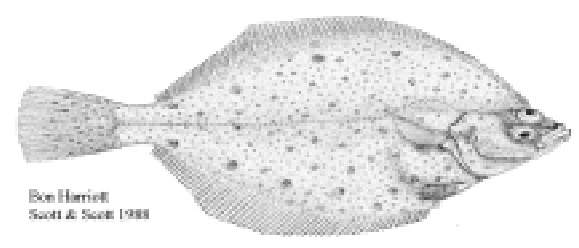
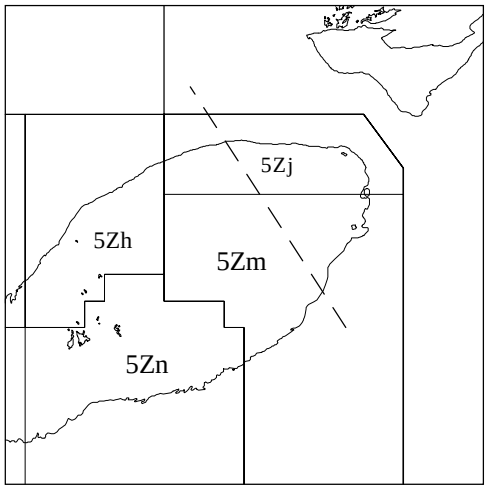


Yellowtail Flounder on Georges Bank



Background

Yellowtail flounder range from Labrador to Chesapeake Bay and are considered relatively sedentary. A major concentration of yellowtail occurs on Georges Bank to the east of the Great South Channel. While tagging work indicates limited movement from Georges Bank to adjacent areas, knowledge of seasonal movement of yellowtail flounder on Georges Bank is poor. Yellowtail flounder are most commonly caught at depths between 37 and 73 meters (20 and 40 fathoms).

On Georges Bank, spawning occurs during the late spring period peaking in May. From the distribution of both ichthyoplankton and mature adults, it appears that spawning occurs on both sides of the international boundary. Yellowtail flounder appear to have variable maturity schedules, with age two females considered 40% mature during periods of high stock biomass to 90% mature during periods of low stock biomass.

The Canadian fishery is mainly pursued using otter trawl gear from vessels less than 65' LOA. This directed fishery for yellowtail flounder is a relatively recent development, with significant catches first occurring after the introduction of specialized gear in 1993. The trawls are equipped with small rollers and employ less headline flotation, giving a smaller vertical opening. The fishery occurs in a relatively limited portion of Georges Bank known as the Yellowtail Hole, and with current management restrictions, operates in the latter half of the year only. Both Canada and the USA employ the same management unit.

Summary

- Combined Canada/USA catches have been increasing since 1995, and in 1998 were 3,111 t.
- Population biomass has increased since 1995, and is now about ¾ of the biomass associated with maximum sustainable yield.
- Recent recruitment has improved relative to the 1980s, and the 1997 year-class appears to be the strongest since 1980.
- Exploitation rates have been less than the $F_{0.1}$ target of 20% during the past three years.
- There is a high probability that population biomass levels will continue to increase with fishery removals in 1999 equal to those of 1998, but the amount of the increase is uncertain.

The Fishery

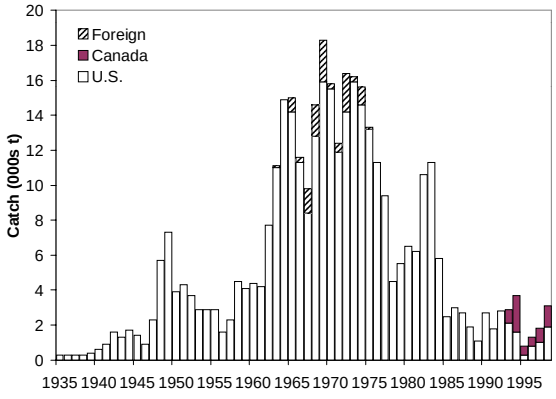
Catches (thousands of tonnes)

Year	1970-1979 Avg.	1980-1989 Avg.	1990-1994 Avg[4]	1995	1996	1997	1998
TAC[1]	-	-	-	0.4	0.4	0.8	1.2
Canada[2]	-	-	1.4	0.5	0.5	0.8	1.2
USA	12.0	5.2	2.2	0.3[3]	0.8[3]	1.0[3]	1.9[3]
Totals				0.8	1.3	1.8	3.1

[1] Canadian quota only.
[2] Canadian yellowtail catches, plus prorated unspecified flounder.
[3] Estimated values, provided by US NMFS, include discards.
[4] Canadian average included 1993 and 1994 only.

Total catches of Georges Bank yellowtail flounder reached historic highs during the mid 1960s to mid 1970s. The USA fishery has made most of the catches, although there were catches by other countries during the late 1960s and early 1970s.

The Canadian directed fishery started in 1993, and peaked in 1994, with catches of 2142 t. Under quota control for the first time in 1995, catches were 495 t against a quota of 400 t. The 1998 Canadian catches were 1175 t, against a TAC of 1200 t. In the past, small quantities of yellowtail flounder were caught and discarded by regulation in the Canadian scallop fishery. No estimates of removals by the Canadian scallop fleet were available in 1998.



Canadian catches of unspecified flounder from Georges Bank have been substantial (523 and 811 t in 1993 and 1994, respectively). Industry sources have indicated that most catches of unspecified flounders were yellowtail flounder. With improvements in dockside monitoring, catches of unspecified flounder have decreased substantially, and in 1998 were only 16 t from 5Zm and for the purposes of the assessment were assumed to be yellowtail flounder. In all years, catches of unspecified flounder assumed to be yellowtail flounder have been included in the stock assessment.

USA catches in 1998 were 1936 t, compared with 1024 t in 1997. The principle fishing gear used in the USA fishery is the otter trawl, but scallop dredges and sink gillnets contribute some catches. In recent years, otter trawls caught greater than 95% of total catches from the Georges Bank stock, dredges caught 2-5% of annual totals, and gillnet catches were less than 0.1%. Current levels of recreational fishing are negligible. Discarding of small yellowtail is an important source of mortality due to intense fishing pressure, discrepancies between minimum size limits and gear selectivity, and recently imposed groundfish trip limits for the scallop dredge fishery. U.S. trawlers that land yellowtail flounder generally target multiple species on the 'Southwest Part' of the Bank and on the northern edge, just west of the closed area.

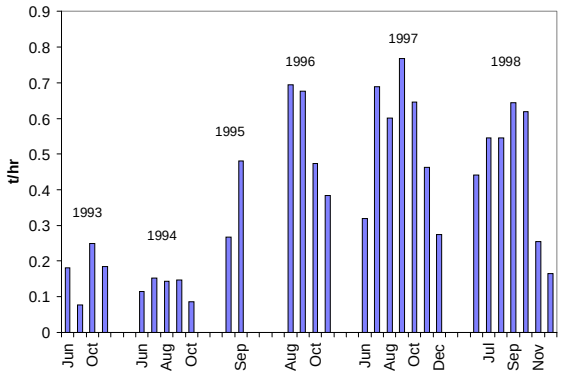
Catch at age and size information indicate that the range of sizes of the Canadian catches has been expanding over the past five years. The Canadian fishery catch at age has a higher proportion of older fish in 1998 compared with 1996 and 1997. The size structure of the USA catch is truncated compared with the Canadian catch, and may reflect culling related to the minimum size regulation or differential distribution of the resource by size. Low sampling rates for the USA fishery and the continued lack of a

Canadian program for age determinations has impacted the reconstruction of the catch at age and length.

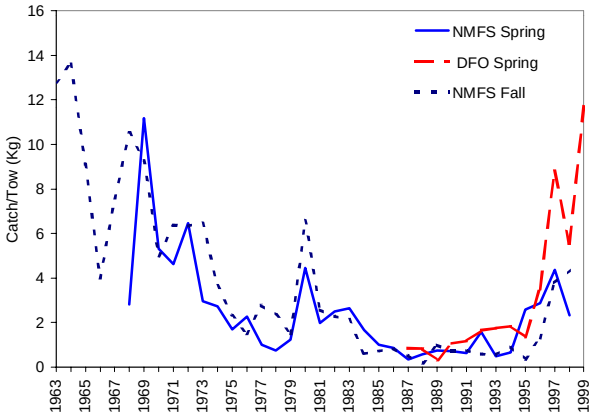
Resource Status

A virtual population analysis (VPA) was employed which incorporated indices of abundance from the USA NMFS and Canadian DFO spring surveys, the USA NMFS fall survey and the NMFS scallop survey (young yellowtail flounder are a common bycatch in scallop surveys). In light of concerns over the reliability of the recent catch at age, an age-aggregated surplus production model was also used. That approach required total catch as input, as well as indices of total biomass from the NMFS and Canadian spring surveys and the NMFS fall survey, but not age composition.

Canadian mobile gear **catch rates** were examined for the directed fishery in 5Zm. Catch rates have increased between 1994 and 1997, and declined slightly in 1998. Factors other than abundance that may have caused such an increase were reviewed with industry. It was concluded that the increases in catch rates up to 1997 probably reflect increased biomass, but were influenced by the developing skill of fishermen in this relatively new fishery and gear changes in 1993 and 1994. While catch rates may prove to be useful as an index of abundance for this resource, they require further investigation before they are included directly in the assessment.



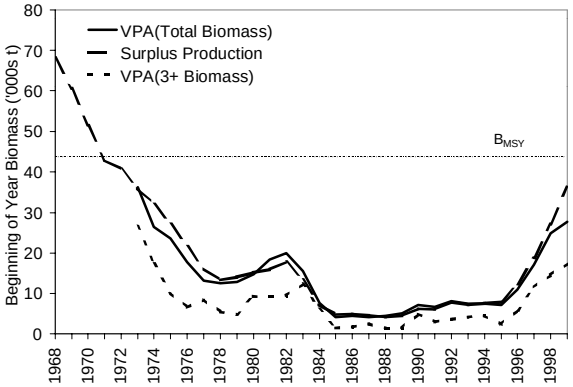
There are three groundfish **research surveys** conducted annually on Georges Bank that cover the entire management unit. They include a Canadian DFO spring survey conducted in February, a USA NMFS spring survey conducted in March/April and a NMFS fall survey completed each October. The mean weight per tow from the DFO spring survey has been increasing, with the 1999 value being the highest in the series.



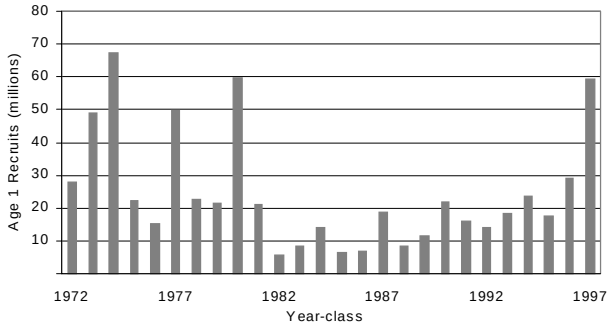
The NMFS spring survey series shows an increasing trend since 1994, but the catch/tow remains about half of that of the late 1960s and early 1970s. The NMFS fall survey series follows a similar trend to the spring survey, but the increase was not coincident with that of the NMFS spring survey. This may be attributable to interannual variability due to the random station design of the survey. Consistent with observations from the Canadian fishery, the size range of fish observed in the DFO and

NMFS spring surveys has increased over the past five years.

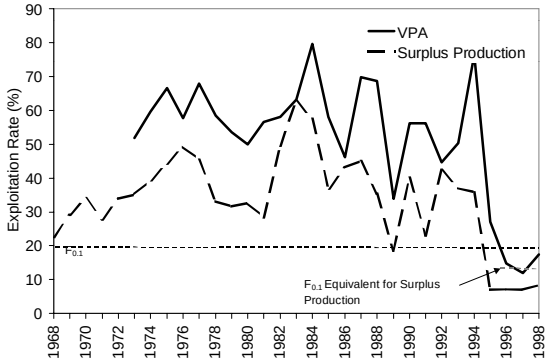
Estimates of **total biomass** (ages 1+) from both assessment models show good concurrence. Both models indicate a steady decline in total biomass from the early 1970s, an increase in the early 1980s attributable to the strong 1980 year-class, then a decrease to under 3,000 t in 1988. Total biomass has been recovering rapidly since then, and in 1999 was estimated as 36,210 and 27,633 t from the surplus production and VPA models, respectively. However, total biomass remains below the B_{MSY} (biomass at maximum sustainable yield) level, as indicated from the surplus production model (44,360 t). Biomass for ages 3+ (considered to reflect mature biomass) shows a similar trend and was estimated at 17,287 t at the beginning of 1999.



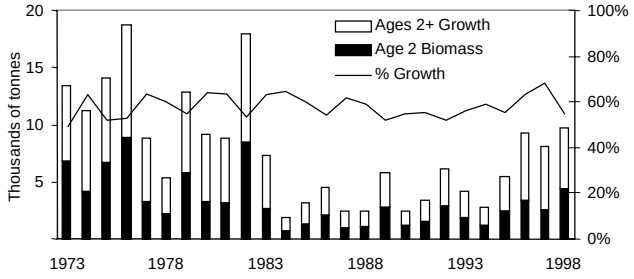
Recruitment estimates were derived from the VPA (1973 to 1998). Recruitment during the 1990s is slightly better than that observed during the 1980s. The 1997 year-class appears to be the third strongest in the series, but it was absent in one of the four indices (NMFS spring).



The VPA and surplus production models produce similar patterns of **exploitation rate** over time, and with respect to $F_{0.1}$ levels. For the production model, an approximation to $F_{0.1}$ was calculated, and is about 14%. The exploitation rate was well above the $F_{0.1}$ target during the 1983 to 1987 period, declined somewhat during the 1988 to 1994 period, and in 1995-1998 included the lowest values observed in the series. The VPA series indicates an increase in exploitation rate from 1997 to 1998.



Using the VPA results, it is possible to partition production into growth and recruitment components. From such an analysis, it appears that growth, on average, contributes about 60% to total production. The proportion contributed by growth has not varied significantly over time. When production is compared with yield from the fishery, it can be seen that since 1995, there has been considerable production in excess of fishery removals.



Sources of Uncertainty

Both assessment methods are subject to significant uncertainties. For the VPA, continued low levels of sampling and the absence of age information for the Canadian fishery removals have compromised the reliability of the results. The surplus production model attempts to describe long term population dynamics in a simple model. However, it is not clear whether past stock productivity will always be a good predictor of stock dynamics.

Outlook

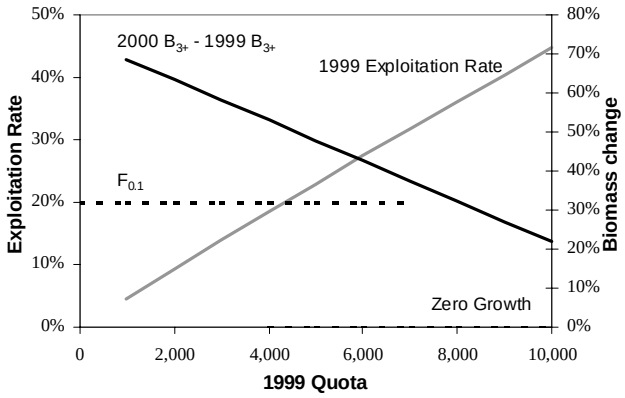
Since two assessment models were used, two projections are provided for a 1999 fishery.

	1999 Yield at $F_{0.1}$ or Equivalent	**1999 Total Biomass**	**2000 Total Biomass**
VPA	4383 t	27633 t	30838 t
Surplus Production	6836 t	36210 t	42620 t

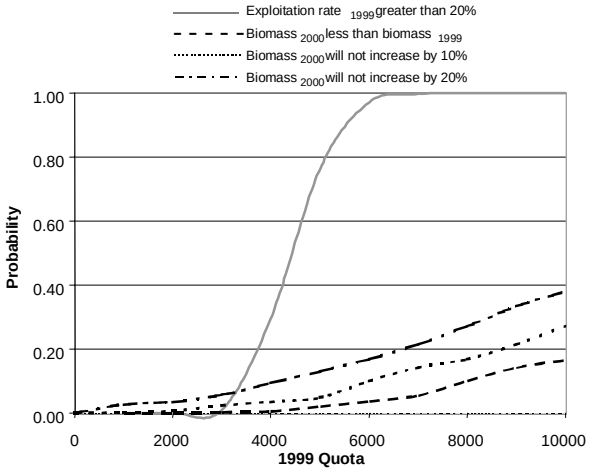
The 1997 year-class contributes about 13% of the expected yield in 1999, and about 42% of the total biomass.

The surplus production approach indicates a greater rate of population biomass increase than does the VPA. To achieve such growth, continued successive strong year-classes are implied. Since consecutive strong year-classes have not been evident in the recruitment series, the projections from the surplus production approach are considered optimistic. Therefore, the information presented below exploring the projection results focuses on the VPA results.

With $F_{0.1}$ combined Canada and USA catch of 4383 t, an increase in 3+ beginning of year biomass of about 50% is anticipated. However, as indicated earlier, much of the increase is dependent on the current estimate of the size of the 1997 year-class.



The probability of not achieving management objectives for population growth and exploitation rate from 1999 to 2000 was explored using projections from the VPA at various levels of yields in 1999.



With status quo Canada and USA catches of 3100 t, there is a small probability of

exceeding $F_{0.1}$, and a very high probability that total biomass will continue to increase.

The uncertainty calculations do not include variations in weights at age, partial recruitment to the fishery and natural mortality, or systematic errors in data reporting and model mismatch. Therefore, overall uncertainty will be greater than that shown here.

Management Considerations

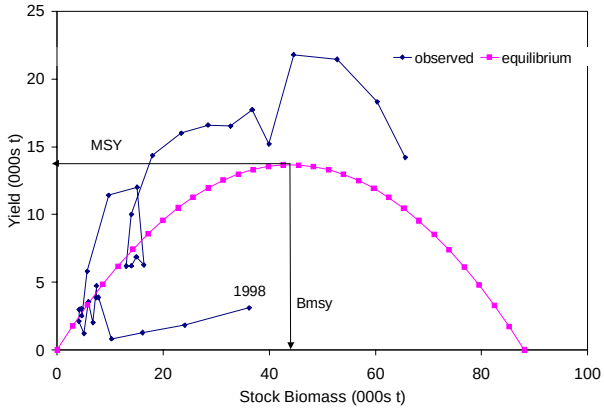
Last year's stock assessment indicated that a Canadian quota of 1,200 t in 1998 will result in a less than 10% probability of exceeding $F_{0.1}$ and a 50% chance of 20% growth in total biomass. The actual combined Canada/USA catch of 3,111 t in 1998 resulted in an exploitation rate of 18%, and the total biomass at the beginning of 1999 was 27,633 t, an 11% increase in total biomass.

The **proportion** of biomass in the Canadian portion of the management unit has generally been about 50%, as indicated by the five year averages from the DFO and NMFS spring and fall surveys. There is, however, considerable interannual variation in the proportion of biomass in Canadian waters.

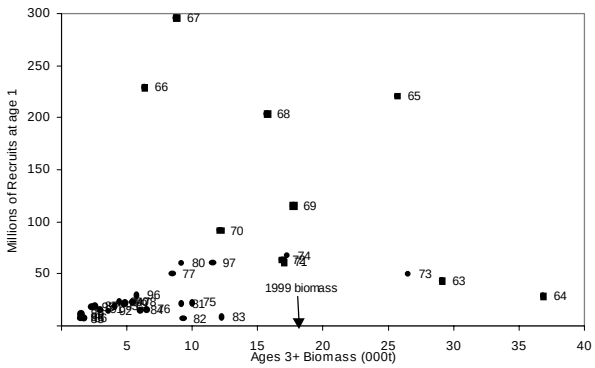
Percentage of biomass on Canadian side

	Spring		Fall
Year	DFO	NMFS	NMFS
1992	22	72	72
1993	64	64	82
1994	21	54	70
1995	40	71	51
1996	53	73	22
1997	25	86	49
1998	60	38	31
1999	39		
5-Yr Av.	43	64	45

The surplus production model allows a description of the potential yield from the resource at various biomass levels. The equilibrium relationship between yield and biomass is expected to be dome-shaped. As indicated below, recent management actions by both Canada and the USA have resulted in movement of the path of the relationship to the right, and continue to have the desired effect of rebuilding the population biomass.



There is evidence of reduced recruitment at low levels of age 3+ biomass. However, management actions by both countries appear to have been successful in building the population to levels where the probability of good recruitment is enhanced.



At present, Canada and the USA establish harvest levels for this resource that assume that the counterpart country limits its removals to the respective previously-established Canadian quotas or target USA TACs. Such assumptions have been shown to be inappropriate, given the dynamic nature of the stock and the non-restrictive nature of the target TAC. The lack of coordination between the two countries in setting country allocations creates the potential for excessive overall harvest levels to be established.

In summary, the yellowtail flounder resource is rebuilding on Georges Bank. Recent estimates of exploitation rate are below commonly used targets such as $F_{0.1}$. Both assessment approaches indicate increasing population biomass. Other measures of stock abundance such as fishery and survey size composition support the view that the resource is recovering.

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References

Neilson, John D. Gavaris, S. and P. Perley. 1999. Update of Stock Status of Yellowtail Flounder on Georges Bank. DFO Canadian Stock Assessment Secretariat Research Document 99/73.

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