization of living aquatic resources. The code is directed at states, sub-regional and regional fisheries management organizations and other fisheries arrangements. Although the code is voluntary, it is widely supported, including by Canada. The 1995 United Nations Fish Stocks Agreement (UNFSA) provides a legal basis for the application of several of the most important provisions of the code. The UNFSA is the first global fisheries agreement requiring a PA for fisheries management. It includes requirements that states apply a prescribed methodology for precautionary measures,

implement improved techniques for dealing with risk and uncertainty, take into account both ecological and socio-economic uncertainties, and develop research and monitoring programs aimed at conserving non-target and dependent species.

Within the Northwest Atlantic Fisheries Organization (NAFO), the Scientific Council adopted a revised PA framework in 2003. The framework includes a more flexible set of management strategies and courses of action as well as reference point definitions that take into account the agreed roles and responsibilities of the Scientific Council and the Fisheries Commission, with the objective of increasing the transparency of the methods underlying the framework

Domestically, the *Oceans Act* of 1997 responds to the challenge of oceans governance through its commitment to the principles of sustainable development of ocean resources, and the PA as part of all operations. The *Act* calls for the wide application of the PA to the conservation, management and exploitation of marine resources. In 2003, the Privy Council Office, on behalf of the Government of Canada, published a framework applicable to all federal government departments. It sets out guiding principles for the application of precaution to decision-making about risks of serious or irreversible harm where there is a lack of scientific certainty. In 2004, DFO conducted an Atlantic Fisheries Policy Review. This recommended a comprehensive risk management framework for decision-making which incorporated the PA, including reference points, objectives and resource use strategies. In 2009, the DFO national Sustainable Fisheries Framework (SFF) was developed. The PA framework as described in the section above is considered part of the SFF.

Practical reasons for implementing a fishery decision-making framework incorporating the PA for the management and sustainability of Canadian marine fisheries include:

- Without fishery-specific objectives and an open and transparent decision-making framework, Government may make decisions to reopen fisheries and keep catch levels too high on non-recovered fish stocks.
- Scientific uncertainty may contribute to delays in decisions to take appropriate conservation action. In the absence of agreed decision-making rules, industry stakeholders and managers may promote less conservative actions.
- International and domestic markets require confirmation of sustainable seafood through eco-labels such as MSC. Such standards require reference points, harvest strategies, harvest decision rules and measures to account for risk and uncertainty.
- It may encourage investment in the fishing industry by providing an open and transparent process and a record of the status and trends of individual stocks relative to conservation (and rebuilding) objectives.

7.3 Setting reference points

DFO's "Fishery Decision-Making Framework Incorporating the Precautionary Approach" specifies the roles of science, managers and stakeholders for the development of its various elements.

The departmental framework specifies that DFO scientists establish the limit reference point (LRP), the point at which a fish stock is subject to serious harm. Limit reference points are based on biological criteria and established by scientists through a peer review process. This is not a responsibility shared with other stakeholders. The LRP for each stock is established after review of various scientific methods and models. The best fit for the available data and risk and uncertainty are considered in the selection of an LRP. The Council has learned that the methodologies used by scientists to develop some of the LRPs are not well understood by many people not directly involved in the process, particularly those in the fishing industry.

The FRCC recommends that a more transparent process involving stakeholders be established for the review and re-evaluation of limit reference points (LRPs). LRPs should be reviewed periodically and re-evaluated after recognition of important changes, such as the accumulation of data critical to interpretation of the stock-recruit relationship or a change of model.

The Council has heard that many within industry are concerned that the LRPs for some groundfish stocks are being set at levels that are too high, given the current low level of productivity of those stocks. For example, for some stocks, recent and current high levels of natural mortality may keep those stocks at a low but stable level for many years. Many stocks are also experiencing low rates of recruitment. However, some or all of the data used to determine the LRPs have come from an earlier period during which the

stocks experienced lower natural mortality and higher recruitment. There is concern that these stocks may not recover to the higher levels of productivity seen in the past. It is felt that consideration should be given to implementing the PA framework in a manner that recognizes the existing productivity regime.

The FRCC recommends that DFO determine how the precautionary approach framework can incorporate variability in productivity regimes.

Development of additional elements of the harvest strategy framework, including the upper stock reference point, the target reference point, and the harvest decision rules (HDRs), is a responsibility shared among DFO managers and stakeholders, with advice and input from DFO scientists. It is expected that this will be an open and transparent process to build consensus on reference levels and HDRs.

Canada has been slow to develop and implement its fishery decision-making framework incorporating the precautionary approach. Since the development of Canada's policy, other management frameworks such as management strategy evaluation (MSE) are being considered in some Canadian fisheries (Greenland halibut and pollock) as pilots and in other jurisdictions such as the International Council for the Exploration of the Sea (ICES). Management strategy evaluation involves assessing the consequences of a range of management strategies or options and presenting the results as tradeoffs in performance across a range of management objectives. MSE does not seek to prescribe an optimal strategy or decision but rather to provide the decision maker with the information on which to base a rational decision given objectives, preferences and attitudes to risk. MSE is a simulation technique based on modeling each part of the adaptive management cycle. The strength of the approach is that instead of using a single model to find an optimal solution, multiple candidate models are put forward to evaluate alternate hypotheses. By modeling each step of the formal adaptive management approach, the consequences of alternate scenarios can be evaluated across the models. The other core strength of the process is that it is consultative - both managers and stakeholders can have input into the candidate models and management scenarios. As the approach demands clear objectives (targets) against which to do the evaluations, the method compels participants to be clear about their objectives and to specify performance indicators that are relevant and well understood by stakeholders.

The Canadian PA framework may well evolve in the direction of MSE or other management feedback strategies that are not dependent on establishing LRPs, but this will take some time. For now, rebuilding plans for most groundfish stocks will be required, using the current PA framework.

The FRCC recommends that DFO review its precautionary approach (PA) framework relative to other PA compliant approaches for decision-making being used internationally, to determine if managing by reference points and risk is consistent with the evolving state of knowledge and practice.

7.4 Rebuilding plans

Under the PA framework and current stock LRPs, many of Canada's cod stocks are in the critical zone. For a stock in the critical zone, a rebuilding plan must be in place with the goal of having a high probability of the stock growing out of the critical zone within a reasonable time frame. Rebuilding timelines are determined by how long it will take to rebuild a stock to meet the objectives of the harvest strategy. The objective could be, for example, to rebuild the spawning stock biomass to the upper stock reference over two generations while permitting a small directed fishery with bycatch. How quickly the stock reaches the objective would depend on the pace of stock growth and the harvest decision rules. The PA indicates that the period to reach the objective should not exceed 1.5 to 2 generations (where a generation time is the time needed for a year-class of fish to contribute to the productive capacity of the stock). Generation time not only varies with species (see Appendix 1) but may vary from stock to stock within a species. For example, the generation time for cod varies from 7.5 years in the relatively warm waters of the western Scotian Shelf and Georges Bank to 11 years in the colder water off Labrador and eastern Newfoundland.

Many stocks in eastern Canada require a rebuilding plan on a priority basis. This urgency is amplified by recent COSEWIC assessments that designated some groundfish stocks as endangered or threatened. In addition, markets require sustainable fisheries and many require an eco-label to verify sustainability. Large retailers have notified Atlantic producers that they will buy only sustainable cod after 2012. To access international markets, eco-certification such as MSC will need an operational PA framework for each groundfish stock.

In order to move forward with implementation of the PA framework, the Council supports the development of harvest decision rules within rebuilding plans for eastern Canadian groundfish stocks. Priority should be given to those stocks that have established reference points, and particularly those cod stocks that are in the critical zone.

The FRCC recommends that priority be given to developing rebuilding plans for groundfish stocks in the critical zone. The rebuilding plans for high priority groundfish stocks should be in place by the end of 2012.

DFO's PA framework is unclear on whether directed fishing can be permitted when the stock level is within the critical zone. The policy states that "when a stock is in the critical zone, removals by all human sources must be kept to the lowest level possible". This statement can be subject to interpretation and cover situations ranging from complete closure to minimal bycatch to directed fisheries. One interpretation of the policy is that fishing removals can be permitted, but only within the context of a rebuilding plan, and only if the level of removals meets constraints specified in the plan (for example, that removals are consistent with a positive stock trajectory and do not threaten stock rebuilding out of the critical zone in the established time frame). Removals may include bycatch, subsistence, commercial or recreational fisheries. Such options could be examined on a case-specific basis and factors such as the slope of the trajectory and level of SSB would be considered. In cases where harvesting is permitted, the recovery plan must include additional restrictions on catches should evaluations fail to show that recovery is occurring. If the SSB is declining, fishing mortality from all sources would need to be reduced further.

The FRCC recommends that the precautionary approach framework include an explicit statement regarding whether directed fishing can be permitted when a stock is in the critical zone, and if so, the circumstances and conditions under which such fishing will be allowed.

For stocks in the critical zone, there would be need for enhanced management to promote stock growth and to improve other measures of stock well-being, such as an expansion of the age and size composition and a return to the historical geographical distribution. Such measures might include the following: reducing catches from all sources; the protection of one or more year classes; further protection during spawning from fishing and other ocean activities; harvesting limitations by area and time on fisheries directed at other species; strategies to maintain bycatch at lowest possible levels; limits on total allowable catches for certain prey species such as capelin; and initiation of targeted seal removals in areas where seal predation has increased natural mortality of cod and is affecting cod recovery. Some of these measures might be relaxed once the stock has cleared the critical zone.

The FRCC recommends that rebuilding plans incorporate enhanced management measures, including prey protection and predator control, to improve the chances for stock recovery.

Accurate reporting of all forms of catch (commercial, recreational, scientific, food, social and ceremonial, whether directed or bycatch, retained or non-retained) is essential. Stocks with recovery plans should have a heightened level of monitoring involving 100% DMP, adequate observer coverage and an accounting for non-retained catch. It is recognized that, when stocks are in the critical zone and small quotas are permitted, then there could be limitations on bycatch of that stock in other fisheries, constraining the catches of those fisheries or leading to discarding. Various strategies will need to be implemented to keep bycatch at the lowest possible level, including bycatch avoidance through gear modification, time and location of fishing and inter-fleet cooperation on access to bycatch.

7.5 Communication and consultation

Among those familiar with government fisheries policy, the PA is well understood. For the industry at large, the PA will be a learning experience. A comprehensive plan outlining the concept, benefits and implications will need to be clearly communicated at regional and local levels. The consequences of not implementing the PA framework are outweighed by its benefits. The PA can be a complicated concept for some and it is important to have the policy and the terminology simplified and clearly explained.

The initial development of reference points and targets are one-time events that are followed up with future refinements and performance evaluation. The analysis of data collected on each fish stock would form the basis for monitoring reference limit trends relative to the harvest decision rules (HDRs) and stock status. Regular review of performance of the HDRs every three years and evaluation of the HDRs after five years would guide implementation of the PA. Short term projections, no more than three to five years, would

also provide a guide and information on the trajectory of stock status relative to the framework and recovery objectives.

The FRCC recommends that the precautionary approach concept and the benefits and consequences of its implementation be clearly communicated to fishermen, their organizations and interested non-governmental institutions at the regional and local level.

There will need to be a good degree of cooperation among stakeholders to reach agreement on most reference points. The regular consultative mechanisms (see Section 8), such as DFO science and fisheries management advisory processes and working groups, should be adequate to develop harvest decision rules and reference points and to steer rebuilding and monitor performance evaluation. In some areas, local community advisory committees could be reactivated and would be good forums for fishermen to be consulted on the PA and HDRs.

A stock currently in the critical zone will present greater challenges for the fishing industry than a stock in the cautious zone. The prospect of further declines in catch accompanied by more management restrictions will require rigorous industry consultation.

The Council recognizes that rebuilding plans will differ from stock to stock, and that some plans may take several years and intensive consultation to implement. Fishermen have indicated that if reference points are established at levels that are far above the current spawning stock biomass, there is no need to develop a recovery strategy or rebuilding plan, since the commercial fishery will be finished. They feel there is little reason to rebuild a fishery if there is no future for those fishermen remaining. Rebuilding plans consistent with the PA will reduce fishing in many stocks in the short term and help with stock recovery over time. The challenge for all stakeholders will be the weaving of long-term stock rebuilding objectives for sustainable fisheries with the immediate requirements of the fishing industry.

The FRCC recommends that, for groundfish stocks within the critical zone, a greater level of consultation through active and reactivated advisory committee processes be held with stakeholders at the regional and local level. It is recognized that implementing rebuilding plans by some fishing sectors and for certain stocks could require more intensive consultations and specialized forums.

8 Governance

Governance has been defined in numerous ways. One definition that can be used to inform discussion and inspire thought on the development of the best approaches to the recovery of groundfish stocks is as follows.

> *"Governance relates to consistent management, cohesive policies, guidance processes and decision rights for a given area of responsibility."*

It is critical to emphasize the importance of governance in the context of the mandate for this report. The Terms of Reference clearly outline that key considerations for the long-term success of commercial fisheries include "effective and efficient governance and management regimes", and that the Department could benefit from advice on these issues.

The Fisheries Renewal initiative of DFO advocates the establishment of new policies, tools and mechanisms to support the fisheries sector. The Department has identified the three objectives to be achieved under Fisheries Renewal as Long-Term Sustainability, Economic Prosperity and Improved Governance. It is envisioned that the Improved Governance objective will be achieved by increasing stability, transparency and accountability in fisheries management and by promoting shared stewardship.

Governance approaches worthy of review in relation to their contribution to the management and recovery of groundfish stocks include Integrated Fisheries Management Plans, Shared Stewardship and a renewed *Fisheries Act*. Another governance mechanism that is exerting notable influence upon DFO management responses is the *Species at Risk Act* (SARA) and the associated Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

8.1 Integrated Fisheries Management Plans

Integrated Fisheries Management Plans (IFMPs) have been identified as a significant tool in implementing provisions of DFO's Sustainable Fisheries Framework (SFF) and other elements of the Fisheries Renewal Program. DFO approved a new template for IFMPs in March of 2009 as part of a renewed IFMP process.

IFMPs are to be developed for every managed fish stock. IFMPs outline short and long-term objectives of each stock's fishery and provide a means for implementing various policies. IFMPs include considerations of economic circumstances and the impacts of environmental conditions on fisheries, and provide for an annual performance review.

An IFMP has been described as both a process and a document. As a process, it is intended to provide an integration of the expertise and activities of the various DFO sectors and is to allow for input by fishermen and other stakeholders into the management process. As a document, its primary goal is to provide a planning framework for the conservation and sustainable use of fisheries resources and to outline the process by which a given fishery will be managed for a period of time.

In 2010, DFO developed a guidance document for preparing an IFMP to ensure further clarity in the content and application of the template and to ensure that various regions use the same approach in the development of the plans. The template calls for the development of clearly-stated long-term objectives for sustainable fisheries under the headings of Stock, Conservation, Ecosystem, Stewardship, Social, Cultural and Economic, and Compliance.

These long-term objectives are viewed as the foundation of the IFMP. Other components of the IFMP are to include an Overview of the Fishery, Stock Assessment including the Precautionary Approach Framework, Management Issues, Access and Allocation and Performance Review.

Since IFMPs are designed to be multi-year plans, the Performance Review is extremely important and is to be carried out each year on a post-season basis. When the Performance Review is incorporated into the plan, it should outline measurable indicators to determine whether or not the long-term objectives are being achieved and that Management Issues that have been identified are being addressed.

The FRCC has reviewed the IFMP template in the context of its use as a tool to assist in the long-term success of groundfish fisheries and stock rebuilding. A number of the elements of the IFMP address factors necessary in developing stock rebuilding plans, including incorporation of the Precautionary Approach (PA), developing long-term objectives for a sustainable fishery, consultation, recognition of Shared Stewardship, Compliance and Performance Review. This would imply that stock recovery plans would

be part of an IFMP, but the IFMP template does not actually state so.

To ensure consistency with the recommendation regarding rebuilding plans in the section of this report dealing with the Precautionary Approach;

The FRCC recommends that the Integrated Fishery Management Plan (IFMP) template be amended to unequivocally state that stock rebuilding plans will be an integral component of IFMPs for stocks in the critical zone of the harvest strategy framework.

The FRCC notes the increasing importance of sustainability in the marketplace, giving rise to eco-certification requirements. These requirements include the existence of and adherence to management plans as one element to ensure sustainability. IFMPs help fulfill that requirement.

The IFMP process will require the completion of plans for more than forty stocks of eastern Canadian groundfish. There is, obviously, a logistical and time sensitivity challenge involved in such an assignment. Some of the stocks in question are healthy and commercially viable; some have been depressed but show signs of rebuilding, while others are still stagnating or declining.

The FRCC recommends that DFO undertake an exercise to prioritize and initiate the development of Integrated Fishery Management Plans (IFMPs) for all groundfish stocks on a timely basis. IFMPs should outline a decision-making process that is participatory, transparent and accountable and incorporate goals and objectives that are clear and measurable.

As referenced in the recommendation above, the IFMP process should be participatory. The Council has observed through the consultation process that the status of groundfish species advisory committees has become inconsistent and in some cases they are no longer functional.

The Council notes that these committees have, over the years, provided an effective forum for managers, scientists, harvesters and processors to exchange information on regional stocks. The closure of some fisheries has, in some instances, discouraged the functioning of the species advisory committees, however, Council feels that they represent a valuable forum that can contribute to the stock rebuilding process.

The FRCC recommends that groundfish species advisory committees become the focal point of industry input to the Integrated Fishery Management Plan (IFMP) process. Regularly-scheduled committee meetings will allow, on an on-going basis, an exchange of information on stock status, economic and social considerations, and effective management measures for stock rebuilding and sustainable exploitation.

8.2 Shared stewardship

Groundfish harvesters have valuable experience, skills and knowledge gained “on the water”. Their insights on the resource are important and their cooperation is essential to stock rebuilding. The need to engage them and other industry members is paramount.

Shared stewardship is a concept which has been promoted in the fishery of eastern Canada for a number of years. The Atlantic Fisheries Policy Review (AFPR) annunciated the principle that governments, resource users and others with an interest in the fisheries share responsibility for the sustainable use and economic viability of fisheries.

The AFPR outlined four strategies to promote shared stewardship:

- adopt a more inclusive approach to policy planning;
- enable resource users to assume more of a role in operational decisions;
- facilitate Aboriginal participation in policy planning and decision making; and
- support building capacity for resource users to take on new responsibilities.

The AFPR also defined co-management as the sharing of responsibility for results between DFO and resource users, and in time and with legislative amendments, the sharing of authority for fisheries management. It was envisaged that in accordance with capacity and degree of interest, organizations would be held accountable for decisions and would bear incremental costs of changes that organizations would propose.

The Council acknowledges the importance of effective industry engagement to processes associated with sustainable groundfish stock management and rebuilding. Shared stewardship and co-management can possibly provide the avenue for engaging the industry.

However, the FRCC would assess the current state of progress with respect to these concepts as limited. There should also be acknowledgement of the fact that the AFPR process envisaged legislative changes to share the authority for fisheries management and to date that has not occurred.

As a result of its consultation process and deliberations, the FRCC has observed a marked difficulty in engaging the industry when cod and other groundfish stocks are at low levels, such as in the Southern Gulf of St. Lawrence. There have been expressions of resignation that stock recovery will not happen in the remaining careers of many fishermen.

There is also the issue of volunteer burn out and meeting fatigue when fishermen comment that the same people go to meeting after meeting, but the state of the groundfish resource remains unchanged. This is also relevant to the larger issue of the capacity of fishermen's organizations to undertake shared stewardship or co-management.

The FRCC notes, based on consultations with industry, that certain sectors of the industry have made substantial progress in assuming strong co-management roles, increasing self-reliance and the ability to make sound business decisions respecting their fishery. It has been demonstrated that groundfish fleets that have adopted quasi-property rights have in many cases carried out self-rationalization and are now seeing the merits of rationalization with an improvement in enterprise viability.

The FRCC also notes that there are some fleets that are not nearly as well positioned. Business decisions need to be made as do decisions on sustainability, but some fleet sectors may not be equipped to make or effect changes that would allow good business decision making. Shared stewardship might work well when stocks are in the healthy zone, but less well when stocks are in the critical zone or when fisheries are closed.

While dialogue between fishermen and fish processors has strengthened in some sectors, other components of the industry still need improvement. There continues to be mistrust of DFO and their intentions for the inshore and a lack of transparency in decision making. In some sectors, the prevailing attitude remains that DFO should make the decisions respecting the fishery and stock recovery since they were at least partly responsible for the current state of affairs.

To be fair to the vision of the AFPR, there was clear acknowledgement that organizations had to build capacity to be involved in the decision-making process. That capacity includes individual and organizational knowledge and skills, and the financial and human resources necessary to effectively engage in the decision-making process. Such capacity is not built overnight. While there is progress, it is better developed in some sectors than in others.

The shared stewardship and co-management concepts can provide the tools for engaging industry, but not all areas are equally organized to collaborate with DFO in this process.

The FRCC recommends that DFO renew and strengthen its commitment to the concepts of shared stewardship and co-management, as discussed in the Atlantic Fishery Policy Review, so that these initiatives may encourage greater participation by the fishing industry in stock rebuilding and self-rationalization.

8.3 The *Fisheries Act*

The *Fisheries Act*, the basis for managing Canada's fisheries, has not been substantially revised since its adoption in 1868. Its limitations are serious and self-evident. The absolute discretionary powers afforded to the Minister, under the Act, leave Ministers open to criticism in decision making on the basis that decisions can be viewed as political or open to favouritism and that the ultimate outcome of decisions can promote claims of not dutifully managing and conserving fish stocks.

Ministers have the challenge of sorting through various forms of advice in reaching decisions on a multitude of fish stocks. Ministers are left without prescriptive legislation to provide clear direction and set measurable targets for stock health.

In the context of groundfish stock rebuilding, the legislative remedies present in some other jurisdictions are not available in Canada. For example, the Magnusson-Stevens Fishery Conservation and Management Act, in the United States, specifies objectives and measurable criteria for determining overfishing and sets specific timeframes for rebuilding stocks, i.e. maximum of ten years.

In its current deliberations respecting groundfish, the FRCC recognizes that the absence of a modern

Fisheries Act represents a fundamental challenge to the implementation of measurable objectives for preventing overfishing and rebuilding depleted fish stocks.

The FRCC recommends that the Minister of Fisheries and Oceans introduce legislation to modernize the *Fisheries Act*.

8.4 The *Species at Risk Act*

The *Species at Risk Act* (SARA) was passed in 2002 and came into effect in stages during 2003 and 2004. It sets out prohibitions for such activities as harming, taking, possessing, buying or selling an individual of any endangered or threatened species that is protected under the Act, or the destruction of its critical habitat. The *Act* requires the development of recovery plans within two years for species listed as threatened and within one year for those listed as endangered. For species of special concern, a management plan is required. The Governor-in-Council (the Governor General acting on the advice of the Cabinet) decides whether or not a species is added to the SARA legal list.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent committee of wildlife experts and scientists created in 1977 to assess the risk that species of wildlife might become extinct or extirpated. COSEWIC was identified under SARA as the advisory body whose designations would be considered recommendations to the government for the legal listing of wildlife species at risk. COSEWIC voting members are made up of the species specialist group chairs as well as appointments from relevant federal and provincial departments, environmental non-government organizations and First Nations. In determining the recommended status of a particular population, COSEWIC bases its assessment criteria on the criteria developed by the International Union for the Conservation of Nature and Natural Resources (IUCN). The criteria include assessment thresholds for declining percentages (most often used for marine fish).

When COSEWIC completes an assessment of the status of a wildlife species, it must provide federal and provincial environment ministers a copy of the assessment and reasons for designation. If the Minister of Environment recommends the listing of a species under SARA, the Governor-in-Council may accept the assessment and add the species to the list, decide not to add the species to the list, or refer the matter back to COSEWIC for further information or consideration. The Minister of Fisheries and Oceans is considered to be the competent Minister with respect to aquatic species.

COSEWIC produced its first assessment of cod in 1998. Although the writer of the report wanted to have most cod stocks designated as endangered, the committee decided to designate cod as "vulnerable" (a designation that later became "special concern"). This designation had no legal implications at that time.

COSEWIC published another assessment of cod in 2003. For this assessment, cod was considered at the level of "evolutionarily significant units" (Figure 7). Of the four units identified during this process, two were designated to be "of special concern", but the other two, which included all cod stocks north and east of the Laurentian Channel, were designated as either "endangered" or "threatened". These latter two designations had serious implications for the conduct of fisheries directed at cod or other fisheries that might take cod as a bycatch. DFO went through an extended consultation process that included socioeconomic analyses and consultations with provinces, First Nations, industry and others with an interest in the species. The Government announced in 2006 that it had decided not to add the Newfoundland and Labrador, Laurentian North and Maritimes populations to the SARA List of Wildlife Species at Risk. The Government said it "believes the best way forward is to manage the recovery of cod through a comprehensive, integrated and Atlantic-wide approach that will build on the unprecedented collaboration of the federal-provincial Cod Action Teams."

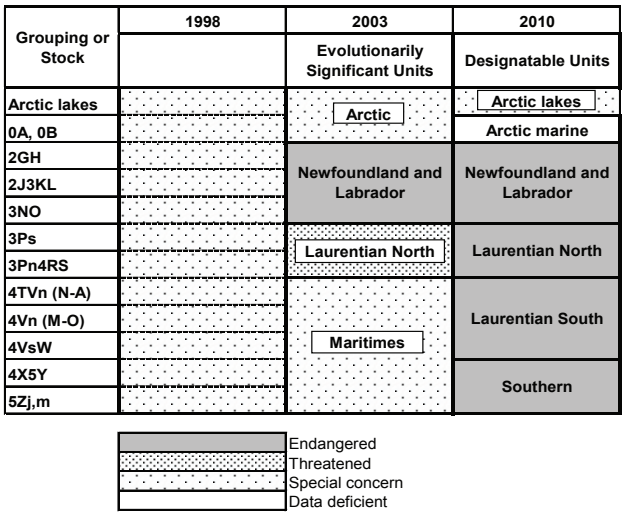


Figure 7. The status of cod as designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1998, 2003 and 2010. Cod in the Arctic lakes and in Arctic marine waters (NAFO Divisions 0A and 0B) are not within the boundaries of any of the stocks recognized for fisheries management by DFO.

COSEWIC assessed cod once again in 2010. This time it identified six populations or designatable units (DUs; Figure 7). Four of these, which encompass all 10 stocks recognized for fisheries management, were designated as endangered. The Government of Canada has again chosen an extended consultation path prior to making a decision regarding listing under SARA.

Cod is not the only groundfish species to have been assessed by COSEWIC. Other species that have received a designation by COSEWIC include winter skate, spiny dogfish, cusk, roundnose grenadier, roughhead grenadier, deepwater redfish, Acadian redfish, American plaice, and 3 species of wolffish (Appendix 7). The only species that have been placed on the SARA Schedule 1 (List of Wildlife Species at Risk) to date are northern wolffish (threatened), spotted wolffish (threatened) and Atlantic wolffish (special concern). The latter two species have commercial value.

During FRCC consultations held to provide input to this report, the fishing industry expressed concerns about COSEWIC assessments of groundfish, especially cod, cusk and redfish, and more generally about the appropriateness and value of assessing marine groundfish of commercial interest under SARA.

The FRCC feels that many of these concerns arise from the management of commercially-exploited marine fish under three separate acts of Parliament and their diverse administration. These acts are the *Fisheries Act* and the *Oceans Act* on one hand and the *Species at Risk Act* on the other.

Under the *Fisheries Act* and the *Oceans Act*, DFO has the authority and mandate to manage the exploitation of marine fish. The recent development of a harvest strategy framework compliant with the precautionary approach (PA) is concerned with reducing the risk of serious harm to the productivity of a stock. The *Species at Risk Act*, in contrast, is concerned with preventing extinction or extirpation.

Application of the PA should ensure that species/stocks do not decline, as a result of human activites, to the extent that there is a risk of extinction. However, most of the groundfish stocks that are currently at low abundance declined during the late 1980s and early 1990s, well before DFO developed its PA framework and before SARA was declared. A consequence is that many groundfish stocks are found to be in the critical zone when harvest strategy frameworks, including limit reference points, are formulated, and also meet decline criteria applied by COSEWIC. This could result in two pieces of legislation prescribing different criteria to stocks at low abundance, with potentially different consequences for fisheries.

The FRCC has several concerns regarding the appropriateness of applying the COSEWIC - SARA process to commercially-exploited marine fish.

First, there is debate whether such species are really at risk of becoming extinct or extirpated. To the FRCC's knowledge, no marine fish species has become extinct in the Arctic and boreal regions of the North Atlantic, despite centuries of exploitation. This is not to say that fisheries do not have impacts, such as reductions of local populations.

Second, the COSEWIC - SARA process is very prescriptive, making it illegal to kill, harm, harass, capture, take, possess, collect, buy, sell or trade an individual of any endangered or threatened species that is protected under the Act. The Minister of Fisheries and Oceans may authorize activities which could affect a species protected under SARA, but only if he/she is of the opinion that affecting the species is incidental to carrying out the activity. In addition, there are several stringent pre-conditions that must be met. SARA has the potential of requiring a cessation or severe curtailment of the fishing industry. Once a species has been listed, there is little opportunity for engagement by the fishing industry. The COSEWIC-SARA process is a constraint to a vision of fisheries in which the fishing industry shares responsibility for the sustainable use of the resource.

Third, for most marine species of commercial interest there is a rich history of biology and dynamics based on information coming from the fishery and usually also from fishery-independent sources, such as scientific surveys. For most groundfish species, the data have been collected according to stocks that were defined, in most instances, decades ago. The stock boundaries were established on the basis of patterns in distribution/migration and geographic differences in biology, such as growth rate, age at maturity and parasites. For some species, COSEWIC combines two or more stocks into one designatable unit (DU). As a consequence, a unit may comprise two or more groups of fish with considerable differences in potential productivity, different histories of exploitation and different constraints on recovery. This can add complexity and confusion to the management of these units. As an example, the Newfoundland and Labrador DU of cod comprises the 2GH, 2J3KL and 3NO cod stocks. The cod stocks at the northern and southern ends of this

DU differ greatly with respect to historic productivity (growth rates, maximum size, size/age at maturity), recent fishing activity, current threat from predation by harp seals and potential for recovery in the near-term.

Fourth, a COSEWIC assessment at a geographic level that is more aggregated than the traditional stock management units may result in the COSEWIC assessment status being at odds with that arising from the traditional stock assessment process. Perhaps the most glaring example has arisen from the merging of the 3Ps and 3Pn4RS cod stocks into a Laurentian North DU. In 2003, COSEWIC determined that this unit was threatened, whereas the DFO assessment of 3Ps cod indicated that it had recovered very well from its decline in the early 1990s. In 2010, COSEWIC promoted the status of the Laurentian North unit to endangered, whereas the DFO assessment of 3Ps cod indicated that the stock was (slightly) above its limit reference point. COSEWIC's procedure of aggregating stocks into higher level populations or DUs has the potential of halting fishing in areas where such a severe constraint is not necessary.

Fifth, in addition to the concerns about the appropriateness of the COSEWIC - SARA process, there is concern about the considerable duplication of effort. For the traditional management of a groundfish stock, data relevant to the status of the stock are reviewed during an assessment meeting. The results of the assessment, which include stock status and advice to managers, are published in a Science Advisory Report (SAR), which is generally supported by one or more research documents and a proceedings document. When COSEWIC decides to assess a species, it advises DFO, which may compile information on the status and general biology of all stocks of that species and peer-review the information in a pre-COSEWIC meeting before making the information available to COSEWIC. DFO has opportunities to review the draft COSEWIC assessment. If COSEWIC designates a species (or a DU) as endangered or threatened, DFO generally embarks upon an extended consultation process. This may include a meeting to assess threats to the species' survival and recovery, mitigation measures, impacts of various management scenarios and the feasibility of the species' recovery. This process is termed a Recovery Potential Assessment (RPA). The long multi-step process that follows COSEWIC's decision to assess a species may result in improved understanding of the biology or status of the species, but for the most part the pre-COSEWIC and RPA exercises are re-workings of the data used in the traditional assessments. At a time when the number of scientists available for conducting assessments is much reduced below historic levels, it seems highly wasteful that they spend so much time and effort attending meetings and preparing documents for the two different assessment streams. There are many additional issues that require their expertise. There is also considerable expense associated with socioeconomic analyses and consultations that may be conducted as part of the extended consultation process.

It must be recognized that the COSEWIC – SARA process is not only a major contributor to the current scientific and management workload of DFO and its clients, but it is likely to remain so for many years to come. Many species of marine fish have yet to be assessed by COSEWIC. For example, a pre-COSEWIC assessment meeting has recently been conducted for smooth skate and thorny skate, and the list of candidate species on the COSEWIC website (April 2011) includes spinytail skate, haddock, pollock and ocean pout. It is not inconceivable that COSEWIC will decide to assess every species of fish in eastern Canadian marine waters. Note as well that COSEWIC is required to reassess all species at regular intervals, whether they have been listed or not.

The FRCC feels that, given the many concerns about the appropriateness of the COSEWIC- SARA process as it relates to the unique aspects of marine species, and the considerable redundancy and cost of assessing commercially-exploited marine fish with two independent processes, it would be appropriate and preferable to manage and afford protection to commercial marine fish using the Department's "Fishery Decision-Making Framework Incorporating the Precautionary Approach", as discussed in Section 7 of this report.

The FRCC recommends that commercial marine fish be managed under a modernized *Fisheries Act* which ensures the mandatory implementation of the precautionary approach to fisheries management decisions and affords protection comparable to that which is provided for under the *Species at Risk Act*.

9 Socio-Economics and Markets

Groundfish dominated seafood landings in eastern Canada until the early 1990s (see section 2.4). Since that time, the groundfish fishery has changed in almost every respect, including overall value, demographics and fleet profile. Markets have changed as well. Change will continue, and the fishery of tomorrow will be different in most respects from the fishery of the past.

9.1 Socio-economics

9.1.1 Value of groundfish landings

The value of the groundfish fishery, and the percentage it represents of the total value of eastern Canadian commercial landings, has changed considerably over the past two decades.

In 1990, the total value of eastern Canadian commercial landings was $956 million. Groundfish accounted for $388 million of that total, or 41%. The landed value of cod was $244 million, which represented 63% of the value of all groundfish and 26% of the value of total landings.

In 2009, the total value of eastern Canadian commercial landings had increased to $1.391 billion. Of this total, groundfish accounted for $143 million, or just 10%. The landed value of cod was $24 million, which represented only 17% of the value of all groundfish and just 2% of the value of total landings.

9.1.2 Demographics

The declines in the quantity and value of landings in the groundfish fishery severely impacted the people in the industry. The number of harvesters declined 49% in the period 1990 to 2007. The workforce is also older. In Nova Scotia, for example, the percentage of harvesters in the 45 - 64 age category increased from 26% of all fishers in 1991 to 43% in 2009. In Newfoundland and Labrador, the percentage of harvesters over age 55 increased from 10% in 1999 to 29% in 2009.

While traditionally viewed as having an older workforce, the processing sector was not dissimilar to other industries in the early 1990s. Since then, the age profile of the processing sector has changed dramatically, and the older-worker profile is now appropriate. As was noted in one recent study:

> *The differences in age structure are likely a result of the early retirement components of the groundfish adjustment programs of the first half of the 1990s. As well, seniority clauses, combined with levels of processing employment, have not provided significant opportunities for new entrants to the processing sector. This also has contributed to the current age structure. This overall ageing of the population and the processing sector labour force has implications for plant productivity and the long-term labour supply prospects of many companies. (Final Report, Fish Processing Policy Review, 2003, p. 27.)*

Since 2001, there has been a trend of outmigration from fishing communities in eastern Canada and a decline in birth rates. Many people have moved out west in search of employment as a result of low incomes in the fishery and better opportunities elsewhere. For many, it has not appeared difficult to choose opportunities elsewhere over 'weeks worked' and Employment Insurance for the balance of the year (FRCC Lobster Report, 2007, pp. 39-40).

There are now only a handful of groundfish primary processing facilities in eastern Canada. The changing demographics means a recovered groundfish fishery, with labour requirements more intensive than other fisheries, will struggle to find workers. Even at present, a number of processing plants in various provinces require an increasing number of foreign workers to fulfill their employment needs. Any increase in groundfish production will require additional workers. Governments need to be cognizant of these changing requirements for temporary immigrant workers.

9.1.3 Fleet profile

The numbers of fishing boats and registered fishermen in eastern Canada declined substantially (by roughly one-third) during the 1990s, largely in response to incentives provided by a series of Government programs intended to assist industry during the period of reduced total allowable catches and closures. For the most part, the boats that were retired were small and the licences that were retired had been held by people who had not been very active. The programs are generally

considered to have had relatively little impact on fishing power and the number of people who were seriously interested in the fishery. Indeed, in some areas fishing power increased considerably as fishermen moved to larger, more powerful boats with greater technological sophistication to take advantage of opportunities in the expanding shellfish fisheries.

Declines in numbers of vessels and registered fishermen have continued. To obtain some insight into the current profile of the fleet licenced to fish groundfish, the Council has compared the number of groundfish licences that existed in 2009 to the number of vessels that landed more than 500 kg of groundfish in that year (Table 1). Although there are some concerns about the validity of this comparison (for example, there may be instances where more than one groundfish licence was fished from a single vessel), the numbers indicate that only about 40% of all groundfish licences were used to a significant extent in 2009. Many enterprises have maintained their groundfish licenses as part of their core licence portfolio, and represent substantial capacity that could potentially return to groundfish.

Numerous reports have discussed concerns related to the fact that the total capacity available for fishing groundfish far exceeds the quantity of groundfish resource available, both now and in the near term.

Excess capacity poses a risk and a complicating factor in the rebuilding of groundfish fisheries. It is a challenge to management because of pressure to increase quotas to allow for wider participation of those with licenses and vessels presently inactive in groundfish. In addition, current participants may be averse to implementing long-term measures to improve the fishery if they think that much of the benefit will go to those who have been on the sideline.

Excess capacity is also a challenge to the long-term viability of fishing enterprises, since there is not enough resource to provide satisfactory economic return for all those with licences. Furthermore, current participants may be reluctant to make necessary investments in their enterprises for fear that returning participants might dissipate benefits from recovering stocks.

Industry and government must work together to create new mechanisms and approaches to reduce overcapacity in the industry.

The FRCC recommends that DFO and industry evaluate the risks that excessive capacity poses to the sustainability of groundfish fisheries.

In recent years, DFO has worked with harvesters in various regions to develop policies to enhance both the short-term and long-term economic viability of fishing enterprises in the < 65ft fleets. This has resulted in policies such as buddy-up and licence stacking. Another such policy is the Fleet Self-rationalization or Enterprise Combining Policy developed for Newfoundland and Labrador. Under the policy, individual enterprise holders can buy out other licence holders for the purpose of combining enterprises, but this transaction must result in the removal of one enterprise, a vessel registration and any duplicate species licences. This policy addresses the long-term economic viability of those who decide to remain in the fishery while reducing the overall number of enterprises.

The FRCC recommends that the Fleet Self-rationalization or Enterprise Combining Policy developed for the < 65ft fleet in Newfoundland and Labrador be provided as an option to other areas of eastern Canada.

Column A	Column B	Column C	Column D
DFO Region	Number of groundfish licences (2009)	Number of vessels with groundfish landings over 500 kg (2009)	Column C divided by Column B (in percent)
Newfoundland and Labrador	4,369	3,029	69%
Quebec	926	325	35%
Gulf	1,885	79	4%
Maritimes	2,694	498	18%
Grand Total	9,874	3,931	40%

Table 1. Groundfish fleet structure. This table provides an indication of the percentage of groundfish licences that were used to fish for groundfish in 2009. Column B shows the number of groundfish licences in existence in each DFO Region in 2009. Column C shows the number of vessels that reported groundfish landings greater than 500 kg in that year. (500 kg was selected arbitrarily as a cutoff so as not to include those vessels that reported only a small amount of groundfish that had been taken as bycatch.) The value in Column C was divided by the value in Column B, and expressed as a percentage in Column D. (Data from Fisheries and Oceans, Statistical Services, Ottawa)

The FRCC recommends that DFO engage in partnerships with provinces to fast-track policies that enable license holders to access long-term capital to facilitate fleet self-rationalization.

9.2 Markets

9.2.1 Market summary and perspective

Markets for fish have changed dramatically. The global supply of whitefish, including both wild groundfish species (e.g. cod, pollock, haddock, hake and redfish) and farmed species (e.g. tilapia, catfish and pangasius), has fluctuated between 8 million and 10 million tons over the past 20 years. Since the 1990s, wild groundfish supply has declined from about 10 million tons to 6 million tons in 2008, but the rapid increase in production of farmed whitefish in the late 1990s reached an estimated 4 million tons in 2008, largely offsetting the decline in groundfish supply. Recent increases in production of wild groundfish from the Barents Sea (cod and haddock) and the Bering Sea (Alaskan pollock) are anticipated to continue under renewed fisheries management programs and productive conditions for fish growth.

At one time, Atlantic whitefish represented a large portion of the 'fish of choice' in the whitefish market, and cod was the largest component of that market. In the period 1980-1985, Canada landed between 420 and 450 thousand tonnes of cod annually, just under 25% of the total Atlantic-wide landings of over 2 million tons. Today, Canada lands much smaller quantities of cod, but cod still comprises about 13% of total groundfish supply globally, a decline from about 16% in the late 1990s. Today, the main groundfish is Alaskan pollock, which accounts for about half of total groundfish landings.

As the eastern Canadian groundfish fishery recovers, developing markets for the additional supply will be a challenge. Although seafood consumption can be expected to increase with a growing world population, the current market has a variety of competitors from both wild groundfish (especially Alaskan pollock) and farmed whitefish.

9.2.2 Quality versus Quantity

Historically, groundfish fisheries of eastern Canada have been supply-driven with the main objective being quantity. This has resulted in landing gluts, poor quality fish, and the production of a few low-valued products. Today, management regimes attempt to slow the race for fish. Mechanisms such as Individual Quotas and Individual Transferable Quotas have been successful in reducing gluts, albeit hand in hand with low quota levels. But low quota levels should of themselves be an incentive to maximize the value per fish.

Quality means different things to consumers, processors and retailers. It can include appearance, texture, eating quality and food safety. Either way, it is important to gain consumer confidence and repeat sales, as well as potentially higher market returns.

There are many reasons why good quality groundfish is not the norm in eastern Canada. These include:

- fleet structure/capacity that may not be conducive to fishing at a time of the year when fish quality is best;
- lack of knowledge about proper handling procedures;
- Employment Insurance program structure that influences fishing patterns (as well as plant operations), and therefore quality;
- port price incentive for premium quality groundfish that is inadequate in current structure;
- groundfish catch that is secondary to crab and or shrimp and may not be well handled on a vessel better outfitted for another fishery;
- fishing gear that is unable to be handled because of poor weather;
- inconsistent demand from buyers for consistent quality; and
- inconsistent policy focus from provincial governments.

The fishing industry needs to unite in pursuit of landing good quality groundfish using a universal grading system to supply consistent quality to markets.

9.2.3 Eco-labeling and traceability

The movement to eco-certification (i.e. the certification of fish as being sourced from sustainable fisheries) is well entrenched in Europe, growing in North America, and making inroads in Asia. Growing demand for conservation minded fisheries and sustainably sourced fish, on the part of both seafood consumers and the general public, has stemmed in part from poor fisheries management practices of the past. In time, fisheries management regimes may satisfy third party sustainability requirements, replacing third party labels like that from the Marine Stewardship Council, but for now, consumers will continue to look for a reputable label they can trust.

The gold standard in eco-certification, particularly in Europe, is the Marine Stewardship Council and their MSC label. Other labels are less rigorous but satisfy some markets. The MSC eco-labeling process is complex and evaluates not only the fisheries management system but the condition and status of the species by stock and fishery.

Groundfish species, notably cod, need an MSC label to be accepted into markets like the United Kingdom. Canadian fishery sectors will need to work together to achieve adequate certifications. Some global seafood buyers have already moved to delist cod products, given the lack of eco-certification, which makes the product unpopular in the marketplace. In some cases, the producer has been notified it has until the end of 2012 to prove its products are produced from sustainable sources.

Canada issues catch certificates to Canadian companies seeking to export fish and seafood products to the European Union and other markets. The catch certificates attest that Canadian seafood products come from a properly licensed, regulated and reported fishery, that is regularly monitored and audited (in contrast to IUU, or Illegal, Unreported, Unregulated fisheries). These traceability requirements are rapidly evolving as a means of ensuring food safety as well as ensuring the seafood originates from sustainable sources.

As these requirements become more widespread, traceability could expand from species/stock area or plant level to the vessel level. This would require identification of vessel name, registration number, gear type and date and location of catches. Such requirements would present logistical problems for small vessel fishermen with multiple landings to one buyer, with subsequent transport to processing plant. Designated landing sites with icing and sorting services would therefore be an asset for traceability purposes.

9.2.4 Global marketing

The current North American groundfish market is radically different from that of the 1980s and early 1990s, when cod was a leading species. Demand for cod blocks and other commodity formats has decreased 90%. During the 1980s, the United States imported 75,000 to 80,000 tonnes of cod fillet blocks. By 2008, the volume had dropped to 7,500 tonnes. Alaskan pollock is now the dominant species. Alaskan pollock fills the low to medium end of the market along with other whitefish species such as tilapia and catfish. The global market has also shifted from commodity formats to individually quick frozen (IQF) products, with greater emphasis on quality.

A major consolidation has occurred in the food service and secondary processing sectors over the past 20 years. In 1990, Canada accounted for about 70% of United States imports (groundfish) by value. This position is now occupied by China, which accounted for about 62% in 2009. Canada currently occupies second place (14%), followed by Iceland (9%), Norway (5%) and Russia (4%). China is a major global supplier of groundfish products, and is the largest exporter to markets in the European Union (>50%).

The value of cod varies greatly depending on its final product form, destination and supply, and demand within particular markets. There is a significant distinction between single-frozen and twice-frozen cod. For single-frozen cod, fresh fish is filleted and graded, and then frozen. For twice-frozen cod, headed and gutted (H&G) fish is frozen then sent to processing factories, where it is thawed out and further processed and refrozen. Twice-frozen cod is sold at a discount to single-frozen cod.

Whether single or double-frozen, cod fillets are sold in various product forms including: shatter-pack fillets, where individual fillets can break apart and be used in restaurants; portions, which are generally tails, middles, and loins, sized to exact specifications; and fish fillet blocks made up of whole fillets or pieces, which are cut to shape for foodservice applications.

In general, lesser quality cod that cannot be used in the fillet market is often processed into blocks and sold at a loss because of the competitive nature of the block market. In addition, the value of cod fillets varies by

how much water is added during processing. Twice-frozen products almost always have higher levels of water added than single-frozen products.

Most cod caught in New England and in Nova Scotia is not processed into frozen cod, but is sold directly into the fresh cod market on the East Coast. Newfoundland and Labrador is too far from these major markets to supply fresh cod cost-effectively. As a result, Newfoundland and Labrador is the only province where producers still provide frozen cod. About 80% of their cod production is currently sold into Europe, and only about 20% goes into the United States market.

In the United Kingdom, cod is the number one consumer fish. Retailers sell a lot of fresh Icelandic cod, but they sell frozen cod as well, including cod from Canada. Other factors contributing to stronger demand in Europe include reduced competition from other whitefish imports such as pangasius and increased competition among Chinese factories for Barents Sea cod.

Although cod prices have risen somewhat over where they were in 2010, the gain in the market has been eroded by the strengthening of the Canadian dollar, especially against the weakening United States dollar. The Canadian dollar has remained relatively stable against United Kingdom and European currencies, and as a result prices have increased for exports of higher valued products such as cod loins.

Canada produces a small percentage of all cod, so Canadian producers must work with the prices set by larger forces in the world market. The market for single-frozen cod loins and fillets (niche products) has improved since May of 2010, and maintaining price stability in niche markets is important to its future health.

There is little to suggest the North American markets for cod will improve significantly, in the near to medium term, though there could be opportunities for exports of seafood including cod to continental Europe and the United Kingdom. The removal of the 7.5% European Union (EU) import tariff would also help Canadian harvesters and producers, and a comprehensive Canada –EU Free Trade Agreement would therefore be of considerable benefit.

The new reality is that eastern Canada's low supply of groundfish will mean that groundfish producers will have difficulties finding markets in the changed, globally competitive markets, with the exception of niche markets for those producers that focus on both value and the intrinsic quality characteristics of cod, along with IQF and fresh products. Other specific marketing could include a focus on consistent quality and cost for set periods of time, an emphasis on the differentiation between wild and farmed fish, the promotion of the healthy aspects of eastern Canadian groundfish species, and the promotion of sustainability and food safety. Adaption will be required to compete in the new global market place.

9.3 Preparing for the future

The fishery of today is different from the fishery of the past, in terms of volume and value of landings, participants, fleet profile, and markets. The fishery will continue to change in all these respects.

Changes to fisheries management will impact harvesters. During the Council's consultations, harvesters expressed concern about the increasing cost burden imposed by government, in addition to third-party user fees, and changing management regulations and policies. In recent decades, government's focus on deficit reductions and reducing costs, coincident with modernizing fisheries and oceans management regulations and policies, has meant more of the burden is born by 'users' of the resource.

Sustainable fisheries policies such as the precautionary approach will require further adjustments to fishing in return for the promise of long-term resource benefits. There is a feeling among fishermen of increasing burden and fatigue in the conduct of the business of fishing. Since the early 1990s, fishermen faced commercial license fee increases, and fees for catch monitoring, basic fisheries science, harbour and wharves, ship safety, enforcement and other fisheries management services. Another round of government deficit reduction in the future may well bring additional user fees to the industry.

A 1990s study on government user fees and third party management fees indicated that fees varied as a percentage of landed value by fishing sector. For example, for core fishermen based in 2J3KL, 1997 user fees amounted to 6% of landed value for crab, capelin, lobster and groundfish. In addition and recently, for species like cod, landed values have declined and unfavourable exchange rates have reduced earnings from fishing. This situation has been exacerbated by fishermen's unsuccessful attempts to pass on increasing harvesting costs to processors in the cost of raw

material, as we know these costs are difficult to pass onto the market by processors who are price-takers in international seafood markets.

While it is impractical to think the fishing industry will get relief from a strong Canadian dollar anytime soon or get the federal government directly involved in port pricing, government and DFO in particular can exert influence over how it assesses and applies its user charges.

It is probable that, in the future, the administration and costs of the fishery will continue to be shared with fishermen and the complexity of fisheries and oceans management will require further adjustments in fishing measures. The options for those fishermen remaining in the industry appear to be limited to one or more of the following: reduce the cost of catching fish by combining or sharing quotas; get better value for catch by maximizing quality and seasonality when yields are best; and support measures such as harvest decision frameworks to promote sustainable fish stocks and improve catch rates.

What was said in the 2009 FRCC herring report applies equally to the groundfish fishery: "the herring fishery of eastern Canada could be much more than it presently is. Most stocks are below their historical averages and the economic return is generally poor. Change leading to a better fishery is possible."

The same factors noted in that report are mentioned above, and represent opportunities and challenges to be addressed in the groundfish fishery. Worldwide demand is growing, and will likely continue to grow. Inconsistent supply of quality products will reduce market returns at a time when costs of harvesting and processing are increasing, along with consumer and market expectations of quality and sustainability.

More directly, the Council can say as it did in 2009:

> *...there is therefore a need for the Canadian industry and governments to focus on a strategy that will enable its fishery to respond to market trends and increase benefits for participants while maintaining a focus on the conservation of the resource….A good start to the development of such a strategy is to focus on high quality products, market demand and industry structure.*

Failure to do so will mean forsaking future markets and their requirements. It will mean marginalizing the fishery - and its returns - even further.

10 Conclusion

This report provides guidance for promoting the recovery of groundfish stocks in eastern Canada and the rebuilding of sustainable fisheries based on those stocks.

The pace of recovery of northern cod has been much slower than indicated by the Minister of Fisheries and Oceans when that stock was first closed to fishing in 1992. Most of the other groundfish stocks remain at very low levels. This has created a high level of frustration in the industry and led to severe criticism of the Government of Canada for not rebuilding the stocks. It must be recognized, however, that we humans do not have the ability to "rebuild" a depleted marine fish stock, in the sense that we can rebuild a house destroyed by an earthquake or a bridge swept away by a flood. It is not simply a matter of exercising will and expending resources. Enhancement, as practiced in lakes and rivers, is impractical in the open ocean.

What we can do is promote recovery by ceasing or greatly reducing activities that are harmful to the stocks. In this respect, the Council strongly endorses DFO's fishery decision-making framework incorporating the precautionary approach. The Council applauds recent progress in the development of harvest strategy frameworks for groundfish stocks and recovery plans for the many groundfish stocks that need them. The Council also draws attention to the need to ensure that fisheries for forage species do not compromise the food requirements of cod and other groundfish, and that fishing practices and other ocean activities do not harm the habitat of groundfish.

In many parts of the world, it has been found that substantially reducing the numbers of fish killed in fishing operations has had the desired effect of promoting recovery. However, in many cases, recovery has not followed immediately upon the reduction of fishing mortality. Many factors in the natural world influence the ability of fish populations to successfully reproduce and grow, and we have little, if any, control or influence over most of them. In general, once we have done what we can to cease doing harm, then we must be patient and wait for nature to take its course.

Nevertheless, the Council agrees with much of the groundfish industry that this approach of "do no harm and wait" is insufficient to allow the recovery of many of the groundfish stocks in eastern Canada. Unlike many other areas of the world, the waters of eastern Canada have seen a dramatic increase in recent decades in the numbers of marine mammals, especially seals. It has been hypothesized since the mid-1990s that predation by seals is the dominant cause of the high rate of natural mortality that has impeded the recovery of many groundfish stocks. The Council believes that evidence supporting this idea is sufficiently strong, and the condition of many stocks sufficiently urgent, that it is now time to proceed as soon as possible with targeted seal removals of sufficient magnitude and duration to test the hypothesis directly.

Promotion of the recovery of groundfish stocks is but one element in the rebuilding of the groundfish industry. Successful implementation of the various elements of the Department's Sustainable Fisheries Framework, including policies such as harvest strategy frameworks and tools such as Integrated Fisheries Management Plans, will require extensive collaboration with industry, accompanied by community consultations to ensure that people understand the intent of the many policies and procedures and appreciate the benefits that can flow from them. There is a great need for an increase in trust and respect between the industry and the regulator. Policies and regulations that promote the recovery of groundfish stocks and their sustainable exploitation may have little effect if industry is not prepared to endorse and comply with them. The Department should continue to promote shared stewardship and co-management, such that industry has an enhanced role in policy planning and operational decisions and also additional responsibility. The process of decision making must be transparent and accountable.

With respect to legislation, the Council strongly supports a modernization of the *Fisheries Act*. The Council is concerned that application of the highly prescriptive *Species at Risk Act* to the management of commercially-important groundfish counters initiatives towards stewardship and co-management.

The Department should help where it can to make the industry more economically viable. This includes policies that help the industry to self-rationalize. It also includes implementing in a timely fashion various policies, such as those regarding sustainability, that will help industry meet market standards for eco-certification and traceability.

Recovered stocks, sustainable fishing practices, economically viable enterprises and an emphasis on quality products will help rebuild the groundfish fisheries and support coastal communities throughout eastern Canada.

APPENDICES

Appendix 1: Major commercially-important groundfish species of eastern Canada

The table below lists the major species of groundfish of commercial importance in waters of eastern Canada. Information on maximum length (cm) and age (years) is taken from FishBase (http://www.fishbase.org/home.htm). Generation times (in years) are taken from COSEWIC documents.

Common name	Scientific name	Length (max)	Age (max)	GenerationTime (COSEWIC)
Family Rajidae (skates)				
Thorny skate	*Amblyraja radiata*	105		
Family Squalidae (dogfish sharks)				
Spiny dogfish	*Squalus acanthias*	160	75	23
Family Gadidae (true cod-like fishes)				
Atlantic cod	*Gadus morhua*	200	25	7.5-11
Haddock	*Melanogrammus aeglefinus*	112	20	
Atlantic pollock	*Pollachius virens*	130	25	
Family Lotidae (cod-like fishes – ling family)				
Cusk	*Brosme brosme*	120	20	9
Family Macrouridae (cod-like fishes - grenadiers or rattails)				
Roundnose Grenadier	*Coryphaenoides rupestris*	110	40-60	17
Roughhead Grenadier	*Macrourus berglax*	110	25	19
Family Merlucciidae (cod-like fishes - merluccid hakes)				
Silver hake	*Merluccius bilinearis*	76	12	
Family Phycidae (cod-like fishes - phycid hakes)				
White hake	*Urophycis tenuis*	135	23	
Family Anarhichadidae (wolffishes)				
Atlantic wolffish	*Anarhichas lupus*	150		6
Spotted wolffish	*Anarhichas minor*	180	21	7+
Family Sebastidae (redfishes)				
Deepwater redfish	*Sebastes mentella*	55-60	75	18-23
Acadian redfish	*Sebastes fasciatus*	30		16-18
Golden redfish	*Sebastes marinus*	100	60	
Family Cyclopteridae (lumpsuckers)				
Lumpfish	*Cyclopterus lumpus*	61		
Family Pleuronectidae (righteye flounders)				
Atlantic halibut	*Hippoglossus hippoglossus*	470	50	
Greenland halibut	*Reinhardtius hippoglossoidses*	120	30	
American plaice	*Hippoglossoides platessoides*	82	30	16
Witch flounder	*Glyptocephalus cynoglossus*	60	25	
Yellowtail flounder	*Limanda ferruginea*	64	12	
Winter flounder	*Pseudopleuronectes americanus*	64	14	
Family Lophiidae (anglerfishes)				
Monkfish	*Lophius americanus*	120	30	

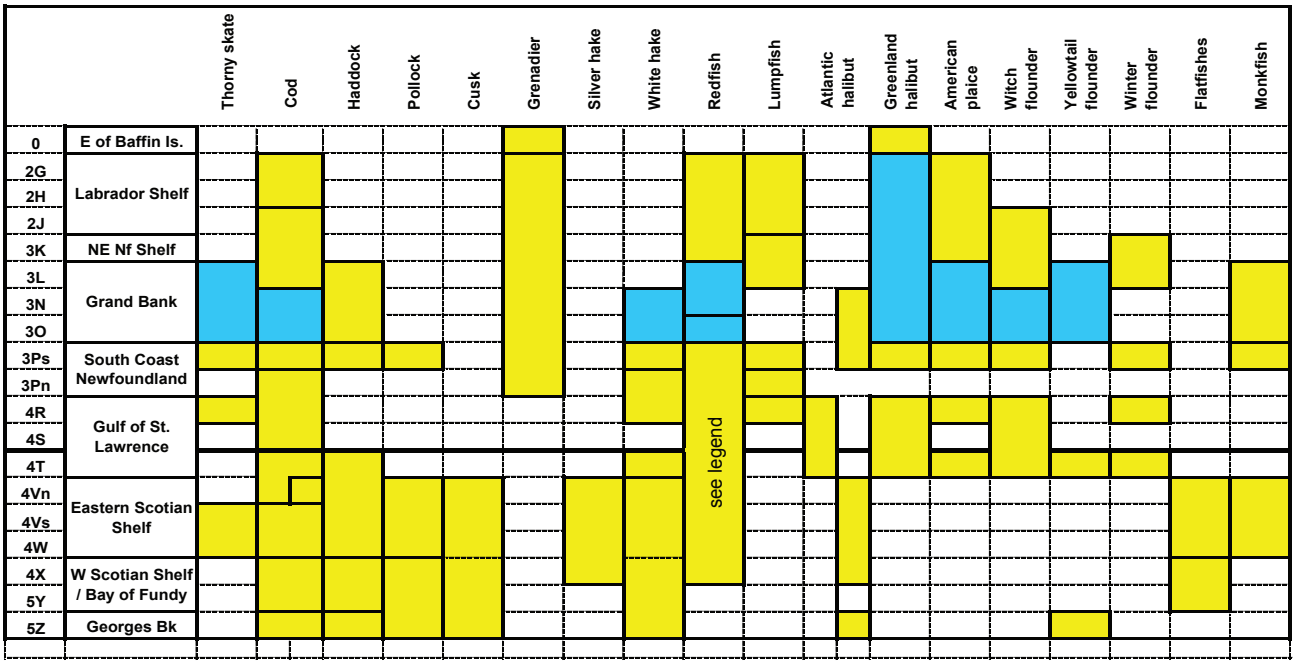
Appendix 2: Stock structure used for management of groundfish off eastern Canada

The following figure is an attempt to indicate the NAFO divisions and subdivisions defining the major stocks of groundfish, as defined for purposes of fisheries management, in waters off eastern Canada. Note that some of these stocks are not under quota management. Note as well that there may be errors in the figure. Readers are advised to check with DFO or the Northwest Atlantic Fisheries Organization (NAFO) for confirmation of stock areas.

The first column lists NAFO divisions and subdivisions in sequence, starting from the north. Division 3M has been omitted, since it is entirely outside Canada's 200 nm fishing zone, and has not been important for Canadian groundfish fishing. The dark horizontal line between 4S and 4T indicates the location of the Laurentian Channel.

The second column names major geographic areas.

The remaining columns indicate the stocks that have been defined for each of the major commercially-important species of groundfish. Stocks that are highlighted in blue are managed by NAFO and those highlighted in yellow are managed by Canada, although with participation by France in the case of stocks that are partially or wholly in Subdivision 3Ps and the United States of America in the case of stocks partially or wholly in Division 5Z.



Additional information regarding some of the species/stocks:

Grenadier comprises both roundnose grenadier and roughhead grenadier, managed as one stock.

The three redfish stocks that are west of 3O and managed by Canada are currently defined as follows: Unit 1 (Gulf of St. Lawrence; 4RST and 3Pn4Vn(Jan-May)); Unit 2 (Laurentian Channel; 3Ps4Vs, 4Wfgj, and 3Pn4Vn(Jun-Dec)); Unit 3 (South Western Scotian Shelf; 4WdehklX).

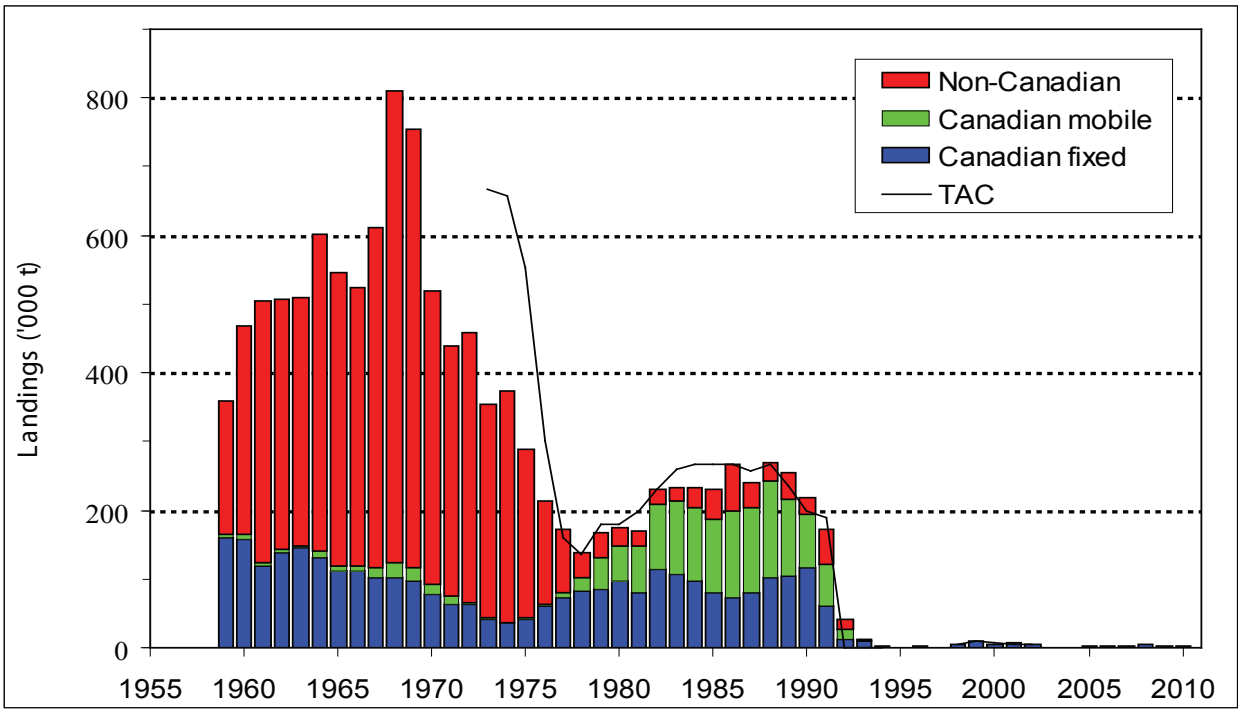
One of the Atlantic halibut stocks is widely distributed outside the Gulf of St. Lawrence (3NOPs4VWX5Zc).

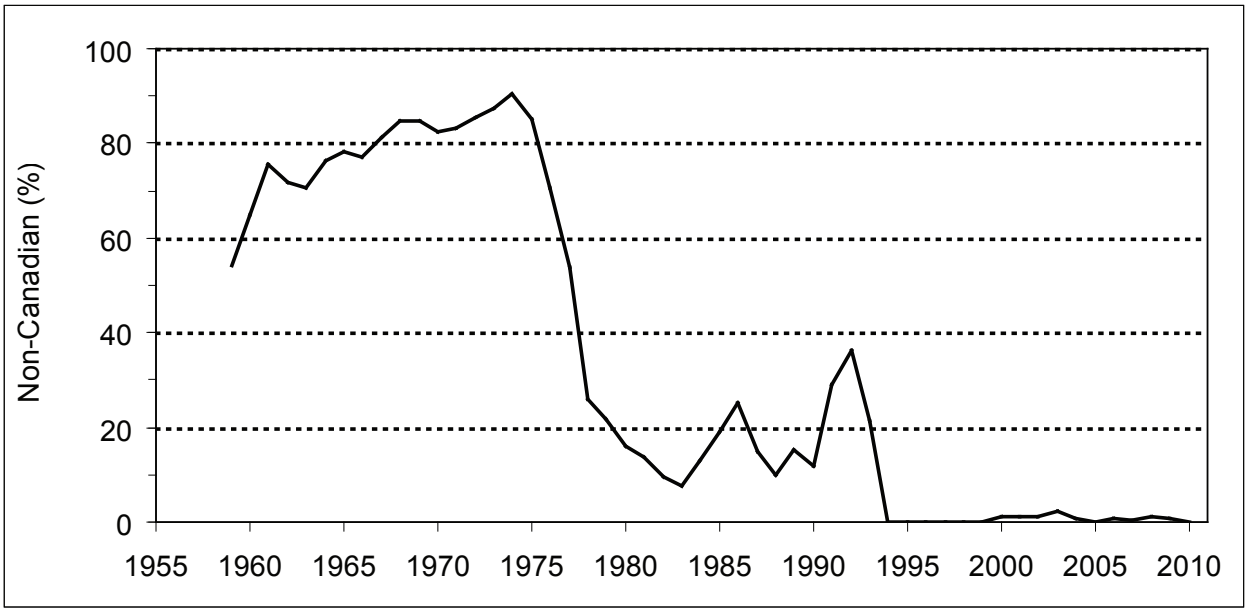
For Greenland halibut indicated in Subarea 0, there is an offshore stock that is widely distributed in waters between Caada and Greenland [0=1A(offshore)+1B-F]. There are also Greenland halibut in inshore waters of eastern Baffin Island, notably Cumberland Sound.

The flatfish stocks on the Scotian Shelf comprise four species; yellowtail flounder, witch flounder, American plaice and winter flounder.

Appendix 3: Landings of northern cod by Canadian and non-Canadian fleets

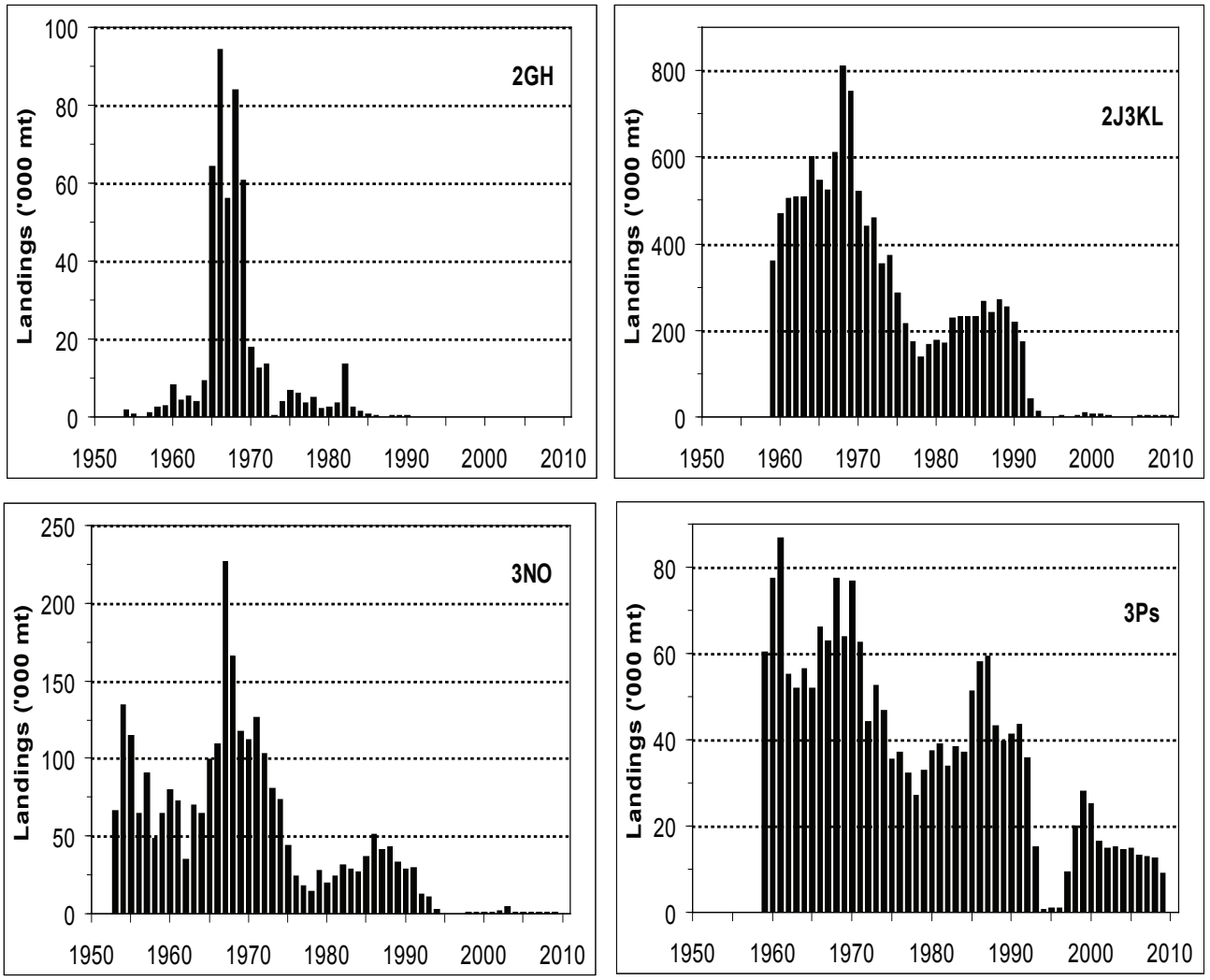
The following figure provides an example of the large contribution of non-Canadian fleets to total landings of cod from waters off eastern Canada. Total allowable catches (TACs) and landings (in thousands of tons) are shown for the period 1959-2010 for northern cod, which is the stock of cod off southern Labrador, northeastern Newfoundland and the northern Grand Bank (NAFO Divisions 2J3KL). The top panel shows landings by non-Canadian and Canadian fleets, with the latter divided into mobile gear (offshore) and fixed gear (mainly inshore). Since initial declaration of the moratorium on directed fishing in 1992, landings have come almost entirely from the inshore, have been small relative to landings in earlier years, and are almost imperceptible on this graph. The lower panel shows the percentage of landings taken by non-Canadian fleets.



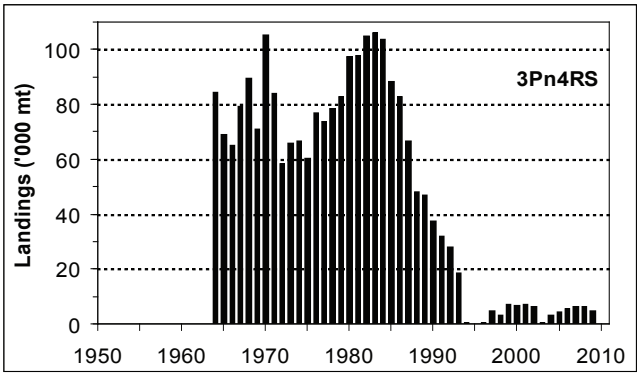


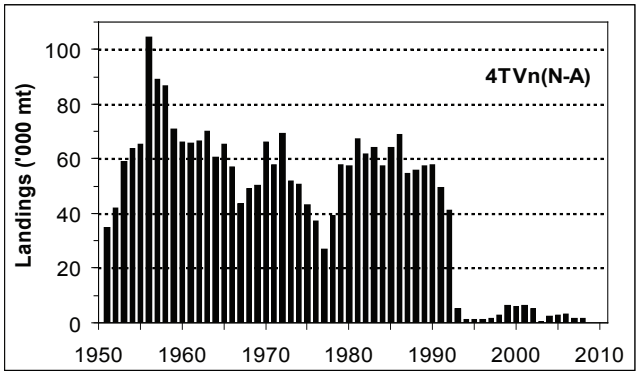
Appendix 4: Historic landings from each of the cod stocks off eastern Canada

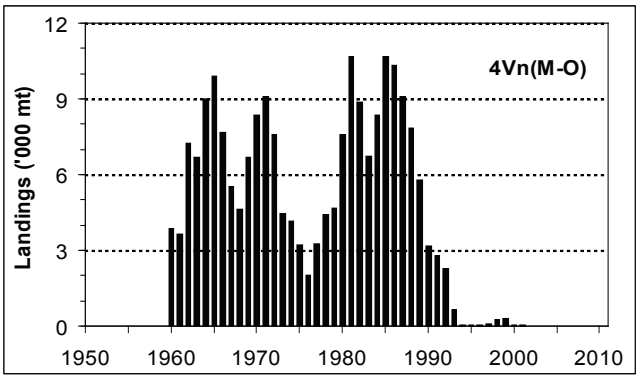
The figure below shows the reported landings of cod (in thousands of tons) from each of the ten cod stocks off eastern Canada. (The stock on Flemish Cap, 3M, is entirely outside Canada's 200 nm fishing zone, has never been important for Canadian fisheries, and is excluded from the figure.) Note that the scales for the landings (the axes on the left sides of the panels) differ greatly among panels, varying from a maximum of 12 thousand tons in the 4Vn(M-O) panel to a maximum of 900 thousand tons in the 2J3KL panel. The data have been extracted from documents produced by the Canadian Science Advisory Secretariat (CSAS), the Northwest Atlantic Fisheries Organization (NAFO), and the Transboundary Resources Assessment Committee (TRAC).

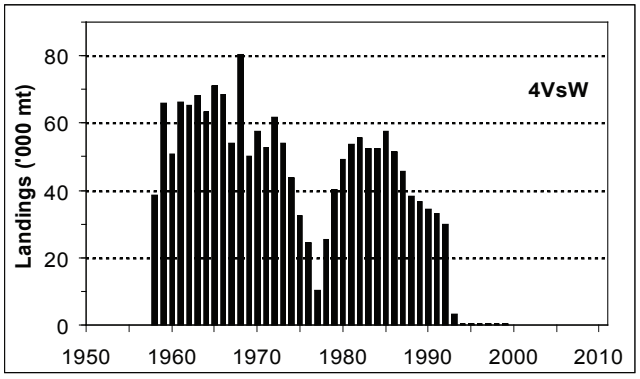


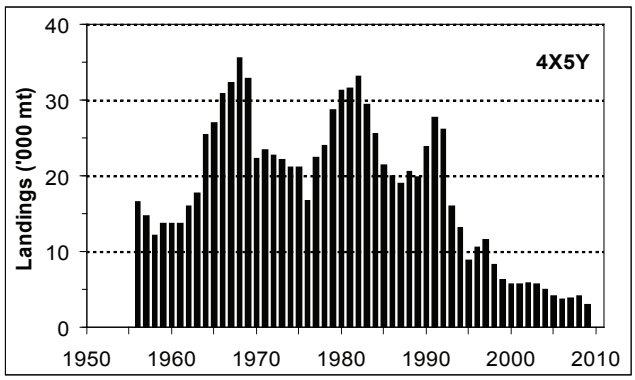
Appendix 4: Historic landings from each of the cod stocks off eastern Canada continued

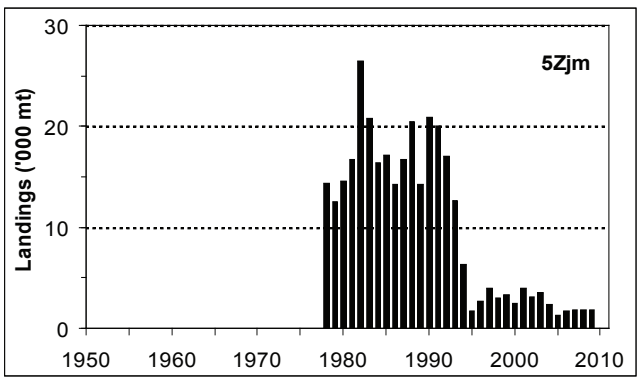






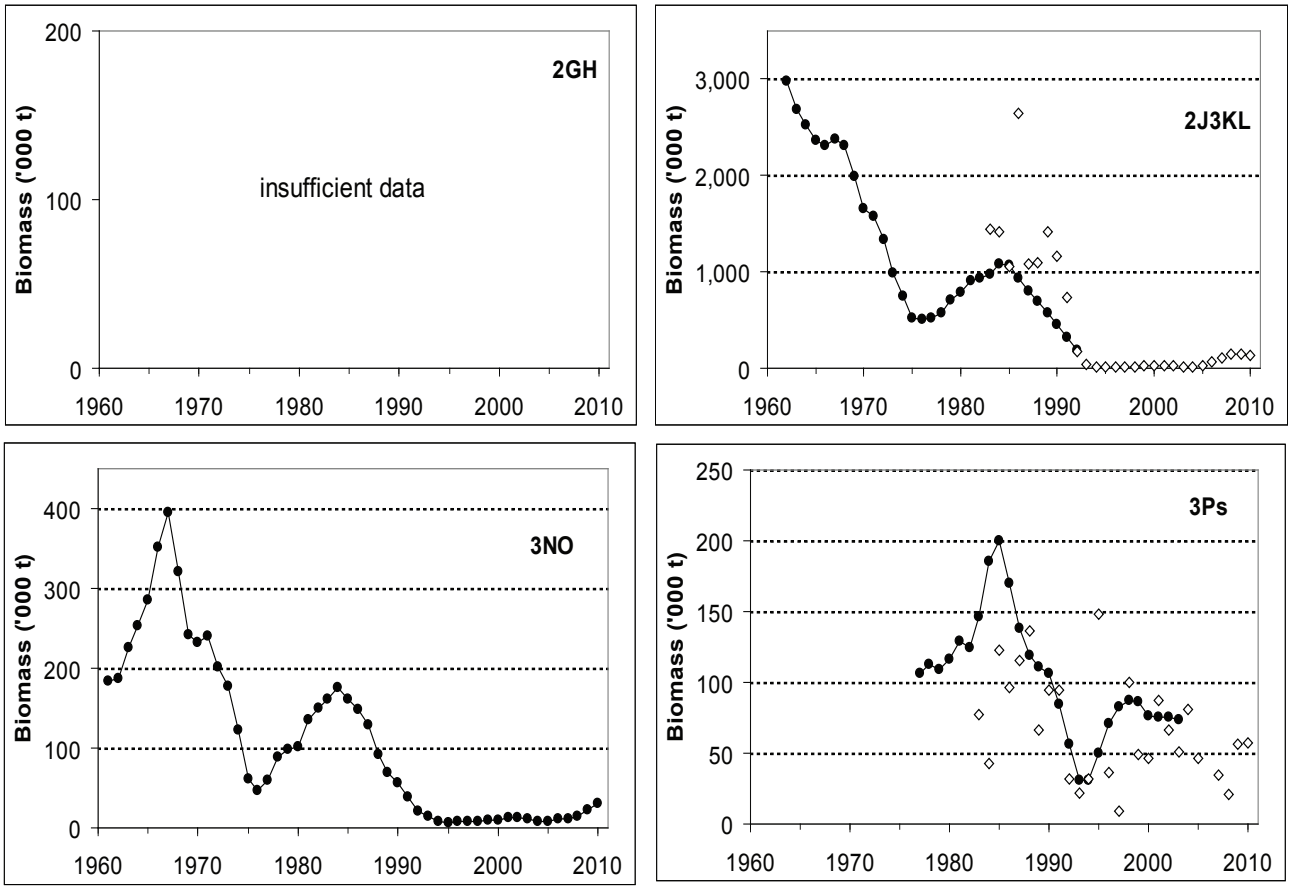




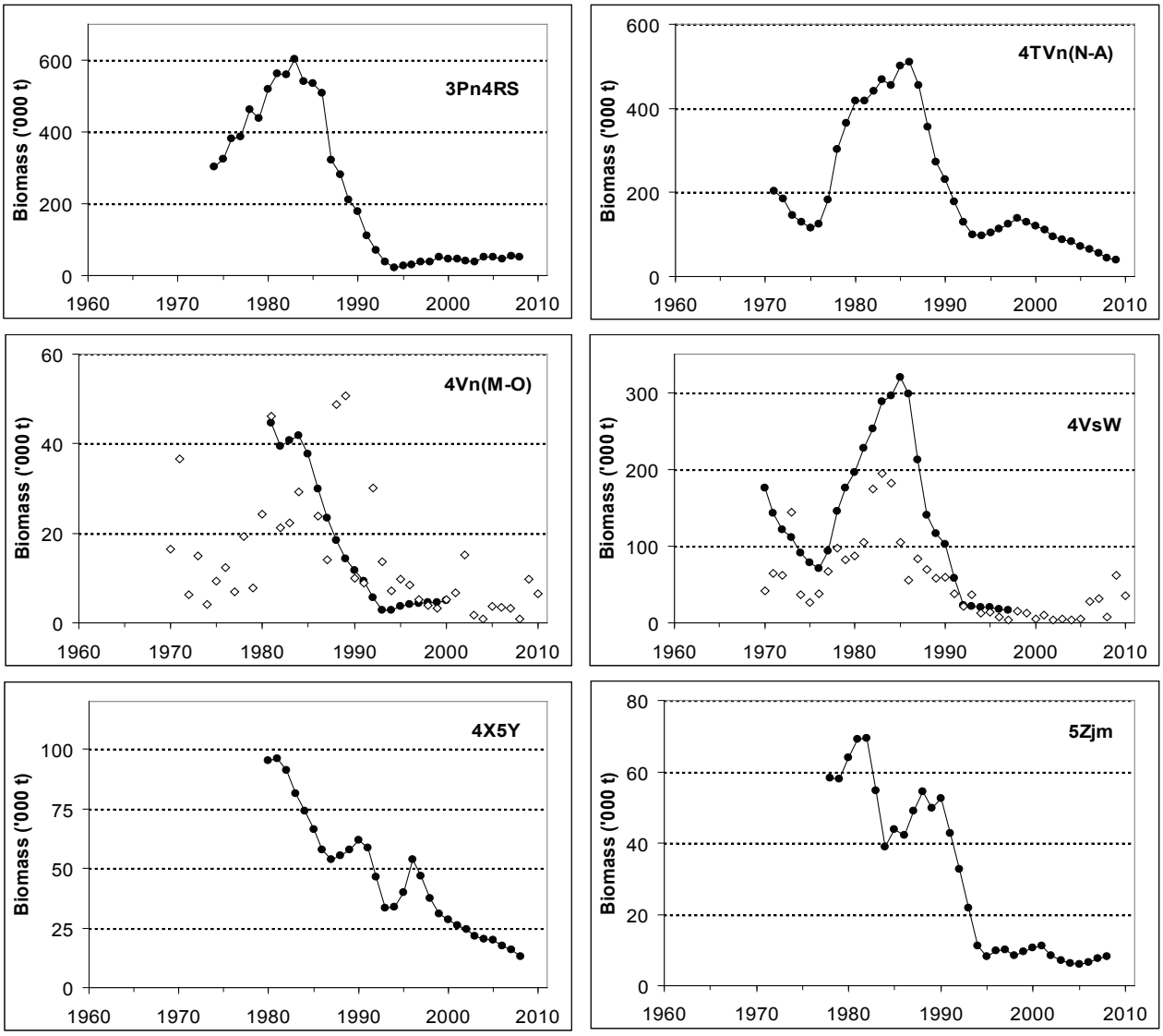


Appendix 5: Changes in biomass of each of the cod stocks off eastern Canada

The figure below shows changes in the biomass (in thousands of tons) of individual cod stocks off eastern Canada. (The stock on Flemish Cap, 3M, is entirely outside Canada's 200 nm fishing zone, has never been important for Canadian fisheries, and is excluded from the figure.) The black circles connected with a line indicate the biomass estimated with a model (sequential population analysis, SPA). The data go back further in time for some stocks than for others. Open diamonds show biomass estimates from DFO bottom-trawl surveys for those stocks that have not been assessed recently with SPA. It is strongly emphasized that biomass estimates from SPA are not directly comparable to those from surveys. The two are plotted together for convenience. The biomass scales (the axes on the left of the panels) differ greatly among stocks. The data have been extracted from documents produced by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC), the Canadian Science Advisory Secretariat (CSAS), the Northwest Atlantic Fisheries Organization (NAFO), and the Transboundary Resources Assessment Committee (TRAC).



APPENDIX 5: CHANGES IN BIOMASS OF EACH OF THE COD STOCKS OFF EASTERN CANADA CONTINUED



Appendix 6: Summary of the FRCC's previous recommendations on seals

The issue of seals eating cod and other groundfish and the extent to which this has impeded the recovery of many of the groundfish stocks has been a consistent theme in FRCC reports since 1993. This appendix provides a summary of previous FRCC conclusions and recommendations regarding seals and groundfish.

In its very first report (August 1993), the Council noted the concerns of fishers that seals were one of the causes for the decline of fish populations and a threat to their recovery.

In its November 1994 report, the Council concluded that studies of seal population and diet left little doubt that seal predation was slowing the recovery of some stocks. It recommended early action be taken to significantly reduce the populations of grey, hooded and harp seals to help the recovery of groundfish stocks.

In order to properly consider and determine the most appropriate course of action, the Council recommended that the Minister of Fisheries and Oceans, on a priority basis, convene a special forum on this issue, with all interested parties; that the forum consider the alternative approaches with all their implications, and develop for early implementation an action plan to achieve a meaningful reduction in the seal populations.

In November 1996, the Council noted that the harp seal herd had increased substantially and recommended that ways to increase the harvest of all three species of seals be pursued. It also recommended that the alternative of contraception to limit the size of the herd, which had been under study for some time, be implemented.

In its 1997 annual report, Council recommended that ways to increase harvests of harp, hooded and grey seals be pursued. Initiatives to encourage product development and identification of new markets should be encouraged. The alternative of contraception to limit the size of the herd should be implemented.

Additionally, in 1997 correspondence to the Minister of Fisheries and Oceans regarding NAFO, the FRCC fully supported the position of the NAFO Scientific Council, recognizing that the number of seals could be having an effect on the rebuilding of groundfish stocks.

In 1998, Council noted "as in our previous reports, the FRCC has asked the Minister to move forward with measures to control and reduce the seal population. We continue to believe that seals represent a renewable resource, which can be harvested sustainably in the context of overall management of the Atlantic Marine ecosystem. We also believe there is a definite imbalance between predator and prey".

The Council, in its groundfish recommendations for 1998 and its science priorities letter to the Minister of the same year, went on to recommend that the Minister of Fisheries and Oceans continue to "move forward with developing new markets and products for seals… and we recommend that immediate ways to significantly increase the harvest of all seals should be pursued." The FRCC also recommended "the effect of predation and predator prey relationships be analyzed. The impact of seal consumption, especially, remains a major concern and work to quantify its impact must be pursued and funded. The potential effect of exploitation on forage species (e.g. capelin, herring, etc.) must be analyzed and quantified." Council made a point of underlining the fact that further research on the quantification of the effects of seal consumption on groundfish stocks does not mean "further study and no action".

In 1999, the Council noted that, as in previous years, the expanding seal population issue was raised at all consultations as a frustrating impediment to the recovery of groundfish. The Council concluded: "The accumulated evidence from scientific assessments, as well as the consistent, continual and corroborating information from fishers throughout Eastern Canada is such that the FRCC is convinced beyond any reasonable doubt that the recovery of groundfish stocks, notably cod, will continue to be jeopardized if the seal herds remain at their current levels".

Council noted the apparent lack of progress in implementing measures to reduce either the harp or grey seal populations, identifying a prevailing view among many within the Atlantic fishing industry that the federal government's inaction on this matter reflects an abandonment of interests of the fishing industry and the groundfish resource in favour of potential political or trade considerations associated with the anticipated reaction of those who oppose action to reduce the seal population.

In its 1999 annual report Council recommended the following:

- Reduce the seal herds by up to 50% of their current population levels in specific areas and

use such reductions as a basis for scientific study and adaptive management.

- Commit new resources towards coordinating seal harvest management plans, and the strict monitoring, control and enforcement of appropriate regulations in the harvest of seals including utilization of carcasses, humane harvests, and minimization of the incidences of struck and lost.
- Establish a Northwest Atlantic working group responsible for: (1) the organization and development of strategies for immediate seal reduction effort; (2) promotion of humane harvesting techniques; and, (3) other activities as deemed appropriate.
- Establish an experimental seal harvest for grey seals on Sable island for the collection of scientific data and industry development activities. This experimental fishery should not exceed the current annual replacement value estimate of 20,000 Sable island seals.
- Define a limited number of experimental seal exclusion zones… for the purpose of preventing the expansion of seals into the fishery, designated bay, or area. This measure is designed to protect spawning and juvenile cod concentrations and prevent seals from inflicting high mortality on localized coastal aggregations of cod on which limited fisheries are being carried out.

The Council's report for 2001/2002 recommended that measures proposed in its 1999 report, to reduce the seal population, be included in a comprehensive seal harvest management plan. The Council further recommended that areas where groundfish are particularly vulnerable to predation be identified and considered for protection as "seal exclusion zones". It was also recommended that seal harvest management plans include recommendations for reductions in herd size to levels that will sustain a long-term seal industry and are compatible with groundfish rebuilding objectives.

In 2002/2003, Council recommended that areas where groundfish in the Gulf of St. Lawrence are particularly vulnerable to predation be identified and considered for protection as "seal exclusion zones". It reiterated its previous recommendation that seal harvest management plans include recommendations for reductions in herd size to levels that will sustain a long-term seal industry and are compatible with groundfish rebuilding objectives.

In 2003/2004, the FRCC recommended, as a priority for stock rebuilding in the Gulf of St. Lawrence, that the Minister act immediately to establish year-round seal exclusion zones in specific areas and that local community groups present proposals for training and acting as seal exclusion zone monitors to carry out the responsibilities associated with the assigned tasks. DFO marine mammal specialists would be responsible for coordinating the management of the seal exclusion zones program.

The Council also recommended that work continue as a follow-up to the Redfish Multi-disciplinary Research Program, to provide annual estimates of the incidence of redfish consumption by seals throughout Unit 1.

In 2004/2005, the Council addressed the subject of natural mortality of cod, noting that natural mortality was typically about 20% by numbers per year. In the Gulf of St. Lawrence, natural mortality for cod in the 1990s was probably closer to 35% by numbers each year. The Council noted that seals were an important source of this mortality, an observation supported both by fishermen and science, and that past scientific review of natural mortality for the Gulf cod stocks concluded that seal predation was a major factor contributing to this elevated mortality. Council recommended the exploration of opportunities for the control of seal populations.

In its 2004/2005 Conservation Requirements for groundfish stocks on the Scotian Shelf and Bay of Fundy, the FRCC acknowledged that predation by seals had been repeatedly identified as an important source of mortality, given the substantial increases in grey seal numbers over the past few decades. In its report, the Council noted that the theme of recent industry consultations, as had been the case in previous years, was that the increase in the seal population was the cause of the poor state of groundfish. The FRCC voiced its support for "proposals to develop a limited harvest of grey seals. A sustainable hunt could limit further growth of the population, or perhaps lead to some reduction in the numbers, thereby limiting or reducing the predation impact on fish by grey seals." The Council also supported the work, focused on seal diets, being done as a result of a Fisheries Science Collaborative Project on seals in northern Cape Breton, and recommended that the work be expanded to other areas.

In its 2004/2005 report on Conservation Requirements for 3Ps cod, the Council expressed concerns about increasing numbers of harp and hooded seals in the western area of 3Ps.

Appendix 7: COSEWIC designations of status of groundfish off eastern Canada

The following table is a list of those groundfish species of eastern Canada that have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and designated as endangered (E), threatened (T) or of special concern (SC). For those species that been divided into populations or designatable units (DUs), the DUs are listed separately. The table also indicates the 3 species that have been listed on SARA Schedule 1 (as of April 2011).

Common name / Population	Scientific name	COSEWIC status			SARA Schedule 1		
		E	T	SC	E	T	SC
Winter skate	*Leucoraja ocellata*						
Southern Gulf of St. Lawrence		✓					
Eastern Scotian Shelf			✓				
Georges Bank – Western Scotian Shelf – Bay of Fundy				✓			
Spiny dogfish	*Squalus acanthias*			✓			
Atlantic cod	*Gadus morhua*						
Newfoundland and Labrador		✓					
Laurentian North		✓					
Laurentian South		✓					
Southern		✓					
Arctic Lakes				✓			
Cusk	*Brosme brosme*		✓				
Roundnose Grenadier	*Coryphaenoides rupestris*	✓					
Roughhead Grenadier	*Macrourus berglax*			✓			
Northern wolffish	*Anarhichas denticulatus*		✓			✓	
Atlantic wolffish	*Anarhichas lupus*			✓			✓
Spotted wolffish	*Anarhichas minor*		✓			✓	
Deepwater redfish	*Sebastes mentella*						
Gulf of St. Lawrence – Laurentian Channel		✓					
Northern			✓				
Acadian redfish	*Sebastes fasciatus*						
Atlantic			✓				
Bonne Bay				✓			
American plaice	*Hippoglossoides platessoides*						
Newfoundland and Labrador			✓				
Maritime			✓				

Appendix 8: Glossary

Adaptive management: A structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.

Assessment, stock assessment: The process of determining what the status of a stock is in relation to exploitation.

Benthic: Bottom-living; adult lobsters are examples of benthic organisms.

Biomass: The total weight of a fish species in a given area.

Demersal: Dwelling at or near the bottom of a body of water.

Distribution, spatial: Patterns in space, e.g. numbers of cod over and around a bank.

Distribution, temporal: Patterns in time, e.g. changes in the numbers of cod with time.

Effective effort: A measure of the effect of the effort that is applied, that is directly related to fishing mortality.

Effort, fishing effort: The amount of fishing used to obtain the catch; can be expressed in numbers of nets, hours etc. (See also effective effort.)

Exploitation rate: The percentage of cod vulnerable to the fishery which are harvested in a given year. Exploitation rate is another way of expressing fishing mortality.

F0.1 (F zero point one): The fishing mortality rate at which the marginal yield-per-recruit (i.e. the increase in yield-per-recruit in weight for an increase in one unit of fishing mortality) is only 10 percent of the marginal yield-per-recruit on the unexploited stock. The fishing mortality rate at which the slope of the yield-per-recruit curve is only one-tenth the slope of the curve at its origin.

Forage species: These species provide a significant source of food for other dependent predators particularly fish, marine mammals and birds. Examples of forage species are herring, capelin and shrimp.

Groundfish: Fish that lives most of its life on or near the sea bottom, such as cod, haddock and flounder.

IQ/ITQs: Individual quota / Individual transferable quotas. Annual quotas assigned to fishing enterprises that set a limit on how much of the resource the enterprise is permitted to catch. Transferable refers to quotas that can be readily transferred from one enterprise to another.

Limit reference point (LRP): The point of the spawner biomass below which the recruitment tends to be consistently poor.

Model: A simplified description of phenomena allowing a practical analysis. Mathematical models involve a set of relationships to quantify those phenomena; they are commonly used in assessments of the status of fish stocks.

Rookery: The breeding ground of certain birds or animals, such as seals and penguins.

Stakeholders: All those who have an interest (a stake) in a fishery.

Trophic level: The position that an organism occupies in a food chain, determined by what eats it and what it eats.

Upper stock reference point (USR): The point of spawner biomass above which the stock is said to be in the healthy zone.

Appendix 9: Briefs received

Newfoundland and Labradro

Valerie Johnson (2010-045-00680)

Fred Winsor – Sierra Club Canada (St. John's, NL) – Presented in Witless Bay (2010-045-00041)

Ahmed Khan, PhD Candidate & Barbara Neis, University Research Professor – CURRA – Presented in Port-aux-Basques (2010-045-00017)

Thomas E. Best, Fish Harvester & President, Pettty Hrb. Fishermen's Cooperative Project Coordinator (Petty Harbour, NL) – Delivered (2010-010-00006)

Frank Leonard (Petite Forte, NL) – By fax (2010-010-00008)

Monty Gould (Port-aux-Choix, NL) – By e-mail (2010-010-00015)

Eugene Caines, Port Saunders, NL – By fax (2010-010-00013)

Gabe Gregory – By e-mail (2010-045-00185)

WWF Canada (Shelley Dwyer) (2010-045-00217)

New Brunswick

Benoit Aubut, Lamèque, NB – Presented in Bathurst (2010-010-00014)

Brian Guptill, President – Grand Manan Fishermen's Assoc. Inc. (Grand Manan, NB) – Presented in Blacks Harbour (2010-010-00012)

Dale Mitchell (Deer Island, NB) – Presented in Blacks Harbour (2010-010-00011)

Nova Scotia

Robert Sciocchetti – D'Eon Fisheries Ltd. & Blue Wave Seafoods Inc. – By e-mail (2010-010-00017)

Alain d'Entremont, General Manager – Scotia Harvest Seafoods Inc. – Presented in Dartmouth (2010-010-00016)

Trevor Kenchington – Gadus Associates (Musquodoboit Harbour) – Presented in Dartmouth (2010-045-00021)

Bernie Berry, Manager – Y.C.F.G.A. – Delivered (2010-045-00019)

Graham Smith (Brookside, NS) – By –e-mail (2010-045-00023)

Denny Morrow – NSFPA – Presented in Yarmouth (2010-045-00018)

Chris Corkett, Dept. of Biology, Dalhousie University (Halifax, NS) – By e-mail (2010-045-00040)

George Walker (Riverport, NS) – By mail (2010-010-00007)

Prince Edward Island

Jeff Hutchings, Dept. of Biology, Dalhousie University (Halifax, NS) – Presented in Charlottetown (2010-010-00010)

Ed Frenette, Executive Director – PEIFA (Charlottetown, PEI) – Presented in Charlottetown (2010-010-00009)

Québec

Gilles Duguay – RPPSG – Presented in Gaspé (2010-045-00026)

Dominique Gladyszewsk, Écologiste (Grosse-Ile, Qué) – Delivered by hand in the Maggies (2010-045-00075)

Nunavut

Joint Presentation by Nunavut Fishery Stakeholders – Presented in Iqaluit (2010-045-00077)

Robert Kidd – Nunavut Wildlife Management Board – Delivered by hand in Iqaluit (2010-045-00077)

Appendix 10: FRCC membership, at time of publication

Council

Gerard Chidley, Chairman
Donald Walker, Vice Chairman
Walter Bruce
Derek Butler
Lina Condo
Lewis Creed
Adlai Cunningham
Gastien Godin
Bruce Hatcher
George Lilly
Michael O'Connor
Gregory Thompson

DFO ex-officios

David Gillis
Brian Lester
Georgine Pastershank
Barry Rashotte
Marc Vachon

Provincial delegates

Tom Dooley
Monique Anne Morin
David MacEwen
François Montminy-Munyan
Cyril Boudreau

FRCC secretariat

Mike Calcutt, A/Executive Director
Helena Da Costa
Tracey Telik

Canada