Scotia-Fundy Spring 1995
Groundfish Stock Status Report

Sciences Branch
Department of Fisheries and Oceans
Scotia-Fundy Region

Bedford Institute of Oceanography
P.O. Box 1006, Dartmouth
Nova Scotia, B2Y 4A2
Canada

Original

June 1995

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Acknowledgements

This report represents the efforts of many staff in DFO's Scotia-Fundy Region. The main authors are indicated at the end of their sections. Numerous other individuals were involved in the review of this material. These are indicated in the Proceedings Report and Research Documents. The report's maps were prepared by Bob Branton, while the fish clipart was prepared by Jeff McRuer using Leim and Scott (1966). A special thanks goes to Bev Scott for allowing us to use this material. Gerry Black assisted in data preparation. Finally, Valerie Myra was the word processor who successfully compiled all the miscellaneous file formats provided by authors into one coherent document.

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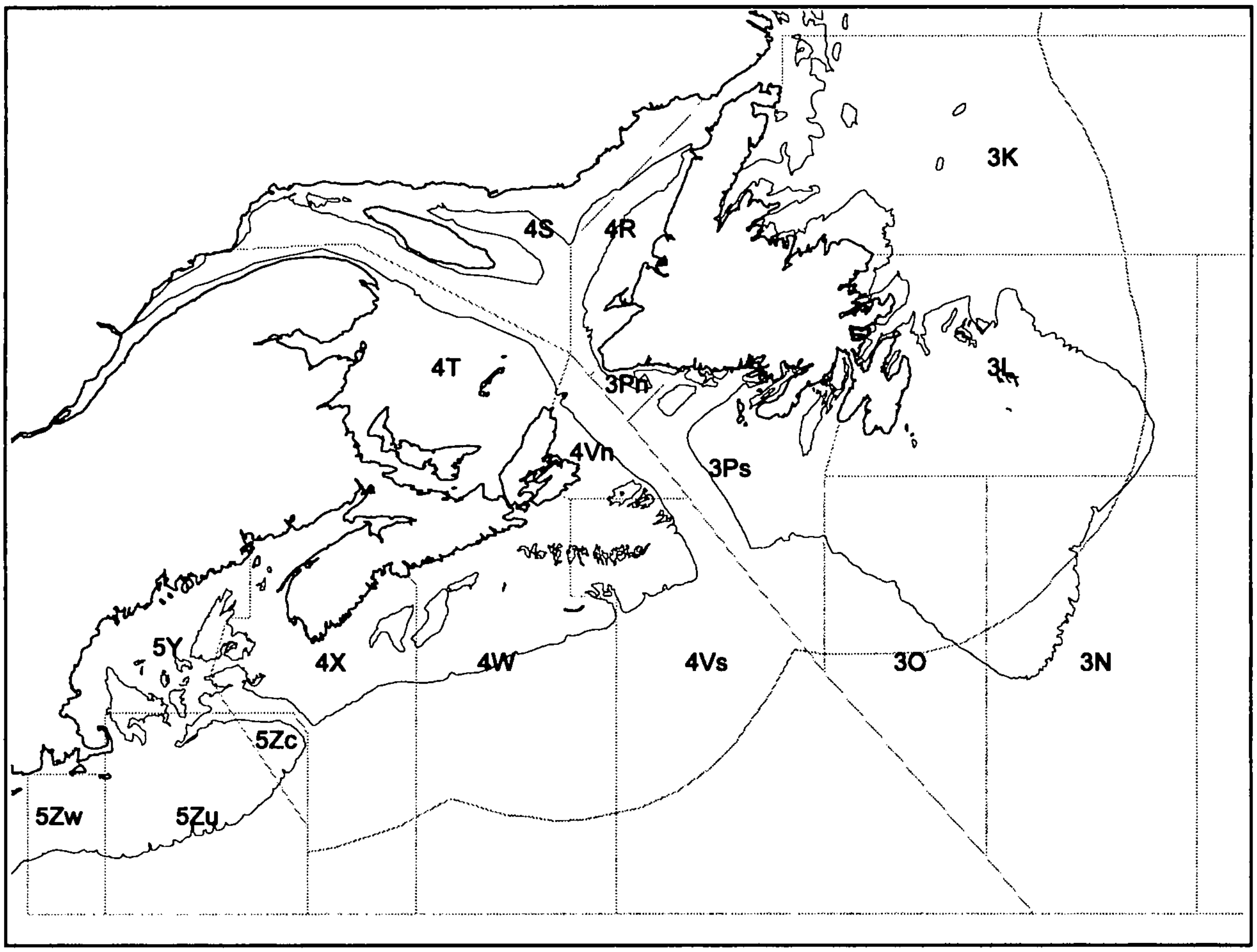
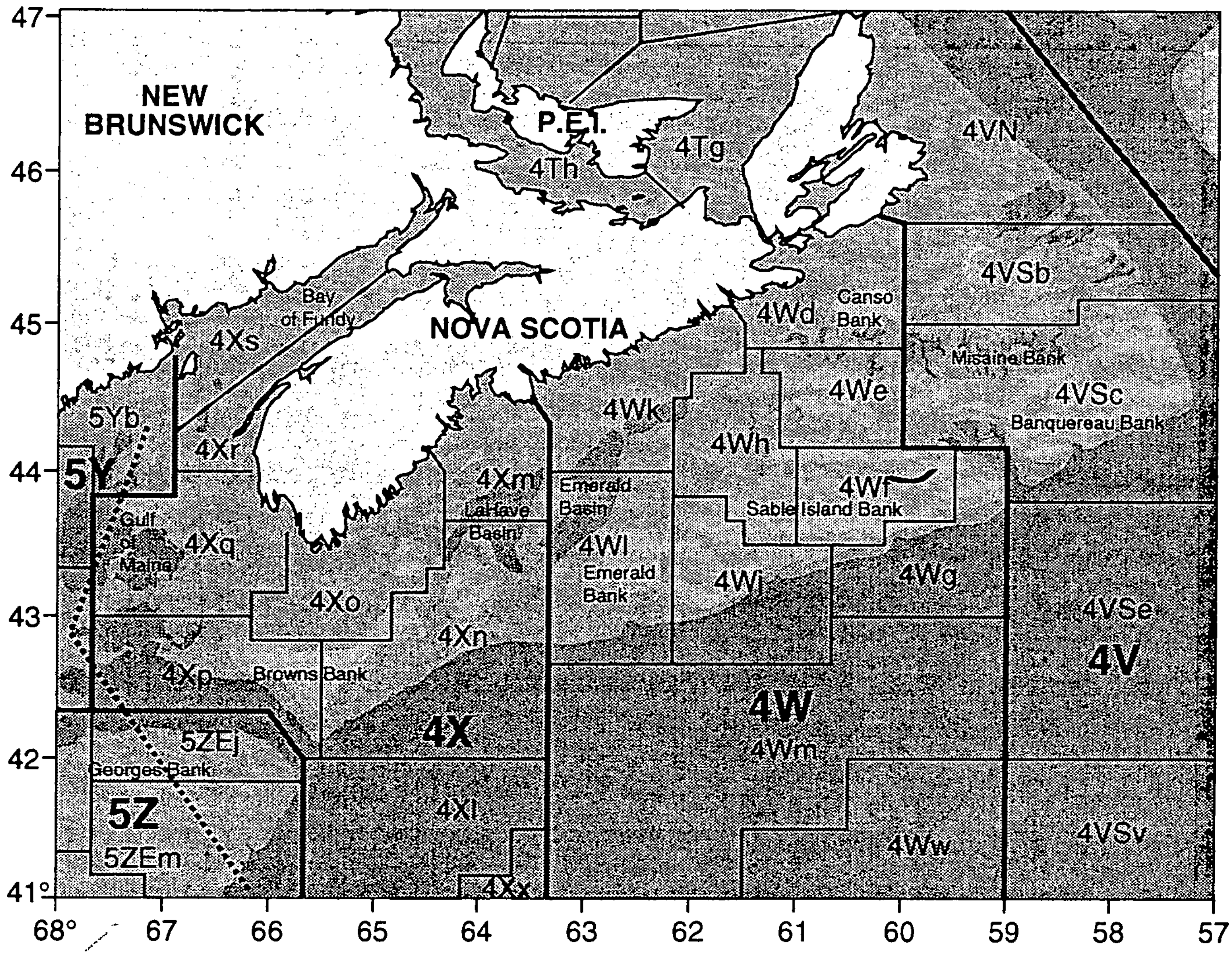


NAFO Divisions



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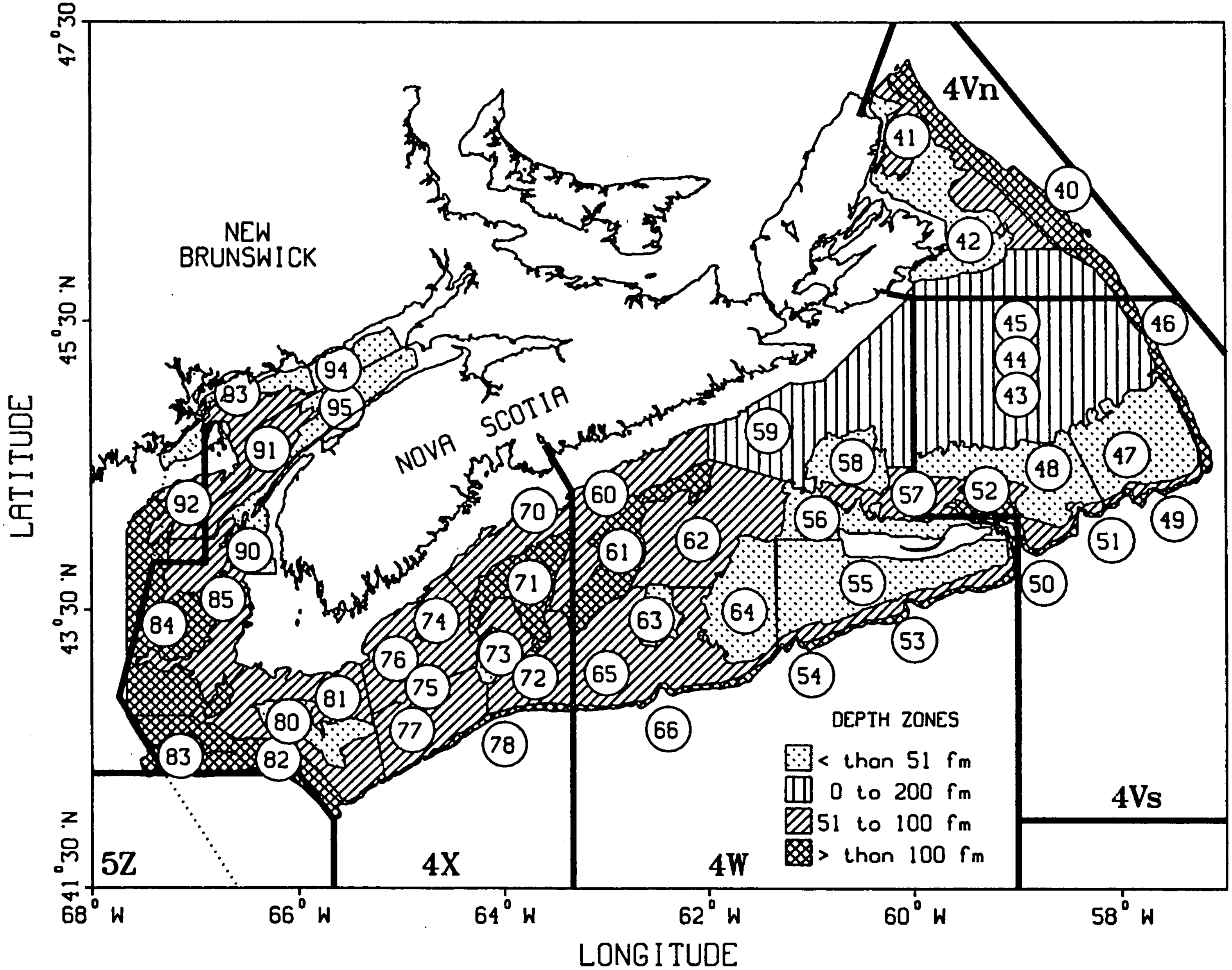
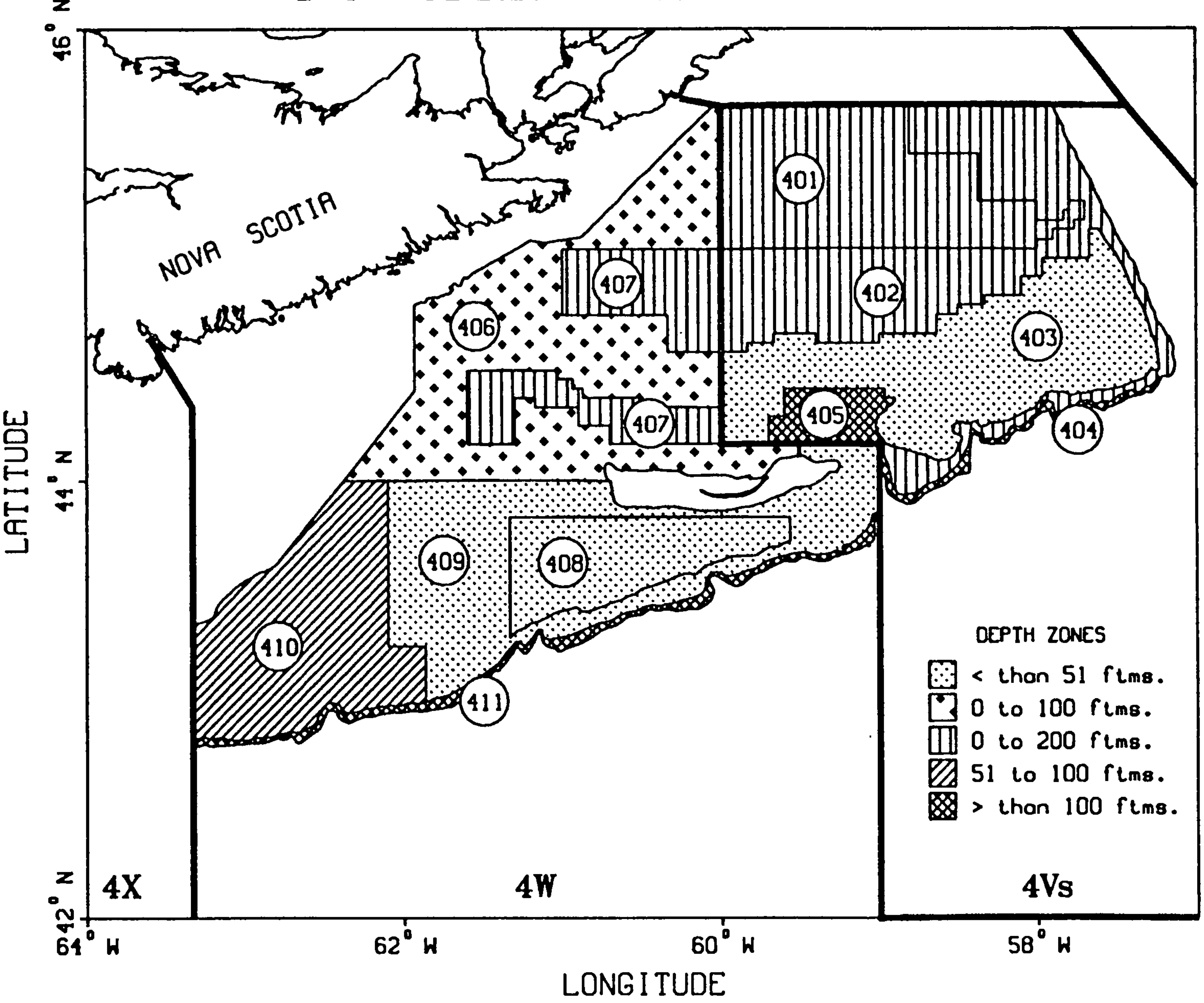


4VsW SPRING STRATA OVERLAY



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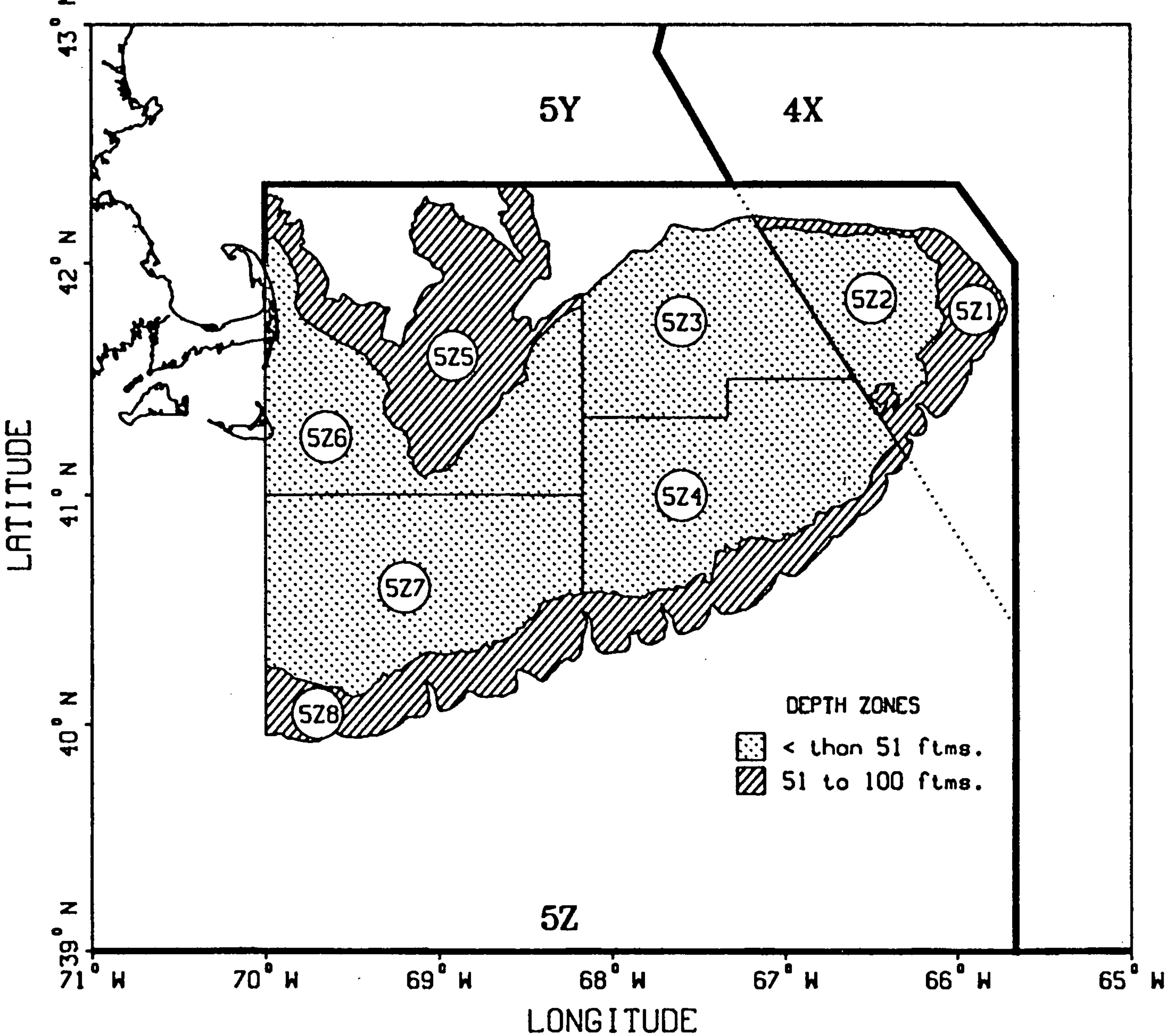


1. Introduction

As part of its conservation mandate, scientists of the Department of Fisheries and Oceans Scotia Fundy Region annually assess the status of the marine resources in the waters ranging from the Laurentian Channel in the North to the Canada/US border on Georges Bank in the South. Until December 1992, these assessments were conducted under the auspices of the Canadian Atlantic Fisheries Advisory Committee (CAFSAC). Since then, each DFO region has established its own review process - similar in intent but designed to suit the needs of local clients. In Scotia-Fundy Region, assessments are now conducted under the auspices of the Regional Advisory Process (RAP). Last year's report (O'Boyle and Zwanenburg, 1994) was the first compiled by RAP.

This report summarizes the groundfish findings of the RAP conducted in the spring of 1995. The emphasis here is on the results of the analyses rather than on the proceedings of the review meetings and the technical details of the assessment. For these, the reader is encouraged to consult the associated Proceedings Report (95/1) and the Research Documents for each resource. These reports can be obtained from the Atlantic Stock Assessment Secretariat (ASAS) located at the Bedford Institute of Oceanography (BIO).

A subsequent Stock Status Report will summarize not only this information , but also that on invertebrates, pelagics, and marine mammals.

The first part of the report provides overviews of the resources and the environment. This section starts with a description of the ocean climate. The environment in which the fish live has undergone dramatic changes since the mid-1980s and is believed to have affected productivity in the northern areas of the region. This is followed by a report on abundance trends at the ecosystem level. Of particular interest will be the information of the plankton trends. These organisms are the prey or feed for many of the species of commercial interest. A section is also provided on the trends in the species composition of the fish communities. Separate summary sections are provided on the groundfish, pelagic and shellfish resources.

The second part of the report documents changes in the fishery -- specifically the relative size of the fleets and how these have changed over time, the amount of fishing effort employed by these fleets, and the management measures employed in 1994. Included in this section is a report on the impacts of trawling on the benthic community. As well, there has been much discussion recently on the requirement for DFO to employ ecosystem principles in its management system. A section is presented that discusses what this may entail and what are its information requirements.

The third part of the report provides Stock Status Reports (SSR) on each of the resources for which an assessment review was undertaken. These reports are only brief summaries. The reader is advised to consult the associated Research Document for more detailed information. As well, the author of each report can be contacted. Reports are provided for the traditional commercial species cod, haddock, pollock, the flatfishes, and redfish. The SSR for silver hake only provides the trends in landings, commercial catch rates and survey abundance, as this stock is assessed by NAFO in June. Finally, interest in a number of non-traditional species, such as skate, monkfish, cusk, white hake, and wolffish, has risen in recent years. SSRs on these resources are presented which document the abundance trends based on the limited information that is available.

References

O'Boyle, R.N., and K.C.T. Zwanenburg [Eds.]. 1994. Report of the Scotia-Fundy Regional Advisory Process (RAP). Can. Manuscr. Rep. Fish. Aquat. Sci. 2252: xii + 208 p.

2. State of the Ocean

The physical oceanographic environment can affect the growth (yield, reproductive potential), behaviour (distribution, catchability, availability) and survival (recruitment, spawning biomass) of marine organisms as well as the operations of the fishing industry. Changes in the physical environment therefore contribute to changes in growth, behaviour and survival. These in turn contribute directly to variations in resource yield, reproductive potential, catchability, year-class size (recruitment) and spawning biomass as well as indirectly by influencing the perception of the status of a resource and the efficiency and profitability of industry. Oceanographic conditions (mainly water temperature and salinity) are therefore measured during research vessel resource surveys. Additional hydrographic data are obtained from other research and industrial operations, including ships of opportunity and fishing vessels. All of these data are edited and archived in Canada's national Marine Environmental Data Service (MEDS) data base. A working copy is maintained in a zonal data base (AFAP) at the Bedford Institute of Oceanography. The data collected during the groundfish and pelagic resource surveys are also maintained in a regional groundfish data base (GSHYD) that is cross-linked with the biological data collected at each survey station. Information on additional oceanographic and meteorological variables such as water currents, wind, waves, ice cover and frontal positions is also obtained from a variety of sources including process oriented studies, computer models and satellite sensors. Detailed descriptions of the means and temporal variations in most of these variables can be found in the Department of Fisheries and Oceans Atlantic Fisheries Research Documents by Drinkwater et al. (1995a,b) and Page et al. (1995). The following is a brief summary that focuses mainly on water temperatures. The summary includes a description of mean conditions, time trends and conditions in 1994.

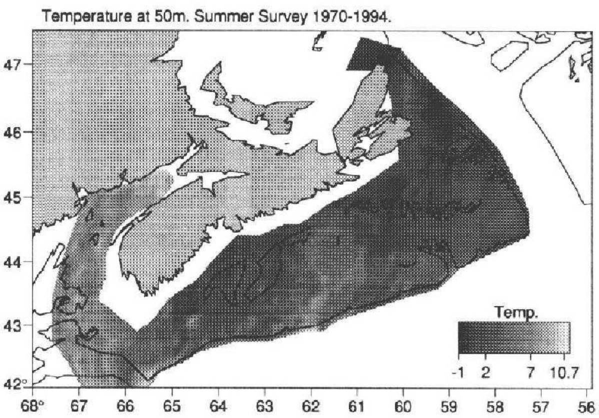
Mean Conditions

Temperature and salinity conditions within the Scotia-Fundy region vary spatially due to complex bottom topography, advection from upstream sources such as the Gulf of St. Lawrence and exchange with the adjacent, offshore slope waters. The water properties are also characterized by large seasonal cycles, depth differences and horizontal east-west and inshore-offshore gradients.

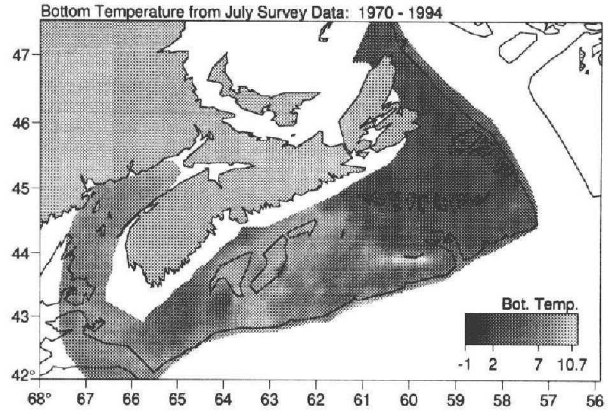
The seasonal temperature range of the waters over the Scotian Shelf decreases with depth. At the surface, the range is about 16°C but there is little or no seasonal change at depths greater than approximately 150 to 200m. In the shallow regions of the Gulf of Maine, such as Lurcher Shoals, the Bay of Fundy and Georges Bank, the seasonal cycle shows much less change with depth due to vertical mixing by the strong tidal currents.

In the winter, the water column in deep regions of the Scotian Shelf such as Emerald Basin consists of two basic layers. The upper layer (100 to 150 m depth) contains cold, low salinity waters and sits above a bottom layer of warm, salty water. The latter originates in the offshore slope region and enters 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 the warm bottom layer remains unchanged. This vertical structure varies over the shelf. The warm offshore waters do not penetrate the eastern Scotian Shelf and hence the CIL extends to the bottom. On the banks shallower than 150 m, there is also no warm bottom layer. In those areas of strong tidal currents, the waters, even in summer, are vertically well-mixed.

Despite these seasonal differences, the horizontal pattern of temperature and salinity is generally the same throughout the year. The temperatures and salinities increase from east to west and from inshore to offshore due to the influences of the warmer, more saline offshore waters and the outflow of the colder, fresher water from the Gulf of St. Lawrence. For example, in the summer at 50m, the long-term (1970-94) composite distribution of temperatures ranged from 0-3°C over the eastern Scotian Shelf, 3-7°C over much of the central shelf and 7 to 9.0°C over the western Scotian Shelf, eastern Gulf of Maine and Bay of Fundy.



The corresponding composite distribution of near-bottom temperatures shows that over much of the eastern Scotian Shelf the temperatures continue to range from 0-3°C and those over the western Scotian Shelf, eastern Gulf of Maine and Bay of Fundy continue to range between 7 to 9°C.



The temperatures over the central shelf now range from 3 to 9°C indicating the influence of the intrusion of the warm offshore waters and the temperatures along the southern and eastern edges of the Scotian Shelf range from 3 to 5°C, due to the higher temperatures of the deep offshore slope waters and the deep waters within the Laurentian Channel. The relatively cold coastal water near Shelburne is still evident in the near-bottom temperatures.

Time Trends

Long-term records of coastal sea surface temperature are available at Halifax and St. Andrews. The only long-term offshore monitoring station within the region is Prince 5, located at the mouth of the Bay of Fundy. However, time series have been reconstructed for the Lurcher Shoals, Browns Bank, Eastern Georges Bank, Georges Basin, Emerald Basin, Western Bank, Misaine Bank, Banquereau Bank, Sydney Bight and Cabot Strait areas from data stored in the AFAP data base.

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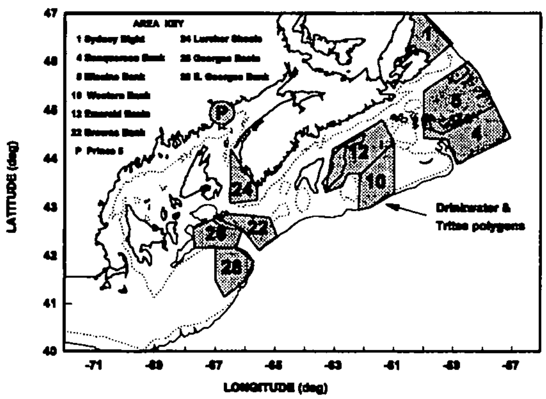
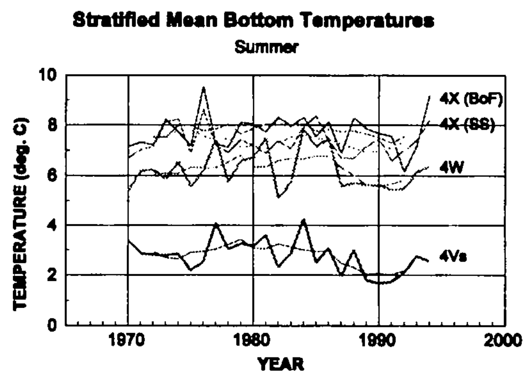
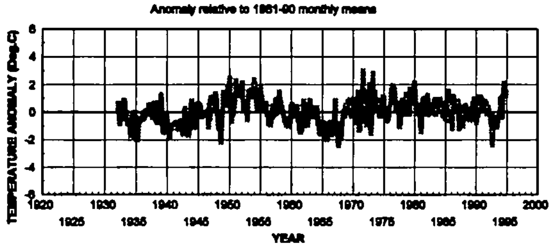


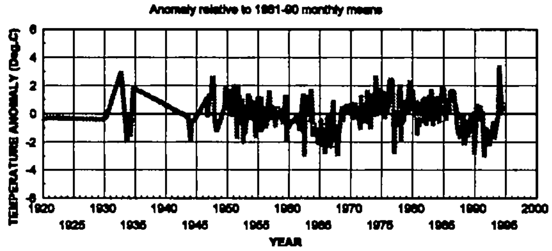
The time series show deviations (anomalies) of temperatures from the long-term (1961-90) monthly means for each area. With the exception of the Prince 5 series, the data are vary sparse in recent years and in the years prior to 1950.

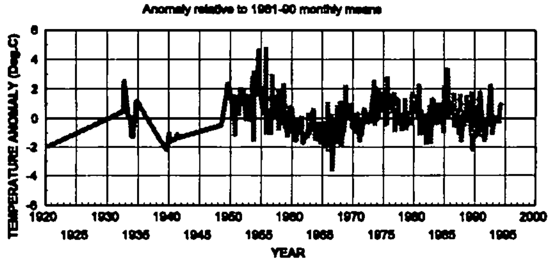
The series (see next two pages) are characterized by short period fluctuations superimposed on long period (10-30 years) trends with amplitudes of 1-2°C. Although the eastern, western and central regions of the Scotia-Fundy area do differ, a common underlying trend is evident. In general, temperatures were above average in the 1950s and declined to below average in the 1960s. This mid-1960s minimum is particularly evident in the western and central shelf areas (Prince 5, Lurcher Shoals, Browns Bank, Georges Basin, Georges Bank, Emerald Basin and Western Bank) where the amplitude of the low frequency trend is largest (about 2°C) and the lowest temperatures occurred during 1965-67. In the eastern shelf areas (Misaine Bank, Banquereau Bank, Sydney Bight and Cabot Strait) the amplitude of the low frequency trend is smaller (order 1°C) and the lowest temperatures occurred a few years earlier (1960-63). The temperatures rose in the late 1960s such that during the 1970s and the early 1980s they were near or above average at all depths. From the mid-1980s to the early 1990s the mid-depth waters cooled again and by the late 1980s to early 1990s temperatures were below average. During this time the deep waters remained near or above average, although they dropped below average in Emerald Basin and the Laurentian Channel in the early 1990s for a short period. The mid-depth and deep temperatures then increased in the western and central Scotia-Fundy areas (Prince 5, Lurcher Shoals, Browns Bank, Georges Basin, Emerald Basin, Western Bank) until about 1993-94 whereas they continued to decline in the eastern areas (Misaine Bank, Banquereau Bank and Sydney Bight).

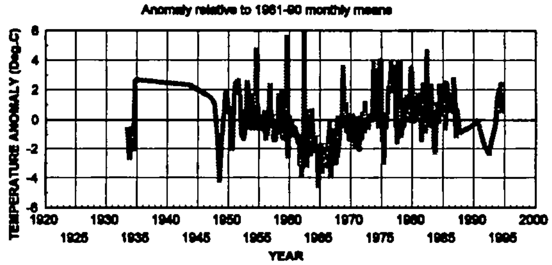
These general trends are also reflected in the time series of the summer research vessel stratified mean near-bottom temperatures for the Bay of Fundy (4X), western (4X), central (4W) and eastern (4Vs) Scotian Shelf areas.




PRINCE 5 at 50m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR


LURCHER SHOALS at 50m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR


E. GEORGES BANK at 50m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR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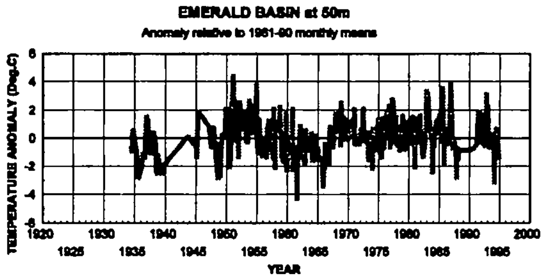
EMERALD BASIN at 50m
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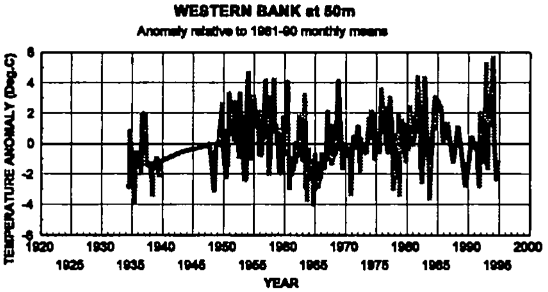
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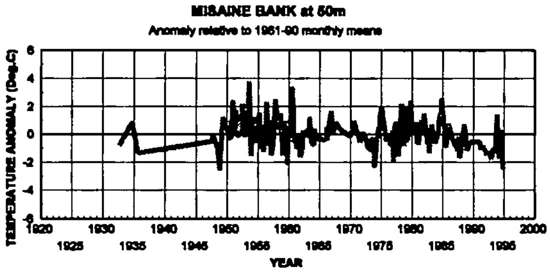
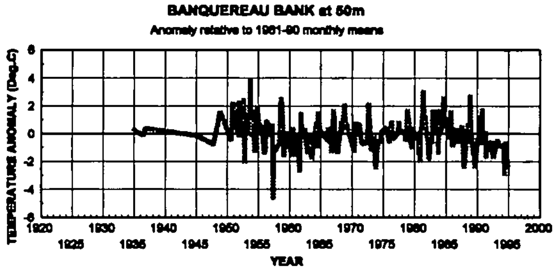
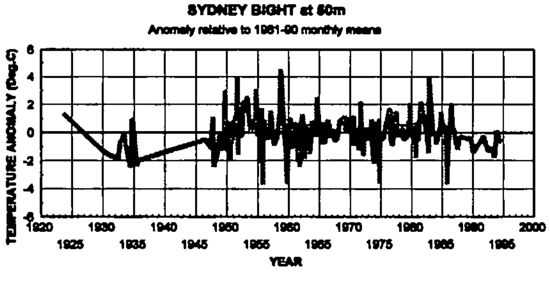

MISAINE BANK at 50m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR


BANQUEREAU BANK at 50m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR


SYDNEY BIGHT at 50m
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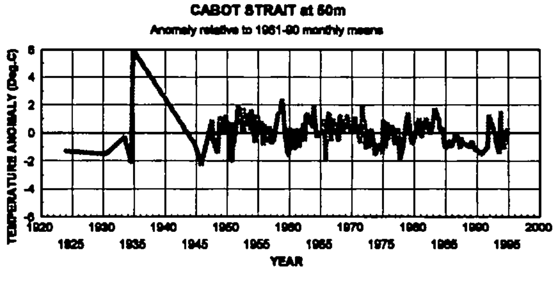
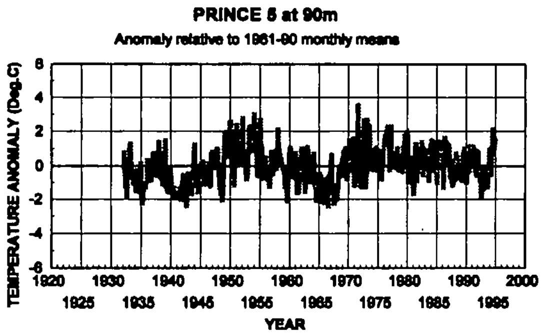
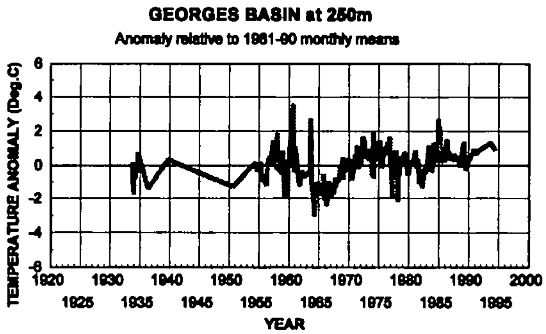

CABOT STRAIT at 50m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR


PRINCE 5 at 90m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR


GEORGES BASIN at 250m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
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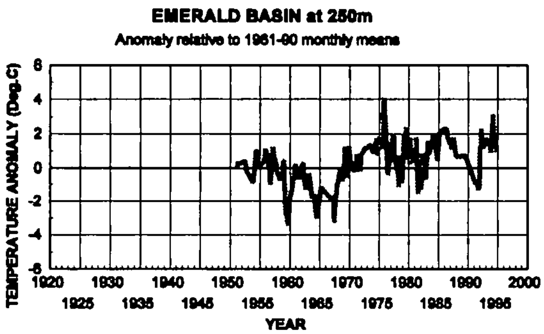
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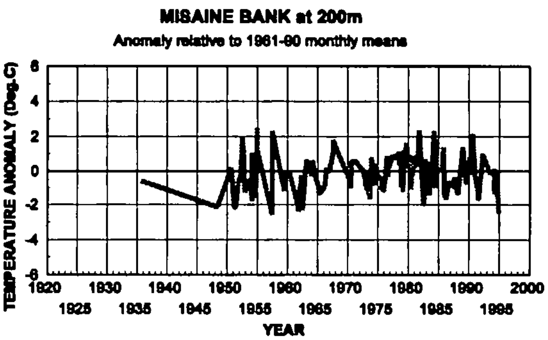
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR


MISAINE BANK at 200m
Anomaly relative to 1961-90 monthly means
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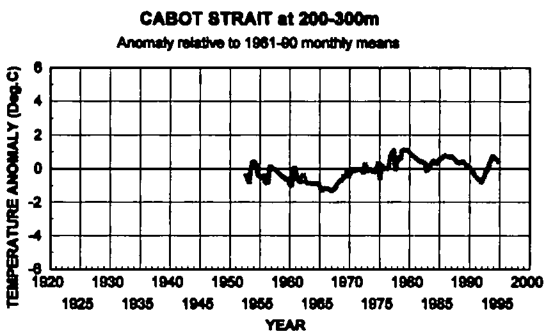
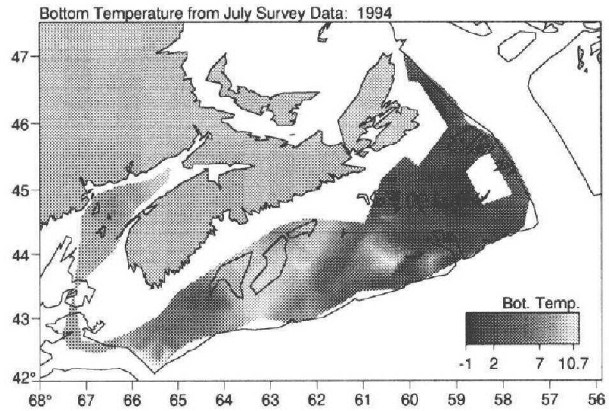

CABOT STRAIT at 200-300m
Anomaly relative to 1961-90 monthly means
TEMPERATURE ANOMALY (Deg.C)
YEAR

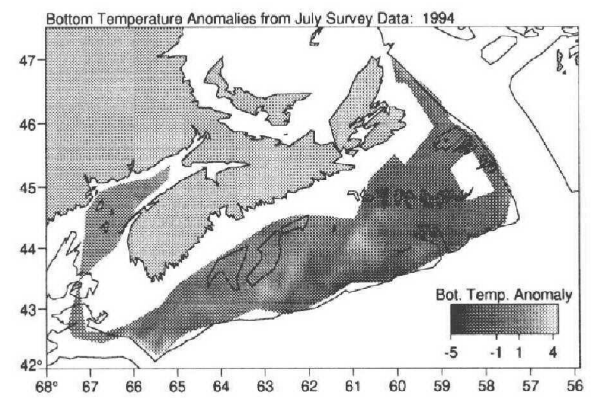
Conditions 1994

During 1994, the atmospheric circulation patterns produced near normal levels of annual precipitation, stronger-than-normal easterly winds during the winter and stronger than normal southwesterly to westerly winds in the summer over the Nova Scotia and Scotian Shelf areas. The winter winds advected northern air masses into the region which led to colder-than-normal winter air temperatures for the 10th year in a row. However, the summer winds produced warmer-than-normal summer temperatures with the net result of a warmer-than-normal or near normal annual mean air temperature for the region. This was reflected at the recording station on Sable Island, on the Scotian Shelf, where the annual mean air temperature was slightly warmer-than normal and warmer than 1993.

The wind and temperature patterns of the cold winter of 1994 caused ice to flow out of the Gulf of St. Lawrence onto the Scotian Shelf such that the ice extended along the coast of Nova Scotia to Halifax and beyond the 1962-87 long-term maximum in February and near the maximum in March.

Ocean temperature conditions in 1994 depended upon location and depth. The annual mean sea-surface temperatures (SSTs) were below normal in Halifax Harbour and above normal at St. Andrews and Boothbay Harbour. This resulted from below and near normal temperatures during the first few months of the year and warmer than normal temperatures for the duration of the year at St. Andrews and Boothbay Harbour. The temperatures at Halifax Harbour were below normal for nine of the twelve months. In the offshore waters temperatures tended to be slightly warmer-than-normal in the western Scotian Shelf/Gulf of Maine and Bay of Fundy areas, particularly in the summer and fall.





In contrast to 1992 and 1993 when the temperatures at Prince 5 and Lurcher were near the lowest on record, they were near the highest on record in 1994. This appears to be due to the intrusion of slope water through the Fundian Channel which in turn may be related to an above average number of warm core eddies formed in 1994 and the more northerly positions, relative to the long-term means, of the Shelf/Slope front and Gulf Stream. On the eastern Scotian Shelf, temperatures at mid-depth continued to be below or near normal.

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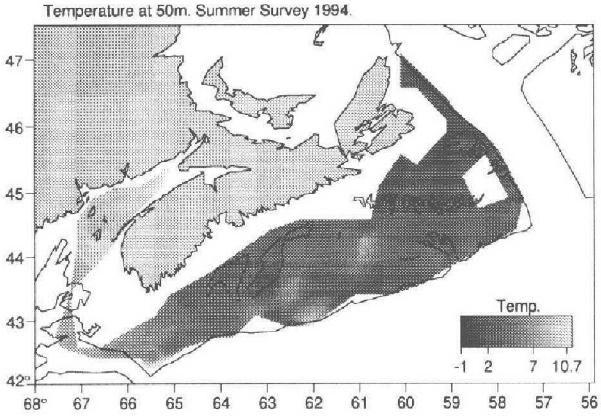
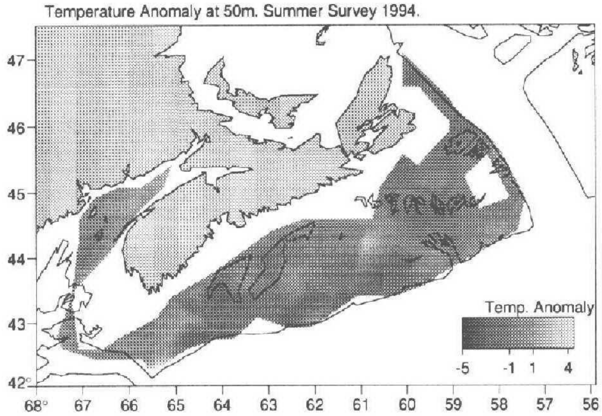
Temperature at 50m. Summer Survey 1994.



Temperature Anomaly at 50m. Summer Survey 1994.



Temperatures in the deep waters of Georges Basin, Emerald Basin and Cabot Strait were warmer than normal in 1994 whereas those in the deep waters around Misaine Bank were below normal. These patterns are also reflected in the time series of the summer research vessel stratified mean near-bottom temperatures and in that the number of summer survey stations with temperatures less than 0°C continued to be less than in 1992.

In summary temperatures within the Gulf of Maine were above normal in 1994, those in the northeast Scotian Shelf remained below normal, and those within the deep basins and channels remained above normal.

For More Information

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3. State of the Ecosystem

3.1 Plankton Trends

Phytoplankton levels as measured by the Continuous Plankton Recorder (CPR) "greenness" index generally decrease westward from the Grand Banks to the Gulf of Maine along the CPR sampling transect. This index reflects a change in the abundance of large species of phytoplankton and may be related to the levels of chlorophyll or primary production. Since 1991, in three regions (Grand Banks, Scotian Shelf and Gulf of Maine) the yearly mean greenness index has been higher than it was during 1961-76. In the period 1991-93, the large phytoplankton species were more abundant in the fall and winter months along the entire transect then they were in 1961-76. This indicates that factors influencing the phytoplankton levels operated over the entire sampled area. In the 1961-76 period the greenness index was generally higher over the Grand Banks than on the Shelf and Gulf of Maine. However, this pattern was not seen between 1991-93.

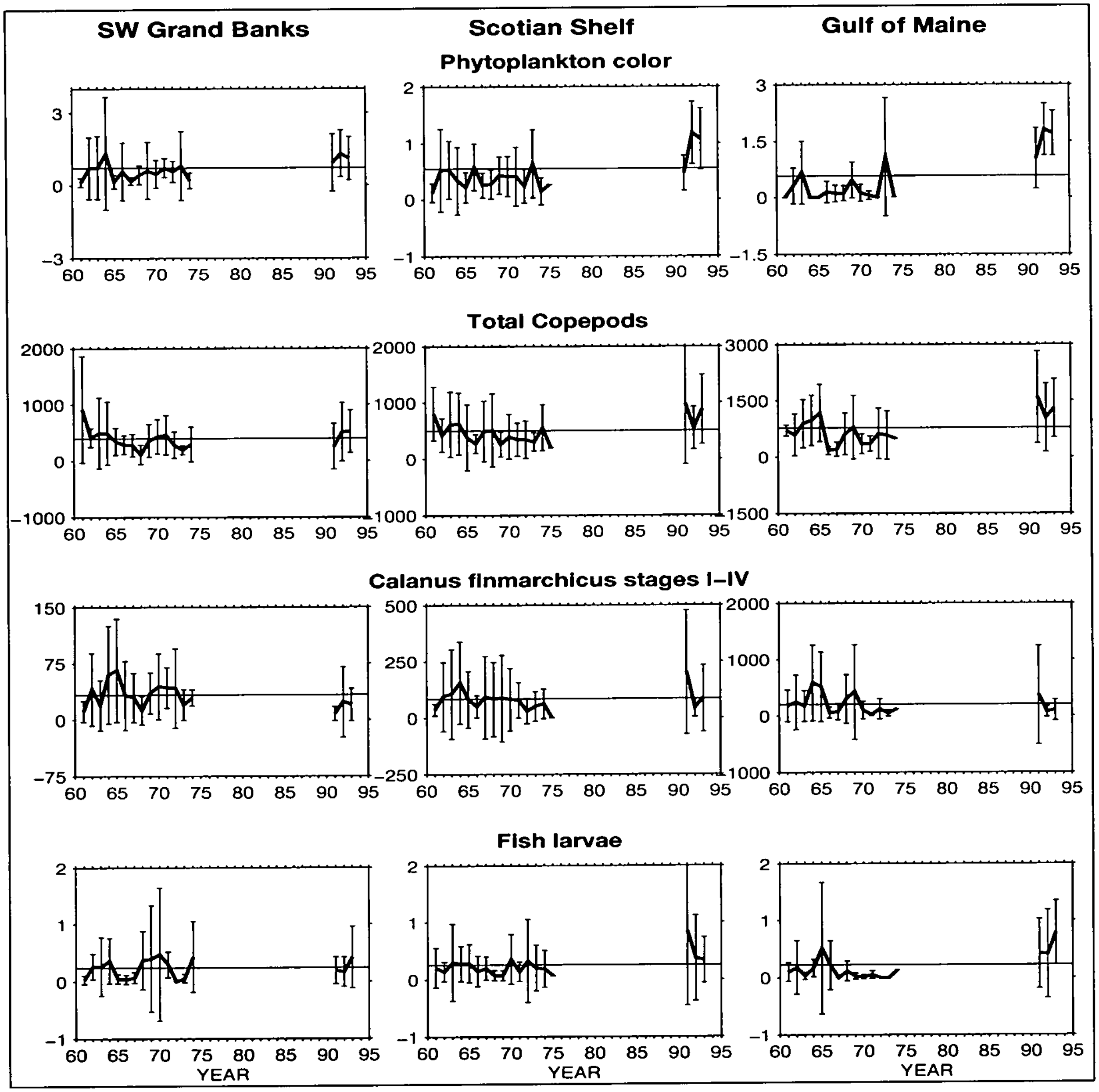
Between 1991-93 the total zooplankton or copepods levels on the Grand Banks were similar to those during 1961-76, while on the Shelf the levels were above the long-term mean. The general distribution pattern with longitude has not markedly changed in 1991-93 compared with the early sampling period. Concentrations of *Calanus finmarchicus* stages 1-4 have generally been lower than the long-term mean with the exception of 1991 on the Shelf and Gulf. A dominant feature of the *C. finmarchicus* stages 5-6 data are the low numbers found on the Grand Banks throughout the entire data series. Low levels of *C. finmarchicus* stages 1-4 were also seen on the Banks, however there were occasional years (i.e. 1971) when the numbers were high. Concentrations of *C. finmarchicus* stages 1-4 and 5-6 increased toward the western end of the transect during the entire time series, which agrees with unpublished results from net surveys that showed the Gulf of Maine generally had a higher concentration of *C. finmarchicus* than the Scotian Shelf. The Grand Banks were a region with consistent low levels of *C. finmarchicus*.

The populations of some species (i.e. *C. finmarchicus* and *Temora longicornis*) responded differently on the Grand Banks, Shelf and Gulf of Maine during different years, while other species (*Pseudocalanus spp.*) seem to be influenced in a similar manner in all regions at the same time. The physical and biological factors influencing *Pseudocalanus spp.* populations are unknown, but they appear to operate over the entire transect area.

Total euphausiids decreased in concentration in all three regions during 1991-93 compared to 1961-76. This may suggest lower levels of prey for juvenile fish.

The fish larvae on the Grand Banks showed evidence of a multi-year fluctuation that was not seen in the other two regions. Fish larvae concentrations have been above the long-term mean in all regions; however, since fish species are not identified, we do not know if this is due to a single or multiple species fluctuation.

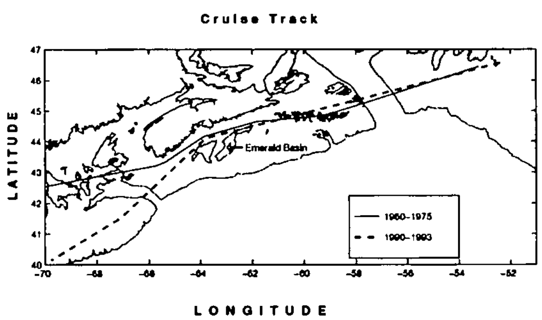
There was no evidence of a consistent long-term trend between 1961 and 1993 to suggest a systematic change in the zooplankton community in any of the regions. The main impressions one gets from the CPR data are that there are infrequent periods of high species abundance and frequent periods of low abundance and that years of low abundance are the norm; secondly, that fluctuations in



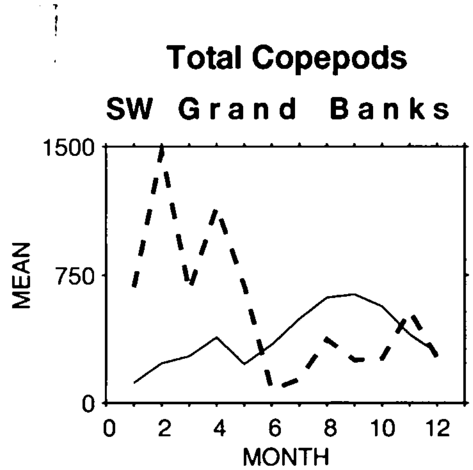
Yearly arithmetic means and standard deviations (SD) for selected CPR plankton taxa for three regions of the CPR sampling line. The SD are presented only to demonstrate that these data are extremely variable. The negative SD values result from zero monthly values in a particular year.

concentrations of some taxa are closely linked (i.e. *C. finmarchicus* stage 1-4 levels were positively correlated with total fish larvae). There were significant differences in the seasonality of the abundance of different components of the plankton in the three regions.

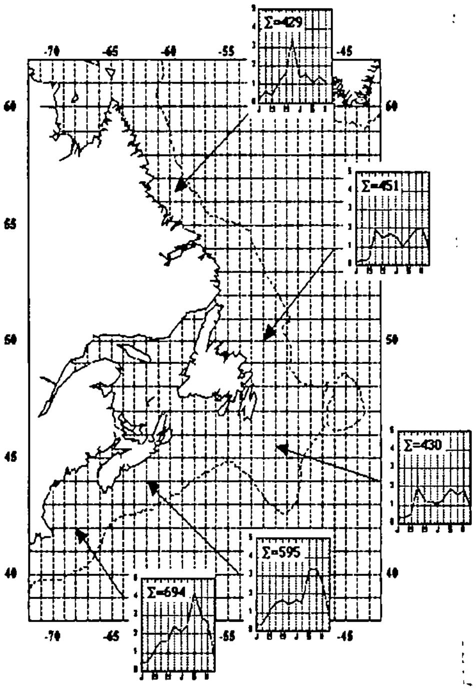
A study conducted in Emerald Basin suggests a possible link between the size of the *C. finmarchicus* population in the fall and the temperature anomalies of the water at 50m during the late spring when the species is reproducing and growing. The levels of *C. finmarchicus* in the Basin between 1987 and 1993 have been low relative to the 1985 and 1986 levels.



In general the CPR data showed relatively high levels of phytoplankton, zooplankton and fish larvae over the transect between 1991 and 1993 compared with the early 1970s. There has been a significant shift in the season for maximum total copepods on Southwest Grand Banks from the fall during 1961-1975 to the spring for the 1991-1993 period. There was no change in season for the other two regions. This is due to increases in *C. finmarchicus* and *Pseudocalanus spp.* in the spring.



Plans are underway to considerably expand the monitoring of phytoplankton in the next few years using satellite remote-sensing technologies. NASA will launch a new ocean colour satellite this summer (called SeaWIFS) which will provide unprecedented spatial (approximately 1 km^2) and temporal (global coverage every 48h) detail in the concentration of phytoplankton pigments in the surface ocean. DFO has put in place satellite receiving facilities at each of the three major Atlantic Zone sites (BIO, IML, Nfld.) providing direct access to these data. Further more, BIO scientists have developed mathematical algorithms to convert the colour signal to phytoplankton biomass and to production rate. These data will provide detailed information on the temporal cycles of phytoplankton in all regions simultaneously, information impossible to obtain by conventional ship-based sampling methods. An example is given below using data from the earlier NASA ocean colour satellite, CZCS which flew from 1978-1986, of the type of data that will be available.



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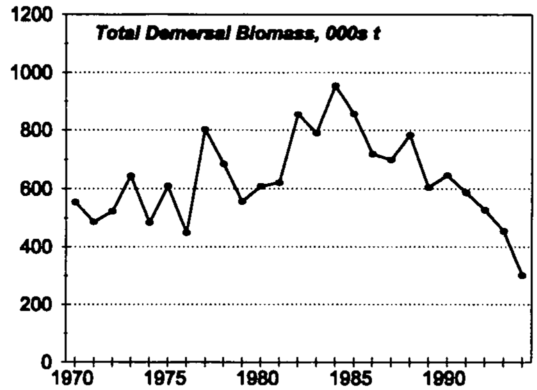
3.2 Finfish Community Trends

With the recent over-exploitation of many of the traditionally exploited fish species, increased attention and fishing pressure is being focused on new species or on species which were previously only lightly exploited. In order to manage this expansion in a rational manner it is imperative that an understanding of the fishery potential and ecological significance of these species be developed.

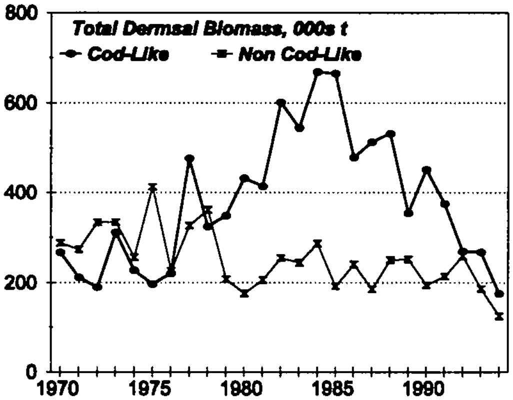
Our ability to determine sustainable harvest rates for these newly emerging fisheries is limited. In many cases the basic data required to address such issues is either unavailable or is scattered among a variety of sources ranging from the published literature to grey literature to unprocessed data. It is our intention to bring together, for a subset of these non-traditional species, the basic information on life history parameters (spatial distribution of life stages, timing of spawning, growth, physical oceanographic preferences), trophic interrelationships, stock structure, and trends in abundance and exploitation. There is a need for compilation and analysis of these basic data to provide a basis for investigating the dynamics of the ecosystem as a whole. Although we have monitored the abundance and age structure of a small number of species over the past 25 or so years, we have as a rule not analyzed the changes occurring in the unexploited or marginally exploited species. Examination of our historical data sets for these species may reveal general indicators of overall system productivity. The present version of these reports represents the first step of what will be an ongoing process over the next two to four years. The ultimate objective being to determine both the productivity of these non-traditional species but also their major roles in the functioning of the ecosystem.

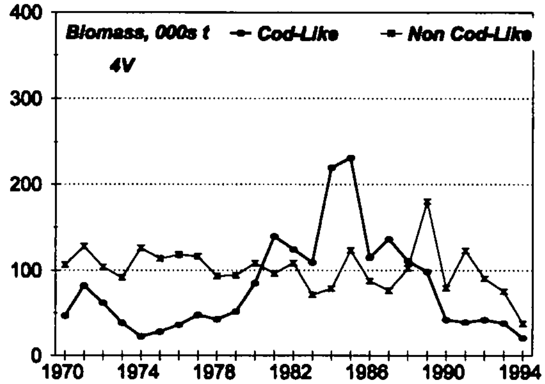
Trends in Fish Biomass

The following section describes trends in the trawlable biomass of finfish species on the Scotian Shelf. Trawlable biomass is calculated from the average weight of a species caught per survey tow multiplied by the number of tows it would take to cover the entire Scotian Shelf. Trawlable biomass is not necessarily an estimate of the absolute biomass of any species, but it is assumed to be a constant proportion of the total. This means that if in any given year a trawlable biomass of 1,000t is equal to a total biomass of 10,000t, this ratio would remain the same, that is, an estimate of trawlable biomass of 500t in the following year would mean a total of 5,000t. Trawlable biomass is an index of total biomass.



The biomass of all bottom dwelling (demersal) fishes on the Scotian Shelf increased from the mid 1970s to the mid 1980s and has declined to the present. Total trawlable biomass peaked at slightly under 1 million tonnes in 1984 and is presently at approximately 300,000t, the lowest observed since the initiation of standard monitoring surveys in 1970.

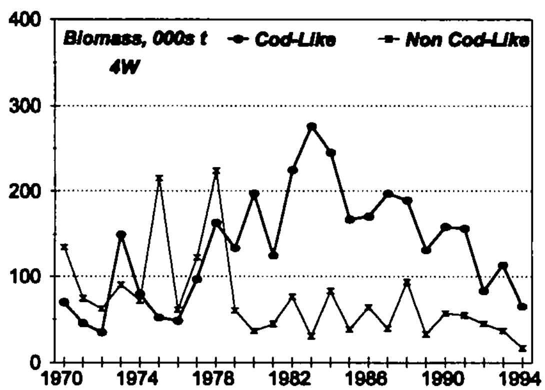




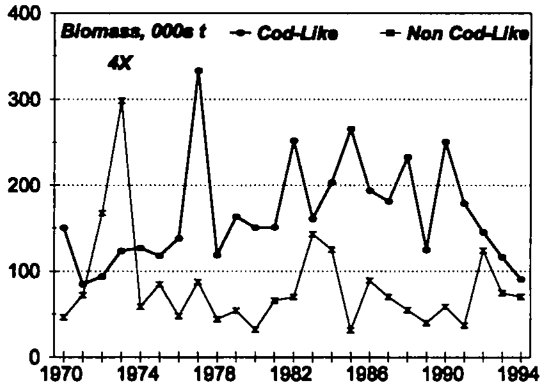
The biomass of all the cod-like fishes (gadids), which comprise the bulk of the commercially exploited demersal fishes and the bulk of the overall fish biomass on the Scotian Shelf, drives this pattern. The biomass of gadids and non-gadids was roughly equivalent during the 1970s whereupon gadid biomass increased rapidly to about 650,000t in 1984-85 and then declined to just under 200,000t in 1994. Non-gadid demersal biomass was relatively stable at about 200,000t over this period with some decline in the last few years.

On the eastern Scotian Shelf (4V) non-gadids were the dominant fishes in all but the period 1980 through 1988 when gadids dominated mainly due to an increase in cod biomass. Non-gadid biomass on this portion of the shelf has declined quite rapidly since 1991, while gadid biomass declined rapidly from 1985 to 1990 and is now at about the same level it was in the mid 1970s. Total trawlable biomass in this area has ranged form a maximum of about 350,000 tonnes to a low of less than 100,000t in 1994.

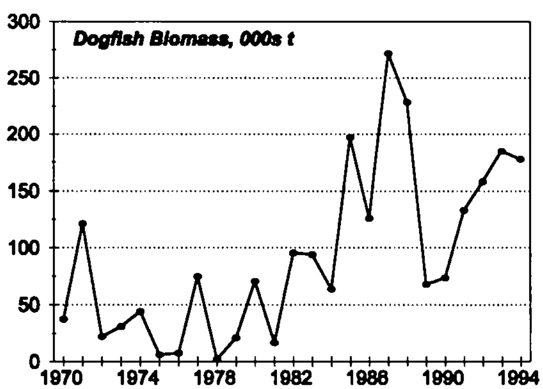
On the central Scotian Shelf (Division 4W) the distribution of demersal fish biomass is quite similar to that shown on the shelf as a whole. Since the late 1970s gadid biomass has dominated. Gadid biomass has been declining since 1983 and is presently at just over 50,000t, similar to what had been estimated in the mid 1970s. Non-gadids had been relatively stable at about 50,000t until 1990, since then the biomass of this group has declined steadily to a low of less than 20,000t in 1994. Total trawlable biomass in this area has ranged from a high of about 350,000 in 1983-84, to a low of less than 80,000t in 1994.



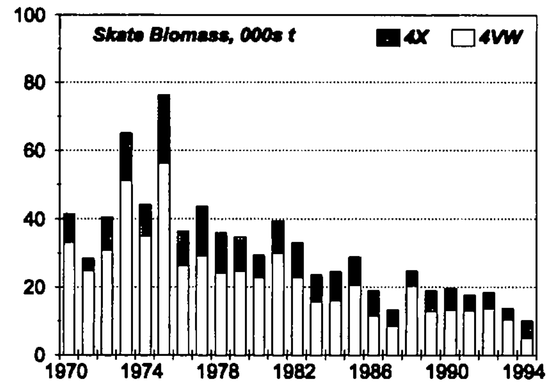
On the southern Scotian Shelf gadids have been the dominant portion of the demersal fish biomass for the last 25 years. Over this period gadid biomass increased gradually until 1985. Since 1990, gadid biomass has declined steadily. Non-gadid biomass, although variable, shows no trend over this period remaining at between 50,000 and 100,000t.



The above results do not include the small cartilaginous fishes (sharks, skates and rays). By far the most dominant species of this group is spiny dogfish. In contrast to most other species dogfish, which are concentrated in Division 4X have become more abundant in recent years. Dogfish biomass throughout the 1970s was generally below 50,000t. Since 1990, the estimated trawlable biomass of dogfish has been about 150,000t and appears to be increasing.



Of the small cartilaginous fishes, only skates are exploited to any degree and then only over the past few years. Skate biomass has traditionally been concentrated on the eastern Scotian Shelf and has shown a slow steady decline since 1970. Skate biomass on the central and southern portions of the Scotian Shelf show a similar pattern. Present estimates of trawlable skate biomass is on the order of 10,000t.



Trends in abundance for the individual non-traditional species considered are presented in individual sections of this report.

Species Assemblages

For any of these species the targetability, or the ability to catch it in isolation of other species, is important to the overall impact of its harvest on the ecosystem. If the species can be harvested in isolation, the direct ecological impacts may be more or less restricted to its immediate prey and predators. If the species is harvested with significant by-catches of other species, the ecological impacts of capturing these incidental species may also need to be evaluated. In either case our present ability to evaluate the ecological impacts of harvesting these species is limited. In the broadest sense, we address the issue of targetability by analyzing the spatial association of fish species as observed by the

July research vessel survey data.

Results of the spatial association analysis show that distinct groupings of fish co-occur in particular areas of the Scotian Shelf and that these associations are reasonably consistent over time. In general these "species assemblages" can be identified for 1) the approaches to the Bay of Fundy, 2) Deepwater basins either on the Scotian Shelf or in the Gulf of Maine, 3) shallow offshore submarine banks, 4) the slope and deepwater edges of the Scotian Shelf as a whole, and 5) the edges of the Fundian and Laurentian channels. Although the strengths of the association between species in any of these assemblage is variable, they are sufficiently strong to allow for the development of expectations of catch compositions. Examination of these associations for the last 25 years show that there have been shifts in associations and that these may indicate changes in environmental conditions which cause some species to move relative to others Further work is planned to refine these analyses and determine their utility in the management of emerging or existing fisheries.

Future Directions

In addition to the spatial association of these fish, we must develop a better understanding of their trophic interrelationships in the form of predator prey interactions. At present these are not well understood beyond a qualitative level, and then only for some of the species. Where these non-traditional species are prey for, or feed on, the more traditionally harvested species we need to be able to assess the effects of changes in their abundance or size structure on productivity of traditional target species. In many cases, the requisite information on detailed diet composition and predators may not be available and will require the initiation of new data collection programs.

This exercise is essentially a prerequisite to evaluating to what extent a more holistic or ecosystem approach could be taken in the management of this system. Changing the emphasis from single species assessments and management to ecosystem assessment and management, will require a substantial modification of the methodologies employed. In the single species models employed to date, the assessed species were treated more or less in isolation from all other components of the system including their prey, predators, and physical environment. In an ecosystem approach, the strengths and effects of these interrelationships must be taken into account. This is an emerging field with many outstanding issues such as 1) determining meaningful boundaries to the ecosystem of interest, 2) identification of the significant biophysical parameters driving the system, 3) determining the nature of the connections between these parameters, particularly how they affect productivity of target species 4) determining the level and nature of monitoring required to generate sufficient information on the behaviour of these parameters, and 5) determining the potential for mitigation. Compiling and analyzing the data on a wider spectrum of fish species, as is the objective of the present exercise, may give us greater insight into the behaviour of the ecosystem.

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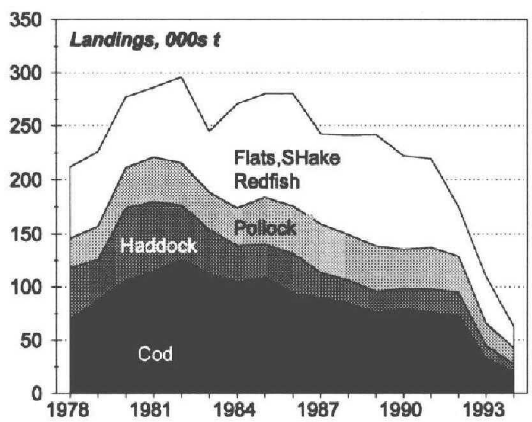
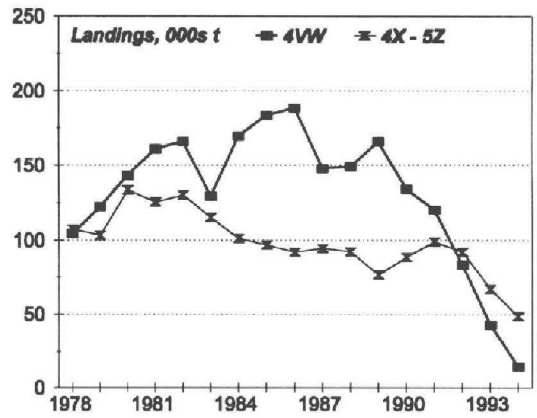
3.3 Groundfish Overview

After extended jurisdiction in 1977, groundfish landings of traditionally sought species in Scotia-Fundy Region rose to a high of almost 300,000t in 1982, and thereafter declined, first gradually and then more rapidly since 1991. The 1994 landings of 60,000t are the lowest ever recorded.



These declines have been most dramatic for cod but are evident for haddock, pollock, silver hake and the flatfishes. While some of this decline has been compensated in increased exploitation of other fish species such as skate and monkfish, much of the economic value of the fishery now depends on invertebrates such as snow crab, shrimp, and scallops. The groundfish decline has been most dramatic on the eastern Scotian Shelf. In the mid-1980s, this area provided much of the Region's yield in groundfish. Since 1989 however, the decline in landings from this area has paralleled those to the Northeast. In contrast, landings from 4X-5Z were almost equal to those in 4VW just after extended jurisdiction, and have only gradually declined since.



The cod stocks have, as elsewhere, suffered the largest decline. During the mid-late 1980s, all four cod stocks (4Vn, 4VsW, 4X and 5Zjm) exhibited relatively high levels of spawning stock biomass (SSB). In contrast, the 1994 SSB is either low or at the lowest observed. These levels are well below the long term median levels and are nearing the SSB considered dangerous to stock conservation.

Cod Stock	1994 SSB, t	Stock Status	Long-Term Median	SSBmin (Dangerous)
4Vn	?	Low	?	?
4VsW	19	Lowest observed	56	20
4X	30	Lowest observed	60	24
5Z	13	Lowest observed	28	14

Trends in exploitation rate can explain some of the recent declines. Prior to closure of the fishery in 1993, the 4VsW cod stock sustained very high rates of harvest, with up to 70-80 percent of the fishable stock taken annually. The 4X and 5Zjm stocks have also been heavily fished, particularly since 1990, with exploitation in the 40-60 percent range.

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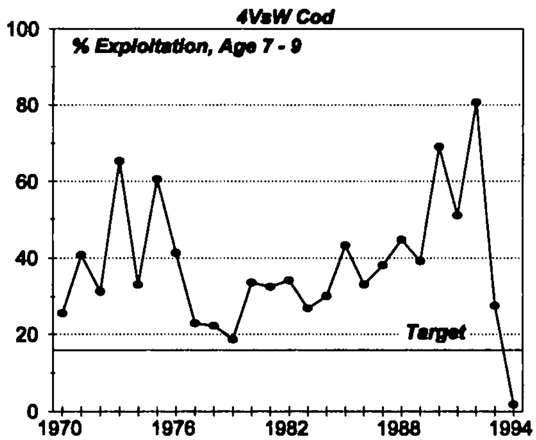
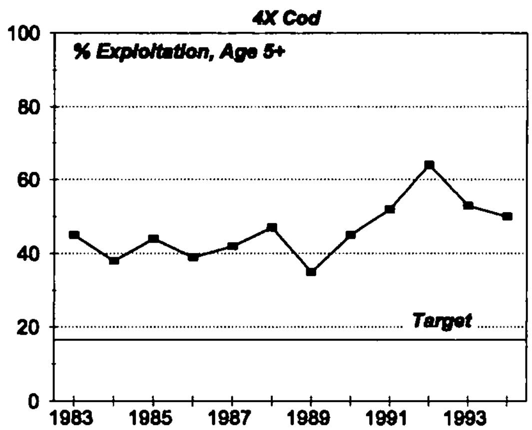
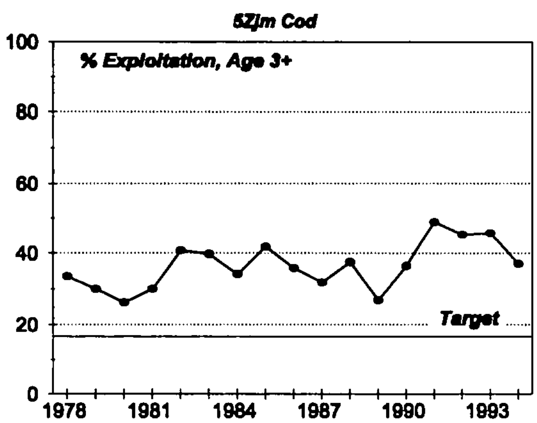






All four cod stocks benefited from either moderate (M) or good (G) recruitment during 1985-87. However, besides the 1989 year-class in 4Vn, the Eastern Shelf stocks have exhibited poor (P) recruitment for at least four consecutive years. There are as yet no positive signs for incoming year-classes for these stocks. This is in contrast to those in 4X-5Z where moderate year-classes have been seen for 1990 and 1992, (only 4X) although the 1994 year-class in 5Z appears to be the lowest ever recorded. The future for these stocks therefore depends on limiting exploitation on the 1990 and 1992 year-classes.

Stock	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
4Vn	P	P	G	P	M	P	P	P		
4VsW	P	M	M	P	P	P	P			
4X	G	M	G	P	P	M	P	M		
5Z	G	P	G	P	P	M	P	P	P	P

P = Poor; M = Moderate, G = Good

The three haddock stocks (4TVW, 4X and 5Zjm) have undergone population trends not dissimilar to those of cod. The Eastern Shelf stock now inhabits the closed area on 4W, whereas historically, it has occupied much of 4V as well. The summer survey indicates that 4X haddock spawning biomass is almost the lowest observed, although this is a odds with the observations of industry. The 5Zjm haddock resource appears to be below the SSB considered dangerous to stock conservation.

Haddock Stock	1994 SSB, t	Stock Status	Long-Term Median	SSBmin (Dangerous)
4TVW	12	Almost lowest observed	17	8
4X	10	Almost lowest observed	30	16
5Z	8.5	Almost lowest observed	12	14

Notwithstanding the low SSBs, it appears that the exploitation rate on these stocks was moderately lower than those on cod. Also, contrary to the cod situation, moderate to good recruitment has been observed in two of the three stocks during 1992-93. There are however signs of poor recruitment in 5Zjm in 1993 and 1994.

Stock	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
4TVW	P	P	P	G	P	P	P	M	G	
4X	P	P	M	M	P	P	P	M	G	
5Z	M	P	M	P	P	P	P	M	P	

P = Poor; M = Moderate, G = Good

Therefore, recovery of the haddock resources could be sooner than that of cod, as long as exploitation on the in-coming recruitment can be kept low.

Pollock has suffered a decline in biomass since 1985, this being due to sustained high exploitation (50 - 60% in recent years). Recruitment during this period has been moderate. Unfortunately, a poor 1990 year-class will require further restrictions on harvesting in the upcoming years.

Flatfishes on the Eastern Shelf have been the target of increased exploitation since the decline in the cod stocks. American plaice, yellowtail and witch all show signs of declining biomass and contraction of the population age structure into the younger age groups -- a sign of overexploitation. For these slow growing, long-lived species, the new management restrictions taken on these resources in recent years will require time for their benefits to become apparent.

On the Southern Shelf, while the flatfishes are being heavily exploited, there are mixed signals on resource status. While plaice and witch appear to be declining, there are encouraging signs for yellowtail. Winter flounder, however, a major resource in 4X, appears to be in decline, particularly in the main fishing areas.

The Unit 3 redfish population appears to be stable with signs of small fish entering the stock since the late 1980s and recent harvest rates being below the recommended level. However, as with the flatfishes, the information base for this assessment is limited and therefore a cautious approach to management is appropriate.

The following table summarizes the information in the stock status reports on the current resource conditions:

Stock	1994 Landings	1994 Exploit. %	1995 TAC	1996 $F_{0.1}$
4Vn Cod	Low	Low	0	Low
4VsW Cod	0.4	Low	0	Low
4X Cod	13.0	53.0	9.0	6.3
5Z Cod	7.3	37.0	2.5($F_{0.1}$)	?
4TVW Haddock	0.1	Low	0	Low
4X Haddock	4.3	40.0	6.0	< 6
5Z Haddock	2.7	35.0	3($F_{0.1}$)	?
Pollock	15.2	40.0	14.5	11.0
Silver Hake	8.0	NAFO	60.0	NAFO
4VW Flatfish	2.8	?	4.1	2.8
4X Flatfish	3.3	?	3.4	3.4
Halibut	1.1	?	0.85	0.85
Unit 3 Redfish	5.2	8*	10.0	10.0

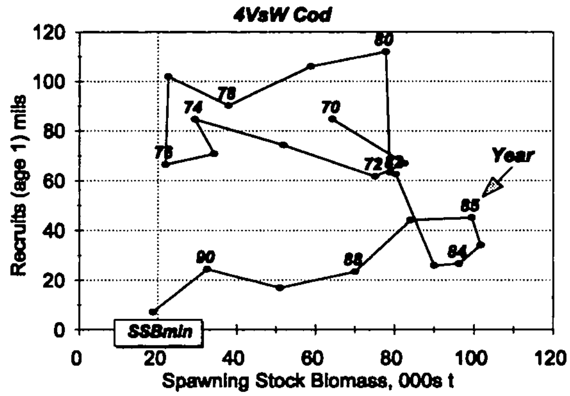
* = Percent of Survey Biomass

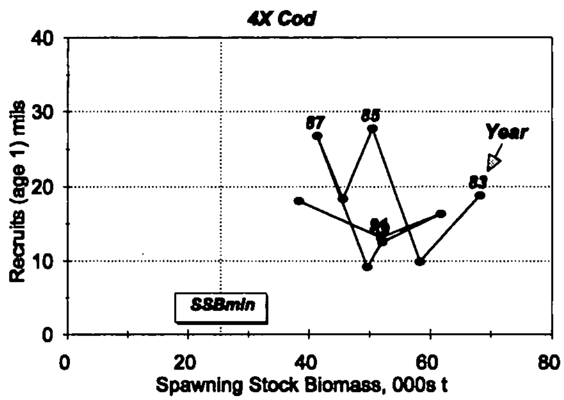
Stocks subject to open fisheries still experience exploitation rates well above the target level. There are signs in the case of haddock however that management measures have reduced exploitation. It is here that incoming recruitment will cause biomass to increase and if exploitation of these resources can be controlled, recovery may continue.

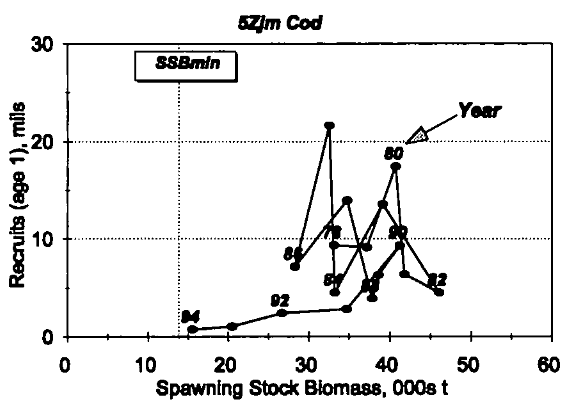
There is no doubt from the analyses presented in the stock status reports that overexploitation has played a major role in the decline of the traditional groundfish stocks. However, there are also signs that the ecology of the region has changed and that this has affected the productivity of the populations. These changes have been dramatic on the eastern Shelf where cold water conditions have predominated since the mid-1980s. Here, the condition of cod has declined over a long period, although with declining population, it should be increasing. The declines in the weights at age observed here have not been apparent in the stocks in 4X-5Zjm. Cold water species such as capelin are in abundance on the eastern Shelf and there have distribution changes of traditional species consistent with the changes in water temperature. Notwithstanding this, cod recruitment is lower than that predicted by temperature, indicating that survival is being affected by other factors, one of the principle being seal predation. This population continues to increase and consume large quantities of young cod.

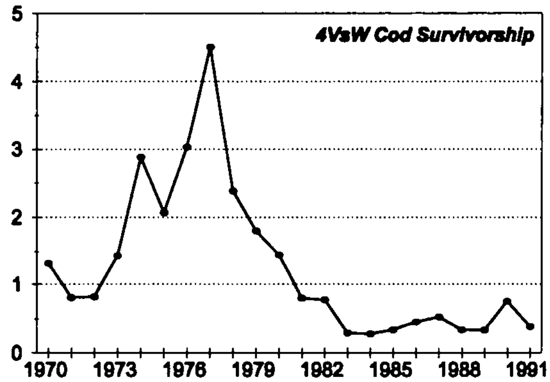
It is worthwhile examining the stock/recruitment relationships for the three cod stocks. These relate the magnitude of recruitment to the biomass that produced it. In general, above a certain SSB, recruitment will be on average good but below this SSB, it has a high probability of being poor. In the case of 4X cod, there is no evidence that recruitment is being affected by low SSB. This is in contrast to the situation in 5Zjm where the decline in recruitment is closely following that of the spawning biomass. Here, overexploitation is clearly influencing stock productivity.

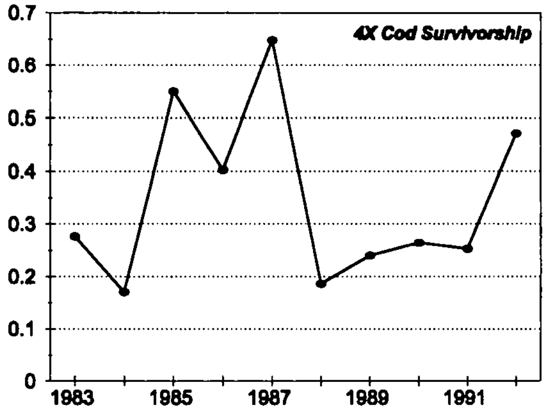
The situation is less clear in 4VsW. Here, recruitment was on average much higher for the same spawning biomass than it was in the 1980s. It is interesting to compare recruitment of the three stocks during this period. With a spawning biomass of 40,000t, 4VsW cod was producing over 80 million recruits annually, compared to 20 million and 10 million for 4X and 5Z cod respectively. Compared to the 4X and 5Zjm stocks, the survivorship (recruits produced per unit of spawning biomass) of 4VsW cod was by far the highest. This made this stock the most productive in the region, at least from a recruitment point of view.

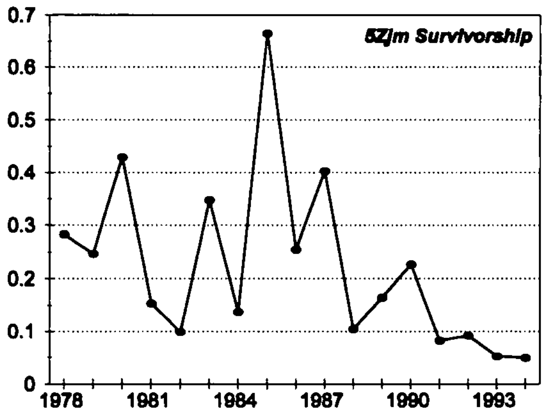












However, during 1980 - 84, there was a dramatic drop in recruitment production of 4VsW cod. This drop preceded the dramatic decline in water temperature and increase in the seal abundance. While it is now apparent that these factors are influencing current productivity, they may not be the cause for the long-term decline. However, the documented loss in the 4VsW cod spring spawning component occurred during this period and could have been a major factor in the loss of stock productivity. What caused this loss has not been determined. It is likely that the combination of unfavourable environmental conditions, predation pressure and overexploitation brought the stocks on the Eastern Shelf to their breaking point sooner than those to the south. Future management of these resources will have to take into account the regional differences in the underlying productivity of these ecosystems.

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3.4 Pelagic Overview

Two major herring resources (one spawning off southwest Nova Scotia, the other resident on Georges Bank), exist in the Region. TACs for the southwest Nova Scotia (4WX) resource have been 125-152,000t since the late 1980s, but recent landings have been declining so that by 1994, just over 80,000t were landed. In 1993, a new dockside monitoring program was introduced and led to accurate landings statistics for the past two years in a fishery which has been plagued by erroneous reporting. The fishery continues to be highly influenced by markets which sought larger fish than were commonly available in 1994. The larval abundance from research surveys, considered to be an index of spawning stock size, decreased considerably in 1994. This, combined with observations on the lack of large fish, low fat content, and distribution anomalies led to concern for the state of this stock.

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 steady recovery, such that an experimental Canada/USA fishery of 5,000t has been permitted since 1992 and up to 20,000t for 1995. Further increases in this 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 of St. Lawrence 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 1982 year-class passed through the population. Egg surveys in the last three years indicate that the spawn population has been stable at approximately 800,000t.

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

A number of large pelagic species (bluefin tuna, yellowfin tuna, bigeye tuna, albacore, swordfish, porbeagle shark, shortfin mako shark, blue shark) are exploited in the Scotia-Fundy Region. These species are highly migratory with the stocks inhabiting the West Atlantic in the case of bluefin tuna and porbeagle and sharks, the North Atlantic in the case of swordfish, albacore, and probably also blue shark 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 1994 West Atlantic bluefin tuna TAC was 1,995t, of which Canada caught 392t. The spawning biomass (8+) has declined steadily since the early 1970s to reach its lowest observed level in 1993, with a small increase in the most recent year. The 1994 West Atlantic bluefin mid-year biomass for 8+ fish was about 16% of the 8+ biomass estimated for 1975. The stock decline is due to a combination of steadily declining recruitment and high exploitation during the 1960s and 1970s.

Although Canada's 1994 harvest of bigeye, yellowfin and albacore was only 111t, 52t, and 32t respectively, all three stocks are being fished near their maximum sustainable yield and are not underutilized.

Recent North Atlantic swordfish landings have been around 15,000t annually with Canada's 1994 catch being 1,676t. Stock biomass has declined since the late 1970s and, in particular, the biomass of age 5+ fish (spawning stock) has shown a steady decline. Despite reductions in catches (in the order of 30%) and fishing mortality since 1988, the population has continued to decline, as catches have exceeded surplus production. The 1994 biomass is 32% below the biomass at maximum sustainable yield. The quotas set by ICCAT for 1995 still exceed surplus production and it is expected that the population will decline further.

Little information is available for the pelagic sharks (porbeagle, shortfin mako, and blue). The 1994 Canadian landings of these species were 1,545t of porbeagle, 157t of mako, 113t of blue, and 107t unspecified. The porbeagle is taken primarily in a directed longline fishery, but the others are caught 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 susceptible to overexploitation, particularly so in the absence of 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.

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3.5 Invertebrate Overview

Sea Scallops

Scallops are fished commercially on offshore beds dispersed along the Scotian Shelf from Middle Ground to and including Georges (major fishery) and Browns banks, and inshore at the Bay of Fundy's entrance (Lurcher Shoals/Brier Island) and on various beds in the Bay of Fundy from Digby (the major fishery) around to Grand Manan. Indicators of abundance (biomass and catch rates) were low for most of these stocks in 1994: the eastern Scotian Shelf stocks cannot sustain the harvest pressures of the recent past and the 1995 catch should be significantly reduced; Georges Bank's estimated 1994 recruit biomass was at a decadal low, decreasing 19% over 1993; and both 1994 catch rates and biomass on the Digby beds were at the lowest levels in 8 years. By contrast, landings on Brier Island/Lurcher beds increased for the fourth consecutive year, however, all three indicators of stock health - catch rates, abundance and pre-recruit abundance decreased. Similarly, catches on both Browns and German banks increased by a factor of about three, but the latter stock likely cannot sustain this removal.

Prognosis for many of the stocks is not good: biomass of three year olds on Georges Bank is at an all time low, but biomass of larger animals is high due to recent selective fishing. A likely overestimate of biomass the past few years, resulted in a quota somewhat higher than optimal. Resource waste through yield overharvesting is a concern, particularly with the larger-than-normal harvests in the year's first quarter. Recruit abundance on the eastern shelf stocks appears poor and closures are recommended. Yield overharvesting is severe for the Digby and Brier/Lurcher stocks; each should be managed to prevent resource waste and optimize yields. The use of both temporary and annual closures were recommended to protect both pre- and early-recruits. Recruitment overharvesting is a concern for both fisheries. Permanent and temporary closure areas were strong options for protecting brood stock, and hence, future recruitment.

Shrimp - Scotian Shelf

This fishery was underdeveloped to 1992 and is likely yet not fully developed. There is a single inclusive quota for the three Holes; Louisburg, Misaine and Canso with landings taking place from March through December. Landings have increased steadily since 1992 as have catch rates as determined by logbook data, and a fisher-directed questionnaire. Allocation by enterprise allocation has allowed the fleet to enhance yield-per-recruit by targeting larger animals through the year. Egg production appears high although some inshore animals appeared to have lost clutches. It was recommended that an annual June survey be undertaken and that bi-monthly sample sizes be increased.

Snow Crab - Eastern Cape Breton

The fishery began in 1978; landings rose in concert with effort to 1982, when both landings and catch rates collapsed. A pulse in recruitment and an expanded fishing area (offshore) allowed catch rates to increase from 1987 through 1993. Landings in 1994 were down overall by 24%; the decrease per stock ranged from 35% to 39% in all but one stock (24), which remained steady (the only stock where fishers landed significant numbers of softshell animals). Catch rates declined in all stocks, which suggests crab abundance has decreased.

Resource concerns include softshell (up to 50% of the catch and 26% of the landings), reduced pre-recruit abundance and record effort levels.

Key recommendations are to cap potential effort (number of trap hauls per day) at 1994 levels in all fisheries and eliminate resource waste (the landing of soft crabs).

Lobster

Eastern Nova Scotia's (LFA 31/32) lobster fishery collapsed during the 1970s. Recruitment overharvesting was one hypothesis developed to account for this collapse. Brood stock ecological studies were initiated to permit a better understanding of egg production. It was learned that lobsters reproduced at a much smaller size in the eastern portion (Canso) of this stock (about 33% have reproduced before entering the fishery) than in the west (Jeddore-about 5% have reproduced before entering the fishery), which has a significant affect on egg production. For every 100 females remaining on the grounds in the east and west, the approximate number of eggs produced will be 900,000 and 100,000 respectively. Remedial measures to improve egg production in the west could range from an increase in minimum legal size through to a maximum legal size for females.

Southwestern Nova Scotia's (LFA 34) inshore lobster fishery yielded stable landings from post-W.W. II through to the early 1980s, when increasing lobster abundance grounds provided the base for improved catch rates; landings increased by about 3.5 times. In fact, 1994 landings were three times higher than the average for the period 1950-1979. Indicators of stock status; landing trends, effort, catch rates and recruitment index suggests a healthy fishery.

The expansion in grounds was seaward to the offshore/inshore lobster line (92 km from shore), grounds (commonly referred to as either the middle or mid-shore grounds). Many believed that this area contained an abundance of large mature females and it was hypothesized to be a major brood stock for the inshore area. A recent study indicated that 10% of the licensed fishers fished the midshore for at least part of the season and that the landings represented 10-12% of the total for LFA 34. At-sea samples of the catch show that lobsters are only moderately larger than in the nearshore. While there is a higher proportion of mature sizes in the mid-shore, the fishery accounts for only 12% of all the mature lobsters landed in the LFA 34 - offshore 4X region. The larger nearshore fishery lands 78% and the offshore 10% of the mature animals. It was accepted that the midshore is not a distinct stock, but extensions of the nearshore and offshore stocks.

Stock status for the short-term appears good; over the longer term however, there is considerable concern. High exploitation rates and low egg production do not bode well for the sustainability of recent catch rates. Measures to decrease exploitation rates and enhance egg production are recommended.

Offshore lobster (LFA 41) grounds are seaward to and contiguous with LFA 34 grounds. The fishery, initiated in 1971, has landed a relatively stable annual catch throughout this period, although 1993/94 yields were up 29% over those of the previous season. Since the mid 1980s the fishery has targeted areas in the Gulf of Maine and Fundian Channel region, in part because of the smaller average size, with less emphasis on the slope region of Georges Bank and the Scotian Shelf. Stock status indicators are landing trends, catch rates, catch size structure and abundance (based on trawl (USA-NMFS) surveys), all of which have remained stable throughout the fishery's history.

Concern was expressed that the only fishery-independent data available were the trawl surveys, which does not target lobster. As well, changing fishing power and practices and the inability to verify logbook based information on the number of traps hauled, weakens the use of catch rates as a long term abundance indicator. Recommendations include an annual fishing plan that distributes effort over the various offshore fishing grounds, to avoid over concentration in any one area, and the institution of a logbook system that satisfies industry's concern for confidentiality.

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4. State of the Fishery

4.1 Fishing Capacity Trends and Economic Performance

The parameters of fishing capacity are both physical and economic, including:

- number of licensed vessels
- size of vessels
- gear technology
- other technology
- knowledge of fishers
- cost of building and maintaining capacity

Some of these can be readily measured, and changes documented. In a case such as technological change, while new developments can be noted as we become aware of them, we cannot easily measure them quantitatively, nor their impacts on capacity.

The economic goals of fisheries management have been defined as viability of harvesters (earning sufficient profit and income to survive without aid), and economic sustainability, which is very long-term viability. There are several gauges available to assess progress towards these goals. These include:

* Gross revenue from fish sales (derived from landings/sales records). Time series can be examined for an entire fish stock, a fleet, an average vessel, or a licence holder.

* Total personal income for fishers, including net fishing income, other earned income, transfers such as UI. This data is obtainable (averages only) from taxfiler data compiled by Statistics Canada.

* Vessel capital and operating costs (collected in costs and earnings surveys). This cost data, with gross revenue, enables estimation of net revenue of active vessels.

There are several limitations to the development of economic performance measurements in the fishing industry:

* Revenue data is subject to increasing problems in matching landings with prices. As dockside monitoring becomes more prevalent, increasing the accuracy of weights in the landings data, the catch reporting activity becomes further removed from the buyer, where price is determined. Hence landings and prices must often be obtained from different sources.

* Costs and earnings surveys are limited by budgets and staff. Licence holders in some fleets resist providing data to the Department, for a variety of reasons.

* Taxfiler data tailored to fisheries requirements is expensive to obtain from Statistics Canada. It is imprecise as to fishery. The data is two or three years old before it is available to DFO.

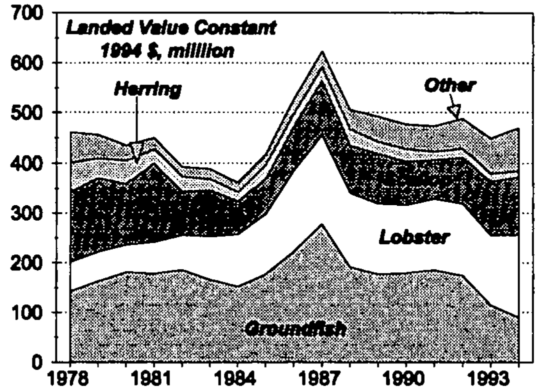
Developing annual series for net revenue and economic rent is time-consuming, and imprecise at best. Sample data is currently collected on a three-year cycle. Many assumptions are required to extend this to the much larger population of fishers and to interpolate between sample years. In the end, reasonable estimates can be obtained for revenues and fishing costs. Profitability, however, under normal business circumstances is a narrow margin between revenues and costs. It is risky to read too much into such margins when they are derived from models based on interview data.

Definitions must be developed and adhered to over time. For example, what are the fisheries whose progress we must monitor? How do we define them? As individuals? As groups of licences? Of vessels? Each alternative will present a different set of answers and require different types of data and analysis.

While consistency in measures over time is essential for monitoring changes in economic activity in the fisheries, it is also important to define fisheries and measures which are meaningful in the context of current management. Much work has been done in the DFO economics community in the past 10 years to set up systems to monitor economic performance. Unfortunately, much of this has not been updated recently due to the emergence of special programs related to both the groundfish problems, and to the DFO Program Review activities. What follows is an overview of broad performance measures, and a selection of more specific measures in a few key fisheries.

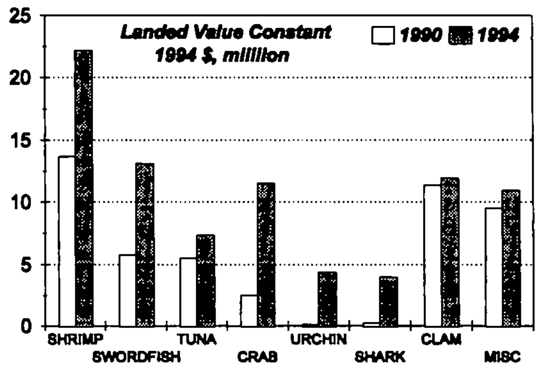
Trends in Scotia-Fundy Landed Value

The data in the figure below have been converted to constant 1994 dollars to illustrate the purchasing power of Regional fish landings (harvesting revenue) since 1978. The surge in demand for fish products in the 1984 to 1987 period, resulting in large price increases, is evident in the graph.



As groundfish catches dropped sharply after 1992, effort diverted to "other" species led to a marked increase in landings in that category, to the extent that the value of the "other" category matched groundfish landed value in 1994.

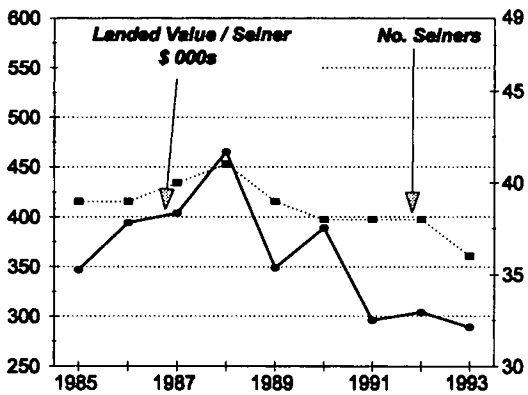
The "other" group is further broken down by species, which compares 1990 and 1994 values, also in constant dollars. The eastern Scotian Shelf shrimp fishery developed quickly during this period, following introduction of the Nordmoor grate to exclude groundfish from the trawls. Resource abundance and prices combined to bring the crab fishery over $10 million in landings. The most dramatic changes have been in the sea urchin and shark fisheries, which have come from nowhere to make significant contributions to the Regional fishery.



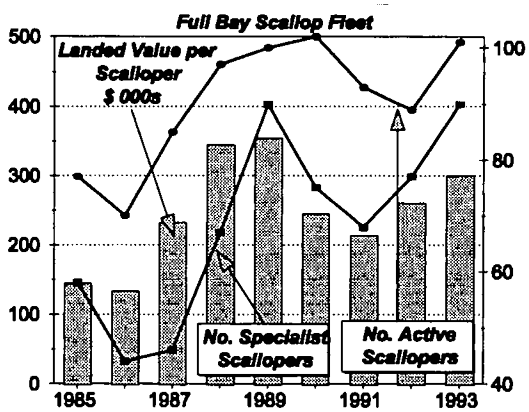
Capacity Utilization

The figures and tables below illustrate the degree to which licensed capacity in terms of numbers of boats has been utilized over the years since 1985. The top of the graphs indicates the total licences issued in each fishery. In some cases, the average landed value per vessel is also indicated.

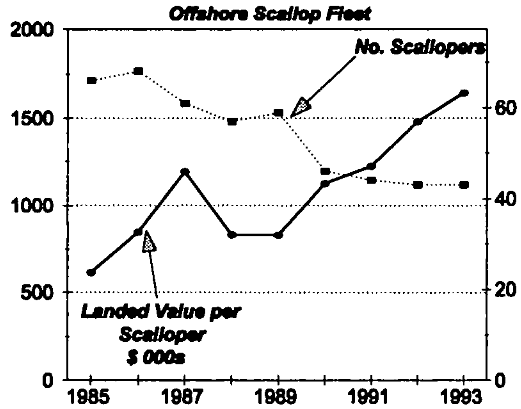
The **herring purse seine fishery** has been managed by means of individual transferable quotas (ITQs) since 1983. At the beginning of this period, there were 49 licences. For a variety of reasons, including the particular ITQ program design, capacity rationalization in this fishery has been slow. Nevertheless, the number of active specialists in the fishery had decreased to 36 by 1993. The average landed value per boat has been on a downward trend since 1988, mostly due to weak product demand and prices.



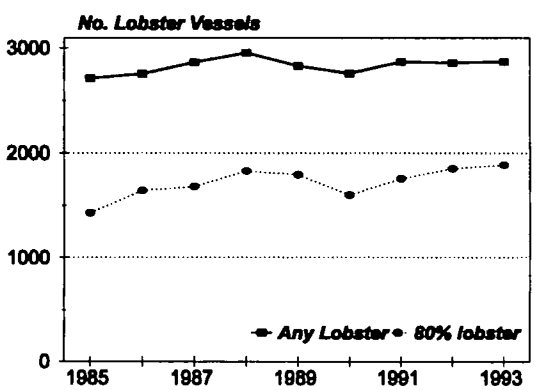
The activity in the **Bay of Fundy (full-Bay fleet) scallop fishery** is illustrated below. In this case, a stock bonanza in the late 1980s brought virtually all 99 licensed vessels into the fishery. (The 101 active vessels indicated in the figure is some years is due to double-counting when a licence is used on two vessels in the same year.) The lower line in the chart represents the number of "specialists" in this fishery. A specialist in these charts and tables is defined to be a vessel with a minimum of $10,000 in gross revenue and earning 80% of gross revenue from the relevant fishery. The vessels which were active but not specialists in this scallop fishery in a particular year, were most likely fishing groundfish. Although groundfish ITQs after 1991 provided some incentive for dual-licence holders to transfer their quota and concentrate their vessels on scallops, the number of active scallopers declined slightly until the scarcity of groundfish in 1993 brought them back to the scallop fishery. Average revenues per vessel (bars) increased dramatically during the 1980s boom, then dropped, but remained above the long-term average into the 1990s.



The **offshore scallop fishery** adopted a TAC and an enterprise allocation management (EA) regime in 1986. The licence holders opted to set conservative TACs in order to increase the stock biomass. This served to increase catch rates, and effort measured in fishing days decreased while the stock was growing. The number of vessels applied to the fishery declined from 68 in 1986 to 43 in 1993. The resulting increase in net earnings by the licence holders enabled the replacement of several very old vessels with newer ones, and the retirement of others.

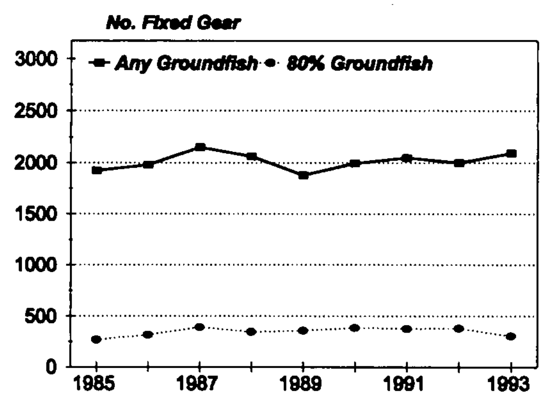


Most **Scotia-Fundy lobster** fishermen earn a relatively good return on their investment and labour during this seasonal fishery. This explains the high utilization of licences with almost all licences being active. Fifty to sixty percent of lobster licence holders are specialists, earning 80% or more of their fishing revenue from lobstering. Most of these depended entirely on lobstering for their fishing earnings. This number has been increasing since 1990, possibly due to the decline in the groundfish fishery.

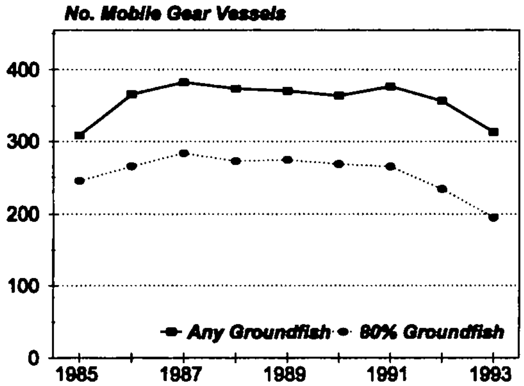


In the early 1990s the lobster specialists caught about 75% of all the lobster caught in the region. The remaining 25% was caught by the more diversified multi-species operators, who also caught some groundfish and other species.

The **groundfish fishery** is in many ways the most complex of Scotia-Fundy fisheries. The inshore fishery for groundfish has more unused licences in any year than any of the other major fisheries. The number of specialists in the large fixed gear sector is only about 10-15% of the total, and this ratio has not changed dramatically over the last ten years. In spite of their small proportion of the licences, the inshore fixed gear specialists together catch 65% of the total catch of the fixed gear group, while the remaining 1500 active licences catch 35%, and the 1000 inactives catch no groundfish. These numbers suggest a large excess capacity for groundfish in the inshore fixed gear fleet.



The mobile gear fleet has a smaller but increasing proportion of unused licences. Vessels in this fleet are constrained by their individual quotas. Inactive vessels cannot fish groundfish without first acquiring quota from another licence holder.

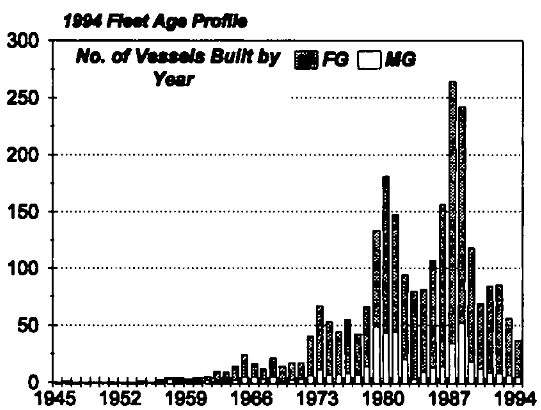


If fixed gear these fishermen directed their full attention to fishing groundfish, their fishing capacity is far in excess of the fixed gear allocation. However, it is not realistic to view this as strictly groundfish capacity. Many of the unused and non-specialist vessels are also involved in fishing lobster, swordfish, scallop or other species. They retain their groundfish licence to supplement earnings in the other fisheries, and value it as an alternative fishery in case of the failure of their other fisheries. This large number of underused licences is a problem only when their activities on the water cannot be controlled, or when by force of numbers they disrupt orderly allocation of TAC shares to deal with some immediate crisis, or when the small fishing activity of large numbers is used by them to access the national income support programs.

In the table at the end of this section, the specialists in each of the major fisheries are isolated to show their numbers (the No. of Vessels column), and the value of their catches of the main species. It is obvious, looking down the columns, that the specialists catch the majority of fish in each column. The "multi-species" groups are non-specialists, split into over and under-45 ft. length categories.

Fleet Age Profile

In the figure below, all currently-licensed Scotia-Fundy groundfish fishing vessels appear in the year in which they were built. The building booms of 1978-82 and 1986-87 are clear. It is also evident that vessel replacement activity has been declining in the mobile gear sector since 1987. The fixed gear fleet had a secondary burst of activity in 1990-91, in spite of the restrictive cubic-number replacement rule then in place. The current state of the groundfishery should dampen interest in boat-building for that fishery for some time.



Some of the more prominent of the traditional and of the newer or growing fisheries are outlined in terms of their contribution to changes in revenue for inshore mobile, inshore fixed, and the midshore/offshore fleets between 1990 and 1994. This is a very generalized depiction, as the individuals and companies experiencing increased earnings are not necessarily the same ones suffering losses of groundfish. However, in this broad sense, the inshore mobile and midshore/offshore sectors were neither better nor worse off on the revenue side than in 1990. The inshore fixed gear or mixed-fishery sector has seen substantial overall revenue increases thanks to higher prices and catches in a number of non-groundfish fisheries.

Species	Inshore Mobile Gear	Inshore Fixed Gear	Vessels Over 65 ft.
Shrimp	+3.1		+6.6
Scallops	+9.1		+26.5
Lobster & Crab		+49.5	
Swordfish/ Tuna/Shark		+9.5	+4.4
Sea Urchins		+4.3	
Groundfish	-11.1	-28.8	-37.2
Approx. Net Change 1990-1994	+1.1	+34.5	+0.3

Summary

From a total revenue point of view, the multi-species nature of the Scotia-Fundy fishery has dampened the blow of groundfish declines in recent years. This diversification is reflected in the landings statistics.

Precise measures of economic performance are difficult to come by, but:

* the fishing revenue base is about the same as it has been since 1988;

* as there has been relatively little boat-building for the fisheries since the 1986-87 period, the fixed costs of fishing should be stable or declining;

* there are reports that the lay arrangements for fishing crews have been changing in recent years, resulting in crews receiving a lower percentage of vessel revenues than they previously had earned; and

* bankruptcy levels are low among fishing enterprises.

There are no comprehensive measures of fishing capacity. Innovations in vessels, gear, electronics, or navigational aids can cause step function increases in the fishing power of the fleet. That means that available quotas are more quickly caught. Fishers who want to remain active can pose a threat to the resource if not controlled.

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Scotia-Fundy Landed Value by Species and Vessel Dependency, 1992

		Landed Value (Current $000)					
	No. of Vessels	Groundfish	Lobster	Scallops	Herring	Other	Total
Gross over $10K with 80% dependency on:							
Groundfish	615	123044	834	229	2	1030	125141
Lobster	1846	2829	103386	51	17	471	106754
Scallop	120	793	60	81153	0	1621	83627
Herring	38	0	0	0	11502	39	11541
Multi-Species < 45	753	24566	31610	5039	61	13860	75137
Multi-Species > 44[1]	53	8165	219	2123	306	21672	32485
Gross less than $10K	988	1227	1792	71	34	198	3321
Total Scotia-Fundy Based Vessels	4413[2]	160625	137901	88665	11922	38893	438006
Landings that are not attributed to specific vessels + Landings by non Scotia-Fundy based vessels		21503	3110	385	6047	15907	46952
Total Landings in Scotia-Fundy[3]		182128	141011	89050	17969	54800	484958

NOTES:

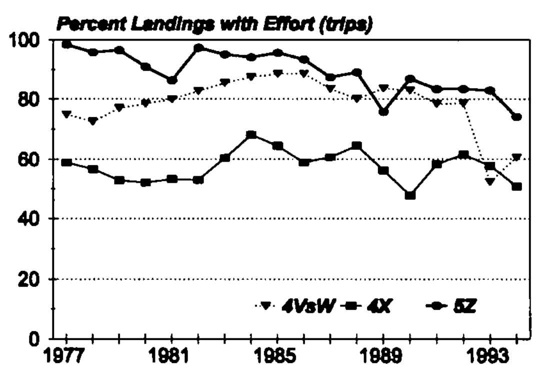
1 = These include shrimp and offshore clam vessels.
2 = In addition, there are over 2000 vessels registered that had no recorded landings.
3 = Totals may not add up due to rounding.

4.2 Effort Trends

A suitable measure of effort can provide an indication of trends in fishing intensity. It would be desirable to get a complete census of all fishing activity in an area. Information from the commercial fishery was available in the Zonal Interchange File Format for all regions from 1987 to the present. From 1977 to 1986, the information was available only for Scotia-Fundy Region in the Scotia-Fundy Analytical File Format. It would have been desirable to use a measure of effort with the greatest resolution, eg. hours fished for trawlers, #hooks-soak time for longliners, etc. or even days fished, but these quantities are not recorded consistently. As we were seeking a complete census of effort and not a sampling to derive catch rates, we were compelled to use trips as a measure of effort, as identified by unique CFV-landed date entries. We describe the trends in fishing effort on traditional groundfish, defined here as cod, haddock and pollock, since 1977 by the principle fishing fleets in each of three zones, the eastern Scotian Shelf (Div. 4VsW), the southwest Scotian Shelf (Div. 4X) and Georges Bank (Subdiv. 5Ze).

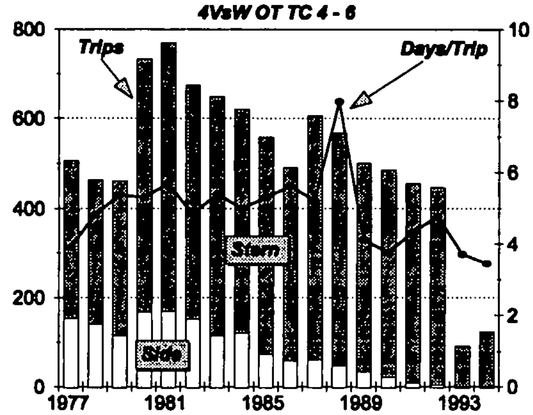
Examination of the database revealed that over the time period 1977 to the present, there were inconsistencies in the recording of information for tonnage classes 0 and 1 vessels. Consequently, this analysis of effort could only be conducted for tonnage classes 2 and greater. The principle gears employed to fish traditional groundfish in the Scotia-Fundy Region are otter trawl, longline, handline and gillnet. Since most of the handline and gillnet fisheries are conducted by tonnage classes 0 and 1 vessels, effort summaries were only produced for longline and otter trawl.

A trip was counted if any amount of cod, haddock or pollock were reported landed from the zone of interest. We have aggregated tonnage classes 2 and 3, commonly referred to as the "inshore", and tonnage classes 4 and 5, commonly referred to as the "offshore". There are few longliners greater than tonnage class 3, therefore statistics for these are not reported. Differences in efficiency between tonnage classes 2 and 3 vessels are not known for either otter trawlers or longliners but we used results from Gavaris and Sinclair (1985) for the relative power of tonnage classes 4 and 5 otter trawlers. Their results showed that tonnage class 5 stern trawlers were about 1.5 times as efficient as tonnage class 4 side trawlers. The results shown are standardized to tonnage class 5 stern trawler effort. The few tonnage class 6 vessels were included with the tonnage class 5 results as these vessels are near the boundary of the tonnage class 5 and 6 distinction. There were few tonnage class 7 vessels and these were not considered. As trip duration may vary, the days fished per trip for those trips where days fished was reported, were computed and examined. Also, since a complete census of all fishery sectors was not possible, the proportion of the total landings represented by the enumerated trips was reported.

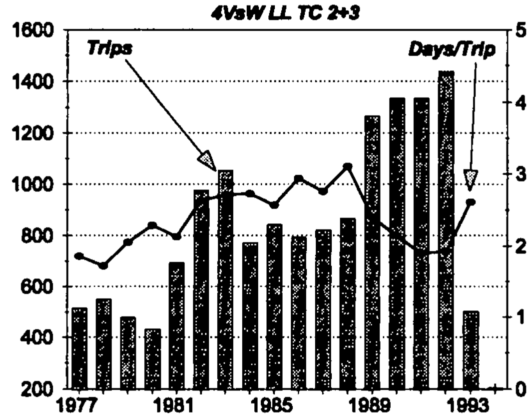


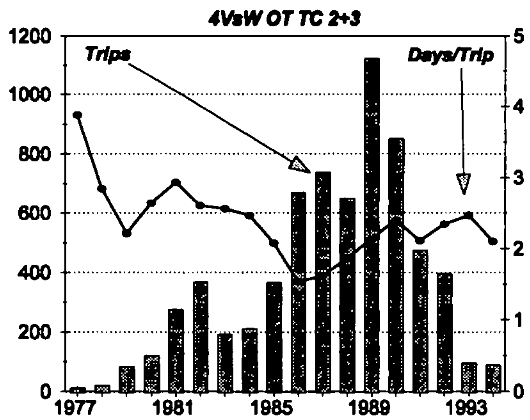
Results for each of the areas are summarized. Note that days fished was not entered on the database for longliners in 1994.

4VsW



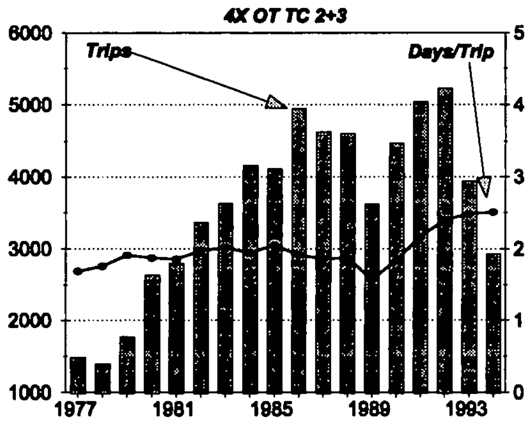
Landings represented by the enumerated trips accounted for about 80% of total landings from 1977 to 1992 and declined to about 50% in 1993 and 1994. This trend suggests that the decline in effort indicated in these graphs is greater than the decline in fishing intensity. There were no persistent trends in days per trip for any of these sectors though the decrease for LL from 1989 to 1992 which corresponds with an increase in trips should be investigated. Longliner effort appeared to increase until 1992 while "inshore" otter trawler effort started declining earlier. The peak in "inshore" otter trawler effort in 1989 was probably associated with the early closures of the 4X and 5Z fisheries in that year. Both longliners and "inshore" otter trawlers show a substantial increase in effort between 1977 and the early 1990s. The effort by "offshore" otter trawlers increased in 1980 and slowly decreased by 1992 to roughly the same level as in 1977. Effort in 1993 and 1994 was greatly reduced.

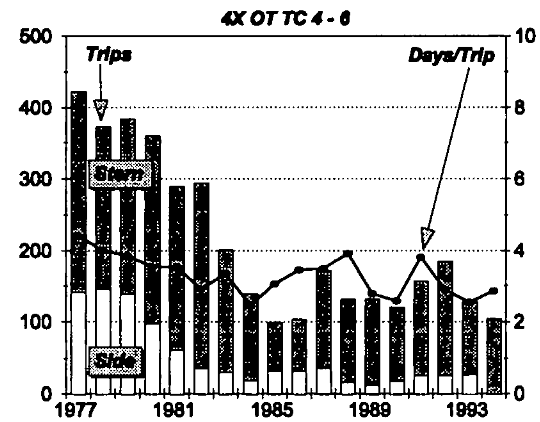


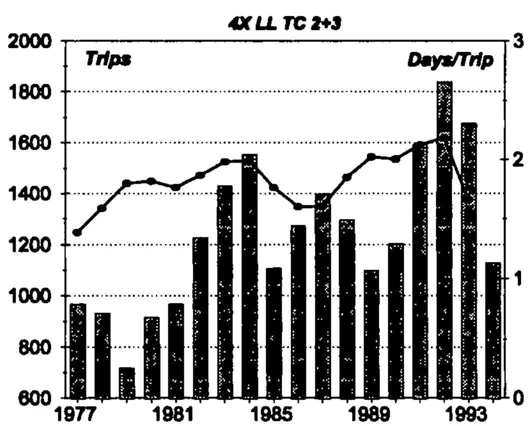


4X

Landings enumerated by trips accounted for about 60% of total landings from 1977 to 1994. There appears to be some increase in days per trip for longliners and "inshore" otter trawler over the series while the trend is more erratic for "offshore" otter trawler. Effort by longliners and "inshore" otter trawlers increased in the early 1980s and remained at high levels until the early 1990s. The reduced effort by "inshore" otter trawlers in 1989 was due to an early closure of the fishery. Effort by "offshore" otter trawlers decreased in the early 1980s and remained relatively stable thereafter. Effort by all three sectors shows a declining trend from 1992 to 1994.

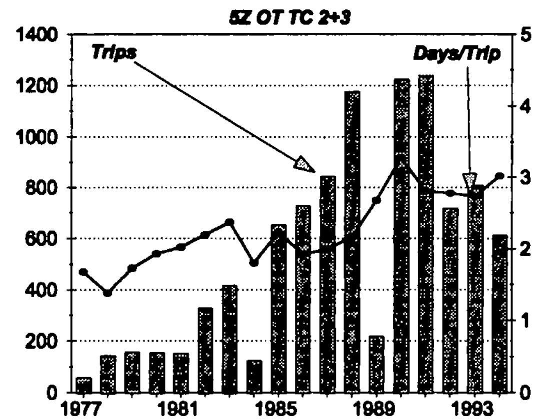


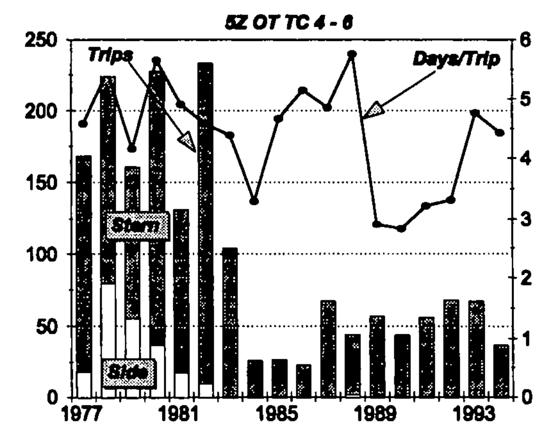


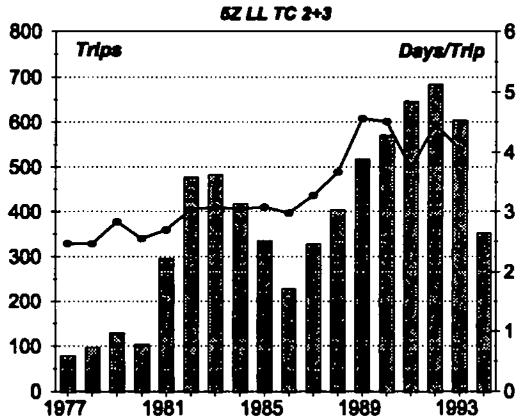


5Ze

Landings enumerated by trips accounted for about 90% of total landings from 1977 to the mid 1980s and then declined to about 80% . There appears to be an increase in days per trip for both longliners and "inshore" otter trawlers during the late 1980s. The number of trips also increased during this period although the increase had begun earlier for longliners. The number of trips by "offshore" otter trawlers declined during the early 1980s and remained relatively stable. The very low number of trips in 1989 by "inshore" otter trawlers was due to a closure after only about 2 weeks of fishing. The number of trips by "inshore" otter trawlers declined markedly in 1992 and remained at about that level while the trips by longline did not decrease substantially until 1994.







Summary

The broad patterns suggest a general increase in effort in all areas between 1977 and the early 1990s with some decline thereafter. It must be recognized that these crude measures of effort do not account for changes in seasonal distribution or spatial distribution of fishing activity which are known to affect catchability. Over this period, the nature of the fishery has changed considerably. For example, in recent years, the tonnage classes 2 and 3 otter trawlers have been placed on an individual quota program and the degree of targeting or directing for cod, haddock and pollock has changed. It may be useful to develop a meaningful way to display the degree of targeting using species composition of the catch.

Two potential complications with this analysis of trip effort may be amenable to reconciliation. One problem with the present analysis is that trips which span more than one of the defined areas will result in a trip being counted in each area. We could develop a more sophisticated algorithm which counts trip fractions based on the portion of fishing days in each zone, when fishing days are reported, or based on portion of the landings in each fishing zone otherwise. The second problem arises from the inclusion of trips where very small amounts of incidental catch are reported, as perhaps might happen in a redfish fishery. After examination of the frequency distribution of proportion traditional groundfish, it may be possible to identify a threshold level for inclusion of trips.

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References

Gavaris, S., and A. Sinclair. 1985. Abundance indices of 4VsW cod. CAFSAC Res. Doc. 85/39.

4.3 Groundfish Regulatory Activities in 1994

On 29 November 1993, the Fisheries Resource Conservation Council (FRCC) released its report to the Minister of Fisheries and Oceans on the 1994 conservation requirements for Atlantic groundfish. In aggregate the recommended TACs for 1994 are approximately 60% lower than the initial TACs set for 1993. Specifically for the Scotian Shelf, the Council recommended that there be no directed fishery for cod on the Eastern Scotian Shelf (4Vn, 4VsW) and reduced TACs for both cod and haddock in Southwest Nova (4X).

Other recommendations concerned the protection of small fish, minimizing by-catches to permit other fisheries to continue and actions to avoid the redirection of effort onto other stocks. In order to implement these conservation requirements, harvesting plans were again required for all fleet sectors prior to beginning fishing for 1994.

Harvesting plans were also required for vessel wishing to direct for any non-traditional species at more than a 10% by-catch level. Four vessels were selected from the ITQ fleet to fish skate, with a 2,000t quota.

Dockside monitoring was continued for the ITQ fleet and all EA companies. A catch reporting system (government funded) was put in place for the fixed gear fleet. For 1995, an industry funded catch reporting system was put in place for the entire fixed gear fleet. The generalist fleet tried a 50% monitoring system in 1994. Generalists able to hail accurately in 1994 were permitted to continue this approach in 1995.

Flounder were separated into a 4X and 4VW component. After a fleet share review, traditional shares were upheld (51% offshore, 49% inshore). Winter flounder were placed under quota management. ITQs were introduced in August of 1994 for 4X while flounder in 4VW remained under a competitive quota throughout 1994. ENS licence holders were given the option to choose an ITQ system or a competitive fishery for 1995.

Georges Bank remained closed to the offshore fleets until July 1st, while other fleets started fishing June 1st. TVRPs continued to be utilized by the offshore. A fixed gear sentinel fishery was established in 4Vn.

The 1994 fixed gear fishery was managed using A and B quota groups, trip limits and gear categories (A1-A10). An interim plan was put in place for 1995 to allow the fleet more time to develop a longer term Conservation and Harvesting Plans (CHP). For 1995 five quota groups were established each with its own quotas, seasons industry trip limits, etc.

For the 1995 fishery, DFO announced that it would not be enforcing any trips limits. Industry initiated their own trip limits and penalties. Licence conditions would only be issued once a year while variation orders would be used to open and close fisheries.

Conservation elements covered by the 1995 CHPs were standardized for all fleet sectors and applied on an Atlantic wide basis as far as possible.

By-catch of non-traditional species was set at 10% at the beginning of 1995, though later adjusted to accommodate fleet requests and proposals for directed fisheries.

The following table lists the general management regulations in effect for 1994/95.

4X5Z	4VW
130 mm square mesh required for ITQ(<65' mobile) vessels, 90 mm or greater for redfish.	No directed fishery allowed in 4Vn January-April 30.
155 mm diamond mesh or equivalent square mesh required for the >65' fleet, changed during the year for Georges Bank, to 130 mm square. For 1995 the fleet required to use 130 square mesh in 4X . Mesh size for Georges Bank is under discussion.	No redfish fishery in 4VW (January 1 to April 30) for the ITQ fleet. No flatfish fishery in 4Vn (January 1 to April 30), for ITQ fleet.
Browns Bank closed to all gear 1 Feb-15 June.	145 diamond mesh permitted for seiners in 4Vn, fishing flatfish, otherwise 155 mm square mesh required.
Redfish small fish closed areas implemented. Flounder ITQs introduced. Winter flounder was placed under quota management in 1994.	130 square mesh, for cod, haddock and pollock, 90 mm or greater for redfish.
Fixed gear industry funded catch reporting system established for 1995.	Minimum size regulations for cod, haddock and pollock (43 cm), 41 cm in 4Vn and 81 cm for halibut.
#12 hook required for fixed gear as of January 1995.	Continued closure of the 4W nursery area to all gear.
6 inch gillnets required on Georges Bank. Reduced amounts (1050 fathom) of gillnets required for new Brunswick side of the mid-Bay Scallop line. Other areas were limited to a 2,400 fathom length.	155 diamond or equivalent square mesh required for >65' vessels. Small fish test areas continued.
DFO enforced trip limits were removed for 1995.	Test fishery required to open mobile gear fisheries.
Mandatory landing continued for all regulated species except for <81 cm halibut, dogfish, skate and lumpfish.	Mandatory landings for all regulated species continued except for <81 cm halibut, dogfish, skate and lumpfish.
Small fish test fishing areas established in 1994 continued. Test fishery not required to open.	#12 hook required for fixed gear as of January 1995.
Georges closed to all gear 1 Jan-1 June, remained closed until 1 July for >65' fleet.	#14 hook required for directed halibut fishery

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References

Annand, C., and J. Hansen. 1995. Management activities for 1994 and early 1995 in the Scotia-Fundy Region. DFO Atl. Fish. Res. Doc. 95/45: 33 p.

4.4 Gear Impacts

In 1990, the Scotia-Fundy and Newfoundland Regions of DFO initiated a collaborative research project on the potential impacts of mobile fishing gear on benthic marine ecosystems. The results of the first experiment conducted in the intertidal zone of Minas Basin suggested that the impacts of otter trawling are relatively minor in that particular high-energy habitat. Attention then shifted to offshore habitats on major fishing banks. Existing equipment was modified and new equipment developed to collect the required benthic information. Most notable are a video-equipped sled for collecting epibenthic organisms, a video-equipped grab for collecting sediment and infaunal organisms, and an acoustic imaging system (mounted in the grab) for gathering non-destructive information on sediment structure and large organisms. Used in conjunction with state-of-the-art navigational technology, this equipment can sample precise locations on the seafloor. Surveys were conducted in 1991 and 1992 to explore possible experimental sites on Western Bank and the Grand Banks. A site was chosen on the Grand Banks about 60 km northeast of Hibernia. This area (mean depth of 137 m) had not been subjected to heavy trawling in the past decade, could be closed to mobile gear for an indefinite period, has a medium-fine sand that is easy to process, and has an abundant and diverse community of benthic organisms.

The experiment began in July 1993 with the establishment of three 13 km long corridors in close proximity to each other but with different bearings. These corridors were trawled twelve times by the *C.S.S. Templeman* using a rockhopper-equipped Engel 145 otter trawl. At the end of each pass, the trawl was retrieved so that the catch could be sorted and the number and biomass of benthic organisms recorded. Sidescan sonar surveys were conducted by the *C.S.S. Parizeau* before and after trawling along each corridor. Benthic samples were collected with the epibenthic sled and videograb before and after trawling along two of the three corridors. In addition, control samples were collected along control corridors immediately adjacent to the trawled corridors. Variables measured include epifauna, macrofauna, meiofauna, bacteria, sediment grain size, organic carbon/nitrogen and acoustic structure of the sediments. The *C.S.S. Parizeau* returned in September 1993 to investigate conditions two months after the initial trawling. During a third cruise in July 1994, conditions one year after initial trawling were investigated, corridors were then trawled a second time in identical fashion, and another set of samples was collected to provide a second data set on immediate impacts.

The Grand Banks experiment is still in progress. Not all samples have been processed, data bases are incomplete and only limited data analysis and interpretation have been possible. Preliminary results could change by the time the experiment is completed and the data fully analyzed.

Sidescan and navigation data indicate that most trawling disturbance (doors were approximately 60 m apart) was restricted to within 100 m of the corridor centre line as intended. Sidescan data indicate that the initial trawl disturbance is still visible on the seabed after one year. Analysis of acoustic data indicates that small-scale structural properties of the sediment are altered by trawling to a depth of at least 4.5 cm. The navigation data processed to date confirms that, with very few exceptions, sled and grab samples were collected from disturbed and control areas as intended.

Trawl catches were dominated by epibenthic invertebrate species, mainly snow crab, basket star, and sea urchins. American plaice and thorny skate dominated the vertebrate catch with some Arctic cod, capelin and a variety of incidental species. The fish catch was extremely small, the maximum being just 80 kg for a 2.5 h tow over a bottom distance in excess of 13 km. In both years, the invertebrate catch in the trawl decreased significantly in all corridors as the number of passes increased. It was clear from the amount of broken snow crab, basket star and other invertebrate parts on the mesh of the trawl belly and wings ahead of the liner that the organisms retained in the cod end of the trawl represent only an unknown fraction of those coming into contact with the trawl and potentially impacted.

A total of 74 epibenthic species were encountered in the sled samples collected in July 1993. Approximately eight were common to all samples. Most occurred in low numbers in just a few samples. The most abundant epibenthic species collected by the sled at the study site are the brittle star, sand dollar, sea urchins and a tube dwelling polychaete. The crustaceans such as the snow crab, toad crab and hermit crab were common but much less abundant. A total of 145 epibenthic and macrobenthic species have been identified in the video grab samples collected in July 1993. Twenty seven were common to all samples while 41 species were encountered in only one sample. The mean number of individuals was 2476 m^{-2} while the mean biomass was 1,171 $g.m^{-2}$ (wet weight). The most common taxa were Polychaete, Crustacea, Mollusca and Echinodermata. Numerically, the Polychaete dominated while most of the biomass was composed of Mollusca and Echinodermata.

Sled samples collected a few days after trawling suggest that 7-12% of sea urchins are damaged and a 50% decrease in small snow crabs (large snow crabs are not adequately sampled by the sled). No apparent effects can be demonstrated for other common invertebrate species, either epifaunal and infaunal. However, there is some suggestion of impacts to smaller, rarer species. The 1993 data suggest that the abundance of sediment bacteria may increase immediately after trawling. The potential for impacts will become clearer as more data become available and a complete statistical analysis is performed.

Overall, the limited number of statistical analyses performed to date on the available data suggest that spatial (both within and between corridors) and seasonal variability may be greater than that due to the effect of trawling, despite the fact that the study site has relatively uniform environmental conditions over a large area.

For the immediate future, priority is being given to completing the analysis of samples already collected and the development of data bases. A third and probably final cruise to the study site is scheduled for July 1995. Initial sampling will determine conditions one year after the second trawling disturbance. Then, a third trawling disturbance will be applied using the same techniques. As quickly as possible thereafter, another set of samples will be collected to provide a third data set on immediate impacts. Once data bases are complete, they will be subjected to various appropriate statistical tests to determine what changes in the benthic community can be ascribed to the trawling disturbance applied.

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4.5 Management Considerations

What is ecosystem management? Ecosystem management in its most basic sense simply involves the recognition that an ecosystem consists of more than a collection of independent species, and that the interactions between these species affect the way in which we manage the system. It therefore includes any management process in which these interactions are taken into account. Thus, ecosystem management implies managing human activities (such as fishing) that affect an ecosystem with the objective of achieving specific ecosystem characteristics. This new approach will include socioeconomic considerations in the planning and implementation of management strategies for sustainable exploitation. However, ecosystem management will mean different things to different people, so to be useful, we need to operationalize this concept. This will require a clear statement of our objectives.

Our focus at the moment is on fisheries, but we must not forget that DFO also has a mandate to provide advice on habitat issues. Thus, ecosystem management is not simply multispecies management of fisheries. Furthermore, DFO policy is to become more of an "oceans-oriented" department and the forthcoming Oceans Act will require us to consider non-fisheries issues to a greater extent than in the past. Therefore, we must take a very broad view in defining ecosystem management to include lower trophic levels and abiotic factors.

Why should fisheries be managed from an ecosystem perspective? Marine ecosystems, especially fish stocks, have traditionally been managed on a single-species basis with little or no reference to interspecies interactions or to external environmental factors. There has been growing awareness of the importance of these interactions and external factors, and as we exploit marine systems more heavily and stress populations, these factors become more important because the internal stabilizing mechanisms of ecosystems are less effective.

The management of living resources within an ecosystem context seeks to make explicit those environmental and biotic interactions which significantly affect population dynamics. For example, 4VsW cod stock appears to show strong temporal trends in growth and perhaps natural mortality. The cause of the observed reduction in condition of cod is not known. It may be related to changes in ocean climate. It is likely that the natural mortality rate of cod has increased particularly in the last several years as a result of grey seal predation, given the rather dramatic and continued increase in the grey seal population. Continued predation by grey seals on cod may delay recovery of this resource and may reduce the yield available to commercial fisheries. Thus, a consideration of seal predation and trends in ocean climate may be useful in providing advice on the future dynamics of this cod stock.

Marine ecosystems change in response to both human activities and natural environmental change. Managing from a broad perspective will be necessary if we hope to be successful in teasing out the relative contributions of these two sources to changes in the resources and benefits produced by marine ecosystems. Such an approach also has the benefit of better preparing Canada to respond to unanticipated need for advice as a result of future ecosystem changes.

Finally, managing within an ecosystem context allows more types of information to be used in the formulation of advice. Species differ in fundamental ways related to their patterns of growth, reproduction, and survivorship. These differences have important implications for the way in which each species responds to factors (including fishing) that affect abundance. For most exploited species, we currently have a considerable amount of life history knowledge. One practical outcome of the use of this knowledge is the realization that fishing mortality targets that are appropriate for one species may not be appropriate for another. Also in recognizing ecosystem management units we make explicit our knowledge that, for example, recovery time of a fish population in warm marine ecosystems (eg., North Sea or Georges Bank) may be longer than that in cold-ocean systems (eg., Labrador Current). It will take considerably longer to recover from a mistake in the Labrador current system than it will in the North Sea or Georges Bank.

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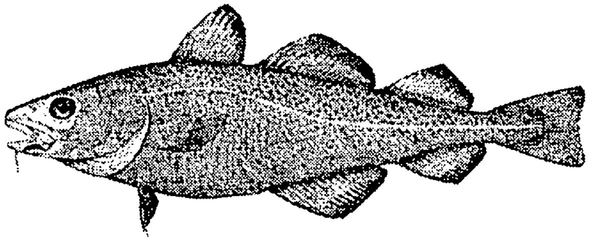
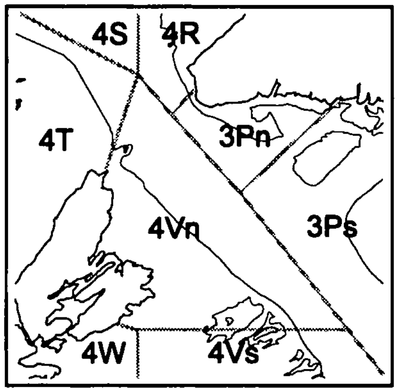
5. Groundfish Stock Status Reports



SYDNEY BIGHT COD



Background

Before extended jurisdiction in 1977 the cod fishery in 4Vn was traditionally a summer inshore longline fishery which exploited the banks south of the Laurentian Channel. During these years, large foreign trawlers fished along the Laurentian Channel edge in deeper water mainly during the winter months. These trawlers were targetting mainly Gulf of St. Lawrence cod which overwinter in the Sydney Bight area, whereas the fixed gear fishery was prosecuted on the 4Vn resident stock. After the 200 mile limit was declared and foreign boats were denied access to this area, an inshore dragger fleet developed. This was not only a response to the absence of foreign boats but also to the fact that catch rates in close inshore areas had declined markedly. The domestic draggers were larger than the average longliner and better able to fish the deeper water farther offshore.

Throughout the 1980s fixed gear landings exceeded those of the mobile gear; however, this reversed as the stock went into steep decline at the turn of the decade. Fixed gear boats were not as able as mobile gear boats to shift their operations into winter months when catch rates were higher due to the influx of Gulf cod.

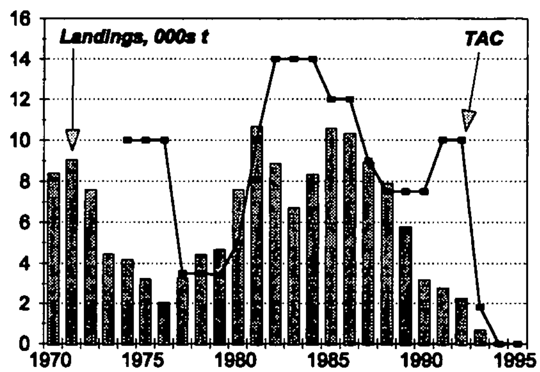
The Fishery

Landings (thousands of tonnes)

Year	70-79	80-89	1990	1991	1992	1993	1994	1995
TAC	6.7	10.5	7.5	10.0	10.0	1.8	-*	-*
Landings**	5.1	8.6	3.2	2.8	2.3	0.7	0.1	

* - by-catch only
** - May-October only

Cod landings in NAFO Subdivision 4Vn have declined sharply during recent years. Throughout most of the 1980s, catch quotas restrained the fishery, but after 1990 the catch was substantially less than the TAC.



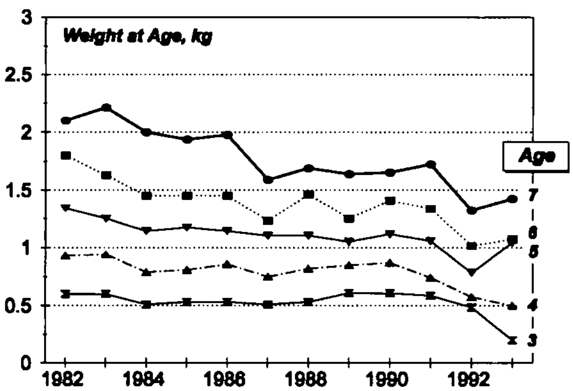
In September 1993 the cod fishery was closed and this moratorium is still in effect. In the few years prior to the closure, vessels using mobile gear generally managed to maintain a catch close to their allocation, whereas the longline fleet faired less well. Mixing of Gulf of St. Lawrence (4T) cod with the resident stock and inability to apportion landings according to stock has complicated the assessment and management of the 4Vn stock.

4T cod overwinter along the shelf edge from Sydney Bight as far as Banquereau Bank region, leaving the Gulf in the late autumn and returning in the spring. During this period the catch of cod in 4Vn comprises both Gulf and resident cod, although the 4T cod make up the bulk, being a much larger stock. Thus, unknown quantities of 4Vn cod are being caught during the overwintering period. Furthermore, the dragger fleet which had traditionally caught most of its catch between May and October began to transfer its activities toward the latter part of the year to exploit migrant cod. The effect was to maintain the overall catch for 4Vn even as the abundance of resident fish fell.

Information on the overwintering migration of Gulf of St. Lawrence (4T) cod into the Sydney Bight area was reviewed in the spring of 1994. From patterns of commercial fleet movements and results of tagging studies it was clear that many 4T cod had departed the Gulf by mid November and probably all by December. Therefore it was decided to modify the 4Vn management unit definition by shortening the assessment period from May to December to May to October, inclusive.

Less than 100 tonnes of cod landings were reported in 1994. This was taken as by-catch from redfish and flounder fisheries. Some discarding of cod by Danish seiners was reported.

The weight at age seen in 4Vn landings has decreased during the past ten years. The increase seen in the older ages in 1993 is probably due to the fact that the fishery was closed in the fall of that year. In recent years many Gulf (4T) cod, which are smaller at age than 4Vn cod, have been included in landings from October to December. Their absence in 1993 would tend to increase the size at age of fish in landings for that year. In 1994 there were not enough landings to make reliable estimates.



Stock Mixing

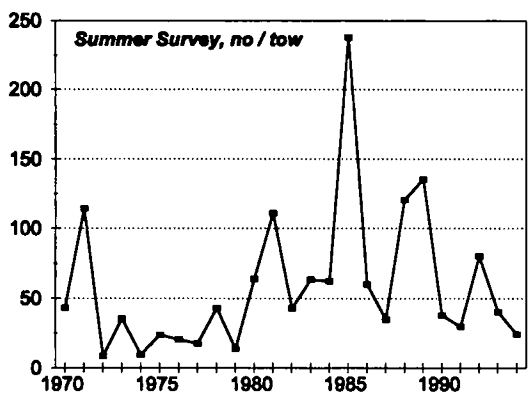
An inter-regional working group met in 1994 and 1995 to consider the sources of error which have long affected the accuracy of scientific advice for 4Vn cod. After reviewing the results of analyses based on published and unpublished data, the working group concluded that there was strong evidence in support of the presence of a resident stock in 4Vn, one of a series of small coastal cod stocks. However, the 4Vn resident stock mixes with the 4T and 4Vs stocks to varying degrees both within and outside of 4Vn. The degree of stock mixing appears to increase with age, particularly with the 4Vs stock. This stock mixing contributes to the difficulty in assessing the 4Vn stock. On the other hand, the well-known winter migration of 4T cod through 4Vn appears to be more restricted to the edge of the Laurentian Channel than is the distribution of either 4Vn or 4Vs cod.

The scientific advantage of assessing 4Vn cod on its own is still under review. In light of the stock mixing problem, which is in part aggravated by the small size of the 4Vn stock assessment unit, there is no obvious benefit in making minor modifications to the 4Vn cod assessment unit boundaries. However, there may be advantages in maintaining a distinct 4Vn management unit, such as the greater ability to protect the resident stock.

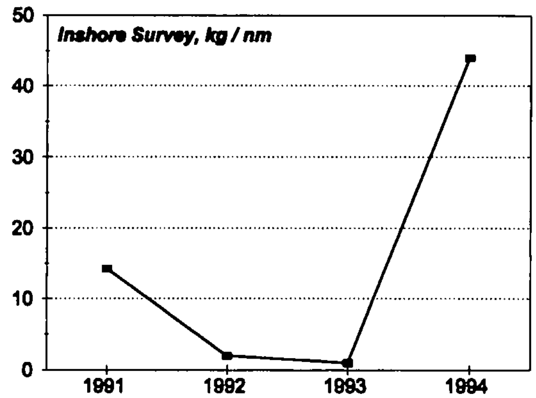
Improvements in the assessment of 4Vn cod will require the ability to identify adult cod as to their stock origin, and improved assessment models capable of dealing with stock mixing.

Resource Status

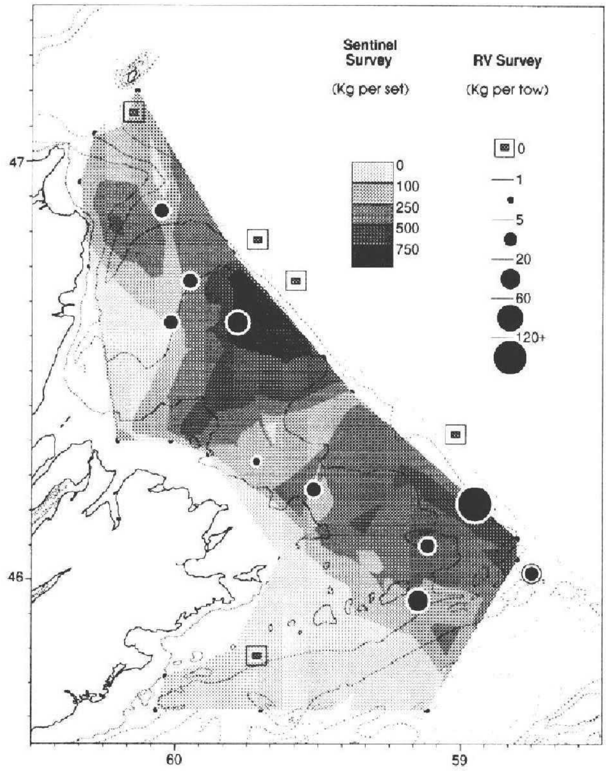
Interpretation of the **July survey** data from 4Vn with its high variability has always been difficult due to small sample size and periodic incursions of other stocks into the area. Nevertheless, the general trend of the survey index does seem to reflect the abundance of cod. In 1994, the index continued to fall. Most cod were taken in the mid-depth stratum (51 to 100 fath.) and, as is often the case in this subdivision, mostly from one set. The bulk of the catch in 1994 comprised the 1987 and 1989 year-classes and there appears to be little sign of recruitment. There were no one year-old cod in the catches and the average number of two year-olds (0.08 per tow) was the third lowest in 25 years. The average length of cod caught was about 50 cm. and the length frequency distribution was more or less unimodal. Very few fish over 60 cm were taken, which has been the case since the late eighties.



DFO has also conducted an **inshore survey** in western Sydney Bight for the past four years. A cod nursery area was located in the southwest corner of the Bight, in the Bird Islands region. In September 1994, the numbers of one year-old cod (average length 12 cm) were the highest in the short time series. In addition, the distributional area of these small fish had expanded. However, although these results look promising, it is too early to say whether the results of the inshore survey can provide a good index of recruitment.



An inaugural **sentinel survey** carried out during September in 4Vn by commercial longliners followed a stratified random design similar to that used by the July groundfish survey. As in the July survey, most of the cod caught by the sentinel survey were taken in the 51 to 100 fathom stratum. The length frequency composition of the catch was almost identical to that of the July survey peaking around 50 cm. The highest concentrations of cod were found on Smokey Bank with the next highest being north-east of Scaterie Bank. In general, the distribution of cod in the July groundfish survey agrees with that of the sentinel survey. (In the figure on the following page, sentinel survey catches are depicted by shaded contours and the July survey catches are superimposed in the form of expanding circles.) In addition, the distribution of cod catch in 4Vn from a groundfish survey carried out by DFO (Gulf Region) as an extension of its routine Gulf survey corresponded closely to the pattern given in the figure below.



Over the 19 day survey period (September 20 to October 8), an estimated 13,634 kg of cod were taken in 4Vn. The average catch rate of cod over this period was 110.5 kg/1000 hooks (SD 111.25). Only ten of the 54 sets made could be considered good; that is, in excess of 500 kg/1000 hooks. A direct comparison between a 1993 test fishery in 4Vn and the sentinel survey cannot be made since the former had a different survey design.

The potential of the sentinel survey for providing an index of abundance is good. There was excellent coverage of the survey area and it was possible to construct distributional maps of a number of groundfish species. However, only if maintained on an annual basis will this survey become a valuable tool in evaluating the status of this stock.

Ecosystem Considerations

Estimates of **seal predation** on young cod have been made for the 4VsW subdivision. While it is difficult to do the same for 4Vn, it is known that grey seals do consume cod in this area.

The sentinel survey found that the distribution of **dogfish** coincided with the areas favoured by juvenile cod; that is, in shallow, inshore areas. Furthermore, a longliner monitoring the fall migration of cod out of the Gulf of St. Lawrence (Oct 30 - Nov 13) reported a decrease in the catch of cod from 2387 kg per trip to 136 kg per trip while there was a concurrent increase in the numbers of dogfish over this period from 21 kg per trip to 4730 kg per trip. Many half-eaten cod were reported on the longline hooks at the time of this high dogfish abundance.

Outlook

The future of this stock looks bleak; the July RV survey index is low and continues its downward trend while there are no signs of incoming year-classes of any note. Until there is substantial recruitment, there can be no thought of reopening the fishery. Abundance of cod in this area may benefit from migration from adjacent stocks. While the July survey does not provide a good early indicator of incoming recruitment, there is also no sign of production of good year-classes in adjacent stocks.

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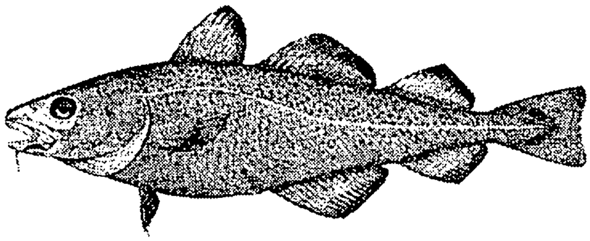
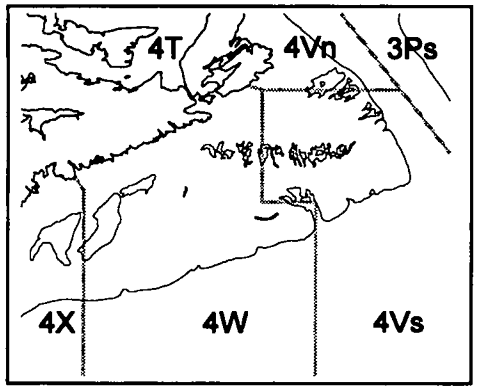




EASTERN SCOTIAN SHELF COD

Background

The cod resource on the Eastern Scotian Shelf is a complex of spawning components including at least two major offshore groups (Western/Sable and Banguereau), smaller offshore groups (Middle Bank, Canso Bank) and a chain of smaller coastal spawning groups. The situation is complicated by the presence of both spring and fall spawning in several of the spawning components (Sable/Western offshore and various inshore areas).

The fishery for 4VsW cod was prosecuted primarily by foreign vessels until the extension of jurisdiction in 1977. Since that time, the Canadian offshore trawler fleet accounted for 70-75% of the landings and longliners most of the rest. Catches from 1958-79 were about 40-50% from 4Vs, however, as the stocks rebuilt in the early 1980s, the fishery shifted more to the east each year and 4Vs accounted for 60-80% of the landings from 1980-93.

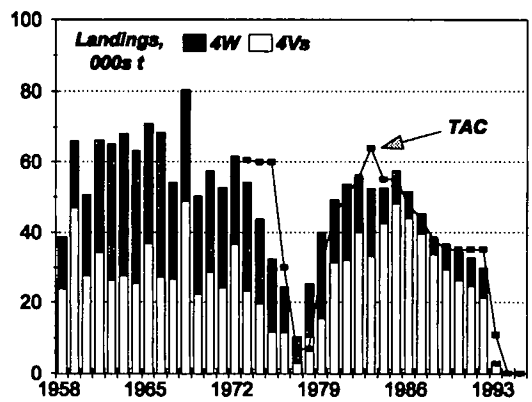
The Fishery

Landings (thousands of tonnes)

Year	58-73 Avg.	73-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC	0	43.5	43.9	35.2	35.2	35.2	11.0	-*	-*
4Vs	30.9	13.8	33.3	26.3	24.6	21.3	2.3	0.2	
4W	30.1	19.2	13.2	8.1	8.2	8.5	1.2	0.2	
TOTAL	60.9	33.0	46.6	34.4	32.8	29.8	3.5	0.4	

* = by-catch only

The fishery for cod was closed for the entire year in 1994 and strict by-catch restrictions were placed on those fisheries which were operating in the area. This continued the closure imposed in September of 1993 and resulted in a total reported landings of 368t, the lowest on record. In recent years, the landings from 4Vs have been adjusted downwards to account for the presence of 4T cod in the winter migrating out of 4Vn into 4Vs. This was not needed in 1994 as there was no winter landings from that area.

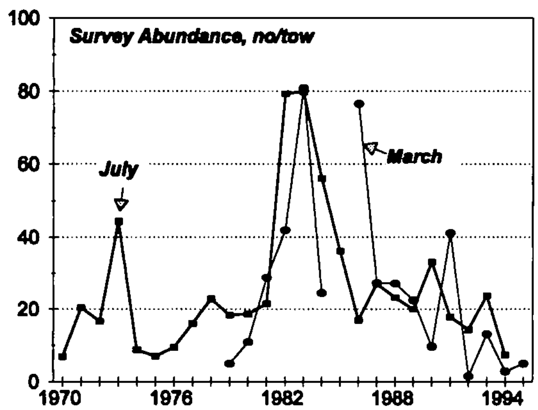


Resource Status

The samples of the commercial catch were difficult to collect because landings were limited to by-catch throughout the year. Consequently, the catch at age must be interpreted carefully in 1994. The numbers at age in the catch indicate that the 1987 and 1989 year-classes were predominant. The mean weights at age for all ages up to seven (1987 year-class) show some increases over the last few years. Weights at ages greater than seven are still low relative to long term means but the small number of fish at those ages makes these estimates unreliable.

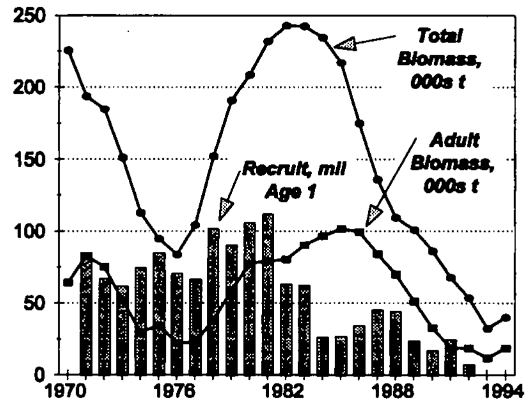
No commercial catch rate information is available for 1994 as the fishery was closed and no cod-directed effort was recorded.

There are two **research survey series** available for this stock, a July series which started in 1970 and a March series since 1979 (except 1985). Both series have tracked substantial declines in abundance since the late 1980s and are now at record lows.

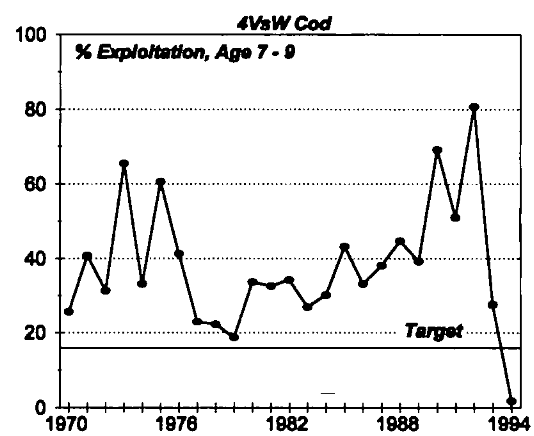


Neither survey indicates any incoming **recruitment**. In the latest two years, the age 2 indices are the two lowest in their respective series (i.e. July 1993, 1994 and March 1994, 1995).

The standard age-based population analysis was used to estimate the current status of the stock. The abundance estimates indicate that the population is severely depleted with the adult (age 6+) biomass in 1993 (12,000t) and 1994 (19,000t) at the lowest values in the series (Average 56,000t from 1970 to 1994). Since 1987 there has been a complete disappearance of fish over 10 years of age and there are no signs of good or even average recruitment.

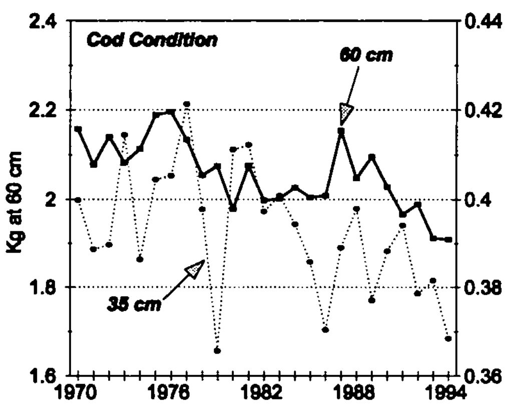


Exploitation rate, the percentage of the recruited population removed by the fishery, indicate that the fishery was removing increasing fractions of the stock from 1979 to 1992. The early closure of the fishery in 1993 continued in 1994 resulted in the first significant decrease in exploitation levels since the removal of foreign effort in 1977.



Stock Biology

Size at age has declined in this stock since the mid-1980s both in the survey and commercial catch data. Since about 1992, the consistent decline in size at age for all ages seems to have levelled off and remains near record lows. **Condition** is the relative weight of the fish for their length, i.e. their plumpness. An index of condition was developed based on the length/weight relationship derived from the annual July surveys. Up to 1989, there was a highly significant negative relationship between population biomass (age 3+) and the condition of the fish which was suggestive of density-dependent effects on the weight at length. Since that time, the population biomass has declined. However the condition index has continued to fall rather than increase as might have been expected. This suggests that the current factors limiting condition in 4VsW cod are not related to the population density but to a less favourable environment.



A recent study conducted under the auspices of OPEN, (1991-93) of the **production of cod eggs and larvae** in 4W found that fall-spawned production accounted for over 90% of the total. This is in contrast to the findings of a major program (SSIP) in 1977-82 in which egg and larval production was nearly equal between the spring and fall spawning components. The disappearance of eggs and larvae from the spring spawning period in 4W would suggest that either the adult 4W spawning component had been eliminated or that, for whatever reason, its reproduction was unsuccessful. Elimination of the spring 4W spawning component is consistent with a shift observed in the distribution of fishing effort in the spring spawning period over the same years. In 1981 fishing effort during the spring spawning period, January-April, was distributed widely over the entire 4VsW area and in the vicinity of all the major offshore banks. During the mid to late 1980s, this had contracted to the eastward and by 1991 virtually all the fishing effort during the spring spawning period was concentrated on the slope of the Laurentian Channel in 4Vs.

Ecosystem Considerations

Estimates of **grey seal predation** on 4VsW cod presented last year were based on information on the composition of grey seal diets collected between 1989 and early 1993. A revised estimate for 1993 was about 14,000t of cod mostly less than 4 years old. The proportion of cod in the diet of grey seals in these samples did not indicate a trend over this time period. However, given the low and declining cod biomass, it was possible that grey seals would reduce predation on cod in favour of more abundant prey. Samples collected from Sable Island between the summer of 1993 and the fall of 1994 show that the proportion of cod in the grey seal diet, although variable among samples, has remained at about 15%. Given the continued increase in the grey seal population, consumption of 4VsW cod by grey seals is estimated at 15,400t in 1994.

Using recent temperature data from Emerald Basin a **temperature-based model** was developed which accounts for about half of the measured recruitment variability in 4VsW cod. Although the actual mechanism is not yet understood, there is some evidence to suggest that this temperature series reflects conditions in the upper water layers near the spawning locations during the time the eggs and larvae are in the water. The model predictions for recent years (1992-94), although low relative to the historical series, have consistently been greater than estimates from VPA.

An analysis of **spatial association** revealed that cod and yellowtail flounder were more spatially correlated in the 1970's than is presently the case. The spatial distribution of yellowtail flounder appears unchanged over this time, remaining concentrated on the offshore banks of the eastern Scotian Shelf, while the distribution of cod has shifted to the northeastern Shelf in the past 10-15 years. Yellowtail flounder are considered to be relatively restricted in their movements and do not appear to migrate in response to changes in water conditions such as temperature. Cod, on the other hand, have been shown to have certain water mass associations, albeit changing with age. While this indicates that cod distribution has changed, this does not account for the decline in abundance.

Capelin have been present in both the July and March surveys in increasing numbers since 1984 and the large numbers occurring since 1990 are unprecedented. Capelin occur in this area in periods of colder than normal bottom water. The rapid increase in their abundance is consistent with the cold conditions that are persisting throughout the year in the area since about 1984. Their continuing presence in 4VsW suggests that a fundamental ecological change has occurred in this area.

The period since about 1986 has been one of significant cooling in the 4VsW area, particularly in 4Vs. The mean temperatures on the bottom declined by 1-2°C during this time. The effect this has had on the biology and ecology of cod in the area is not known, however a number of the biological observations noted above can be interpreted plausibly, if somewhat speculatively, in terms of changes in the ecosystem dynamics of the area. For example, individual fish are now smaller at age and in lower condition as well. This may be due to reduced growth due to harsh environmental conditions (low temperature, lack of food?), or to selective removal of large fish by the fishery. Lack of recruitment and the apparent disappearance of a major 4W spring spawning component may also be due to environmental change or fishery effects.

The establishment of a capelin population in 4Vs is, by itself, a clear indication that an ecological disturbance has occurred in the area with respect to the period prior to 1986. Although capelin are known to be a key food resource for cod in other areas, their presence on the Scotian Shelf coincides with a reduction in size and condition of 4VsW cod. This comes at about the same time that a previously consistent correlation between cod and yellowtail flounder appears to have broken down. These two changes in cod associations coincide with the onset of the colder environmental conditions and may in fact be in response to them. However, the coincidental increase in a significant cod predator has come in a period of low reproductive success for cod, thus increasing the ecological pressure on the cod population.

Outlook

The short-term prospects for this stock remain dismal. The adult population is at historic low levels; there is no indication of any significant recruitment; both growth and condition of the fish are poor; and there is a significant and increasing predation by seals contributing to natural mortality. The last significant recruitment was the 1986 and 1987 year-classes, both of which were well below the long-term average; the last average year-classes were in 1981 and 1982. If the conditions discussed above persist, there seems little chance of recruitment of a large year-class from the current 4VsW cod population. In addition, until a number of year-classes are demonstrated to be of near average size and reach maturity, this stock cannot sustain a directed fishery. The spawning stock biomass is about 33% of the long term mean and less than spawning stock biomass considered dangerous to stock conservation. Thus even by-catch in other fisheries may pose a serious threat to the recovery of this stock.

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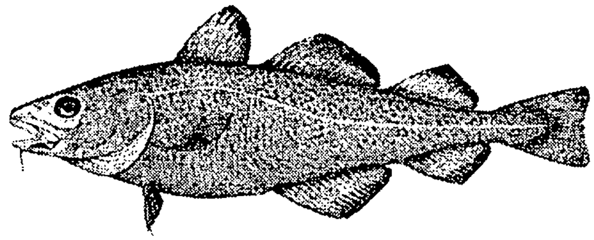
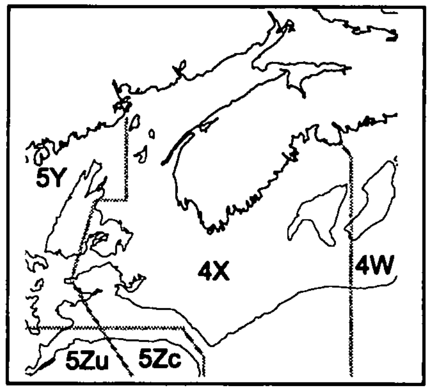




SOUTHERN SCOTIAN SHELF AND BAY OF FUNDY COD

Background

Atlantic cod is a bottom dwelling fish occurring on both sides of the North Atlantic. In the Canadian Atlantic, cod range from northern Georges Bank to northern Labrador. There are several concentrations of cod within this range, one of which occurs in the southern Scotian Shelf and Bay of Fundy (NAFO Division 4X).

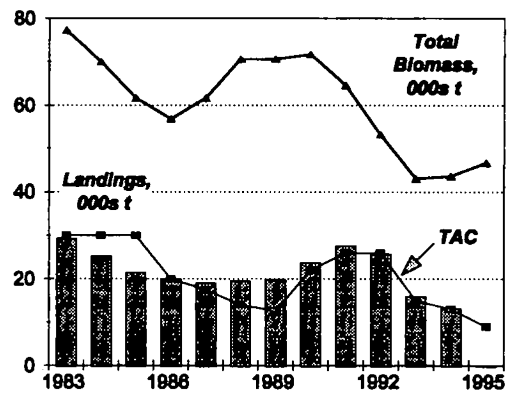
Juvenile cod in Division 4X feed on a wide variety of invertebrates and as they grow include fish in their diet. Seasonal movements associated with spawning occur and a number of spawning areas exist in Division 4X with the largest occurring during winter on Browns Bank. Growth rates vary among cod in Division 4X with more rapid growth noted in the Bay of Fundy. Cod in Division 4X reach on average 53 cm (21 inches) by age 3 years and increase to 72 cm (29 inches) by age 5 and 110 cm (43 inches) by age 10. Age at first reproduction generally occurs at 3 years and individuals tend to spawn several batches of eggs during a single spawning period.

Cod in Division 4X has supported a commercial fishery since the 1700s and until the 1960s was primarily an inshore fishery. Following extension of jurisdiction to 200 miles by coastal states in 1977, only Canada has made substantial landings of cod from this area. Minimum mesh size and hook size regulations have been imposed to reduce the catch of juvenile cod. Spawning area/seasonal closure of Browns Bank is imposed from 1 February-15 June. Scientific advice is presented on the basis of a target capture rate of roughly 18% of the population.

The Fishery

Landings (thousands of tonnes)

Year	71-80 Avg.	81-90 Avg.	1991	1992	1993	1994	1995
TAC	-	-	26	26	15	13	9
TOTAL	23	24	28	26	16	13	



Landings increased through the 1960s from 14,000t to 33,000t as large offshore trawlers became active in the fishery.

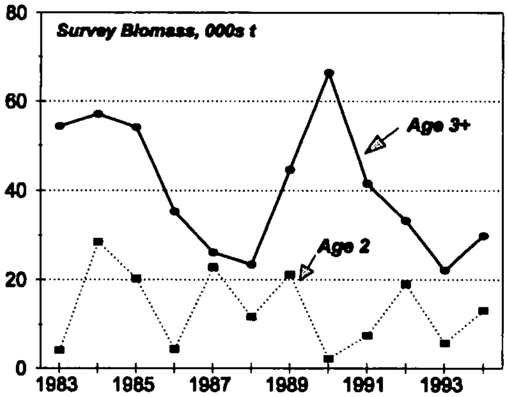
Since 1970, landings have varied between about 16,000t and 33,000t reaching their lowest level of 13,000t in 1994. These landings are a reflection of the Total Allowable Catch, which declined from 26,000t in 1992 to 13,000t in 1994 and has been further reduced to 9,000t for 1995. The fishery takes place year round, with catches peaking in June and July, and is prosecuted predominantly by otter trawlers of tonnage classes 2 and 3, and longliners of tonnage classes 1 and 2. The distribution of landings in 4X has shifted west in recent years, with landings from 4Xmno declining to a greater degree since 1992 than in other areas.

In 1994, catches were comprised to a greater degree of young fish in comparison to the long-term average. The 1990 year-class (age 4, 63 cm, 25 inches) and the 1991 year-class (age 2, 53 cm, 21 inches) were predominant in both otter trawl and longline catches. The recent decline in the proportion of landings comprised older cod is likely due in part to reduced fishing effort during the winter-spring fishery when large cod are commonly harvested.

Resource Status

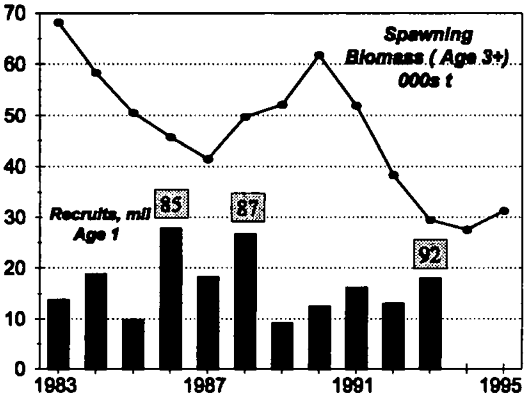
Stock status evaluation was based on an analytical assessment using landings statistics, samples for size and age composition of the commercial catch, and trends in abundance from the July research survey from 1983-1994. While research survey data from before 1983 have been used in previous assessments, a number of factors were examined which indicated that these data should not be included. Commercial sampling was quite poor in the 1970s, and a trend in residual patterns had been noted in previous assessments (predominantly positive residuals since 1983 and negative before 1983) which was related to uncertainties in relative fishing power between different vessels used in the longer time series. With a shorter time series, the pattern in the residuals was eliminated. Furthermore, the survey index at age 2 now appears to be reliable, and is included in the present assessment.

The 1994 survey catches were higher than for 1993 for age 2 and for ages 3 and older combined (the spawning stock). Initial indications suggest that the 1992 year-class (age 2 in 1994) is average. Increases in the survey index were all in the Bay of Fundy area. The Bay of Fundy has generally accounted for 30-40% of the overall index of abundance in 4X, however in 1994 it made up over 60%



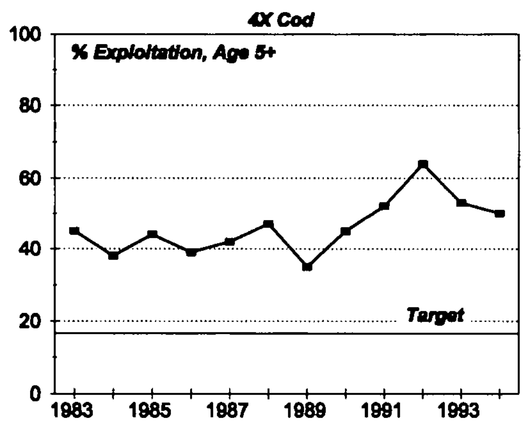
Commercial catch rates for both longline and otter trawl fisheries (tonnage classes 2 and 3) were high from 1989-1991, and have since declined, although the longline catch rate in 1994 was slightly higher than in 1993. Neither catch rate series was used to estimate stock abundance due to changes in fishing practices associated with the introduction of individual quotas (dragger captains no longer target for cod) and other factors such as mesh size changes and trip limits for the longline fishery.

Population abundance estimates indicate that the stock is showing a slight increase in 1995 after declining rapidly from a peak in 1990 to the lowest levels in the time series in 1993 and 1994. This decline occurred as the strong 1985 and 1987 year classes were being fished down. The present age 3+ biomass of 30,000t is down from the early 1980s when it was close to 70,000t.



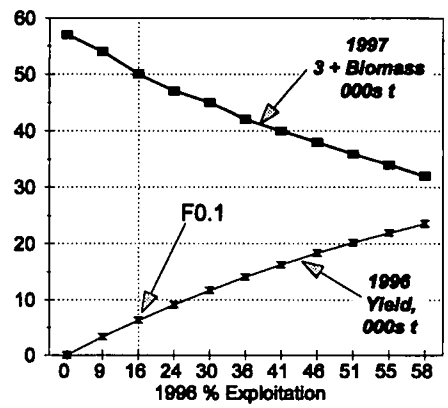
Recruitment estimates indicate that the 1985 and 1987 year-classes were the strongest since 1982 and the 1990 and 1992 year-classes are about average. The 1988 year class was very weak and the 1991 year-class slightly below average. The exploitation rate has generally been more that twice the target and has fluctuated at about 50%.

It increased after 1989 to about 65% in 1992. In the past two years it has declined, but still remains very high. The retrospective pattern (a discrepancy between past estimates of stock status and current estimates using additional data) was negligible and was considered to have no impact on the interpretation of results.



Outlook

The expected catch of about 9,000t in 1995 would result in an exploitation rate of 30%, exceeding the target exploitation rate. The projected yield at the target exploitation rate for 1996 would be about 6,300t. At this level of exploitation, the spawning stock biomass is projected to increase to about 50,000t by 1997. The projected increase in cod biomass is conditional on reducing landings to target levels and largely depends on recruitment of the 1992 year-class, which will be 3 years old in 1995, and recruitment of the as yet unestimated 1993 and 1994 year-classes. About half, or 26,000t, of the spawning stock biomass estimated for 1997 is based on the assumption of average recruitment for these two year classes.



Continuing conservation efforts are needed to rebuild the population biomass and to expand the age structure. An updated report on resource status following the 1995 July research survey will provide additional information on the size of the 1992 year-class and the first estimate of the 1993 year-class size.

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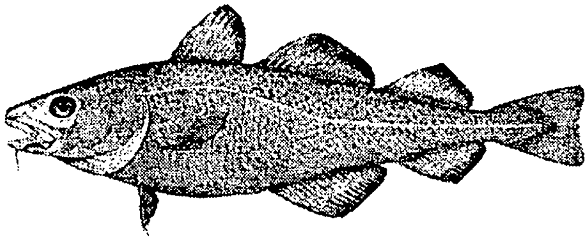
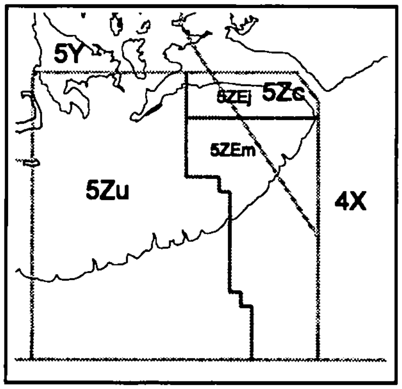
References

Clark, D., E.A. Trippel, and L.L. Brown. 1995. Assessment of cod in Division 4X in 1994. DFO Atl. Fish. Res. Doc. 95/28.





GEORGES BANK COD

Background

The cod fishery on Georges Bank has been in operation since the late 1700s. Since 1977, only Canada and the USA have had directed fisheries and, with the establishment of the Canada/USA boundary in 1985, each country has been limited to their respective sides. Canadian catches of cod are taken primarily between June and October. Management of the Canadian fishery has been by seasonal closures and by ITQ for <65' mobile gear since June 1992, EAs for offshore boats since 1984 and by competitive quota for fixed gear. In 1994, there was a substantial decrease in the TAC. The USA fishery has been greatly constrained by establishment of a closed area between January and June in 1994 and by expansion of the area in 1995.

In recent years most of the biomass has been found on the Canadian side of the international boundary, although substantial seasonal movements relative to the boundary occur.

Georges Bank cod prey heavily on fish followed by crustaceans and molluscs. Cod in this area have a very fast growth rate, reach 50 cm (20 in) and begin to spawn for the first time by age 2 and by age 3 almost all are sexually mature.

All data relating to USA catches and research vessel surveys were provided by the National Marine Fisheries Service (NMFS) at the Woods Hole, Mass., Laboratory.

The Fishery

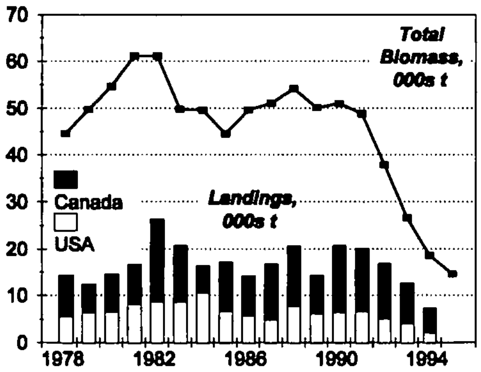
Landings (thousands of tonnes)

Year	78-90 Avg.	1991	1992	1993	1994
TAC	-	15	15	15	6
Canada	10	13	12	8	5
USA	7	7	5	4	2
TOTAL	17	20	17	13	7

Combined Canada/USA catches peaked at 26,000t in 1982, averaged about 17,000t between 1978-90 and were the lowest observed in 1994 at 7,277t. Since 1985, Canada has taken about 65% of the total catch.

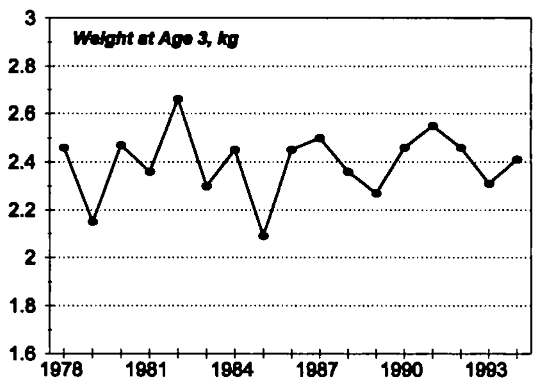
Canadian landings have been dominated by otter trawlers, except in 1984 and 1989, but the proportion of total landings taken by fixed gears (longline and gillnet) has increased in recent years. In 1994, the Georges Bank fishery became more of a mixed species fishery with little targeting for cod. Canadian landings in 1994 were 5,300t, well below the long-term average.

The Canadian fishery was closed to all vessels from 1 January to 31 May and to 30 June for vessels >65 '.



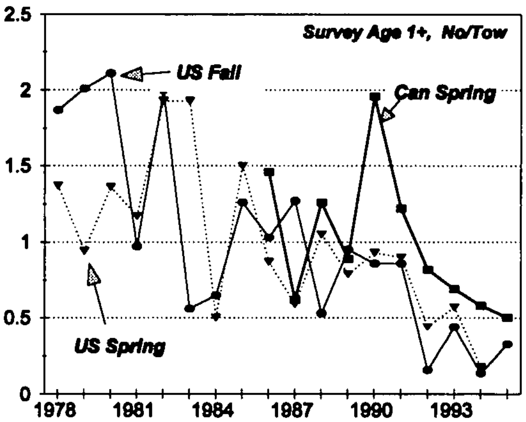
USA landings in 1994 continue to be below the long-term average and are estimated to be 2,000t. The USA imposed a closed area in 1994 and expanded the area and duration in 1995.

Mean weight at age three has been variable without trend between 1978 and 1994. Total catch at age in 1994 was estimated from Canadian sampling data. The 1990 year-class accounted for about 42% of the total catch in numbers and in weight.



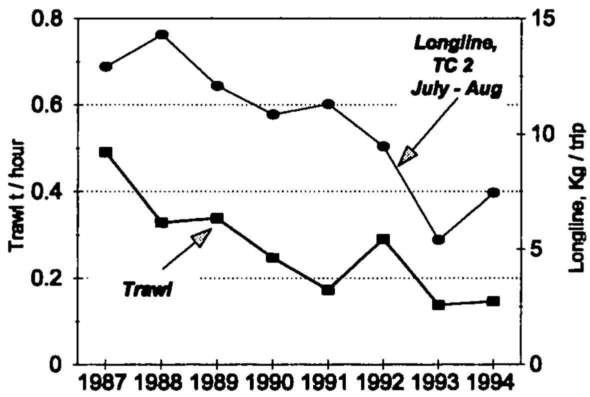
Resource Status

Stock status evaluations were based on an analytical assessment using landings statistics, age composition of the commercial catch and trends in abundance from three bottom trawl research surveys and a commercial fishery mobile gear catch rate index.

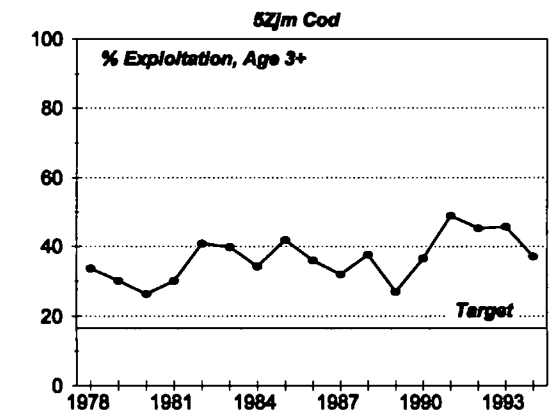


The **fall survey** is lagged by one year for comparison of indices (ie. fall 1977 age one vs spring 1978 age two) with the USA and Canadian spring surveys. In general, all three surveys appear to demonstrate similar relative year-class strengths and an overall decline in total numbers since 1989. The 1980, 1983, 1985 and 1990 year-classes were above average while those since 1990 are well below average.

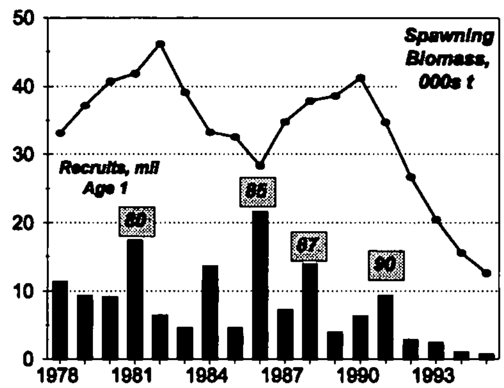
Mobile gear catch rates for the 1987-94 period showed a general decline between 1987 and 1993 with a slight increase for directed trips in 1994. Longline catch rates also show a decrease over the 1987-93 time period with an increase in 1994. However, further evaluation of longline catch rates is required to account for variation in measures of effort and to standardize for trip length.



Population abundance estimates indicate that there has been a substantial decline in total (1+) biomass from 51,000t in 1990 to 14,500t in 1995, the lowest observed. Spawning stock biomass (40% age 2, 75% age three and 100% age 4+) is also at the lowest observed. Fishing mortality increased rapidly between 1989 and 1991 to almost four times the $F_{0.1}$ = 0.2 reference level. The decline seen in 1994, due to reduced effort, still results in a fishing mortality of over twice $F_{0.1}$. The exploitation rate exceeded 40% between 1991 and 1993 and was 37% in 1994.

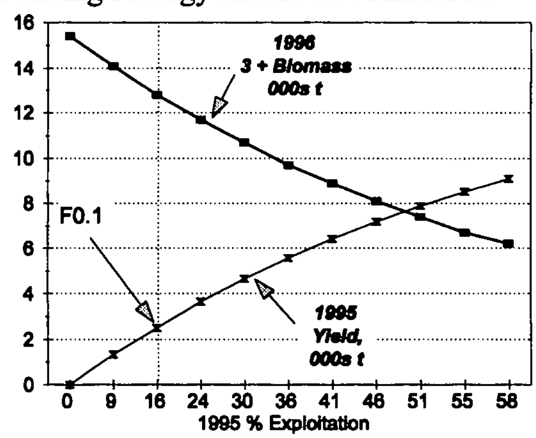


Recruitment has shown an alternating pattern in the 1980s and was above average for the 1980, 1983, 1985 and 1987 year-classes. However, since the 1990 year-class, it has been well below average and was the lowest observed for the 1994 year-class.



Outlook

Yield projection at $F_{0.1}$ in 1995 indicates a **combined** Canada/USA yield of about 2,500t for 1995. Fishing at that level in 1995 will not result in any substantial increase in biomass in 1996. Given the extremely low spawning stock biomass in 1994 (13,000t compared to the recent 10 year average of 28,000t) and low levels of recruitment since 1990, a stock rebuilding strategy should be considered.



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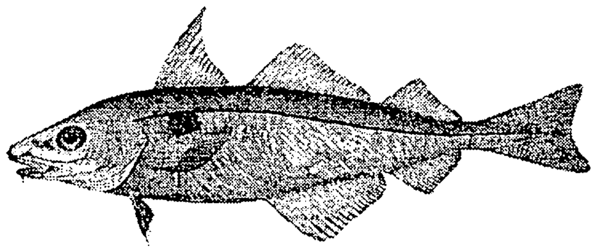
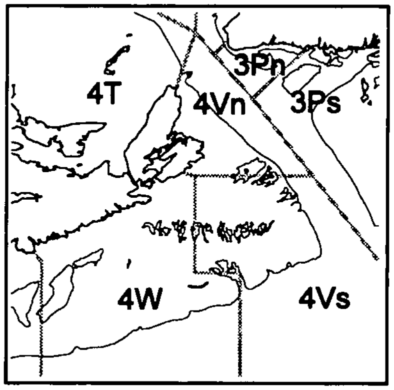




EASTERN SCOTIAN SHELF HADDOCK

Background

Haddock on the eastern Scotian Shelf and southern Gulf of St. Lawrence are considered as a single management unit distinct from adjacent populations on the southern Scotian Shelf (Division 4X) and across the Laurentian Channel (Division 3P).

The majority of 4TVW haddock occur on the complex of offshore banks ranging from Emerald Bank in the west to Banquereau Bank in the east. Significant concentrations of haddock did occur inshore of these banks and in the Gulf of St. Lawrence; however, in recent years these more inshore components have become rare. Historically it was considered that haddock from the offshore banks migrated to inshore waters during the summer, moved east along the shore of eastern Nova Scotia and Cape Breton and then entered the Gulf of St. Lawrence. In the fall this migration was reversed. It is unclear whether or not this migratory pattern still occurs because there are now so few haddock found in these inshore waters. None of almost 15,000 tags applied to haddock on Emerald, Western, and Banquereau Banks in the late 1980s were recovered from inshore waters.

Haddock prefer hard sand or gravel bottoms at depths ranging from less than 50 m to about 350 m, and temperatures ranging from 4-8°C. During the summer, haddock congregate on the tops and upper slopes of banks, while in the winter months, when the water on the banks cools, they move to deeper warmer waters in the gullies between banks and the slopes of the continental shelf. During the spring (March-April), haddock once again move up on the banks (mainly Emerald and Western banks) to spawn in dense aggregations. These spawning aggregations formed the target of intense fisheries until the imposition of a closed area encompassing Emerald and parts of Western Banks in 1987.

A mature female can produce several hundred thousand eggs depending on her size. The eggs are very small, and although released near bottom, float in the water. The eggs hatch in anywhere from 9 days to a month depending on water temperatures, hatching is slower at colder temperatures. Newly hatched haddock are only 3 or 4 mm (1/10 of an inch) long but grow to about 80 mm (3 inches) by the end of their first summer. During the first few months of life the young haddock live off bottom and are often associated with jellyfish. They become bottom dwellers at about 50 mm (2 inches). It is difficult to determine the age of a haddock from the eastern Scotian Shelf. The pattern of rings in their otoliths (earbones), particularly in larger fish, is complex and difficult to interpret. This also makes it difficult to determine the growth rates of these fish. There is however some evidence that growth varies with area, overall size of the haddock population, and environmental conditions.

Adult haddock are bottom feeders and forage on some 200 different species of bottom dwelling invertebrates and small fishes, including: brittle stars and other echinoderms (starfish like animals), worms, and sand lance. Haddock themselves are eaten by cod, pollock and white hake.

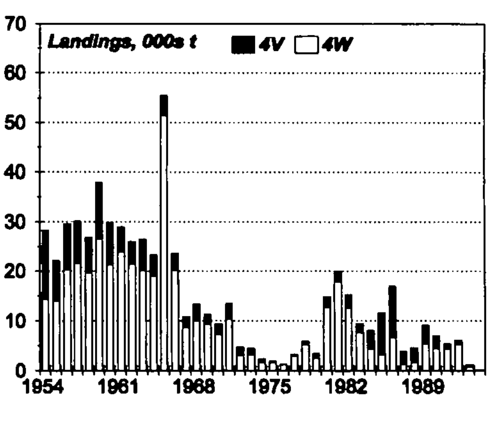
The Fishery

Landings (thousands of tonnes)

Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC			6.0	-*	-*	-*	-*	-*
Reported Landings	5.0	11.4	7.0	5.4	6.1	1.2	0.1	

* - By-catch only

Annual landings averaged 26,500t from 1950 to 1969, 5,000t from 1970 to 1979, and ranged between 8,000 and 20,000t until 1987. The nominal catches for 1987 through 1994, have been taken almost exclusively as by-catch in other groundfish fisheries operating in divisions 4T, 4V and 4W, and totalled just over 100t in 1994.



The year-round nursery ground closure (mainly Emerald and Western banks) imposed in 1987 remains in effect to the present. Throughout 1987 to 1992, fixed gear vessels had been allowed to fish inside the closed area. In 1993 the closed area was closed to all fishing. Since 1987 the fishery has been regulated using by-catch restrictions and trip limits. In 1994, the fishery was severely restricted and limited to 10% (or 500 lbs) by-catches in the hake, cusk, and pollock fisheries, and to 10% or 200 lb trip limits in the fixed gear fishery in 4Vn.

Between 1954 and 1984, most of the catch from this stock was taken from Division 4W by large otter trawlers in the spring. In 1984, Division 4W was closed to trawlers from May to December to prevent the capture of the abundant early 1980s year-classes. This caused a shift in the fishery to 4Vs. From 1984 to 1986, favourable catch rates in 4Vs resulted in an increase in landings from 4Vs to the point where they represented 40-60% of the reported total. In 1994 reported landings from 4Vs totalled only 35t. Since 1987, landings in 4W have increased five-fold to just over 5200t due largely to the expansion of the fixed gear fishery inside the closed area. In 1993, following the exclusion of all gears from the closed area, landings in 4W fell to just over 800t, and then to only 60t in 1994. Landings in Division 4T and Subdivision 4Vn have been negligible since 1989.

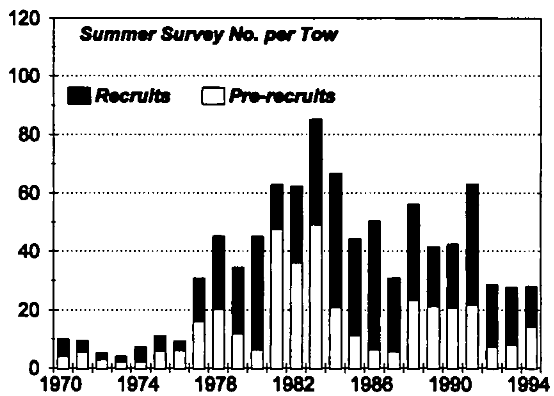
Resource Status

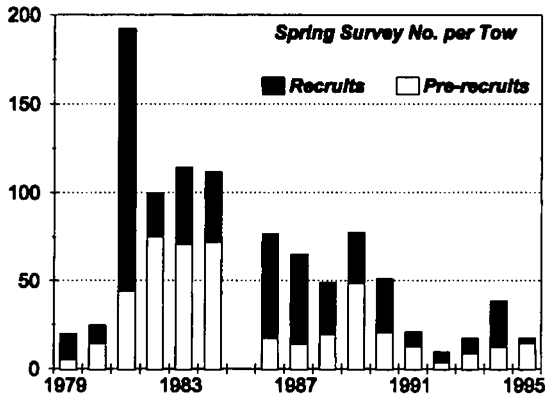
The evaluation of stock status was derived from reported landings, samples taken from commercial landings for size and age composition both by shore-based (Port Technicians) and at sea (Observers) sampling programs, and from the trends in abundance from two research vessel surveys (July and March).

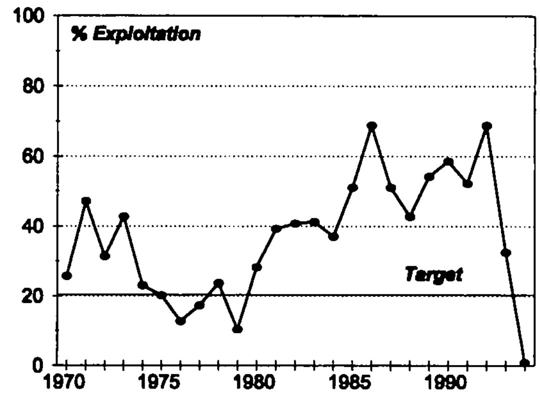
Questions regarding the validity of the ageing criteria used for eastern Scotian Shelf haddock have precluded the use of age-structured models for this resource since 1989 and have led to the development of length-based methods. These length-based methods are not, however, entirely independent of age determinations and therefore an age validation study has been initiated.

Assessments of this resource have shown significant retrospective patterns. These patterns indicate that exploitation in the current year is usually significantly underestimated, and that population abundance in the current year is overestimated. The current assessment continues to show this significant retrospective pattern.

Population abundance is presently low, relative to its long-term average; this is particularly true of larger haddock. Estimates of the abundance of pre-recruit (<36 cm) and recruited size classes from both the March and July surveys are below long-term averages and have declined significantly since the early 1980s.







Results of the length-based population analysis also indicate that population abundance is presently at about the same level as was observed in 1977, immediately following the exclusion of the foreign small-meshed mobile-gear fisheries.

Trends in estimates of **exploitation** are consistent with recent events in the fishery. Exploitation increased steadily from 1979 to 1986 to approximately four times the target level. In 1986, landings of approximately 17,000t were reported resulting in a significant increase in exploitation. In 1987, with the imposition of the Emerald Western closed area, exploitation declined due to exclusion of the mobile gear fishery from these grounds. From 1987 through 1992, the expansion of fixed gear effort in the closed area, coupled with the significant by-catch fisheries operating outside the closed area, again resulted in an increase in exploitation. With the removal of all fishing activity from the closed area in 1993 and a virtual closure of the fishery in 1994, exploitation has fallen to the lowest observed since 1970.

The range of fish sizes in this population has been reduced over its documented history. This is usually indicative of overexploitation. The average weight and length of fish in the population have also shown a gradual decline over this period.

The largest year-class to enter the fishery since the early 1980s was that of 1988. The modal length of this cohort can be tracked through the population. The modal length of the survivors of this cohort was 40.5 cm in 1994. This is well below the estimated average length at age for 6-year old haddock and may indicate a reduced growth rate or extremely high exploitation or both.

The range of this stock has again become more or less limited to Division 4W since the recruitment pulse of the 1980s. There are now fewer fish in Sub-Division 4Vs. This is likely related to the significant cooling trend observed on the shallow offshore banks (<100m) of Sub-Division 4Vs during the late 1980s

At present, **spawning stock biomass** estimated from surveys is on the order of 12,000t and is near the lowest observed since 1970. This estimate assumes that all fish larger than 43 cm are mature.

The summer survey indicates that the **1992 and 1993 year-classes** appear to be more numerous than the average (1970-1993) cohort observed at these sizes. However, these cohorts were not estimated to be of above average abundance by the spring 1995 survey.

Abundant year-classes are more widely distributed than weak ones. The distributional patterns of both the 1992 and 1993 year-classes are consistent with those of abundant year-classes. The spatial pattern of the 1994 year-class also appears to be that of an abundant cohort although estimates based on survey catches of these small fish must be interpreted with caution.

Outlook

Spawning biomass, as indicated by the biomass of 43 cm and larger fish is presently low. However, there are signs that moderate (1992) to large (1993) year-classes have been produced. These year-classes must be protected to promote stock rebuilding. The reduced exploitation which has been achieved over the past two years, if maintained in the near future, may initiate this rebuilding process.

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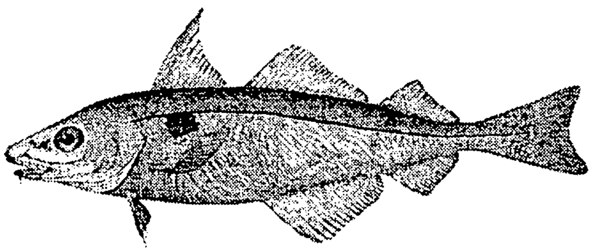
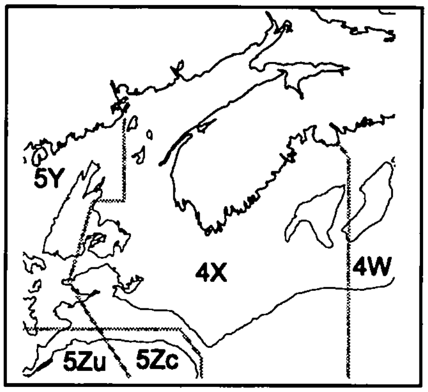




SOUTHERN SCOTIAN SHELF AND BAY OF FUNDY HADDOCK

Background

Haddock are found on both sides of the North Atlantic. In the west Atlantic, they occur from southwest Greenland to Cape Hatteras. A major stock exists in the southern Scotian Shelf and Bay of Fundy area. This bottom-dwelling species is a member of the cod family and feeds mainly on small invertebrates. It is most common at depths ranging from 25-75 fathoms and in bottom temperatures above 2°C. Although seasonal migrations are evident within the stock area, there is relatively little exchange between adjacent haddock stocks.

Young haddock in this stock are relatively fast growing, reaching 17 inches and 1.7 pounds by age 3 on average. Growth slows thereafter and haddock reach only about 26 inches in length by age 10. Haddock in the Bay of Fundy grow more rapidly than those on the southern Scotian Shelf. Approximately 50% of female haddock are mature by age 3; however the number of eggs produced by a female of this age is low and increases dramatically with age. Browns Bank is the major spawning area for the stock and peak spawning may occur from April to June.

Reported annual landings have been as high as 36,000t and the long-term average is about 20,000t. Landings have been below 11,000t since 1988. While this fishery has been dominated by mobile gear historically, the proportion of landings taken by fixed gear has increased in recent years and has been greater than 50% since 1990. Quotas for this stock were introduced in 1970 and a spawning season/area closure has been in place since that time.

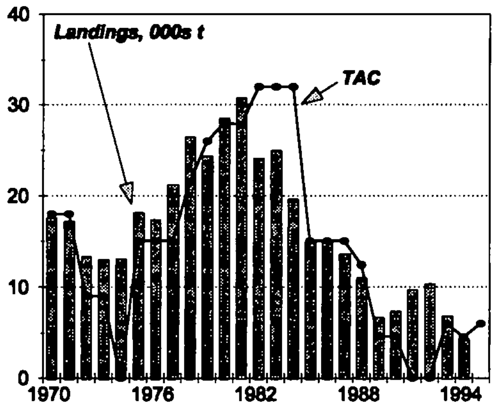
The Fishery

Landings (thousands of tonnes)

Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC	14.7	21.4	<4.6*	-*	-*	6.0	4.5	6.0
Reported Landings	18.2	18.9	7.3	9.7	10.4	6.8	4.3	

* - By-catch only

Landings in 1994 were 4,273t, the lowest level observed in recent history. This level was a result of a decrease in the quota to 4,500t and very stringent management plans, which resulted in substantial changes in temporal and spatial patterns in the fishery in 1994. Mobile gear landings from Browns Bank continued to decrease in 1994 as the fleet attempted to avoid haddock and directed for other species (flatfish, redfish, monkfish). Mobile gear landings from the Bay of Fundy and approaches remained stable as the fleet shifted away from the banks and into deeper water. Fixed gear landings also decreased, due primarily to restrictive trip limits throughout most of the year and to closures during the first quarter as a result of landings of undersize cod and haddock. During industry consultations, it was indicated that considerable discarding of undersized haddock occurred in the fixed gear sector after the closure for undersized fish and that both discarding and misreporting of haddock increased as fixed gear trip limits decreased. Catches are considered to have been higher than indicated by reported landings. Anecdotal information suggests that the amount of unreported catches was not more than 1,000t.



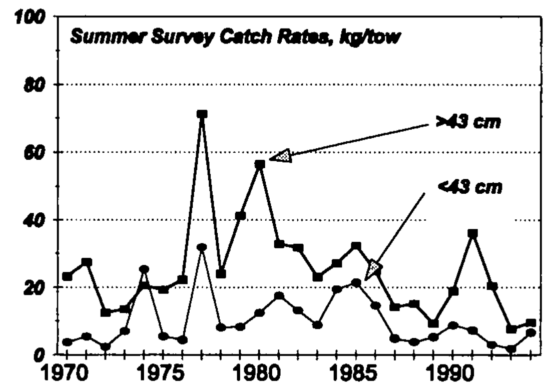
Due to problems with accurate reading of the otoliths, the age composition of the landings has not been estimated in recent years. There has been an increase in the mean length in the mobile gear landings since the introduction of square mesh gear and ITQs; over the same period (1990-1993), however, there was a decrease in the mean length in the fixed gear landings. Mean length in the fixed gear landings increased slightly in 1994 but was still smaller than that in the mobile gear landings (50.5 vs 53.5 cm respectively in 1994).

Resource Status

The stock status evaluation was based on landings statistics, sampling for size composition of the commercial catch and trends in abundance from the research vessel survey. It has been shown that a time-dependent bias is present in the ageing data for this stock since 1983. Therefore, a length-based analysis was conducted with an adjustment made for this bias. All following references to ages and year-classes were inferred from length data and analysis.

Changes to regulations and gear modifications make comparisons of commercial catch rates from year to year difficult to interpret. As a result, commercial catch rates were not used.

Abundance in the **1994 survey** increased from a historic low level in 1993; however, this increase was mainly due to the catch of large numbers of small haddock (<43 cm). The abundance of market size haddock (>43 cm) in 1994 increased only slightly.

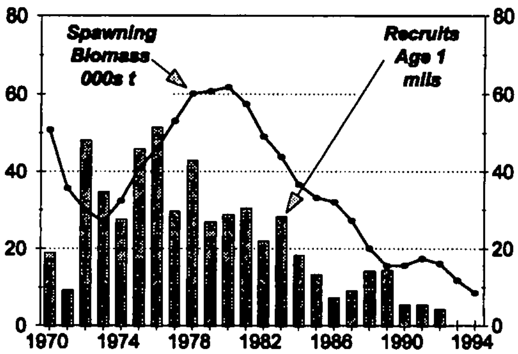


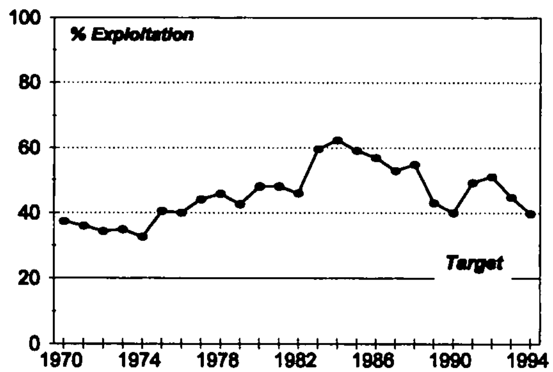
The distribution of haddock in the 1994 survey indicates that abundance increased slightly in the eastern portion of the survey area, predominantly on LaHave and Baccaro banks; however it is still below average levels. Abundance in the Browns Bank area increased relative to 1993 but shows no consistent trend. Abundance in the western portion of the survey area (Bay of Fundy and approaches) increased substantially in 1994, due almost entirely to large catches of small haddock (<43 cm) in the Trinity Ledge/Lurcher Shoal area.

Catches of the 1992 year-class (modal length of 34 cm) in the 1994 survey were below average; in contrast, the 1993 survey had indicated this year-class was average or above average. Catches of the 1993 and 1994 year-classes (modal lengths of 24 and 8 cm respectively) in the 1994 survey were much larger than average.

The strengths of these year-classes need to be confirmed by future surveys.

Assessments of this resource have shown significant retrospective patterns. These patterns have indicated that exploitation in the current year is usually significantly underestimated and population abundance is overestimated. These patterns are still evident. Also, it was noted that there was a discontinuity in the calibration between the survey and the model in the early 1980s. An adjustment was made to compensate for this. The results of this analysis indicate that **exploitation** decreased from 1992 to 1994 but is still well above $F_{0.1}$. **Spawning stock biomass** is at historically low levels.





Outlook

Recruitment in this stock has been below average since 1983, with the moderate sized 1987 and 1988 year-classes being the strongest in the recent period. Spawning stock biomass is at historically low levels. The survey indicates that the abundance of market size haddock is low over most of the stock area. While abundance has increased on the banks, a large part of this increase is due to small fish.

This view of the resource differs from that often expressed by members of the industry. During consultations with the mobile gear fleet, haddock abundance was felt to have increased in the last 3-4 years but is still lower than that in the early to mid-1980s. Vessels avoid areas where haddock catch rates have traditionally been high. Consultations with the fixed gear fleet have not resulted in a consensus. Opinions range from haddock abundance being high to abundance being at very low levels. In general, fishermen fishing the banks report that haddock abundance is high, while fishermen fishing in the inshore areas in the eastern portion of 4X off Sambro and Lunenburg report that haddock have been scarce in recent years.

Given indications from the survey that one average (1992) and one above average year-class (1993) may be recruiting to the fishery, measures such as strict small fish protocols should be enforced to allow these year-classes to become mature and reproduce.

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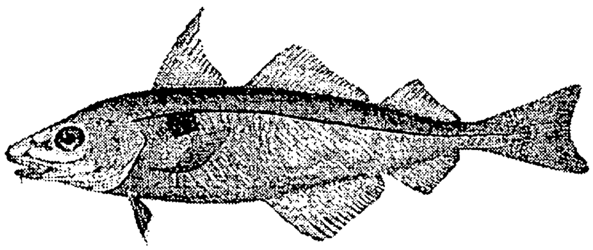
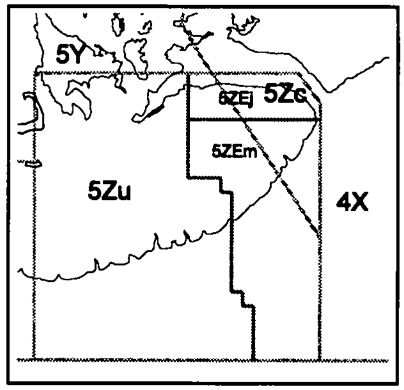




EASTERN GEORGES BANK HADDOCK

Background

The haddock, a fish found on both sides of the North Atlantic, is a bottom dwelling species in the cod family. In the western Atlantic, haddock range from Greenland to Cape Hatteras, with a major concentration on eastern Georges Bank.

Georges Bank haddock feed primarily on small invertebrates and are most commonly caught at depths of 45 to 240 meters (25 to 130 fathoms). Adult haddock appear relatively sedentary but seasonal movements occur. On Georges Bank, young haddock grow rapidly at first, reaching over 50 centimetres (20 inches) by age 3 on average, but grow slowly after, reaching about 75 centimetres (30 inches) by age 10. Many haddock mature by age 2 but it is uncertain if these young fish spawn successfully.

Georges Bank haddock have supported a commercial fishery since prior to 1900. Bottom trawlers have been the principal gear since their introduction in the 1920s. Landings from Georges Bank, which includes the eastern Georges Bank component and the Great South Channel component, averaged about 46,000t between 1935 and 1960 and increased to over 100,000t in the 1960s under heavy exploitation. Subsequently, during the early 1970s, spawning season/area closures were introduced as a means of controlling effort and are still in use today. Following the extension of jurisdiction to 200 miles by coastal states in 1977, only Canada and the USA have had haddock fisheries. Both Canada and the USA impose minimum fish size and mesh size regulations. Additionally, Canada establishes quotas with a target exploitation rate of roughly 20% of the population.

The Fishery

Landings (thousands of tonnes)

Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994
TAC[1]	-	-	n/a	5.0	5.0	5.0	3.0
Canada	2.7	4.4	3.3	5.4	4.1	3.7	2.4
USA	2.6	3.8	1.2	0.9	1.6	0.4	0.3
TOTAL	6.1[2]	9.2[2]	4.5	6.4	5.7	4.1	2.7

[1] Canadian quota only
[2] Includes foreign catches, discard estimates

Under management restrictions, landings have declined steadily since 1991, reaching a low of 2,711t in 1994 and approaching the historical low levels observed during the mid 1970s. Canadian landings in 1994 declined to 2,411t with decreases in both bottom otter trawl and longline, the predominant gears. The Canadian fishery was closed during January 1 to May 31 in 1994 for all groundfisheries and vessels over 65 feet were excluded through June 30. Fewer vessels participated in the Georges Bank fishery in 1994 compared to 1993 and at-sea monitoring was increased to check the capture of small fish. USA landings for 1994 were estimated at about 300t, the lowest on record. The USA fishery was further restricted in 1994 by an expansion of the closed area, an extension of the closed period through June 30 and 500 pound trip limits.

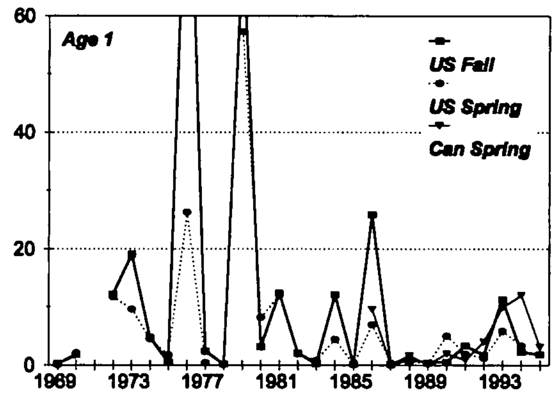
Few ages contributed to the 1994 landings with about 50% (by weight) accounted for by the 1991 year-class, with an average length of 53 cm (21 in). The 1987 year-class, which was one of the most abundant in recent years, continued to contribute substantially, accounting for about 15% (by weight) of landings. Fewer age 2 haddock were caught than had been forecast and may be due in part to increased use of larger mesh and/or square mesh by otter trawlers and changing fishing patterns.

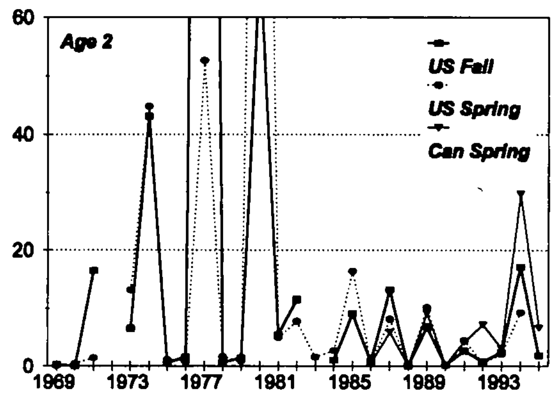
Though attempts have been made to adjust for known discards and misreporting, there continue to be unquantified reports of further discrepancies in landings. The quality of information however, is reported to be much improved since 1992, after the introduction of dockside monitoring.

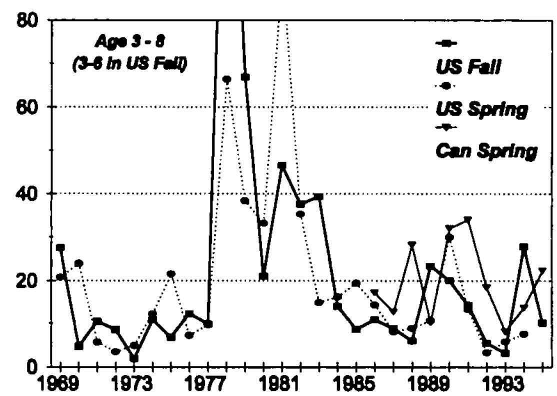
Resource Status

Stock status evaluations were based on an analytical assessment using landings statistics, sampling for size and age composition of the commercial catch and trends in abundance from three bottom trawl research surveys (USA spring and fall and Canadian spring).

Changes to regulations and gear modifications in recent years make comparison of catch rates from year to year difficult to interpret. Generally though, the catch per hour by otter trawlers appeared somewhat higher in 1994 compared to 1993 while the catch per trip by longliners remained at comparable levels. Longline fishermen reported however, that trips were shorter in 1994 and they experienced better fishing.

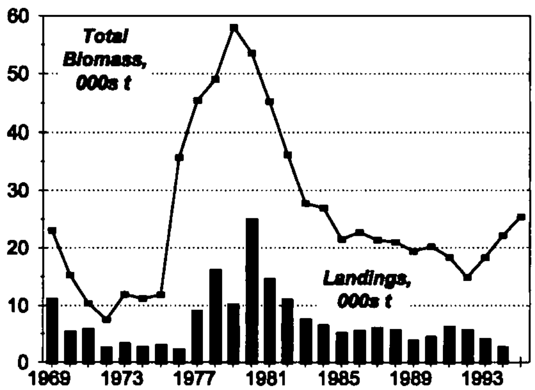




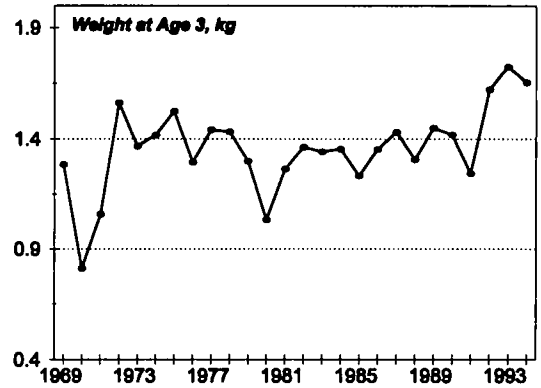


The USA **fall survey** results were compared to the beginning of year indices from the Canadian and USA spring surveys for the respective cohorts. The trend in adult biomass indices, ages 3 and older, from the three surveys declined between 1990 and 1993 to near the historical lows observed during the early 1970s, and increased in 1994. The Canadian survey continued to increase in 1995 while the USA fall survey declined but remained higher than the early 1990s level. The surveys indicated that the 1992 year-class was the largest since the 1987 year-class and of comparable abundance while the 1993 and 1994 year-classes were weaker.

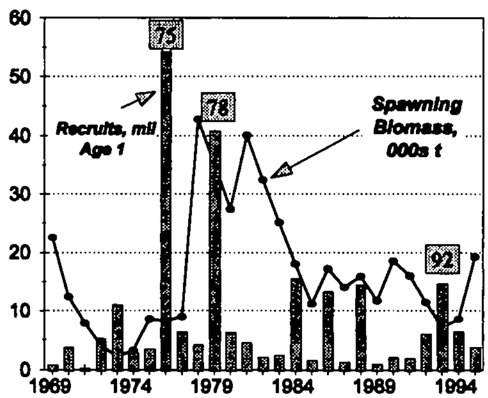
Population abundance estimates indicated that the total stock biomass (ages 1 and older) declined steadily since the mid 1980s after a rapid decrease in the early 1980s when the strong 1975 and 1978 year-classes were fished down. The biomass reached a low of 15,000t in 1992 and subsequently increased to about 25,000t in 1995.



Spawning stock biomass (as approximated by biomass for ages 3 and older) showed a similar pattern with an increase in recent years. Through the late 1980s, the biomass was supported by the 1983, 1985 and 1987 year-classes. The most recent increase, due principally to the recruitment of the 1992 year-class was enhanced by increased weight at age of haddock from this and adjacent year-classes as well as increased survivorship of young haddock from reduced exploitation by commercial fisheries.

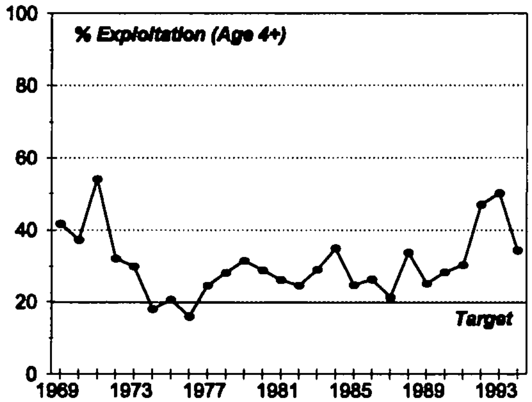


Recruitment during the 1980s was poor and only the 1983, 1985 and 1987 year-classes were of moderate strength. The 1992 year-class was estimated to be comparable to these while the 1991 and 1993 year-classes were about a third this magnitude. The 1994 year-class was not well estimated but appears somewhat weaker than the 1993 year-class.



The **exploitation rate**, on ages 4 and older, has generally been above the target and shows a marked increase since 1991, reaching roughly 50% in 1993. The previous occasion when the exploitation rate was this high occurred in 1971 when the stock was near its lowest abundance. The exploitation rate declined in 1994 to about

35%. Results from assessments for several other stocks have identified a discrepancy between past estimates of stock status and current estimates using additional data (retrospective pattern). Results for this stock indicate that this assessment does not suffer from a retrospective pattern.

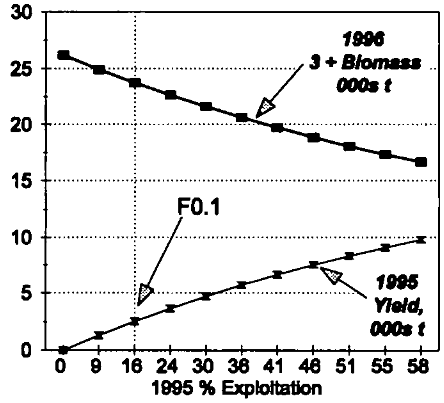


The Georges Bank ecosystem is complex with numerous species interactions. Further, species adapt to fluctuations in abundance of both their prey and predators. These interactions were modelled by a constant natural mortality and there were no indications that this assumption was severely violated. Currently available information does not permit more complex models to be employed.

Environmental conditions on Georges Bank have varied but have not displayed extreme deviations in recent years. Though environmental conditions are thought to influence fisheries processes, convincing relationships with quantities such as recruitment, survival rates and fish catchability have not been established.

Outlook

The **projected** yield at the target exploitation rate (20%, $F_{0.1}$=0.25) for 1995 would be about 3,000t with the 1992 year-class accounting for roughly half of that weight. During this period the adult biomass (ages 3+) is projected to increase to about 23,000t by 1996.



With the current state of the stock, younger aged haddock make a relatively large contribution to the projected yield. The precision of the abundance estimates is poorest at the youngest ages. This uncertainty gets translated to the projected yield and its relative error is roughly 25%. Increasing the number of age groups contributing to the catch should lead to greater precision in the advice.

The projected increase in haddock abundance is due primarily to recruitment of the moderately strong 1992 year-class. Continuing conservation efforts such as low exploitation and fishing practices which permit recruits to realize their growth and reproductive potential are needed to rebuild the population biomass and to expand the age structure.

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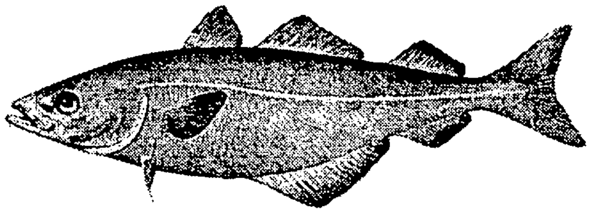
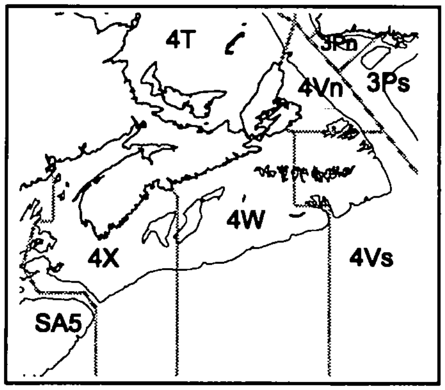
References

Gavaris, S., and L. Van Eeckhaute. 1995. Assessment of haddock on eastern Georges Bank. DFO Atl. Fish. Res. Doc. 95/6: 36 p.



POLLOCK IN 4VWX5Zc



Background

Pollock in the western Atlantic range from southern Labrador south to about Cape Hatteras. The main fishable concentrations, however, occur in the Georges Bank, Gulf of Maine, and Scotian Shelf areas.

Young pollock are closely associated with nearshore habitats, recruiting to the offshore populations at around age 2. Of all the cod-like fish, pollock spend the least time on the bottom. Pollock show strong schooling behaviour. Food of adult pollock include euphausiids and fish such as herring, sand lance and silver hake.

Pollock are mature at ages 3 to 5 depending on the area. Pollock also show marked differences in growth rate by area, with fish in the Bay of Fundy area growing faster than those on the Eastern Scotian Shelf.

The management unit includes the Canadian portion of Georges Bank and the Gulf of Maine, and the Scotian Shelf. A variety of fishing gear are used to fish pollock, including primarily otter trawls, gillnets, handlines and longlines. Pollock are also landed as by-catch in the small-mesh silver hake fishery. The Canadian fishery is managed on the basis of a target exploitation rate of about 25% of the population.

The Fishery

Landings (thousand metric tons)

Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC	-	-	43.0	43.0	43.0	21.0	24.0	14.5
Canada[1]	23.3	39.5	36.2	37.9	32.0	20.3	15.2	
TOTAL[1]	37.2	40.9	37.5	39.6	34.1	21.1	15.2	

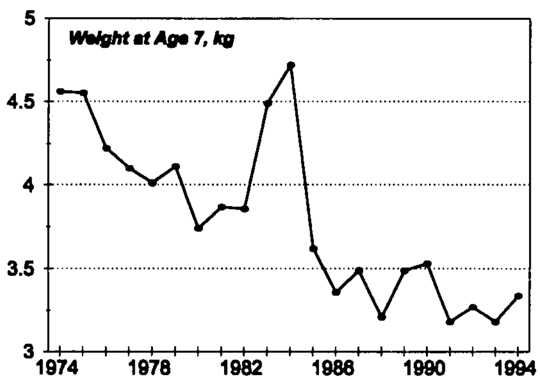
[1] The management unit included NAFO Subarea 6 and divisions 5Y and 5Z prior to 1988. Starting with 1988, only the Canadian portions of divisions 5Y and 5Z were included in the landings.

Landings in 1994 declined to 15,250t, the lowest observed during the period 1960 to 1994. Landings in the small mesh silver hake fishery have declined to only 10t from 820t in 1993, due to a late start in the fishery, reduced silver hake quota, the mandatory use of grates which excluded the capture of larger pollock, and revisions to the boundaries where the small mesh gear fishery was allowed to operate. Landings throughout the management unit have declined in general, but Georges Bank landings did not decrease to the same extent. The distribution of the fishery within the management unit has changed, with landings from the western side (4X, 5Z) comprising an increasing proportion of the total.

Most gear sectors did not land their quotas. In particular, vessels >100' caught only 34% of their quota. In contrast, fixed gear vessels <45' were able to catch their quota.

Fish aged 5-8 are accounting for a greater proportion of total landings than they have in the past, and there are comparatively few age 3 and 4 fish. The lack of these ages may be attributable, in part, to the use of larger mesh and/or square mesh by otter trawlers and the much diminished catch of pollock in the small mesh silver hake fishery. Small inshore pollock were reported abundant in 1994. Landings in the inshore trap fishery were high compared with the last few years.

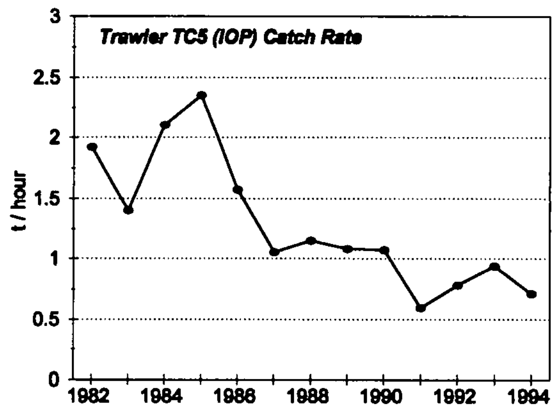
There has been a trend of decreasing weights at age for this resource.



Resource Status

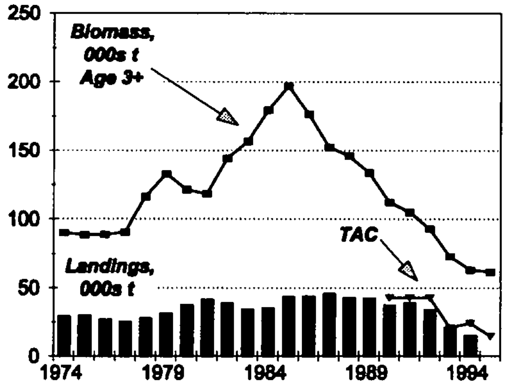
The stock status evaluation was based on an analytical assessment employing landings statistics, sampling for size and age composition of the commercial catch and trends in commercial fishery catch rate. Changes in the 1994 assessment include development of a new approach for the construction of the catch at age which reflects observed differences in growth rate by season and area within the management unit, correction of miscoded ages through 1991 to 1994, and development of the commercial catch rate information.

The **stern trawler TC5 catch rates** from the International Observer Program (IOP) play an important part in this assessment. This catch rate series has declined since 1985. Given the trend of diminishing contribution to total landings for this gear sector, development of an alternative index of abundance seemed advisable.

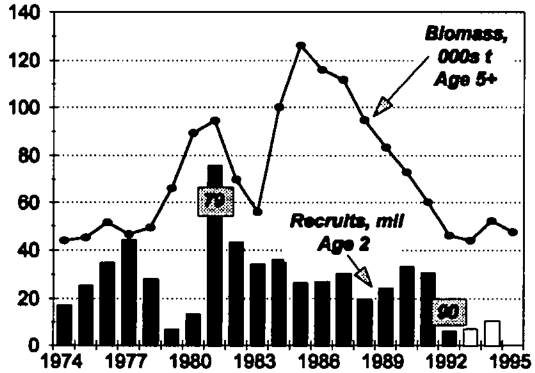


To include a broader spectrum of the fishery, a standardized catch rate series was constructed using catch rate information from all tonnage classes. This analyses attempted to account for known differences in catch rate by tonnage class, mesh type, area, month and year. However, the IOP catch rate series seemed a more useful index at present, since the series is of longer duration. The downward trend in commercial fishery catch rates appears generally consistent with the experience of fishermen with the exception of longliners.

Research vessel survey data are not currently employed in this assessment, as there is considerable unexplained interannual variation of many year-classes concurrently, which is inconsistent with our knowledge of fisheries dynamics.

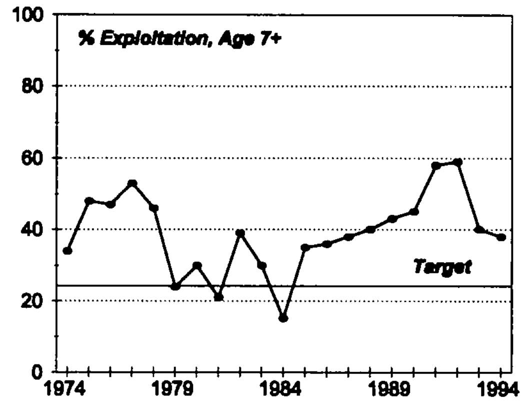


Population abundance estimates indicate that the stock is in a depleted state. Biomass has declined steadily since 1985 and is now at the lowest level in the series. This decline has been due to high exploitation, not poor recruitment, as indicated on the following figure.



Recruitment after the strong 1979 year-class has been close to the long-term average of 28 million fish. The most recently estimated year-class (1990; more recent years are estimated by trends in partial recruitment), however, appears to be the weakest in the series.

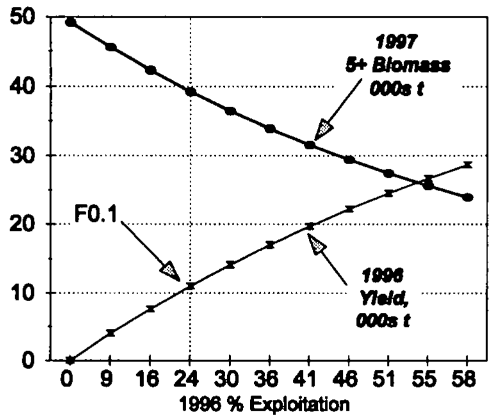
The **exploitation rate** has been increasing since 1984 and reached a peak in 1992. Although recent values have declined somewhat, the current exploitation rate is still almost twice the target level.



Outlook

If the TAC of 14,500 is taken in 1995, the resulting fully recruited fishing mortality will be about 0.38. The beginning of year biomass will drop from 47,022t in 1995 to 39,565t in 1996 as the weak 1990 year-class moves into the fishery. The $F_{0.1}$ catch in 1996 is 11,000t. Even with an $F_{0.1}$ harvest strategy, the 5+ biomass will not start to increase in 1997. The uncertainty associated with the projected yield is about 29%, based on the precision of the estimates of ages 5-10 in the current assessment.

With increased use of square mesh gear and by-catch reduction measures in the small mesh silver hake fishery, year-classes recruiting to the fishery will have a greater opportunity to spawn.



For More Information

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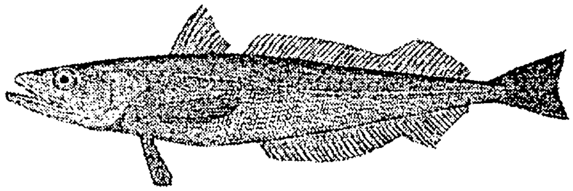
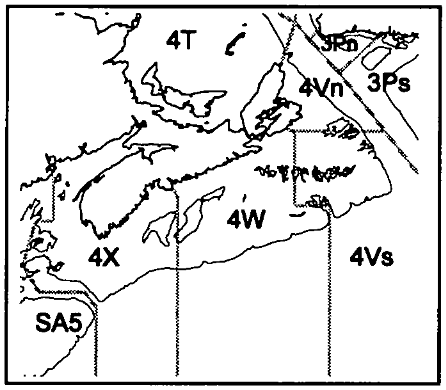
References

Neilson, J., and P. Perley. 1995. The 1995 asessment of pollock (*Pollachius virens*) in NAFO Divisions 4VWX and Subdivision 5Zc. DFO Atl. Fish. Res. Doc. 95/30: 38 p.



SILVER HAKE IN 4VWX



Background

Silver hake, Merluccius bilinearis, is a small gadoid found on the Eastern seaboard of the United States and Canada. Its range extends from Cape Hatteras to the Grand Banks, with a large stock located in the slope waters of the Scotia Shelf. Silver hake have a preference for warmer water than most other gadoids, in a 7 to 10° C range. On the Scotian Shelf this temperature preference restricts this species to deeper waters (>200 m) in basins and on the shelf edge for much of the year. Only in late summer, when temperatures on Western and Emerald banks have risen do silver hake move to more shallow water to spawn.

Silver hake matures at age 2, with 100% of males and 50% of females mature at this point. Natural mortality is estimated at 0.4, twice that of most cod stocks. Maximum age in the population is approximately 9 years.

Silver hake has formed the basis of a fishery since the early 1960s, with the USSR and Cuba the most active participants. Recruitment occurs at a relatively young age, with ages 3, 4, and 5 considered fully recruited. The catch consists almost entirely of ages 2, 3 and 4. Canadian companies have been active in the harvesting of silver hake since 1990, primarily through charter arrangements with Russian and Cuban fishing vessels. A small domestic fishery with 45 and 65' vessels fishing in LaHave and Emerald Basins is in a developmental phase.

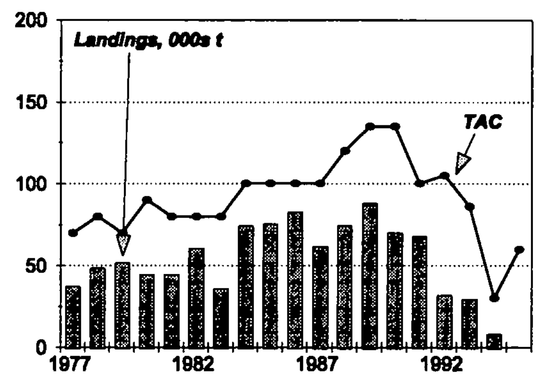
Since 1977 fishing for this species on the Scotian Shelf has been restricted to an area offshore of the 'small mesh gear line' (SMGL), with a minimum codend mesh size of 60 mm. With populations of traditional groundfish species at very low levels, domestic fishing interests have expressed concern over by-catch in the silver hake fishery. As a result, in 1994 Canada implemented additional regulatory measures designed to reduce by-catch. These included a repositioning of the SMGL to restrict fishing to deeper water, and the mandatory use of a separator grate in trawls. These measures were very successful in reducing by-catch, did not reduce the silver hake catch rate, and have continued into 1995.

The Fishery

Landings (thousands of tonnes)

Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC	73	99	135	100	105	86	30	60
Foreign[1]					6	2	1	
Domestic Charter[2]					26	27	7	
TOTAL	46	64	70	65	32	29	8	

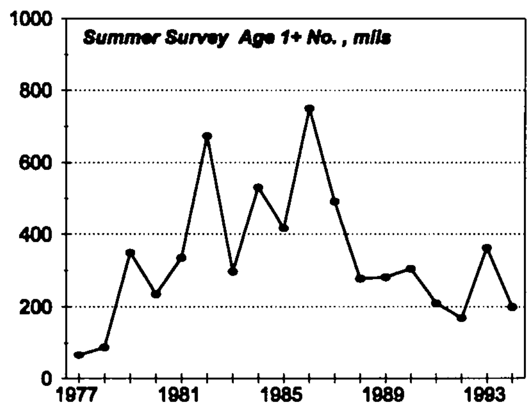
[1] Foreign vessels fishing under National allocations
[2] Foreign vessels fishing under Canadian allocations
[3] Includes catch by Canadian vessels under Canadian allocation, maximum 70 tons.



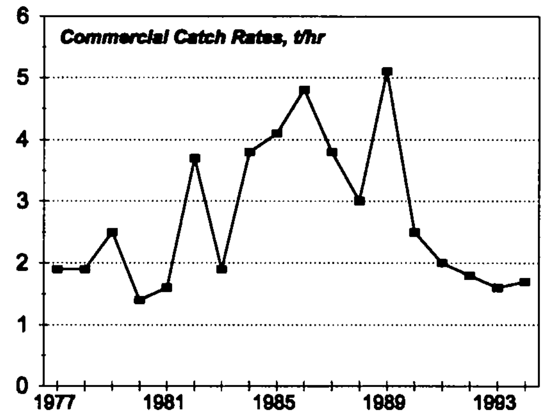
Nominal catches have declined from 60-80,000t in the mid-1980s to 30,000t in 1992 and 1993. Effort in the 1994 fishery was greatly reduced over historical levels. The fishery opened very late, and Canadian companies had difficulty in making charter arrangements as many potential vessels were committed to other ventures. As a result, only seven Cuban vessels were participants in 1994, and the provisional catch was 8,000t.

Resource Status

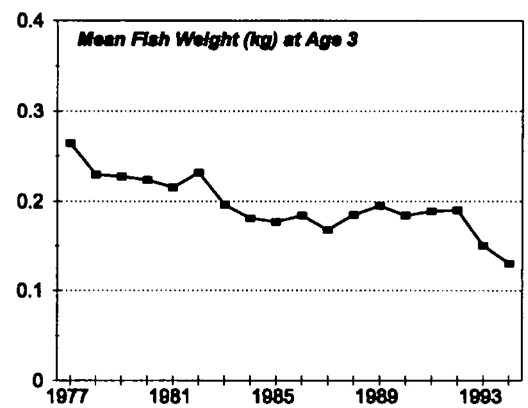
July survey indices of abundance and biomass declined from 1988-94 and are now at a relatively stable but lower level than that seen in the mid-1980s. A moderate increase in abundance and biomass was seen in 1993, but the 1994 survey indices have dropped to levels similar to those for the 1988-1992 period.



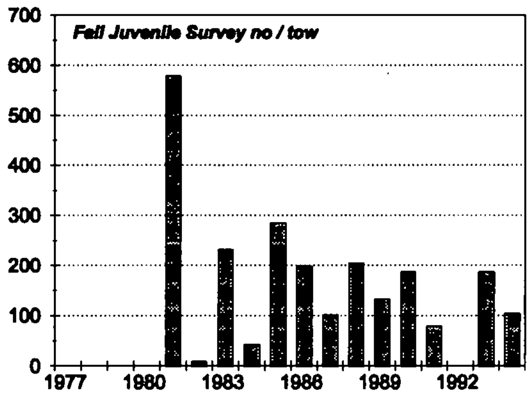
Standardized **commercial catch rates** was relatively high from 1984-89. However the catch rate dropped by approximately 50% in 1990, and has declined further since. The catch rates from 1992 through 1994 has remained constant at a low level of approximately 1.7t/hr.



Mean weight at age in the commercial fishery was stable from 1985 to 1992, but has declined for most ages in 1993 and dropped further in 1994. In the ages most important to the fishery (2-4), the decrease in weight is approximately 30%. In projecting a TAC at target fishing levels, this will have a negative effect on the 1996 TAC.



Results from the **O-group survey** and survey age 1 numbers show the 1983, 1985 and 1988 year-classes to be strong, and these year-classes sustained the fishery through the mid to late 1980s. The 1990 and 1991 year-classes were below average, but 1992 was slightly above average. Indices of abundance for the 1993 year-class are contradictory; based on survey age one estimates, this cohort may be below average in size, but the O-group index indicates the year-class to be relatively strong. Based on the O-group survey, the 1994 year-class appears weak.



Outlook

The analytical assessment of this stock shows a retrospective pattern whereby fishing mortality in the most recent year is apparently underestimated by 40-60%. Given this, advice on harvesting levels from the NAFO Scientific Council since 1993 has included projections of catch which were corrected to account for this retrospective problem. These lower levels of projected catch have largely determined the levels of TAC set. Projections for this stock will be made following review of the assessment at the June 1995 meeting of the NAFO Scientific Council. However, with recruitment estimated to be moderate to poor, and the substantial reduction observed in mean weight, yield prospects for 1996 will likely be lower than 1995.

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References

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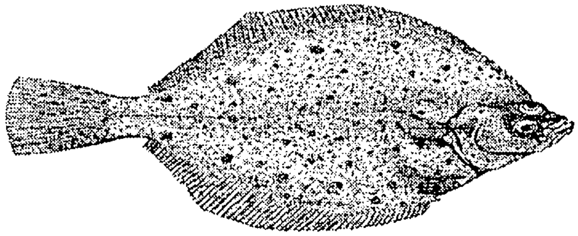
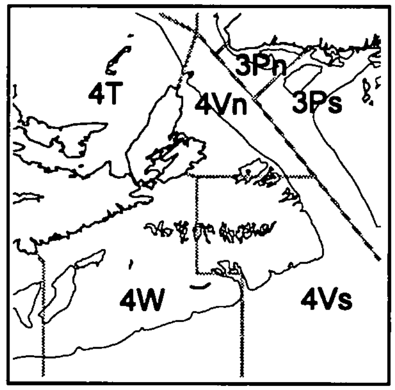




EASTERN NOVA SCOTIA FLATFISH

Background

Flatfish are bottom dwelling fishes primarily associated with soft substrate (mud and sand bottom). They are unique among other fish in being asymmetrical, both eyes lying on either side of the highly flattened body. They commence life swimming in the normal manner, but early in life they start to swim on one side and the eye on the underside migrates to the upper side. Flatfishes lie on the bottom on the blind side. Principle food items include crustaceans, mollusks, polychaete worms and small fishes. The three commercially important species fished in the 4VW area are. American plaice, witch flounder and yellowtail flounder.

Up to and including 1993, flounders were managed as one stock complex (4VWX). In 1994, the management area was divided into an eastern (4VW) and western (4X) component and the overall TAC reduced to 10,000t, with 5,500t allocated to the 4VW area, based on catch history. As well, winter flounder was included in the western component. The 1995 management plan was set at a TAC of 7,500t which was partitioned between 4VW and 4X giving the eastern component a TAC of 4,125t.

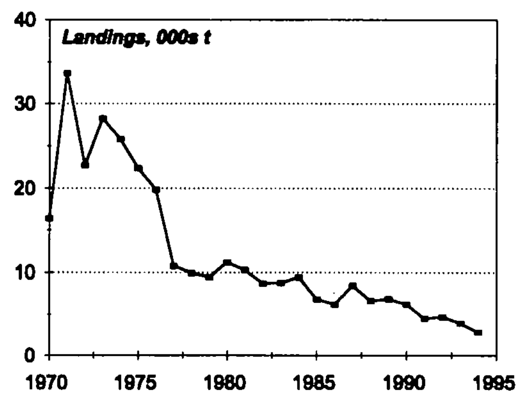
Management of the three species together under one TAC reflects the fact that it has to date been impossible to obtain reliable statistics on landings by each species separately. A system initiated in the late 1960s, which assigned landings to species based on regional keys, and equated local names with official ones for each species was abandoned in 1991. However, the system which replaced it (ITQ logs and dockside monitoring of landings) was unsuccessful in assigning more than 50% of the landings to individual species because landings were not separated at weighout or were misidentified by the weighmaster. Separation by species, although requested formally in 1993 (letter to ITQ holders and weighmasters) was never enforced. The absence of reliable landing statistics makes it difficult to determine the level of exploitation for the individual species.

The Fishery

Landings (thousands of tonnes)

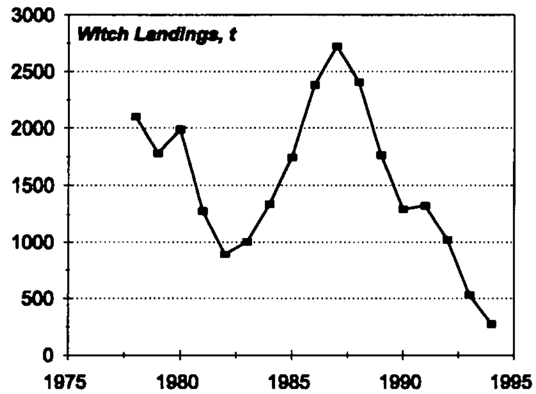
Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC*							5.5	4.1
Canada	11.2	8.3	6.2	4.2	4.7	3.9	2.8	
Foreign	8.5	0.1	0.1	0.1	0.1	-	-	
TOTAL	19.7	8.3	6.3	4.3	4.8	3.9	2.8	

* New management unit established 1994



Total landings of 4VW flatfish in 1994 amounted to 2,824t, a decrease from 3,959t taken in 1993. The decrease is likely due to the TAC reduction and the new sharing arrangements for the fleet sectors. Fixed Gear landings dropped to 14t in 1994 from several hundred in the recent past. Traditional share percentages used in 1994 resulted in the mobile gear less than 65ft sector receiving an allocation well below recent average catches and the fishery for this sector was closed in August. However, only 15% of the allocation to mobile gear vessels greater than 65ft was taken.

Landings for witch flounder (usually identified due to higher prices) have declined significantly since the late 1970s to a low of 275t in 1994.

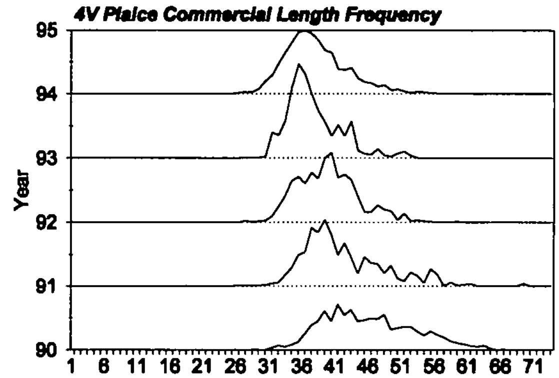


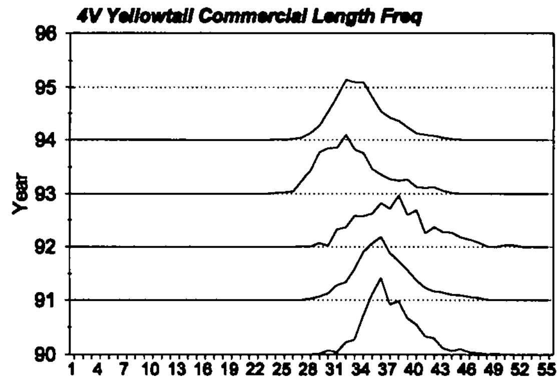
In recent years, the commercial fishery was conducted almost entirely in 4V. The yellowtail fishery was on Banquereau Bank while plaice was fished throughout 4V. Witch flounder was fished throughout 4V and to a certain limited extent in 4W, especially in the Gully area. There was no significant fishery for winter flounder in 4VW.

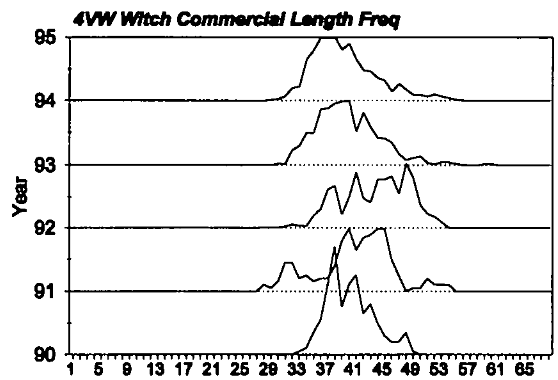
Resource Status

Stock status evaluations were based on sampling the commercial landings for size composition, the commercial catch rates for combined flounders, and survey abundance indices and size composition by species.

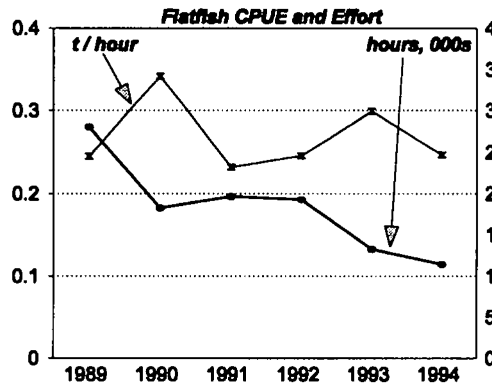
Length frequencies of the commercial fishery landings indicated a shift toward smaller fish since 1990 for American plaice, and a shift toward smaller fish in 1993 and 1994 for yellowtail flounder. Witch flounder also exhibit a trend toward smaller fish although not as pronounced as for plaice and yellowtail.

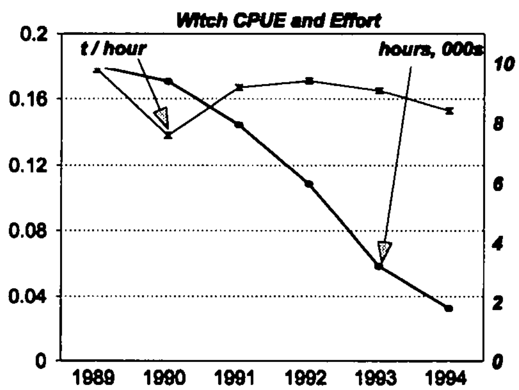






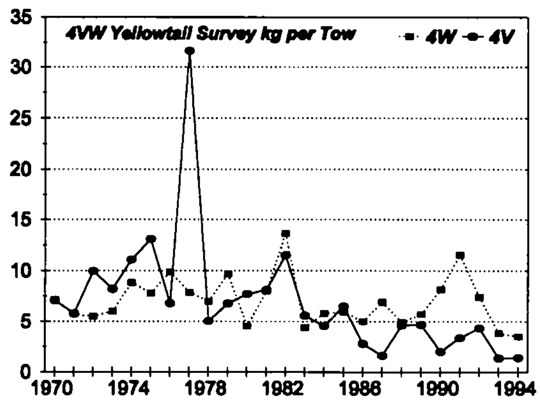
Commercial catch rates for flounders for less than 65ft mobile gear declined in 1994, although catch rates have been relatively stable over the last six years. Fishing effort for this fleet remained at about the 1993 level and indeed has been stable after the large increase in 1991. However, total effort has declined since 1992 likely due to the virtual absence of the less than 65ft fleets from the flounder fishery. Catch rates for witch flounder have remained relatively stable since 1989 even though landings have declined significantly. Total witch effort has also declined significantly from 9915 hr in 1989 to 1797 hr in 1994.

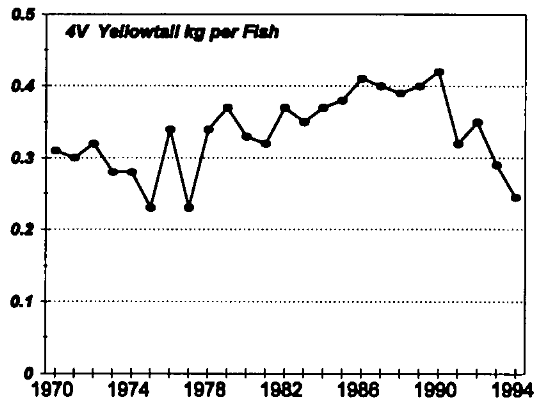




Yellowtail

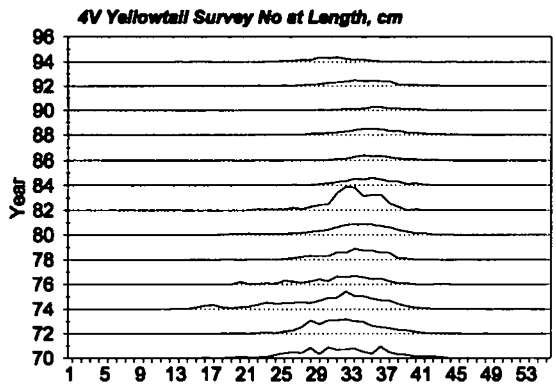
Survey abundance estimates of yellowtail in 4V have declined since the late 1970s and the population is now composed of older fish, almost all in the size range exploited by the commercial fishery. Yellowtail are smaller and more abundant in 4W, and generally not of commercial size. Weight per tow has been decreasing in 4W but at a lesser rate than in 4V; however, numbers per tow are still at previous levels. Interrelationships may occur between the two areas. Tagging results indicate some movement between the two areas, mainly from 4W to 4V.





The average weight of a yellowtail in 4V surveys shows a declining trend since 1990.

Survey length frequency distributions of yellowtail in 4V indicate a similar shift to a smaller size as seen in the commercial length frequencies. Modal length in both the survey and the commercial fishery declined from about 35cm in 1990 to 30cm in 1994. Relative to past surveys in which fish less than 25cm were generally well represented, signs of good recruitment in 4V are not apparent in the last ten years.

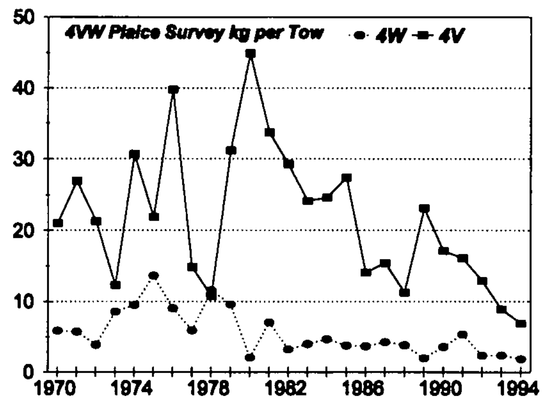


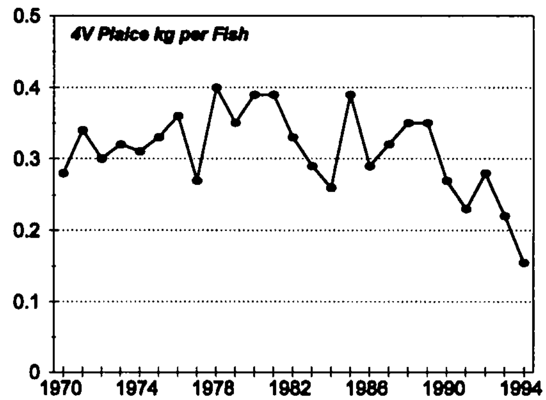
In summary, mean numbers and weights per tow of yellowtail, especially in 4V, declined gradually from the early 1980s and now appears to be at a very low level. Indices in 4Wwere more stable, the most noteable decline occurring after 1992. The modal length for both the survey and the commercial fishery has decreased in 4V and is now very close to the minimum market size of 30cm. The average weight per fish from surveys is at the lowest point in the time series. Modal length of both the survey and commercial length frequencies has decreased and there are no signs of good recruitment.

American Plaice

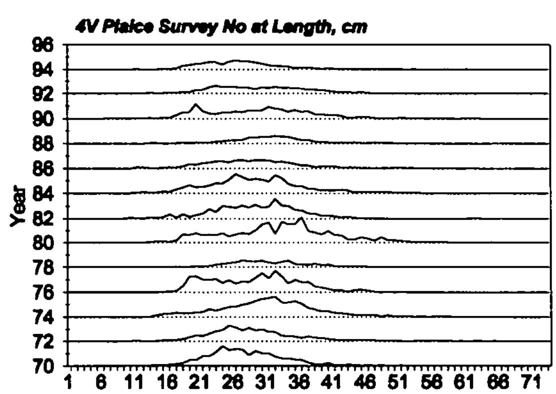
American plaice survey mean numbers and weight per tow in 1994 were among the lowest in the time series. Survey abundance indices for 4V are substantially higher than for 4W but show the greatest, particularly in terms of weight per tow.

The average weight of a plaice in 4V has declined since the late 1980s.





Survey length frequency distributions in 4V indicate that there are fewer large fish in the survey in recent years, with relatively few fish over 40 cm caught, although numbers of small fish remain relatively high.

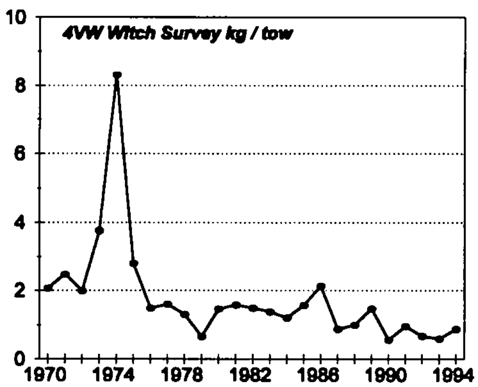


The commercial fishery takes most of its catch at lengths not observed in large numbers in the survey length distributions.

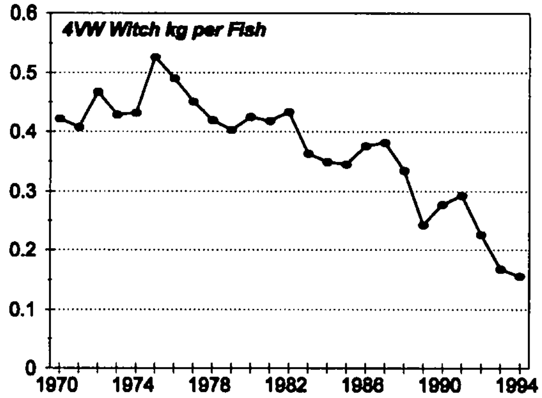
In summary, the plaice resource is at a fairly depleted state with mean weight and number per tow in 4V declining since 1980, with 1994 weight per tow the lowest in the time series. Both the survey and commercial fishery indicated fewer large fish than in the past and average fish weight has declined since the late 1980s. There are signs of potential recruitment but in conjunction with the absence of larger fish nonetheless indicates declining biomass.

Witch Flounder

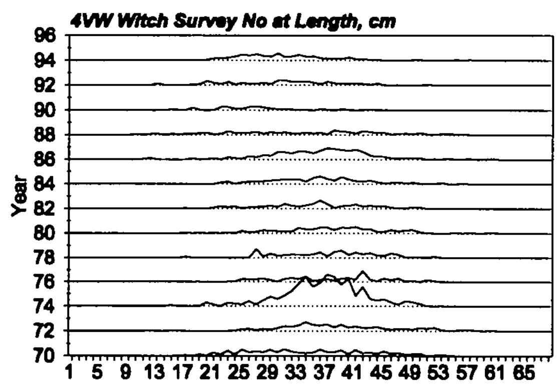
Witch flounder **survey mean weight per tow** has declined gradually since the early 1970s. Mean numbers have been relatively stable but have shown an increase since 1990. Survey indices are quite variable, likely due to the distribution of witch in deep holes and the segregation by size. Survey catches of witch occur mostly in the 4Vn and Gully areas.



The **average weight** of a witch declined since the mid 1970s. This long decline is no doubt influenced by incoming recruitment, but the extent of the decline is likely related primarily to the disappearance of larger fish.



Witch flounder survey **length frequencies** indicate a trend toward smaller fish in the latter half of the survey series with commercial size fish declining in abundance. In recent years, the survey appears to be picking up more <30cm witch than in the past.



In summary, witch flounder mean weight per tow has shown a slow decline over time and the average weight of a fish has declined. Survey length frequencies indicate potential for improved recruitment although there are few large fish in the population.

Winter Flounder

For winter flounder, the entire survey biomass is found in 4W with a large portion contained within the closed area. Coastal populations of winter flounder are not sampled by the survey. The survey numbers and weights per tow have been increasing since 1983 and abundance remains relatively high. Winter flounder is not fished commercially in 4VW and interrelationship with the coastal populations of winter flounder are unknown.

Outlook

In the last few years, all commercially exploited flatfish have shown a declining biomass, and an absence of larger fish in both the survey and the commercial fishery. In 4V, particularly 4Vc, these signs are most evident. Aside from some modest recruitment, fishing conditions appear to have deteriorated over the last few years and are not likely to improve substantially in the near future. It is noteworthy however, that the 4W component of the population also showed some decline in abundance even in the absence of any significant level of fishing. This suggests that the declines observed in 4V are likely not entirely related to fishing. Without any information on the exploitation rates, the relative contributions by the fishery or other related factors, to the population declines cannot be determined. Until such time as accurate catch information by species can be provided, little guidance can be provided on appropriate levels of fishing. Results of consultations with industry were mixed but indicated a scarcer flatfish resource. The shift to smaller fish in both the survey and commercial fishery may result in discarding.

In 1994 a substantial reduction in effort was advised with the objective of reducing fishing mortality to below recent levels. Total landings decreased by about 30% in 1994 and total effort has declined since 1992. The reduction in TAC for 1995 to 4,125t from 5,500t should result in catches in the 2,000t range assuming similar utilization of fleet allocations. It would be prudent to continue to restrict catches in 1996 at no more than the 1994 level, because catches of about 4,000t taken between 1991 and 1993 did not result in any improvement in stock status. However it should be noted that both catch and effort could increase in 1995 if fleet allocations are taken.

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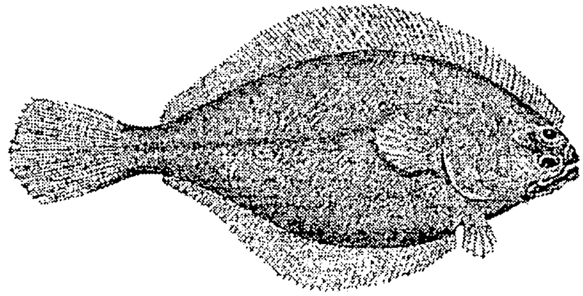
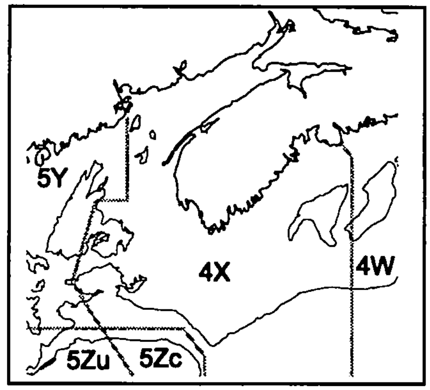




SOUTHWEST NOVA FLATFISH

Background

Flatfish are bottom dwelling fishes primarily associated with soft substrate (mud and sand bottom). They are unique among other fish in being asymmetrical, both eyes lying on either side of the highly flattened body. They commence life swimming in the normal manner but early in life they start to swim on one side, and the eye on the underside migrates to the upper side. Flatfishes lie on the bottom on the blind side. Principle food items include crustaceans, mollusks, polychaete worms and small fishes. All four commercially important species fished in the 4X area (winter flounder, witch flounder, American plaice and yellowtail flounder) are right eyed flounders.

Up to and including 1993, flounders were managed as one stock complex (4VWX). In 1994, the management area was divided into an eastern (4VW) and western (4X) component and the overall TAC reduced to 10,000, with 4,500t allocated to the 4X area based on catch history. The 1995 management plan set a TAC of 7,500t which was partitioned between 4VW and 4X giving the western component a TAC of 3,375t. This allocation included winter flounder.

The flounder fishery in 4X was placed under the ITQ program in August 1994.

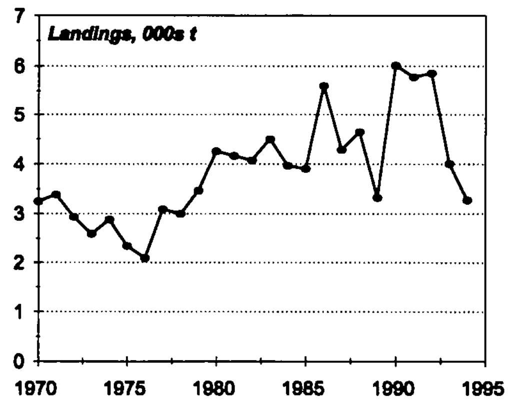
Management of the four species together under one TAC reflects the fact that it has to date been impossible to obtain reliable statistics on landings by each species separately. A system initiated in the late 1960s which assigned landings to species based on regional keys, and equated local names with official ones for each species was abandoned in 1991. However, the system which replaced it (ITQ logs and dockside monitoring of landings) was unsuccessful in assigning more than one-third of the landings in 4X to individual species because landings were not separated at weighout or were misidentified by the weighmaster. Separation by species, although requested formally in 1993 (letter to ITQ holders and weighmasters) was never enforced. The absence of reliable landing statistics makes it difficult to determine the level of exploitation for the individual species. The bulk of landings in 4X are made up of winter flounder and witch flounder. Plaice and yellowtail make a relatively small contribution to the fishery.

The Fishery

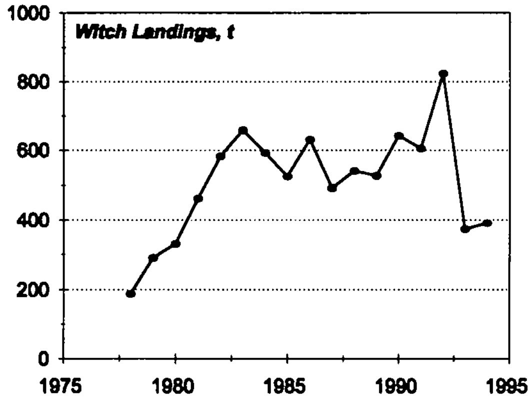
Landings (thousands of tonnes)

Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC*							4.5	3.4
Canada	2.7	4.2	6.1	5.8	5.9	4.0	3.3	
Foreign	0.2	0.1	0.1	0.1	0.1			
TOTAL	2.9	4.3	6.1	5.8	5.9	4.0	3.3	

* New management unit established in 1994.



Total landings for flatfish in 4X for 1994 amounted to 3,277t, a decrease from 4,011t taken in the 1993 fishery. Landings for the greater than 65ft mobile gear fleet have been insignificant in the 4X area since the early 1980s. Fixed gear landings increased slightly in 1994 due to increased landings by longliners. For witch flounder (usually identified in the catch statistics due to higher price), landings declined significantly in 1993 and 1994. Allocations in 1994 were not restrictive to the mobile gear less than 65ft fleet. Even so, landings for that fleet dropped by about 20%.

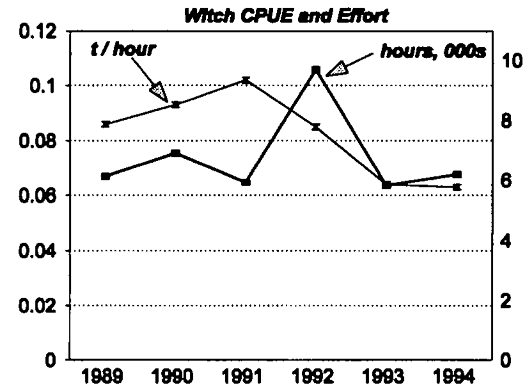


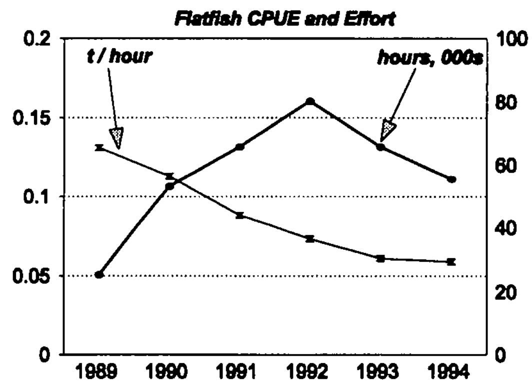
In 1994, the commercial fishery was conducted on Browns Bank and in the Bay of Fundy area for winter flounder. The witch flounder fishery was more widespread throughout 4X. There is very little directed fishery for plaice and yellowtail flounder.

Resource Status

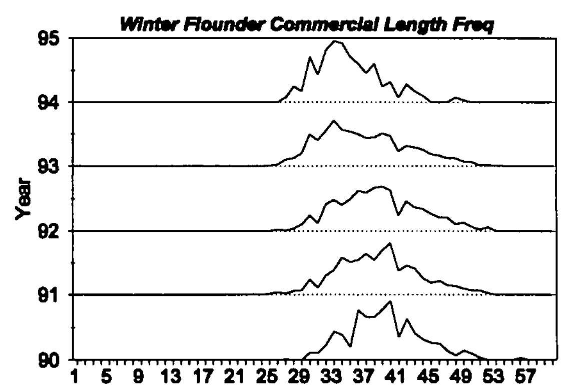
Stock Status evaluations were based on sampling the commercial landings for size composition, the commercial catch rates for combined flounders, and survey abundance indices and size composition by species.

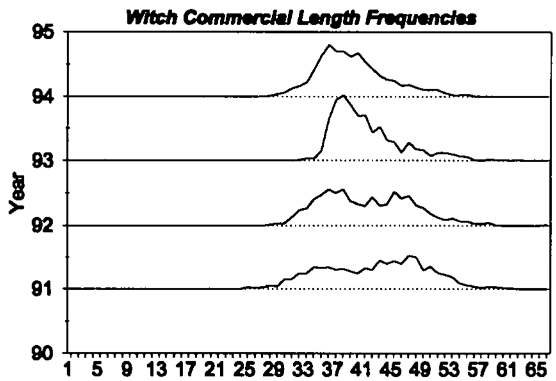
Commercial catch rates for all flounders declined slightly while total effort has declined significantly. Before 1992, total fishing effort on flatfish increased, possibly due to the introduction of ITQs and interest by the ITQ fleet in developing a catch history in flatfish. For witch flounder, catch rates were stable in 1993 and 1994 although they have declined since 1989. Except for a high point in 1992, effort has been relatively stable.

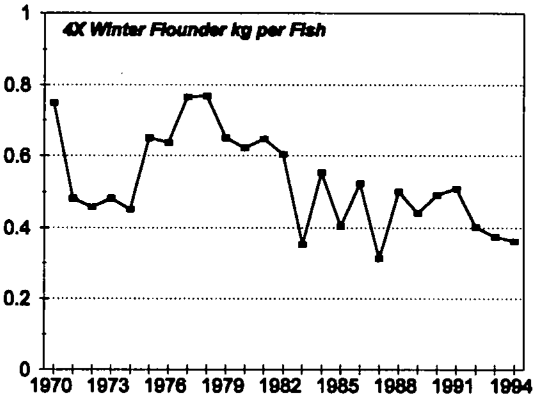




Length frequencies of commercial fishery landings for witch and winter flounder show the modal length to be shifting to a smaller size, with fewer large fish caught in the commercial fishery. Yellowtail and plaice represent a small portion of the landings and a time series is not available.



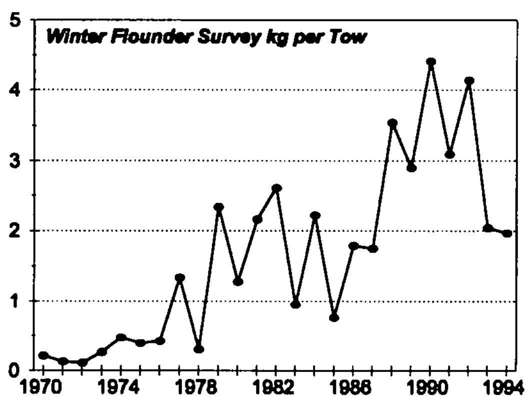


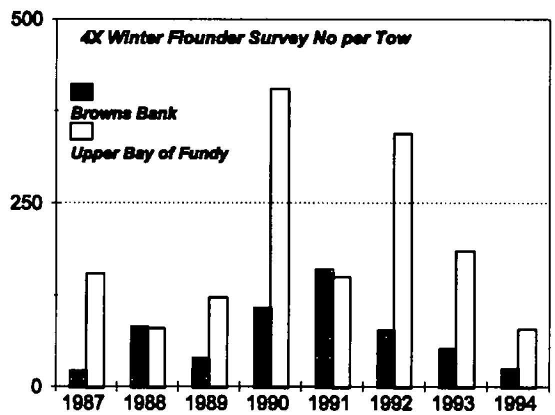


Winter Flounder

Survey abundance estimates of winter flounder increased in the late 1980s and have remained at a relatively high level since. However, the 1993 and 1994 points are approximately half the 1992 value, although still above the long-term average.

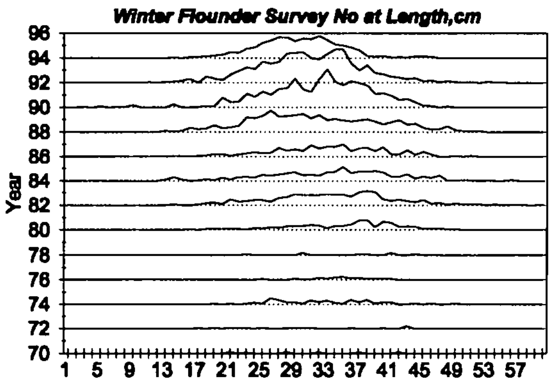
It should be noted that the summer survey does not cover the inshore portion of 4X which is thought to contain a large portion of the winter flounder resource. Abundance in the upper Bay of Fundy declined significantly while that on Browns Bank has shown a declining trend since 1991.

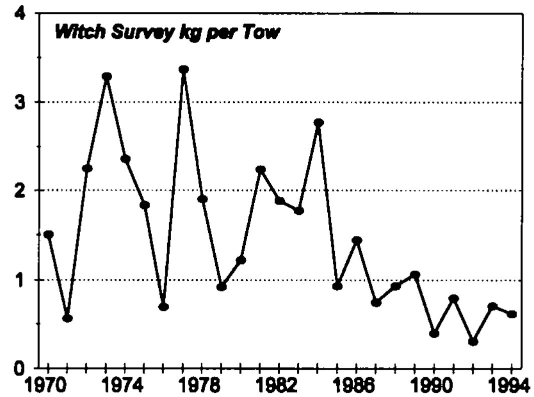




The average weight per fish of winter flounder in 4X surveys declined gradually since the late 1970s.

Survey length frequency distributions indicate that winter flounder above 40 cm are less abundant in recent years.





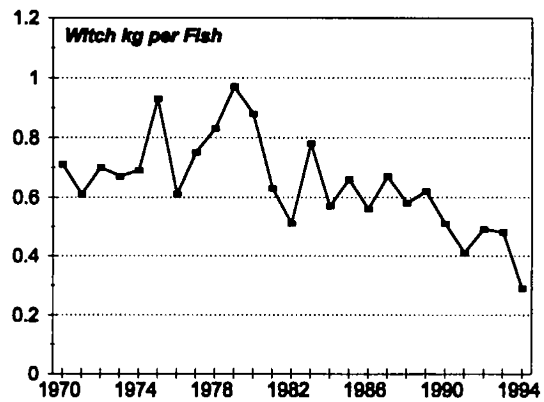
In summary, survey abundance estimates for winter flounder in 4X are still relatively high but have declined significantly in recent years. However, the steady decline in weights per tow in the Browns Bank area, which is an important area for the fishery, is of some concern. Average weight declined in recent years and the commercial fishery has shifted toward smaller fish. This could reflect a decreased abundance of older fish or increased recruitment. In the fishery, no dramatic change is apparent, although some industry sources have expressed concern for winter flounder in localized areas.

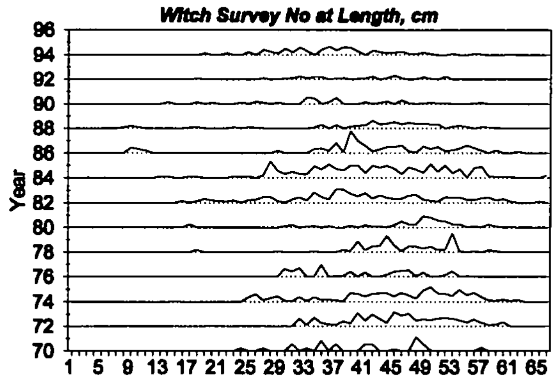
Witch Flounder

Survey abundance estimates for witch flounder exhibited a declining trend since the early 1980s with weight per tow below the long-term mean. The small increase in numbers per tow since 1992 as well as the length frequency distribution do indicate some incoming recruitment.

The **average weight** of a witch flounder in 4X has declined since the early 1980s, with the 1994 value the lowest in the time series.

Survey length frequencies indicated fewer large fish in recent years; however, larger numbers of small witch flounder were present in recent years including 1994.

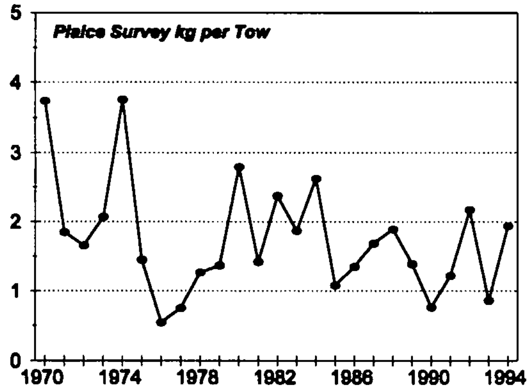




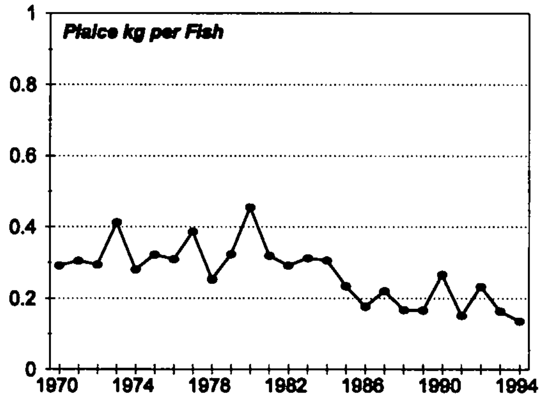
In summary, the situation for witch flounder in 4X includes a low weight per tow, fewer large fish in the population, declining average weight and signs of modest recruitment. As well landings have declined in 1993 and 1994 even though witch commands a much higher price than other flounders. Industry groups have commented that good concentrations of witch flounder are more difficult to find.

American Plaice

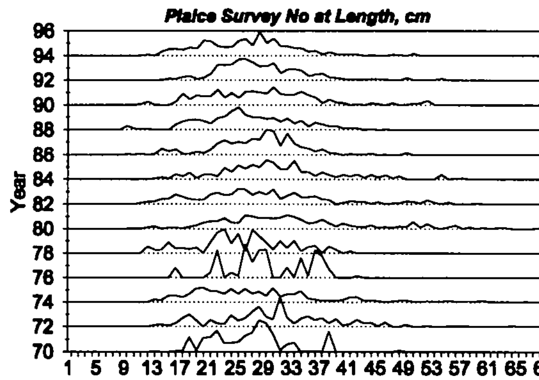
Survey abundance estimates of American plaice, on the other hand, have been variable but without trend throughout the time series.



The **average weight** of a plaice in 4X has gradually declined since the early 1980s.



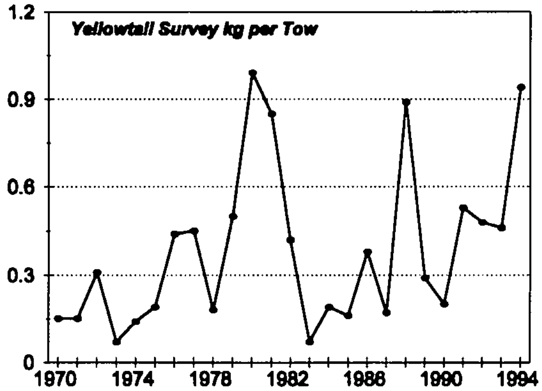
Survey length frequency distributions show little change in mean size in recent years; however, there are fewer large plaice currently in the population when compared to the 1970s and early 1980s.



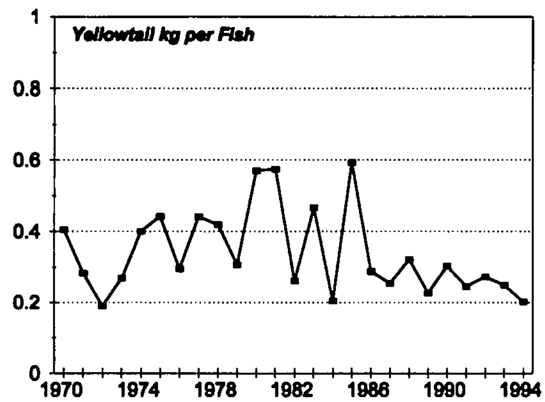
In summary, indices for American plaice have been relatively stable with some indication of incoming recruitment.

Yellowtail

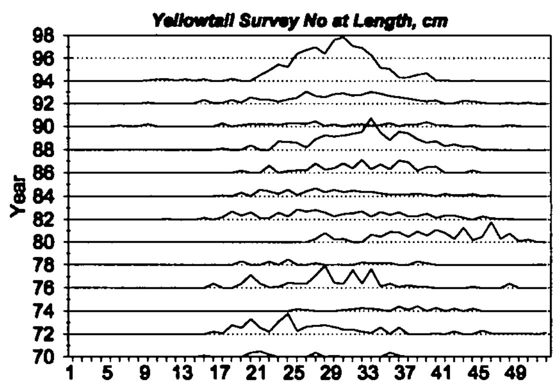
Survey abundance estimates of yellowtail have increased since the early 1980s. Numbers and weight per tow are currently near the historic high.



The **average weight** of a yellowtail in 4X has undergone a small decline since the mid-1980s.



Survey length distributions are highly variable, reflecting low catch rates. In summary, yellowtail appears to be either stable or increasing.



Outlook

The primary species fished in the area, winter flounder, and also the two species of minor importance, plaice and yellowtail, appear to be maintaining their abundance, although some decline in the size of winter flounder was observed. Witch flounder continues to decline in abundance as well as exhibiting a declining average weight, modest recruitment and fewer large fish in the population. Thus the reduction in TAC for 1995 to about the level of the 1994 catch should stabilize effort at about the 1994 level or possibly result in some further reduction. In general resource prospects for 1996 are expected to be similar to those for 1995.

However the extent of the declines in survey abundance and commercial landings suggests that protective measures directed at witch flounder are warranted for the 1996 fishery. Lowering the overall TAC would not achieve this result since witch represent a relatively small portion of the total landings. But as industry appears to be capable of directing specifically for witch, closed areas, or seasons, or a special allocation for witch under the overall TAC may be useful.

Some industry groups have expressed concern about particular localized winter flounder stocks. As was stated last year, given that these winter flounder populations are highly localized, and the extent of mixing is unclear, every effort should be made to distribute catch among these populations. Consideration should also be given to developing a management plan that recognizes the possibility of several population units that may changing abundance at different rates.

The FRCC recommended a reduction of both catch and effort for the entire flatfish resource for 1995. The 1994 catch allocation, in the 4X flounder fishery, to the major participants, the less than 65' mobile gear fleet, did not restrict their fishing activities but nonetheless landings declined by about 20% from the 1993 level. However catch rate declined only slightly in 1994 from 1993, the reduced landings being accounted for primarily by a reduction in effort. Redirection of effort by the less than 65ft mobile gear fleet to developing fisheries for yellowtail on Georges Bank and monkfish in 4X may have accounted for the reduced effort on flounders. As well the by-catch of cod, haddock and pollock was considered by industry as limiting to the flatfish fishery.

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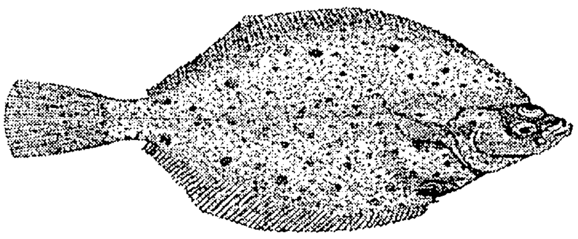
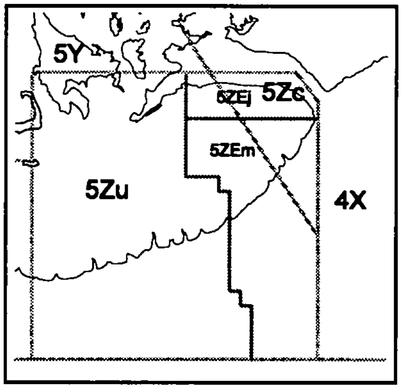
References

Annand, C., and A. Macdonald. 1995. An update of the status of 4VW and 4X flatfish stocks. DFO. Atl. Fish. Res. Doc. 95/43: 89 p.





YELLOWTAIL FLOUNDER ON GEORGES BANK

Background

Yellowtail flounder (Limanda ferruginea) occurring on Georges Bank are a transboundary resource. Yellowtail are considered a relatively sedentary flatfish, with unpublished tagging results from the Scotian Shelf indicating that the longest distance between release and recapture is 48 km. The stock is considered to occur to the east of the Great South Channel based on tagging investigations. While tagging work indicates limited movement from Georges Bank to adjacent areas, knowledge of seasonal movement of yellowtail flounder on Georges Bank is poor.

On Georges Bank, spawning occurs during the late March-April period. From the distribution of both ichthyoplankton and mature adults, it appears that spawning occurs on both sides of the international boundary. Yellowtail flounder are considered about 80% mature at age 2 and 100% mature at age 3.

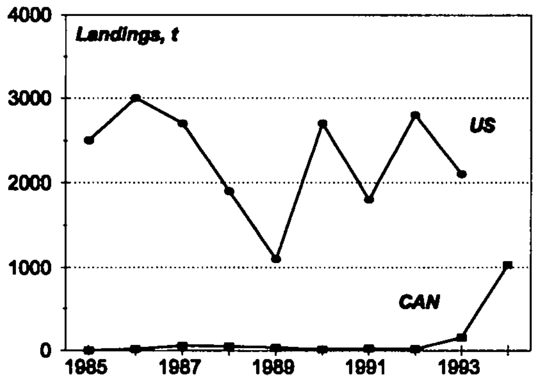
The Fishery

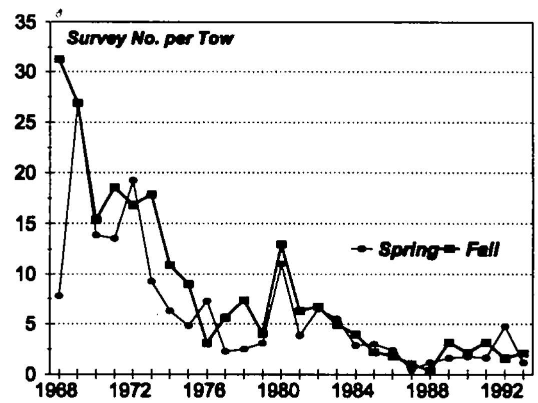
A directed fishery for yellowtail flounder has recently commenced. In 1993, the fishery began on 1 June and ended 15 December, and was pursued by about 8-10 boats. Most of the boats were 45' (TC 2 and 3), based out of Gunnings Cove. These draggers used the 155 mm square mesh gear and averaged 30,000 to 40,000 lbs per 3 to 4 day long trip.

In 1994, the fishery again commenced on 1 June. About 40 vessels pursued the fishery. Such vessels were based out of Pubnico and were 45' to 65' in length. Catches have dropped to 20,000 to 30,000 lbs per trip. The 1994 yellowtail fishery was closed in early October by agreement between DFO and industry, after 1029t had been removed.

The trawl rigging features reduced headline flotation resulting in a small vertical opening, and comparatively small rollers on the footgear. Such a rigging apparently results in an insignificant by-catch of gadids. Market preferences are for comparatively small fish, thus smaller fish command a higher value per unit of weight. Comparison of commercial fishery length frequency information with known ages at length revealed that the catch is comprised primarily of ages 2, 3, and 4. There appeared to be a greater proportion of 2 year olds in the 1994 landings (1992 year-class).

The landings of yellowtail flounder in the Canadian and US fisheries are shown below.



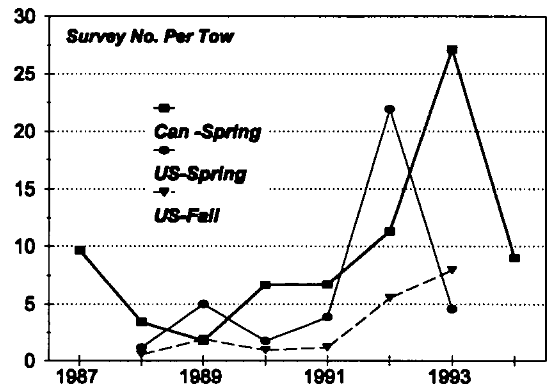


Resource Status

An analytical assessment of the overall Georges Bank yellowtail flounder stock was conducted by the United States NMFS in 1994. (Extracted, with permission, from NEFSC (Northeast Fisheries Science Center), 1994. Report of the 18th Northeast Regional Stock Assessment Workshop (18th SAW): The Plenary. NOAA/NMFS/NEFSC: Woods Hole, MA. NEFSC Reference Document 94-23.) It was concluded that the stock is at a low biomass level and overexploited (Fs averaging 1.2 since 1990). The spawning stock biomass is considered to be about 3,010t. Landings in 1993 were 2,100t, about equal to the 1987 to 1992 mean, but less than 15% of the 1963-1972 mean value. Most fish landed are younger than age 5. Although estimates of the 1992 year-class were considered imprecise, the cohort appears to consist of 12 million fish, which is slightly greater than the average annual recruitment of 9 million fish from 1988 to 1991.

There are three surveys conducted annually on Georges Bank. The abundance indices from the US surveys are summarized below.

The **mean number per tow** of yellowtail on Georges Bank have increased slightly since 1988. However, current abundance indices from the US surveys are still considerably lower than those observed in the late 1960s. Results from surveys on the Canadian portion of Georges Bank are shown below.



These results also indicate an increasing trend since the late 1980s, but the recent values have declined considerably for the Canadian and US spring survey.

Outlook

Yellowtail flounder on the Canadian portion of Georges Bank could be the basis of a small sustainable fishery, and NAFO Subdivisions 5Zjm could be viewed as a management unit.

This conclusion was reached based on the observation that yellowtail flounder are comparatively sedentary as adults, the presence of more than one year-class in the Canadian landings and the observation that spawning is likely occurring in Canadian waters. This conclusion is consistent with that of GOMAC, arrived at during their deliberations of Gulf of Maine stock structure in 1994. However, the sources of recruitment and degree of mixing across the international boundary are not clear. The latter could be investigated by detailed examination of the research vessel information.

Present harvest levels are likely exceeding F_{max}. Based on the proportion of biomass occurring on the Canadian side of Georges Bank in 1992 and 1993 as observed during the United States fall surveys (about 68%) and assuming a harvest of 20% from the biomass estimated as 3,200t, the annual removals should not exceed 435t.

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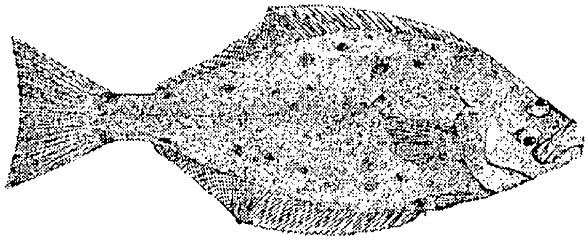
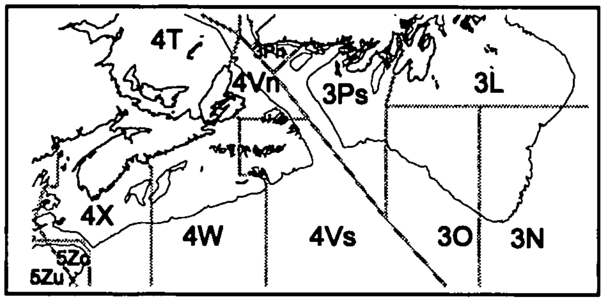
Sinclair, M., and R. O'Boyle [Eds.]. 1994. Report of the 1994 Fall Regional Assessment Process (RAP) Meeting - 31 October to 2 November 1994. DFO Atl. Fish. Proc. Doc. 94/1.





SCOTIAN SHELF AND SOUTHERN GRAND BANK HALIBUT

Background

Atlantic halibut, the largest of the flatfishes, ranges widely over Canada's Atlantic fishing grounds. Halibut are demersal living on or near the bottom at temperatures within a few degrees of 5°C. Atlantic halibut are most abundant at depths of 200-500 m in the deep water channels running between the banks and the along the edge of the continental shelf, with larger individuals moving into deeper water in winter. The management unit definition (4VWX3NOPs) was based largely on tagging results which indicated that Atlantic halibut move extensively throughout the Canadian North Atlantic with smaller fish moving further than larger fish. Migrations of larger fish were thought to be related to spawning. Studies have shown that the Brown's Bank area may be an important rearing area for juvenile halibut.

Females grow faster than males, and attain a much larger maximum size. Females start to mature at about age 6 and reach 50% maturity at about 46 inches, while males start to mature at about 4 years of age and reach 50% maturity at about 29 inches. Most of the commercial catch is taken between 8 and 12 years of age. Halibut are voracious feeders and up to a length of 12 inches, food consists almost exclusively of invertebrates. Between 12 and 26 inches both invertebrates and fish are eaten while halibut over this size eat fish almost exclusively.

Prior to 1988 the Atlantic halibut fishery was unregulated. This was mainly due to a shortage of stock assessment data and a lack of interest in halibut management prior to that time. A halibut working group was formed in 1987 to look at management alternatives for the 1988 fishery. With increased interest in the fishery and concerns expressed by industry, a precautionary TAC of 3,200t was set in 1988, based largely on recent catch levels.

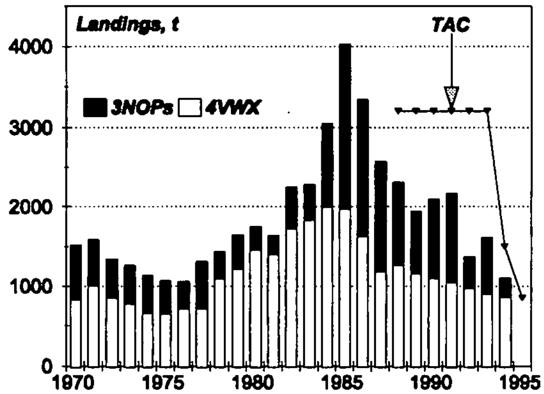
The Fishery

Landings (thousands of tonnes)

Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC*	n/a	3.2-2.0	3.2	3.2	3.2	3.2	1.5	0.9
4VWX								
Canada	0.8	1.5	1.1	1.0	0.9	0.9	0.9	
Foreign	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
3NOPs								
Canada	0.4	0.7	0.7	0.4	0.3	0.3	0.2	
Foreign	0.1	0.2	0.3	0.7	0.1	0.4	0.1	
Total								
4VWX	0.8	1.6	1.1	1.0	1.0	0.9	0.9	
3NOPs	0.5	1.0	1.0	1.1	0.4	0.7	0.2	
TOTAL	1.3	2.5	2.1	2.2	1.4	1.6	1.1	

* TAC Canadian only
N/A - None set

Canadian domestic landings reached a peak in 1985 (3,531t), declined to 1,189t in 1993 and to 1,024t in 1994. Scotian Shelf landings for 1994 remained similar to those in 1993 at about 800t; however, the Southern Grand Banks fishery declined by about 50%. Declines may be related to the cod moratorium in 4VW and 3NO. Longliners are the dominant fleet in both the Scotian Shelf and Southern Grand Banks fishery accounting for over 70% of the landings. In 1994 over 90% of the Scotian Shelf landings can be attributed to this fleet.



Halibut landings by season indicated that the Canadian fishery is prosecuted mainly in the spring and summer in 4VWX and primarily in the spring in 3NOPs. Foreign landings are incidental on the Scotian Shelf, taken as by-catch in the silver hake fishery while the EU prosecute a spring and summer groundfish fishery in 3NO outside the 200 mile limit. These EU vessels report variable halibut catches that are not accounted for under the current management plan.

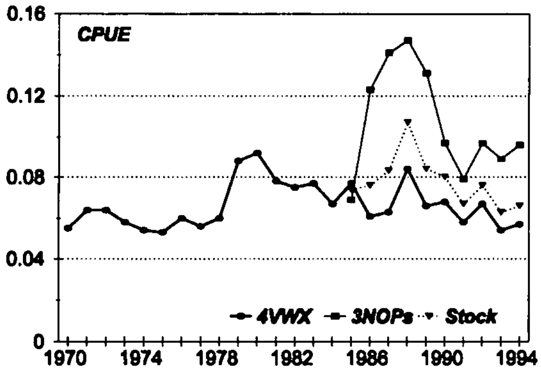
Allocations in 1994 under the 1,500t TAC were restrictive only to the 4VWX less than 65ft fixed gear fleet and the less than 65ft mobile gear fleet by-catch fishery. In 3NOPs the allocation to the less than 65ft fleet was not restrictive as only 29% of the allocation was taken. The mobile offshore fleet is only permitted a by-catch fishery, and caught only 7% of their allocation. The offshore fixed gear vessels with an allocation for the whole area took 39% of their quota. The 1995 TAC of 850t, under present allocations, was thought to be very restrictive by the less than 65ft fixed gear fleet and has resulted in industry harvesting plans permitting a by-catch only fishery for halibut in 1995. The absence of a directed fishery may impact our ability to use the commercial data to assess the stock status.

A minimum size limit of 32" was put in place in 1988, though not enforced until 1990. The introduction of the mandatory landing of all groundfish in 1993 eliminated the minimum size regulation for halibut. Upon request by fixed gear interests, regulations were amended to permit the release of undersized halibut. Licence conditions have since been used to enforce the regulation for the inshore fleets. The offshore may release undersized halibut but is not required to do so by licence condition. Preliminary data from the Fisherman and Scientist Research Society (FSRS) indicated that the amount released could be as high as 25% by weight of the total less than 65ft longline landings. Studies have shown that the survival of released halibut from longline gear is in the order of 75%.

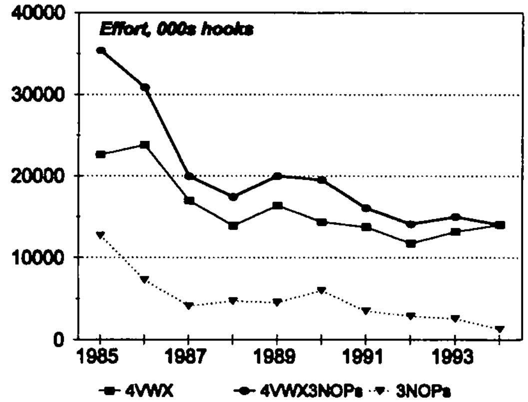
Resource Status

Stock status evaluations were based on landing statistics, and catch rate trends in the commercial fishery. Typically the surveys catch very few halibut, and are quite variable from year to year, making it difficult to interpret the results. The survey catches a different size distribution (smaller) of halibut compared to the commercial fishery. Because the survey tends to catch smaller halibut, it was not considered useful as an indicator of fishable biomass.

Canadian landings have declined very slowly since the mid 1980s for the Scotian Shelf while showing more of a decline for the stock area as a whole as the landings from 3NOPs showed a sharper decline. Commercial catch rates have declined gradually in the 4VWX area for the directed longline fishery in recent years while showing stability since 1990 for 3NOPs. For the stock area as a whole, catch rates reflect the decline in 4VWX where most of the fishery takes place. The sharp increase in the mid 1980s through to 1988 was thought to be due to the introduction of the more efficient circle hook. The release of halibut less than 32" since 1988 likely had a negative impact on the commercial catch rates, being most evident since 1992 as enforcement improved. Although the impact cannot be quantified it could change our perception of the stock.



Total estimated effort has shown a declining trend from 1985 to 1992 and remained stable between 1992 and 1994. For 4VWX, total effort increased between 1992 and 1994 while effort decreased during the same time period in 3NOPs. Last year concern was expressed by the FRCC that large scale redirection of fishing effort to halibut would occur as a result of closures in other groundfish fisheries. However, although catch rates declined gradually in recent years (about 15 % over the last five years, total effort for the whole stock area remained relatively stable since 1992. Thus a large scale redirection of fishing effort is not evident for this stock.



Outlook

Halibut are a long lived species and stock conditions in 1996 are not expected to be generally different from those in 1995. Domestic reported landings declined slightly in 1994 to about 1,000t. Due to allocation of quota, the reduction in the TAC in 1995, to 57% of the 1994 level, will be restrictive to the directed longline fishery, and catches will likely be substantially less than 850t. This reduction in catch from levels of 1,000t in 1994 and 1,300t on average over the last five years should be ample to reduce effective fishing effort, and thus fishing mortality, as advised last year. It will be necessary to maintain present restrictions on the fishery for several years before it can be determined whether or not these are having the desired positive effect on stock status.

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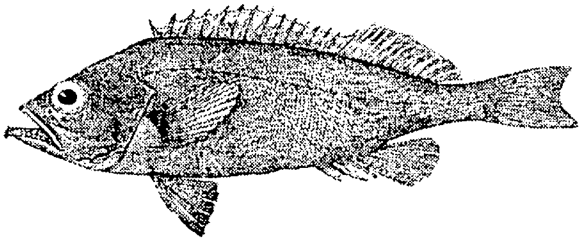
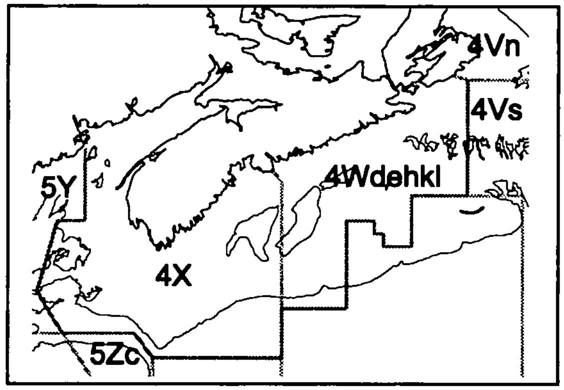




UNIT 3 REDFISH

Background

Redfish are widely distributed in all deepwater areas of Canada's Atlantic fishing grounds. The predominant species in Unit 3 (4Wdehkl and 4X) is <u>*Sebastes fasciatus*</u> *(Acadian Redfish), occurring in the basins and at the edge of the continental shelf, with* <u>*S. mentella*</u> *(Beaked Redfish) occurring in the deeper waters of the continental slope. Differences between these two species are not readily apparent, therefore commercial and research catches are not routinely separated by species.*

All Northwest Atlantic redfish species have similar biological characteristics, including slow growth and a long lifespan. Unit 3 <u>*S. fasciatus*</u> *probably reach maturity after 5 to 6 years at a length of 20-23 cm similar to Gulf of Maine redfish. Redfish feed off the bottom. Small redfish feeding mainly on pelagic crustaceans with fish becoming increasingly important as redfish grow larger.*

Canada has been the primary participant in the Unit 3 redfish fishery since extension of jurisdiction to 200 miles in 1977. The Unit 3 management area for redfish was first implemented in the 1993 Groundfish Management Plan. Redfish in this area were previously managed as part of a larger 4VWX management area.

Redfish are caught on the Scotian Shelf by otter trawlers using 90 mm mesh. Current regulations limit the by-catch of other species to 10% of the redfish catch.

The Fishery

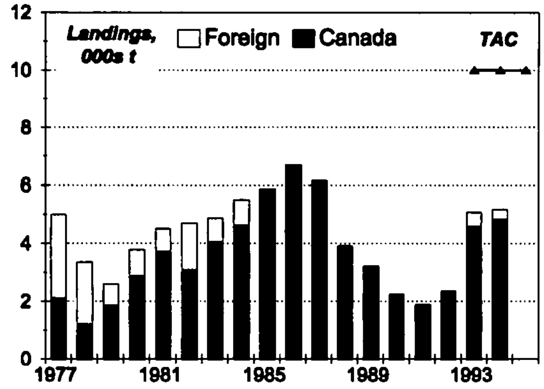
Landings (thousands of tonnes)

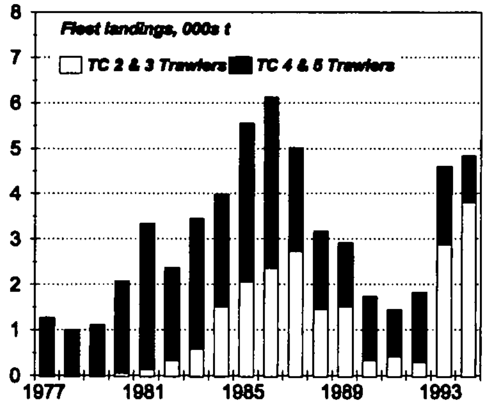
Year	70-79 Avg.	80-89 Avg.	1990	1991	1992	1993	1994	1995
TAC						10.0	10.0	10.0
Canada	4.1	4.4	2.2	1.9	2.1	5.1	5.2	
Foreign	5.7[1]	0.5	+	0.1	0.1	0.1	+	
TOTAL	9.7	4.9	2.3	2.0	2.2	5.2	5.2	

[1] 1970-79 foreign landings excludes up to 4,420 tonnes/year on average not assignable to statistical unit area.

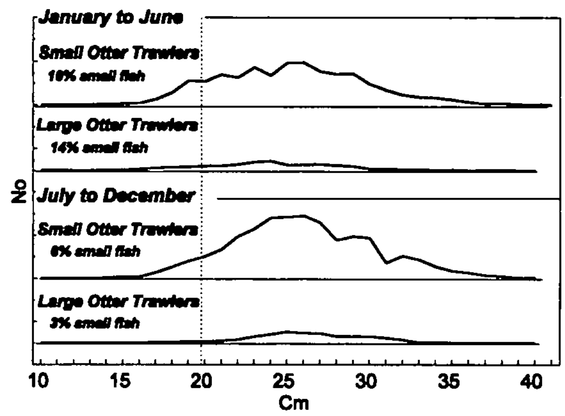
In the period 1977 to 1994, redfish landings assigned to Unit 3 peaked at almost 7,000t in 1986, followed by a decline to about 2,000t in 1991. Provisional catches for 1994 were about 5,200t, approximately equal to 1993, and a 100% increase from 1992, but substantially below the 10,000t TAC.

Small otter trawlers (less than 65ft) took most of the catch in 1994. This is the highest catch taken by these vessels since they entered the fishery in the early 1980s. The small otter trawl fishery was closed on 31 August. Large otter trawlers (greater than 65 feet) caught less than one third of their allocation.



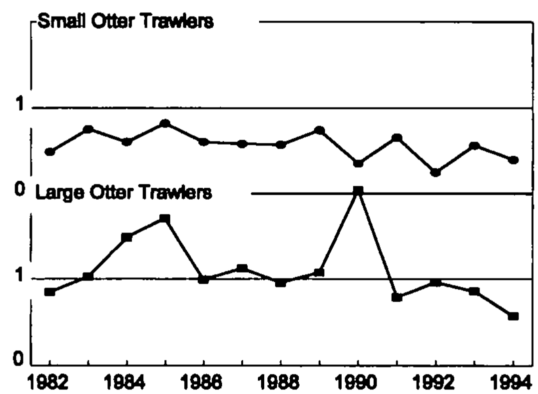


There were many reports early in 1994, that small redfish were being landed from an area north and east of Browns Bank for use as bait. On industry's request, the fishery in this area was closed to small otter trawlers until it was demonstrated that small redfish could be avoided. Unit 3 landings have traditionally had a high proportion of fish in the 20-25 cm range, therefore the definition of a small fish was taken as being less than 20 cm for the purpose of examining the small fish issue. In the first half of 1994, the occurrence of small redfish in port samples from this area ranged as high as 28% by number, while in the second half of the year after lobster season had closed the occurrence of small fish in port samples did not exceed 9% . The total landings from Unit 3 as a whole were estimated to contain 7% small fish by number in 1994.

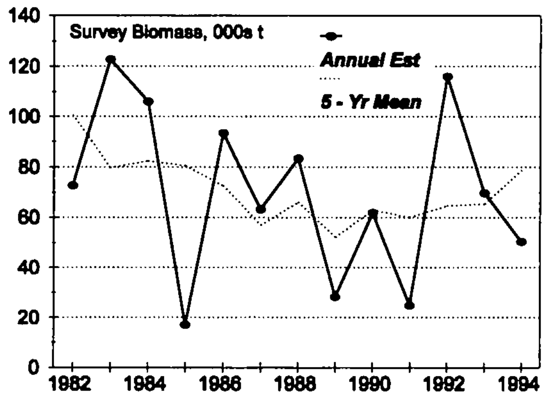


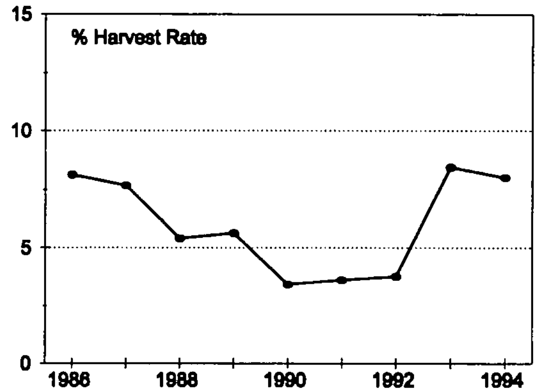
Resource Status

Catch rates for large and small otter trawlers declined over the period 1982 to 1994. The small otter trawler catch rate was 0.4 tons per hour (tph) in 1994, slightly less than the 5 year average annual rate of 0.5 tph, while the large otter trawler catch rate was 0.6 tph, substantially less than the 5 year average of 1.1 tph.

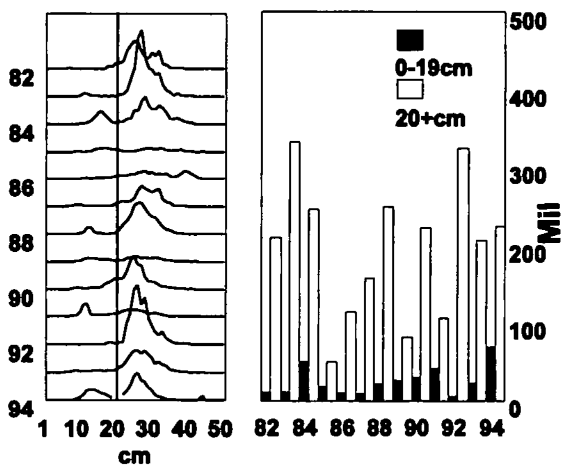


Survey estimates of population size (5 year running average) indicate that the population has been quite stable in biomass and abundance since the late 1980s.





The **size compositions** of survey catches in the late 1980s and the early 1990s provide some evidence of small fish entering the population. A decline in the average length of fish in the survey catches after 1986 supports this indication that some recruitment occurred in this period. The 1994 survey in particular showed the presence of moderate numbers of fish less than 20 cm long in the population.



The target harvest rate (ratio of commercial catch to minimum research survey biomass estimate) of this stock is 0.15 and is assumed equivalent to fishing at $F_{0.1}$. Recent survey biomass estimates indicate a maximum harvest rate of about 0.08.

Outlook

The increase in catches for 1993 and 1994, compared to 1992, resulted from an increase in fishing effort, reflecting decreased fishing opportunities for more valuable species. Commercial catch rates have declined slightly over the last five years but many changes in the fishery make these difficult to interpret in the context of redfish abundance. Research vessel surveys indicate stability in the population biomass and suggest some improvement in recruitment in recent years. It is likely that the survey biomass is a significant under-estimate of total biomass. The low harvest rates which currently prevail, should result in fishing and stock conditions in 1996 being much the same as in recent years. Catches of 10,000t in 1995 and 1996 would be consistent with the currently established 0.15 target harvest rate. It appears that fishing in 1994 was directed towards small fish because of their accessability and a ready market and that these catches could be avoided when required.

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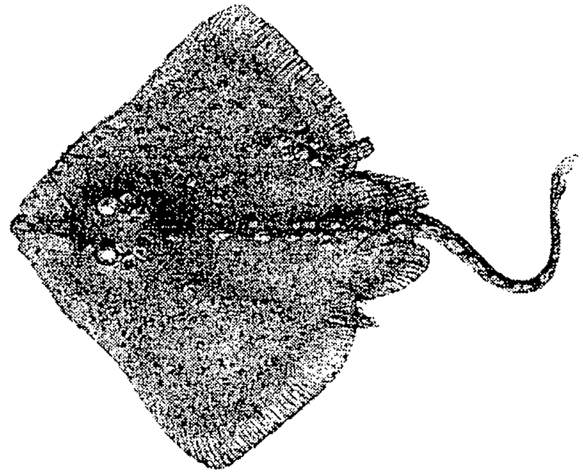
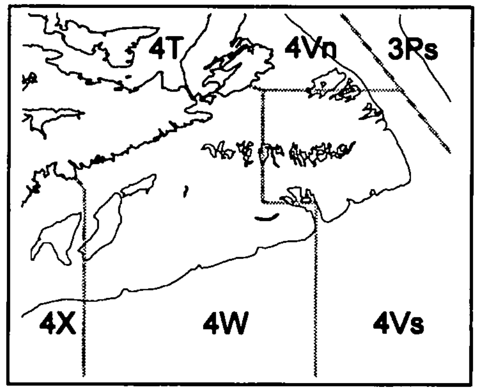




SCOTIAN SHELF SKATE

Background

Most elasmobranch fisheries have followed a general pattern of high initial exploitation followed by a rapid collapse. It is intended that the developing skate fishery on the eastern Scotian Shelf does not follow this course. There are, however, many limitations to our knowledge of skate on the Scotian Shelf. We currently lack information on age- or size-structure of the population, along with associated biological parameters such as size at maturity, growth rate and weight at age. Furthermore, five species of skates regularly co-occur, but are not reported separately. Winter and thorny skate are the focus of the commercial fishery. These species are most abundant in Div. 4VsW with particularly high concentrations on Banquereau Bank. Lesser quantities occur in Div. 4X. The distribution of these two species suggests a natural division between the eastern and western Scotian Shelf. No other information on stock structure is available. Historical information shows that skates consume considerable quantities of sand lance. No recent diet information exists and skate predators have yet to be identified.

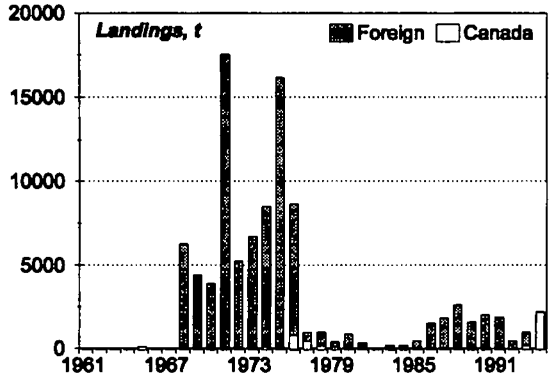
The Fishery

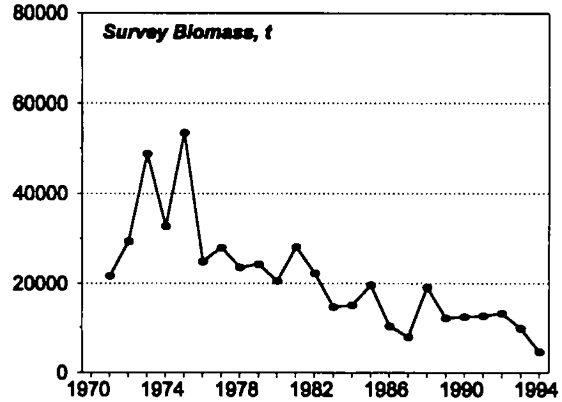
Landings (thousands of tonnes)

Year	1989	1990	1991	1992	1993	1994	1995
TAC	-	-	-	-	-	2.0	1.6
Foreign	1.5	1.9	1.8	0.4	0.8	0.1	
Canada[1]	0.1	0.1	0.1	0.2	0.2	2.1	
Est. Cdn[2]	2.3	3.0	2.4	1.9	1.1	0.9	
TOTAL	3.8	5.0	4.3	2.3	2.0	3.1	

[1] Reported landings by Canadian vessels.
[2] Estimated removals based on by-catch from Canadian groundfish directed fisheries.

There has never been a regulated fishery for skates on the Scotian Shelf, however landings data exist since 1961. Canadian landings on the Scotian Shelf have generally been low, but are not reflective of total removals due to unlimited discards. Prior to 1977 reported foreign landings were as high as 6,100t in Division 4Vs, 16,000t in Division 4W, and 2,100t in Division 4X. After 1977, reported skate landings never exceeded 2,600t and were generally restricted to Division 4W.





In 1994, a combination of closures of traditional groundfish fisheries on the Scotian Shelf and openings in the markets for skate wings resulted in the development of a directed Canadian skate fishery. Based on the 10 year mean minimum trawlable biomass from the summer survey in 4VsW of 12,000 mt, a preliminary TAC of 1,200t was established with an additional 800t allocated to conduct joint industry/science surveys. The fishery landed 2152 mt by the end of the year. The 1995 directed fishery is regulated by a 1600 TAC with an additional 20% by-catch allowed in the directed flatfish fishery. There are no restrictions on discarding skates in any fishery.

Resource Status

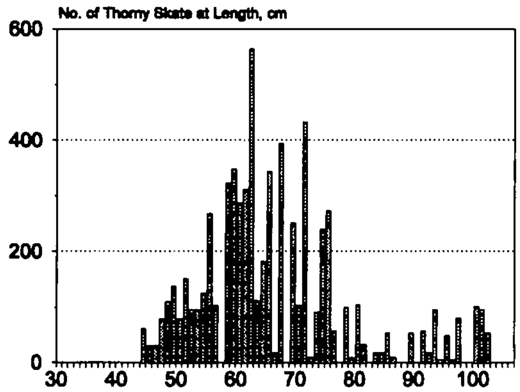
Trends in Abundance

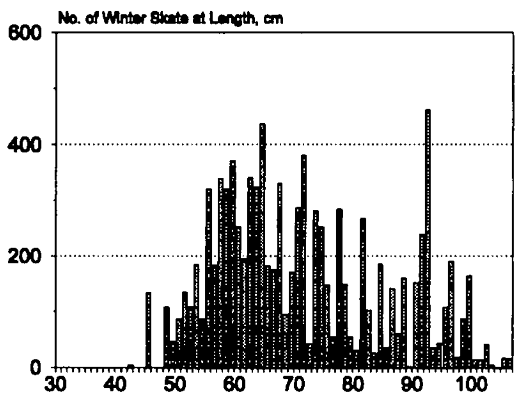
The minimum trawlable biomass of skates from the summer survey has shown a slow decline since 1982. The average biomass over the past 10 years (1985-1994) was 12,000 mt. Nearly all of the decline in skate biomass was due to the reduction in thorny skate biomass. The spring survey estimate of minimum trawlable biomass, although on average 50 percent higher than the summer survey, was variable and no temporal trend could be discerned.

Industry/Science Skate Directed Survey

As part of the Conservation Harvesting Plan for skates established in 1994, industry agreed to conduct two surveys during August and September. Science designated the fishing locations and requested the use of 155mm mesh gear. Catch rates during the science-directed portion of the surveys were between 100-600 kg/hour for thorny and winter skate combined. In contrast, catch rates for both species during the fishery-directed portion (using 255mm mesh) of the survey were between 1900-2500 kg/hour. The by-catch of other species was low in the 255 mm mesh gear during both surveys. By-catch was less than 1% during the industry-directed portion of the survey.

Thorny skate less than 62cm and winter skates less than 73cm are normally discarded in the fishery. The occurrence of significant quantities of skates below these size thresholds in the fishery-directed portion of the survey suggests discard rates are likely to be high.





Outlook

The low reproductive rate of skates combined with declining biomass, high discards of small skates during the directed fishery, and the need to limit by-catch of traditional species, all indicate continuation of a conservative approach to harvesting. For such a slow growing species, a low exploitation rate of 10% is appropriate. The 1985-94 mean trawlable biomass estimated from the summer survey for all skates combined in Div. 4VsW was 12000t. The harvest advice provided for 1994 was for a TAC of 1200t. This is reiterated for 1995. As well, the continued sustainability of this level is critically dependent upon limitations of the high discard rates in the directed fishery.

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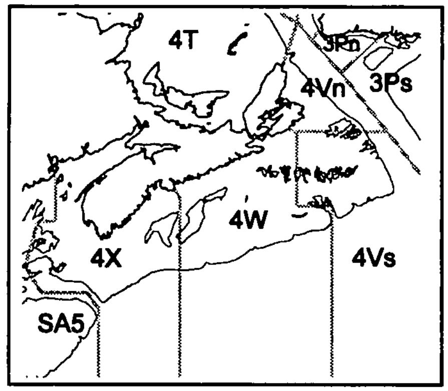
References

Simon, J.E., and K.T. Frank. 1995. An assessment of the skate fishery in Division 4VsW. DFO Atl. Fish. Res. Doc. 95/71.

SCOTIAN SHELF SAND LANCE



Background

Sand lance occupy a strategic niche as a forage species in the marine ecosystem. They are of limited importance as a commercial species in Canadian waters but fishermen welcome their appearance because catch rates of cod and haddock are reportedly high when sand lance are plentiful on offshore banks. Bottom type, particularly sand, is important for burrowing (to escape predators) and reproduction.

The stock structure of sand lance is unknown and compounded by the fact that two species co-occur whose taxonomic separation is poorly resolved. Analysis of maturity data indicates a well defined winter breeding season starting in November and ending before March. Newly hatched larvae are concentrated in the vicinity of Sable Island and Middle Bank suggesting these are major spawning sites for sand lance. They exhibit relatively fast growth (4 to 6 cm/year) during the first four to five years of life. Maximum age is 9 yrs. old at a size of 30 cm. Sand lance tend to be distributed across the Scotian Shelf in association with most of the offshore banks. Sand lance have been captured at depths ranging from 20-150 m with highest concentration at depths less than 50 m. During summer, sand lance have been captured over a wide range of temperatures (1-11° C), however most catches occurred between 1- 5° C.

Sand lance is considered a planktonic feeder and copepods (mainly Calanus finmarchicus) are their primary food source. Euphausiids and polychaete larvae also make significant contributions to the sand lance diet. Sand lance contribute to the diet of most groundfish species on the Scotian Shelf, although their importance varies seasonally. Cod, haddock, and pollock have been found to consume sand lance on a year round basis while white hake, redfish and skates feed more intermittently on sand lance. Large marine mammals such as fin and humpback whales feed heavily on sand lance as do most seal species.

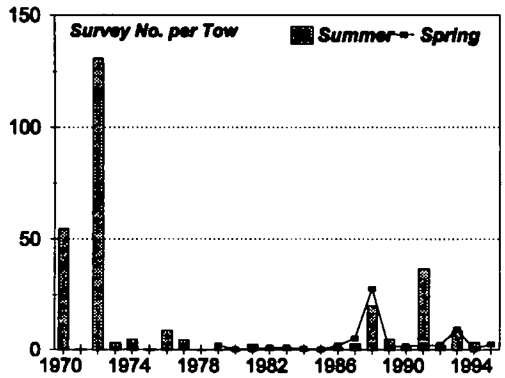
The Fishery

There is no Canadian fishery for sand lance, however a bait fishery exists in New England waters which landed 20 mt in 1982. In the eastern Atlantic a major fishery exists for sand lance with a peak in landings of 770,000 mt recorded in 1980.

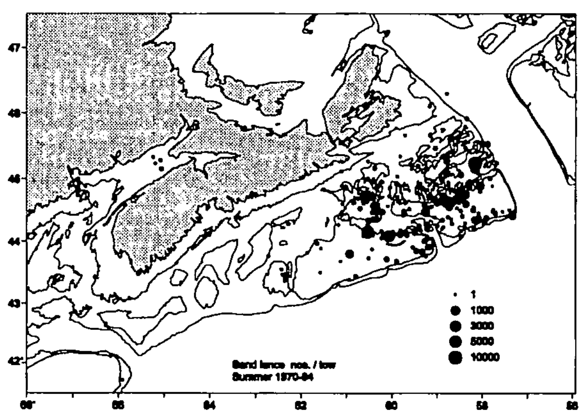
Resource Status

Trends in Abundance

The behaviour of this species makes it difficult to quantify using standard trawl survey techniques. They burrow into sandy bottom sediments to avoid predators and presumably capture by nets. Diel vertical migration occurs associated with feeding and tidal conditions, and the formation of dense schools is common. Collectively, this makes any conclusions about the catch rate time series of sand lance from the spring and summer trawl surveys dubious at best. As well sand lance do not possess a swimbladder which makes acoustic surveying of biomass a difficult task. In other geographic areas abundance trends have been based on systematic larval surveys. Recent analysis of seal diets and resultant total fish consumption estimates suggest that approximately 70,000 mt of sand lance were consumed by grey seals in 1993 on the eastern Scotian Shelf.



Trends in abundance based on spring and summer data from the Scotian Shelf reveal a variable pattern of abundance. Peaks in abundance were evident in the early 1970s and late 1980s to early 1990s.



Based on summer surveys, this species is largely confined to the eastern half of the Scotian Shelf. Peak catches were generally associated with the offshore banks of Middle, Sable Island and Banquereau. Historical sand lance distributions based on non-standard bottom trawl surveys conducted between 1956 and 1967 show a much broader distribution pattern than that indicated by summer surveys with concentrations over most of the offshore banks including Browns, LaHave, Emerald, Western, Sable Island, and Banquereau. The heaviest concentrations were in the central part of the shelf.

Outlook

Sand lance occupies a central position in the marine food web on the Scotian Shelf. This fact alone should be sufficient to negate the development of a fishery for this species. It is unfortunate that our standard trawl survey gear has not proved capable of adequately monitoring changes in the distribution and abundance of this species and at present we have no reliable estimate of sand lance biomass on the Scotian Shelf.

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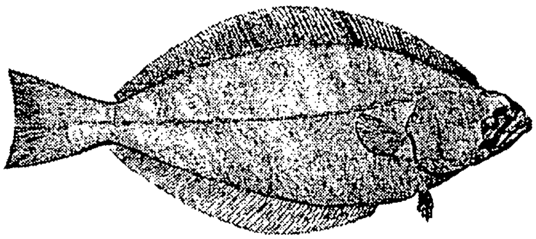
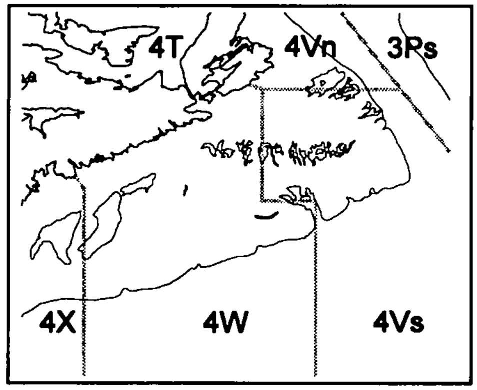




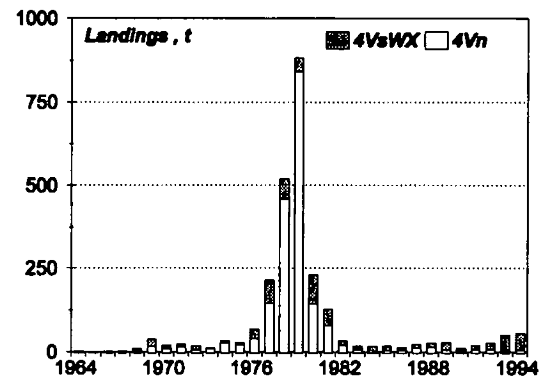
GREENLAND HALIBUT (TURBOT)

Background

Greenland halibut are generally found north of the Scotian Shelf, although they occur as far south as the Gulf of Maine. They exhibit an episodic pattern of peak occurrences associated with colder-than-normal conditions on the eastern Scotian Shelf, a response similar to that of capelin. In contrast to capelin, most Greenland halibut collected on the Scotian Shelf are immature (<45 cm) given that lengths at 50% maturity for males and females from the Gulf of St. Lawrence are 39.8 and 55.6 cm respectively. The dominance of immature fish suggests that mature fish move away from the eastern Scotian Shelf. In fact, a similar dearth of mature fish has been noted in the Gulf of St. Lawrence which has prompted speculation that many fish leave the area through the Strait of Belle Isle as they mature and join the mature stock in southern Labrador.

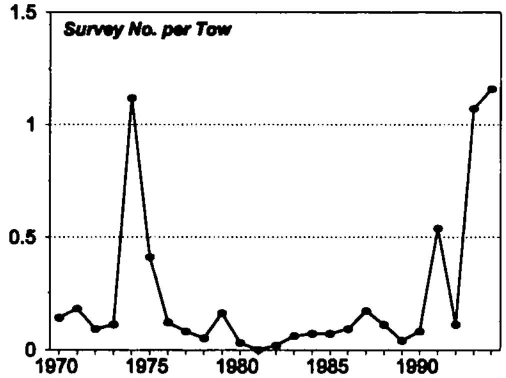
Although no management unit is recognized for Greenland halibut on the Scotian Shelf there is one in the Gulf of St. Lawrence (Division 4RST) where landings have been as high 11,000t (1987) and gillnets comprise the principal gear type.

The Fishery

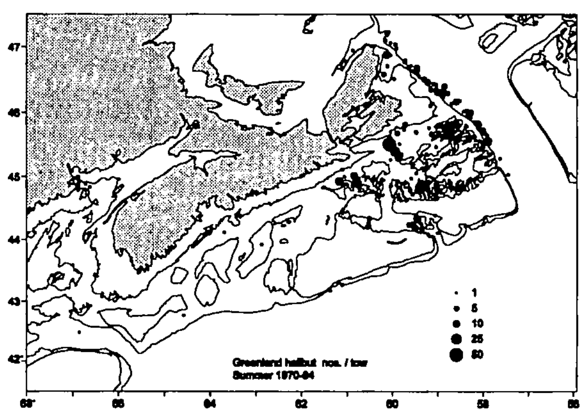


Landings on the Scotian Shelf have been generally low and restricted to Division 4Vn where a peak of 842t was recorded in 1979. The nearest large-scale commercial fishery for turbot exists in the Gulf of St. Lawrence and the management unit for the stock is Division 4RST. Two peaks in landings since 1970 have occurred in Division 4RST: 8,800t in 1979 and 11,000t in 1987. The coincidence of peak landings between the two adjacent areas in 1979 suggests that when abundant the stock extends into Division 4Vn.

Resource Status



Two distinct peaks in abundance have been noted in the summer research vessel surveys of the Scotian Shelf: a peak was noted in the mid-1970s and another more recent one in the 1990s. This episodic pattern of peak catch rates matches that of capelin quite closely and suggests that increases in turbot abundance are linked to colder-than-normal temperature conditions on the eastern Scotian Shelf.



Based on the summer research vessel surveys, Greenland halibut are confined to the eastern half of the Scotian Shelf. They are found in the deeper waters of the shelf and slope waters especially near the Gully, along the Laurentian Channel and off Canso and Cape Breton.

Outlook

Their generally low level of abundance and the predominance of immature fish in the area suggests that the fishery potential for Greenland halibut on the Scotian Shelf is limited. The occurrence of Greenland halibut on the eastern Scotian Shelf may be an extension of the stock inhabiting the Gulf of St. Lawrence.

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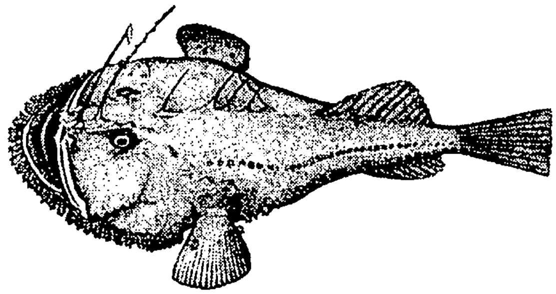
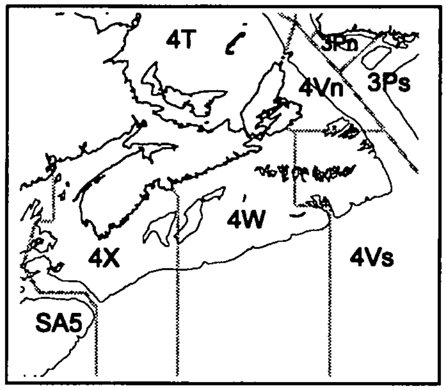




MONKFISH ON THE SCOTIAN SHELF

Background

Monkfish (Lophius americanus) are a bottom dwelling fish in warmish waters, found from the tideline down to 668 m, on fine gravel or soft mud. It is widely distributed along the Scotian Shelf at all depths, and along the Laurentian Channel. They are more abundant on the central Scotian Shelf than on either the southern or eastern ends. Some monkfish are found along the edge of the Laurentian Channel and in the approaches to the Bay of Fundy. In the past 5 years monkfish have become less widespread and are caught in fewer locations than during the 1970s and 1980s.

Monkfish catches were higher during the winter months than during the summer. In summer, monkfish are caught in waters less than 120 fathoms deep while in winter there are significant catches in waters exceeding 200 fathoms. Monkfish have been caught in water temperatures ranging from 0 - 24°C. Summer survey catch rates are not significantly correlated with depth or temperature, and show no strong diel pattern. Monkfish are occasionally caught in water temperatures as low as 0°, and as high as 12°, but are usually caught between 3 and 10°C. They appear to have no preference as to depth, or time of day.

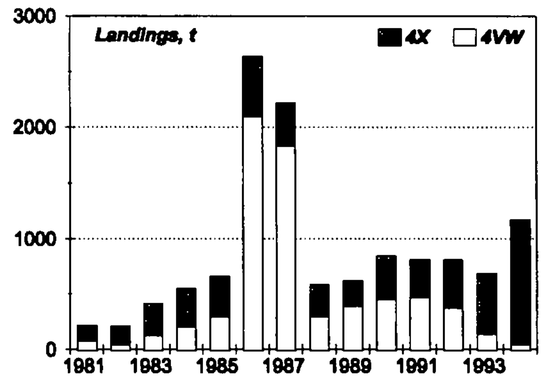
Spawning occurs from June to September on the Scotian Shelf. Eggs are spawned in light violet grey or purplish brown mucus veils (Bigelow and Schroeder 1953). These veils are believed to be the product of a single ovary and may be 9.1-12.2 m long, 30 cm or more in width (Scott and Scott, 1988). Storms may shred the veils, resulting in free floating eggs. Eggs are 1.61-1.84 mm in diameter, with a single copper or pinkish oil globule or several smaller ones. The free floating larvae are 2.5-4.5 mm long when they hatch, eventually descending to the bottom. Development of their characteristic shape occurs when the fish are still pelagic. Monkfish may reach a length of 5.9 cm before their first winter, and 11.4 cm when a little more than a year old. A 76 cm monkfish is about 9 years old, and a 12 year old is about 100 cm (Scott and Scott 1988). Maturity is usually not reached until they are approximately 76 cm long (Bigelow and Schroeder 1953). Some early work on monkfish growth rates using vertebral growth rings, estimated fish growing from 12 cm at age 1 to 100 cm in 12 years (Conolly, 1920)

Summer surveys shows a wide range of sizes (10-120 cm) with the bulk of the population measuring 20-75 cm. In the past five years, fish larger than 40 cm are significantly less abundant than they were historically, while smaller fish are more abundant.

Monkfish are voracious predators, and not very choosy as to prey. If it moves and is found in or on the water, they will eat it. Once the juveniles have reached the bottom, they become mainly fish eaters, and are capable of eating fish of almost its own size. Stomach contents have included; fish of all kinds, cod, haddock, herring, gaspereau, smelt, mackerel, sculpins, sea ravens, flounders, skates, eels. crabs, lobsters, squid, starfish, marine worms, sand dollars, etc., also seabirds and lobster pot buoys. Monkfish larvae feed on copepods, Sagitta, and crustacean larvae. Monkfish use the little flap of skin on the end of their first dorsal spine as a lure, enticing their prey closer, until it is within range, when it will be swallowed whole, usually head first. Swordfish are known to eat monkfish, and the young are likely susceptible to other fish-eating fish.

The Fishery

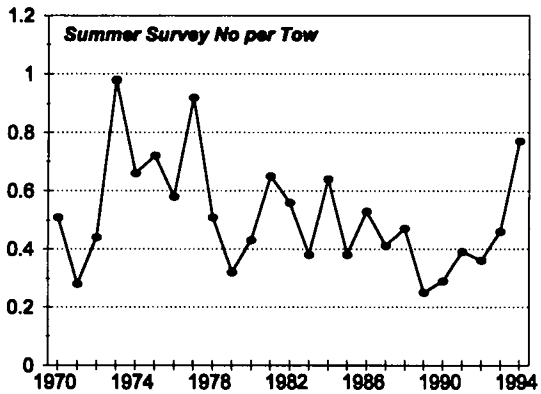
Historically, monkfish have been almost exclusively a by-catch fishery of groundfish and scalloping ventures with the highest landings being reported by the scallop fleet fishing Western Bank during 1986 and 1987. Landings in 4W have declined since that time, reaching a low of 27t in 1994. As a by-catch in the groundfish fishery, monkfish were caught equally by fixed gear and mobile gear less than 65ft vessels while greater than 65ft mobile gear vessels made sporadic large catches (i.e. greater than 100t) in 4W. Since 1992 the less than 65ft mobile gear fleet have been directing for monkfish in 4X. As a result of this increased effort, 4X landings increased from just over 300t in 1991 to over 1,100t in 1994.



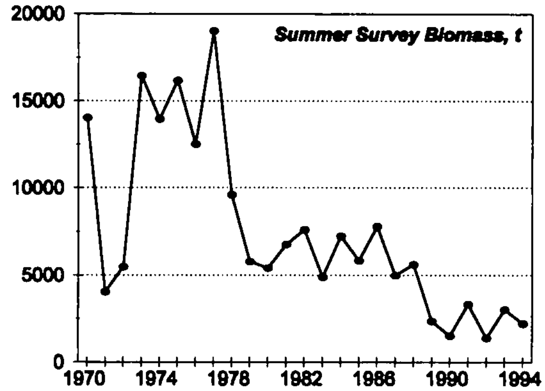
Samples of monkfish landings are only available for 1995 and indicate that these fish are landed at lengths ranging from 30 to approximately 120 cm in length. Most of the fish landed range from 45 to 70 cm.

Resource Status

Summer survey results are highly variable from year to year but tend to indicate a period of relatively high abundance through the mid 1970s, lower abundance through the 1980s, and a rise in overall numbers since 1989.



Estimates of trawlable biomass show that this resources was, historically, concentrated in divisions 4W and 4X, and that biomass was highest through the 1970s (6,000-12,000 tonnes) and has shown a gradual decline since the early 1980s. Present estimates of trawlable biomass are on the order of about 2,000t.



Outlook

Present information shows that the biomass of this resource has declined from higher levels during the 1970s. The increased interest in this species as an alternative to the more traditionally exploited species will serve to increase pressure on this resource. Coupled with the presently low biomass, this could result in very high exploitation rates. High exploitation rates will not be conducive to stock rebuilding. At a minimum catches should be limited to less than 800t, which represents the average landings since 1988.

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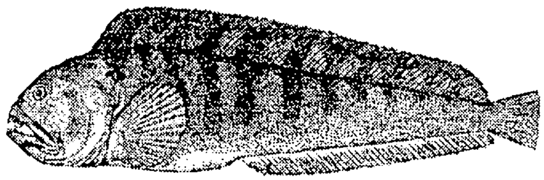
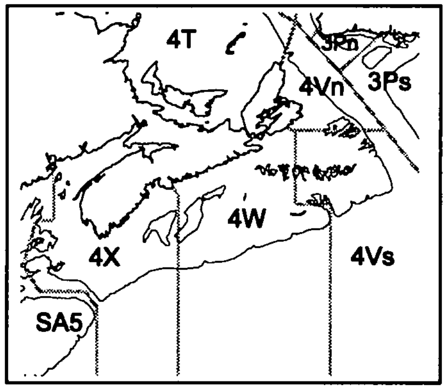




WOLFFISH ON THE SCOTIAN SHELF

Background

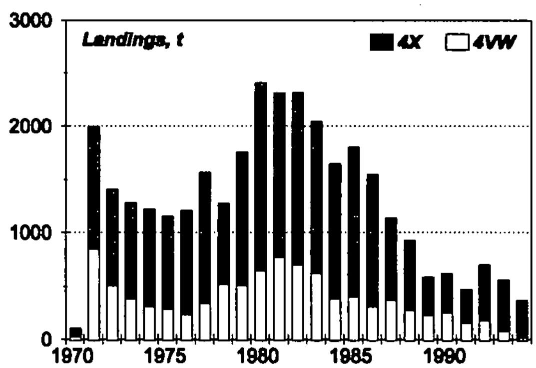
The Atlantic Wolffish (Anarhichas lupus) is found on the Scotian Shelf from shallow water to waters approximately 150 m deep with a few occurring even deeper. Seasonal inshore migrations may occur in spring when mature fish are found in shallow waters 0 to 15 m. These fish are solitary by nature and do not exist in schools. Wolffish are found to be most prevalent in the approaches to the Bay of Fundy, the Browns, Roseway and La Have Banks areas, and the North-eastern portion of the Scotian Shelf adjacent to the Laurentian Channel. During the past 5 years, wolffish appear to have decreased in prevalence in the southwestern portion of this range and have become more abundant and highly concentrated along the Laurentian Channel in the Northeast. Stock structure is presently unknown, although it is interesting to note that the increase in abundance of wolffish along the Laurentian Channel coincides with a decline in this same species on the Southern Grand Banks. Although there is no evidence for exchange between these areas, this observation raises that possibility. Summer surveys show that wolffish are caught at temperatures ranging from 0-9°C with some apparent preference for the cooler temperatures. They have been caught at depths ranging from 50-200 m with some preference for depths of 50-100 m. More wolffish are caught at night than during the day.

In Newfoundland wolffish spawn in September, in the White Sea in July, and in Iceland in January-February. Powles (1967) reported egg masses in abundance south of LaHave Bank in March 1966 and empty egg masses were found near Sable Island in February. However the actual spawning time on the Scotian Shelf remains unknown. The large cohesive eggs range from 5.5 to 6.5 mm, are demersal, and are laid in clusters. These egg clusters may be guarded by an adult male. Partially hatched larvae were 17-18 mm in length. The larvae are pelagic, but remain close to the bottom until the yolk sac is absorbed. The entire larval stage is spent near the area where the eggs were laid (Bigelow and Schroeder 1953). Growth may be rapid for the first year, and then slows; in subartic water, fish at five years of age, were only 24 cm.

Wolffish feed on rocky bottom on whelks, sea urchins, brittle stars, crabs, scallops (shells are crushed), and occasionally redfish (Templeman 1985). Cod have been reported predators of small wolffish.

The Fishery

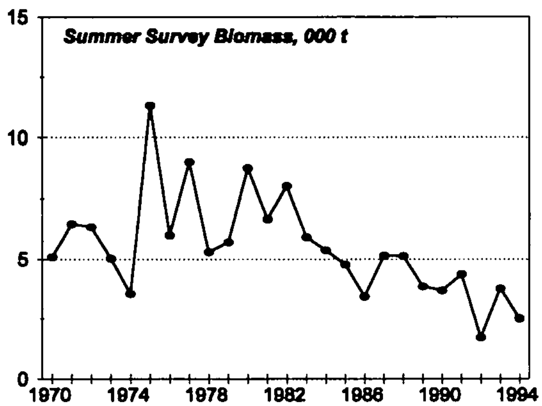
Wolffish are primarily landed from Division 4X, with over seventy percent of the catch being landed by trawlers. In 4VW, most wolffish are landed by longline (up to 60%) followed by trawlers. Landings in 4X peaked in 1980 at 1,500t and dropped to less than 500t by 1991. Reported landings in 4X have remained at below 500t since. Wolffish landings in from the rest of the Scotian shelf have usually totalled less than 300t, and are presently negligible.



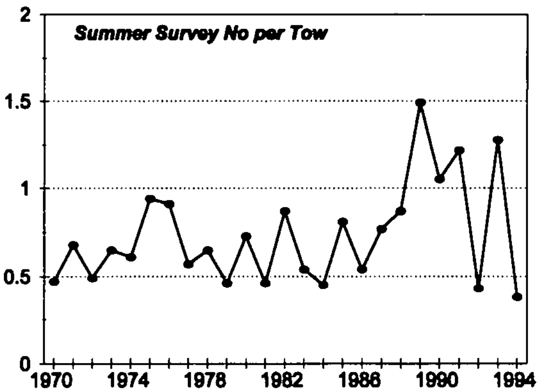
This species has only been sampled sporadically because it is usually landed in small quantities as by-catch in other fisheries. These samples do not at present provide a clear indication of sizes landed or of trends in landed sizes.

Resource Status

Until 1984, most of the wolffish trawlable biomass was concentrated in Division 4X. Biomass in 4X has shown a gradual decline, most notably since 1984. At present wolffish biomass is distributed about equally in Divisions 4V and 4X. Biomass in Division 4W has shown a gradual but steady decline since 1981. Total trawlable biomass estimates have ranged from a high of about 11,000t to present estimates of about 2,000t.



Overall numbers of wolffish, as estimated from surveys has been highly variable form year to year and without apparent trend until 1987 when abundance appeared to increase. This increase is most evident in Division 4V and particularly along the edge of the Laurentian Channel and appears to be due to an increase in the prevalence of smaller fish.



Research survey results show a marked increase in the numbers of small (10-43 cm) wolffish caught in the last six years versus the last twenty-five years. Larger wolffish (longer than 50 cm) are less abundant now (1989-1994) than they were over the long-term (1970-1994).

Outlook

Wolffish biomass in 4X and 4W has declined since the mid 1980s while biomass in 4V has remained relatively stable over that period. The fishery has been concentrated in 4X and has likely contributed to the observed decline. Continued heavy fishing pressure will not be conducive to stock rebuilding. The appearance of small fish in 4V may be indicative of incoming recruitment, although our understanding of this resource is insufficient to state where (or if) on the Scotian Shelf these fish will recruit to the population. A cautious approach which maintains catches at the 1988-1994 average of about 600t is warranted.

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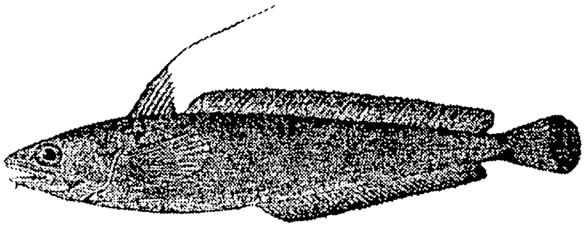
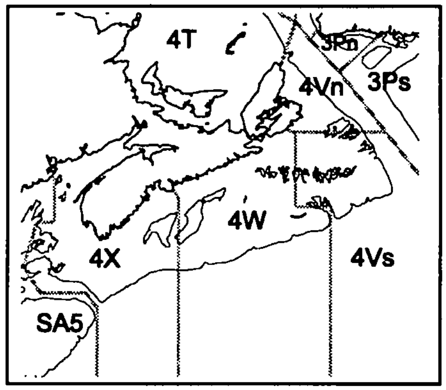




WHITE HAKE ON THE SCOTIAN SHELF

Background

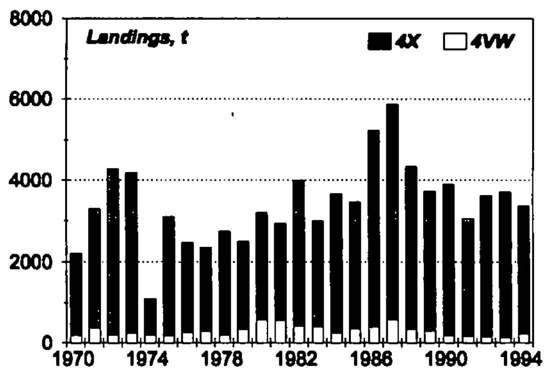
White hake (Urophycis tenuis) are bottom dwelling fish, found in areas with a mud bottom. Although they have been caught at depths ranging from 200 to 1000 m, the majority of white hake catches occur from 50 to 400 m in depth. As the surveys do not fish deeper than 400 m, the concentrations may go deeper. White hake appear to favour temperatures from 3 to 10 °C, with few fish being caught above or below these limits. There does not appear to be a bias towards time of day for better catches. Bigelow and Schroeder (1953) suggests that white hake feed mainly between sunset and sunrise. Summer research surveys indicate that the largest concentrations are in the Fundian Channel and in the Bay of Fundy. The other area of concentration is along the Laurentian Channel, from the edge of Banquereau up into 4Vn towards St Paul's Island. The long-term (1970-1989) and the more recent (1990-1994) geographic distribution as derived from summer surveys show no significant differences. Although stock structure is presently unknown, the geographic distribution of white hake suggests that those hake in 4Vn occurring along the Laurentian Channel, may be somewhat distinct from those further to the south and west. Improved knowledge of hake distribution in waters inshore of the presently surveyed areas would show whether or not these concentrations are contiguous. It should be noted that at various times another species of hake (red hake, Urophycis chuss) may have been misidentified as white hake. This is particularly true at smaller sizes when these two species look very much alike. It is likely that this problem was most prevalent during the mid 1970s.

White hake spawn at different times depending on location. On the Scotian Shelf they likely spawn in winter and early spring. They produce large numbers of pelagic eggs, 0.70-0.79 mm in diameter. Larvae and juveniles are pelagic often hiding in floating seaweed (Bigelow and Schroeder 1953), until approximately 50 to 60 mm in length, when they settle to the bottom in shallow waters. Small fish are known to inhabit the shells of living scallops, or may hide in sand. Very young white hake are known to occur close inshore and then to move offshore as they grow. The inshore distribution of the young may indicate the feasibility of inshore surveys to monitor incoming recruitment.

Growth rates of larvae and juveniles are unknown but believed to be rapid, with three year old fish in the southern Gulf of St Lawrence reaching a length of 41 cm. Size of first maturity of Gulf of St. Lawrence fish was estimated as 40 cm for males and 47 cm for females, with indications that size at maturity changed over time. Adults prey heavily on herring, silver hake and red hake, with squid, shrimp, amphipods, and other small crustaceans also being a significant portion of their diet. Known predators are fish (cod) as well as other white hake. White Hake may also be preyed upon by harbour and grey seals.

The Fishery

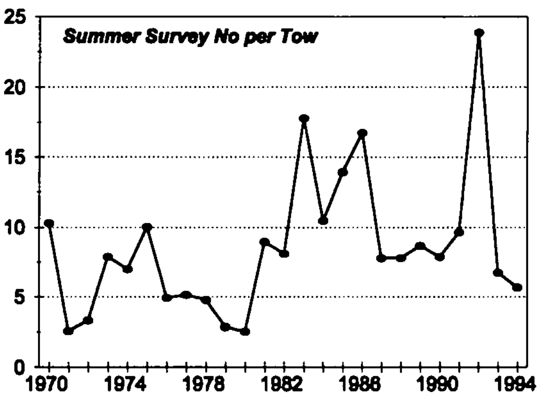
Commercial landings of white hake from the Scotian Shelf, are largely from 4X (70%) and 4W (10-20%), with small amounts coming from 4Vn and 4Vs. Reported landings from 4X appear to have increased gradually form 1970 to 1993 with peak landings of 4,000t in 1972 and 1987. Landings in 4W have ranged from 500 to 1,500t while landings from 4V have generally been less than 500t per year. The majority of white hake are caught by longline with some caught by handline.



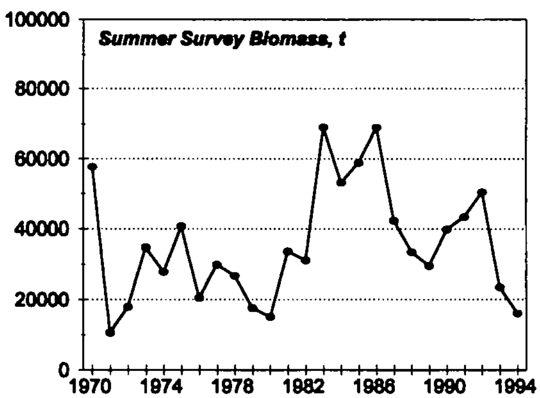
Prior to 1985 length composition of landings is inferred from a relatively small number of shore based samples. Since then, sampling rates have been higher with the exception of 1985 and 1987 when only one sample was collected. The more recent length compositions appear to show a decrease in the sizes of fish being landed.

Resource Status

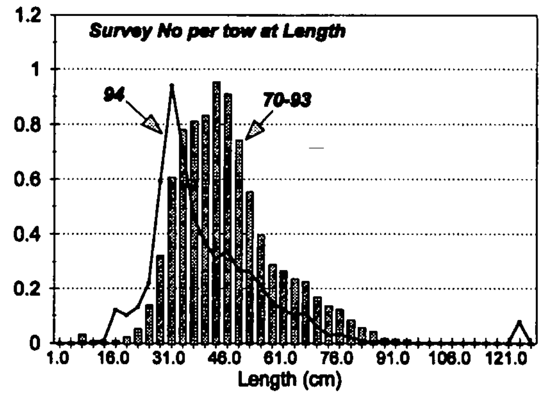
Results of the summer surveys show generally lower abundance through the 1970s with somewhat higher numbers caught through the 1980s to the present.



Estimates of trawlable biomass show that white hake biomass in Division 4X increased through the early 1980s and has declined since. White hake biomass is presently at levels equivalent to those observed in the 1970s. Total trawlable biomass has ranged from a high of about 70,000t in the early 1980s to present estimates of about 20,000t.



The long-term (1970-1993) population length composition and the more recent population length composition (1994) as estimated from summer surveys indicate that the bulk of the fish caught were in the 28 to 55 cm group, with increased production in this group recently. There is no indication of any shift in the overall size composition of this population in recent years.



Outlook

Results of the summer surveys suggest that white hake biomass has been relatively high throughout the 1980s and is now approaching the lower levels of the 1970s. Given this lower level of biomass, catches should be restricted to the average landings of 2,500t observed during the 1970s.

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References

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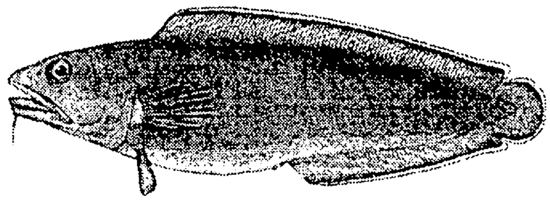
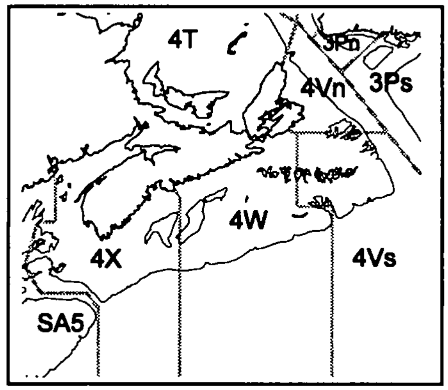




CUSK ON THE SCOTIAN SHELF

Background

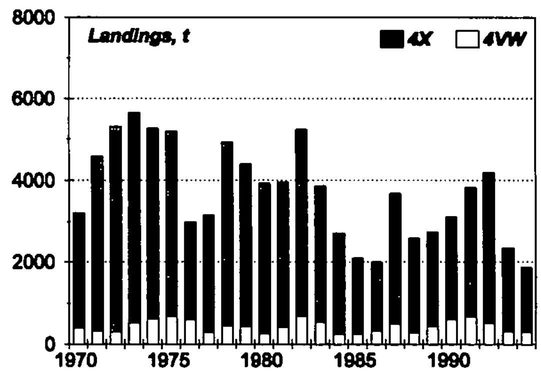
Cusk (Brosme brosme) are a solitary, weak swimming fish, found primarily in 4X, on the southwestern Scotian Shelf and Slope and in the Fundian Channel, that seldom move from bank to bank. Based on July research surveys, cusk occur in temperatures ranging from 3 to 11 °C with most being caught in the 6-10° C range, in depths of 50 to 200 meters with some apparent preference for the 75-150 m range. They also prefer a rocky bottom, or gravel and occasional mud but seldom sand, (Bigelow and Schroeder 1953). There is no evidence for any day night effects on catch rates.

Spawning on the Scotian Shelf is believed to occur from May to Aug., peaking in June. The buoyant eggs are 1.3-1.5 mm in diameter with a pinkish oil globule. The entire surface of the egg is finely pitted. The pelagic larvae are about 4 mm when hatched, migrating to the bottom when they are grown to approximately 50 mm in length. Males appear to grow slightly faster than females, (reaching 45 cm at five years of age) and appear to mature more rapidly.

The diet of cusk on the Scotian Shelf is unknown, as their stomachs evert when they are brought to the surface. In European waters, cusk feeds primarily on crabs and molluscs, along with the occasional starfish. A feeding record on this side of the Atlantic, by Bigelow and Schroeder (1953), has them feeding on crabs and the occasional mollusc off the coast of Maine. The only known predation record was by a hooded seal off Greenland, dining on cusk (Scott and Scott 1988). There is no record of cusk occurring in seal stomachs on the Scotian Shelf.

The Fishery

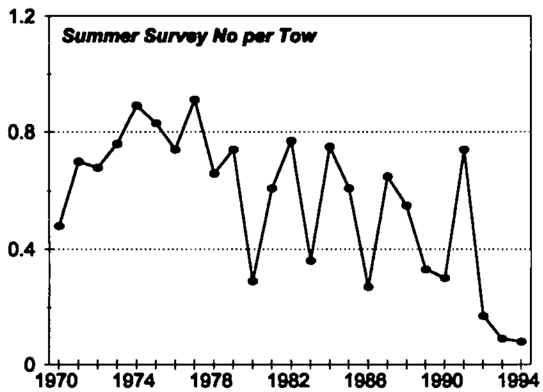
Commercial landings, were derived from Halliday and Clark (1995), NAFO Statistical Bulletins, and provisional catch statistics for recent years. Cusk are primarily caught by longline (95%), with over 80% of the landings coming from 4X. In 4X landings have varied from a maximum of 5,130t in 1973 to a low of 1,572t in 1994. The general pattern is one of a slow decrease form the early 1970s to the present. Landings in Division 4W rarely exceed 500t, while landings in Division 4V have been negligible.



Commercial sampling data shows that the most abundant size fish caught in the 1970s to the early 1980s were 64 to 67 cm long, similar to the research surveys. In 1985, the three longline samples showed a marked decrease in size, down to a peak of 52 cm, with several other smaller peaks. Since 1985 this peak has varied greatly, and indicates more fish at smaller sizes.

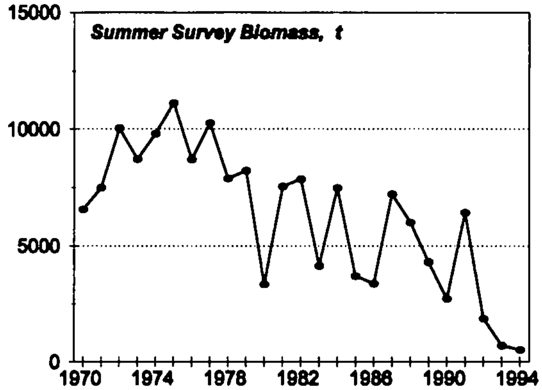
Resource Status

A comparison of the long-term (1970-1989) geographic distribution from summer surveys to that of the more recent distribution (1990-1994) indicates a significant decline in both the prevalence and abundance of cusk in recent years. The range of this species appears to have contracted with no cusk now caught along the seaward edges of Western/Emerald/Sable Island and Banquereau Banks. Research survey information shows a decrease in numbers of fish per tow from 1987 to 1994.



Summer surveys also show that cusk at lengths greater than 52 cm have become less abundant than they were over the long-term average (1970-1993).

Cusk biomass in both 4W and 4X (the centre of the historic distribution) has shown a gradual decline since the inception of groundfish monitoring surveys in 1970. Trawlable biomass in 4X has declined from a high of over 8,000t to well under 1,000t presently. The most significant decline has occurred since 1987. Estimates of trawlable biomass in 4V and 4V are presently negligible.



Outlook

This resource has shown a long-term decline in biomass, with present estimates at their lowest observed values. Given the estimate of low and declining biomass, catches should be restricted to below the 1994 total of 2,000t.

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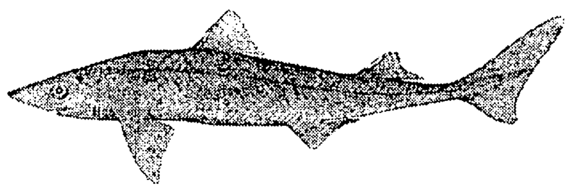
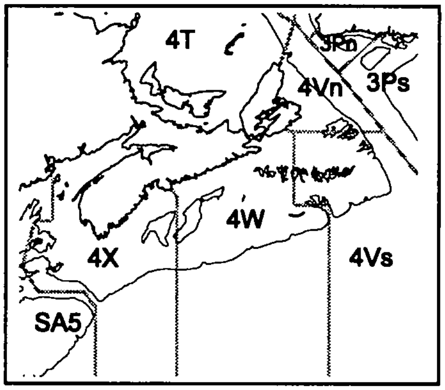
Scott, W.B., and M.G. Scott. 1988. Atlantic Fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219: 731 p.





SCOTIAN SHELF SPINY DOGFISH

Background

The spiny dogfish (Squalus acanthias) is a migratory species distributed in Northwest Atlantic waters between Labrador and Florida but are most abundant from Cape Hatteras to Nova Scotia. They prefer temperatures ranging from 7.2º to 12.8ºC. and begin seasonal migrations from wintering grounds in southern offshore waters in the late spring. The larger fish (predominantly female) migrate northward first and generally spread north along the edge of the shelf to the Laurentian Channel, making limited excursions onto the shelf. It has been reported that there is some limited overwintering in deeper waters off the Nova Scotia shelf and these fish probably contribute to this more northerly migration. The largest group of smaller fish and males follow but move only as far north as Subareas 4X and 5.

Younger dogfish tend to school by size and larger mature individuals by sex. They are opportunistic feeders, feeding primarily on sand lance, mackerel and herring but also include other fish species, crustaceans and molluscs in their diet. Dogfish are a very long lived, slow growing species, living to ages of approximately 40 years reaching maximum lengths of 120 cm for females and 96 cm. for males. Males reach sexual maturity at age of 6 years and at a length of 60 cm and females at age 12 years and at a length of 75 cm. Reproduction occurs offshore in the winter when female dogfish bear live offspring after a gestation period of 18 to 22 months. The 2 to 15 pups (ave. 6) produced and are 25 to 30 cm in length.

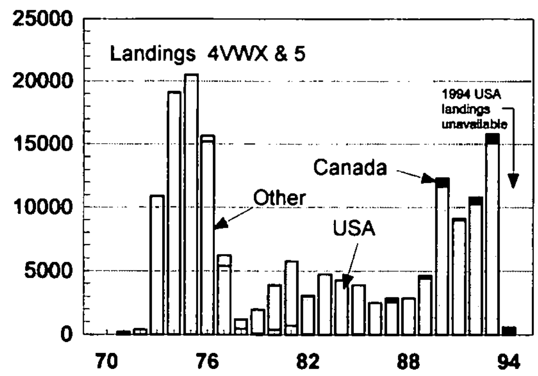
Spiny Dogfish in the North Atlantic are considered one stock unit stretching from NAFO Subareas 2-6. They have long been considered a nuisance by fishermen causing a loss of gear and fishing time for other species. There has been a relatively small directed foreign fishery and recently a very small and market driven Canadian fishery has started in 4X.

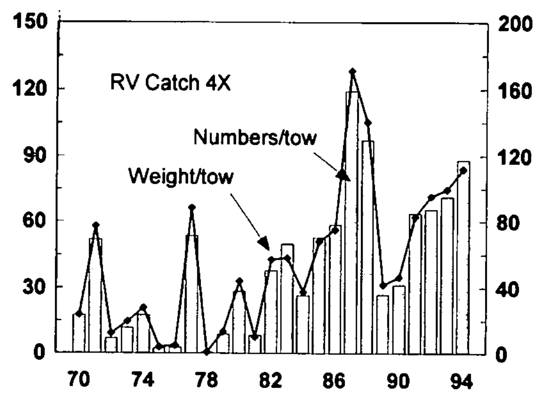
The Fishery

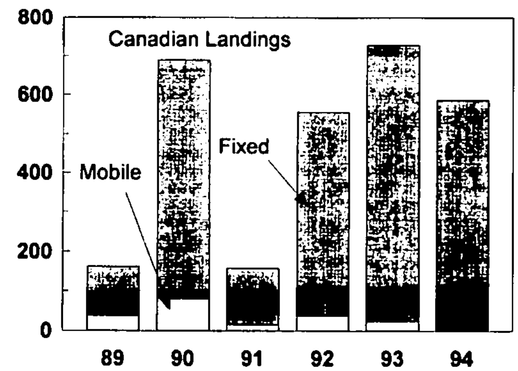
Landings (thousands of tonnes)

Year	70-77 Avg.	78-79 Avg.	1990	1991	1992	1993	1994
Canada	0.1	0.1	0.6	0.1	0.5	0.7	0.5
USA	0.1	3.3	11.7	9.0	10.2	15.1	n/a
Other	9.0	0.1	0.0	0.0	0.0	0.0	n/a
TOTAL	9.1	3.4	12.3	9.1	10.8	15.8	-

Landings of dogfish in Subareas 4VWX and 5 increased dramatically in the early 1970s when the foreign fleet began to direct effort to the species. This peaked at 20,000t and declined to very low levels by 1978. The USA effort increased steadily from 1976 to 1980. Landings remained fairly steady at from 3000 to 5,000t through the 1980s, increased sharply to 12,000t in 1990 and are expected to be in excess of 20,000t for 1994. Canadian landings were generally lower than 30 metric tons until the mid 1980s. Since 1987 a small directed fishery, primarily by fixed gear, has had landing of from 500 to 700t.







Resource Status

The information on this stock is derived from surveys as the Canadian fishery is small. The catch rates on the summer surveys show variable but larger numbers during the period from the late 1980s to 1994 than during the earlier years of the survey with most of the fish caught in 4X. This is consistent with results in the USA which show a two fold increase in biomass over the same period. The large scale expansion of dogfish onto the Scotian Shelf in the mid 1980s appears, from recent surveys, to be receding perhaps in response to colder than normal temperatures. The fishing mortality by the directed Canadian is small, but the effect of discards by other sectors of the fishing industry is unknown.

Outlook

Biomass of dogfish is presently high and the Canadian fishery small. If the market expands and handling methods improve there could be pressure to expand quickly. However, the low fecundity, the slow growth, the high proportion of larger females taken by the USA fishery, high discards and the USA stock assessment stating the species is close to full exploitation all indicate caution. There may be room for expansion of this fishery but more information is required. Until such time a conservative approach is warranted.

For More Information

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