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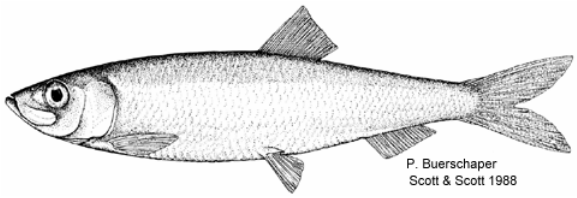
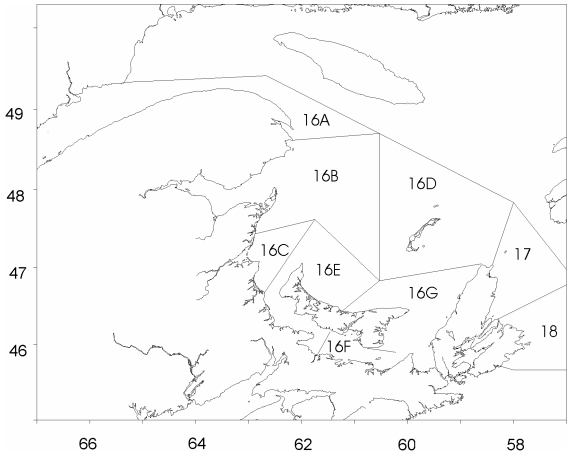
Canadian Science Advisory Secretariat
Science Advisory Report 2005/021

STOCK ASSESSMENT REPORT ON SOUTHERN GULF OF ST. LAWRENCE (4T) HERRING





Context

Herring are a pelagic species which form schools during feeding and spawning periods. Herring in the southern Gulf of St. Lawrence consist of a spring spawner component and a fall spawner component. Spring spawning occurs primarily in April-May but extends into June at depths <10m. Fall spawning occurs from mid-August to October at depths 5 to 20m. Eggs are attached to the bottom and large females produce more eggs than small females. First spawning occurs primarily at age four. The largest spring spawning populations are in the Northumberland Strait and Magdalen Islands areas and the largest fall spawning population is in Chaleur Bay.

The stock area for southern Gulf of St. Lawrence herring extends from the north shore of the Gaspé Peninsula to the northern tip of Cape Breton Island and includes the Magdalen Islands. Available information suggests that adults overwinter off the east coast of Cape Breton primarily in NAFO area 4Vn.

Southern Gulf of St. Lawrence herring are harvested by an inshore gillnet fleet on spawning grounds and a purse seine fleet (vessels >65') in deeper water. The percentage of spring and fall spawner component in the catch varies according to season and gear type. As a result, landings during the fall and spring fisheries must be separated into the appropriate spring and fall spawning groups to determine if the TAC for these groups has been attained. Spawning group assignment is done using a gonado-somatic index to assign maturity stage and a monthly key that links maturity stage and month to spawning group. Juvenile spawning group assignment is done by otolith shape type.

The inshore fleet harvests almost solely the spring spawner component in the spring and almost solely the fall spawner component in the fall. The purse seine fleet harvests a mixture of spring and fall spawner component during their spring fishery which occurs in the area between Cape Breton Island and the Magdalen Islands. In the fall, the purse seine fleet concentrates in Chaleur Bay, north PEI and western Cape Breton, and harvests a mixture of fall and spring spawner component.

TAC management was initiated in 1972. Currently there are approximately 3,500 inshore licenses and 5 active seiners (>65') from 4T and 4 from 4R.

SUMMARY

Fall Spawner Component

- Reported 2004 landings of the fall spawner component were 43,208t against the fall spawner TAC of 73,000t. There was no fishery in the 4Vn (Area 17) overwintering area by the purse seine fleet.

- Mean inshore catch rates in 2004 were slightly less than 2003, but remain high recently compared to the mid-1990s.

- The 2004 telephone survey of fish harvesters indicated that the abundance of fall herring was considered either the same or higher in Escuminac, west P.E.I. and Nova Scotia, while it was estimated lower than 2003 in northern N.B. and Gaspé, southeast N.B. and east P.E.I.

- The 1995, 1996, 1998 and 2000 year-classes are estimated to be above average.

- The 2005 beginning-of-year age 4+ biomass is estimated to be about 255,000t, the lowest in the last six years, but remains amongst the highest levels since 1978.

- The age 7+ exploitation rate in 2004 is estimated to be below the target.

- The estimated catch at $F_{0.1}$ for 2005 is 71,900t. A catch of 64,000t corresponds to a 20% chance of exceeding $F_{0.1}$.

Spring Spawner Component

- Reported 2004 landings of the spring spawner component were 8,414t against a TAC of 13,500t.

- Mean inshore catch rate in 2004 was slightly lower than in 2003, and is the lowest in the series that starts in 1990.

- Opinions of fishers from the telephone survey indicate a declining spring abundance from 2003 in areas where most of the landings occurred in the spring gillnet fishery (Escuminac, southeast N.B., Magdalen Islands and west P.E.I.). Opinions from Nova Scotia indicate that abundance has increased.

- Most year-classes produced after 1991 are estimated to be below average. The 1997 and 1999 year-classes appear to be slightly above average. The 2000 year-class (age 4 in 2004) was estimated for the first time in this assessment and is the lowest observed since the 1978 year-class.

- Age 4+ spawning biomass has declined since 1995 and is estimated to be 47,600t at the beginning of 2005.

- The fully recruited ages 6 to 8 exploitation rate was below the target in 2004.

- The $F_{0.1}$ catch for the spring spawner component in 2005 is 12,900t. A catch of 11,000t corresponds to a 20% chance of exceeding $F_{0.1}$. For a 10% increase in biomass, a catch of about 6,000t would be advised.

DESCRIPTION OF THE ISSUE

A meeting of the Regional Advisory Process was held during 29–31 of March, 2005 in St Andrews N.B. to assess the status of the spring and fall spawner components of 4T herring in support of the management of the 2005 fishery. Participants included DFO scientists and fishery managers, representatives of the industry, provincial governments and non-DFO scientists.

In **the fishery**, the catch allocations for the fall and spring seasons are based on the TACs set for each spawning component. Landings are compiled by fishing season.

2004 FALL FISHERY

Area	Fall Spawner Allocation TAC	Fall Season Landings (t)	Fall Spawner Component Landings in the Fall (t)
INSHORE			
Isle Verte	438	2	2
Chaleur Bay	26,396	14,557	14,520
Escuminac-West PEI	8,759	9,449	9,449
Magdalen	1,826	0	0
Pictou	9,053	5,453	5,453
Fisherman's Bank	9,053	6,565	6,565
4Vn (Area 17)	730	-	-
Total Inshore	**56,255**	**36,026**	**35,989**
Seiners (>65') 4T	**16,745**	**7,499**	**7,095**
Grand Total	**73,000**	**43,525**	**43,084**

2004 SPRING FISHERY

Area	Spring Spawner Allocation TAC	Spring Season Landings (t)	Spring Spawner Component Landings in the Spring (t)
INSHORE			
Chaleur Bay (Jan-June 15)	655	443	443
Escuminac (Jan-May)	3,354	278	278
Magdalen Islands 16D (Jan-June15) *	982	* 3,087	* 3,080
Southeast NB – West PEI (Jan-May)	4,173	3,302	3,112
Bait and Roe all 4T (Jan –June 30)	1,233	934	934
Total Inshore	**10,397**	**8,044**	**7,870**
Seiners (>65') 4T	**3,103**	**52**	**23**
Grand Total	**13,500**	**8,096**	**7,893**

**16D landings include bait fishery not counted against the spring TAC*

The TAC has been set separately for spring and fall spawner components since 1985. As in previous years, for both spring and fall, 77% of the TAC is allocated to the inshore fleet and 23% to the seiner (>65') fleet.

2004 Percentage of Spring and Fall Spawning Components

		Spawning Group %	
Season	**Gear**	**Spring**	**Fall**
Spring	Inshore	98	2
	Seiner	44	56
Fall	Inshore	1	99
	Seiner	5	95

The TAC for the fall spawner component in 2004 was 73,000t, compared to 62,000t in 2003 (Figure 1). The seiner allocation for 4Vn (Area 17) is included with the fall spawner component. The combined 2004 **landings of the fall spawner component** in both the spring and fall fisheries were 43,208t. Fall inshore landings are primarily driven by the roe market. There was no fishery in the 4Vn (Area 17) overwintering area by the purse seine fleet.

Total Fall Component Landings (000s t)

Year	Average 90-2000	2001	2002	2003	2004
TAC	69.5	60.5	51.5	62.0	73.0
Landings	49.8	52.8	53.1	60.9	43.2

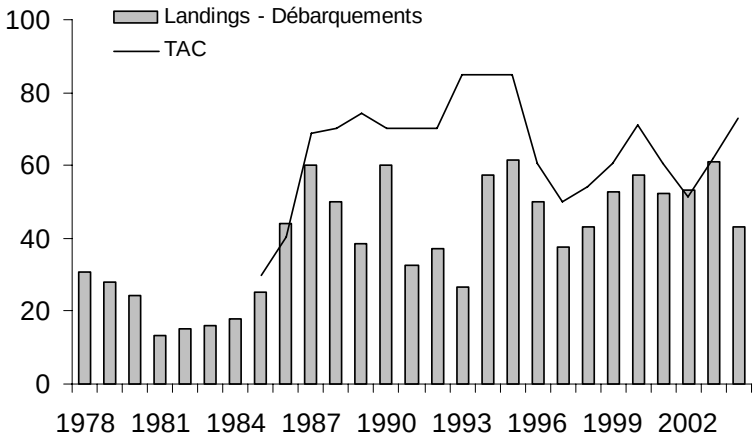


Figure 1. 4T Total Fall Spawner Component Landings and TAC (000t).

In 2004, the fall spawner TAC was not attained due to several factors: poor roe market conditions resulting in a late start for the inshore fleet; lower daily inshore boat limits in one area; a later start and bad weather during the fall seiner fishery.

For the **fall spawner component,** the 2000 year-class (age 4) was dominant in the 2004 **catch-at-age** (Figure 2). Since 1990, the **average weights-at-age** for the fall spawner component have been below those observed during the 1980s. This decline in mean weights has levelled off for most ages in recent years (Figure 3).

Figure 2. Fall Spawner 2004 Catch-at-Age (millions of fish).

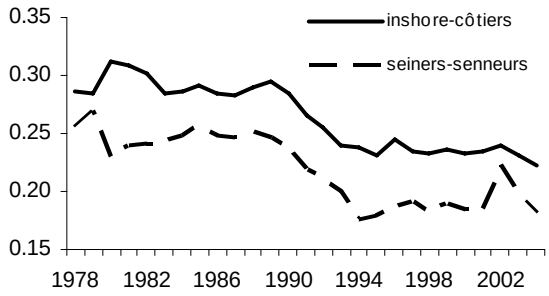


Figure 3. Weight (kg) of 5-Year-Old Fall Spawners.

The 2004 TAC for the spring spawner component was 13,500t compared to 11,000t in 2003 (Figure 4). The combined 2004 **landings of the spring spawner component** in both the spring and the fall fisheries were 8,414t. The market for the spring fishery is different from that of the fall fishery. Spring herring caught by the inshore fleet are sold primarily for bait and to the bloater (smoked herring) markets.

Total Spring Component Landings (000s t)

Year	Average 90-2000	2001	2002	2003	2004
TAC	18.8	12.5	8.0	11.0	13.5
Landings	19.8	14.7	10.4	9.3	8.4

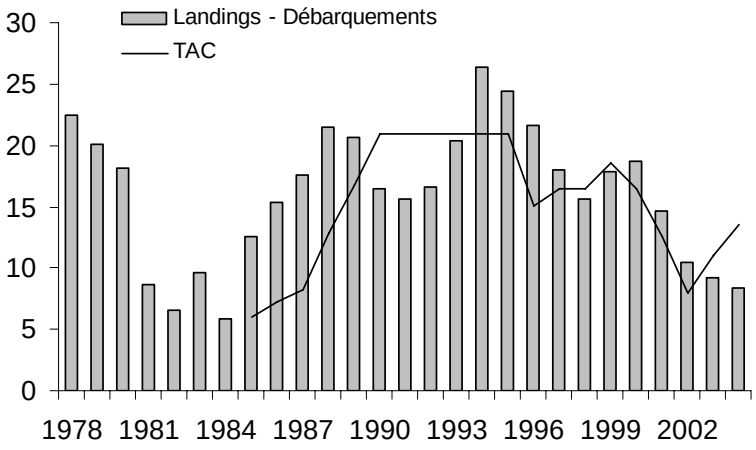


Figure 4. 4T Total Spring Spawner Component Landings and TAC (000t).

The 2004 spring spawner component TAC was not reached mainly because the spring seiner effort was low with a catch amounting to 2% of their allotted spring quota and the fact that the 16C Escuminac gillnet fishery caught only 8% of their allotted quota. The Magdalen Islands was the only area where the gillnet allocation was reached or exceeded.

The **catch-at-age** of the 2004 **spring spawner component** was dominated by the 1999 year-class (age 5) (Figure 5). Since 1990, average **weights-at-age** for the spring spawner component also have been below those observed during the 1980s. This decline in mean weights has levelled off for most ages in recent years. Weights-at-age in the seiner catches were generally lower in 2003 (Figure 6).

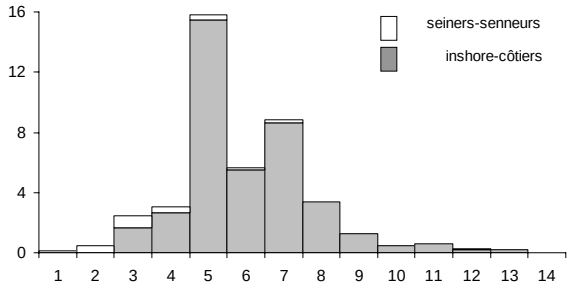


Figure 5. Spring Spawner 2004 Catch-at-Age (millions of fish).

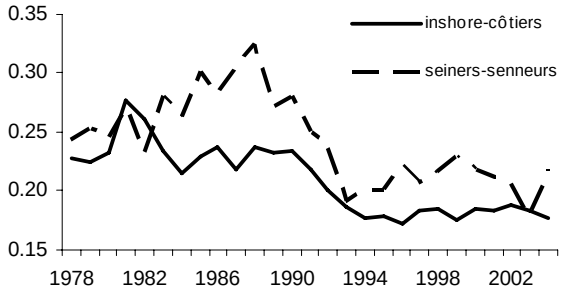


Figure 6. Weight (kg) of 5-Year-Old Spring Spawners.

FALL SPAWNER COMPONENT

ASSESSMENT

The **acoustic survey** in 2004 indicates that abundance was lower than in 2003. For the fall spawning component, this survey index is not used to calibrate the population analysis because it does not follow year-class strength consistently.

The 2004 **telephone survey** of fish harvesters indicated that the abundance of fall herring was considered either the same or higher in Escuminac, west P.E.I. and Nova Scotia, while it was estimated lower than 2003 in northern N.B., Gaspé, southeast N.B. and east P.E.I.

The **abundance index** used to calibrate the population analysis for the fall spawning component is a catch rate (CPUE) index based on fishery data of inshore catches determined from purchase slips and the Dockside Monitoring Program (DMP) combined with effort

information derived from a telephone survey of approximately 25% of the active inshore fishers (Figure 7). This index covers the entire inshore fleet and extends from 1978 to 2004. The mean CPUE in 2004 was slightly less than 2003, but remains high recently compared to the mid-1990s.

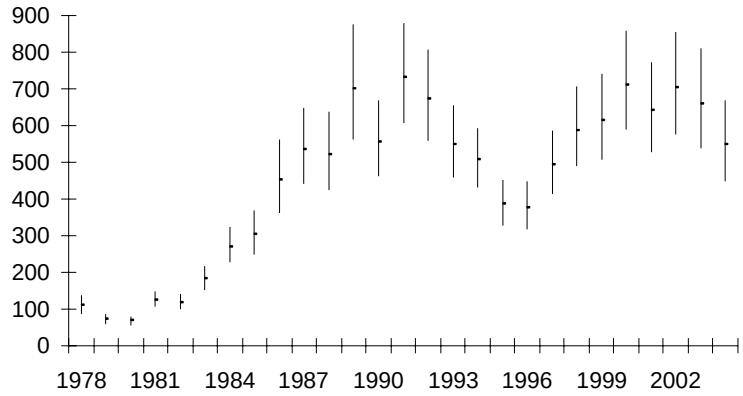


Figure 7. Fall Spawner CPUE index (kg/net/trip).

Retrospective patterns (in this case, a tendency to overestimate stock abundance) were present in the 2003 assessment and persist in this assessment. The retrospective pattern indicated that the current estimates of population abundance in 2000 were about 26% lower than the initial estimates. To take into account this tendency, population numbers in 2005 were reduced by 26% equally for all ages. All results for the fall spawner component (numbers, biomass and exploitation rates) incorporate this adjustment.

Recruitment estimates (age 4) from the analysis (Figure 8) suggest that the abundance of the 1995, 1996, 1998 and 2000 year-classes in the commercial fishery is above average and that overall abundance is currently high. The analysis indicates that **population biomass** (Figure 9) of age 4+ fall spawner component peaked in 2002, when the large 1998 year-class entered the fishery as 4 year-olds. Biomass has increased since 1998. The 2005 beginning-of-year age 4+ biomass is estimated to be about 255,000t, the lowest in the last six years, but remains amongst the highest levels since 1978. The target **exploitation rate** ($F_{0.1}$) (Figure 10) for fall spawner component is about 28% for fully recruited age-groups (7+). Exploitation rate remains below the target.

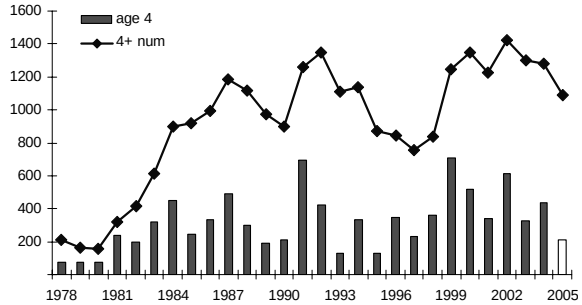


Figure 8. Fall Spawner Component Population Numbers (millions of fish). Age 4 in 2005 is the geometric mean of 1978-2004.

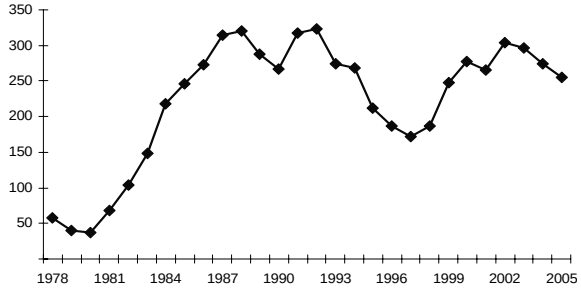


Figure 9. **Fall Spawner Component 4+ Biomass (000t).**

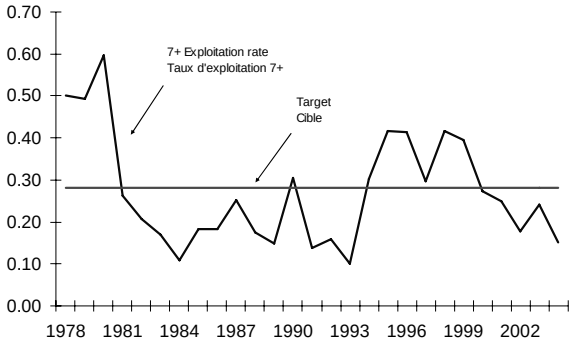


Figure 10. Fall Spawner Age 7+ Exploitation Rate.

Retrospective patterns in the assessment are a **source of uncertainty**. The estimated population numbers in 2005 have been reduced by 26% to account for a potential overestimation of population size in the current year, indicated by the retrospective patterns. Catch rates from the gillnet fishery continue to be among the highest in the series. There is concern that catch rates may not accurately track population biomass because of the nature of the fishery. For example, boat limits and saturation of nets may impact CPUE negatively, while searching behaviour could positively influence CPUE. There is uncertainty about the recent year-classes (2001-2003) as there are no estimates of recruitment prior to age 4.

CONCLUSIONS AND ADVICE

Overall, the stock appears to remain at a high level relative to the late 1970's and early 1980's. The $F_{0.1}$ estimation of fall spawner catch for 2005 is 71,900t. This level includes adjustment for potential over-estimation of population numbers in the current year. With a catch of 71,900t, a 23% decline in 4+ biomass is expected. This is not uncommon at such high population biomass levels.

It is also possible to estimate the uncertainties regarding stock size and then use these in a **risk analysis** (Figure 11). The risk analysis considered the probability of exceeding $F_{0.1}$. This analysis can provide some guidelines for decision making. For example, it indicates that a probability of 20% of exceeding $F_{0.1}$ corresponds to a catch of 64,000 t.

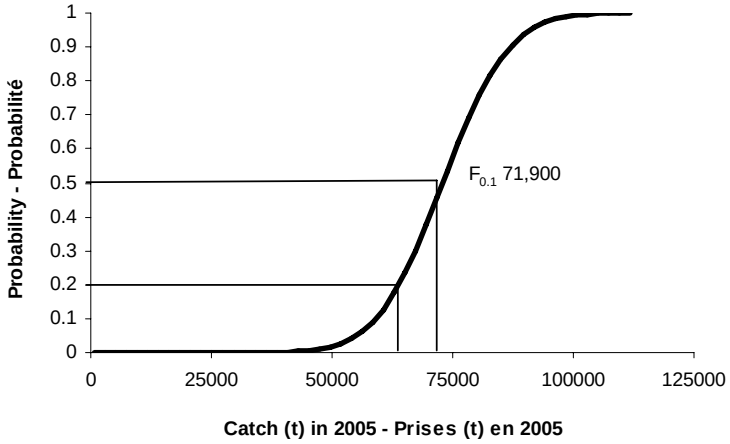


Figure 11. Risk Analysis for the Fall Component.

This risk analysis includes uncertainties in population estimates but not those associated with the retrospective pattern, natural mortality, weight at age or partial recruitment.

SPRING SPAWNER COMPONENT

ASSESSMENT

Opinions of fishers from the **telephone survey** indicate a declining spring abundance from 2003 in areas where most of the landings occurred in the spring gillnet fishery (Escuminac, southeast N.B., Magdalen Islands and west P.E.I.). Opinions from Nova Scotia indicate that abundance has increased.

Resource status of the 4T spring spawning herring was determined using a population analysis that included both the gillnet catch rate (CPUE) and acoustic survey indices.

The spring CPUE analysis included dockside monitoring data from all areas with recorded landings data. Effort was calculated using the average number of nets used in each area, as determined by the telephone survey. CPUE was defined as kg/net/trip. **Mean spring spawner catch rate in 2004** (Figure 12) was slightly lower than in 2003, and is the lowest in the series that starts in 1990.

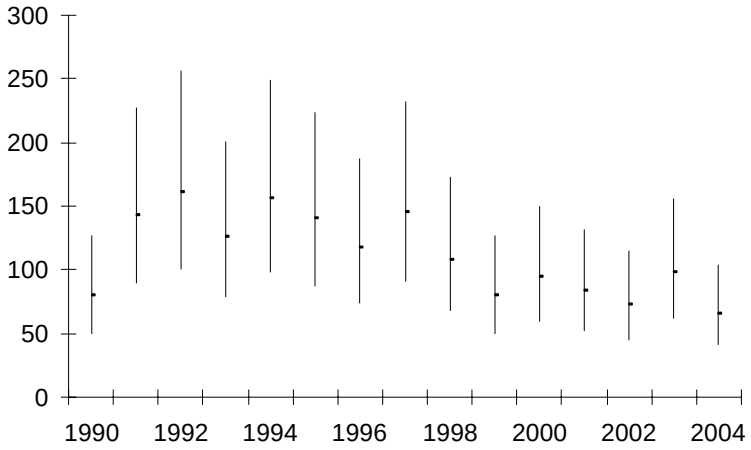


Figure 12. Spring Spawner CPUE index (kg/net/trip).

The 2004 **acoustic survey abundance** (Figure 13) of the age 4+ spring spawner component was the lowest in the time series that starts in 1994.

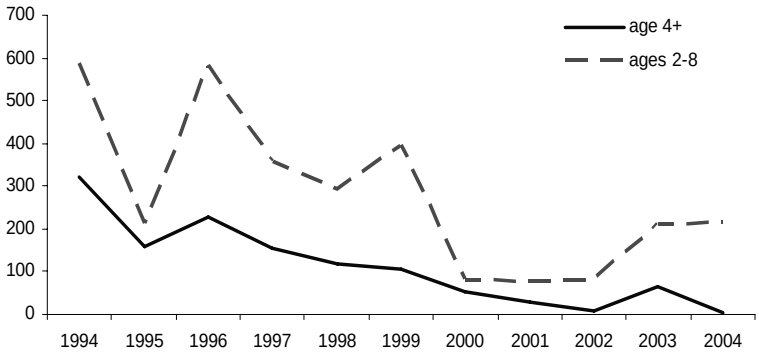


Figure 13. Spring Spawner Component Acoustic Survey Index (millions of fish).

The population analysis showed no retrospective pattern. An internal weighting procedure was used to estimate population abundance. This tends to give more weight to the more coherent index in terms of its ability to track cohorts.

Recruitment estimates (age 4) from the analysis (Figure 14) indicate that most year-classes after 1991 were below average. The 1997 and 1999 year-classes appear to be slightly above average. The 2000 year-class (age 4 in 2004) was estimated for the first time in this assessment and is the lowest observed since the 1978 year-class. The analysis indicates that both **population abundance and biomass** (Figure 15) of ages 4+ spring spawner component peaked in 1995, when the large 1991 year-class entered the fishery as 4 year-olds. Biomass has declined since 1995. Age 4+ biomass is estimated to be about 47,600t at the beginning of 2005. The target **exploitation rate** at $F_{0.1}$ for the spring spawner component is about 31% over fully recruited ages 6 to 8. The estimated exploitation rate (Figure 16) has been close to the target in recent years. The exploitation rate in 2004 was below the target.

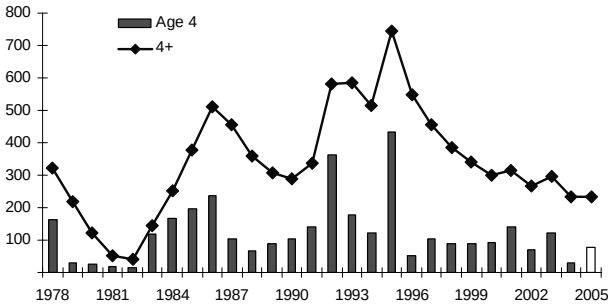


Figure 14. Spring Spawner Component Population Numbers (millions of fish). Age 4 in 2005 is the geometric mean of 1978-2004.

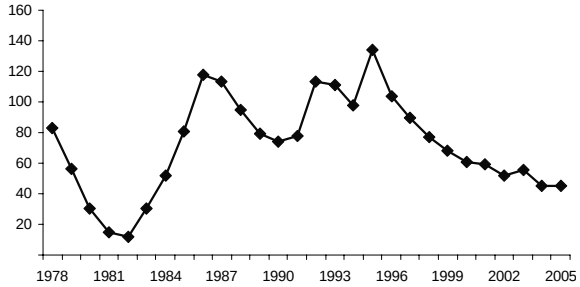


Figure 15. Spring Spawner Component Age 4+ Biomass (000t).

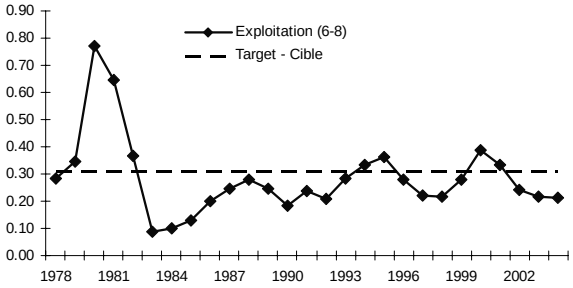


Figure 16. Spring Spawner Exploitation Rates (ages 6 to 8).

Regarding **sources of uncertainty**, recent gillnet catch rates are the lowest in the time series that starts in 1990. There is uncertainty relative to the catch rates particularly as they relate to the amount of effort used (size (depth) of nets). Fish harvesters report that they are using deeper mesh gillnets in some areas as they fish in deeper water and that this could influence the gillnet catch rates. There is uncertainty about the recent year-classes (2001-2003) as there are no recruitment estimates (ages 2 to 4).

CONCLUSIONS AND ADVICE

The **risk analyses** (Figure 17) conducted were: 1) the probability of exceeding $F_{0.1}$, 2) the probability of any decline in biomass, and 3) the probability of a 10% increase in biomass. The point estimate of the $F_{0.1}$ catch for the spring spawner component in 2005 is 12,900t. The risks associated with different catch levels can be examined. For example, a 20% chance of exceeding $F_{0.1}$ corresponds to a catch of 11,000t. Alternatively, a low risk of decline in spawning stock biomass corresponds to a catch of 10,000t. For a 10% increase in biomass, a catch of

about 6,000t would be advised. Given the current state of the spring spawner component, harvesting strategies that promote rebuilding should be strongly considered.

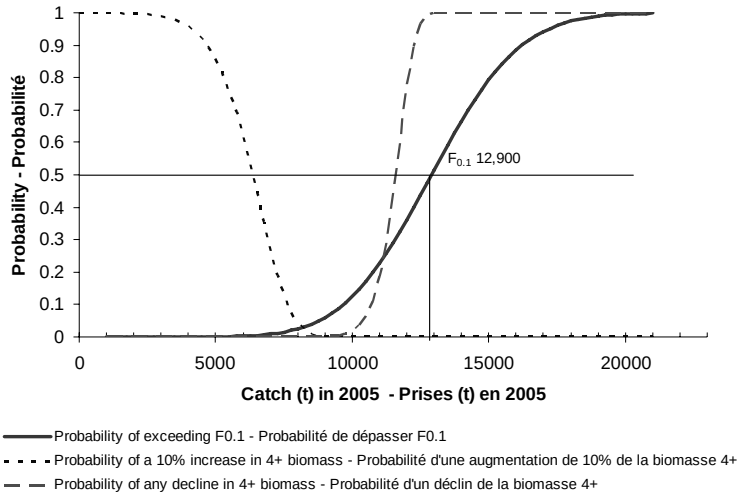


Figure 17. Spring Spawner Component Risk Analysis.

These risk analyses include uncertainties of the population estimates but not those associated with natural mortality, weight at age and partial recruitment.

There is concern about the decline in catches in the Escuminac gillnet fishery (herring fishing area 16C).

SOURCES OF INFORMATION

LeBlanc, C.H., G.A. Poirier, C. MacDougall, and C. Bourque. 2005. Assessment of the NAFO Division 4T southern Gulf of St. Lawrence herring stocks in 2004 / Évaluation des stocks de hareng de la zone 4T de l'OPANO dans le sud du Golfe du Saint-Laurent en 2004. DFO Can. Sci. Advis. Sec. Res. Doc 2005/016 / Secr. can. de consult. sci. du MPO, Doc de rech. 2005/016.

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