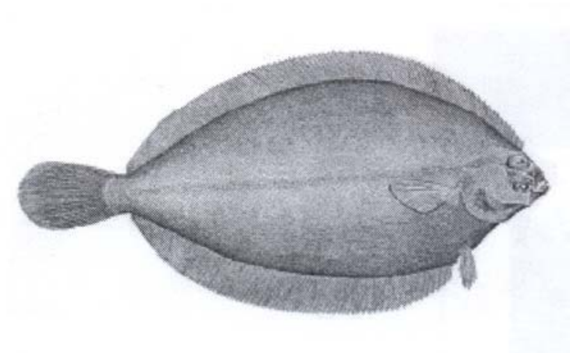
ASSESSMENT OF WITCH FLOUNDER IN THE GULF OF ST. LAWRENCE (NAFO DIV. 4RST)



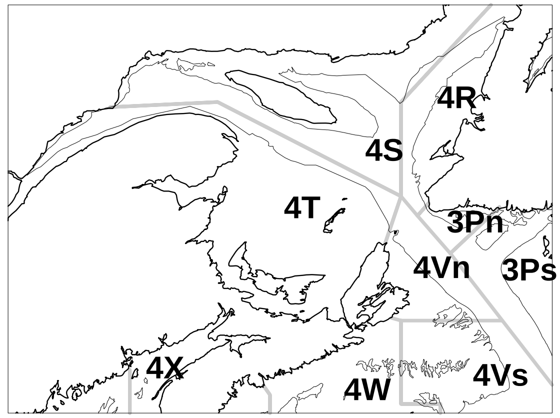


Figure 1: Gulf of St. Lawrence and adjacent areas showing NAFO Divisions.

Context

Commercial fisheries for witch flounder developed significantly with the introduction of otter trawling to Newfoundland in the 1940s. Stocks in the Gulf of St. Lawrence became exploited in the 1950s when declining stocks caused Danish seiners in Fortune Bay, Newfoundland (NAFO Division 3Ps) to move to St. George's Bay in 4R. A small directed fishery for witch developed in St. George's Bay during the summertime, with offshore, winter catches of witch gaining in importance as bycatch in cod- and redfish-directed fisheries. The witch fishery expanded in the Gulf from St. George's Bay during the 1970s to the Esquiman Channel and the northern shores of Cape Breton Island.

Witch flounder in the northern Gulf of St. Lawrence (NAFO Division 4RS) came under quota management in 1977, with a quota of 3500 t. In 1979, the Total Allowable Catch (TAC) on 4RS was increased to 5000 t to remove an old and slow-growing component of the stock. This measure succeeded in reducing the age composition of the stock; however, landings declined and by 1982, the TAC was reduced to 3500 t. The first detailed assessment of 4RS witch was conducted in 1978 and continued yearly until 1981. During the 1980s, 4T landings increasingly dominated Gulf witch landings; however, the management unit remained as 4RS. Stock assessments resumed in 1991 and following the recommendation of the Fisheries Resource Conservation Council in 1994, the management unit was extended to 4RST in 1995. The most recent full assessment of the status of this stock was conducted in February 2006 (Swain and Morin, 2006; SAR 2006/013).

SUMMARY

- In 2006, the TAC remained at 1000 t. Total landings were 960 t. Seine fleets directing for witch flounder caught or exceeded their quotas in both 4R and 4T.
- The research vessel (RV) survey biomass index for commercial sizes (30+ cm) over the entire 4RST area decreased to low values in the mid-1990s. The index increased to an intermediate level in 1999 and 2000 but has declined since then.
- In contrast to other areas of the Gulf, the RV biomass index for eastern 4T was at a relatively high level in the late 1990s and early 2000s, though it has declined since then.

- Unlike the RV surveys, sentinel surveys of the northern Gulf (primarily 4R and 4S) provide no indication of an increase in biomass in the late 1990s nor of a decrease in recent years. Indices from these surveys have tended to increase in recent years.
- Juvenile growth currently appears to be very slow compared to the growth rates reported for this stock in the early 1980s.
- Since the early 1990s, juvenile abundance has been high compared to the late 1980s. A strong year-class has been observed in the RV survey of the northern Gulf since 1997 and has now recruited to commercial sizes. However, it has not resulted in the anticipated increase in adult biomass.
- The abundance of large fish over 45 cm in length appears to be very low compared to the abundance in the 1970s and early 1980s.
- Recent trends in biomass are uncertain. The RV index has declined but the sentinel indices have tended to increase.
- Little trend in fishing mortality is evident from 1987 to 2006. Biomass changes over this period do not appear to be attributable to effects of fishing alone.
- It is not clear whether landings at the current level near 1000 t are sustainable at this stock's current low level of productivity.

BACKGROUND

Species Biology

Witch flounder (*Glyptocephalus cynoglossus* L.) are found in the deeper waters of the North Atlantic. In the Northwest Atlantic, witch range from the lower Labrador coast to Cape Hatteras, North Carolina. Relative to other flounders, witch are slow-growing and long-lived. Spawning occurs from spring to late summer, depending on the region, and in the Gulf of St. Lawrence (NAFO Division 4RST), spawners aggregate in channel waters in January and February. Spawning in the Gulf is believed to occur in deep water in late spring or early summer. The females are highly fertile, releasing as many as 500,000 eggs in a single spawn. In the late 1970s and early 1980s, 50% of females reached maturity at lengths of 40-45 cm (9-14 years of age) and 50% of males matured at lengths of 30-34 cm (5-8 years of age, Bowering and Brodie 1984). The fertilized eggs float and hatching occurs after several days, followed by a lengthy pelagic stage that may last a year. Juveniles eventually settle to the bottom in deep waters. In northern areas of their range, including the Gulf of St. Lawrence, witch flounder move into deep water during winter months and cease feeding. Witch grow faster in the Gulf of Maine and Georges Bank, where water temperature is higher and feeding occurs year-round.

Fishery

Landings and TAC's (thousand tonnes)

Year	Average 1981-90	Average 1991-99	Average 2000-02	2003	2004	2005	2006*
TAC	3.7	1.8	1.0	1.0	1.0	1.0	1.0
Landing	1.8	0.7	0.9	0.7	0.7	0.9	1.0

* Preliminary statistics
(TAC in 2000-2006 for May 15 to May 14 of the following year)

Landings of witch flounder in NAFO Divs. 4RST exceeded 3000 t in most years from 1960 to 1980 (Fig. 2). Landings declined to 1100 t in the early 1980s. Following an increase to about

2500 t in the late 1980s, landings again declined in the 1990s, reaching very low levels in 1994 to 1997. The decline in the mid-1990s reflected very low landings from 4R. Landings from 4R increased in 1998, when total landings increased to the level of the TAC. Landings remained near the TAC until 2003 when they declined to 65% of the TAC. Total landings in 2004 were 750 t, 75% of the TAC. In 2004, seine fleets directing for witch flounder caught their quota in 4R, but only 74% of their quota in 4T. Landings rose to 930 t in 2005 and 960 t in 2006, when seine fleets directing for witch flounder caught or exceeded their quota in both 4R and 4T.

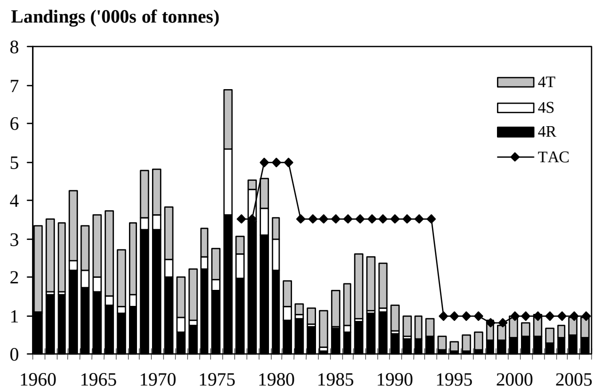


Figure 2. Landings and TAC of 4RST witch flounder.

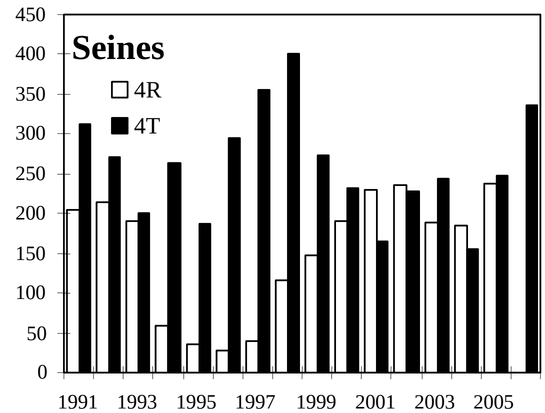


Figure 3. Fishing effort (days) by seines directing for witch flounder. Data not available for 4R in 2006.

Since the mid-1980s, landings have been mostly by seiners directing for witch flounder between May and October in St. George's Bay, Newfoundland (4Rd) and off the west coast of Cape Breton Island (4Tf and 4Tg). The drop in landings in the 4R area in 1994-1997 reflected a sharp decline in fishing effort in this area (Fig. 3). In this period, a high incidence of crab gear interfered with the fishery for witch flounder in 4R in early summer, a period when fishing effort was traditionally high. Fishing effort in 4R increased again in 1998, as did the landings. The seine fleet in 4R caught its quota each year from 1998 to 2006, except for 2003.

Since the mid-1990s, the fishery for witch flounder in 4T has opened later than usual. This has prevented fishing during spring periods when catch rates have traditionally been high. Despite late openings, the 4T fleet caught all or most of its quota in 2002-2006, except in 2004. In 2004, the late opening in the spring combined with bad weather in the fall prevented the 4T fleet from catching its quota.

In recent years, landings of witch flounder have been primarily of fish between 30 and 45 cm in length (Fig. 4). This is similar to the size composition of landings since the mid-1990s, but much smaller than the sizes landed in the mid-1970s and early 1980s.

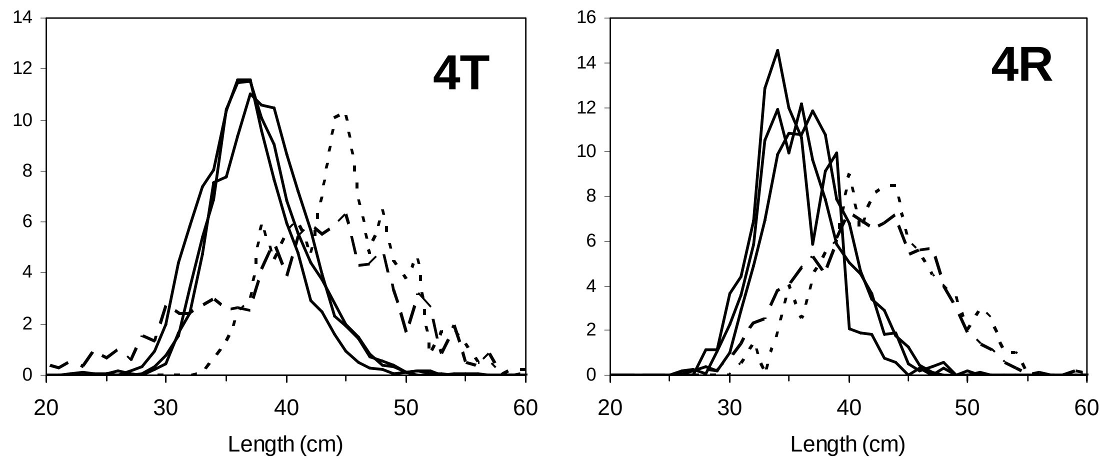


Figure 4. Length distribution (%) of witch flounder landings in recent years (2001, 2003, 2005; solid lines) compared to those in the mid-1970s (dotted line) and early 1980s (dashed line).

ASSESSMENT

Stock Trends and Current Status

A biomass index for commercial sizes (30+ cm) of witch flounder in 4RST has been calculated for 1987-2006 by combining data from annual **research vessel (RV) surveys** conducted in the southern Gulf each September and in the northern Gulf each August. Adjustments are made for changes in vessel or gear based on comparative fishing experiments (except for the 2003 September survey which was conducted by an uncalibrated vessel). The adjusted index (the catch per tow expanded to the area surveyed) should reflect changes in witch flounder biomass over time but should not be taken as a measure of the actual biomass present in the area.

A sharp decline in witch flounder biomass occurred in the Gulf (4RST) from 1990 to 1993 (Fig. 5). The index of biomass remained at a low but steady level from 1993 to 1998. It increased to an intermediate level in 1999 and 2000 but has decreased since then. The increase in biomass in the late 1990s and early 2000s was primarily due to increased abundance of fish under 40 cm in length. Biomass of fish 40 cm and longer was at a low level from 2004 to 2006.

Changes in biomass have not occurred uniformly throughout the 4RST area (Fig. 6). The biomass index declined in 4R, 4S and western 4T but not in eastern 4T. Biomass has remained low in 4S and western 4T. In the late 1990s and early 2000s, biomass was relatively high in eastern 4T, though it has declined in recent years. In 4R, biomass has increased from the very low 1993 level to a moderate level since about 2000.

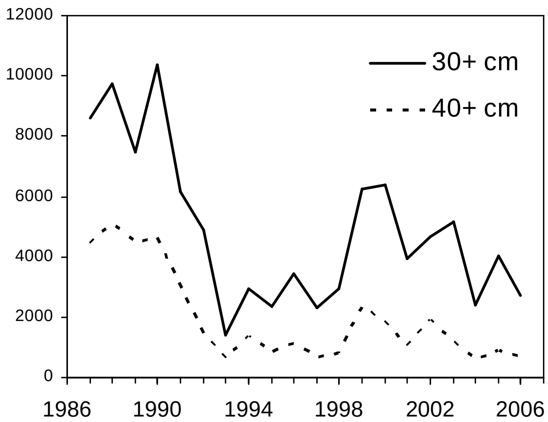


Figure 5. Biomass index for commercial sizes of witch flounder.

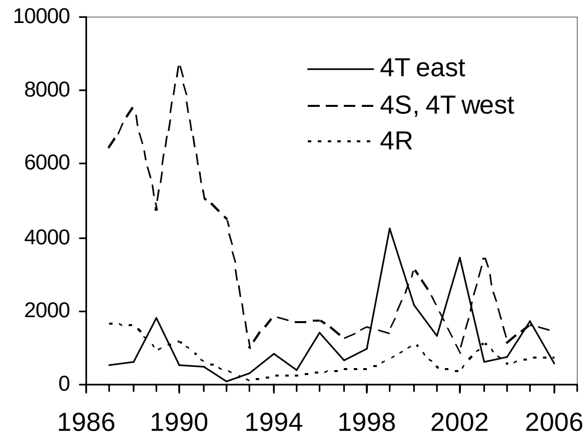


Figure 6. Biomass index for witch flounder in three regions of the Gulf of St. Lawrence.

The geographic distribution of catches in the RV surveys in 2006 was typical of the pattern seen in recent years, with catches highest in the Cape Breton Trough off northwestern Cape Breton (Fig. 7). Relatively high catches also occurred in the St. Lawrence Estuary and along the southern slope of the Laurentian Channel. Catches on the shelf off western Newfoundland were lower than in recent years.

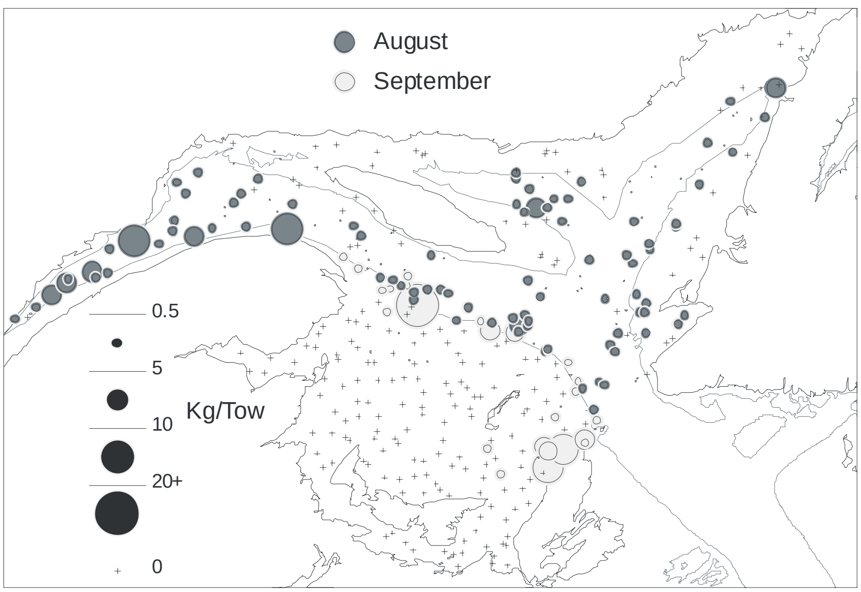


Figure 7. Geographic distribution of witch flounder in the summer RV surveys of the Gulf of St. Lawrence

Pre-recruit abundance (fish 16 – 29 cm in length) has tended to be higher since 1991 than in the late 1980s (Fig. 8). Catches in the September survey of the southern Gulf, conducted since 1971, provide a longer term perspective. The composition of catches in this survey has shifted to much smaller sizes in the last decade compared to the first decade of this survey (Fig. 9). Fish under 30 cm in length are now common in this survey, but were very rare in catches in the 1970s. In contrast, fish over 45 cm in length were abundant in the 1970s catches but are now very rare in the survey.

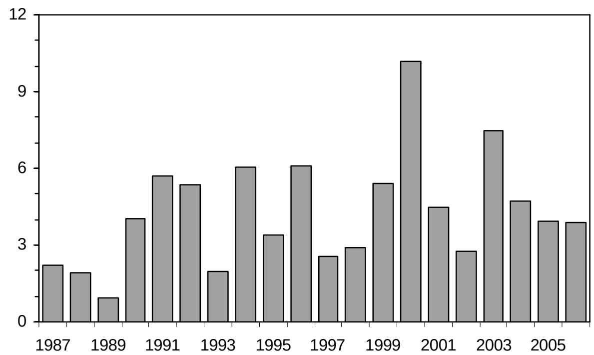


Figure 8. Pre-recruit abundance (mean number per tow, 16-29 cm in length) in RV surveys of the Gulf of St. Lawrence.

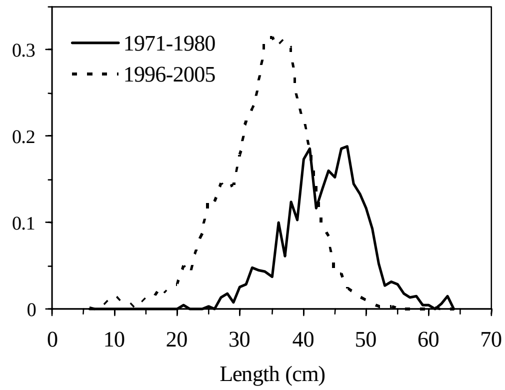


Figure 9. Length composition (mean number per tow) of catches in the September RV survey of the southern Gulf of St. Lawrence in two periods.

Catches in the August RV survey suggest the appearance of a strong year-class in the late 1990s (Fig. 10). The progression of this year-class through the survey length distribution indicates that juvenile growth is now very slow compared to that reported for the early 1980s (Bowering and Brodie 1984). This year-class has now recruited to commercial sizes and has not resulted in the anticipated increase in adult biomass.

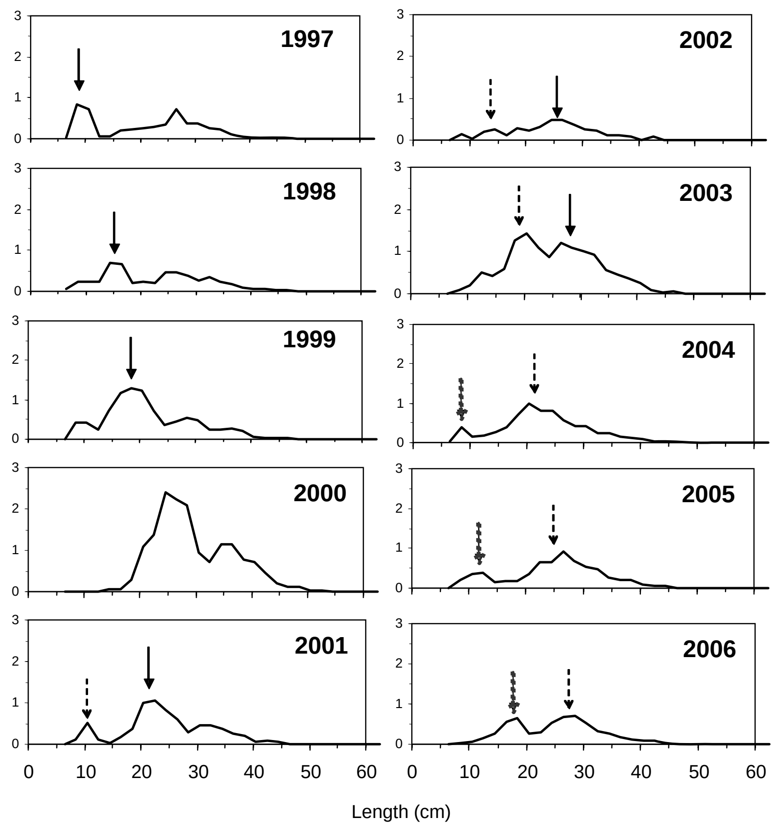


Figure 10. Length composition (mean number per tow) of catches in the August RV survey of the northern Gulf of St. Lawrence. The three different arrows mark the progression of year-classes through the length frequencies. Different line types indicate different year-classes. Interpretation of the length distribution in 2000 is unclear.

Stratified random **sentinel surveys** have been conducted in the northern Gulf of St. Lawrence in July since 1995 and in the southern Gulf in August beginning in 2003. These surveys provide a second view of witch flounder distribution over much of the management unit, though they do not cover the Estuary west of about 67°W, an area where RV catch rates are often high. As in the RV surveys, juveniles comprise a higher proportion of catches in the northern Gulf sentinel survey than in the southern Gulf survey, reflecting its greater coverage of juvenile habitats. However, vulnerability of small fish is lower to the sentinel survey gears than to the RV survey gears and few fish smaller than 20 cm are caught in the sentinel surveys.

In the 2006 sentinel surveys, the largest catches of witch flounder occurred in the Cape Breton Trough and in St. George's Bay, southwestern Newfoundland (Fig. 11). Large catches also occurred in other areas on the shelf along the west coast of Newfoundland and along the southern slope of the Laurentian Channel.

Catch rates in the July sentinel survey reveal no clear trends in witch flounder biomass in the northern Gulf between 1995 and 2006 (Fig. 12). The high catch rate in the 1997 survey is due to a single tow. The increase in biomass suggested by including this tow in the index is not supported by the mean catch rates in subsequent years. In contrast to the RV surveys, catch rates in the July sentinel survey provide no indication of an increase in biomass in the late 1990s nor of a decrease in recent years, though this may reflect differences in the area covered or in the lengths included in the index. Both the July and August sentinel catch rates show an increasing trend in recent years.

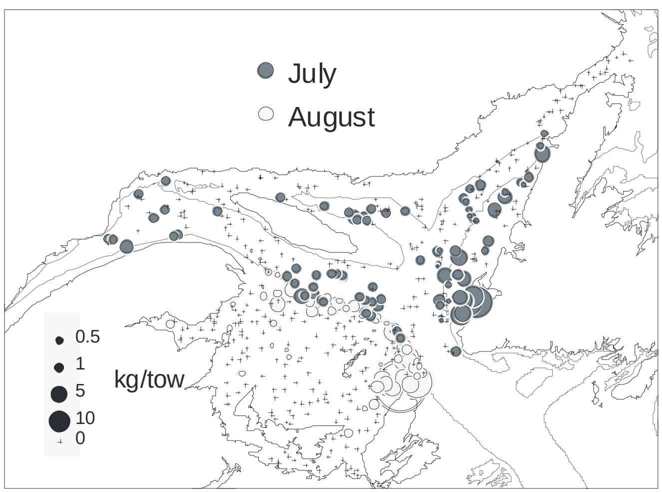


Figure 11. Geographic distribution of witch flounder in the summer sentinel surveys of the Gulf of St. Lawrence.

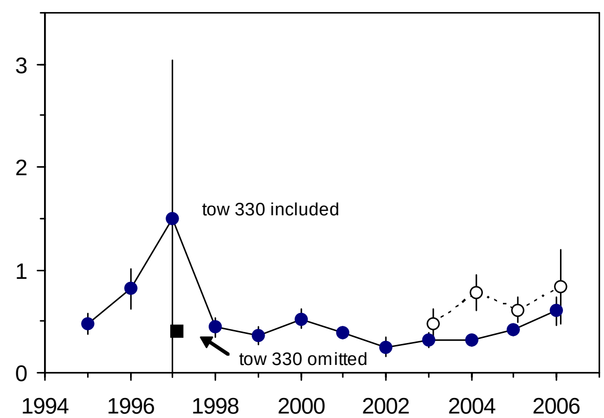


Figure 12. Mean catch rates (kg/tow) in the July sentinel survey of the northern Gulf (closed circles) and the August sentinel survey of the southern Gulf (open circles). Vertical lines are ± 1 standard error.

Fishery catch divided by survey estimates of abundance (mean catch per tow expanded to the survey area) provides an index of fishing mortality termed relative *F*. Relative *F* does not provide an estimate of the magnitude of fishing mortality (because catchability to the survey is not 100%), but should reveal changes in fishing mortality over time. No strong trends in fishing mortality are evident over the 1987 – 2006 period, though relative *F* has tended to increase in recent years (Fig. 13). In the 2006 assessment, exploratory population models also suggested that there have been no strong trends in fishing mortality over this period. This suggests that the changes in biomass evident for this stock cannot be attributed to effects of fishing alone.

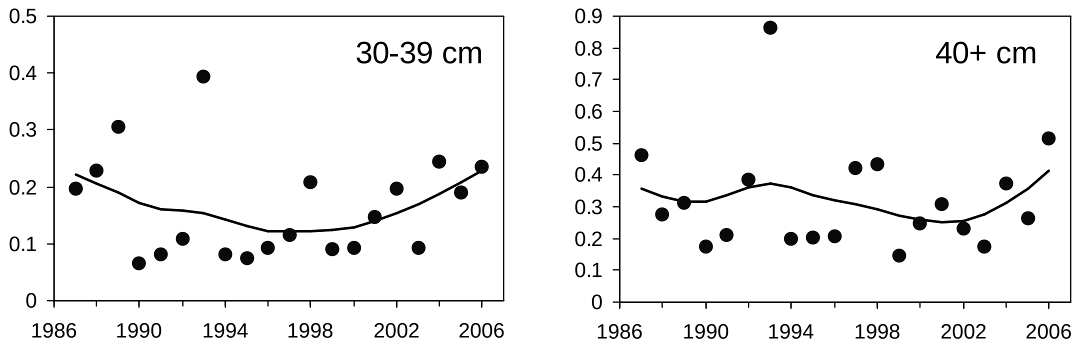


Figure 13. Relative fishing mortality for two length classes of witch flounder in the Gulf of St. Lawrence. The line is a smoothed fit to the annual estimates.

Sources of Uncertainty

Fishing efficiency for witch flounder varies substantially between day and night and among the vessels and gears used to conduct the summer research surveys. Adjustments have been made for these changes in fishing efficiency using calibration factors estimated from comparative fishing experiments. However, there is uncertainty around these estimated factors.

The availability of ageing information would allow estimates of growth and mortality rates.

Stock structure is a source of uncertainty for this resource, affecting the interpretation of the regional differences observed in biomass trends in the Gulf. Biomass declines in the early 1990s were restricted to 4R, 4S and western 4T. Survey catch rates in eastern 4T (primarily in the Cape Breton Trough) have tended to be high since the mid-1990s. If witch flounder comprise a single stock over the 4RST area, these high catch rates in the Cape Breton Trough reflect a shift in distribution, with an increased proportion of the stock concentrated in this part of their range. On the other hand, witch flounder in the Cape Breton Trough may be linked to those in NAFO Divs. 4VW. A number of exceptionally strong year-classes have been produced on the Scotian Shelf in the 1990s, perhaps contributing to the increase in abundance of larger witch flounder in the Cape Breton Trough.

Strong year effects (both positive and negative) have been evident in the RV surveys in recent years. This makes it more difficult to discern trends in abundance.

Recent trends in biomass are uncertain. The RV index has tended to decline since 2001, but the sentinel indices have tended to increase since 2003.

The population dynamics of this stock are poorly understood. Recent juvenile growth appears to be unusually slow, but the reasons for this are not known. High juvenile abundance has not resulted in increases in adult biomass, and the abundance of large fish is low compared to earlier periods. Large changes in biomass have occurred between periods of relatively stable biomass, even though fishing mortality has remained roughly constant over this time period.

CONCLUSIONS AND ADVICE

The survey biomass index for commercial sizes of witch flounder declined sharply from a relatively high level in 1987-1990 to a relatively low level in 1993-1998. Biomass increased to an intermediate level in 1999 and 2000, but appears to have been slowly declining since then. No changes in fishing mortality are evident from the late 1980s to the early 2000s, suggesting that additional factors (e.g., changes in productivity) are involved in these biomass changes.

Productivity of this stock appears to currently be low. Juvenile growth is slow compared to the early 1980s. Large fish over 45 cm are rare compared to their abundance in the 1970s and 1980s. A strong year-class evident in survey catches since the late 1990s has now recruited to commercial sizes but has not resulted in the anticipated increase in adult biomass.

Current fishery removals are less than a third of those sustained by this stock throughout the 1960s and 1970s. Nonetheless, the RV biomass index for commercial-sized witch flounder, which had improved in the late 1990s, now appears to be slowly declining. On the other hand, the sentinel survey biomass indices have tended to increase in recent years. It is unclear whether landings at the current level near 1000 t are sustainable at the current productivity of this stock.

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