DFO Atlantic Fisheries
Stocks Status Report 94/4

REPORT ON THE STATUS OF GROUNDFISH STOCKS IN THE CANADIAN NORTHWEST ATLANTIC

Atlantic Stock Assessment Secretariat
Science Branch, Stn . 215
Department of Fisheries and Oceans
P .O. Box 1006
Dartmouth, Nova Scotia B2Y 4A2
Canada

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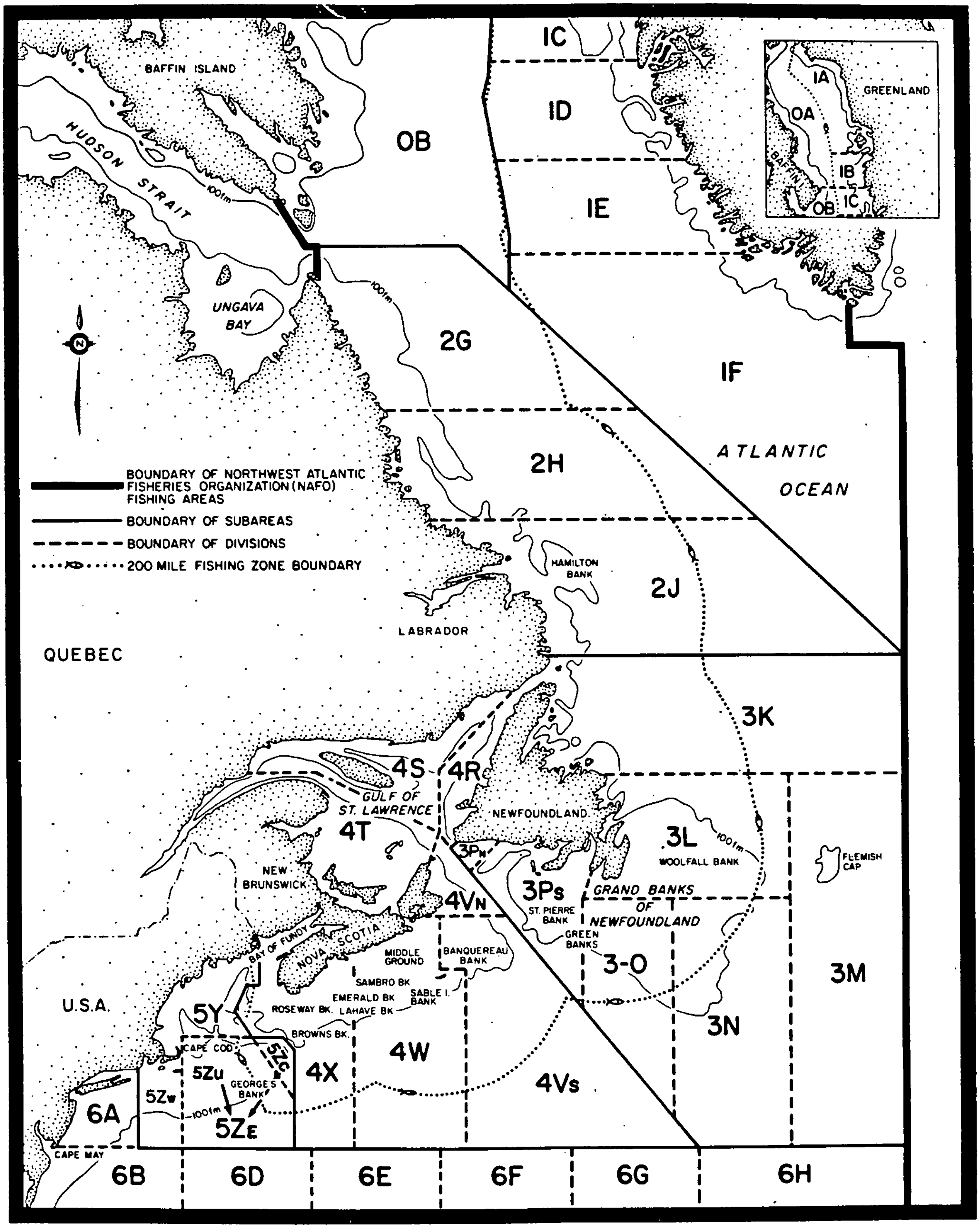

Figure 1. Subareas and divisions of the NAFO Convention Area and limits of Canadian fishing zones (east coast). Includes modifications to Subdivision 5Ze to take into account the Canadian side of 5Ze (5Zc) and USA side of 5Ze (5Zu).

Abbreviations

ADAPT	-	The adaptive framework for SPA calibration
BIO	-	Bedford Institute of Oceanography
CAFSAC	-	Canadian Atlantic Fisheries Scientific Advisory Committee (ceased operation in December 1992)
Can.	-	Canadian/Canada
C/E - CPUE	-	Catch per unit of effort
CIL	-	Cold intermediate layer
cm	-	centimeters
CPR	-	Continuous Plankton Recorder Program (run by the United Kingdom)
DFO	-	Department of Fisheries and Oceans
DMP	-	Dockside Monitoring Progam
EA	-	Enterprise allocations
f	-	Fishing effort
F	-	Instantaneous rate of fishing mortality
F(50%)	-	Fishing mortality corresponding to the 50% rule (see Section ix of Anon. 1992)
$F_{0.1}$	-	The instantaneous rate of fishing mortality (calculated from a yield-per-recruit curve) at which a unit increase in fishing effort (proportional to fishing mortality) will give an increase in yield 1/10th that of a unit of effort on the virgin stock (dynamic pool model)
FG	-	Fixed gear
Fgn	-	Foreign
F_{max}	-	The instantaneous rate of fishing mortality which maximizes the yield per recruit (dynamic pool model)
FOC	-	Fisheries Oceanography Committee (DFO)
FRCC	-	Fisheries Resource Conservation Council
Freq.	-	Frequency
ft.	-	Foot
GM	-	Geometric mean
hks.	-	Hooks
ICATT	-	International Commission for the Conservation of Atlantic Tunas
IOP	-	International Observer Program
ITQ	-	Individual transferable quotas (also written IQ)
kg	-	Kilograms
LL	-	Longline
m	-	Meter
MG	-	Mobile gear
mm	-	Millimeter
MR	-	Age dependent natural mortality
M	-	Instantaneous rate of natural mortality
N/A	-	Not applicable
NAFO	-	Northwest Atlantic Fisheries Organization
no./tow	-	number/tow
nm.	-	number
NSP	-	National Sampling Program
OT	-	Otter trawl
OTB	-	Bottom otter trawl
OTM	-	Midwater otter trawl
PR	-	Partial recruitment
q	-	Catchability coefficient
RIVSUM	-	Combined river discharge from the St. Lawrence, Ottawa, and Saguenay rivers
RV	-	Research vessel
SPA	-	Sequential population analysis
SPR	-	Spawning stock biomass per recruit
SSB	-	Spawning stock biomass
t	-	tonnes
TAC	-	Total allowable catch
TC	-	Tonnage class
USA	-	United States of America (also written US)
USSR	-	Union of Soviet Socialists Republic
VPA	-	Virtual population analysis
vs.	-	versus
wt./tow	-	weight per tow
XSA	-	Extend survivors method of SPA calibration
Z	-	Instantaneous rate of total mortality
ZIF	-	Zonal interchange file (also written ZIFF)

Reference

Anon. 1992b. 1992 Atlantic Groundfish Management Plan. Communications Directorate, Department of Fisheries and Oceans.

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Atlantic Overview

All groundfish stocks remain at very low levels and some appear to have declined further in 1993.

Southern Gulf cod, St. Pierre Bank cod, Eastern Scotian Shelf cod, Brown's Bank cod and Georges Bank cod appear to remain at or close to historical low levels. According to research vessel surveys, Northern Gulf cod and northern cod have declined further in 1993. Changes in geographical distribution observed in recent years continued in 1993; the remaining northern cod were concentrated in the autumn in a small area at the border of 3K-3L straddling the 200 mile limit. The southern Gulf of St. Lawrence cod, again in 1993, extended their winter migration further south well into 4Vs while the northern Gulf stock appears to have migrated into 3Ps. Incoming year-classes are generally weaker than average and stock rebuilding depends on future recruitment being average or better. Cod stocks south of Halifax (4X, 5Zj,m) would benefit more rapidly from stringent management measures because cod in these areas grow much more rapidly than those to the north.

Haddock stocks on the Grand Banks and on St. Pierre Bank supported large fisheries in the 1950s - early 1960s. The stocks collapsed, mostly as a result of over exploitation, and they were never given a chance to rebuild. One or two relatively strong year-classes were produced in the early 1980s. These could have contributed to stock rebuilding if they had been allowed to grow and reproduce but they were quickly harvested, mostly by the Canadian domestic fleets. On the eastern Scotian Shelf, only one year-class, that of 1988, accounts for most of the biomass. In 4X, some fishermen argue that the stock is increasing, which may be the case in some localized areas, but overall the biomass in the survey remains considerably lower than average. On Georges Bank, the 1992 year-class appears stronger than average and if protected adequately, could contribute to the beginning of stock rebuilding. Sustained conservation efforts are needed to rebuild the population biomass and expand the age structure of all these haddock stocks.

Pollock abundance is also near the lowest observed and recruitment in the 1990s appears weak. Much of the population is now centred in the southern shelf area.

Nominal fishing effort in the Gulf of St. Lawrence and on the Scotian Shelf increased markedly during the 1980s. Considering that fleet renewal and improvements in fishing and navigation technology also took place during this period, effective fishing effort and therefore fishing mortality also increased considerably during the late 1980s. In fact, fishing capacity is so high now that the fishing mortality exerted on the southern Gulf of St. Lawrence cod in 1993, with the fishery being closed for most of the year, is estimated to have been at the $F_{0.1}$ level.

In the Gulf of St. Lawrence and in Scotia-Fundy, the severe restrictions or closures imposed on traditional groundfish species have resulted in a diversion of fishing effort on flatfish species and other unregulated species. This is a cause for concern. The biomass of these species is not high and could be reduced very rapidly by over exploitation given the considerable amount of fishing effort that could be applied. The information on stock productivity and abundance is not sufficient to establish TACs that would correspond to a pre-determined reasonable exploitation rate while a precautionary TAC, based on current catches, would likely be set too high. Therefore, the only reasonable approach in the immediate term seems to require that fishing effort be decreased.

Redfish stocks, especially Unit 1 redfish, have also suffered from increased exploitation as a result of restrictions in traditional groundfish species. Unit 1 redfish appear to have migrated out of the Gulf earlier than normal in 1993, similar to cod stocks in the Gulf of St. Lawrence. Therefore, catches made in 3Pn and

4Vn in November and December, were originating in fact from Unit 1 redfish. In addition, the 1988 year-class, which had appeared to be strong in earlier surveys, has virtually disappeared from Unit 1 either as a result of high mortality, non-availability to the fishing gear or emigration. Unit 2 redfish is also expected to decrease in the near future. Exploitation of Unit 3 redfish is estimated to be below $F_{0.1}$.

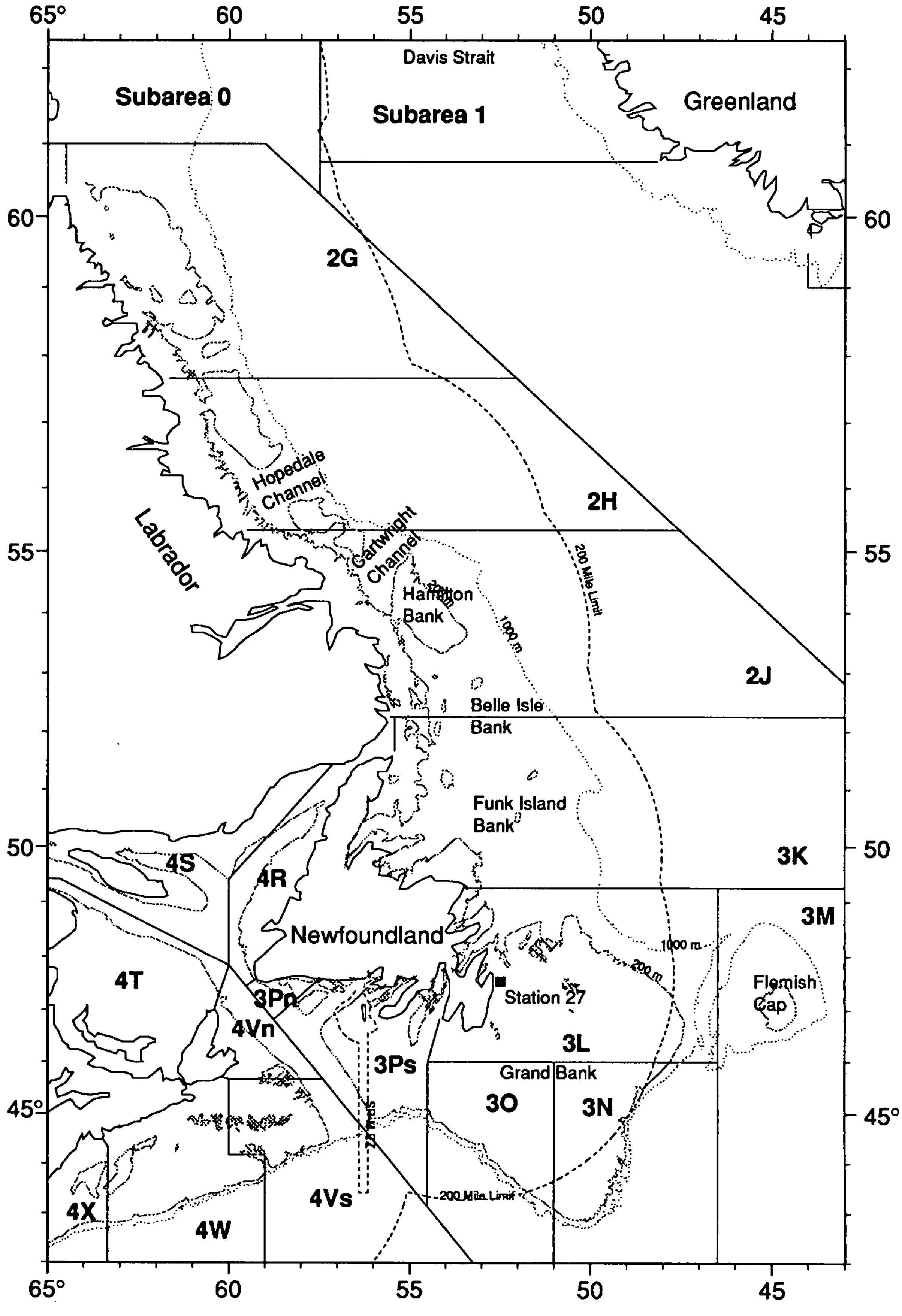
Climatic conditions in 1993 remained much colder than normal in waters off Labrador and northeastern Newfoundland. In the Gulf of St. Lawrence, 1993 was also colder than normal although in the deep waters of the Laurentian Channel temperatures were warmer than normal. Conditions in the Scotia-Fundy Region were generally similar, that is colder than normal at the surface and warmer in deeper waters, but there were north/south variations within the region.

It is estimated that, in 1993, there were 61,900 grey seals in the Gulf of St. Lawrence population and 81,600 in the Sable Island population. Both populations are increasing steadily. These 143,500 grey seals are estimated to have consumed a total of about 40,000t of cod mostly in the Gulf of St. Lawrence and on the eastern Scotian Shelf in 1993. The relative impact of grey seal on cod depends on whether they represent an additional mortality or if they displaced another predator who was already consuming cod.

Stock assessments are simplified models of nature and their results depend on a certain number of assumptions. When important assumptions are violated, the assessments results will be erroneous. For example, if misreporting and discarding took place and if these are not accounted for in the assessment, then trends in population sizes and fishing mortality estimates will not be reliable. However, despite these uncertainties in the assessments, there is no doubt, as indicated by surveys and catch per unit of effort from the fishery, that stock sizes are currently very low.

Although climatic conditions have been harsh and grey seal populations have been increasing, the effects of the fishery have also been devastating. Effective fishing effort increased substantially since 1977 and fishing mortality reached very high levels in the early 1990s. Reduction in fishing effort is essential to the rebuilding of stocks and to the long term viability of the fisheries.

Newfoundland Region


65°
60
55
50
45
Davis Strait
Subarea 0
Subarea 1
Greenland
60
2G
Hopedale Channel
2H
Labrador
Cartwright Channel
55
Hamilton Bank
1000 m
200 Mile Limit
2J
Belle Isle Bank
Funk Island Bank
50
3K
4S
4R
3M
Newfoundland
1000 m
200 m
4T
Station 27
Flemish Cap
3Pn
4Vn
3L
3Ps
Grand Bank
45°
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200 Mile Limit
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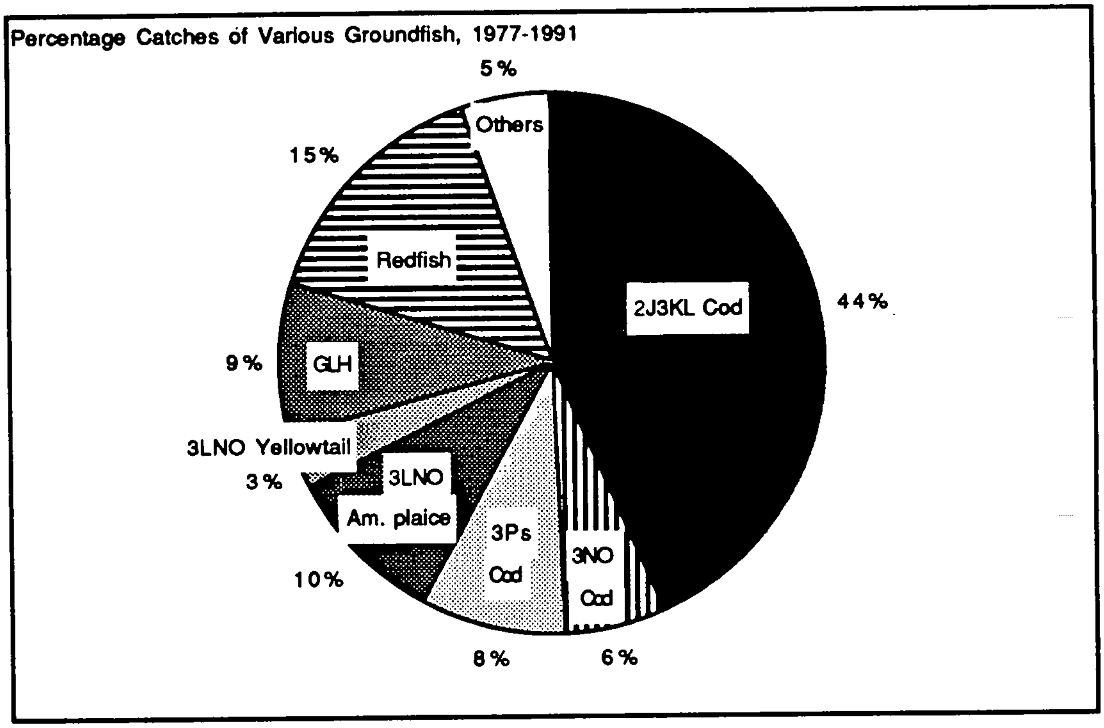
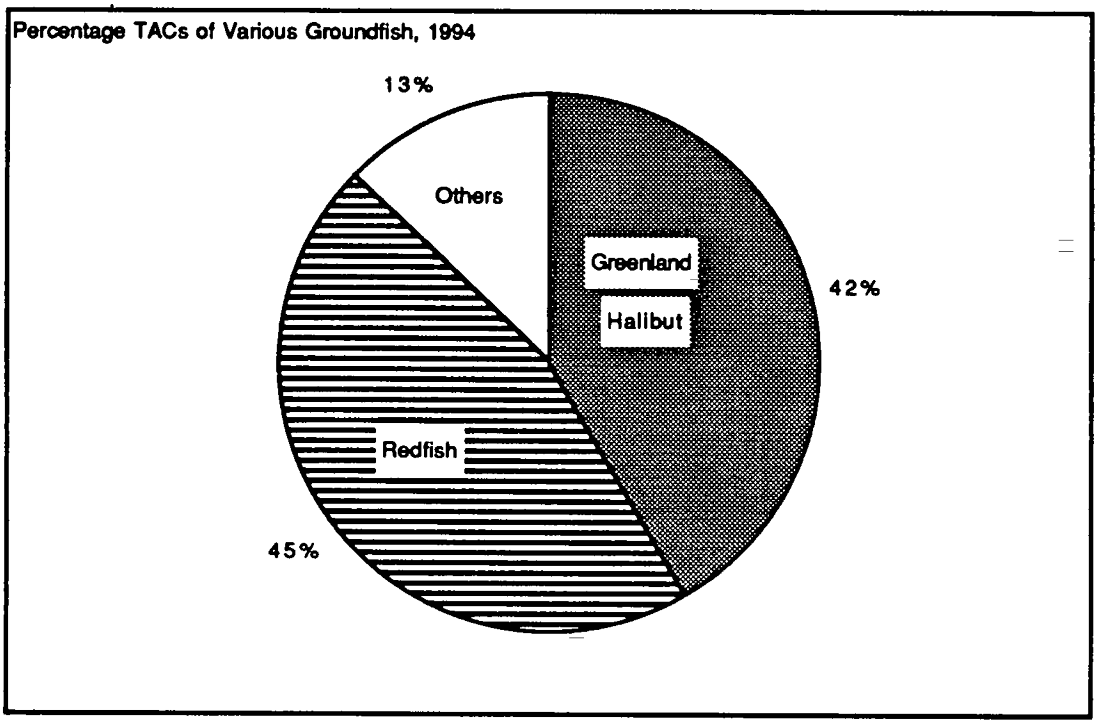
Regional Overview

Groundfish

Three main species groups of groundfish have traditionally been fished in the waters around Newfoundland. These are the gadoids (mainly cod with some haddock, pollock and hake), flatfish (American plaice, yellowtail flounder, witch flounder, Greenland halibut and Atlantic halibut) and others such as redfish and grenadiers. Overall, the abundance of the groundfish resources today is very much lower than the average catches since the extension of jurisdiction and 1993 catches are also much lower than those in 1991.





Cod traditionally dominated catches, with the most important stock being that in divisions 2J3KL or "northern" cod. Important cod fisheries also take place on the southern Grand Banks (divisions 3NO stock) and off the south coast (Subdivision 3Ps stock). Catches from all of these stocks peaked in the 1960s, before declining again until the extension of jurisdiction, primarily the result of excessive fishing. After 1977 the trajectories of the different stocks have shown both similarities and differences. The northern cod increased in biomass through the mid 1980s before declining somewhat to 1990 and rapidly thereafter. In divisions 3NO on the other hand, the biomass increased rapidly until the mid to late 1980s then declined rapidly thereafter. The biomass of cod in Subdivision 3Ps also increased until about 1988 before declining.

The causes for the recent declines appear to be different in the different areas. After 1990, the biomass of northern cod declined very rapidly based on survey data; by 50% between 1990 and 1991, about 70% between 1991 and 1992, and by about 80% between 1992 and 1993. The 1993 survey estimate is only about 3% of that for 1990. The reasons for this dramatic decline are still unclear. Fishing on spawning grounds, foreign fisheries, traps, gillnets, dumping and discarding, seals and the ocean climate have all been implicated to various degrees for the decline in northern cod. All have probably played a role but the relative importance of each remains unknown. It is clear that since the moratorium was put in effect in July, 1992, estimated catches cannot explain the continuing declines observed.

On the southern Grand Banks, the declines appear to be more easily understood. Beginning around 1986, fishing effort increased significantly outside 200 miles such that TACs were exceeded for many years. To add to this problem, the foreign fleets were taking mainly small, undersized fish probably through illegal modification to the net including the use of illegal small mesh gear. Over the same period, there were a number of successive years of poor recruitment. Fishing mortality has been very high over the past number of years. The fishery is closed for 1994 because of the low stock size.

Catches of cod in Subdivision 3Ps increased significantly after 1985 because of increased effort by the

French. After settlement of the boundary dispute in 1992, their catches again declined and none were reported taken in 1993. Survey results for cod have fluctuated considerably between years, but suggest a decline in the recent period. It is not possible to determine the exact status of this stock, but a number of indicators suggest a declining population: declining age at maturity, declining numbers of older fish in the area and declining size at age. Some of the fish in the area may be from adjacent stocks (divisions 3Pn4RS, Division 3O) but these stocks are also at low levels at present.

Of the flatfish stocks, American plaice on the Grand Banks (divisions 3LNO) is the most important historically, but American plaice fisheries also take place in Subarea 2+Division 3K, and Subdivision 3Ps. As with cod on the Grand Banks, foreign catches of the 3LNO stock outside 200 miles have been greater than allocations since 1986, and they have caught smaller fish than taken in the Canadian fishery. This has resulted in exploitation rates exceeding reference levels, and the most recent survey estimates show the biomass to be the lowest in the time series. There are however, indications that the declines in biomass in Division 3L are greater than can be explained by the fishery alone. It is unknown if this is related to factors contributing to the decline in divisions 2J3KL cod or not. NAFO has closed this fishery for 1994 because of the low stock size. Further north, research vessel survey results indicate that through the 1980s, the greatest proportion of biomass was in Division 2J where it peaked in 1983 then gradually declined thereafter. In Division 3K, biomass was stable until about 1987 then declined. Estimates in the 1990s from both divisions continued to decline, and the 1993 estimates are the lowest on record. The observed declines cannot be accounted for by the fishery alone. For 1994, the fishery is restricted to by-catch only. Recruitment has been declining in recent years, and because of this, recovery cannot be anticipated before at least 10 years.

In Subdivision 3Ps through the 1980s, survey estimates of trawlable biomass of American plaice fluctuated but there has been a gradual and systematic decline since about 1989. The decline continued into 1994 based on the most recent survey results. Although fishing mortality has probably been above $F_{0.1}$ in recent years, it is not believed that catches in the range of 2,500 - 5,000 t could be fully responsible for declines of about 90% (from surveys) since 1986-1988. As with other American plaice stocks around Newfoundland, it appears that non-fishery related factors may be contributing to the observed declines. The fishery in this area is also restricted to by-catch only for 1994.

The only significant fishery for yellowtail flounder is on the Grand Banks (divisions 3LNO). After extension of jurisdiction, catches fluctuated between 10,000 - 20,000 t, but were about 30,000 t in 1985 and 1986. This increase was due to increased foreign effort on the "tail." Subsequent catches dropped back to about 15,000 t, but have been about double the TACs in the 1990s again because of the foreign fishery. It is important to note that recent foreign catches have been primarily of juveniles so the catch in numbers has not decreased as much as suggested by the tonnage change. After remaining stable through most of the 1980s, biomass as estimated from Canadian surveys steadily declined and in 1992 was only about one third that estimated from the 1985 and 1986 surveys. The fishery is closed for 1994.

Witch flounder fisheries take place in divisions 2J3KL, divisions 3NO and Subdivision 3Ps. Biomass estimates from surveys in the north peaked in Division 2J in 1986 but declined during the more recent period. In Division 3K, estimates were stable through the early 1980s (about 30,000 t) but declined subsequently. The total estimated biomass in these two divisions in 1993 was only 900 t. In Division 3L, estimates were between 6,000 - 7,000 t until 1988 but declined to only 1500 t in 1992, and 400 t in 1993. In 1993, the total estimated biomass, at 1,300 t, is the lowest in the time series, and only slightly greater than the 1994 TAC of 1,000 t. As with other flatfish stocks in the area, current fishing effort cannot account for the observed declines in biomass.

On the Grand Banks in divisions 3NO, witch flounder TACs of 5,000 t were exceeded in 1985-1988, again due to increased foreign effort, but declined below that reference level since. Survey estimates of biomass show considerable fluctuation over the time series, but are generally lower now than in the mid 1980s. Whether this indicates a decline in stock size, or a movement of the fish to deeper water outside the survey area is unclear. The fishery is closed for 1994.

Biomass estimates of witch from surveys in Subdivision 3Ps have fluctuated substantially between years, but there does not appear to be any long term trend in the estimates. The fluctuations may be the result of some portion of the stock being distributed in deeper water outside the survey area. Possible impacts of the fishery cannot be determined, but current by-catch restrictions related to other species will probably result in relatively low exploitation.

It is currently believed that with the exception of those in the Gulf of St. Lawrence, Greenland halibut in the northwest Atlantic constitute one stock extending from Davis Strait (subareas 0+1) to around the Grand Banks (Subarea 3). Results of surveys to divisions 2GH in the early and late 1980s indicated that the biomass had decreased by about 50% between the 2 periods. The biomass in divisions 2J3K also declined by about 50% between 1987 and 1990. Catches in subareas 2 and 3 began to increase dramatically in 1990 with the development of a foreign fishery in divisions 3LM outside the Canadian 200 mile zone. This fishery has since extended into divisions 3NO. The 1993 catch has been estimated to be about 62,000 t. At present there are no data to suggest that this foreign fishery is being prosecuted on a separate stock, and the high catches of recent years from this fishery are cause for concern. There is also concern about the expanding Canadian fisheries to deeper water and further north. It is expected that the fishery in divisions 2J3K (gillnet) over the past 4 years significantly reduced the resource in that area. This effort is now being displaced further north and the same declines are anticipated. Only through reduced effort will the future of this resource be secured.

There are 4 stocks of redfish in the Newfoundland area; Subarea 2 + Division 3K, divisions 3LN, Division 3O and the Laurentian Channel (Unit 2) stock. In Subarea 2 + Division 3K, estimated biomass declined from over 100,000 t in the early 1980s to only about 1,180 t in 1993 in Division 2J. In Division 3K, the decline over the same period was from over 200,000 t to only 686 t in 1993. There can be no optimistic outlook for this resource until about 9-10 years after good recruitment occurs. None is apparent at present.

In divisions 3LN, much of the redfish resource is distributed outside the 200 mile limit in both divisions 3L and 3N. Catches increased to over 78,000 t in 1987 due to a greatly expanded foreign fishery. This catch was three times the TAC of 25,000 t. Since then catches declined to 24,000 t in 1992, but this was still above the reduced TAC of 14,000 t. There are indications that the foreign fishery continues to be excessive, and concern exists that this stock is being rapidly depleted. This is supported by the fact that the Baltic states vessels returned home in 1994 because of the very low catch rates achieved.

In Division 3O, redfish catches increased to about 35,000 t in 1986 because of increased foreign activity. After 1988, catches again declined to about 15,000 t. Whether this decline is reflective of a decrease in the size of the stock or a reduction of effort is unknown. Because of rough bottom in much of the area, it is difficult to carry out trawling and the fleets are restricted to shallower water where smaller fish reside. These are unsuitable to the Canadian processors although acceptable to the foreign fleets which fish in the area outside 200 miles. Little is known about the status of this resource, but research survey data suggest an increase in biomass in the area in recent years. This increase is difficult to interpret.

Catches of Unit 2 redfish increased from about 23,000 t in 1959 to between 30,000 t and 60,000 t from 1963 to 1978. After that they declined somewhat and have fluctuated between 10,000 t and 20,000 t since then. The 1993 catch was about 27,000 t, the highest since extension of jurisdiction, but some 6,000 t were from Unit 1 redfish. Estimates of biomass in Division 3P have fluctuated considerably over the period of surveys, but there are no long-term trends in the data. There are concerns that the size of this resource is declining, and survey data suggest that the year-classes of the mid-1980s are not strong enough to reverse this trend.

In the more northern areas, trends in groundfish biomass for exploited and unexploited species generally show the same downward trend in recent times. Fishing pressure alone cannot account for this, and although fishing may well have played a significant role, other factors such as the ocean climate are considered to be involved. It is not yet possible to clarify the mechanisms involved. Further south, it appears that the stocks have declined primarily in response to fishing pressure. Non-commercial species do not exhibit the same downward trends as indicated for most of the commercial species. Catches taken outside 200 miles have been significant, and since these fisheries have taken primarily small fish, the fishing mortalities exerted are greater than suggested by comparisons of tonnes caught alone. There are some indications that declines in American plaice in the southern areas may not be totally fishery related.

Pelagics and Invertebrates

During the 1990s, declines were also observed in the estimated offshore capelin biomass although information from inshore indices suggest that biomass has remained at normal levels for the period covered by the indices. If the biomass has not declined, then results from the recent acoustic surveys would suggest distributional or behavioral changes There are also reports of capelin appearing on Flemish Cap, as well as increases on the Scotian Shelf. These too are suggestive of behavioral changes possibly induced by the ocean climate. It is presently unclear how these changes may have affected the predator fish species and seals.

Recent exploratory fishing for shrimp indicates that they are widely distributed, and commercial concentrations are now found in areas which were unproductive previously. At present, quantitative links with various groundfish species are unknown but it is clear that during the period when many groundfish species have declined to very low levels in divisions 2J and 3K, the shrimp resource has increased. The significance of these relationships is not understood, but it may represent a complex process rather than a simple predator-prey relationship. It is known that shrimp are prey for groundfish, most notably cod and Greenland halibut.

The crab resources have also shown dramatic increases in recent years. Not only have the densities increased in some areas, but there has also been an expansion of the fishing grounds. It is not possible to relate these changes to changes in the groundfish resources. Because crab of commercial size are about 7-10 years of age, the increased survival possibly occurred before the major observed declines in many of the groundfish species. Also, most recent data suggest that the crab resource will decline because of recent poor recruitment.

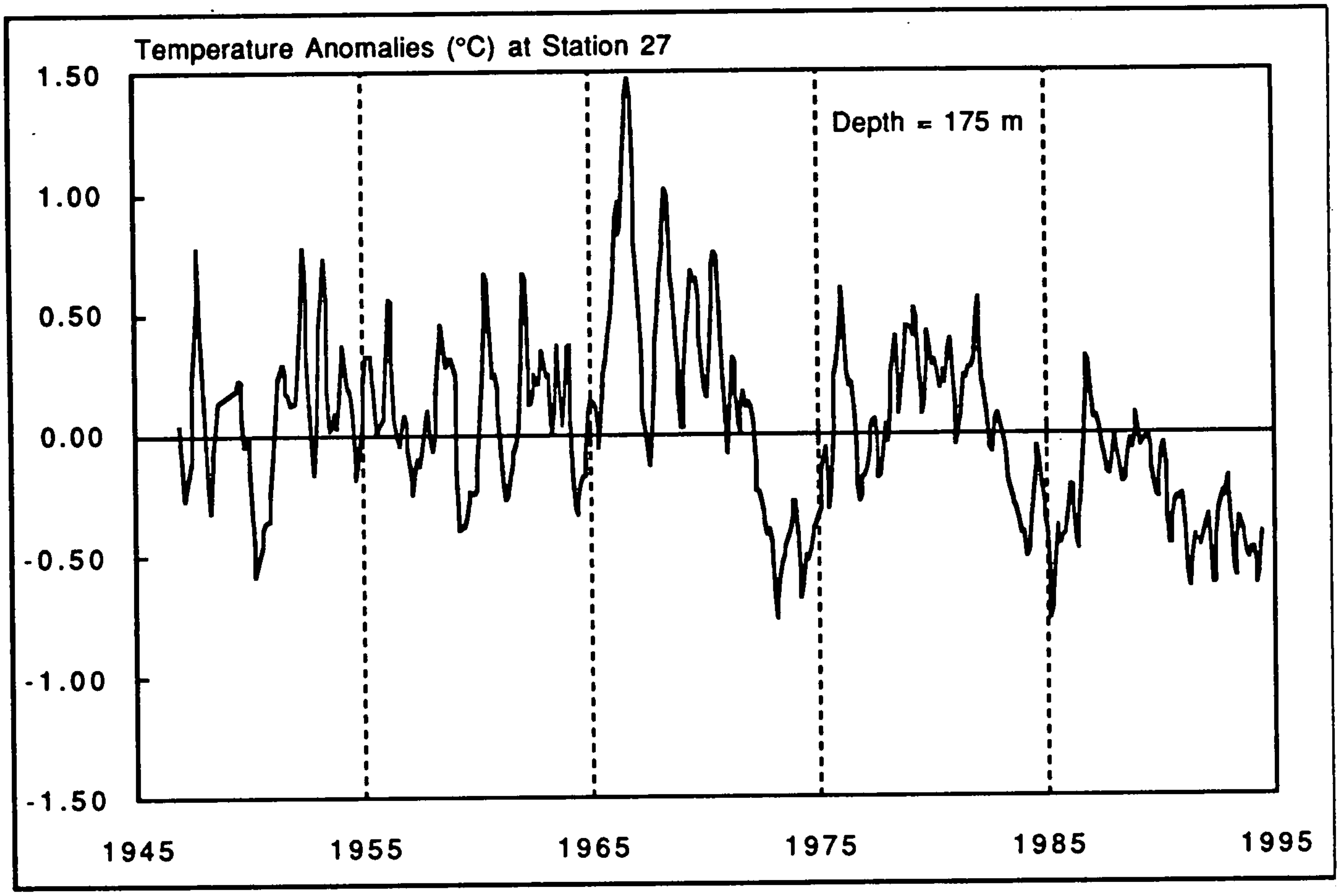
Squid are migrants to Canadian waters from the south, and their presence is thought to be in part related to water temperatures in the area since fluctuations in local catches contrast with stable catches (and recruitment) further south off the USA. Extended periods of low squid abundance are coincident with cool periods (1968-1974, and 1983-1993). The most recent period of absence is the longest recorded. Squid are predators, competitors and prey for groundfish in coastal Newfoundland waters. Otoliths from small 0-group cod were common in squid stomachs until the early 1990s when sand launce and hake otoliths became most prevalent.

Marine Mammals

The total population of harp seals in the Northwest Atlantic was estimated to be approximately 3.1 million in 1990. Abundance has likely increased but the rate cannot be estimated at present, and no clear assessment of the harp seal's impact on cod can be made at this time. Available feeding data suggest that capelin are important in the seal diet offshore, while Arctic cod are more important inshore. The amounts of Atlantic cod found varied greatly between years, but were generally small. It is presently not possible to quantify overall consumption. Limited information on the feeding of hooded seals indicates that any potential impacts may be greater for deeper species such as witch flounder and Greenland halibut.

Ocean Climate Summary

Oceanographic data suggest a gradual cooling trend in the area through the 1980s. This can be seen in the trend in bottom temperature deviations from the long term mean (1949-1993) at Station 27 off St. John's.



In many ways, ocean climate conditions in 1993 resembled those in 1992. Ice coverage was near the long term maximum during the first three months, and persisted longer than normal during spring. The areal extent of the Cold Intermediate Layer (CIL) remained above normal. During summer, it increased compared to 1992, but in the fall there has been a steady increase since 1991. Air temperatures were below normal throughout the year except in late summer. Although recent temperatures are anomalously low relative to the 1945-1993 average, they are actually returning to conditions reflective of the longer term average from the early 1800s to the present.

It is still unclear how these conditions may be affecting the groundfish resources in the area. It is unknown if the decreased or complete cessation of fishing will result in improvements in stock status in the short term. No meaningful predictions concerning the future of these resources can therefore be made.

Cod in Divisions 2GH

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000t	20	20	20	20	20	20	1				
TAC '000t	20	20	20	20	20	20	1	1			
Reported catches '000t	.1	.5	.4	.4	0[2]	0[2]	0[2]		0	3.3	94
Unreported catches					N/A						
Estimated discards '000t [2]					N/A						
Total catches '000t	.1	.5	.4	.4	0[2]	0[2]	0[2]				
Total biomass '000t					N/A						
Spawning biomass '000t					N/A						
Mean - F					N/A						

[1] 1953-1993
[2] Provisional

Catches: The annual catches for this stock since the early 1950s ranged from 94,000 t in 1966 to 134 t in 1987. Since 1985 catches have been less than 500 t and there has been no reported catch since 1990. The current TAC of only 1,000 t is not based on any resource assessment. The shrimp and turbot fisheries in this area have reported no significant cod by-catch.

Data and Assessment:Assessments of this stock have not been possible in recent years because of the lack of abundance indices. Catches have been low or non-existent and there is no sampling available. Research vessel surveys were available from 1986 to 1988 but were not used as an indicator of cod stock abundance because of limited spatial coverage and inappropriate timing. A survey conducted in 1991 attempted to address these problems but this survey detected very few fish.

Fishing Mortality:

Recruitment: Not Known

Environmental Factors: No recent data are available, but the general cooling trend observed further south is probably taking place here as well.

Multispecies Considerations: The shrimp fishery in 2G discards very few cod. Estimates from observer data are as low as 3 t annually. In 2H the discard estimates average approximately 70 t annually.

State of the Stock: The status of the resource is unknown but thought to be low.

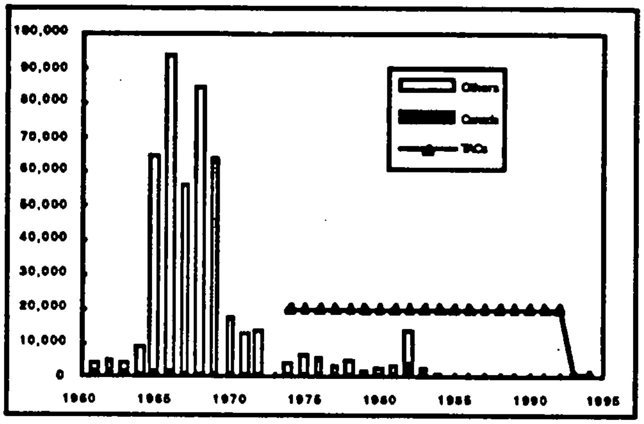
Forecast for 1995: Expected to be low in 1995.

Long-term Prospects: Any rebuilding is dependent on appearance and survival of relatively strong year-classes.

Special Comment: The recovery of this stock may be related to and dependent upon events with neighbouring cod stocks. There are possible links with cod in divisions 2J3KL, and recent analyses (Dickson and Brander 1993) suggest possible past exchange of larval and adult cod between West Greenland and the north Labrador coast. Both of the latter two neighbouring stocks are at low levels at present.

Reference: Dickson, R.R. and K.M. Brander. 1993. Effects of a changing windfield on cod stocks of the North Atlantic. Fish. Oceanogr. 2:3/4, 124-153.

Catches and TACs (t)



Status of Cod in Divisions 2J3KL

Summary

Although it was not possible to precisely determine the stock size in 1993, the research survey data available suggest that there has been a further stock decline. Low numbers of older cod in the offshore surveys indicate that the spawning stock is also lower. The sizes of incoming year-classes continue to be low. Re-evaluation of estimates of the most recent "good" year-classes (1986, 1987) indicate that they may now be below average. Until there is evidence of the presence of a significant number of young cod, which then survive to maturity, stock recovery will not occur.

The Fishery

Prior to the 1950s, landings from this stock generally ranged between 200,000 t and 300,000 t. With the increased effort by foreign fleets, catches increased in the late 1950s and early 1960s and peaked at just over 800,000 t in 1968. Catches then declined to 139,000 t in 1978 but increased thereafter mostly as a result of increased catches by the Canadian offshore fleet. Severe reductions in stock size led to reduced TACs and eventually a moratorium on commercial fishing in mid-1992 which was extended to all types of fishing effective January 1, 1994. The total catch estimate for the "recreational," foreign (outside 200 miles) and by-catch fisheries in 1993 has been estimated at about 11,000 t, although the reliability of this is unknown.

Analysis

The main data sources used in assessing this stock are estimates of catch at age from the fisheries and estimates of population numbers at age from annual research vessel surveys. The catch in 1993 was mainly from a recreational or food fishery and could only be roughly estimated. Research vessel surveys are conducted during the fall in divisions 2J3KL and in the spring in Division 3L. Survey estimates of biomass and abundance have declined sharply in recent years, with the 1993 values extremely low and no cod caught older than age 9. The survey age structure has changed in recent years with younger (age 4) cod predominating as opposed to ages 5 to 6 in the 1980s.

Hydroacoustic surveys in 1993 also suggested a continuing decline in numbers as well as some distributional changes to deeper water and toward the Nose of the Grand Bank in Division 3L.

Although stock size and fishing mortality could not be estimated, analyses incorporating the extremely low RV abundance estimate for 1993 suggest that total mortalities in recent years have been very high and most likely in excess of 1.0 for the fully recruited age groups. Total mortality appears to have declined between 1992 and 1993 because of the fishery closure, but still appears to be higher than can be explained by the estimated catch. Thus the total estimated catch for 1993 of about 11,000 t seems to have been too low to account for the continuing decline in the RV estimates. Three alternative possibilities exist: a) the survey results are real which implies that factors other than fishing must be responsible for the observed declines, b) recent surveys have underestimated stock size and made the calibration of SPA unreliable, or c) the 1993 catch has been underestimated. It is not possible to determine which of these is correct. Furthermore, it is also possible that the recreational fishery in 1993 took fish predominantly originating from supposed inshore stocks. The areas where these fish would occur are not covered during the fall surveys, and no information exists concerning possible trends in inshore 'stock' abundance.

Prognosis

The 2J3KL cod stock abundance increased from the mid-1970s to the mid-1980s but has since declined. There is little doubt that the stock decline observed in recent years has continued in 1993 and that the stock is at a dangerously low level.

Survey data, including estimates of spawning stock size, indicate that the low recruitment levels estimated for recent years will persist. Stock recovery cannot begin until there is production and survival of significant numbers of new recruits.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t	246	293	125	121	100						
Advised TAC '000t	266	293	125	174	100						
TAC '000t	256	266	235	199	190	120	-[2]	0			
Reported catches '000t	235	269	253	219	171[3]	44[3]	11[3]		11	270	810
Unreported catches					N/A						
Estimated discards					N/A						
Total catches '000t	235	269	253	219	171[3]	44[3]	11[3]				
Total biomass '000t											
Spawning biomass											
Mean - F ( )											

[1]For 1962-1993
[2]June 1992 - lowest possible
[3]Provisional

Catches: A moratorium on commercial fishing was imposed on the Canadian fishery in July 1992 and subsequently by the European Union on its fleet. Estimated catches by the recreational, foreign (outside 200 miles) and by-catch fisheries in 1993 totalled approximately 11,000 t. The moratorium was extended to include the recreational fishery effective in January 1994.

Data and Assessment: The principal index of abundance is a fall offshore research vessel survey series. From 1978 to 1990, the catch per tow averaged about 50 cod with the 1990 catch per tow equal to the average. This declined to 33 fish per tow in 1991. The decline was more pronounced for fish age 6 and older. Despite the severe reduction in fishing activity as a result of the moratorium, the catches decreased further during the 1992 and 1993 surveys to 9 and 2 fish per tow respectively.

Fishing Mortality: Although stock size and fishing mortality could not be estimated, analyses incorporating the extremely low RV abundance estimate for 1993 suggest that total mortalities in recent years have been very high and most likely in excess of 1.0 for the fully recruited age groups. The continued drastic decline in survey abundance occurred in the virtual absence of an offshore fishery and with a low 'recreational' fishery.

Recruitment: The 1986 and 1987 year-classes were originally estimated to be strong but subsequent analyses resulted in downward revisions of the estimates such that they now appear to be below average. Survey data would suggest that year-classes since that time are weak. Spawning stock biomass remains low, and based on previous analyses strong recruitment is not anticipated.

Environmental Factors: Temperatures recorded at Station 27 during the 1990s have been anomalously low when compared with the mean for years since 1946. However, temperatures during the 1990s may be close to the average in the longer term perspective going back to the 1800s.

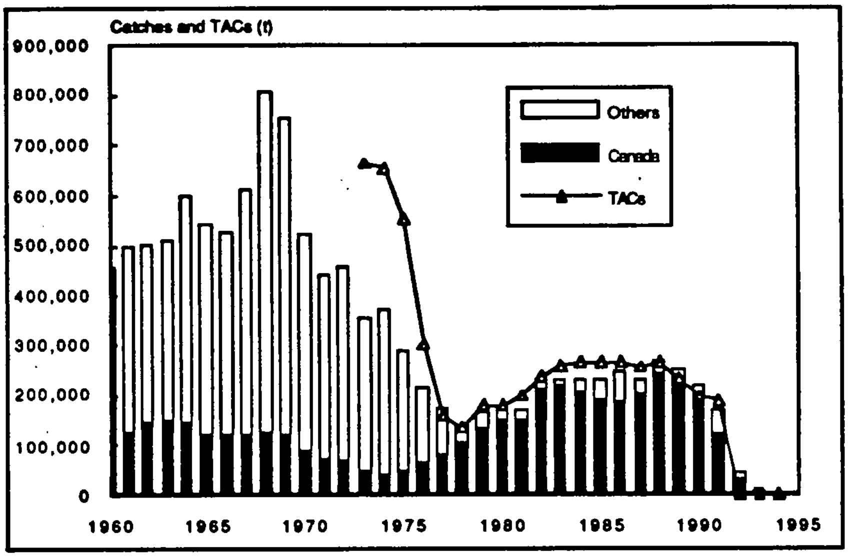
Multispecies Considerations: Capelin abundance estimates from offshore acoustic surveys have been very low since 1990 although inshore indices suggest 1993 abundance at or above average levels. The biomass of some other very lightly exploited groundfish stocks in this area have also decreased markedly since the 1980s. The harp seal herd appears to be increasing although their impact on cod as a predator or competitor has not been quantified. During the period when many groundfish species have declined to very low levels, the northern shrimp resource, particularly in the southern 2J and 3K areas, has increased. The snow crab population off eastern Newfoundland has also increased in recent years as evidenced by increasing catch rates with relatively stable effort although the improved recruitment occurred prior to the decline in the cod stock.

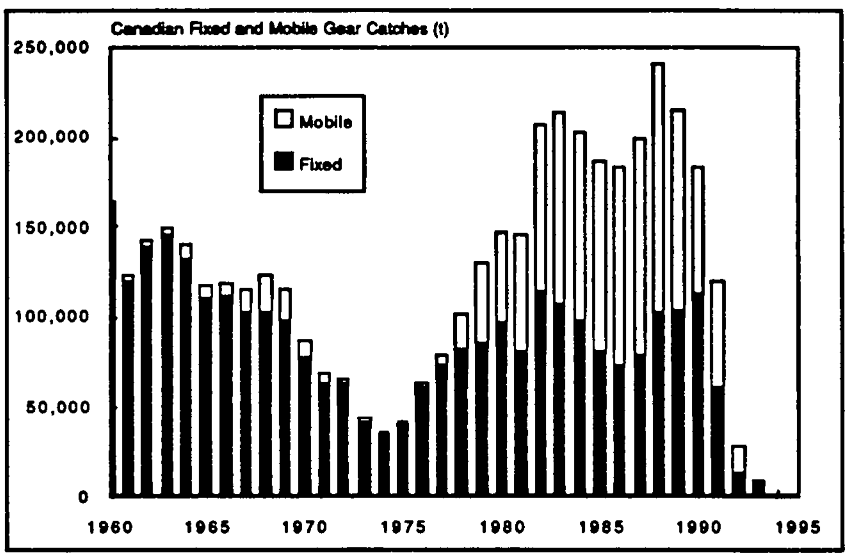
State of the Stock: The stock is in a very depressed state, probably at an all-time low.

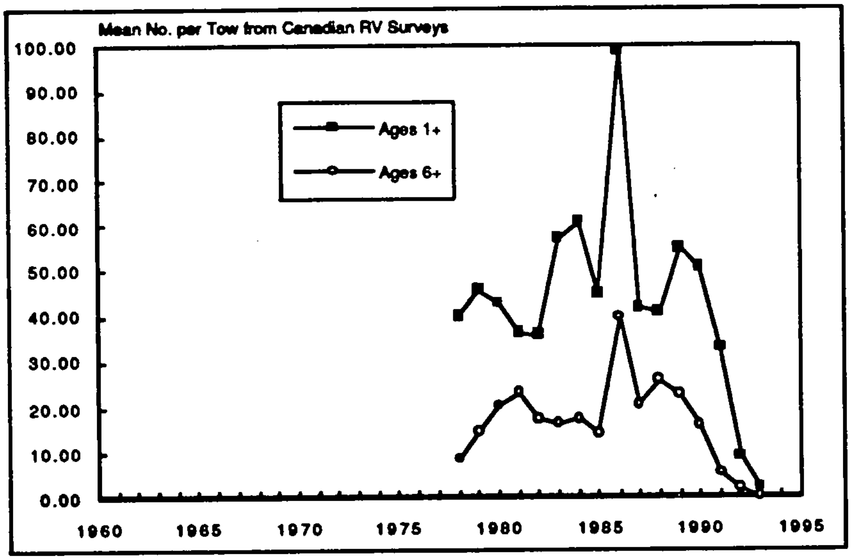
Forecast for 1995: Current data suggest further stock declines. No fisheries should be considered until there is evidence of adequate recovery.

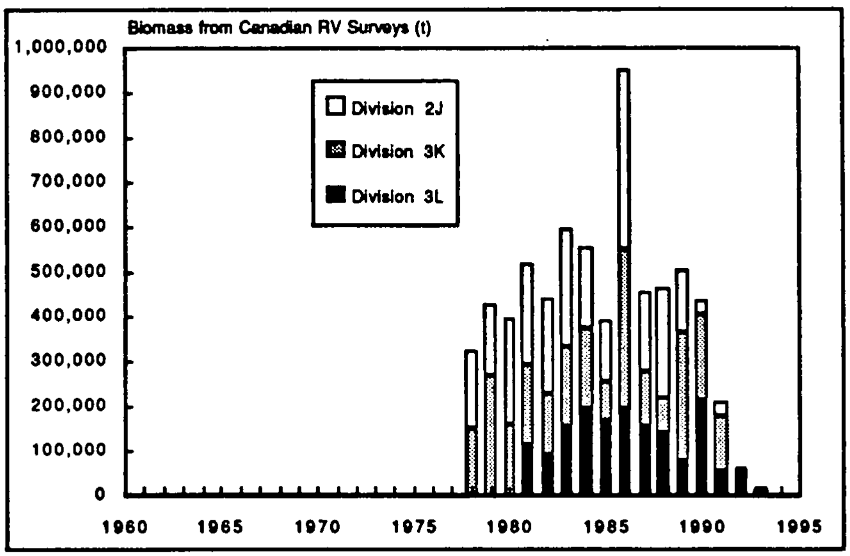
Long-term Prospects: Before the expansion of the fishery in the 1960s, catches were generally in the 200,000 t to 300,000 t range. During the 1960s, good recruitment along with exploitation rates ranging from 25% to 50% saw catches averaging about 580,000 t. Given the current depressed state of the stock which continues to decline, the low current spawning stock biomass and the apparent low recruitment levels of recent years, stock recovery in terms of total and spawning stock biomass is not possible in the next 5-7 years. Stock recovery cannot begin until there is production and survival of significant numbers of new recruits.

Special Comment: Total mortality appears to have declined between 1992 and 1993 because of the fishery closure, but the total estimated catch for 1993 of about 11,000 t seems to have been too low to account for the continuing decline in the RV estimates. Three alternative possibilities exist: a) the survey results are real which implies that factors other than fishing must be responsible for the observed declines, b) recent surveys have underestimated stock size and made the calibration of the SPA unreliable or c) the 1993 catch has been underestimated. It is not possible to determine which of these is correct. It is possible that the recreational fishery in 1993 took fish predominantly originating from supposed inshore stocks. The areas where these fish would occur are not covered during the fall surveys, and no information exists concerning possible trends in inshore 'stock' abundance.


Catches and TACs (t)
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs


Canadian Fixed and Mobile Gear Catches (t)
250,000
200,000
150,000
100,000
50,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Mobile
Fixed


Mean No. per Tow from Canadian RV Surveys
Ages 1+
Ages 6+
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1960
1965
1970
1975
1980
1985
1990
1995


Biomass from Canadian RV Surveys (t)
Division 2J
Division 3K
Division 3L
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1960
1965
1970
1975
1980
1985
1990
1995

Cod in Subdivision 3Ps

Summary

This stock appears to have declined in population numbers and biomass since the late 1980s. Research survey biomass continues to be low, the numbers of older (ages 6+) fish found during the surveys have declined, lengths-at-age are decreasing particularly at older ages and both males and females are becoming mature at a younger age. The fishery was closed in September 1993 and will remain closed until at least the end of 1994.

The Fishery

After extension of jurisdiction in 1977, catches averaged slightly over 30,000 t until the mid-1980s when catches by France increased significantly such that total landings peaked at about 57,000 t in 1986 and 1987. Catches then declined to about 40,000 t through 1991 before dropping to 32,000 t in 1992 and only 15,000 t in 1993. In 1993, there were no catches reported by France, and the Canadian fishery was closed in September. The Canadian fishery remains closed in 1994.

Analyses

Stock assessments have relied upon results from bottom trawl research surveys conducted by Canada since 1972 and by France for the period 1978-1991. However, inter-annual variabilities of cod migrations between Subdivision 3Ps and adjacent stock areas (3Pn4RS, 3NO) complicate the interpretation of survey results. Changing the timing of the surveys from February to April in 1993 and 1994 appears to have helped resolve this problem of possible mixing in that large aggregations were not found near stock boundaries in April. Also, there has been a tendency for both survey and commercial trawler catches to be larger in deeper water (e.g. the Laurentian Channel and Southern Halibut Channel) in recent years.

Reports from inshore fishermen suggest an increase in abundance of fish in the northern end of Placentia Bay. The distribution, stock affinity and behaviour of these inshore fish are not well understood. For example, it is not known if the same fish return to the same area of the Bay every winter or if there is some cycling of fish between the offshore and inshore each winter. Although the 1994 survey coverage was extended into parts of Placentia Bay, the entire area was not surveyed because of rough bottom conditions.

Because of the identified problems with the survey data time series, coupled with difficulties in assigning a portion of the annual commercial catches in the 3Ps/3Pn boundary area in winter to the appropriate stock unit, sequential population analysis was not considered appropriate for this stock at this time.

Prognosis

Despite difficulties in interpreting the available data, there are a number of trends observed in them which suggest caution should be exercised. Total mortality estimates from survey data show an increasing trend, size at age is decreasing, age at maturity is decreasing, and there appears to be a loss of older age classes in surveys in recent years. The 1989 year-class appears to be relatively strong and this will begin to contribute significantly to the spawning stock biomass in 1995.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t	26-58	37	20.5	N/A	29	39					
Advised TAC '000t	26-58	37	20.5	N/A	29-44.5	39-44.5	20				
TAC '000t	60.6	60.6	50	45	44	44	20	0			
Reported catches '000t	57	43	39.5	41	43[2]	31.5[2]	15[2]		15	49	84
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	57	43	39.5	41	43[2]	31.5[2]	15[2]				
Total biomass '000t											
Spawning biomass '000t											
Mean - F (7-10)											

[1] 1959-1993
[2] Provisional

Catches: The 1993 catch was 15,000 t, approximately half of the 1992 catch. The decrease was partly due to the closure of the fishery in September 1993.

Data and Assessment: Research vessel surveys have been conducted by Canada since 1972 and by France during 1978-1991. The April, 1994 survey was expanded to include parts of Placentia Bay and additional strata in deeper water. Abundance estimates were low, consistent with low survey estimates in 1992 and 1993.

Fishing Mortality: Estimates for the most recent years are not possible because of calibration problems. SPA results for the converged portion of the time series indicate that fully recruited fishing mortalities have been greater than twice $F_{0.1}$ since the extension of jurisdiction, and have gradually increased since that time.

Recruitment: The 1994 survey results indicate that the 1989 year-class is still relatively strong. There is no indication of strong year-classes since that time.

Environmental Factors: Since 1991, water temperatures have generally increased from the lows experienced during the mid-1980s and in 1990 but large spatial areas with negative temperature anomalies have continued into the spring of 1994, particularly on the eastern portion of St. Pierre Bank, on the continental slope areas and in Placentia Bay. Possible impacts of these changes cannot be determined.

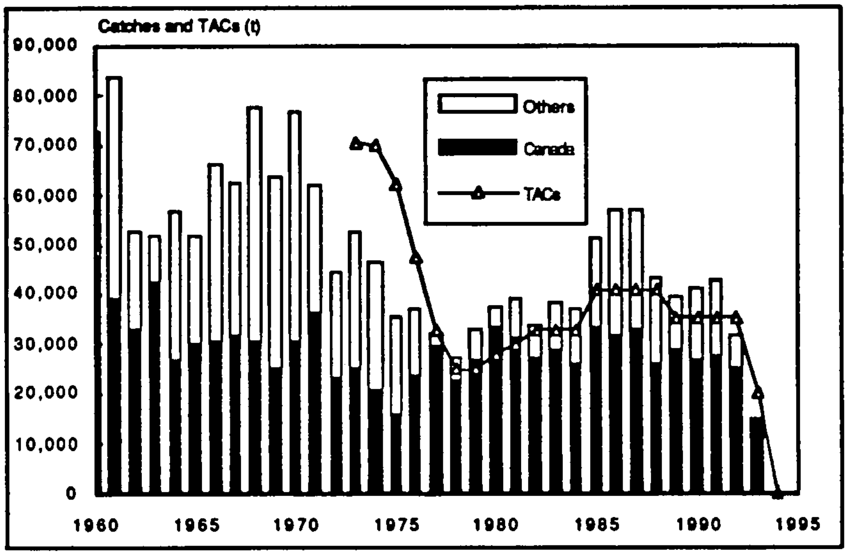
Multispecies Considerations: There are no data available to allow for consideration of multispecies interactions for this stock.

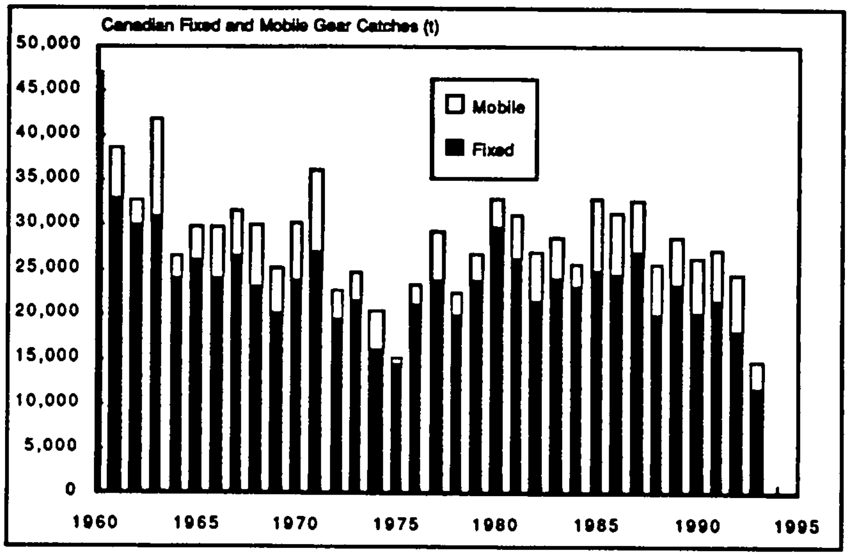
State of the Stock: Based on RV data, the stock abundance and biomass are among the lowest values observed. It is possible that some of the cod encountered during the surveys in some years may have been migrants from 3Pn4RS or 3O, but the cod stocks in these areas are currently at low levels also.

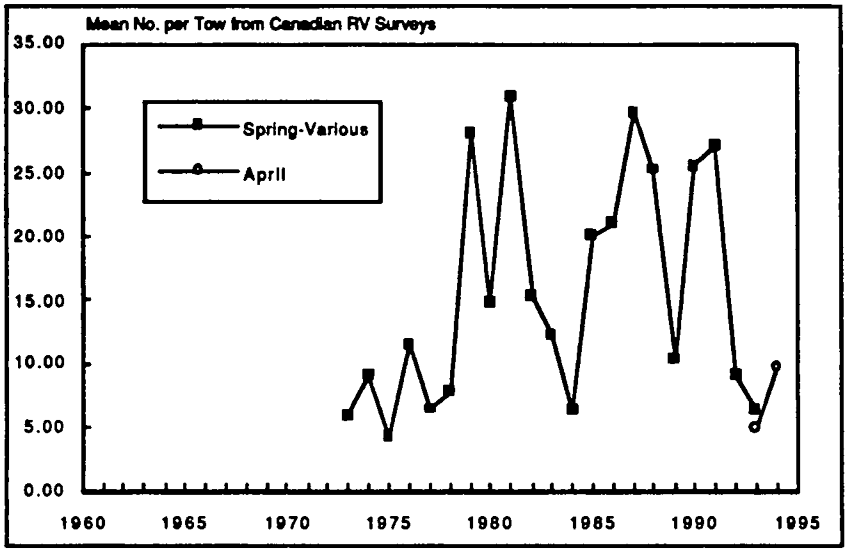
Forecast for 1995: Based on the research survey results, it is expected that the stock will remain low in 1995. Although there are difficulties interpreting the research vessel data, size at age is decreasing, age at maturity is decreasing and there is a loss of older age classes. These trends are commonly associated with declining fish stock abundance. The 1989 year-class appears to be relatively strong and this will begin to contribute significantly to the spawning stock biomass in 1995.

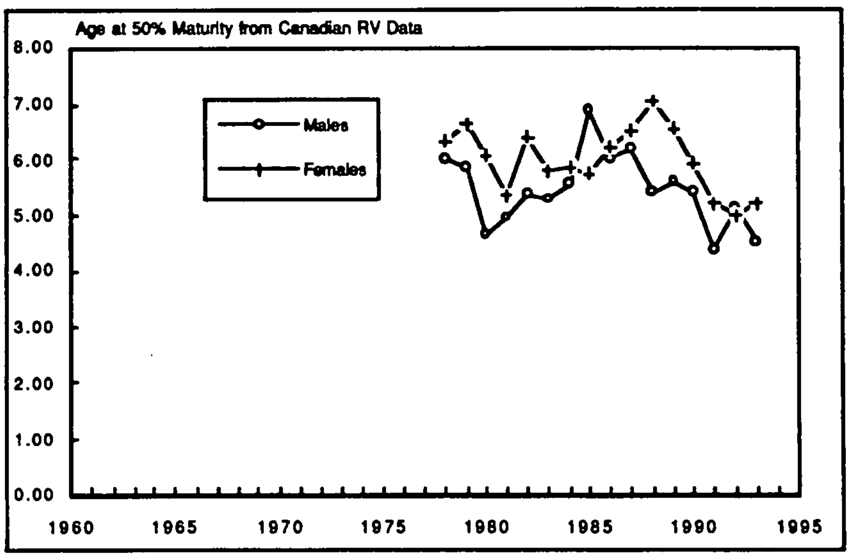
Long-term Prospects: Based on research vessel data, there are no indications of good recruitment after the year-class of 1989. Additional good year-classes will be required to promote stock rebuilding.

Special Comment: There are difficulties in interpreting the time series of survey data because of possible mixing of fish from adjacent areas (3Pn4RS, 3O). Nonetheless, the results suggest that stock levels have declined somewhat in recent years. Changing the timing of the surveys from February to April in 1993 and 1994 has helped resolve the problem of possible mixing in that large aggregations were not found in the areas of the stock boundaries in April. It is important that the stock affinities of catches in the research surveys and commercial fisheries (both inshore and offshore) be clarified in order to better determine the status of this resource.


Catches and TACs (t)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs


Canadian Fixed and Mobile Gear Catches (t)
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Mobile
Fixed


Mean No. per Tow from Canadian RV Surveys
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Spring-Various
April
1960
1965
1970
1975
1980
1985
1990
1995


Age at 50% Maturity from Canadian RV Data
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Males
Females
1960
1965
1970
1975
1980
1985
1990
1995

Haddock in Divisions 3LNO

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t					N/A					—	
Advised TAC '000t	a	a	a	a	a	a	b				
TAC '000t	4.1	8.1	8.1	10.0	4.1	4.1	.5	.5			
Reported catches '000t	5.7	8.2	6.7	3.2	1.3[2]	1[2]	.9[2]		.1	3.7	76
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	5.7	8.2	6.7	3.2	1.3[2]	1[2]	.9[2]				
Total biomass '000t					N/A						
Spawning biomass '000t					N/A						
Mean - F ( )					N/A						

[1] 1953-1993 [a] by-catch only
[2] Provisional [b] by-catch only with ceiling of 500 t

Catches: Catches were highest during the 1950s and early 1960s with a maximum of 76,000 t in 1961. These catches were the result of the presence of the strong 1949 and 1955 year-classes. Catches have remained low from the 1960s to the mid-1980s as a result of poor recruitment. Catches increased to 8,200 t in 1988, the highest since 1967, and have since declined to less than 1,000 t.

Data and Assessment: Abundance and biomass estimates of haddock from Canadian surveys were low from 1973 to 1982 when both increased substantially. The mean numbers and weight per tow were highest in 1984, declined sharply in 1985, and showed a moderate increase in 1988. Both indices have been low since.

Fishing Mortality: Not known, but believed to be high during the late 1980s.

Recruitment: Recruitment since 1981 has been poor.

Environmental Factors: Haddock in Newfoundland waters are at the northern most extension of their range in the Northwest Atlantic. Cold water throughout the area in recent years have probably been restrictive to their distribution and behaviour.

Multispecies Considerations:

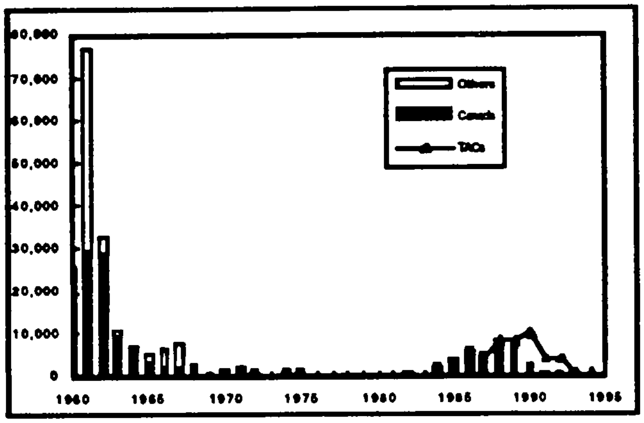
State of the Stock: The high catches of the 1980s were the result of increased effort on the relatively strong year-classes of the early 1980s, mainly those of 1980 and 1981. The very low abundance of these year-classes at ages 6 and older during surveys, and the concurrent relatively large commercial catches would suggest that fishing mortality was high and most of these fish did not survive to spawning age (age of 50% maturity about age 5). Recent survey show no indication of increased recruitment .

Forecast for 1995: Because of no signs of improved recruitment in recent years, the stock is not expected to increase in 1995.

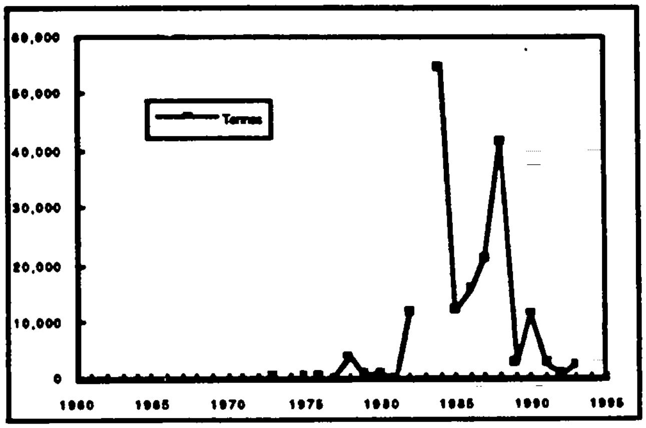
Long-term Prospects: The stock has traditionally shown considerable variation in recruitment levels but the mechanisms are not understood. The possibility of good recruitment should be increased with a larger spawning stock size.

Special Comment: CAFSAC advised through the 1980s that there be no directed fishery on this stock, yet TACs were set between 4,100 and 10,000 t during 1987-1992. A catch of 500 t approximates the average taken during the 1970s when recruitment was low. Should another good year-class occur in the future, it should be protected so it can reach spawning age.

Catches and TACs (t)



Biomass from Canadian RV Surveys (t)



Haddock in Subdivision 3Ps

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000t	a	a	a	a	a	a	b				
TAC '000t	.15	2.2	3.2	3.2	3.2	3.2	.5	.5			
Reported catches '000t	2.7	2.4	2.9	1.5	.5[2]	.5[2]	.1[2]		.1	1.9	57.8
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	2.7	2.4	2.9	1.5	.5[2]	.5[2]	.1[2]				
Total biomass '000t					N/A						
Spawning biomass '000t					N/A						
Mean - F ( )					N/A						

[1] 1954-1993 a by-catch only
[2] Provisional b by-catch only with ceiling of 500 t

Catches: Catches from this stock peaked at 57,797 t in 1955 then declined to less than 5,000 t in the 1960s. Catches showed a further decline to less than 1,000 t in the 1970s, increased to 7,500 t in 1985 but have since declined to less than 500 t.

Data and Assessment: Abundance and biomass estimates from Canadian surveys conducted since 1972 were highest in 1985 but have decreased to low levels in the 1990s. Biomass and abundance increased in the mid-1980s with the appearance of a moderately successful 1981 year-class. The 1994 estimates of biomass and abundance were up somewhat, but most of this increase can be accounted for by one large catch in deep water.

Fishing Mortality: Survey data suggest that the mortality on the 1981 year-class was high and the number reaching maturity was small.

Recruitment: Has been poor since 1981.

Environmental Factors: Bottom temperature data indicate cooling since the mid-1980s. Although there has been some warming since 1991, water remains colder than average on the eastern portion of St. Pierre Bank and slope area. The effects this may be having on haddock are unknown, but this species does prefer warmer waters.

Multispecies Considerations:

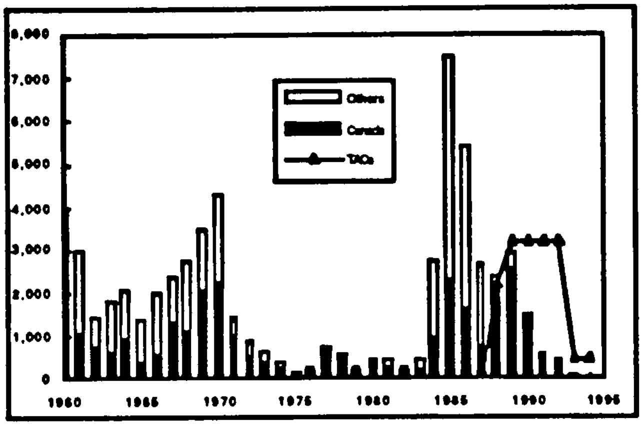
State of the Stock: Survey data suggest that the relatively strong 1981 year-class was severely reduced in number by age 7. The age of 50% maturity is about age 5-6, but fishery information suggests most were taken in 1985 at only age 4. Only a small proportion survived to spawning age.

Forecast for 1995: There are no indications of any stock increase for 1995.

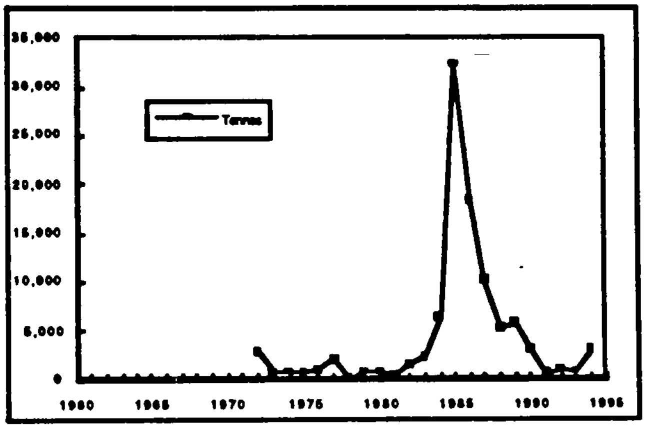
Long-term Prospects: Chances of stock increase would be enhanced by allowing any new strong recruitment to survive to spawning age.

Special Comment: Although CAFSAC continually advised that the catches should be restricted to by-catch only through the 1980s, TAC ranging between 150 to 3,200 t were put in place from 1987-1992. The 500 t by-catch level was based on average catches from the mid-1970s to early 1980s when recruitment was low.

Catches and TACs (t)



Biomass from Canadian RV Surveys (t)



Pollock in Subdivision 3Ps

Year	1987	1988	1989	1990	1991	1992	1993	1994	Mi	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000t							a				
TAC '000t	1.5	5.4	5.4	5.4	5.4	5.4	.6	.5			
Reported catches '000t	5.1	4.2	3.3	2.0	1.3[2]	.5[2]	.1[2]		.1	.6	7.6
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	5.1	4.2	3.3	2.0	1.3[2]	.5[2]	.1[2]				
Total biomass '000t					N/A						
Spawning biomass '000t					N/A						
Mean - F ( )					N/A						

[1] 1967-1993 a by-catch only with precautionary ceiling of 600 t
[2] provisional

Catches: Catches averaged about 400 t from 1967 to 1982, increased to 7,550 t in 1986 but have since declined to only 137 t in 1993. Years of high catches coincided with years with high survey estimates.

Data and Assessment: Estimates of biomass from research surveys were highest in 1987 but have been declining since and there appears to be few pollock in 3Ps.

Fishing Mortality: Unknown.

Recruitment: There are no survey data by age available.

Environmental Factors: It is not known how the recent cooling in Subdivision 3Ps may affect pollock.

Multispecies Considerations:

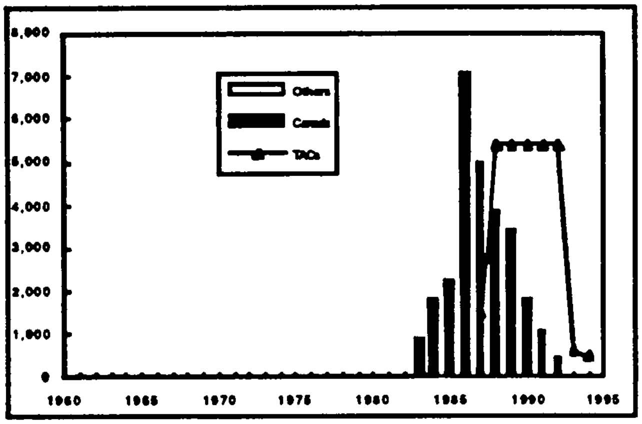
State of the Stock: Stock considered to be at a low level based on survey data and commercial catches.

Forecast for 1995: Unknown but it is assumed that the stock will remain low.

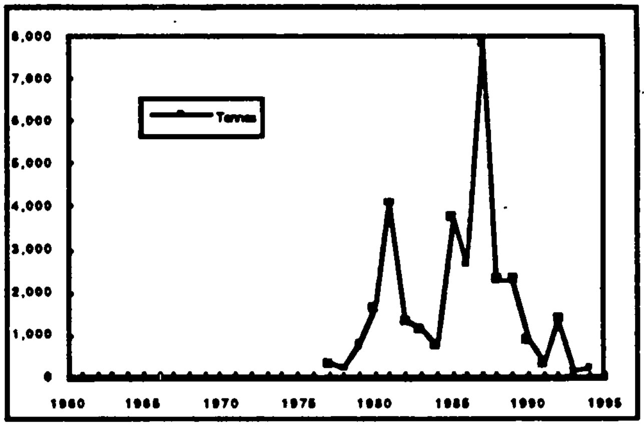
Long-term Prospects: Unknown.

Special Comment:

Catches and TACs (t)



Biomass from Canadian RV Surveys (t)



American Plaice in Subarea 2 and Division 3K

Summary

This stock is at its lowest level in at least 17 years. The numbers of older fish in the population have declined and there is no evidence of increased numbers of young fish.

The Fishery

Catches from this stock were at their highest in the early 1970s but have declined in recent years to their lowest observed levels in 1992 and 1993. Only a by-catch TAC exists for 1994.

Data

Research vessel surveys have shown that this stock has declined by 95% from the early 1980s to the present. The numbers of fish at all ages has been decreasing. It is very unlikely that fishing alone can account for the magnitude of the decline in this stock since the early 1980s.

Prognosis

This stock is at a very low level and any fishing would be detrimental to its recovery. There does not appear to be any prospect of the stock rebuilding in the short to medium term.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000t	10	10	10	10	10	10	5				
TAC '000t	10	10	10	10	10	10	5	0.5			
Reported catches '000t	1.1	1	4.2	1.8	.5[2]	.1[2]	.1[2]		0.1	3.5	12.7
Unreported catches				N/A							
Estimated discards '000t				N/A							
Total catches '000t	1.1	1	4.2	1.8	.5[2]	.1[2]	.1[2]				
Total biomass '000t				N/A							
Spawning biomass '000t				N/A							
Mean - F ( )				N/A							

[1]For 1963-1993 [2]Provisional

Catches: Catches have been declining since 1989 and in 1992 and 1993 were about 100 t each year. Catches have been less than 1900 t in nine of the past eleven years.

Data and Assessment: Research vessel surveys indicate sharp declines in biomass in all divisions since the mid-1980s. The biomass estimates for divisions 2J and 3K were about 5,500 t in both 1992 and 1993, compared to an average of over 105,000 t from 1980-84.

Fishing Mortality: Total mortality is likely to have been very high to have caused such rapid declines in abundance. Fishing mortality from reported catches cannot explain these decreases. Misreporting of catches and migration are thought to be unlikely causes.

Recruitment: Research vessel survey data indicate a decline in recent years.

Environmental Factors: Anomalously low water temperatures since the mid-1980s may have had an effect on distribution and abundance through some unknown mechanism. From 1989 onward, research vessel surveys showed a very low proportion of biomass in the shallower areas of divisions 2J and 3K compared to the earlier period.

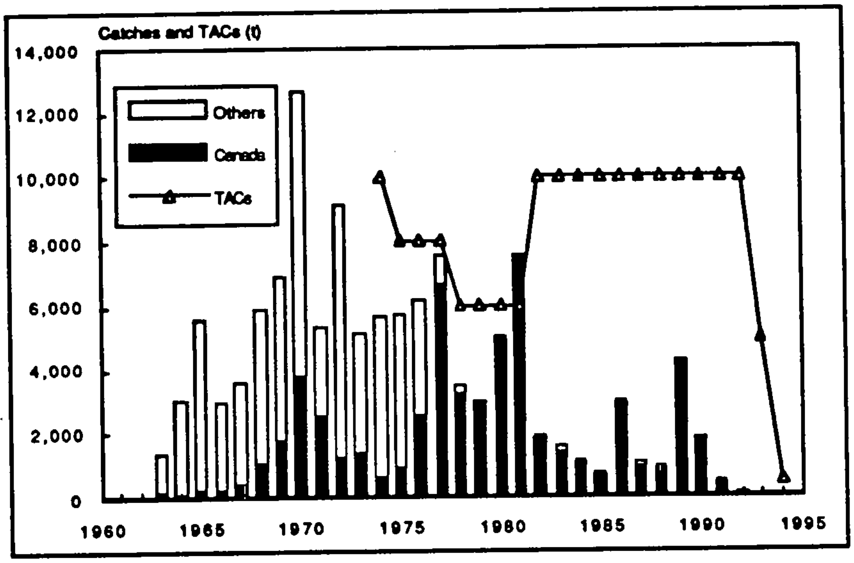
Multispecies Considerations: There are strong negative correlations between shrimp CPUE and the biomass estimates of American plaice and other groundfish in the fall research vessel surveys in divisions 2J and 3K. This is unlikely to be a simple predator-prey relationship and may be indicative of a more complex process.

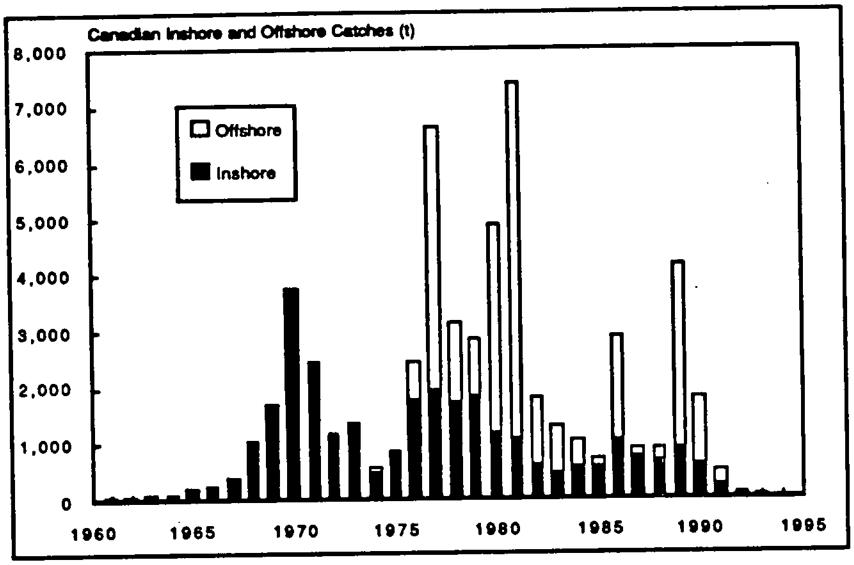
State of the Stock: Stock size is the lowest observed in at least 17 years. There are no indications of recruitment necessary to rebuild the stock. It is very unlikely that fishing mortality has contributed substantially to the recent declines in biomass. Causes of the decline are not known.

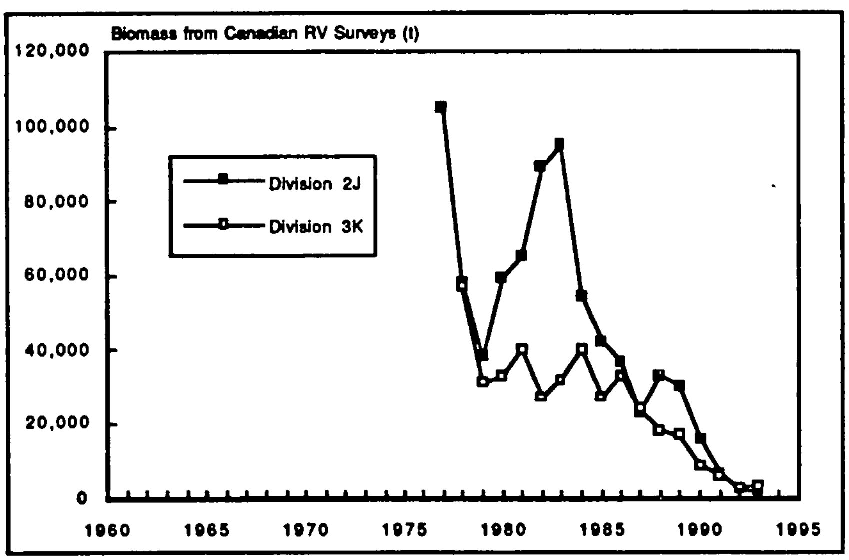
Forecast for 1995: Given the very low biomass, any commercial fishery on this stock would be detrimental.

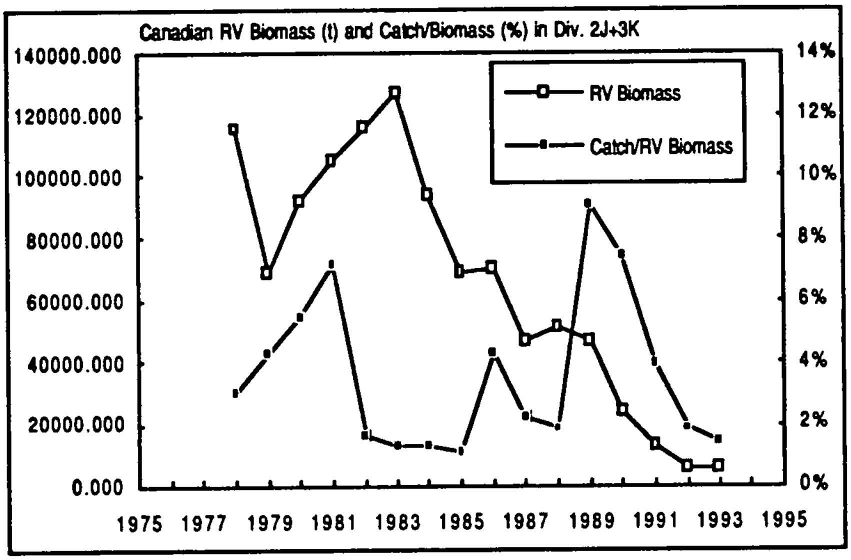
Long-term Prospects: Unknown, but a recovery of the fishery is unlikely before at least 10 years, given recent recruitment estimates and the age structure required to support a fishery.

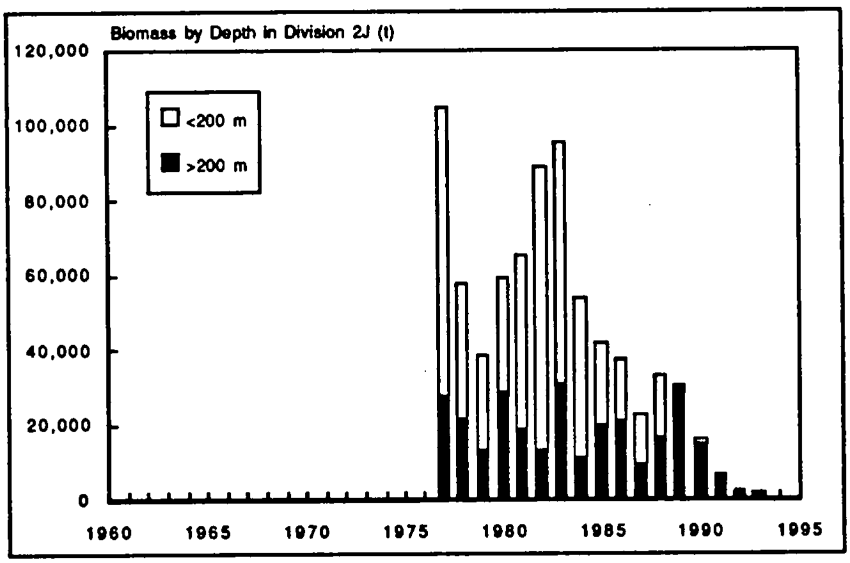
Special Comment:


Catches and TACs (t)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs


Canadian Inshore and Offshore Catches (t)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Offshore
Inshore


Biomass from Canadian RV Surveys (t)
120,000
100,000
80,000
60,000
40,000
20,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Division 2J
Division 3K


Canadian RV Biomass (t) and Catch/Biomass (%) in Div. 2J+3K
RV Biomass
Catch/RV Biomass
140000.000
120000.000
100000.000
80000.000
60000.000
40000.000
20000.000
0.000
14%
12%
10%
8%
6%
4%
2%
0%
1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995


Biomass by Depth in Division 2J (t)
<200 m
>200 m
120,000
100,000
80,000
60,000
40,000
20,000
0
1960 1965 1970 1975 1980 1985 1990 1995

American Plaice in Subdivision 3Ps

Summary

This stock is at its lowest level in at least 15 years. The number of older fish in the population has declined and there is no indication of increased numbers of young fish. The fishery was closed in late 1993 and remains closed in 1994 except for a small by-catch TAC.

The Fishery

The peak catches for this stock were in the 1968 to 1973 period. Catches and catch rates have declined in recent years to their lowest observed levels. In 1993, only 751 t were caught before the fishery was closed in September. The catch is mainly made up of fish ages 8 to 12.

Data

Research vessel surveys have shown that the stock has been declining since the mid-1980s and is now at a very low level. The numbers of fish at all.ages have been decreasing. The fish, both male and female, have been maturing at a younger age.

Prognosis

This stock is at a very low level and any fishing would be detrimental to its recovery. There does not appear to be any prospect for stock rebuilding in the short to intermediate term.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000t		5	5	4	4	3	3				
TAC '000t		5	5	4	4	4	3	0.5			
Reported catches '000t	5.3	4.4	4.0	4.8	4.4[2]	2.3[2]	0.8[2]		0.8	4	14
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	5.3	4.4	4.0	4.8	4.4[2]	2.3[2]	0.8[2]				
Total biomass '000t					N/A						
Spawning biomass					N/A						
Mean - F ( )					N/A						

[1]For 1963-1993 [2]Provisional

Catches: Overall the catch in 1993 was 751 t, the lowest since the early 1960s. The catch by Canadian offshore trawlers was the lowest in the time series and the inshore catch the lowest since 1985.

Data and Assessment: The commercial catch per unit effort analyses done in 1993 showed that there has been a sharp decline since the mid-1980s. Research survey biomass estimates were relatively stable around 30,000 t in 1986-88 but have declined substantially since 1989 with five of the six surveys since then (including 1994) giving an estimated biomass at less than 7,000 t.

Fishing Mortality: Total mortality is likely very high in light of the rapid decrease in abundance. It is unlikely that reported catches are solely responsible for the observed decline in abundance, although fishing mortalities themselves are likely to have been high in recent years.

Recruitment: Surveys indicate that recruitment is very low.

Environmental Factors: There is some indication that temperatures have been low in recent years, but the possible impacts of this on the stock cannot be determined.

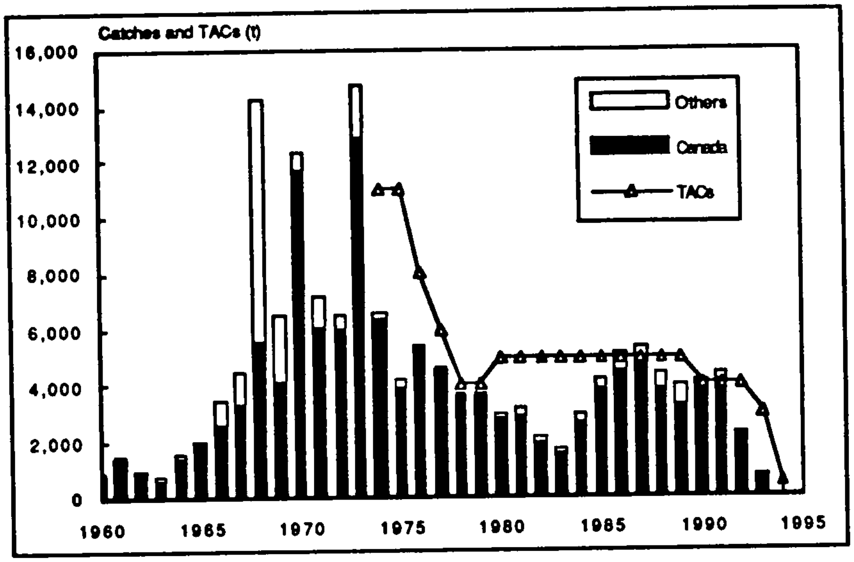
Multispecies Considerations: There are no data available to allow for consideration of multispecies interactions for this stock.

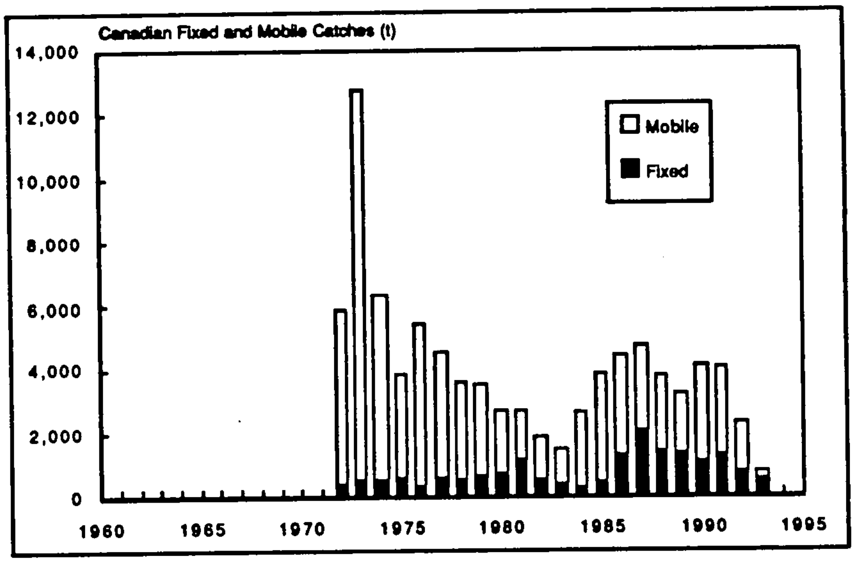
State of the Stock: This stock is currently at an extremely low level coupled with low levels of recruitment.

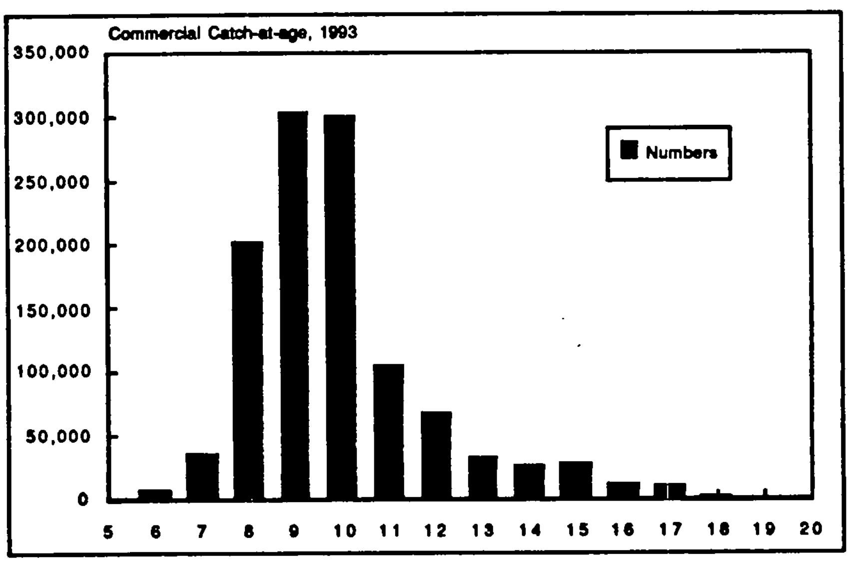
Forecast for 1995: In the short term, there is no prospect for stock rebuilding.

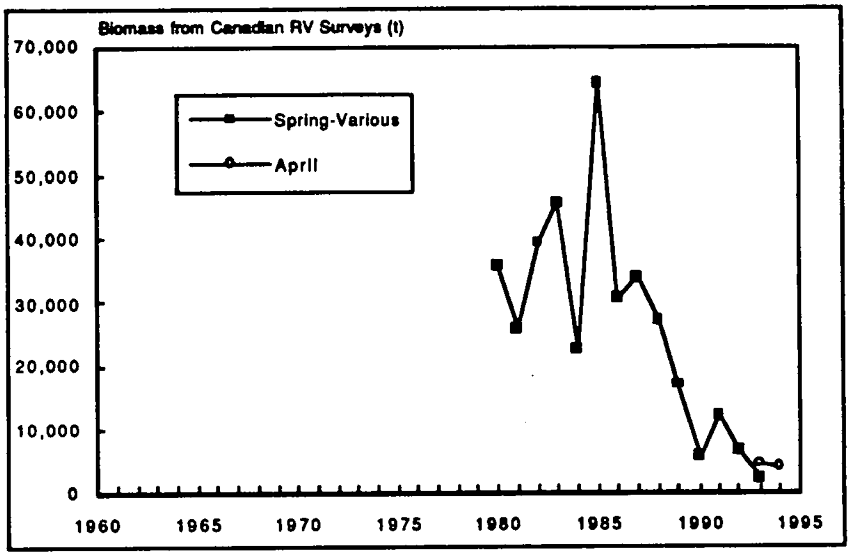
Long-term Prospects:The longer term outlook is pessimistic given the low stock size and lack of recruitment. Rebuilding cannot be expected until there are indications of improved recruitment.

Special Comment: Given the current status, any commercial fishery on this stock would be detrimental.

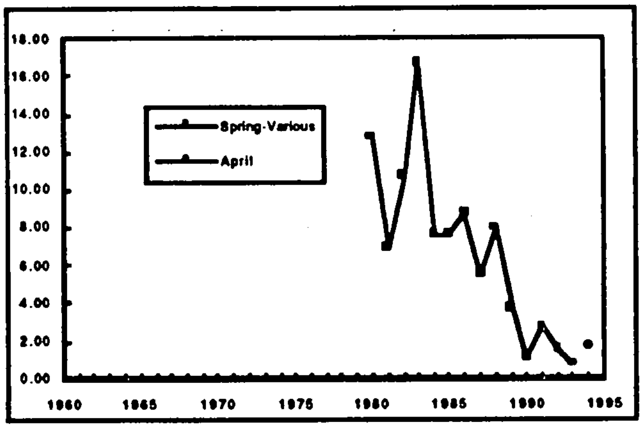

Catches and TACs (t)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs

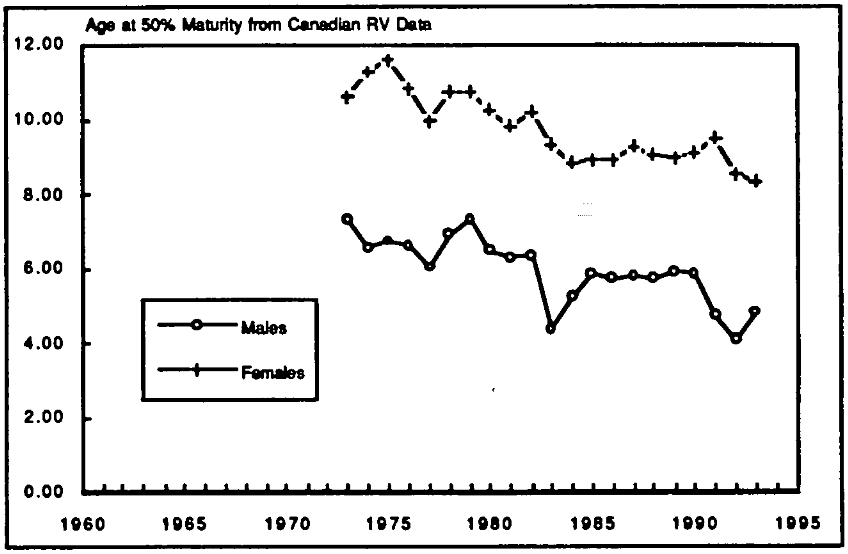

Canadian Fixed and Mobile Catches (t)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Mobile
Fixed


Commercial Catch-at-age, 1993
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Numbers



Age 6 Recruitment from Canadian RV Surveys (millions)





Witch in Divisions 2J3KL

Summary

Both the total and spawning biomasses have been declining since the mid-1980s. Recruitment has also been poor to non-existent since the mid-1980s. The estimated biomass in 1993 is the lowest since surveys began in 1978. What remains of the stock appears to be located in very deep water (>1000 m) near the divisions 3KL border. However, during the winter of 1993, quantities were insufficient to support a viable fishery.

The Fishery

The fishery for witch flounder started in the late 1960s by large trawlers from the USSR and Poland and catches peaked at 24,000 t in 1973. After the introduction of the 200 mile limit, foreign countries were gradually phased out and Canada became the only participant in the fishery. Catches declined systematically from 1973 and levelled out at about 3,000 to 4,000 t annually from 1978 to 1991. Since then, catches declined dramatically with a catch in 1993 of less than 400 t. The 1994 catch is anticipated to be even less.

Data

The status of this stock is generally evaluated by following trends in biomass and abundance from research vessel surveys. Biomass has declined considerably from an average of about 40,000 t in the early 1980s to just 1,300 t in the fall of 1993. When the fishery began, there were fish as old as 26 years in the stock whereas today none are found older than 14 years. What remains of the stock appears to be located in depths greater than 1,000 meters near the divisions 3K and 3L boundary although quantities are now insufficient to support a viable fishery.

Prognosis

This stock has reached a dangerously low level and any exploitation is ill-advised. Short-term prospects for rebuilding are poor and in the long term are unknown.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000t		4	4	4	4	4	4				
TAC '000t		5	5	4	4	4	4	1			
Reported catches '000t	4.5	4.2	4.9	4.0	4[2]	2.3[2]	0.3[2]		0.3	4	24
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	4.5	4.2	4.9	4.0	4[2]	2.3[2]	0.3[2]				
Total biomass '000t					N/A						
Spawning biomass '000t					N/A						
Mean - F ( )					N/A						

[1]For 1963-1993 [2]Provisional

Catches: Catches fluctuated between 3,000 t and 4,500 t from 1980 to 1991. Catches in 1992 decreased to 2,300 t and further declined to less than 400 t in 1993. The catch in 1994 is expected to be less than 100 t.

Data and Assessment: Commercial catch per unit of effort fluctuated widely in the late 1980s, reaching very high values in 1986 and 1989, perhaps reflecting increased concentrations of fish rather than higher stock sizes. Biomass estimates from research surveys have decreased from about 40,000-45,000 t in the early 1980s, to about 1,300 t by 1993. The geographical distribution of witch in the surveys changed suddenly after the 1985 survey. The area of distribution has gradually decreased since. The fishery in recent years has been prosecuted in depths deeper than those covered by the survey.

Fishing Mortality: No information available.

Recruitment: The decrease in biomass from the mid-1980s implies that recruitment was very small to non-existent during that period.

Environmental Factors: Harsh oceanographic conditions may have played a role in the decreased abundance of witch.

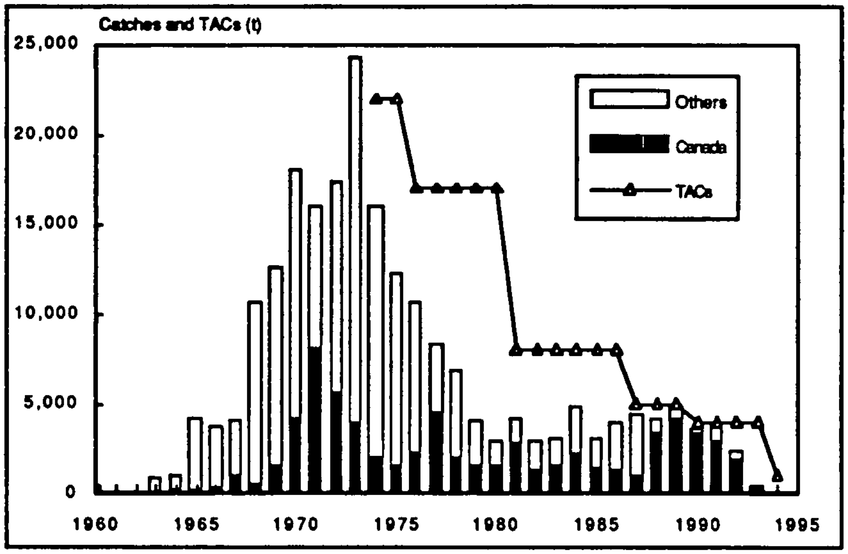
Multispecies Considerations: No information available.

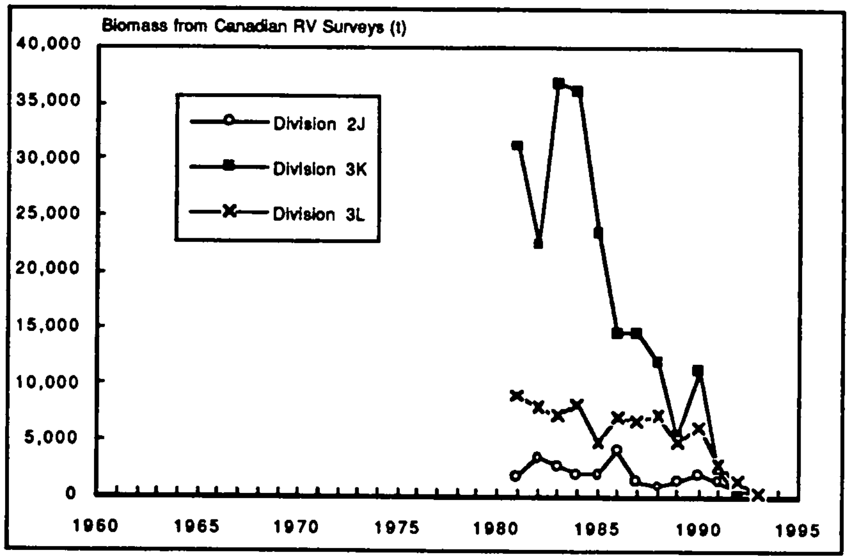
State of the Stock: The stock is presently at the lowest level ever recorded. The biomass outside of the survey area is believed to be insignificant.

Forecast for 1995: No quantitative forecast is possible, but the stock is not expected to increase in biomass.

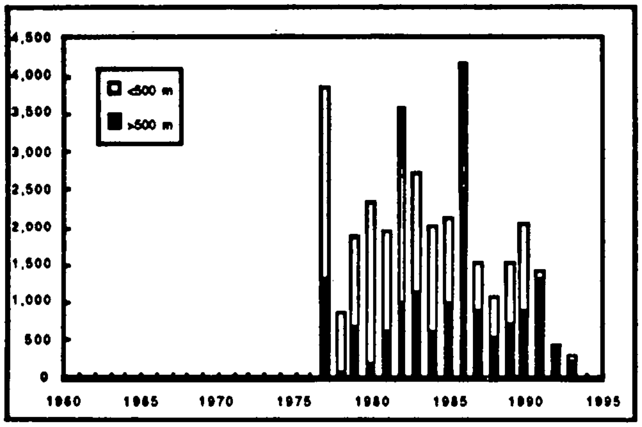
Long-term Prospects: The prospects for rebuilding in the long term are unknown. Both the total and the spawning stock biomasses are far below any previous estimate in the 16 year time series and are considered to be at dangerously low levels.

Special Comment: Given the low state of this stock, any commercial fishery will be detrimental.

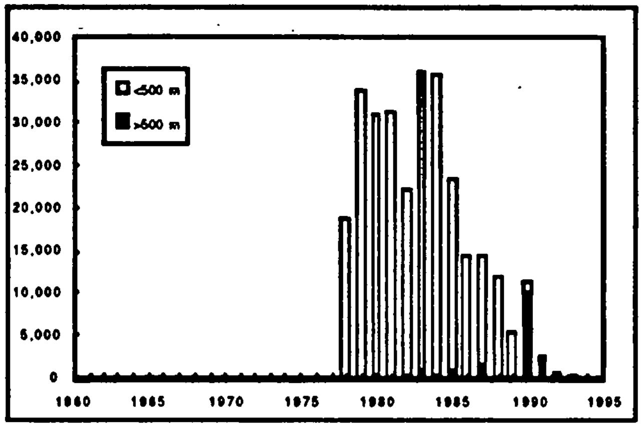

Catches and TACs (t)
25,000
20,000
15,000
10,000
5,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs


Biomass from Canadian RV Surveys (t)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Division 2J
Division 3K
Division 3L

Biomass by Depth in Division 2J (t)



Biomass by depth in Division 3K (t)



Witch in Subdivision 3Ps

Summary

Research vessel survey biomass indices have been variable during the last 16 years, however, the range of variation has generally been small suggesting some stability in the stock size. The most recent three surveys, on the other hand, have all estimated the biomass to be at the low end of the range. Catches in 1994 are expected to be low due to constraints on the by-catch of other groundfish species.

The Fishery

Until recent years, the fishery for witch flounder was largely a by-catch of other groundfish offshore and part of a small mixed groundfish fishery in Fortune Bay. The catch never exceeded 5,000 t. Recently, catches have generally been taken around the TAC of 1,000 t as more directed effort has been placed on the stock due to shutdowns in other fisheries. The catch in 1994 is expected to be quite low as a result of constraints on the by-catch of American plaice and cod.

Data

The status of this stock is generally evaluated by following trends in biomass and abundance from research vessel surveys. In the past 16 years there has been little in the way of persistent trends in biomass. However, the most recent three surveys all estimate the biomass to be at the low end of the range of estimates for the 16 year period.

Prognosis

Although the catch is expected to be quite low for 1994 because of by-catch regulations, it is unclear if catches may have been low because of low stock size. Given the recent low estimates of biomass caution is advised.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000	3max	1	1	1	1	1	1				
TAC '000t		1	1	1	1	1	1	1			
Reported catches '000t	1.3	.6	.9	1.0	1.1[2]	1.0[2]	1.0[2]		0.4	1.0	4.8
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	1.3	.6	.9	1.0	1.1[2]	1.0[2]	1.0[2]				
Total biomass '000t					N/A						
Spawning biomass					N/A						
Mean - F ( )					N/A						

[1]For 1963-1993 [2]Provisional

Catches: Catches have generally averaged about 1,000 t annually since 1979. The 1994 catch is not expected to exceed 200 t due to by-catch constraints.

Data and Assessment: Biomass has been estimated by research surveys since 1976. Biomass estimates were generally between 3,000 t and 6,000 t during the 1980s, with no identifiable persistent trend. Estimated biomass was about 2,000 t in February 1993, but the 1993 April survey estimate increased to about 3,000 t. A preliminary estimate for the 1994 April survey was 2000 t.

Fishing Mortality: No information is available.

Recruitment: No information is available, but spawning stock biomass may have declined in recent years based on the reduction in the older aged fish in the catches.

Environmental Factors: No links to the environment can be made at present.

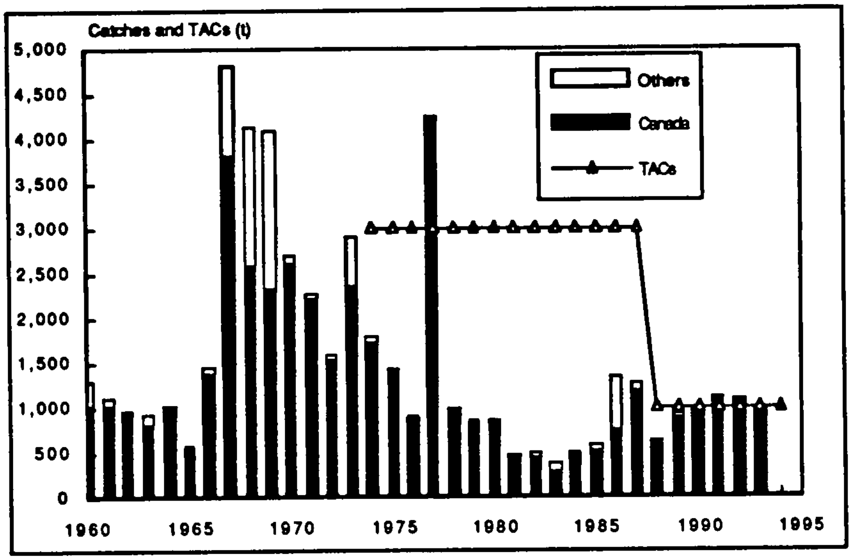
Multispecies Considerations: No information is available.

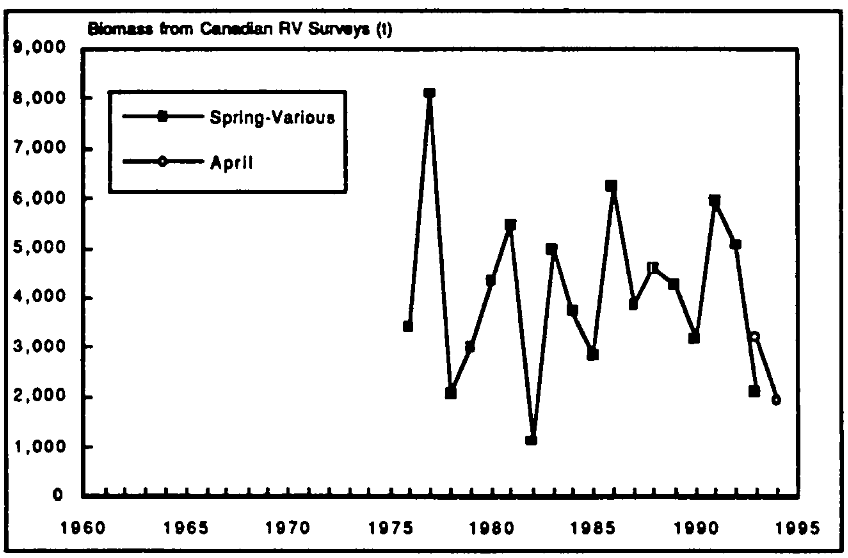
State of the Stock: The state of the stock is uncertain. The 1993 and 1994 survey estimates are within the range of variability during the last 10-15 years, however, all three surveys are at the low end of the range. Based on these research survey data, the stock appears to be declining but it is not clear whether this is the result of fishing mortality only.

Forecast for 1995: A quantitative forecast is not possible. However, caution is advised given recent low levels of estimated biomass.

Long-term Prospects: The long-term prospects are uncertain. The 1993 fishery was considered highly successful, however, it occurred on a very densely aggregated pre-spawning concentration and may not be representative of stock abundance. The 1994 fishery was poor due to regulations restricting by-catch. It could not be determined if low stock size may have contributed to low catch.

Special Comment:


Catches and TACs (t)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs


Biomass from Canadian RV Surveys (t)
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Spring-Various
April

Redfish in Subarea 2 and Division 3K

Summary

This stock is at an extremely low level of abundance. There is no evidence of any incoming recruitment.

The Fishery

Catches from this stock peaked at 187,000 t in 1959 but declined to an average of 27,000 t by 1984-86. Since 1986, catches declined dramatically to the point that there has been virtually no commercial catch taken since 1991.

Data

Research vessel survey data indicated that the size of this stock had declined to an extremely low level by the 1990s. Fish length compositions observed in the survey catches indicate that there has been little or no new recruitment entering the population since the early 1970s.

Prognosis

The stock is at a very low level due to poor recruitment. Should recruitment improve, it would be at least 10 years before it would contribute to a fishery.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000t	35	35	35	35	20	20	20				
TAC '000t	35	35	35	35	20	20	20	1	1[1]	32[1]	35[1]
Reported catches '000t	19	7	3.2	2.4	0.2[2]	+[2]	+[2]				
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	19	7	3.2	2.4	0.2[2]	+[2]	+[2]		+[3]	20[3]	187[3]
Total biomass '000t					N/A						
Spawning biomass '000t					N/A						
Mean - F ( )					N/A						

[1] For 1973-1994
[2] 15t in 1992, 2t in 1993, Provisional from 1991-1993

Catches: Catches since 1960 have been as high as 130,000 t. Between 1961 and 1977, catches averaged about 28,000 t. In the early 1980s, landings ranged from 14,000 t to 18,000 t then increased to between 24,000 t to 29,000 t from 1984 to 1986 in response to improved markets. Since 1986, landings have drastically declined annually such that there has been virtually no catch in recent years. These reductions have come about because of the very low catch rates, as well as persistent complaints of external parasite infestation.

Data and Assessment: Available information is not adequate for an analytical assessment. Standardized catch rates show high variability between some years but indicate a general decrease from 1984 to 1990. Limited fishing effort has occurred since 1990. Research vessel trawl surveys in divisions 2J and 3K indicate a declining trend in both divisions since the 1980s. Trawlable biomass estimates since 1989 are exceptionally low in divisions 2J and 3K and suggests that the population is at a very low level especially when compared to estimates of the early 1980s.

Fishing Mortality: No information.

Recruitment: There has been virtually no recruitment since the year-classes of the early 1970s.

Environmental Factors: A cooling trend has been observed in the area during the 1980s, but its potential impact on this stock is unknown.

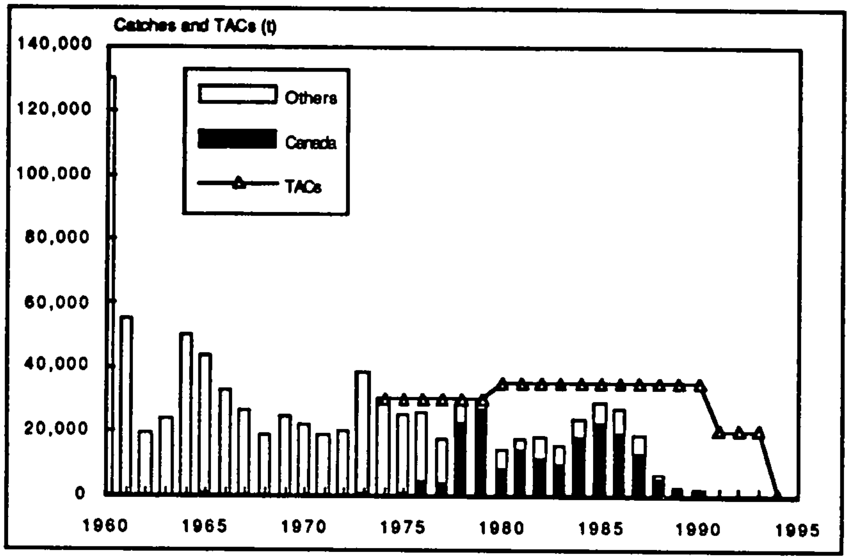
Multispecies Considerations: No information.

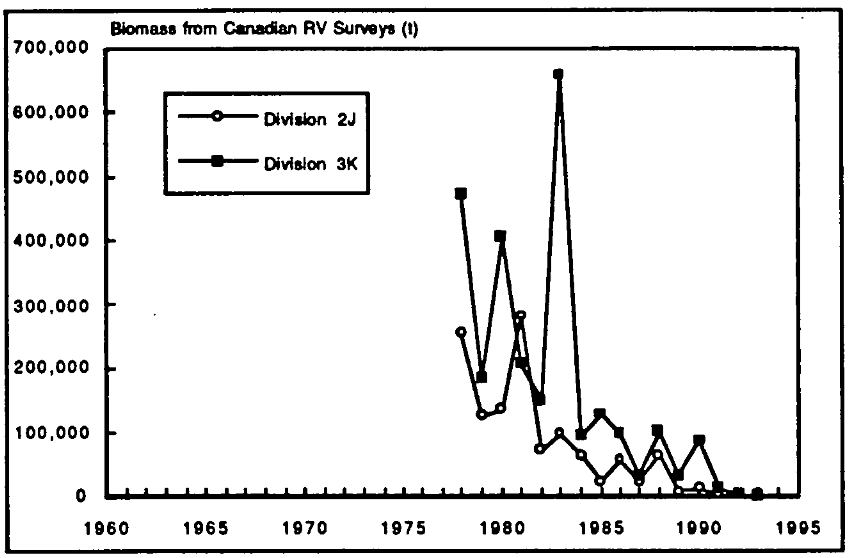
State of the Stock: The stock is at a very low level due to poor recruitment. The surveys in divisions 2J and 3K since 1981 indicate trawable biomass to be at historically low levels.

Forecast for 1995: There is not expected to be any increase in the size of this resource in 1995.

Long-term Prospects: Largely unknown given the long history of recruitment failure. Should recruitment improve it would be at least 10 years before it would contribute to a fishery.

Special Comment: Given the low biomass, any exploitation of this resource would be detrimental.


Catches and TACs (t)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs


Biomass from Canadian RV Surveys (t)
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Division 2J
Division 3K

Redfish in Division 3O

Summary

Recently, more small redfish appear to be available in Division 3O based on research vessel surveys conducted during the 1990s. However, it is unclear whether redfish in this area are resident or migrants from another area. Based on the research vessel data, the stock appears to be mostly comprised of young immature fish, although significant amounts of larger fish have been found in the past in the deeper, hard-to-fish areas of the Division .

The Fishery

Since 1959, nominal catches have been in the range of 5,000 to 35,000 t. Up to 1986, catches averaged 13,000 t, increased to 27,000 t in 1987 with a further increase to 35,000 t in 1988. Catches declined to 13,000 in 1989 and were about this amount to 1992. The 1993 catch is estimated to be about 16,000 t. The fishery has primarily been conducted by foreign fleets, some of which have allocation agreements with Canada.

Data

Commercial catch rates suggest that the stock may have declined during the 1979-92 period. Research surveys beginning in the fall of 1992, however, indicate that there are more redfish in the area than in 1991 or the spring of 1992. Fish caught during the research surveys consist mostly of small immature fish.

Prognosis

Given the predominance of young fish in the area, any fishery, especially in depths less than 375 m, is likely to capture mainly immature fish.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
$F_{0.1}$ Catch '000t					N/A						
Advised TAC '000t	20	14	14	14	14	14	14				
TAC '000t	20	14	14	14	14	14	14	10	10[1]	16[1]	21.9[1]
Reported catches '000t	13	11.5	11	9	7.5[2]	12.5[2]	12.6[2]				
Unreported catches	14	23.5	2.2	5.2	0.8	1.8	3.1				
Estimated discards '000t					N/A						
Total catches '000t	27	35	13.2	14.2	8.3[2]	14.3[2]	15.7[2]		5[3]	13.6[3]	35[3]
Total biomass '000t					N/A						
Spawning biomass '000t					N/A						
Mean - F ( )					N/A						

[1] From 1974-1994
[2] Provisional

Catches: Since 1959 nominal catches have been in the range of 5,000 to 35,000 t. Up to 1986, catches averaged 13,000 t, increased to 27,000 t in 1987 with a further increase to 35,000 t in 1988. Catches declined to 13,000 in 1989 then remained at about this level through to 1992. The 1993 catch is estimated to be about 16,000 t. The fishery has primarily been conducted by foreign fleets, some of which have allocation agreements with Canada.

Data and Assessment: The information available is not adequate for an analytical assessment of this stock. Standardized CPUE indicates a declining trend from 1979 to 1992, however, this trend may be more indicative of a declining component of the stock in the area outside of the 200 mile limit rather than the stock as a whole. Most of the activity occurs outside the 200 mile limit given limited fishing within Canadian waters by foreign fleets, and limited Canadian interest in the resource because of the small fish size. Beginning in the fall of 1992, estimates of biomass from research vessel surveys have increased fairly steadily compared to 1991. The size distribution during this period of increase, nevertheless, has remained relatively stable. This apparent lack of growth is difficult to reconcile given the increase in biomass but may be related to migration to and from the area at certain size ranges.

Fishing Mortality: No information.

Recruitment: With the stability in size composition observed in recent surveys it is difficult to evaluate potential recruitment.

Environmental Factors: No information.

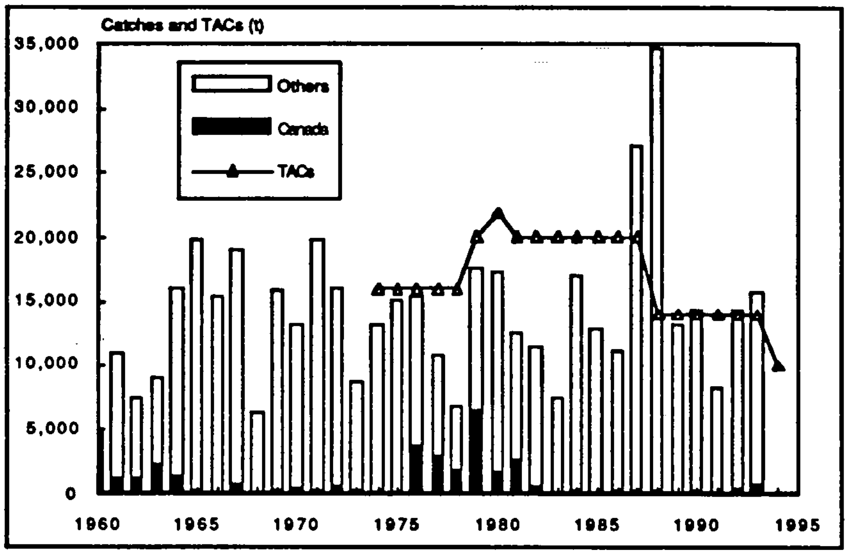
Multispecies Considerations: No information.

State of the Stock: Research vessel survey indices suggest that the stock has increased beginning in the fall of 1992, however, the static size composition is difficult to interpret.

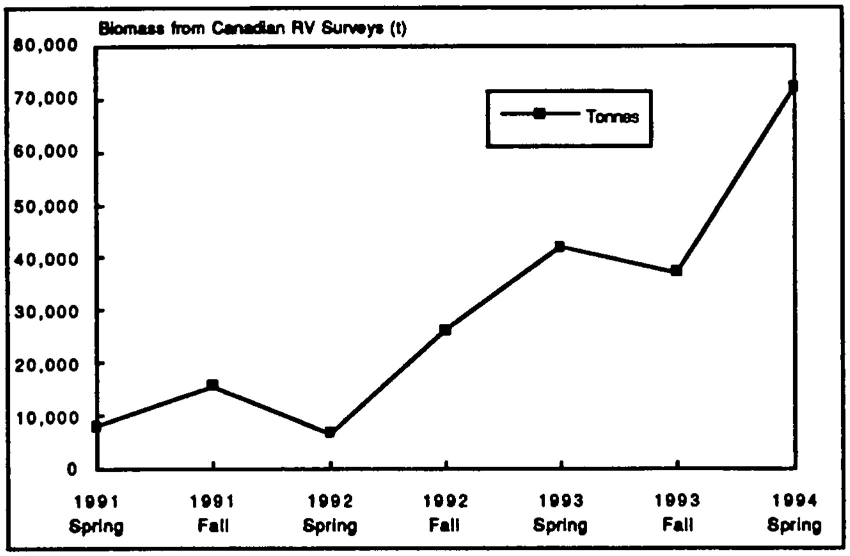
Forecast for 1995: Given the predominance of young fish in the area, a fishery, especially in depths less than 375 m, is likely to capture mainly immature fish.

Long-term Prospects: Unknown given the uncertainty in stock structure.

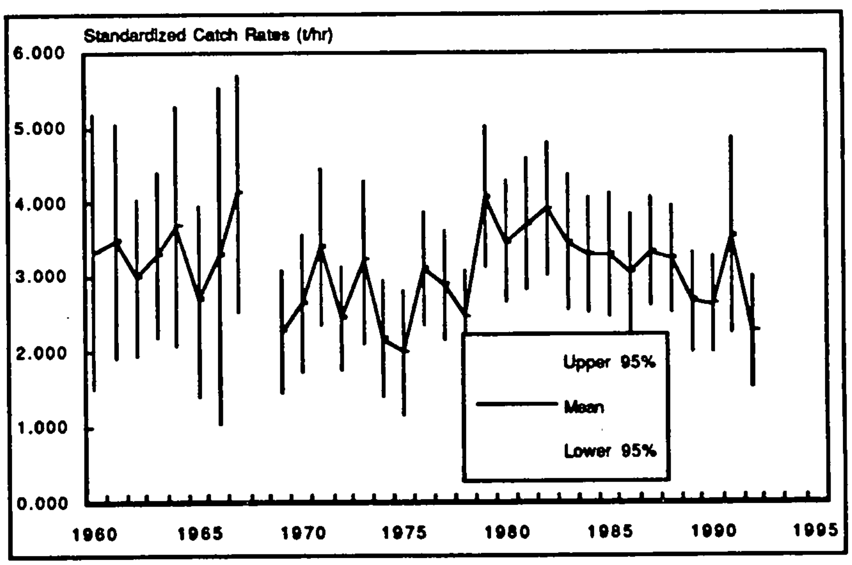
Special Comment: It should be noted that any consideration of calculating a TAC based on an average catch over some period should incorporate the revised catch figures from 1983 to 1993.



Catches and TACs (t)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs



Biomass from Canadian RV Surveys (t)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Tonnes
1991 Spring
1991 Fall
1992 Spring
1992 Fall
1993 Spring
1993 Fall
1994 Spring



Standardized Catch Rates (t/hr)
6.000
5.000
4.000
3.000
2.000
1.000
0.000
1960
1965
1970
1975
1980
1985
1990
1995
Upper 95%
Mean
Lower 95%

Redfish in Laurentian Channel (Unit 2)

Summary

This stock is probably lower than it has been in recent years. The fishing pattern has changed in response to the implementation of this new management unit in 1993. The fishery is currently targeting the relatively good year-classes of the early 1980s. Above average recruitment to the fishery is expected within the next few years based on the relatively strong year-classes of the mid-1980s, but their contribution is likely to be less than that of those of the early 1980s.

The Fishery

Catches have steadily increased from about 8,000 t in 1984 to 27,000 t in 1993. Of the 1993 catch, 10,000 t was taken in 3Pn during October to December. It is likely that these catches, particularly the 6,000 t taken in November and December, were of Unit 1 redfish that had migrated to the area earlier in 1993.

Data

Catch rates have been declining since 1990. Research surveys do not cover the entire stock area and therefore are not representative of year to year changes in stock size. Above average recruitment to the fishery is expected in the mid to late 1990s because of relatively strong year-classes of the mid and late 1980s. It is unlikely that their contribution will be as great as that of the early 1980s year-classes that have supported the fishery for the past 5 years.

Prognosis

This stock is probably lower than it has been in recent years and will continue to decline although this may be reversed due to growth of the relatively strong year-classes of the mid and late 1980s. Their contribution however, is likely to be less than that of the year-classes of the early 1980s so that the current decline in catch rates may continue but at a reduced rate.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
$F_{0.1}$ Catch '000t							N/A				
						25	25				
TAC '000t							28	25	25[1]	26.5[1]	28[1]
Reported catches '000t	14	11	15	15	24[2]	17[2]	27[2]				
Unreported catches					N/A						
Estimated discards '000t					N/A						
Total catches '000t	14	11	15	15	24[2]	17[2]	27[2]		8[3]	22[3]	58[3]
Total biomass '000t					N/A						
Spawning biomass '000t					N/A						
Mean - F ( )					N/A						

[1] TAC applied to new management unit starting in 1993
[2] Provisional

Catches: Catches have ranged from 8,100 t (1984) to 58,000 t (1971). From 1960-1968 landings were at a level of 20,000 t, increased to an average of 43,000 t up to 1975 mainly due to increases by foreign fleets and subsequently declined to the lowest on record in 1984 at 8,100 t. Catches have steadily increased to the 1993 value of about 27,000 t. About 10,000 t of this was taken in October-December, and 6,000 t taken in November-December may have been Unit 1 redfish which moved into the area earlier in 1993.

Data and Assessment: CPUE series show large increases in 1989 and again in 1990 to the highest rate observed over the time series, but have subsequently declined through to 1992. The trends over this time period are confounded with the introduction of the highly efficient midwater "turbo" trawl which distorts the historical relationships. Research vessel survey data only cover part of the stock area and are not considered reflective of year to year changes in stock abundance.

Fishing Mortality: Not possible to estimate.

Recruitment: The 1984-1985 and 1987-1988 year-classes represented about 40% of the research survey catches in 1993. Although it is not possible to precisely estimate the abundance of these year-classes, it is likely that the contribution of these year-classes to the fishery in the future will be less than that of the year-classes of the early 1980s which the fishery currently targets.

Environmental Factors:

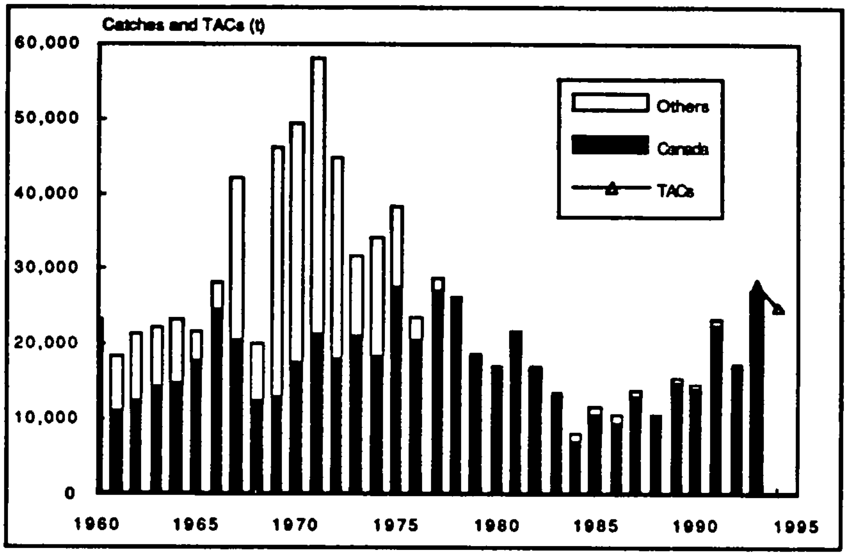
Multispecies Considerations:

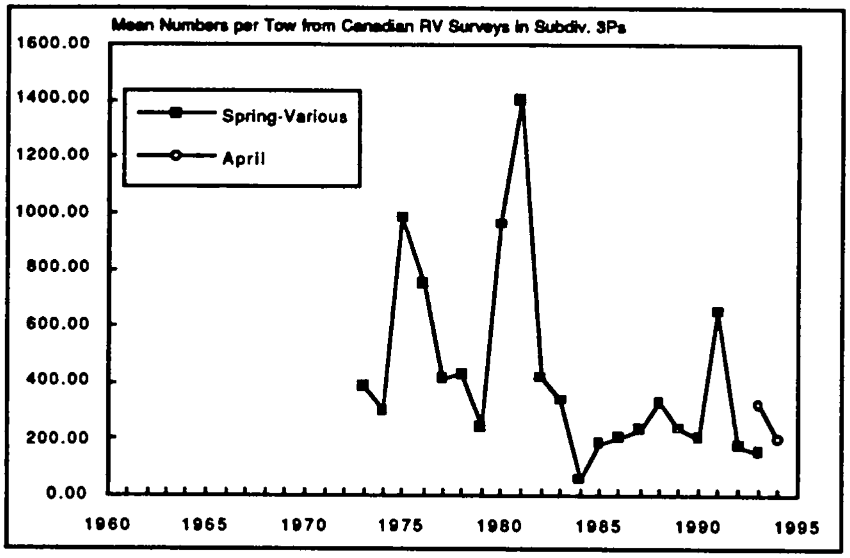
State of the Stock: Unknown but probably lower than previous years because the year-classes of the early 1980s have been fished for about five years. Two other above average year-classes are evident in the survey data, but their sizes are likely less than those of the currently exploited year-classes of the early 1980s. Catch rates are declining as these year-classes are fished down. Because subsequent year-classes do not appear as strong, the downward trend in these rates may not be reversed.

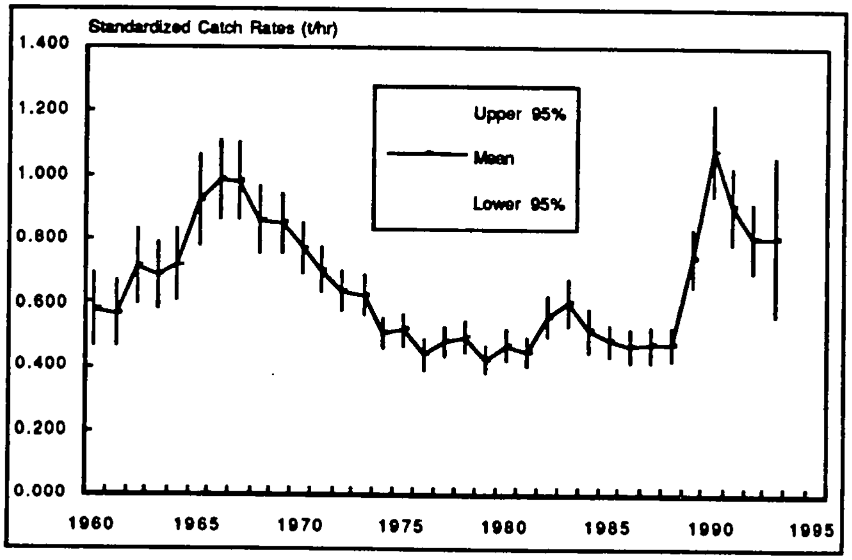
Forecast for 1995: The 1984-1985 year-classes should start to contribute to the fishery but the impact of their contribution cannot be estimated.

Long-term Prospects: During the mid to late 1990s, the year-classes of the late 1980s should begin to contribute to the fishery. The magnitude of this contribution cannot be determined.

Special Comment: Anecdotal information from the fishing industry suggests a decline in the resource in recent years.


Catches and TACs (t)
60,000
50,000
40,000
30,000
20,000
10,000
0
1960
1965
1970
1975
1980
1985
1990
1995
Others
Canada
TACs


Mean Numbers per Tow from Canadian RV Surveys in Subdiv. 3Ps
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1960
1965
1970
1975
1980
1985
1990
1995
Spring-Various
April


Standardized Catch Rates (t/hr)
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
1960
1965
1970
1975
1980
1985
1990
1995
Upper 95%
Mean
Lower 95%

Gulf of St. Lawrence

Regional Overview

Groundfish stocks generally show marked declines following heavy fishing and low production (growth and recruitment), probably linked with marine climate. Pelagic stocks are more abundant, but they have also declined recently because of the absence of strong year-classes in recent years.

It appears that pelagic fish were more abundant in periods of lower groundfish abundance such as the early and mid-1970s and in recent years. American plaice were abundant in the 1970s when cod abundance was low. As cod abundance increased, American plaice decreased suggesting possible biological interactions between the two species. Currently, both the flatfish and gadoid biomass are low. Spiny dogfish have appeared in the Gulf of St. Lawrence in the mid-1980s and were most abundant in 1993. As cod abundance decreased in the late 1980s and early 1990s, the snow crab and shrimp abundance increased. As well, estimates of the abundance of grey and harp seals in the Gulf of St. Lawrence are at their highest level.

Groundfish

The Gulf of St. Lawrence groundfish fishery exploits three major species group: gadoid (cod, north (3Pn4RS) and south (4TVn [Nov.-Apr.]) of the Laurentian Channel and white hake), redfish (Unit 1 -4RST, 3Pn4Vn[jan.-may]) in the deep waters of the Laurentian Channel, and flatfish (American plaice on the Magdalen Shallows, Greenland halibut in the western Gulf and the St. Lawrence Estuary, witch flounder along the west coast of Newfoundland and in 4T, and winter flounder in nearshore waters). Traditionally, the cod fisheries have dominated in terms of landings. Because of the reduction of allowable catches for the cod stocks in 1993, cod landings represented only about 28% of groundfish landings in the Gulf of St. Lawrence while redfish catches accounted for over 60% of the landings. Landings of other species such as American plaice and white hake, which are often a by-catch in the cod fishery, also declined in 1993.

The seasonal migrations of the cod and redfish stocks to their overwintering areas in Cabot Strait (subdivisions 3Pn and 4Vn) at the entrance of Gulf of St. Lawrence have been known for some time. Analyses conducted in early 1994 indicate that the migrations vary in both timing and extent. White hake are found almost exclusively in Cabot Strait (3Pn and 4Vn) during the winter. For this species and for witch flounder, which exhibit a continuous distribution between the Gulf of St. Lawrence (4RST) and Cabot Strait (3Pn and 4Vn), the existing management units may not account for all catches from the stocks.

For the southern Gulf of St. Lawrence cod stock, the migration from 4T to 4Vn regularly occurs in November. In recent years, some catches in May in 4Vn may also have been from the 4T-Vn stock. The assessment of the stock described later includes the catches made in November and December in 4Vn. Similarly, the northern Gulf of St. Lawrence cod stock may have extended its migration in 3Ps in the winter. A detailed examination of catch location during the winter for the commercial fishery and the research surveys in 3P will be undertaken to ascertain the stock of origin. As for redfish, the catches made in 3Pn4Vn in November-December 1993 are considered to be originating from the Unit 1 stock and the assessment described later takes this into account.

The Gulf Region has the assessment mandate for most marine fish stocks in the southern Gulf of St. Lawrence while the Québec Region has the assessment mandate for most marine fish stocks in the northern Gulf. The abundance of the cod stocks in the Gulf of St. Lawrence has followed similar abundance trends to adjacent stocks (2J3KL, 3Ps, 4VsW). The abundance declined to a low level from the early 1970s to the mid-1970s. Abundance subsequently increased rapidly until the early to mid-1980s because of good recruitment. It has steadily declined since to reach the lowest levels on record in 1992-1993. Exploitation rates increased abruptly in the late 1980s and early 1990s. Reduced TACs and a fishery closure in the southern Gulf decreased the exploitation rate in 1993. The low catches in 1993 have arrested the decline of the southern Gulf stock, but the northern Gulf cod may still be declining. Recruitment for both stocks has been well below average since the mid-1980s, despite high levels of spawning biomass when the recruits were produced. Recruitment does not appear to have improved for 1994. Cod of a given age continue to be smaller than in the 1970s. In recent years, the condition of cod, that is the weight for a given length, has decreased especially in the northern Gulf where decreased growth has been accompanied by increased discarding at sea of small cod (less than 41 cm) in the commercial fishery.

Unit 1 redfish comprises two distinct species (*Sebastes fasciatus* and *Sebastes mentella*). Efficient methods to distinguish the two species have been developed in recent years, allowing the confirmation of biological differences (distribution, spawning) between the two species, but the effect of those differences remains unknown. Unit 1 redfish appears closely linked to Unit 2 redfish. The stock, and therefore the fishery have been dominated by the appearance of sporadic strong year-classes, particularly those born around 1946, 1956-58, 1970, 1980. Recruitment was negligible in other years. The successive passage of these strong year-classes caused large variations in catches. The 1988 year-class appeared strong in surveys, but it does not seem to have persisted in the Gulf and it is not expected that this year-class will contribute significantly to the fishery in the future. Considering that the 1980 year-class has been heavily exploited and that there has been no strong year-class produced since, the redfish biomass has decreased considerably. Stock rebuilding will occur 7-8 years after a strong year-class has been detected.

The abundance of white hake in 4T has been declining at least since the late 1980s and reached a very low level in 1993. Few fish older than 7 years of age are caught. The exploitation rate increased in the late 1980s and early 1990s but declined in 1993. There are no signs of improvement in recruitment.

The American plaice stock in 4T attained its highest level of abundance on record in the mid-1970s. Abundance then declined and has fluctuated at a low level since the early-1980s. This fishery was plagued by extensive discarding. This may have been reduced in 1993 with regulations requiring mandatory landing, however there is evidence that some discarding still took place.

Greenland halibut shows larger fluctuations than other flatfish species, because of greater fluctuations in recruitment (by a factor of 5 between the strong and weak year-classes). The exploitation rate is high and the fishery is based on incoming recruitment.

With the decline in cod allowable catches, winter flounders are also becoming a more attractive species. The abundance of this species in the 4T area as a whole does not show any clear trends. It is likely, however, that the resource in 4T is composed of several local stocks and there are indications that the abundance is declining in the waters around the Magdalen Islands.

Witch flounder in the Gulf of St. Lawrence has declined since the mid-1980s. Spiny dogfish has increased since the mid-1980s to reach its maximum abundance in 1993.

There are similarities between the groundfish stocks. In particular, migration patterns appear to have changed, as well as the timing and extent of migrations for cod, redfish and herring. In addition, the condition of fish, that is the weight for a given length, has decreased, especially in the northern Gulf, on species where it has been measured. These changes are not related to fishing and are likely linked to climate which in recent years has been very different from average values.

Pelagic Fishes

Herring in the Gulf of St. Lawrence are composed of two spawning components: spring and fall. Similar to all other pelagic fishes, herring stocks show wide variability in recruitment from year to year. For the two components in the southern Gulf, abundance was very low in the late seventies and early eighties following a series of poor year-classes but increased rapidly in the late eighties and is currently high. The large 1987 year-class accounts for approximately 40% of the population. Exploitation rates on this stock appear to have been near the reference level during the eighties. There are no indications of new strong incoming year-classes. In the northeastern Gulf (Div. 4R), the biomass also reached a minimum in the early 1980s following a series of weak year-classes. The strong 1982 year-class resulted in the biomass increasing quickly until 1989-1990 but biomass has been decreasing since despite relatively abundant 1986-87 year-classes. The spawning biomass of the autumn spawners remains high, but that of spring spawners is very low, partly because of heavy exploitation targeted on this spawning component.

Mackerel is a seasonal migrant in the Gulf of St. Lawrence. In winter, mackerel are concentrated on the edge of the continental shelf off New England and Nova Scotia. In summer, a large portion of this population enters into the Gulf of St. Lawrence to spawn (June-July). After spawning, mackerel disperse to feed. Young mackerel grow quickly and at the end of their first summer, when they are about 20 cm long, they migrate out of the Gulf to overwinter offshore with adults. This migration pattern implies a net export of biological production out of the Gulf, considering that the biomass of mackerel is probably close to 1 million tonnes. Since extension of jurisdiction, the exploitation rate by Canada and the United States has been very low and changes in abundance are largely the result of recruitment variability. In the last 30 years, the 1967 and 1982 year-classes have been particularly strong and allowed the mackerel biomass to increase to high levels. Since the mid-1980s, the biomass has probably been decreasing slowly in the absence of such strong year-class. The 1988 year-class could be strong, but the low exploitation rate does not allow precise estimation of abundance.

Capelin are also present in the Gulf and are lightly exploited, with only a small fishery in the northwestern Gulf (Division 4R). Capelin biomass is believed to be high but there is no information on the absolute level or on biomass changes. Capelin are the principal prey species for cod in the northern Gulf, for seals, and for several whale species present in the Gulf during the summer.

Invertebrates

Three crustaceans species support important commercial fisheries in the Gulf of St. Lawrence: northern shrimp (*Pandalus borealis*), snow crab (*Chionocetes opilio*) and the american lobster (*Homarus americanus*). Each species occupies distinct habitats in the Gulf ecosystem.

Shrimp is an epi-pelagic species which remains close to the bottom during the day at depths ranging from 180 to 250m. There are four main concentrations in the Gulf: in the Estuary, west of Anticosti Island, north of Anticosti Island and in the Esquiman Channel. Shrimp biomass increased steadily from the early 1980s to 1990, but it has decreased slightly since. There is presently some good recruitment in the stock and the biomass is expected to remain stable or increase in the short term. Cod and redfish predate heavily on shrimp when they are on the same grounds as shrimp.

Snow crab are fished on relatively soft bottom at depths averaging 100m. The biology of snow crab is particularly complex. Only mature males larger than 95mm carapace width are exploited and they enter the fishery at an age of 7 to 10 years. Snow crab biomass is presently very high but it is expected to decrease substantially beginning in 1995 because of poor recruitment in 1985 to 1987. Subsequent recruitment (1989-1992) could be strong and the biomass is expected to increase again at the turn of the century. Similar cycles have been observed in the past and the low landings in 1987-1989 could be due the small year-classes produced in 1977-1979.

Lobster live in relatively shallow waters on rocky bottom. Landings have generally increased over the last 20 years, but they have decreased slightly in 1992 and 1993. Lobster landings are dependent on yearly recruitment and the steady increase in catches is due to a combination of oceanographic factors and increased fishing capacity. There are few indices of recruitment, but there are signs that landings may decrease in coming years.

Marine Mammals

Four species of seals are abundant in the Gulf of St. Lawrence: harbour seal, harp seal, hooded seal and grey seal.

The grey seal population in the Gulf is increasing at a rate of 8% per year. In addition, there is another grey seal population which breeds on Sable Island outside the Gulf. Pup production on Sable Island was about 10,000 pups in 1990 and it is growing at 12.6% per year. Some seals from the Gulf population spend part of the year outside the Gulf, while some seals from Sable Island spend part of the year in the Gulf. There are data on growth, population dynamics and feeding habits in the Gulf. It is estimated that in 1993 there were some 62,000 grey seals in the Gulf population and about 82,000 in the Sable Island population. Quantitative information on the diet and on the seasonal distribution are incomplete. Some information is available from the northern Gulf (May-September) since the mid and late 1980s, and throughout the year in 4VsW for recent years. Quantitative diet information is not available for other regions including the southern Gulf, 4X, 3P, and 2J3KL. Grey seal consumption of cod in eastern Canada is estimated to have increased from approximately 14,000 tonnes in the early 1980's to approximately 40,000 tonnes in 1993 mostly in the Gulf and on the Eastern Scotian Shelf. Assuming that on average 88% of the Sable Island herd and 25% of the Gulf herd remains outside of the Gulf, then total consumption of cod by grey seals in 1993 would be in the order of 18,000 tonnes in the Gulf of St. Lawrence, 17,000t in 4VsW and 5,000t in the remaining areas. The majority of cod consumed by grey seals consists of pre-recruits, with only an estimated 20% of the fish consumed being large enough (>45 cm) to be taken by the commercial fishery. It is not possible to assess the impact of this consumption by grey seals in the Gulf of St. Lawrence on Gulf cod stocks.

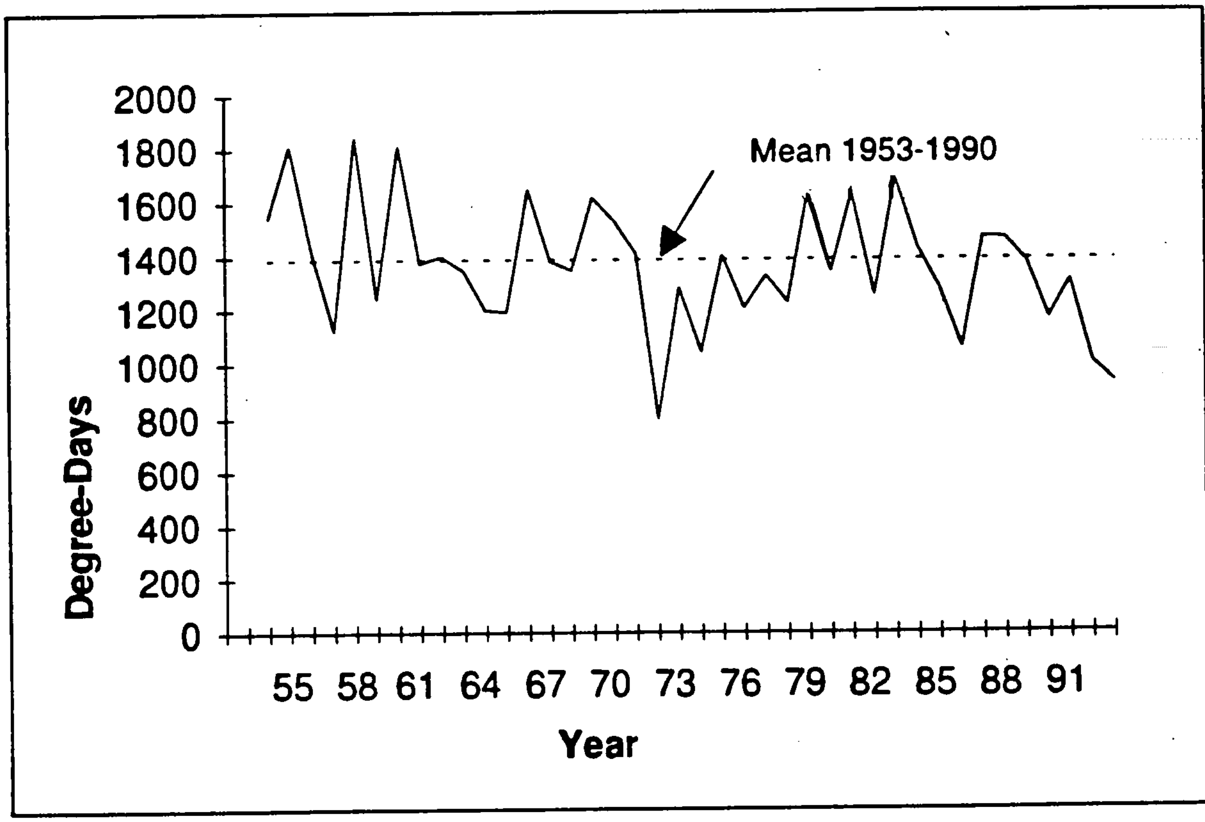
Harps seal are the most abundant pinniped in the northwest Atlantic. Pup production in the Gulf was estimated at 110,000 pups in 1990, and at 466,000 pups on the Front off Labrador and northeastern Newfoundland. Aerial surveys were conducted in March 1994 to obtain a new estimate of pup production and the results are expected to be available during the autumn. Information on the diet of harp seal shows that capelin, sand lance, herring and redfish are important preys. The consumption of cod by harp seals is currently being estimated.

There is little information on the abundance of hooded seals. Pup production in 1991 in the Gulf of St. Lawrence was about 2,000 pups. There is no information on the diet of hooded seals in the Gulf, but the information from the Front suggests that capelin, turbot and redfish are important preys. Little is known about the relationships between hooded seals in the Gulf and those on the Front, or on the proportion of juvenile hooded seal which return to the Gulf in winter.

Marine Climate Summary

Air temperatures over the Gulf of St. Lawrence were colder than normal from October 92 to March 93. The greatest difference from the average was recorded in February 1993 (-6°C). The cold air mass extended from Baffin Island in the north to Chaleurs Bay. Temperatures were slightly above normal in April and May 1993, they decreased below normal in June and July and increased again to above normal in August and September. Seasonal averages were consistenly below average from September 1992 to September 1993. Average degree-days for six air monitoring stations in the southern Gulf of St. Lawrence were also below normal .

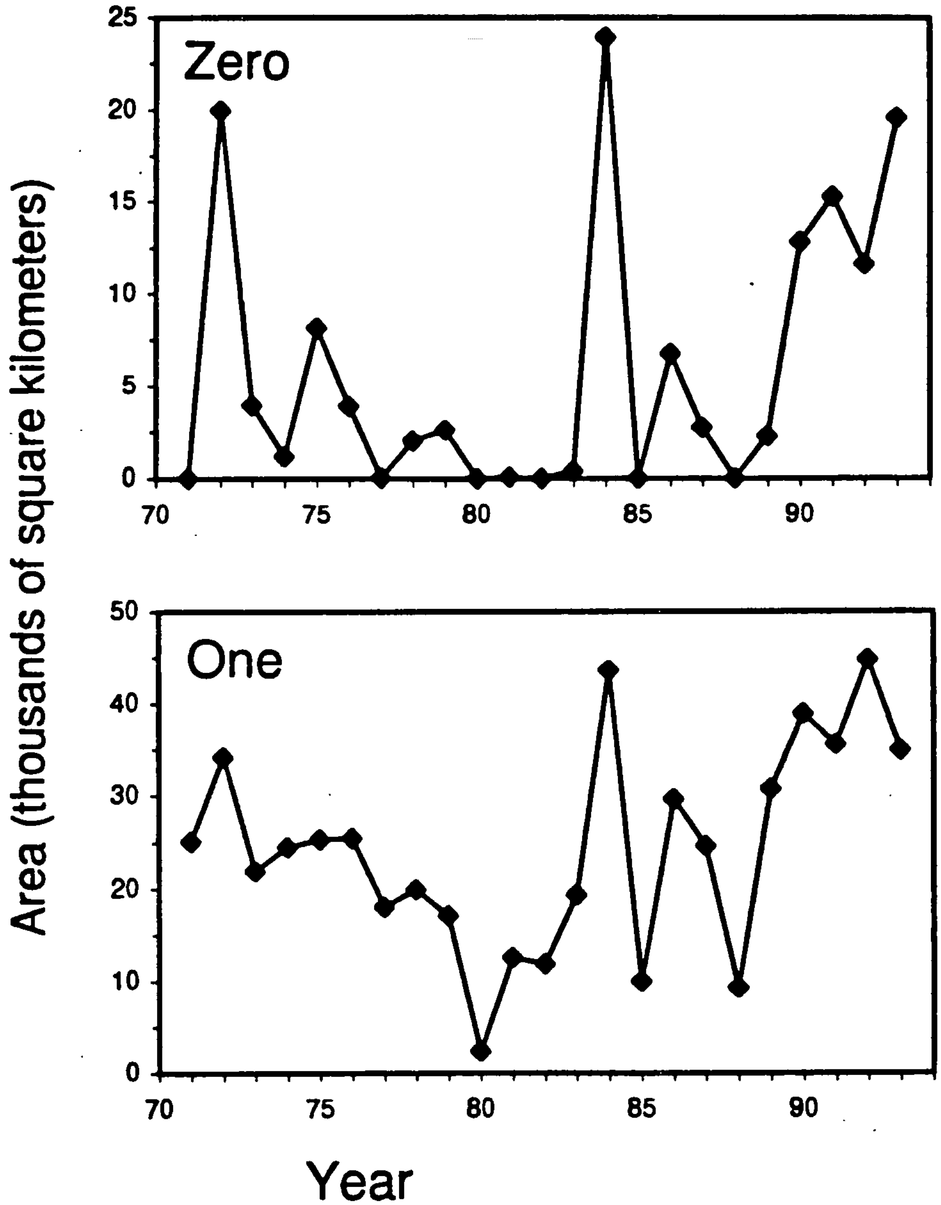
Average degree-days (air temperature) in the Gulf of St. Lawrence



As in recent years, ice coverage in the Gulf was greater than average in the winter of 1992-93. The maximum observed ice cover was approached in February and exceeded in March when ice coverage extended to a few tens of kilometers west of Halifax. The St. Lawrence Estuary was almost ice-free by the end of March. During April, ice progressively disappeared from the Gulf. Ice was last observed on May 10 in the southwestern Gulf and on June 14 in the northwestern Gulf, near the Strait of Belle Isle.

The cold intermeditate layer (CIL) is defined as cold water less than 0° C (as low as -1 or -2° C) with a salinity between 31.5 to 33 parts per thousand which can extend from 30 to 125 m depth. The maximum depth of the cold intermediate layer is found every year near the Strait of Belle-Isle. The CIL is thicker in the Laurentian Channel than in Cabot Strait and its thickness decreases moving upstream of the Laurentian Channel. In 1992-1993, the CIL was about 55 m thick near the Strait of Belle-Isle, between 30 and 40 m thick near Cabot Strait, 40-50 m in the Laurentian Channel and about 30 m at the end of the St. Lawrence

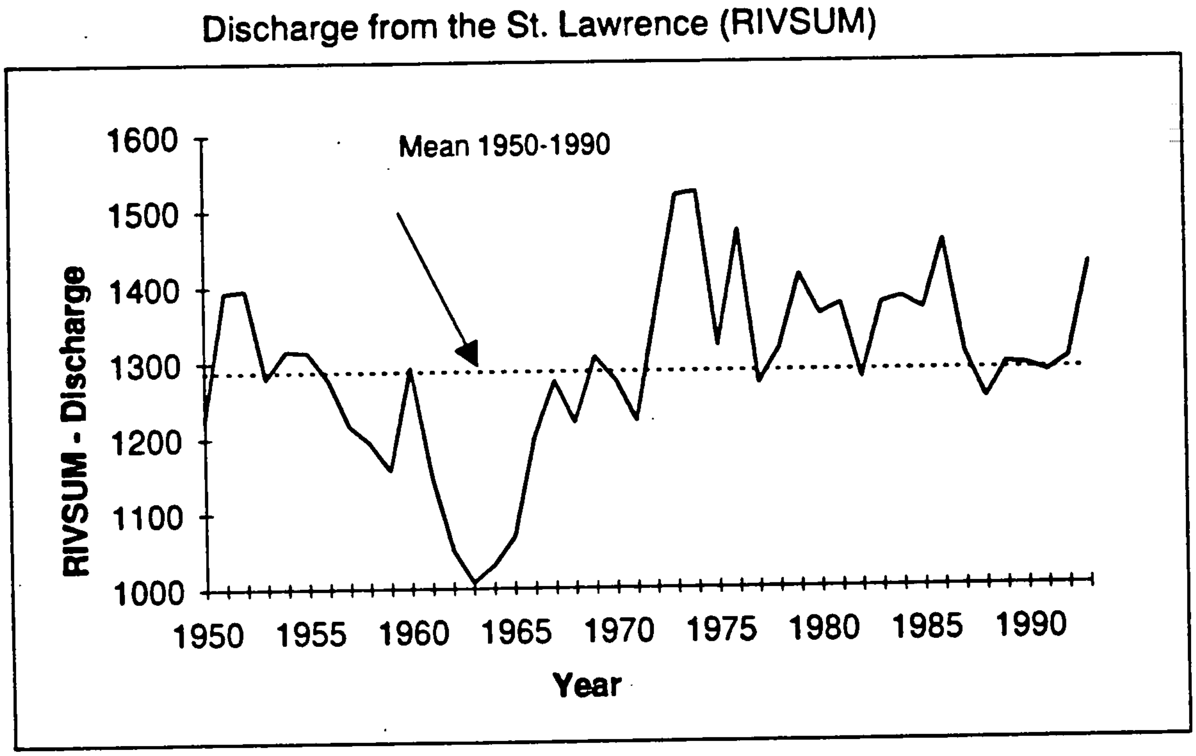
Estuary near Pointe-des-Monts. Generally, the thickness of the CIL has steadily decreased over the last three years. However, on the Magdalen Shallows, the surface area where the CIL was in contact with the bottom was greater than normal for the fourth consecutive year. Between 1971 to 1989, only in 1972 and 1984 were such large areas of the CIL observed during the September survey.



. Area within the survey region (excluding strata 415, 425 and 439) with bottom temperature below 0C or 1C, 1971-1993.

Between 30 and 100 m layer, the coldest waters were in the Laurentian Channel where the average temperatures were more than 1° lower than the average. Near the Strait of Belle-Isle, the temperature was 2.2° lower than average. Between 100 and 200m, waters were colder than average everywhere but in the Cabot Strait. Between 200 and 300m in the Cabot Strait waters were much warmer. At these depths, temperature were above average everywhere in the Laurentian Channel, but decreasingly so moving upstream. In the Esquiman Channel, temperatures were below normal. There has been a progressive warming of the 200-300m depth range since 1991.

Freshwater discharge from the St. Lawrence River was higher than average in 1993 .



Cod in the Northern Gulf of St Lawrence (NAFO divisions 3Pn, 4R and 4S)

Summary

The population is probably at its lowest level since 1974. The relatively large 1986 and 1987 year-classes which supported the fishery for a number of years virtually disappeared in 1993. The adult biomass may have been as low as 10,000 t in 1993. The TAC for 1993 was reduced in midseason from 31,000 t to 18,000 t, the equivalent of catches at the $F_{0.1}$ level on the basis of last year's assessment. Catches totalled 18,171 t.

Analysis

Recorded landings totalled 106,000 t in 1983 and have declined steadily since that time. Catches by mobile gear have generally been limited by their allocations, while fixed-gear catches are not generally limited in this way.

The number of fish landed in 1993 was the lowest since 1974, the first year for which data are available. The weights at age of fish landed were also the lowest since 1974. The industry's complaint of low weight yields in 1993 has been confirmed by measurements of fish condition taken in the course of research vessel surveys. A commercial catch monitoring program established in 1993 found conditions conducive to growth in only a few months. Fish condition (that is, weight for a given length) was also very poor. Significant mortality has been observed in cod in tanks under similar conditions. Estimated cod abundance in the two surveys (January and August-September) were at, or near, the lowest levels ever recorded; both indices have declined by more than 50% over the past year. Similarly, catch rates for trawlers are very low (the third lowest level since 1974).

Sequential population analysis could not be calibrated in 1994. Calibration results indicated very high mortalities attributable to fishing in 1992 and 1993, a finding incompatible with the reduction in TAC (and effort) in 1993. The source of the problem cannot yet be precisely identified, but a number of uncertainties surrounding these stocks probably affect our ability to perform quantitative analyses. It is suspected that many landings were not reported during the 1980s, and that many small fish were discarded during this period; consequently, the data on catch at age may not be entirely accurate. In addition, the surveys may not adequately reflect stock levels. During the winter, a large and varying proportion of the stock may be outside the sampled area. For several years, the cod biomass has been found farther and farther south, at the limit of its range, during the winter survey, and there may well be large concentrations of Gulf cod in 3Ps, resulting in underestimates of its abundance. The series from the summer survey is too short to permit adequate assessment of its utility, but the inshore areas (0-20 fathoms, and Quebec's North Shore) cannot be sampled. Given the fact that the winter survey has been discontinued, if this survey does not, in fact, provide an adequate indication of stock levels, we would have no abundance index for this stock. Finally, natural mortality may have increased recently as a result of the cod's physiological condition.

Assessment

The stock abundance is clearly very low, possibly at its lowest level since data has been available (1974). This is evident from all the abundance indices, and it appears that the situation has probably deteriorated in 1993. The outlook for the short and medium term is not encouraging; there is no indication of significant recruitment, fish growth is low and their physiological condition is precarious.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference level ($F_{0.1}$)	56	69	72	56		24	31	20			
Biological advice	80.3[2]	73.9[2]	72	56	[3]	33-35	35				
TAC	80.3	73.9	76.5	58	35	35	18[4]	0			
Reported catches	67	48	47	37	32[5]	29[5]	18[5]		18	78	106
Unreported catches	Unknown, but assumed to be large										
Estimated discards	Unknown										
Total catches											
Total biomasse	No estimate, SPA not valid										
Spawning biomass (7+)	No estimate, SPA not valid										
Mean F	No estimate, SPA not valid										

All catches and biomasses are expressed in thousands of tonnes (t). [1] For 1974-1993. [2]50% Rule. [3] Catches by mobile gear are not to exceed those for 1990. [4] Initially set at 31,000 t. [5] Provisional statistics.

Catches: Landings in 1993 were 18,171 t, the lowest observed since the series began in 1964. These landings corresponded to the TAC for 1993, which was revised in mid-season (original TAC 31,000 t).

Data and Assessment: The results of the surveys have declined sharply in recent years. The SPA could not be calibrated, indicating irreconcilable differences between the catch at age data and the survey data.

Fishing Mortality: Impossible to estimate in 1993. Mortality values are believed to have been well above the $F_{0.1}$ level in recent years and to have declined in 1993.

Recruitment: Mean numbers per tow of the 1990 and 1991 year-classes on the winter survey corresponded to the mean values observed, indicating that these year-classes may have been of average strength.

Environmental Factors: While the temperatures of the deep water masses moving in through Cabot Strait appear to have risen significantly over the past two years, recent winters have been particularly cold, mean air temperatures have been very low and break-up has been late.

Multispecies Considerations: Grey seal abundance is increasing in the Gulf of St. Lawrence. Current information is insufficient to determine the impact of grey seal predation on cod production.

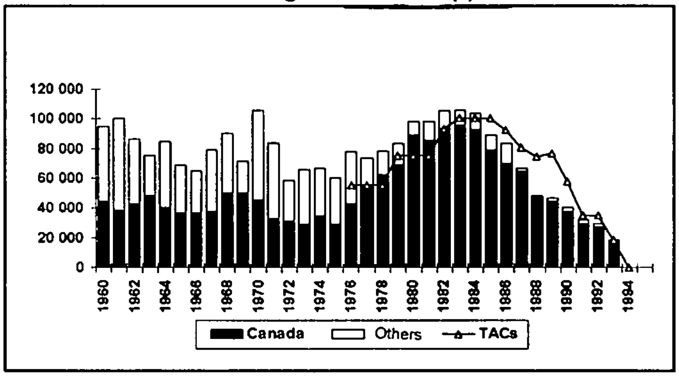
State of the Stock: The stock level is very low, possibly at the lowest level ever recorded.

Forecast for 1995: No projections have been attempted but, given the absence of significant recruitment, stock levels are not expected to increase significantly in 1995.

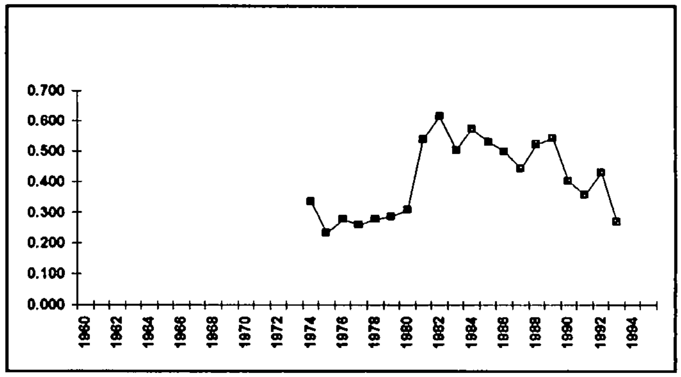
Long-Term Prospects: Mean weights are very low, and the 1990 and 1991 year-classes may, at best, be at average levels. Since the fish do not become available to the commercial fishery in large numbers until the age of 5 or 6 years, the stock cannot really begin to recover until 1997-1998, or even later, depending on the size of the most recent year-classes (1992-1994).

Comments: There are a number of uncertainties associated with this assessment: 1) reported catches during the 1980s probably considerably underestimated the actual catches as a result of inaccurate reports and discards at sea; 2) the winter survey probably does not provide a quantitative reflection of the changes in stock levels, because of the presence of varying numbers of Gulf cod in Subdivison 3Ps at the time of the survey; and 3) natural mortality may have changed, since significant mortality has been observed among cod in tanks under similar conditions to those observed in 1992-1994; 4) the summer survey may not reflect changes in stock levels.

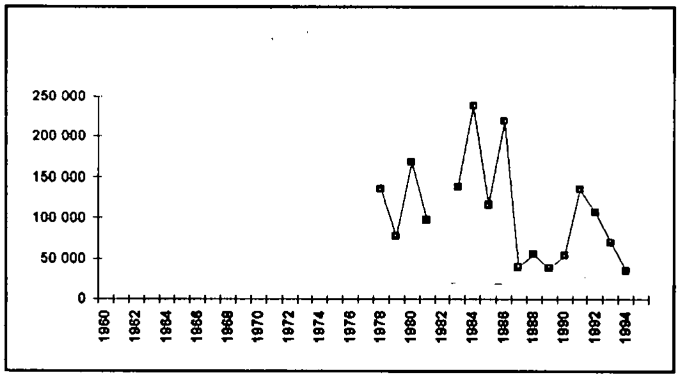
Landings and TACs (t)



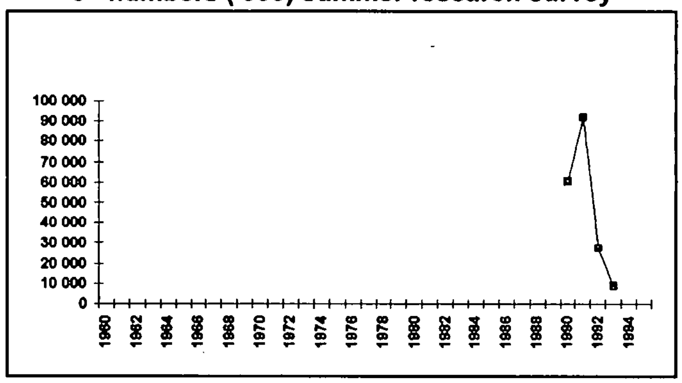
Catch rate



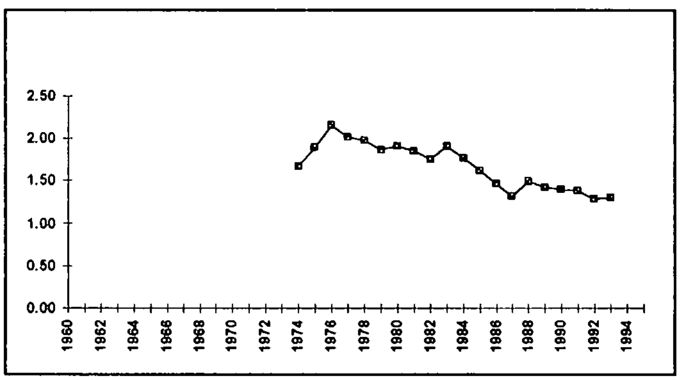
3+numbers ('000) winter research survey



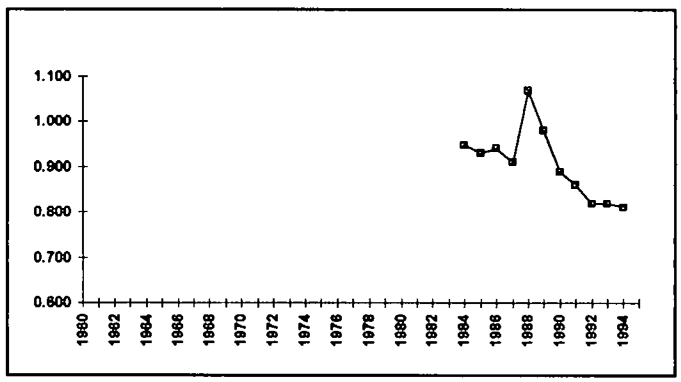
3+ numbers ('000) summer research survey



Average weight (kg) age 7



Condition factor



Cod in the Southern Gulf of St. Lawrence

Summary

Stock abundance and biomass remain very low. Prospects for future recruitment are poor. Fishing mortality has been reduced and was close to the $F_{0.1}$ target in 1993. Fishing effort needs to remain at or below 1993 levels and recruitment has to improve to achieve recovery to former stock levels.

The assessment unit for this stock has been modified to account for the migration of southern Gulf cod from 4T into 4Vn in November. All cod catches in 4T, in 4Vn during November through April, and the catches made in 4Vs during January to April that have been associated with the southern Gulf stock are included in this assessment.

Analysis

Landings from this stock varied between 20,000 and 40,000 t between 1917-1940. Landings then increased over the next 15 years due to increased fishing effort and peaked at 104,000 t in 1956. Between 1960 and 1975, landings fluctuated between about 40,000 and 70,000 t then declined to 22,000 t in 1977, corresponding to a reduced TAC. Landings then increased and averaged 60,000 t during the 1980s. Since 1990, landings have declined, to 40,700 t in 1992 and 5,200 t in 1993.

The recovery of the fishery in the late 1970s and early 1980s was supported by the 1974 and 1975 year-classes. These were followed by above average year-classes spawned in 1979-80, which carried the fishery to the end of the decade. The 1979-80 year-classes, while being very abundant, had very low growth rates, as have all subsequent year-classes. Since the early 1980s, recruitment has declined and has been below average for many years. This led to the decline in biomass of the southern Gulf stock which was exacerbated by increased fishing pressure. Between 1989 and 1992, the fishery removed over 50% of the stock biomass annually and new recruits have not made up for these losses.

The TAC was reduced in 1993 and the fishery was closed in September following the release of the stock status report and recommendation of the FRCC. The result of these management measures was that the very high exploitation rates have been reduced to a level more in line with the long-term management target. Continued low fishing effort (days fished) together with improved recruitment is required to achieve recovery to former stock levels.

Assessment

The number and biomass of cod 3 years and older reached a record low in 1993. A slight increase is predicted over the next 2 years if fishing effort remains low.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.[1]	Max.
Reference Level '000t	24	49	55	53	48-53	43	13-15				
TAC '000t	45.2	54	54	53	48	43	13	0	0[1]	53[1]	67[1]
Reported catches '000 t 4TVn (J-A)[2]	51.1	52.1	52.8	51.3	38.7[3]	34.3[3]	5.2[3]		5.2[4]	55.74[4]	104.5[4]
Reported catches '000t stock [5]	54.6	55.7	57.3	57.9	49.4[3]	40.7[3]	5.2[3]		5.2[6]	57.1[6]	69.3[6]
Unreported catches											
Estimated discards '000t					3.0	2.6					
Total catches '000t											
Total biomass '000t	263	219	201	177	139	108	73	93	73[7]	210[7]	355[7]
Spawning biomass '000t	220	180	151	118	95	70	49	61	49[7]	139[7]	262[7]
Mean - F (7 +)	0.47	0.62	0.80	0.98	1.03	1.12	0.19		0.19[7]	0.58[7]	1.12[7]

[1]for period 1974-1993; [2] not including catches in 4Vs (included in previous reports); [3]preliminary statistics; [4] for period 1950-1993; [5] in 4TVn (J-A), 4Vn (N-D), and 4Vs (J-A); [6] for period 1965-1993; [7] for period 1971-1993

Catches: Landings varied between 20,000 and 40,000 t between 1917-1940, increased over the next 15 years and peaked at 104,000 t in 1956. Between 1960 and 1975, landings fluctuated between 40,000 and 70,000 t then declined to a low level of 22,000 t in 1977, corresponding to a reduced TAC. Landings then increased and averaged 60,000 t during the 1980s. Since 1990, landings have declined, to 40,700 t in 1992 and 5,200 t in 1993.

Data and Assessment: The average catch per tow in the September 1993 research survey was slightly higher than in 1992 but it is still among the lowest observed. The commercial catch per unit effort declined in 1993 but numerous closures and other management measures may have contributed to the decline. Nevertheless, CPUE has declined steadily since 1986. The research survey data were analyzed to directly estimate trends in abundance and mortality and several methods of sequential population analysis were also used (ADAPT, Laurec-Shepherd, Hybrid, Extended Survivors).

Fishing Mortality: Fishing mortality peaked at very high levels in 1992, in excess of 1.0. However, the greatly reduced fishery in 1993 resulted in a large decrease in fishing mortality to close to the fishing mortality target $F_{0,1}$=0.20.

Recruitment: Recruitment prospects are poor, recent year-classes (1988-91) are all estimated to be well below average abundance.

Environmental Factors: For the past four years, the extent of sub-zero bottom temperatures in 4T has been the highest seen since 1971.

Multispecies Considerations: Cod is an important predator in the southern Gulf, consuming large amounts of herring (about 60,000 t per year), shrimp (about 25,000 t per year), and highly variable amounts of capelin. They also eat small amounts of snow crab, American plaice, cod and hake. Grey seals, a known predator of cod are increasing in abundance in the southern Gulf. Current information is insufficient to determine the impact of seal predation on cod production.

State of the Stock: Stock abundance and biomass remain very low. Prospects for future recruitment (the 1990-1993 year-classes) are poor. Fishing mortality has been reduced and is now close to the $F_{0.1}$ target.

In the past, there has been a tendency to overestimate the abundance of this stock. Attempts have been made to solve this retrospective pattern by using a different method (Hydbrid) and analyzing the abundance indices on their own. The current assessment indicates that the stock is at its lowest level observed and the same conclusion is reached regardless of which assessment method is used.

Forecast for 1995: A slight increase in total stock and spawning biomass is forecast in 1995 if fishing mortality in 1994 is maintained at the 1993 level.

Long-term Prospects: Provided there is an improvement in recruitment, and that fishing mortality remains low, future yields may vary between 20,000 and 40,000 t in the long term.

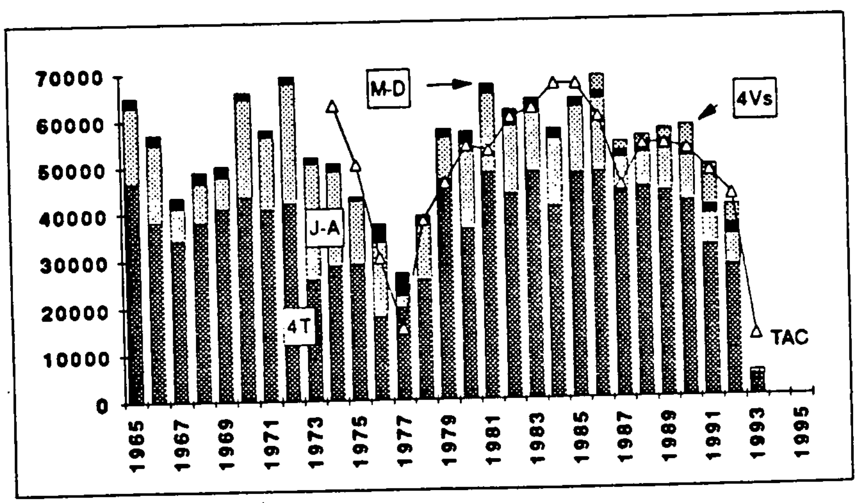
Special Comment: The assessment unit for this stock has been modified to include cod catches made in 4Vn during November and December since this is a better reflection of the timing of the migrations of cod from 4T into 4Vn in the fall. The assessment now includes all cod landings in 4T, in 4Vn during November through April, and those from 4Vs during January to April that may be associated with the southern Gulf stock.

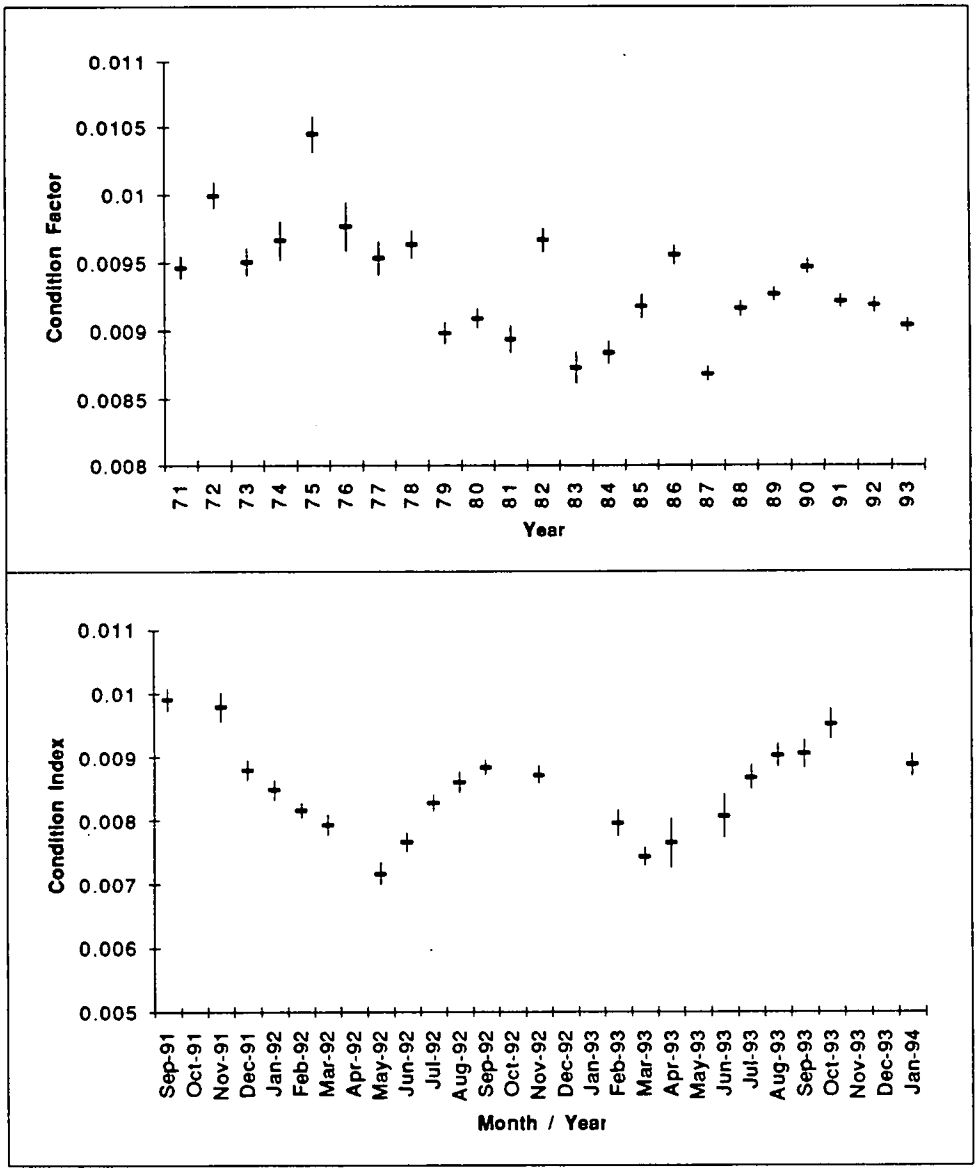
Seasonal variation in fish condition (fish weight at a given length) is such that a fall fishery would give 25 to 40% higher yield than in the spring for a given number of fish caught.

Despite the cod fishery closure, cod will continue to be taken as by-catch in other fisheries. Control measures to limit the total amount of cod by-catch need to account for differences in by-catch rates among areas, seasons, and directed species while not promoting discarding.

Cod in 4T-Vn (J.-A.)

Total catches (t) by area and TACs (t).

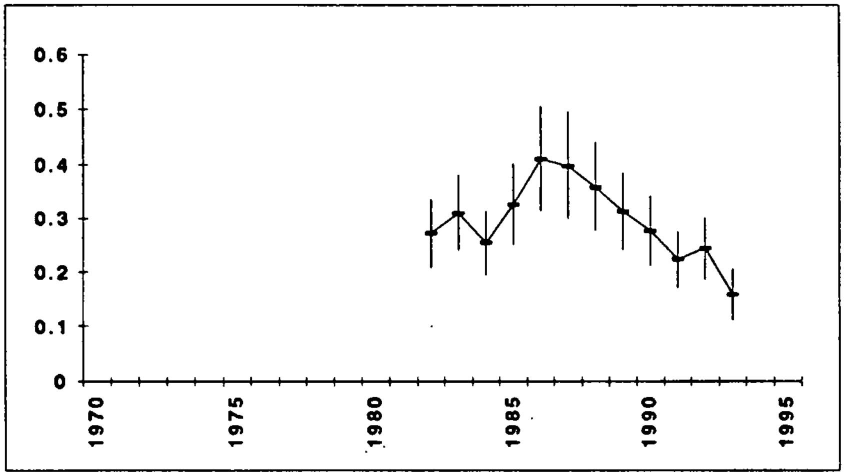




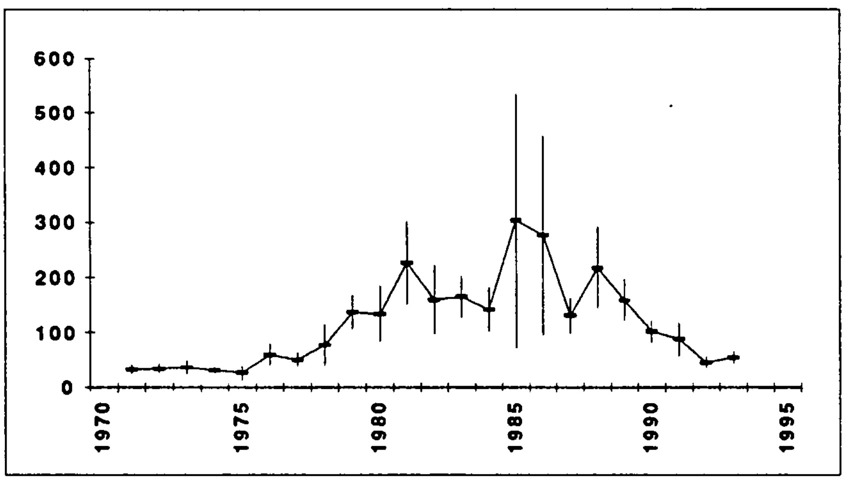
Annual (upper panel) and seasonal (lower panel) trends in cod condition.

Cod In 4T-Vn (J.-A.) Abundance Indices

OT CPUE (t/hour) 5+



RV (Nb/tow) - fall 1+

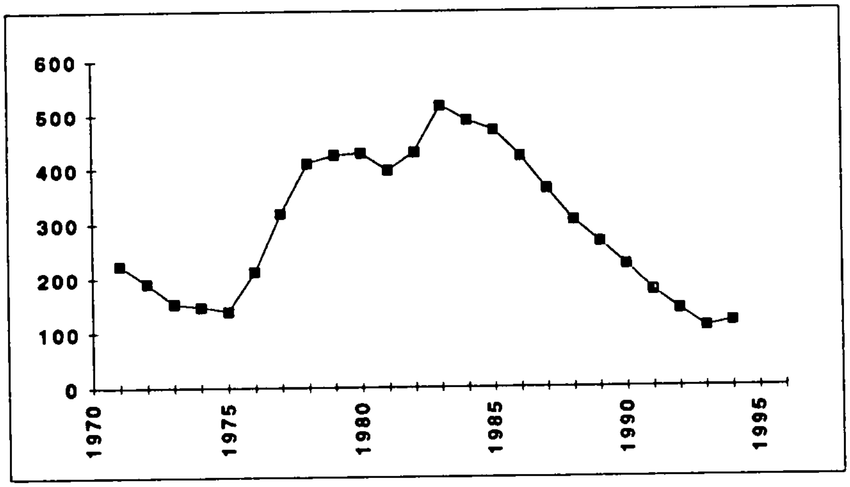


Cod In 4T-Vn (J.-A.)

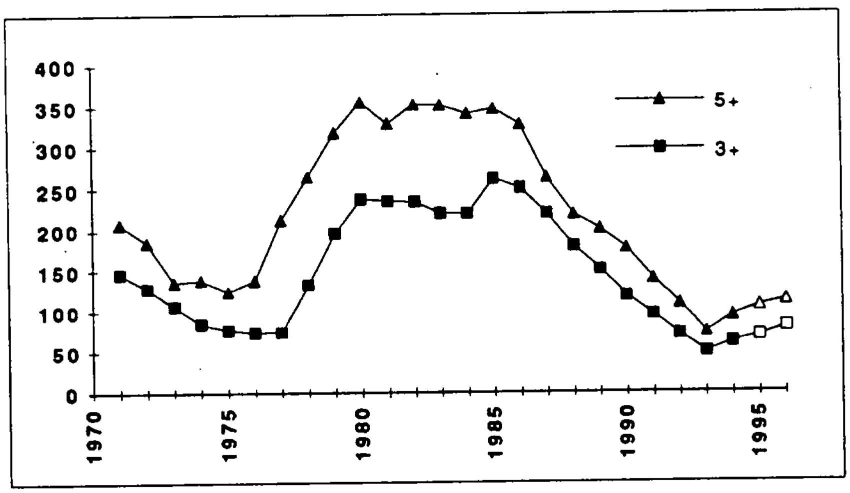
Hybrid

Total Abundance (million)

3+



Stock Biomass (thousand t)

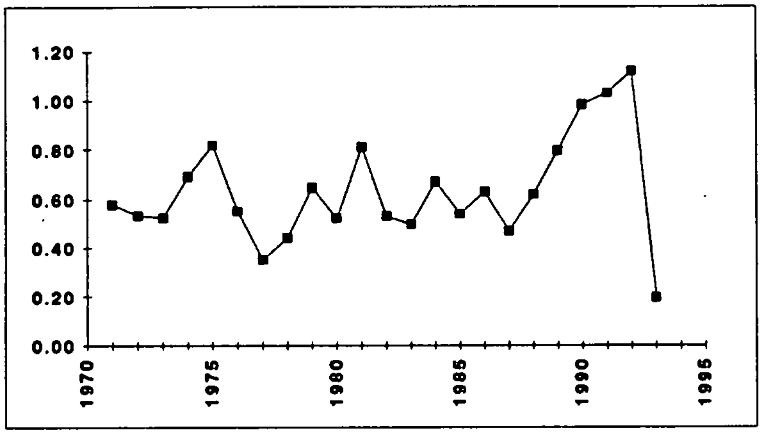


Cod in 4T-Vn (J.-A.)

Hybrid

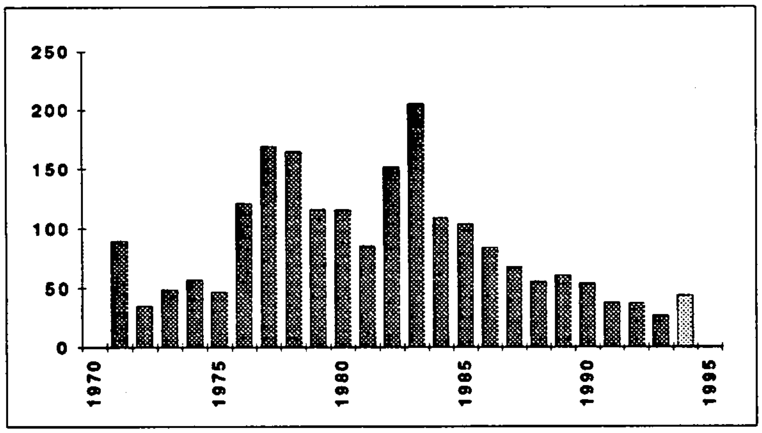
Fishing mortality rates.

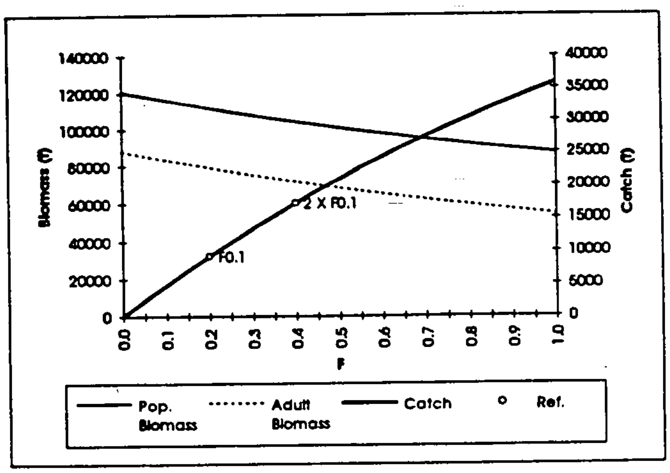
7+



Recruitment (million)

Age 3





Projection for 1995 assuming a catch of 5,000 t in 1994
(Biomasses are beginning of 1996)

Redfish in the Gulf of St Lawrence (Unit 1: NAFO divisions 4R, 4S, 4T, plus 3Pn and 4Vn [Jan-May])

Summary

Stock levels are declining and the exploitation rate (% of fish removed by fishing) is high for a slow-growing species like redfish. The fishery in 1993 was dominated by fish born around 1980 and in the early 1970s. The fish in these two groups are primarily members of the species *Sebastes mentella*. Recruitment has been low since 1980. The numbers in the 1985 and 1988 year-classes have declined rapidly since 1991; they are identified as *S. fasciatus*, a species whose biology is not well known.

The TAC for new management Unit 1 was 60,000 t in 1993 but was reduced as a preventive measure to 30,000 t in 1994. The Fisheries Oceanography Committee has concluded that the November and December catches in subdivisions 3Pn and 4Vn consisted primarily of redfish from Unit 1, and that the management unit should therefore be modified.

Analysis

Landings of these stocks have averaged 46,000 t. In the past 4 years, they have exceeded 60,000 t, except in 1993, when they declined to 51,000 t following the introduction of new management areas (units 1, 2 and 3). Including the November and December catches in subdivisions 3Pn and 4Vn, however, the 1993 total for Unit 1 would be 57,000 t. In previous years, catches of redfish in these two subdivisions have generally been less than 1000 t in these two months.

Catches by bottom trawlers fishing between May and October have been affected less by technological change than those involving mid-water trawls and are believed to reflect actual redfish levels more accurately. The CPUE (tonnes/hour) show two large peaks (in 1981 and 1990) and have declined by 34% since 1990. Daily catch rates, which include time spent by vessels looking for fish, show a similar tendency (decline of 34% between 1990 and 1993). The nominal effort rose from 4600 days in 1990 to 5600 days in 1993, but this last figure does not include the major effort in subdivisions 3Pn and 4Vn in November and December 1993. Given the species' gregarious nature and the exchange of information between the boats of the same company, these catch rates probably overestimate stock levels. When stocks decline, fleets can maintain their CPUE by locating dense aggregations even as they decrease in number and size. For these reasons, CPUEs are not considered a quantitative index of stock levels.

Two groundfish surveys (summer and winter) are undertaken to obtain abundance indices for the resource. The estimates have declined by nearly 50% in the two most recent surveys. The summer survey is also used to estimate the abundance of schools (modes) of fish and to monitor their decline over time. Estimated mortality rates are relatively high (total mortality of 0.44, implying a fishing mortality of 0.34, well above the generally accepted reference level $F_{0.1}$ for redfish of 0.15. Similar calculations have been performed on the commercial catch per unit effort data, (daily catch, bottom trawlers, [May to October]). While these are more difficult to interpret because of the biases inherent in CPUE data, they also indicate that mortality attributable to fishing was relatively high in 1992-1993 (0.18).

One large year-class (1988) was identified in the 1990 survey, but its numbers have declined sharply since that time. By 1993, it had virtually disappeared, and is unlikely to contribute significantly to the fishery in the future. The reason for its disappearance is unclear; it may be due to emigration (into Unit 2), mortality, or non-availability to bottom trawling because of a pelagic distribution. The latter explanation can be readily verified by examining the catches of mid-water trawlers once these fish are of adequate size (1995).

Redfish are highly concentrated in the Cabot Strait area; over the past three years, this concentration has moved into Subdivision 3Pn and even spilled over into 3Ps. In 1993, fishing began in 3Pn in October, very early compared to previous years, suggesting that the redfish may have moved out of the Gulf early. Fishing of these concentrations of Gulf redfish intensifies the exploitation rate for Gulf redfish.

Assessment

Heavy fishing pressure and low recruitment levels over the past 4 years explain the reduction in abundance observed by the summer research survey since 1991. Stock levels will continue to decline until one or more sizable year-classes become available to the commercial fishery. No such sizable year-classes currently exist, and the one on which our hopes was based (1988) does not appear to have remained in the Gulf. It is impossible to predict when a sizable new year-classes will appear but, even when it does, it will not be recruited to the fishery until seven or eight years later. The exploitation rate was approximately 28% (F=0.34), very high for a slow-growing species like the redfish. In addition, fishing appears to have expanded in 1993. The reduction of the TAC to 30,000 t in 1994 will permit a reduction in the exploitation rate. However, this catch level is probably not sustainable over the medium term, given the existing biomass (probably less than 200,000 t) and the absence of any significant recruitment. The exploitation rate should tend to rise if the TAC remains at 30,000 t over the next few years. This TAC should require a nominal effort of approximately 3300 days in 1994 and, if the exploitation rate is to be maintained at the 1994 level, the total number of days fished should remain at this level for the next few years.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference level											
Biological advice						67	60				
TAC			New Management Unit			67	60	30			
Reported catches [3]	43	52	52	60	59[2]	77[2]	51[2]		7	44	136
Unreported catches											
Estimated discards											
Total catches											
Total biomass[4]				379	222	177	95				
Spawning biomass (7+)											
Mean F											

All catches and biomasses are expressed in thousands of tonnes (t). [1] For 1960-1993.
[2] Provisional statistics. [3] Excluding catches in 3Pn-4Vn in November and December. [4] Biomass based on abundance survey.

Catches: Catches were 9000 t below the 60,000 t TAC in 1993. However, nearly 6000 t of redfish from Unit 1 were caught in 3Pn-4Vn in November-December 1993.

Data and Assessment: The CPUEs for bottom trawlers (May to October) declined by 34% between 1990 and 1993, while the abundance index observed by the research survey declined by 74% over the same period.

Fishing Mortality: Fishing mortality for the period 1990-1993 is estimated at approximately 0.34%, higher than $F_{0.1}$=0.15.

Recruitment: Two recent year-classes (1986 and 1988) have declined sharply in abundance and it appears that their contribution to the exploitable biomass of Gulf stocks will be minimal. These two year-classes consisted primarily of the species *Sebastes fasciatus*, while the principal species in the Gulf is *S. mentella*. They appear to have emigrated to Unit 2 (where *Sebastes fasciatus* is more dominant), although they may also be dead, or simply inaccessible to the bottom trawl used in the survey.

Environmental Factors: The deep waters of the Gulf have become warmer since 1992, but it is not known whether the redfish is affected by this warming.

Multispecies Considerations: Redfish, like cod, appear to migrate longer distances in the winter in the Cabot Strait area. The winter redfish fishery also takes large by-catches of cod, which are currently found at the same depths as redfish during the winter.

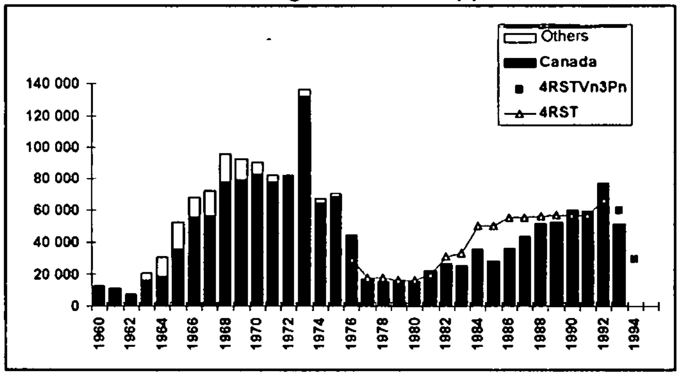
State of Stock: Stock levels are declining rapidly, and no significant recruitment is currently anticipated.

Forecast for 1995: Stock levels should continue to decline in the absence of recruitment.

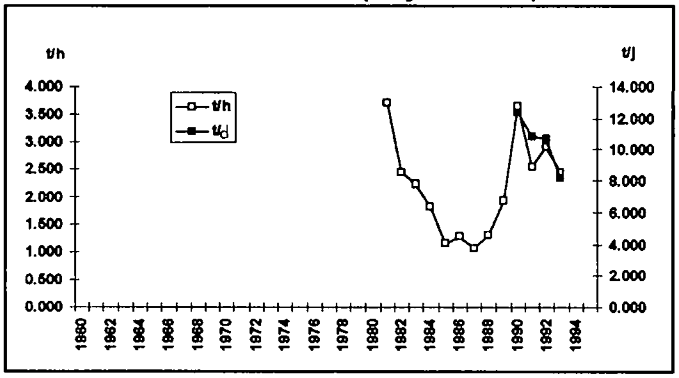
Long-Term Prospects : The stocks have been subject to intense fishing and the biomass has declined considerably since 1990. No significant recruitment is anticipated and the next sizable year-classes will not become available to the commercial fishery until 7 or 8 years after its appearance. Under these conditions, the biomass will continue to decline in response to even moderate fishing, and catches must be reduced if the exploitation rate is to remain constant. No recovery is expected before the year 2000.

Special Comments: Catches in 3Pn in October to December rose sharply in 1993 (> 9000 t), apparently indicating earlier migration from the Gulf in 1993. This change has been confirmed by the industry. A working group of the Fisheries Oceanography Committee recommended in March 1994 that the November and December catches in subdivisions 3Pn and 4Vn be considered Gulf of St. Lawrence redfish.

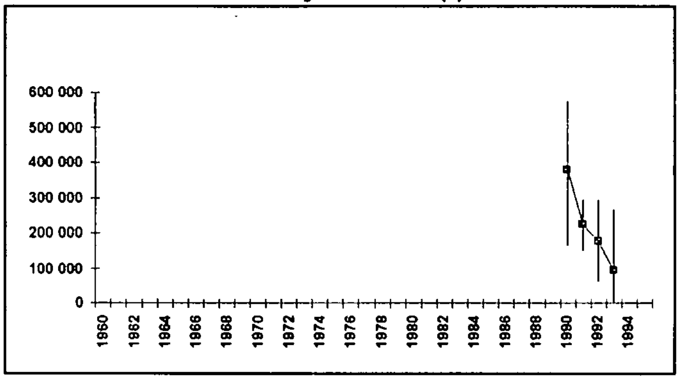
Landings and TACs (t)



Otter trawl CPUE (May-October)



Summer research survey biomass (t)



ATLANTIC HALIBUT IN THE GULF OF ST LAWRENCE (4R, 4S and 4T)

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference level[2]		0.3	0.3	0.3	0.3	0.3	0.3				
Biological advice		0.3	0.3	0.3	0.3	0.3	0.3				
TAC		0.3	0.3	0.3	0.3	0.3	0.3	0.3			
Reported catches	0.3	0.2	0.3	0.4	0.3[3]	0.2[3]	0.1[3]		0.09	0.22	0.45
Unreported catches											
Estimated discards											
Total catches											
Total biomass											
Spawning biomass											
Mean F											

All catches and biomasses are expressed in thousands of tonnes (t). [1] Mean 1979-1993.
[2] Mean catch. [3] Provisional data.

Catches: Official catches have declined regularly since 1990 but by-catches may have been unreported. No estimate of unreported catch is available. Catches are made essentially on longlines during the summer. With the introduction of the Nordmore grid, catches by shrimpers have largely ceased.

Data and Assessment: The halibut landed ranged in size from 40 to 140 cm and consisted of 2 major year-classes: 7-9 years and 12-14 years.

Fishing Mortality: We have no information which would enable us to estimate the mortality attributable to fishing.

Recruitment:

Environmental Factors: The deep waters of the Gulf have become warmer since 1992, but it is not known whether halibut is affected by this warming.

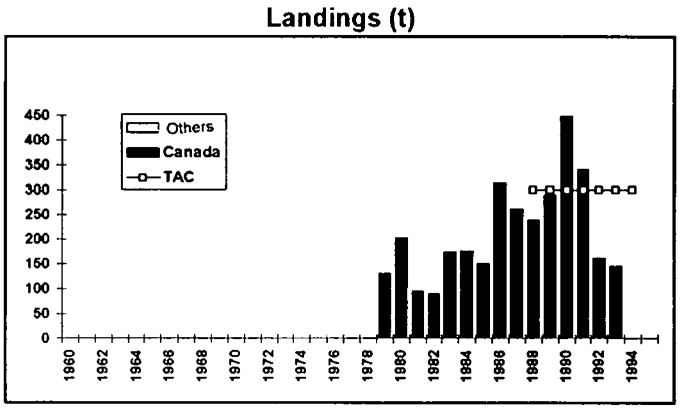
Multispecies Considerations : The impact of the shrimp fishery should decline considerably since the introduction of the Nordmore grid.

State of Stock: Too little information is available at the present time to assess the condition of the stocks. With the establishment of the index fishermen's program, a great deal of information will become available in the future.

Forecast for 1995: No predictions can be made for 1995.

Long-Term Prospect:

Special Comments: The minimum size of 80 cm has never been applied in the Gulf.


Landings (t)
Others
Canada
TAC
450
400
350
300
250
200
150
100
50
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994

American Plaice in 4T

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference Level '000t	10	10	8	10	10	10	5	5			
TAC '000t	10	10	10	10	10	10	5				
Reported catches '000t	8.1	7.0	5.7	4.9	5.2[2]	5.1[2]	1.9[2]		1.9[1]	6.9[1]	11.8[1]
Unreported catches											
Estimated discards '000t					3.2	3.3					
Total catches '000t					8.4	8.3					
Total biomass '000t [3]	76.0	87.3	62.5	92.5	108.1	67.2	57.5		57.5[4]	172.6[4]	287.7[4]
Spawning biomass '000t											
Mean - F ( )											

[1] for period 1965 -1993; [2] Preliminary statistics; [3] Survey estimates; [4] For period 1971-1993

Catches: Total catches are unknown due to substantial discarding. Landings have been consistently lower than the TAC. Landings decreased steadily since the mid-1980s, but declined sharply in 1993 due to by-catch restrictions, mandatory landings, mesh size restrictions and reduced effort. Discarding persisted in 1993 in this fishery despite mandatory landing regulations. Significant loss of yield from the fishery is attributed to discarding commercially undersized plaice.

Data and Assessment: The results of a September groundfish survey, conducted annually since 1971, are used as an index of abundance. They have also been used to estimate mortality trends, biomass trends and year-class strength.

Fishing Mortality: Recent total mortality for plaice aged 7-20 years estimated from the survey is 0.57. Assuming M=0.20, fishing mortality is estimated at F=0.37.

Recruitment: Recruitment appears to have peaked in 1971 and declined through the 1970s. An analysis conducted in 1993 had indicated improving recruitment in the 1980s. An updated analysis now suggests that recruitment has remained close to the 1980s average. Both analyses indicated that the recruitment levels are lower in the eighties than they were in the early seventies.

Environmental Factors:

Multispecies Considerations: By-catch restrictions for cod are expected to reduce the total catch of plaice in 1994.

State of the Stock: The abundance index from the September groundfish survey indicates that abundance of plaice in 1993 was near its lowest level on record since 1971. Stock biomass in 1993, based on survey data, was the lowest since 1971. Mortality on this stock has increased over time. Year-class abundance declined in the mid-1970s and has remained lower than in the early seventies.

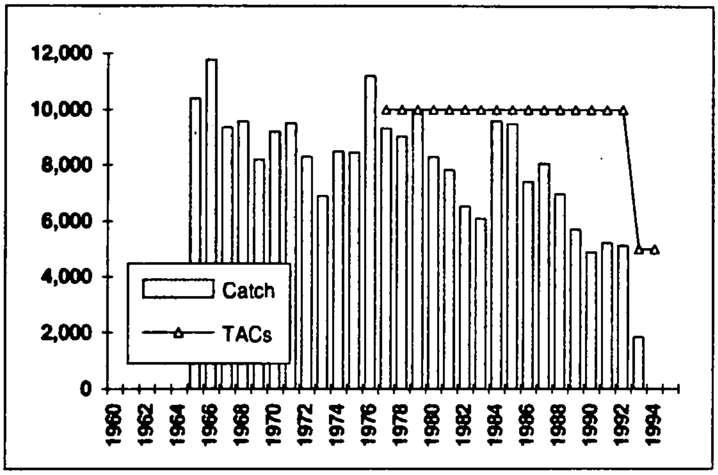
Forecast for 1995: The stock is expected to remain at a low level.

Long-term Prospects: Yield from this fishery could be substantially increased if discarded plaice were not caught and were allowed to grow to commercial size.

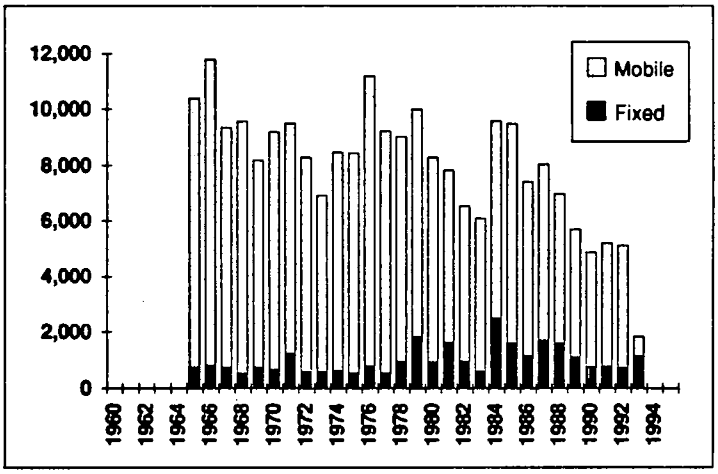
Assessment Synopsis:

Special Comment: Discarding appears to have persisted in 1993 despite a mandatory landing regulation. Measures are required to detect and prevent its occurrence.

Total catches (t) and TACs (t)

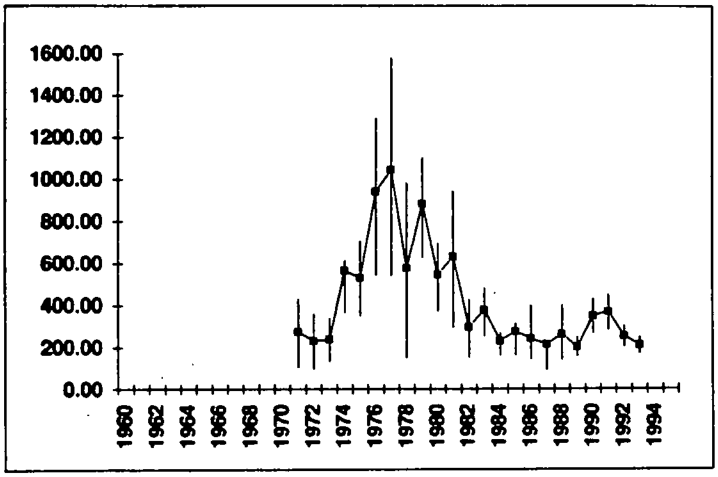


Fixed and Mobile Canadian Catch (t).



Abundance Indices

RV (#/tow) - Fall 1+



Greenland Halibut in the Gulf of St Lawrence (NAFO Divisions 4R, 4S and 4T)

Summary

Stock levels are declining and the exploitation rate (% of fish removed by fishing) appears high. The 1993 fishery was dominated by fish born in 1987-88.

The TAC for 1993 was 4000 t and remained at this level in 1994.

Analysis

Landings of this stock have averaged 3600 t. In the past 4 years, they have not exceeded this level. The fishery is dominated by a fleet of inshore vessels from Quebec using gillnets.

Analysis of size frequencies in the commercial fishery in 1982-93 shows that the majority of gillnet catches were between 41 and 43 cm, corresponding to the 1988 year-classes, and 70% were females. Sexual maturity occurs, on average, at about 50 cm. A large proportion of the catch consists of immature fish, but there is currently no legal minimum size.

Since 1984, two groundfish surveys (summer and winter) have taken place to obtain indices of the resource's abundance. The biomass estimates have declined considerably in the most recent surveys, particularly the summer survey. This decline in biomass is confirmed by the CPUEs of index fishermen, which also declined substantially in 1993.

Assessment

This fishery, which is dominated by gillnets, is heavily dependent on annual recruitment and catches large numbers of immature fish. The abundance indices available show a large decline between 1992 and 1993 and low recruitment in the future as a result of the complete recruitment of the 1988 year-class. It is important that the fishing effort be reduced, together with the proportion of immature fish caught, to permit the protection and conservation of Greenland halibut in the Gulf of St Lawrence.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference level											
Biological advice			No TAC required				4.0				
TAC	8.9	10.5	10.5	10.5	10.5	10.5	4.0	4.0	4.0	7.5	10.5
Reported catches	11.0	8.0	5.0	2.4	2.3[2]	3.4[2]	2.7[2]		0.7	2.3	11
Non-reported catches											
Estimated discards											
Total catches											
Total biomass[3]				12.5	21.1	22.0	9.9				
Spawning biomasse											
Mean - F											

All catches and biomasses are expressed in thousands of tonnes (t). [1] For 1960-1993.
[2] Provisional statistics. [3] Biomass based on abundance survey.

Catches: Catches are closely related to recruitment. Catches by shrimpers declined sharply in 1993 with the introduction of the Nordmore grid.

Data and Assessment: The stock levels estimated by the summer research survey declined sharply in 1993.

Fishing Mortality: No accurate figures are available on fishing mortality, but it is probably high.

Recruitment: The 1988 year-class will be fully recruited to the fishery in 1994; from 1989 to 1993 recruitment appears low.

Environmental Factors: The deep waters of the Gulf have become warmer since 1992, but it is not known whether the Greenland halibut is affected by this warming.

Multispecies Considerations:

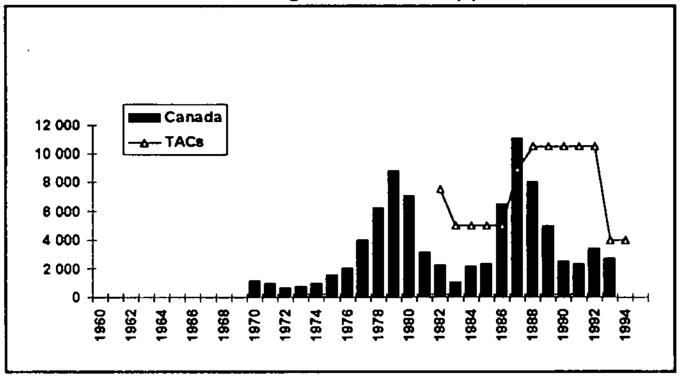
State of Stock: Stocks are low and declining.

Forecast for 1995: Catches should be stable in 1994, as a result of the recruitment of the 1988 year-classes, but should decline thereafter.

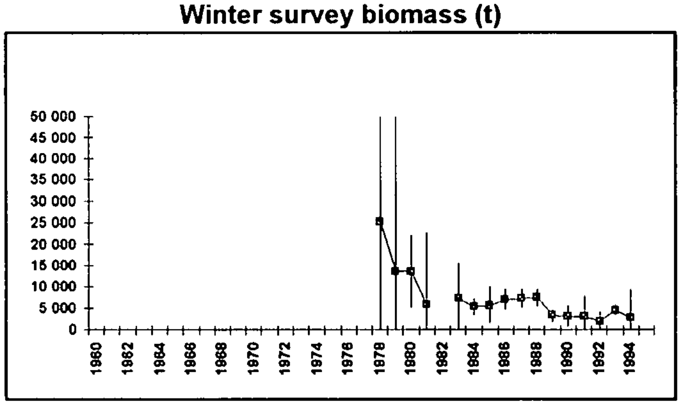
Long-Term Prospects: Long-term prospects are dependent on recruitment. Stock conservation and recovery appear unlikely unless exploitation rates are sharply reduced and the size of the fish caught is increased. If large quantities of immature fish continue to be caught, no sustained recovery can be expected.

Special Comments:

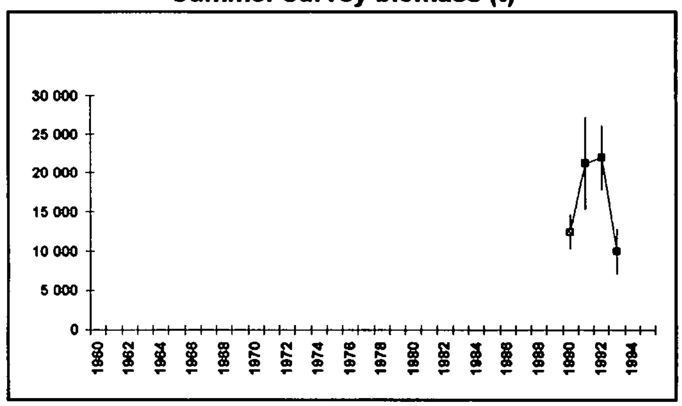
Landings and TACs (t)



Winter survey biomass (t)



Summer survey biomass (t)



Witch Flounder in 4RST

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference Level '000t											
TAC '000t[2]	3.5	3.5	3.5	3.5	3.5	3.5	3.5	1.0	1.0	3.5	3.5
Reported catches '000t[3]	2.6	2.5	2.3	1.3	1.0[4]	1.0[4]	0.9[4]		0.9	3.9	6.9
Unreported catches											
Estimated discards '000t											
Reported catches '000t[3]											
Total catches '000t											
Total biomass '000t[5]	7.8	6.6	N/A	3.6	3.1	1.5	0.4				
Spawning biomass '000t											
Mean - F ( )											

[1] for period 1960-1993; [2] TACs for 4RS; [3] 4RST; [4] Preliminary statistics; [5] Summer survey estimates - 4RST

Catches: Landings of 4RST witch flounder are currently at their lowest level on record since 1960. Landings in 1993 were 901 t, well below the average of 2,880 t. The maximum of 4RST landings was 6,875 t in 1976. Seine gear have contributed most of the witch landings since 1984.

Data and Assessment: Survey data from the Quebec and Gulf regions were combined in an analysis of the distribution of witch flounder in relation to NAFO boundaries in the Gulf of St. Lawrence. Witch flounder are distributed across NAFO boundaries during summer surveys and appear to concentrate in deep waters in the eastern Gulf during winter, possibly extending into 4Vn.

Fishing Mortality:
Recruitment:
Environmental Factors:
Multispecies Considerations:

State of the Stock: The abundance of witch flounder in 4RST appears to be declining. The current TAC of 3,500 t is high in relation to catches since 1981.

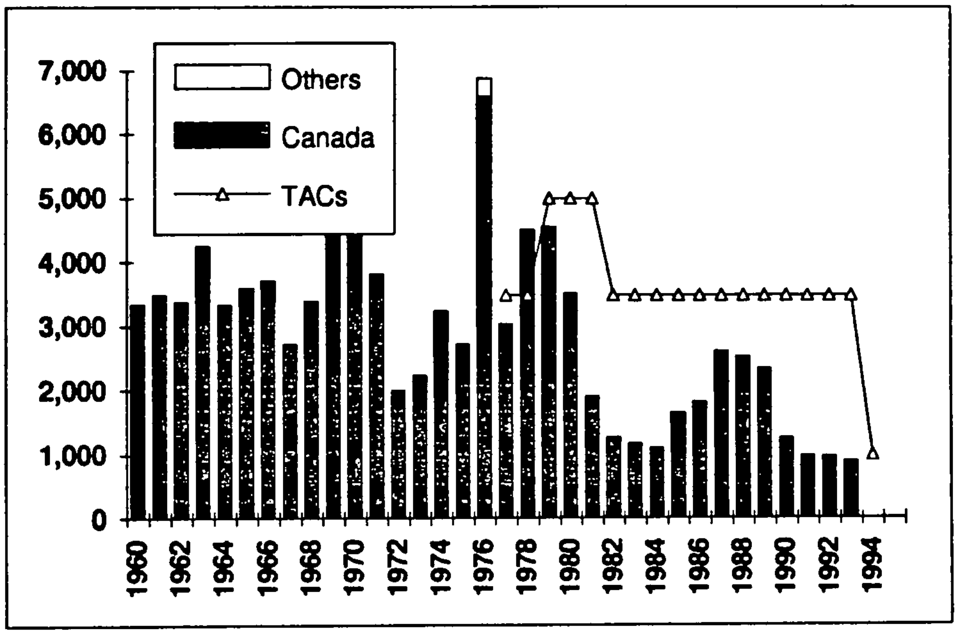
Forecast for 1995: A quantitative forecast is not possible; however, based on research surveys and the commercial fishery, landings are expected to decline or stabilize.

Long-term Prospects: Catches in 4RST are significantly below the average since 1960. Given the current stock size and the age of recruitment, stock rebuilding is expected to be slow.

Assessment Synopsis:

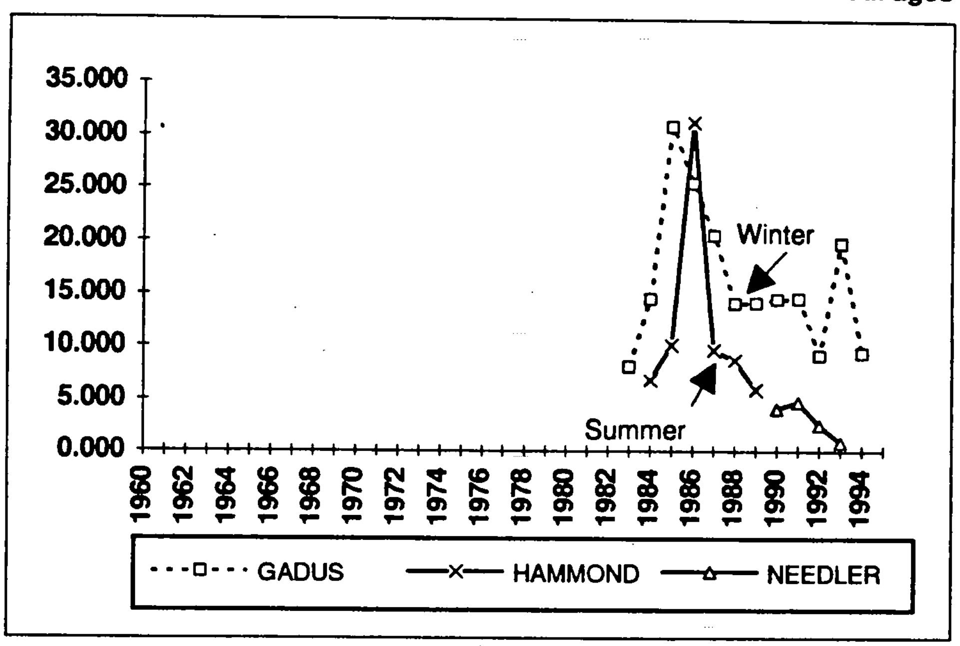
Special Comment: The current management unit, 4RS, is inadequate for this stock which is distributed across boundaries within the Gulf of St. Lawrence. It is also possible that during winter the stock is distributed outside of the Gulf into Cabot Strait.

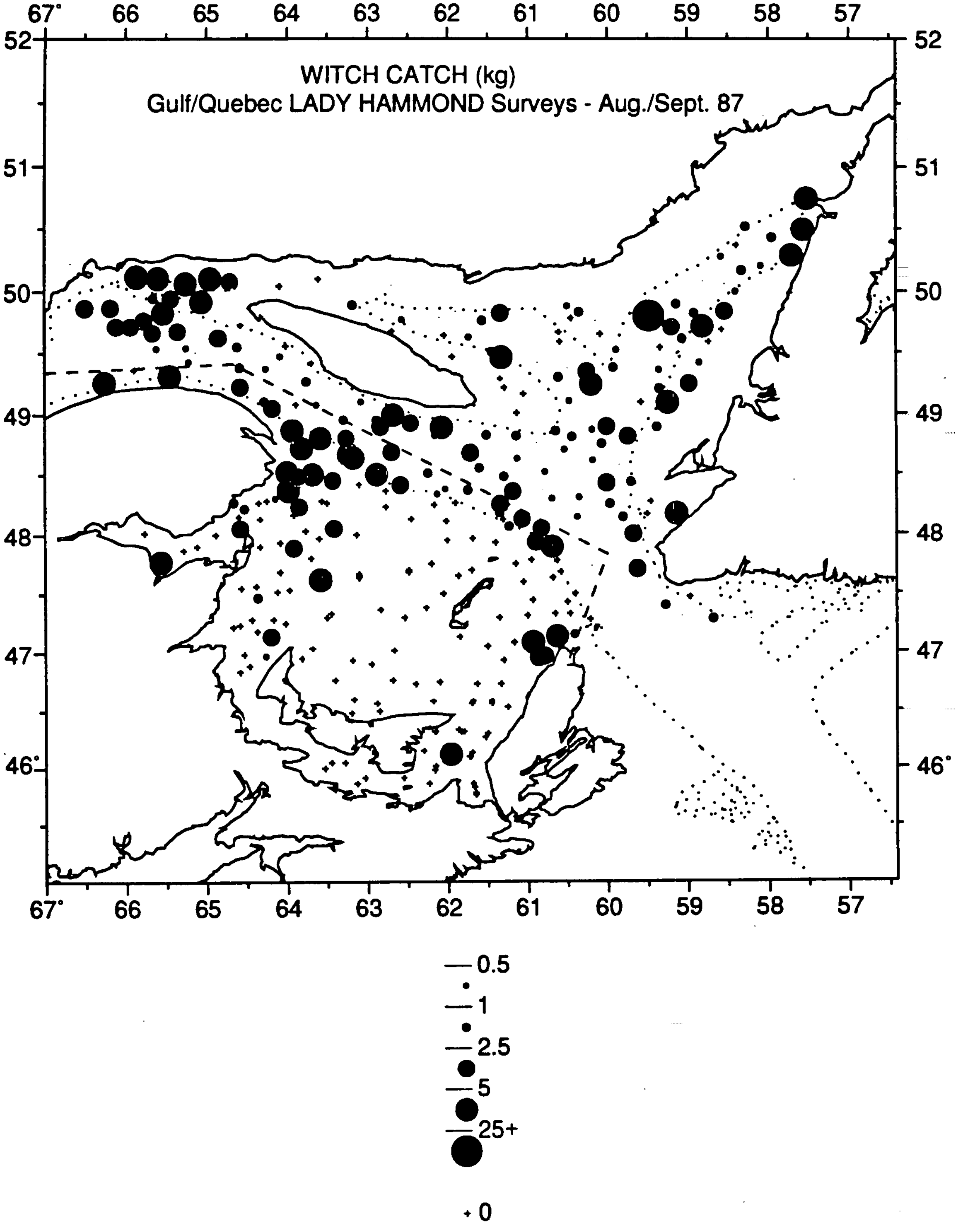
Total catches (t) and TACs (t)



Witch in 4RST

RV (#/tow) in 4RST **All ages**




WITCH CATCH (kg)
Gulf/Quebec LADY HAMMOND Surveys - Aug./Sept. 87
67° 66 65 64 63 62 61 60 59 58 57
52 51 50 49 48 47 46°
0.5
1
2.5
5
25+
0

Winter Flounder in 4T

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference Level '000t											
TAC '000t											
Reported catches '000t	1.8	1.4	2.1	2.1	2.5[1]	1.9[1]	1.2[1]		0.1	2.3	4.4
Unreported catches											
Estimated discards '000t											
Total catches '000t											
Total biomass '000t				16.6[2]	9.7[2]	15.6[2]	9.7[2]				
Spawning biomass '000t											
Mean - F ( )											

[1] for period 1960-1993; [2] Preliminary statistics; [3] Research survey estimates

Catches: This stock is not under quota management. There is uncertainty as to total catches due to discarding, unreporting and incorrect identification of the species in landings statistics. Landings have varied widely since 1960, without a clear long-term trend. Reported landings are 1,238 t for 1993 were somewhat less than the average of 1,984 t since 1960. Landings have decreased by 50% since 1991, but these are within the observed variability for this fishery and may be due to by-catch restrictions, mesh size restrictions and reduced effort.

Data and Assessment: The ageing of port and research survey samples has been undertaken recently, resulting in data available for 1990 to 1993. The results of a September groundfish survey, conducted annually since 1971, are used as an index of abundance for the whole of 4T and for sectors where it was considered that local stocks of winter flounder may be centered.

Fishing Mortality: Fishing mortality has not been estimated for this resource.

Recruitment: No index of recruitment is available for this stock.

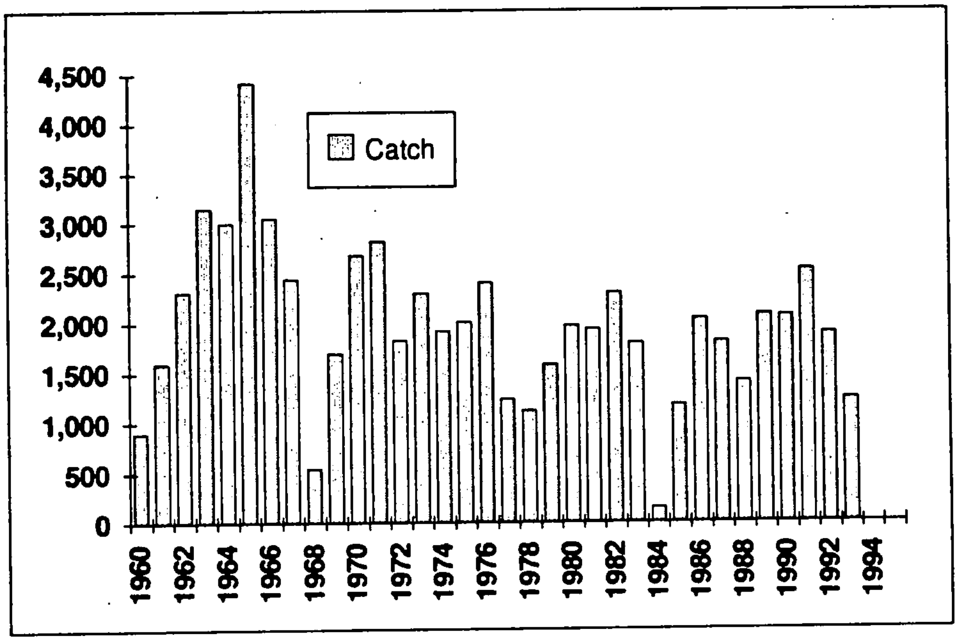
Environmental Factors:
Multispecies Considerations:

State of the Stock: 4T winter flounder are currently at a level of abundance that is intermediate to abundance since 1971. It appears that several separate stocks exist in 4T and that abundance varies regionally. Abundance in the Miramichi area appears to be higher than in the seventies while that around the Magdalen Islands area has decreased.

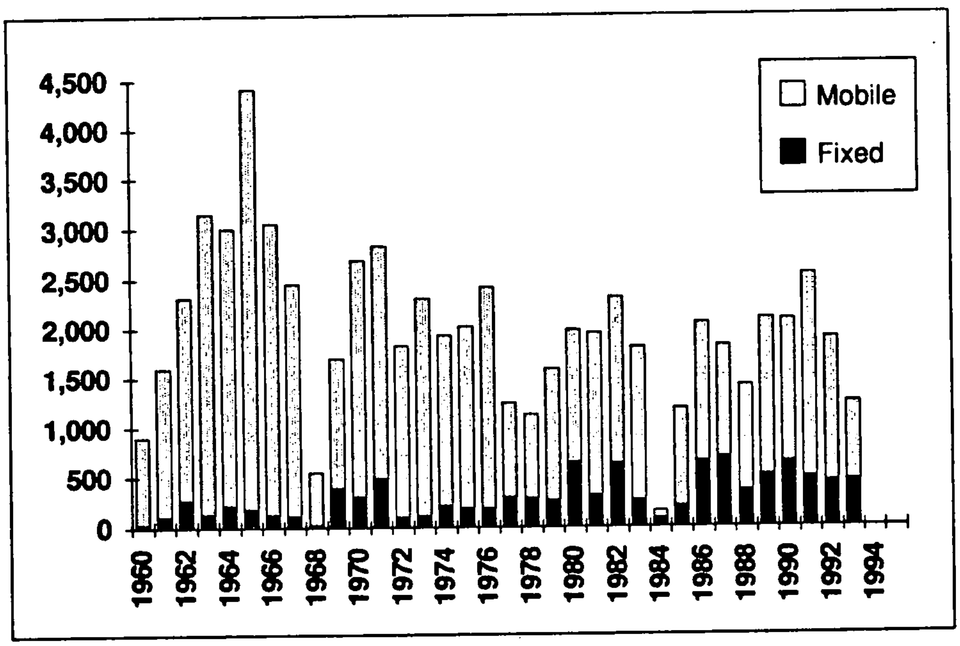
Forecast for 1995: A quantitative forecast is not possible, but landings are expected to vary in response to changes in harvest restrictions on other groundfish stocks.

Long-term Prospects:
Assessment Synopsis:
Special Comment:

Total catches (t) and TACs (t)



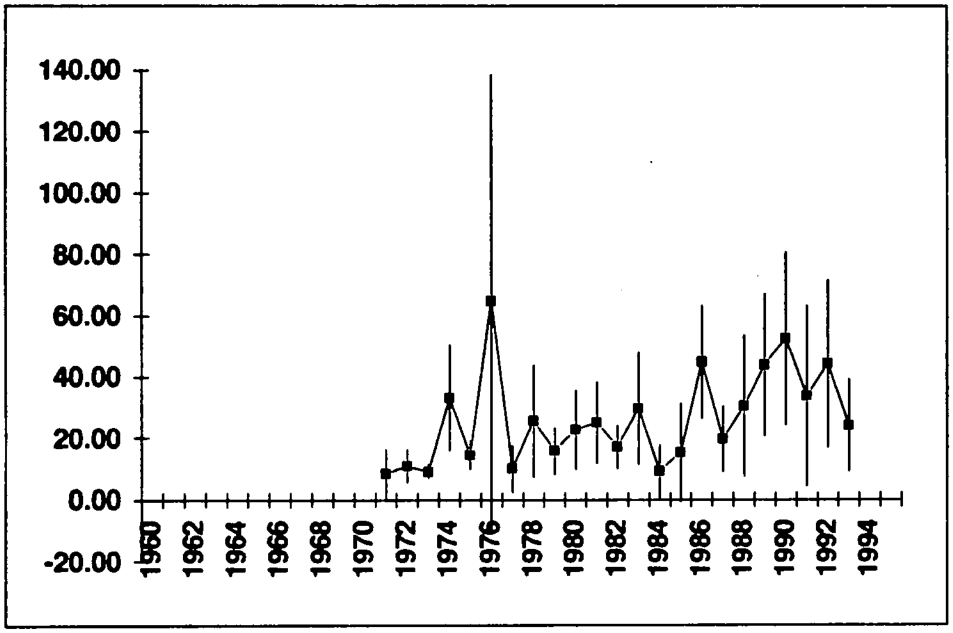
Fixed and Mobile Canadian Catch (t).



Abundance Indices

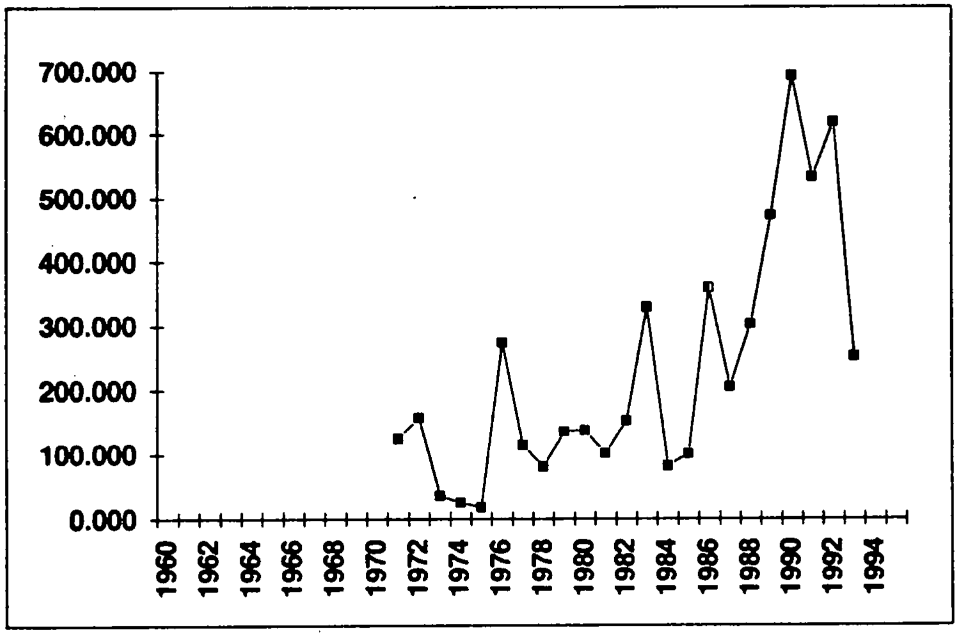
RV (#/tow) - Fall

1+

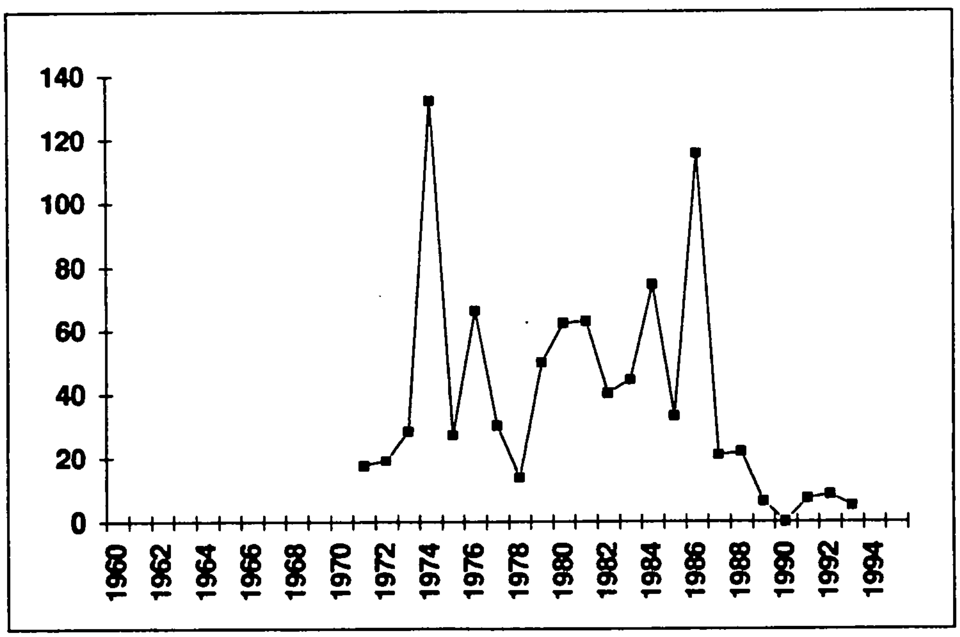


Abundance Indices

Miramichi (St: 20+21) **(all ages)**



Magdalen Is. (St: 28+35) **(all ages)**



White Hake in 4T

Summary

White hake in 4T may be at its lowest level since the first quota was placed upon the fishery in 1982. Low prices and reduced effort contributed to the record low catch in 1993. Fewer older (ie. age 6 and over) white hake have been caught since 1989 and the fishery is now dependent on only three to four age groups, compared to five to six in the years before 1989. Recovery of this resource will depend on the occurrence of favourable recruitment.

Results from the 1993 research vessel survey indicate that the abundance and biomass of white hake are at very low levels. The research vessel abundance index has declined by about 50% from the 1992, and is the lowest since 1983. An examination of the length composition of white hake caught during the 1993 survey did not indicate significant improvement in recruitment. The research vessel survey also revealed that the number of large hake has decreased and that the distribution of hake along the Laurentian Channel may be shrinking.

Index fishermen have reported that hake were "smaller" and "scarcer" in recent years and other comments from industry indicate that the abundance of white hake has declined. Continued closure of the cod fishery and the possibility of competitive prices for hake in 1994 could result in increased effort directed at hake and a higher rate of exploitation.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t	-	5.5	5.5	N/A	N/A	N/A	5.5	N/A			
TAC '000t	9.4	5.5	5.5	5.5	5.5	5.5	3.6	2.0	2.0[1]	5.5[1]	12[1]
Reported catches '000t	6.4	3.9	5.4	5.2	4.5[2]	3.8[2]	1.5[2]		1.5[3]	5.8[3]	14.0[3]
Unreported catches											
Estimated discards '000t											
Total catches '000t											
Total biomass '000t	17.8	17.8	13.4	10.6	11.3	7.7	4.1		4.1[4]	11.8[4]	17.8[4]
Spawning biomass '000t											
Mean - F ( )											

[1] For 1982-1994; [2] Preliminary statistics; [3] For 1960-1993; [4] For 1987-1993

Catches: Landings peaked at 14,039 t in 1981 and have declined almost every year since to a historic low of 1,465 t in 1993. Catches since 1988 have been lower than the average for the period (1960-1993) which equals 5,808 t.

Data and Assessment: A formal analytical assessment of this resource has not been conducted since 1989 due to the lack of a reliable index of abundance and because of uncertainties associated with stock definition and the adequacy of the management unit. Indices of abundance and of fishing mortality were calculated from survey data.

Fishing Mortality: A trend of increasing fishing mortality on the year-classes that support the fishery (ages 4-6), was apparent from 1988-92, followed by a reduction in 1993.

Recruitment: The length frequency of white hake caught during the 1993 abundance survey indicates that numbers of juvenile hake remain low.

Environmental Factors: The distribution of hake (based on research survey data) along the Laurentian Channel has changed suggesting contraction of the range into the deeper, eastern limits of the channel area.

Multispecies Considerations:

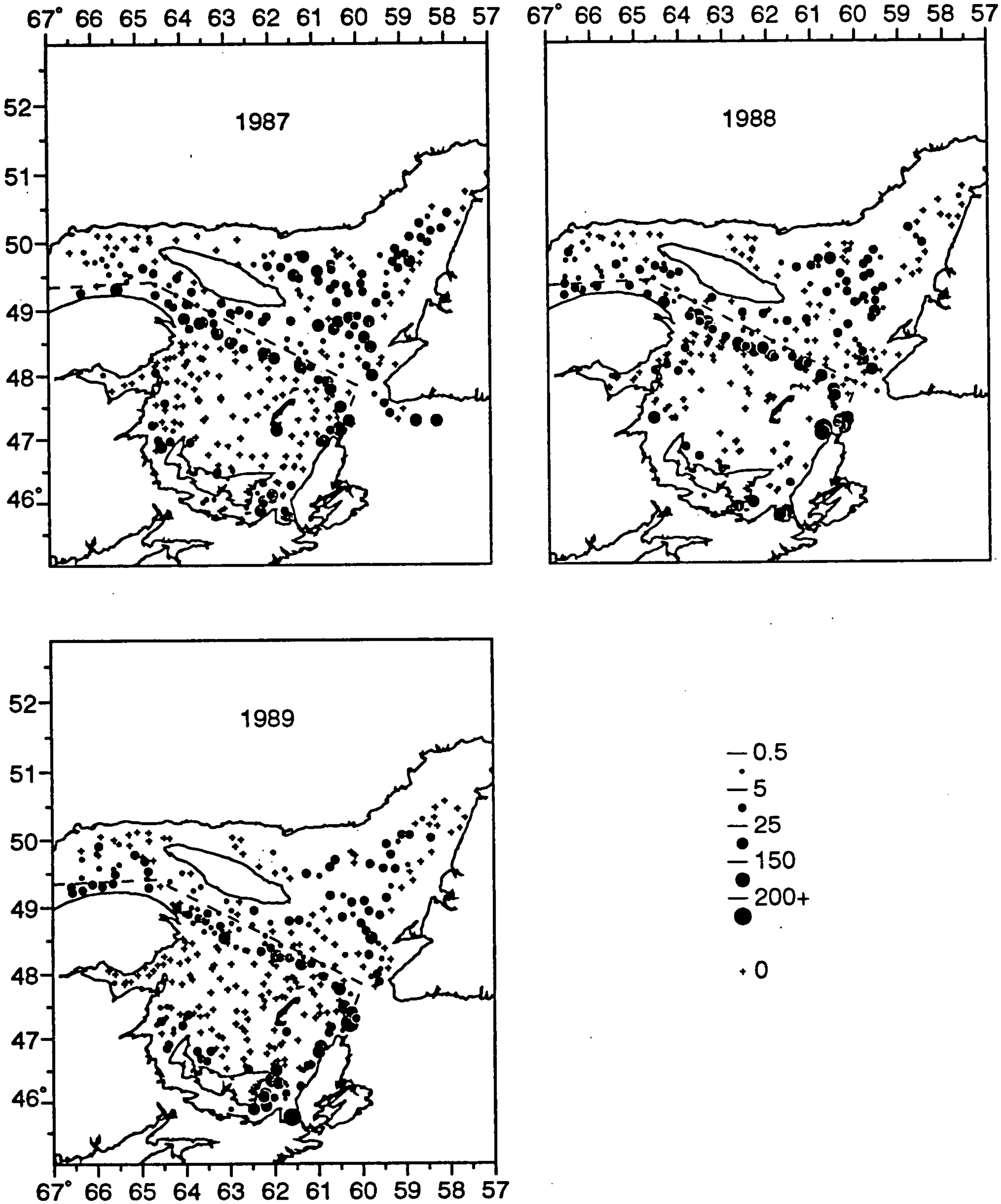
State of the Stock: Research vessel estimates indicate that the abundance and biomass of this stock are at a very low level. Most of the comments from industry confirm this view.

Forecast for 1995: A quantitative forecast is not possible but low prices and reduced effort contributed to the record low catch in 1993. Continued closure of the cod fishery and the possibility of competitive prices for hake in 1994 could result in increased effort directed at hake and a higher rate of exploitation. Abundance of hake in 1995 is not anticipated to be higher than in 1993 and could be lower.

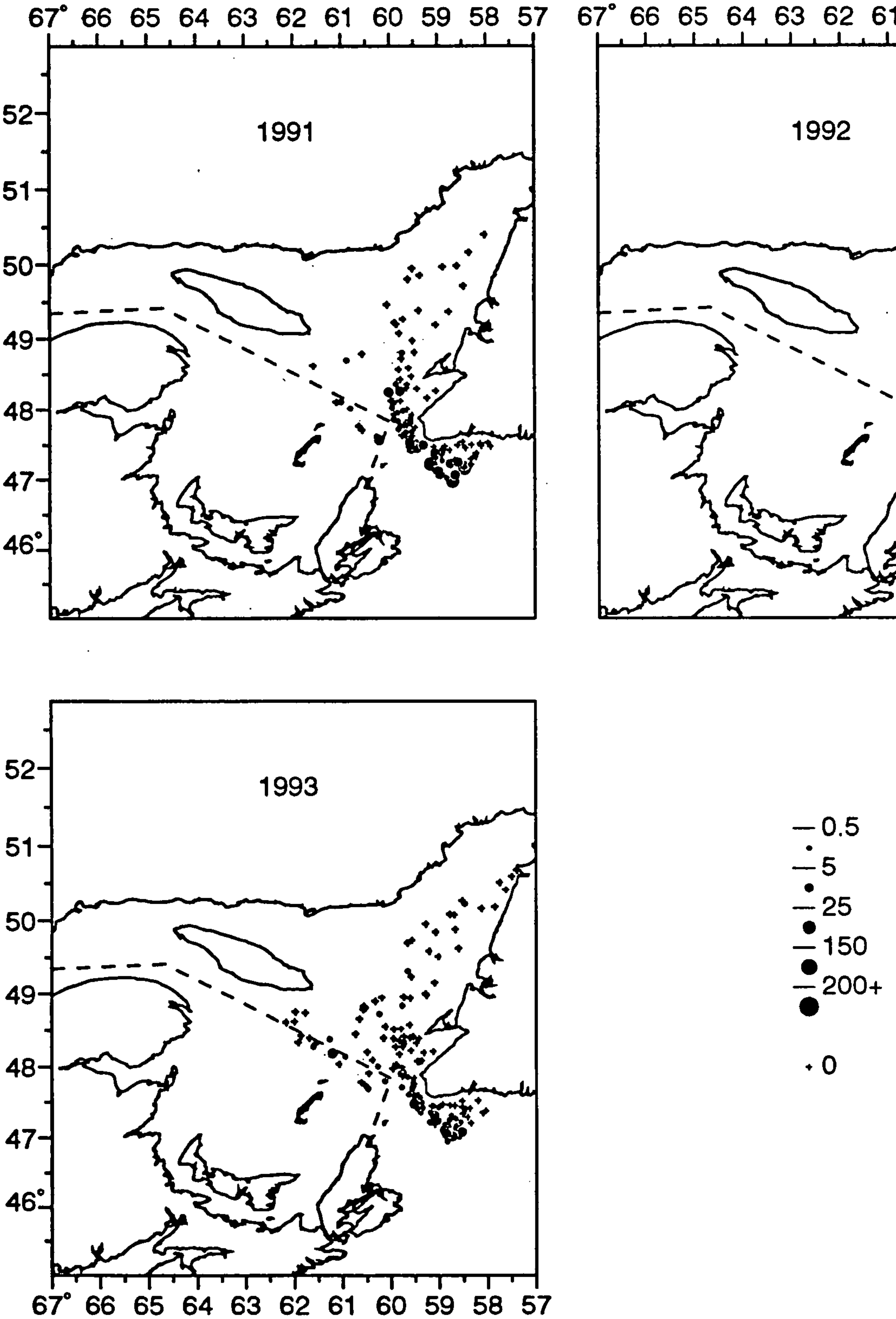
Long-term Prospects: The catches of recent years appear to have resulted in a high rate of exploitation. This fishery is dependent on only three to four year-classes and as a result, it will be sensitive to annual fluctuations in recruitment. Rebuilding is unlikely given the current low abundance and indications of weak incoming recruitment.

Special Comment: Distribution of white hake in Cabot Strait in winter suggest that white hake from the Gulf of St. Lawrence migrate to this area. On that basis, the present management unit may not be entirely appropriate. Juvenile white hake are often taken as by-catch in estuarine smelt fisheries. The impact of these catches on the associated fisheries is currently unquantified.

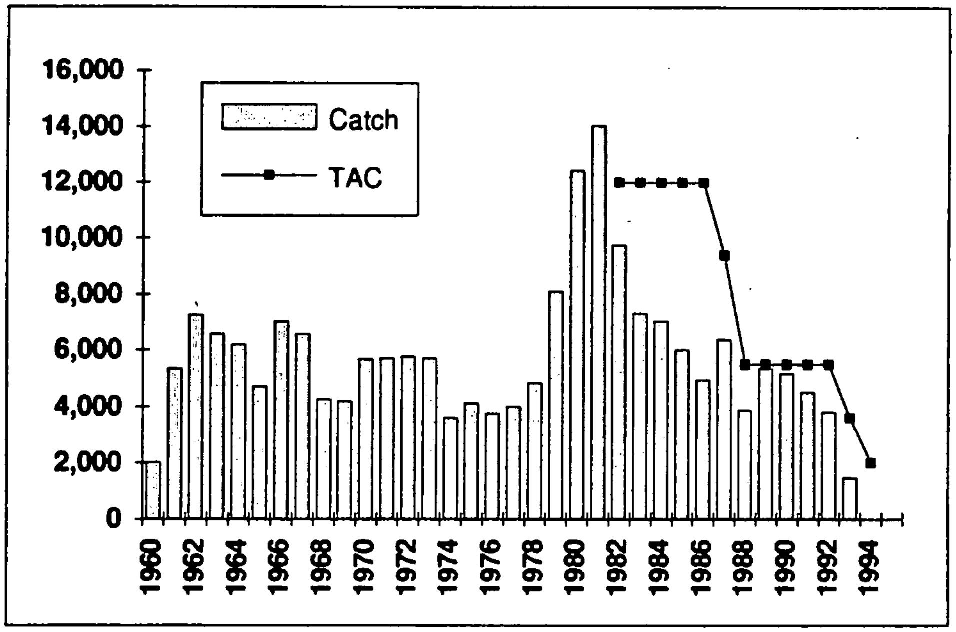
WHITE HAKE CATCH (kg)
Gulf/Quebec LADY HAMMOND Surveys - Aug./Sept.



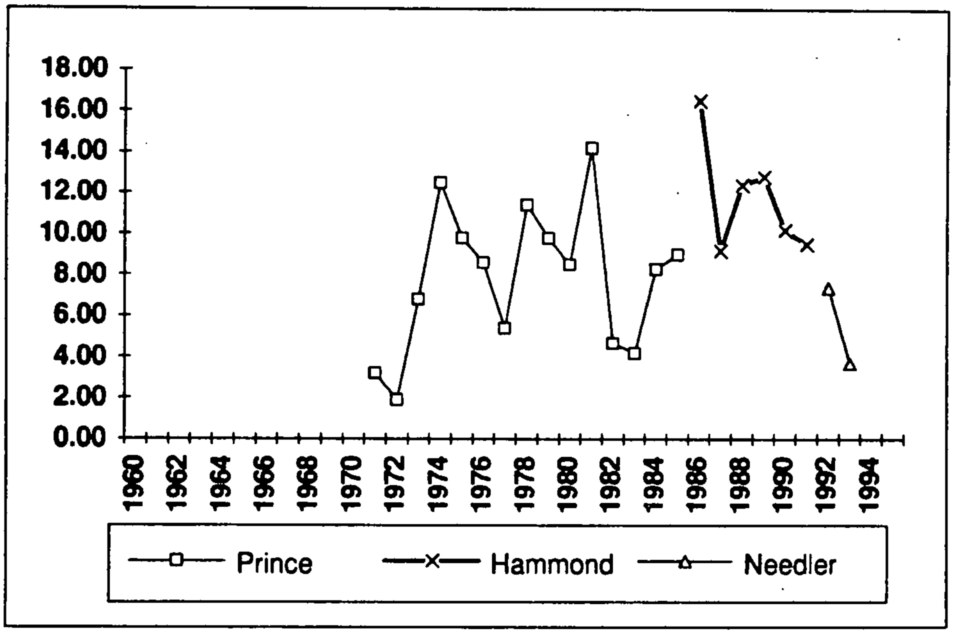
WHITE HAKE CATCH (kg)
Quebec GADUS ATLANTICA Surveys - Jan.



Total catches (t) and TACs (t)



RV (#/tow) - Fall All ages



Scotia-Fundy Region

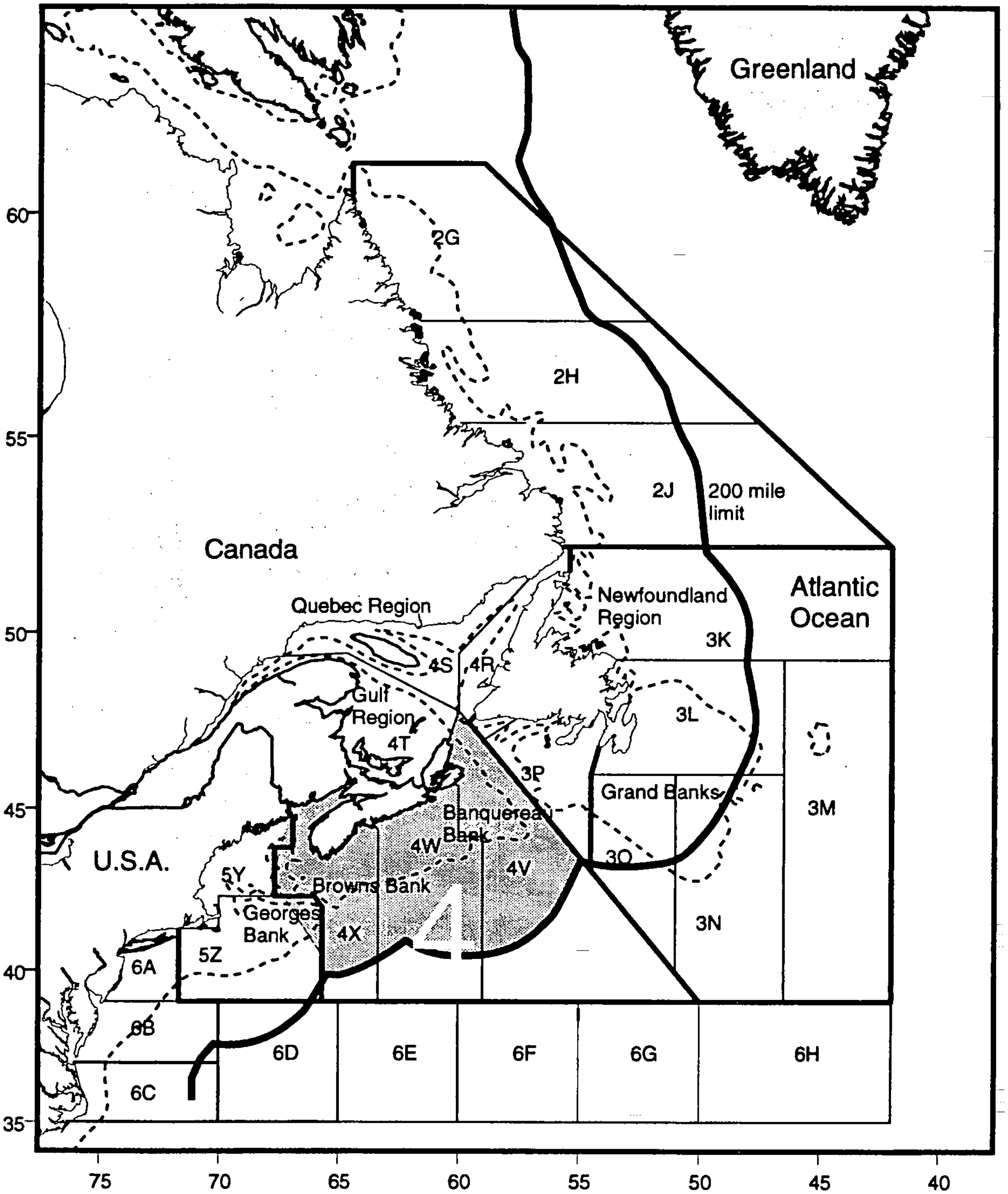


Figure 1: Canada's East Coast showing the Divisions used by the North Atlantic Fisheries Organization (NAFO). Scotia-Fundy Region highlighted.

Overview of the Ecosystem

Community Structure Changes

In this section, we summarize the most recent information on the resources in the Region by their position in the food chain. A recurring theme throughout is the striking difference between the communities on the eastern shelf and those to the south being more productive.

Phytoplankton and Zooplankton Trends

The plankton is the source of food for larval fish and pelagic species such as herring and mackerel. It has been proposed that changes in its abundance influence larval survival. Plankton monitoring of Scotian Shelf waters (as part of the continuous plankton recorder program (CPR) run by the United Kingdom) was started again in 1991 after a gap of over a decade. The recent observations are compared to those of the 1960s and 1970s. Data are only processed for 1991 and 1992. For the Gulf of Maine, the USA has been monitoring plankton using the same methodology for the past 3 decades. Data are available up to 1989.

The abundance of the dinoflagellate *Ceratium arcticum*, a cold water phytoplankton species, was the highest recorded by the CPR program in the region. The 1992 phytoplankton colour index, which is the colour due to all phytoplankton species, was above average for most months, which made 1992 an abnormal year. No other year has shown a pattern of such high phytoplankton colour for as many months in one year.

NAFO divisions 4W and 4X appear to have different temporal patterns of zooplankton abundance, which may be due to different physical influences in the two regions. The Gulf of Maine zooplankton community appears to have a different population dynamic than those seen in 4W and 4X, again probably due to the different physical influences that are operating in the Gulf.

The eastern Scotian Shelf exhibited the lowest levels of zooplankton species *Calanus finmarchicus* ever recorded on the shelf. However in 4X, the abundance of juvenile and adult *Calanus finmarchicus* was above average during the summer of 1992, suggesting that 4W and 4X have different populations. This is supported by studies that show that the timing of the reproductive cycle of *C. finmarchicus* is different between these two regions.

In summary, the Scotian Shelf waters during 1992 were characterized by high levels of phytoplankton "greenness" yet variable levels of zooplankton. Given the gap in monitoring, decadal scale trends cannot be described for this area. Interestingly, the moderate to above average 1992 year-class of haddock throughout the Scotia Shelf/Gulf of Maine is coincident with low abundance of the dominant zooplankton species (*Calanus finmarchicus*).

Finfish Species Trends

Temporal patterns in trawlable biomass from over 25 species of finfish were assessed from the 1970-1993 summer groundfish surveys. Species groups examined included the gadids (cod, haddock, pollock, cusk, white hake, and red hake); flatfish (yellowtail, witch, American plaice, winter flounder, and halibut); demersals (wolffish, longhorn sculpin, ocean pout, monkfish, sea raven, and lumpfish); skates (thorny, winter, little, and smooth); semi-pelagics (redfish, silver hake, longfin hake, and squid); pelagics (argentine, herring, gaspereau, and mackerel); and spiny dogfish.

Gadids dominated the fish biomass on the shelf except in Division 4X where spiny dogfish dominated. Gadid biomass was highest in 4Vn from 1981-1989. In 4Vs, gadid biomass increased to a peak in 1984 and subsequently fell to the lowest value on record in 1992. Changes in 4W have been less extreme. In 4X, biomass has remained relatively stable although the 1993 value was one of the lowest on record.

Except in 4Vs, flatfish biomass has remained relatively stable across the shelf. In 4Vs, biomass peaked in 1980 falling to its lowest observed value in 1993. Most of this decline was due to a loss in American plaice biomass. In 4W and 4X, winter flounder biomass has shown recent increases.

Although overall demersal biomass in all areas has not exhibited major trends recently, some individual species have experienced substantial change. For example, monkfish has declined dramatically in 4W since 1973-78 and Division 4X ocean pout have increased.

Skate biomass has shown a gradual decline in all areas. The 1992 and 1993 values were among the lowest on record.

The biomass of the other species groups are poorly estimated by the bottom trawl surveys and therefore tend to show much greater variation. Semi-pelagics biomass has been most variable in 4Vn with peaks in 1971, 1979 and 1989. In 4X, biomass increased in 1992 and remained above average in 1993. Pelagic biomass was even more variable. In 4Vn, there was a particularly high biomass of herring. The 1984 to present pelagic estimates in 4W have been much higher than before. In 4X, the 1992 and 1993 catches were above average.

Spiny dogfish have made a major contribution to the total biomass in 4X in recent years (since 1987). They only appear sporadically over the remainder of the shelf. The 1993 estimate in 4W is the second highest of the series.

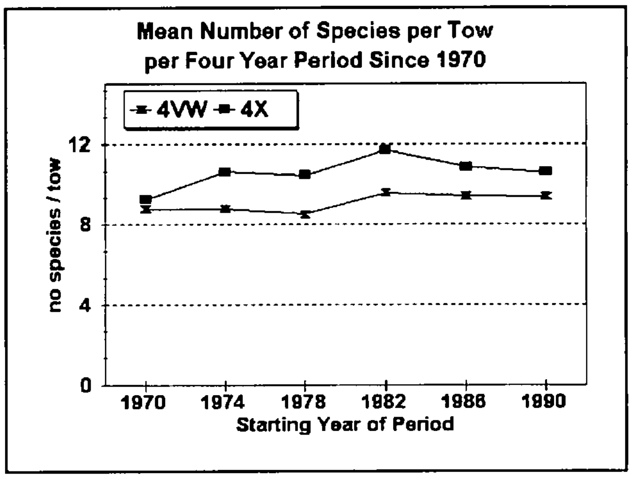
Finfish Species Diversity

Patterns and gradients of the diversity of finfish found within the Scotia-Fundy Region were investigated using the regional bottom trawl surveys database for summer (1970 to 1993), and seasonal data (1979 to 1985).

An index of diversity, the number of species reported per representative survey set, was used with positional data to create contour plots of the relative diversity found by time period, season, and region. The regions demonstrating the greatest diversity for the 1970 to 1993 summer series were found in the Bay of Fundy, and the Gully region east of Sable Island. The least diverse areas were generally found on the shallow offshore banks, especially in the LaHave, Baccaro, Roseway and Banquereau areas.

Seasonal data revealed that the greatest diversity occurred in most areas in the fall, followed by the summer and spring. However, some deeper regions demonstrate greater diversity in the spring along the shelf edge when temperatures are at the lowest.

In general, NAFO divisions 4VW were characterized by a less diverse bottom community than in 4X.



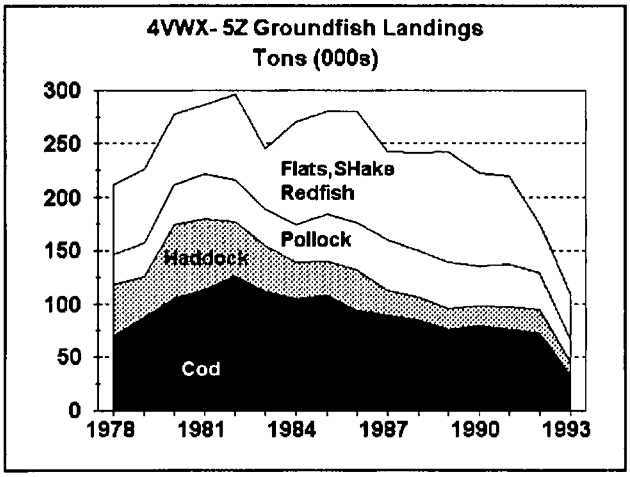
To qualify species assemblages present in offshore areas, community compositions and the frequencies of occurrence of each species were determined for regions delimited by the summer survey strata. The most diverse strata contained many species with high frequencies of occurrence; the least diverse strata were the opposite. A third group of strata had many species, all with low frequency of occurrence, and a fourth with few species of high frequency of occurrence. Generally, the Bay of Fundy strata were of the first group, the banks strata were of the second group, strata from the shelf edge were of the third group, and the basin strata were of the fourth group. Comparing the most diverse stratum (Bay of Fundy) to the least diverse stratum (LaHave Banks), the former had a greater species inventory with species of a higher frequency of occurrence, more year round residents, and a higher rate of influx of seasonal migrants.

Long-term decreases in the frequency of occurrence of 26 species were detected in the summer season; those most greatly affected were smooth skate (20 strata), thorny skate (12 strata), anglerfish (10 strata), cusk (9 strata), haddock (8 strata), halibut (6 strata) and dogfish and witch (5 strata).

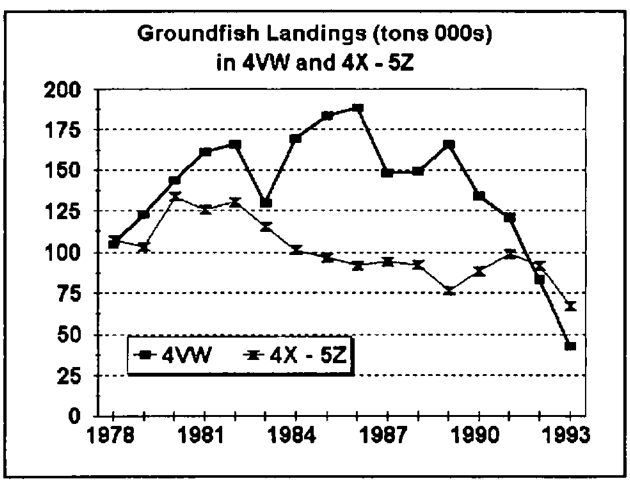
The above observations are relevant to the management of the fisheries. In areas of high diversity such as 4X, fisheries prosecute a broader range of non-directed species than areas of low diversity such as 4W. Single species fisheries are easier to manage in areas of low species diversity such as the eastern Scotian Shelf.

Groundfish Overview

The groundfish landings from the Scotia-Fundy Region from 1978 to 1993 are shown below. The major species are cod, haddock, pollock and silver hake. Five species of flatfish (Atlantic halibut, American plaice, yellowtail, witch and winter flounder) and redfish are also important. The overall landings increased between 1978 and 1982, declined gradually between 1983 and 1991, and then dropped sharply in 1992/93.



The temporal pattern in landings have been different in the eastern (4VW) and western (4X and 5Z) parts of the region. The landings in 4VW have been higher than 4X and 5, peaked in 1986 and have declined dramatically since 1989. On the western shelf the peak landings occurred in 1980, with a more gradual decline to 1993.



The above trends in landings reflect the trends in stock abundance in the diverse management units, as well as what appears to be different ecosystems in the eastern and western parts of the region. The climate conditions and grey seal predation are more severe for the eastern shelf. For example, weights-at-age have been declining throughout the 1980s for cod in 4VW, but not so much in 4X and 5. Also relative recruitment levels for cod and haddock in 4VW have been lower during the late 1980s compared to 4X and 5 (in spite of comparable levels of fishing). The tidally well mixed waters of the Gulf of Maine area (including Browns Bank and the Bay of Fundy) are more productive than the eastern Scotian Shelf. The groundfish grow quicker and mature at a younger age, and the populations are characterized by a higher frequency of moderate to strong year-classes. The water temperatures in the Gulf of Maine area are well within the preferred temperature range of the commercially important species, such that small changes in temperature are unlikely to have a major impact on population processes. The eastern shelf (with somewhat colder waters, greater inter-annual variability in circulation and mixing, and higher seal abundance levels) may be a more "fragile" environment for groundfish stocks, and thus more sensitive to high fishing exploitation.

The temporal patterns in fishing mortality are remarkably similar for those management units which have an analytical assessment (4VsW cod, 4X cod, 5Zjm cod, 5Zjm haddock, and 4+5c pollock). Subsequent to extension of jurisdiction in 1977, fishing mortalities climbed gradually to the early 1980s, and then were relatively stable until the end of the decade. From 1990 to 1992, however, fishing mortalities increased dramatically to high levels, as the stocks declined rapidly. With the "closure" of some management units in 1993, and mid-year reductions of TACs in others, fishing mortality has declined in some cases. However, with the reduction of fishing effort on cod, haddock and pollock, the fleets have targeted on flatfish, hakes, redfish, monkfish, etc. We do not have estimates of fishing mortality for these latter species but the information available infers that some of the stocks are declining (e.g witch, American plaice, yellowtail in 4V, winter flounder in 4X). Fishing effort, in spite of the major reductions in TACs, has not declined very much in 4X and 5. Rather the effort has been redirected. As a result, there are reports of extensive discarding (of 4X haddock in particular). The fishing effort in 4VW, however, dropped sharply in 1993. In sum, single species quota management for multi-species fisheries makes it very difficult to control fishing mortalities at the target level. Fishing mortalities (for those management units for which it is estimated) have exceeded F_{max} from 1990 to 1993 (except for 4VsW cod in 1993, and for silver hake throughout the 1978 to 1993 period). In order to reduce fishing mortality to $F_{0.1}$ levels, the days fishing needs to be reduced by over 50% in the 4X and 5 management units.

The stock abundance levels and indicators of incoming recruitment are summarized below:

Management Unit	1995 Spawning Stock Abundance	Signs of Recruitment
4Vn cod	very low (no SPA)	No sign of strong year-classes
4VsW cod	critically low, possible loss of spawning components	1990 year-class looks moderate
4X cod	low	1990 year-class looks moderate
5Z cod	very low	1990 year-class looks moderate
4TVW haddock	very low	1992 above average; 1993 early indications of average to above average
4X haddock	low	1992 above average; 1993 early indications of average to above average
5Zjm haddock	low	1992 above average; 1993 early indications of average to above average
pollock	low	1988 above average; 1989 average; 1990-91 poor
4VW American plaice	declining	no index
4X American plaice	stable	no index
4VW yellowtail	declining in 4V, stable in 4W	no index
4X yellowtail	stable	no index
4VW witch	declining	no index
4X witch	declining	no index
4VW winter flounder	stable	no index
4X winter flounder	declining in the inshore areas, stable on banks	no index
Atlantic halibut	declining	no index
redfish (Unit 3)	stable	no index

In summary, for the past several years, there are very few management units for which fishing effort has been at a level low enough to allow stock rebuilding. For 1995, most stocks are at low to critically low levels of spawning biomass. For all of the haddock populations, the 1992 (and possibly 1993) year-classes look promising. For cod, however, with the exception of the moderate 1990 year-class, which is presently recruiting to the fishery, there are no signs of above average recruitment.

The 1994 TACs, 1994 and 1995 $F_{0.1}$ reference levels ('000 t) are summarized below.

	1994 $F_{0.1}$ Reference Level	1994 TAC	1995 $F_{0.1}$ Reference Level
4Vn cod	0	0	0
4VsW cod	3	0	<5
4X cod	7	13	5
5Zjm cod	<2	6[2]	3
4TVW haddock	<2	0	<2
4X haddock	<6	4.5	<7
5Zjm haddock	2	3[2]	4
pollock	20	24	13
4VW flatfish[1]	<10	10	~2.5
4X flatfish[1]			~2.5
Atlantic halibut[1]	<3.2	3.2	~1.5
redfish (Unit 3)	10	10	10

[1]For the flatfish species, including halibut, fishing effort needs to be reduced by about half. The stock abundance is not increasing (which appears to be the case for most species) a reduction in landings by 50% would be expected with this level of effort reduction.
[2]Canadian allocation.

Pelagics Overview

Two major herring resources (one spawning off southwest Nova Scotia, the other resident on Georges Bank), exist in the Region. While the TAC of the southwest Nova Scotia has been 125-152,000t since the late 1980s, recent landings have been declining so that by 1993, just over 100,000t was landed. In 1993, a new dockside monitoring program was introduced and led to the most accurate landings statistics to date, for a fishery which has been plagued by erroneous reporting. The fishery continues to be highly influenced by the roe market which has been soft in recent years. Although indices of abundance for this resource indicate a healthy population, changes in the geographical distribution, in particular the relative change in abundance at traditional spawning locations, have led to concerns that some spawning components may have been lost.

The Georges Bank herring population was fished to commercial extinction prior to extension of Canadian jurisdiction in 1977. Essentially no herring were observed on the Bank until the mid-1980s. Since that time, there have been signs of a steady recovery, such that an experimental Canada/US fishery of 5,000t has been permitted since 1992. Further increases in this experimental fishery can be expected if current stock conditions continue.

Mackerel is a seasonal inhabitant of the Scotian Shelf, on its way during the spring from the southern feeding grounds off New England to spawn in the Gulf in June-July. The return trip occurs in the late fall. Since extension of jurisdiction, exploitation by Canada and the US has been very low, with changes in abundance largely the result of natural variation in recruitment. Since the mid-1980s, stock biomass has probably been declining from the high levels experienced earlier when the particularly strong 1967 and 1982 year-classes passed through the population.

Capelin has been observed in quantity on the eastern Scotian Shelf since the late 1980s, coincident with the increased intrusion of cold water into that region. Very little is known about this resource and its affinity to adjacent populations in the Gulf and off Newfoundland.

A number of large pelagic species (bluefin tuna, albacore, swordfish and a variety of sharks) are exploited in the Scotia-Fundy Region. These species are highly migratory with the stocks inhabiting the West Atlantic in the case of bluefin and sharks, the North Atlantic in the case of swordfish and albacore, and the whole Atlantic in the case of bigeye and yellowfin tuna. Tuna and swordfish assessment advice is produced by the International Commission for the Conservation of Atlantic Tunas (ICCAT). The 1993 West Atlantic bluefin tuna TAC was about 2,400t of which Canada caught 459t. The spawning biomass has declined steadily since the early 1970s to reach the lowest observed levels. This is due to a combination of steadily declining recruitment and high exploitation during the 1960s and 1970s.

The North Atlantic albacore stock is generally experiencing low exploitation with the 1993 Canadian catch being 9t. Although Canada's 1993 harvest of Atlantic bigeye and yellowfin was only 124t and 71t, respectively, both stocks are being fished at their maximum sustainable yield and should not be considered under-utilized.

Recent North Atlantic swordfish landings have been around 15,000t annually with Canada's 1993 catch being 2,234t. Stock biomass has declined since the late 1970s and, in particular, the biomass of age 5+ fish (spawning stock) has shown a steady decline. However, reduction in catches (in the order of 30%) and fishing mortality since 1988 have slowed and may have reversed this decline. Swordfish is currently being fished at its maximum sustainable yield.

Little information exist on sharks (porbeagle, mako and blue). The 1993 landings of these species in the Canadian zone have been about 1,664t, much of this caught by foreign vessels and as by-catch to other fisheries. These catches are underestimates, as sharks have been unregulated and due to the extent of the by-catch. Sharks are long-lived, slow growing and produce relatively few young per adult female. Consequently, they are sensitive to overexploitation without good estimates of stock size and production. While there is considerable interest in developing fisheries for these resources, this has to proceed cautiously to parallel our growth in understanding of the resources and thus limit the possibility of overexploitation.

Marine Mammals Overview

Two breeding components to the northwest Atlantic grey seal population have been identified: both components breed in January-February, one on the coast and land-fast ice of the southern Gulf of St. Lawrence and the other at Sable Island on the Scotian Shelf. Limited interchange occurs between the breeding components. Although the majority of each component spends the year in their respective areas of the Gulf and eastern Scotian Shelf, portions of both components disperse into adjacent areas after the breeding season. Pup production of the Sable population is well documented and has been increasing steadily at a rate of over 12% annually since the early 1960s. This corresponds to a doubling of production in slightly less than 6 years. The estimated biomass of 4VsW cod consumed by grey seals has increased from about 1,500t in 1970 to 17,300t in 1993, much of this in age groups 1-4 (pre-recruits to the fishery). In comparison, the 1993 commercial fishery landed 3,500t of 4VsW cod.

Harbour seals are the only other seal species resident on the Scotian Shelf. They breed in May-June congregated in many small discrete breeding groups along the coast. The largest breeding colony occurs on Sable Island. Between the early 1970s and 1989 pup production on Sable Island increased at an annual rate of about 5% from less than 300 to over 600 per year. Since then, however, production has declined steadily and in 1993 about 350 pups were produced. There is as yet no explanation for this decline.

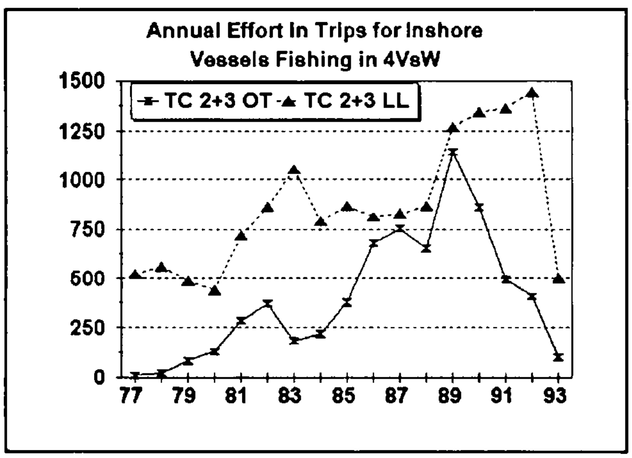
Harbour porpoise are thought to comprise three subpopulations in the Northwest Atlantic: one in eastern Newfoundland, one in the Gulf of St. Lawrence and one in the Bay of Fundy-Gulf of Maine area. Recent evidence based on mitochondrial DNA analysis indicates these to be distinct populations with only limited interchange between them. There is little historical information on the biological production of these groups. Surveys conducted in 1991 and 1992 provide an average abundance of harbour porpoise in the Gulf of Maine/Bay of Fundy area of 47,000t. Porpoise are caught as by-catch to gillnet fisheries in both Canada and the US. The limited information on this activity suggests that this by-catch is too high and needs to be reduced. Studies are currently underway to both better define the problem and find solutions.

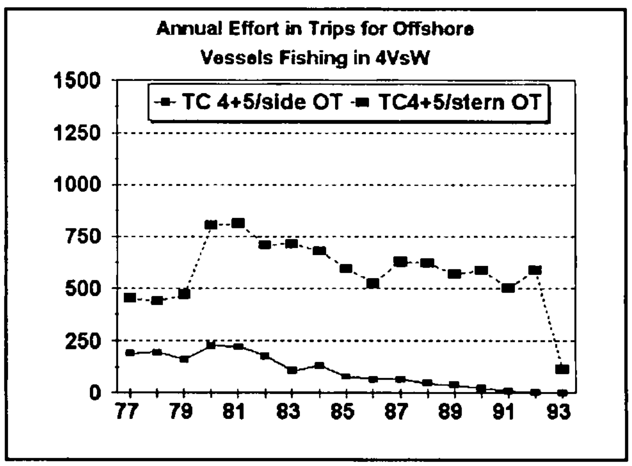
Overview of Management and Issues in the Fishery

Effort Trends Since 1977

There have been substantial changes in the composition of the fishing fleets harvesting groundfish in the Scotia-Fundy Region since the extension of jurisdiction. There are a variety of problems which complicate interpretation of catch and effort data as recorded in DFO statistics. Notwithstanding this, the databases are adequate to provide a "broad brush" overview of trends in effort as measured by number of trips for tonnage classes greater than 2 (25 gross tons or greater). Much of the effort in Subdivision 4Vn is by smaller vessels, therefore no summary is given for this area. Similarly, much of the gillnet fishery is conducted by smaller vessels and no summary is given for them.

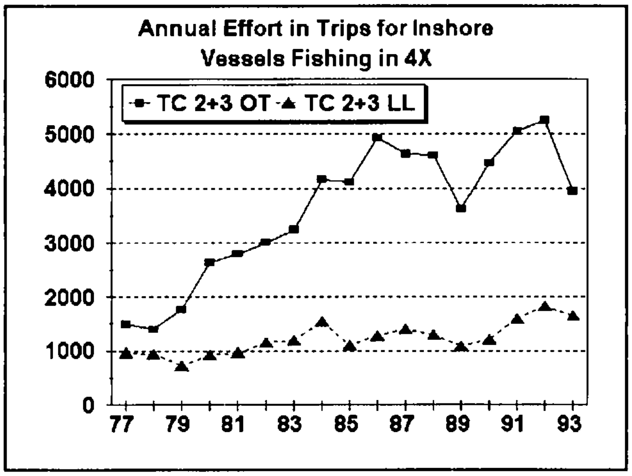
The longline effort in Subdivision 4Vs and Division 4W increased steadily since 1977 by a factor of 2 to 3 times until 1992. Longline effort increased in 4W in 1989 following the build up of the longline fleet in response to the establishment of haddock nursery area which was open to fixed gear only. The small dragger effort showed a similarly increasing pattern, but peaked in 1989 and declined thereafter. The effort of large offshore otter trawlers remained relatively constant over the time period except for a few years in the early 1980s when effort was about 50% higher.

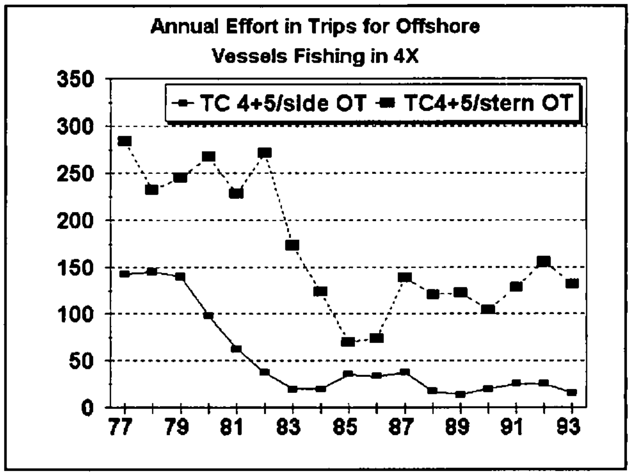


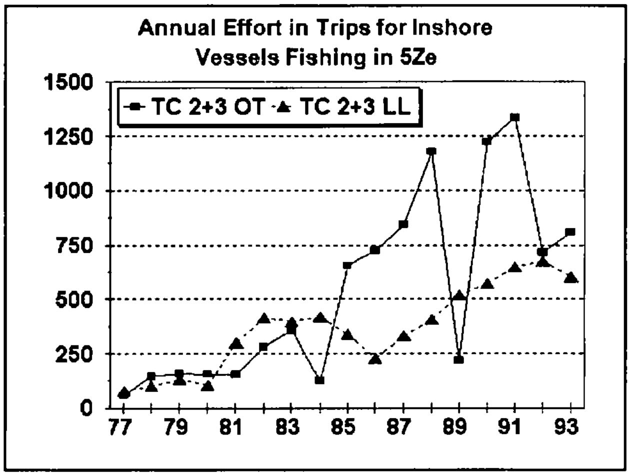


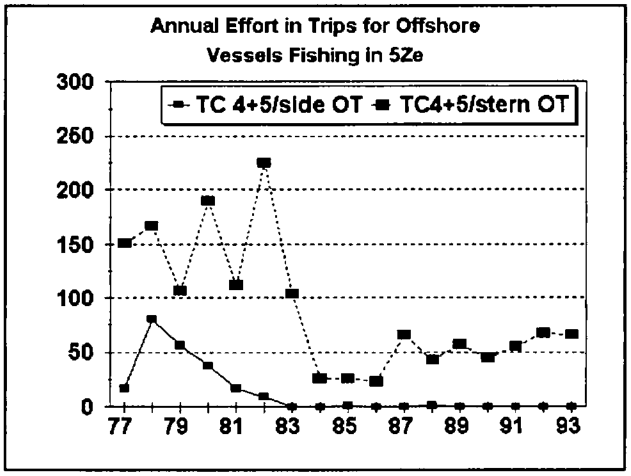
All sectors show a substantial decrease in 1993 due to closure of the fishery.

In Division 4X, the longline effort gradually increased by about 50% over the time period while the small dragger fleet shows a steady increase to the late 1980s by a factor of about 2 to 3. The offshore fleet shows a decline in effort during the mid-1980s and remained relatively constant thereafter. The effort trends on Georges Bank reflect the same pattern as those in 4X. The decrease in effort by the small dragger fleet during 1989 in 4X-5Ze reflects the closure of that fishery in mid-June of that year.









These trends provide a useful context which is referred to in the assessments.

Discarding and Misreporting

Since 1977, there have been ongoing reports of extensive misreporting (by species and area), underreporting, discarding and dumping of fish by the fleets. What information is available was examined at the 1993 Groundfish Workshop (Angel et al., 1994). In general, these activities are all a response to management measures imposed as part of the quota regulatory package. For instance, restrictive quotas in one area would result in catch being reported in an adjacent area. More recently, the introduction of the Dockside Monitoring Program (DMP) has apparently reduced the incidence of unreported landings and misreporting by species, but has had little impact on misreporting by area, dumping, discarding and transhipping, all which occur at sea. Therefore, the absolute amount of fish coming ashore is being recorded comprehensively, but there is still doubt as to what is occurring at sea. This conclusion in supported by examination of cost/earning data and comparisons of landings to export.

Industry Observations

In 1993, as in previous years, considerable effort was devoted to consultation with members of the fishing industry on a broad range of topics. For instance, a series of formal discussions were held during October-November 1993 with participants of the fishing industry on the composition, direction and gaps in the regional groundfish research program (O'Boyle, 1993).

Discussions on the status of the resources have always been a combination of ongoing communication with selected fishermen along with formal meetings with associations. Discussions were held in Shelburne, Pubnico and Yarmouth on 21 April 1994, with representatives of the fixed and mobile gear sectors. Unfortunately, only the Pubnico meeting was well attended. DFO staff had prepared handouts illustrating the catch statistics and sampling information, surveys trend and length composition, etc., for 1993 that were distributed at the meeting. The information for each stock was discussed and debated in turn. At the end of the meeting, participants were encouraged to consider the information further and in the following week faxed their comments to BIO. As a result, a submission was received which represented the discussion on each of the stocks in 4X-5Z among five skippers. This report proved very useful in determining consistencies/ inconsistencies between scientific information and views by the industry. These interactions will be further developed in 1994.

Another possible avenue for industry input into the assessment process is by questionnaire survey. Such surveys have proven useful elsewhere in the zone in cataloguing effort trends in the small inshore fleet sector. The recently established Fishermen and Scientists Research Society has provided a pool of knowledgeable fishermen resident along the Eastern Shore of Nova Scotia, that were sent a questionnaire on catch rate differences for fish in 4VW during 1990-93. As well, they were queried on reasons for the observed patterns. Forty-eight of the 55 members polled responded.

Respondents were asked to indicate a percentage increase or decrease in the catch rates (Question 1: all sizes; Question 2: <17"), of four fish species -- cod, haddock, hake and halibut. The responses are summarized in the following table.

Species	Question	No. of Respondents	Percentage Who Indicated an Increase	Percentage Who Indicated a Decrease	Percentage Who Indicated no Change
Cod	All sizes	47	21	76	3
	Less than 17"	29	48	45	7
Haddock	All sizes	36	8	92	-
	Less than 17"	26	35	55	10
Hake	All sizes	25	8	88	4
	Less than 17	13	62	31	7
Halibut	All sizes	26	12	73	15
	Less than 17"	17	35	41	24

These results are in general agreement with the available assessments for these resources. This poll is referred to in the relevant stock sections. As with the consultations in southwest Nova Scotia, this initiative proved useful in defining differences and commonalities between scientists and fishermen in eastern Nova Scotia in relation to stock trends.

The above two initiatives are in addition to input received through ongoing DFO Science activities, such as the National Sampling and Observer programs.

References

Angel, J.R., D.L. Burke, R.N. O'Boyle, F.G. Peacock, M. Sinclair, and K.C.T. Zwanenburg. 1994. Report of the Workshop on Scotia-Fundy Groundfish Management from 1977 to 1993. Can. Tech. Rep. Fish. Aquat. Sci. 1979.

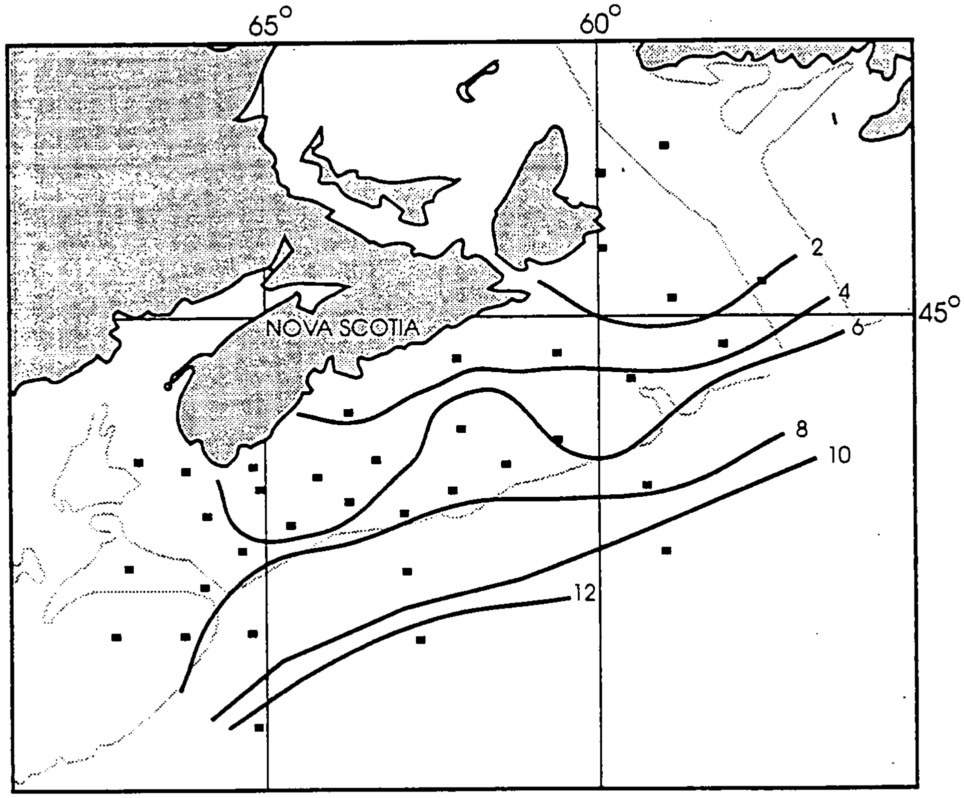
O'Boyle, R. (Editor) 1993. 1993 Consultation on the groundfish research program of DFO Scotia-Fundy Science. DFO Atlantic Fisheries Res. Doc. 93/72 (p. 47).

Ocean Climate Summary

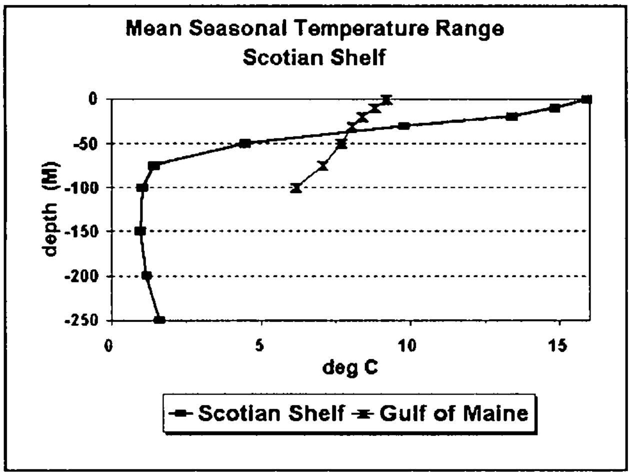
The physical oceanographic environment can affect fish distribution, catchability, recruitment, growth rates, and migration routes. Some fish species are found only within a specific temperature range and any change in temperature distribution may cause the fish to move. It is, therefore, important to monitor oceanographic conditions and to be able to describe how these conditions compare to the long-term mean or "normal" conditions. In this overview we focus upon the physical environmental conditions within the Scotia-Fundy Region, first providing a general description and then discussing the 1993 conditions including results from the groundfish survey cruises.

Mean Conditions

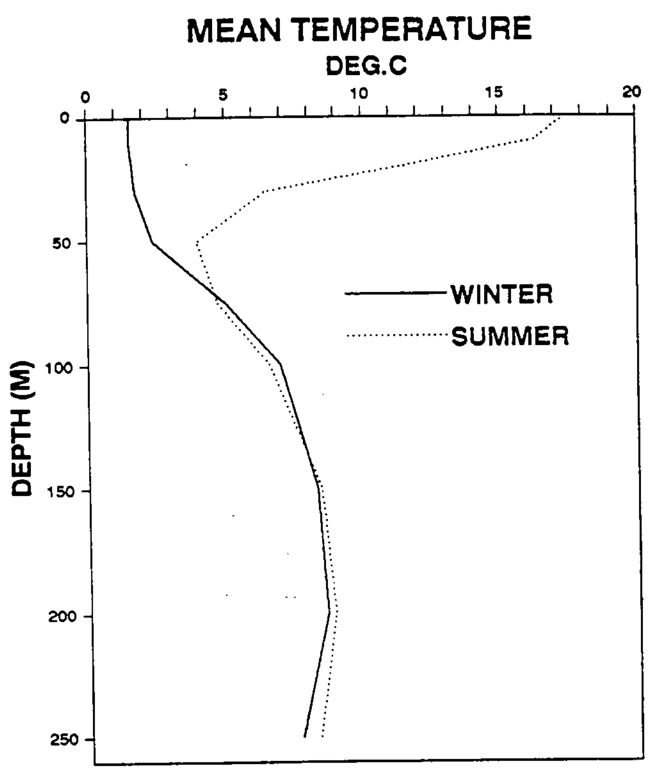
Temperature and salinity conditions within the Scotia-Fundy Region vary spatially due to complex bottom topography, advection from upstream sources (Gulf of St. Lawrence) and exchange with the offshore (Slope) waters. The water properties are also characterized by large seasonal cycles, depth differences and strong gradients both east-west and inshore-offshore. In general, temperatures and salinities tend to increase towards the west and offshore due to the greater influence of the warmer, more saline offshore waters and the reduced influence of the outflow from the Gulf of St. Lawrence.



The seasonal temperature range of the waters over the Scotian Shelf decreases with depth. At the surface, the range is of the order of 16°C but there is little or no seasonal change at depths below 150 to 200 m. The seasonal cycle in the shallow regions of the Gulf of Maine (4X, 5Z) shows much less change with depth due to vertical mixing by the strong tidal currents .

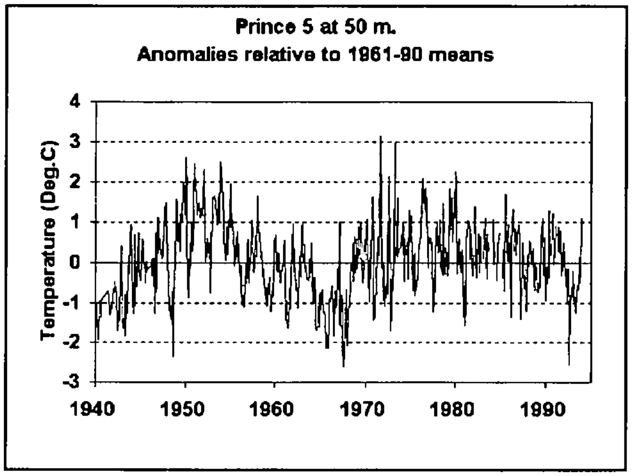


In the winter, the water column in the deep regions of the Scotian Shelf, such as Emerald Basin consists of two vertical layers. The upper layer contains relatively cold, low salinity waters and sits above a bottom layer of warm, salty water. These bottom waters originate from offshore and enter the shelf through the deep channels or gullies. In summer, there are three layers. Seasonal heating forms a thin (30-40 m) warm upper layer. The deeper, winter-cooled waters form a cold intermediate layer (CIL) and these are augmented by advection of similar waters from the Gulf of St. Lawrence. The warm bottom layer remains unchanged. In 4W, the shallow outer banks prevent the warm offshore waters from penetrating very far onto the shelf with the result that the cold waters extend to the bottom. Over most banks there is only one layer in winter and two in summer as their depths lay above the warm bottom layer. In shallow areas with strong tidal currents, there is only one layer even in summer, as water properties are vertically well-mixed.

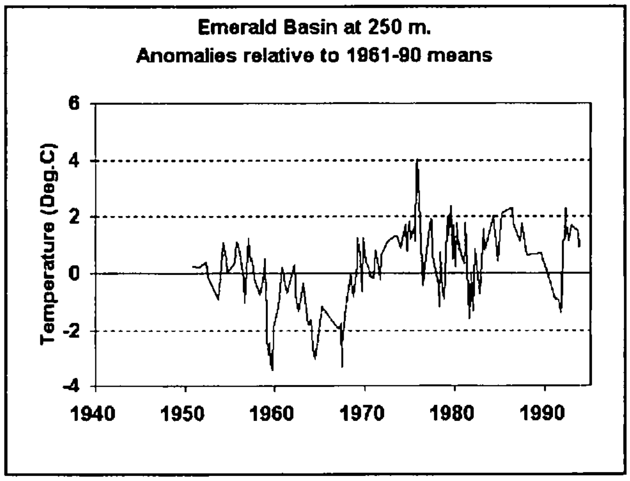


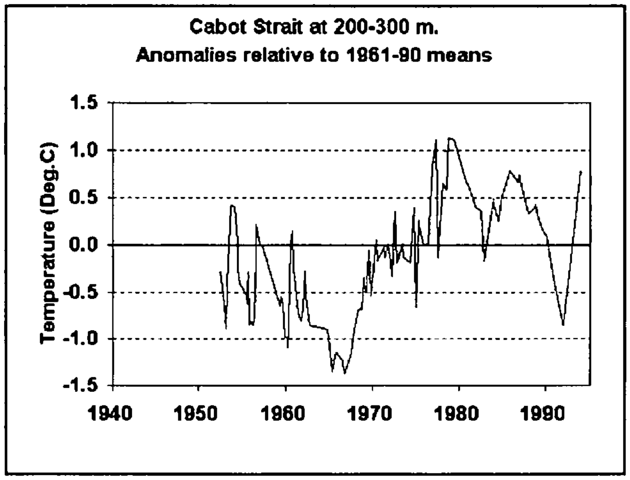
Long-Term Trends

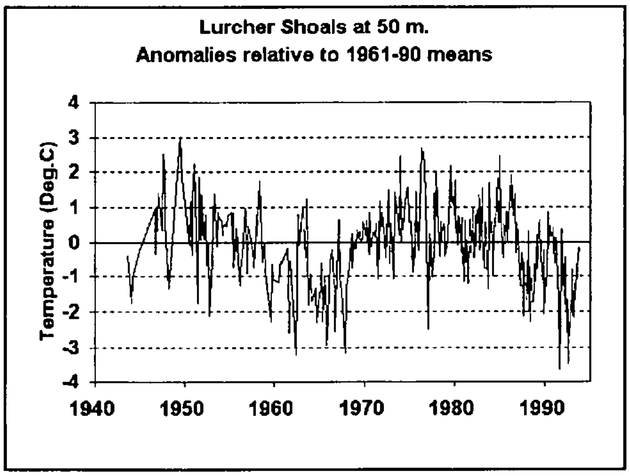
Long-term records of coastal sea surface temperature are available at Halifax and St. Andrews. The only long-term offshore monitoring station in the region is Prince 5, located at the mouth of the Bay of Fundy (4X). However, temperature time series have been reconstructed for other areas from data collected opportunistically.

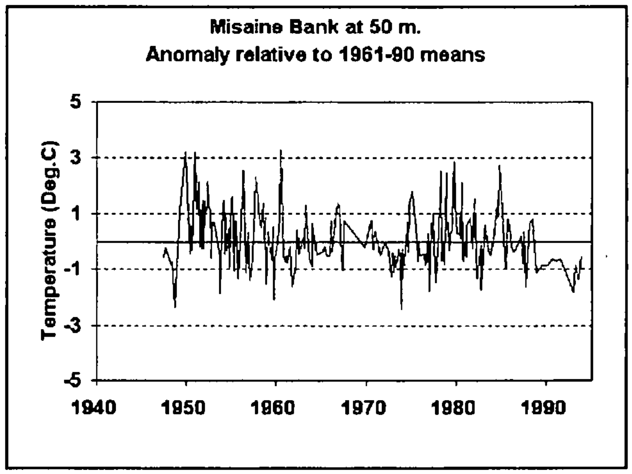


In general, temperatures throughout the water column declined during the 1950s to a minimum in the mid-1960s . Temperatures rose sharply in the late 1960s such that during the 1970s and the early 1980s they were warmer-than-normal. Since the mid-1980s, the mid-depth waters (50-100m) have cooled considerably reaching values near to or as low as those in the mid-1960s in many regions (Lurcher Shoals, Misaine Bank and eastern Georges Bank). In the deep basins and channels (Emerald Basin and Cabot Strait) the bottom water temperatures decreased in the early 1990s but, during the last two years, warmed rapidly and are now well-above normal. In the near surface layer, trends are less obvious with monthly means fluctuating about the long-term average. During recent years there has been a slight tendency towards cooler temperatures.


Emerald Basin at 250 m.
Anomalies relative to 1961-90 means
Temperature (Deg.C)
6
4
2
0
-2
-4
1940
1950
1960
1970
1980
1990


Cabot Strait at 200-300 m.
Anomalies relative to 1961-90 means
Temperature (Deg.C)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1940
1950
1960
1970
1980
1990


Lurcher Shoals at 50 m.
Anomalies relative to 1961-90 means
Temperature (Deg.C)
4
3
2
1
0
-1
-2
-3
-4
1940
1950
1960
1970
1980
1990


Misaine Bank at 50 m.
Anomaly relative to 1961-90 means
Temperature (Deg.C)
5
3
1
-1
-3
-5
1940
1950
1960
1970
1980
1990

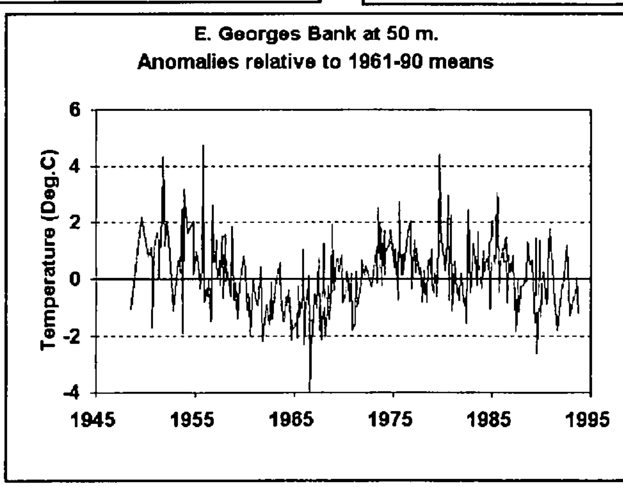

E. Georges Bank at 50 m.
Anomalies relative to 1961-90 means
Temperature (Deg.C)
6
4
2
0
-2
-4
1945
1955
1965
1975
1985
1995

Table 1. Summary of temperatures by depth for representative areas within each of the NAFO divisions subdivisions in the Scotia-Fundy Region. For each area the first line gives the mean temperature, the second line indicates whether 1993 was colder (-) or warmer (+) than normal (N). The third line indicates whether temperature in 1993 increased (I) or decreased (D) or were steady (S) compared with 1992. The comparison with 1992 is based on few data points and may not indicate changes in trends.

Area		Depth			
		0 m	50 m	100 m	200 m
4Vn (Sydney Bight)	Mean	6.5	1.8	1.4	4.4*
	1993 vs. mean	-	-	-	+
	1993 vs. 1992	S	S	D	I
4Vs (Banquereau)	Mean	7.5	2.7	2.8	
	1993 vs mean	Weak -	-	-	
	1993 vs. 1992	I	S	D	
4W (Emerald Basin)	Mean	8.5	4.0	6.5	8.6
	1993 vs. mean	Weak -	-	-	+
	1993 vs. 1992	S	D	S	I
4X (Roseway Basin)	Mean	7.9	4.6	4.7	
	1993 vs. mean	Weak -	-	-	
	1993 vs. 1992	S	S	I	
5Z (eastern Georges Bank)	Mean	9.4	7.6	7.1	7.8**
	1993 vs. mean	N	-	+	+
	1993 vs. 1992	S	D	I	I

* = Data from southern edge of Laurentian Channel.
** = Data from Georges Basin.

Conditions During Research Vessel Surveys

The trends in near-bottom temperatures and salinities obtained during research vessel bottom-trawl surveys are unique to each strata. Temperatures in some strata have been increasing in recent years whereas those in other strata have been declining. These differences are due in part to differences in the bottom depths within each strata since temperature trends vary with depth.

The aggregate trends for stock areas, for example 4X and 4VsW, indicate that near-bottom temperature conditions have been relatively stable in the western Scotian Shelf area. In the eastern shelf area, the temperatures declined during the late 1980s and early 1990s, but in 1992 and 1993 they have been increasing so they are now near the long-term means. This warming is also indicated in the 1993 surveys by the lower number of sampling stations at which water temperatures were less than zero degrees.

The near-bottom temperatures observed during the spring surveys in 5Z increased from 1986 to 1991 and decreased from 1991 to 1993. The apparent trend is generated by changes in the timing of the surveys and is not indicative of any climate trend.

During the summer 4VWX research vessel surveys, the long-term trend in temperatures within the Bay of Fundy and off southwestern Nova Scotia and at approximately 100 m over the Scotian Shelf have decreased throughout the 1980s. This trend is evident within most of the shallow survey strata (42, 47, 48, 56, 58, 63, 73, 74, 75, 80) with the exception that in 1993 temperatures increased relative to 1992, in several of the strata (47, 48, 56, 58, 74, 80). In the shallow strata within the Bay of Fundy (90, 93-95) the cooling occurred only during the 1987-92 period. In many of the deep strata (40, 46, 61, 71, 78, 82, 83, 84) temperatures have been relatively stable since 1980 and as such are consistent with the long-term trends in the deep basins over the shelf. Unlike the deep basins, the temperatures in strata along the shelf edge near the Scotian Gulf (53, 66) have been increasing throughout the survey period.

Implications for Interpretation of Survey Trends

Although the amplitude of interannual variation in temperatures and salinities is of the order 1°C and 0.1%, these can potentially be sufficient to cause changes in finfish distribution and hence estimates of abundance as well as an overlap in species distributions, which in turn, influences by-catch characteristics and fishing practices. Some finfish species are known to associate with distinct ranges of environmental conditions. For example, haddock are seldom found below 2°C and yellowtail are generally found within a narrow depth range. Preliminary analyses suggest that changes in the distribution and abundance of some species, for example haddock, and in the species composition within areas covaries with changes in temperatures and salinities.

In general, the temperatures and salinities at which cod and haddock were captured in the research surveys have changed throughout the time series of available survey data, and preliminary analyses suggest changes in the survey estimate of abundance of cod and haddock on the eastern Scotian Shelf may be associated with (although not uniquely related to) trends in the strata-specific temperature and salinity. In 5Z preliminary analyses of the survey estimates of abundance and deviations of these from SPA estimates (the residuals from ADAPT runs) does not indicate a relationship between survey timing and indices of abundance. Ongoing research is aimed at better identifying and quantifying the impacts of the hydrography on the changes in distribution and estimated abundance, and the impact on stock status estimates.

Conditions in 1993

During 1993, the atmospheric circulation patterns produced stronger-than-normal northwesterly winds over much of eastern Canada in the winter which, in turn, advected cold air masses into the region. However, at the coast in the Scotia-Fundy Region, the average temperatures for the year were less than 0.5°C cooler than the long-term mean which represents a slight warming relative to last year. However, at Sable Island, the annual mean air temperature was warmer-than-normal by 0.2°C.

The relatively cold winter of 1993 lead to severe ice conditions in the Gulf of St. Lawrence with earlier ice formation, longer duration, greater areal extent and later retreat than usual. Ice flowed out of the Gulf onto the Scotian Shelf and extended southwestward along the coast of Nova Scotia during late February and early March. The southward extent (beyond Halifax) exceeded the long-term (1962-87) maximum whereas the offshore extent on the eastern Scotian Shelf at this time was shoreward of its long-term maximum.

Ocean temperature anomalies in 1993 varied with location and depth. In the tidally well-mixed waters in the Bay of Fundy and on Lurcher Shoals the waters were colder-than-normal down to depths of 100 m. The surface waters over the Scotian Shelf were also generally cooler than normal. The cold intermediate layer (50 to 100 m depth), which has been relatively cold in recent years, has warmed slightly suggesting that conditions are moderating.

In contrast, waters in the deep basins, such as Emerald and Georges, and in the channels and gullies, such as Laurentian and Northeast channels, were warmer-than-normal. In the Laurentian Channel and in Emerald Basin, temperatures rose for the second year from very cold values observed in 1991. The source of these deep waters is the offshore Slope region which in 1993 appears to be warmer-than-normal. This may be related to the observed northward shift in the position of the boundary between the shelf and Slope waters known as the Shelf/Slope frontal boundary. A strong Gulf Stream eddy was observed in the vicinity of the mouth of the Northeast Channel from June to October. This may have lead to significant exchange of water between the shelf and the slope region. The trends in temperatures at different depths and areas are summarized in Table 1.

Sydney Bight Cod

* The TAC has not been taken since 1989.

* Fixed gear landings from the resident stock have declined steadily since the mid-80s.

* Mobile gear landings maintained their catch in recent years due to a shift in fishing pattern to target the southern Gulf of St. Lawrence cod migrating into 4Vn during November and December.

* The results of the 1993 autumn "test fishery" in 4Vn supported the interpretation that a large proportion of the November catch was comprised of fish migrating from the southern Gulf.

* The age span in the landings is reduced, with 63% of the landings coming from the 1986 and 1987 year-classes.

* Weight-at-age and length-at-age continue their downward trend of the past decade.

* Catch rates for tonnage class 2 longliners has decreased since 1989.

* Although the summer research vessel survey has not been a precise indicator of stock abundance, it has qualitatively identified the relative strength of year-classes. There has been no sign of good recruitment in the surveys since the 1987 year-class. The results of recently initiated juvenile surveys are consistent with this conclusion.

* Although an analytical assessment has not been carried out for this management unit, the indicators from the fishery show that the stock is at a very low level of abundance with no signs of increase in the short-term.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t[2]	6.1	6.2	7.5	7.5	7.5-10	<10	-	-	-	-	-
Advised catch '000t[2]	6.0	6.0	7.5	7.5	7.5-10	<10	1.8	0	0[3]	7.5[3]	15.0[3]
TAC '000t[2]	9.0	7.5	7.5	7.5	10	10	1.8	0	1.8[3]	7.5[3]	14.0[3]
Reported landings '000t[2]	10.5	9.0	7.6	5.2	4.6[4]	4.5[4]	0.7[4]		0.7[1]	8.5[1]	12.6[1]
Reported landings '000t (M-O)	8.9	7.9	5.8	3.2	2.8[4]	2.3[4]	0.7[4]				
Unreported catches											
Estimated discards '000t											
Total catches '000t											
Total biomass '000t											
Spawning biomass '000t											
Mean - F											

[1] 1970-1993. [2] These refer to the May-December period and therefore include landings of 4T cod made during November-December.
[3] 1978-1994. [4] Preliminary statistics.

Catches: Catches continue to decrease, particularly in the fixed gear sector which has been unable to catch its allocation in the past four years.

Data and Assessment: Limited catch rate information and research survey data are available for this stock. The assessment was based on this information as well as qualitative observations made by industry.

Fishing Mortality: Likely above $F_{0.1}$ prior to 1993.

Recruitment: The 1987, and to a lesser extent 1986, year-classes form the bulk of this population. Little or no recruitment is indicated since 1987.

Environmental Factors: Water temperatures in the upper 100-150m have been below normal in recent years and this may have had an effect on recruitment. Temperatures in deep water of the Laurentian Channel have increased sharply over the last two years to warmer than normal.

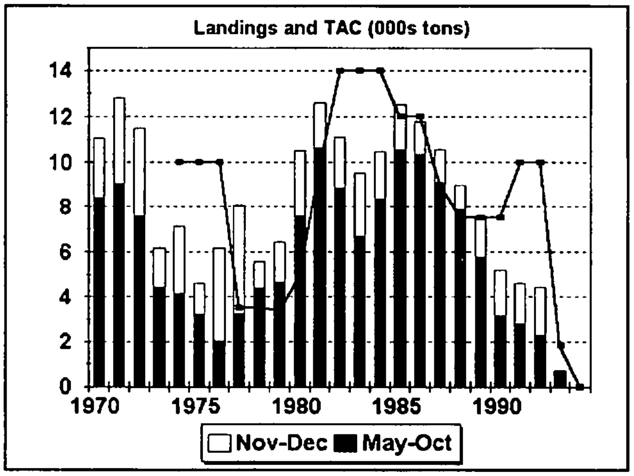
Multispecies Considerations: Sydney Bight is a migratory area for grey seals, a known predator of cod.

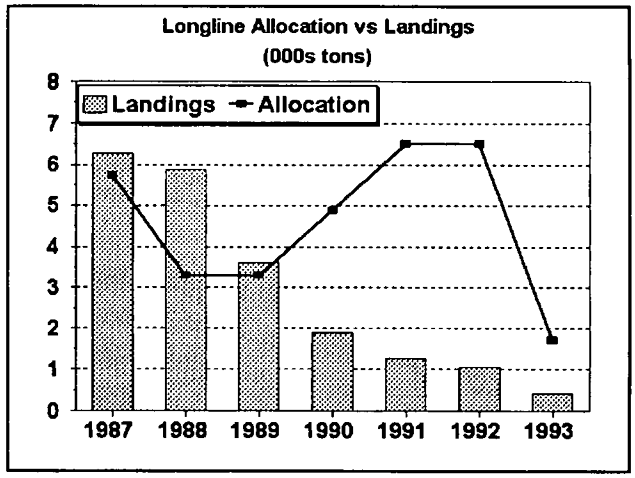
State of the Stock: The stock is probably at least as low as it was in the mid-1970s, if not lower and there are fewer age groups present now than at that time.

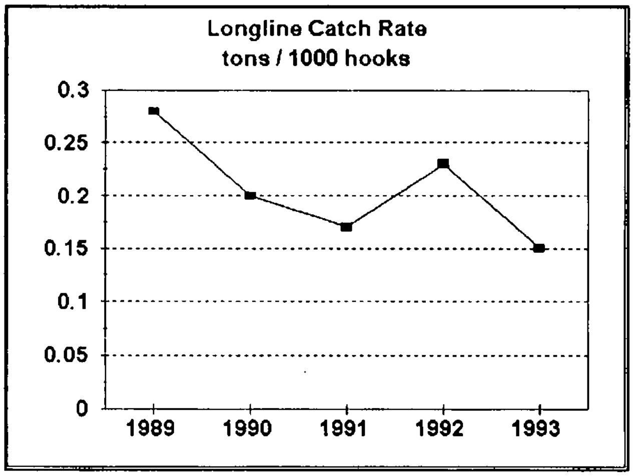
Forecast for 1995: The stock is at a low level of abundance with no signs of increase in the short-term.

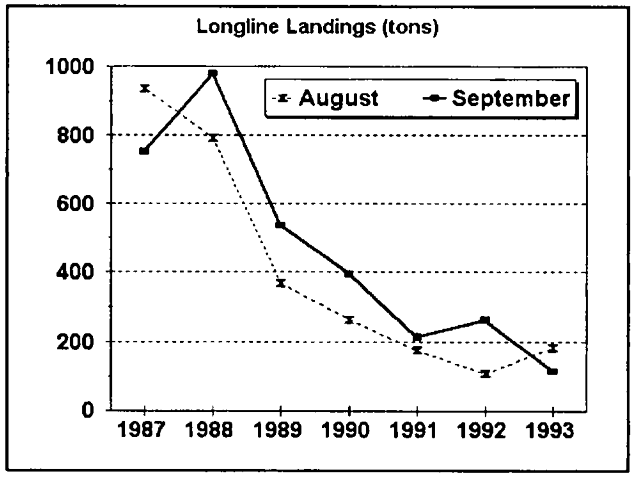
Long-term Prospects: The stock's future depends on new recruitment. The 1987 year-class needs to be protected in order to sustain the spawning stock biomass and increase the chances of future good recruitment.

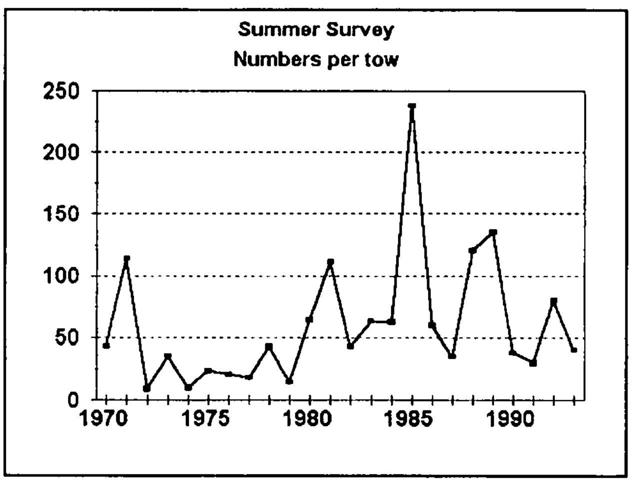
Special Comment: 4Vn is an area of mixing between 4T, resident, and 4VsW cod stocks. The dynamics of the mixing are not well defined and, given the lack of quantitative estimates of this, continue to preclude an SPA based assessment of the local stock.

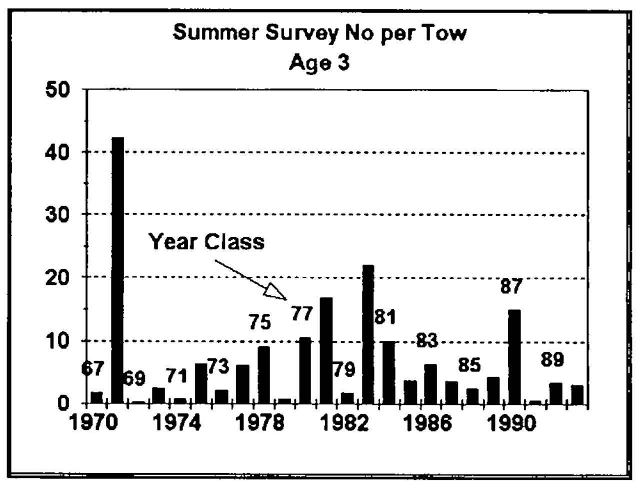

Landings and TAC (000s tons)
0
2
4
6
8
10
12
14
1970
1975
1980
1985
1990
Nov-Dec
May-Oct

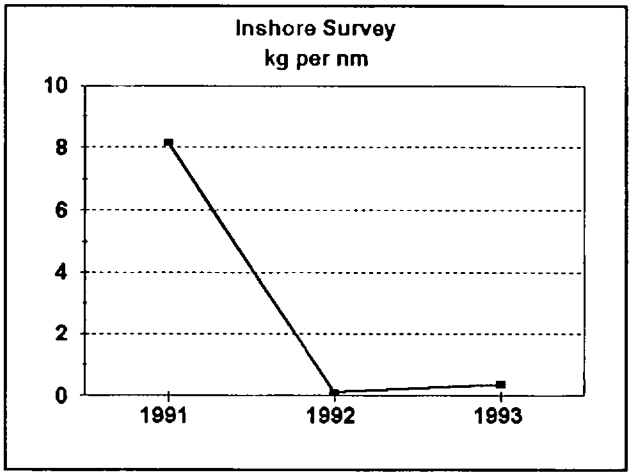

Longline Allocation vs Landings
(000s tons)
Landings
Allocation
0
1
2
3
4
5
6
7
8
1987
1988
1989
1990
1991
1992
1993


Longline Catch Rate
tons / 1000 hooks
0
0.05
0.1
0.15
0.2
0.25
0.3
1989
1990
1991
1992
1993


Longline Landings (tons)
August
September
0
200
400
600
800
1000
1987
1988
1989
1990
1991
1992
1993


Summer Survey
Numbers per tow
0
50
100
150
200
250
1970
1975
1980
1985
1990


Summer Survey No per Tow
Age 3
0
10
20
30
40
50
Year Class
67
69
71
73
75
77
79
81
83
85
87
89
1970
1974
1978
1982
1986
1990


Inshore Survey
kg per nm
10
8
6
4
2
0
1991
1992
1993

Eastern Scotian Shelf Cod

- Fixed-gear have not caught their allocation since the late 1980s. Mobile gear, however, caught their allocation until 1991 in part due to the changes in fishing pattern that targeted on southern Gulf of St. Lawrence fish overwintering in 4Vs.

- The management unit was closed in September 1993 with estimated landings of 3,500t.

- Since the early 1980s, weights at age have decreased.

- Due to the inconsistencies between mobile gear catch rate time series from Observers and commercial catch effort data sets, this information was not used for SPA calibration but is used to indicate trends in fishable biomass. Both series show a decline in recent years. Interviews with fishermen indicate severely reduced stock abundance in recent years.

- The spring and summer research vessel surveys indicate very low fishable biomass in 1993/94, but the 1990 year-class which has not yet entered the fishery appears to be of average strength.

- A model of seal/cod interactions provides annual estimates of cod consumption by grey seals in the 4VsW area. The estimated biomass of cod consumed by grey seals was 17,300 t in 1993. Most of this predation was on cod aged 1 - 4 (i.e. pre-recruits to the fishery).

- Implication of seal predation on present and future cod population dynamics, and thus on projections of cod abundance trends, is highly dependent on assumptions concerning compensatory food-habit processes (both by other predators of juvenile cod and changes in seal feeding in response to shifting abundance levels of various components of the diet). There is presently no information available to test these assumptions.

- The analytical assessments for this management unit show a retrospective pattern using both the ADAPT and Laurec/Shepherd techniques. The size of the retrospective discrepancy has decreased in recent years.

- The analytical assessment (with and without seal predation) indicates that spawning stock biomass is currently at historically low levels (about 16,000t).

- Fishing mortality increased sharply in the early 1990s to well above Fmax (as high as 1.4 for ages 7 to 9 in 1992). With the September 1993 closure, and associated sharp reduction in fishing effort, fishing mortality declined to 0.28 (which is still above the $F_{0.1}$ target).

- The assumptions on natural mortality at younger ages, and the changing role of seal predation, influence the estimates of the historical year-class sizes. With seal predation included in the SPA, the recruitment time series is better correlated with some environmental data that had previously been good predictors of trends in year-class sizes (i.e., the freshwater run-off from the St. Lawrence River).

- The analytical assessment indicates that the 1990 year-class which is just entering the fishery is of average abundance. It is the strongest since the 1982 year-class and on par with that of 1987.

- Seal predation may be reducing the yield per recruit available to the commercial fishery by up to about 50% in recent years (again depending on assumptions concerning feeding compensatory processes).

- The severely reduced level of spawning stock size, and the indications of only moderate recruitment, imply that stock rebuilding will be slow even with the absence of a directed fishery.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t	38	32	33.2	34	21	-	11	3	11[2]	36[2]	64[2]
Advised catch '000t	38	32	33.2	35.2	35.2	35.2	11	0	7[2]	35[2]	64[2]
TAC '000t	44	38	35.2	35.2	35.2	35.2	11	0	11[3]	44[3]	61[3]
Reported landings '000t	45.5	38.4	36.8	34.3[1,4]	32.9[1,4]	29.8[1]	3.5[1]		10[5]	49[5]	80[5]
Estimated discards '000t											
Total catches '000t											
Total biomass '000t	136	111	103	90	76	65	47		47[2]	148[2]	243[2]
Spawning biomass '000t	84	70	50	33	19	19	16		16[2]	57[2]	102[2]
Mean - F (7-9)	0.54	0.67	0.56	1.31	0.74	1.37	0.28		0.23[2]	0.60[2]	1.37[2]

[1] provisional
[2] for 1979-1993
[3] for 1973-1993
[4] estimated 4T catches are not removed
[5] for 1960-1993

Catches: Nominal catches have been near the TAC in recent years, except 1993. Only 32% of the TAC in 1993 was landed due to resource scarcity and more restrictive management measures which included tighter controls on fish size and a closure in September .

Data and Assessment: Commercial catch and a summer survey series covering 1970-93, and a March survey from 1979 to 1993 were used to tune a SPA. Commercial catch rates from Statistics and the International Observer Program were compiled, but only used for comparison to the SPA results.

Fishing Mortality: Fishing mortality averaged over ages 7-9 has increased in recent years until 1992 and was well above either $F_{0.1}$ (= 0.22) or even F_{max} as estimated by twice $F_{0.1}$. The 1993 fishing mortality fell in 1993 to the lowest level in recent years.

Recruitment: Recruitment has been generally below average for almost a decade with only the 1987 and 1990 year-classes being of moderate strength.

Environmental Factors: Bottom temperatures have fallen in 4Vs since the mid-1980s, while those in 4W have been relatively stable. The decline in recruitment follows the 4V temperature pattern well, but a cause and effect relationship cannot be ascribed.

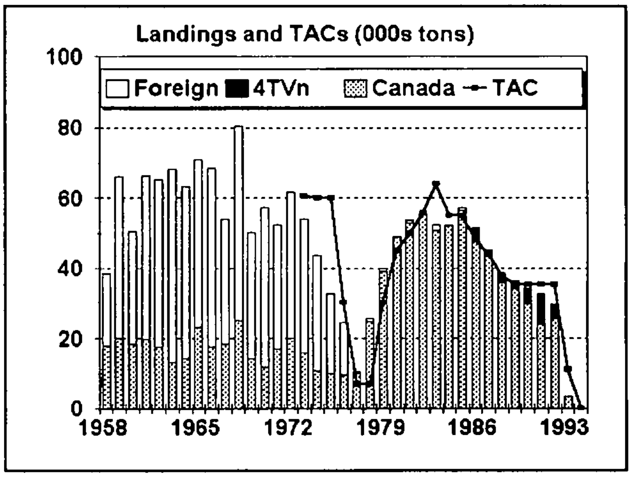
Multispecies Considerations: An analysis of seal populations and diet indicated that in 1993 grey seals consumed about 17,000t of 4VsW cod, most of which were pre-recruits.

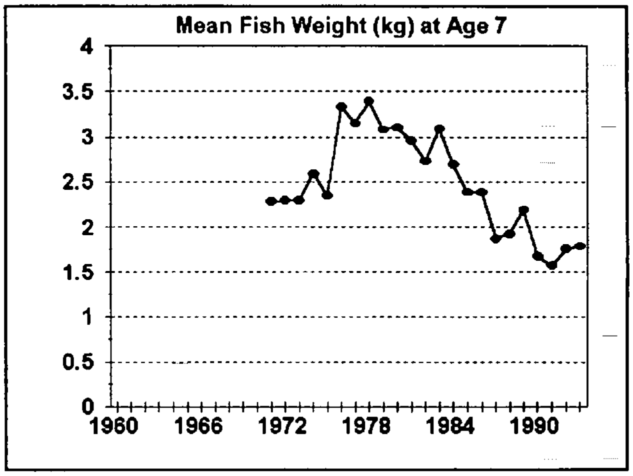
State of the Stock: The stock is at its lowest biomass seen since assessments were begun. The catch contains fewer older ages in recent years, mean weight at age is decreasing, and recent recruitment has been poor.

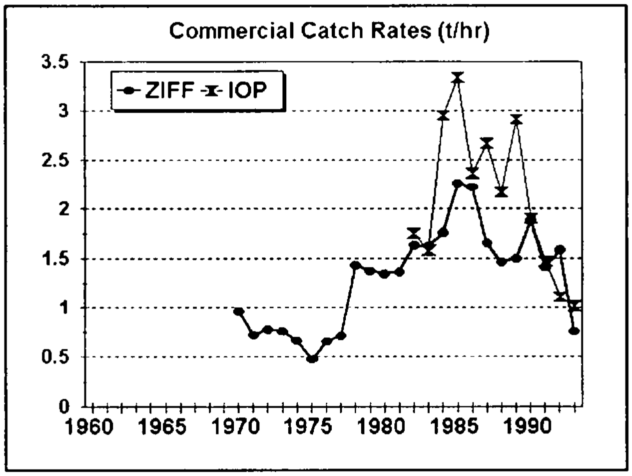
Forecast for 1995: The conjunction of overfishing, low recruitments, and to some extent, increasing seal population has placed this stock in jeopardy. A number of years of good recruitment will be required before the fishable and spawning stock biomass can support a fishery.

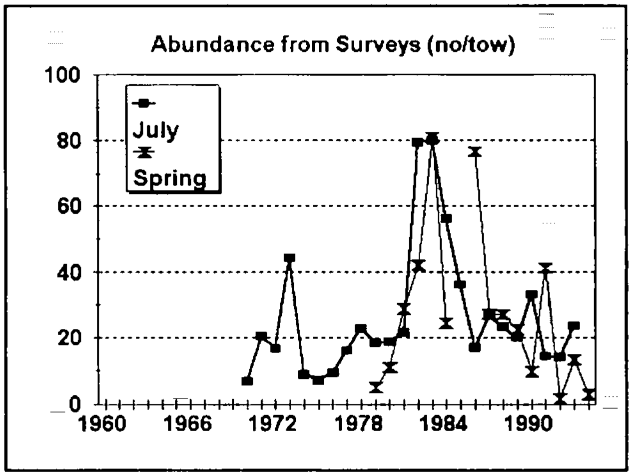
Long-term Prospects:

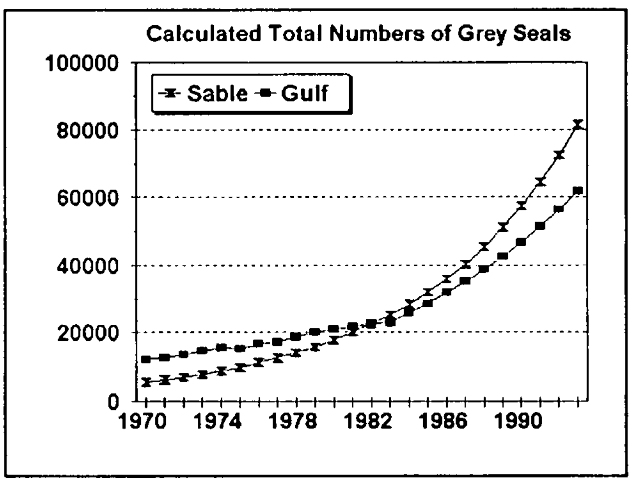
Special Comment:

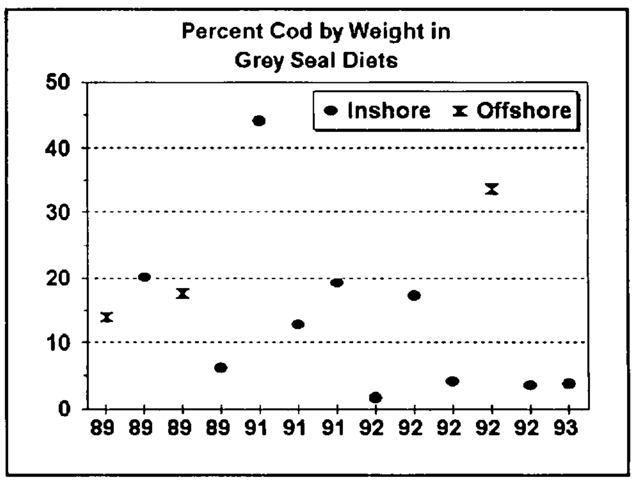

Landings and TACs (000s tons)
Foreign
4TVn
Canada
TAC
100
80
60
40
20
0
1958
1965
1972
1979
1986
1993


Mean Fish Weight (kg) at Age 7
4
3.5
3
2.5
2
1.5
1
0.5
0
1960
1966
1972
1978
1984
1990

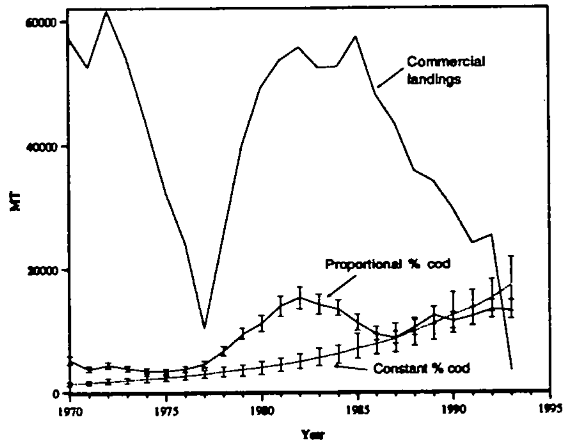

Commercial Catch Rates (t/hr)
ZIFF
IOP
3.5
3
2.5
2
1.5
1
0.5
0
1960
1965
1970
1975
1980
1985
1990

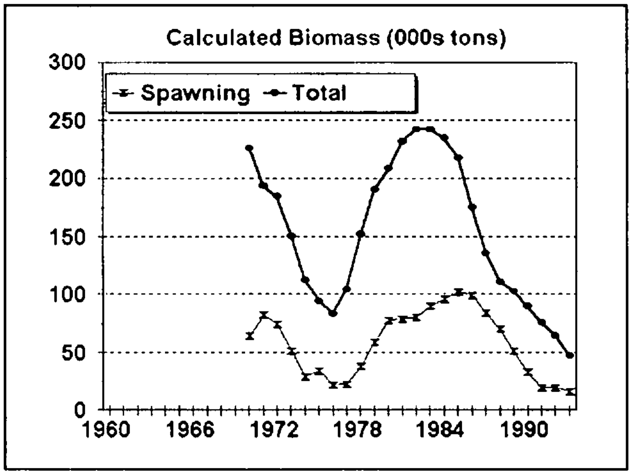

Abundance from Surveys (no/tow)
July
Spring
100
80
60
40
20
0
1960
1966
1972
1978
1984
1990

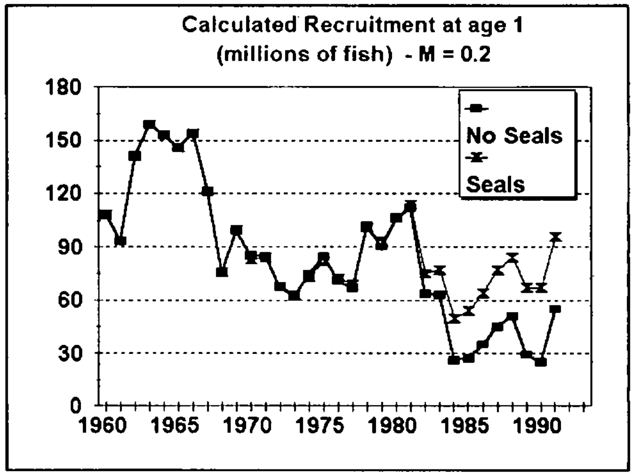

Calculated Total Numbers of Grey Seals
Sable
Gulf
100000
80000
60000
40000
20000
0
1970
1974
1978
1982
1986
1990

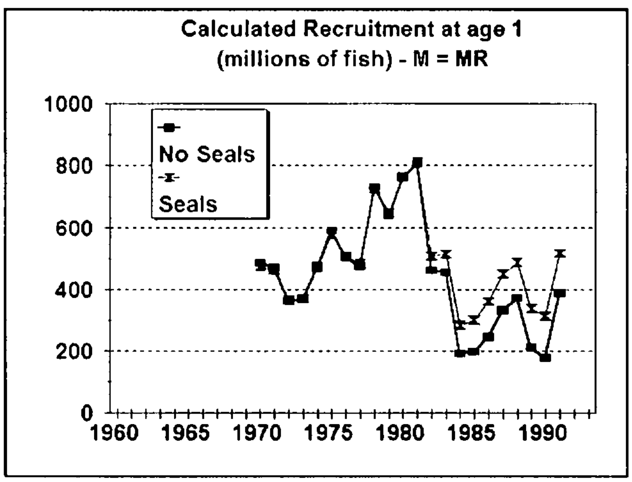

Percent Cod by Weight in
Grey Seal Diets
Inshore
Offshore
50
40
30
20
10
0
89 89 89 89 91 91 91 92 92 92 92 92 93

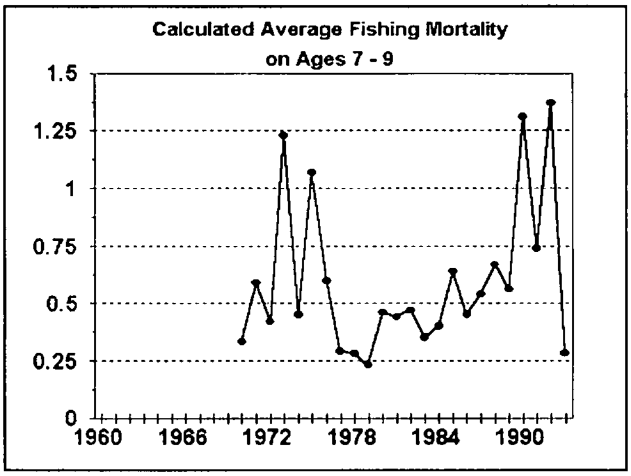
. Two models for extrapolating 4VsW cod consumption by seals with 95% error bars.
The commercial landings are shown for comparison.

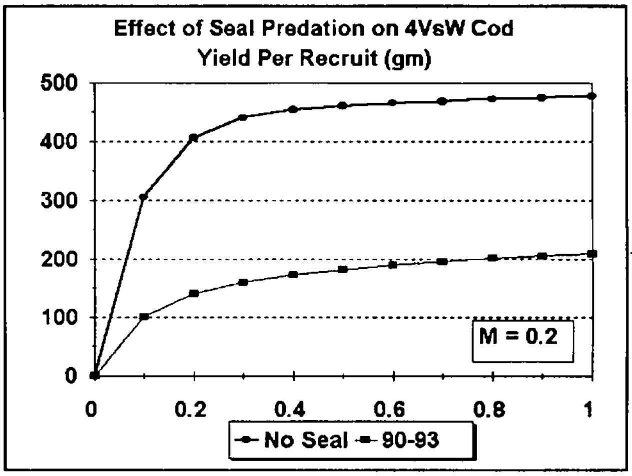


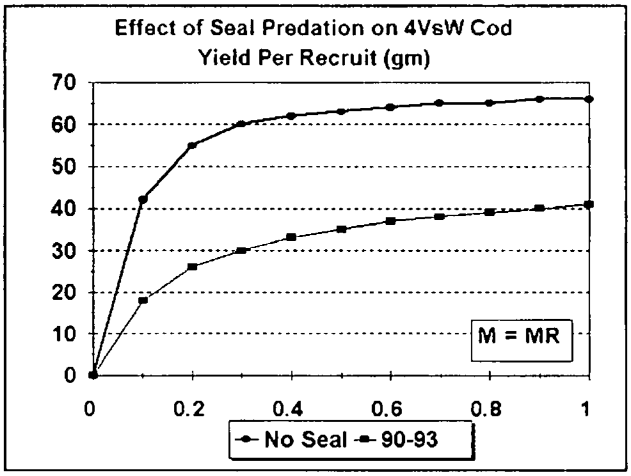







Calculated Average Fishing Mortality
on Ages 7 - 9
1.5
1.25
1
0.75
0.5
0.25
0
1960 1966 1972 1978 1984 1990


Effect of Seal Predation on 4VsW Cod
Yield Per Recruit (gm)
500
400
300
200
100
0
M = 0.2
0 0.2 0.4 0.6 0.8 1
No Seal 90-93


Effect of Seal Predation on 4VsW Cod
Yield Per Recruit (gm)
70
60
50
40
30
20
10
0
M = MR
0 0.2 0.4 0.6 0.8 1
No Seal 90-93

Southern Scotian Shelf and Bay of Fundy Cod

* Landings in 1993 of 16,000t are the lowest since 1969. The majority of the reduction has been in the eastern part of the management unit with landings from the Browns Bank and Bay of Fundy areas being more stable.

* The proportion of 3 year olds in the 1993 landings (i.e., the 1990 year-class) was higher than forecast, while fewer cod than expected were caught of the strong 1987 year-class.

* There has been no persistent temporal trend in mean weight at age 5.

* Commercial catch rates for tonnage class 2 and 3 otter trawlers and longliners indicate a declining trend since 1990. The rate of decline, however, is influenced by changes in fishing practices induced by regulatory changes (ITQs and trip limits).

* The 1993 summer research vessel survey indicates a sharp decline in spawning stock biomass. Consistent with the geographic pattern in landings, the declines are more marked in the eastern part of the management unit. The surveys indicate that the 1988 year-class is very poor, with the 1989 and 1990 year-classes being about average.

* The assessment estimates that the cycles in spawning stock biomass are of progressively shorter periods, with an overall declining trend in spawning stock biomass with time. The 1994 beginning of year biomass has increased slightly from the historically low level of 1993. This increase is due to the growth in biomass of the moderate sized 1990 year-class which is entering the spawning stock.

* Fishing mortality has increased sharply since 1989, and has been well above twice $F_{0.1}$ from 1990 to 1993. While there was a moderate reduction in fishing mortality, analysis of catch and effort information indicates that the 1993 reduction in quota did not result in a significant reduction in fishing effort in 4X.

* The assessment indicates that the frequency of good year-classes has declined in the 1980s compared to those estimated for the 1970s. The 1990 year-class which is presently supporting the fishery is of moderate size.

* If the TAC of 13,000t is taken in 1994, the fishing mortality on older ages (5+) will be about 0.6.

* The yield for 1995 at $F_{0.1}$ (0.2) would be about 6,300t. This assessment has been characterized by a retrospective pattern where successive estimates have been lower by about 25%. A catch of about 4,400t in 1995 would more closely approximate the $F_{0.1}$ catch that would be calculated in retrospect if the pattern persists.

* Spawning stock biomass in 1993 is the lowest recorded, and other than the moderate sized 1990 year-class, indications of recruitment are poor. A lower exploitation rate would prolong the contribution of the 1990 year-class to the fishery over the coming years and promote rebuilding of spawning biomass.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference level '000t	13	9	8.2	9	NA/ND	NA/ND	8.2[2]	7			
Advised catch '000t	13	9	8	12	20	26					
TAC '000t	17.5	14	12.5	22	26	26	15[2]	13			
Reported landings '000t	19	20	20	24	28[3]	26[3]	16[3]		12.2	21.2	35.5
Unreported catches											
Estimated discards '000t											
Total catches '000t											
Total biomass '000t	62	71	71	75	70	59	54	57	54	79	113
Spawning biomass '000t	42	51	53	64	55	42	36	39	36	60	95
Mean - F (4+)	0.63	0.68	0.45	0.62	0.77	1.05	0.86	0.6	0.27	0.50	1.05

[1] 1948-1992. [2] Revised in September. [3] Preliminary statistics

Catches: The 1993 landings declined to 16,000t with most of the decrease occurring in the Scotian Shelf area while smaller decreases were observed in the Bay of Fundy area. Catches have been irregularly cyclical with peaks occurring in 1968, 1982 and 1991.

Data and Assessment: The assessment of the status of the stock was based on calibration of SPA with Canadian summer research survey abundance indices using ADAPT. Survey results showed a marked decline, particularly at older ages, for Division 4X as a whole, however the abundance in the Bay of Fundy area was more stable.

Fishing Mortality: Fishing mortality has generally fluctuated around 0.5 but increased rapidly since 1989 to about 1.0 in 1992 and decreased somewhat in 1993.

Recruitment: The 1985 and 1987 year-classes were the strongest since 1970 and sustained the recent high catches. The 1990 year-class is estimated to be about average and there are no indications of subsequent good recruitment.

Environmental Factors: Water temperatures in the upper 100m declined through the 1980s whereas the deep waters of the eastern Gulf of Maine have remained warm since 1970. Bottom temperatures within the shallow bank strata on the Scotian Shelf reflect the cooling trend.

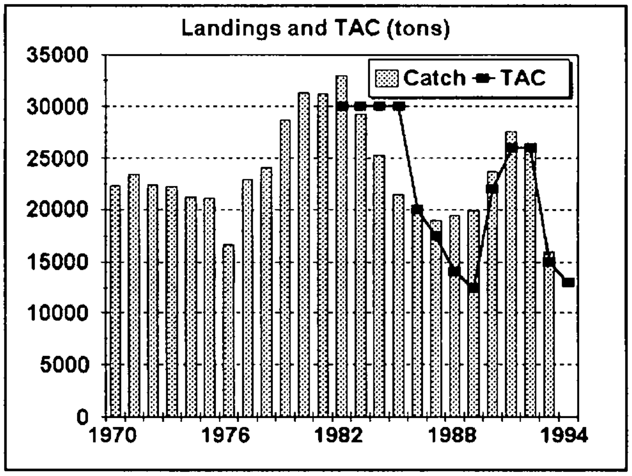
Multispecies Considerations: The distribution of herring, a common prey species, has displayed some unusual patterns in 1993, in that herring did not spawn in the traditional areas off southwest Nova Scotia.

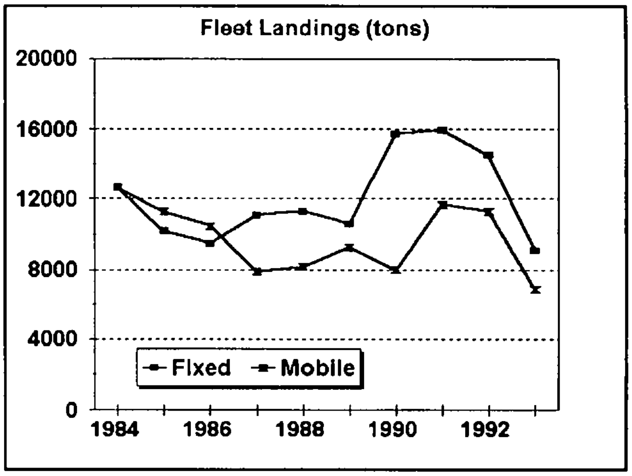
State of the Stock: The stock has decreased to its lowest abundance but the decline appears to have been arrested by the recruitment of the 1990 year-class which is estimated to be of average strength.

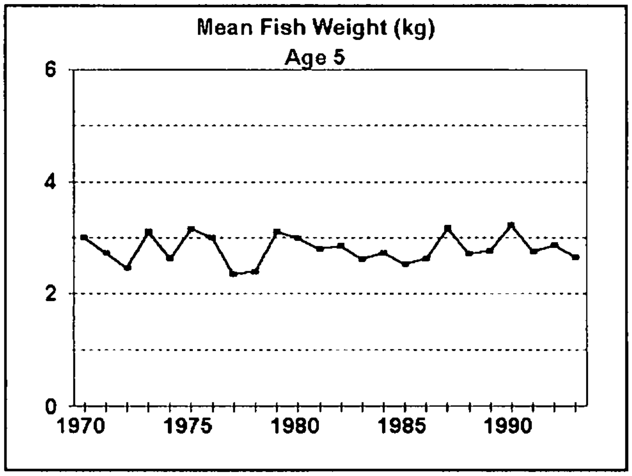
Forecast for 1995: The TAC of 13,000t in 1994 will result in a fully recruited fishing mortality of about 0.6, exceeding twice $F_{0.1}$. The yield for 1995 at $F_{0.1}$ would be about 6,300t. This stock assessment has displayed a retrospective pattern where successive estimates have been lower by about 25%. A catch of about 4,400t in 1995 would more closely approximate the $F_{0.1}$ catch that would be calculated in retrospect if the same pattern persists.

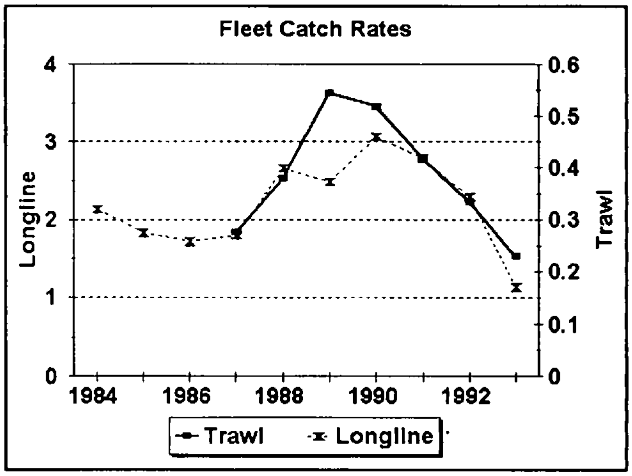
Long-term Prospects: The stock has shown irregular cyclical fluctuations in population abundance but the peaks have been getting progressively smaller and more peaked reflecting a contraction in the age span and an increased reliance on recruitment. Greater stability and dampening of natural fluctuations requires a lower exploitation rate and rebuilding of the adult stock biomass.

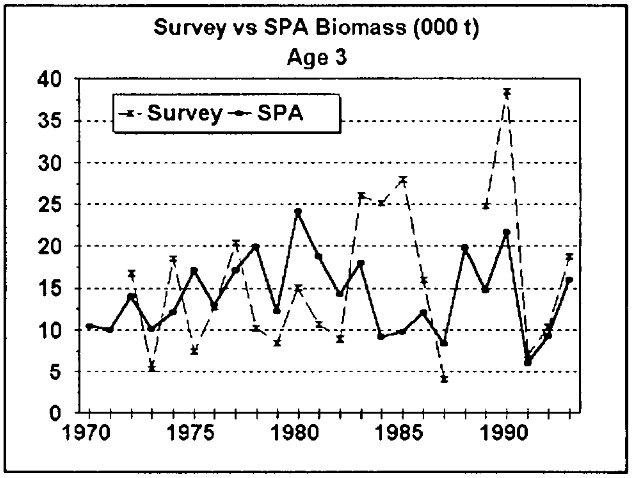
Special Comment:

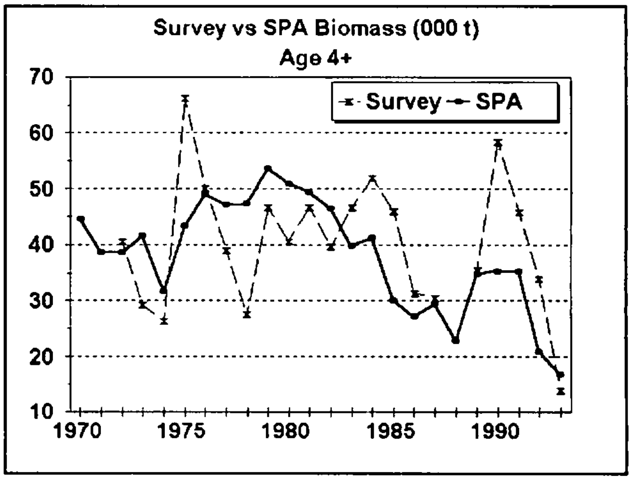

Landings and TAC (tons)
Catch
TAC
35000
30000
25000
20000
15000
10000
5000
0
1970
1976
1982
1988
1994

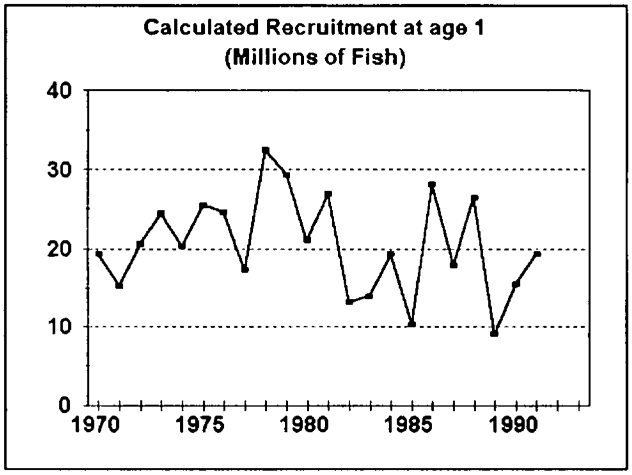

Fleet Landings (tons)
20000
16000
12000
8000
4000
0
Fixed
Mobile
1984
1986
1988
1990
1992

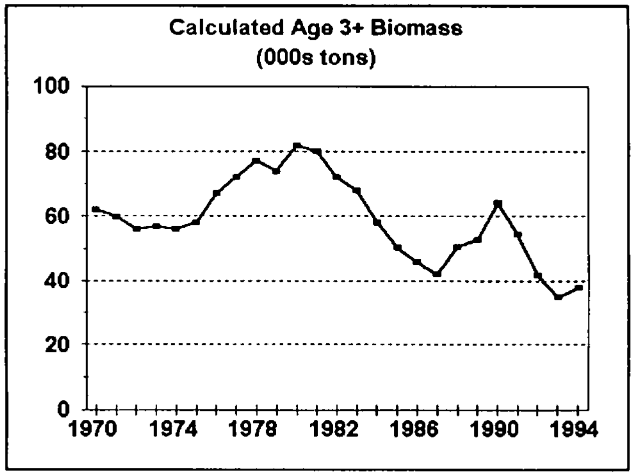

Mean Fish Weight (kg)
Age 5
6
4
2
0
1970
1975
1980
1985
1990

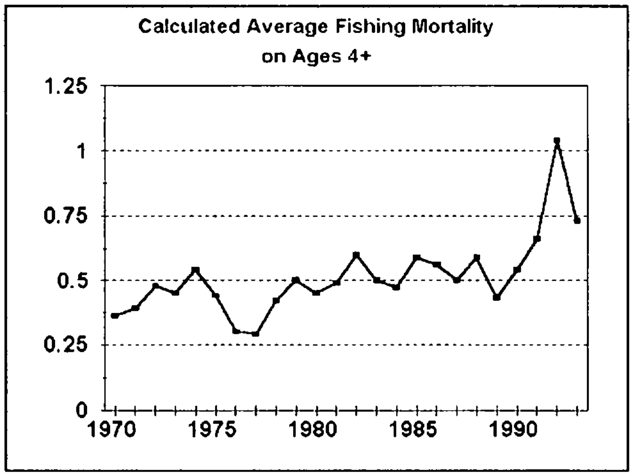

Fleet Catch Rates
Longline
Trawl
4
3
2
1
0
0.6
0.5
0.4
0.3
0.2
0.1
0
1984
1986
1988
1990
1992
Trawl
Longline

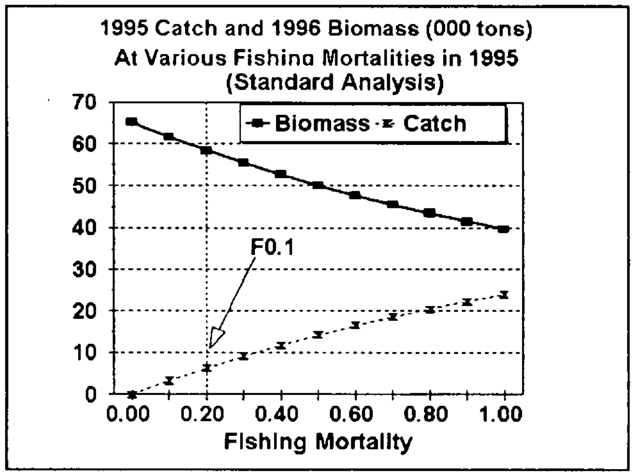

Survey vs SPA Biomass (000 t)
Age 3
Survey
SPA
40
35
30
25
20
15
10
5
0
1970
1975
1980
1985
1990

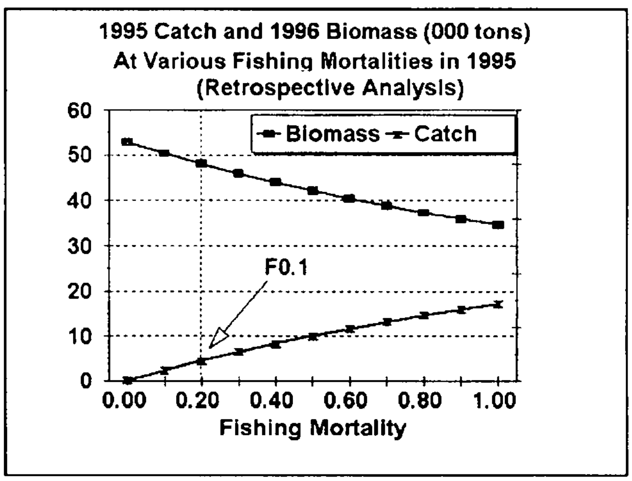

Survey vs SPA Biomass (000 t)
Age 4+
Survey
SPA
70
60
50
40
30
20
10
1970
1975
1980
1985
1990


Calculated Recruitment at age 1
(Millions of Fish)
40
30
20
10
0
1970
1975
1980
1985
1990


Calculated Age 3+ Biomass
(000s tons)
100
80
60
40
20
0
1970
1974
1978
1982
1986
1990
1994


Calculated Average Fishing Mortality
on Ages 4+
1.25
1
0.75
0.5
0.25
0
1970
1975
1980
1985
1990


1995 Catch and 1996 Biomass (000 tons)
At Various Fishing Mortalities in 1995
(Standard Analysis)
Biomass
Catch
F0.1
70
60
50
40
30
20
10
0
0.00
0.20
0.40
0.60
0.80
1.00
Fishing Mortality


1995 Catch and 1996 Biomass (000 tons)
At Various Fishing Mortalities in 1995
(Retrospective Analysis)
Biomass
Catch
F0.1
60
50
40
30
20
10
0
0.00
0.20
0.40
0.60
0.80
1.00
Fishing Mortality

Georges Bank Cod

- This management unit is transboundary. The combined USA and Canadian 1993 landings of 13,000t are below the long term average. The Canadian landings in 1993 were 8,519t, well below the allocation of 15,000t. Based on an analysis of logbook information, the number of fishing trips to Georges Bank by both the mobile and fixed gear components (less than 65ft) has not declined in recent years.

- The Canadian portion of the Georges Bank management unit has been closed to fishing for the first 5 months of 1994. The 1994 Canadian allocation is 6,000t.

- On average, about 80% of the fishable biomass in the spring and 90% in the fall is located in the Canadian portion of the management unit.

- Landings in 1993 were dominated by the 1990 year-class which made up 43% (by number) of the reported landings.

- Commercial catch rates for tonnage class 2 and 3 otter trawlers and longliners have been declining sharply in recent years. Some of the rate of decline may be due to changes in fishing practices induced by regulatory changes (mesh size, ITQs, trip limits).

- The three research vessel surveys (USA spring and fall, Canadian spring) show similar trends in the 1978 to 1994 time period with the 1993/94 observations at historically low levels. The last strong year-class (1987) has been depleted. The 1990 year-class is estimated to be of moderate size, but subsequent year-classes are below average.

- The SPA-based assessment indicates that the spawning stock biomass is declining extremely rapidly in the 1990s, presently at the lowest level estimated.

- Age 3+ fishing mortalities increased sharply since 1989 and have been well above twice $F_{0.1}$ during 1990-1993. Although ITQs are intended to reduce capacity, there has been only a slight decline in fishing mortality since 1990.

- The assessment estimates that the 1990 year-class is of average size and that subsequent recruitment has been below average.

- With a Canadian allocation of 6,000t, and expected total landings of 7,500t in 1994, the $F_{0.1}$ (0.2) catch in 1995 would be 1,836t. Restricting the 1994 total landings to the $F_{0.1}$ level of 2,616t, would increase the 1995 $F_{0.1}$ catch to 2,767t. This stock does not suffer from a restrospective pattern.

- This resource is being exploited at exceptionally high levels and recruitment in the short-term will be below average. Urgent measures to protect the spawning stock are required.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference level '000t	12.5	9.9	8	8	11-22	15-22	4	3	-	-	-
Advised catch '000t											
TAC '000t	12.5[2]	12.5[2]	8[2]	-	15[3]	15[3]	15[3]	6[3]			
Reported landings '000t	17	21	14	21	20[4]	17[4]	13[4]	-	12	17	26
Unreported catches											
Estimated discards'000t											
Total catches '000t											
Total biomass '000t	51	53	50	51	49	38	26	17	16	47	61
Spawning biomass '000t	26	39	33	43	33	22	21	15	14	33	41
Mean - F (3+)	.44	.53	.36	.51	.75	.69	.64		.34	.52	.76

[1] for 1978-1993
[2] Canadian allocation
[3] Canadian quota in the new management unit
[4] preliminary statistics

Catches: Landings in 1993 were the lowest since 1978 for the USA, and Canadian landings were the second lowest, next to 1989. The total 1993 landings were 12,538t, the second lowest since 1978. Canadian landings account for about 65% of the total.

Data and Assessment: The 1993 and 1994 Canadian research surveys show a continuing decline. USA spring surveys also show a decline. The USA autumn survey estimate increased slightly in 1992, but is the lowest in the series in 1993. Canadian commercial catch rates show a substantial decline since 1987.

Fishing Mortality: Exploitation rates were above twice $F_{0.1}$ during 1978-1990 and about four times $F_{0.1}$ in 1991. Age 3+ fishing mortality decreased to 3 times $F_{0.1}$ in 1992 and 1993 (0.69 and 0.64, respectively).

Recruitment: Estimates of the 1991 and 1992 year-classes based on research vessel surveys are below average and the 1993 year-class is the lowest observed.

Environmental Factors: Water temperatures in recent years have generally been colder than normal at depths less than 75m. At deeper depths, conditions appear to be warmer than the long-term average.

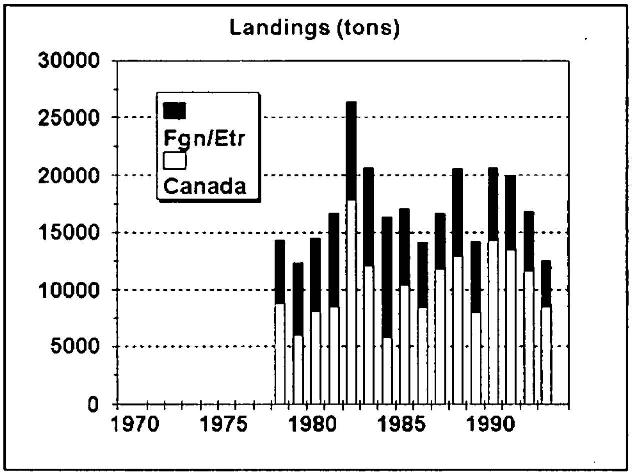
Multispecies Considerations: Available prey species for cod have changed in recent years with the increase in herring abundance and decrease in sand lance abundance.

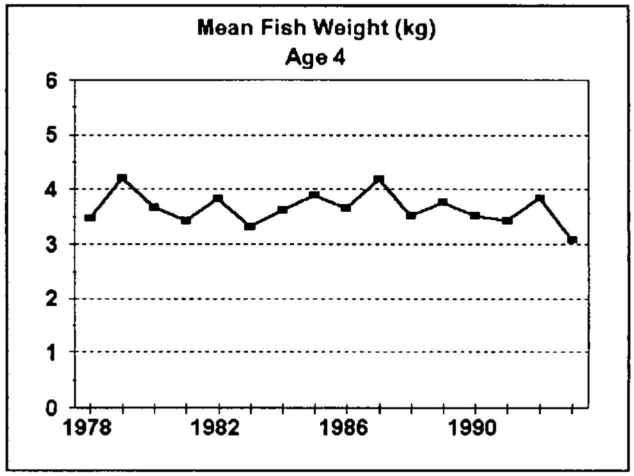
State of the Stock: Total and spawning (3+) biomasses are the lowest observed in the time series which begins in 1978. At about 15,000t in 1994, the 3+ biomass is less than 50% of the long-term average and almost equal to recent landings.

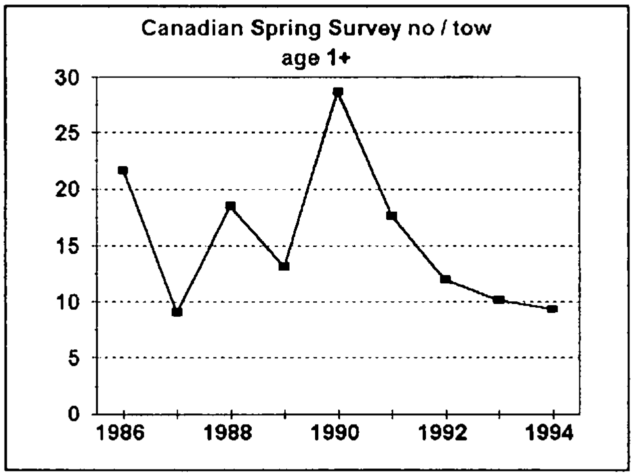
Forecast for 1995: All indications are that this stock has declined substantially since 1990 and that further reductions are expected if fishing continues at the present level. The indications are that the 1991-93 year-classes are well below average abundance and a catch equal to that of recent years will result in a very high exploitation rate of the 1990 year-class (over four times the $F_{0.1}$ reference). This year-class will have to support both the 1994 and 1995 fisheries. $F_{0.1}$ catches in 1994 and 1995 would be around 2,700t. This stock does not suffer from a restrospective pattern.

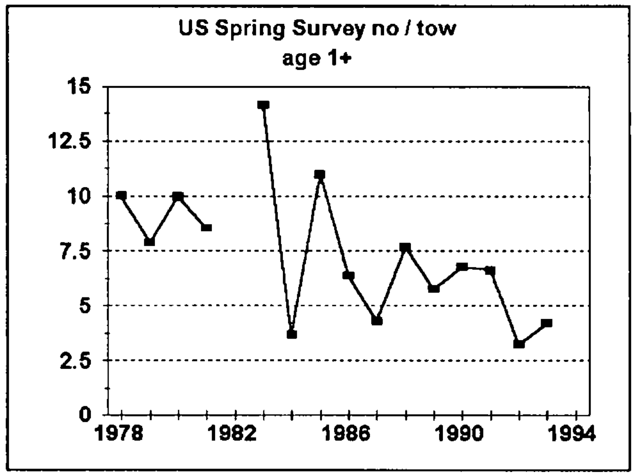
Long-term Prospects: Sustained stock rebuilding will require consistent management by the USA and Canada. Because of the rapid growth rate of this cod stock, if good recruitment occurs and exploitation is reduced, the biomass could increase rapidly. An immediate and substantial reduction in exploitation is required if the decline in stock biomass is to be slowed or reversed.

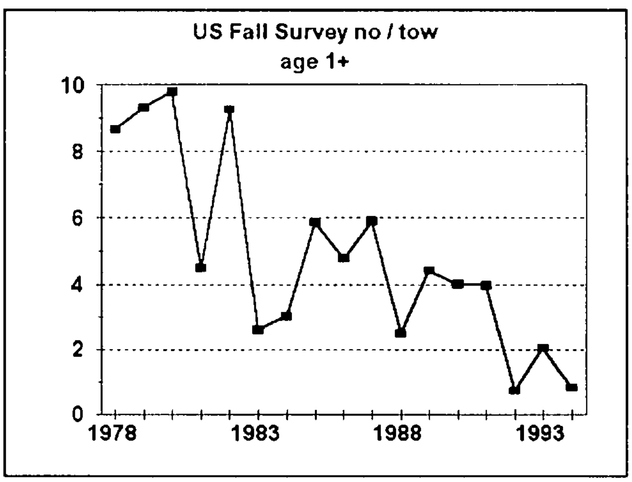
Special Comment:

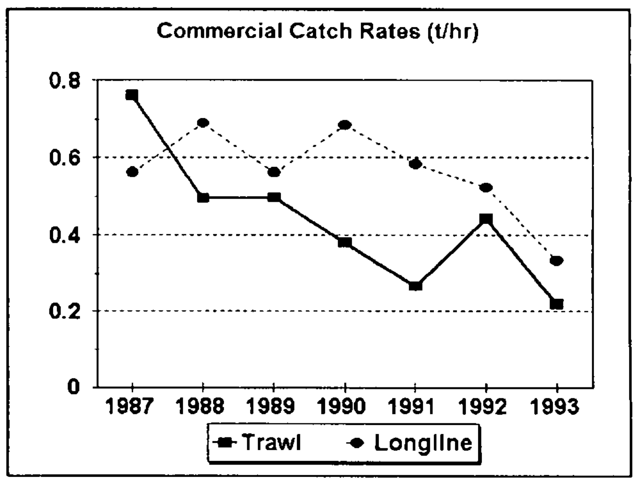

Landings (tons)
30000
25000
20000
15000
10000
5000
0
Fgn/Etr
Canada
1970
1975
1980
1985
1990

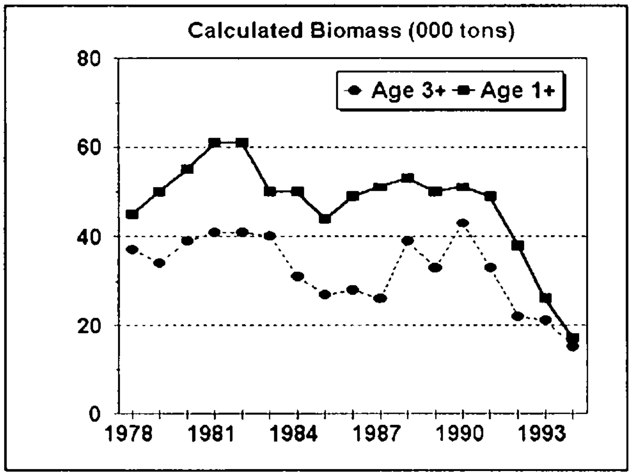

Mean Fish Weight (kg)
Age 4
6
5
4
3
2
1
0
1978
1982
1986
1990

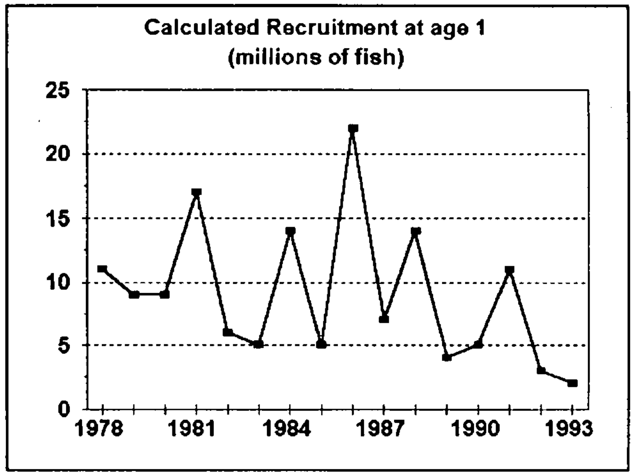

Canadian Spring Survey no / tow
age 1+
30
25
20
15
10
5
0
1986
1988
1990
1992
1994

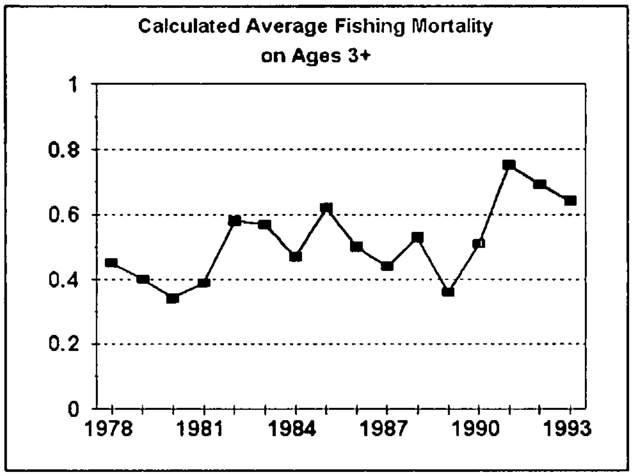

US Spring Survey no / tow
age 1+
15
12.5
10
7.5
5
2.5
0
1978
1982
1986
1990
1994

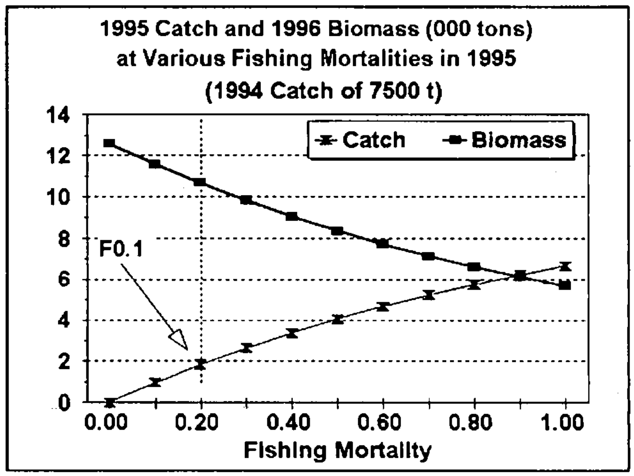

US Fall Survey no / tow
age 1+
10
8
6
4
2
0
1978
1983
1988
1993

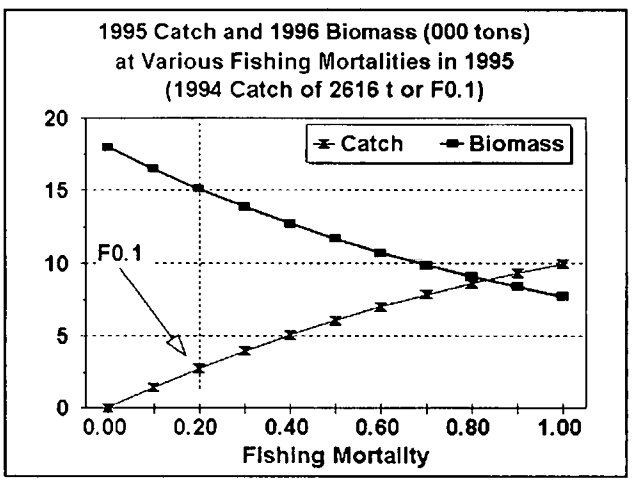

Commercial Catch Rates (t/hr)
0.8
0.6
0.4
0.2
0
1987
1988
1989
1990
1991
1992
1993
Trawl
Longline


Calculated Biomass (000 tons)
Age 3+
Age 1+
80
60
40
20
0
1978
1981
1984
1987
1990
1993


Calculated Recruitment at age 1
(millions of fish)
25
20
15
10
5
0
1978
1981
1984
1987
1990
1993


Calculated Average Fishing Mortality
on Ages 3+
1
0.8
0.6
0.4
0.2
0
1978
1981
1984
1987
1990
1993


1995 Catch and 1996 Biomass (000 tons)
at Various Fishing Mortalities in 1995
(1994 Catch of 7500 t)
Catch
Biomass
F0.1
14
12
10
8
6
4
2
0
0.00
0.20
0.40
0.60
0.80
1.00
Fishing Mortality


1995 Catch and 1996 Biomass (000 tons)
at Various Fishing Mortalities in 1995
(1994 Catch of 2616 t or F0.1)
Catch
Biomass
F0.1
20
15
10
5
0
0.00
0.20
0.40
0.60
0.80
1.00
Fishing Mortality

Eastern Scotian Shelf Haddock

* During 1987-1992, there was a directed fixed gear fishery within the Emerald/Western Bank closed area (to mobile gear). The landings of haddock by other gear sectors were taken as by-catch in other groundfish fisheries. The closed area was expanded to all gear sectors in 1993. The landings in 1993 were 1,300t, the lowest recorded. The majority of the recent landings are from 4V and 4W, with negligible catches in 4T and 4Vn since 1989.

* The age composition of the landings has not been derived in recent years due to problems with accurate readings of the otoliths. The catches-at-length for 1993 (peak at 42.5 cm) were well below the long-term average (peak at 46.5 cm).

* Interviews with members of the Fishermen Scientist Research Society indicate that commercial catch rates have declined considerably in recent years.

* The spring and summer research vessel surveys show that the present geographic distribution of mature fish is more restricted (principally in 4W) compared to earlier time periods. The estimates of spawning stock biomass are at very low levels (comparable to the early 1970s).

* The survey results indicate that the relatively strong 1988 year-class may have either anomalously slow growth since 1992, or extremely high mortality.

* There is some evidence that the 1992 and 1993 year-classes are of above average abundance and are broadly distributed.

* The spawning biomass is very low, concentrated almost entirely in 4W, and is comprised predominantly of the 1988 year-class. Given the severely reduced spawning stock size, the closed area within 4W should be continued and new measures should be taken to protect juveniles in 4V.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t	5.1	4.5	6.7	6	-[2]	-[2]	4-6				
Advised catch '000t	5.1	0	6.7	6	0	0	0	0			
TAC '000t	-[2]	-[2]	6.7	6	-[2]	-[2]	-[2]		0.0[1]	2.0[1]	23.0[1]
Reported landings '000t	3.9	4.5	9.1	7	5.4[4]	6[4]	1.3[4]		1.3[1]	11.5[1]	55.5[1]
Unreported catches									-		
Estimated discards '000t									-		
Total catches '000t											
Survey #/Tow	30.9	56.2	41.6	42.4	63	28.6	27.7		3.3	34.3	85.5
Survey spawning biomass[3] '000t	19.0	26.4	20.6	15.8	18.6	7.9	7.9		2.2	16.0	30.6
Mean - F											

[1] 1954-1993 . [2] By-catch only. [3] Assuming knife-edged maturity at 43.0 cm. [4]Preliminary statistics.

Catches: Landings averaged 26,500t per year during 1950-1969. The average during 1970-1979 was 5,000t. From 1980-1987 landings ranged from 8,000-20,000t. Since 1987, landings have come from by-catches and restricted fisheries. The 1993 total was about 1,300t.

Data and Assessment: Results of the summer research vessel survey in 1993 show little difference in overall abundance from 1992; however, the spring 1994 survey shows an increase since 1992. The bulk of the stock is concentrated in 4W with abundance in Subdivision 4V presently negligible.

Fishing Mortality: Total mortality is believed to have been high in recent years, but to have decreased in 1993.

Recruitment: The July 1993 survey showed above average catch rates of the 1993 and 1992 year-classes. The March 1994 survey also showed slightly above average catch rates for the 1993 year-class, but not for the 1992 year-class.

Environmental Factors: Bottom water temperatures in large portions of the stock area (4V) have been cold for haddock in recent years. These may have reduced growth rates, caused additional mortality, or migration. By restricting the distribution of the stock, these low temperatures may be resulting in increased fishing mortality by increasing haddock availability, and therefore increasing fishing efficiency.

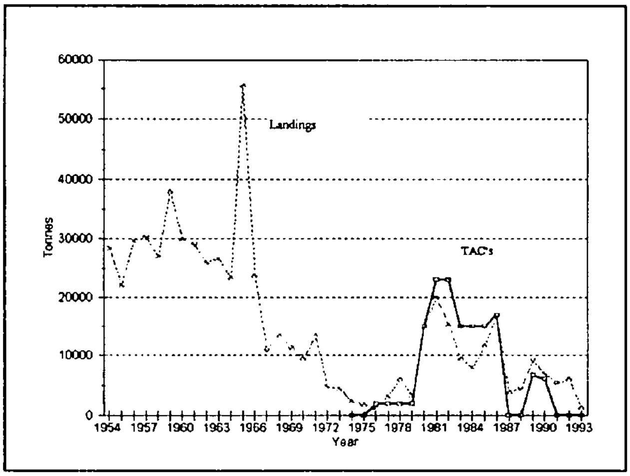
Multispecies Considerations: Grey seal diet analysis show that haddock are not eaten in significant quantities. Haddock continue to be one of the most frequently caught fish during surveys although in amounts below the long-term average.

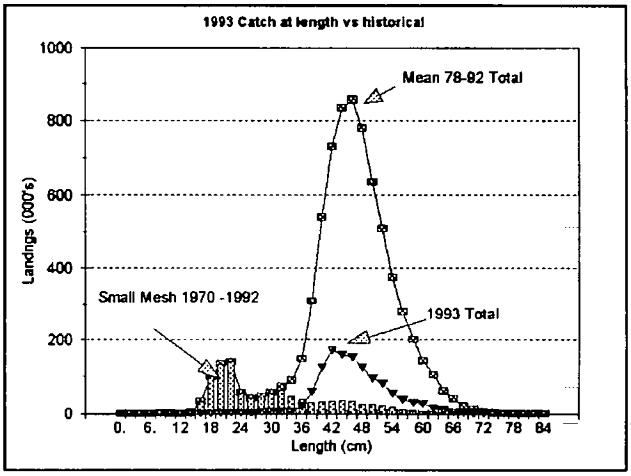
State of the Stock: This stock remains at low abundance with the 1988 year-class probably making up the bulk of the biomass of this resource. There is some indication of the 1993 year-class being of above average abundance.

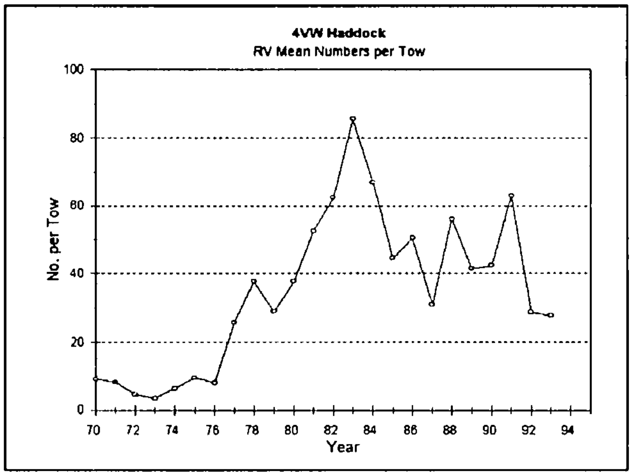
Forecast for 1995: The 1992 and 1993 year-classes should be protected to allow biomass to increase.

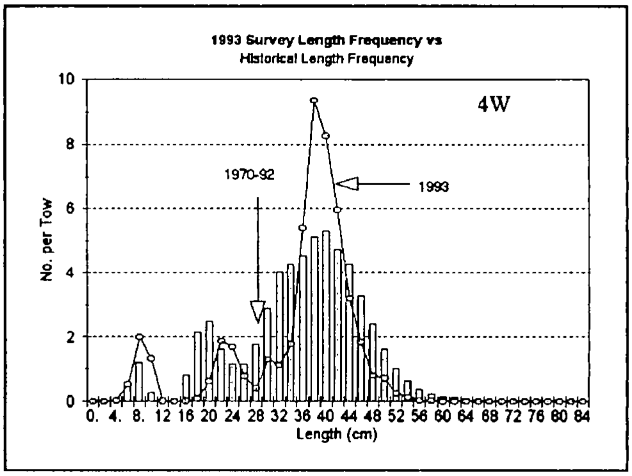
Long-term Prospects: The stock size is lower than those which produced average catches of 25,000t or more per annum in the 1950-1969 period. It is presently not possible to predict whether the stock can rebuild to these levels. The reduction in exploitation as observed in 1993 should allow for more growth of the 1988 year-class and an increased probability of larger future year-classes.

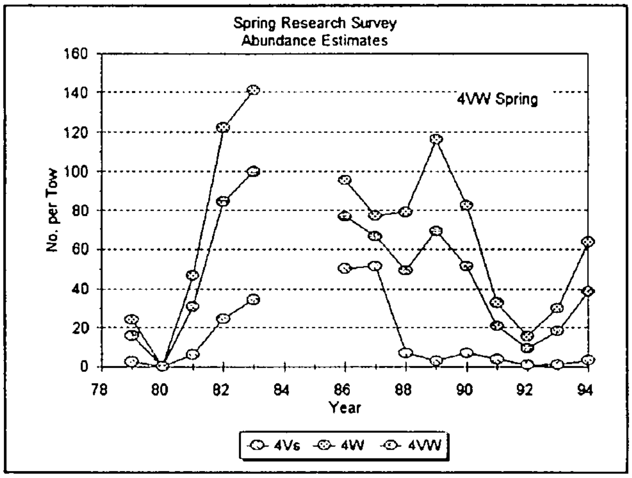
Special Comment: The redefinition of the small mesh gear box should result in a reduced haddock by-catch in the foreign fishery.

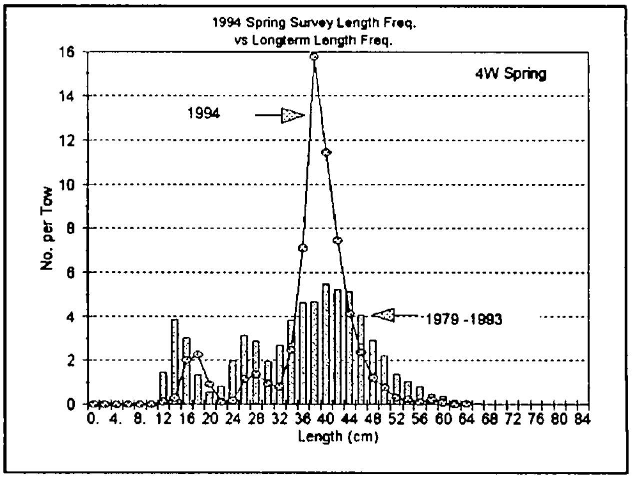

Landings
TAC's
Tonnes
Year

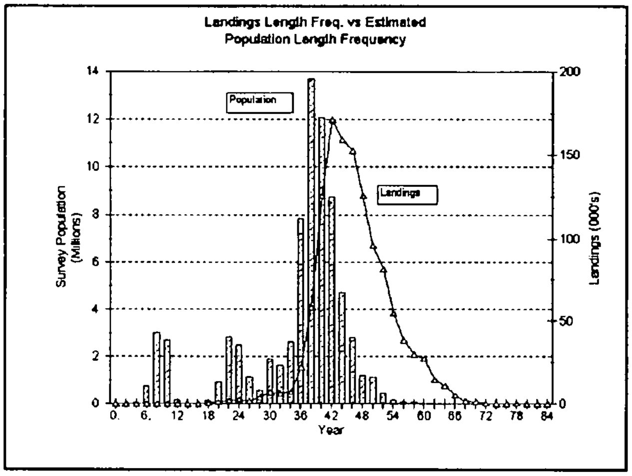

1993 Catch at length vs historical
Mean 78-92 Total
Small Mesh 1970 -1992
1993 Total
Landings (000's)
Length (cm)

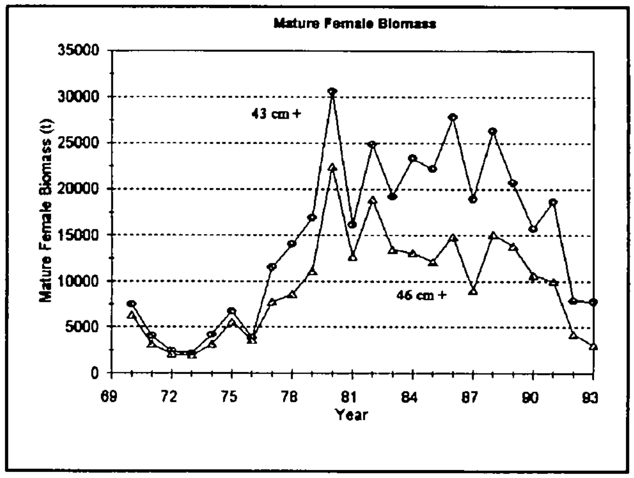

4VW Haddock
RV Mean Numbers per Tow
No. per Tow
Year


1993 Survey Length Frequency vs
Historical Length Frequency
4W
1970-92
1993
No. per Tow
Length (cm)


Spring Research Survey
Abundance Estimates
4VW Spring
No. per Tow
Year
4Vs 4W 4VW


1994 Spring Survey Length Freq.
vs Longterm Length Freq.
4W Spring
1994
1979 -1993
No. per Tow
Length (cm)


Landings Length Freq. vs Estimated
Population Length Frequency
Population
Landings
Survey Population (Millions)
Landings (000's)
Year


Mature Female Biomass
43 cm +
46 cm +
Mature Female Biomass (t)
Year

Southern Scotian Shelf and Bay of Fundy Haddock

* The 1993 landings of 6,800t are well below the long-term average of about 20,000t. Discarding of haddock was a problem in early 1994 due to an unrealistically low trip limit (200 pound/trip) for the longliners.

* Due to problems with accurate reading of the otoliths, the age composition of the landings has not been estimated in recent years. There has been an increase in the mean length in the landings of the mobile gear since the introduction of larger square mesh gear and ITQs. Over the same time period, however, there has been a decrease in the mean length in the fixed gear landings.

* The number of fishing trips by tonnage class 2 and 3 vessels in 4X has not declined in recent years (gradual increase for fixed gear, relative stability for mobile gear).

* Commercial longliner catch rates from the central part (Browns Bank) of 4X show slight increases during 1989-1993. Anecdotal information from interviews with fishermen indicate stable or increasing levels of fishable biomass.

* The summer research vessel survey indicates a gradual increase in spawning stock biomass from 1987 to 1991, with a subsequent decline to the lowest recorded estimate in 1993. Analysis of geographic patterns shows that the abundance in the Browns Bank area has been relatively stable until 1992. The recent decreases in abundance has been particularly marked in the eastern portion of 4X and the mouth of the Bay of Fundy. The trends in longliner commercial catch rates and research vessel survey fishable biomass estimates for the predominant fishing area are therefore consistent.

* The research surveys indicate that the 1992 year-class is either average or above average. This is consistent with the high proportion of the 1992 year-class seen in the foreign silver hake fishery.

* Given the very low overall estimates of spawning stock biomass within 4X as estimated from the research vessel surveys, as well as the weak 1989, 1990 and 1991 year-classes and the potentially abundant 1992 year-class, fishing effort should not be increased in 1995.

* Discussions are needed with the fishing industry in order to exchange information on the geographic patterns in commercial and research vessel survey catch rates. It may be that the apparent different viewpoints may be related to geographic differences in haddock abundance trends.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t	12.3			4.6			3				
Advised catch '000t	12.3	12.0	8.2	<4.6[2]	-[2,3]	-[2,3]	-	-			
TAC '000t	15	12.4	4.6	4.6	-	-	6	4.5			
Reported landings '000t	13.5	11	6.7	7.6	9.6[4]	10.3[4]	6.8[4]		6.7[1]	18.5[1]	35.9[1]
Unreported catches											
Estimated discards '000t											
Total catches '000t											
Total biomass '000t											
Female spawning biomass '000t	9.5	9.9	6.3	13.7	23.7	13.3	5.0				
Mean - F											

[1] 1948-1993
[2] lowest possible level
[3] by-catch only
[4] preliminary statistics

Catches: Long-term reported landings (1930-88) have averaged about 20,000t and exceeded 30,000t during the 1960s and early 1980s. Landings have been below the long-term average since 1984, reached a low of 6,700t in 1989, but then increased recently reaching 10,000t under a by-catch fishery. Landings decreased to 6,800t in 1993.

Data and Assessment: Commercial catch rates for longliners have increased in recent years. Survey indices of abundance are at the lowest level observed.

Fishing Mortality: Fishing mortality decreased from high levels in 1984 and has increased since 1989-90.

Recruitment: Recruitment has been average or below average since 1983. Survey results suggest the 1992 year-class may be of average abundance or above.

Environmental Factors: A trend of decreasing haddock abundance in the July research survey strata east of Browns Bank may be associated with a decreasing trend in mean bottom temperatures observed on LaHave, Roseway and Baccaro banks in recent years.

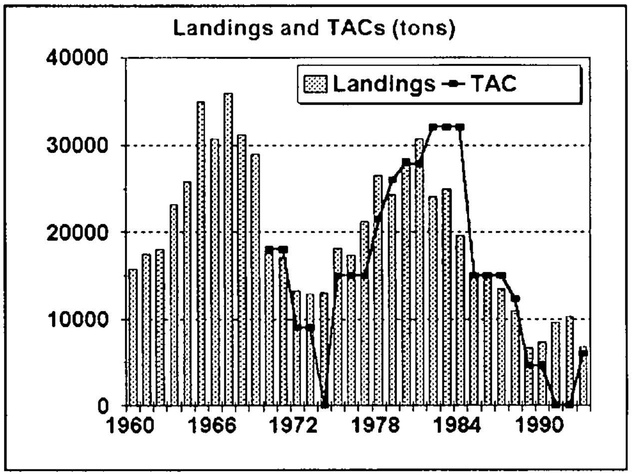
Multispecies Considerations:

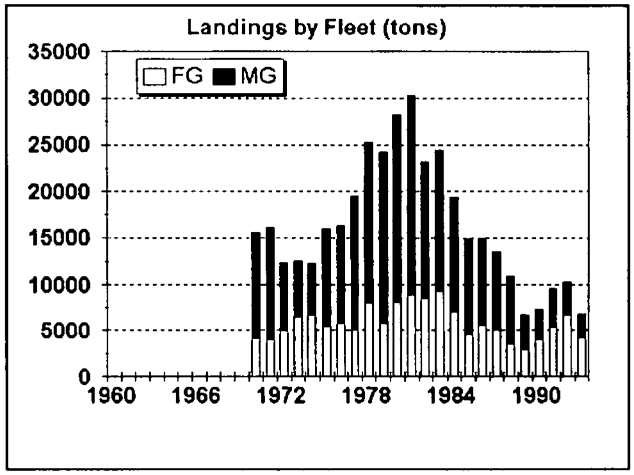
State of the Stock: Stock abundance is low, perhaps at its lowest level since estimates were initiated; however the latter is based on the very low 1993 survey result. This view of the resource is not shared by all members of industry. Stock status will be reviewed after the July 1994 survey.

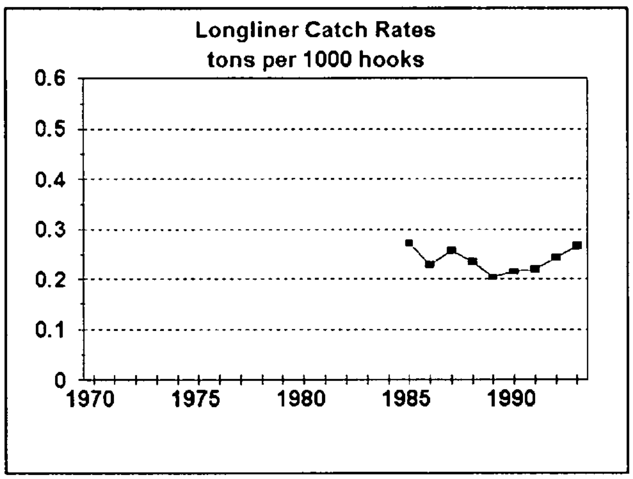
Forecast for 1995: Research vessel surveys indicate very low spawning stock biomass and weak 1989, 1990, and 1991 year-classes. This differs from the view of 4X haddock stock status expressed during industry consultations. There should be no increase in fishing effort until this is resolved.

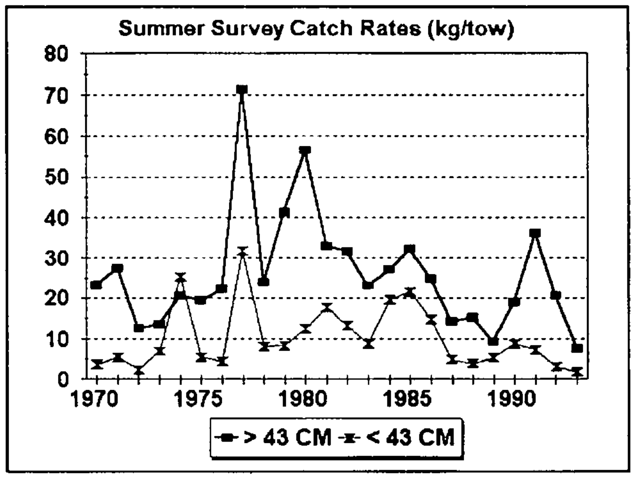
Long-term Prospects: The 1987 and 1988 year-classes were close to average but the 1989-91 year-classes are less abundant than average. Stock rebuilding is unlikely in the absence of large year-classes.

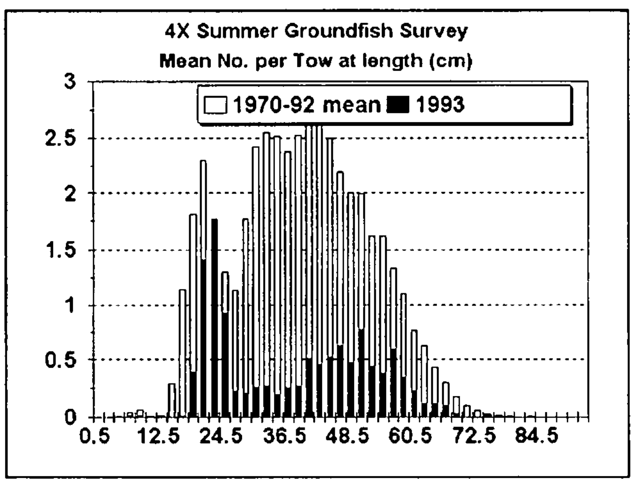
Special Comment:

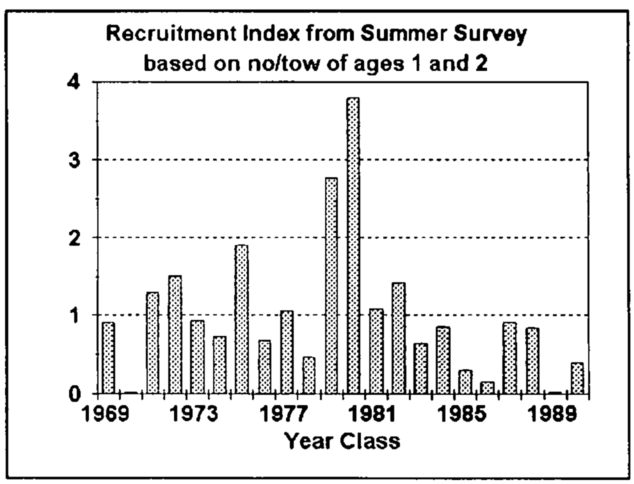

Landings and TACs (tons)
Landings
TAC
40000
30000
20000
10000
0
1960
1966
1972
1978
1984
1990

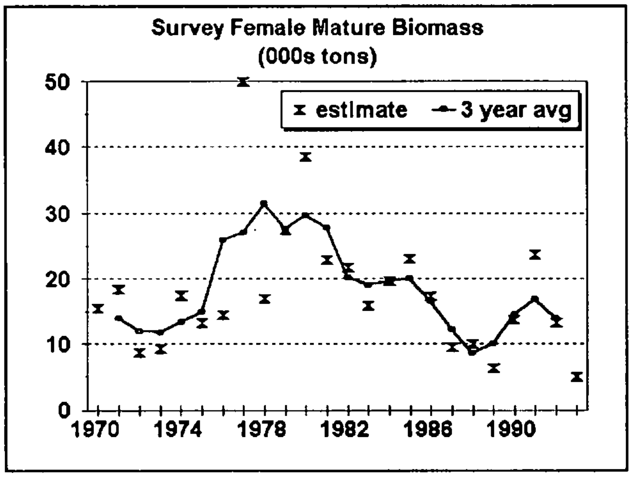

Landings by Fleet (tons)
FG
MG
35000
30000
25000
20000
15000
10000
5000
0
1960
1966
1972
1978
1984
1990


Longliner Catch Rates
tons per 1000 hooks
0.6
0.5
0.4
0.3
0.2
0.1
0
1970
1975
1980
1985
1990


Summer Survey Catch Rates (kg/tow)
80
70
60
50
40
30
20
10
0
1970
1975
1980
1985
1990
> 43 CM
< 43 CM


4X Summer Groundfish Survey
Mean No. per Tow at length (cm)
1970-92 mean
1993
3
2.5
2
1.5
1
0.5
0
0.5
12.5
24.5
36.5
48.5
60.5
72.5
84.5


Recruitment Index from Summer Survey
based on no/tow of ages 1 and 2
4
3
2
1
0
1969
1973
1977
1981
1985
1989
Year Class


Survey Female Mature Biomass
(000s tons)
estimate
3 year avg
50
40
30
20
10
0
1970
1974
1978
1982
1986
1990

Georges Bank Haddock

- This is a transboundary management unit. Most of the resource is in the Canadian portion of 5Z. The combined USA and Canadian 1993 landings of 4,143t are well below the long-term average. The Canadian landings of 3,722t were not restrictive to the overall fleet (Canadian TAC 5,000t) though the mobile gear caught their allocation. The combined number of fishing trips by the Canadian mobile (less than 65 ft) and fixed gear components has not declined in recent years. The Canadian portion of the management unit was closed for the first 5 months of 1994.

- Few ages contributed to the 1993 landings with 43% (by weight) accounted by the 1987 year-class. Discarding of juvenile haddock was not much of a problem in 1993, due to relatively weak incoming 1990/91 year-classes and the use of large square mesh gear. The Enterprise Allocation fleet, using diamond mesh gear, caught a higher proportion of small haddock during the pollock-directed fishery in quarter four. There has been no trend in age 5 weight-at-age.

- The tonnage class 2 and 3 mobile gear (less than 65 ft) catch rates have been declining steadily since 1989. Part of the decline is attributed to changes in fishing practices due to regulatory changes.

- The three research vessel surveys (USA spring and fall, and Canadian spring) indicate a decline in spawning stock biomass (age 3+) since 1990. Levels near the lowest in the series were recorded in 1992/93, with a slight increase in 1993/94.

- The surveys show that the 1992 year-class is of moderate to above average abundance. There are indications that the 1993 year-class is of moderate to above average abundance but it is too early to estimate reliably.

- The assessment indicates that the spawning stock biomass at the beginning of 1994 has increased slightly from levels near the lowest recorded.

- Fishing mortality has been increasing sharply in the 1990s, with the 1993 estimate the highest in the time series (F = 1.13). This level of fishing mortality removed about 60% of the fishable biomass in 1993.

- Combined Canadian and USA landings of 3,000t in 1994 will result in a fishing mortality rate of almost twice $F_{0.1}$. The $F_{0.1}$ yield projected for 1995 is about 4,000t with the 1992 year-class accounting for roughly half the landed weight. This stock does not suffer from a retrospective pattern.

- The projected increase in haddock biomass is due primarily to recruitment of the moderately strong 1992 year-class. This year-class will only be 2 years old in 1994, and restraint should be exercised to allow these fish to grow and contribute to spawning. Continuing conservation efforts are needed to rebuild the population biomass and to expand the age structure.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.[1]	Med.[1]	Max.[1]
Reference level '000t	8.3[5]	6.4[5]	8.1[5]	NA/ND	5.4	6.25	2	2			
Advised catch '000t	8.3[5]	8.3[5]	8.1[5]	3[6]	5.4	5[6]	3[6]				
TAC '000t	8.3[4]	8.3[4]	8.3[4]	NA/ND	5[2]	5[2]	5[2]	3[2]			
Reported landings '000t	6.1	5.7	3.8	4.5	6.4[3]	5.7[3]	4.1[3]		2.4	5.7	25.0
Unreported catches											
Estimated discards '000t											
Total catches '000t											
Total biomass '000t	20.9	20.4	18.6	19.3	17.6	14.4	18.1	24.7	7.5	20.9	57.9
Spawning biomass '000t	13.8	15.6	11.3	17.8	15.1	10.7	6.8	7.7	2.2	12.4	42.7
Mean - F (4+)	0.52	0.53	0.39	0.41	0.49	0.85	1.13		0.19	0.43	1.13

[1] for 1969-1992
[2] Canadian quota for the current management unit
[3] preliminary statistics
[4] Canadian allocations for the management unit used prior to 1990
[5] for 5Z
[6] Canada only

Catches: The 1993 landings by Canada declined to 3,722t with reductions in both mobile and fixed gear. USA landings declined to a historical low of 421t. The Canadian fishery remained closed during January to May 1994. The USA fishery was further restricted by an expansion of the spawning closed area and an extension of the closed period.

Data and Assessment: The assessment of the status of the stock was based on calibration of an SPA with research survey abundance indices (Canadian spring survey and USA spring and fall surveys) using ADAPT. Survey spawning biomass has declined since 1990, with a small increase in 1993 due to incoming recruitment.

Fishing Mortality: Fishing mortality has generally been about twice $F_{0.1}$ but shows a marked increase since 1991 and reached its highest level in 1993 which corresponds roughly to a harvest rate of about 60%.

Recruitment: Since the strong 1975 and 1978 year-classes, only the 1983, 1985 and 1987 year-classes were of moderate strength. The 1992 year-class is estimated to be comparable to that of 1987. There are early indications that the 1993 year-class may also be of moderate strength, but it is too early to estimate it reliably.

Environmental Factors: Water temperatures in recent years have generally been colder than normal at depths less than 75m. At greater depths, conditions appear to be warmer than the long-term average.

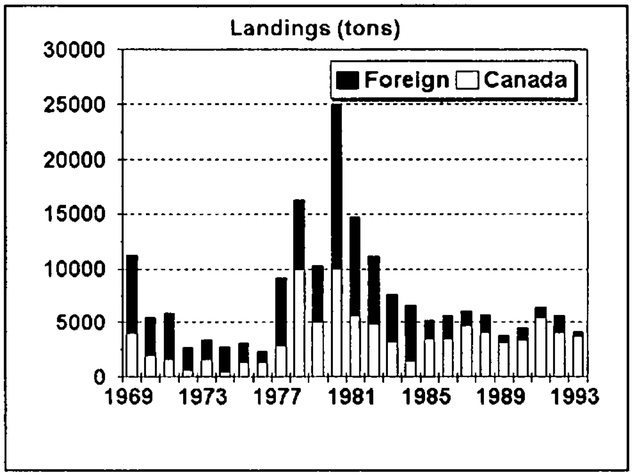
Multispecies Considerations: Herring abundance (haddock feed on herring roe) has increased in recent years while the abundance of cod (a predator) has declined.

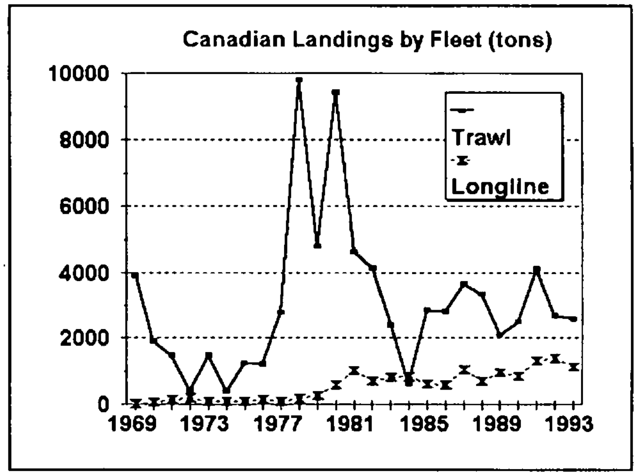
State of the Stock: The stock is near its historically lowest abundance with few older fish remaining in the population. There is an indication of improved recruitment.

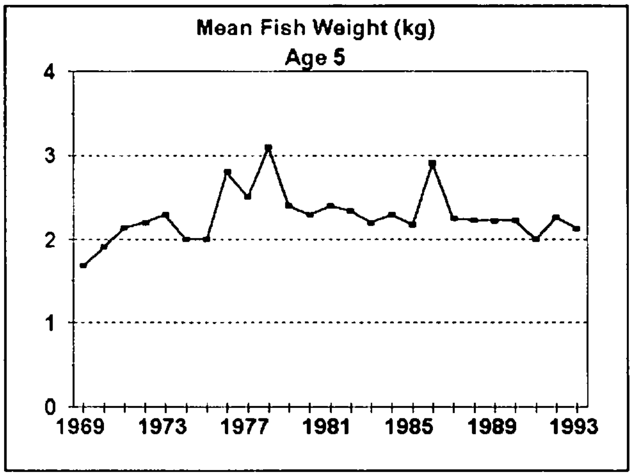
Forecast for 1995: The expected catch of about 3,000t in 1994 would result in a fishing mortality of about 0.4, exceeding $F_{0.1}$ (0.25). The projected $F_{0.1}$ yield for 1995 would be about 4,000t, with the 1992 year-class accounting for roughly half the landed weight. This stock does not suffer from a retrospective pattern.

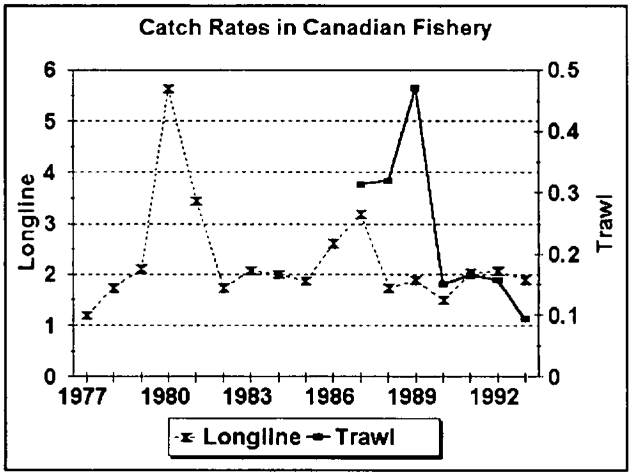
Long-term Prospects: Though haddock abundance appears to be increasing, it should be noted that this is due primarily to one moderately strong year-class. This year-class will only be 2 years old in 1994 and restraint should be exercised to allow these fish to grow and to contribute to spawning. Continuing conservation efforts are needed to rebuild the population biomass and to expand the age structure.

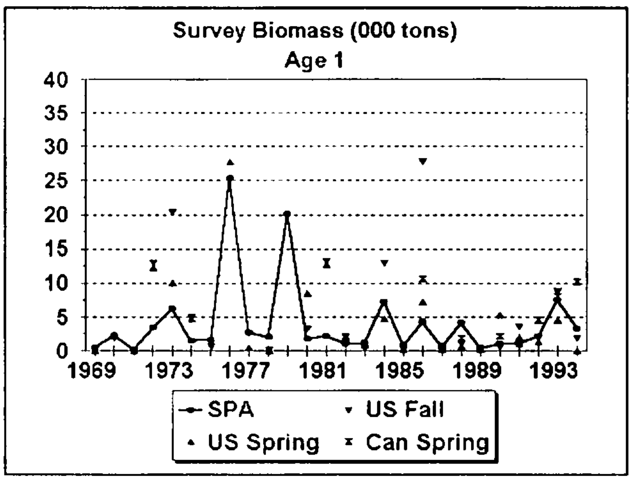
Special Comment:

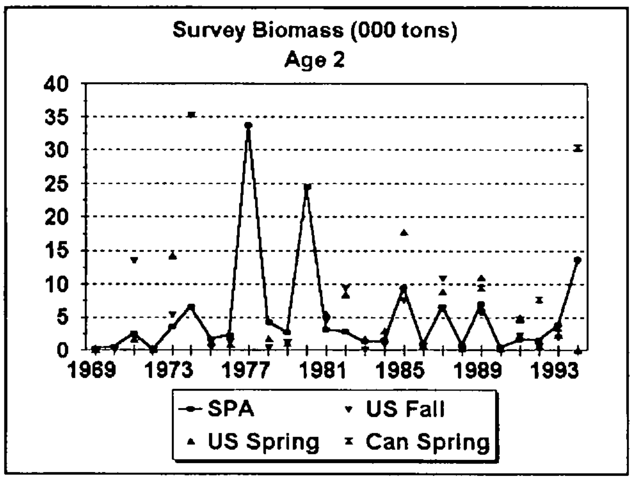

Landings (tons)
Foreign
Canada
30000
25000
20000
15000
10000
5000
0
1969 1973 1977 1981 1985 1989 1993

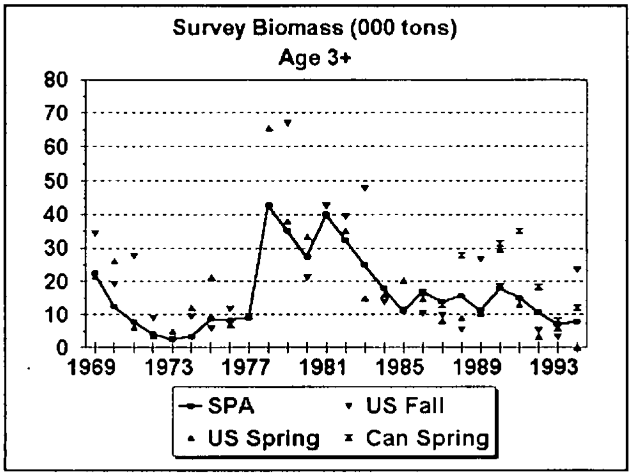

Canadian Landings by Fleet (tons)
Trawl
Longline
10000
8000
6000
4000
2000
0
1969 1973 1977 1981 1985 1989 1993

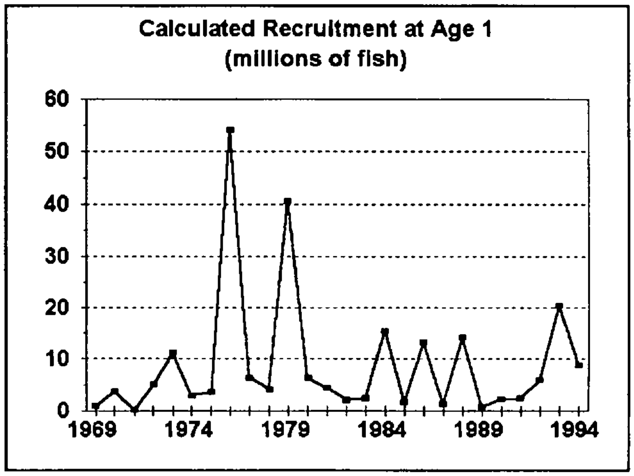

Mean Fish Weight (kg)
Age 5
4
3
2
1
0
1969 1973 1977 1981 1985 1989 1993

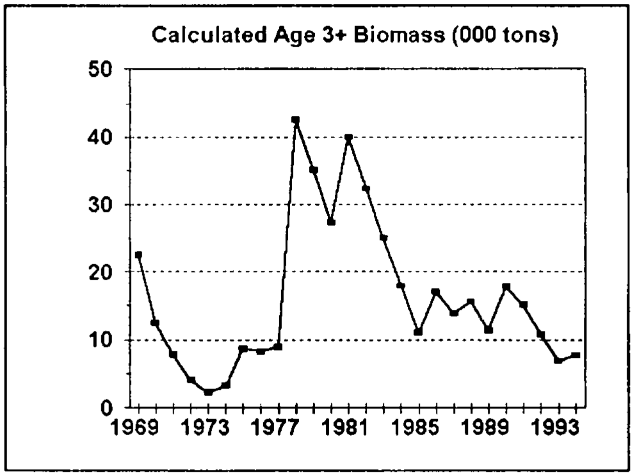

Catch Rates in Canadian Fishery
Longline
Trawl
6
5
4
3
2
1
0
0.5
0.4
0.3
0.2
0.1
0
1977 1980 1983 1986 1989 1992
Longline Trawl

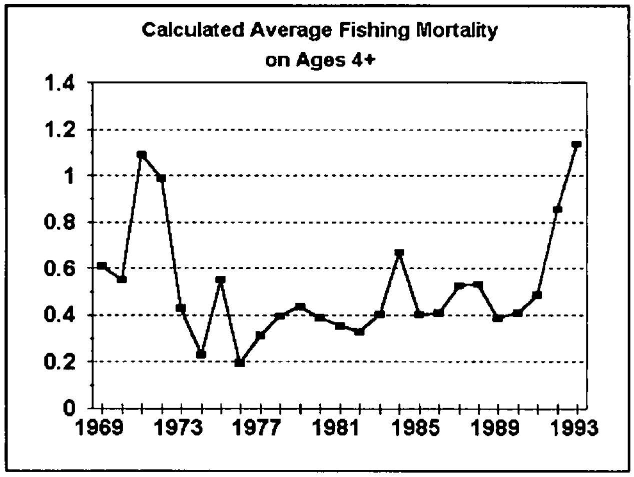

Survey Biomass (000 tons)
Age 1
40
35
30
25
20
15
10
5
0
1969 1973 1977 1981 1985 1989 1993
SPA
US Fall
US Spring
Can Spring

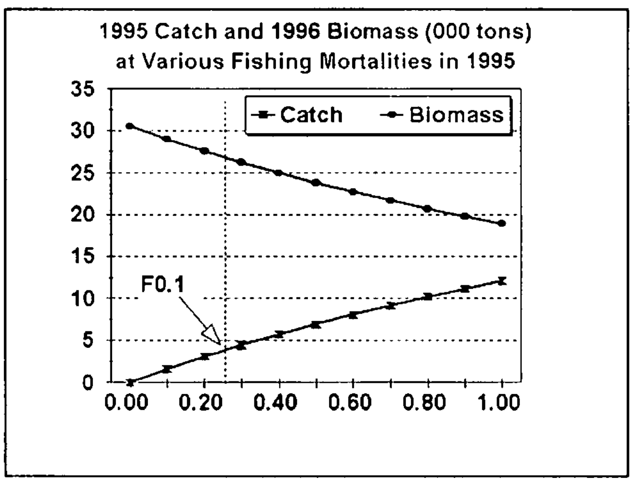

Survey Biomass (000 tons)
Age 2
40
35
30
25
20
15
10
5
0
1969 1973 1977 1981 1985 1989 1993
SPA
US Fall
US Spring
Can Spring

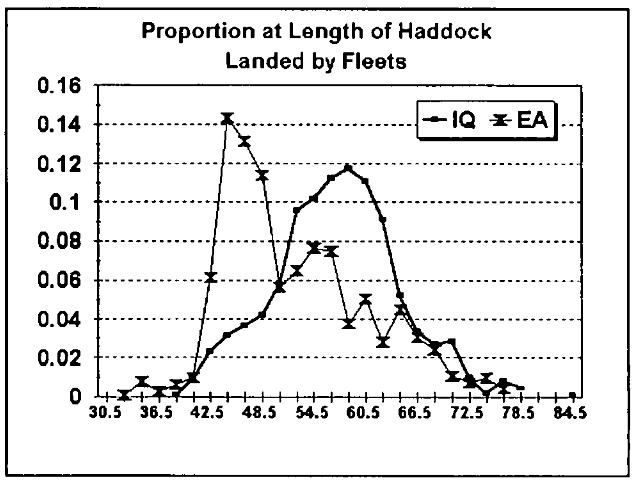

Survey Biomass (000 tons)
Age 3+
SPA
US Fall
US Spring
Can Spring


Calculated Recruitment at Age 1
(millions of fish)


Calculated Age 3+ Biomass (000 tons)


Calculated Average Fishing Mortality
on Ages 4+


1995 Catch and 1996 Biomass (000 tons)
at Various Fishing Mortalities in 1995
Catch
Biomass
F0.1


Proportion at Length of Haddock
Landed by Fleets
IQ
EA

Scotia Fundy Pollock

* From 1990 to 1992, the TAC did not restrict the overall fishery (with shortfalls of 6,800; 5,200 and 11,800t). The 1993 TAC was reduced to 21,000t from 43,000t in previous years (1987 to 1992). This TAC was reached.

* The geographic pattern in landings indicate a marked decline in 4VW, with relative stability in 4X and 5.

* The number of 1993 groundfish fishing trips also declined sharply in 4VW, but was relatively stable in 4X and 5.

* The age composition of the landings show that the contribution of age 7 and older is down substantially from the mid-1980s. Weights at age have also been declining over the past decade.

* The mobile gear tonnage class 5 catch rates (Observer data) for ages 4-10 have been declining steadily from 1984 to 1991 with catch rates in 1992 and 1993 slightly higher than in 1991.

* The summer research vessel survey data show high abundance in 1993 (second highest in survey). Estimates of stock size that utilized the survey data produced optimistic assessments that were inconsistent with information about fishing effort, commercial catch rates and other views of the resource. For these reasons the survey was not used to estimate abundance trends.

* Tonnage class 5 catch rates (Observer data) were used as estimates of abundance in the assessment. Diamond mesh has not been replaced by square mesh on this fleet sector. Observer catch rates were estimated by using data from vessels fishing from April-November for which more than 50% of the catch was pollock.

* The assessment estimates that spawning stock biomass (as estimated by age 4+) has been declining steadily from 1985 to the present and is projected to continue declining into 1995.

* Fishing mortalities have been close to twice $F_{0.1}$ and higher since 1985 with F in 1991 being the highest at 0.95.

* The 1988 year-class is estimated to be above average in strength and the 1989 year-class is average. Both are nearly fully recruited to the fishery in 1994. Estimates of subsequent year-classes appear weak. In the last assessment of this resource, the strength of the 1988 and 1989 year-classes were estimated to be greater.

* If the TAC of 24,000t is caught in 1994, the resulting fishing mortality would be 0.56 (about twice the $F_{0.1}$ of 0.30). With this level of fishing in 1994, the $F_{0.1}$ catch for 1995 is estimated at 13,000t.

* Pollock abundance is very low with poor recruitment prospects for the near future. Reduced exploitation would prolong the contribution of existing year-classes to the fishery and maintain a higher spawning biomass.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t	30	42	42.5	38	43	43	21	24			
Advised catch '000t	30	42	42.5	38	43	43	21[4]	-			
TAC '000t	43[2]	43[2]	43[2]	43	43	43	21	24			
Reported landings '000t	46	43	43	37	39[3]	34[3]	21[3]		21[1]	36[1]	46[1]
Unreported catches											
Estimated discards '000t											
Total catches '000t											
Total biomass '000t	163	169	149	132	119	102	85	88	85[1]	136[1]	205[1]
Spawning biomass '000t	133	120	115	97	88	83	77	76	57[1]	83[1]	158[1]
Mean - F (7+)	.55	.57	.65	.68	.95	.77	.51		.26[1]	.61[1]	.95[1]

[1] for 1974-1993
[2] before 1990 Canadian allocation
[3] preliminary statistics
[4] reduced in September from 35,000t

Catches: Decreased from 39,000t in 1991 to 21,000t in 1993, continuing a general decreasing trend since 1987. The decrease in catches is more pronounced in 4VW than in 4X+5Zc. 1993 landings of 3,000t in 4VW are lower than 1992 landings (9,000t) and indicate a marked decrease compared to the 1985-1990 annual landings which were in the 15,000-20,000t range. About 85% of the landings occurred in 4X. The foreign small mesh landings as by-catch from the silver hake fishery declined from 2,000t in 1992 to 860t in 1993.

Data and Assessment: Estimation of population size was made using sequential population analysis calibrated with Observer tonnage class 5 catch rates. The research survey shows strong annual variability and was not used to estimate stock abundance.

Fishing Mortality: Fishing mortalities have been close to twice $F_{0.1}$ and higher since 1985 with F in 1991 being the highest at 0.95. The 1993 fully recruited age 7+ was 0.51.

Recruitment: Recruitment has averaged about 28 million since 1974. The 1979 year-class is the largest in the time series at 76 million. The 1988 year-class is above average and the 1989 year-class is average. There are no signs of any strong year-classes since 1989. The 1990 year-class was estimated to be amongst the weakest and the 1991 year-class was weaker than any previously observed.

Environmental Factors: Large catches of pollock occurred in warm water along the edges of the shelf in 4VW during the 1993 summer survey. The temperature in Emerald Basin was well above normal.

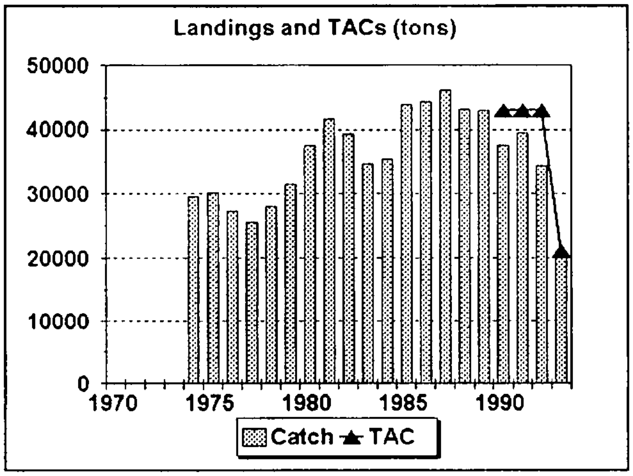
Multispecies Considerations:

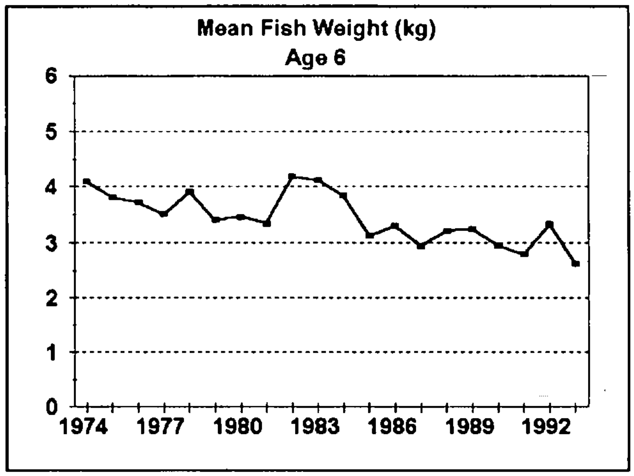
State of the Stock: Total biomass (age 2+) and spawning stock biomass (age 4+) declined from the mid-1980s and are currently near 88,000 and 76,000 t, respectively. The 1988 and 1989 year-classes are moderate to above average in size, but lower than estimated in the last assessment of this stock. The abundance of large pollock (age 7+) has declined in recent years.

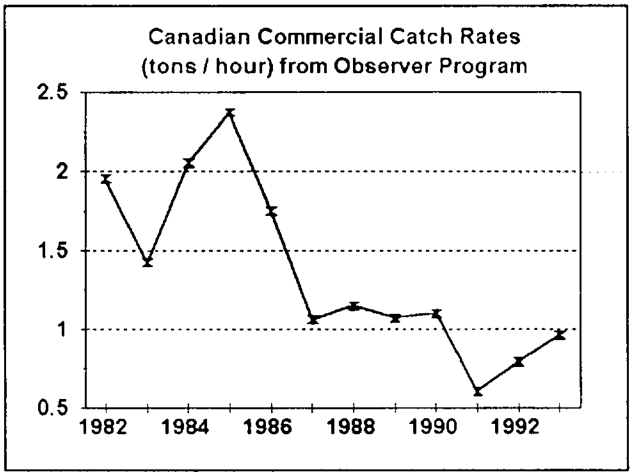
Forecast for 1995: Assuming the 24,000t TAC for 1994 is caught, this would result in $F_{0.1}$ catches in 1995 of 13,000t. A catch of 24,000t in 1994 implies a 1994 F=0.56 which is nearly twice the $F_{0.1}$ of 0.30.

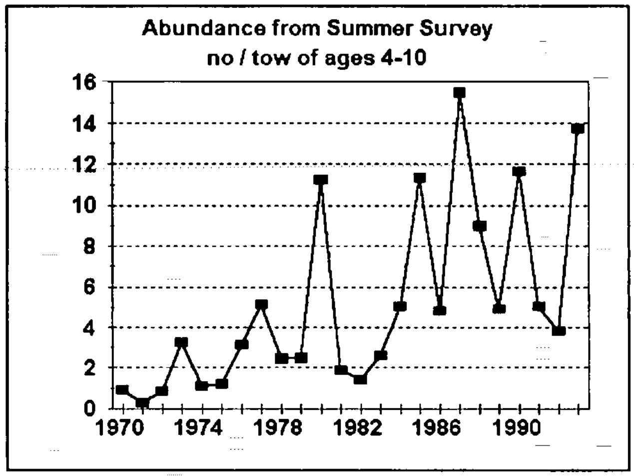
Long-term Prospects: Pollock abundance is very low with poor recruitment prospects for the near future. Reduced exploitation would prolong the contribution of existing year-classes to the fishery and maintain a higher spawning biomass.

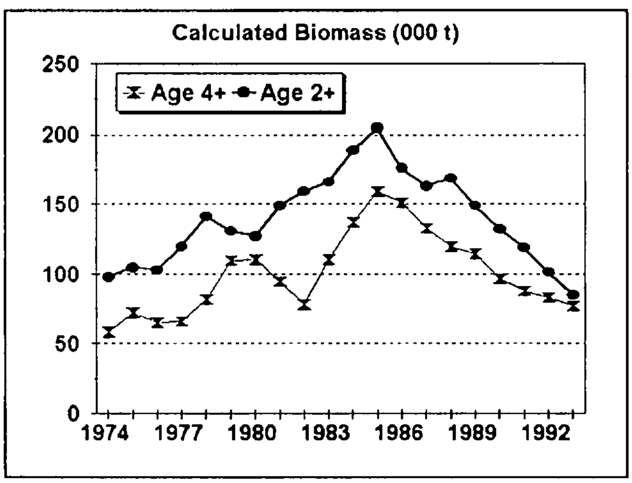
Special Comment: The change from using survey data to using commercial catch rate data to estimate population numbers marks a significant change in methodology and produces an assessment that is more consistent with industry's preception of stock status. Further exploration and discussion with industry in the use of catch rates is recommended for this resource.

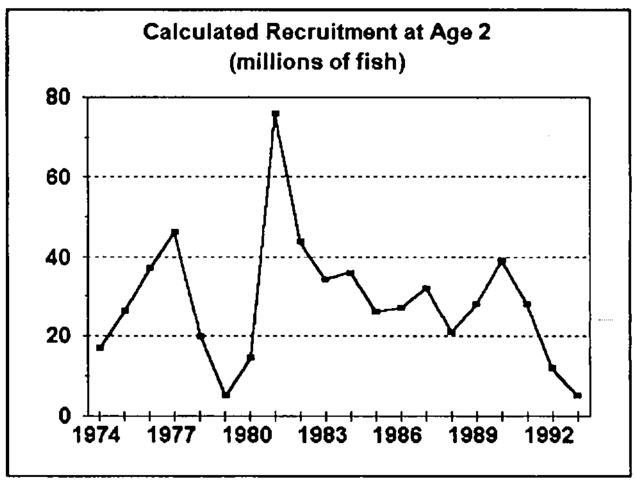

Landings and TACs (tons)
50000
40000
30000
20000
10000
0
1970
1975
1980
1985
1990
Catch
TAC

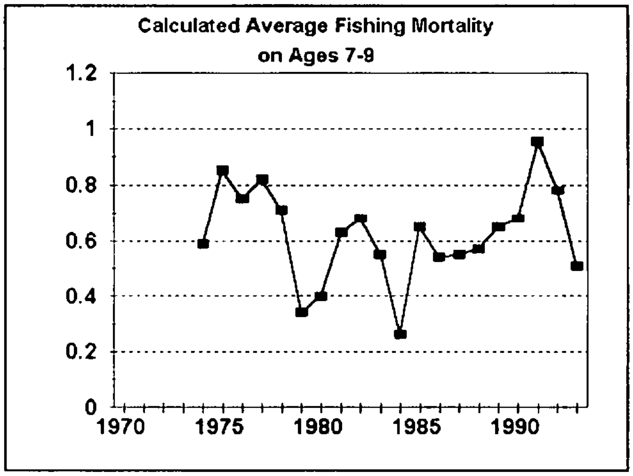

Mean Fish Weight (kg)
Age 6
6
5
4
3
2
1
0
1974
1977
1980
1983
1986
1989
1992

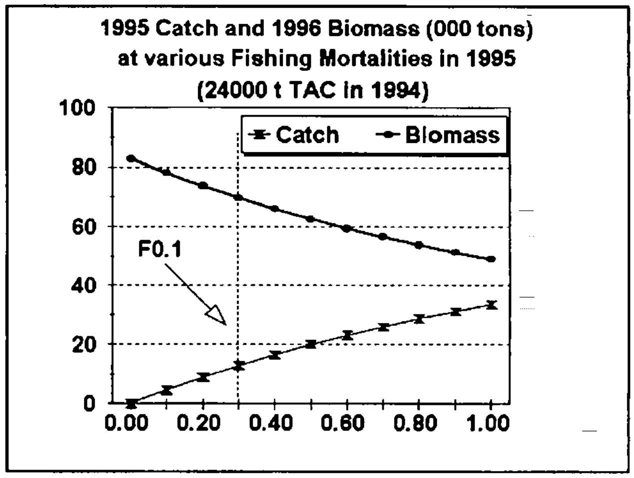

Canadian Commercial Catch Rates
(tons / hour) from Observer Program
2.5
2
1.5
1
0.5
1982
1984
1986
1988
1990
1992


Abundance from Summer Survey
no / tow of ages 4-10
16
14
12
10
8
6
4
2
0
1970
1974
1978
1982
1986
1990


Calculated Biomass (000 t)
250
200
150
100
50
0
Age 4+
Age 2+
1974
1977
1980
1983
1986
1989
1992


Calculated Recruitment at Age 2
(millions of fish)
80
60
40
20
0
1974
1977
1980
1983
1986
1989
1992


Calculated Average Fishing Mortality
on Ages 7-9
1.2
1
0.8
0.6
0.4
0.2
0
1970
1975
1980
1985
1990


1995 Catch and 1996 Biomass (000 tons)
at various Fishing Mortalities in 1995
(24000 t TAC in 1994)
Catch
Biomass
F0.1
100
80
60
40
20
0
0.00
0.20
0.40
0.60
0.80
1.00

Eastern Scotian Shelf Flatfish

* The combined 1993 landings of four species of flounder (American plaice, yellowtail flounder, witch and winter flounder) was 4,000t. These are the lowest landings for several decades. The landings have never been restricted by TAC, and fishing effort on flatfish by the less than 65' mobile gear sector has been increasing in recent years as gadoid stocks in 4VW have declined.

* Length frequencies of 1993 commercial landings indicate that far fewer larger female plaice, yellowtail and witch are available than was the case in 1991.

* Although commercial catch rate data from the catch/effort statistics are unreliable, interviews with members of the fishing industry infer that the resource is in decline and is being increasingly exploited due to the unrestrictive TACs.

* American plaice summer research vessel survey abundance estimates for 4V (the predominant area of the fishery) have been declining since the late 1970s but have been stable in 4W. The average weight of individual plaice has been declining, indicative of a reduction in the number of large, older fish.

* The 1993 yellowtail summer research vessel survey abundance estimate is the lowest in the 23 year time series. The average weight per tow declined sharply from 1990 to 1993. Very few yellowtail were caught during the survey in 4V, the predominant area of the commercial fishery.

* Witch summer research vessel survey abundance estimates have been relatively stable in 4V but have decreased in 4W. There has been a steady decline in average weight of fish caught since the late 1970s.

* Survey abundance estimates of winter flounder increased in 4W in recent years, although inshore areas where winter flounder occur, are not surveyed.

* Qualitative information from the commercial fishery (on length composition, landings trends, and effort), as well as the summer research vessel survey estimates of abundance and size composition, indicate that present levels of fishing are causing the flatfish resource to decline and the loss of larger fish from the populations.

* A substantial reduction in effort is required in order to reverse current trends (on the order of 50% of that required to catch the 1993 landings). The controls need to be restrictive as opposed to present regulations which do not restrict effort.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t											
Advised catch '000t											
TAC '000t[2]	New Management Unit - TAC to be established for each area after industry consultation										
Total landings '000t	8.3	6.5	6.9	6.2	4.3[3]	4.8[3]	4.0[3]		4.0[1]	6.2[1]	8.3[1]
Reported landings by											
species '000t	4.7	3.1	3.4	2.0	.4	.6	.1				
American plaice	1.0	1.0	1.4	3.0	1.3	1.4	1.6				
Yellowtail flounder	2.7	2.4	1.8	1.3	1.4	1.0	.5				
Witch flounder	.01	.1	.15	.1	<.1	.<.1	<.1				
Winter flounder	.04	.08	.09	.03	1.5		1.6				
Unspecified											

[1] 1987-1993. [2] TAC - 14,000 in 1993; 10,000 proposed 1994. [3]Preliminary statistics.

Catches: Overall landings have been declining, individual species data are not reliable due to misidentification of flounder.

Data and Assessment: Catch rates from the spring and summer research vessel surveys were used as indices of abundance. Estimates of average weights from the survey along with commercial length frequencies were used to provide information on the abundance of large and small fish over time. Industry reports were also considered.

Fishing Mortality: Fishing mortality is thought to have recently increased with a redirection of effort on flatfish from the cod, haddock and pollock fisheries.

Recruitment: Small yellowtail are abundant in 4W and may provide recruitment to the 4Vsc fishery.

Environmental Factors: Temperatures in 4V and western 4W were generally colder than normal especially at 50-150m. In the deep (>200m) waters of the Laurentian Channel, Emerald Basin, and through the entire upper 200m in the offshore waters along the slope, temperatures were warmer than normal.

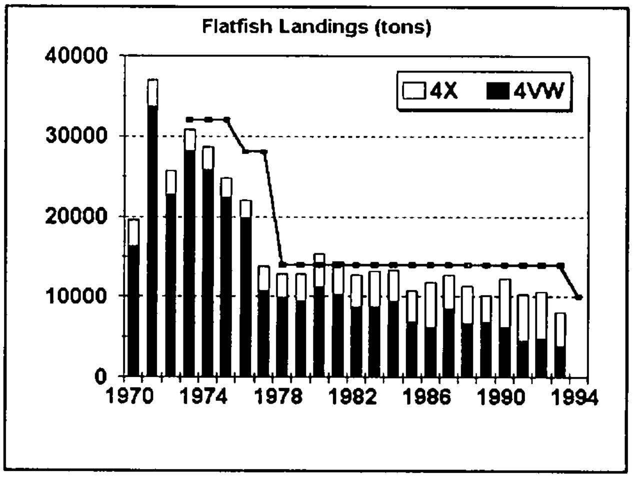
Multispecies Considerations:

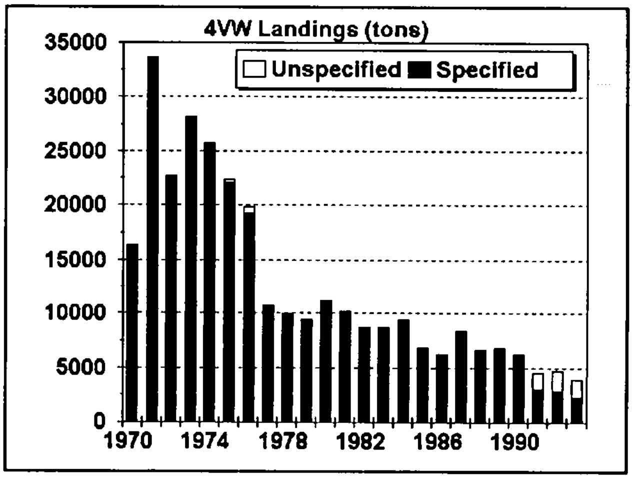
State of the Stock: American plaice -- Based on survey results and commercial information, stock size appears to be decreasing - numbers and weights/tow for 1993 are the lowest on record in 4V.
Yellowtail -- Based on survey results and commercial information, the stock appears to be decreasing. The 1993 survey weights/tow in 4V are the lowest on record.
Witch -- Based on the survey the stock size appears stable although the 4W portion is declining. The survey does not cover the deep waters of the Laurentian Channel. Average weights have decreased since the 1970s to the lowest value in the series. Industry reported increased effort.
Winter flounder -- Based on the survey, winter flounder abundance is increasing, especially in 4W.

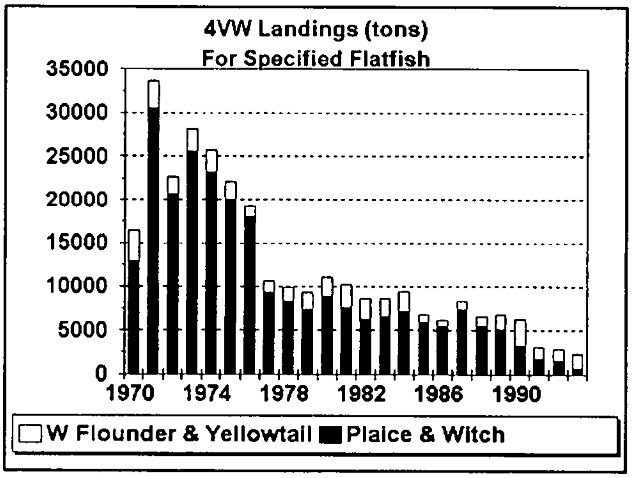
Forecast for 1995: American plaice -- Catches should decrease as a result of declining abundance.
Yellowtail -- Catches should decrease as a result of declining abundance, especially in the 4V area. Higher abundance of small yellowtail in 4W may provide recruitment to the 4V area.
Witch -- Catch may decline based on industry reports of increased effort. Average weight of witch in 4VW has declined since the late 1970s.
Winter flounder -- Not currently a directed fishery - only a small by-catch fishery. Abundance is relatively high in 4W.

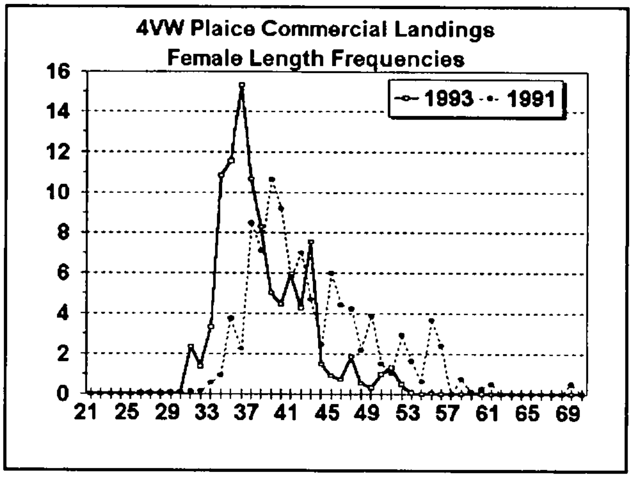
Long-term Prospects:

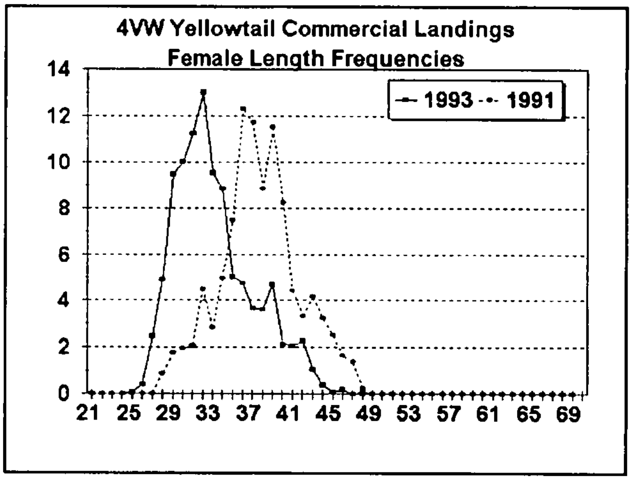
Special Comment: The 1993 yellowtail and plaice 4V survey biomass estimates are the lowest on record. Discussions are underway with industry to establish fleet shares, in light of the new management units, the reduced TAC, and the inclusion of winter flounder under quota management. ITQs should be implemented in 1994.

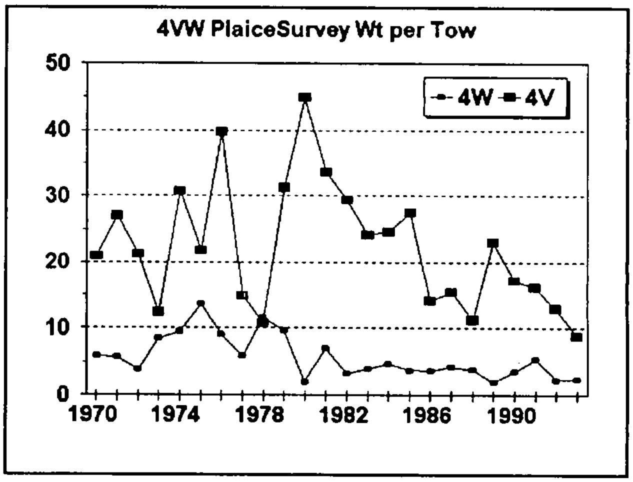

Flatfish Landings (tons)
4X
4VW
40000
30000
20000
10000
0
1970 1974 1978 1982 1986 1990 1994

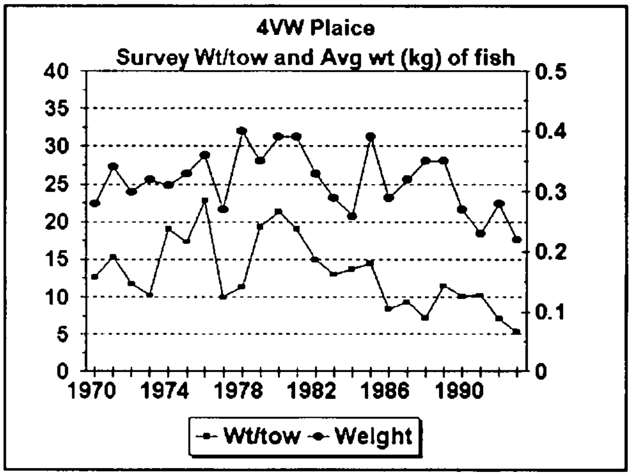

4VW Landings (tons)
Unspecified
Specified
35000
30000
25000
20000
15000
10000
5000
0
1970 1974 1978 1982 1986 1990

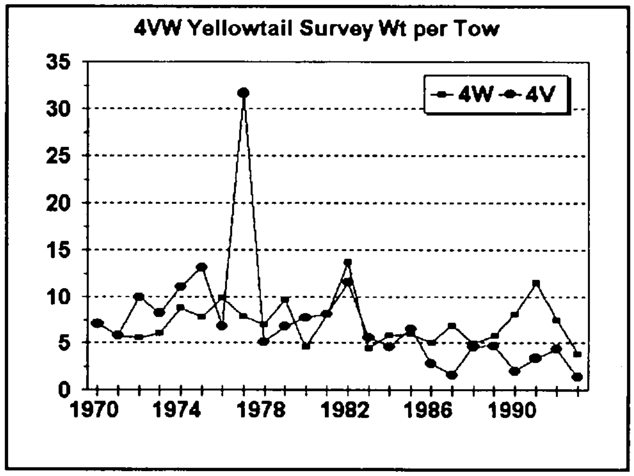

4VW Landings (tons)
For Specified Flatfish
35000
30000
25000
20000
15000
10000
5000
0
1970 1974 1978 1982 1986 1990
W Flounder & Yellowtail
Plaice & Witch

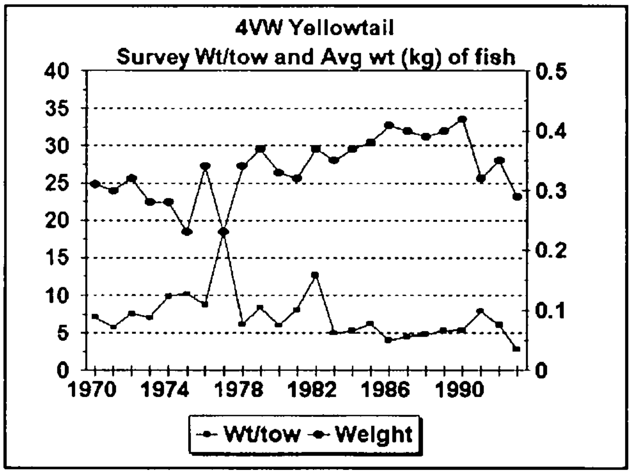

4VW Plaice Commercial Landings
Female Length Frequencies
1993
1991
16
14
12
10
8
6
4
2
0
21 25 29 33 37 41 45 49 53 57 61 65 69

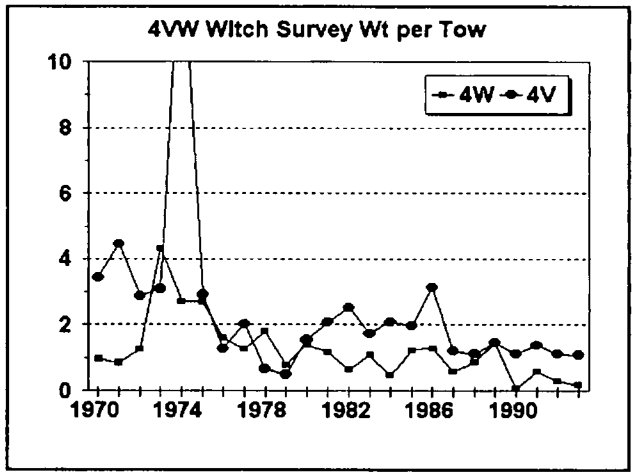

4VW Yellowtail Commercial Landings
Female Length Frequencies
1993
1991
14
12
10
8
6
4
2
0
21 25 29 33 37 41 45 49 53 57 61 65 69

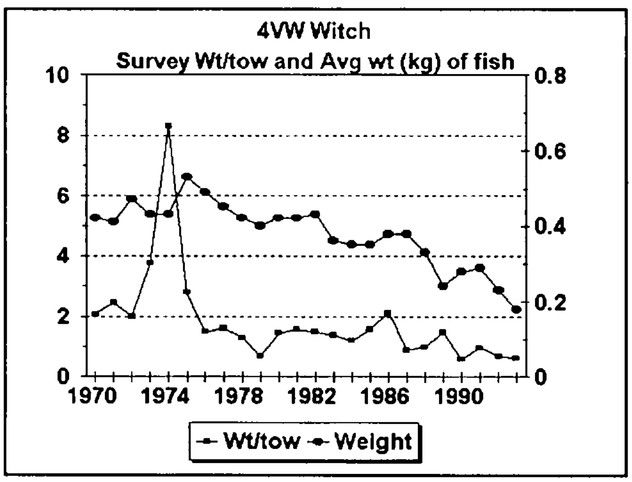

4VW PlaiceSurvey Wt per Tow
4W
4V
50
40
30
20
10
0
1970 1974 1978 1982 1986 1990


4VW Plaice
Survey Wt/tow and Avg wt (kg) of fish
40
35
30
25
20
15
10
5
0
0.5
0.4
0.3
0.2
0.1
0
1970
1974
1978
1982
1986
1990
Wt/tow
Weight


4VW Yellowtail Survey Wt per Tow
35
30
25
20
15
10
5
0
1970
1974
1978
1982
1986
1990
4W
4V


4VW Yellowtail
Survey Wt/tow and Avg wt (kg) of fish
40
35
30
25
20
15
10
5
0
0.5
0.4
0.3
0.2
0.1
0
1970
1974
1978
1982
1986
1990
Wt/tow
Weight


4VW Witch Survey Wt per Tow
10
8
6
4
2
0
1970
1974
1978
1982
1986
1990
4W
4V


4VW Witch
Survey Wt/tow and Avg wt (kg) of fish
10
8
6
4
2
0
0.8
0.6
0.4
0.2
0
1970
1974
1978
1982
1986
1990
Wt/tow
Weight

Southern Scotian Shelf - Bay of Fundy Flatfish

* The combined 1993 landings of American plaice, yellowtail flounder, witch and winter flounder was 4,000t. Only witch and winter flounder are directed for in 4X. Landings have never been restricted by TAC and anecdotal information from industry indicates that fishing effort on this management unit has been expanding considerably during recent years as the gadoid stocks have declined in 4X and 5.

* The length frequency of the 1993 commercial fishery landings indicate that there are smaller witch and male winter flounder in the landings relative to 1991.

* Interviews with representatives of the fishing industry consistently report that catch rates for the directed flounder species (witch and winter flounder) have been declining.

* Witch flounder summer research vessel survey estimates have declined since the 1980s. There has been a sharp decline in the average weight per fish since 1990.

* Winter flounder summer research vessel survey estimates for the offshore banks show increasing abundance until 1992, with the 1993 point dropping to half the 1992 value. The average weight of winter flounder has dropped during the past two years.

* The inshore area of 4X, which is of considerable importance for winter flounder habitat, is not covered by the survey.

* American plaice and yellowtail flounder are not prevalent in 4X. The survey estimates indicate relatively stable abundance with no trends in mean size in the populations.

* The qualitative information from the fishery, as well as the summer research vessel survey results, imply that witch flounder are at very low abundance and that fishing effort is high. The fishery has been unrestricted to date.

* The status of the winter flounder stock complex is not well understood. Data on the commercial fishery are limited and the summer research vessel survey does not cover a major part of the distributional area. Given the uncertainty, and the recent increase in the directed fishery, a prudent approach is to restrict fishing effort until there is an improved understanding of both the resource and the fishery. Given the probable existence of a number of relatively distinct populations within 4X, effort should be distributed across the area.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t											
Advised catch '000t											
TAC '000t[2]	New Management Unit - TAC to be established for each area after industry consultation										
Total landings '000t	4.2	4.6	3.3	6.0	5.8[3]	5.9[3]	4.0[3]		4.0[1]	4.6[1]	6.0[1]
Reported landings by species '000t	.49	.54	.53	.65	.61	.83	.37				
Witch flounder	1.0	1.5	1.3	1.9	.6	.6	.3				
Winter flounder	.1	.08	.05	.08	.14	.12	.05				
Yellowtail flounder	.26	.37	.48	.47	.99	.42	.09				
American plaice	2.4	2.2	1.0	3.0	3.4	4.0	3.2				
Unspecified											

[1] 1987-1993. [2] TAC - 14,000 in 1993; 10,000 proposed 1994. [3]Preliminary statistics.

Catches: Overall landings have been declining; individual species data are not reliable due to misidentification of flounder.

Data and Assessment: Catch rates from the spring and summer research vessel surveys were used as indices of abundance. Estimates of average weights from the survey along with commercial length frequencies were used to provide information on the abundance of large and small fish over time. Industry discussions and the general biology of some species were also considered.

Fishing Mortality: Fishing mortality is thought to have increased due to a redirection of effort from the cod, haddock and pollock fishery.

Recruitment:

Environmental Factors: In the Bay of Fundy/Lurcher Shoals, and in depths of 50-100m, temperatures have declined since the mid to late 1980s and have been as cool as the mid 1960s. In the deep waters (>150m) temperatures have warmed slightly or remained steady in recent years.

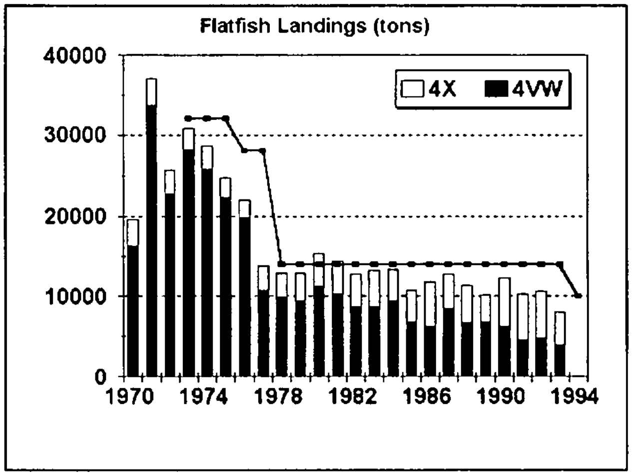
Multispecies Considerations:

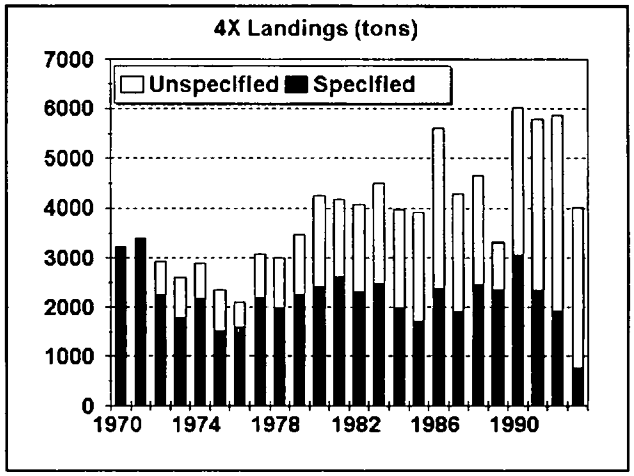
State of the Stock: Witch flounder -- Based on the survey estimates, length frequencies and average weights, the stock appears to be decreasing in abundance.
Winter flounder -- Survey estimates of abundance are relatively high, however the survey does not cover a large portion of the species distribution. Anecdotal reports indicate increased effort and lower catches - the stock may be declining. Average weight and length frequencies indicate some decrease in size of male winter flounder.
American plaice -- Stock size is stable or increasing.
Yellowtail -- Stock size is stable.

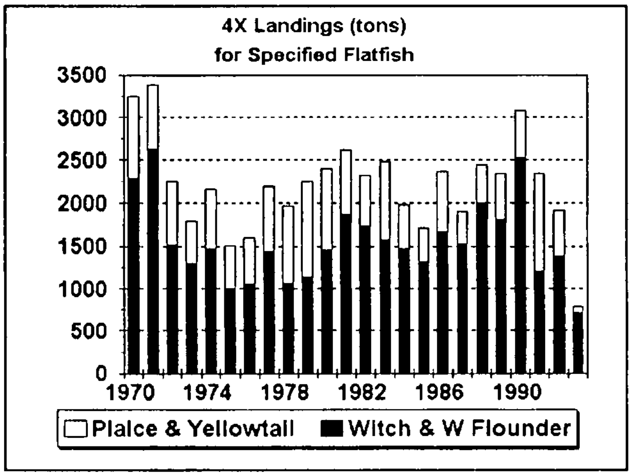
Forecast for 1995: Witch flounder -- Catches should decrease as a result of declining abundance and reduced size range.
Winter flounder -- Catches may decrease, especially in localized areas, based on some decline in average weight and size and industry reports of increased effort.
American plaice – Catches should remain stable but low.
Yellowtail – Catches should remain stable or increase slightly.

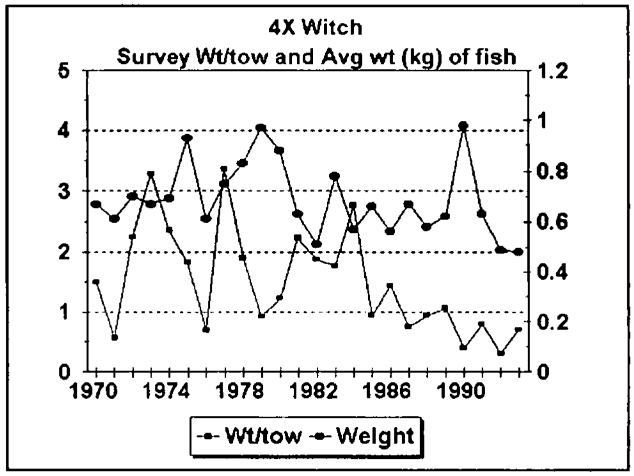
Long-term Prospects:

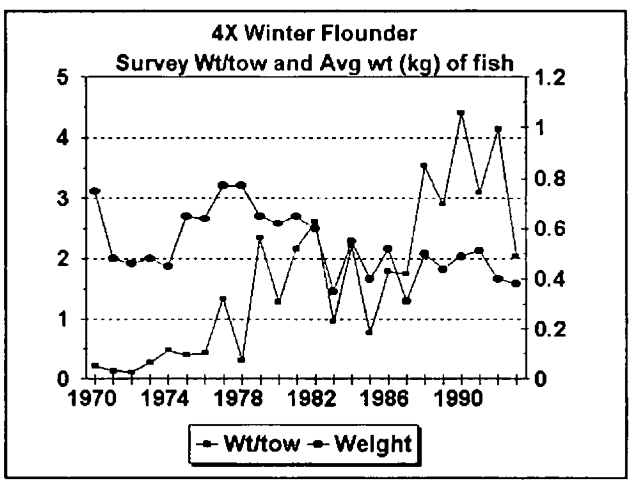
Special Comment: Winter flounder is now included under the 4X flounder quota. Consideration should be given to developing a management plan for winter flounder that recognizes the possibility of several population units.


Flatfish Landings (tons)
4X
4VW
40000
30000
20000
10000
0
1970 1974 1978 1982 1986 1990 1994


4X Landings (tons)
Unspecified
Specified
7000
6000
5000
4000
3000
2000
1000
0
1970 1974 1978 1982 1986 1990


4X Landings (tons)
for Specified Flatfish
3500
3000
2500
2000
1500
1000
500
0
1970 1974 1978 1982 1986 1990
Plaice & Yellowtail
Witch & W Flounder


4X Witch
Survey Wt/tow and Avg wt (kg) of fish
5
4
3
2
1
0
1.2
1
0.8
0.6
0.4
0.2
0
1970 1974 1978 1982 1986 1990
Wt/tow
Weight


4X Winter Flounder
Survey Wt/tow and Avg wt (kg) of fish
5
4
3
2
1
0
1.2
1
0.8
0.6
0.4
0.2
0
1970 1974 1978 1982 1986 1990
Wt/tow
Weight

Atlantic Halibut (3NOPs4VWX)

* The 1993 landings of Atlantic halibut were 1,200t. The TAC for this resource has never been restrictive. Landings are their lowest in recent decades while directed effort has been increasing as the gadoid stocks have declined.

* Most halibut are caught by small longliners with mobile gear restricted to a by-catch fishery. A large proportion of the mobile gear catch is below the minimum size limit.

* On the Scotian Shelf, commercial catch rates by longliners have been declining since 1981 in spite of the introduction of the more efficient circle hook. Interviews with the Fishermen and Scientist Research Society also indicate that catch rates have declined in recent years.

* Biomass estimates from the Scotian Shelf summer research vessel surveys increased from 1983 to 1990, but have since declined. The spring eastern Scotian Shelf survey also have declined since 1991.

* Restrictions on groundfish fishing effort are a pre-requisite to stock rebuilding.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min.	Med.	Max.
Reference level '000t	-	3.2	3.2	3.2	3.2	3.2	3.2	1.5	1.5[3]	3.2[3]	3.2[3]
Advised catch '000t	-	3.2	3.2	3.2	3.2	3.2	3.2	1.5	1.5[3]	3.2[3]	3.2[3]
TAC '000t	-	3.2	3.2	3.2	3.2	3.2	3.2	1.5	1.5[3]	3.2[3]	3.2[3]
Reported landings '000t	2.6	2.3	1.9	2.1	2.2[2]	1.3[2]	1.2[2]		1.1[1]	1.9[1]	4.0[1]
Unreported catches											
Estimated discards '000t											
Total catches '000t											
Total biomass '000t											
Spawning biomass '000t											
Mean - F											

[1] 1961-1993. [2] Preliminary statistics. [3] 1988-1994

Catches: Catches have decreased slowly from a maximum of 4,031t in 1985 to 1,243t in 1993.

Data and Assessment: Commercial catch rates and biomass estimates from the survey were used as indices of abundance. The landings suggest a decreasing stock size while the commercial catch rates have decreased slowly since 1981 despite the introduction of the more efficient circle hook. Biomass estimates from the summer surveys increased from 1983 to 1990, but have declined since. The spring eastern shelf research vessel survey has been variable to 1991 but has also declined steadily since.

Fishing Mortality:

Recruitment: Browns Bank may be a nursery area for this stock.

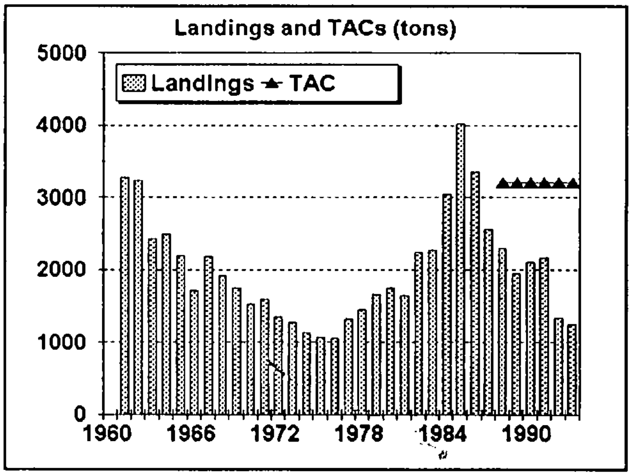
Environmental Factors:
Multispecies Considerations:

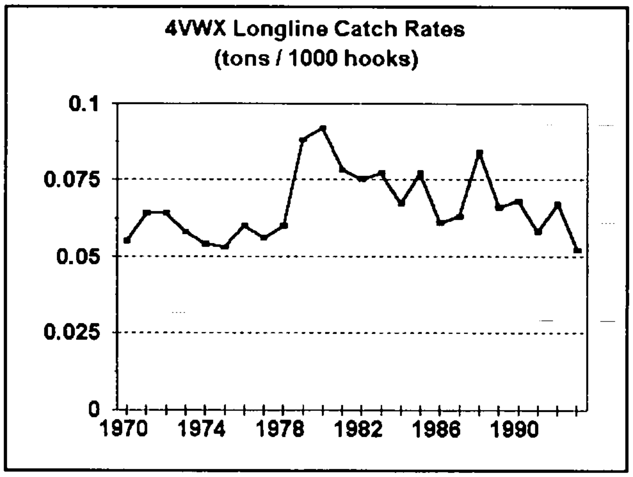
State of the Stock: Based on declining commercial and survey catch rates, as well as landings, the stock is decreasing. Increased effort was noted by industry as well as a lack of larger fish.

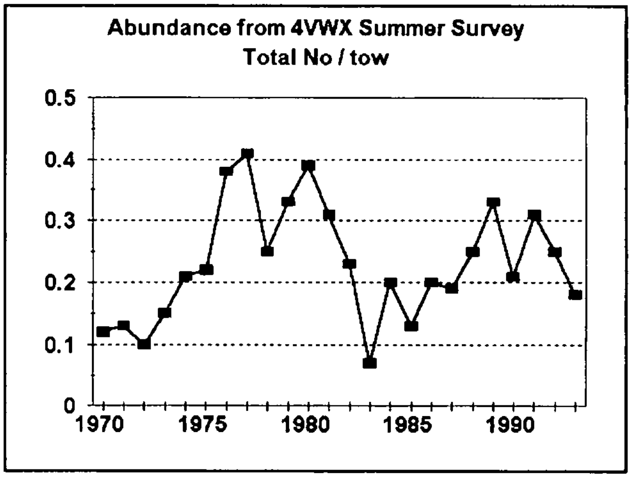
Forecast for 1995: The Atlantic halibut stock size appears to be decreasing and catches are expected to continue to decline.

Long-term Prospects:

Special Comment: TACs on Atlantic halibut have never been met and effort has not been restricted.


Landings and TACs (tons)
Landings
TAC
5000
4000
3000
2000
1000
0
1960
1966
1972
1978
1984
1990


4VWX Longline Catch Rates
(tons / 1000 hooks)
0.1
0.075
0.05
0.025
0
1970
1974
1978
1982
1986
1990


Abundance from 4VWX Summer Survey
Total No / tow
0.5
0.4
0.3
0.2
0.1
0
1970
1975
1980
1985
1990

Scotian Shelf Redfish

* The 1993 landings of redfish in this management unit increased to 5,100t. The TAC of 10,000t has not been restrictive. Fishing effort increased in 1993 which accounted for the increased catch.

* The commercial catch rates do not show any trends. The length frequency samples from the landings indicate that in 1993/94 more small fish (less than 20 cm) are being landed than was historically the case.

* The summer research vessel survey shows no trends in biomass since the early 1980s. The absence of increased biomass in the 1980s/90s during a period of low fishing effort implies that the recruiting year-classes have been of low abundance.

* There is no indication of any large year-classes about to enter the fished part of the stock and therefore stock conditions are expected to be similar to those of recent years if current fishing pressure does not change.

* If the research vessel survey biomass estimates are taken as the actual levels (and they are likely to be underestimates) then exploitation has been about 7% during 1982-1993. The precautionary TAC of 10,000t in place since 1992 implies an exploitation rate of 15%.

Year	1987	1988	1989	1990	1991	1992	1993	1994	Min[1]	Med[1]	Max[1]
Reference level '000t	-	-	-	-	-	10	10	10			
Advised catch '000t											
TAC '000t[2]	-	-	-	-	-	-	10	10			
Rep. landings '000t	6.1	3.9	3.2	2.3	2.0[3]	2.4[3]	5.1[3]		2.0	5.0	18.6
Unreported catches	-	-	-	-	-	-	-		-	-	-
Estimated discards	-	-	-	-	-	-	-		-	-	-
Total catches '000t	6.1	3.9	3.2	2.3	2.0[3]	2.4[3]	5.1[3]		2.0	5.0	18.6
Total biomass '000t	-	-	-	-	-	-	-	-	-	-	-
Spawning Biomass '000t	-	-	-	-	-	-	-	-	-	-	-
Mean - F	-	-	-	-	-	-	-	-	-	-	-

[1] 1970-1993 . [2] New management unit from 1993. [3] Preliminary statistics

Catches: Catches peaked at almost 19,000t in 1974 to then decline gradually to a low of less than 2,600t in 1979. A second peak occurred in 1986 at 6,700t followed by a decline again to about 2,000t in 1991 and a rise to over 5,000t in 1993.

Data and Assessment: The 1987 CAFSAC Advisory Document, and a series of previous annual reviews, established that there was an inadequate scientific basis for an analytical assessment and for annual adjustment of TAC advice. The 1993 TAC levels for the new management units were established on the basis of the sum of the 1991 TACs for the previous units prorated by historical (1981-90) catches in the new units. This gave a Unit 3 TAC of 10,000t.

Fishing Mortality: Exploitation rate, calculated as the ratio of commercial catch to survey biomass, averaged 5% over the last 5 years, well below the 15% target which has previously been taken as equivalent to fishing at $F_{0.1}$.

Recruitment: There is no indication of any large year-classes about to enter the fished part of the stock.

Environmental Factors: Temperatures (below approximately 150m) in the deep basins, such as Emerald and Roseway, and on the outer edge of the continental shelf were warmer-than-normal and have increased over the last couple of years. On the banks, in waters shallower than 100m, temperatures were generally colder than normal.

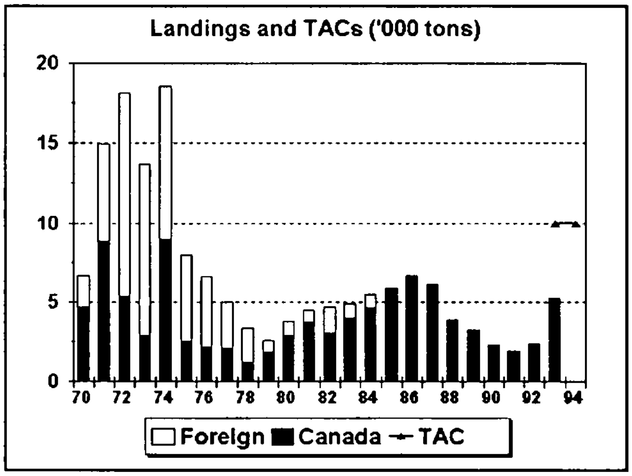
Multispecies Considerations: The majority of the redfish catch is taken on redfish directed trips. Coincidental by-catch of other species in the redfish catch was not considered.

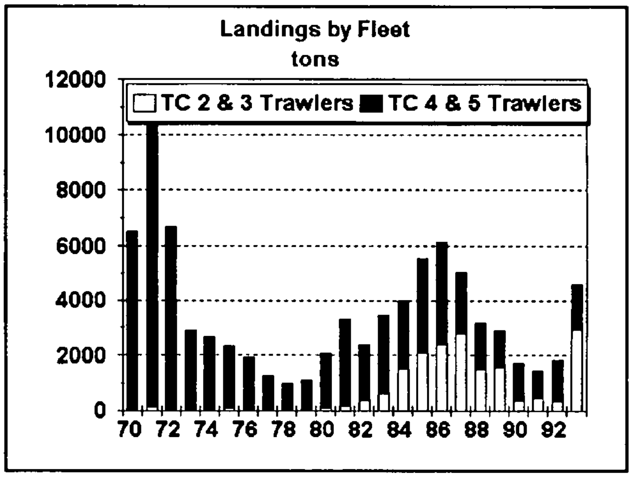
State of the Stock: The present biomass is equal to the average over the last decade or so. Increased 1993 catches were primarily a result of increased fishing effort, reflecting decreased fishing opportunities for other species.

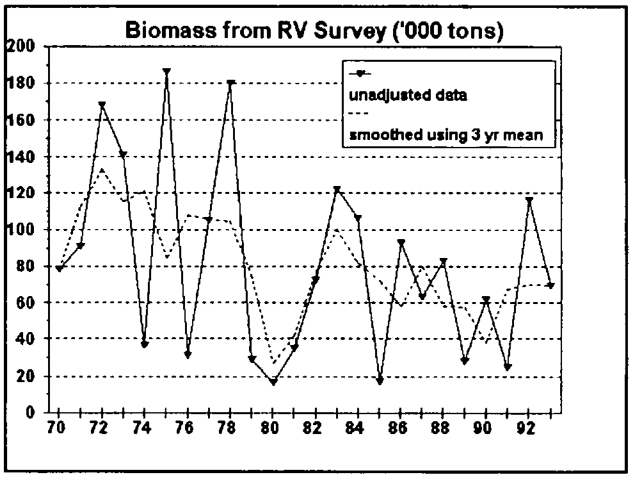
Forecast for 1995: Fishing and stock conditions in 1995 might be expected not to differ greatly from those in recent years.

Long-term Prospects: Biomass has been constant or declining slightly over the last 10 years with low exploitation rates. No above average year-classes have entered the population since 1970. If recruitment rates remain low, the situation of the past 10 years should continue.

Special Comment: The Unit 3 management unit for 4Wdehkl and 4X Scotian Shelf redfish includes redfish previously managed as part of a larger 4VWX management unit.


Landings and TACs ('000 tons)
20
15
10
5
0
70 72 74 76 78 80 82 84 86 88 90 92 94
Foreign Canada TAC


Landings by Fleet
tons
12000
10000
8000
6000
4000
2000
0
TC 2 & 3 Trawlers TC 4 & 5 Trawlers
70 72 74 76 78 80 82 84 86 88 90 92


Biomass from RV Survey ('000 tons)
200
180
160
140
120
100
80
60
40
20
0
unadjusted data
smoothed using 3 yr mean
70 72 74 76 78 80 82 84 86 88 90 92