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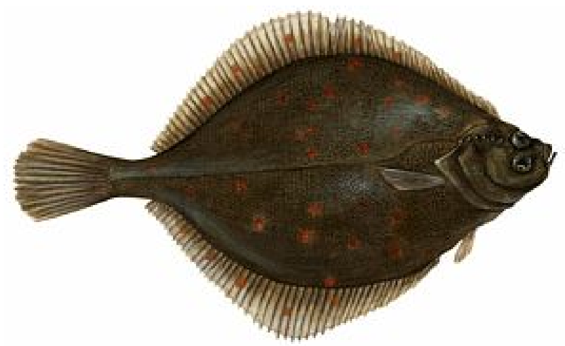
Gulf Region

Canadian Science Advisory Secretariat
Science Advisory Report 2017/022

STOCK ASSESSMENT OF WINTER FLOUNDER (*PSEUDOPLEURONECTES AMERICANUS*) OF THE SOUTHERN GULF OF ST. LAWRENCE (NAFO DIV. 4T) TO 2016



Winter Flounder (Pseudopleuronectes americanus)

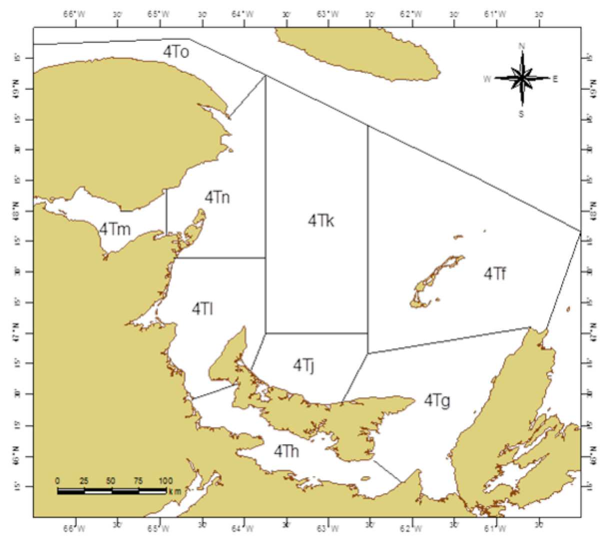


Figure 1. Subdivisions within NAFO Div. 4T in the southern Gulf of St. Lawrence.

Context:

Winter Flounder (Pseudopleuronectes americanus) range from southern Labrador to Chesapeake Bay (Scott and Scott, 1988). In the southern Gulf of St. Lawrence (NAFO Div. 4T), Winter Flounder tend to be distributed in shallow, near shore areas where it is fished primarily for bait. A total allowable catch was first instituted in 1996 at 1,000 t. The most recent assessment dates to 2011 (DFO 2012; Morin and Swain 2012. Following that assessment, the TAC was reduced to 300 t and has been in effect for the period 2012 to 2016. DFO Ecosystems and Fisheries Management has instituted a multi-year management approach for Winter Flounder and requested advice for a TAC decision for May 2017 to May 2022 for the southern Gulf of St. Lawrence Winter Flounder stock.

This Science Advisory Report is from the March 1, 2017 science peer review meeting on the Stock status and fishery advice for May 2017 to May 2022 for Winter Flounder from NAFO Division 4T, southern Gulf of St. Lawrence. Participants at the meeting included DFO Science (Gulf, Newfoundland and Labrador regions), DFO Fisheries Management (Gulf, Quebec regions), the fishing industry, and a non-governmental organization.

SUMMARY

- Winter Flounder is currently caught in a relatively small directed fishery concentrated mainly around the Magdalen Islands with landings ranging from 190 to 320 tonnes over the past 10 years. Preliminary landings in 2016 were 192 tonnes.
- In samples of catches in the September Research Vessel survey, there has been a decrease in the size distribution of the Winter Flounder stock with percentages of fish >= 25 cm (minimum size limit for the fishery) decreasing from an average of 85% in 1971 to 1975 to 30% during 2011 to 2015.
- Estimates of spawning stock biomass (SSB) were highest in the period from 1975 to 1994 at an average of 356,100 t (median). Over the recent period, the SSB estimate has declined to 235,700 t in 2003 and 76,270 t in 2016. The proportion of the SSB represented by older fish (5+) has also decreased over time, from 63% in the 1970s and early 1980s to 39% since 2010.
- Based on a population model, the estimates of natural mortality have recently increased for young fish (ages 2 to 4) and continually increased for older fish (aged 5+). The rates are high for ages 5+ and increasing from 0.68 at the start of the time series in 1973 to greater than 1 (63% annual mortality) recently.
- The instantaneous fishing mortality rate is estimated to be low to very low for all ages with maximum fishing rates over the series of 0.05 for ages 8+. Overall, the fishing mortality rate is very low compared to the estimated natural mortality rate.
- A limit reference point (LRP; 147.8 thousand tonnes), based on a proxy value for biomass at maximum sustainable yield (B_{msy}), was defined as the average biomass over a productive period from 1973 to 1994. This period was chosen because the SSB was high and the SSB comprised an important number of older and larger fish. The stock is considered to have been below the LRP since 2006. In 2016, the estimated SSB was 54% of the LRP.
- Projections at catch levels of 0 t, 100 t, and 300 t show no perceivable difference in stock trends over the next five years. Fishing mortality is a very small proportion of the total mortality of Winter Flounder in the southern Gulf of St. Lawrence and natural mortality is estimated to be the dominant factor affecting abundance.
- The contraction in size structure of Winter Flounder, the decline in the estimated size at 50% maturity, and the decline in abundance indices of the previously abundant commercial sized group are consistent with a stock experiencing very high levels of mortality.

INTRODUCTION

Winter Flounder (*Pseudopleuronectes americanus*) is a widely distributed flatfish found in the Northwest Atlantic, from Labrador southward to Georgia. Inhabiting mainly shallow coastal waters, Winter Flounder in the southern Gulf of St. Lawrence (NAFO division 4T) are limited to the Magdalen Islands and the southern parts of the Gulf: the Chaleur Bay, the Shediac Valley-Miramichi area, Northumberland Strait, and St. George’s Bay. It can tolerate a wide range of water temperatures and is capable of inhabiting sub-zero water conditions due to serum antifreeze proteins that lower the freezing point of their blood to about -1.4°C. Winter Flounder does not leave the Gulf in winter or migrate to deep water; it overwinters in estuaries or coastal areas as well as at intermediate depths on the Magdalen shallows.

Winter Flounder is a relatively small flatfish. Asymptotic mean length from southern Gulf of St. Lawrence sampling is 36 cm and the maximum size of Winter Flounder sampled from the research vessel surveys dating to 1971 was 49 cm. It is relatively short lived with a maximum age estimated from samples of 15 years. Spawning occurs in late winter or early spring. Female Winter Flounder release several hundreds of thousands of eggs which adhere to rocks and vegetation. The larvae drift in surface waters before metamorphosis. Winter Flounder feed opportunistically on a variety of benthic organisms, mainly mollusks and small crustaceans. They also feed on the eggs of other spawning fish, in particular capelin and herring.

Fisheries

Winter Flounder landings in NAFO Div. 4T have varied widely, from peaks of 4,500 t in 1965 to less than 500 t since 2002 (Fig. 2). Preliminary landings for the 2016 fishery are 192 t, far below the long-term average of 1,481 t. In previous assessments, the variable pattern annual landings of Winter Flounder in NAFO Div. 4T were attributed in part to unreliable catch statistics. Prior to 1985, a considerable portion of flatfish landings in the southern Gulf was not identified to species or incorrectly identified and the landings of Winter Flounder may be incomplete in some years, as for example in 1984 (Fig. 2). Since 2012, the fishery has a total allowable catch (TAC) of 300 t. The fisheries management annual cycle to which this TAC applies begins on May 15 of a year and ends on May 14 of the following year. The landings reported in Figure 2 are for the calendar year and the values may not fully correspond to those of specific management years.

Winter Flounder in the sGSL has been fished primarily for bait, which has shaped the development of the fishery. From 2001 to 2012, an experimental bait fishery prosecuted mainly by lobster boats using small trawls fishing inshore developed in the Magdalen Islands catching Winter Flounder, Yellowtail Flounder and Windowpane. Landings in this fishery peaked during 2009 to 2011 at 122 t and landings have declined in recent years to 10 t or less (Fig. 2).

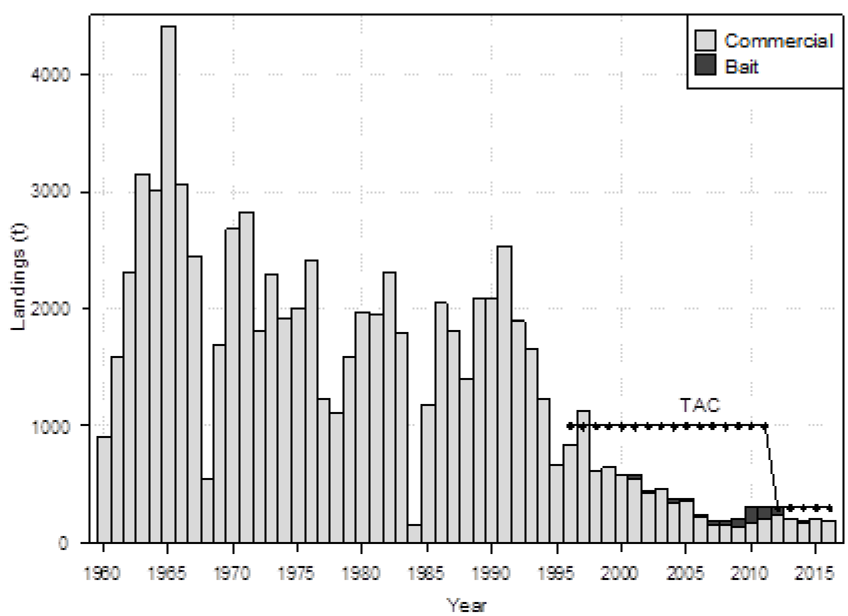


Figure 2. Winter Flounder landings from 1960 to 2016. The annual total allowable catch (TAC) is shown as the diamond-dotted line. Black shaded bars show the Magdalen Island bait fishery component. Landings for 2016 are preliminary.

In 1991, it became a license condition for mobile gear captains to maintain a logbook. In addition in 1995, mobile gear logbooks began to indicate Winter Flounder as a landed species.

Logbooks in previous years included a column indicating “flounder” which was frequently used to indicate the weight of mixed flatfish catches.

For the time series with available data, 1991 to 2015, the catches of Winter Flounder have shifted from a general distribution within NAFO Div. 4T to being increasingly concentrated around the Magdalen Islands (area 4Tf). Since 2009, catches around the Magdalen Islands have represented over 75% of the total reported landings in NAFO Div. 4T (Figs. 3 and 4). There has also been a shift in the timing of the fishery landings, from a predominantly summer and fall fishery in the mid-1990s to a predominantly May and June fishery in the past decade (Fig. 3). In 2015, a third of landings were made in July (Fig. 3). The shift to early fishing coincided with the concentration of Winter Flounder fishing off the Magdalen Islands.

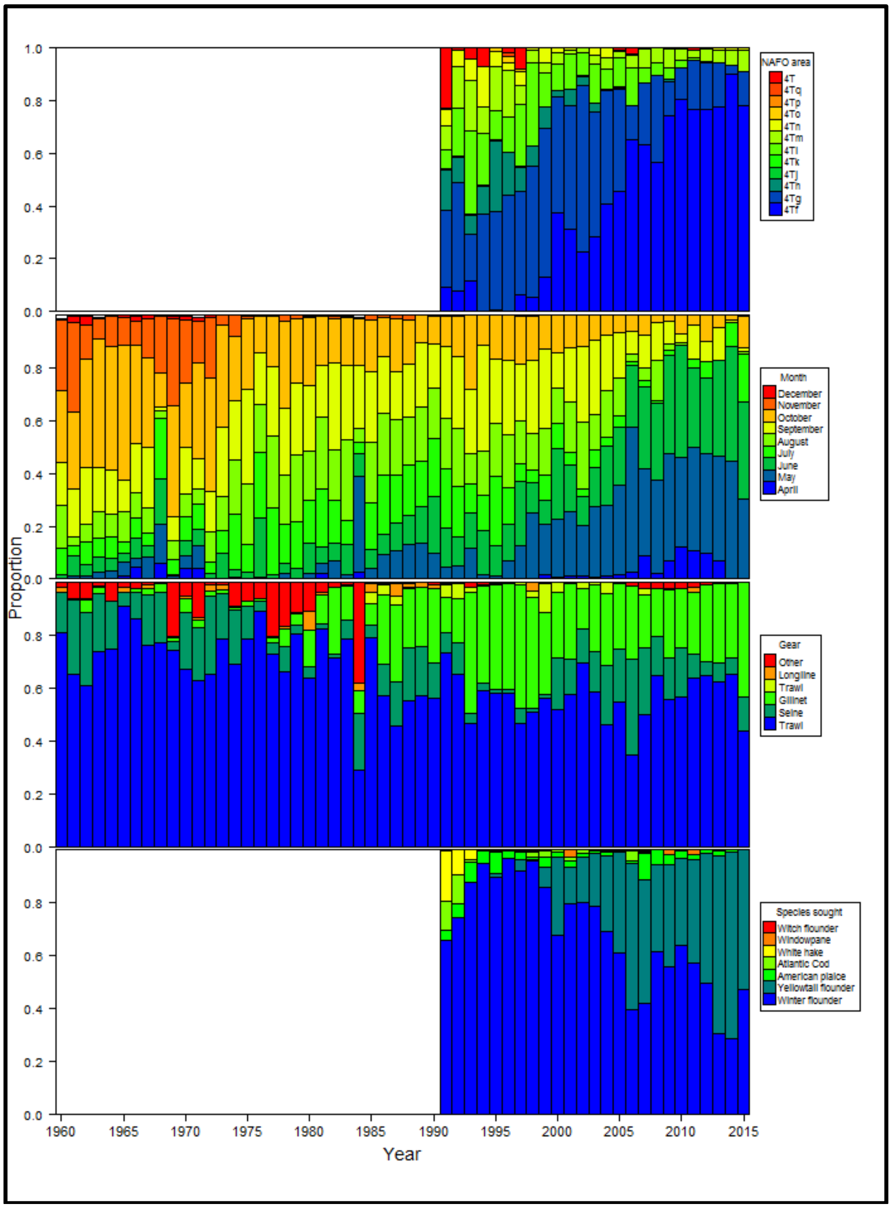


Figure 3. Proportion of annual landings of Winter Flounder by NAFO 4T subdivision (first panel, top), by fishing month (second panel), by type of fishing gear (third panel), and by reported target fish species (fourth panel, bottom), 1960 to 2015. NAFO data are used for 1960 to 1990 and ZIFF data for 1991 to 2015.

Otter trawls have been the dominant gear used to capture Winter Flounder in the commercial fishery. Gillnets increased in importance from the mid-1980s due to the increasing use of "tangle nets" (gillnets with flotation removed). Since about 2000, Winter Flounder catches have increasingly been reported in fisheries targeting Yellowtail Flounder (Fig. 3)

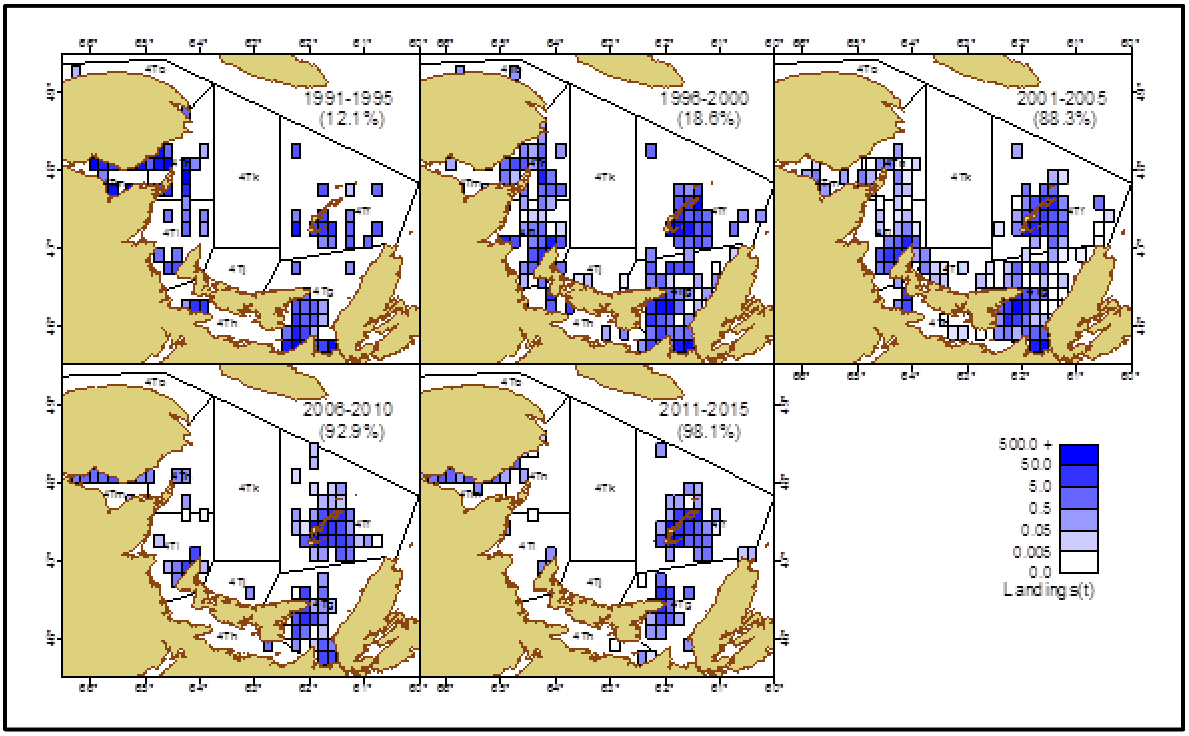


Figure 4. Spatial distribution of Winter Flounder catches as reported in logbooks by five-year periods. Shown in each map is the percentage of reported landings with geographic coordinates for each period. Geographically referenced landings were scaled to total landings for display purposes.

Maximum sizes of Winter Flounder in the fishery were greater early in the time series. Until 1990, maximum size was mostly between 45 and 55 cm. The decline in size of Winter Flounder in the catch is noted in the declining value of the 97.5^{th} percentile of measured fish lengths (Fig. 5).

The size limit for Winter Flounder in the sGSL fishery has been 25 cm since 1995. Length frequency sampling of Winter Flounder catches show a large increase in the catches of smaller fish beginning in 2000, with the proportion of catches below 25 cm peaking at about 40% in 2010 and 2011 and decreasing since (Fig. 6).

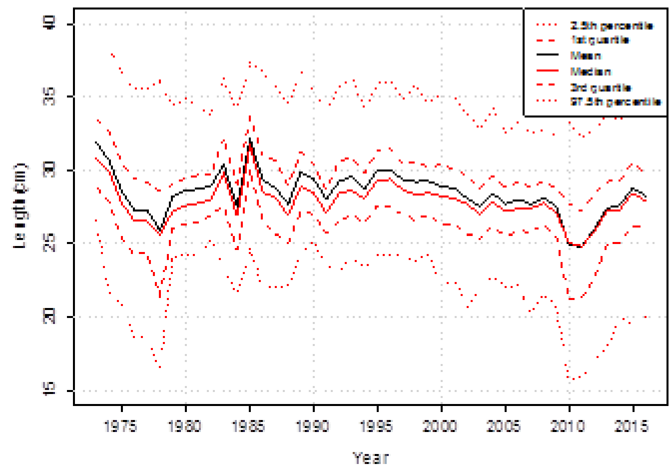


Figure 5. Length distribution statistics for Winter Flounder from the NAFO Div. 4T commercial catches, 1973 to 2016.

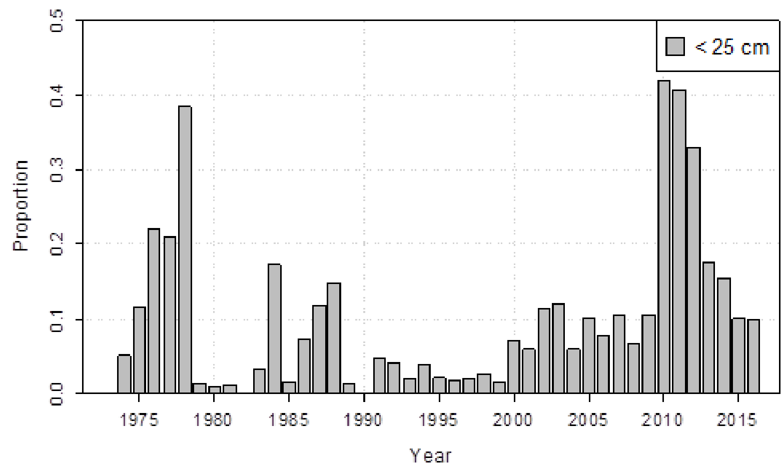


Figure 6. Proportion of Winter Flounder measuring less than 25 cm in sampled commercial catches from NAFO Div. 4T, 1974 to 2016.

Catch at Age

Figure 7 shows the estimated catch-at-age from the commercial fisheries for 1973 to 2016. These were calculated by applying the smoothed age-length key derived from the September survey to the commercial catch-at-length estimates described in the previous section. Though the scales of catches have changed a lot through time, the proportions-at-age have not. The modal age has not varied much through time except for 2010 to 2012 which reflects the smaller sizes in the fishery catches during those years. The fishery harvests mainly ages 5 through 9, with maximum ages of 12 years.

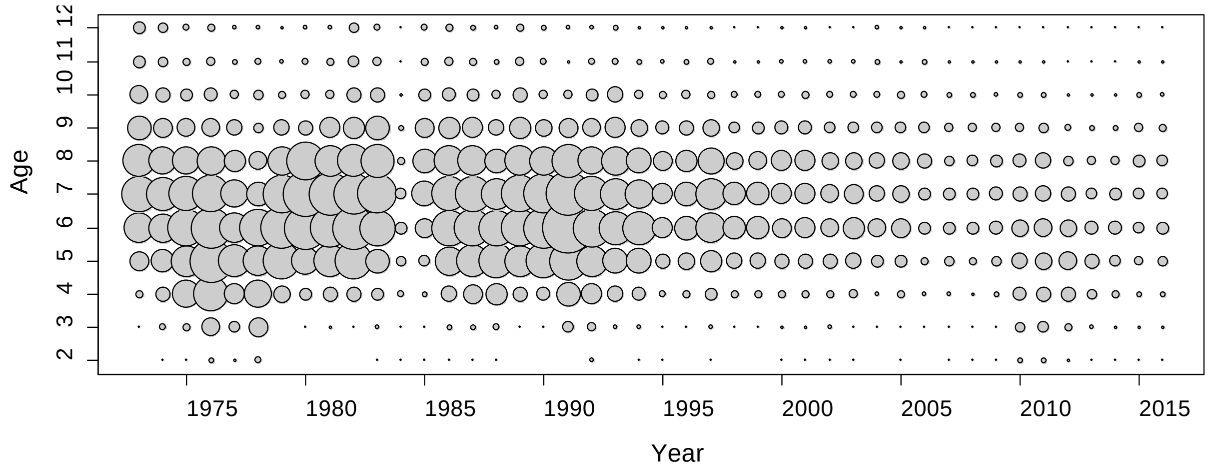


Figure 7. Estimated catches (numbers in millions) at age (years) of Winter Flounder in commercial fisheries (all gears) of NAFO Div. 4T, 1973 to 2016. Age 12 represents a plus group. Circle area is proportional to catch amount.

ASSESSMENT

An annual multi-species bottom trawl research vessel (RV) survey has been conducted in the sGSL using standardized protocols each September since 1971. In addition, a sentinel August otter trawl survey has been conducted since 2003. Results of these surveys provide information on trends in abundance and biomass as well as size and spatial distribution for groundfish species in the sGSL.

The September RV survey of the sGSL follows a stratified random sampling design. The same stratification scheme has been used since 1971, except for the addition of three inshore strata (401-403) in 1984, which were not included in the following results to have a constant survey area over the entire time series. Comparative fishing experiments were conducted to test for species-specific changes in fishing efficiency whenever there was a change in research vessel (1985, 1992, and 2004 to 2005) or trawl gear (1985). Furthermore there was a change from day-only to 24-hr fishing in 1985, and both comparative fishing experiments and analyses of survey catches have been undertaken to estimate any species-specific changes in fishing efficiency that resulted from this change in protocol. When a change in fishing efficiency was detected for a particular species, catch rates for that species were standardized to a constant level of efficiency so that indices remained comparable for the entire time series (Benoît and Swain 2003; Benoît 2006).

Size and Age

Length-frequencies from the RV survey show a marked reduction in the size of Winter Flounder in the survey catches (Fig. 8). Modal lengths were between 27 and 31 cm during the early portion of the survey (1971 to 1985), decreased to 24 cm from the mid-1980s to the early 2000s, and to between 18 and 20 cm in the past 16 years (Fig. 8). The proportion of Winter Flounder larger than 25 cm has gradually decreased from a peak of 86% in 1971 to present levels of 31% for 2011 to 2015 and 20% for 2016 (Fig. 9).

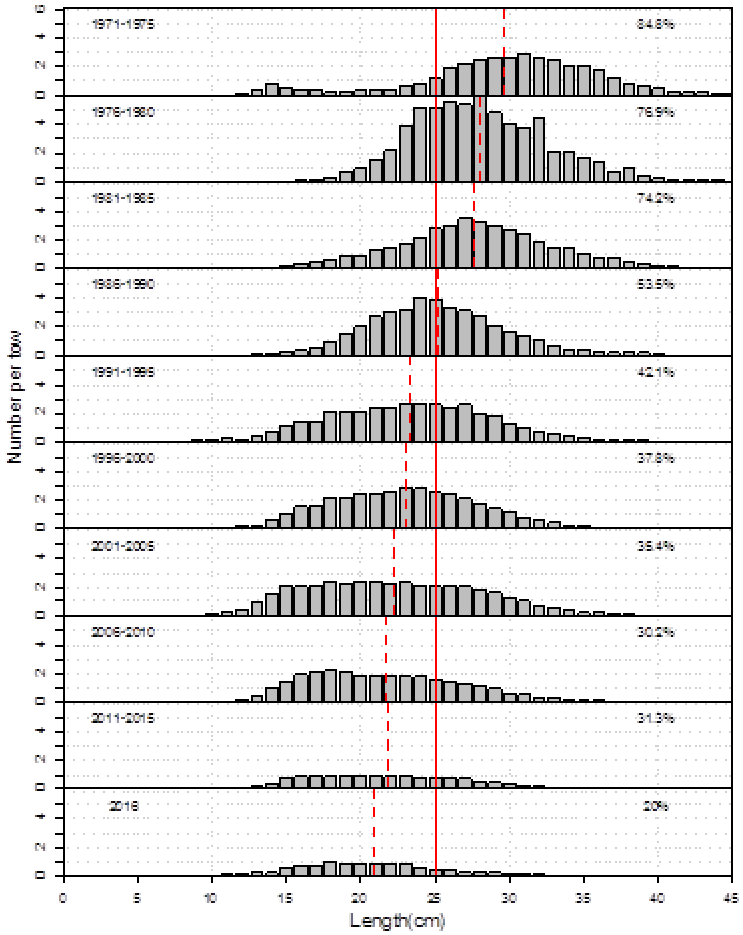


Figure 8. Length (cm) frequency distributions (number of fish per tow) of Winter Flounder from the September research vessel survey of the southern Gulf of St. Lawrence in five year blocks, 1971 to 2016. The solid red vertical line shows the commercial-size limit (25 cm), the dashed red line shows the mean length over the period, and the labels are the percentages of the catches >= 25 cm.

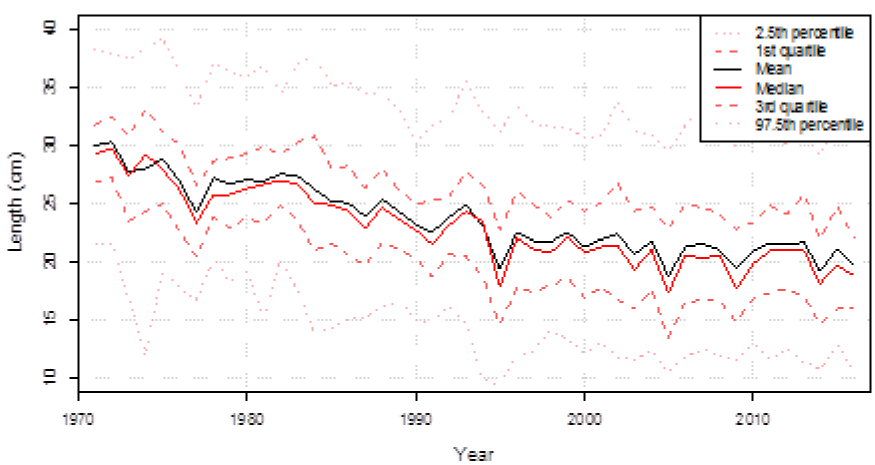


Figure 9. Annual change in fish length statistics of Winter Flounder in the September research vessel surveys of the southern Gulf of St. Lawrence, 1971 to 2016.

The size-at-maturity defined as the fish length at which 50% of fish are mature was estimated for each year and sex from RV survey observations (Fig. 10). There has been a decreasing trend in the length at maturity of male and female Winter Flounder, from 23 to 24 cm in the 1970s to present sizes of 14 to 15 cm for females and 12 to 13 for males.

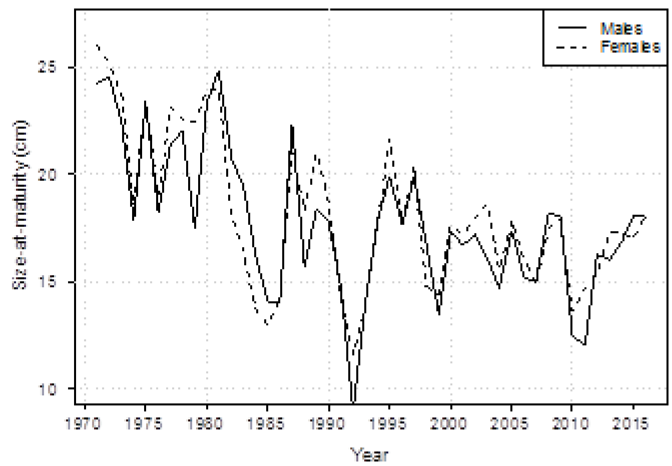


Figure 10. Size (cm) at 50% maturity of male and female Winter Flounder estimated from samples in the September research vessel survey of the southern Gulf of St. Lawrence, 1971 to 2016.

The mean length-at-age has generally decreased through time on the order of 2 to 3 cm and this is apparent across all ages from 1975 to 2014 (Fig. 11). This downward trend is consistent across periods, except for the most recent period from 2012 to 2014 in which the size increased slightly, although the sample sizes are small for this time period. The age at commercial size (25 cm) changes from 5 to 6 years over the time period.

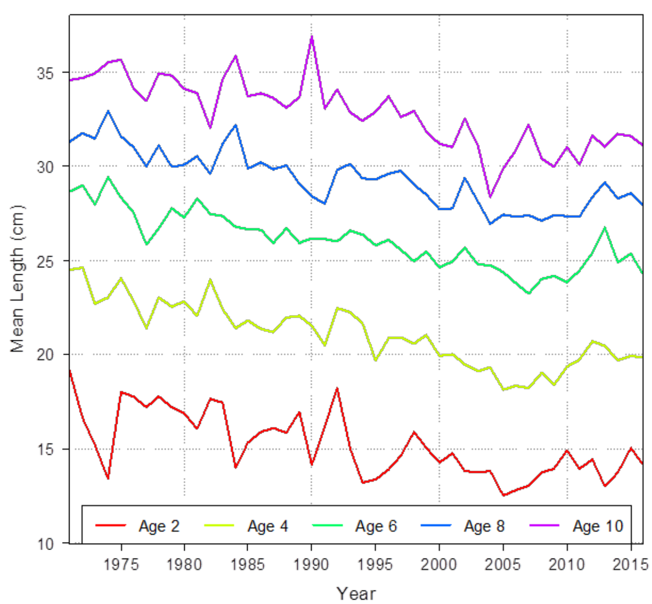


Figure 11. Estimated mean length-at-age (cm) of Winter Flounder for ages 2, 4, 6, 8, and 10 years old, based on the research vessel survey length frequencies and the smoothed age-length key model for the southern Gulf of St. Lawrence, 1971 to 2016.

Spatial Distribution

Winter Flounder are distributed along the mid-shore area throughout the sGSL but survey catches have declined in all areas (Fig. 12). The relative distribution of Winter Flounder catches decreased in the stations < 30 m and increased at depths between 30 and 50 m, over the time series since 1971, but has been more pronounced since 2011 (Fig. 13).

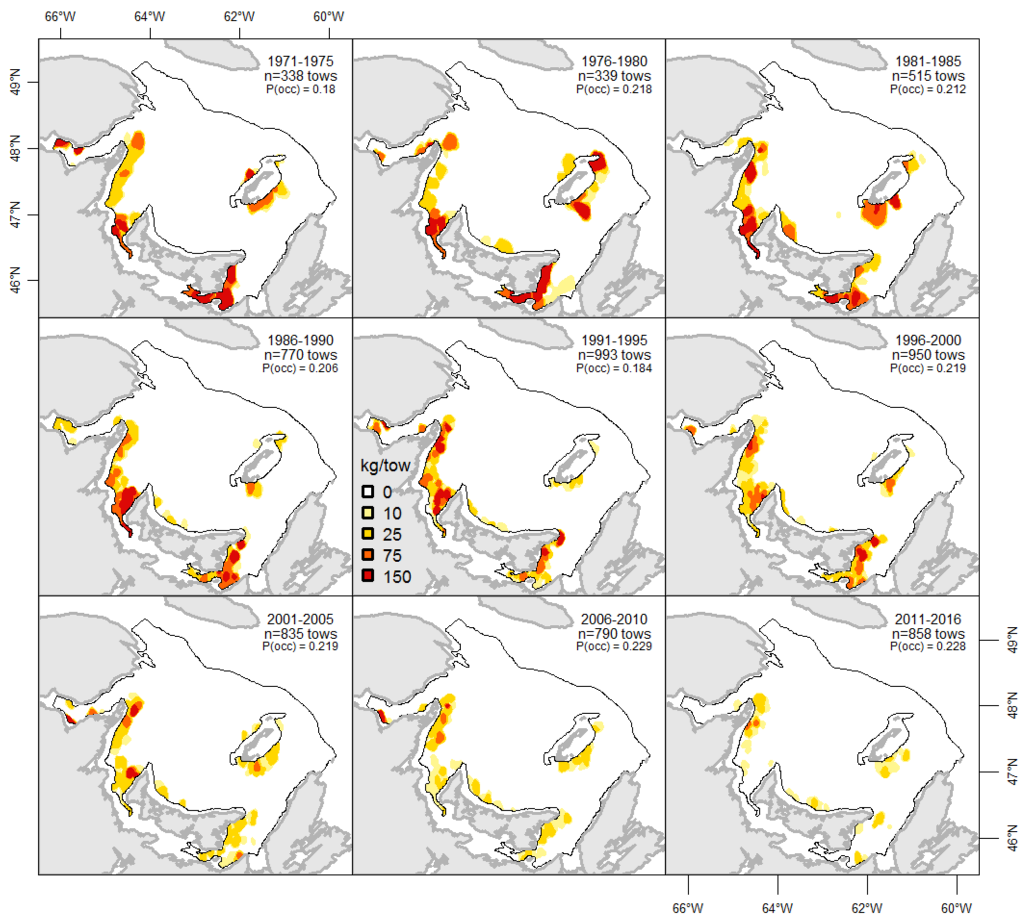


Figure 12. Spatial distribution of standardized Winter Flounder biomass indices (kg per tow) from the September research vessel survey of the southern Gulf of St. Lawrence by blocks of five years, 1971 to 2016. Shown in each map are the total number of tows used in the analyses and the proportion of tows having non-zero catches (Pocc).

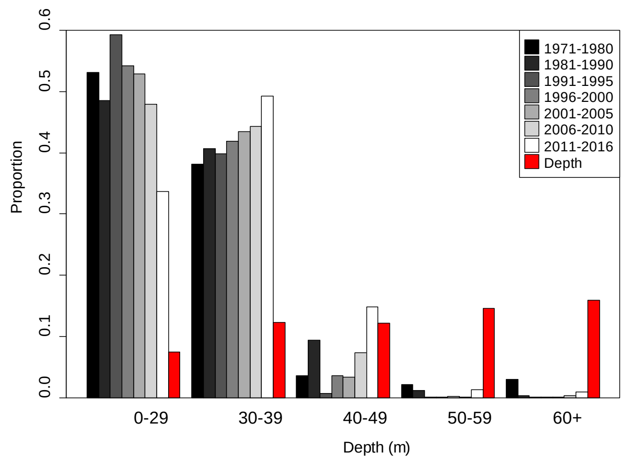


Figure 13. Depth distribution of Winter Flounder in the research vessel survey catches expressed as the proportion of the survey catches by depth bin and decadal block, 1971 to 2016. The red coloured bars are the proportion of the survey stations at depth in the research vessel survey of the southern Gulf of St. Lawrence.

Abundance Indices

The RV survey biomass index of small fish (< 25 cm) increased in the early 1970s and remained fairly stable subsequently until 2010 when the biomass index declined by about half and remained at that level since then (Fig. 14). In contrast, the biomass index of commercial sized (>= 25cm) fish has declined significantly and consistently throughout the time series to record lows in the last five years. The decline in the biomass index of all size groups is largely due to the decline in the abundance of larger fish (Fig. 14).

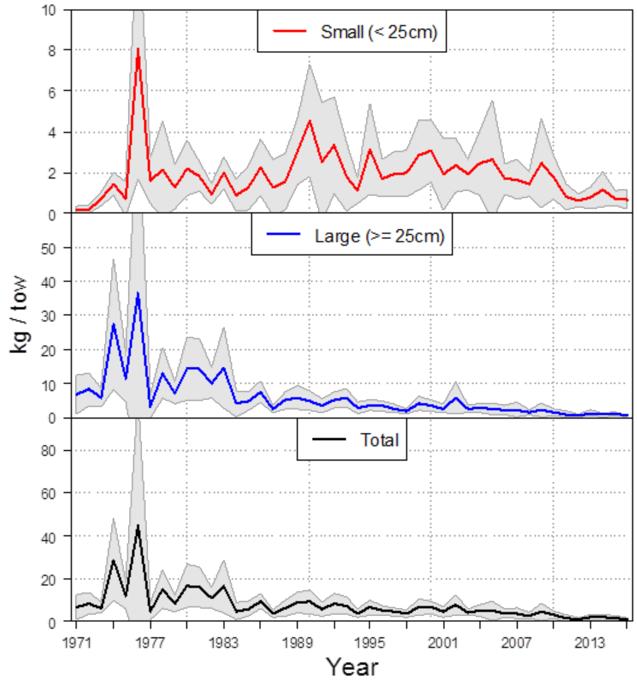


Figure 14. Research vessel survey biomass indices (kg per tow) for Winter Flounder with lengths < 25 cm (top), ≥ 25 cm (middle), and sizes combined (bottom panel) from the southern Gulf of St. Lawrence, 1971 to 2016. Black lines indicate the means and the shaded areas indicate the 95% confidence intervals.

The abundance and biomass indices of Winter Flounder from the mobile Sentinel surveys show a large overall decline from a mean of 10 fish per tow in 2003 to approximately 1 fish per tow in 2016 (Fig. 15). The trend in the biomass index is very similar.

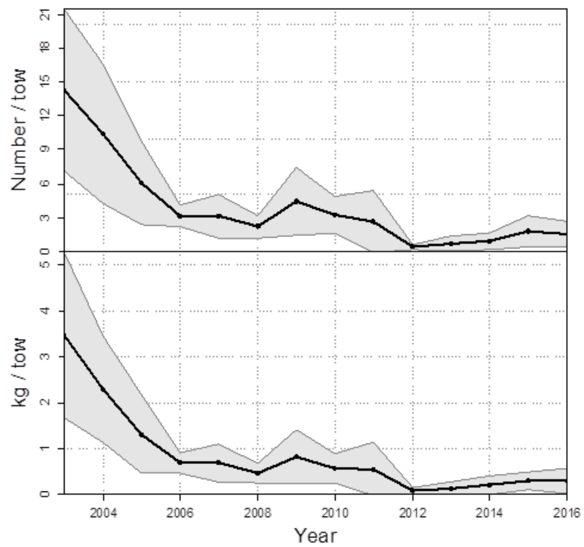


Figure 15. Mobile Sentinel survey indices (number per tow in the upper panel; weight per tow in the lower panel) for all sizes of Winter Flounder in the southern Gulf of St. Lawrence, 2003 to 2016. Black lines indicate the means and the shaded areas indicate the 95% confidence intervals.

There is a shift in the age distribution towards younger Winter Flounder sampled in the September RV survey, corresponding to the decreased size of Winter Flounder in the southern Gulf of St. Lawrence RV catches (Fig. 16). The evidence for cohort tracking in the population is weak.

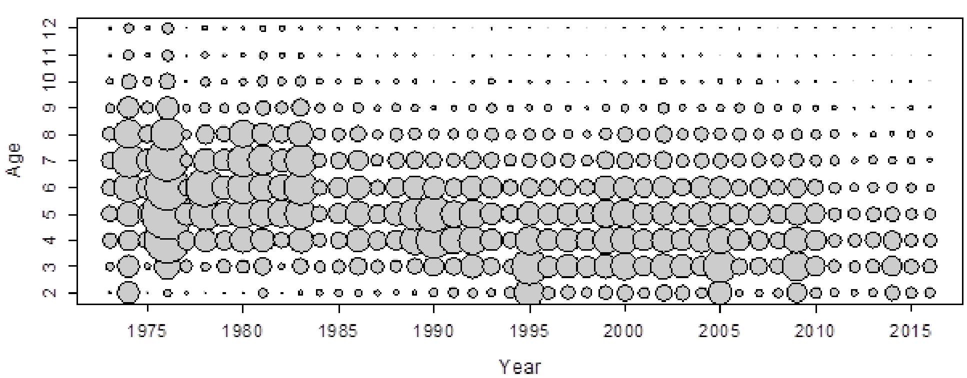


Figure 16. Catch at age (in trawlable abundance number) of Winter Flounder from the September research vessel survey for the southern Gulf of St. Lawrence strata 415 to 439 which were sampled every year, 1973 to 2016. Circle area is proportional to trawlable abundance.

Population Modelling

Winter Flounder in the southern Gulf of St. Lawrence (NAFO Div. 4T) was modelled as a single population.

Methods

In the previous assessment, a Virtual Population Analysis (VPA) was used (DFO 2012). In the current assessment, a Statistical Catch-at-Age (SCA) model is implemented. The model fits catches and abundance indices aggregated over ages as well as the respective age proportions in the survey indices and the fisheries. The sexes are combined. The population model begins in 1973, the first year of commercial fishery sampling. The data inputs include:

- the total landings from 1973 to 2016 (Fig. 2),
- the estimated RV survey trawlable biomass from 1973 to 2016 (Fig. 14),
- the commercial catch-at-age proportions (in numbers) for ages 2 to 12+ years from 1973 to 2016 (Fig. 7),
- the RV survey abundance at-age proportions (in numbers) for ages 2 to 12+ years from 1973 to 2016 (Fig. 16),
- the estimated annual mean weights-at-age by year for the RV survey and in the fishery.

The proportions of mature fish at-age from the RV survey 1973 to 2016 are used to calculate the spawning stock biomass. Selectivity curves for the survey indices and the fishery were assumed to be logistic curves over fish age. Natural mortality (M) was treated as piecewise constant over time in blocks of five years starting from 1973, with the last period from 2013 to 2016 consisting of four years.

Several model variants were explored that included two or three age group blocks for modelling natural mortality and selectivity curves for the commercial fisheries that varied by time blocks corresponding with changes in fishing patterns (gears used, fishing locations and timing of the fisheries).

The model retained consisted of two age blocks for M, two selectivity curves for the RV survey index, and one selectivity curve over the time series for the commercial fisheries. For the RV survey selectivity curves, the time series was partitioned into two blocks; one from 1973 to 1985 corresponding to the period during which the vessel E.E. Prince was used, and the other from 1986 to 2016.

Results

The selected model fit the abundance indices fairly well although the small fish index tended to be underestimated in recent years (Fig. 17). Fit to the length-group proportions in the fishery catch was good, except for a tendency to slightly overestimate the contribution of large fish to the fishery catches in the early to mid-2000s. The estimated catchability to the RV survey was near zero for age 1 fish (0.008) and increasing to 0.25 by age 8+.

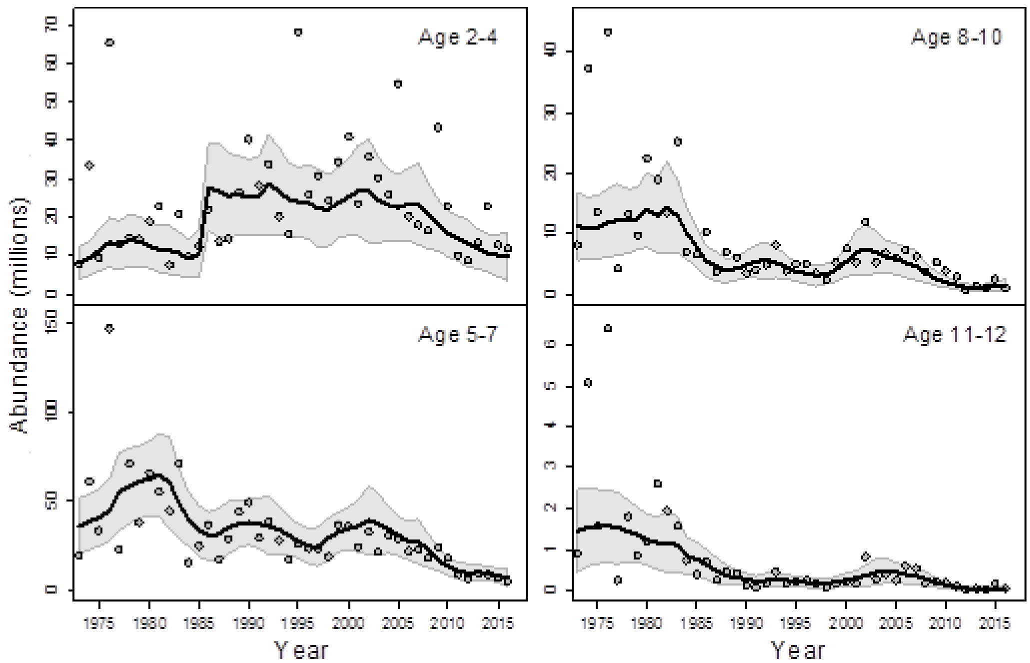


Figure 17. Observed (open circle symbols) versus predicted (black solid lines are the maximum likelihood estimates and the shaded area represent the 95% confidence interval range) trawlable abundance (in millions) of Winter Flounder by age groups from the research vessel catches in the southern Gulf of St. Lawrence, 1973 to 2016.

Estimated abundances of ages 2 to 4 are fairly stable through time though there is a decrease of about 20% in the past 10 years (Fig. 18). For fish aged 5 to 7, peaks in abundance were estimated around 1980, 1990 and 2003, but there was a marked decline from 744 million fish in 2008 to 203 million in 2016. Similarly, abundance at ages 8 to 10 peaked at 117 million in 1983 with intermittent lower spikes in abundance in 1993 and 2003 and a subsequent decline to present levels of 12 to 13.5 million. For this age group, this represents a decline of 89% from peak abundance. A similar pattern is evident for ages 11 and 12+ with a peak abundance of approximately 10 million fish in the 1970s and early 1980s, followed by a decrease to 1.4 million in 1998 and following a modest increase in mid 2000s, a further decrease to present levels of 0.46 million fish, the lowest of the time series (Fig. 18).

Recruitment of age-3 fish is represented by a peak in abundance in the mid-1970s followed by a fairly stable level during 1980 to 2009. The estimated abundances declined from 1.2 billion fish in 2009 to 0.7 billion fish in 2016, a decline of 36%.

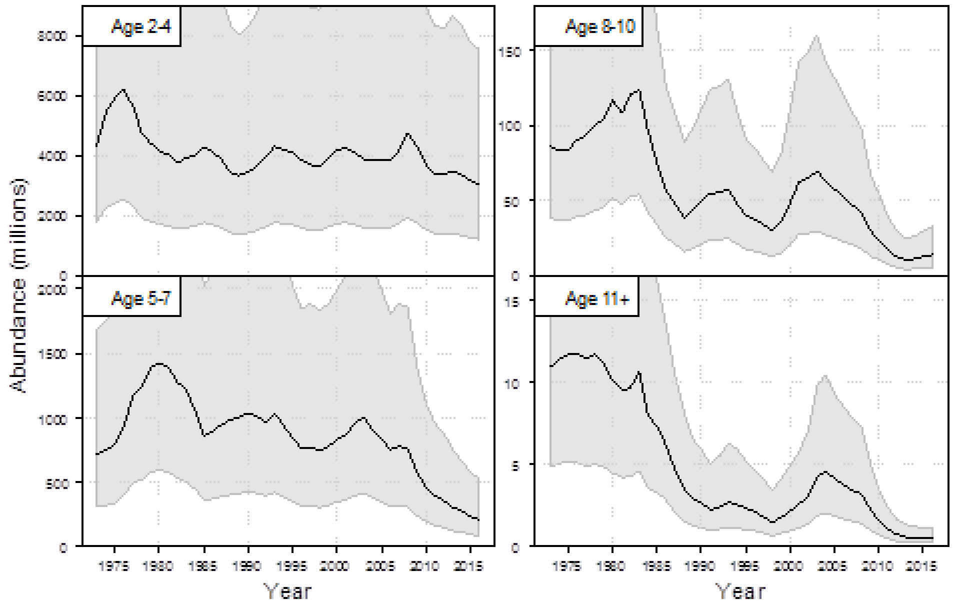


Figure 18. Statistical catch at age estimated abundances at age of Winter Flounder in the southern Gulf of St. Lawrence, 1973 to 2016. The solid lines show the maximum likelihood estimates and the grey shading the range representing +/- one standard deviation.

Estimates of spawning stock biomass (SSB) were highest in the period from 1973 to 1994 at an average of 369,601 t. The average SSB over the period from 1995 to 2016 was 171,100 t (Fig. 19). Over the latter period, the SSB estimate declined from 235,700 t in 2003 to 76,270 t in 2016, a reduction of 67%. Uncertainty in the estimates of SSB was high. The proportion of the SSB represented by older fish (5+) has also decreased over time, from a mean of 63% in the 1970s to the early 1980s to a mean of 39% since 2010. In contrast, the estimated contribution of 2 to 4 year old fish to the SSB increased from 37% in the 1980s to 61% since 2010.

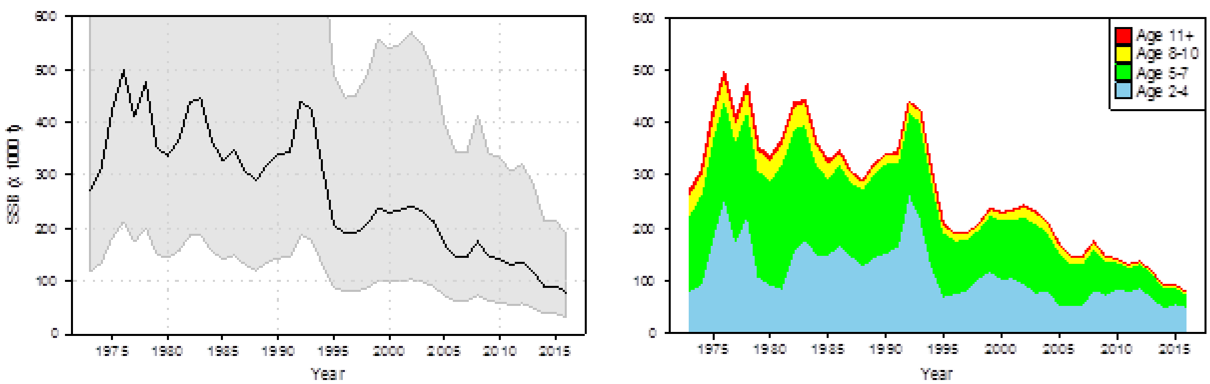


Figure 19. Estimated spawning stock biomass (left panel; SSB by 1000 t) of Winter Flounder in the southern Gulf of St. Lawrence, 1973 to 2016. The black solid line is the maximum likelihood value and the shaded area shows the uncertainty (+/- one standard deviation on the log-scale). In the right panel, the maximum likelihood estimates of SSB by age group are shown for the same period, 1973 to 2016.

The estimated natural mortality rate for ages 2 to 4, starts at 0.48, declines to 0.25, but subsequently increase over the last decade to 0.90 in the last year blocks (Fig. 20). The rates are high for ages 5+ and show an increase through time, going from 0.68 to 1.25 and 1.02 in the last year blocks (Fig. 20).

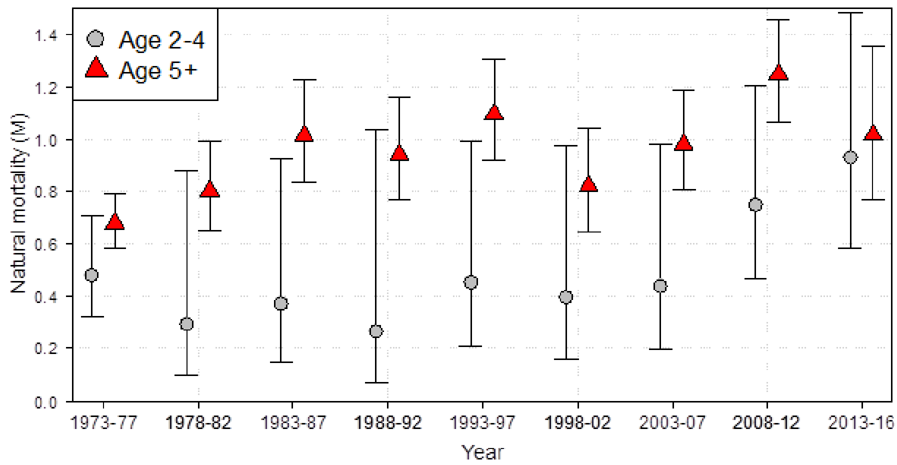


Figure 20. Model derived estimates of natural mortality for two age group blocks (ages 2 to 4, ages 5+) of Winter Flounder from the southern Gulf of St. Lawrence, in five year blocks from 1973 to 2016. The symbols are the maximum likelihood estimates and the vertical lines are 95% confidence interval error bars.

The instantaneous fishing mortality rate (*F*) is estimated to be very low for ages 2 to 4 years, with all values over the time series being less than 0.001 (Fig. 21). Maximum fishing rates over the series were 0.003 for age 4, 0.015 for age 5, 0.039 for age 6, 0.049 for age 7, and 0.051 for ages 8+. Overall, the fishing mortality rate is very low compared to the estimated natural mortality rate.

Figure 21. Model estimated instantaneous fishing mortality rates of Winter Flounder for ages 2 to 4 (left panel) and ages 5+ (right panel) from the southern Gulf of St. Lawrence, 1973 to 2016. The symbols are the maximum likelihood estimates and the shaded area shows the uncertainty (+/- one standard deviation on the log-scale).

Reference Points for Winter Flounder from NAFO Div. 4T

In the absence of an acceptable surplus production model or stock and recruitment model to derive B_{msy}-based reference points, a proxy for B_{msy} was defined as the spawning stock biomass of Winter Flounder during a productive period, 1973 to 1994 (DFO 2009). This period was chosen because the SSB was high and the SSB comprised an important number of older / larger fish. The average biomass over the productive period is 369.6 thousand tonnes, and the limit reference point (LRP; 40% B_{msy}) value from the model is 147.8 thousand tonnes (Fig. 22).

The modelled SSB has been below the LRP since 2006, except for 2008. In 2016, the modelled SSB was estimated at 52% of the LRP, with a 76 % chance of being below the LRP.

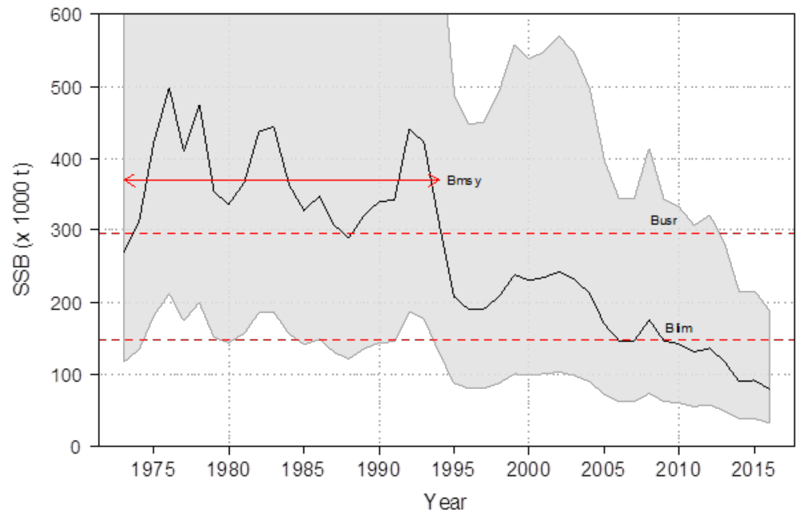


Figure 22. Proxy value for B_{msy} derived from the average of the estimated spawning stock biomass (SSB) from a productive period from 1973 to 1994 and the corresponding upper stock reference point (B_{usr}) defined as 80% of B_{msy} and the limit reference point (B_{lim}) defined as 40% of B_{msy}. Shaded area shows the uncertainty (+/- one standard deviation on the log-scale) of the spawning stock biomass estimate.

Projections Relative to Different Catch Options

The population was projected forward five years assuming current productivity conditions would persist over the period from 2017 to 2021. Recruitment over this period was assumed to be the mean recruitment level of the past five years. Four levels of annual fishery catches were considered; 0, 100, 200 and 300 t.

Projections at catch levels examined show no perceivable difference in stock trends over the next five years relative to no fishing. Projected SSB in the absence of fishing declined slightly over the period from 74.7 thousand t in 2017 to 73.8 thousand t in 2021. Under the 300 t catch scenario, the decline was 0.1 t greater. Estimated uncertainty is very large over the projection period (Fig. 23). For all catch scenarios including no catch, the SSB is expected to be below the LRP in all projection years. Fishing mortality is a very small proportion of the total mortality of Winter Flounder in the sGSL and at the scale of the southern Gulf, natural mortality is estimated to be the dominant factor affecting abundance.

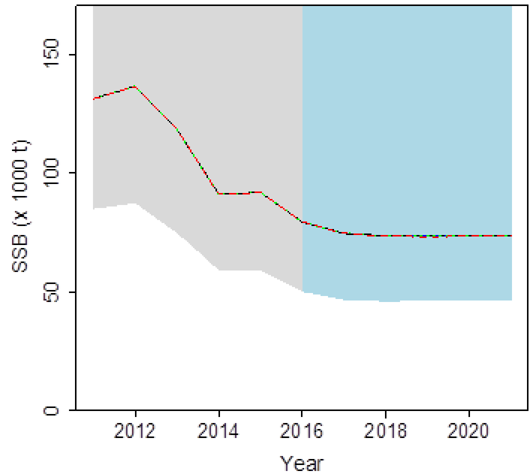


Figure 23. Projected spawning stock biomass (SSB; 1000 t) of Winter Flounder of the southern Gulf of St. Lawrence at four levels of annual fishery catch (0t, 100 t, 200 t, 300 t). Lines show historical and projected estimates (median). There is no difference in stock abundance over the range of catch levels examined. Shading shows the uncertainty bands (+/- 1 std. dev.) for the historical period (grey shading) and the projection period (blue shading) with no catch.

Sources of Uncertainty

There have generally been uncertainties with the completeness of the landings data particularly prior to the early 1990s. Presently, the commercial fishery has mandatory 100% dockside monitoring.

The scale of the population abundance depends upon the catchability estimates of the RV survey gear. The available data provides little information to estimate catchability of the survey gear (proportion of the total population sampled by a standard RV tow) and consequently the absolute abundance scale is uncertain. Therefore, values for catchability were assumed, based on previous studies.

Stock structure is a source of uncertainty for this resource. Winter Flounder have a discontinuous, near shore distribution and some known traits, such as their adhesive eggs and the limited movement of tagged animals, suggest that there may be local breeding populations within NAFO Div. 4T. Some degree of mixing, however, may be expected due to the pelagic larval stage and straying of adult Winter Flounder.

While the densities of Winter Flounder over shallow depths are unknown, those depths which have been sampled by the RV survey tend to indicate that shallow depths may be important and that they are primarily occupied by smaller fish. The consequences of incomplete sampling of shallower depths by the RV survey on estimates of adult biomass are therefore considered to be small.

There is uncertainty in the ageing data because these are generally uncalibrated against a reference set and a recent ageing exercise was not compared for consistency with older samples. The absence or sparseness of data required that a model be used to smooth out the age-length key estimates and the appropriateness of the interpolated values is not fully known.

There are also some observational uncertainties about the maturity curves of Winter Flounder over time, in that maturity criteria were not consistently applied from year to year. Although, these issues are mainly found in intermediate survey years, the early and recent years do suggest significant changes in size-at-maturity, and intermediate years largely reflect the transition between the two states. Uncertainty in annual maturity curves carry over to estimates of spawning stock biomass.

CONCLUSIONS AND ADVICE

Winter Flounder is currently caught in relatively small directed fisheries with landings that have varied between 190 and 320 tons over the past 10 years. The fishery is primarily concentrated around the Magdalen Islands and supplies the market for bait. There has been a decline in fish length distributions and size at age over the time period 1973 to 2016. The percentages of Winter Flounder larger than 25 cm now account for about 30% of RV survey catches in 2011 to 2015, in contrast to 85% of the catches in the early 1970s. Mean length in the survey has declined from 30 cm to 20 cm over the period 1971 to 2016.

Indices from the RV survey show that the abundance of small (< 25 cm) Winter Flounder has been generally stable through time, though there has been a decrease in the past eight years, whereas the abundance of large (>= 25 cm) Winter Flounder has declined over much of the time series, after a period of relatively high abundance in the early to mid-1970s.

Natural mortalities for Winter Flounder are generally high and are estimated to have increased from 49% annual mortality during 1973 to 1977 to 64% in 2013 to 2016 in older Winter Flounder (ages 5+) and from 38% to 60% for younger Winter Flounder (ages 2 to 4).

Spawning stock biomass has declined over much of the series, down 78% in recent years from the average value from 1975 to 1994. In addition, the proportion represented by older fish (ages 5+) has decreased from 30 to 40% at the start of the time series to 20% in the 2000s.

Fishing mortality is estimated to generally be very low over all ages and years. Fishing mortality is such a small proportion of the estimated total mortality of Winter Flounder that there is no perceived difference in stock trends over the next five years at catch projections of 0 t, 100 t, 200t and 300 t annually.

A limit reference point for this stock (LRP = 150 thousands t) was calculated based on modelled estimates of SSB during a productive period. The modelled SSB (median) has been below the LRP since 2006, with exception of 2008. In 2016 the SSB was estimated at 52% of the LRP with a 76 % chance of being below the LRP.

The contraction in size structure of Winter Flounder, the decline in the estimated size at 50% maturity from 23 to 24 cm in the 1970s to 17 to 18 cm in recent years, and the decline in abundance indices of the previously abundant commercial sized group are consistent with a stock experiencing very high mortality levels. At the scale of the southern Gulf, natural mortality appears to be the dominant factor affecting stock status. The causes of the high natural mortality are not fully known but available evidence supports the hypothesis that predation by grey seals is a major component of this increased natural mortality.

OTHER CONSIDERATIONS

Stock Status Indicators

The NAFO 4T Winter Flounder stock is currently assessed and managed on a five-year cycle. Indicators are needed to characterize stock status in the intervening years between assessments (DFO 2016b). The chosen indicator is the RV survey biomass index of commercial-sized Winter Flounder, defined as fish measuring 25 cm and longer. Since this index can have large observation error and changes in stock status should not be inferred from annual variations in the index, a three-year moving average is recommended.

In order to implement this approach it is necessary to relate the limit reference point (LRP) from its modelled population scale to the scale of the September RV biomass index of commercial-sized Winter Flounder. Over the productive period used to define the proxy value for B_{msy}, 1973 to 1994, the trawlable biomass index for Winter Flounder >= 25 cm averaged 16,523 t (Fig. 24). The re-scaled limit reference point, 40% B_{msy} scaled to the trawlable biomass index, is 6,609 t (40% of 16,523 t).

In 2016, the trawlable biomass index of commercial-sized Winter Flounder was estimated at 744 t, 11.3 % of the re-scaled LRP (Fig. 24). The three-year average of the index to 2016 was estimated at 20.2% of the re-scaled LRP. As the stock is currently below the LRP and expected to remain there even in the absence of fishing, a re-assessment would be recommended if the stock status indicator signaled an increase in abundance to a level above the LRP.

An interim year update will be provided mid-way in the five-year assessment cycle, i.e. in early December 2019, to allow sufficient time to complete a full assessment and plan the peer review if the indicator signals that a re-assessment is warranted in the winter of 2020.

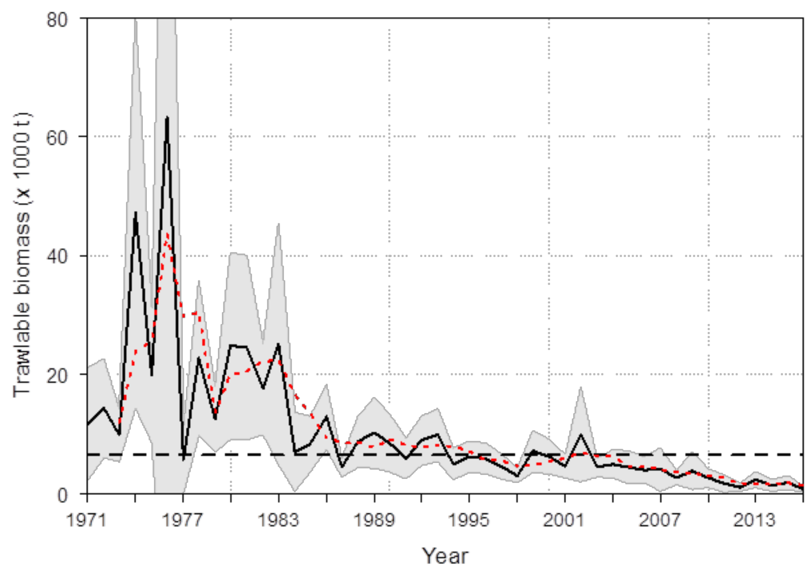


Figure 24. Trend in the stock status indicator (black solid line is the annual point estimates, grey shading is the 95% confidence interval band of the annual estimate, red dotted line is the three-year moving average value of the point estimate) of commercial-sized (>= 25 cm) Winter Flounder in units of trawlable biomass (thousand t) in the southern Gulf of St. Lawrence, 1971 to 2016. Also shown, as the dashed horizontal black line, is the limit reference point re-scaled to units of trawlable biomass of commercial-sized Winter Flounder.

SOURCES OF INFORMATION

This Science Advisory Report is from the March 1, 2017 regional science peer review meeting on the Stock status and fishery advice for May 2017 to May 2022 for Winter Flounder (*Pseudopleuronectes americanus*) from NAFO Division 4T, southern Gulf of St. Lawrence. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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Center for Science Advice (CSA)
Gulf Region
Fisheries and Oceans Canada
P.O. Box 5030, Moncton (NB) E1C 9B6

Telephone: 506-851-6253
E-Mail: csas-sccs@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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Aussi disponible en français :

MPO. 2017. Évaluation du stock de plie rouge (Pseudopleuronectes americanus) du sud du golfe du Saint-Laurent (division 4T de l'OPANO) jusqu'en 2016. Secr. can. de consult. sci. du MPO, Avis. Sci. 2017/022.