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Bycatch on the High Seas:

A Review of the Effectiveness of the Northwest Atlantic Fisheries Organization

Andrew Rosenberg, Marjorie Mooney-Seus and Chris Ninnes

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Prepared for World Wildlife Fund Canada by:

MRAG Americas, Inc., Tampa Florida

Cover Photo: Discarded catch by deep sea trawler. North Atlantic.

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About the Authors

Andrew Rosenberg
Dr. Andrew Rosenberg is a professor at the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire (UNH) where, prior to April 2004, he was dean of the College of Life Sciences and Agriculture. Over the past three years he has also been a member of the U.S. Commission on Ocean Policy.

Prior to coming to UNH he worked at NOAA's National Marine Fisheries Service (NMFS) from 1998 to 2000, where, as deputy director, he held the senior career position in the agency. As deputy director he dealt with policy decisions on science and resource management issues nationwide as well as with the administration of the agency. He was also a principal agency spokesperson before Congress, the public and technical audiences. Before becoming NMFS deputy director, Dr. Rosenberg was the NMFS Northeast regional administrator. He negotiated and implemented the recovery program for New England fisheries, reversing overfishing and resource declines on George's Bank as well as in other areas for groundfish and scallop fisheries. He also worked to develop and implement marine mammal recovery programs and endangered species protections throughout the northeast. He has also served as the US lead representative in several international fishery management organizations such as NAFO, NASCO and FAO.

Dr. Rosenberg's scientific work is in the field of population dynamics, resource assessment and resource management policy. He holds a B.S. in fisheries biology from the University of Massachusetts, an M.S. in oceanography from Oregon State University and a Ph.D. in biology from Dalhousie University. He was on the faculty of the Imperial College of Science and Technology in London for six years and was the deputy director of the Renewable Resources Assessment Group, an internationally known quantitative analysis and policy consultancy group. He currently also serves as the senior vice president of MRAG Americas Inc., a consulting company with offices in Florida and Massachusetts that is affiliated with MRAG Ltd., a London-based international marine resource consultancy.

Marjorie Mooney-Seus
Marjorie Mooney-Seus is an independent consultant providing facilitation, report production and granting writing services to government, nonprofit and private companies. Some recent work involved analysis of the application of the "Precautionary Approach" by international fisheries management agencies and fisheries certification bodies for MRAG Americas, which is based in the United States and the UK; coordination of a government-mandated task force to design a cod-tagging program for Gulf of Maine and Georges Bank for the National Marine Fisheries Service; facilitation of community meetings to identify collaborative research priorities for Gloucester Fishermen's Wives Association; grant writing for the dean of the College of Agriculture and Life Sciences, University of New Hampshire; grantwriting for the First US Unitarian Church Restoration/Capital Campaign; and organization and publicity for the Alternative Health Fair, Cape Ann Food Coop.

Ms. Mooney-Seus has over 15 years' experience in marine environmental policy. Up until 2002, she served as manager of the New England Aquarium Conservation Department, a post she held for nearly seven years. In this position she helped to successfully build a two-person department into a comprehensive marine education, public policy and outreach program with five full-time staff members and a one-million-dollar operating budget through grant support from private and federal funding sources. Ms. Mooney-Seus also produced several award-winning documentaries, published a number of articles and reports on marine-related topics and organized and facilitated both large-scale forums and small-scale, multi-stakeholder discussion groups on a variety of marine conservation issues. Throughout her career she also has participated in a number of field research projects and rehabilitation efforts including rescuing and rehabilitating stranded marine mammals (e.g., pilot whales, North Atlantic white-sided dolphins and several seal species); monitoring right whale populations via boat surveys in the Bay of Fundy and via arial surveys off the Florida and Georgia coasts; and participating in boat surveys to study movements of endangered Hector's dolphins in New Zealand. She has a master's degree in environmental policy, specialization in fisheries management, from Tufts University.

Chris Ninnes
Chris Ninnes is an aquatic resources management specialist with over 25 years of international experience. He has recently taken up a position as vice president of MRAG Americas Inc., the US based component of the Marine Resources Assessment Group (MRAG Ltd.). Prior to this appointment he was technical director of MRAG's London office and was responsible for the development and management of the company's core business areas and functions, the development of new business and the running of the IT department.

He has worked in over 30 countries and territories, gaining extensive project and personnel management experience from his involvement in regional and national development programmes and from the management of an extensive commercial portfolio of projects and research programmes.

He has wide-ranging experience in the development and management of fisheries and aquatic environmental institutions, including regional management bodies and national institutions such as government departments, national trusts, cooperatives, parastatals and private sector companies. He has been responsible for developing and implementing national strategies to promote aquatic and terrestrial protected area management.

Through his work he has extensive experience in developing and managing integrated aquatic resource management programmes, including experience in developing inter-agency co-operation, regional co-operation and the implementation of national policy initiatives. He also has experience in commercial fishing and processing operations and the rationalization of fisheries investment with resource availability.

A key aspect of his work has been the development of information and communication systems at regional and national levels for policy development and implementation.

Chris Ninnes has received a B.S. (honours) in biology from the University of Exeter in 1980, a postgraduate diploma in fisheries management from the University of Humberside in 1984, and an M.Phil. in zoology (fisheries) from the University of Newcastle in 1996.

Acronyms And Abbreviations

CPUE	Catch Per Unit Effort
DFO	Department of Fisheries and Oceans
EU	European Union
MCS	Monitoring, Control and Surveillance
NAFO	Northwest Atlantic Fisheries Organization
NEAFC	Northeast Atlantic Fisheries Commission
NRA	NAFO Regulatory Area
RFMO	regional fisheries management organization
STACFAC	Standing Committee on Fishing Activities of Non-Contracting Parties in the Regulatory Area
STACFEN	Standing Committee on Fisheries Environment
STACFIS	Standing Committee on Fisheries Science
STACREC	Standing Committee on Research Coordination
STACTIC	Standing Committee on International Control
TACs	Total Allowable Catches
VMS	Vessel Monitoring System

Definitions

B_{lim} : A biomass level, below which stock productivity is likely to be seriously impaired, that should have a very low probability of being violated.[1]

B_{buf} : A stock biomass level above B_{lim} that is required in the absence of analyses of the probability that current or projected biomass is below B_{lim}. In the absence of such analyses, B_{buf} should be specified by managers and should satisfy the requirement that there is a very low probability that any biomass estimated to be above B_{buf} will actually be below B_{lim}. The more uncertain the stock assessment, the greater the buffer zone should be. In all cases, a buffer is required to signify the need for more restrictive measures.[1]

Biomass/catch index: The total weight of all the fish in a stock or other group added together.[2]

Catch per unit of effort (CPUE): The amount of fish caught by a fixed amount of fishing. For example, this could be kilograms of fish per one-hour tow of an otter trawl or kilograms of fish per hundred longline hooks hauled.[2]

Caudal Length (CL): A length measurement for fish. Generally from just behind pectoral fin to caudal (tail) fin.

Exploitation index: Index (ratio) used to assess level of fishing effort (e.g., catch/exploitable biomass).

F: "F" stands for the fishing mortality rate in a particular stock. It is roughly the proportion of fishable stock that is caught in a year.[2]

F_{lim}: A fishing mortality rate that should have only a low probability of being exceeded. F_{lim} cannot be greater than F_{msy}. If F_{msy} cannot be estimated, then an appropriate surrogate may be used instead.[1]

F_{buf}: A fishing mortality rate below F_{lim} that is required in the absence of analyses of the probability that current or projected fishing mortality exceeds F_{lim}. In the absence of such analyses, F_{buf} should be specified by managers and should satisfy the requirement that there is a low probability that any fishing mortality rate estimated to be below F_{buf} will actually be above F_{lim}. The more uncertain the stock assessment, the greater the buffer zone should be. In all cases, a buffer is required to signify the need for more restrictive measures.[1]

F_{max}: The fishing mortality rate that would give the maximum yield-per-recruit from a particular stock. In theory, this would give the maximum catch year after year.[2]

F_{msy}: The fishing mortality rate that would, in theory, give the maximum sustainable yield (MSY) from a particular stock year after year.[2]

$F_{0.1}$: A simple mathematical rule that calculates an F value close to the one that would give the best management. Broadly speaking, it is similar to the concept of fishing at the Optimum Sustainable Yield level. It is calculated by yield-per-recruit models. Compared with F_{max}, fishing at $F_{0.1}$ provides more of a safety margin to help avoid overfishing. It lets more fish survive and grow larger before they are caught.[2]

$^2/_3\ F_{MSY}$: Two-thirds of the fishing mortality rate that would give the maximum sustainable yield year after year.[2]

High-grading: Discarding of fish that could have been sold, to make room for more valuable fish.[2]

Maximum Sustainable Yield: The greatest sustainable yield for a particular stock. In theory, this catch would be sustainable year after year.[2]

Provisional Catch Estimate: Preliminary catch estimate for a year prior to compilation of all year end reported catch and landings.[3]

Small Fish Protocol: Minimum size limits to promote return of juvenile fish to the water.[3]

Spawning Stock Biomass (SSB): The total weight of sexually mature fish in the stock.[2]

Sources:
1. NAFO SCS Doc. 03/23. Scientific Council Meeting – September 2003
   Proposed NAFO Precautionary Approach Framework from Scientific Council
2. Department of Fisheries and Oceans
3. NAFO, 2004

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Preface

Commercial fishing for groundfish species has occurred for over 400 years of recorded history in the area that has become the Northwest Atlantic Fisheries Organization (NAFO) Convention Area. Increasing fishing power of vessels from many European and North American countries put growing pressure on the stocks, a number of which are seriously overfished. International management began with the formation of the International Convention for the Northwest Atlantic Fisheries, which NAFO subsequently replaced in 1979.

Nine NAFO regulated fish stocks are currently at historically low biomass levels and as a result are under fishing moratoria in the NAFO Convention Area. Two others are under partial closures — they are closed to fishing in the NAFO Regulatory Area (NRA), but are being fished inside the Exclusive Economic Zone (EEZ) of bordering nations. Twelve more are managed under Total Allowable Catch (TAC) or effort control schemes within the NRA. Three other stocks are directly targeted or taken as bycatch in the NRA and are unregulated by NAFO. Other stocks are solely managed by Canada or under the shared jurisdiction of Denmark and Iceland or Denmark and Canada.

This report evaluates the effectiveness of NAFO management, especially with respect to bycatch and its implications on the NAFO-managed stocks. The report identifies three institutional limitations to NAFO authority:

1. The NAFO management authority primarily focuses on the impact of directed fishing activities on a target species. Concerns over the impact of indirect fishing (bycatch and discarding practices) on target species and direct and indirect impacts to associated, non-target species and the marine community as a whole are difficult to reconcile within single-species management objectives.
2. The restrictive nature of international law, which requires that nations consent to abide by regulatory measures of an international management organization with high seas jurisdiction, limits NAFO to voluntary compliance by Contracting Parties.
3. Alleged illegal, unreported, and unregulated (IUU) fishing activities by Contracting Parties and non-Contracting Parties continue to restrict the effectiveness of stock rebuilding measures. NAFO is unable to prevent unregulated fishing in the NRA.

Due primarily to historic overfishing within NAFO's jurisdiction and adjacent EEZs of member countries including, NAFO adopted moratoria that prohibit directed fishing on a number of NAFO regulated stocks. Chapter 2 presents data and information on the stock status and bycatch and discards for nine moratoria stocks. Some additional data are included on three Canadian managed stocks that may be mixing with stocks found in the NRA.

NAFO manages nine stocks subjected to directed fishing in the NRA. These stocks are currently regulated via TAC or effort controls. Five other stocks are fished primarily under national control beyond NAFO jurisdiction. Chapter 3 presents a summary of the current state of these 14 stocks managed by NAFO or domestic TAC or effort controls. The chapter concludes with a summary and a number of recommendations on how to address the issues identified.

A number of stocks within the NRA have few or no regulations that establish moratoria, set TACs, or limit effort. The basis for management of these stocks is usually poorly understood and certain stocks are severely depleted. Chapter 4 reviews the stock status and adherence to management advice (where it exists), quantifies bycatch and discards where possible, and assesses the impact on the stocks from directed or indirect fishing activities from other fisheries.

Chapter 5 addresses a concern that increasing numbers of non-Contracting Party vessels are conducting IUU fishing activities in the NRA. For instance, non-Contracting Party vessels are believed to be targeting oceanic redfish. It is not known what impact this activity is having on moratoria stocks but cod and other species are probably being caught as bycatch.

Chapter 6 presents a number of simple summary analyses to indicate the current status of moratoria and TAC-managed stocks, using information previously provided in Chapters 2 and 3. It was not possible to undertake these analyses for NAFO stocks currently not managed by TAC or effort control as information was inadequate. The analyses addressed such issues as

- whether the scientific information base is adequate to determine reference points or TAC
- whether TAC advice was followed
- the current ratio of spawning stock biomass (SSB) to biomass (B)
- the current size of the stock relative to the largest historical reference
- the current level of bycatch removals
- which fisheries are reporting moratoria bycatch

Chapter 6 concludes with recommendations for the following: development and implementation of fisheries management within NAFO, availability of fisheries information, monitoring and enforcement, and governance.

Introduction

Historical Overview

Commercial fishing for groundfish species has occurred over 400 years of recorded history in the area that has become the Northwest Atlantic Fisheries Organization (NAFO) Convention Area, which encompasses the EEZ waters off the northeastern United States (USA), the east coast of Canada, Saint Pierre and Miquelon (in respect of France), and western Greenland and the international waters that extend north to 78° 10´ N and west to 80° 00´ W.

The rich cod resources off Newfoundland were first documented by a European, John Cabot, in 1497. By the early 1500s fishing was well established by the French and Portuguese on the Grand Banks. Commercial fishing in US waters began soon after the first colonists arrived in New England in the early 1600s, with fishing on Georges Bank beginning in the 1700s initially for cod, then later for halibut and haddock (Anderson, 1998). From the 17th to the 19th centuries, cod stock fluctuations off west Greenland were dramatic, so fisheries were slow to develop. An increase in cod stock abundance and spatial distribution, attributed to a general warming of the Arctic and subarctic regions, resulted in increased interest in fishing in this area in later years (Horsted, 2000).

By the 1840s, the British distant water fishery came to an end as the trade passed to branches of English fish merchants operating from ports in Newfoundland. The French continued their distant water fishery and were responsible for many of the technological innovations that changed the industry in the 19th and 20th centuries. They introduced the bultow, or longline fishing, to replace the traditional handline used from the deck of vessels. The bultow was simply long lines of several hundred metres with hundreds of baited hooks attached at regular intervals. The line was set or moored on the sea floor by fishers operating from flat-bottomed craft called dories (Lear, 1998).

In the late 1860s, US fishermen began raising concerns over the decline in abundance of some near-shore species. This led to the establishment of the US Fish Commission, headed by Spencer Baird, and the first US research station, which were to investigate and recommend remedial actions including enhancement (i.e., hatchery construction). In Canada, Dr. E. E. Prince was appointed the first Commissioner of Fisheries in 1893. A board of management and the first marine biological station also were established (Anderson, 1998).

The local Greenland Fishery began to develop around 1910. It consisted of coastal and inshore small-boats using mainly handline, longlines, and pound nets. These same gear types were used up until the mid-1960s (Horsted, 2000).

Early attempts at fishery management by the USA included the use of hatcheries to maintain or increase commercially exploited stocks. Lobster was, perhaps, the first and most closely regulated resource in Canada, with measures first imposed in the late 1800s. Around 1919, minimum mesh sizes were adopted for cod in nets around Newfoundland.

Before the mid-20th century landings of principal groundfish stocks were primarily taken by fishers from Newfoundland (a British dominion until 1949, when it became the tenth Canadian province), Canada, the USA, Spain, Portugal and France (Murawski et al., 1997).

After the First World War, French, Spanish, and Portuguese fishers continued to fish on the Grand Banks alongside Americans, Canadians, and Newfoundlanders. Many of the Europeans who came to fish on the Grand Banks were encouraged to do so by bounties paid by their home governments. With the advent of the “otter trawler,” a steam-powered ship equipped with a bottom-dragging trawl, fishing was forever changed. Sailing ships were gradually replaced by steamers, which allowed fishers to use more complicated and effective catching technologies. In the 1920s and 1930s, in response to pressure from hook-and-line fishermen, Canada placed a limit on the number of otter trawlers which was later relaxed towards the end of World War II. There were no other management measures enacted by Canada until the late-1940s, when fishing for groundfish, especially Atlantic cod, silver hake, haddock, and redfish, by “distant water” fleets from Europe and Asia rapidly expanded in the waters off West Greenland, Labrador, and Newfoundland (Murawski et al., 1997).

In the late 1940s, Spanish fishers on the Grand Banks began using pair-trawling, a most effective method of fishing where a large net was towed by two vessels. The Portuguese, on the other hand, ignored much of the technology and returned to the traditional line fishery, carried on from one-man, 5-metre dories. Further expansion of the fishing industry was facilitated by improvements in transportation, supply and demand of markets, and new facilities for handling and processing fish. Major improvements in fishing technology also occurred after the Second World War, including acoustic fish finders, radar, synthetic netting, mid-water trawlers, purse seine nets, and improved refrigeration (Pauly and Maclean, 2003).

Concern over declining abundance prompted the USA to convene a conference of ten countries in Washington, D.C., in January 1949, which led to the establishment of the International Convention for the Northwest Atlantic Fisheries (ICNAF) (Anderson, 1998).

In March 1954, the first factory freezer trawler and the first commercial stern trawler, the *Fairtry,* representing the latest in fishing technology, was launched from a shipyard in Scotland and dispatched to the Grand Banks. The *Fairtry* retrieved its nets by pulling them up a ramp at the stern of the ship rather than over the side as the older otter trawlers had. This allowed the vessel to use larger nets and to fish in almost any weather. The ship was equipped with a quick-freezing facility, automated filleting machines, cold-storage units, and a fish reduction unit. Shortly thereafter, the Russians developed their own fleet of freezer factory trawlers. Moreover, fuel tankers, salvage tugs, refrigerated transport ships, and floating repair shops accompanied the Soviet fleet. One of its most notable vessels was the *Professor Baranov,* a factory ship 165 metres in length. It processed the catch of a fleet of 20 trawlers, each between 40 and 50 metres long. In a single day, it could salt 200t of herring, reduce 150t of fish and offal into fish meal, fillet and freeze 100t of ground fish, manufacture 5t of fish oil, produce 20t of ice and distill 100t of water (Blake, 2005).

By the mid-1960s the West and East Germans, Poles, Romanians, Norwegians, Italians, Belgians, Dutch, Greeks, Japanese, Cubans, and Koreans had come to join the Soviets, Americans, Spanish, Portuguese, French, and Canadians on the Grand Banks in catching record numbers of haddock, then whiting, redfish (ocean perch), red hake, mackerel, and herring (Blake, 2005).

From the mid-1960s, larger handliners and longliners fished offshore, but it was not until 1968 that the first large trawlers were introduced into waters around Greenland. At the same time, a Faroese land-based small-boat fishery operated offshore using mainly handlines but later switched to trawlers. The Portuguese initially fished offshore using longline, handline and dory vessels and eventually trawl vessels (Horsted, 2000). The West Germans earned a reputation for finding the fish with the aid of sophisticated electronic equipment and, in 1969, perfected the mid-water trawl which allowed a vessel to tow its nets at any depth. Some of the mid-water trawls were 300 metres long, the length of three football fields, and used underwater sonars that were able to scan the ocean for up to three kilometres, making the net very effective. Soon all of the fishing nations were using the new technology (Blake, 2005).

Total landings of principle groundfish stocks expanded from about 1 million tons in the early 1950s to over 2 million tons by 1965 (Fordham, 1996). Soon after abundance of various stocks declined despite extensive management measures enacted by ICNAF (i.e., TACs for yellowtail flounder, preemptive quotas for mackerel due to uncertainty of stock status, minimum fish size regulations, and minimum mesh size requirements, etc.). As a result, Canada and the USA passed authorizing legislation and extended their exclusive economic zones (EEZs) to 200 nautical miles in 1977. In 1979, the Northwest Atlantic Fisheries Organization (NAFO) was formed to replace ICNAF.

With the adoption of EEZs, fishing pressure once again increased, but this time by modernized domestic fleets. This lead to further declines of groundfish stocks in the region. Between the peak of principal groundfish landings in 1965 and the extensions of territorial jurisdictions in 1977, landings declined 65% to 760,000t. Landings peaked again in the 1980s at just over a million tons but plummeted to 337,000t in 1993, a 68% decline to the lowest level in the century (Murawski et al, 1997). Increased capacity and efficiency of the domestic fleet were viewed as the key contributing factors in the decline.

NAFO

The Work of NAFO is similar to ICNAF, although on a smaller scale. Initially it managed 23 stocks versus ICNAF's 70 stock mandate. It adopted ICNAF's trawl regulations and quota allocation scheme but not the minimum fish size or area/season closure restrictions (Anderson 1998).

NAFO's mission is *"… to establish and maintain an international organization whose object shall be to contribute to the optimum utilization, rational management and conservation of the fishery resources of the Convention Area."* Member countries include: Bulgaria, Canada, Cuba, Denmark (in respect to Faroe Islands and Greenland), European Union (representing: Estonia, German Democratic Republic, Latvia, Lithuania, Poland, Portugal, Romania, Spain,), France (Saint Pierre and Miquelon), Iceland, Japan, Republic of Korea, Norway, Russian Federation, Ukraine, and the United States. NAFO's area of competence is detailed in Figure 1.

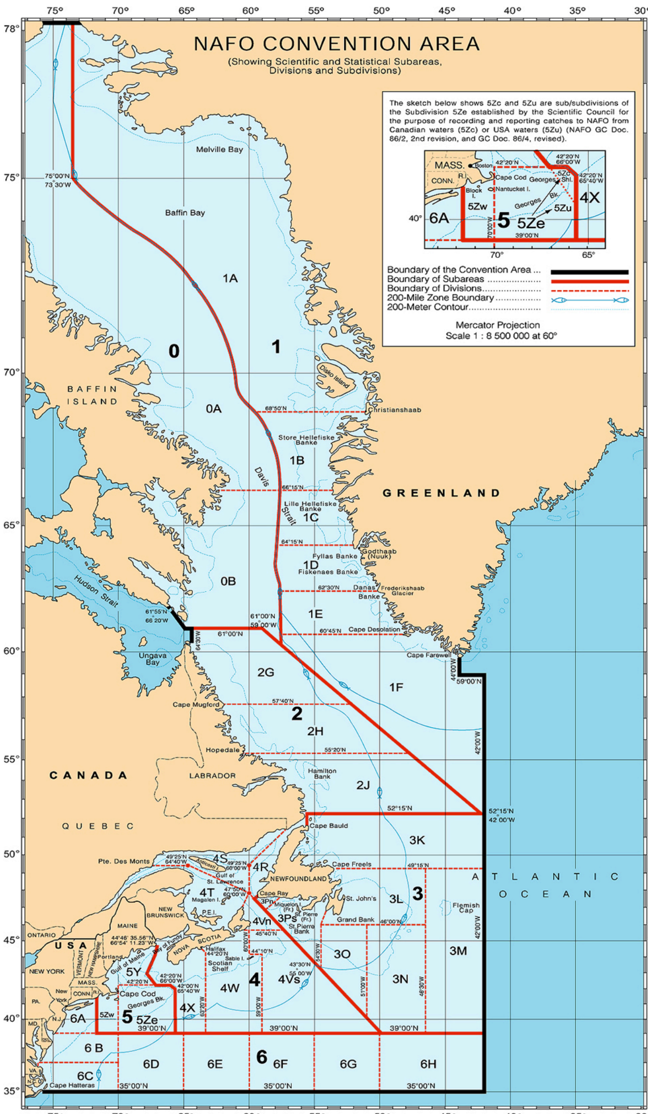

Figure 1. NAFO Convention Area. NAFO Regulatory Area (NRA) lies beyond EEZ boundaries in international waters.

Nine fish stocks are under fishing moratoriums in the NAFO Regulatory Area (NRA) and ten others are being fished under Total Allowable Catch (TACs) or effort control. In addition, some information is provided on seven stocks, three of which are solely managed by Canada and three others are managed jointly by Canada and Greenland (Denmark). The last stock is under the shared jurisdiction of Denmark and Iceland. Since the relationship with stocks in the NRA is unclear, and the management or lack thereof of these seven stocks could be affecting efforts to manage NRA regulated stocks they were included in this report (i.e., 2GH cod, Subarea 2 and Division 3K American plaice, 3Ps American Plaice, Subarea 0 and Division 1A (offshore) and Division 1B-1F Greenland halibut, Division 0A and 1A and 1F shrimp, and Subarea 0 +1 roundose grenadier and Denmark Strait and off East Greenland Shrimp).

Table 1 details stocks under moratorium and stocks managed under Total Allowable Catch (TAC) and/or effort regulation in the NRA (generally for 2005, unless otherwise indicated). All NAFO-managed stocks were included in the table. Several unregulated stocks directly fished or taken as bycatch by NAFO Contracting Parties and non-Contracting Parties in the NRA also were included where sufficient catch and/or effort data were available. In addition, national TACs for a few Canadian, Denmark/Greenland and Icelandic managed stocks were included because there is evidence to suggest that these stocks are mixing with stocks found in the NRA and, therefore, may be impacting NAFO's ability to effectively manage its own stocks.

Like many international organizations charged with regulating fisheries NAFO struggles under limitations posed by

a) single-species management approaches,
b) the consensual nature of international legal framework that NAFO works within,
c) the consequences of illegal and unreported fishing by Contracting Parties, and
d) unregulated fishing by non-Contracting Parties.

First, under a single species management regime, a management authority's primary focus remains on the impact of directed fishing activities on a target species. Concerns over the impact of indirect fishing (bycatch and discarding practices) on target species and direct and indirect impacts to associated, non-target species and the marine community as a whole are difficult to reconcile within management objectives focused on a single species. As a result, NAFO regulatory measures poorly define a set of controls to limit bycatch and discards, and these measures may

a) impact timescales for recovery of moratorium stocks because they are still subject to indirect fishing pressure,
b) result in exceeding catch limits for stocks where fishing still is permitted, and
c) threaten stocks for which no management measures exist.

Secondly, NAFO is further burdened by the restrictive nature of international law, which requires that nations consent to abide by regulatory measures of an international management organization with high seas jurisdiction. As a result, NAFO management measures are undermined by negotiations concerning allocations, which have led to

a) TACs being set above or in the upper range of scientific advice,
b) continued operation of unsustainable fisheries on juveniles, and
c) fishing on species without any management measures in place despite indications that the stock has declined.

Even in cases where NAFO claims to have adopted measures based on scientific advice, the perceived misuse of NAFO's objection and withdrawal procedures in setting the quotas, which allow unilateral disregard of allocations, undermines their effectiveness. NAFO members may opt out of NAFO regulations and object to allocated catch quotas either at the time a regulatory measure has been proposed and before it enters into force, or at any time during the next 12 months. States can then continue to fish without penalty.

Thirdly, alleged illegal, unreported, and unregulated (IUU) fishing activities by Contracting Parties (e.g., Canadian scientists and fishers report that direct targeting of moratorium species and high-grading are a recurring problem in NAFO-regulated shrimp fisheries (NAFO, 2004b and NAFO 2004c, DFO, 2003a) and non-Contracting Parties will continue to restrict the effectiveness of stock rebuilding measures. According to Canadian officials, a pervasive problem is over marketable species too small or otherwise prohibited from landings which are nevertheless retained in the gear and subsequently marketed. For the moratoria species, the vast majority of the bycatch is in fact marketed. The species that are being taken as bycatch are often more valuable than those that are being directed for and there is therefore an economic incentive to "maximize bycatch." This is done either through ignoring bycatch limits or by ensuring that each fishing trip catches the full limit of bycatch.

Table 1. Regulations for NAFO stocks including quotas by area.

Species	Stock	NAFO NRA 2005[1]	Canadian TAC] 2005[2]	Denmark/ Greenland TAC[2]	Iceland TAC[2]
Cod	2J 3KL	X	X	N/A	N/A
	2GH	N/A	X	N/A	N/A
	3M	X	N/A	N/A	N/A
	3NO	X	x (3NO)	N/A	N/A
Redfish	3LN	X	NO QUOTA	N/A	N/A
	3M	5,000	N/A	N/A	N/A
	3O	20,000	6,000	N/A	N/A
	Subarea 2 and Div 1F and 3K	32,500	NO QUOTA (2 and 3K)	? (Subarea 1)	?
American plaice	Subarea 2 and Div 3K	N/A	X	N/A	N/A
	3LNO	X	X	N/A	N/A
	3M	X	X	N/A	N/A
	3Ps	N/A	X	N/A	N/A
Yellowtail flounder	3LNO	15,000	14,624	N/A	N/A
Witch flounder	2J 3KL	X	X	N/A	N/A
	3NO	X	X	N/A	N/A
White hake	3LNO and Subdiv 3P	8,500 (3NO)	2,500	N/A	N/A
Capelin	3NO	X	x (2J 3KLPs)	N/A	N/A
Skates	3K	no mgt	no mgt	N/A	N/A
	3LNO	13,500	2,225 (2005), 449 (3LN), 1501 (3O) [2002]	N/A	N/A
Greenland halibut	Subarea 0 and Div 1A Offshore and Div 1B-1F	N/A	4,000 (0A), 11,053 (2 and 3K)	19,000	N/A
	Subarea 2 and 3KLMNO	14,079 (3LMNO)	(3LMNO) 2,112	N/A	N/A
Squid (Illex)	Subareas 3 and 4	34,000	X	N/A	N/A
Shrimp	Denmark Strait and off East Greenland Shrimp	N/A	N/A	15,600	No mgt
	Div. 0A and Div. 1A and 1F	150,000*	6,293 (0A-Davis Strait)	N/A	N/A
	3L	13,000	10,833	N/A	N/A
	3M	effort reg	effort reg	N/A	N/A
	Subarea 2 and 3KNO	x (3NO)	8,008 (2G), 4,715 (2J), 18,458 (3K), 14,178 (3L)	N/A	N/A
Roughhead grenadier	Subareas 2 and 3	no mgt	x (unspecified)	N/A	N/A

Table 1 continued

Species	Stock	NAFO NRA 2005[1]	Canadian TAC] 2005[2]	Denmark/ Greenland TAC[2]	Iceland TAC[2]
Roundnose grenadier	Subarea 1 and 0	no mgt	N/A	4,200 (2002)	N/A
Other finfish stocks	Subarea 1	no mgt	?	?	N/A
Demersal redfish	Subarea 1	partial mgt	?	?	N/A

"x" denotes species under moratorium.
"?" denotes inadequate information to make an assessment.
* The 150,000 TAC was the total TAC set by Greenland and Canada for Subarea 0 and 1. (Sources: NAFO CEM Report, 2005 Quota Table [NAFO FC Doc. 05/1]. Canadian quotas were taken from DFO website [www.dfo-mpo.gc.ca]).
* N/A = not applicable

Lastly, the inability to prevent unregulated fishing in the NRA by non-Contracting Parties is another product of the restrictive nature of international law. Since 2000, the following countries were identified as having fishing vessels within the NRA and thereby undermining NAFO conservation measures: Liberia, Belize, Malta, Cyprus, Sao Tome and Principe, Panama, Honduras, and Sierra Leone. Many of these nations were reportedly fishing on redfish in Division 1F.

Report Structure

In addition to this introductory chapter, the substantive body of the report consists of five additional chapters. The first three chapters each assess the effectiveness of NAFO's fisheries management for stocks currently under moratoria, for those managed by TAC or other effort limitation method, and for those not currently managed. Chapter 4 reviews available information concerning unregulated fishing of NAFO stocks and summarizes those actions taken by NAFO to address bycatch and IUU fishing by Contracting and non-Contracting Parties. The final chapter presents a series of summary analyses that capture stock status information and relates these to bycatch removals when possible. For TAC-managed stocks, a brief review of the information base available to establish TACs and the adherence of the TAC allocation process to TAC recommendations is presented. The chapter concludes with a series of recommendations that address management issues identified in the main body of the report.

Data and Information Quality

The findings within this report rely entirely on data and information gathered from NAFO and other published documentation. In some instances, to develop summary bycatch information by species, division or subarea, bycatch catch rates have been extrapolated from information available for similar fisheries. Such extrapolations are noted in the text.

No modeling or simulation work has been conducted to assess the impact of current bycatch removals on stock rebuilding time frames. As a result summaries of current impact remain essentially qualitative. However, given the low levels of a number of NAFO regulated stocks it is not unreasonable to assume that current removals for certain stocks will impair rebuilding time frames.

There is no consistent format in the NAFO literature reviewed for reporting the information compiled in this report. As a result the information collated by species and NAFO Division or Subarea lacks similar consistency. Every attempt has been made to present as complete a picture as was possible within the time frames available, but the quality (or in many instances the lack) of consistent data available for our analyses leaves gaps that will be readily apparent to the reader. Use of descriptors like "low" or "lower" or omissions for a bycatch total or a biomass estimate, to the extent that we have been able to ascertain, reflect the language or omissions in the documents sourced.

There are further uncertainties concerning stock status and catch estimates derived from the literature for stocks shared with Canada, Denmark/Greenland, and Iceland. In some instances, these estimates are for the entire NAFO division or subarea (e.g., 3N), which covers both waters within and outside the Canadian EEZ. In other instances, they refer to only that part of the stock contained within the Canadian EEZ or that part contained within the NRA. Unless otherwise noted, data presented refer to the stock or fishery within the NRA.

The primary sources of information and data used to compile this report include the following:

- NAFO Annual Reports (2000–2004)
- Scientific Council Reports (2000–2004)
- Meeting Proceedings of the General Council & Fisheries Commission and relevant Committees (2002–2004)
- Scientific Council Summary (SCS) Documents (2003–2004)
- Scientific Council Research (SCR) Documents (2003–2004)
- *E-Journal of Northwest Atlantic Fishery Science*
- NAFO Annual Fisheries Statistics Databases (i.e., 21A database and 21B)
- NAFO Conservation and Enforcement Measures (i.e., NAFO FC Doc. 05/1)
- Various Department of Fisheries and Oceans (DFO) publications and media releases

Chapter 2

Current Status of Species under Fishing Moratoria

Due primarily to historic overfishing within NAFO's jurisdiction and adjacent EEZs of member countries including Canada, Greenland and France (in respect of Saint Pierre and Miquelon), moratoria which prohibit directed fishing on a number of NAFO regulated stocks were adopted (Table 1). According to NAFO for any stock that is under moratorium to directed fishing, any catch is considered "bycatch." In addition, despite the moratoria, all these stocks are taken as bycatch in fisheries targeting other species. Moratoria species are being discarded or, in some instances, possibly misreported as having been taken from another area not under moratorium. Canada alleges that there has actually been direct targeting of moratorium species reported under the guise of bycatch (NAFO, 2004b), which constitutes illegal and unreported fishing under NAFO regulation. These stocks are also subject to unregulated fishing by non-member countries.

Another concern is that while a variety of age classes are caught as bycatch, juveniles are consistently being taken for many moratoria species. NAFO has only adopted Small Fish Protocols (minimum size limits) for cod (41 cm), American plaice (25 cm), and yellowtail flounder (25cm), and Greenland halibut (30cm) (NAFO, 2005a). In cases where NAFO does not specify what size is considered a juvenile, the Canadian Small Fish Protocol was used as a proxy for determining the age at capture for moratoria species (e.g., witch flounder and redfish).

In this chapter, data and information will be presented on the stock status and bycatch and discards for nine stocks currently under moratorium in the NAFO Convention Area, which extends into national waters (i.e., 2J 3KL cod, 3M cod, 3NO cod, 3LN redfish, 3LNO American plaice, 3M American plaice, 2J 3KL witch flounder, 3NO witch flounder and 3NO capelin). In addition, some data are included on three Canadian-managed stocks that may be mixing with stocks found in the NRA (i.e., 2GH cod, Subarea 2 and Division 3K American plaice, and 3Ps American plaice). Table 2 provides current SSB and biomass estimates (tonnes), where available, a minimum bycatch estimate based on reported bycatch by various fisheries in a given subarea or division and an estimated percentage of biomass and/or SSB which was taken in a given year (in most cases, 2003 unless otherwise indicated) as bycatch for each moratorium stock. Table 3 presents the bycatch of moratoria stocks by fishery.

The chapter concludes with a summary of the main issues affecting the management of moratoria species, current data and information gaps and a number of categorized recommendations to address issues and gaps.

Table 2. NAFO Management of Moratoria Stocks.

Species	Stock	SSB	Biomass	Bycatch Est. in 2003	% of Catch/SSB**	% of Catch/Biomass	Age at Capture
Cod	2J 3KL	unknown	30,000t (<1% of 1980s levels)	1,103t (including Can directed fishery, which is now under moratoria)	unknown	3.7% (2002/2003)	unknown
	2GH	unknown	extremely depressed	<1t in Can fisheries inside EEZ	unknown	unknown	unknown
	3M	846t (2004)	3,812t	about 100t	12%	2.51%	unknown
	3NO	4,500t	6,100t	4,280–5,459t	As much as 100%	70–89%	some juveniles
Redfish	3LN	unknown	No analytical assessment. Decline in Biomass/Catch Index from 1991 (Biomass estimates “considerably” lower than those from the 1980s)	2,739–2751t	unknown	unknown	juveniles in Can shrimp & Rus G.halibut fisheries
American plaice	2 + 3K	unknown	3-5% of 1980s levels	34t	unknown	<1%	mainly sexually mature females
	3LNO	20,000t (only 10% of the level in mid-1960s & 16% of level in mid-1980s)	5% of 1960s levels. Currently 20–30,000t	3,100t–5,48t	unknown	15–27%	Juveniles taken since 1959 in 3LNO. Most in G. halibut fisheries
	3M	2,000 t	2,500 t	130t	Up to 6.5%	5%	unknown
	3Ps	unknown	20% of 1983–1987 levels. 9,206t in 1999.	881t	unknown	5% of 1999 estimate	unknown
Witch flounder	2J 3KL	unknown	Varies by sub-stock. 2J = 7.9% 3K = 1% 3L = 18%	1,042t	unknown	unknown	21.2% of 2002 data averaged by sub-stock
	3NO	unknown	Varies by stock and survey series	850–2,239t	unknown	unknown	Varies by stock and survey series
Capelin	3NO	unknown	50,000–100,000	No information available	unknown	unknown	unknown

* Only available biomass estimate. ** Assumes all bycatch taken was mature fish, age distributed bycatch data were not available to more accurately estimate actual percentages of SSB taken. 1. All SSB and Biomass estimates are taken from SC, 2003 and 2004 Stock Assessments and/or Species Summary Sheets. 2. Total bycatch estimates for each stock derived from various sources cited in Table 3.

Table 3. Bycatch of moratoria stocks by fishery (2003 unless otherwise indicated). (Sources: 2002, 2003, and 2004 NAFO stock assessments, SC Summary Sheets and national reports as indicated in the following narrative)

Bycatch Species	Stock	Fishery and Region of Take 2003	Recent Bycatch Estimates (2003 Unless Otherwise Indicated)
Cod	2J 3KL	EU (unspecified) (2J3KL)	54t (2001); 60-70t (2002)
		Canadian shrimp fishery (3LMNO)	4t
		Russian Greenland halibut fishery (3L)	5t (0.22% of total Greenland halibut catch)
	2GH	Canadian fisheries (2GH)	<1t
	3M	Denmark (3M)	24t
		EU (unspecified Portuguese and Spanish in 3M)	<100/1,000 (10% of total catch)
	3NO	STACFIS est. for bycatch (3NO)	4,280 - 5,459t
		Multi-nation redfish fishery (Russia, Portugal, Canada) (3NO)	1,646-4,409/22,047t (at least a portion of which was cod) total bycatch = 7–20% of total catch
		Combined Canadian shrimp fishery (3KLNO in EEZ)	total bycatch for shrimp fishery = 2.6/44,022t = 0.005%
		Canadian yellowtail flounder fishery (3LNO)	445/12,709t (3.5% of total yellowtail flounder catch)
		Canadian white hake fishery (3KLNO)	ave 109t
		EU (all Spanish fisheries) (3LMNO)	24t (cod) & 175t (unspecified groundfish)
		EU (Spain) Skate fishery (3NO)	2/275t (0.7% of total catch)
		All Portuguese fisheries in 3NO (likely primarily redfish and skate)	653t
		EU (Portuguese) skate fishery (3NO)	328/1,665t (20% total skate catch was combined bycatch cod and Am. plaice)
		EU (Portuguese) roughhead grenadier	cod one of top bycatch species (23.5% of total catch in April in 3O)
		EU (Portuguese) redfish fishery (3O)	(26.1–29% of total catch)
		Russian directed skate fishery (3NO)	97/3,226t (3% of total skate catch)
		Russian redfish fishery	93t (from 3N), 82t (from 3O) (2002)
Redfish	3LN	STACFIS est. for all NRA bycatch	850–2,300t since start of moratorium in 1998
		EU (Spanish) trawlers targeting Greenland Halibut (3LN)	515/9,542t (5.4% of total Greenland halibut catch)
		EU (Spanish) fishery (3N)	72/1,844t (4% of total catch)
		EU (Spanish) fishery (3O)	446t/2,029t (22% of total catch)

Table 3 continued

Bycatch Species	Stock	Fishery and Region of Take 2003	Recent Bycatch Estimates (2003 Unless Otherwise Indicated)
Redfish	3LN	Total EU (Spanish) take in all fisheries (3LMNO)	1,870t (5.3% of total catch)
		Canadian shrimp fishery (3KL)	13/44,017t (<0.001% of total shrimp catch)
		Canada (Division 3O)	3,093t not under moratorium
		Norway (3LN)	<< 1t / ton shrimp (2001)
		Russian vessels likely targeting Greenland halibut (3LN)	70/3,005t (2.4% of total catch)
American plaice			
	3LNO	total bycatches for unspecified countries (mainly by Skate and Greenland halibut fisheries in NRA) (3LNO)	3,100t (provisional)
		Canadian shrimp fisheries (3L)	7.6t (<0.01% of total shrimp catch)
		Canadian yellowtail flounder fishery (3LNO)	1,047/10,700t (9.8 % of total yellowtail flounder catch)
		Canadian white hake fishery (3LNO)	0.72/360t (0.2% of total white hake catch)
		Canadian otter trawl for Greenland halibut and other fisheries (3LNO)	1,640t
		EU (Spanish) fishery (3N)	81/2,029t (3% of total catch)
		EU (Spanish) fishery (3O)	36/1,844t (4% of total catch)
		EU (Spanish) skate trawl (3NO)	846/5,878t (14% of total skate catch)
		EU (Spanish) Greenland halibut and skate fishery combined (3LMNO)	1,200/19,717t (6.1% of total combined catch)
		EU (Portuguese) Greenland halibut fishery (3N)	409t (10–20% assumed) (25% of total catch in April, 2003 in 3N)
		EU (Portuguese) skate fishery (3NO)	21% of total catch in October 2003 in 3N, 25% of total catch in November in 3O
		EU (Portuguese) redfish fishery (3O)	(15% of total catch in November)
		EU (Portuguese) roughhead grenadier (3LMN)	among top two species (24% of total catch in October 2003 in 3N)
		Russian Greenland halibut fishery (3L)	27/2,262t (1.2% of total Greenland halibut catch)
		Russian Greenland Halibut & skate fisheries (3N)	162/4,940t (3.3% of total Greenland halibut catch)
		Russian directed fisheries (3O)	157t
		Norway	<< 1t / tonne shrimp
	3M	Various NAFO fisheries (3M)	130t
		Russian Greenland halibut fishery (3M)	7/138t (5% of total Greenland halibut catch)
		EU (Spain) fishery unspecified (3M)	75t
	3Ps	Canadian witch flounder & cod fisheries (3P)	881t

Table 3 continued

Bycatch Species	Stock	Fishery and Region of Take 2003	Recent Bycatch Estimates (2003 Unless Otherwise Indicated)
	2 + 3K	Canadian Greenland halibut fishery (2 + 3K)	34t
Witch flounder	2J 3KL	Unspecified fisheries (2J 3KL)	700t (2002)
		EU (Portugese) Roughhead grenadier (3L)	3.4% average (7.2% high in April 2003 in 3L)
		primarily Canadian otter trawl for Greenland halibut (Subarea 2 + 3KLMNO)	111/5,207t (2.5% of directed Greenland halibut catch)
		EU (Portuguese) total for all fisheries in Subarea 3	502t
		EU (Portuguese) Greenland halibut fishery (3LMNO)	witch flounder among top three species taken (3.6% in January 2003 in 3L, 1.5% for fishing season in 3L)
		EU (Spanish) Greenland halibut fishery (3LMNO)	929/4,364t (21% of total Greenland halibut catch)
		Russian fisheries (e.g., Greenland halibut fishery [3NO])	59t
	3NO	All fisheries (unspecified) (3NO)	844–2239t
		Canadian EEZ (3N)	52t (Newfoundland regions); 300–1,000t (Division 3Ps)
		EU (Spanish) fishery (3O)	61/2,029t (3% of total catch)
		EU (Spanish) Skate trawl (3NO)	1.1% of skate catch
		EU (Portuguese) Redfish fishery (3O)	(1.3–3.5% of total catch) (av. 2.4%) of total catch
		EU (Portuguese) Roughhead grenadier fishery (3NO)	Average 3.8% (high 7.9% in August) in 3N; 2.1% in 3O (all of catch was in April) of roughhead grenadier catch
		EU (Portuguese) Greenland halibut fishery (3N)	5.5% average over eight months (high of 24% in November) in 3N of Greenland halibut catch
		EU (Portuguese) skate fishery (3NO)	Average over six months 4.7% in 3NO; high in 3N of 8.3 % in October of skate catch
		Russia redfish fishery (3LMNO)	60/10,972t (0.05% of total redfish catch
Capelin	3NO	no information available	unknown

2J3KL Cod (*Gadus morhua*)

Stock Status and Current Fisheries Information

Considerable uncertainty exists about the structure of the Division 2J3KL stock. The available tagging, genetic, survey and biological data are consistent with two possible hypotheses suggesting that a) the inshore component of the population constitutes a separate inshore stock that is distinct from the offshore stock, or b) that the inshore and offshore stocks together constitute a single functional population.

Prior to the collapse of this stock, the major over-wintering aggregations were associated primarily with offshore grounds, including those of the NAFO Regulatory Area. The only aggregation known to exist at the present time over-winters in a deep-water inlet in northern Division 3L, Smith Sound. Acoustic studies have estimated this aggregation to be around 20,000t. Fish from this aggregation migrate seasonally out of the sound in the spring, mainly northward in Division 3L and into southern Division 3K, supporting most of the commercial fishery, which took place in the autumn between 1998 and 2003. The fishery was closed in 2003 (DFO, 2005). Elsewhere densities are extremely low throughout the 2J3KL area, with the exception of the southern portion of Division 3L where there is a seasonal migration of fish from Sub Division 3P. In NAFO regulated waters, the 2J3KL stock has been under moratorium since 1992.

Recent stock biomass trends have fluctuated, increasing from 1998 to 1999 but subsequently declining in 2000 and 2001 (Figure 2). However, the biomass index from the 2001 Canadian spring bottom-trawl survey was less than 1% of the average in the 1980s; clearly illustrating that a longer historical perspective must be considered before determining management responses to recent biomass fluctuations (STACFIS, 2002a).

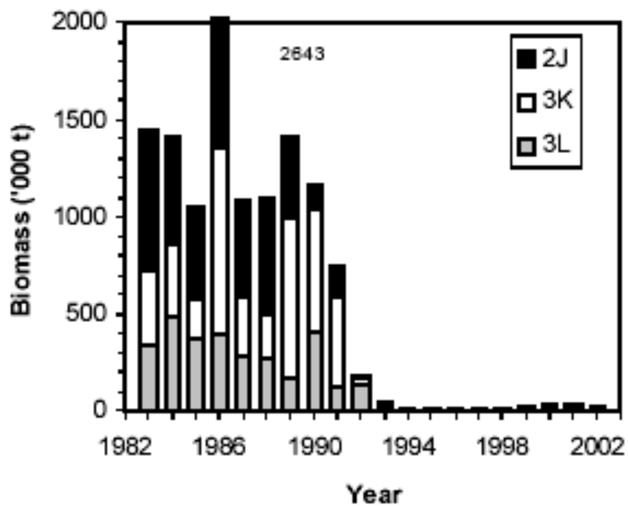

Figure 2. 2J 3KL cod biomass index from autumn bottom-trawl surveys 1982–2002. (Source: STACFIS, 2002a)

Cod catches (1998–2003) came from directed fisheries, bycatches, sentinel surveys, and food and recreational fisheries (Figure 3). In 3L (inside the Canadian EEZ), a TAC of 5,600t for 2002/2003 was to include all catches, including those from the food and recreational fishery. It was alleged during the last years of the fishery that removals were in excess of reported landings, but the magnitude of such removals is unknown (Lilly et al., 2003a). The landings have been increasingly concentrated in space throughout the duration of this fishery. In 2002, 36% was taken in Trinity Bay and an additional 13% was landed at the community of Bonavista just to the north of Trinity Bay. Results of tagging experiments indicate an exploitation rate close to 20% in inshore waters in 2002 associated with a reported catch of 4,200t (Lilly et al., 2003a). This harvest rate was in percent of exploitable biomass (approximately ages 4+), which was estimated to be 22,000t in the inshore regions of Division 3KL and 30,000t throughout 2J3KL. The exploitable biomass estimates increased during 1999–2001, but declined sharply in 2002. The tagging studies provided evidence of a natural mortality of 55% in Division 3K and 33% in Division

3L. These estimates are considered to be independent of unreported catch. According to Canadian stock assessment data, the inshore SSB decreased since 1998 when the fishery reopened. The indices of biomass from research bottom trawl surveys (autumn) (2J3KL) and spring (3L only) are at less than 2% their levels during the 1980s (Lilly et al., 2003b).

In April 2003, the whole stock area was closed indefinitely to directed commercial and recreational fishing. Sentinel surveys continue. Reported landings during 2003 were 939t from the commercial fishery and 90t from sentinel surveys, for a total of 1,029t (Richards et al., 2004). Most (780t) of the commercial catch came from a mass mortality of cod in Smith Sound, Trinity Bay, during April 2003. The exact cause of this event remains uncertain, but it was clearly associated with unusually cold water within the sound. The rest of the reported catch was bycatch in fisheries directed at other species. Most (84t) of this came from gillnets set for winter flounder. The bycatch from Canadian trawlers was 3t. Bycatch estimates for fishing in international waters in 3L were estimated at 60–70t in 2002 (DFO, 2004).

The most recent full assessment of this stock was conducted in February 2003. An update of major indices was reported in March 2004. Prospects for recovery in the offshore remain very poor because of very low spawner biomass and extremely high mortality. Prospects for the small inshore populations are unclear. Their biomass appeared to decline by about half from 1998 to 2003 as a result of fishing mortality, high natural mortality on adults, and weak recruitment. It is hoped that a recent improvement in recruitment will result in an increase in spawner biomass in the inshore during the next few years (Richards et al., 2004).

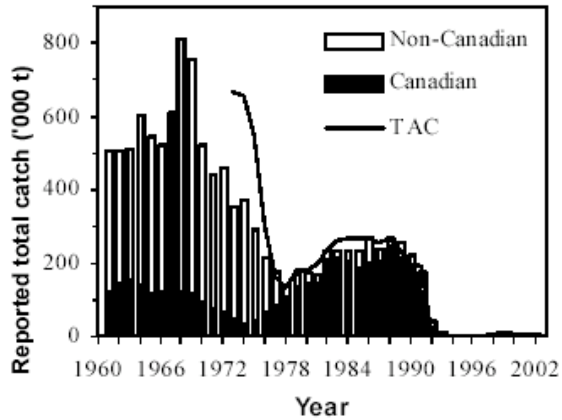

Figure 3. 2J 3KL cod reported catch and Total Allowable Catch (TAC in tonnes). (Source: STACFIS, 2002a)

Adherence to Management Advice

In 2001, the Scientific Council stated there is no doubt that the Divisions 2J3KL cod spawner biomass remains at an extremely low stock level, that there is no evidence of a recovery, and that any fishery on the remnant inshore will delay recovery of the stock. In 2003, Canada closed the inshore fishery.

Bycatch and Discards

European Union
In 2001, the EU reportedly took 54t of cod in Divisions 2J3KL as bycatch (Lilly et al., 2003b).

Canada
In 2003, the Canadian shrimp fishery in 3LMNO reported taking 2t of Atlantic cod aged 1-3 years. The 3LMNO shrimp stock is distributed along the edge of the Grand Banks, mainly in Division 3L. Canada has approximately 12 large (>500 ton) fishing vessels and more than 300 smaller (<500 ton; <100′) vessels catching shrimp within the Davis Strait, along the coast of Labrador, and off the east coast of Newfoundland. There is 100% mandatory observer coverage of the large vessels, but less than 10% coverage of the small vessels. A total of 9,953t of shrimp were taken from 3L in 2003, and no shrimp catches were reported in 3MNO. The percentages of the catch taken inside the Canadian EEZ and that taken in the NRA were not identified, nor is it known where the cod was taken as bycatch.

Russia

The Russian Greenland halibut fishery reported taking 5t of Atlantic cod out of a total catch of 2,262t in 2003 from Division 3L, constituting 0.22% of the total catch. In 3L, cod taken as bycatch in the Russian Greenland halibut fishery varied in total length from 33 to 69 cm, with a mean length of 52.4cm (Sigaev and Rikhter, 2004). According to the NAFO's Small Fish Protocol, cod measuring less than 41cm are below minimum size and can not exceed 10% by number in any one haul (NAFO, 2005a). According to the Canadian Small Fish Protocol fish less than 45cm have likely not spawned once and would be considered undersized or juveniles. Although it is impossible to determine precise estimates without modeling these catches, at least some portion of the cod taken in the Russian Greenland halibut fishery are juveniles.

Impact on Stock from Direct and Indirect Fishing

Given a biomass estimate of 30,000t for 2J 3KL cod and calculated removals from direct fishing (including the mass mortality event reported above) and indirect fishing activities of 1,103t, 3.7% of the biomass was "removed" in 2002/2003. At least some portion of this catch was juveniles. After 2002/2003 the Canadian directed fishery ceased to operate. Assuming bycatches remain the same for the other fisheries in 2003/2004, the bycatch rate likely will reduce significantly.

2GH Cod

Stock Status and Current Fisheries Information

This stock has been under moratorium since 1986 and is under Canadian management because the majority of its habitat lies within the Canadian EEZ (Richards et al*.,* 2004).

Bycatch and Discards

According to the Canadian Research report for 2003, Canadian (Newfoundland) bycatch of this stock has been extremely low (<1t) since 1992 (Richards et al*.,* 2004).

Adherence to Management Advice

Based on available information, it appears that the moratorium is being obeyed. Stocks likely remain in an extremely depressed state as evidenced by the very low reported bycatch levels.

Impact on Stock from Direct and Indirect Fishing

There is insufficient information to make any conclusions about the impact of fishing on this stock. Such low bycatch suggests the stock is still in poor condition and has undergone no significant rebuilding since 1986. If there is mixing between this stock and stocks found inside the NRA, the national bycatch data warrants more careful review and consideration, which is beyond the scope of this current report.

3M Cod

Stock Status and Current Fisheries Information

The cod stock on the Flemish Cap is considered a discrete population and has been under moratorium since 1999. The moratorium is in place until (at least) 2006.

The most recent assessment indicates peaks in total (1+) biomass in 1976 and 1989 (Figure 4). Peaks followed the production of good year-classes by three to four years, but were very short-lived because of intensive fishing. Spawning stock biomass (Figure 4) tended to fluctuate between 10 000t and 30 000t from the mid-1970s to the mid-1990s, but has been very low since 1996. Catches exceeded established TAC for the period from 1987 to1995 (Figure 5) prior to the stock collapse. Year-classes have been very small since 1992.

Estimates of the current spawning stock biomass, based on survey results, are from 1,000 to 2,000t, well below B_{lim} (Vázquez and Cerviño, 2002).

An SSB of 14,000t was identified as the preliminary B_{lim} for this stock by the Scientific Council, although the Serebryakov method suggests a lower value (4,000t to 6,000t). Cerviño and Vázquez (2004) estimate current SSB at 846t. In either case, the current SSB estimate is significantly lower than historic levels and well below the B_{lim} (SC Summary Sheet, 2004).

Given the almost complete absence of recruitment to the stock since 1992, little improvement can be expected in the foreseeable future. More recent biomass estimates have suggested that current biomass may be between 1,000 and 2,000t (Vazquez and Cervino, 2002) and 3,812t (Cerviño and Vázquez 2004). Historic estimates of stock biomass based on USSR/Russian data suggest biomass was around 136,000t in 1976. More recent estimates in 1988 put stock biomass at 100,000t, based on Canadian survey estimates, or about 35,000t based on EU estimates.

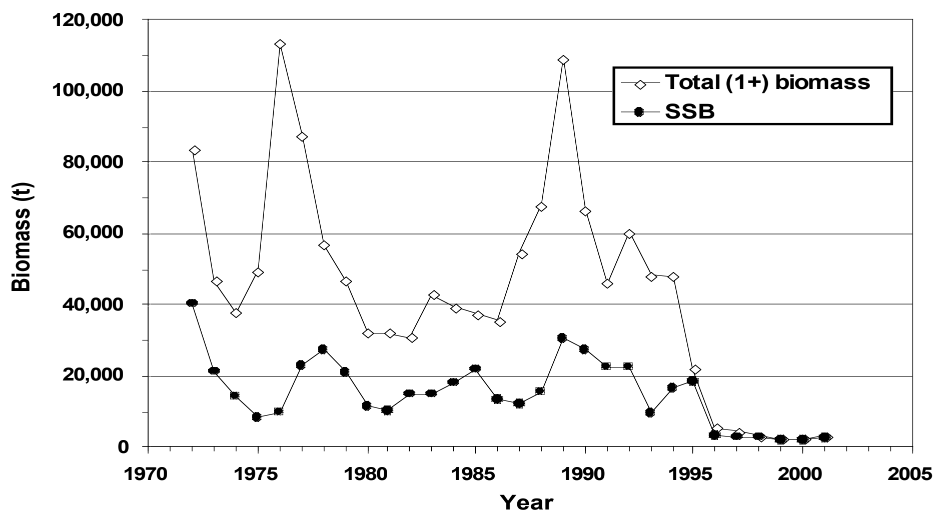

Figure 4. Cod in Division 3M. Total (1+) biomass and spawning stock biomass (SSB). (Source: Vázquez and Cerviño, 2002)

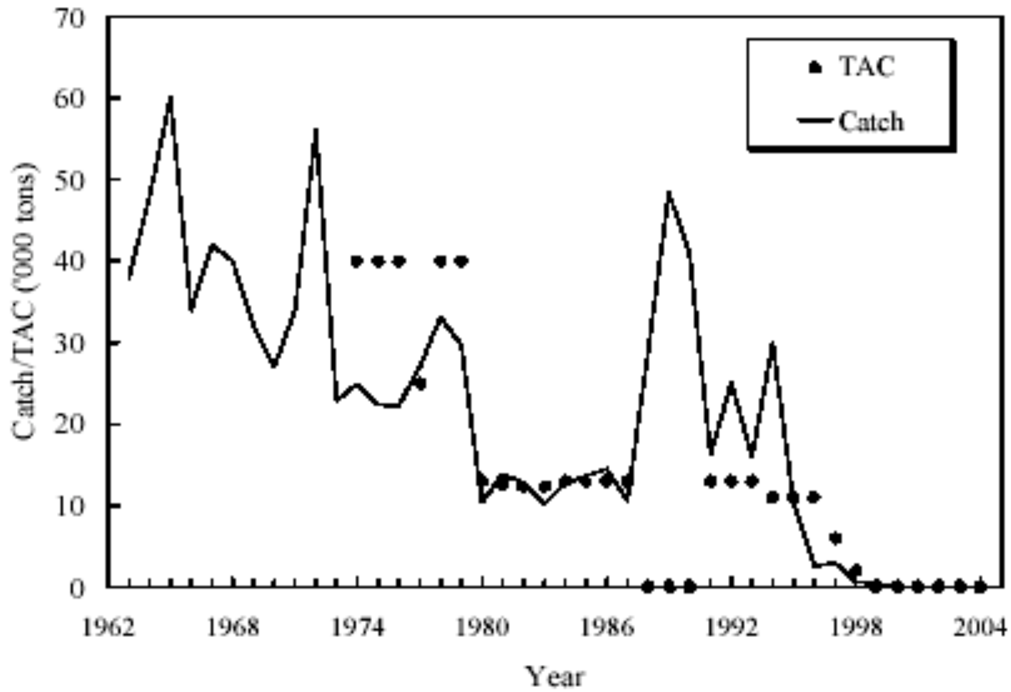

Figure 5. 3M cod catch and TAC 1962–2004. (Source: SC Summary Sheet, 2004)

Adherence to Management Advice

The Scientific Council recommends no directed fishery for cod in Division 3M for 2005 and 2006. Also, bycatch of cod in fisheries directed to other species on the Flemish Cap should be kept at the lowest possible level (SC Summary Sheet, 2004).

Bycatch and Discards

European Union
Annual catches of 3M cod were as high as 50,000t in the mid-1980s and then fluctuated between 25,000 and 30,000 in the late 1980s (Figure 5) but declined again after that until the stock eventually collapsed. From 1997 to 2000, less than 1,000t were taken annually as bycatch, primarily by Spain and Portugal. Since 2000, cod catches were less than 100t, again mainly attributed to bycatches of Spanish and Portuguese fleets in the area (Cerviño and Vázquez, 2004)

Denmark/Greenland
The 3M Greenland shrimp fishery had a total catch of 648t in 2002 and 811t in 2003. Total bycatch in 2002 and 2003 amounted to about 2% of the total shrimp catches or 14t and 13t respectively. Most of this bycatch consisted of redfish and other finfish including cod (Siegstad, 2003b).

Impact on Stock from Direct and Indirect Fishing

Given estimates of 846t and 3,812t for SSB and biomass respectively and an estimated indirect catch of approximately 100t of cod, approximately 2% to 5% of the biomass was removed as bycatch. Based on the available data, it appears that the most problematic fisheries are unidentified Spanish and Portuguese fleets in 3M.

3NO Cod

Stock Status and Current Fisheries Information

There has been no directed fishery on this stock since mid-1994 (Figure 6). The stock remains close to historical low levels with weak representation from all year-classes (SC Summary Sheet, 2003).

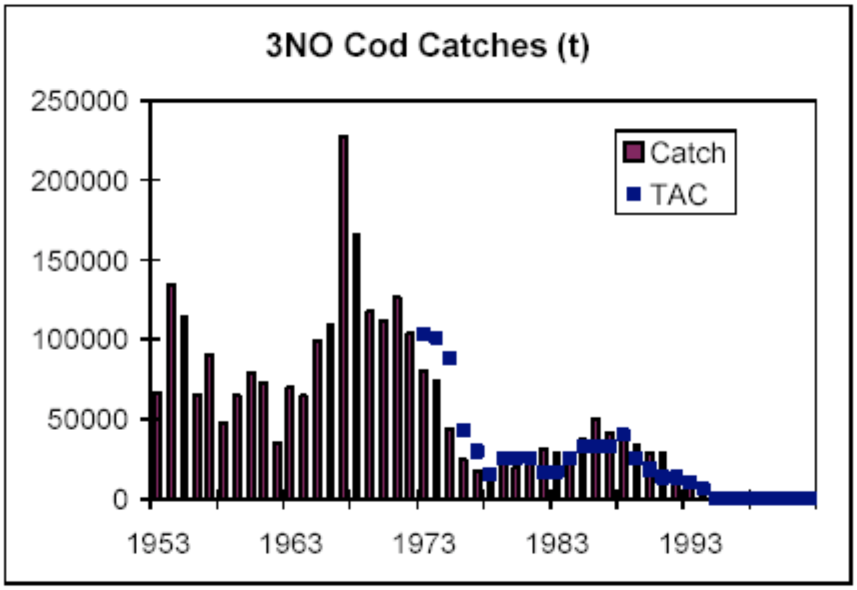

Figure 6. 3NO cod catch and TAC 1950–2003. (Source: SC Summary Sheet, 2003)

The estimates of biomass of cod three years and older (Figure 7) fluctuated around 200,000t during the late 1950s, increased quickly to a peak of almost 400,000t in 1967, and then declined rapidly to a low of 46,000t in 1976. Then there was a steady rise to a peak of 175,000t in 1985, followed by a steady decline to 14,000t in 1993. The biomass reached a nadir in 1995, started to increase a little toward the end of the decade, and has since declined once again.

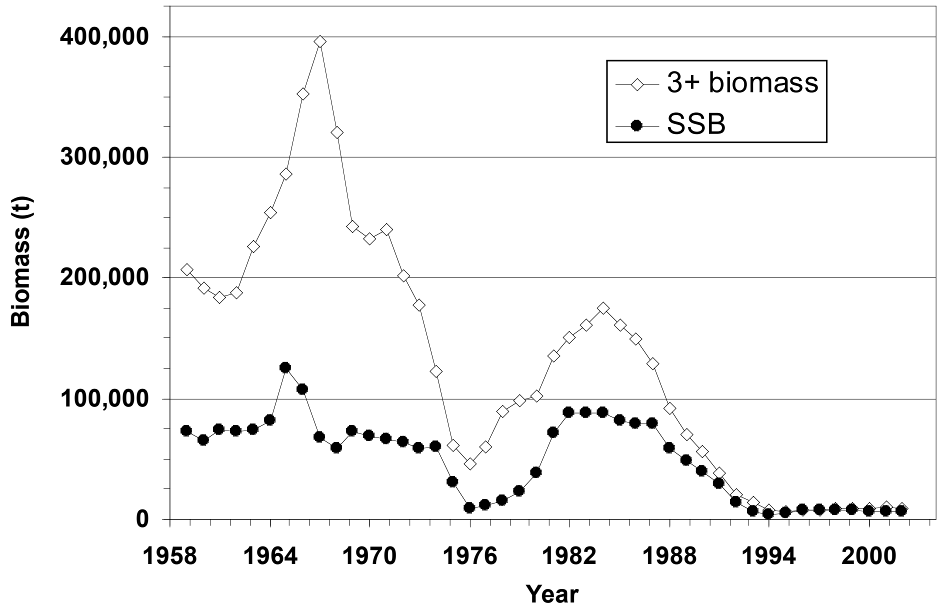

Figure 7. Cod in Division 3NO. Total (3+) biomass and spawning stock biomass (SSB). (Source: Healey et al. 2003)

The Scientific Council estimates a B_{lim} of 60,000t. The last assessment of this stock was conducted in 2003 and, using an accepted Virtual Population Analysis model, estimated total biomass and spawning stock biomass at 6,100t and 4,500t, respectively (NAFO, 2004c).

Adherence to Scientific Advice

The Scientific Council recommended that there should be no directed fishing for cod in Division 3N and Division 3O in 2004 and 2005. Bycatches of cod should be kept to the lowest possible level and restricted to unavoidable bycatch in fisheries directing for other species (SC Summary Sheet, 2003). Given the problems acknowledged by NAFO concerning the reporting of bycatch information it is unlikely that the increasing trend observed for cod bycatch (see below) is the result of an improvement in cod stock condition. This would suggest that scientific advice is not being followed by the Contracting Parties.

Bycatch and Discards

3NO cod bycatch has increased more than tenfold during the moratorium period from 172t in 1995 to 2,194t in 2002. In 2002, Canada took 444t, Spain 40t, Portugal 405t, Russia 338t and other countries 967t for a total of 2,194t (all reported as bycatch). This is almost half the current biomass estimate (Healey et. al., 2003).

According to STACFIS, the total catch of cod for 2003 in Division 3NO from all fisheries was estimated to be within the range of 4,280t and 5,459t (NAFO, 2004c). However, in STATLANT A data, total cod catch was reported to be only 1,600t in 2003.

Multinational redfish fisheries
In Division 3O, based on NAFO STATLANT 21B data for 1998 to 2000, Atlantic cod, American plaice, Greenland halibut, witch flounder, and yellowtail flounder constitute the major bycatch species in the directed redfish fishery in this division. The percentage of bycatch, calculated as the sum of bycatch for all species as a percentage of redfish catch, suggests that there are differences by fleet and by year, which ranged between 2% and 20% from 1998 to 2000. There were large differences between bycatch within the Canadian EEZ (at less than 3% each year) and bycatch within the NRA (between 12% to 20% annually, depending on the fleet) (STACFIS, 2002a).

Canada
According to Canadian white hake fishery observer data from 1997 to 2003, cod under moratorium dominated in longline catches. Estimated amounts averaged 109t annually from 1994 to 2003 (Kulka et al., 2004b).

The Canadian 3LNO yellowtail flounder fishery, which uses primarily otter trawl, often takes cod and American plaice as bycatch. The use of sorting grates was widespread in 2002 (present in 67% of observed sets), but declined to only 20% of observed sets in 2003. This likely contributed to an increase in cod bycatch from 2.1% of the observed catch in 2002 to 3.5% in 2003 (Brodie et al., 2004a). In 2003, Canada caught an estimated 12,709t of yellowtail flounder in 3LNO, of which all but 35t came from 3NO NAFO, 2003d). It also took an estimated 445t of cod in the area.

European Union
Spain reports taking 24t of cod in all its fisheries operating in Division 3LMNO in 2003 (9t in 3N, 15t in 3O) and an additional 175t of unspecified groundfish in 3LMNO (González et al., 2004). Also in 2003, the 3NO Spanish trawl fishery for skate caught 275t of skate and about 2t of cod or about 0.7% of its catch (CPUE 0.0074t/hr). It also was reported that the bycatch in this fishery has diminished with time. Bycatch consisted of mainly American plaice, yellowtail flounder, and cod (del Rio et al., 2003).

Considerably higher bycatch rates were reported by Portuguese vessels. In total, Portuguese fisheries (unidentified fisheries, but most likely skate and redfish) took about 653t of cod as bycatch in 3NO in 2003 (Vargas et al., 2004). It is estimated that 79% of the catch is bycatch in the 3NO Portuguese skate fishery. The dominant bycatch species (proportions not specified for the entire year) were Greenland halibut, American plaice, and white hake; in certain months, however, cod was reported at around 20% of the total catch: in November, 19.1% (3N); in April, 27.3% (3O); and in May, 29.3% (3O) (Vargas et al., 2004). So, in 2003, 1,641t of skate were taken in 3NO and as much as 328t of cod were caught as bycatch in certain months (NAFO, 2003d).

As well, in the Portuguese roughhead grenadier fishery in 3LMNO, cod was also the top bycatch species taken in area 3O in 2003. The fishery operated in 3O in April and reported 23.5% cod bycatch (Vargas et al., 2004).

In Division 3O, the Portuguese redfish fishery reported that in 2003 it took 6,382t of redfish (unspecified species), and around 26.1% to 29.0% of the catch was cod, or approximately 1,666–1,851t. The fishery operated in April, May, August, October, and November and had an average cod bycatch rate of 22.4% (Vargas et al., 2004).

Russia
Reported bycatch in the Russian directed skate (unspecified species) fishery in Division 3NO amounted to 12%, a quarter of which was cod in 2003. In other words, for 3,226t of skate taken, 97t of cod were taken as bycatch. In 2002, the main Russian fishery for redfish, which takes place at a depth of 350–550m, cod reportedly constituted less than 1% of the bycatch (Vaskov, 2003).

Impact on Stock from Direct and Indirect Fishing

Given a biomass of 6,100t and STACFIS bycatch estimate of between 4,280 and 5,459t in 2003, between 70 and 89 % of 3NO cod biomass may have been caught. It seems reasonable to assume that the STACFIS bycatch rates are reliable given that there is good correlation between the 2002 NAFO data (2,194t) and our compilation of bycatch data from individual fisheries (2,446 t). However, an accurate assessment is difficult because some fisheries only report percentage bycatch or present a range of bycatch estimates. If the majority of this bycatch was mature fish, almost all of the current spawning biomass may have been removed. The most problematic fisheries appear to be the Portuguese redfish fishery and the combined skate fisheries of Portugal, Spain and Russia in 3N.

3LN Redfish (*Sebastes mentella*) (*Sebastes fasciatus*)

Stock Status and Current Fisheries Information

There are two species of redfish, *Sebastes mentella* and *Sebastes fasciatus*, which occur in Division 3LN and are managed together. These are very similar in appearance and are reported collectively as redfish in NAFO statistics. The stock has been under moratorium since 1998. Recruitment since the 1986 and 1987 year-classes has been poor. Biomass estimates from recent surveys are considerably lower than those from the 1980s, indicating a reduced and low stock size in Division 3L. The catch/biomass index for 3L redfish was around 1.0 in 1985 (Figure 8). In 1991, the estimate was about 0.5. No recent analytical assessment is available. For 3N redfish, the catch/biomass index has been around 0.0 since about 1995 (SC Summary Sheet, 2003).

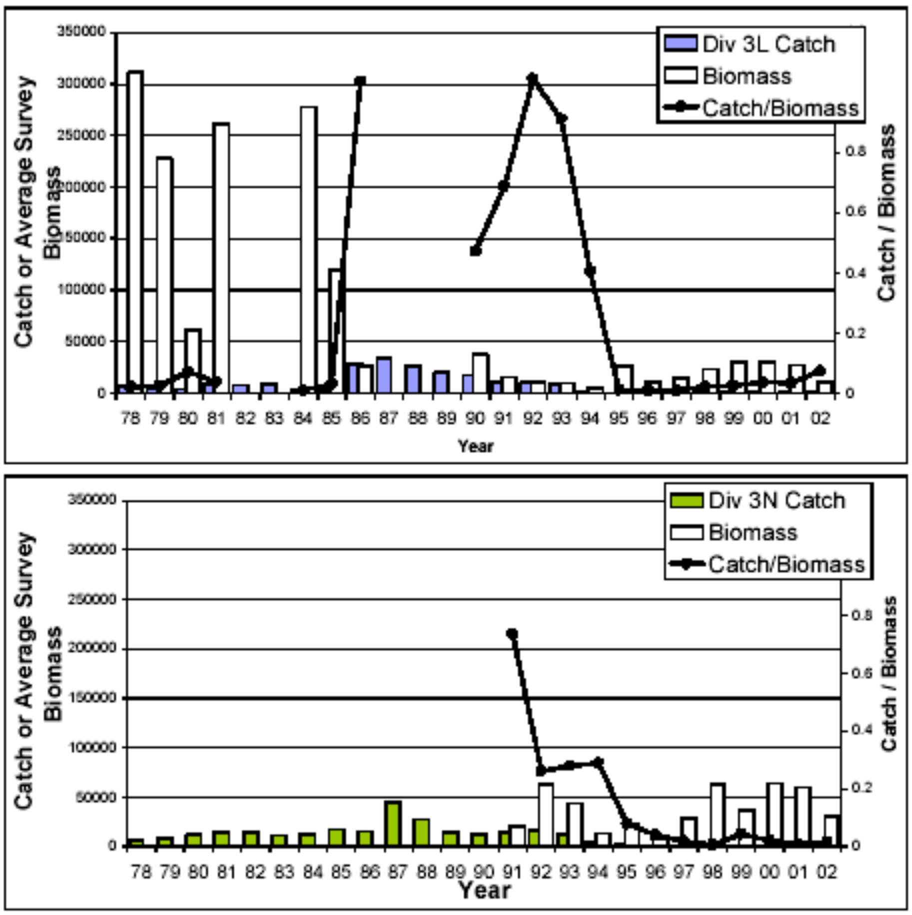

Figure 8. Redfish catch biomass ratios for Div 3L (upper panel) and Div 3N (lower panel). Plotted are average survey biomass between spring and autumn for year in which catch was taken. (Source: Power, 2003)

The continuing uncertainties regarding the relationship between redfish in Division 3LN and adjacent areas, most notably Division 3O, have important impacts on interpretation of available data (SC Summary Sheet, 2003). Given this uncertainty, bycatch data from Division 3O also are included in this section. In addition, since the Canadian shrimp fishery reported total redfish bycatch from 3KL and does not specify the actual amount taken from just 3L, the combined information is presented under the Bycatch and Discard subsection for this stock.

Adherence to Management Advice

The Scientific Council recommended no directed fishing for redfish in Division 3LN in years 2004 and 2005 and that bycatches of redfish in fisheries targeting other species should be kept at the lowest possible level (SC Summary Sheet, 2003).

Bycatch and Discards

Since the moratorium, 3LN redfish bycatch has ranged between 850t and 2,300t (Power, 2003) (Figure 9). According to STACFIS the 2002 catch was 1,212t. However, national reports indicate a lower catch of 651t in 3L and 327t in 3N. The 3L bycatches by country were as follows: Canada (48t), Japan (86t), Portugal (103t), Spain (262t), Russia (126t), Lithuania (3t) and Estonia (21t). In 3N, the following catches were reported: Portugal (120t), Spain (136t), and Russia (71t). In 2003, 1,330t were caught (NAFO, 2004c). Catches since 1998 were taken as bycatch primarily in Greenland halibut fisheries by EU and Russian vessels. A portion of the catches, which in some years were substantial, were taken by non-Contracting Parties from 1987 to 1994. These countries have not fished in Division 3LN since 1994 (Power, 2003).

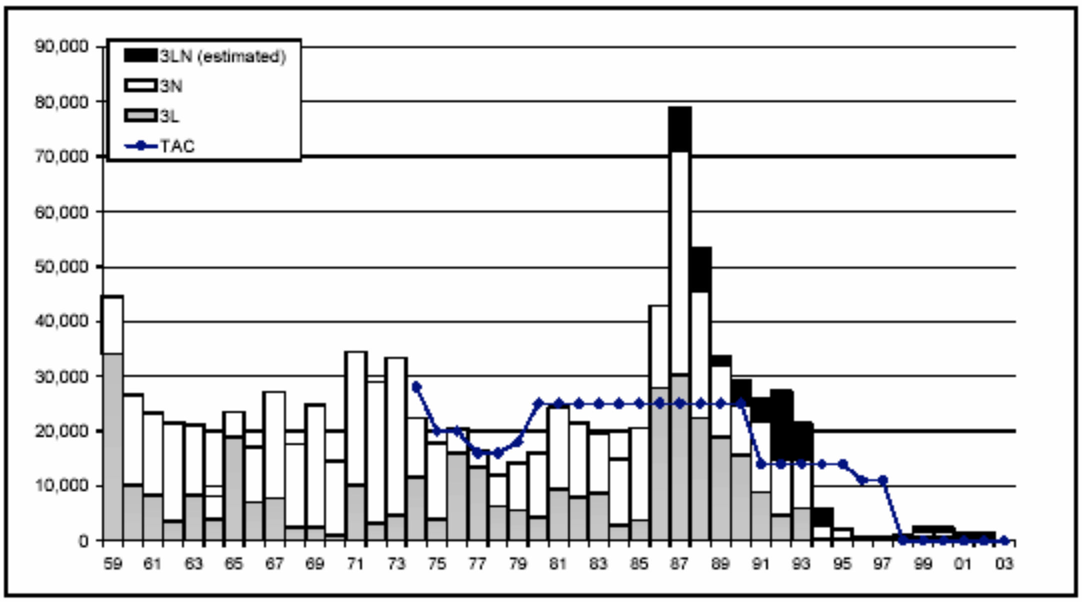

Figure 9. Nominal catches and TACs of redfish in Div 3LN are provisional (2000–2002). (Source: Power, 2003)

European Union

In 2003, redfish bycatches were taken by Spanish trawlers fishing for Greenland halibut in Division 3LN and 3M. Spain reported taking 284t of redfish from 3L and 231t of redfish from 3N. It also took 9,542t of Greenland halibut from 3LN. So, 5.4% of the total catch was redfish bycatch. The amount of redfish bycatch by weight, because of their small size relative to halibut, is small compared to total catch. The compilation of annual catch at length for redfish bycatches in Division 3L was dominated by lengths between 27 and 32cm for Portuguese and Spanish fleets (González et al*.,* 2004).

In 2003, in Division 3N, the total Spanish catch was 1,844t, about 74t (4% of the total catch) of which was redfish bycatch and only 332t (18%) was white hake (the target species). In Division 3O, white hake was the main species in Spanish catches (56%) and redfish was the main bycatch (22%). An estimated 446t of redfish bycatch were taken out of a total catch of 2,029t in the division where the targeted white hake catch was 1,136t (González and del Río, 2004). The 3O data is included here because it is unclear what relationship redfish in 3O have with fish in 3LN.

In total, in all of its fisheries operating in 3LMNO, Spain reported taking 1,870t of redfish bycatch in 2003 from 3L (316t), 3M (552t), 3N (310t), and 3O (692t). Redfish accounted for approximately 5.3% of Spain's total catch in all these fisheries (González et al., 2004).

Canada

In 3KL in 2003, 12 Canadian large shrimp vessels >500t took 2.9t of redfish; and 300 small shrimp vessels <500t took 10.1t of redfish. The total shrimp catch was 44,017t, the majority of which came from 3K where redfish are not under moratorium (Orr et al., 2003). Redfish bycatch constitutes a small percentage of shrimp catch. The relative "cleanness" of this fishery could be due in part to Canadian fishing vessels' use of sorting grates. However, Canada also took 3,093t of redfish in adjacent Division 3O, which is not under moratorium. There also remain unresolved questions about the relationship between this stock and the 3LN stock. If these stocks are more closely linked, directed fishing activities in 3O could certainly be impacting 3LN stock recovery given its depleted state. Both shrimp and juvenile redfish (<=16 cm total length) are commonly found along the edge of the Grand Banks in water between 200m and 500m. Areas of overlap occur where juvenile redfish have traditionally been found, particularly in the Sackville Spur and on the nose of the Grand Banks. These are areas of highest shrimp concentrations. However, the largest concentrations of redfish are found along the southern edge of Division 3NO (Orr et al., 2003). In 2003, the Canadian shrimp fishery in 3LMNO reported taking 12t of redfish between the ages of two and seven years old compared to an average trawlable biomass (over the 1996 to 2002 period) of 21,000t in NAFO Division 3L (Orr et al., 2004).

Norway

In 2001, observer data for Norwegian bycatch in 3L from an estimated 70t catch of shrimp indicated 0.43kg/ton for redfish, per ton of shrimp caught (STACFIS, 2002b).

Russia

In 2003, Russia operated seven vessels in the directed Division 3LMNO Greenland halibut fishery. These vessels took a total estimated catch of 3,005t of Greenland halibut. Redfish along with skates, hake, American plaice and other fish species are listed among the bycatch in this fishery. However, the only specific bycatch data available for the Russian Greenland halibut fishery is from the Flemish Cap where 119t of redfish were reported as bycatch. Individuals of 17 to 29cm in length made up the major proportion of the catch in the Russian Greenland halibut fishery. According to the Canadian Small Fish Protocol, the majority of the fish taken were juveniles. In Division 3M, the length distribution of redfish ranged between 8cm and 41 cm, with the mode at 17 to18cm long. The majority of the fish taken there were juveniles as well (Sigaev and Rikhter, 2004).

In addition, Russia reported catching 25t of redfish in 3N and 48t of redfish in 3L. Since there is a moratorium in effect for this area, it is assumed it was taken as bycatch, but Russia did not report which fishery caught the redfish. However, since the Scientific Council reported that most catches since 1998 were taken as bycatch primarily in the Greenland halibut fisheries of Portugal, Spain, and Russia, it is assumed that most of this catch occurred in Russian Greenland halibut fisheries (SC Summary Sheet, 2003). The length of redfish in Division 3N ranged from 11cm to 42cm with a mean length of 30cm. Length frequencies showed a bimodal distribution at 22cm to 23cm and 34cm to 35cm (Sigaev and Rikhter, 2004). The mean catch at length for redfish bycatches sampled by observers in Division 3L were 31cm to 33cm for the Russian fleet. Based on the Canadian Small Fish Protocol, the majority of the bycatch taken in this area is over 22cm in length and thus is sexually mature (Sigaev and Rikhter, 2004).

Of most concern is that Russia also reported taking 10,794t (provisional estimate) of redfish in 3O, which may be directly impacting stock recovery in 3LN (Sigaev and Rikhter, 2004) and where there was no TAC established until 2005. The length of redfish in Division 3O varied from 11cm to 44cm; with a mean of 24.3cm and a mode of 23cm to 24cm (Sigaev and Rikhter, 2004). Assuming a normal distribution of bycatch for length (although see reference to bimodal distributions above), a significant proportion of the catch would be immature.

Even though, reportedly, only 73t of redfish was taken as bycatch by Russian vessels in 3LN in 2003, the high catches from directed and non-directed fisheries taking redfish may impact 3LN stocks.

Impact on Stock from Direct and Indirect Fishing

There is no current stock assessment for redfish. However, biomass time series data indicate a decline in the 3L stock since the late 1970s and early 1980s. Biomass estimates for 3N redfish are only available since 1991 and have fluctuated between 15,000t and 60,000t. The bycatch as a percentage of biomass for these two stocks was low in 2002 (1–2%) and, providing bycatch is not being misreported, would not appear to be at a level that will retard stock rebuilding. However, bycatch rules are higher for certain fisheries and for certain areas. Spain took an estimated 21% of redfish as bycatch in its white hake fishery in 3O in 2003. The Russian fisheries also appear to be taking significant numbers of redfish in 3LMNO. In 3LNO the majority of redfish captured as bycatch appear to be juveniles. Canadian shrimp fisheries also report taking some juveniles. In addition, the Scientific Council noted from its "Special Requests for Management" that recent studies suggested a closer connection between redfish stocks in Divisions 3N and 3O. Depending on the results of Canadian genetic studies to be conducted in 2005, NAFO will consider whether it is still appropriate to manage these as separate stocks (2004c).

3LNO American Plaice (*Hippoglossoides platessoides*)

Stock Status and Current Fisheries Information

Historically, American plaice in Division 3LNO comprised the largest flatfish fishery in the Northwest Atlantic. However, there has been no directed fishing there since 1994, and a moratorium has been in place since 1995. Despite the moratorium, the average fishing mortality on fish aged 9 to 14 years was above 0.2 for the period 1999 to 2001, decreasing to 0.18 in 2002. There has been no good recruitment to the exploitable biomass since the mid-1980s. Natural mortality was assumed to be 0.2 for all ages, except from 1989 to 1996 when it was assumed to be 0.53. Biomass and SSB are very low compared to historic levels (Figure 10). Historic biomasss estimates from the 1960s were as high as 575,000t but have declined to around 20,000 to 30,000t since the 1995–2003 period. SSB declined to the lowest observed level in 1994 to1995. It has increased since then, but still remains very low. B_{lim} for this stock is estimated to be 50,000t (SC Summary Sheet, 2003). In the 1960s the SSB for this stock was as high as 240,000t. In 2003, the SSB was reportedly only around 20,000t (SC Summary Sheet, 2003), only 8.3% of the level in the mid-1960s and 16% of the level in the mid-1980s (Richards et al., 2004). However, Morgan (2005) has reported that, depending on the index of reproductive potential used, SSB may be as low as 8,000t or 16% of B_{lim}.

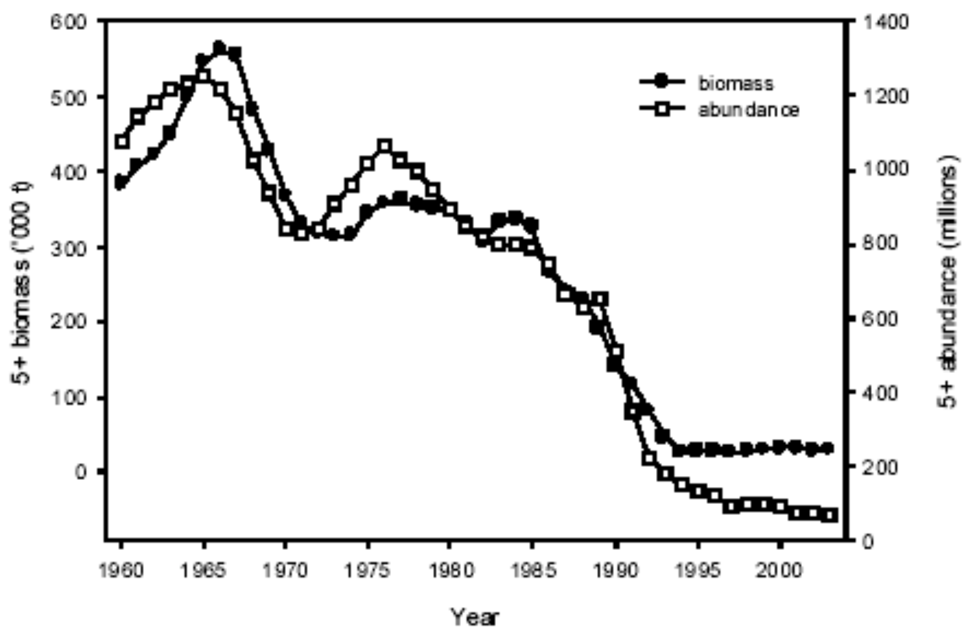

Figure 10. American plaice biomass and abundance estimates 1959–2002. (Source: Morgan et. al., 2003)

For 3LNO American plaice, mortality on younger (less than five) ages remained high throughout the time series from 1959 to 2003. For older ages, mortality declined after the mid 1990s but increased on most ages over six in Canadian and Greenland fishery surveys. Bycatch in 2002, the majority of which came from Division 3N, comprised mainly fish aged seven to eleven years, with a mode at age eight. Ages eight to eleven were most dominant in the Portuguese and Russian catches. These ages also were prevalent in the Spanish catch, along with younger fish, ages four to five, in Division 3N (Morgan et al*.,* 2003).

Adherence to Management Advice

The Scientific Council recommended that there should be no directed fishing on American plaice in Division 3LNO in 2004 and 2005, and that bycatches of American plaice should be kept to the lowest possible level and restricted to unavoidable bycatch in fisheries directing for other species (SC Summary Sheet, 2003). However, although it has not been possible to model the impact of such bycatches on stock rebuilding measures, it is hard to imagine, given the low biomass estimates for this stock, that bycatch mortality at such levels will not impede stock recovery. Efforts should be made to reduce current levels of bycatch.

Bycatch and Discards

Despite the moratorium, 3LNO American plaice bycatches increased steadily, reaching 5,700t in 2001 (Figure 11). Catch decreased somewhat in 2002 to 4,870t. Most of these catches occurred as bycatch in the skate and Greenland halibut fisheries in the NRA. In 2002, the Canadian catch totaled about 1,380t, most of which was taken as bycatch in the yellowtail flounder fishery. In 2003, the catch was reported to be 3,100t (provisional estimate). In addition, American plaice, along with Atlantic cod, Greenland halibut, witch flounder, and yellowtail flounder, constitute the majority of the bycatch in the directed redfish fishery, representing in total between 2% and 20% of the total catch recorded between 1998 and 2000 (STACFIS, 2002a). In 2002, recorded bycatch by country was as follows: Portugal (2,111t), Canada (1,380t), Spain (854t), and Russia (400t) (Morgan et al., 2003).

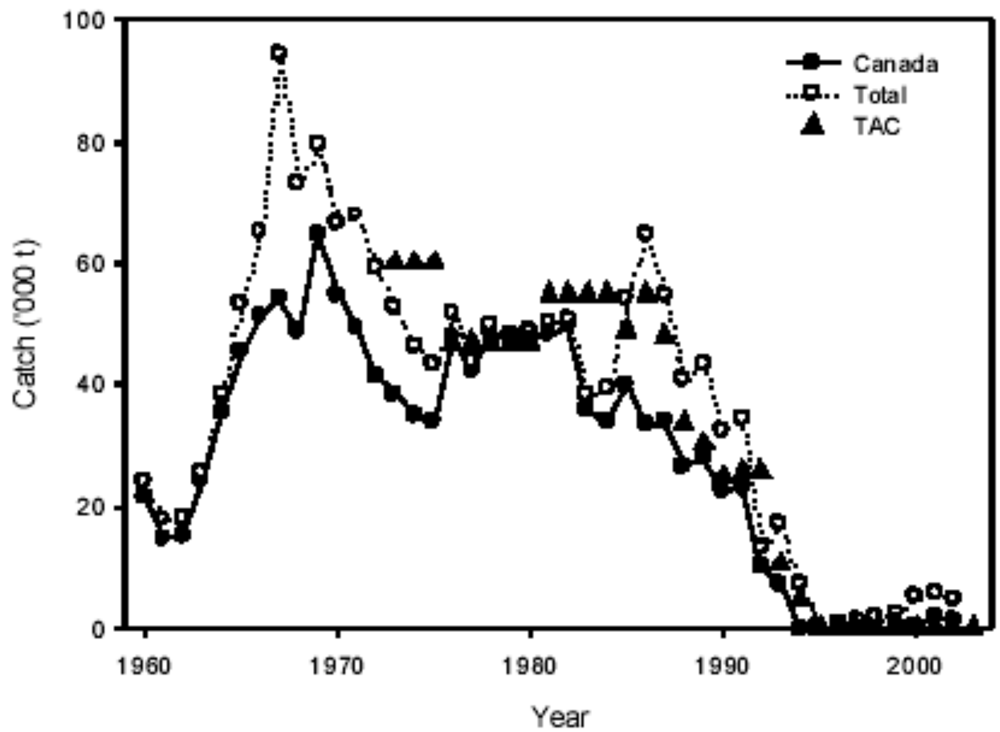

Figure 11. 3LNO American plaice catch and TAC. (Source: Morgan et. al., 2003)

Canada

In 2003, Canadian small shrimp vessels in 3LNO took 6.5t of American plaice, and large vessels took 1.1t. Reportedly 5t of these bycatch were between the ages of 2 and 7 years old. Canadian fishers caught no shrimp in 3NO but took an estimated 9,953t of shrimp in 3L in 2003. Canada's largest shrimp (northern prawn) fishery is in 3K, where 34,064t of shrimp were taken in that same year.

Until 1994 in the Canadian EEZ, American plaice was part of a mixed fishery, consisting of cod, yellowtail flounder, and American plaice. Since 1998, only the yellowtail flounder has been directly fished, and American plaice is now the main bycatch in this Canadian fishery. During 2001 to 2003, it constituted about 10% (range 9.7 to 10.4) of the total catch observed in the yellowtail flounder directed fishery, compared to about 4 to 6% during 1998 to 2000 (Brodie et al., 2004a). A reported 1,047t of American plaice was taken in the yellowtail flounder fishery in 2002 (Morgan et. al., 2003) out of a total catch 10,700t in 3LNO, and almost half of this occurred in the period from September to December (Brodie et. al, 2003a). So, in 2002, Canadian yellowtail fisheries took an estimated 9.8% American plaice bycatch, which far exceeds the 5% bycatch allotted for a moratorium stock. In 2003, the yellowtail flounder catch was 12,678t and the American plaice bycatch was around 1,319t, which still represents about 10% of total catch (NAFO, 2003d).

In 2003 in 3O, American plaice constituted 0.2 % or 0.72t in the Canadian white hake gillnet and longline fisheries, which took approximately 360t of white hake in 2003 (Kulka, et al*.,* 2004b).

In the 2004 Canadian Research Summary Report, American plaice also was reported as bycatch in the Canadian otter trawl fishery for Greenland halibut in Subarea 2 and Division 3KLNMO where 6,620t of Greenland halibut were caught (Richards et al*.*, 2004). Reportedly, 1,640t of American plaice were taken as bycatch in this and other Canadian fisheries in 2003 in 3LNO (NAFO, 2003d).

European Union

In 3O, the Spanish fisheries took a total catch of 2,029t of fish of which the directed white hake catch was 1,136t (56% of the total catch) and the American plaice bycatch was 81t or 4% of the total catch. In 3N, the total Spanish catch was 1,844t of fish. The hake catch was 332t or 18% of the total catch and the American plaice bycatch was 36 t or 3% of the total catch (González and del Río, 2004)

In 2003, Spain took 5,878t of skate (unspecified) in 3NO (most of the catch was from 3N), and bycatch of American plaice was estimated to be 846t or 14 % of the total catch (González et al*.*, 2004). In 2002 in the 3NO Spanish skate trawl fishery, based on CPUE data, American plaice (5.4% of catch/ 0.05t/hr) is the main bycatch species (del Río et al*.*, 2003). It also was reported that Spanish bycatch from the 3NO skate fishery had diminished with time. In the years 1998 to 2001, American plaice comprised 12 to 14% of the total catch in Spain's 3NO skate fishery (del Río et al*.*, 2003).

In the Greenland halibut and skate fisheries combined in that same year, Spain reported taking 1,200t of American plaice in 2003 (303t in 3L, 51t in 3M, 736t in 3N, 110t in 3O) (Kulka et al*.*, 2004a). The combined total catch in these directed fisheries was 19,717 (7,377t of skate and 12,340t of Greenland halibut). This amounts to American plaice bycatch constituting 6.1 % of the total catch in these two fisheries. It would be worthwhile to know exactly how much of the bycatch came from each of the Greenland halibut and skate fisheries specifically in order to assess which is having the greatest impact on the American plaice resource. Unfortunately, American plaice bycatch information in all these areas was not separated by fishery in the Spanish report.

Considerably higher bycatch rates were reported by Portugal in some months in 2003.

In Division 3O, the Portuguese redfish fishery reported that in October of 2003, 15.5% of the total catch for the month was plaice (unspecified). The entire amount of bycatch in this fishery represented 49% of the total catch that month (Vargas et al*.*, 2004). According to Portugal, for the entire year, it took 6,309t of redfish from this area but only 383t of plaice (unspecified) (NAFO*,* 2003d), which amounts to just 6% of the total catch. This suggests that either the bycatch rates were much lower in other months or that Portugal is misreporting its actual plaice bycatch to meet the bycatch allotment of 5% for a moratorium species (Vargas et al*.*, 2004).

In the Portuguese Greenland halibut fishery in 3N in April of 2003, plaice (unspecified species) was among the most common bycatch species, amounting to 25% of the total catch. Total Greenland halibut catch was 1,967t in 2003 (NAFO, 2003d) and total plaice (unspecified) catch was 409t. It is not clear that all of this plaice was taken in the halibut fishery because there were also Portuguese fisheries for roughhead grenadier and skate operating in the area in other months, and these are known to take plaice as bycatch (Vargas et al*.*, 2004).

For instance, in the Portuguese roughhead grenadier fishery in 3N, the amount of American plaice taken as bycatch was 24% for the month of October 2003. While it is not clear what the actual bycatch rate was throughout the year for this species, it is known that a total of 126t of roughhead grenadier was taken in 3N by the directed fishery and plaice (unspecified) was among the top two species listed as bycatch (Vargas et al., 2004).

In addition, the Portuguese skate fishery, which also operated in October of 2003 in 3N and in November in 3O, captured plaice (unspecified) constituting 21% and 25% respectively of its total catch for those months. Approximately 883t (3N) and 644t of skate (mostly thorny) were caught in total throughout 2003. It is unclear from NAFO reports how much skate was taken in just October and November in 3NO (Vargas et al., 2004).

Russia
In 3LMNO, Russia reported taking 353t of American plaice in 2003 (i.e., 27t in 3L, 7t in 3M, 162t in 3N, and 157t in 3O) (NAFO, 2003d; Sigaev and Rikhter, 2004).

In Division 3L, 27t of American plaice was taken as bycatch in the Russian Greenland halibut fishery. The Greenland halibut fishery took an estimated 2,262t of Greenland halibut in the division in 2003. Approximately 1.2 % of the total catch consisted of American plaice bycatch (Sigaev and Rikhter, 2004).

Some 162t of American plaice was taken in 3N in 2003. The only directed fisheries operated by Russia in the division in this year were Greenland halibut, which caught 2,262t of Greenland halibut, and skate, which caught 2,678t of thorny skate (Sigaev and Rikhter, 2004).

An estimated 157t of American plaice was taken as bycatch in 3O. Four Russian directed fisheries operated in 3O in 2003, at least three of which likely took American plaice as bycatch. One is inconsequential due to its low level of directed catch (i.e., Greenland halibut [7 t]). The white hake fishery, with only two vessels fishing from June to August in 2003, reported taking between 1% and 10% of its total catch (803t)as bycatch. However, details of species caught as bycatch were not reported.

In 2003, Russia captured 10,794t of redfish in 3O. Hakes, American plaice and cod were listed as the main bycatch, but actual catch estimates were not provided (Sigaev and Rikhter, 2004).

The skate fishery reported catching 548t of thorny skate in the division from June to December. The Skate fishery did not provide bycatch information, but it likely did take some American plaice as bycatch if the previous year is a reflection of 2003. For example, Vinnichenko et al. (2002) reported that in the Russian skate-directed fishery in the NRA, presumed to be in Division 3N, but not specified in that paper, skates dominated catches at about 88% in 2001 and 2002. With a codend mesh size of 240 to 320mm in 2001, the predominant bycatch species were yellowtail flounder, American plaice, and Atlantic cod, with very small amounts of redfish and "other" species. These authors also indicated that the proportions of different bycatch species were very similar in 2000, when a codend mesh size of 136mm was used. This suggests that increasing codend mesh size to 240 to 320cm has no significant effect on bycatch composition in the skate-directed fishery (Kulka, et al., 2004).

In Division 3L, American plaice bycatch taken by the Russian Greenland halibut fisheries had a length distribution of 22 to 58cm total length (Sigaev and Rikhter, 2004). NAFO's minimum size limits, identified in its Conservation and Enforcement Measures, indicate that American plaice under 25cm must constitute no more than 10% by number of the catch in any one haul and assume that fish under 25cm are juveniles. By comparison, the Canadian Small Fish Protocol assumes fish under 30cm are juveniles. At least some portion of the bycatch taken was juveniles, although the precise value is unknown without modelling. The length distribution of the American plaice taken as bycatch by Russian vessels fishing for Greenland halibut in Division 3O varied from 20-74cm with a mean length of 38.4cm (Sigaev and Rikhter, 2004). This fishery appears to be taking a mix of juveniles and sexually mature fish.

Norway
In 2001, observer data for Norwegian bycatch in 3L from an estimated 70t catch of shrimp indicated that 0.44kg/ton of American plaice was captured per ton of shrimp (STACFIS, 2002b).

Impact on Stock from Direct and Indirect Fishing

Based on an estimate for biomass of 20,000 and a STACTIC provisional estimate of American plaice bycatch of 3,100t, approximately 15 % of the biomass was removed in 2003. It is very likely that this provisional estimate is low. When the above national data are summed with an extrapolation for Portuguese bycatch from the skate fishery by using rates reported for Spain (likely to be conservative) the result suggests that the bycatch was at least 5,487t in 2003. This may suggest that 27% of the biomass was removed in 2003.

Juvenile American plaice have consistently been taken since 1959 in 3LNO. The Canadian yellowtail flounder fishery has had an American plaice bycatch of 10% for the past three years. The impact of the Russian white hake fishery in 3O is also worthy of further study to determine if American plaice is a component of the bycatch, particularly when bycatch levels are reported to be 10%. At present, this is a small, concentrated fishery with only two vessels operating for just three months but taking a sizable amount of directed catch. If Russia expands this fishery, it could be of more concern for moratoria species found in the division, such as American plaice.

3M American Plaice

Stock Status and Current Fishing

The stock occurs mainly at depths shallower than 600m on the Flemish Cap. In terms of recruitment to this stock, there have been only weak year-classes observed since 1991. Stock biomass and the SSB are at very low levels and there is no sign of recovery due to the consistent year-to-year recruitment failure since the beginning of the 1990s (SC Summary Sheet, 2004).

Despite the fact that a moratorium is still in place on this stock, in 2003, F is near the level of both M and $F_{0.1}$, and this is a matter of concern for a stock in a very poor condition and under moratorium. The ratio of catch biomass to EU survey biomass (F index) and fishing mortality declined from the mid-1980s to the mid-1990s, and fluctuated between 0.05 and 0.2 since 1996. The biomass for this stock has declined from approximately 15,000t in 1987 to around 2,500t in 2003 (Figure 12). The SSB has declined from around 11,000t to just under 2,000t during the same period (SC Summary Sheet, 2004).

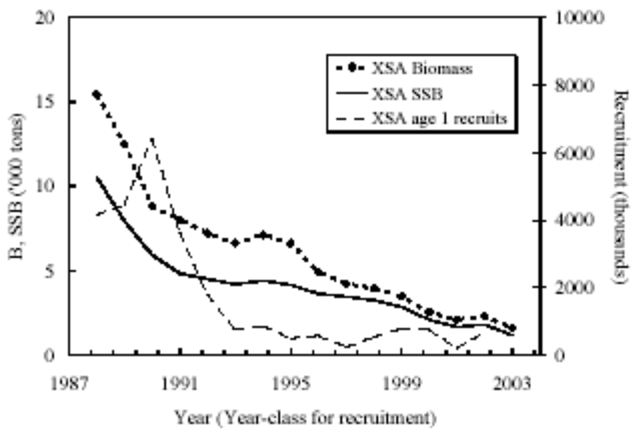

Figure 12. 3M American plaice biomass & SSB estimates 1987–2003. (Source: SC Summary Sheet, 2004)

Adherence to Management Advice

The Scientific Council stated in 2004 that there should be no directed fishery on American plaice in Division 3M in 2005 and 2006. Bycatch should be kept at the lowest possible level (SC Summary Sheet, 2004). Bycatch levels appear to be low for this species in this area if reports from various countries are accurate.

Bycatch and Discards

During 2001 and 2002, bycatch was less than 200t per year, taken mainly by otter trawl (Figure 13). In 2003, a total of 130t of 3M American plaice were taken as bycatch in various NAFO fisheries as follows: Spain 75t, Portugal 28t, Russia 7t, and Japan 3t. In addition, the Icelandic fisheries operating in 3M reportedly also took some American plaice as bycatch, although redfish was the primary bycatch species.

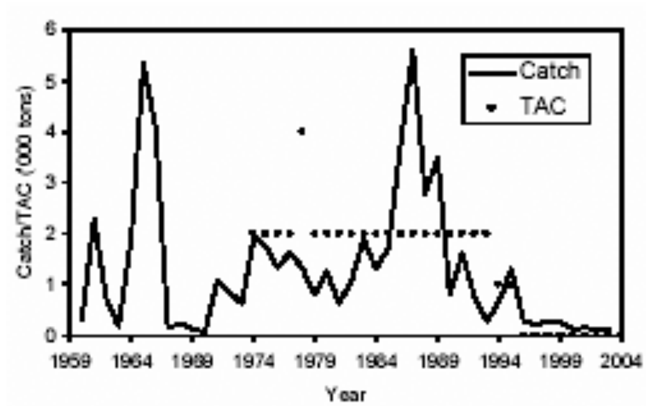

Figure 13. 3M American plaice catch and TAC 1959–2003. (Source: Alpoim and Avila de Melo, 2004)

Russia
In 2003, Russia operated seven vessels in the directed 3LMNO Greenland halibut fishery, reportedly taking 7 t American plaice and 138t of Greenland halibut in 3M. (Sigaev and Rikhter, 2004). Around 5% of the total directed catch consisted of American plaice bycatch.

European Union
In 2003, Spain reportedly took 75t of American plaice as bycatch in 3M in unspecified fisheries (SC Summary Sheet, 2004). It is known that in 2003 Spain operated the following fisheries in 3M: roundnose grenadier (1,314t), shrimp (857t), skates (unspecified) (444t), and roughhead grenadier (322t) (NAFO, 2003d).

Impact on Stock from Direct and Indirect Fishing

Given the current biomass of 2,500t and SSB of roughly 2,000t and a conservative bycatch estimate of 130t, some 5.2% of the biomass and up to 6.5% of the SSB could have been taken in 2003.

3Ps American Plaice

This fishery lies entirely within the Canadian EEZ and has been under moratorium since 1993. Catches from this stock were highest from 1968 to 1973, averaging 10,000t over the period and only exceeding 12,000t in three years. Catches by non-Canadian vessels peaked at about 8,800t in 1968, due mainly to the USSR catch, but have not exceeded 800t since 1973. Since 1977, only Canada and France have been involved in this fishery. Catches averaged just under 4,000t during the 1980s but rapidly declined after 1991. The fishery has remained closed since September of 1993. From 1994 to 1998, the catch was 400t or less. Catch since that time has increased substantially. The catch in both 1999 and 2000 was about 650t. In 2001, the catch was greater than 1,000t and up to October 2002, it was over 900t. Catch has been mainly as bycatch in the Canadian cod and witch flounder directed fisheries.

The last assessment of this stock was carried out in October 2002. Research vessel survey results indicate that this stock has remained at a low level since 1992. Biomass in the last 5 to 6 years is somewhat higher than that seen in the mid-1990s. However, the average biomass from 2000 to 2003 is only 20% of the 1983–1987 average, and the SSB is 26% of the 1983–87 average (DFO, 2002 and Richards, et al., 2004). In 1999, biomass was estimated to be 9,206t and 78% of this estimate was considered to be mature fish (McClintock, 1999).

The Canadian Department of Fisheries and Oceans (DFO, 2002) uses catch to research vessel biomass ratio (C/B) as an index of exploitation rate. This ratio increased steadily through the 1980s and reached values of approximately 0.15 during the early 1990s. (The high value in 1990 was caused by an anomalously low research vessel biomass estimate in that year). The ratio declined substantially as catches decreased and reached a minimum in 1995. Since then, there has been a fairly steady increase in C/B. Levels of the last few years are similar to those in the early to mid-1980s, when there was a directed fishery on this stock (Figure 14).

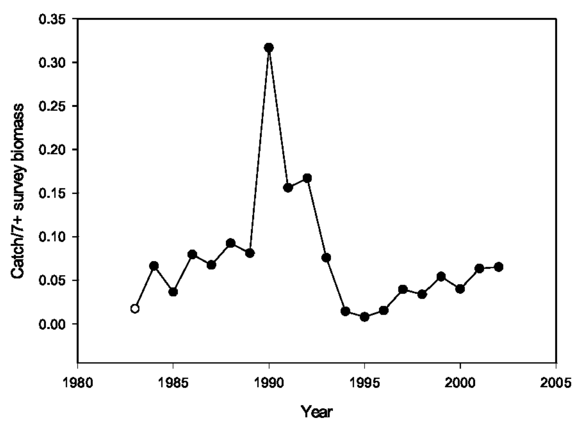

Figure 14. Catch + survey biomass for 1980–2003.

Adherence to Management Advice

While the stock remains under moratorium, bycatch of this species has increased over the past several years. DFO reports that stock condition has correspondingly improved; increased bycatch may actually be a reflection of this improved stock condition.

Bycatch and Discards

In 2003, 34t bycatch of American plaice was taken in the Canadian Greenland halibut fishery. The total catch of Greenland halibut by Canadian fishermen in this area amounted to around 5,418t in 2003; thus, only about 0.6% of the total catch was American plaice bycatch (Richards et al., 2004).

Impact on Stock from Direct and Indirect Fishing

In the next few years, the weak 1994–1997 year-classes will be moving into the age range of the biomass subject to the bycatch fishery. This will likely result in a decrease in exploitable biomass. At current levels of catch, this should result in a further increase in fishing mortality. More recent year-classes appear stronger, but these will not contribute to the exploitable biomass or SSB for several more years (DFO, 2002).

Complicating the assessment of impact on this stock is the fact that the relationship between this stock and NAFO-managed 3L and 3O stocks are poorly understood. If there is mixing between this stock and stocks found inside the NRA, the Canadian bycatch data warrants more careful review and consideration.

DFO (2002) also reported that, although most of the catch comes from cod directed fisheries, 25% to 30% of the total American plaice catch in the last three years has been taken in the directed witch flounder fishery being conducted by the otter trawl fleet. While the allowable bycatch of American plaice in this fishery is 50%, compared with 10% in other fisheries, actual bycatch rates have been in the range of 93% to 143% in the last three years. If bycatches in this fishery were limited to levels similar to other fisheries, the total catch of American plaice could decrease by more than 20%. This should result in increased prospects for stock rebuilding.

Subarea 2 and Division 3K American Plaice

This is a Canadian managed fishery, and there has been no directed fishery since 2003. It is included because the relationship between this stock and other NAFO-managed American plaice stocks is not clearly understood. Research vessel surveys indicate that the stock size is currently about 3 to 5% of the values measured in the early 1980s. Stock size has remained at this low level for several years following the closure of the directed fishery. Changes in the distribution of the fish were observed in the mid-1980s, and size and age at maturity declined through the mid-1990s but has stabilized since then. Since the stock did not recover when catch levels were very low (mid-1990s to late 1990s), commercial catches do not appear to be a major contributor to the current high mortality estimated in this stock. This is supported by recent catch/biomass ratios of less than 1%. Further, with no strong year-classes present in the population and with relatively high mortality rates, the prospects for stock rebuilding continue to be extremely poor (Richards et al*.,* 2004).

Canadian studies into the factors affecting the maturation of American plaice, including the reasons for changes in maturity at age and size in Subarea 2 and 3K, Division 3LNO, and Division 3P, are ongoing. In addition, studies are being conducted on seasonal and interannual changes in the condition in American plaice (Richards et al*.,* 2004).

Adherence to Management Advice

The stock remains under moratorium, but bycatch is recorded from the Greenland halibut fishery.

Bycatch and Discards

Canada

The 2004 Canadian Research Summary reported that catches have increased since 1999, due mainly to bycatch in the Greenland halibut fishery. A total of 34t of American plaice bycatch was taken in 2003, consisting mainly of sexually mature females (Richards, et. al., 2004).

Impact on Stock from Direct and Indirect Fishing

Data are inadequate to make an assessment of bycatch impact on this stock.

2J3KL Witch Flounder (*Glyptocephalus cynoglossus*)

Stock Status and Current Fisheries Information

Historically, the stock occurred mainly in Division 3K although recently the proportion of the stock in Division 3L is greater. The stock has been under a moratorium since 1995. No stock assessment has been conducted for this stock (SC Summary Sheet, 2003).

Survey mean catch weights (kg/tow) showed a rapid downward trend since the mid-1980s and since 1995 have remained at an extremely low level (Figure 15). Around 1983, witch flounder catch rates in 3K were approximately 13kg/tow. By 2002, this had declined to catch rates less than 1kg/tow. Witch flounder catch rates in 2J and 3L have fluctuated around 2kg/tow since at least the early 1980s. In 2002 both appeared to be near 1kg/tow (SC Summary Sheet, 2003).

Parsons and Bowering (2003) provided time series estimates of witch flounder biomass for 2J, 3K, and 3L. In 2002, these were 404t, 471t, and 2,428t, respectively; in 2001, they were 209t, 1,427t, and 1,042t, respectively. The highest historical biomass for 2J of 5,123t was recorded in 1978; for 3K, of 49,789t in 1979; and, for 3L, of 13,210t in 1984.

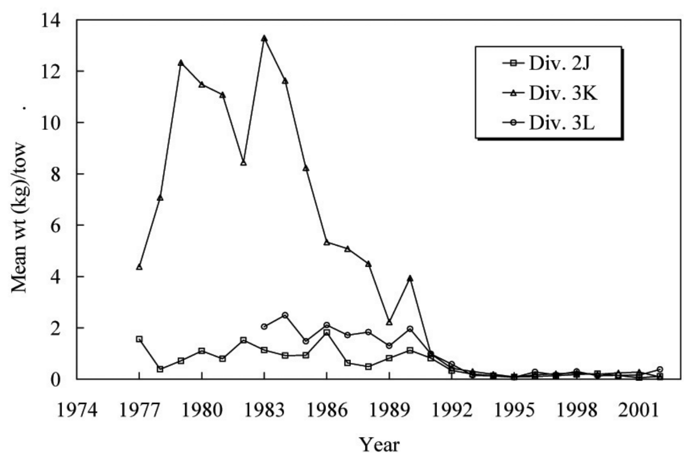

Figure 15. 2J3KL witch flounder mean weight per tow (kg) 1974–2002. (Source: SC Summary Sheet, 2003)

Adherence to Scientific Advice

The Scientific Council recommended that there be no directed fishing on witch flounder in the years 2004 and 2005 in Division 2J3KL to allow for stock rebuilding. Bycatches of witch flounder in fisheries targeting other species should be kept at the lowest possible level (SC Summary Sheet, 2003).

Bycatch and Discards

The catches from 1995 to1999 ranged from 300 to 1,400t, including estimates of unreported catches (Figure 16). Catch in 2001 was reported as 800t (Parsons and Bowering, 2002). In 2002, catches were reported to be around 700t (SC Summary Sheet, 2003). Based on available data from 2003, the bycatch rates in 2003 are similar to the previous year (see national information below).

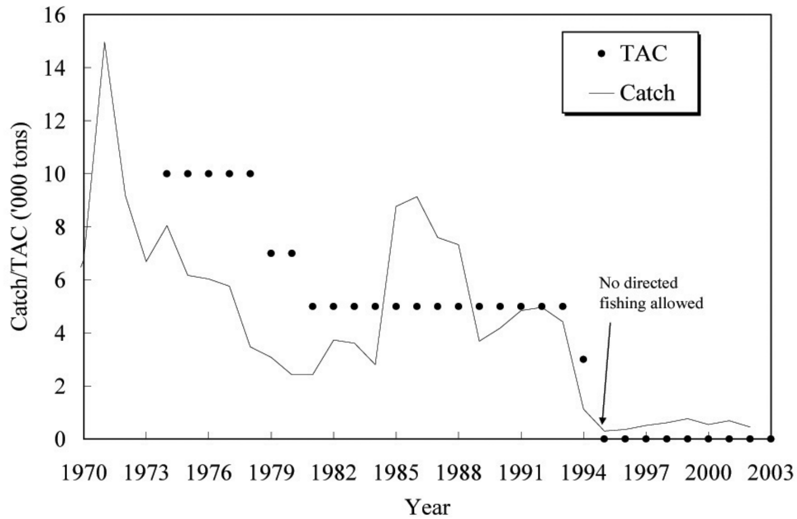

Figure 16. 2J3KL witch flounder catch and TAC 1970–2003. (Source: SC Summary Sheet, 2003)

Russia
A total of 59t of witch flounder was taken as bycatch in Division 3NO. Russia reported no witch flounder bycatch in 3L. In 3NO, Russia operated Greenland halibut, redfish, white hake, and skate fisheries. Only the Greenland halibut fishery reported taking witch flounder as bycatch. No information was available from the other three fisheries so it can not be ruled out that they too caught some witch flounder as bycatch. However, witch flounder was not identified as a major bycatch species in the redfish fishery in 3O. The white hake fishery reported bycatch rates of 1% to 10% in 3O, but no bycatch species were identified by Russia. (Sigaev and Rikhter, 2004).

Canada
According to the 2004 Canadian Research Summary Report bycatch of witch flounder in fisheries from Newfoundland and a very small amount from Maritimes fisheries amounted to 111t in 2003, or about 2.5% of the directed catch (Richards et al., 2004). These fish were taken primarily in the Canadian otter trawl fishery for Greenland halibut in Subarea 2 and Division 3KL (Richards et al., 2004) where approximately 4,518t of Greenland halibut were caught in 2003 (NAFO, 2003d).

European Union
A total of 501t of witch flounder was taken as bycatch in 2003 in various Portuguese fisheries throughout Subarea 3. No information was provided on Division 2J.

The 2004 Portuguese Research Summary reported that in 2003 in the 3LMNO Greenland halibut fishery, witch flounder was among the top three species taken as bycatch.[2] Portugal reported a total Greenland halibut catch of 12,337, more than half of which came from 3L (NAFO, 2003d). In January, witch flounder bycatch in the 3L fishery was 3.6% of the total Greenland halibut catch for the month. However, witch flounder was taken as bycatch, although in lower amounts, throughout the entire eight months of this fishery, averaging about 1.5% of total catch. Worth noting is that in some months no witch flounder bycatch was reported. In addition, witch flounder was 15.5% and 17.7% in January and February, respectively, in 3M in 2003. Throughout the six months (January, February, March, April, June, and October) of this fishery, the average witch flounder bycatch was nearly 7% of the total catch in 3M (Vargas et al., 2004).

In Portugal's roughhead grenadier fishery in 3L, which operated for four months (February, March, April, and October) in 2003, witch flounder bycatch as a percentage of total catch averaged 3.4%, with the highest month being April, at 7.2%. By comparison, , the Portuguese roughhead grenadier fishery in 3M took a reported 14.4% average witch flounder bycatch in 2003 for the three months of this fishery: February (14.6%), March (18.4%), and April (10.2%) (Vargas et al., 2004), thus overall and in each month exceeding the bycatch allotment for this moratorium stock.

[2] 3NO witch flounder bycatch will be discussed in the next section of this report, "3NO Witch Flounder."

In addition, in 2003, the Portuguese skate fishery in 3L also reported taking witch flounder as bycatch, averaging about 2% of total catch for its four months of operation: February (4.4%), March (1.8%), April (0.3%), and October (1.4%). Witch flounder bycatch rates were much higher in Division 3M, where the average was 19.7% of total catch. In February, witch flounder bycatch as a percentage of total catch was 36.8%; March was somewhat lower, but still high at 16.8% (Vargas et al, 2004).

In addition, in Spain's Greenland halibut fishery in Division 3L, which took 7,891t of Greenland halibut in 2003, a reported 255t of witch flounder was taken as bycatch, constituting 3.2 % of the total catch (González, et al., 2004).

Impact on Stock from Direct and Indirect Fishing

No analytical assessment is available for this stock. However, the CPUE has declined dramatically since 1983. In 3L, the Portuguese roughhead grenadier fishery stands out as problematic. This fishery is unregulated. For the sake of the witch flounder stock, which is currently under moratorium, as well as to ensure the long-term health of the roughhead grenadier stock, management measures should be adopted.

3NO Witch Flounder

Stock Status and Current Fisheries Information

This stock mainly occurs in Division 3O along the deeper slopes of the Grand Bank. It has been fished mainly in winter and springtime on spawning concentrations. Catches exceeded the TAC by large margins during the mid-1980s. This stock has been under a moratorium since 1995 (SC Summary Sheet, 2004).

No analytical assessment has been conducted on this stock. Spring and fall trawl survey data are available, but interpretation of these is difficult as no clear and consistent trends are apparent.

Biomass and abundance indices from Canadian spring surveys in Division 3N have been at very low levels since 1984. In most years, the biomass index was estimated to be less than 1,000t or 2 million fish. For Division 3O, estimates of stock size exhibited considerable annual fluctuations: on average, between 3,000 and 24,000t or 6 million to 44 million fish, particularly in the late 1980s (Parsons, 2004). The indices show overall declining trends from the mid-1980s to lowest values in 1998 and 1999. Although wide fluctuations continue to occur since then, some improvement in the estimates is indicated. However, peaks in the indices in some years may be related to distribution changes or single large catches, considering the wide confidence limits. For example, in 2003, a single large set (684 fish) in one stratum increased the indices from 2002 with very wide confidence limits.

Indices derived from the fall surveys in Division 3N are, similar to the spring series, very low and lack trend (Table 4). The data trends for Division 3O in the fall surveys are similar in that confidence limits are wide, arguing against any significant trend in the indices.

Table 4. 2002, 2003 and historical high biomass estimates (t) for witch flounder in Division 3N and 3O.

Period	Division	2002	2003	Historical High
Spring	3N	380	532	2,205 (1984)
	3O	7,182	15,323	23,820 (1985)
Fall	3N	1,511	1,516	2,235 (1992)
	3O	9,619	8,798	9,619 (2002)

With Division 3NO combined (Figure 17), the most recent indices from the spring surveys, although variable, are improved since 1998. The fall survey series for Division 3NO combined is less clear, with no real trend in biomass, mean number, or weight per tow. It should be emphasized as well that the more recent estimates are also based on more detailed survey coverage than in the earlier years.

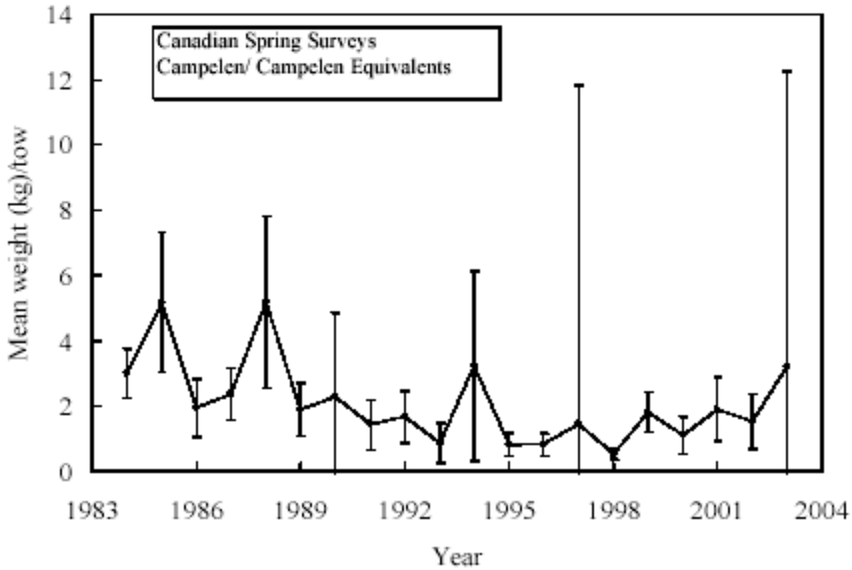

Figure 17. 3NO witch flounder mean weight per tow (kg) 1983–2003. (Source: SC Summary Sheet, 2004)

Resource Status

The spring survey indices indicate that the resource was at its lowest levels in the mid-1990s to late 1990s compared to higher levels in the 1980s. The general trend in this longer (spring) survey series suggests that the stock showed some slight improvement since then. No aging data have been available since 1994. Therefore, it is difficult to comment on any recruitment prospects for the resource.

Catches in the 1960s peaked at 11,000t–12,000t in the 1967–68 period and remained relatively high during the next several years (Figure 18). During the 1971–84 period, catches ranged from a low of about 2,400t in 1980 and 1981 to as high as 15,000t in 1971, which is the highest recorded catch in the history of the fishery; however, from 1975 to 1984, annual catches rarely exceeded 6,000 tons. Species-specific catch statistics for flatfish prior to 1973 were largely developed from breakdowns of unspecified flounders and therefore should be quoted with caution. As a result of an increase in fishing effort in the NRA during 1985 and 1986, especially by Spain and Portugal, catches rose rapidly to levels of 8,800t and 9,100t, respectively. This increased effort was primarily concentrated on the “tail” of the Grand Bank in the NAFO Regulatory area of Division 3N. Non-Contracting parties such as South Korea, USA, Cayman Islands and Panama also contributed to increased catch levels during this period. Catches remained relatively high in 1987 and 1988 at 7,600t and 7,300t, respectively. From 1990 to 1993, estimated catches were in the range of 4,200–5,000t. The estimated catch for 1994 was still in the order of 1100t despite a moratorium being introduced on fishing this stock. The catch dropped to 300t in 1995, likely as a result of a substantial reduction in fishing effort for Greenland halibut, where witch flounder comprises a bycatch. Since then, catches have increased steadily and by 1999 were about 800t, although they declined again to an estimated 450t in 2002. In 2003, several sources of catch data were available and a single source could not be considered more valid. As a result, catches were estimated to range between 850t and 2,239t.

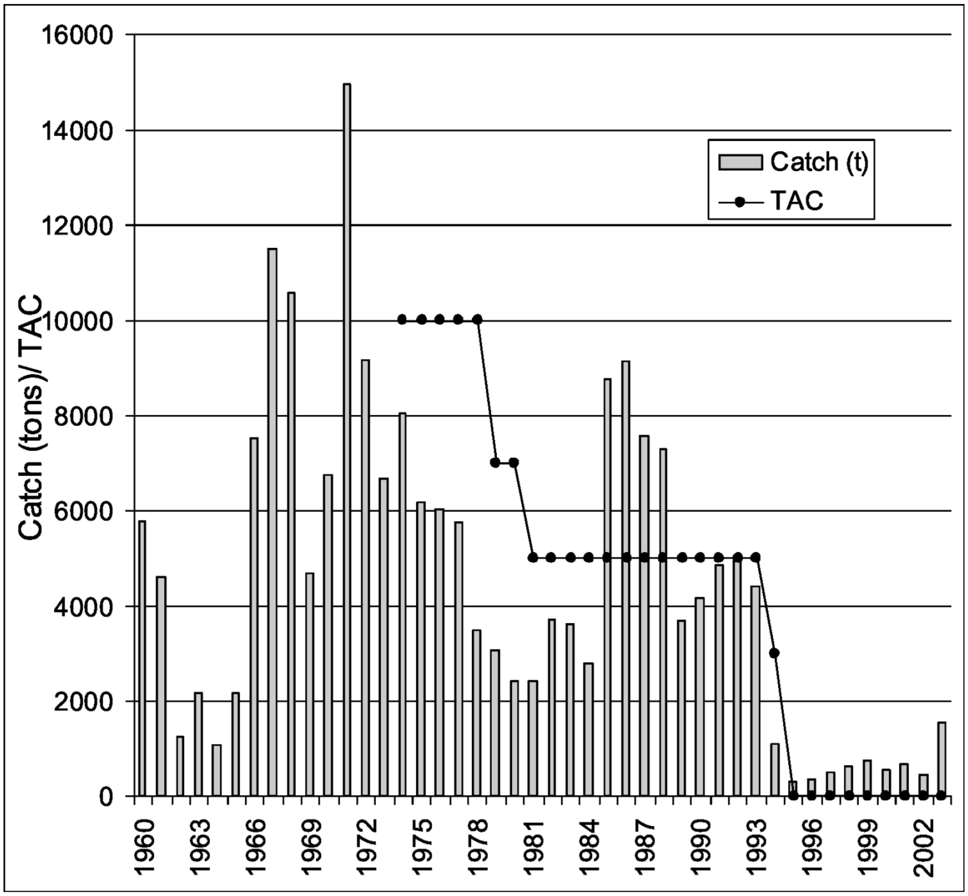

Figure 18. Commercial catches of witch flounder in Division 3NO from 1960 to 2003 and TACs from 1974 to 2003.

Note: Although a TAC of 3000 tons was agreed by the Fisheries Commission, it was also agreed that no directed fishing on witch flounder in Division 3NO take place during 1994 due to the poor state of the stock. Estimated catch in 2003 is the mean of a range of catch from several sources. (Source: Parsons, 2004)

Adherence to Scientific Advice

The Scientific Council recommended that there be no directed fishing on witch flounder in the years 2005 and 2006 in Division 3N and 3O to allow for stock rebuilding. Bycatches in fisheries targeting other species should be kept at the lowest possible level (SC Summary Sheet, 2004).

Bycatch and Discards

It is estimated that 3NO witch flounder bycatches for the period 1995–2002 ranged between 300t and 800t, including estimates for unreported catches (Parsons, 2004). Between 1999 and 2002, Russia caught 50–112t of witch flounder as bycatch. In 2001, 459t were taken as follows: Russia 31t, EU 362t, and Canada 102t. In 2002, the following bycatch totals were recorded: Canada 26t, Russia 112t, and other countries 312t (Parsons and Bowering, 2003). In 2003, catches were estimated to range between 844t and 2,239t. (SC Summary Sheet, 2004)

Multinational redfish fishery

Based on STATLANT 21B catch returns for 1998–2000 for Atlantic cod, American plaice, Greenland halibut, witch flounder, and yellowtail flounder constitute the majority of the bycatch in the directed redfish fishery. Between 2% and 20% of the total catch is recorded as bycatch during this period by vessels operating in the NRA (STACFIS, 2002a). In 2003, a total of 19,006t of redfish were taken in directed fisheries in 3N (508t) and 3O (18,498t) as follows: Russia (15t/10,794t), Portugal (243t/6,383t), Spain (231t/1,289t), Canada-Maritimes (0t/32t), Estonia (14t/0t) and the Ukraine (5t/0t)(NAFO, 2003d). In 3NO, between 380t and 3,801t of moratorium species, including witch flounder, were taken in 2003 in the multinational redfish fishery (NAFO, 2003d).

Canada
In the Canadian EEZ, within Division 3N, there has been no directed fishing for witch flounder since 1994. Bycatch in 2003 (Newfoundland region) was 52t. In the adjacent inshore Division 3Ps, between 300t and 1,000t of witch flounder have been taken annually in a directed fishery over the last 20 years (Richards et al., 2004).

European Union (Spain and Portugal)
In 2003, in Division 3NO, Spain reportedly took 417t of witch flounder in unspecified fisheries (3N, 349t; 3,O 68t)(González, et al., 2004). In 2003 in 3O, Spanish total catches were 2,029t, which included 1,136t (56% of the total catch) of white hake (target species) and 61t (3% of total catch) of witch flounder bycatch. In 2002, in the 3NO Spanish skate trawl fishery, 1.1% of witch flounder was taken (del Río et al., 2003).

In 3O, the Portuguese redfish fishery reported taking an average of 2.4% witch flounder bycatch over a five-month period (April, May, August, October, and November). In nearby Division 3M in 2003, the bycatch rates by the Portuguese redfish fishery were reportedly much higher on average. There, the Portuguese redfish fishery took an average of 6.2% witch flounder bycatch over four months (January–March). Bycatch in February (the highest month) was reportedly 16.5% of total catch (Vargas et al., 2004). The question remains whether witch flounder is more concentrated in this area or whether bycatch is being underreported in the moratorium area.

The roughhead grenadier fishery in 3N reported high witch flounder bycatch rates, particularly in the month of August, which had a bycatch rate of 7.9%. On average over four months (May, July, August and October), witch flounder bycatch was 3.8% of total catch in 3N. In 3O, witch flounder bycatch rates were reported only for April, which had a rate of 2.1% (Vargas et al., 2004).

In Division 3N in 2003, the Portuguese Greenland halibut fishery reported taking 24% witch flounder bycatch in November. However, witch flounder bycatch rates over eight months (April–October) in this area averaged 5.5%. Only two other months exceeded the bycatch allotment for this stock, August (5.6%) and October (7.8%) (Vargas et al., 2004).

In 2003, the Portuguese skate fishery reportedly operated for six months in 3N and in four of these months in 3O as well. Bycatch of witch flounder ranged from a high of 8.3% of total catch in 3NO in May to a low of 2.2% in 3N in October. The average bycatch rate was 4.7% for the six months of fishing, respecting that in two months (June and October) the fishing was concentrated in 3N (Vargas et al., 2004).

Russia
In 2002, the main Russian fishery for redfish took place at a 350–550m depth in 3NO. Witch flounder was one of the bycatch species which together constituted less than 1% of the total catch (Vaskov, 20003). In 3LMNO, Russia reported taking 60t of witch flounder as bycatch in 2003 (6t in 3L, 1t in 3M, 30t in 3N, 29t in 3O) where it also caught 10,972t of redfish, the vast majority in 3O (NAFO, 2003d).

Impact on Stock from Direct and Indirect Fishing

No stock assessments have been conducted on this stock, although CPUE is known to have declined since the 1980s (SC Summary Sheet, 2004). In 2003, catches were estimated to range between 844t and 2,239t. Over the past three years bycatch estimates have ranged from 12% to 20% of catch for groundfish and flatfish stocks, which include witch flounder in the NRA. As a result, bycatch may be impeding stock rebuilding. In 3NO, redfish fisheries of various countries and Greenland halibut fisheries appear to pose the greatest threat to this stock.

3NO Capelin (*Mallotus villosus*)

Stock Status and Current Fisheries Information

The fishery for capelin commenced in 1971 and total catch peaked at 132,000 metric tons in 1975 (Figure 19). There was no fishery from 1979 to 1986 but it resumed from 1987 to 1992. Annual catches in that period did not exceed 25,000 tons. In subsequent years, no directed fishery for capelin was carried out. Historically, the largest contribution to the total catch was made by Russia (former USSR), Norway, Iceland, and Japan. A TAC first set in 1974 reached its maximum of 200,000 tons in1977/1978. The TAC was 30,000 tons from1990 to1992 and has never been overfished. A moratorium has been in place since 1993. On account of intermingling during the spawning period, the stock distributed in Division 3LNO and Subdivision 3Ps at first was managed as a single one. Concurrent (June–July) spawning of capelin in both coastal Newfoundland and Southeast Shoal (Division 3N) led to the assumption that the stocks were separate. Further research into meristics and morphometrics as well as data on tagging and distribution supported the above assumption (Gorchinsky, 2004).

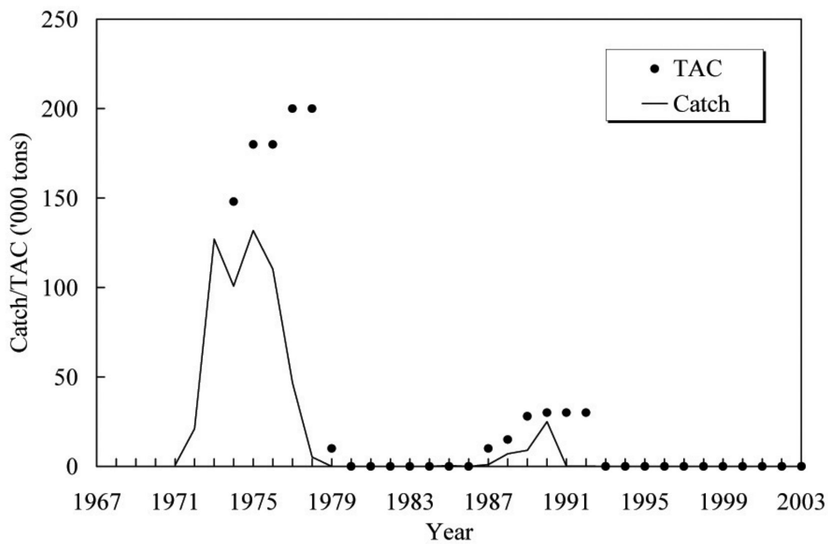

Figure 19. 3NO capelin catch and TAC 1967–2002. (Source: SC Summary Sheet, 2003)

Assuming the existence of a correlation between biomass estimates derived by the acoustic and the trawl methods, it was concluded that in 1990–1994, both the calculated and the trawlable biomass of capelin in Division 3LNO fluctuated within a wide range. It is contested that trawl survey data for capelin, which is essentially a pelagic species, represents availability to the gear type and that there is not necessarily a relationship between trawl survey CPUE and biomass (Gorchinsky, 2004). Since 1995, capelin biomass has remained at a low level compared to the late 1980s.

According to Russian acoustic survey data, the biomass has fluctuated throughout the time series from the late 1970s to 2002, with highs around 80–90,000t to more recent lows of about 50,000t. The lower estimates have been sustained since the mid-1990s. Canadian survey estimates suggest that current biomass may be double this, at around 100,000t (SC Summary Sheet, 2003) (Figure 20).

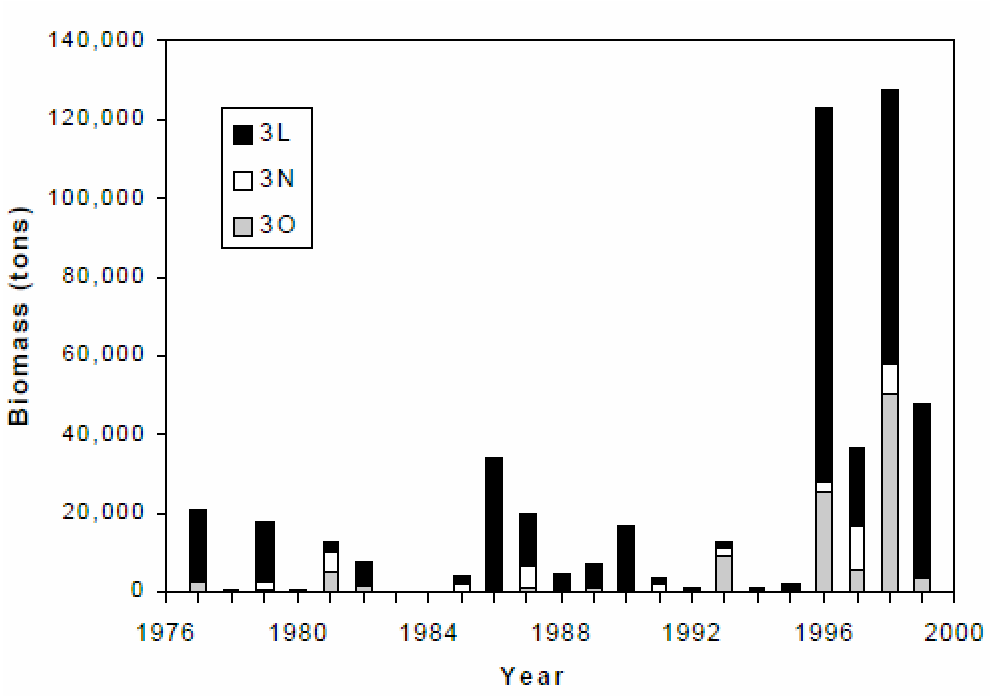

Figure 20. Trawlable biomass estimates for capelin in Division 3LNO in spring of 1977–1999. (Source: Lilly and Simpson, 2000)

Table 5. Capelin biomass estimates from Russian and Canadian acoustic surveys, 1975–1994 (000s t) (Source: Gorchinsky, 2004)

Year	USSR 3LNO	Canada 3NO	Year	USSR 3LNO	Canada 3NO
1975	1,050*		1985	2,200	212
1976	685*		1986	1,491	494
1977	1,000*		1987	2,161	229
1978	310		1988	3,900	561
1979	483		1989	2,455	28
1980	0		1990	3,752	
1981	109	223	1991	118	
1982		419	1992		4
1983	346	219	1993	315	
1984	2,880	85	1994	83	

* Biomass estimates of mature capelin

Targeted fisheries for capelin exist in nearby Canadian waters in Divisions 2J and 3KL. Inshore capelin catches in 2 and 3KL are taken during the inshore spawning migration. Catches increased from 10,200t in 2002 to about 18,100t in 2003, which was similar to the 2001 catch of 18,700t. The resource status has not been determined since 2000 (Richards et al., 2004).

Adherence to Scientific Advice

The Scientific Council recommended that there be no directed fishing of capelin in Division 3NO in 2004–2005 (SC Summary Sheet, 2003).

Bycatch and Discards

There are no data available.

Impact on Stock from Direct and Indirect Fishing

Information is insufficient to conduct a full assessment, but based on Canadian stratified-random bottom trawl surveys and acoustic data, biomass appears low.

Summary

Without modeling the actual impacts of current bycatch removals, it is not possible to fully assess whether stock recovery is being impeded. However, it appears that bycatch is likely impeding the recovery of at least five of the nine moratoria stocks. For example:

- Bycatch of 3NO cod has increased tenfold since the first year of the moratorium in 1995 and most of the bycatch is juveniles.
- Bycatch of 3LN redfish, particularly in the Greenland halibut fishery, ranges between 850t and 2,300t per year despite being under moratorium. Many of the fish captured are juveniles.
- In 2002, 4,800t of 3LNO American plaice were taken as bycatch, mostly in skate and Greenland halibut fisheries.
- Bycatches of witch flounder in Divisions 2J3KL and 3NO were somewhat smaller but still significant, 700t and 844t-2,239t, respectively, in 2003. Consistently, countries targeting redfish, skate, Greenland halibut, and roughhead grenadier (assumed to be using the same gear type across divisions) appear to be within allotted bycatch limits for species, such as witch flounder, in moratorium areas, but exceed these levels (often by large amounts) for the same species in areas where no moratorium is in place (e.g., 3M). Either bycatch levels actually are much higher than reported in moratorium areas or biomass is larger in these non- moratorium areas. In addition, understanding the rate of exchange between moratorium and non-moratorium areas should be a priority for NAFO, particularly in the case of witch flounder, where the scientific community within NAFO already has identified the strong possibility of a relationship between 3M and moratoria areas 3NO and 2J3KL.

Table 6 provides an overview of the main fisheries reporting bycatch of moratoria stocks.

Table 6. Fisheries with known bycatch of moratorium species.

Fisheries	Moratoria Stocks Taken in NAFO Convention Area
Contracting Parties	
3LNO skate	3NO cod, 3LNO American plaice, 3NO witch flounder
2J 3KLMNO Greenland halibut	2J 3KL cod, 3LN redfish, 2J3KL American plaice, 3LNO American plaice, 3M American plaice, 2J 3KL witch flounder
3O redfish	3NO cod, 3LNO American plaice, 3NO witch flounder
2J3KLMNO shrimp	2J 3KL cod, 3LN redfish, 3LNO American plaice, 3M groundfish
3LNO white hake	3NO cod, 3LN redfish, 3LNO American plaice, 3NO witch flounder
Others:	
roughhead grenadier	3NO cod, 3LNO American plaice, 3NO witch flounder
3LNO yellowtail flounder	3LNO American plaice and 3NO cod
Non-Contracting Parties	
Oceanic redfish	suspect cod in 1F & 2J

From a fisheries management perspective it is disquieting to observe that bycatch for certain species has increased over the moratoria period and that there are apparent discrepancies in bycatch rates for similar fisheries prosecuted by vessels from different Contracting Parties. Indeed some fisheries (e.g., Norwegian shrimp fisheries) show relatively low levels of bycatch. Such discrepancies and trends are worthy of further study by NAFO to determine if this is the result of more efficient fishing or misreporting.

As mentioned before, without undertaking simulation studies it is difficult to assess to what extent stock rebuilding is being retarded. However, for certain NAFO stocks at such historical low levels of biomass, and particularly for those with continued low recruitment, bycatch removals could be having a significant impact on the rebuilding process (see Table 2).

A number of fisheries also stood out in terms of having higher levels of bycatch relative to catch rates of target species for a number of moratoria stocks and these are briefly mentioned below.

Of the NAFO regulated fisheries:

- **Skate fisheries** may be retarding the recovery of 3LNO American plaice and, to a lesser extent, 3NO cod and 3LN redfish in Division 3LMNO. Many of the fish being taken are reportedly juveniles. The Portuguese fleet records much higher bycatch than the Spanish fishery. Of this bycatch, in some months, cod and American plaice from 3NO amounted to more than 20% of the catch. In other months, these two species were among the top three species taken as bycatch along with redfish. Overall, total bycatch in the Portuguese skate fishery ranges between a low of 36% to a high of 85%. In some months, moratoria cod, witch flounder, and redfish are among the species taken. While bycatch levels are lower in terms of the percentage of total catch reported, Spain, Russia and Canada also record taking cod, American plaice, and witch flounder in their respective skate fisheries.

- **Greenland halibut fisheries** catch significant numbers of cod, American plaice, and witch flounder, many of which appear to be juveniles in 3LNO. Portugal, Spain, and Russia list these three species as representing the largest portion of their bycatch, particularly in 3LMNO. If the Portuguese Greenland halibut fishery in 3LMNO is any reflection of fishing effort by other nations fishing for Greenland halibut in the division, then the fishery has very high total bycatch rates. Total bycatch for this fishery ranges between 12.8% and 62.3% in some months. Plaice (unspecified), witch flounder, and redfish are part of the bycatch in some of these months. In addition, Canadian Greenland halibut fishermen reported taking cod with gillnets in Divisions 2J3KL, 2GH, 3M and 3NO, and witch flounder in Divisions 2J3KL and 3NO in the Canadian Greenland halibut otter trawl fisheries. Canada also reported capturing American plaice in otter trawls in Subarea 2 and Division 3KLMNO (34t of which came from Subarea 2). The stock size of American plaice in Subarea 2 Division 3K was reported to be just 3% to 5% of 1980s levels.

- **Redfish fisheries** in the NRA also have high bycatch levels. According to Portuguese catch information in Division 3NO, between 26.1% and 29.0 % of its catch is comprised of cod, while in 3O, 15% is American plaice and between 1.3% and 3.5% is witch flounder. Russia also reports catching cod in 3NO in its redfish fishery, although this reportedly constitutes less than 1% of its catch. Similarly in Division 3LMNO, Russia reports having taken less than 1% of American plaice (at depths of 350–550m) and less than 1% of witch flounder. It also reported taking 60t of witch flounder, with a breakdown by area as follows: 6t in 3L, 1t in 3M, 30t in 3N, and 29t in 3O. The Portuguese redfish fisheries report high levels of total bycatch in 3M and 3O. In 3M it ranged between 61% and 80 % in 2003. In 3O, it ranged between 49% and 79%, with moratoria cod and plaice (unspecified) being taken at levels well exceeding permitted bycatch allotments in some months. In a Canadian report (2003), it was stated that bycatch of cod and American plaice in various redfish fisheries operating inside the NRA is between 2% and 20%, compared with 3% inside the Canadian EEZ. Canada also reported taking 52t of witch flounder in Division 3N as bycatch and more than 520t in Division 3Ps. The clear differences between national bycatch levels suggest differences in the gears used or in how the fisheries are operated. Useful lessons could be learned from those fisheries with lower bycatch levels.

- **Shrimp fisheries** not only have historically high levels of bycatch (which have subsequently decreased with the use of the sorting grate) but also high discarding rates of both small shrimp and finfish. The information available regarding finfish species bycatch and discards is extremely limited, although some data is available regarding the level of shrimp discards in various fisheries. For instance, the Russian shrimp fisheries took 48t and 25t of redfish in 3L and 3N. The Canadian shrimp fishery reported taking approximately 2t of juvenile cod in Division 3L, 1.97t of cod in 3NO, 13t of redfish in 3LN. and

5t of American plaice between the ages of 2 and 8 years old in 2002. The Greenland shrimp fishery also took 4.7t of finfish in 3M. Very small amounts of redfish and American plaice in 3L were taken as bycatch by Norwegian vessels (i.e., 0.43kg/tow per 1t of shrimp and 0.44kg/per tow per 1t of shrimp, respectively). As previously noted, the lower bycatch levels in the Norwegian fishery warrant further study to identify why this is occurring. Worth noting is that juvenile Greenland halibut bycatch also is problematic in many shrimp fisheries, particularly in 2J 3KL, even though Greenland halibut is not a moratorium stock. In addition, throughout Subarea 1, juvenile redfish are being captured and discarded, and high levels of juvenile redfish are being captured on the Flemish Cap. In fact, in 2001–2002, redfish bycatch in numbers from the Flemish Cap shrimp fishery reached 71% of total catch. The latter prompted the Scientific Council to express concern that high bycatch of redfish is jeopardizing sustainability of redfish stocks (STACFIS, 2003a).

- The 3LNO **white hake fisheries** also have significant levels of bycatch, particularly redfish, many of which are juveniles and are discarded. In the Spanish white hake fishery at depths greater than 600 m, redfish represent 22% of the bycatch in 3O, while American plaice are 4% of the catch and witch flounder 3% of the catch in this division. In addition, between 1994 and 2003, Canadian white hake gillnet fishers took an average of 109t of cod in 3NO. This fishery also took 0.2% of its catch as American plaice. Cod bycatch as a percentage of total catch was 0.6% in the gillnet fishery and 17.7% in the longline fishery.

- There are three other fisheries of note:
    - The 3LNO Portuguese roughhead grenadier fishery, which operates without TAC or effort controls, reported cod as one of its top bycatch species in Division 3O and American plaice among the top two species taken in Division 3N. In 2003, this fishery in 3O caught only around 13% of its target species (roughhead grenadier) and the rest of its catch (87%) was bycatch, with moratorium cod constituting 24% of that total catch. This fishery has a bycatch to catch ratio of 7:1. Throughout 3M and 3N, where the fishery also was conducted in 2003, the bycatch averaged 77 % of the total catches in all months it operated (February–May, August–October).
    - The Canadian 3LNO yellowtail flounder fisheries (which mostly use otter trawls, although some seine and gillnets are also used) reported bycatch of 3.5% for cod and 10% for American plaice.
    - The Subarea 2 Canadian witch flounder and cod fishery is the last fishery of note. It took less than 1,000t of American plaice in Subarea 2 in 2001 as bycatch. As of writing, all cod and witch flounder fisheries are closed in Subarea 2 (2005).

Impact of Non-Contracting Party Fishing Activity on Moratorium Stocks

- Very little information is available about actual catch and bycatch of moratoria stocks by non-Contracting Parties. However, it is known that, since 2000, countries such as Belize, Cyprus, and Dominica have directed on oceanic redfish in Divisions 1F and 2J. The only NAFO moratorium species known to inhabit these waters is cod. Since NAFO regulated fisheries have consistently reported taking cod along with redfish as bycatch in many of its fisheries in this area, it is assumed that some moratorium cod is being taken by these vessels as well.

Existing Data and Information Gaps

- With the exception of shrimp fisheries, no other information is available on discarding practices of moratoria stocks.

- There are no data available on high-grading practices other than anecdotal evidence from media accounts of high-grading in shrimp fisheries off Canada.

- Bycatch and discarding is likely occurring at higher levels than is evident from this review. Despite the fact that in most instances, Contracting Parties bycatch levels appear to be within NAFO regulatory limits (often just slightly below the allowed bycatch percentage [5%] per catch), it is reasonable to assume that some countries are underreporting their bycatch to ensure compliance with NAFO regulations. This is evidenced by the fact that the EU (through Portuguese and Spanish vessels) and Russia were both cited by NAFO fishery observers for directing on moratoria species, misreporting of catch, and using illegal mesh sizes, all of which supports the assumption regarding underreporting in the NAFO first Compliance Report presented during the September Fisheries Commission meeting (NAFO, 2004).

- When reviewing the information available on catches and bycatch for Spanish, Portuguese, Russian, and Canadian operations, it is important to note that many Contracting Parties, including Norway, Denmark, Estonia, Latvia, Lithuania, Japan, Korea, and Germany, also operate fisheries in the NRA, but there are no publicly available data from which to assess their respective fishing activities impact. However, whilst recognizing the limitations of drawing conclusions from partial data, the countries currently reporting to NAFO represent a significant component of the total fishing effort applied in the NRA.

- Although United States and Germany also provided Summary Research Reports in 2003 and 2004, the reports were not useful in this assessment. The US data were not incorporated into this document because it only provided bycatch estimates for marine mammals and only a general comment that bycatch numbers for finfish etc. were recorded. The German Summary Research Report included no bycatch information at all.

Impediments to Effective Management of Moratoria Stocks

- Even though observer coverage is mandatory in NAFO regulated fisheries, the data collected are often inconsistent and/or incomplete. NAFO's first compliance report, which was published in 2004, cited a number of problems with observer data and data being submitted to the Secretariat by member states, including:
  1) reports compiled in different languages;
  2) unreadable or difficult to read reports because of poor quality of reproduction;
  3) incomplete information in the reports, (e.g. no information on fishing dates, division or subarea, mesh size, missing hail reports);
  4) inconsistent information in electronic report submissions and subsequent report cover letters and in Reports on Inspection and Surveillance activities; and,
  5) lack of care in specifying units (kg or mt) and in placing decimal points in reporting catches.

- STACTIC also noted significant discrepancies between different data sources (observer reports, VMS, and Port Inspections), and called attention to the need to exercise quality control through the data available from VMS communications. Due to the discrepancies in data, it was impossible to determine compliance with the catch limits set by NAFO (NAFO Compliance Report, 2004).

- A number of delays in the transmittal of notifications and the follow-up of infringements have been noted. For 2003, out of the 24 citations issued, only one report on the follow-up action initiated had been submitted by the due date; and only a handful of follow up reports had been provided to the Secretariat at a later date.

Recommendations

A set of recommendations to address issues identified in the body of this chapter are presented below.

Addressing Information Availability

The Fisheries Commission should consider:

- The current inconsistent manner of information reporting needs to be addressed comprehensively for all information collected and used in stock assessments. This has been effectively done within other regional bodies (e.g., The Commission for the Conservation of Antarctic Marine Living Resources [CCAMLR]) and is well within the existing resources of NAFO. Such measures would increase the transparency of current fisheries operations and of third party audit of NAFO science and management deliberations.
- The reporting annual catch data by Contracting Parties and public availability of that data should be priority for NAFO.
- Despite the current deficiencies in bycatch information reporting, there are probably sufficient data available to model the impact of current removals to assess the impact on some stock rebuilding timescales. This should be done with some urgency to assess this impact and to improve the scientific base for taking appropriate management action.

Monitoring and Enforcement

The Fisheries Commission should consider the following:

- Notwithstanding the current quality issues with NAFO observer data, the fact that they are not available to NAFO monitoring, control and surveillance (MCS) operations in the NRA on a near real-time basis in an electronic format limits the effectiveness of NAFO surveillance operations. These data, when coupled with VMS data, would enhance the likelihood of early detection of infringements (e.g., the direct targeting of moratoria species to fish up to allowable bycatch levels). Such measures, backed by greater involvement of flag (and Port) state control personnel, would significantly enhance current enforcement operations. Improved timeliness of information availability would allow the mobilization of flag state based personnel to intercept vessels before their catches have been discharged.
- To improve the effectiveness of flag state involvement in vessel inspections, a standard port inspection protocol should be developed that is backed up with monitored commitments to increase the frequency of inspections.
- To address current shortcomings in VMS data, the Secretariat should undertake a comprehensive review of VMS reporting to determine the frequency of missing data.
- Third party audits should be conducted. Such audits have resulted in useful lessons being learned and best practices being put into place within other international and national regional management bodies. Review of current operations and procedures by independent third parties with relevant experience may be a useful mechanism to integrate such lessons and practices within NAFO.
- Standard protocols for observers should be adopted, including a consistent reporting format by neutral observers. NAFO has made some progress on this front, requiring that all reports now be submitted in English. It is worth noting that the EU observer program did not previously suffer from many of the problems now reported. There has clearly been a decrease in the effectiveness of this program that is undermining its contribution to NAFO's science and management base.
- The observer program has the ability to collect a range of more comprehensive scientific and monitoring data that it now currently does. A useful example of an expanded scientific and monitoring protocol can be found with CCAMLR, which could well serve as a model on which to develop more specifically for NAFO.
- Any improvements to MCS operations that involve fishers and/or observers must ensure that adequate training resources are committed to ensure that required logbooks and other reporting measures are clearly understood.
- By improving observer information availability STACTIC will be able to be more responsive to reports of infringements
- A black list program of vessels known to have violated NAFO regulations should be implemented. This has been under discussion for several years, and it has been suggested that blacklisted vessels will be identified via NAFO webpage posting and other means.

Governance

The Fisheries Commission should consider collaborating more closely with Canada, Greenland, and Iceland to develop joint stock assessments and complementary management measures for shared stocks.

Chapter 3

Compliance under TAC/Effort Regulated Stocks

Fourteen stocks are reviewed in this chapter. There are nine stocks in the NAFO Regulatory Area subjected to directed fishing which are currently regulated via Total Allowable Catch (TAC) or effort controls (redfish in 3M, 3O and Subarea 2 and Division 1F3K; 3LNO yellowtail flounder; Greenland halibut in Subarea 2 and 3KLMNO, squid in Subareas 3 and 4; shrimp in 3M; 3LNO white hake; and 3LNO thorny skate). For one other stock, Subarea 2 and 3LNO shrimp, fishing has been restricted in the NAFO Regulatory Area to 3L, but fishing also is occurring inside the Canadian EEZ in adjacent 3K and Subarea 2. Greenland halibut in Subarea 0 and Division 1A Offshore and Division 1B-1F; northern pink shrimp in Division 0A and Divisions 1A and 1F; and roundnose grenadier in subarea 0 and 1 are under the shared jurisdiction of Canada and Greenland (Denmark) and their relationship to the NRA is poorly understood. Another is solely under the jurisdiction of Denmark and Iceland; however, its relationship with nearby stocks in the NRA are poorly understood so it, too, is included here (Denmark Strait and off East Greenland shrimp stock).

Fisheries targeting at least four of these stocks catch mainly juveniles, as determined by NAFO or by using the Canadian Small Fish Protocol as a proxy for determining sexual maturity. For all except one of the fisheries, member states established TACs beyond or at the upper end of scientific recommendations. In some situations catches regularly exceeded the agreed-upon TACs. Canadian scientists and fishermen expressed concern over unreported high-grading (discarding) in some NAFO-managed fisheries (NAFO, 2004c). Limited information available on discarding and high-grading practices in NAFO-regulated shrimp fisheries, and to a lesser degree from the Greenland halibut fishery in Subarea 2 and 3KLMNO, indicates variable impacts on the resources.

The following sections presents summary of the current state of 14 stocks managed by NAFO or domestic TAC or effort controls. The chapter concludes with a summary and a number of recommendations on how to address the issues identified.

3M Redfish *(Sebastes mentella) (Sebastes marinus) (Sebastes fasciatus)*

Stock Status and Current Fisheries Information

Three species of redfish are fished commercially in Area 3M, primarily on the Flemish Cap: deep-water redfish *(Sebastes mentella*), golden redfish (*Sebastes marinus*), and Acadian redfish (*Sebastes fasciatus*). The most recent assessment evaluates the status of the Division 3M beaked redfish stock, regarded as a management unit composed of two populations of two very similar species (*Sebastes mentella* and *Sebastes fasciatus*). Evidence indicates that beaked redfish dominate catches of the redfish group on the Flemish Cap (SC Summary Sheet, 2003).

The 3M beaked redfish SSB averaged around 61,000t from the late 1970s through the 1980s. It then declined to about 25,000t around 1989 and averaged less than 5,000t since. There also was a decline in total biomass, which historically was above 100,000t, with an unusual peak in the early 1970s to almost 300,000t (Figure 21). Since the early 1990s, biomass fluctuated annually between highs of close to 100,000t and lows just below 50,000t. Since 1997 fishing mortality has been relatively low. Redfish catches reached 3,800t in 2000, and then declined to around 3,000t in 2001–2002 (Figure 22). Portugal and Russia account for most of the recent catch. Despite recent fluctuations, biomass and female spawning biomass appear to increase marginally (since 1997) but are still well bellow the SSB that produced the 1990 year-class (SC Summary Sheet, 2003). The EU survey data (2003) put biomass at 59,500t and SSB at 6,600t (Avila de Melo et al*.,* 2004).

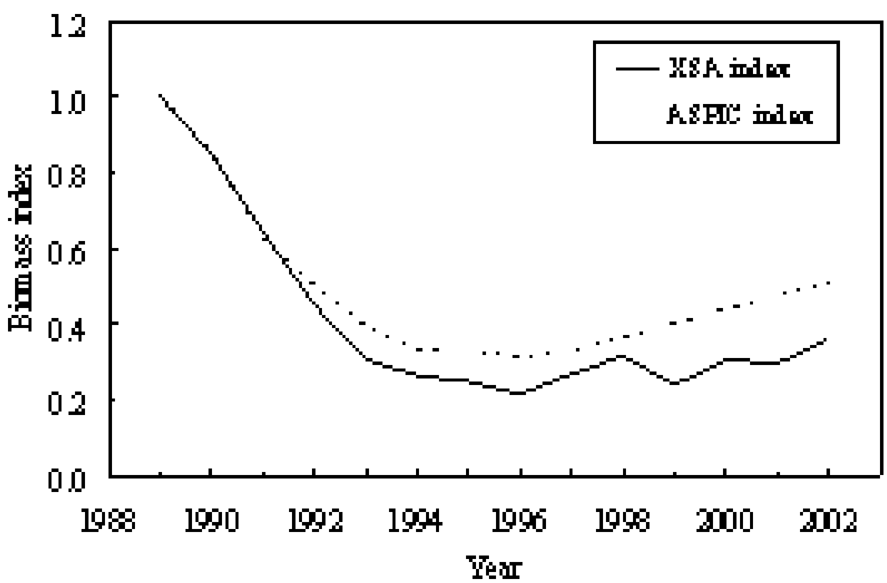

Figure 21. 3M redfish biomass index 1988–2002. (Source: SC Summary Sheet. 2003)

The total stock and spawning stock are currently at a low level compared to the earlier period in the time series. At the low fishing mortalities of the most recent years, with growth of the relatively strong 1990 year-class followed by the promising 1998 year-class, spawning biomass should gradually increase. Contracting Parties agreed to a 2004 and 2005 TAC of 5,000t which is consistent with the TAC agreed to for the past four years for this stock (SC Summary Sheet, 2003). Catches in 2003 were 1,988t (NAFO, 2005b).

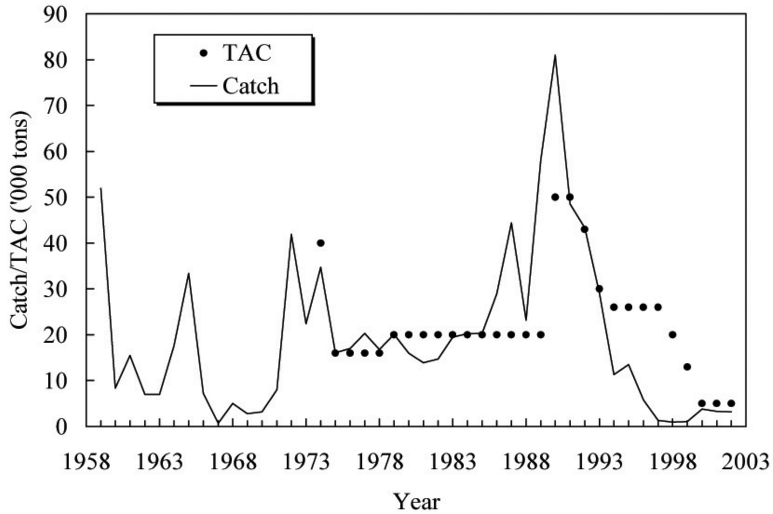

Figure 22. 3M redfish catch and TAC data from 1958–2003. (Source: SC, Summary Sheet, 2003)

Adherence to Scientific Advice

The Scientific Council was unable to recommend a specific TAC for 2003/2004 or 2004/ 2005. However, to maintain relatively low fishing mortalities and to promote stock recovery, Scientific Council recommended a total catch (including bycatch) for Division 3M redfish in the years 2004 and 2005 in the range of 3,000-5,000t. Stock growth in biomass and in abundance is dependent upon the appearance and survival of cohorts so that they recruit to the SSB and commercial fishery. The Scientific Council is extremely concerned about sharp increases of bycatch of small redfish taken in the shrimp fishery in 2001/2002 (750 t). The Scientific Council considers that it is important to keep the bycatch of such fish to a minimum (SC Summary Sheet, 2003). The Fisheries Commission's decision to adopt a TAC of 5,000t at the high end of the scientific advice range, which does not explicitly account for bycatch, is clearly not in line with the organization's commitment to operate under the Precautionary Approach.

Bycatch and Discards in Redfish Fishery

European Union

In the Portuguese redfish fishery, Greenland halibut dominated bycatch and represented 29.5-47.6% of the total catch in 3M (January–April in 2003) (Vargas, et al. 2003). Total bycatch in this fishery during its four months of operation in 3M averaged 69% of total catch. Greenland halibut at lengths between 42cm and 50cm dominated bycatch in the 3M redfish fishery, with a mode at 46cm (mean length 47cm and mean weight 1,036 g) (Vargas, et al. 2003). NAFO established 30cm (whole fish) as the minimum size for Greenland halibut so it appears that most fish taken in this fishery may be sexually mature (NAFO, 2005a).

Bycatch and Discards of Redfish in Other Fisheries

Most of the fish taken as bycatch in the 3M shrimp fishery are juvenile redfish. Development of the shrimp fishery on the Flemish Cap in 1993 led to high levels of redfish bycatch in 1993-1994. From 1995 through 2000, redfish bycatch in weight fell to apparently low levels. In 2002, redfish bycatch reached 750t, the highest level observed since 1994. In 2003, bycatch again exceeded this when 1,006t were taken (Avila de Melo et al., 2003).

In 3M, total bycatch in 2002 and 2003 is reported to a level around 2% of total shrimp catches, or 1,240t of bycatch from 62,000t of shrimp, most of which is apparently juvenile redfish (Avila de Melo, et al., 2003). Sixteen fishing nations participate in the shrimp fishery. Since 1993 the number of vessels ranged from 40 to 110. In 2004, there were approximately 50 vessels fishing shrimp in Division 3M. In 2005, 33 vessels are expected from the EU (including Poland, 1; Estonia, 8; Latvia, 4; Lithuania, 7; plus others). Estonia has the majority of days at sea with 1,667 days. Norway has 32 vessels Denmark-Faroe Islands has 8, Greenland has 14, Canada has 16 vessels, the USA, Ukraine, Korea, Japan, France, and Cuba each have one vessel. Russia has a large number of days but reportedly no vessels there.

Russia
In the Russian shrimp fishery in 3M, which caught 1,176t of shrimp in 2002, bycatches of redfish consisted of fish 6cm to 20cm in length, and predominantly from 12cm to 14cm. Young fish, with the length <12 cm, constituted 21.8% of that catch. Bycatches of redfish in percentage of catches' weight fluctuated from 0% to 4.89%. Re-calculating per the entire Russian catch of shrimp in 2002, it is possible to estimate the weight and number of redfish caught to be 28t and 974,344 specimens, respectively (Bakanev and Gorchinsky, 2003).

Iceland
In the Icelandic fishery, the bycatch was about 0.3% in the years 2002 and 2003, 0.9% in 2000, and 0.8% in 2001 as compared to 0.8% of the shrimp catch in 1999 and 1998, 1.8% in 1997, and 3% in 1996. Most of this was redfish or 0.7–0.8% in the years 1999 to 2002. (Skúladóttir, 2003a)

Impact on Stock from Direct and Indirect Fishing

Catches in 2002 were 2,934t, which was lower than the TAC set. However, bycatch in 2002 (750t) was approximately 15% of the established TAC and, as this was composed almost entirely of juvenile bycatch from the 3M shrimp fisheries, represented 68.3% of the total removals in numbers. In 2003, catches were 1,988t and bycatch 1,006t, with bycatch in numbers representing 82.6% of the total catch in numbers. Without simulating the impact of such removals, it is difficult to truly assess to what extent the future recovery of this stock is being impeded, but the concern expressed by the NAFO Secretariat would not seem misguided.

3O Redfish *(Sebastes mentella) (Sebastes fasciatus)*

Stock Status and Current Fisheries Information

Two primary species of redfish, *Sebastes mentella* and *Sebastes fasciatus*, occur in Division 3O. They are very similar in appearance and are reported collectively as redfish in statistics. The relationship to adjacent NAFO Divisions, in particular to Division 3LN, is unclear and further investigations are necessary to clarify the relationship between redfish in Division 3O and Division 3LN. There has been no increase in Area 3O redfish stock size over the past few years and no sign of good recruitment since the 1988 year-class (SC Summary Sheet, 2003).[3]

Historic catches averaged 13,000t from the late 1960s to the mid-1980s (Figure 23). In 1987, catches increased to 27,000t with a further increase to 35,000 tons in 1988. Catches declined to about 16,000t in 1993 and declined further to about 3,000 tons in 1995, partly due to reductions in non-Canadian allocations within the Canadian zone since 1993. Catches increased to 14,000t by 1998, declined to 10,000t in 2000 and increased to 20,000 in 2001. Russia resumed directed fishing in the NRA in 2000, rapidly increasing its catch from 2,200t to about 11,000t in 2001 and 2002. Portugal's historically small catches escalated to 5,500t in 1999 and then averaged about 4,200t for 2000 to 2002. Spanish vessels, which had taken less than 50t before 1995, increased harvest to a peak of 4,500t in 1999 before declining to 700t in 2002. Between 1996 and 2002, Canadian catches fluctuated between levels of about 9,000t in 2002 and 2,500t. In 2001, total catches were approximately 20,000t; in 2002, 17,000t. (SC Summary Sheet, 2003). Total catches in 2003 were 21,591t (NAFO, 2003d).

According to the Scientific Council the bulk of the redfish catches in recent years are comprised of redfish less than 25cm in length (SC Summary Sheet, 2003). NAFO considers these as immature fish. Fish taken in this fishery are just slightly above the Canadian minimum size limit (22cm) for its own fisheries so some may have just reached sexual maturity.

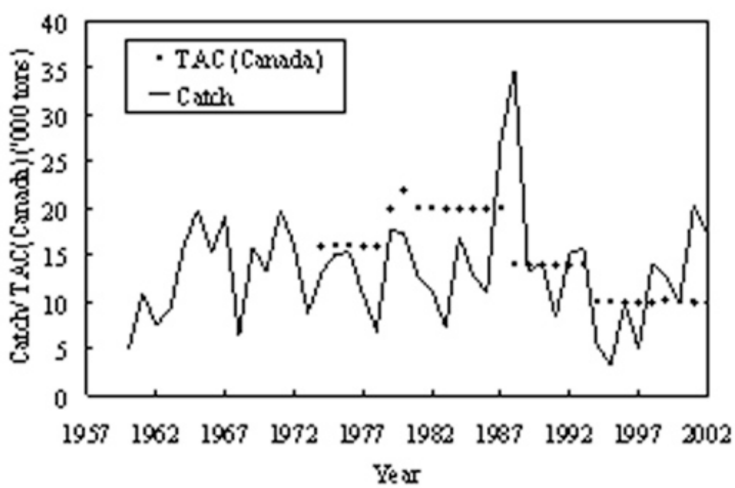

Figure 23. 3O redfish catch and Canadian TAC 1957–2002. (Source: SC Summary Sheet, 2003)

[3] This particular SC Summary Sheet was the result of a Special Request for Advice and can be found in the SC Meeting Report June 5–19, 2003.

Adherence to Scientific Advice

According to the Scientific Council, the average catch of 13,000t since the 1960s appears not to be detrimental to the stock (SC Summary Sheet, 2003). The Scientific Council has not made a TAC recommendation for 2003 to 2005. However, the USA and Canada proposed a range of 13,000-20,000t based on Scientific Council advice during the 2004 Annual Meeting. The 20,000t quota subsequently agreed to by the Contracting Parties is at the high end of the proposed range. At least one Contracting Party objected to the 20,000t quota as too low. Ukraine objected to the quota because "the state of the stock does not seem to be impaired so regulation beyond those measures that already exist do not seem necessary. Any additional regulation would need proper justification." Canada further proposed a list of measures including closed areas to protect juveniles, minimum size limits, and effort controls similar to those adopted by the Northeast Atlantic Fisheries Commission (NEAFC) Working Group Report on the Management of 3O Redfish (2004). No further action was taken beyond accepting a TAC. The Parties did not address bycatch of redfish in shrimp and other fisheries. Another stock assessment is expected to be conducted on this stock in 2004 (NAFO, 2004e).

Bycatch and Discards in the Redfish Fishery

Russia

Data show that in catches in the Russian 3O redfish fishery at a depth of 300–600m in 2002, redfish catch dominated with minimal bycatch of other fish species. Red hake,
American plaice and cod prevailed in bycatches while harvesting redfish (Vaskov, 2003).

European Union

In Division 3O, in 2000, the bycatch percentages were low (1%) with white hake being a primary bycatch species in the Spanish redfish fishery (González et al., 2004).

The Portuguese redfish fishery operates in 3O in April to November. The main species taken as bycatch is cod representing 26.1–29.0% of the catch, followed by white hake (15.5–26.2% of the catch), plaice (15%), and witch flounder (1.3–3.5%) (Vargas, et al., 2004).

Canada

Bycatch in the Canadian redfish fishery occurs at a lower rate in the EEZ (3%) than by multinationals in the NRA (12–20%), based on STATLANT 21B data for 1998–2000 (STACFIS, 2002a).

Bycatch and Discards of Redfish in Other Fisheries

In 2003, Spain reported taking 1,136t of white hake from 3O and 250t (22% of total catch) of redfish bycatch (González and del Río, 2004).

Impact on Stock from Direct and Indirect Fishing

The Scientific Council noted there is insufficient information on which to base predictions of annual yield potential for this resource. Stock dynamics and recruitment patterns also are poorly understood. The greatest concern for this stock appears to be directed redfish fisheries that are capturing fish less than 25cm, which are predominantly immature fish (SC Summary Sheet, 2003).

Subareas 1 and 2 and 3K Redfish (*Sebastes mentella*) (*Sebastes marinus*)

Stock Status and Current Fisheries Information

Subarea 1

Two species of redfish of commercial interest occur off West Greenland inshore and offshore (Subarea 1), golden redfish (*Sebastes marinus* L.) and deep-sea redfish (*Sebastes mentella* Travin).

Historically, redfish were taken mainly as bycatch in the trawl fisheries for cod and shrimp. However, occasionally during 1984 to 1986, a directed fishery on redfish was observed for German and Japanese trawlers. With the collapse of the Greenland cod stock during the early 1990s, resulting in a termination of that fishery, catches of commercial-sized redfish were taken inshore by longlining or jigging and offshore by shrimp fisheries only. There are also substantial numbers of juveniles discarded in the shrimp fishery.

Both redfish species, golden redfish (*Sebastes marinus* L.) and deep-sea redfish (*Sebastes mentella* Travin), are included in the catch statistics since no species-specific data are available. Other data suggest that until 1986, landings were composed almost exclusively of golden redfish. Subsequently, the proportion of deep-sea redfish represented in the catches increased, and since 1991, the majority of catches are believed to be deep-sea redfish. In 1977, total reported catches peaked at 31,000 tons (Figure 24). During the period 1978–83, reported catches of redfish varied between 6,000 and 9,000 tons. From 1984 to 1986, catches declined to an average level of 5,000 tons due to a reduction of effort directed to cod by trawlers of the EU-German fleet. With the closure of this offshore fishery in 1987, catches decreased further to 1,200 tons, and remained at that low level. The estimated catch figure in 2001 and 2002 of demersal redfish in Sub-Area 1 is 332 tons and 487 tons, respectively (NAFO, 2003c).

According to the Scientific Council no current analytical assessment of either species is possible; however, scientific data exist that offer insight into the state of the stocks. The relationship of these stocks to other North Atlantic redfish stocks is unclear (NAFO, 2003c).

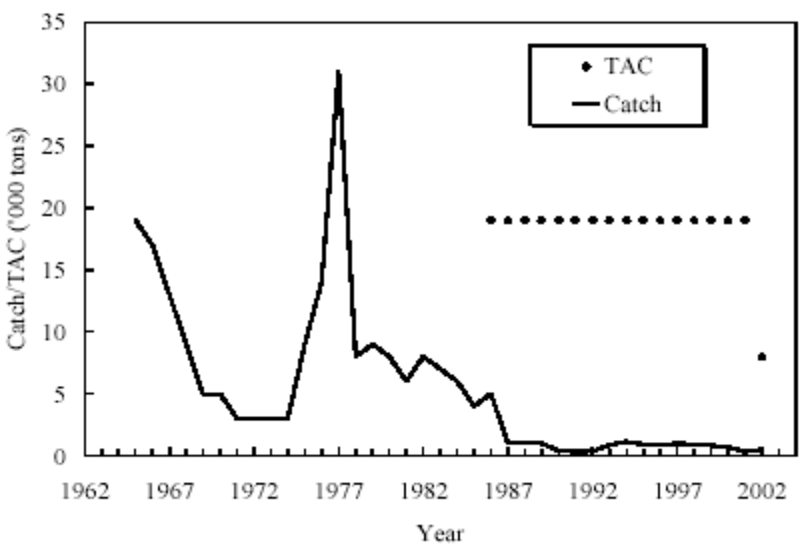

Figure 24. Subarea 1 redfish catch and TAC 1962–2002. (Source: SC Summary Sheet, 2003)

Survey data are available for redfish in Subarea 1 but they were essentially designed to monitor stock trends for other species. As such, high inter-annual variability is observed. However, there is general agreement that SSB and recruitment indices for golden redfish have decreased drastically since 1982 and remained significantly below the average level since 1989. Taking into account the recent very low SSB and the recruitment failure together with the absence of golden redfish in the Greenland surveys, the stock of golden redfish in Subarea 1 is considered to be severely depleted with no signs of recovery. The deep-sea redfish SSB has been extremely low since 1989 and shows high variation in recruitment. Good recruitment occurred in 1997, 2000, and 2001, while the recruitment in 2002 was very poor. The spawning stock biomass of golden redfish in Subarea 1 remains severely depleted, declining from around 24,000t in 1981 to 2,000 to 2,500t in 2001. There are indications that recruitment is reduced due to the current low SSB and that short-term recovery is very unlikely (NAFO, 2003c). Biomass estimates of less than 5,000t were recorded in 2002 (Siegstad, et al., 2003a).

The golden redfish SSB was estimated using biomass-at-length from the EU-Germany groundfish survey and assuming knife-edge maturity at 35 cm as observed in East Greenland. The 17–20cm length groups were chosen as recruitment indices. SSB and recruitment indices decreased drastically from 1982 and have remained significantly below the average level since 1989 (Figure 25). Taking into account the recent very low SSB and the recruitment failure together with the absence of golden redfish in the Greenland surveys, the stock of golden redfish in Subarea 1 is considered to be severely depleted with no signs of recovery.

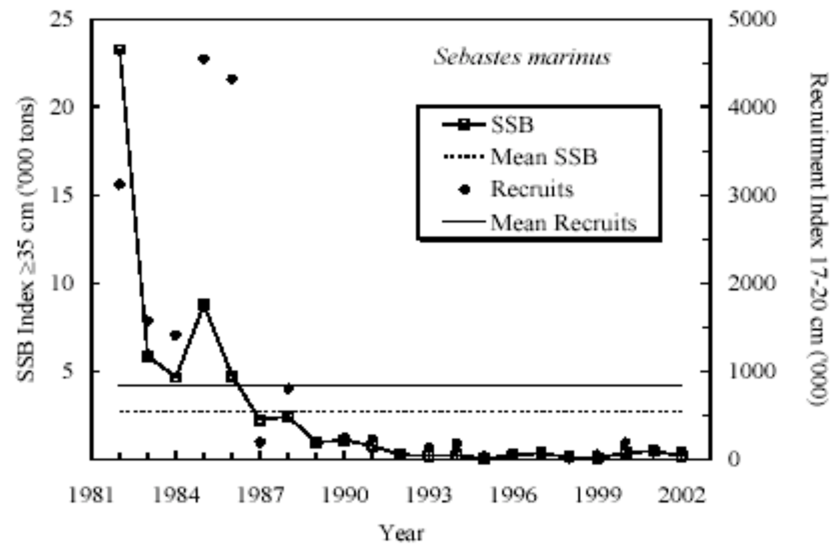

Figure 25. Subarea 1 redfish SSB index and recruitment index for golden redfish 1981-2002 (NAFO, 2003c).

The German survey biomass of fish ≥35cm and the abundance of 17–20cm length groups were taken as proxies for deep-sea redfish SSB and recruitment, respectively. No clear trend can de derived from these estimates but SSB has been below average since 1989 (Figure 25-Figure 26). The recently depleted status of the SSB is confirmed by the lack of adult fish in the Greenland deep-water survey. Recruitment variation for deep-sea redfish is high, although there is indication of recent improvement (1997, 2000 and 2001).

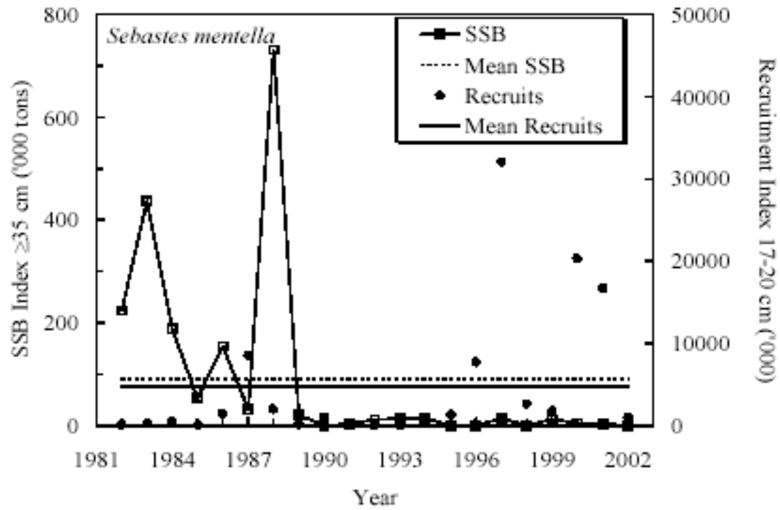

Figure 26. Subarea 1 redfish SSB index and catch index for deep-sea redfish 1981–2002. (NAFO, 2003c).

In view of dramatic declines in survey biomass indices of golden and deep-sea redfish (≥17cm) to an extremely low level along with significant reduction in fish sizes, it is concluded that the stocks of golden and deep-sea redfish in Subarea 1 remain severely depleted and there are no signs of any short-term recovery. Substantial numbers of redfish are caught and discarded by the shrimp fishery, and concern was expressed about the continuing failure of the juveniles to rebuild the pre-mature and mature stock components. Considering the depleted SSBs, the recruitment potential of the very abundant early life stages at an age of zero to two years to the Subarea 1 stocks remains unclear. Recruitment indices for golden redfish have been extremely poor while those for deep-sea redfish indicate some recent improvement (1997, 2000, and 2001). It was noted that the probability of recovery of the redfish stocks in Subarea 1 should increase if the bycatches taken by the shrimp fishery were reduced to the lowest level possible.

Given the lack of long-term data on SSB and recruitment, and the uncertainties regarding reproduction and maturation of redfish in this area, proposals for any limit of buffer reference points for fishing mortality or spawning stock biomass for the stocks of golden and deep-sea redfish stocks in Subarea 1 could not be made. However, given the relationship observed for golden redfish between adult biomass and recruitment, there appears to be a very high probability of decreased recruitment below biomass index levels of 5,000 tons. Recent survey results indicate that biomass of golden redfish remains below this level.

Subarea 2 and Division 3K

This fishery first came under TAC regulation in 1974 with a 30,000t quota, increasing to 35,000t in 1980 until 1991 when it was lowered to 20,000t. In 1994 the TAC was decreased to 1,000t and to 200t for 1995 and 1996. In 1997, a moratorium was introduced in Canadian waters.

DFO surveys continue to indicate the resource is at a very low level with poor recruitment for the past 25 years. Survey biomass for Division 2J3K averaged 32,000t (1995–2000) and is less than 5% of the 1978–1990 average (775,000t).

Stock structure is poorly understood, particularly the relationship between redfish in Subarea 2 and Division 3K and those in Davis Strait and the Irminger Sea pelagic stock. Catches made by non-Canadian vessels fishing outside the 200-mile limit are likely targeting the pelagic stock. It has been hypothesized that this stock has shifted its summer distribution and that a portion extends into NAFO Division 1F and to some degree into Division 2J. The stock relationship between redfish that reside in SA2+3K on the continental slope and the areas shoreward with the pelagic stock is unknown. Because of these uncertainties it is very difficult to provide detailed scientific advice on the current status of the stock (DFO, 2001).

Golden redfish (*Sebastes marinus*) and deep-sea redfish (*Sebastes mentella*) are both fished in Subarea 1. With the collapse of the Greenland cod stock during the early 1990s, commercial-sized redfish were only taken inshore by longlining or jigging and offshore as bycatch in the shrimp fisheries. With the termination of the Greenland cod fishery, directed redfish catches increased. The nominal catch of redfish by Greenland in Subarea 1 in 2000, 2001, and 2002 was 735t, 332t and 487t, respectively. In 2003, Greenland took 2,039t from Subarea 1 (Siegstad et al*,* 2003a).

In 2003, the 11 countries that reportedly took redfish in Subarea 1 and Division 2J and 3K are listed below in Table 7.

Table 7. Redfish catches from Subareas 1 and 2 and Division 3K in 2003. (Source: STATLANT, 2005)

Country	Species	Division	Catch (t)
Greenland	Atlantic redfishes	1NK*	63
Greenland	Beaked redfish	1NK	1,561
Greenland	Atlantic redfishes	1A	12
Greenland	Atlantic redfishes	1B	136
Greenland	Atlantic redfishes	1C	99
Norway	Atlantic redfishes	1C	1
Greenland	Atlantic redfishes	1D	113
Greenland	Atlantic redfishes	1E	48
Faroe Island	Atlantic redfishes	1F	1,431
Greenland	Atlantic redfishes	1F	7
Germany	Atlantic redfishes	1F	2,535
Norway	Atlantic redfishes	1F	3
Portugal	Atlantic redfishes	1F	1,333
Latvia	Atlantic redfishes	1F	461
Estonia	Atlantic redfishes	1F	6,861
Russia	Atlantic redfishes	1F	9,365
Iceland	Beaked redfish	1F	2,329
Poland	Beaked redfish	1F	471
Russia	Atlantic redfishes	2H	325
Canada	Atlantic redfishes	2J	2
Faroe Island	Atlantic redfishes	2J	30
Germany	Atlantic redfishes	2J	467
Portugal	Atlantic redfishes	2J	82
Latvia	Atlantic redfishes	2J	437
Estonia	Atlantic redfishes	2J	447
Russia	Atlantic redfishes	2J	3,249
Iceland	Beaked redfish	2J	49
Poland	Beaked redfish	2J	305
Canada	Atlantic redfishes	3K	20
Total			32,242

*NK=unknown

In the NRA, from 1987 until 2002, the TAC was set at 19,000t and catches remained consistently well below, averaging 500t during this time frame. In 2005, Contracting Parties set a quota of 32,500t in Subarea 2 and Division 1F and 3K, allocated as follows: Canada, USA, Cuba, Japan, France (Saint Pierre and Miquelon), Korea, and Ukraine to share 1000t and Denmark (Faroe Islands and Greenland), EU, Iceland, Norway, and Russia to share 25,000t; Lithuania, 5,800t; and Latvia, 700t.

A moratorium on redfish is in place in Canadian waters of Subarea 2 and Division 3K. However, catches increased rapidly in the NAFO regulatory area to 1,600t in 2001, with further increases to 3,200t in 2002 and to 5,413t in 2003. The increases, beginning in 2001, were from non-Canadian directed fisheries outside the 200-mile limit utilizing large midwater trawls. It is likely these catches were from the pelagic stock of redfish that resides primarily in the Irminger Sea between Greenland and Iceland (Richards et al*.,* 2004).

Adherence to Scientific Advice

From 2000 to 2003, the recommended TAC was 0 in Subarea 1. In 2002 member countries agreed to a TAC of 8,000t in Subarea 1, contrary to Scientific Advice. The Scientific Council further stated that there should be no directed fishery on redfish in Subarea 1 in 2004 and 2005. The Scientific Council also recommended that redfish bycatch in the shrimp fishery should be at the lowest possible level, which would increase the probability of recovery of the redfish stocks in Subarea 1 (STACFIS, 2003a). It was recognized that the probability of recovery of the redfish stocks in Subarea 1 would be enhanced if the bycatch of demersal redfish taken in the shrimp fishery was significantly reduced (SC Summary Sheet, 2003). Nevertheless, an 8,000t TAC was established for finfish in the area in 2002, and the catch was reported to be 500t. In 2003, again the Scientific Council recommended that there be no directed fishing effort. This time, no TAC was adopted and the total directed catch of redfish amounted to roughly 32,242t (26,829 from Sub Area 1, 5,393t from Sub Area 2, and 20t from 3K). The majority of the catch in Sub Area 1 was taken from 1F (24,796t), with Russia (9,365t), Estonia (6,861t), Germany (2,535t), and Iceland (2,329t) contributing to most of the catch (NAFO, 2005b). In 2005, a total area TAC of 32,500 was agreed to for all of Subarea 2 and Divisions 1F and 3K (NAFO, 2005b).

Bycatch and Discards

During the last decade, redfish were taken mainly as bycatch in the trawl fisheries for cod and shrimp. Both redfish species were tallied together in the catch statistics. Recent catch figures do not include the weight of small redfish discarded by the trawl fisheries directed to shrimp.

Bycatch and Discards in the Redfish Fishery

Germany

In 2002, the German redfish fishery in NAFO Regulatory Area and Greenland EEZ in Division 1F and NAFO Regulatory Area Division 2J reportedly targeted mature redfish with almost no discard and bycatch of other species (Rätz, 2003).

Canada

White hake are taken as a bycatch in the Canadian redfish, monkfish, and halibut fisheries and to a lesser extent in the Canadian skate and Greenland halibut fisheries in relatively small amounts (Kulka et al., 2004).

Bycatch and Discards of Redfish in Other Fisheries

Canada

Since the moratorium, Canadian landings of redfish were less than 40t or 0.7% annually as bycatch from Greenland halibut fisheries, which harvested 5,421t of halibut in 2GHJ and 3K in 2003.

Juvenile redfish are taken in the directed shrimp fishery, which operates in Subarea 1. Estimates of redfish bycatch discarded from shrimp fisheries in Division 2G to Division 3K since 1980 ranged from 14t in 1983 to 665t in 1990. Since 2000, estimates ranged from 60t to 135t (Richards et al., 2004). Given the size of the shrimp fishery catch in this region, 207,615t (which includes all catches recorded by Canada, Denmark, and Greenland [NAFO 2005b]), this bycatch rate is very small compared to the redfish bycatch in the 3M shrimp fishery.

Impact on Stock from Direct and Indirect Fishing

The status reports for redfish in Subarea 1 and Divisions 2J and 3K are inconsistent with the activities of the directed fishery on the pelagic stock of redfish. Given the state of both stocks reported above, particularly the golden redfish stock with a SSB less than 5,000t, and the fact that the majority of deep-sea redfish taken are juveniles, continued directed fishing would appear to pose a serious threat to the recovery of these two stocks. The most problematic areas are the directed fishing in 1F led by Russia, Iceland, and Portugal.

There is reported uncertainty with respect to the degree of mixing between the pelagic redfish stock and the Subareas 1 and 2 and Division 3K stock. If the pelagic stock represents a separate and essentially unsurveyed stock, then catches on the order of 32,242t may be sustainable. If these stocks are not distinct (and there is some evidence to support this), such directed fishing may pose a significant threat to the recovery of the Subareas 1 and 2 and Division 3K demersal stock.

In addition, bycatch and discarding of redfish in the 2G and 3K shrimp fishery, while small relative to total shrimp catches, may still be significant in the effort to rebuild this stock. More information is needed to fully assess impact of fishing effort in offshore areas of 2G and 3K.

3LNO Yellowtail Flounder *(Limanda ferruginea)*

Stock Status and Current Fisheries Information

The stock is mainly concentrated on the southern Grand Bank. Fishing mortality has been below F_{msy} since 1994 and is projected to be about 65% of F_{msy} in 2004 if the fishery takes the full TAC of 14,500t. TACs were exceeded each year from 1985 to 1993, and from 1998 to 2001, but not in 2002 and 2003 (the 2003 TAC was 13,500, and the catch was 13,303). Based on the 2002 assessment, recruitment improved in the 1990s, and cohorts since 1992 are the highest in the series. Biomass estimates in the Spanish and both Canadian surveys have been relatively high since 2000. Relative biomass estimated from a production model has shown an increasing trend since 1994 and is estimated to have been above B_{msy} since 1999 and about 25% above B_{msy} in 2004 (Figure 27) (SC Summary Sheet, 2004). Recruited fish come from the Southeast Shoal area nursery ground, where the juvenile and adult components overlap in their distribution.

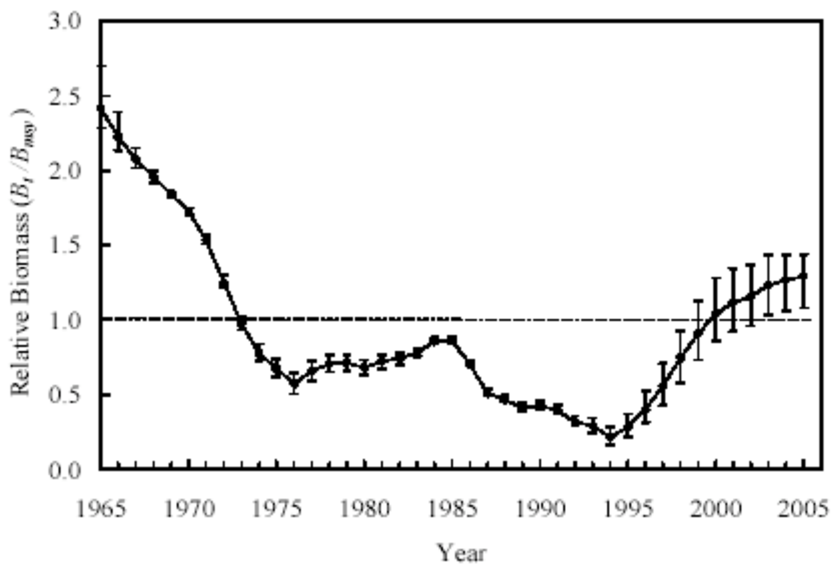

Figure 27. 3LNO yellowtail flounder relative biomass 1965–2005. (Source: SC Summary Sheet, 2004)

There was a moratorium on directed yellowtail flounder fishing from 1994 to 1997, and small catches were taken as bycatch in other fisheries. The fishery was reopened in 1998 and catches increased from 4,400t in 1998 to 13,800t in 2003 (SC Stock Assessment, 2004). The Canadian yellowtail fishery in both 2002 and 2003 was almost all otter trawl, with small catches by seine in 2002, and a very small amount of gillnet catch from inshore Division 3L in both years (Richards et al*.,* 2004).

Length frequencies of yellowtail flounder are available from the Portuguese fisheries in Division 3N during July to November and from Canadian fisheries. The model length frequency in the Canadian fishery was 36–37cm, compared to 34–35cm in the Portuguese fishery (Brodie et al., 2004a). Few fish in the catch fall below the NAFO legal size limit (25 cm), and most fish exceed the Canadian Small Fish Protocol, which considers fish less than 30cm to be sexually immature.

Adherence to Scientific Advice

Since the mid-1990s, catches have been compliant with the TAC set (Figure 28), fishing mortality has not exceeded F_{msy} and the stock appears healthy. The Scientific Council recommended that total catch, including bycatch, should not exceed 15,000t in 2005 and 2006. The TAC was set at 14,500t. Depending on bycatch removals, this TAC may not be judged a conservative TAC since it is only marginally in keeping with Scientific Council advice to stay below 15,000t (SC Stock Assessment, 2004).

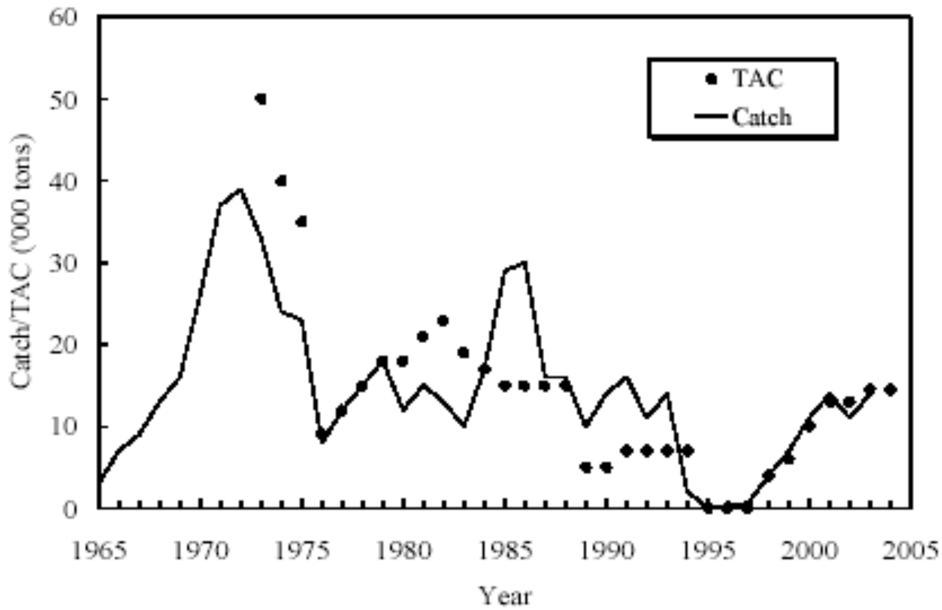

Figure 28. 3LNO yellowtail flounder catch and TAC 1965–2005. (Source: SC Summary Sheet, 2004)

Bycatch and Discards in the Yellowtail Flounder Fishery

Canada

The Canadian yellowtail fishery in 2002 and 2003 almost entirely used otter trawls, with small catches taken by seine nets in 2002 and very small amounts taken in gillnet catch from inshore waters of Division 3L in both years. Cod and American plaice are two species most often taken as bycatch in this fishery. The use of sorting grates was widespread in 2002 (present in 67% of observed sets), but declined to only 20% of observed sets in 2003. This likely contributed to an increase in cod bycatch from 2.1% of the observed catch in 2002 to 3.5% in 2003. American plaice has been the main bycatch in the Canadian fishery for yellowtail flounder since 1998. During 2001 to 2003, it constituted about 10% (a range of 9.7% to 10.4%) of the total catch observed in the yellowtail flounder directed fishery, compared to about 4% to 6% during 1998 to 2000 (Brodie et al., 2004a).

Impact on Stock from Direct and Indirect Fishing

Currently, the stock appears healthy and lower bounds of the estimates for relative biomass are above 1.0. Relative biomass is still, not surprisingly, below the historic levels of the mid-1960s (today the ratio is 1.25 versus 2.40 in 1965).

Subarea 0, Division 1A Offshore and Division 1B-1F Greenland Halibut *(Reinhardtius hippoglossoides)*

Stock Status and Current Fisheries Information

The Greenland halibut stock in Subarea 0 and Division 1A Offshore and Divisions 1B-1F is part of a common stock distributed from the Davis Strait southward to Subarea 3. Due to an increase in offshore effort, catches increased from 2,000t in 1989 to 18,000t in 1992 and remained at about 10,000t annually until 2000 (Figure 29). Since then catches increased gradually to 20,000t in 2003 primarily due to increased effort in Divisions 0A and 1A.

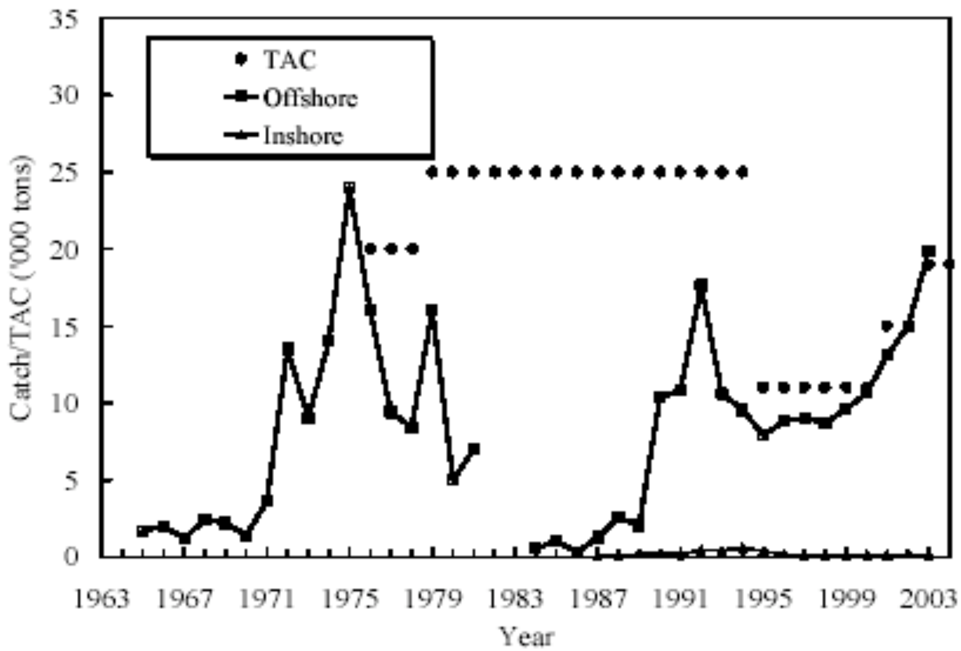

Figure 29. Subarea 0, Division 1A Offshore and Division 1B-1F Greenland halibut catch and TAC 1963–2003. (Source: SC Summary Sheet, 2004)

Catch data reported in 2003 (STATLANT, 2005) (Table 8) differ from the above estimate of 20,000t. STATLANT data report for both the inshore and the offshore fisheries. Reported landings from the inshore fishery in 1A are shown in Table 9 below. This suggests catch in Subarea 0, Division 1A (offshore), and Division 1B-1F was 15,318t.

Table 8. Greenland halibut 2003 catch data for Subarea 0, Division 1A Offshore and Division 1B-1F. (Source: STATLANT, 2005)

Country	Division	Catch (t)
Faroe Islands	0A	2
Canada	0B	4,017
Norway	0B	1,366
Faroe Islands	1A	107
Greenland	1A	24,078
Norway	1A	77
Russia	1A	254
Faroe Island	1B	10
Greenland	1B	121
Russia	1B	5
Greenland	1C	27
Norway	1C	292
Russia	1C	247
Faroe Islands	1D	135
Greenland	1D	2,060
Germany	1D	541
Norway	1D	928
Russia	1D	1,081
Greenland	1E	19
Norway	1E	124
Greenland	1NK*	321
Total		35,812

*NK=unknown

Table 9. Inshore catch and TAC by Division 1A location. (Source: NAFO, 2004g)

1A Inshore Location	2003 Catch (t)	TAC (t)
Disko Bay	11,571	7,900
Uummannaq	5,039	6,000
Upernavik	3,884	2,400
TOTAL	20,494	16,300

Recruitment of the 2000 year-class at age 1 was the largest in the time series, while the 2002 year-class was well above average. The biomass in Division 1CD in 2003 was estimated at 69,000t, slightly above the average in the seven-year time series, 1997–2003 (SC Summary Sheet, 2004) (Figure 30).

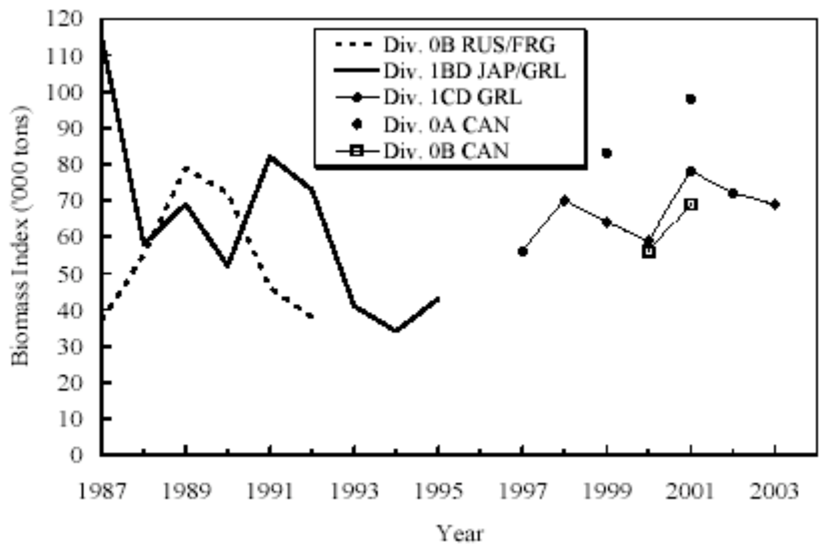

Figure 30. Subarea 0, Division 1A Offshore and Division 1B-1F Greenland halibut biomass index 1987-2003 (source: SC Summary Sheet, 2004)

The Division 1A inshore area covers the fjords in the three distinctive geographical areas, Disko Bay, Uummannaq and Upernavik. New fishing grounds in the northern part of the district are being exploited; however, little information exists from these areas. The fishery is traditionally performed with longlines from small open boats or by means of dog sledges. Since the 1980s bigger vessels (>25 feet) increased in numbers. Typically the fishery is carried out in the inner parts of the ice fjords at depths between 500m to 800m. In the middle of the 1980s, gillnets were introduced to the inshore fishery and have been commonly used since then (Simonsen and Boje, 2003).

Length compositions for Greenland halibut and sampled from catches have been stable in recent years. Based on survey indices the stock increased since 1994 and is now at the level of the late 1980s and early 1990s (SC Summary Sheet, 2004). The age compositions from sampled catches in all three inshore areas has reduced and fewer age groups are present compared to the early-1990s and the fishery is more dependent on incoming year classes. Combined standardized catch rates for Subarea 0 and Division 1CD during 1990–2000 and standardized catch rates from Division 1CD during 1990–2003 are stable. Unstandardized catch rates in Division 0A increased between 2001 and 2003, while they decreased in Division 1A between 2002 and 2003. (Simonsen and Boje, 2003).

Abundance trends for each inshore area are as follows (Figure 31):

- Disko Bay indices of abundance were relatively stable since 1993.
- Uummannaq indices indicate an increase in abundance until 1999, but then decreased significantly since 2001. In the same period landings also declined.
- In Upernavik, there is no basis to evaluate the state of the Greenland halibut stock in that area (Simonsen and Boje, 2003).

For Greenland halibut in Subarea 0 and Division 1A Offshore and Divisions 1B-1F, the fishing mortality level is not known (Simonsen and Boje, 2003).

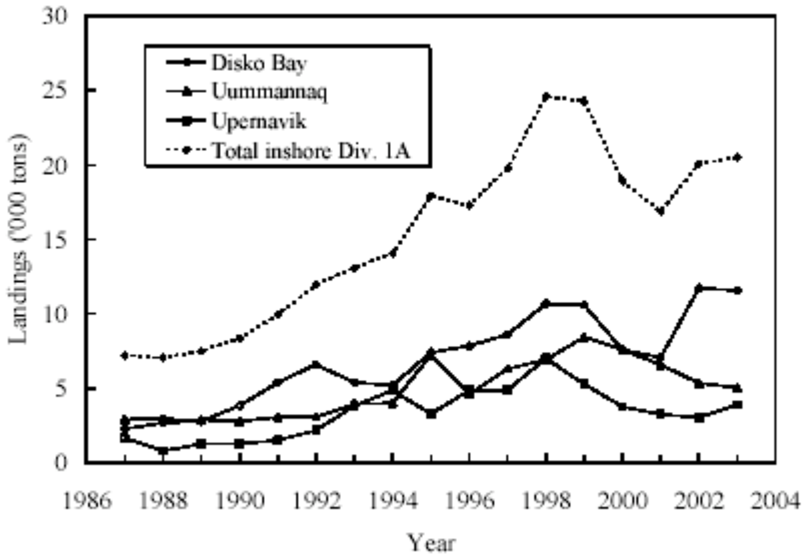

Figure 31. Greenland halibut in Division 1A catches by area. (Source: SC Summary Sheet, 2002)

Adherence to Scientific Advice

Considering the relative stability in biomass indices and CPUE rates for Greenland halibut in Division 0B and 1C–1F, the TAC for 2005 should not exceed 11,000t. In 2002, Scientific Council advised a catch of 8,000t for the developing fisheries in Divisions 0A and 1A. The recommended and agreed to TAC in 2003 for Subarea 0, Division 1A Offshore and Division 1B-1F Greenland Halibut was 19,000t. However, the reported catch according to STACFIS exceeded this by 1,000t (SC Summary Sheet, 2004).

In the inshore Division 1A, total landings in 2002 increased by 20% from about 17,000t in 2001 to about 20,000t in 2002 due to a 66% increase in catches for the Disko Bay area. Catches in Upernavik decreased slightly (8%) from 2001–2002, while catches in Uummannaq decreased by 20%. Landings in 1A constitute by far the majority (approximately 99%) of inshore landings in Greenland. Catch data for 2003 in Division 1A inshore is reported above in Table 9.

Impact on Stock from Direct and Indirect Fishing

There is inadequate information to fully assess this stock. No analytical assessments were conducted by the Scientific Council. The fishing mortality level is not known for Greenland halibut in SA 0 and Division 1A Offshore and Division 1B-1F. In addition, there is no bycatch information available. Even though the stock appears to be healthy, catch levels slightly exceeded the TAC in 2003 in the offshore area. In the “developing fisheries” in the inshore area, Division 0A-1A, overfishing is occurring. Catches (22,494 t) exceeded the recommended TAC (16,300 t). Changes in the distribution of catches (and presumably effort) between the three areas may be the result of a shift in stock distribution, and they warrant further study. An alternative explanation is that local depletions have occurred because of fishing pressure.

Subarea 2 and 3KLMNO Greenland Halibut

Stock Status and Current Fisheries Information

The Greenland halibut stock in Subarea 2 and Division 3KLMNO is considered to be part of a biological stock complex, which includes Subareas 0 and 1. The exploitable biomass (age 5+) was reduced to low levels in 1995 to 1997 due to very high catches and high fishing mortality (Figure 32). It increased during the 1998–2000 period due to greatly reduced catches, much lower fishing mortality and improved recruitment. However, increasingly higher catches and fishing mortality since then accompanied by poorer recruitment contributed to a further decline in biomass. In 1990, the estimated exploitable biomass was approximately 220,000t. The 2003 and 2004 biomass estimates are the lowest in the 12-year time series at just above 60,000t (SC Summary Sheet, 2004).

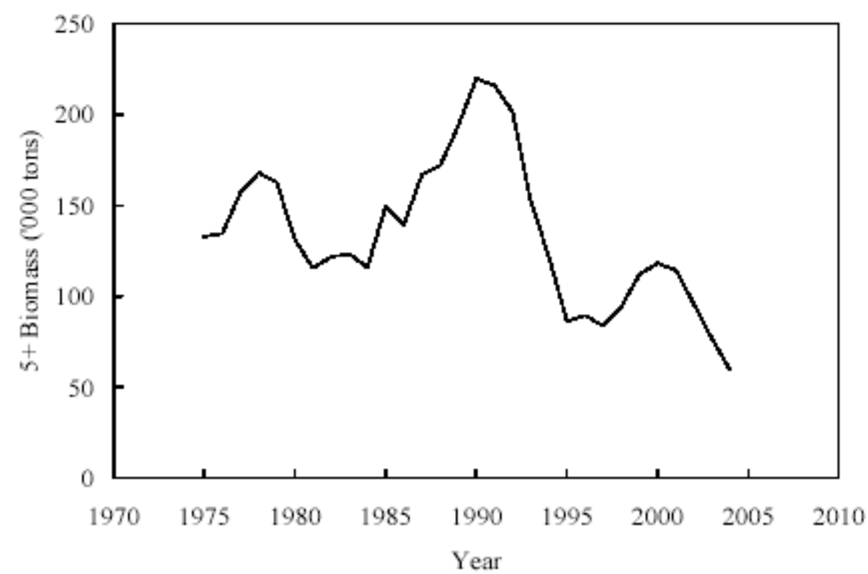

Figure 32. Subareas 2 and 3KLMNO Greenland halibut exploitable biomass 1970–2005. (Source: SC Summary Sheet, 2004)

This stock is being managed under a ten-year rebuilding strategy. The objective of this plan is to attain an average exploitable biomass of 140,000t, allowing for a stable yield over the long term in the fishery. For this purpose, a total allowable catch for the following years was established: 2004: 20,000t; 2005: 19,000t; 2006: 18,500t; and 2007: 16,000t (NAFO, 2005a). Assuming that the catches in 2004 and 2005 do not exceed the TAC of 20,000t and 19,000t, the exploitable biomass will remain stable at a low level. Fishing mortality, however, will remain high (~0.60). Furthermore, if catches during 2006 and 2007 equal the TACs established for these years in the rebuilding strategy, there is a high probability that stock biomass increases will occur in 2007 and 2008 and that fishing mortality will decline by about 50%. The target biomass in the rebuilding plan has a very low probability of being achieved by 2008 (SC Stock Assessment, 2004).

TACs prior to 1995 were set autonomously by Canada; subsequent TACs were established by the Fisheries Commission. The catch increased since 1998, and by 2001 was estimated to be 38,000t, the highest since 1994. The estimated catch for 2002 was 34,000t. The 2003 catch is provided below in Table 10.

Table 10. Greenland halibut catch (t) in 2003 for Subareas 2 and Divisions 3KLMNO. (Source: STATLANT, 2005).

	Division								
Country	2G	2H	2J	3K	3L	3M	3N	3O	Total
Canada	258	1,601	1,213	2,346	959			258	6,635
Estonia					1,256	135	349		1,740
Japan					2,505	14			2,519
Norway						37	43		80
Portugal					1,651	627	1,883	208	4,369
Russia					2,262	138	598	7	3,005
Spain					7,075	2,738	2,467	60	12,340
Total	258	1,601	1,213	2,346	15,708	3,689	5,340	533	30,688

In its 2004 Stock Assessment, the Scientific Council reiterated its concern that the catches taken from this stock consist mainly of young, immature fish of ages several years less than that at which sexual maturity is achieved. During previous assessments, the Scientific Council noted that fishing effort should be distributed in a similar fashion to biomass geographic distribution in order to ensure sustainability of all spawning components (STACFIS, 2004).

The Russian fisheries reported that Greenland halibut of 14cm to 98cm in length were captured with the mean length of 43.7cm occurring in catches of fishing vessels in Division 3LMN. Individuals of 40cm to 42cm in length, at age 5 to 7, from 1997 to 1999 year-classes were predominant. Immature individuals dominated the catches. Bycatch of Greenland halibut of smaller length than allowed (30cm) made up less than 0.7% (Sigaev and Rikhter, 2004).

Adherence to Scientific Advice

During 2002 and 2003, the agreed-upon TACs were 44,000t and 42,000t (Figure 33). In both these years, these TACs were higher than recommended by the Scientific Council, which recommended TACs of 40,000t and 36,000t, respectively. However, actual catches in each year were below the TAC recommended by scientific advice.

It was strongly recommended that the Fisheries Commission take steps to ensure that any bycatches of other species during the Greenland halibut fishery are true and unavoidable bycatches. There are no other measures mentioned in the rebuilding plan to address bycatch.

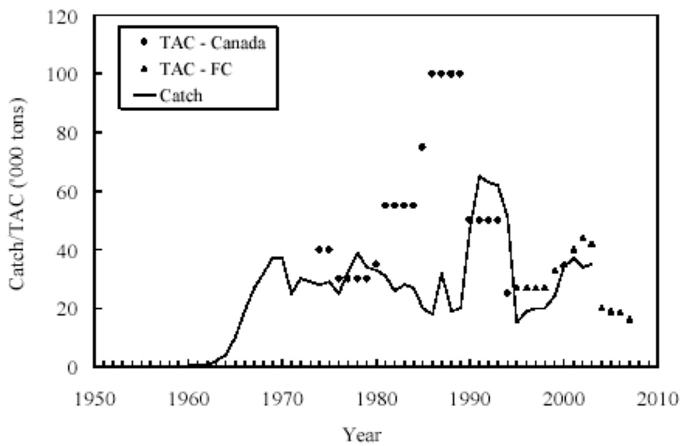

Figure 33. Subarea 2 and 3KLMNO Greenland halibut catch and TAC 1950–2010. (Source: SC Summary Sheet, 2004)

Bycatch and Discards in the Greenland Halibut Fishery

Russia

Russia has seven vessels in the Greenland halibut directed fishery. Bycatch in 2003 included the following (unspecified units, assumed to be kg/per tow, or CPUE data): grenadiers, 8; skates, 5; hakes, 4; redfishes, 3; witch flounder, 2; American plaice, 3; and wolffishes,1. The breakdown by area is as follows: In 3LM, grenadiers, 4; skates, 2; hakes, 2; redfishes, 1; American plaice, 1; and other fish species. Bycatch in Division 3NO included grenadiers, 4; redfishes, 2; skates, 3; hakes, 2; witch flounder, 2; American plaice, 2; wolffishes, 1; and other fish species. In total, all bycatch amounted to less than 1% of the total directed catch in both 3LM and 3NO (Sigaev and Rikhter, 2004).

Division 3L

- Roughhead grenadier in Division 3L varied from 12cm to 93cm with a mean length of 44cm. Individuals of 42cm to 45cm in length made up the largest proportion.
- Length of the beaked redfish in bycatches during the Greenland halibut fishery in Division 3L varied from 16cm to 47cm with mean length being 30.1cm. Individuals of 17cm to 29cm in length made up the major proportion of the catch. The majority of individuals taken were below or just slightly above the Canadian minimum size requirement.
- Division 3L cod length varied from 33cm to 69cm with a mean length of 52.4cm. Thus, a portion of this catch was likely immature (based on both NAFO and Canadian Small Fish Protocols).
- In Division 3L length distribution of American plaice included individuals from 22cm to 58cm in length, and at least some portion of these fish are immature (NAFO minimum size limit is 25cm;Canada's minimum size limit is 30 cm).
- The skate length in Division 3L varied from 15cm to 84cm with a mean length of 43.1cm (Sigaev and Rikhter, 2004). No minimum size limits exist for this species within Canadian or NAFO regulated fisheries so no assumptions were made as to the age of the skates taken in this fishery.

Division 3M

Roughhead grenadier of 33cm to 69cm in length occurred in Division 3M. In Division 3M length distribution of the redfish ranged within 8cm to 41cm. The bulk of the catches comprised individuals of 17cm to 18cm long (Sigaev and Rikhter, 2004).

Division 3NO

In Division 3NO Russian fisheries reported the following sizes:

- Roughhead grenadier individual length in Division 3N varied from 24cm to 84cm; mean length was estimated at 49.5cm. Total length of the roughhead grenadier in catches in Division 3O was observed to be in the range of 30cm to 69cm.
- Length of the redfish in Division 3O varied from 11cm to 44cm; mean length was 24.3cm. Catches were dominated by individuals of 23cm

to 24cm in length. So the majority were likely juveniles.

- Length of the redfish in Division 3N was from 11cm to 42cm with mean length of 30cm. Length frequencies showed bimodal distribution with modal groups of 22–23cm and 34–35cm. This fishery appears to be taking a mix of juveniles and adults.
- In Division 3M length of the red hake was measured to be within the 30–51cm range.
- In Division 3N length of the white hake varied from 21cm to 84cm with mean length constituted 50.4cm. The main catch of this species was taken in Division 3O. Individual length in this Division fluctuated from 12cm to 100cm with a mean length of 45.3cm. Individuals of 48–51cm in length represented the major proportion of catches.
- Length distribution of the American plaice in Division 3O varied from 20cm to 74cm with mean length being 38.4. So at least some portion of this catch were juveniles (<30cm is Canadian minimum size, <25cm NAFO minimum size) (Sigaev and Rikhter, 2004).

European Union
There are a total of 31 Spanish trawlers operating in the Greenland halibut fishery and other fisheries, depending upon the season. Roughhead grenadier is the main bycatch species, and most of the 2003 catches were taken in Divisions 3LN. During 2003, catches in Divisions 3LMO were very similar to those of 2002, but catches in Division 3N were double that taken in 2002. According to Spanish reports, most of their roughhead grenadier catches taken as bycatch in the Greenland halibut fishery in Subarea 2 and 3KLMNO consist of ages 4 to 13. Most of the redfish catches in Division 3LN and 3M were bycatch in the Greenland halibut fishery. Redfish catches in Division 3M increased from 159t in 2002 to 552t in 2003. A total of 14,184 redfish were caught in Division 3L in May, June, and December, and 5,095 redfish were caught in May–June in Division 3M. Most catches of American plaice were taken in Division 3LNO as bycatch of the Greenland halibut and skate fisheries (1,200 t). Bycatches of American plaice in Division 3M amounted to only 51t. In addition, 922t of witch flounder and 1,389t of skates were taken in this fishery (González et al., 2004). In 2003, in Division 3N, white hake was taken as bycatch in the Greenland halibut fishery (4%) in strata more than 600m in depth. (González and del Río, 2004).

The main species taken as bycatch as a percentage of the total catch in Portuguese Greenland halibut fisheries by area are noted below. In 3L: roughhead grenadier (June, 15.2%; July, 14.2%; September, 9.4%; October, 15.9%), skate (February, 8.7%; March, 13.2%; and April, 13.2%), and witch flounder (3.6%). Witch flounder was taken throughout the entire seven months of the reported period in 3L. In 3M: witch flounder (January, 14.5%; and February, 17.7%); roughhead grenadier (March, 11.0%; June, 2.8%; October, 19.9%) and redfish (April, 18.8.%). In 3N: plaice (April, 24.7%); skate (May, 14.8%); roughhead grenadier (June, 7.3%; July, 14.0%; August, 13.4%; September, 15.7%; October, 11.0%) and witch flounder (November, 23.9%). In 3O: dogfish (May, 23.0%) (Vargas et al., 2004).

Canada
Canada uses both otter trawl and gillnets to target Greenland halibut. As in previous years, bycatches in the gillnet fishery include cod and snow crab, particularly in the GN <400 sector, while American plaice and witch flounder were important bycatches in the otter trawl fishery (Brodie and Power, 2004).

Bycatch and Discards of Greenland Halibut in Other Fisheries

European Union
The Spanish white hake fishery reports taking 1,136t of white hake in Division 3O in 2003 and 636t (56% of the total catch) of Greenland halibut. In Division 3N, the Spanish white hake fishery reportedly took 332t of white hake and around 73t (22% of the total catch) of Greenland halibut. In both Divisions Greenland halibut constituted the number one species in total bycatch taken (González and del Río, 2004).

Management Action Taken to Address Bycatch

Canada
Since early 2002, an area in the Funk Island Deep region of Division 3K was closed to gillnetting in order to reduce bycatch of snow crab (Brodie and Power, 2004).

Impact on Stock from Direct and Indirect Fishing

Immature individuals dominated the catches in the Russian and other Contracting Party Greenland halibut fisheries. In addition, the 15-year rebuilding plan says nothing about addressing bycatch of this species in other fisheries, which likely has an impact on the recovery time frame.

Subareas 3 and 4 Squid *(Illex illecebrosus)*

Stock Status and Current Fisheries Information

Northern shortfin squid has a 1-year life cycle that is considered to comprise a unit stock throughout its range in the Northwest Atlantic Ocean from Newfoundland to Florida, including NAFO Subareas 3-6. Research survey biomass indices from Division 4VWX reached peak levels during the late-1970s, indicating that this was a period of high squid productivity (Figure 34). Since 1982, survey biomass indices were markedly lower, and during 1998-2003, were below the 1982-2002 average for the low productivity period (predominately below 5kg per tow). Mean body weight was the lowest on record in 2000, and during 2001-2003, mean weights were similar to the 1982-2002 average for the low productivity period. The range of mean mantle lengths of squid caught in the Newfoundland inshore jig fishery at New Bonaventure, during September of 2003, were much smaller and males less mature than those caught during 2002 (STACFIS, 2004).

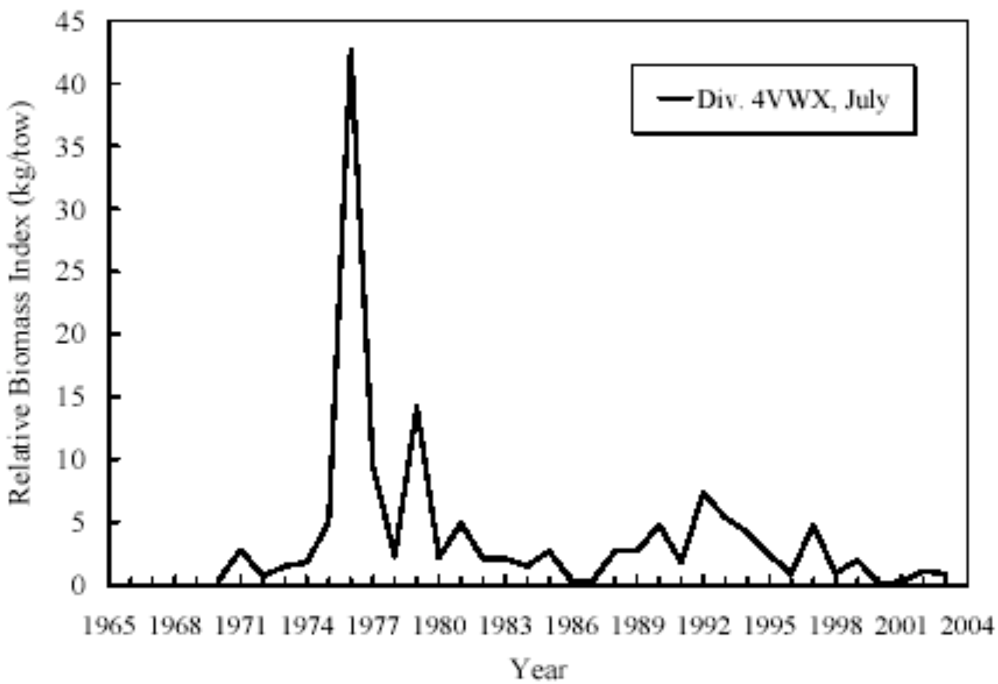

Figure 34. Subareas 3 and 4 squid relative biomass 1965–2004. (Source: SC Summary Sheet, 2003)

Catches declined from 1,900t in 1998 to 60t in 2001, and then subsequently increased to 1,100t in 2003 (Figure 35). The Subareas 3 and 4 TAC remained at 150,000t during 1980-1998 and was set at 75,000t for 1999 and 34,000t for 2000-2003 (STACFIS, 2004).

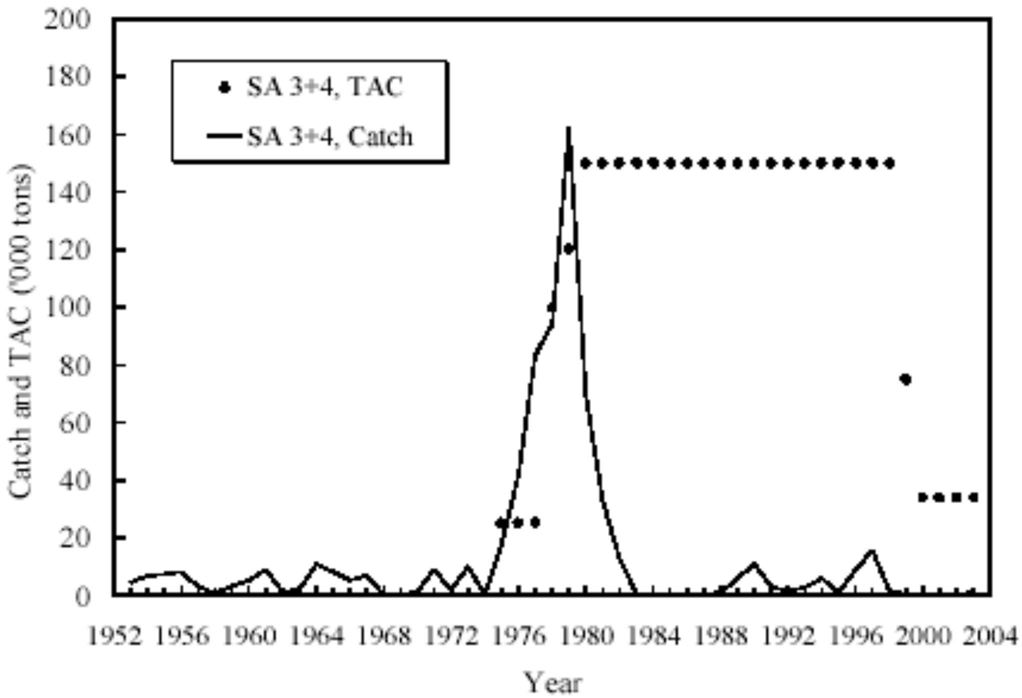

Figure 35. Subareas 3 and 4 squid catch and TAC 1952–2004. (Source: SC Summary Sheet, 2003)

Adherence to Scientific Advice

Based on available information (including an analysis of the upper range of yields that might be expected under the present low productivity regime), the Scientific Council advised that the TAC for years 2005 and 2006, for northern shortfin squid in Subareas 3 and 4, be set between 19,000t and 34,000t. This advised TAC range is applicable only during periods of low productivity. In periods of high productivity, higher catches and TAC levels are appropriate. The high end of the recommended TAC, 34,000t, was accepted by Contracting Parties (STACFIS, 2004). This is allocated in 2005 and 2006 as follows: Canada (not determined yet); Cuba 510t; EU (not determined yet); Estonia, Latvia, and Lithuania, 128t each; Poland, 227t; France, 453t; Japan, 510t; Korea, 453t; Norway, 749t; USA, 453 t; Others 794t (NAFO, 2005b).

Bycatch and Discards

No bycatch and discard information was available for this stock.

Impact on Stock from Direct and Indirect Fishing

This stock is reported to be in a low productivity period. While the TAC was within the range of scientific advice provided by Scientific Council, it still represents the upper end of the range. Since the late 1970s, catches were below the agreed-upon TAC for this stock most likely due to low biomass levels consistent with a period of low stock productivity

Shrimp Subarea 2 and Division 3LNO (Northern Pink Shrimp) (*Pandalus borealis koyer*)

Stock Status and Current Fisheries Information

The 3LNO shrimp stock is distributed along the edge of the Grand Banks, mainly in Division 3L. Exploratory fishing began in this area in 1993. Subarea 3 was divided into two shrimp management areas, 3LNO and 3M. The stock came under TAC regulation in 2000, and fishing was restricted to Division 3L.

The 1998 and 1999 year-classes are the two strongest year-classes in the short time series. They are followed by the 2000 year-class which was slightly above average and the 2001 year-class which was the third strongest in the time series. There was a significant increase in SSB and total biomass between 1995 and 1997 followed by a period of stability between 1997 and 1999. In 1995 and 1996, SSB was approximately 6,000t and in 1999, the SSB was reported to be around 20,000t. By 2001, it had increased to about 60,000t and to approximately 75,000t in 2002. However, there are large margins of error surrounding some of these estimates. Autumn SSB and total biomass indices have been at high levels since 2000 and since 2002 for the spring series (Figure 36-Figure 38). In general, the fishable biomass increased over time. The exploitation index (catch/autumn fishable biomass) increased during 2000–2001, at the beginning of the fishery, and has since decreased (STACFIS, 2003b).

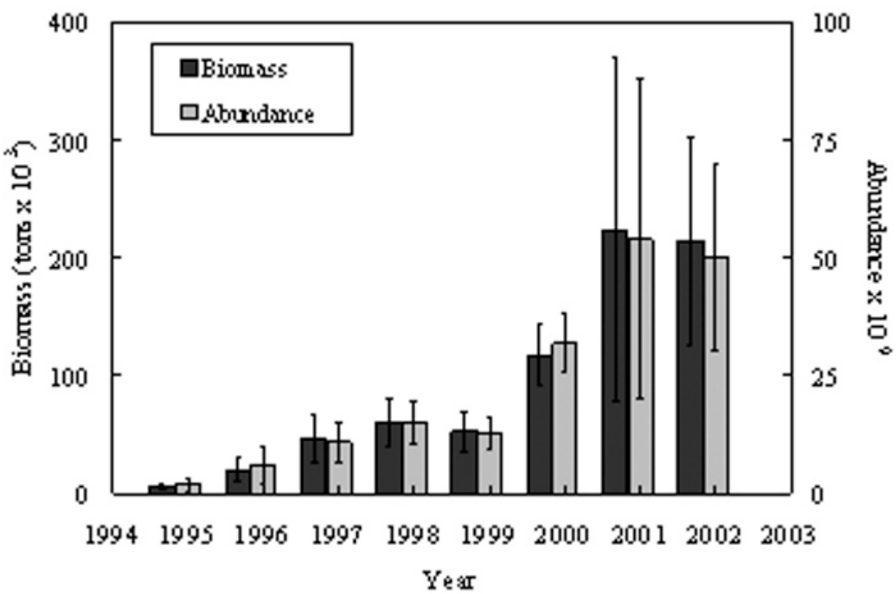

Figure 36. Autumn 3LNO northern pink shrimp biomass and abundance estimates from Canadian multi-species surveys with 95% confidence intervals. (Source: STACFIS, 2003b).

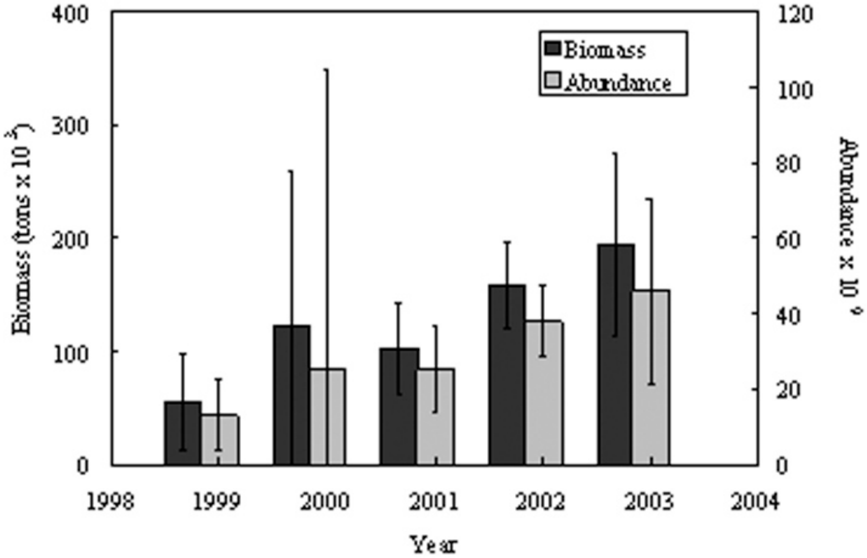

Figure 37. Spring 3LNO northern pink shrimp biomass and abundance estimates from Canadian multi-species surveys with 95% confidence intervals. (Source: STACFIS, 2003b).

Despite the large margins of error, there is general agreement between the spring and autumn survey data with both data sets trending upwards. Autumn survey data suggests a mean biomass of only 10,000t in 1995 (compared to approximately 50,000t from spring survey data) and both series predict the highest biomass observed in the series in recent years. For the spring series, a mean biomass of 210,000t was predicted in 2001 (closely followed in 2002 by approximately 200,000t) and for the autumn series, a mean biomass of 200,000t was also predicted.

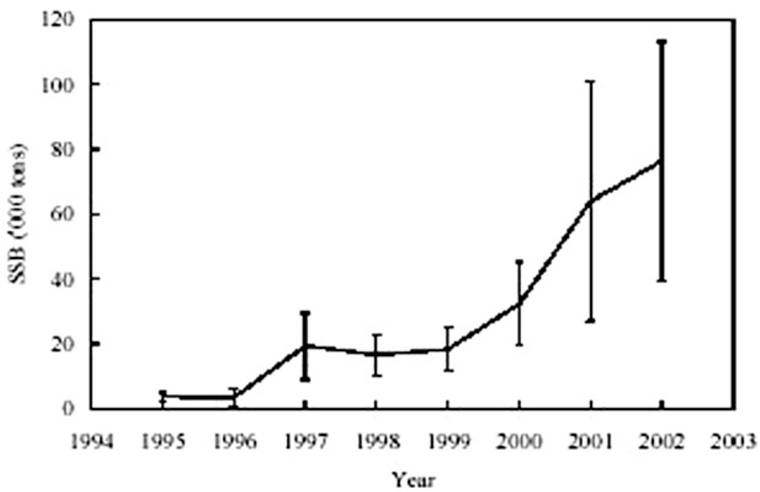

Figure 38. 3LNO northern pink shrimp spawning stock biomass (SSB) estimates from Canadian autumn multi-species surveys with 95% confidence intervals (source: STACFIS, 2003b).

In total 12 nations participate in this fishery and the countries with the largest fishing presence in the area in 2003 were Canada, EU, and Denmark/Greenland. An average of about 10,500t of shrimp were caught in 2002 and 2003, mostly by small vessels <50t (Figure 39). In 2004, 13,000t of shrimp were reportedly taken according to STACFIS (STACFIS, 2003b). In 2005, Division 3NO was put under moratorium.

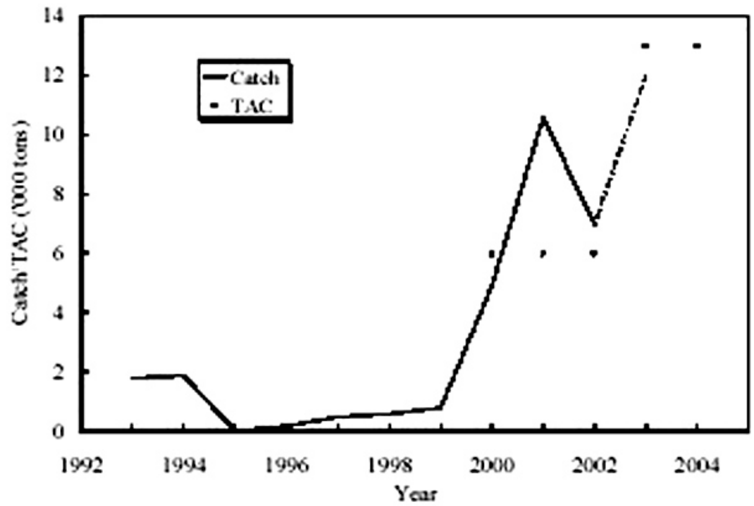

Figure 39. 3LNO (northern pink) shrimp catches and TAC. (Source: STACFIS, 2003b)

Adherence to Scientific Advice

In 2003, the catches appear to be slightly under the recommended and agreed-upon TAC of 13,000t (at around 12,000t according to STACFIS). However, historically, catches have exceeded the TAC. In 2004, the Scientific Council reiterated its recommendations that the fishery be restricted to Division 3L and that the use of a sorting grate with a maximum bar spacing of 22mm be mandatory for all vessels in the fishery (SC Summary Report, 2004). The Scientific Council further noted that the TAC, within an adjacent Canadian shrimp stock, has been at only 12% of the fishable biomass since 1997. The Scientific Council recommends that the 2006 TAC should not exceed 22,000t and that this TAC should not be raised for a number of years to allow time to monitor the impact of the fishery upon the Division 3LNO shrimp stock. While the use of the sorting grate remains mandatory, compliance report information is not always comprehensive when it is supplied by member countries and is not publicly available.

Bycatch and Discards in Shrimp Fishery

Denmark/Greenland

In the 3L Greenland shrimp trawl fishery 1.2t of shrimp out of a total catch of 287t were discarded in 2003 (Siegstad, 2003).

Canada

High-grading is believed to be occurring in Canadian waters. According to various CBC news reports in November 2002, trawlermen from Labrador claimed that the dumping of undersized shrimp by factory trawlers is damaging the stocks. The fishermen said the practice known as high-grading had been occurring for years. Fishermen reported millions of small shrimp had been dumped overboard because it would fetch a low price, and claim that widespread dumping by the shrimp fleet in the 1990s is why larger shrimp are now getting harder and harder to find. A Canadian fishing company, Ocean Prawns, was reportedly fined $22,000 by the DFO for dumping shrimp.

For Canada, approximately 12 large (>500t) fishing vessels and more than 300 smaller (<500t; <100′) vessels fish shrimp within Davis Strait, along the coast of Labrador and off the east coast of Newfoundland. There is 100% mandatory observer coverage of the large vessels, but less than 10% coverage of the small vessels. Canadian vessels fish for northern shrimp in NAFO Subarea 2 and Divisions 3KL. The Canadian shrimp catch was 80,084t in 2003 (2G: 7,216t; 2H 2,682t; 2J 26,169t; 3K 34,064t; and 3L: 9953t) (NAFO, 2003d).

During 1996 to 2000, on average less than 5% by year-class of Greenland halibut was taken as bycatch in the northern shrimp fishery. The most recent assessment of the Greenland halibut resource estimates the average recruitment to be about 119 million fish (Darby et al., 2004). It was calculated that this represents a potential loss in yield to the Greenland halibut fishery of about 900t to1,400t annually given recent fishing patterns. The estimated number of Greenland halibut caught in the Canadian shrimp fishery (all ages) in Subarea 2 and Division 3KL during the 1996–2003 period ranged from 3.0 million to 5.2 million fish. There has been an increasing trend in bycatch since 1996, which might be expected, as shrimp catch is increasing (Bowering and Orr, 2004).

In 2003, the majority of Greenland halibut taken by Canadian shrimp vessels were between the ages of zero to five years in age. Other species also caught include American plaice mostly between two and seven years, redfish between two and eight years, and cod between one and three years of age. Although sorting grates are required by licence in the Canadian fishery to reduce the bycatch of finfish, Greenland halibut of all ages are captured in most years with the bulk of the bycatch being fish aged one to three years old. Since many young Greenland halibut of the year are demersal in the early autumn and the small-boat shrimp fishery operates until late in the year, some Greenland halibut caught as bycatch are less than a year old. In 2003, large vessels in 2GH took about 40t of Greenland halibut ages one to five; large vessels in 2J3K took about 84t of Greenland halibut ages one to five; small vessels in 2J3K took about 118t of Greenland halibut ages zero to four; large vessels in 3L took about 6t of Greenland halibut ages one to five; and small vessels in 3L took about 19t of Greenland halibut ages mostly one to two years old, but more broadly zero to four year old (Richards, 2004; Bowering and Orr, 2004).

Norway

In 2001, observer information on the Norwegian bycatch from an estimated 7t catch of shrimp indicated that there was no bycatch of cod, and 0.44kg/t of American plaice, 0.43kg/t of redfish and 0.39kg/t of Greenland halibut per ton of shrimp (STACFIS, 2002b). It is not known how much, if any, of this fish is discarded. However, it can be assumed that since fish are not the target of this fishery at least some of it is being discarded.

Management Action Taken to Address Bycatch

As of October 1, 2000, sorting grids are obligatory for NAFO shrimp fisheries (STACFIS, 2003b).

Impact on Stock from Direct and Indirect Fishing

This stock appears to be healthy and catches are within scientific advice (of TAC = 13,000t). At 12% of fishable biomass, the TAC appears to be fairly conservative. However, the discarding of shrimp in the 3L Greenland shrimp trawl fishery is worthy of further investigation to determine if high-grading is occurring. Anecdotal evidence from Canadian fishermen and governmental officials suggests that high-grading is occurring in waters outside the Canadian EEZ. In addition, while the SSB appears to be increasing, there are large margins of error surrounding some seasonal estimates for this stock.

Impact of Shrimp Fishery on Other Stocks

While the use of the sorting grate is mandatory in this fishery, bycatch from the Canadian fishing fleet includes juvenile redfish, cod, and American plaice which are all under moratorium as well as juvenile Greenland halibut in 2GH and 3KL. While it is not clear what percentage of the 5.3 million Greenland halibut taken as bycatch in this fishery in 2003 were juveniles, given that the average recruitment age biomass (age one fish) estimate was 119 million fish, these bycatch rates are not insignificant.

0A and 1A-1F Northern Shrimp *(Pandalus borealis)*

Stock Status and Current Fisheries Information

A small-scale inshore fishery for the northern prawn began in Subarea 1 during the 1930s. In 1969, an offshore fishery developed. The shrimp stock off West Greenland is distributed in Subarea 1 and Division 0A east of 60°W. Since the late 1990s, the stock increased and reached its highest level in 2004 (Figure 40-Figure 41). The estimated risk of current stock biomass being below B_{msy} was less than 5% and less than 1% of being below B_{lim}. The abundance of males between 17mm and 22mm CL in 2004 is estimated to have been high and should sustain catch rates of larger shrimp in 2005. However, a recruitment index of shrimp at age 2 decreased in 2002 and was below average in 2003 as well as in 2004, which may suggest a decline in fishable biomass after 2005 (NAFO, 2004f).

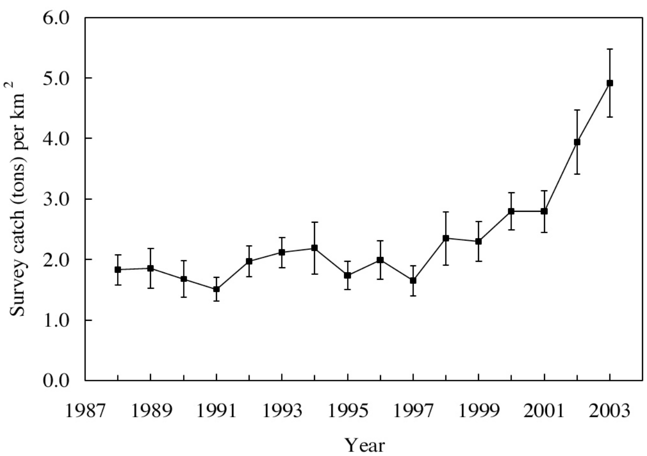

Figure 40. 0A and 1A-1F northern shrimp survey indices of biomass, ±1 standard error. (Source: STACFIS, 2003b)

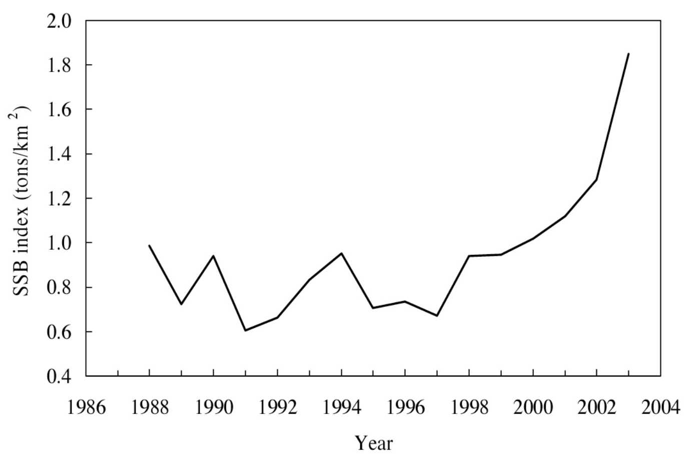

Figure 41. 0A and 1A-1F northern shrimp female spawning stock biomass index. (Source: STACFIS, 2003b)

Today, the two primary fishing nations in this fishery are Canada and Greenland. The Greenland fleet has two components exploiting the stock in Subarea 1: an offshore fleet, which at present consists of 15 large factory trawlers (500–4000 GRT) and a small vessel fleet composed of about 60 vessels below 80 GRT. The Canadian fleet exploits the stock component in Division 0A east of 60°W. Seventeen companies are currently licensed to fish in the area but in recent years only six to seven vessels (2000–4000 GRT) participated. Roughly 75% of the shrimp catch is taken in the offshore area. A total of 141,000t of shrimp were taken from both areas in 2003 according to STACFIS (Hvingel, 2004).

This catch total agrees closely with that provided by STATLANT (2005) (See Table 11 below.)

Table 11. Shrimp catches (t) in Subareas 0 and 1 for 2003 by country and NAFO fishing area.

	Division									
Country	0A	0B	1A	1B	1C	1D	1E	1F	Unknown	Total
Canada	2,170	986		1						3,157
Greenland			19,995	40,087	18,667	17,018	6,473	16,555		118,795
Denmark				512	327	139	28		16,670	17,676
Total	2,170	986	19,995	40,600	18,994	17,157	6,501	16,555	16,670	139,628

Adherence to Scientific Advice

The recommended TAC for 2004 was 130,000t, but Contracting Parties agreed to a TAC of 150,000. Each year since 2000 the TAC was set beyond Scientific Council advice and the catch consistently exceeded the TAC (Figure 42).

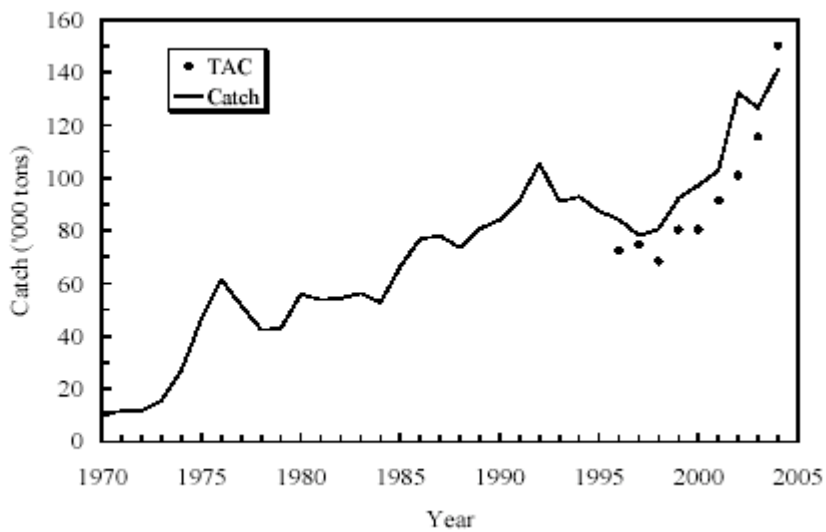

Figure 42. Shrimp in Subareas 0 and 1 total catches (2003 projected to the end of the year) and actual TACs. (Source: NAFO, 2004f)

In addition, according to the Scientific Council Precautionary Approach (PA) Working Group, both model simulations of stock development and indices of recruitment indicate that the fishable biomass can be expected to follow a decreasing trend after 2005. With a catch of 130,000t/yr, there is less than a 10% risk of stock biomass falling below B_{msy} and less than 1% of falling below B_{lim} in the first three years. However, this level of exploitation might not be sustainable in the medium to longer term, as the estimated risk of falling below optimum biomass continues to increase through time. Catches greater than 130,000t/yr are not likely to be sustainable in the medium to longer term. The Scientific Council PA Working Group also looked at lower catch level options and found that a catch of 100,000t/yr will just about meet the estimated median MSY and is not likely to drive the stock below B_{msy} in the short to medium term (i.e., the risk is less than 10% within the first five years and just above 25% after year 10). However, this level of exploitation might not be sustainable in the longer term, as the risk of falling below B_{msy} continues to increase through time. Removing 110,000t/yr bears a 75% risk of being above MSY, thus this catch level is not likely to be sustainable in the longer term. Owing to the current high stock level the risk of falling B_{msy} is still less than 20% after five years at this catch level, although after 10 years it is close to 50%. A catch of 120,000t/yr is associated with an 85% risk of exceeding MSY and the stock biomass will rapidly decline to below B_{msy}. After just two years there is a 50% risk of exceeding Z_{msy} (NAFO, 2003a).

The decision to set TAC at 150,000t by member countries does not comply with the scientific advice of the Scientific Council or the SCPA Working Group. The Scientific Council recommended a TAC 30,000t higher than the precautionary TAC based on the Working Group analysis. To be truly precautionary, the Scientific Council should recommend a TAC of less than 100,000t/yr (NAFO, 2003a).

Bycatch and Discards in the Shrimp Fishery

Denmark/Greenland

In 2003 bycatch in the 3L Greenland fishery was reported to be less than 0.5% of total shrimp catches. A total of 0.61t redfish and 0.68t other finfish were taken as bycatch. There also were substantial numbers of juvenile redfish discarded in the Subarea 1 shrimp fishery.

The Denmark/Greenland nominal catch of redfish in Subarea 1 in 2000, 2001 and 2002 is 735t, 332t and 487t, respectively (NAFO, 2003a). Other fish reported taken as bycatch were cod, Greenland halibut, wolffishes, American plaice and starry skate (Siegstad and Frandsen, 2003). In 2003, this fishery took 135,465t of shrimp and 924t of northern prawns in this area. The bycatch of redfish constituted 0.36% of the combined catch (NAFO, 2003d).

However, according to a 2004 Scientific Council report in the fishery for northern prawn off West Greenland from 1970 to 2004, recent and historical catch figures do not include the weight of substantial numbers of small redfish discarded by the trawl fisheries directed to shrimp (Hvingel, 2004).

The reported discard of shrimp remained less than 1% (weight) of total catch throughout the period 1975–2004. The discard of fish was 1% to 3% of total catch in the years 1987–1998. In 2003, a total of 643t of northern prawn were discarded, representing 0.05 percent of the shrimp catch, 1,300t of fish, representing 1% of the shrimp catch, and 974t of *P. montgaui* were landed (Hvingel, 2004).

Denmark/Mainland

In 2003, Denmark/Mainland took 1,006t of shrimp *(Pandalus montagui)* in this area (NAFO, 2003d).

Norway

Norway reported taking 5t of bycatch in its respective shrimp fishery in 1C in 2002. (Gundersen and Høines, 2003).

Management Action taken to Address Bycatch and Discards

As of October 1, 2000, sorting grids are obligatory for the NAFO shrimp fisheries ((Hvingel, 2004).

Impact on Stock from Direct and Indirect Fishing

According to the Scientific Council, the below average recruitment index in 2003 and 2004 suggests that the fishable biomass may decline after 2005. Given this and the fact that the TAC is consistently set above the scientific advice warrants concern. This is one stock where the Precautionary Approach and corresponding Limit and Target Reference Points were devised. However, current management does not appear to take a long-term management approach necessary for precautionary management. The Scientific Council did not heed the advice of its own Working Group when it recommended a TAC of 130,000t, which proposed that 100,000t would be the most sustainable over the long term.

Discarding of shrimp (*P. borealis),* while reportedly small (less than 1% in Denmark/Greenland fisheries), also occurs in this fishery, possibly due to high-grading.

Impact of Shrimp Fishery on Other Stocks

The majority of redfish captured as bycatch in this shrimp fishery are juveniles. In addition, the Scientific Council reports that the discarding of juvenile redfish in shrimp fisheries is underestimated and could be substantial in Subarea 1. More data are required to better understand the amount of usage of sorting grids in this fishery. The most problematic fishery here appears to be the Denmark/Greenland shrimp fishery in terms of bycatch and discards rates. The Scientific Council expressed concern that bycatch of redfish in the shrimp fishery could adversely impact redfish stock status.

3M Shrimp Fishery/Flemish Cap *(Pandalus sp)*

Stock Status and Current Fisheries Information

The shrimp fishery in Division 3M began in late April 1993. It is under effort regulation. Since 1993 the number of vessels ranged from 40 to 110. Standardized catch rates declined between 1993 and 1994, varied without a trend to 1997, increased in 2003, and declined in 2004. The 2000 year-class appears weak. Based both on survey and commercial fishery data the 2001and 2002 year-classes appear to be above average. From 1988 onward female biomass has continued to increase, albeit with some fluctuation. All indices of female biomass increased from 1997 to 1998 and fluctuated without a trend since then. Stock size indicators have been stable since 1998. The 2001 and 2002 year-classes are both above the average and are likely to contribute to the fishery in 2005 and 2006. The total biomass index fluctuated between 16,000 and 22,000 tons in the years 1997 to 2001, increasing to about 27,000 in 2002 and 2003 (STACFIS, 2003b).

The female biomass index varies depending on the survey series considered (Figure 43). The longer Faroese series shows considerable variation, with a peak in 1992 and an increasing trend from 1994 to 2002. Female biomass was lowest in 1990 (approximately 0.25) and has shown an approximate eightfold increase to 2002. The time series for EU survey data only extends from 1997 to 2003 and also follows an increasing trend over this period. The increase in female biomass over the period 1990 to 2003 is almost five fold.

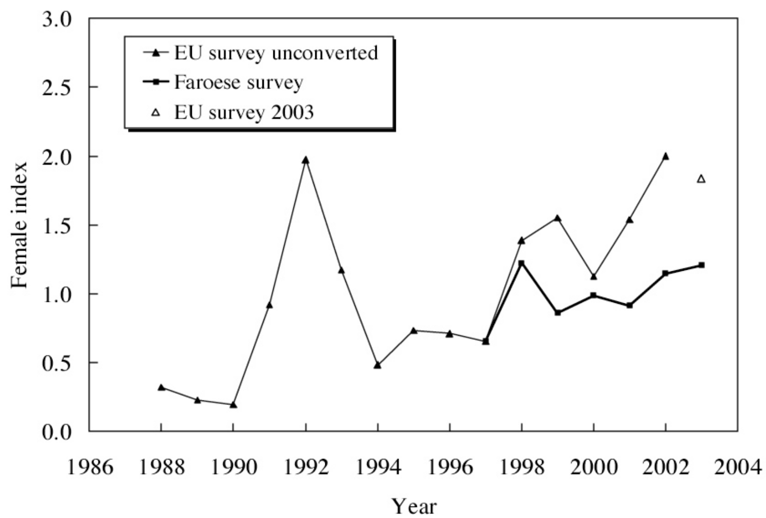

Figure 43. 3M Shrimp female biomass index from EU trawl surveys, 1988–2003, and Faroese survey, 1997–2003. Each series was standardized to the mean of that series. (Source: STACFIS, 2003b)

In 2004 there were approximately 50 vessels fishing shrimp in Division 3M. In 2005; 33 vessels are expected from EU (Poland, 1; Estonia, 8; Latvia, 4; Lithuania, 7; and others). Estonia was allocated the majority of days at sea with 1,667 days. Norway has 32 vessels; Denmark–Faroe Islands has 8; Greenland has 14; Canada has 16; and the USA, Ukraine, Korea, Japan, France, and Cuba each have one vessel. Russia has a large number of days but reportedly no vessels there. There is no TAC in place in this area; fishing is regulated by fishing effort (DAS) and catches continue to exceed NAFO Scientific TAC recommendations. According to STACFIS, catches of shrimp in this area were 62,000t in 2003, and 48,000t in 2004 (Figure 44). The 2003 catch tallies well with the STATLANT (2005) data detailed below by country (Table 12).

Table 12. 3M shrimp catch (t) by country for 2003. (Source: STATLANT, 2005)

Country	3M 2003 catch (t)
Faroe Islands	12,648
Greenland	1,181
Iceland	4,715
Japan	117
Norway	22,765
Spain	857
Spain	547
Latvia	3,533
Estonia	12,851
Estonia	3,744
Russia	3
Ukraine	237
TOTAL	63,198

Based on weekly reporting to Greenland authorities by Greenland vessels the total shrimp catch on the Flemish Cap in 2002 and 2003 amounted to 683t and 888t, respectively. No catches were reported from Flemish Cap by mid-October in 2004 (Siegstad, 2003b).

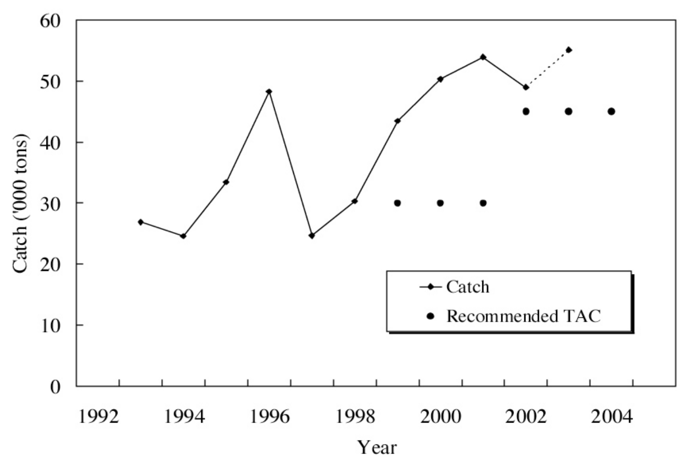

Figure 44. 3M shrimp catches (2003 projected to end of the year). (Source: STACFIS, 2003b)

Adherence to Scientific Advice

The Scientific Council recommended a quota of 45,000t for each year since 2002. This fishery is currently managed by effort control, with no TAC in place. Each year catches exceeded the recommended catch limit (SC Summary Advice, 2004). However, in 2004, the Scientific Council stated that the stock sustained an average annual catch of about 48,000t since 1998 with no detectable effect on stock biomass. Of the year-classes that will be the main contributors to the fishery over the next few years, the 2000 year-class seems weak and the 2001 and

2002 year-classes appear above average. The Scientific Council advises a catch of 48,000t for 2006. It remains to be seen if Contracting Parties will continue to exceed the suggested TAC now that it is higher.

Bycatch and Discards in the Shrimp Fishery

Flemish Cap
In 1993, the shrimp fishery on the Flemish Cap had high levels of redfish bycatch. Since 1995, bycatch in weight fell to apparent low levels, but in 2001, 2002, and 2003, redfish bycatch reached 738,767t and 1,006t respectively, which are the highest levels observed since 1994. The Scientific Council translated these weights to numbers and determined that this represents an increase from an annual bycatch level of 3.8 million redfish, recorded in the1998–2000 period, to 25.8, 18.5, and 21.3 million, respectively, in 2001, 2002, and 2003. In the years 1998 to2000, this bycatch represented on average 44% of the total Division 3M redfish catch in numbers (Avila de Melo et al*.,* 2003). In 2001, 2002, and 2003, the redfish bycatch in numbers from the Flemish Cap shrimp fishery represented 73.7, 68.3, and 82.6%, respectively, of the total catch in numbers (Avila de Melo et al*.,* 2004).

Russia
In the Russian shrimp fishery on the Flemish Cap during January to December 2002 and April 2003, four Russian vessels participated in the fishery for deep-water shrimp (Bakanev, 2003). Redfish were the most frequent in bycatch, which also included common wolffish, spotted wolffish, roughhead grenadier, and Greenland halibut. Bycatch of the other species in the shrimp fishery accounted for 1% to 4.5% in the year 2002. Maximum catch of redfish was registered on the western slope of the bank (2.47% by weight) in June and August 2002. The redfish length varied from 8cm to 23cm. They occurred in catches taken during operations in the areas of 280m to 400m depths. However, in large quantities the redfish were observed in a depth range of 280m to 320m. Bycatch of the redfish decreased with an increase in the tow depth (Bakanev, 2003). In the Russian 3M shrimp fishery, bycatches of redfish consisted of fish 6cm to 20cm, predominantly 12cm to 14cm. Young fish with the length <12cm constituted 21.8%. Bycatches of redfish in percentage of catches' weight fluctuated from 0% to 4.89%. Recalculating per the entire Russian catch of shrimp in 2002, it is possible to assess the weight and a number of redfish bycatch at the level of 28t and 974,344 specimens, correspondingly (Bakanev and Gorchinsky, 2003).

Denmark/Greenland
The Greenland shrimp trawl fishery began in 3M and 3L in 1993. There were two vessels in 2002 and 2003. In 3M, the total bycatch in 2002 and 2003 was reported to be 2% of total shrimp catches that amounted to 1,460t in these two years. A total of 9.3t redfish and 3.5t finfish were taken as bycatch in 2003. In the Greenland fishery in 3M in 2003, 6.9t shrimp also were discarded. It also was stated that finfish were discarded in the past, although the amounts were not provided. According to NAFO (2004), the 2001 and 2002 catch figures do not include the weight of fish discarded by the trawl fisheries directed to shrimp. It is likely given the large numbers of juvenile redfish taken as bycatch in this fishery that it constituted the majority of the finfish discards (Siegstad, 2003).

Iceland
One Icelandic vessel fished for shrimp in the waters of the Flemish Cap in 2004 as compared to three in 2003. There are three primary species taken as bycatch in the Icelandic shrimp fishery: Greenland halibut, wolffish, and redfish, with redfish the most prevalent. The redfish bycatch fell from 1.6% in 1996 to 0.26% and 0.32% in 2002 and 2003, respectively. Cod and American plaice were reported in very small numbers. The bycatch as a whole was about 0.3% in the years 2002 and 2003, 0.8% in 2001, and 0.9% in 2000, as compared to 1% of the shrimp catch in 1999, 0.8% in 1998, 1.8% in 1997, and 2% in 1996. Most of this was redfish or 0.7% to 0.8% in the years 1999 to 2001. This amounted to 90–770t of redfish being caught per year over the period, with a peak in 1996. In 2003 the following amounts were taken: redfish, 4.6t; wolffish, 0.126t; Greenland halibut, 0.05t; and shrimp, 1,446,288t. Together, these catches constituted a bycatch rate of 0.33% of shrimp catch. Redfish represented 0.32% of the catch. The bycatch was about 0.5 % in the years 2003 and 2004. The percent of bycatch decreased from the highs 2.1% and 1.8% in 1996 and 1997 to 0.8% and 1.0% in the years 1998–2001. Bycatch was only 0.3% in 2002 (Skúladóttir, 2004).

Management Action Taken to Address Bycatch and Discards

As of October 1, 2000, sorting grids are obligatory for the shrimp fisheries.

Impact on Stock from Direct and Indirect Fishing

There is no TAC in place and the days at sea limits do not limit catch recommended level. Although SSB appears to be increasing, continually exceeding harvest guideline recommendations could jeopardize long-term sustainability. In addition, discards in the Denmark/Greenland fishery in 2003 are worthy of further investigation to determine if high-grading is occurring.

Impact of Shrimp Fishery on Other Stocks

The enormous growth in bycatch of redfish in the Flemish Cap fishery warrants immediate attention. While this stock is not under moratorium, given that 70% by number of directed and indirect redfish catch is being taken in the shrimp fishery is of concern. The Denmark/Greenland fishery reported catching and discarding juvenile redfish, and reported that juvenile redfish constituted almost a quarter of the Flemish Cap shrimp catch. The Scientific Council expressed concern that high bycatch of redfish jeopardizes sustainability of redfish stocks.

Also worthy of further study is 1) the compliance by all countries with requirement to use sorting grids and 2) various fishing strategies to reduce redfish bycatch as it was indicated by the Russian fisheries that bycatch of redfish decreased with an increase in the tow depth, possibly due to decreasing abundance of redfish with depth.

Denmark Strait and Off East Greenland Shrimp *(Pandalus sp)*

Stock Status and Current Fisheries Information

The fishery began in 1978 in areas north of 65°N in the Denmark Strait, where it occurs on both sides of the midline between Greenland and Iceland. Areas south of 65°N in Greenlandic waters were exploited since 1993. Standardized CPUE data for all the areas combined indicate an increasing trend in fishable biomass from 1993 to 2000 (Figure 45). The 2000 to 2004 values equal the relatively high values at which the series started in 1987. Since 1994, annual catches remain near the recently recommended TAC of 12,400t, while stock biomass indices increased. There are no direct biomass or recruitment estimates available for this stock. CPUE data for all the areas combined indicate an increasing trend in fishable biomass from 1993 to 2000. The 2000 to 2004 values equal the relatively high values at which the series started in 1987. However, this increase may not have continued after 1999 (SC Summary Sheet, 2004).

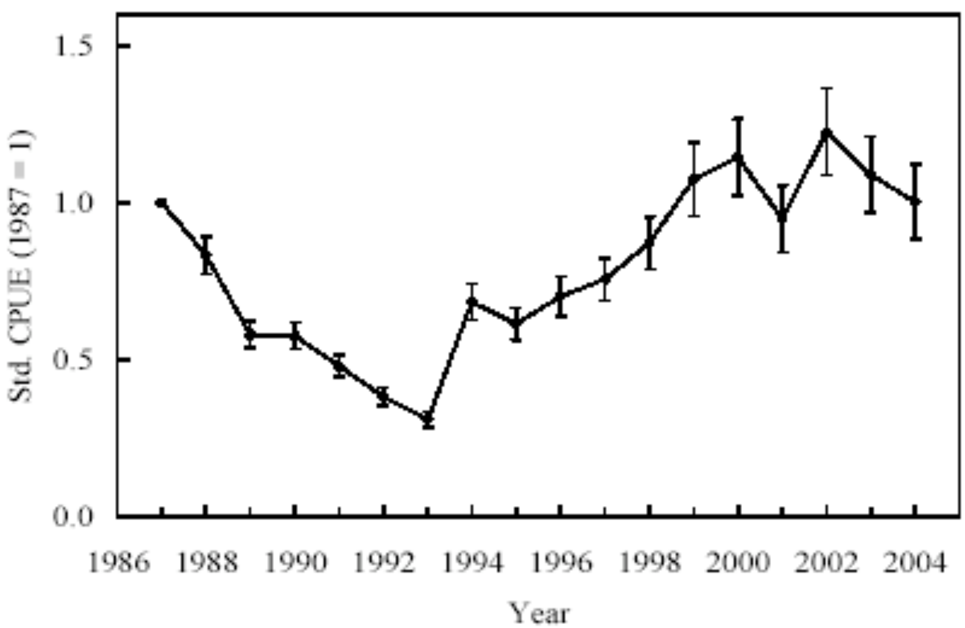

Figure 45. Denmark Strait and off east Greenland shrimp standardized CPUE 1986–2004. (Source: SC Summary Sheet, 2004)

Five nations participated in the fishery in 2004. One Icelandic vessel went fishing for shrimp in the EEZ waters in 2004 as compared to three in 2003. STACFIS estimated catches as 13,900t in 2001; 11,200t in 2002; 12,100t in 2003; and 13,500t in 2004 (Figure 46).

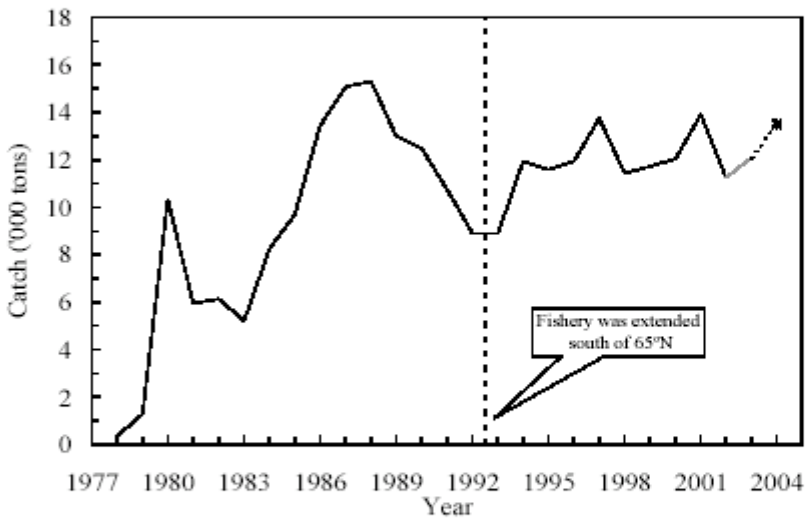

Figure 46. Denmark Strait and off east Greenland shrimp catch 1978–2004. (Source: SC Summary Sheet, 2004)

Adherence to Scientific Advice

There is no TAC in place in the Icelandic EEZ. In Greenland's EEZ for 2004, scientific advice recommended a TAC of 12,400 t. The TAC was set at 15,600t and the actual catch was 13,500t. Both the agreed-upon TAC and the actual catches exceeded the scientific advice.

Bycatch and Discards in the Shrimp Fishery

Iceland

The majority of the bycatch in the shrimp fishery consists of three species: Greenland halibut, wolffish and redfish, where redfish is by far the most prevalent (Skúladóttir, 2003).

Impact on Stock from Direct and Indirect Fishing

The cause for concern about the long-term well-being of this stock is threefold:

- There is no TAC in place in Icelandic waters.
- The TAC recommendation inside Greenland's EEZ in 2003 was exceeded and the actual catch exceeded the original recommendation.
- There are no direct biomass or recruitment estimates available for this stock and scientists are not sure if stock biomass increases, evidenced by CPUE data, continued to occur after 1999.

3LNO and Subdivision 3Ps White Hake *(Urophycis tenuis)*

Stock Status and Current Fisheries Information

White hake biomass and abundance fluctuates widely (Figure 47). However, the abundance peak in 2000 was the highest on record amounting to 140,000,000 individuals and the highest biomass well above 25,000t, of mostly one year of age. This peak followed large estimates of larvae in the pelagic survey conducted in 1999 (Kulka and Simpson, 2002). Very small average sizes were recorded in the recent surveys indicating a large component of juvenile fish. In 2003, juvenile biomass was reported to be around 8,215t based on fall and spring surveys (Kulka et al*.,* 2004b).

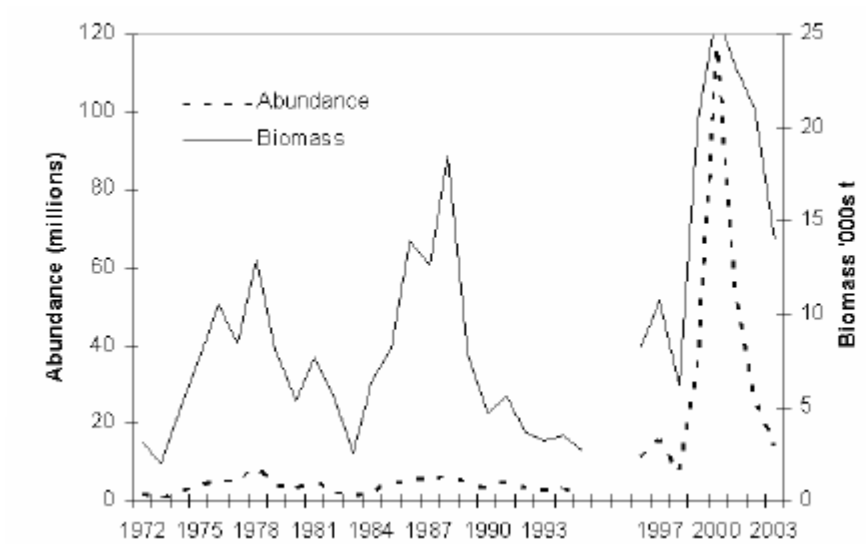

Figure 47. 3LNO white hake minimum trawlable biomass and abundance based on spring surveys in NAFO Division 3LNOPs. (Source: Kulka et al*.,* 2004b)

Presently there is a limited directed fishery for white hake on the southern Grand Bank. It is more commonly taken in mixed fisheries with cod, monkfish and skate. The first year a quota was established was in 2005, allocated amongst member countries as follows: divided as follows: Canada, 2,500t; EU, 5,000t; Russia, 500t; and Others, 500t. A TAC of 8,50t has been set for 2005, 2006, and 2007. Total catch was reported to be 3,103t in 2003 (Kulka et al., 2004b), but STACFIS estimated this to be 5,083t. STATLANT (2005) reported a slightly higher catch for 2003 (Table 13).

Table 13. Catches of white hake (t) in 2003 for 3LNO and 3Ps.

Country	Division	Catch (t)
Spain	3L	197
Estonia	3L	1
Portugal	3N	2,309
Spain	3N	373
Estonia	3N	6
Canada	3O	360
Portugal	3O	1,781
Spain	3O	1,272
Canada-Maritimes	3O	57
Canada	3Ps	880
France	3Ps	3
Canada-Maritimes	3Ps	225
Total		7,464

The increase in catches 2002 to 2003 (Figure 48) was attributed mainly to Spain and Portugal fishing primarily in Division 3O just outside Canada's 200-mile limit. An examination of NAFO Research Reports did not identify white hake as a directed species for countries other than Canada although the majority of the catch (~80%) was attributable to Spain and Portugal.

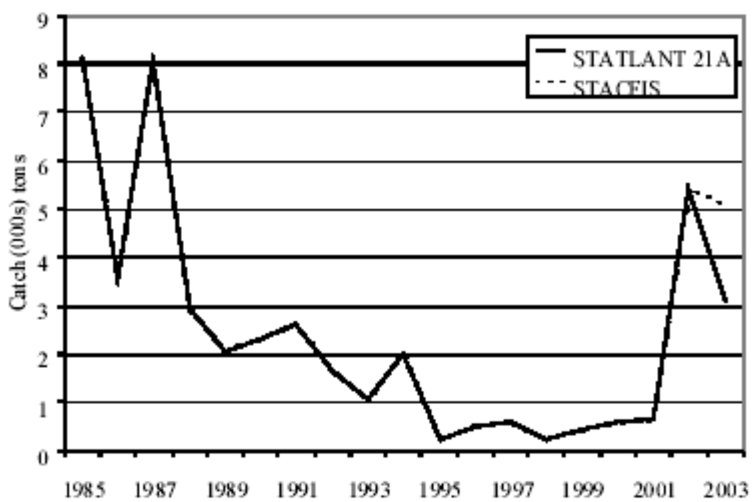

Figure 48. 3LNO white hake catch history. (Source: Kulka et al., 2004b)

Canada commenced a directed fishery for white hake in 1994 in 3N, 3O and 3Ps but the majority of the fishery took place in Subdivision 3Ps; catches in Division 3NO were restricted to a few hundred tons per year. Since the start of the fishery, observers were deployed on approximately 8% of the Canadian fishing vessels taking white hake. Observers collect set by set information of the catches. Canadian catches largely comprise mature fish. Little is known about white hake on the Grand Banks as there is no directed research on this species. Ages are not available, and data on length, individual weights, and maturity of fish in research survey catches is incomplete. There is little sampling of commercial catches although this situation improved in recent years. Recent information suggests that fish are at least 3 years old before being taken in commercial gears (Kulka et al., 2004b).

Spanish catches in white hake fishery in Division 3LMNO began in 2002 and it is developed mainly in the Division 3O at depths of 200m to 500m. The biggest catches are carried out during the third quarter, and more than 80% of the catches, in abundance and biomass, are mature (González and del Río, 2004).

Adherence to Scientific Advice

2005 is first year with a quota in 3NO. The fishery was not regulated in the past. No management measures are in place in other areas.

Bycatch and Discards in the White Hake Fishery

Canada
Canadian fisheries observer data from 1997 to 2003 shows white hake comprises 85% of catch in Canadian gillnet fishery and 55% in Canadian longline fishery. Monkfish are the primary bycatch in gillnet fishery. For species under moratorium, cod dominated in longline catches and American plaice bycatch was negligible. The Canadian longline fishery took an average of 332t annually from 1994 to 2003. Other species taken in Canadian gillnet and longline fishery respectively included haddock 1%/3.7%, cod 0.6%/17.7%, pollock 0.5%/0.0%, *Lithodes maja* 0.4%/8.9%, halibut 0.3%/8.3%, plaice 0.2%/ 0.0%, spiny dogfish 0.2%/0.1%, snow crab 0.1%/0%, skates (unspecified) NS 0.1%/3.7%, swordfish 0.1%/0.0%, thorny skate 0.1%/0.1%, and Other 0.4%/2.6% (Kulka et al., 2004b).

European Union
In 2003, in Division 3O, 1,136t of white hake were caught by Spain, and the following bycatch was taken: Greenland halibut, 636t (56% of total catch); redfish, 250t (22%); skate (6%); plaice (unspecified), 45t (4%); and witch flounder 11t (1%) (González and del Río, 2004). In 2003, in Division 3N, only 332t of white hake was taken, and bycatch amounted to the following: Greenland halibut, 73t (22%); skate, 70t (21%); roundnose grenadier, 50t (15%); redfish, 13t (4%); dogfish, 13t (4%); and plaice (unspecified), 10t (3%) (González and del Río, 2004). Interestingly, while Spain refers to this as a directed white hake fishery, white hake constituted only 18% of the total directed/indirect catch. Kulka (2004b) referred to this as a mixed fishery.

Impact on Stock from Direct and Indirect Fishing

Data were inadequate to assess the impact of direct and indirect fishing on this stock. Reports that the majority of the catches of Russia, Spain, and Portugal combined comprise immature fish while Canada catches mostly mature fish are worthy of further investigation (Kulka et al., 2004b). However, Spanish catch data suggest that the majority of their catch is of mature fish (González and del Río, 2004).

Impact of White Hake Fishery on Other Stocks

Although adult components of cod and American plaice overlap the distribution of white hake, juvenile distributions of those species are mainly associated with the Southeast Shoal, an area that is well to the northwest of the distribution of white hake (Kulka et al., 2004). Redfish bycatch in the Spanish fishery is high (22%) even though the fishery operates predominately in 3O. Because nearby redfish stocks in 3LN are under moratorium, there is a need for further study of this fishery's impact on rebuilding redfish stocks. Given the vulnerable life history of skate and that it represented 24% of the bycatch in this fishery in 2003, further study of the fishery is warranted.

3LNO Thorny (Starry) Skate *(Amblyraja radiata)*

Stock Status and Current Fisheries Information

Although the stock structure of thorny skate in the NAFO area is unknown, thorny skate in Division 3LNO were treated as an assessment unit. In Division 3LNO, there is a 50% probability that thorny skate attaining 50cm total length will be mature. They have low fecundity and long reproductive cycles. The Canadian spring survey biomass indices fluctuated without trend prior to the mid-1980s, and then declined rapidly until the early 1990s (Figure 49). During this period, the stock declined from around 85,000t to a current estimate of around 25,000t. During the subsequent spring Campelen series surveys, 1996 to 2003, the biomass was reported to be stable or slightly increased from 75,000t in 1996 to approximately 115,000t in 2003 (Figure 50). The pattern from the Canadian autumn survey, for comparable periods, was similar. The life history characteristics of thorny skate result in low intrinsic rates of increase resulting in low resilience to fishing mortality. While the biomass remained relatively constant from the mid-1990s on, the spatial dynamics did not. The density of skate continued to increase within the area on the southwest Grand Bank where >80% of the biomass has been concentrated in recent years (STACFIS, 2004).

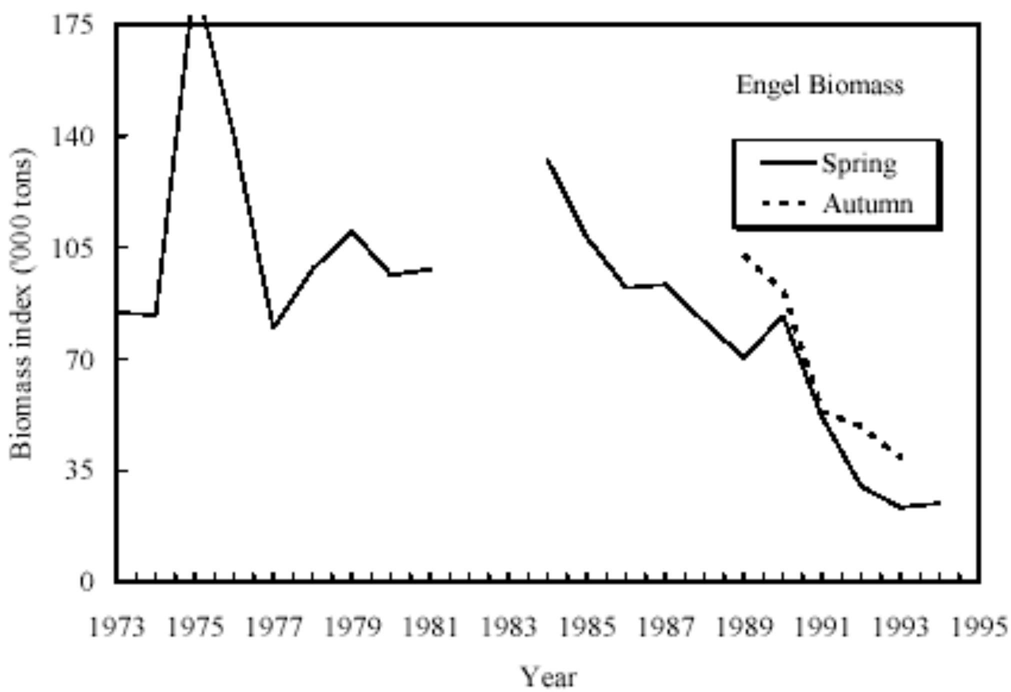

Figure 49. 3LNO thorny (starry) skate Engel biomass estimate (1973–1994). (Source: SC Summary Sheet, 2003)

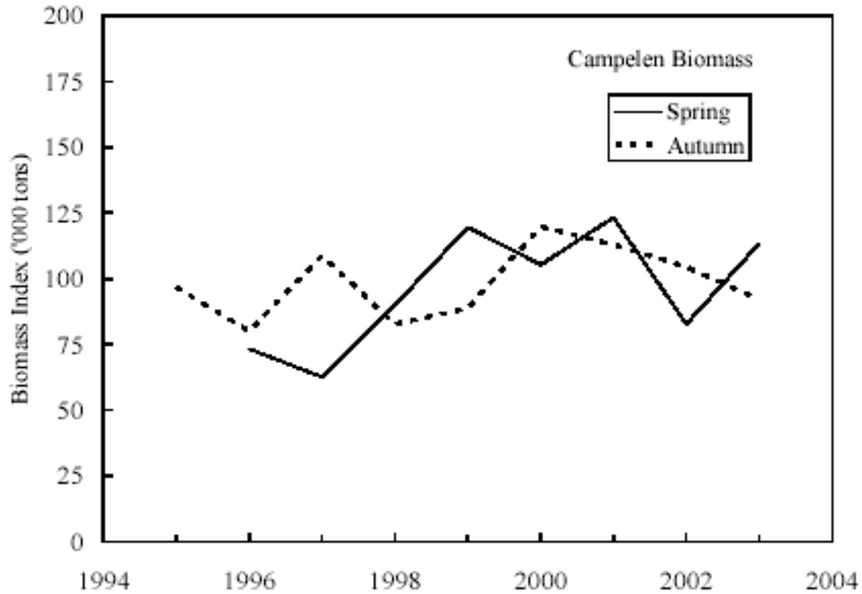

Figure 50. 3LNO thorny (starry) skate Campelen biomass estimate (1994–2003). (Source: SC Summary Sheet, 2003)

Commercial catches of skates comprise a mix of skate species. However, thorny skate represents about 95% of the skates taken in the catches. Thus, the skate fishery on the Grand Banks can be considered as directed for thorny skate. Since the mid-1980s, Spain prosecuted a directed fishery for skate (*Raja sp.*) outside Canada's 200-mile limit on the Tail of the Grand Banks. Russia commenced its fishery for thorny skate in 2000 (Kulka et al., 2004a).

The main participants in this fishery today are Spain, Canada, Russia, and Portugal. Catch levels as estimated by STACFIS have averaged 10,800t since 1996 (Figure 51). This species is not regulated by quota, except within Canadian waters (STACFIS, 2004).

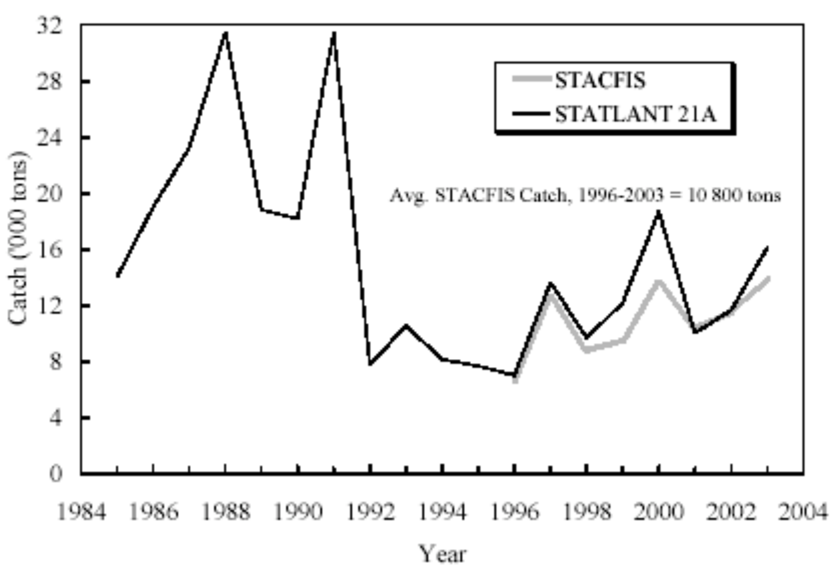

Figure 51. 3LNO thorny (starry) skate catches 1984–2003. (Source: SC Summary Sheet, 2003)

Adherence to Scientific Advice

The Scientific Council advised that catches in 2005 and 2006 should not exceed 11,000t (STACFIS, 2004). However, for 2005, 2006, and 2007, Contracting Parties agreed to a higher TAC of 13,500t, allocated as follows: Canada, 2,250; EU, 8,500; Russia, 2,250; and Others 500 (NAFO, 2005b). Recent catches in this fishery were substantially higher than the current TAC.

Bycatch and Discards in Skate Fishery

European Union

In the 3NO Spanish trawler fishery for skate, CPUE data provides the only available data on bycatch. American plaice (5.5% of catch/53.2kg/hr) is the main bycatch species. Other less important species in the bycatch are yellowtail flounder (1.5% of catch/14.8kg/hr), witch flounder (1.1%of catch/10.7kg/hr) and cod (0.7% of catch/7.4kg/hr). All the information on fishing effort and catches for this study was obtained from NAFO Observers on board the commercial fleet in Division 3NO. In 2003, it was reported that bycatch reported by Spain in the Division 3NO skate fishery diminished with time (del Río et al., 2003). Almost all of the catches of yellowtail flounder were taken as bycatch in the skate fishery in Division 3N. Catches decreased from 90t in 2002 to 60t in 2003 (González et al., 2004). Previously, Spain reported taking the following amounts of bycatch: American plaice at 14–31% of the bycatch, yellowtail flounder at 15–18% in 1997 and 2000, Greenland halibut at 7% in 2000, and Atlantic cod at 3% in 1997 (Kulka et al., 2004a).

In 2002, more small American plaice were taken in the Spanish commercial fisheries than in previous years. Up until 2001 the majority of American plaice taken were from 31–55cm; in 2002 the majority of American plaice ranged from 23–32cm, within the size range of juvenile fish. Since 2000, yellowtail flounder generally ranged from 27–45cm. Many of these individuals are just slightly over the NAFO minimum size limit and a portion of them are under the Canadian minimum size limit. Witch flounder sizes fluctuated in 2000–2003, ranging from 35cm to 62cm. These individuals are above Canadian minimum size limits (30cm) so may have spawned at least once. There is no minimum size limit for this species under NAFO. Cod ranged between 89cm and 121cm in 2000, but much smaller fish were captured in 2001, ranging from 33cm to 65cm. So at least a portion of the catch in 2001 constituted juvenile cod (del Río et al., 2003).

Considerably higher bycatch rates were reported by Portugal, totaling about 79% for all species combined in a Division 3NO fishery. Dominant bycatch species (proportions not specified for the entire year) were Greenland halibut, American plaice, and white hake; in certain months, American plaice and cod were each reported to exceed 20% (Kulka et al., 2004a). In addition, the breakdown of main species taken as bycatch by area in the 3LMNO Portuguese Skate Fishery in 2003 is as follows: 3L Greenland halibut (averaging 33% of total catch over the four months of the fishery's operation in the division); 3M witch flounder (37% in February); and Greenland halibut (28% in March and 34% in April); 3N Greenland halibut (45% in May); cod (19.1% in November); plaice (unspecified species) (22% in October); and redfish (13% in April and 19% in August); and in 3O cod (27% in April and 29% in May); white hake (26% in August); and plaice (unspecified) (25% in November). Overall, this fishery had a very high level of total bycatch rate in 3LMNO in 2003, with 36% to 87% of the total catch taken as bycatch (Vargas et al., 2004). In 2002, in Division 3N, American plaice was the most common bycatch species at 22%, at depths of 160–252m (this depth range would encompass that area of the Grand Banks where fishing effort targeted skates). Atlantic cod comprised 20% of the bycatch at depths of 93–1,100 m; Greenland halibut was 31% at depths of 675–1,299m; and roughhead grenadier was 32% at depths of 1,023–1,121m. In Division 3O, bycatch of commercially important species remained significant at depths of 93–750m; American plaice was 22.9–27.7%; Atlantic cod was 25.5%; and white hake was 19.4–24.4% (*ibid.*). In Division 3L at greater depths (684–1,094 m), Greenland halibut was consistently the main bycatch species at 25–30% (Kulka, 2004a).

Russia

Russia operates its skate fishery with two vessels during June to December in this division, mainly targeting thorny skate (Sigaev and Rikhter, 2004). Reported bycatch in the Russian directed fishery in Division 3NO amounted to 12%, mainly yellowtail flounder (5%), American plaice (4%), and cod (3%) (Kulka et al., 2004a).

Canada

Bycatch in the Canadian fishery, further to the west in Division 3O, was 16%, comprising mainly monkfish and Atlantic halibut with very little cod and plaice, and no yellowtail flounder (Kulka et al., 2004a)

Bycatch and Discards of Skate in Other Fisheries

Thorny skate are taken as bycatch as far north as Davis Strait. North of Lat. 52°N, skate catch rates are generally lower, but skates are reported as relatively common bycatch as far north as Lat. 70°N in NAFO Subarea 0A in shrimp and Greenland halibut fisheries. Most bycatch in the Greenland halibut fishery is discarded, and survival rates of discarded fish are unknown. South of Lat. 52°N, higher skate catch rates are observed as far south as Lat. 48°N, on the northern section of the Grand Banks. Highest skate catch rates occurred on the southern Grand Banks (close to where the Canadian directed fishery operates) and on the northern part of St. Pierre Bank. A large number of rough- and roundnose grenadier also are taken, but whether they are discarded is unknown (Murua, 2003).

European Union
The Spanish white hake fishery in Division 3O reported taking 1,136t of white hake and 4t (6% of total catch) of skate as bycatch in 2003. In 3N, it took only 332t of white hake but 70t (21%) of skate. In the latter case, skate constituted the second most frequently caught bycatch species (González and J.L. del Río, 2004).

Impact on Stock from Direct and Indirect Fishing

There is cause for concern about this stock because of the following:

- The TAC exceeded scientific advice.
- The stock structure is compressed and nearly half the size it was in the late 1980s, despite reportedly being stabilized at the lower level in the 1990s and 2000s.
- The species' life-history characteristics render it vulnerable.
- Knowledge of population dynamics is lacking.

In addition, a fuller assessment of the impact of discarding of skate in the Greenland halibut and shrimp fisheries should also be undertaken.

Impact from Skate Fishery on Other Stocks

The high level of moratorium cod and American plaice bycatch in the Russian skate fishery in some months is of concern and warrants immediate attention.

Subareas 0–1 Roundnose Grenadier *(Coryphaenoides rupestris)*

Stock Status and Current Fisheries Information

The delimitation of the roundnose grenadier stock in the Davis Strait is uncertain but it is probably connected to other stocks in the North Atlantic. The stock component found in Subareas 0 and 1 is at the margin of the stock's distribution. Canadian and Russian surveys that covered both Subareas 0 and 1 showed that most of the biomass is generally found in Subarea 1.

There are no recent estimates of biomass of roundnose grenadier for the entire stock in Subareas 0 and 1. In 2001, the biomass of roundnose grenadier was estimated at 1,600t for Division 1CD, the lowest ever observed (Figure 52). Surveys in Division 0B in 2000 and 2001 also showed a very low biomass; 1,700 and 1,300t, respectively (STACFIS, 2002a). In the Greenland survey in 2002, the biomass in Division 1CD was estimated at 1,563 tons, which is the second lowest on record (STACFIS, 2003a, Jørgensen, 2003).

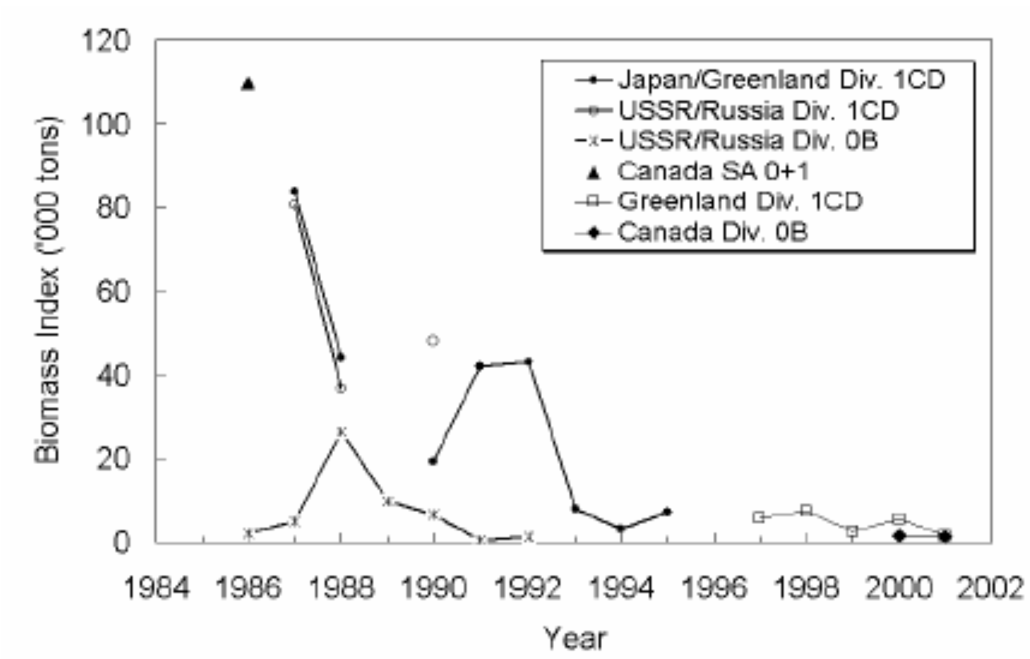

Figure 52. Roundnose grenadier biomass estimates from USSR/Russian, Japan/Greenland and Greenland surveys in Divisions 0B and ICD. (Source: SC Summary Sheet, 2002)

Adherence to Scientific Advice

The SC recommended that there should be no directed fishing for roundnose grenadier in Subareas 0 and 1 in 2003–2005 and that catches should be restricted to bycatches in fisheries targeting other species. However, Greenland set a TAC for Subarea 1 of 3,400t in 2001 and the actual catch was 50t (Figure 53). In 2002, Greenland raised its TAC to 4,200t after the Scientific Council again recommended a TAC of 0 (STACFIS, 2001). Actual catches for 2002, 2003, and 2004 are not known. There has been no directed fishery for this stock in the NRA since 1978.

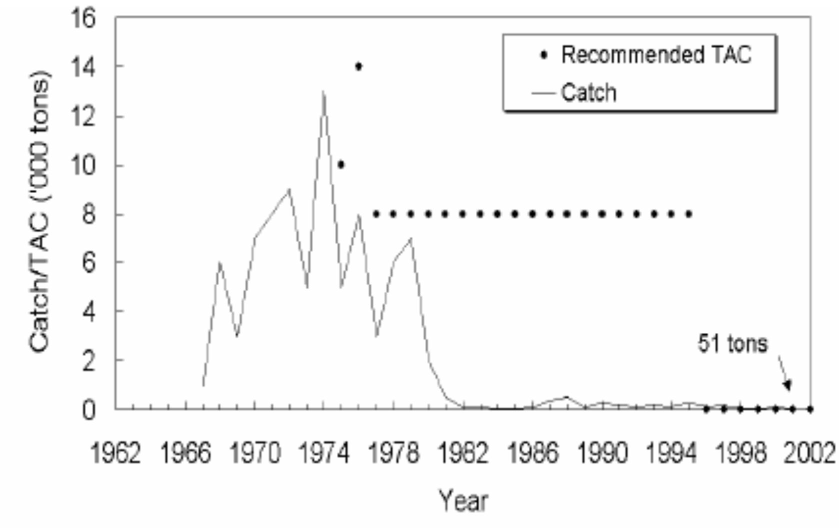

Figure 53. SubAreas 0 +1 roundnose grenadier catches and recommended TAC. (Source: SC Summary Sheet, 2002)

Bycatch and Discards of Roundnose Grenadier in Other Fisheries

A total catch of 34t, taken as bycatch in the fishery for Greenland halibut, was reported from 2002 compared to 61t in 2001 (STACFIS, 2003a).

Russia
The Russian demersal fishery for Greenland halibut in Division 1D inside the EEZ, which operates from September to November, took 5t of roundnose grenadier as bycatch in 2003 out of a total Greenland halibut catch of 1,081 t. An unknown proportion of the reported catches are roughhead grenadier (*Macrourus beglax*) (STACFIS, 2001).

Canada
Since 1996, Nunavut companies have had exclusive access to an exploratory fishery license to harvest Greenland halibut in NAFO Division 0A. There were 28.9t of unspecified Grenadier caught and an additional 2.6t of roughhead grenadier.

Denmark/Greenland
The Greenland halibut fishery in SA1 took 34t of roundnose and roughhead grenadier. All catches were reported as roundnose grenadier. The total Greenland halibut catch for this area was 26,636 t; thus the bycatch rate was relatively small.

Germany
In 2003, demersal fishing was conducted with low effort in Division 1D inside the Greenland EEZ from September until November. The fishery was directed towards Greenland halibut. By the end of the year, reported landings amounted to 542t of Greenland halibut. Bycatch of roundnose grenadiers amounted to 6t (Rätz et al., 2004).

European Union
In 2003, in the Spanish white hake fishery in 3N, 332t of white hake and 50t (15% of total catch) of roughhead grenadier were taken (González and del Río, 2004).

Impact on Stock from Direct and Indirect Fishing

Continued confusion and misreporting of grenadier species is a problem and complicates the ability to effectively evaluate the condition of this stock and the impact on it from other fisheries. Low biomass estimates for this stock in 2001 and the Scientific Council's recommendation for no directed fishery on this stock were not heeded and the stock is still being exploited. The Greenland halibut fishery clearly takes the greatest amount of grenadier bycatch. There has been no directed fishery on this stock in the NRA since 1978 and the stock has not shown any apparent signs of recovery, suggesting that bycatch and the continued directed Denmark/Greenland fishery may be a contributing factor in impeding stock recovery.

Summary

Due to the inherent weakness of international law and the organizations which operate under it, NAFO management measures are undermined by negotiations being based on allocation which lead to 1) TACs being set above or in the upper range of scientific advice. This is the case for half of the stocks reported on in this report; and 2) TACs being exceeded once they are agreed to; and 3) continued operation fisheries catching large proportions of juveniles (e.g., 3O redfish and Subareas 2 and 3KLMNO Greenland halibut).

Table 14 provides an overview of the current status of the NAFO stocks regulated via TAC or effort control. Biomass classifications have been taken from NAFO literature, primarily 2003. The year 2003 represents the most recent, complete year for comparative purposes providing each of the following: SSB estimates, biomass estimates, catch figures, Scientific Council TAC recommendations, and the ultimate TAC adopted by Contracting Parties for the 2003/2004 fishing season. In having all these data we are able to understand not only if fishing effort is exceeding adopted TACs, but if the TACs themselves have been set beyond scientific advice.

Table 14. Status of TAC-managed stocks.

Species	Stock	Status/Biomass (SC Classification)	Recommend TAC (mt)	Adopted TAC (mt)	Catch (mt) 2003	SSB 2003	Biomass (mt) 2003	Bycatch in 2003 (mt)	Age at Capture	Sources
Redfish	3M	low	3,000–5,000*	5 ,000	1,988	6,600	59,500	1,006 (in 2002/2003 shrimp fishery. 22.1% of TAC & 82.6% of catch in numbers	large amount of juveniles in shrimp catch	SC Summary Sheet 2003
	3O	no overall trend in stock size in the last decade	13,000–20,000* (US/Can)	20,000	21,591	unknown	unknown	unknown	stock mostly juveniles	SC Summary Sheet 2003
	Subarea 2 & Division 1F & 3K	golden redfish/deep-sea redfish: dramatic decline in survey biomass & abundance indices of juveniles & reduced fish sizes Subarea 1	0 Subarea 1	inshore 8,000t in Subarea 1	0.5t in Sub Area 1	Golden redfish mean SSB is <2-2,500	<5,000	<175 t	stock mostly juveniles	SC Summary Sheet 2003
				19,000 offshore Sub Area 2 & Div 1F & 3K		Deep-sea redfish mean SSB is <100,000			stock mostly juveniles	SC Summary Sheet 2003
Yellowtail flounder	3LNO	relatively high	13,500 including bycatches	13,500 not including bycatches	13,303	?	25% above Bmsy in 2004	unknown	mix of age classes	SC Summary Sheet 2004
Greenland halibut	Subarea 0, Div. 1A Offshore & Div. 1B-1F	unknown — TAC is being exceeded	19,000 NRA + 16,300 1A in 2003. For Div. 0B and 1C-1F the TAC for 2005 should	19,000 Subarea 0 & Div. 1A Offshore + 16,300 1A inshore	20,000 NRA	unknown	only available estimates in 2003 -- 69,000 in 1CD, slightly above average	unknown	juveniles	SC Summary Sheet 2004

Table 14 continued

Species	Stock	Status/Biomass (SC Classification)	Recommend TAC (mt)	Adopted TAC (mt)	Catch (mt) 2003	SSB 2003	Biomass (mt) 2003	Bycatch in 2003 (mt)	Age at Capture	Sources
			not exceed 11,000		20,494 1A	Unknown	Disko Bay: abundance relatively stable; Uummannaq: decreased abundance & landings; Upernavik: no basis to evaluate			SC Summary Sheet 2004
	Subarea 2 & 3KLMNO	exploitable biomass lowest observed	36,000	42,000	30,688	2003 & 2004 biomass est. lowest in 12-year time series, just above 60,000	unknown	unknown	young, immature fish of ages several years less than that at which sexual maturity is achieved	SC Summary Sheet 2004
Squid (Illex)	Subarea s 3 & 4	Low productivity	19,000–34,000	34,000	1,100	Unknown	low biomass index, small mean size	unknown	body weight, lowest on record in 2000, Nfdl inshore jig fishery at New Bona-venture (2003) much smaller & males less mature than in 2002	SC Summary Sheet 2003
Shrimp	Denmark Strait and off East Greenlan d Shrimp	unknown	12,400	no TAC in Iceland EEZ; Greenland EEZ 15,600	13,500	no direct biomass or recruitment indices	no direct biomass or recruitment indices	unknown	Unknown	SC Summary Sheet 2003

Table 14 continued

Species	Stock	Status/Biomass (SC Classification)	Recommend TAC (mt)	Adopted TAC (mt)	Catch (mt) 2003	SSB 2003	Biomass (mt) 2003	Bycatch in 2003 (mt)	Age at Capture	Sources
	Div. 0A & Div. 1A & 1F	recruitment index declining? Biomass highest in time series (1988-2003)	100,000	115,700	126,500	SSB index increasing	abundance of males high	< 1%	mix of age classes	2004 SA
	Subarea 2 3KLNO	appears high	13,000 in 2000. TAC should not > 22,000 for next several years	13,000 in 2003	12,000 in 2003	SSB >75,000 in 2002 (increasing) No analytical assessment available	Approximately 200,000	3L Greenland shrimp trawl fishery 1,212 shrimp discarded in 2003	some juveniles	2003 SA / 2004 SA
	3M	stable	45,000	no TAC/effort control	63,198	SSB increasing	biomass well above B_{lim}	3,150 indv. Den/Gre	mix of age classes	2003 SA
White hake	3LNO & Sub-Div 3P	stable at low level	8,500 recommended for 2005. (No quota set previously)	8,500	7,464 (2003)	Unknown	8,215	unknown	large amount of juveniles	Kulka et al. 2004
Roundnose Grenadier	Subarea s 0-1	In 2001 1CD, the lowest ever observed; In Div 0B in 2000 and 2001 also showed a very low biomass; In Division 1CD stable at low level	0	TAC in Greenland EEZ 3,400t increased to 4,200t in 2003	50 (Den/Greenland: directed)	u/k	111,000 (0+1A in 1986). Greenland survey 2001 1CD: 1,557 & Canadian survey 2001 0B: 1,256	>70.5 (bycatch)	Small fish(5–10cm in 1CD	2002 SA

Table 14 continued

Species	Stock	Status/Biomass (SC Classification)	Recommend TAC (mt)	Adopted TAC (mt)	Catch (mt) 2003	SSB 2003	Biomass (mt) 2003	Bycatch in 2003 (mt)	Age at Capture	Sources
Skates	3LNO	stable at lower level	11,000 (2005)	13,500 (2005)	av. of 10,500 since 1986	unknown	approx. 25,000	Most bycatch in G.halibut fishery discarded & survival rates unknown; 24% in Spanish white hake fishery in 2003 in 3LNO; skates reported as relatively common Bycatch as far north as Lat. 70°N in 0A in shrimp & G. halibut fisheries; high skate catch rates occurred on southern Grand Banks (in vicinity of Canadian directed fishery and on north part of St. Pierre Bank)	unknown	SC Summary Sheet 2004

Fisheries targeting at least four of these stocks catch mainly juveniles, as determined by NAFO or by using the Canadian Small Fish Protocol as a proxy for determining sexual maturity. For all except one of the fisheries, member states established TACs beyond or at the upper end of scientific recommendations. In some situations catches exceeded the agreed-upon TACs. Canadian scientists and fishermen expressed concerned over unreported high-grading (discarding) in some NAFO-managed fisheries (NAFO, 2004c). Limited information available on discarding and high-grading practices in NAFO-regulated shrimp fisheries, and to a lesser degree from the Greenland halibut fishery in Subarea 2 and 3KLMNO, indicates variable impacts on the resources.

A number of underlying issues have been identified from this study and have been categorized and listed under the headings of data and information gaps, and impediments to effective regulation. A series of categorized recommendations follows to address these issues in the following topic areas: management measures, information gaps, monitoring and enforcement, and governance.

Data and Information Gaps

- There are considerable inconsistencies in the manner in which stock and stock assessment information is reported.
- Not all countries submit catch reports in a timely manner and there are a number of instances where no information has been received at all, making it impossible for NAFO to accurately estimate catch levels.
- Data are reported collectively and not by individual species for some multi-species stocks (e.g., redfish and skates).

Impediments to Effective Regulation of Stocks Under TACs or Effort Controls

- NAFO does not have the authority to compel member states to follow scientific advice when enacting management measures. Typically, NAFO quota allocations were based on historical catches or equal share allocations. Scientific advice is not necessarily required as the basis for deciding TACs under the Convention. At most, the Fisheries Commission, which institutes regulations, is only allowed to take into account any relevant information or advice provided by the Scientific Council. The Scientific Council carries out the scientific activities of NAFO, including the conduct of research, compilation of statistics and records, and the provision of scientific advice; it may also carry out programs in cooperation with other public or private organizations.
- NAFO's objection and withdrawal procedures in setting the quotas allow unilateral disregard of allocations, which undermines their effectiveness. NAFO members may opt out of NAFO regulations and object to allocated catch quotas either at the time a regulatory measure is proposed and before it enters into force, or at any time after a year. States can then continue to fish more without penalty.
- Member Parties often produce reports with quality and consistency issues (previously cited in last section on moratoria stocks, e.g., VMS, observer reports, and port inspections).

Recommendations

Recommendations to address issues identified in the body of this chapter are presented below.

Developing and Implementing Management Measures

The Fisheries Commission should consider the following:

- The role played by scientific advice in determining the TAC should be separated from political decisions concerned with allocation between Member States. Where scientific information is inadequate as the basis for determining total allocations the use of precautionary reference points for target and bycatch species should be introduced.
- Effort should be made to move away from managing fisheries based on TAC allocating determined by historical fishing effort and catches. Adopting adaptive fishery management plans (underpinned with simulation work to determine reference points under a range of management scenarios that will trigger future management response) is suggested. These should provide a realistic appraisal of the range of outcomes under fishing and the probabilities of these outcomes under different management actions.
- Collaboration with countries with bordering EEZs would help ensure consistent management of shared resources.

Addressing Information Availability

The Fisheries Commission should consider the following measures:

- Evaluating bycatch rates of fishing nations for species in an area. Large differences in some rates suggest either procedures for reducing bycatch rates, or nations perhaps under-reporting bycatch.
- Developing a consistent reporting format from each member state for biological, catch, and assessment information.
- Minimizing mortality (retained catch or discards) of immature fish in target fisheries by taking active measures to do so.
- Evaluating impacts of bycatch (especially immature) on status of target fishery (e.g., bycatch of redfish in shrimp fishery on the redfish stock). Simulate effects of bycatch mortality of (immature) fish on biomass from growth rates compared to fishing mortality rates, and loss to commercial fishery.
- Evaluating the impact of bycatch (especially juvenile/immature) of various species on predators that forage on that bycatch.
- Developing bycatch mitigation measures for fisheries in addition to shrimp

Monitoring and Enforcement

The Fisheries Commission should consider the following measures:

- Reporting catch and bycatch information by species.
- Developing standard port inspection protocol.

Governance

The Fisheries Commission should consider the following measures:

- Making changes to the voting system to reflect a "weighting" for degree of interest and involvement in a fishery.
- Eliminating or reforming the objection system in management decision-making.
- Developing a Dispute Settlement System or utilizing diplomatic dispute settlement tools provided for under the United Nations Fishery Agreement and Part XV of Law of the Sea Treaty 1982.

Chapter 4

Unregulated Fishing by NAFO Contracting Parties

There are a number of stocks within the NRA for which there are few or no regulations establishing moratoria, setting TACs, or limiting effort. The basis for their management is usually poorly understood and certain stocks are severely depleted.

This section reviews the stock status, adherence to management advice (where it exists), quantifies bycatch and discards where possible, and assesses the impact on the stock from directed or indirect fishing activities for 3K skate, roughhead grenadier in Subareas 2 and 3, and finfish stocks in Subarea 1.

3K Skate

Stock Status and Current Fisheries Information

There are no catch or assessment data available for skate in area 3K. In 2003, most of the reported directed fishing for skate occurred in 3LNO.

Adherence to Management Advice

No regulations are currently in place.

Bycatch and Discards of 3K Skate

In 2003, 100t of skate (unspecified by species) were reported taken as bycatch from various fisheries (most likely Greenland halibut fishery), all of it discarded (Kulka et al., 2004).

Impact on Stock from Direct and Indirect Fishing

Unknown.

Subareas 2 and 3 Roughhead Grenadier

Stock Status and Current Fisheries Information

Roughhead grenadier are distributed throughout Subareas 2 and 3 in depths between 300m and 2,000m. The Scientific Council maintains that no analytical assessment is currently possible on this stock. The only available biomass information is derived from the Canadian autumn survey biomass index, which has been stable since 1996. Based on this survey information, biomass fluctuated between 30,000t and 45,000t from 1996 to 2003 (SC Stock Assessment, 2003). However, the catch/biomass index obtained using the Canadian autumn survey biomass index has been declining since 1997 (SC Summary Sheet, 2003).

With the start of the Greenland halibut fishery in Subarea 3 in 1988, roughhead grenadier were initially misreported as roundnose grenadier (Alpoim et al., 1994; Power and Parsons, 1998; Junquera, 1998). This was not corrected until 1997 and the misreporting problem has not been resolved in the statistics prior to 1996. The level of catches prior to 1988 remains uncertain in Subareas 2 and 3 (SC Stock Assessment, 2003).

In 2002, catches of roughhead grenadier were made by Spain (2,588t), Canada (244t), Portugal (438t), Russia (228t), Japan (120t), and Lithuania (25t) (Murua, 2003) (Figure 54). In 2003, the Portuguese operated a targeted fishery for roughhead grenadier in Division 3LMNO, taking a total of 302t (Vargas et al., 2004).

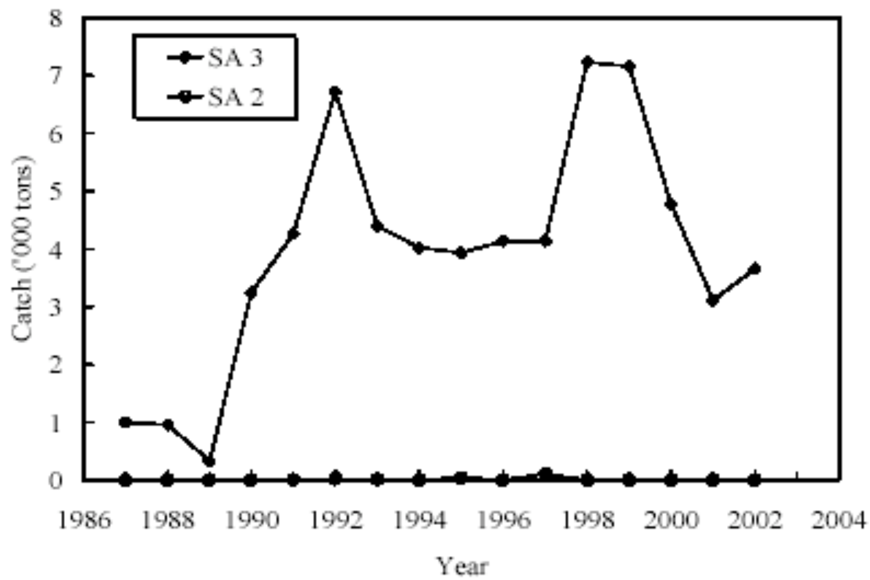

Figure 54. Subareas 2 and 3 roughhead grenadier catch 1986–2003. (SC Summary Sheet, 2003)

Adherence to Management Advice

No regulations are currently in place of this fishery.

Bycatch and Discards of Roughhead Grenadier

Most roughhead grenadier catches taken as bycatch in the Greenland halibut fishery are mainly from Division 3LMN. In 3L, 43% of the catch is roughhead grenadier. In 2000, 2001, 2002, and 2003, bycatch of roughhead grenadier was 4,800t, 3,200t, 3,657t, and 3,700t, respectively (STACFIS, 2004).

European Union
In 2003, in 3L Portuguese fisheries, Greenland halibut and roughhead grenadier continued to represent the bulk of the catches in Division 3L (71% in 2002 and 78% in 2003). A total of 1,777t of Greenland halibut were taken and 102t of roughhead grenadier also were caught in this division (Vargas et al*.,* 2004).

In the Portuguese Greenland halibut fishery in 3LMNO, the main species taken as bycatch include: roughhead grenadier, skate, and witch flounder in 3L; roughhead grenadier, redfish, and witch flounder in 3M; and plaice, witch flounder, roughhead grenadier, and skate in 3N (Vargas et al*.,* 2004). In 3L, roughhead grenadier bycatch was as follows: 15.2% (June), 14% (July), 9.4% (September), and 15.9% (October). In 3M, roughhead grenadier bycatch as a percentage of total catch was 11% in March. In 3N, it was 7.3% (June), 14% (July) 13.4% (August) 15.7% (September) 11.0% (October) Vargas et al*.,* 2004).

In the Spanish fishery for Greenland halibut in 3LMNO (which is mainly undertaken in the Flemish pass), a total of 31 Spanish trawlers operated in 2003. Roughhead grenadier is the main bycatch species and most of the 2003 catches were taken in Divisions 3LN. Catches in Divisions 3LMO were very similar to those of 2002, but catches in Division 3N were double those made in 2002 (González et al., 2004). Most of the roughhead grenadier bycatch taken in the Spanish fishery are aged between 4 and 13 years (González et al., 2004).

Russia
Some 29t of roughhead grenadier were taken in 3N in 2003. The only directed fisheries operated by Russia in the division in this year were for Greenland halibut, which caught 598t of Greenland halibut (operating year-round); and for skate, which caught 2,678t of thorny skate (June to December) (Sigaev and Rikhter, 2004).

In 3L, 71t of roughhead grenadier was taken as bycatch in 2003. The only directed fishery operating in the area was for Greenland halibut, which took 2,262t of Greenland halibut. Approximately 3.2% of the total catch was roughhead grenadier bycatch.

In 3M, 16t of roughhead grenadier was reported as bycatch by Russia in 2003. Greenland halibut was Russia's only directed fishery in the division, catching 138t in 2003. Thus, nearly 12% of the total catch consisted of roughhead grenadier.

In the Russian Greenland halibut fishery, bycatches of roughhead grenadier in Division 3LMNO were dominated by individuals of 12cm to 93cm in length, with a mean length of 44.3cm. A portion of these fish were juveniles (Sigaev and Rikhter, 2004).

Canada
The Canadian Greenland halibut fishery operating in 3L, took 2,346t of halibut in this area and 1,009t of roughhead grenadier as bycatch in 2003.

Bycatch and Discards in the Roughhead Grenadier Fisheries

In the Portuguese directed roughhead grenadier fishery, the main species taken as bycatch include Greenland halibut and skate in 3L, Greenland halibut in 3M, Greenland halibut and plaice in 3N, and cod in 3O. In 2003, in 3L, during March, April, and October, Greenland halibut constituted 31%, 32%, and 45% of the total catch, respectively. Similarly in 3NO, bycatch of Greenland halibut was between 32% and 46% throughout the fishing season (Vargas et al., 2004).

Impact on Stock from Direct and Indirect Fishing

Previous misreporting of the two similar species complicates stock assessment, and there is no current stock status report. The fishery with the highest bycatch of roughhead grenadier is the 3LNO Greenland halibut fishery, particularly in 3LM.

Finfish Stocks in Subarea 1

Stock Status and Current Fisheries Information

The stocks of finfish in Subarea 1 considered under this grouping are: Greenland cod (*Gadus ogac*), American plaice (*Hippoglossoides platessoides*), Atlantic and spotted wolffishes (*Anarhichas lupus* and *A. minor*), thorny skate (*Raja radiata*), lumpsucker (*Cyclopterus lumpus*), Atlantic halibut (*Hippoglossus hippoglossus*), and a number of shark species.

In 2002, reported catches of "other" finfish amounted to 7,437t, representing an increase of about 2,400t, up from the 2001 catch of 5,800t. This was mainly caused by an increase in catch of lumpsucker. These catch figures do not include the weight of fish discarded by the trawl fisheries directed at shrimp.

Greenland cod and lumpsucker are taken from inshore waters by directed fisheries. Other species are mainly taken as bycatch from offshore trawl fisheries directed at shrimp and Greenland halibut. In 2003, Denmark/Greenland reportedly took 1,288t of Greenland cod in inshore waters.

Data limitations do not allow stock assessments or TAC recommendations to be made for Greenland cod, lumpsucker, Atlantic halibut, and sharks. Some stock status information is available as follows (STACFIS, 2003a).

- For American plaice, in 1981, the total biomass index was about 22,000t (Figure 55). From 1982 to 1991, the SSB and total biomass index decreased drastically to a very low level. There has been no significant increase in biomass since then and the stock is considered severely depleted at between 1,000t and 2,000t in 2003.
- For Atlantic wolffish, the SSB and total biomass index decreased drastically since 1982 and has remained severely depleted since the early 1990s (Figure 56). The stock remains severely depleted despite a steady increase in recruitment since the early 1980s. In 2003, the total biomass index was between 1,000t and 3,000t, compared with about 26,000t in 1981.
- Survey results revealed dramatic declines for both spotted wolffish (Figure 57) and thorny skate (Figure 58) to very low levels, from about 8,000t to between 500t and 1,500t, and from about 6,000t to between 1,000t and 3,000t, respectively.

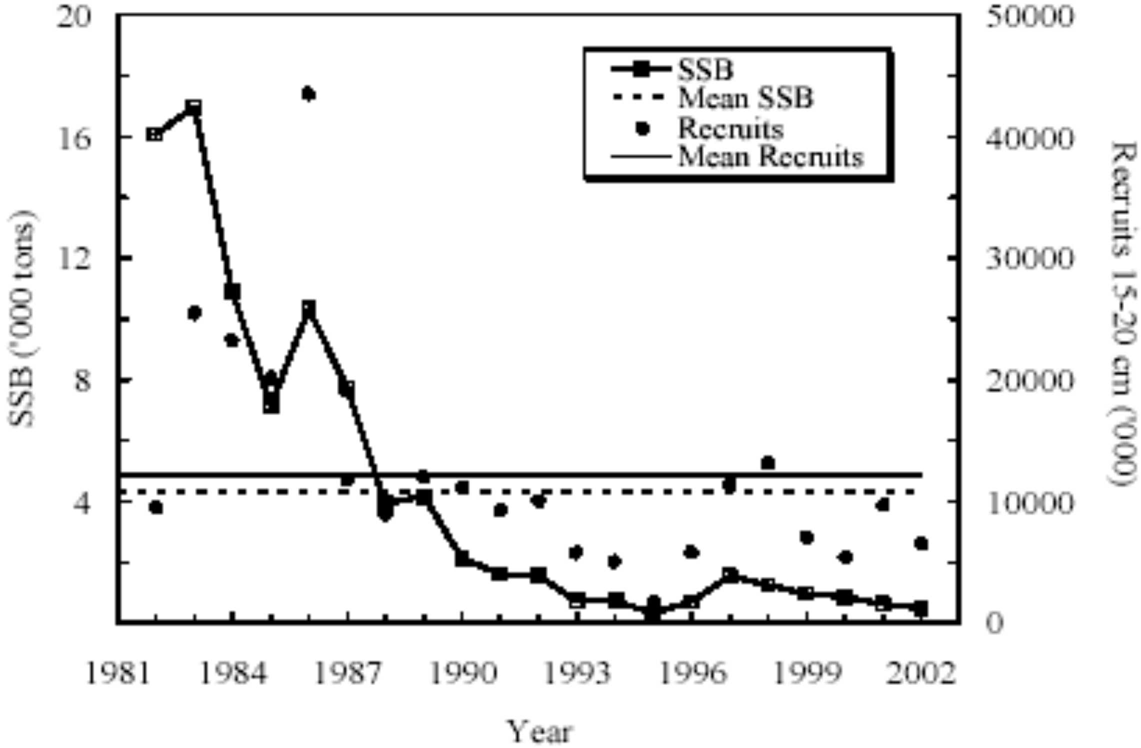

Figure 55. Subarea 1 American plaice biomass 1981–2002. (Source: SC Summary Sheet, 2003)

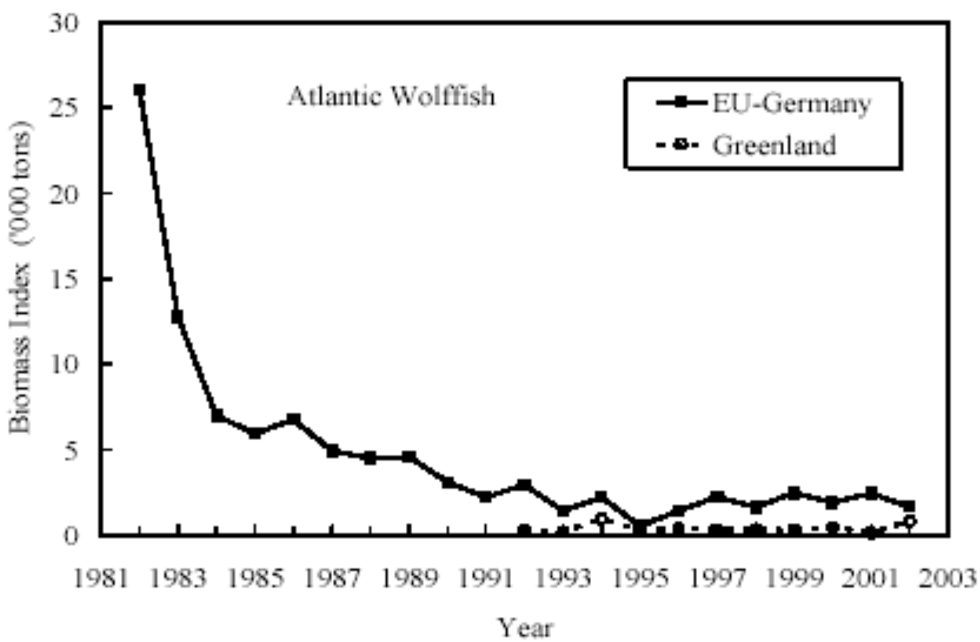

Figure 56. Subarea 1 Atlantic wolffish biomass 1981–2002. (Source: SC Summary Sheet, 2003)

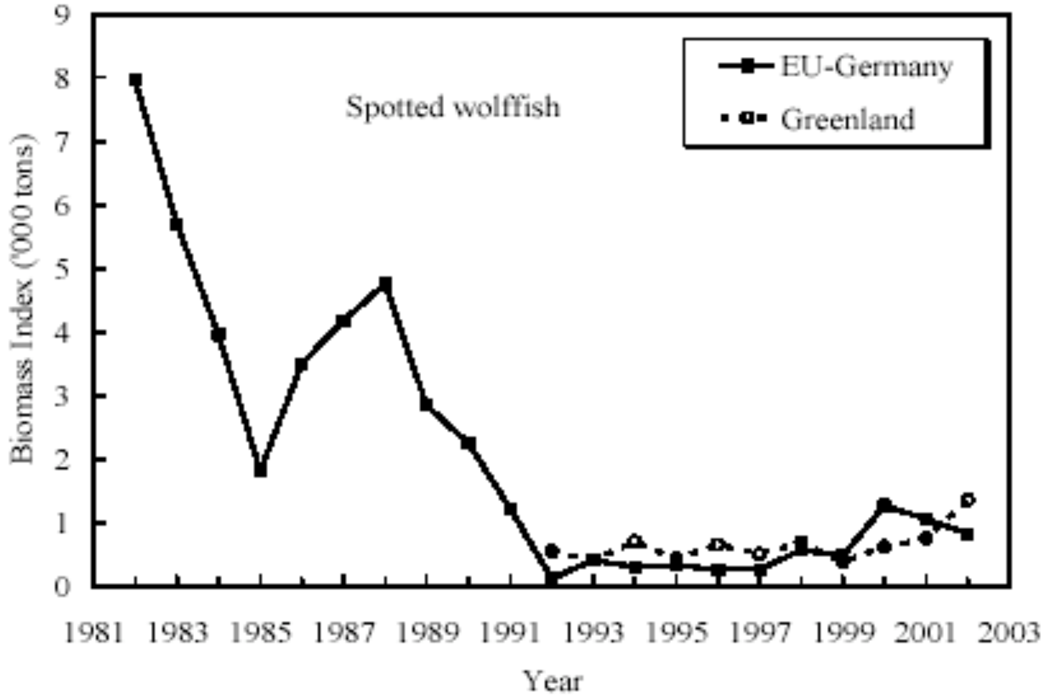

Figure 57. Subarea 1 spotted wolffish biomass 1981–2002. (Source: SC Summary Sheet, 2003)

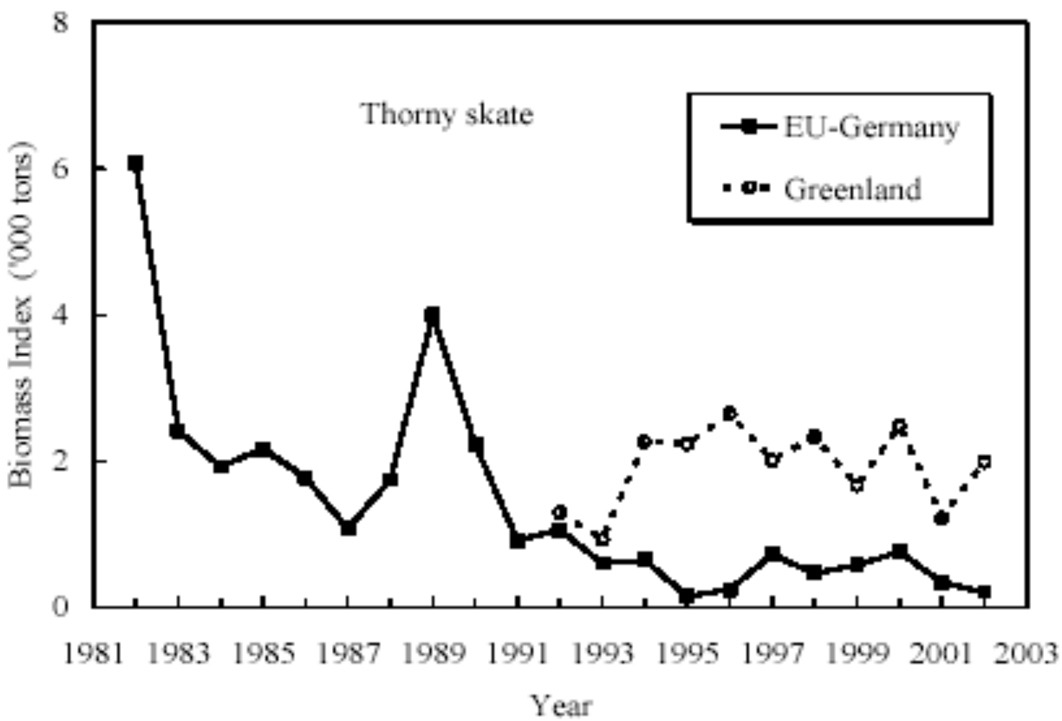

Figure 58. Subarea 1 thorny skate biomass 1981–2002. (Source: SC Summary Sheet, 2003)

Adherence to Scientific Advice

The Scientific Council recommended no directed fishery in 2004 and 2005 for stocks of American plaice, Atlantic wolffish, spotted wolffish, and thorny skate in Subarea 1, and that bycatches of these species in the shrimp fisheries also should be kept at the lowest possible level. It was also noted that the probability for recovery of these stocks would be enhanced if the bycatch taken in the shrimp fishery were significantly reduced.

In order to reduce the bycatch in the shrimp fishery, on October 1, 2000, Greenland introduced the mandatory use of 22mm sorting grids into the full geographic range of the Greenland shrimp fishery. Results of experimental fishing using these sorting grids shows near complete protection to finfish larger than about 20 cm, but poor protection of smaller fish (Engelstoft and Jørgensen, 2001). In addition to introducing sorting grids, Greenland shrimp trawling regulations require ships to move at least five miles from fishing grounds where bycatch exceeded certain limits before resuming fishing (Storr-Paulsen and Jørgensen, 2003).

Bycatch and Discards of Finfish in Other Fisheries

Shrimp Fisheries
Shrimp fisheries account for the largest bycatches of finfish classified under "other" and are recognized as an impediment to stock recovery.

Russia
The Russian demersal fishery for Greenland Halibut Division 1D, which operates inside Greenland's EEZ from September to November, reported taking less than 1t of wolffish and skates as bycatch in 2003 (Vaskov et al., 2004).

Germany
A German redfish fishery operates in the NAFO Regulatory Area and Greenland EEZ in Division 1F and NRA Division 2J, but reported no bycatch at all in 2003 (Rätz et al., 2004). This seems unlikely given the reported bycatch from other redfish fisheries within the NRA.

Greenland
Greenland operated a pelagic fishery in NAFO Div 1F in 2002 for roughhead grenadier, but no bycatch information was reported (Siegstad et al., 2003a). Based on the Greenland Annual Abundance Survey conducted in Division 1AN-1D for shrimp and groundfish species, the following species were captured in this area: wolffish, cod, Greenland halibut, redfish, American plaice, and starry skate (Siegstad et al., 2003a). It might be expected that at least some of them would be caught as bycatch in the roughhead grenadier fishery.

Impact on Stock from Direct and Indirect Fishing

The increase in finfish bycatch in the area by shrimp fisheries in 2003 is worthy of further investigation, to evaluate if this trend continued in 2004 and 2005. Given the precarious state of the finfish stocks in this region and the Scientific Council's recommendation to keep bycatch of these stocks to a minimum, such bycatch levels could have a detrimental impact on stock recovery. The increase in lumpsucker catches, together with the lack of information of the stock status, is a cause for concern (STACFIS, 2003a). Further analysis of the impact of this inshore fishery, along with the cod fisheries and roughhead grenadier directed fishery, are needed.

Summary

Available data are inadequate to undertake stock assessments or formulate management advice (other than to prohibit fishing for severely depleted stocks) for all stocks considered in this chapter. Four stocks are subject to directed fishing (redfish, Greenland cod, lumpsucker, and roughhead grenadier) and all others are caught indirectly as bycatch in other target fisheries.

The stock status of American plaice, Atlantic wolffish, spotted wolffish, and thorny skate is reported as poor with either current biomass or SSB estimates at, or near to, historic lows. Poor stock indices were recorded for American plaice, Atlantic wolffish, and redfish for over a decade.

Bycatch of "other" finfish in the shrimp fishery is a management concern likely impeding stock recovery. Although sorting grids were introduced, these do not appear effective for fish < 20cm total length.

Table 15 summarizes available stock (SSB) status and bycatch and catch data, and where available, age of capture of the unmanaged species.

Table 15. Status of unmanaged stocks.

Stock	SSB	Catch	Age at Capture
3K skate	Unknown	>100t (bycatch)	?
Subareas 2 and 3 roughhead grenadier	30,000 to 45,000t from 1996 to 2003	3,700t (bycatch); 301t (Portugal: directed catch)	Juveniles
Other finfish stocks in Subarea 1	American plaice (1,000–2000t), Atlantic wolffish (1,000–3,000t in 2003), spotted wolffish (500–1,500t), and thorny skate (1,000–3,000t)	Shrimp fishery bycatch 7,437t (2002); Denmark/Greenland reportedly took 1,288t of Greenland cod in the inshore waters. Russian demersal fishery for Greenland halibut Division 1D <1t (wolffish & skate),	?

Data and Information Gaps

Limited current research is being conducted to determine appropriate management actions for these species.

Impediments to Effective Regulation of Stocks Under TACs or Effort Controls

Research on these stocks is only conducted at the request of individual Contracting Parties or the Fisheries Commission. There appears to be limited current incentives for regulating these stocks.

Recommendations

Recommendations to address issues identified in the body of this chapter are presented below.

Developing and Implementing Management Measures

The Fisheries Commission should consider adopting management measures — either effort control, reasonable TACs, and/or stock recovery plans — for 3K Skate, Subareas 2 and 3 roughhead grenadier and demersal redfish.

Improving Information Availability

The Fisheries Commission should consider the following:

- Implementing a comprehensive program to monitor bycatch, discards and high-grading of these stocks.
- Consistently recording catch and discards by species for these fisheries

Chapter 5

Unregulated Fishing of NAFO Stocks by Non-Member NAFO Countries

During its June 2004 STAFAC Meeting in Copenhagen, Denmark, several Contracting Parties who are also party to NEAFC, voiced concern that an increasing number of non-Contracting Party (NCP) vessels were targeting oceanic redfish in the NEAFC and following the fish into the NAFO Regulatory Area in the summer and fall months (NAFO, 2004a).

Three cargo vessels were seen in the NEAFC Regulatory Area in 2004 from the flag states of Liberia, Belize and Malta in April, May, and June, respectively. They were not witnessed in the process of trans-shipping, thought this was suspected. In addition, diplomatic demarches were issued to Belize, Dominica and Dominican Republic. Belize replied and indicated that it had deregistered the vessels in question, and the Dominican Republic responded that the vessels sighted were in fact from Dominica, not the Dominican Republic.

In the previous two years, Canada indicated that the following eight non-Contracting Party vessels were sighted fishing in Subarea 2 and Division 1F of the NAFO Regulatory Area: *Oyra, Ostroe, Okhotino, Olchan, Ostrovets, Ozherelye, Lisa, and Pavlosk*. The first five of these vessels were flying the flag of Dominica in 2003 and the flag of Belize in 2002. The vessel *Lisa* is believed to have been the *Kadri*, which has changed its name and its flag. Canada explained that in attempting to determine the flag and the registration of these vessels, it encountered conflicting information from Lloyd's Register, Cypriot officials and the masters of four vessels which were contacted. Specifically, *Okhotino, Orchan, Ostrovet,s and Ozherelye* were initially believed to be registered in the Dominican Republic, but during the 2004 annual meeting, the EU was able to confirm that all four were actually flagged by Dominica. Based on the area in which the vessels were sighted fishing, as well of the time of year, it may be inferred that they were directing their fishing activities towards oceanic redfish (NAFO, 2004a).

In 2002, six vessels registered to Belize reportedly harvested an estimated 6,000t of oceanic redfish in divisions 1F and 2J. The Russian Federation (a Contracting Party with reportedly six vessels engaged in illegal fishing) and Cyprus were also engaged in fishing activities for 1F redfish. In the early 2000s, Sao Tome, Principe, Panama, Honduras, and Sierra Leone were all found to be illegally fishing in the NAFO Regulatory Area.

Summary

Oceanic redfish continues to be a prime target for non-Contracting Parties in the NAFO Regulatory Area in Divisions 1F and 2J. It is not known what impact this fishing activity is having on moratorium stocks. However, since cod are under moratorium in Division 2J, and redfish and cod are consistently captured together by NAFO regulated fisheries, it is assumed that some level of cod bycatch is occurring.

Data and Information Gaps

- There are no comprehensive data collection efforts concerning non-Contracting Parties.

Impediments to Effective Regulation of Non-Contracting Party Fishing in NRA

- Non-Contracting Parties must first agree to be inspected by NAFO inspectors.

Recommendations

Recommendations to address issues identified in the body of this chapter are presented below.

- Implement a blacklist and publicize it on the NAFO website.
- Explore the use of trade sanctions against violators.

Action Taken by NAFO to Address Bycatch and IUU Fishing

Against Contracting Parties

Illegal and unreported fishing activities of Contracting Parties (e.g., Canadian scientists and fishermen report direct targeting of moratorium species and high-grading) are problems in a number of NAFO-regulated fisheries. In 2003, the most recent year for which complete data are available from the Secretariat on Contracting Party compliance with NAFO regulations, a total of 26 citations were issued. Of these, the majority were issued to EU-Portugal (11). Five of these citations were issued for directly fishing on moratorium species, one citation was issued for illegally using smaller mesh and seven other citations were issued for misreporting of catch. Spain and Russia each had four violations for the following actions: directing on moratorium species, illegal gear modification or illegal mesh sizes, and misreporting of catches. Other countries with violations in 2003 included France (one violation) for failure to have an independent observer onboard, Estonia (two) for using a smaller mesh size than the regulatory requirement set by NAFO (in one case it was using 125cm versus 130 cm), Japan (two) for not having an independent observer onboard and for illegal mesh size or gear modifications, and Lithuania (three) for not having vessel monitoring systems (VMS) on two of its vessels and for misreporting of catches.

The only available information from the NAFO Secretariat for 2004 based on inspection reports received to date is for the first quarter (January–March 2004), which indicated that the EU had taken 8,048t of fish over the course of 2,204 fishing days and had been boarded 42 times for the purpose of inspections, resulting in two citations issued. Between one to four inspections were carried out on vessels of the following countries during this same time frame: Estonia (3 boardings/0 citations issued), Latvia (1/1), Lithuania (3/0), Norway (1/0), Poland (1/0), Russia (4/0), Denmark/Faroes (1/0). Of a total of 56 boardings, only three citations were issued during this time period. This suggests that either the majority of the time, vessels are fishing by the regulations, or they may be dumping any illegal catch prior to inspection. The latter is not an unlikely scenario given that in May 2004, Canadian officials recovered a net from the bottom of the ocean containing rotting cod, American plaice and redfish — all species under moratoria. The net was believed to have been recently cut from the vessel *Brites* in the early hours of May 4 while on the Grand Banks since the net was not on board when Canadian fisheries inspectors boarded it. The net had an illegal mesh of 107mm; the smallest net size allowed under NAFO regulations to protect threatened species is 130mm.

Most of the reported high-grading taking place appears to be occurring in shrimp fisheries. For instance, in the 3L Greenland trawl shrimp fishery, 1.2t shrimp were discarded in 2003. In 3M, more than 3.1t shrimp were discarded along with redfish and "other" finfish. The Subarea 1 shrimp fishery reports discarding not only shrimp but also juvenile redfish. In some of these cases, the shrimp discards may be due to high-grading. Evidence in support of this comes from Canadian 3L fishermen who claim to have witnessed the discarding of small shrimp by various countries in the NRA just beyond the Canadian EEZ.

A more complete record of citations issued in 2004 is available through the Canadian Department of Fisheries and Oceans. In 2004, Canadian officials issued a total of 15 citations to nine vessels: two citations issued to one Latvian vessel, four citations to two Lithuanian vessels, five citations to three Portuguese vessels, three citations to two Spanish vessels and one citation to one Estonian vessel. This does not include additional citations issued by the EU and other countries over the course of the year, although it is likely these represent the majority of citations issued, as Canada appears to conduct the majority of enforcement activities for NAFO.

Preliminary information for 2005 includes the following citations issued by Canada's NAFO inspectors to vessels fishing in the NAFO Regulatory Area:

1. January 15, 2005. Three citations were issued to the Latvian vessel *Atlas* for fishing shrimp without authorization from the Contracting Party, not having an independent and impartial observer on board, and for having an inoperable VMS;
2. February 8, 2005. The Spanish vessel *Playa de Tambo* was issued two citations for failure to record catches on a daily basis and for failing to facilitate the work of a NAFO inspector (http://www.dfo-mpo.gc.ca/overfishing-surpeche/en_citations_e.htm).

Revisions of Conservation and Enforcement Measures

NAFO has made a number of improvements to its inspection scheme, outlined below:

1. Product labelling and storage plans are now obligatory for all species and vessels. The aim of the proposed modification is to ensure more effective inspection of fishing vessels at sea and in port by extending the provisions regarding product labeling, and introducing the requirement for masters of the vessels to keep stowage plans of the catch stored on board. It is also necessary to distinguish between catches taken inside and outside the NAFO Convention Area. The Fisheries Commission agreed that the application of the measure shall be reviewed by STACTIC in 2006.

2. Harmonization of NAFO reports is occurring (e.g., for VMS and reporting of catch information) with formats already used in the Northeast Atlantic by NEAFC, which are more succinct.

3. A workshop for NAFO inspectors is planned to examine procedures and methods for inspections at sea and in port. The goal of this workshop is to increase confidence and to harmonize the approach of inspection authorities of NAFO Contracting Parties.

4. Upon request, detailed observer data (catch and effort for each haul, location [longitude and latitude], depth, time of net on bottom, catch composition, and discards) are to be made available to the Scientific Council by submitting them in an electronic format to the NAFO Secretariat.

5. NAFO inspectors are to be permitted to remain onboard until a vessel caught in violation reaches port (NAFO, 2004b).

However, despite these improvements, a number of problems remain, particularly with respect to observer coverage. Even though observer coverage is mandatory for all member-state vessels, a few nations have been consistently cited for not having observers onboard their vessels. In addition, not all member states were forthcoming with their catch reports, so data on actual catch and bycatch levels by individual countries is incomplete and/or inaccurate. For instance, in 2003 and 2004, only a handful of countries (Canada, United States, Russia, Denmark, Portugal, Spain and Greenland) appear to have provided the Secretariat with summary research reports that included such information as status of the resource, fishing effort, locations based on national non-fishery-dependent research surveys, and observer coverage on fishing vessels. The reports submitted lacked consistency in both presentation style as well as substance. In only one instance were both bycatch and discard information and the actions taken to address the problem included in a national research summary report. Furthermore, a number of Contracting Parties (e.g., Japan) were cited for lack of impartiality on the part of their onboard observers (NAFO, 2004a).

To specifically help curtail bycatch of groundfish in 3L shrimp fisheries Canada proposed modifications to NAFO Conservation and Enforcement measures in 2004, which were accepted to help demonstrate the proper use of toggle chains. Toggle chains which are at least 72cm in length are used to promote minimum spacing between the footrope and fishing line, thereby providing a means of escapement for groundfish.

Bycatch Limits

Vessels of a Contracting Party must limit their bycatch to a maximum of 2,500kg or 10%, whichever is the greater, for 3NO shrimp and Subarea 2 and 3KLMNO Greenland halibut, for which no quota was allocated in that division to that Contracting Party. In cases where a ban on fishing is in force, bycatches of the species concerned (e.g., 3NO cod, 3LNO American plaice, 3NO witch flounder, and 3NO capelin) may not exceed 1,250kg, or 5%, of the catch retained onboard, whichever is the greater. If the percentages of bycatches foreseen in the above mentioned cases are exceeded in any one haul, the vessel must immediately move a minimum of five nautical miles from any position of the previous haul. If any future haul exceeds these bycatch limits, the vessel must again immediately move a minimum of five nautical miles from any position of the previous hauls and must not return to the area for at least 48 hours. In the event that total bycatches of all groundfish species subject to quota in any haul in the shrimp fishery exceed 5% by weight in Division 3M, or 2.5% by weight in Division 3L, the vessel must move a minimum of five nautical miles from the position of the previous haul (NAFO, 2005a).

Mesh Size Requirements

Minimum authorized mesh sizes are as follows: a) 40mm for shrimps and prawns, b) 60mm for short-finned squid (*Illex*), c) 280mm in the codend and 220mm in all other parts of the trawl for skate, and d) 130mm for groundfish (NAFO, 2005a). However, vessels conducting a directed fishery for species other than these are permitted to take regulated species with nets having a mesh size less than specified, provided that they comply with bycatch requirements.

Sorting Grids

Beginning on October 1, 2000, vessels fishing for shrimp in Divisions 3L or 3M shall use sorting grids or grates with a maximum bar spacing of 22mm. Vessels fishing for shrimp in Division 3L shall also be equipped with toggle chains of a minimum 72cm in length, as described in Annex XXII (CEM, 2004). According to the Scientific Council, actual sorting grates are not effective for avoiding large amounts of bycatch of small-sized redfish up to 14cm in Area 3M (Avila de Melo et al*.,* 2003).

Minimum Fish Sizes

Contracting Party vessels are not permitted to retain on board any fish of a species for which minimum fish size requirements apply (e.g., Atlantic cod, 41cm; Greenland halibut, 30cm; American plaice and yellowtail flounder, 25cm; respectively). If the amount of undersized fish in any one haul exceeds 10% by number, the vessel must immediately move a minimum of five nautical miles from any position of the previous haul. Undersized fish are not allowed to be processed, trans-shipped, landed, transported, stored, displayed, or offered for sale, but shall be returned immediately to the sea. Any processed fish for which minimum fish size requirements apply and which is below the legal size shall be deemed to originate from fish that is below the minimum fish size. Canadian vessels must abide by their equivalent national regulations, which require landing of all catches (NAFO, 2005a). Of particular concern is that there are no minimum sizes in place for, *inter alia*, 1) newly regulated species such as skate for which only a quota allocation exists, but which has an extremely vulnerable life history; 2) other moratorium species like witch flounder; and 3) redfish, which in most fisheries are being captured as juveniles.

Enhanced Monitoring and Reporting Requirements

NAFO recently entered into an arrangement with FIRMS, which is a partnership of international organizations, regional fishery bodies, and national scientific institutes, to report and share information on status and trends of fishery resources within a formal agreement. This information is published through the Fisheries Global Information System (FIGIS), a web-based information management tool operated by the Food and Agriculture Organization of the United Nations (FAO) (http://www.nafo.ca/publications/frames/PuFrRep.html).

NAFO has taken steps to evaluate its own data collection efforts. It identified a number of quality and consistency problems in VMS, observer reports, and port inspection reports in the first Compliance Report, which was prepared by STACTIC, in 2004. In response to these findings, the NAFO Secretariat recommended that the following be done: 1) All reports would be prepared in the official language, English; 2) efforts should proceed in standardization of format of observer reports; and 3) reports should be submitted electronically.

Against Non-Contracting Parties

Revisions of Conservation and Enforcement Measures

In 2003, NAFO completed Chapter VI of its Conservation and Enforcement measures, which is a scheme to promote compliance of enforcement measures by non-Contracting Parties. The shortcoming of this scheme is that non-Contracting Parties must consent to be boarded and inspected. And while the vessel may be subject to inspection if it tries to land its catch in the port of a Contracting Party, if it can prove that its catch was taken outside the NAFO Regulatory Area (NRA), then it is free to go. In more recent years, there were discussions about strengthening measures to penalize non-Contracting Parties for fishing on NAFO regulated stocks, both inside the NRA and in EEZ waters, and at ports of Contracting Parties (e.g., for trans-shipment activities). These measures include 1) in regards to national confidentiality, possibly including information like flag state, vessel name, letters and numbers of registration, and other identifying features of the vessel as set out in Annex XII of the NAFO CEM, on a list held by the Secretariat that would be publicly available through the NAFO webpage; and 2) implementing a trade-tracking system that could trigger trade sanctions against violating vessels and/or flag states.

However, these actions have not progressed beyond the discussion stage. This is due to reservations by Canada, Japan, and the EU until similar or stronger measures are adopted for regulating Contracting Parties. This is necessary to ensure that the NAFO process is fair, open, and transparent and hence consistent with international law, including WTO requirements (NAFO, 2004a). Canada suggested that a similar scheme should be adopted within two years for Contracting Parties, but again there was resistance from other Contracting Parties who stated that they felt more time was needed to develop such a scheme. Even under this scheme, much of the burden would continue to fall on individual Contracting Parties to utilize domestic measures to exercise jurisdiction over such vessels, given the current limitations under international law.

At present under international law, the only action taken to address illegal fishing activities by non-Contracting Parties under NAFO is for Contracting Parties to issue a letter or diplomatic demarche to the nation found in violation, asking them to respond on any administrative or legal actions taken by the responsible flag state authorities against these vessels. For instance, with respect to the Dominica registered vessels found to be illegally fishing in the NRA in 2004, Canada and the EU drafted a letter to Dominica requesting that authorities investigate the reported activities by these Dominica-flagged vessels and provide NAFO members with feedback on the results of the investigation taken, as well as on any administrative or legal actions that the Dominican authorities might have taken against these vessels (NAFO, 2004a).

Summary

Some progress has been made in evaluating the shortcomings of current monitoring programs and steps have been taken to more effectively regulate activities of Contracting and non-Contracting Parties in the NRA. The improvements that NAFO has made with respect to its inspection scheme (discussed in section A above) can have positive impacts on reducing bycatch and discards, discouraging IUU fishing, protecting juveniles, and enforcing moratoria. Table 16 provides an overview of these likely impacts.

Table 16. Summary of likely impacts of NAFO regulatory measures.

Measures Taken	Bycatch and Discards	IUU	Juvenile Protection	Moratoria Stock Protection
Improvement to inspection scheme				
Product labelling and storage plans	x	x	x	x
Harmonization of NAFO reports	x	x	x	x
Inspector workshop		x		
Detailed observer data	x	x	x	x
NAFO inspector remains onboard until port is reached	x	x	x	x
Proper use of toggle chains	x		x	x
Bycatch limits	Bycatch to a maximum of 2,500kg or 10%, whichever is the greater, for 3NO shrimp, Subarea 2 and 3KLMNO Greenland halibut			Limits on bycatches of moratorium species may not exceed 1,250kg or 5%, whichever is the greater. If total bycatches of all groundfish species subject to quota in any shrimp fishery haul exceed 5% by weight in Div 3M or 2.5% by weight in Div 3L, vessel must move 5 nautical miles from position of previous haul.
Sorting grids			October 1, 2000, vessels fishing for shrimp in Divisions 3L or 3M required to use sorting grids or grates with max bar spacing of 22mm.	
Mesh size requirements			40mm for shrimps and prawns; b) 60mm for short-finned squid (Illex); c) 280mm in the codend and 220mm in all other parts of the trawl for skate; and d) 130mm for groundfish.	
Small Fish Protocol			Atlantic cod, 41 cm, Greenland halibut, 30 cm, American plaice	

Table 16 continued

Measures Taken	Bycatch and Discards	IUU	Juvenile Protection	Moratoria Stock Protection
			and yellowtail flounder, 25cm.	
Enhanced monitoring (e.g., FIRMS)	X	x	x	x
Scheme to promote Compliance of Enforcement Measures by non-Contracting Parties		x		

However, more needs to be done to ensure comprehensive management of all targeted stocks within the NRA.

Data and Information Gaps

- Monitoring of currently implemented management measures (e.g., the percentage of usage of sorting grids by various shrimp fisheries) is limited, making it difficult to evaluate their effectiveness.

Impediments to Effective Regulation of Stocks

- Managing illegal, unregulated and unreported fishing activities by non-Contracting Parties is proving to be another enormous challenge for NAFO, as is the case for most international organizations. Any fishing vessel sighted in the Regulatory Area is presumed to be fishing in the area and is reported to both the NAFO Secretariat and the non-member flag state. However, only if the vessel consents may it be boarded and inspected. And while the vessel may be subject to inspection if it tries to land its catch in the port of a Contracting Party, if it can prove that its catch was taken outside the NAFO Regulatory Area (NRA) then it is free to go.
- There exists no adequate deterrent to illegal fishing of moratorium stocks by Contracting Parties.

Recommendations

Recommendations to address issues identified in the body of this chapter are presented below.

Developing and Implementing Management Measures

The Fisheries Commission should consider the following:

- Taking measures to better enforce regulations currently in place either through improved voluntary compliance (perhaps supported through appropriate investigations into, e.g., current discrepancies in bycatch rates) or through improved MCS operations (see previous chapter recommendations).
- Defining and implementing Small Fish Protocols for all species currently fished within NAFO.
- Gathering data and beginning to explore development of ecosystem management plans.
- Expanding the use of experimental, coordinated areas and seasonal area closures during the fishing season.

Monitoring and Enforcement

The Fisheries Commission should consider the following:

- Expanding observer coverage and data collection with respect to the use of sorting grates, amount of juvenile bycatch and discards, etc.
- Instituting appropriate scientific monitoring (e.g., surveys of multiple trophic levels), which leads to determinations of conservation-based fishery harvest levels within the ecosystem context.

Chapter 6

Summary Analyses and Recommendations

This chapter reviews and analyses information presented in Chapters 2 and 3, which collate available information on moratoria stocks and TAC-managed stocks. A number of simple summary analyses are presented to indicate current[4] status of moratoria and TAC-managed stocks. It was not possible to undertake these analyses for NAFO stocks currently not managed by TAC or effort control as information was inadequate.

The availability of the information required to undertake these analyses provides insight into the status of the information base currently being used to manage these stocks.

The following two subsections present and discuss the results of these analyses for moratoria and TAC-managed stocks. A third subsection briefly summarizes information about stocks not managed by TAC control. The concluding subsection summarizes the key issues highlighted in this and the previous three chapters and presents a series of recommendations to address these.

Moratoria Stocks

Chapter 2 presented data and information on the stock status, bycatch, and discards for nine stocks currently under moratoria in the NAFO Convention Area (2J 3KL cod, 3M cod, 3NO cod, 3LN redfish, 3LNO American plaice, 3M American plaice, 2J 3KL witch flounder, 3NO witch flounder and 3NO capelin). In addition, some data were included on three Canadian-managed stocks that may mix with stocks found in the NRA (2GH cod, Subarea 2 and Division 3K American plaice, and 3Ps American plaice).

[4] This report is largely based on fisheries information reported for 2003 because it is the year for which the most comprehensive data was available at the time this report was written.

Table 17 presents a summary of key information concerning moratoria stocks drawn from the data presented in Chapter 2. The following subsections address the utility of the available information base with respect to understanding basic stock dynamics and the impacts of bycatch on rebuilding plans for moratoria stocks by reviewing the following:

- whether the scientific information base is adequate to determine reference points
- the current ratio of SSB to B
- the current size of the stock relative to the largest historical reference
- the current level of bycatch removals
- which fisheries are reporting moratoria bycatch

Is the scientific information base adequate to determine reference points?

For five of the twelve moratoria stocks reviewed in Chapter 2 (2J 3KL Cod, 3M Cod, 3NO Cod, 3LNO American plaice, and 3M American plaice), science is adequate to enable stock reference points to be established; for four (3LN redfish, 2J 3KL witch flounder, 3NO witch flounder and 3NO capelin) others, no such information is available; and for the remaining three Canadian stocks (2GH cod, Subarea 2 and Division 3K American plaice, and 3Ps American plaice), it was not clear from the literature whether reference points have been developed. Rebuilding moratoria stocks with such limited scientific information is obviously challenging, suggesting that precautionary approaches must be fully integrated in stock rebuilding plans.

What is the current ratio of SSB to B?

The ratio of spawning stock to biomass is proposed here as a proxy metric that can be used to assess and monitor changes in the age structure of a population. The current age structure reflects the dynamic balance achieved by a population as the result of mortality, recruitment and growth. Changes to the age structure, when combined with other stock parameters, can inform how well a population is responding to management measures. The ratio has limitations, partly because it is based on weight rather than abundance, for which there were even fewer data available. Ultimately, it should also not be used without some reference to the life history of the species in question, but this was beyond the scope of the current study. For the majority of stocks (seven of twelve: 2J 3KL cod, 3LN redfish, 2J 3KL witch flounder, 3NO witch flounder, 3NO capelin, 2GH cod, and Subarea 2 and Division 3K American plaice), it was not possible to calculate the ratio. As previously suggested, rebuilding moratoria fisheries with such limited scientific information is obviously challenging, further supporting the suggestion that precautionary approaches must be incorporated into rebuilding plans. For the two cod stocks (3M and 3NO cod), two very different ratios were obtained, 0.2 and 0.74. Both stocks have been at very low biomass levels for a number of years, and the different ratios probably reflect differences in the relative success of recruitment for each stock. Review of changes to these ratios over time would provide a better indication as to whether age structure trends are improving or worsening. For the other three (which are all American plaice stocks: 3LNO, 3M, and 3Ps), ratios of 0.26–0.66, 0.8 and 0.78 were obtained. The current biomass of these three stocks is 7%, 15.6%, and 20%, respectively, of their recorded historical high. The upper values are similar and may suggest that very little recruitment is occurring. Stocks benefiting from strong recruitment (and hopefully rebuilding) would perhaps have lower ratios.

What is the current size of the stock relative to the largest historical reference?

All fished stocks are (typically) expected to be at biomass levels lower than those in the historical record. In their simplest form, production models predict maximum sustainable yield (MSY) to be achieved when biomass is at 50% of its unexploited value. Life history considerations and more precautionary approaches to management usually demand that biomass target reference points be higher than this. Such reference points are also not constant, in that an ecosystem's capacity to support a particular biomass will change according to a complex and interlinked array of variables associated with temperature, food availability, and the presence (or absence) of predator species. While referencing current biomass to a historical high point would be more meaningful if a reference to the current carrying capacity of the ecosystem could be made, the current low levels recorded for a number of NAFO moratoria stocks are still strikingly illustrative of their poor current conditions. For 2GH cod and 3NO capelin, there are inadequate data to compare current and historical biomass levels. However, it is clear that

3NO capelin, for which there are widely divergent estimates of historical abundance (ranging from several hundred thousand tons to 4 million tons), was a significant resource within the ecosystem. Six of twelve stocks (2J 3KL cod, 3M cod, 3NO cod, 3LN redfish, Subarea 2 and Division 3K American plaice, and 3LNO American plaice) have current biomass estimates less than 5% of the historical high. For 2J3KL witch flounder, there are data for each of three stock subcomponents, and the biomass percentages are estimated at 1% 7.9%, and 18% of the respective historical highs. Two American plaice stocks (3M and 3Ps) are at 16.6% and 20% of the historical highs. Current biomass for 3NO witch flounder is at 24–64% (spring) and 68–92% (autumn) of the respective historical high biomass estimate.

All moratoria stocks are at low levels compared to historical values, and the majority are still at very low levels. Given the length of time fishing has been prohibited, such poor rebuilding success is worrying and suggests measures to further limit bycatch should be considered.

What is the current level of bycatch removals?

For four stocks, current bycatch removals (expressed as a percentage of current biomass) are very high (3NO cod, 70–89%; 3LNO American plaice, 15–27%; 2J3KL witch flounder, 29.8% and 3NO witch flounder, 8.6–18.9%). For two others, they are higher than or equal to 5%[5] (3M American plaice, 5.2% and 3P American plaice, 5%). For two others (2GH cod and 3NO capelin), there are no adequate data, and the remaining four (2J3KL cod, 3M cod, Subarea 2+3K American plaice, and 3LN redfish) have bycatch removals less than 5%.

Collating bycatch information from the NAFO record and elsewhere has been difficult because there is no consistency in how it is reported. This partly reflects the lack of a systematic approach to recording such information. However, perhaps more importantly, it probably reflects the inconsistent way in which such data are submitted by the member states to the NAFO Secretariat.

Table 18 presents available bycatch information for nations fishing in the NRA. Canada, members of the European Union, Russia and Norway appear to be the only Contracting Parties that consistently report bycatch data, although it is often done in an inconsistent manner. Table 3 provides an overview of fisheries that have recorded bycatch of moratoria stocks. When the nations reporting bycatch data are compared to those that are actually fishing (see Annex 1) within those fisheries for which bycatch of moratoria stocks is recorded, it is clear that many fishing nations did not report their (presumed) bycatch. It is unclear how such omissions are considered within the NAFO record. In some instances, total bycatch by area is recorded and for others gaps are apparent. These uncertainties suggest that the bycatch totals collated for this report may represent minimum estimates.

Fisheries Reporting Moratoria Bycatch

Fisheries which appear to have the most impact on stocks currently under moratoria include the following:

- For NAFO regulated fisheries: shrimp, Greenland halibut, skate, redfish, yellowtail flounder and white hake fisheries. Fisheries operating within the Exclusive Economic Zones (EEZs) of Canada take moratoria species as bycatch in directed national fisheries (see Table 3).
- The fisheries of Belize, Dominica, Liberia, Belize, Malta, Cyprus, Sao Tome, Principe, Panama, Honduras and Sierra Leone. These non-Contracting Party nations have been reportedly fishing on redfish in Division 1F. It is likely that cod under moratorium are being taken by at least some of these fisheries as NAFO Contracting Party fishing vessels operating in the area have reported catching cod as bycatch in their redfish and other directed fisheries.

Several Contracting Party fisheries appear to be taking high levels of moratoria species in the following areas:

- 3LNO skate fisheries are taking 3NO cod, 3LNO American plaice, and 3NO witch flounder.
- Greenland halibut fisheries operating in 2J 3KLMNO are taking redfish in 3LN cod, American plaice, and witch flounder in 2J 3KL; American plaice in 3M; and American plaice in 3LNO.
- Redfish fisheries in 3O are capturing cod, witch flounder, and American plaice.

[5] 5% is the allowable bycatch limit (expressed as a percentage of the catch retained onboard) for a moratorium stock within the NRA.

- Shrimp fisheries in 2J 3KLMNO are taking 2J 3KL and 3NO cod, 3LNO American plaice, and 3LN redfish.
- The 3LNO white hake fishery reported taking cod and witch flounder in 3NO, redfish in 3LN, and American plaice in 3LNO.
- Roughhead grenadier fisheries have taken cod in 3O and American plaice in 3N.
- Yellowtail flounder fisheries have reported taking cod and American plaice in 3L to a small degree, but to a larger extent in 3NO.
- Witch flounder is reported as bycatch of American plaice in Subarea 2.

Illegal Fishing of Moratoria Species and NAFO Measures to Address This Problem

Illegal fishing may be a problem in many fisheries, where Contracting Parties fish for moratorium species under the guise of permitted bycatch limits. For the past two years, Canada has raised this concern during its annual report on fishing infractions to the Fisheries Commission. In addition, vessels from the following countries were cited in 2003 and 2004 for, *inter alia*, directed fishing on moratorium stocks, using smaller mesh size than permitted, underreporting catches, illegal gear modifications, not having an independent observer onboard and/or not having vessel monitoring systems: Portugal, Spain, Russia, Latvia, Estonia, Japan, and Lithuania.

NAFO has instituted a number of measures to restrict bycatch, such as mesh size requirements for cod and Greenland halibut, and Small Fish Protocols for cod, Greenland halibut, yellowtail flounder, and American plaice, to limit the taking of juveniles. However, Small Fish Protocols do not exist for several NAFO moratoria species (e.g., redfish and witch flounder).

In addition, NAFO mandates the use of shrimp grids or grates in all of its shrimp fisheries, but the level of usage by Contracting Party vessels is poorly understood because these data are being collected at the national level and not always shared with the NAFO Secretariat or made publicly available.

NAFO has made some progress towards evaluating Contracting Party compliance records and improving monitoring and deterrence of their illegal fishing by Contracting Parties. In addition, steps have also been taken to reduce unregulated and unreported fishing by non-Contracting Parties. For instance, in the past few years, NAFO Contracting Parties have taken steps to strengthen their enforcement capabilities for stocks within their regulatory area. NAFO has instituted a new Conservation and Enforcement policy for managing fishing activities by non-Contracting Parties. In addition, in 2004, it presented the results of its first formal review of regulation compliance by Contracting Parties. It has held preliminary discussions on the use of public blacklists of violating vessels and trade sanctions against both Contracting and non-Contracting Parties as means for penalizing nation states for undermining NAFO management measures. Unfortunately, little has been done yet in terms of implementing these measures.

The reason behind many of the problems mentioned above is the inherent weakness of international law, whereby national political agendas often override efforts to impose sufficient deterrents to impede violations on the high seas. This problem is also evident when Contracting Parties are defining and implementing management measures in the first place. For instance, Contracting Parties consistently ignore scientific advice or adopt the least conservative option when establishing quotas, or they exceed quotas once they are in place.

TAC-Managed Stocks

Chapter 3 reviewed 14 managed stocks. There are nine stocks in the NAFO Regulatory Area subjected to directed fishing which are currently regulated via Total Allowable Catch (TAC) or effort controls (redfish in 3M, 3O and Subarea 2 and Division 1F3K; 3LNO yellowtail flounder; Greenland halibut in Subarea 2 and 3KLMNO, squid in Subareas 3 and 4; shrimp in 3M; 3LNO white hake; and 3LNO thorny skate). For one other stock, Subarea 2 and 3LNO shrimp, fishing has been restricted in the NAFO Regulatory Area to 3L, but fishing also is occurring inside the Canadian EEZ in adjacent 3K and Subarea 2. Greenland halibut in Subarea 0 and Division 1A Offshore and Division 1B-1F; northern pink shrimp in Division 0A and Divisions 1A and 1F; and roundnose grenadier in subarea 0 and 1 are under the shared jurisdiction of Canada and Greenland (Denmark) and their relationship to the NRA is poorly understood. Another is solely under the jurisdiction of Denmark and Iceland; however, its relationship with nearby stocks in the NRA are poorly understood so it, too, is included here (Denmark Strait and off East Greenland shrimp stock).

Table 18 presents a summary of key information concerning TAC- and effort-managed stocks drawn from the data presented in Chapter 3. A similar approach to that utilized above for moratoria stocks has been used, although additional information has been summarized relating to the setting of TACs, the scientific basis for this, whether advice was followed, and whether catch limits were observed.

Is science adequate to advise a TAC?

For 7 of 14 stocks reviewed, science-based information was adequate to advise a TAC (3M redfish, Subarea 2 and Division 1F3K redfish, 3LNO yellowtail flounder, Subarea 2 and 3KLMNO Greenland halibut, Subarea 3 and 4 squid, Subarea 2 and 3KLNO shrimp, Divisions 0A and 1AF northern shrimp). A single point estimate was established for five of these stocks (Subarea 2 and Division 1F3K redfish, 3LNO yellowtail flounder, Subarea 2 and 3KLMNO Greenland halibut, Subarea 2 and 3KLNO shrimp, Divisions 0A and 1AF northern shrimp) while a range was proposed for the other two stocks (3M redfish and Subarea 3 and 4 squid). Regarding the five stocks for which scientific information was inadequate to advise a TAC, a number of measures were proposed, including a catch range for 3O redfish and a TAC for Subarea 0 and Division 1A (offshore) and Division 1BCDEF Greenland halibut. Also a decision was made to introduce a TAC for 3LNO white hake in 2005, and a recommendation made that no directed fishing occur for Subarea 1 and 0 roundnose grenadier. For 3M shrimp, the advised TAC was unknown. Finally, for the remaining two stocks (3LNO thorny skate and Denmark Strait and East Greenland shrimp), it was not clear if there was sufficient scientific basis on which to advise a TAC.

The information base on which to determine a TAC was only adequate for half of the stocks reviewed in Chapter 3. Prudent management of those stocks that have inadequate information to establish a TAC demands the adoption of precautionary approaches when making total catch allocations.

Was the TAC advice followed?

For the stocks for which a TAC was proposed (irrespective of the information used to determine the TAC and including two stocks for which a TAC of zero was proposed), only four stocks had a TAC adopted at, or lower than, the advised TAC level (Subarea 3 and 4 squid, Subarea 2 and 3KLNO shrimp, 3LNO yellowtail flounder, and Subarea 2 and 3KLMNO Greenland halibut). In seven cases, the TAC established was either higher than that advised or at the higher end of the range proposed (3M redfish, 30 redfish, Subarea 2 and 3KLMNO Greenland halibut, Divisions 0A and 1AF northern shrimp, Denmark Strait and East Greenland shrimp, 3LNO thorny skate, and Subarea 1 and 0 roundnose grenadier). For the two stocks for which the advised TAC was zero, Subarea 1 and 0 roundnose grenadier had a TAC established by Greenland and the other (Subarea 2 and Division 1F3K redfish), although a zero TAC was proposed, member nations continued to fish. For the two remaining stocks, no TAC was established for 3LNO white hake[6] (so that fishing was conducted without any imposed limits) while no information was available on the TAC proposed for 3M shrimp. For the 3M shrimp stock, a TAC of 45,000t was set but the basis for this, or whether scientific advice was followed, is unclear.

Given the apparent poor information base on which to determine TACs and the fact that only 4 of 14 stocks had TACs established at, or lower than, the proposed TAC, it does not appear that precautionary approaches are being followed for all stocks. It is also not clear from the NAFO record how such decisions

[6] There was no TAC established in 2003, although a TAC is in place for 2005.

were supported or why they were taken. Making available such information would greatly enhance the transparency of NAFO's decision-making processes.

Did the TAC constrain catches?

For five of the managed stocks, catches were higher than the established or in the case of shrimp, which is under effort control, recommended TAC (3O redfish, Subarea 2 and Division 1F3K redfish, 3M shrimp, Northern pink shrimp Subarea 2, and 3KLNO and 3LNO thorny skate), while no TAC was established for 3LNO white hake in 2003.Catches lower than the established TACs were recorded for all other stocks. Three (3M shrimp, 3O redfish, and 3LNO thorny skate) of the stocks whose catches exceeded the TAC also had TACs set that were higher than originally proposed. The overfishing of these TACs in such instances obviously compounds the incautious approaches taken when the TACs were set.

What is the current ratio of SSB to B?

It was possible to establish this ratio for four stocks only. For the two shrimp stocks (Subarea 2 and 3KLNO shrimp and Divisions 0A and 1AF northern shrimp), and assuming that the ratio applies in both cases to estimating the female SSB, the ratios of 0.38 and 0.34 respectively would appear to represent a healthy age structure. For 3M redfish, the ratio (0.11) would appear uncomfortably low, given the period of time this fishery has been closed. Trend data would help determine whether the age structure is improving and whether the current low ratio reflects recruitment success or a declining adult stock. For Subarea 2 and Division 1F3K redfish, the ratio was 0.4. Further research is required to establish whether this represents an adequate age structure.

The limited data available to calculate the SSB:B ratios is a reflection of the wider deficiencies in the information available to determine appropriate target reference points. This again underlines the need for precautionary approaches when such targets are set.

What is the current size of the stock relative to the largest historical reference?

There is a remarkable dichotomy between the ratios exhibited for shrimp stocks, 3LNO yellowtail flounder, and 3LNO white hake and the other stocks reviewed. Current biomass and SSB estimates for shrimp are at historical highs. Estimates for yellowtail flounder are currently at 25% above B_{MSY} and current white hake biomass estimates are more than three fold higher than the previously lowest historical record. For 3LNO skate, the current biomass ratio fluctuates depending on the particular trawl survey data referenced. For four other stocks (3M redfish [0.2]), Subarea 2 and Division 1F3K [golden redfish = 0.21, deepsea redfish = <0.01], Subarea 2 and 3KLMNO Greenland halibut [0.27] and Subarea 3 and 4 squid [0.05]), the derived ratios are comparable to those recorded for certain moratoria stocks (e.g., 3M [0.166] and 3Ps [0.2] American plaice). The low values for squid are thought to reflect current stock condition under poor environmental conditions and not necessarily as the result of overfishing. For four stocks, it was not possible to calculate the ratio (Denmark Strait and East Greenland shrimp, 3LNO white hake, 3LNO thorny skate, and roundnose grenadier Subarea 1 and 0).

What is the current level of bycatch removals?

In all but one case (3M redfish), there are no reported bycatch summaries that allow an assessment of the impact of bycatch removals. Bycatch of 3M redfish in the shrimp fishery is of concern for the NAFO Secretariat and, if continued, it is the authors' view that this stock will likely be placed under moratorium. The lack of bycatch reporting, or the inability to extrapolate bycatch data from current catch data, represents a serious gap in the current information base.

As noted above, the number of countries reporting bycatch is smaller than the total number of nations operating within fisheries known to take bycatch.

Fisheries Reporting TAC-managed Stock Bycatch

As noted above, the number of countries reporting bycatch is smaller than the total number of nations operating

- The redfish fishery in 3M appears to be taking high levels of Greenland halibut as evidenced by the Portuguese redfish fishery operating in the area, which reported Greenland halibut bycatch of 29.5–47.6% of its total catch of redfish from January to April in 2003.
- The shrimp fishery operating on the Flemish Cap also is taking high levels of predominantly juvenile redfish as bycatch, much of which is being discarded. In 2001/2002, redfish bycatch reached 750t, the highest level observed since 1994. Translated into numbers, this represents

an increase from the 1999–2000 bycatch level of 3.4 million redfish to 22.1 million, representing 71% of the total 2001–2002 redfish catch in numbers. The Scientific Council expressed concern that such high bycatch jeopardizes sustainability of redfish stocks in this area.

- The Scientific Council suspects that the level of bycatch and discarding of predominately juvenile redfish by shrimp fisheries in Subarea 1 could be substantial.
- The white hake fishery operating in 3O is reportedly taking high levels of redfsh and skate bycatch.
- In addition to moratorium cod and American plaice, the skate fishery in 3NO is reportedly taking high levels of bycatch, including 3LNO yellowtail flounder, monkfish, and Atlantic halibut.

Stocks Currently Not Managed by TAC

Three stocks that are not currently managed by TAC were briefly reviewed in Chapter 4: 3K skate, Subarea 2 and 3 roughhead grenadier, and Subarea 1 finfish stocks. Available data are inadequate to undertake stock assessments or formulate management advice (other than to prohibit fishing for severely depleted stocks) for all stocks not currently managed by TAC. Three stocks are subject to directed fishing (Subarea 1 Greenland cod and lumpsucker, both of which are considered Subarea 1 finfish stocks, and Subarea 2 and 3 roughhead grenadier), and all others are caught indirectly as bycatch in other target fisheries.

The status of a number of Subarea 1 finfish stocks (American plaice, Atlantic wolffish, spotted wolffish, and thorny skate) are reported as poor, with either current biomass or SSB estimates at or near historic lows. Poor stock indices have been recorded for Subarea 1 American plaice and Atlantic wolffish and for Subarea 2 and 3 redfish for over a decade.

Fisheries for 3K skate and Subarea 2 and 3 roughhead grenadier occur without regulations restricting fishing operations or catches. Subarea 1 finfish fisheries are similarly prosecuted but the Scientific Council recommended that no directed fisheries occur for Subarea 1 American plaice, Atlantic wolffish, spotted wolffish, and thorny skates in 2004 and 2005. The Council also recommended that bycatch be restricted to their lowest levels possible. Greenland has introduced 22mm sorting grids within its shrimp fisheries to reduce bycatch. However, bycatch of Subarea 1 finfish from the shrimp fishery is still likely impeding stock recovery since the introduced sorting grids do not appear effective for fish <20cm total length. The fact that finfish stock bycatch in this area is not differentiated into species when reported also limits an analysis of the impact of bycatch on these species.

Recommendations

NAFO is one of several RFMOs charged with managing fisheries on the high seas. Like most international organizations, it struggles to effectively enforce its regulations under the limitations of international law whereby countries must, in essence, consent to be regulated.

Considering the period of time they have been under regulation, the current status of most NAFO-managed stocks is a strong indictment of the inefficiencies of RFMOs in general and of NAFO in particular. The lack of political will to fundamentally address the current management problems that are essentially within the remit of the existing Contracting Parties (there being little evidence available in the public domain that non-Contracting Parties are the major contributors to the problem) is startling.

To address the current problems identified within this report, a series of recommendations are proposed to improve the following:

- development and implementation of fisheries management within NAFO
- availability of fisheries information
- monitoring and enforcement
- governance

Fundamentally, however, to improve the dire state of many NAFO stocks, a precautionary approach must be fully embraced by Contracting Parties and appropriately applied. While there are deficiencies in the information base available to those undertaking proper scientific analyses for certain stocks, this, or the analyses themselves, does not represent the major stumbling block to implementing better management. At some level NAFO clearly recognizes the information deficiencies and has developed a framework that addresses when and how precautionary principles are to be applied to management decision-making. Unfortunately, unless these measures are fully embraced by the Contracting Parties when they are determining TACs or methods to reduce bycatch, the precautionary framework developed (despite its merits) will be meaningless.

Developing and Implementing Management Measures

The Fisheries Commission should consider measures to accomplish the following:

- Separate the role played by scientific advice in determining the TAC from political decisions concerned with allocation between Contracting Parties. Where scientific information is inadequate as the basis for determining total allocations, the use of precautionary reference points for target and bycatch species should be introduced.
- Move away from managing fisheries based on allocating TACs according to historical fishing effort and catches. Adopting adaptive fishery management plans (underpinned with simulation work to determine reference points under a range of management scenarios that will trigger future management response) is suggested. These should provide a realistic appraisal of the range of outcomes under fishing and the probabilities of these outcomes under different management actions.
- Collaborate with countries with bordering EEZs to ensure consistent management of shared resources.
- Adopt management measures including effort controls, reasonable TACs and/or stock recovery plans for 3K Skate, Subareas 2 and 3 roughhead grenadier, and Subarea 1 finfish.
- Develop bycatch mitigation measures for fisheries in addition to shrimp.

Addressing Information Availability

The Fisheries Commission should consider measures to accomplish the following:

- Improve the current inconsistent manner of information reporting and address this comprehensively for all catch and bycatch information collected and used in stock assessments and formulation of management measures (e.g., TACs). This has been effectively done within other RFMOs (e.g., CCAMLR) and is well within the existing resources of NAFO. Such measures would increase the transparency of current fisheries operations and allow for third party auditing of NAFO science and management deliberations.
- Ensure the timely reporting of annual catch and bycatch information by species and area by all Contracting Parties fishing in the NRA and make this information publicly available in a timely manner.

- Evaluate bycatch rates for different fishing nations targeting the same species in an area. Large differences in some rates suggest either procedures for reducing bycatch rates are required or certain nations are underreporting bycatch.
- Model the impact of current bycatch removals to assess the impact on some moratoria stock rebuilding timescales. This should be done with some urgency to assess this impact and to improve the scientific base for taking appropriate management action.
- Evaluate impacts of bycatch (especially of immature fish) on the status of a number of managed stocks (e.g., the impact of bycatch of redfish in the 3M shrimp fishery on the 3M redfish stock).
- Simulate the effects of bycatch mortality of (immature) fish on biomass, compare the potential gains to the stock from their growth had they not been caught, and calculate the potential loss to the fishery.

Monitoring and Enforcement

The Fisheries Commission should consider the following:

- Developing near real-time reporting protocols for all observer data that would be integrated into a comprehensive VMS reporting scheme.
- Developing a standard port inspection protocol.
- Undertaking a comprehensive review of VMS reporting to determine the frequency of missing data.
- Conducting third party audits of NAFO's information system and incorporate best practice from other RFMOs.
- Adopting Standard Protocols for Observers, including a consistent reporting format by neutral observers.
- Incorporating a comprehensive scientific data collection protocol into the existing observer program.
- Supporting through adequate training resources any improvements to MCS operations that involve fishers and/or observers to ensure that required logbooks and other reporting measures are clearly understood.
- Implementing a black-list program of vessels known to have violated NAFO regulations.

Governance

The Fisheries Commission should consider measures to accomplish the following:

- Improve effective collaboration with Canada, Greenland, and Iceland to develop complementary management measures for shared stocks.Make changes to the voting system to reflect a "weighting" for degree of interest and involvement in a fishery.
- Eliminate or reform the objection system in management decision-making.
- Develop a dispute settlement system or utilize diplomatic dispute settlement tools provided for under the United Nations Fishery Agreement (UNFA) and Part XV of Law of the Sea Treaty (LOS) 1982.

Table 17. Current Status and Bycatch of Moratoria Stocks

Moratoria Stock[7]	Indices of the Stocks			Bycatch Issues			
	Have reference points been established?	SSB[8]: B[9] ratio?	Ratio of current biomass to historical high?	Fisheries taking bycatch	Countries [10]reporting bycatch from ndf[11]	Countries reporting size composition data collected?	Bycatch as a % of B or SSB
Cod 2J 3KL	Yes	ND[12]	B_{1980} <1%	CAN: 3LMNO shrimp trawl CAN: 3KLMNO halibut gill net EU: n/k[13] RUS:3L halibut trawl	CAN, EU, RUS	RUS	3.7% of B[14]
Cod 2GH	n/k	ND	ND	ND	ND	No	ND
Cod 3M	Yes	0.22	B_{1976} 2.8%	DEN: 3M Greenland shrimp ESP/POR: trawl	DEN, ESP, POR	No	2.5 of B
Cod 3NO	Yes	0.74	B_{1967} 1–2%	CAN: 3KLNO shrimp CAN: 3LNO yellowtail flounder CAN: white hake CAN, POR, RUS: redfish ESP/POR: skate trawl RUS: 3NO skate trawl	CAN, ESP, POR, RUS	No	70–89% of B
Redfish 3LN	No	ND	B_{1984} 4%	3L bycatch recorded for CAN, ESP, EST, JAP, LIT, POR, RUS. ESP: halibut trawl & white hake trawl CAN: 3KL & 3LMNO shrimp NOR: shrimp RUS: 3LMNO halibut	CAN, ESP, NOR, RUS	EU, RUS	1–2% of B
American plaice Subarea 2 & 3K	n/k	ND	B_{1980} 3–5%	CAN fishery CAN: halibut trawl	ND	no	<1% of B
American plaice 3LNO	Yes	0.26-0.66	B_{1960s} 5.2% SSB_{1960s} 8.3%	CAN: 3LNO shrimp trawl CAN: 3LNO yellowtail flounder CAN: 3O white hake gillnet & longline CAN: Subarea 2 &	CAN, ESP, NOR, POR, RUS	no	15–27% of B

[7] Data for 2003 unless otherwise indicated.
[8] SSB = Spawning stock biomass.
[9] B = Biomass.
[10] Where: CAN = Canada; ESP = Spain; EST = Estonia; EU = European Union; FAR = Faroe Islands; GRE = Greenland; ICE = Iceland; JAP = Japan; LAT = Latvia; NOR = Norway; POR = Portugal, RUS = Russia; UKR = Ukraine.
[11] ndf = non directed fishing.
[12] ND = no data.
[13] n/k = not known.
[14] Likely to reduce with closure of Canadian directed fishery if other bycatches remain same.

Table 17 continued

Moratoria Stock[7]	Indices of the Stocks			Bycatch Issues			
	Have reference points been established?	SSB[8]: B[9] ratio?	Ratio of current biomass to historical high?	Fisheries taking bycatch	Countries [10]reporting bycatch from ndf[11]	Countries reporting size composition data collected?	Bycatch as a % of B or SSB
				3KLNMO halibut ESP: 3O white hake trawl, 3NO skate trawl, 3LMNO halibut POR: 3NO skate trawl, 3LMNO halibut, 3O redfish RUS: 3LMNO halibut NOR: shrimp			
American plaice 3M	Yes	0.8	B_{1987} 16.6% SSB_{1987} 18.2%	3M bycatch recorded by ESP, JAP, POR, RUS. RUS: 3LMNO halibut	RUS, ESP	no	5.2% of B Up to 6.5% of SSB
American plaice 3Ps	n/k	0.78	$B_{83\text{-}87}$ 20% $SSB_{83\text{-}87}$ 26%	CAN fishery			5% of B_{99}
Witch flounder 2J 3KL	No	ND	2J: B_{77} 7.9%$_{02}$ 3K: B_{79} 1%$_{02}$ 3L: B_{84} 18%$_{02}$	CAN: sub area 2 & 3KLMNO halibut trawl ESP: 3LMNO halibut trawl POR: 3LMNO halibut trawl RUS: 2J&3KLMNO halibut	CAN, EU	no	B_{2001} 29.8[8] B_{2002} 21.2%
Witch flounder 3NO	No	ND	Spring: 3N: B_{84} 24%$_{03}$ 3O: B_{85} 64%$_{03}$ Autumn 3N: B_{92} 68%$_{03}$ 3O: B_{02} 92%$_{03}$	CAN: u/k ESP: 3O white hake, 3NO skate trawl POR: 3O redfish RUS: 3LMNO redfish	CAN, ESP, POR, RUS	no	Spring B_{2003} 3.2 to 8.6 Autumn B_{2003} 7.1 to 18.9
Capelin 3NO	No	ND	ND	ND	ND	no	ND

Table 18. Current Status and Bycatch of Managed Stocks.

Managed Stock	Indices of the Stocks						Bycatch Data				
	Is science adequate to recommend a TAC?	Ratio of advised TAC to that set[16]	Has TAC followed scientific advice?	What is the catch + bycatch compared to the TAC?	SSB: Biomass ratio?	Ratio of current biomass to historical high?	Fisheries taking TAC species as bycatch	Countries reporting bycatch from directed fishery	Are size composition data collected (length/wt)?	Are bycatch retained (r) or discards (d)?	Ratio of bycatch to TAC
Redfish 3M	Yes?[17] TAC proposed 3–5,000t	1 to 1.67[18]	Yes, but decided on higher end of TAC range	Lower. $Catch_{2003}$ = 1,988t,	0.11	0.20	3M shrimp (ESP, EST, FAR, GRE, ICE, JAP, LAT, NOR, POR, RUS, UKR).	RUS, ICE (2 of 7 nations fishing) (see Annex 1)	RUS, ICE	d	In 2002 bycatch of 750t equivalent to 71% of total removals in numbers
Redfish 3O	No. Catch range proposed of 13-20,000t	1 to 1.35[19]	Yes, but decided on higher end of range	Higher. $Catch_{2003}$ = 21,591	u/k	u/k	CAN 2GHJ & 3K halibut fisheries Div1, 2G & 3K shrimp	CAN, ESP, POR, RUS (4 of 5 nations fishing)	u/k	u/k	u/k
Redfish Subarea 2 and Div 1F and 3K Data for Subarea 1	Yes. Zero TAC_{2003} proposed	Zero TAC adopted	Yes in 2003. Previously not	Higher. $Catch_{2003}$ = 32,242t	Golden redfish = 0.16 - 0.20	Golden SSB_{2002} = 0.21_{1981} Deep-sea SSB_{2001} = $<.01_{1983}$	Trawl fisheries for cod (historically), halibut and shrimp	CAN, GER (2 of 9 nations fishing)	u/k	d	Reported to be small (<1%)[20] relative to directed catch.

[16] Where a value of 1 means that the advice and TAC set are the same. Values less than 1 suggests that a precautionary approach has been applied.
[17] Unable to set a TAC 02/03 & 03/04 but range set for 04/05 & 05/06.
[18] Scientific advice recommended a 3,000–5,000 TAC; the TAC set was at the upper range and the ratio reflects this.
[19] Harvest range proposed by Canada and US.
[20] 40t reported for CAN 2GHJ & 3K halibut fishery in 2003 and 60–135t since 2000 for 2G and 3K shrimp fishery.
[21] Inadequate information is available to fully assess this stock and no stock assessments have been undertaken.

Table 18 continued

Managed Stock	Indices of the Stocks						Bycatch Data				
	Is science adequate to recommend a TAC?	Ratio of advised TAC to that set[16]	Has TAC followed scientific advice?	What is the catch + bycatch compared to the TAC?	SSB: Biomass ratio?	Ratio of current biomass to historical high?	Fisheries taking TAC species as bycatch	Countries reporting bycatch from directed fishery	Are size composition data collected (length/wt)?	Are bycatch retained (r) or discards (d)?	Ratio of bycatch to TAC
Yellowtail flounder 3LNO	Yes	0.97 for 05 & 06	Yes. F below FMSY since 1994	Lower 0.99 TAC_{2003} = 13,500: $Catch_{2003}$ = 13,303. u/k for bycatch	u/k	Currently 25% above B_{msy}	u/k	CAN (1 of 5 nations fishing)	u/k	u/k	u/k
Greenland halibut Subarea 0 and Div 1A Offshore and Div 1B-1F	No. TAC_{2003} = 19,000[21]	1.0	Yes	Lower. STACFIS $catch_{2003}$ = 15,318	SSB & B not available for all stock areas	u/k	u/k	u/k	u/k	u/k	u/k
Greenland halibut Subarea 2 and 3KLMNO	Yes. Advised TAC_{2003} = 36,000	1.17	No, higher TAC set	Lower. STATLANT $Catch_{2003}$ = 30,688 $Bycatch_{2003}$ u/k	u/k	B_{2004} = $.27_{1990}$	u/k	CAN, ESP, POR, RUS (4 of 7 nations fishing)	RUS	Both	u/k
Squid Subareas 3 and 4	Yes. Advised TAC_{2004} = 19 - 34,000t	0.56 to 1	Yes	Lower. $Catch_{2003}$ = 1,084. $Bycatch_{2003}$ u/k	No SSB	B_{2004} = $.05^{22}_{1976}$	u/k	u/k	yes	u/k	u/k
Northern pink shrimp Subarea 2 and 3KLNO	Yes. Advised TAC_{2003} = 13,000	1.0	Yes	Lower. STATLANT $catch_{2003}$ = 11,550. $Bycatch_{2003}$ u/k	SSB_{2002} = 0.38 B_{2002}	B^{23}_{2002} = 21.0_{1995} SSB_{2002} = 12.5_{1995}	u/k	CAN, GRE, NOR (3 of 12 nations fishing)	yes	d	u/k
Northern shrimp	Yes. Advised	1.15	No	Higher	SSB^{24}_{2003} = 0.34 B_{2003}	B^{25}_{2003} = 2.63_{1997}	u/k	GRE, NOR[26]	u/k	u/k	u/k

22 Stock currently considered to be in a low productivity period.
23 Considerable improvements in B and SSB seen from survey data, although large error bars on estimates.
24 Calculated for female shrimp only.
25 Considerable improvements in B and SSB seen from survey data.
26 NOR not reported in STATLANT as catching shrimp in these areas.

Table 18 continued

Managed Stock	Indices of the Stocks						Bycatch Data				
	Is science adequate to recommend a TAC?	Ratio of advised TAC to that set[16]	Has TAC followed scientific advice?	What is the catch + bycatch compared to the TAC?	SSB: Biomass ratio?	Ratio of current biomass to historical high?	Fisheries taking TAC species as bycatch	Countries reporting bycatch from directed fishery	Are size composition data collected (length/wt)?	Are bycatch retained (r) or discards (d)?	Ratio of bycatch to TAC
Div. 0A and Div. 1A and 1F	TAC_{2003} = 130,000			STATLANT $catch_{2003}$ = 139,628. $Bycatch_{2003}$ u/k		SSB_{2003} = 2.83_{1991}		(CAN not reporting)			
Shrimp 3M	NO. Advised TAC_{2003} = u/k	Set TAC_{2003} = 45,000	u/k	Higher. STATLANT $catch_{2003}$ = 63,198. $Bycatch_{2003}$ u/k	u/k	SSB_{2003} = 4.8 – 8.0_{1990}	Some discarding reported	GRE, ICE, RUS (3 of 11 nations fishing)	u/k	d	u/k
Shrimp: Denmark Strait and off East Greenland	u/k. Advised TAC_{2004} = 12,400[27]	1.26	No	Lower. STATLANT $catch_{2003}$ = 12,100t	u/k	u/k	u/k	ICE (1 of 5 nations fishing)	u/k	u/k	u/k
White hake 3LNO	No. No advised TAC until 2005	n/a	n/a	STATLANT $catch_{2003}$ = 7,464t[28]	u/k	B_{2003} = 3.3_{1973}	u/k	CAN, ESP ICE (2 of 4 nations fishing)	Incomplete	u/k	u/k
Thorny skate 3LNO	n/k. Advised TAC_{2005} = 11,000t	1.23	No	Higher. STATLANT $catch_{2003}$ = 14,253t	u/k	Engel: B_{2003} = 0.29_{1985} Campelen: B_{2003} = 1.53_{1996}	u/k	CAN, ESP, POR, RUS All fishing nations reporting.	Yes	Both	u/k
Roundnose grenadier Subarea 1 and 0	No. No directed fishing advised 2003–2005	GRE set TAC for SA1 of $3,400_{2001}$ & $4,200_{2002}$	No	Lower. STATLANT $catch_{2003}$ = 47t	u/k	u/k	CAN: Div 0A halibut GRE: SA1 halibut RUS: ID halibut	No, none from directed fishery at present.	Yes	u/k	u/k

[27] TAC set for Greenland only, no TAC set for Iceland.

[28] Catch represented 90.8% of estimated B_{2003} of 8,215t.

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Annex 1. 2003 Catch (STATLANT, 2005)

Table 1. 2003 catch in Subarea 0A.

Country	Species	Weight (t)
Faroe Islands	GREENLAND HALIBUT	2
Canada	NORTHERN PRAWN	2,170
	TOTAL 0A CATCH	2,172

Table 2. 2003 catch in Subarea 0B.

Country	Species	Weight (t)
Canada	AESOP SHRIMP	53
Canada	ATLANTIC HALIBUT	1
Canada	ATLANTIC REDFISHES (NS)	3
Canada	GREENLAND HALIBUT	4,017
Canada	NORTHERN PRAWN	986
Canada	ROUGHHEAD GRENADIER	6
	CANADA TOTAL	5,066
Norway	GREENLAND HALIBUT	1,366
Norway	ROUGHHEAD GRENADIER	5
	NORWAY TOTAL	1,371
	TOTAL 0B CATCH	6,437

Table 3. 2003 catch in Subarea 1A.

Country	Species	Weight (t)
Faroe Islands	GREENLAND HALIBUT	107
Greenland	AESOP SHRIMP	1
Greenland	ATLANTIC COD	1,074
Greenland	ATLANTIC REDFISHES (NS)	12
Greenland	BOREAL (GREENLAND) SHARK	1
Greenland	CAPELIN	31
Greenland	FINFISHES (NS)	97
Greenland	GREENLAND COD	98
Greenland	GREENLAND HALIBUT	24,078
Greenland	ICELANDIC SCALLOP	176
Greenland	LUMPFISH (LUMPSUCKER)	539
Greenland	NORTHERN PRAWN	19,995
Greenland	POLAR COD	4
Greenland	QUEEN CRAB	761
Greenland	ROUNDNOSE GRENADIER	11
Greenland	SKATES (NS)	10
Greenland	WOLFFISHES (NS)	143
	GREENLAND TOTAL	4,7031
Norway	GREENLAND HALIBUT	77
Russia	GREENLAND HALIBUT	254
	TOTAL 1A CATCH	47,469

Table 4. 2003 catch in Subarea 1B.

Country	Species	Weight (t)
Canada	NORTHERN PRAWN	1
Denmark	NORTHERN PRAWN	512
Faroe Islands	GREENLAND HALIBUT	10
Greenland	AESOP SHRIMP	59
Greenland	ATLANTIC COD	1,128
Greenland	ATLANTIC REDFISHES (NS)	136
Greenland	CAPELIN	2
Greenland	FINFISHES (NS)	150
Greenland	GREENLAND COD	503
Greenland	GREENLAND HALIBUT	121
Greenland	ICELANDIC SCALLOP	1,816
Greenland	LUMPFISH (LUMPSUCKER)	614
Greenland	NORTHERN PRAWN	40,087
Greenland	QUEEN CRAB	2081
Greenland	WOLFFISHES (NS)	2
	GREENLAND TOTAL	46,699
Norway	ATLANTIC COD	156
Russia	GREENLAND HALIBUT	5
	TOTAL 1B CATCH	47,383

Table 5. 2003 catch in Subarea 1C.

Country	Species	Weight (t)
Denmark	NORTHERN PRAWN	327
Greenland	AESOP SHRIMP	92
Greenland	ATLANTIC COD	265
Greenland	ATLANTIC REDFISHES (NS)	99
Greenland	FINFISHES (NS)	91
Greenland	GREENLAND COD	108
Greenland	GREENLAND HALIBUT	27
Greenland	ICELANDIC SCALLOP	131
Greenland	LUMPFISH (LUMPSUCKER)	1,015
Greenland	NORTHERN PRAWN	18,667
Greenland	QUEEN CRAB	48
Greenland	ROUNDNOSE GRENADIER	2
Greenland	WOLFFISHES (NS)	90
	GREENLAND TOTAL	2,0635
Norway	ATLANTIC COD	218
Norway	ATLANTIC REDFISHES (NS)	1
Norway	GREENLAND HALIBUT	292

Country	Species	Weight (t)
	NORWAY TOTAL	511
Russia	GREENLAND HALIBUT	247
	TOTAL 1C CATCH	21,720

Table 6. 2003 catch in Subarea 1D.

Country	Species	Weight (t)
Denmark	NORTHERN PRAWN	139
Faroe Islands	GREENLAND HALIBUT	135
Germany	GREENLAND HALIBUT	541
Germany	ROUNDNOSE GRENADIER	6
	GERMANY TOTAL	547
Greenland	AESOP SHRIMP	535
Greenland	ATLANTIC COD	40
Greenland	ATLANTIC REDFISHES (NS)	113
Greenland	FINFISHES (NS)	94
Greenland	GREENLAND COD	115
Greenland	GREENLAND HALIBUT	2,060
Greenland	ICELANDIC SCALLOP	442
Greenland	LUMPFISH (LUMPSUCKER)	973
Greenland	NORTHERN PRAWN	17,018
Greenland	QUEEN CRAB	393
Greenland	ROUNDNOSE GRENADIER	24
Greenland	SKATES (NS)	1
Greenland	WOLFFISHES (NS)	3
	GREENLAND TOTAL	21,811
Norway	ATLANTIC COD	83
Norway	ATLANTIC HALIBUT	2
Norway	BEAKED REDFISH	12
Norway	GREENLAND HALIBUT	928
Norway	ROUNDNOSE GRENADIER	4
	NORWAY TOTAL	1,029
Russia	GREENLAND HALIBUT	1,081
	TOTAL 1D CATCH	24,742

Table 7. 2003 catch in Subarea 1E.

Country	Species	Weight (t)
Denmark	NORTHERN PRAWN	28
Greenland	AESOP SHRIMP	237
Greenland	ATLANTIC COD	194
Greenland	ATLANTIC REDFISHES (NS)	48
Greenland	FINFISHES (NS)	34
Greenland	GREENLAND COD	44
Greenland	GREENLAND HALIBUT	19
Greenland	LUMPFISH (LUMPSUCKER)	398
Greenland	NORTHERN PRAWN	6473
Greenland	QUEEN CRAB	630
Greenland	WOLFFISHES (NS)	26
	GREENLAND TOTAL	8103
Norway	GREENLAND HALIBUT	124
	TOTAL 1E CATCH	8255

Table 8. 2003 catch in Subarea 1F.

Country	Species	Weight (t)
Estonia	ATLANTIC REDFISHES (NS)	6,861
Faroe Islands	ATLANTIC REDFISHES (NS)	1,431
Germany	ATLANTIC REDFISHES (NS)	2,535
Greenland	ATLANTIC COD	377
Greenland	ATLANTIC REDFISHES (NS)	7
Greenland	FINFISHES (NS)	8
Greenland	GREENLAND COD	247
Greenland	GREENLAND HALIBUT	10
Greenland	LUMPFISH (LUMPSUCKER)	103
Greenland	NORTHERN PRAWN	16,555
Greenland	QUEEN CRAB	86
Greenland	WOLFFISHES (NS)	48
	GREENLAND TOTAL	1,7441
Iceland	BEAKED REDFISH	2,329
Latvia	ATLANTIC REDFISHES (NS)	461
Norway	ATLANTIC HALIBUT	19
Norway	ATLANTIC REDFISHES (NS)	3
Norway	GREENLAND HALIBUT	1
	NORWAY TOTAL	23
Poland	BEAKED REDFISH	471
Portugal	ATLANTIC REDFISHES (NS)	1,333
Russia	ATLANTIC REDFISHES (NS)	9,365
	TOTAL 1F CATCH	42,250

Table 9. 2003 catch in Subarea 1NK.

Country	Species	Weight (t)
Greenland	ATLANTIC COD	875
Greenland	ATLANTIC REDFISHES (NS)	63
Greenland	BEAKED REDFISH	1,561
Greenland	CAPELIN	9
Greenland	GREENLAND COD	173

Greenland	GREENLAND HALIBUT	321
Greenland	LUMPFISH (LUMPSUCKER)	2,935
Greenland	NORTHERN PRAWN	16,670
Greenland	QUEEN CRAB	2,642
Greenland	WOLFFISHES (NS)	81
	TOTAL 1NK CATCH	25,330

Table 10. 2003 catch in Subarea 2G.

Country	Species	Weight (t)
Canada	AESOP SHRIMP	49
Canada	GREENLAND HALIBUT	258
Canada	NORTHERN PRAWN	7,216
Canada	ROUGHHEAD GRENADIER	1
	TOTAL 2G CATCH	7,524

Table 11. 2003 catch in Subarea 2H.

Country	Species	Weight (t)
CAN _ Maritimes	GREENLAND HALIBUT	15
Canada	AESOP SHRIMP	2
Canada	CHARS (NS)	15
Canada	GREENLAND HALIBUT	1,586
Canada	ICELANDIC SCALLOP	396
Canada	NORTHERN PRAWN	2,682
Canada	QUEEN CRAB	19
Canada	ROUGHHEAD GRENADIER	4
	CANADA TOTAL	4,719
Russia	ATLANTIC REDFISHES (NS)	325
	TOTAL 2H CATCH	5,044

Table 12. 2003 catch in Subarea 2J.

Country	Species	Weight (t)
CAN-Quebec	NORTHERN PRAWN	26
Canada	AESOP SHRIMP	82
Canada	ATLANTIC REDFISHES (NS)	2
Canada	CHARS (NS)	1
Canada	GREENLAND HALIBUT	1213
Canada	ICELANDIC SCALLOP	134
Canada	MARINE CRABS (NS)	48
Canada	NORTHERN PRAWN	26,169
Canada	QUEEN CRAB	2,512
Canada	ROUGHHEAD GRENADIER	16
Canada	SEA URCHIN	42
Canada	SKATES (NS)	2
Canada	WHELKS (NS)	143
Canada	WITCH FLOUNDER	2
	CANADA TOTAL	30,392
Estonia	ATLANTIC REDFISHES (NS)	447
Faroe nds	ATLANTIC REDFISHES (NS)	30
Germany	ATLANTIC REDFISHES (NS)	467
Iceland	BEAKED REDFISH	49
Latvia	ATLANTIC REDFISHES (NS)	437
Poland	BEAKED REDFISH	305
Portugal	ATLANTIC REDFISHES (NS)	82
Russia	ATLANTIC REDFISHES (NS)	3,249
	TOTAL 2J CATCH	35,458

Table 13. 2003 catch in Subarea 3K.

Country	Species	Weight (t)
Canada	ALBACORE TUNA	1
Canada	AMERICAN EEL	14
Canada	AMERICAN LOBSTER	207
Canada	AMERICAN PLAICE	33
Canada	ATLANTIC COD	33
Canada	ATLANTIC HERRING	310
Canada	ATLANTIC MACKEREL	589
Canada	ATLANTIC REDFISHES (NS)	20
Canada	ATLANTIC ROCK CRAB	71
Canada	BIGEYE TUNA	2
Canada	CAPELIN	4,067
Canada	GREENLAND HALIBUT	2,346
Canada	MARINE CRABS (NS)	743
Canada	MARINE INVERTEBRATES (NS)	38
Canada	NORTHERN BLUEFIN TUNA	1
Canada	NORTHERN PRAWN	34,064
Canada	QUEEN CRAB	16,503
Canada	ROUGHHEAD GRENADIER	91
Canada	SEA URCHIN	232
Canada	SHORTFIN SQUID	629
Canada	SKATES (NS)	38
Canada	SWORDFISH	1
Canada	WHELKS (NS)	74
Canada	WINTER FLOUNDER	19
Canada	WITCH FLOUNDER	51
Canada	WOLFFISHES (NS)	5
	TOTAL 3K CATCH	60,182

Table 14. 2003 catch in Subarea 3L.

Country	Species	Weight (t)
Canada	AMERICAN ANGLER	3
Canada	AMERICAN EEL	17
Canada	AMERICAN LOBSTER	116
Canada	AMERICAN PLAICE	95
Canada	ATLANTIC COD	943
Canada	ATLANTIC HALIBUT	3
Canada	ATLANTIC HERRING	501
Canada	ATLANTIC REDFISHES (NS)	9
Canada	ATLANTIC ROCK CRAB	38
Canada	CAPELIN	13,270
Canada	GREENLAND HALIBUT	959
Canada	MARINE CRABS (NS)	131
Canada	NORTHERN BLUEFIN TUNA	2
Canada	NORTHERN PRAWN	9,953
Canada	QUEEN CRAB	26,048
Canada	RAINBOW SMELT	5
Canada	ROUGHHEAD GRENADIER	65
Canada	SEA URCHIN	557
Canada	SHORTFIN SQUID	455
Canada	SKATES (NS)	17
Canada	WHELKS (NS)	5
Canada	WINTER FLOUNDER	83
Canada	WITCH FLOUNDER	57
Canada	YELLOWTAIL FLOUNDER	31
	CANADA TOTAL	53,363
Estonia	AMERICAN PLAICE	27
Estonia	ATLANTIC REDFISHES (NS)	28
Estonia	GREENLAND HALIBUT	1,235
Estonia	GREENLAND HALIBUT	21
Estonia	NORTHERN PRAWN	117
Estonia	NORTHERN PRAWN	142
Estonia	RED HAKE	13
Estonia	ROUGHHEAD GRENADIER	37
Estonia	ROUNDNOSE GRENADIER	47
Estonia	ROUNDNOSE GRENADIER	2
Estonia	SKATES (NS)	71
Estonia	WHITE HAKE	1
Estonia	WITCH FLOUNDER	15
Estonia	WOLFFISHES (NS)	18
	ESTONIA TOTAL	1,774
Faroe Islands	NORTHERN PRAWN	25

Country	Species	Weight (t)
France	NORTHERN PRAWN	144
Greenland	NORTHERN PRAWN	379
Iceland	NORTHERN PRAWN	133
Japan	AMERICAN PLAICE	71
Japan	ATLANTIC HALIBUT	2
Japan	ATLANTIC REDFISHES (NS)	86
Japan	GREENLAND HALIBUT	2,505
Japan	GROUNDFISHES (NS)	27
Japan	ROUGHHEAD GRENADIER	2
Japan	ROUNDNOSE GRENADIER	183
Japan	SKATES (NS)	64
Japan	WITCH FLOUNDER	12
Japan	WOLFFISHES (NS)	26
	JAPAN TOTAL	2,978
Latvia	NORTHERN PRAWN	144
Norway	NORTHERN PRAWN	68
Poland	NORTHERN PRAWN	145
Portugal	AMERICAN PLAICE	79
Portugal	ATLANTIC COD	18
Portugal	ATLANTIC HALIBUT	3
Portugal	ATLANTIC REDFISHES (NS)	66
Portugal	FINFISHES (NS)	3
Portugal	GREENLAND HALIBUT	1,651
Portugal	RED HAKE	2
Portugal	ROUGHHEAD GRENADIER	103
Portugal	SKATES (NS)	252
Portugal	WITCH FLOUNDER	38
Portugal	WOLFFISHES (NS)	25
	PORTUGAL TOTAL	2,240
Russia	AMERICAN PLAICE	27
Russia	ATLANTIC COD	5
Russia	ATLANTIC HALIBUT	1
Russia	ATLANTIC REDFISHES (NS)	48
Russia	FINFISHES (NS)	11
Russia	GREENLAND HALIBUT	2,262
Russia	RED HAKE	39
Russia	ROUNDNOSE GRENADIER	71
Russia	SKATES (NS)	47
Russia	WITCH FLOUNDER	6
Russia	WOLFFISHES (NS)	6
	RUSSIA TOTAL	2,523

Country	Species	Weight (t)
Spain	AMERICAN PLAICE	334
Spain	ATLANTIC HALIBUT	61
Spain	ATLANTIC REDFISHES (NS)	284
Spain	ATLANTIC WOLFFISH	4
Spain	BLUE ANTIMORA	6
Spain	BOREAL (GREENLAND) SHARK	1
Spain	DOGFISHES (NS)	248
Spain	GREENLAND HALIBUT	7,075
Spain	GROUNDFISHES (NS)	143
Spain	NORTHERN PRAWN	151
Spain	RED HAKE	437
Spain	ROUGHHEAD GRENADIER	631
Spain	ROUNDNOSE GRENADIER	987
Spain	SKATES (NS)	1,241
Spain	SPINY (=PICKED) DOGFISH	6
Spain	WHITE HAKE	197
Spain	WITCH FLOUNDER	309
Spain	WOLFFISHES (NS)	320
Spain	YELLOWTAIL FLOUNDER	9
	SPAIN TOTAL	12,444
Ukraine	NORTHERN PRAWN	144
	TOTAL 3L CATCH	76,504

Table 15. 2003 catch in Subarea 3M.

Country	Species	Weight (t)
CAN _ Maritimes	BIGEYE TUNA	1
CAN _ Maritimes	SWORDFISH	2
Canada	ALBACORE TUNA	10
Canada	BIGEYE TUNA	58
Canada	LARGE SHARKS (NS)	3
Canada	NORTHERN BLUEFIN TUNA	4
Canada	SWORDFISH	54
	CANADA CATCH	132
Estonia	AMERICAN PLAICE	17
Estonia	ATLANTIC COD	9
Estonia	ATLANTIC REDFISHES (NS)	23
Estonia	ATLANTIC REDFISHES (NS)	1
Estonia	GREENLAND HALIBUT	133
Estonia	GREENLAND HALIBUT	2
Estonia	NORTHERN PRAWN	12,851
Estonia	NORTHERN PRAWN	3,744
Estonia	ROUGHHEAD GRENADIER	1
Estonia	ROUNDNOSE GRENADIER	2
Estonia	SKATES (NS)	7
Estonia	WITCH FLOUNDER	11
Estonia	WOLFFISHES (NS)	1
Estonia	YELLOWTAIL FLOUNDER	15
	ESTONIA CATCH	16,817
Faroe Islands	NORTHERN PRAWN	12,648
Greenland	NORTHERN PRAWN	1,181
Iceland	NORTHERN PRAWN	4,715
Japan	AMERICAN PLAICE	3
Japan	ATLANTIC REDFISHES (NS)	98
Japan	GREENLAND HALIBUT	14
Japan	GROUNDFISHES (NS)	1
Japan	NORTHERN PRAWN	117
Japan	ROUGHHEAD GRENADIER	3
Japan	ROUNDNOSE GRENADIER	2
	JAPAN CATCH	238
Latvia	NORTHERN PRAWN	3,533
Norway	ATLANTIC HALIBUT	2
Norway	CUSK (TUSK)	5
Norway	GREENLAND HALIBUT	37
Norway	NORTHERN PRAWN	22,765
Norway	ROUNDNOSE GRENADIER	9
	NORWAY TOTAL	22,818
Portugal	AMERICAN PLAICE	28
Portugal	ATLANTIC COD	7
Portugal	ATLANTIC REDFISHES (NS)	1,113
Portugal	FINFISHES (NS)	3
Portugal	GREENLAND HALIBUT	627
Portugal	ROUGHHEAD GRENADIER	56
Portugal	SKATES (NS)	50
Portugal	WITCH FLOUNDER	51
Portugal	WOLFFISHES (NS)	10
	PORTUGAL TOTAL	1,945
Russia	AMERICAN PLAICE	7
Russia	ATLANTIC REDFISHES (NS)	115
Russia	FINFISHES (NS)	2
Russia	GREENLAND HALIBUT	138
Russia	NORTHERN PRAWN	3
Russia	RED HAKE	2

Country	Species	Weight (t)
Russia	ROUNDNOSE GRENADIER	16
Russia	SKATES (NS)	5
Russia	WITCH FLOUNDER	1
	RUSSIA TOTAL	289
Spain	AMERICAN PLAICE	75
Spain	ATLANTIC HALIBUT	3
Spain	ATLANTIC REDFISHES (NS)	633
Spain	ATLANTIC WOLFFISH	1
Spain	BLUE ANTIMORA	1
Spain	BOREAL (GREENLAND) SHARK	1
Spain	DOGFISHES (NS)	89
Spain	GREENLAND HALIBUT	2,738
Spain	GROUNDFISHES (NS)	37
Spain	NORTHERN PRAWN	857
Spain	NORTHERN PRAWN	547
Spain	RED HAKE	572
Spain	ROUGHHEAD GRENADIER	322
Spain	ROUNDNOSE GRENADIER	1,314
Spain	SKATES (NS)	444
Spain	SPINY (=PICKED) DOGFISH	3
Spain	WHITE HAKE	184
Spain	WITCH FLOUNDER	407
Spain	WOLFFISHES (NS)	105
	SPAIN TOTAL	8,333
Ukraine	ATLANTIC REDFISHES (NS)	5
Ukraine	FINFISHES (NS)	1
Ukraine	NORTHERN PRAWN	237
Ukraine	WOLFFISHES (NS)	1
	UKRAINE TOTAL	244
	TOTAL 3M CATCH	72,893

Table 16. 2003 catch in Subarea 3N.

Country	Species	Weight (t)
CAN _ Maritimes	ALBACORE TUNA	1
CAN _ Maritimes	ATLANTIC COD	4
CAN _ Maritimes	ATLANTIC HALIBUT	27
CAN _ Maritimes	ATLANTIC HERRING	2
CAN _ Maritimes	BIGEYE TUNA	21
CAN _ Maritimes	HARD CLAM	712
CAN _ Maritimes	MARINE MOLLUSCS (NS)	2,009
CAN _ Maritimes	QUEEN CRAB	7
CAN _ Maritimes	STIMPSON SURF CLAM	4,302
CAN _ Maritimes	SWORDFISH	18
CAN _ Maritimes	WOLFFISHES (NS)	9
Canada	ALBACORE TUNA	1
Canada	AMERICAN PLAICE	924
Canada	ATLANTIC COD	168
Canada	ATLANTIC HALIBUT	10
Canada	BIGEYE TUNA	7
Canada	CLAMS (NS)	553
Canada	HADDOCK	16
Canada	OCEAN QUAHOG	2,945
Canada	QUEEN CRAB	3,358
Canada	SKATES (NS)	8
Canada	SURF CLAM	6,213
Canada	SWORDFISH	4
Canada	WITCH FLOUNDER	10
Canada	WOLFFISHES (NS)	8
Canada	YELLOWTAIL FLOUNDER	8,187
	CANADA TOTAL	29,524
Estonia	AMERICAN PLAICE	32
Estonia	AMERICAN PLAICE	16
Estonia	ATLANTIC COD	13
Estonia	ATLANTIC COD	1
Estonia	ATLANTIC REDFISHES (NS)	14
Estonia	ATLANTIC REDFISHES (NS)	1
Estonia	GREENLAND HALIBUT	329
Estonia	GREENLAND HALIBUT	20
Estonia	GROUNDFISHES (NS)	1
Estonia	ROUGHHEAD GRENADIER	55
Estonia	ROUNDNOSE GRENADIER	6
Estonia	SKATES (NS)	803
Estonia	SKATES (NS)	406
Estonia	WHITE HAKE	6
Estonia	WITCH FLOUNDER	18
Estonia	WOLFFISHES (NS)	9
Estonia	YELLOWTAIL FLOUNDER	42
	ESTONIA TOTAL	1,772
Norway	ATLANTIC COD	2

Country	Species	Weight (t)
Norway	ATLANTIC HALIBUT	45
Norway	GREENLAND HALIBUT	43
Norway	ROUGHHEAD GRENADIER	30
Norway	WOLFFISHES (NS)	11
	NORWAY TOTAL	131
Portugal	AMERICAN ANGLER	20
Portugal	AMERICAN PLAICE	322
Portugal	ATLANTIC COD	296
Portugal	ATLANTIC HALIBUT	34
Portugal	ATLANTIC REDFISHES (NS)	243
Portugal	FINFISHES (NS)	3
Portugal	GREENLAND HALIBUT	1,883
Portugal	HADDOCK	12
Portugal	POLLOCK (SAITHE)	87
Portugal	ROUGHHEAD GRENADIER	134
Portugal	SKATES (NS)	938
Portugal	WHITE HAKE	2,309
Portugal	WITCH FLOUNDER	177
Portugal	WOLFFISHES (NS)	63
Portugal	YELLOWTAIL FLOUNDER	266
	PORTUGAL TOTAL	6,787
Russia	AMERICAN PLAICE	162
Russia	ATLANTIC COD	93
Russia	ATLANTIC HALIBUT	1
Russia	ATLANTIC REDFISHES (NS)	15
Russia	FINFISHES (NS)	16
Russia	GREENLAND HALIBUT	598
Russia	RED HAKE	95
Russia	ROUNDNOSE GRENADIER	29
Russia	SKATES (NS)	2,914
Russia	WITCH FLOUNDER	30
Russia	WOLFFISHES (NS)	8
Russia	YELLOWTAIL FLOUNDER	184
	RUSSIA TOTAL	4,145
Spain	AMERICAN ANGLER	10
Spain	AMERICAN PLAICE	433
Spain	ATLANTIC HALIBUT	148
Spain	ATLANTIC REDFISHES (NS)	231
Spain	BAIRD'S SLICKHEAD	1
Spain	DOGFISHES (NS)	256
Spain	GREENLAND HALIBUT	2,467
Spain	GROUNDFISHES (NS)	15
Spain	HADDOCK	2
Spain	NORTHERN PRAWN	5
Spain	POLLOCK (SAITHE)	15
Spain	RED HAKE	191
Spain	ROUGHHEAD GRENADIER	242
Spain	ROUNDNOSE GRENADIER	1081
Spain	SKATES (NS)	5,676
Spain	SPINY (=PICKED) DOGFISH	22
Spain	WHITE HAKE	373
Spain	WITCH FLOUNDER	307
Spain	WOLFFISHES (NS)	152
Spain	YELLOWTAIL FLOUNDER	50
	SPAIN TOTAL	11,677
	TOTAL 3N CATCH	54,036

Table 17. 2003 catch in Subarea 3O.

Country	Species	Weight (t)
CAN _ Maritimes	0	6
CAN _ Maritimes	ALBACORE TUNA	1
CAN _ Maritimes	AMERICAN ANGLER	33
CAN _ Maritimes	ATLANTIC COD	100
CAN _ Maritimes	ATLANTIC HALIBUT	43
CAN _ Maritimes	ATLANTIC HERRING	27
CAN _ Maritimes	ATLANTIC REDFISHES (NS)	32
CAN _ Maritimes	BIGEYE TUNA	3
CAN _ Maritimes	CUSK (TUSK)	1
CAN _ Maritimes	HADDOCK	35
CAN _ Maritimes	MARINE MOLLUSCS (NS)	5
CAN _ Maritimes	NORTHERN BLUEFIN TUNA	4
CAN _ Maritimes	PELAGIC FISHES (NS)	2
CAN _ Maritimes	PORBEAGLE	1
CAN _ Maritimes	QUEEN CRAB	1
CAN _ Maritimes	SKATES (NS)	51
CAN _ Maritimes	SWORDFISH	234
CAN _	WHITE HAKE	57

Country	Species	Weight (t)
Maritimes		
CAN _ Maritimes	WOLFFISHES (NS)	1
CAN _ Maritimes	YELLOWTAIL FLOUNDER	4
Canada	AMERICAN ANGLER	2,136
Canada	AMERICAN PLAICE	588
Canada	ATLANTIC COD	546
Canada	ATLANTIC HALIBUT	179
Canada	ATLANTIC REDFISHES (NS)	3,093
Canada	GREENLAND HALIBUT	258
Canada	HADDOCK	51
Canada	NORTHERN BLUEFIN TUNA	29
Canada	POLLOCK (SAITHE)	45
Canada	QUEEN CRAB	2,233
Canada	ROUGHHEAD GRENADIER	5
Canada	SKATES (NS)	595
Canada	WHITE HAKE	360
Canada	WITCH FLOUNDER	52
Canada	YELLOWTAIL FLOUNDER	4,487
	CANADA TOTAL	15,298
Portugal	AMERICAN ANGLER	145
Portugal	AMERICAN PLAICE	319
Portugal	ATLANTIC COD	281
Portugal	ATLANTIC HALIBUT	52
Portugal	ATLANTIC REDFISHES (NS)	6,382
Portugal	FINFISHES (NS)	4
Portugal	GREENLAND HALIBUT	208
Portugal	HADDOCK	129
Portugal	POLLOCK (SAITHE)	27
Portugal	ROUGHHEAD GRENADIER	9
Portugal	SKATES (NS)	702
Portugal	WHITE HAKE	1,781
Portugal	WITCH FLOUNDER	219
Portugal	WOLFFISHES (NS)	14
Portugal	YELLOWTAIL FLOUNDER	21
	PORTUGAL TOTAL	10,293
Russia	AMERICAN ANGLER	38
Russia	AMERICAN PLAICE	157
Russia	ATLANTIC COD	82
Russia	ATLANTIC HALIBUT	2
Russia	ATLANTIC REDFISHES (NS)	10,794
Russia	FINFISHES (NS)	75

Country	Species	Weight (t)
CAN _ Maritimes	WOLFFISHES (NS)	1
CAN _ Maritimes	YELLOWTAIL FLOUNDER	4
Canada	AMERICAN ANGLER	2,136
Canada	AMERICAN PLAICE	588
Canada	ATLANTIC COD	546
Canada	ATLANTIC HALIBUT	179
Canada	ATLANTIC REDFISHES (NS)	3,093
Canada	GREENLAND HALIBUT	258
Canada	HADDOCK	51
Canada	NORTHERN BLUEFIN TUNA	29
Canada	POLLOCK (SAITHE)	45
Canada	QUEEN CRAB	2,233
Canada	ROUGHHEAD GRENADIER	5
Canada	SKATES (NS)	595
Canada	WHITE HAKE	360
Canada	WITCH FLOUNDER	52
Canada	YELLOWTAIL FLOUNDER	4,487
	CANADA TOTAL	15,298
Portugal	AMERICAN ANGLER	145
Portugal	AMERICAN PLAICE	319
Portugal	ATLANTIC COD	281
Portugal	ATLANTIC HALIBUT	52
Portugal	ATLANTIC REDFISHES (NS)	6,382
Portugal	FINFISHES (NS)	4
Portugal	GREENLAND HALIBUT	208
Portugal	HADDOCK	129
Portugal	POLLOCK (SAITHE)	27
Portugal	ROUGHHEAD GRENADIER	9
Portugal	SKATES (NS)	702
Portugal	WHITE HAKE	1,781
Portugal	WITCH FLOUNDER	219
Portugal	WOLFFISHES (NS)	14
Portugal	YELLOWTAIL FLOUNDER	21
	PORTUGAL TOTAL	10,293
Russia	AMERICAN ANGLER	38
Russia	AMERICAN PLAICE	157
Russia	ATLANTIC COD	82
Russia	ATLANTIC HALIBUT	2
Russia	ATLANTIC REDFISHES (NS)	10,794
Russia	FINFISHES (NS)	75

Country	Species	Weight (t)
Russia	GREENLAND HALIBUT	7
Russia	HADDOCK	15
Russia	POLLOCK (SAITHE)	13
Russia	RED HAKE	803
Russia	SILVER HAKE	4
Russia	SKATES (NS)	312
Russia	WITCH FLOUNDER	29
Russia	WOLFFISHES (NS)	43
	RUSSIA TOTAL	12,374
Spain	AMERICAN ANGLER	60
Spain	AMERICAN PLAICE	83
Spain	ATLANTIC HALIBUT	14
Spain	ATLANTIC REDFISHES (NS)	1,289
Spain	DOGFISHES (NS)	19
Spain	GREENLAND HALIBUT	60
Spain	GROUNDFISHES (NS)	1
Spain	HADDOCK	15
Spain	POLLOCK (SAITHE)	16
Spain	RED HAKE	33
Spain	ROUGHHEAD GRENADIER	1
Spain	ROUNDNOSE GRENADIER	19
Spain	SILVER HAKE	10
Spain	SKATES (NS)	156
Spain	WHITE HAKE	1,272
Spain	WITCH FLOUNDER	65
Spain	WOLFFISHES (NS)	8
Spain	YELLOWTAIL FLOUNDER	22
	SPAIN TOTAL	3,143
Ukraine	ATLANTIC REDFISHES (NS)	1
	TOTAL 3O CATCH	41109

Table 18. 2003 catch in Subarea 3PN.

Country	Species	Weight (t)
Canada	AMERICAN ANGLER	5
Canada	AMERICAN LOBSTER	22
Canada	AMERICAN PLAICE	1
Canada	ATLANTIC COD	83
CAN-Quebec	ATLANTIC COD	3
Canada	ATLANTIC HALIBUT	24
CAN-Quebec	ATLANTIC HALIBUT	1
Canada	ATLANTIC HERRING	130
Canada	ATLANTIC MACKEREL	105
Canada	ATLANTIC REDFISHES (NS)	20
CAN _ Maritimes	ATLANTIC REDFISHES (NS)	1
CAN-Quebec	ATLANTIC REDFISHES (NS)	13
Canada	LARGE SHARKS (NS)	1
Canada	QUEEN CRAB	4
Canada	SKATES (NS)	17
Canada	WHITE HAKE	207
CAN-Quebec	WHITE HAKE	5
	TOTAL 3PN CATCH	642

Table 19. 2003 catch in Subarea 3PS.

Country	Species	Weight (t)
CAN _ Maritimes	AMERICAN ANGLER	183
CAN _ Maritimes	AMERICAN PLAICE	20
CAN _ Maritimes	ATLANTIC COD	660
CAN _ Maritimes	ATLANTIC HALIBUT	202
CAN _ Maritimes	ATLANTIC REDFISHES (NS)	1,094
CAN _ Maritimes	CUSK (TUSK)	3
CAN _ Maritimes	GREENLAND HALIBUT	20
CAN _ Maritimes	HADDOCK	12
CAN _ Maritimes	LARGE SHARKS (NS)	2
CAN _ Maritimes	POLLOCK (SAITHE)	58
CAN _ Maritimes	PORBEAGLE	1
CAN _ Maritimes	QUEEN CRAB	49
CAN _ Maritimes	SKATES (NS)	232
CAN _ Maritimes	SWORDFISH	1
CAN _ Maritimes	WHITE HAKE	225
CAN _ Maritimes	WITCH FLOUNDER	8
CAN _ Maritimes	WOLFFISHES (NS)	3
CAN _ Maritimes	YELLOWTAIL FLOUNDER	5
Canada	AMERICAN ANGLER	447
Canada	AMERICAN EEL	1
Canada	AMERICAN LOBSTER	786

Country	Species	Weight (t)
Canada	AMERICAN PLAICE	883
Canada	ATLANTIC COD	12,303
Canada	ATLANTIC HALIBUT	183
Canada	ATLANTIC HERRING	4,577
Canada	ATLANTIC MACKEREL	43
Canada	ATLANTIC REDFISHES (NS)	3,019
Canada	CUSK (TUSK)	2
Canada	GREENLAND HALIBUT	328
Canada	HADDOCK	137
Canada	ICELANDIC SCALLOP	87
Canada	MARINE INVERTEBRATES (NS)	432
Canada	NORTHERN PRAWN	122
Canada	POLLOCK (SAITHE)	333
Canada	PORBEAGLE	1
Canada	QUEEN CRAB	6,116
Canada	ROUGHHEAD GRENADIER	1
Canada	SEA SCALLOP	649
Canada	SEA URCHIN	61
Canada	SHORTFIN SQUID	1
Canada	SKATES (NS)	1,473
Canada	WHELKS (NS)	72
Canada	WHITE HAKE	880
Canada	WINTER FLOUNDER	145
Canada	WITCH FLOUNDER	529
Canada	WOLFFISHES (NS)	65
Canada	YELLOWTAIL FLOUNDER	56
	CANADA TOTAL	36,510
France	AMERICAN ANGLER	1
France	AMERICAN LOBSTER	4
France	AMERICAN PLAICE	131
France	ATLANTIC COD	2,385
France	ATLANTIC HALIBUT	2
France	ATLANTIC MACKEREL	6
France	ATLANTIC REDFISHES (NS)	219
France	ATLANTIC SALMON	2
France	CAPELIN	21
France	GREENLAND HALIBUT	5
France	HADDOCK	251
France	ICELANDIC SCALLOP	19
France	LUMPFISH (LUMPSUCKER)	36
France	MARINE MOLLUSCS (NS)	1

Country	Species	Weight (t)
France	POLLOCK (SAITHE)	225
France	PORBEAGLE	2
France	QUEEN CRAB	85
France	SKATES (NS)	82
France	WHITE HAKE	3
France	WITCH FLOUNDER	4
France	WOLFFISHES (NS)	1
France	YELLOWTAIL FLOUNDER	261
	FRANCE TOTAL	3,746
	TOTAL 3PS CATCH	40,256

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WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption.

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