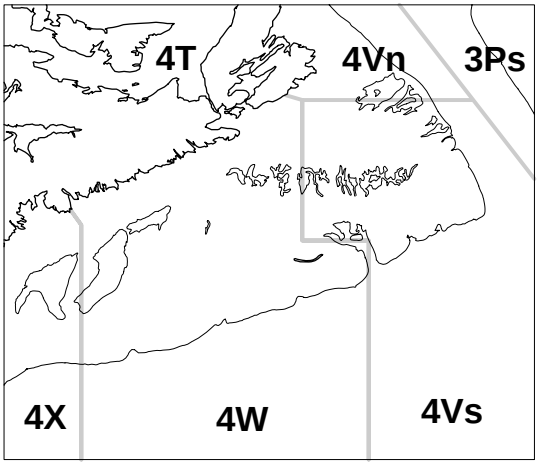
EASTERN SCOTIAN SHELF COD



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 Banquereau), smaller offshore groups (Middle and Canso banks) 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).

Growth rates differ between 4Vs and 4W so that in the 1970s fish in 4Vs fish reached 68cm at age 7 while in 4W reached 72cm. In the mid-1980s growth declined in both areas and the average length at age 7 dropped to 59 and 54 cm respectively from 1985 to 1995.

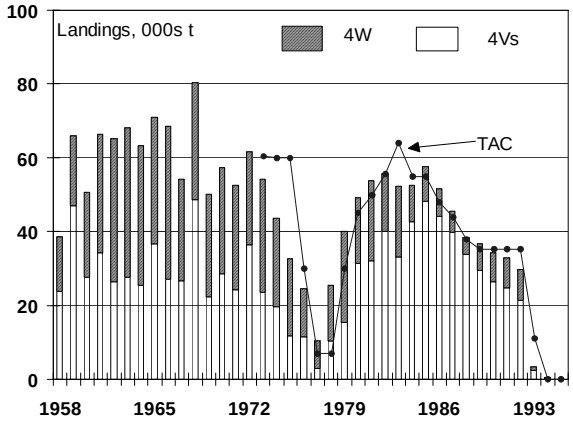
The fishery for 4VsW cod was prosecuted primarily by foreign vessels until the extension of jurisdiction in 1977. Since that time, the Canadian offshore trawler fleet accounted for 70-75% of the landings and longliners most of the rest. Catches from 1958-79 were about 40-50% from 4Vs, however, as the 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	70-79 Avg.	80-89 Avg.	1991	1992	1993	1994	1995
TAC**	43.5	43.9	35.2	35.2	11.0	-*	-*
4Vs	19.8	33.3	24.6	21.3	2.3	0.2	0.2
4W	22.3	13.2	8.2	8.5	1.2	0.2	0.1
TOTAL	42.1	46.6	32.8	29.8	3.5	0.4	0.3

* = by-catch only
** = no TAC from 1970 to 1973



The **fishery** for cod was closed for the entire year in 1995 and strict by-catch restrictions were placed on those fisheries which were

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operating in the area. This continued the closure imposed in September of 1993 and resulted in a total landings of 276t, 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 1995 as there were negligible winter landings from that area. The fishery has remained closed in 1996.

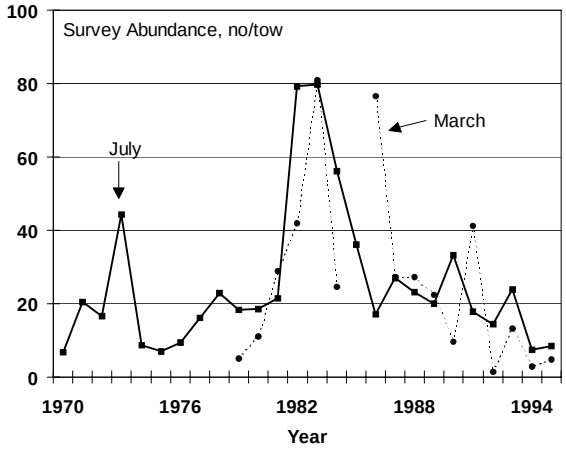
Resource Status

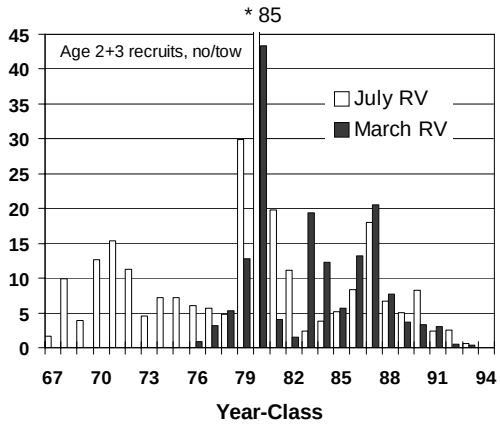
The samples of the commercial catch were again difficult to collect in 1995 because landings were limited to by-catch throughout the year. Consequently, the catch at age is not well estimated since the closure of the fishery. The numbers at age in the catch indicate that the 1989 year-class was predominant and no fish over age ten were observed. The mean weights at age for ages three to ten 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 1995 as the fishery was closed and no cod-directed effort was recorded.

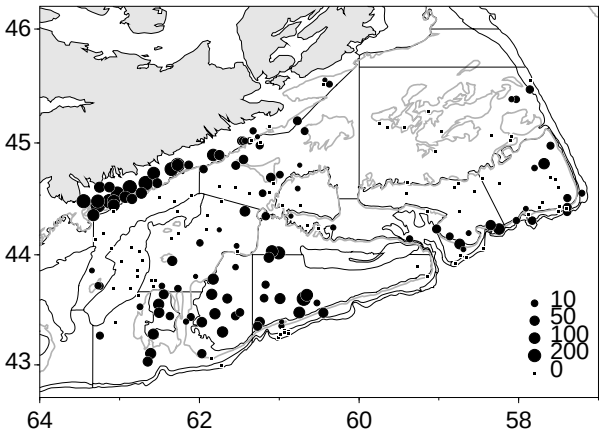
There are two **research survey series** available for this stock, a July series which started in 1970 and a March series since 1979 (except 1985). Both series have revealed substantial declines in abundance since the late 1980s and are now near record lows.

Both surveys indicate continuing low **recruitment**. In the latest three years, the average index of ages 2 and 3 includes the lowest observations in their respective series.



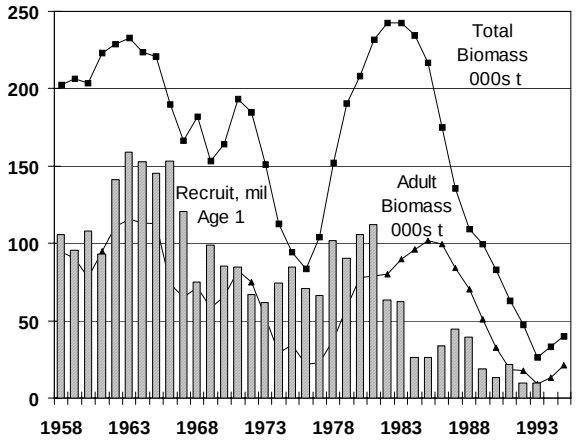


The **4VsW Sentinel Survey** conducted in October 1995 landed a total of 6.7t of cod from a total of over 200 standardized longline sets (1500 hooks per set). Sets were distributed throughout divisions 4Vs and 4W from inshore waters (approximately 18 m contour) to the 370 m contour offshore.

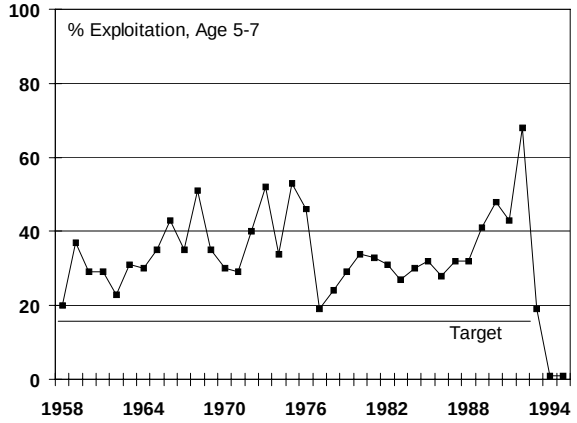


Although the results of this single survey do not allow for conclusions about resource abundance they are indicative of distribution of cod in the fall. As the majority of the sentinel catches came from the area inshore of the 92 m contour, an area not included in the DFO research vessel surveys, the two approaches provide a more comprehensive picture of the distribution and abundance of adult cod. The sentinel survey does not provide an index of prerecruit abundance due to the selectivity of the longline gear.

The standard age-based **population analysis (VPA)** was used to estimate the current status of the stock. The abundance estimates indicate that the population is severely depleted. There was a slight increase in the 1995 adult (age 6+) biomass to 21,000t over 1993 (12,000t) and 1994 (19,000t). These were the lowest values in the series which averaged 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. The biomass increase observed in the last two years is due to growth of older fish which are surviving on account of the fishery closure. It is not due to incoming recruitment.



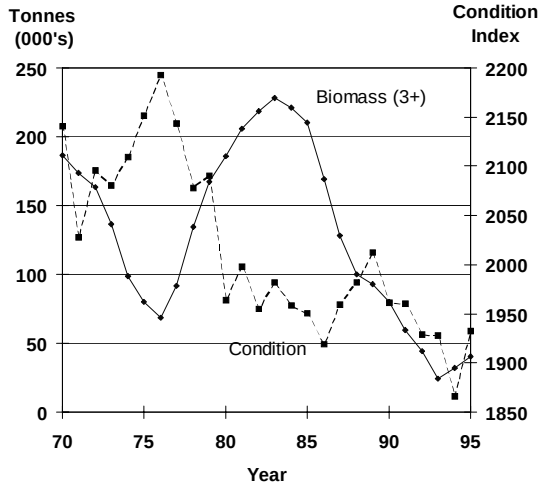
Exploitation rate, the percentage of the recruited population removed by the fishery, indicates that the fishery was removing increasing fractions of the stock from 1979 to 1992. The early closure of the fishery in 1993, continued in 1994 and 1995, resulted in the first significant decrease in exploitation levels since the removal of foreign effort in 1977. This was consistent with the 75-80% decrease in numbers of trips in both inshore and offshore sectors during this time.



Population Considerations

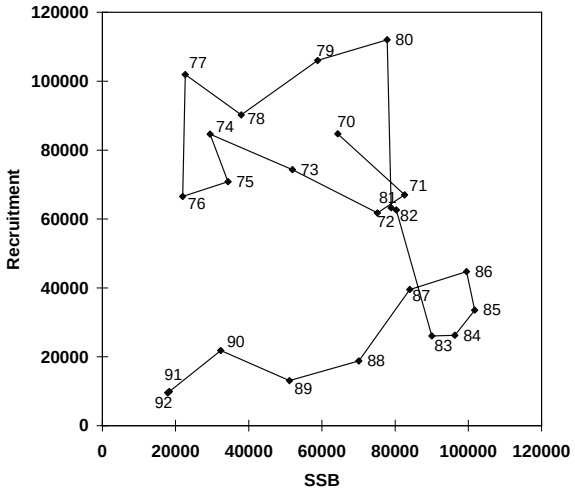
Size at age has declined in this stock since the mid-1980s both in the survey and commercial catch data. Since about 1992, the consistent

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 continued to fall and remains low, rather than increasing as was expected. Although the cause and significance of a low condition factor is debatable, there is no indication of a pending return to the plumper cod observed in the late 1970s. These condition observations are consistent with the widely reported loss of weight seen by the industry and the presence of "slinky" fish in the catch.



A recent study (1991-93) of the production of cod eggs and larvae in 4W (OPEN) found that fall-spawned production accounted for over 90% of the total. This is in contrast to the findings of a major program in 1977-82 (SSIP) 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 the adult 4W spawning component may have been greatly reduced by fishing. Alternatively, conditions in the area may have changed, making it unfavourable for spawning; either for the aggregation of adult spawners or for their successful reproduction. The distribution of fishing effort in the 1980s suggests that adult fish became less available in 4W after 1985.

Based on long-term population model (VPA) results (1958-1995), both net biomass production (net change in biomass from year to year) and age one recruitment show substantial breaks in the mid-1980s with respect to population 0biomass relations. Historically, net production had shown increases in times of low or declining biomass and vice versa. This pattern was broken in the late 1980s when, with low biomass and production, the production failed to increase and biomass fell to the lowest observed levels. In the earlier time period, age one recruitment was variable, showing little relationship to spawning stock biomass, but always producing year-classes in excess of 60 million recruits. Since 1983, recruitment has been less than 60 million recruits per year even when the spawning stock biomass was high. The most recent estimated year-classes are less than 15 million and spawning stock biomass is the lowest ever seen.



Ecosystem Considerations

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 in the late 1980s by 1-2^{o}C and have remained cold to the present. The effect this has had on the biology and ecology of cod in the area is not fully understood. However, reduced temperatures may well be responsible for the slower growth and poorer condition of the cod. Similarly, lack of recruitment and the apparent disappearance of a major 4W spring spawning component may also be due to environmental effects.

Estimates of **grey seal predation** were first presented in 1993 using information on the composition of grey seal diets collected between 1989 and early 1993. The proportion of cod (mostly less than 4 years old) in these samples did not indicate a trend over the sampling period. Given the low and declining biomass of cod, it was considered likely that grey seals would reduce their predation on cod in favour of more abundant prey. However, samples collected from Sable Island between the summer of 1993 and January, 1996 show that the proportion of cod in the diet, although variable among samples, has shown no trend over the five years of sampling on the Island. The mean percentage of cod in the grey seal diet has remained at about 15%. Given that the grey seal population has continued to increase at the same rate as previously measured, the average estimate of consumption of 4VsW cod by grey seal is 17,700t in 1995; an increase of 12% over 1994. This increase in a significant cod predator is coincidental with an apparent period of low production and reproduction for cod, thus increasing the ecological pressure on the cod population.

A suite of **ecological factors**, briefly described below, has been examined for plausible links to cod biology or population dynamics. Each case can be interpreted as suggesting a fundamental change in the cod ecodynamics but none of them are conclusive. Taken as a whole however, and considering the changes in stock biology noted above, there emerges a coherent picture which indicates that in the mid-1980s there was the onset of a different environmental and ecosystem regime for cod and other species on the eastern Scotian Shelf.

Cod and yellowtail flounder occurred together more often in the 1970s than is presently the case. The spatial distribution of yellowtail flounder appears unchanged over this time while the distribution of cod has shifted to the northeastern Shelf in the past 10-15 years. However, the changes in cod distribution do not account for the decline in cod 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. **Shrimp** surveys indicate that shrimp is also at record high biomass. Both shrimp and capelin abundance increase in this area in periods of colder than

normal bottom water. In addition, both shrimp and capelin are preferred food of cod over its distributional range. It is, therefore, paradoxical that cod condition and production is declining at a time when food items are at high levels.

In summary, there are clear changes in the ecological communities in 4VsW, particularly in 4Vs, since the mid-1980s. Although some are negative and others positive for cod production, the eventual balance is not yet clear. The establishment of a capelin population in 4Vs is, by itself, a clear indication that an ecological change has occurred. The timing of their presence on the Scotian Shelf coincides with a reduction in size and condition of 4VsW cod, a major reduction of the 4W spring spawning component, and the breakdown of the cod and yellowtail flounder association. These changes in cod communities and biology coincide with the colder environmental conditions and may in fact be in response to them. In addition to the effects of these ecological changes, the 4VsW cod population was under continuous and severe fishing pressure thoughout the 1980s and early 1990s. These combined stresses resulted in the observed declines in population abundance.

Outlook

The short-term prospects for this fishery remain dismal. The adult population remains near 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 average and less than the 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.

For More Information

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