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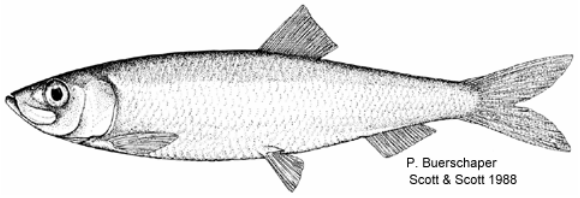
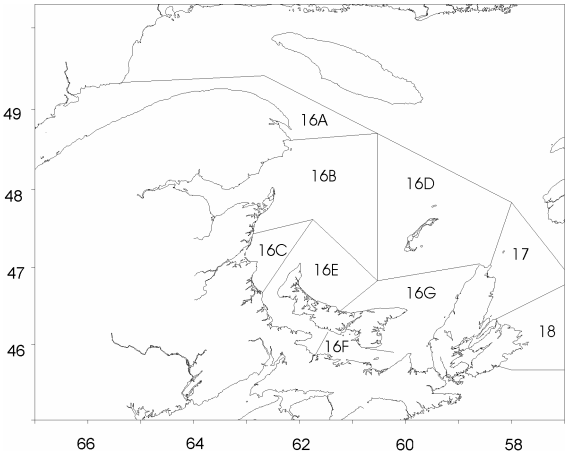
Canadian Science Advisory Secretariat
Science Advisory Report 2006/016

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





Context

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. Studies in the early 1970's indicated that southern Gulf herring also overwintered off the south coast of Newfoundland.

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. Spring herring are sold primarily for bait, to the bloater (smoked herring) and filet markets. 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. Fall landings are primarily driven by the roe and filet markets. TAC management was initiated in 1972. Currently there are approximately 3,500 inshore licenses and 11 seiner licenses (>65'), 6 from 4T and 5 from 4R.

Assessments of the spring and fall spawning herring from the southern Gulf of St. Lawrence are required on an annual basis and form a part of the information base used to establish the TAC. In December 2005, a meeting on the assessment framework was held to determine spawning stock biomass reference points, to update the $F_{0.1}$ calculations and the methodology for short term projections. A meeting of the Regional Advisory Process was held during 28–29 of March, 2006 in Moncton N.B. to assess the status of the spring and fall spawner components of 4T herring in support of the management of the 2006 fishery. Participants included DFO scientists and fishery managers, representatives of the industry, provincial governments and non-DFO scientists.

SUMMARY

Fall Spawner Component

- Reported 2005 landings of the fall spawner component were 59,924t against the fall spawner TAC of 70,000t. There was no fishery in the 4Vn (Area 17) overwintering area by the purse seine fleet.
- Mean inshore catch rates in 2005 were higher than 2004 and remain high compared to the mid-1990s.
- The 2005 telephone survey of fish harvesters indicated that the abundance of fall herring was considered either the same or higher in all areas.
- The 1995, 1996, 1998 and 2000 year-classes are estimated to be above average.
- The 2006 beginning-of-year age 4+ spawning biomass is estimated to be about 283,600t and remains amongst the highest levels since 1978.
- The fully recruited (age 5+) exploitation rate in 2005 is below the $F_{0.1}$ target.
- The catch at $F_{0.1}$ for 2006 is 68,800t. A catch of 52,000t would result in an estimated 10% decline in biomass for 2007.

Spring Spawner Component

- Reported 2005 landings of the spring spawner component were 5,139t against a TAC of 11,000t.
- Mean inshore catch rate in 2005 was similar to that in 2004, and remains near the lowest in the series that starts in 1990.
- Opinions of fishers in the telephone survey indicate that abundance has declined 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 fishermen from Gulf Nova Scotia indicate that abundance has increased.
- Most year-classes produced after 1991 are estimated to be below average. The 1997, 1999 and 2001 year-classes appear to be slightly above average. The 1998 year-class is below average as is the 2000 year-class (age 5 in 2005) which is estimated as the lowest observed since the 1978 year-class.
- Age 4 to 10 spawning biomass has declined since 1995 and is estimated to be 50,600t at the beginning of 2006.
- The fully recruited (ages 6 to 8) exploitation rate was below the $F_{0.1}$ target in 2005.
- The $F_{0.1}$ catch for the spring spawner component in 2006 is 12,600t. A catch of 7,500t corresponds to a 5% increase in biomass. For a 10% increase in biomass, a catch of slightly less than 5,000t would be required.
- The current estimate of spawning stock biomass (50,000t) is below the upper stock reference point of 54,000t. To be compliant with the precautionary approach, catch levels below 7,500t (5% increase in biomass) are advised.

BACKGROUND

Species Biology

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 less than 10m. Fall spawning occurs from mid-August to October at depths of 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. In recent years, the largest spring spawning populations are in the Northumberland Strait and Magdalen Islands areas and the largest fall spawning population is in Chaleur Bay.

Fishery

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.

2005 FALL FISHERY

Area	Fall Spawner Final Allocation	Fall Season Landings (t)	Fall Spawner Component Landings in the Fall (t)
INSHORE			
Isle Verte 16A	147	3	2
Chaleur Bay 16B	25,412	24,116	24,089
Escuminac-West PEI 16CE	9,360	9,642	9,642
Magdalen 16D	350	0	0
Pictou 16F	9,162	8,986	8,967
Fisherman's Bank 16G	9,162	8,982	8,974
4Vn (Area 17)	350	0	0
Total Inshore	**53,943**	**51,729**	**51,674**
Seiners (>65') 4T	**16,057**	**8,840**	**7,770**
Grand Total	**70,000**	**60,569**	**59,444**

2005 SPRING FISHERY

Area	Spring Spawner Final Allocation	Spring Season Landings (t)	Spring Spawner Component Landings in the Spring (t)
INSHORE			
Isle Verte 16A	35	1	1
Chaleur Bay 16B (Jan-June 15)	590	*667	667
Escuminac 16C (Jan-May)	1,114	76	76
Magdalen Islands 16D (Jan-June15) *	2,114	* 1,095	1,095
Southeast NB – West PEI 16E (Jan-May)	3,753	1,682	1,670
16F	239	513	423
16G	103	267	79
June (16A-G), Reserve and 4Vn	524	195	3
Total Inshore	**8,472**	**4,496**	**4,014**
Seiners (>65') 4T	**2,528**	**0**	**0**
Grand Total	**11,000**	**4,496**	**4,014**

**16D and part of 16B (Gaspésie) landings include bait fishery catches 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 components, 77% of the TAC is allocated to the inshore fleet and 23% to the seiner (>65') fleet.

2005 Percentage of Spring and Fall Spawning Components

		Spawning Group %	
Season	**Gear**	**Spring**	**Fall**
Spring	Inshore	89	11
	Seiner	0	0
Fall	Inshore	1	99
	Seiner	12	88

The TAC for the fall spawner component in 2005 was 70,000t, compared to 73,000t in 2004 (Figure 1). The seiner allocation for 4Vn (Area 17) is included with the fall spawner component. The combined 2005 **landings of the fall spawner component** in both the spring and fall fisheries were 59,924t. There was no fishery in the 4Vn (Area 17) overwintering area by the purse seine fleet.

Total Fall Component Landings (000s t)

Year	Average 90-2001	2002	2003	2004	2005
TAC	68.8	51.5	62.0	73.0	70.0
Landings	50.0	53.1	60.9	43.2	59.9

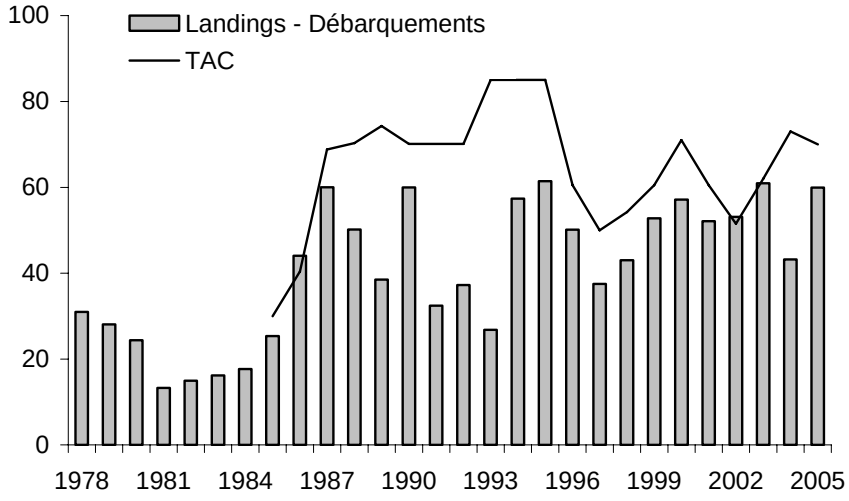


Figure 1. 4T Total Fall Spawner Component Landings and TAC (000t).

In 2005, the fall spawner TAC was not attained mostly because seiners only caught approximately 50% of their share of the allocation. For the **fall spawner component,** the 2000 year-class (age 5) was dominant in the 2005 **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 (Figure 3).

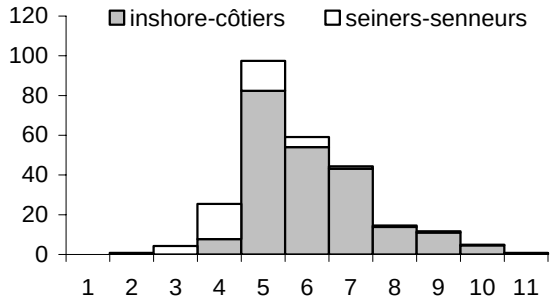


Figure 2. Fall Spawner 2005 Catch-at-Age (millions of fish).

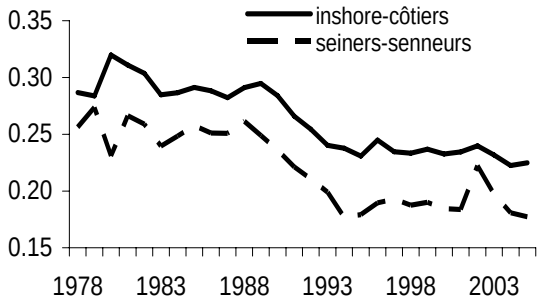


Figure 3. Weight (kg) of 5-Year-Old Fall Spawners.

The 2005 TAC for the spring spawner component was 11,000t compared to 13,500t in 2004 (Figure 4). The combined 2005 **landings of the spring spawner component** in both the spring and the fall fisheries were 5,139t.

Total Spring Component Landings (000s t)

Year	Average 90-2001	2002	2003	2004	2005
TAC	18.3	8.0	11.0	13.5	11.0
Landings	19.4	10.4	9.3	8.4	5.1

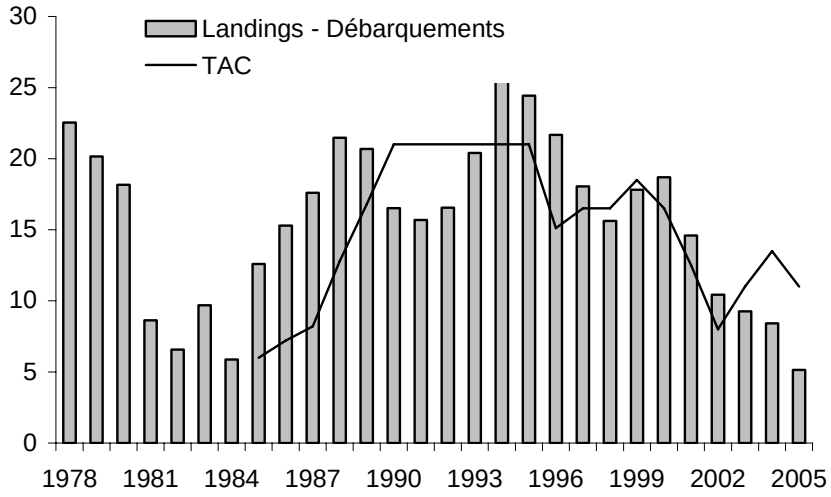


Figure 4. 4T Total Spring Spawner Component Landings and TAC (000t).

The 2005 spring spawner component TAC was not reached. There was no spring seiner effort; also the 16C Escuminac gillnet fishery caught only 7% of their allotted quota and the Magdalen Islands 16D and Northumberland Strait 16E gillnet fisheries caught approximately half of their allotted quotas.

The **catch-at-age** of the 2005 **spring spawner component** was dominated by the 1999 (age 6) and the 2001 (age 4) year-classes (Figure 5). Since 1990, average **weights-at-age** for the spring spawner component also have been below those observed during the 1980s (Figure 6).

Figure 5. Spring Spawner 2005 Catch-at-Age (millions of fish).

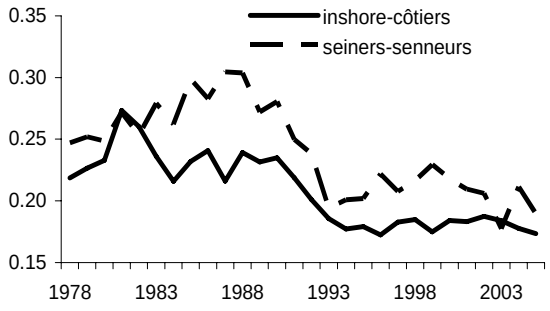


Figure 6. Weight (kg) of 5-Year-Old Spring Spawners.

ASSESSMENT

Fall Spawner Component

Stock Trends and Current Status

The **acoustic survey** in 2005 indicates that abundance was higher than in 2004. For the fall spawning component, this index is not used to calibrate the population analysis because it does not follow year-class strength consistently.

The 2005 **telephone survey** of fish harvesters indicated that the abundance of fall herring was considered either the same or higher than in 2004 in all areas.

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 2005. The mean CPUE in 2005 was higher than in 2004 and remains high compared to the mid-1990s.

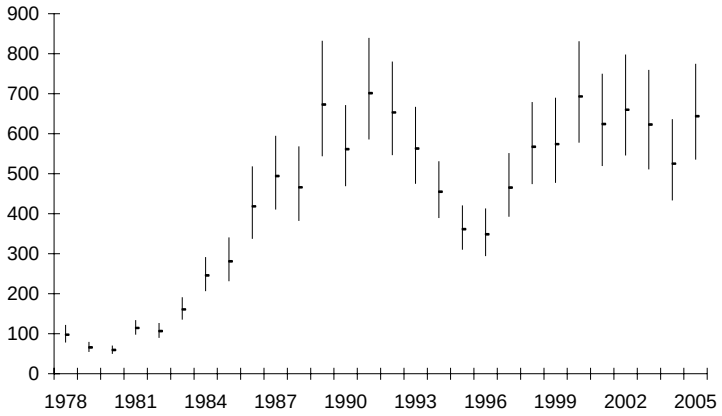


Figure 7. Fall Spawner CPUE index (kg/net/trip).

Retrospective patterns (in this case, a tendency to overestimate stock abundance) were present in recent assessments and were compensated by reducing the estimated numbers. However, with the addition of the 2005 data, recent biomass estimates were close to those obtained in the previous assessment, suggesting that the retrospective pattern is reduced or does not exist. As a result, it was considered that no reduction of population estimates was necessary for the beginning of 2006 (Figure 8).

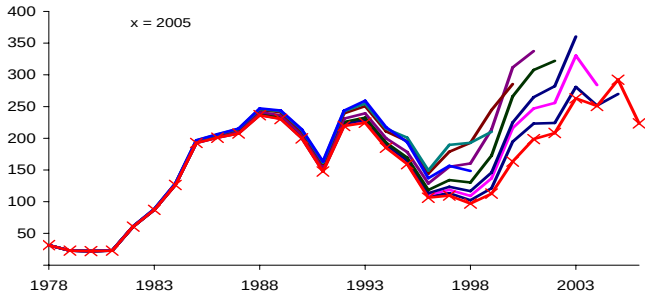


Figure 8. Fall Spawner age 5 – 10 biomass (000t) retrospective.

Recruitment estimates (age 4) from the analysis (Figure 9) suggest that the abundance of the 1995, 1996, 1998 and 2000 year-classes is above average and that overall abundance is currently high. The analysis indicates that **spawning population biomass** (Figure 10) of age 4+ fall component peaked in 2004, when the large 1998 and 2000 year-classes were contributing to the fishery. The 2006 beginning-of-year age 4+ spawning biomass is estimated to be about 283,600t and remains amongst the highest levels since 1978, well above the upper stock reference (USR) biomass level of 172,000t. The target **exploitation rate** ($F_{0.1}$) (Figure 11) for fall spawner component is about 25% for fully recruited age-groups (5+). Exploitation rate remains below the target.

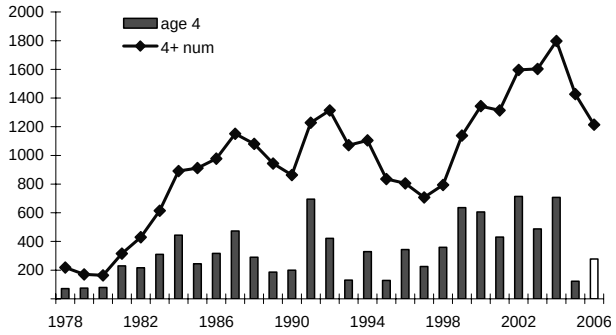


Figure 9. Fall Spawner Component Population Numbers (millions of fish). Age 4 in 2006 is the geometric mean of 1978-2005.

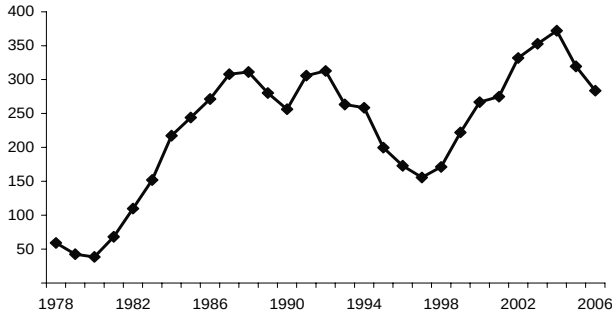


Figure 10. Fall Spawner Component 4+ Biomass (000t).

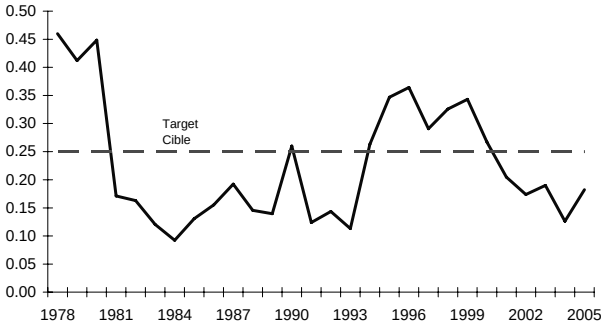


Figure 11. Fall Spawner Age 5+ Exploitation Rate.

Sources of Uncertainty

Retrospective patterns continue to be a **source of uncertainty**. In recent years, this is the first time that the estimates of population size for the previous year are higher than those estimated in the previous assessment, suggesting that retrospective pattern may be reduced. While 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 (2002-2004) as there are no estimates of recruitment prior to age 5 in 2006.

Conclusions and Advice

Overall, the stock appears to remain at a high level relative to the late 1970's and early 1980's. Estimated recruitment at age 4 has been above average from 1998 to 2004, but below average in 2005. The $F_{0.1}$ estimation of fall spawner catch for 2006 is 68,800t. Fishing at the $F_{0.1}$ level

will result in an 18% decline in 4+ spawning biomass for 2007. Fishing at $F_{0.1}$ is usually considered a safe exploitation rate, but it does not preclude fluctuations in biomass.

It is also possible to estimate the uncertainties regarding stock size and then use these in **risk analyses** (Figure 12). These analyses can provide some guidelines for decision making. The risk analyses considered the probability of exceeding $F_{0.1}$, and those of obtaining a 5% or a 10% decline in biomass. For example, it indicates that a 50% probability of a 10% decline in biomass corresponds to a catch of 52,000 t.

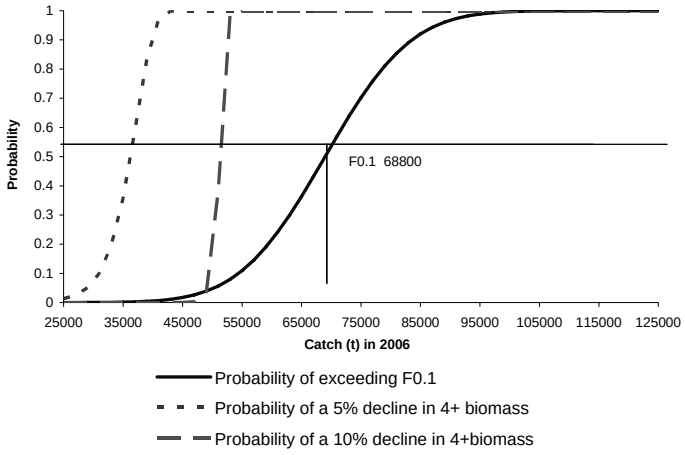


Figure 12. Risk Analysis for the Fall Component.

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

Stock Trends and Current Status

Opinions of fishers in the **telephone survey** indicate that abundance has declined 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 fishermen from Gulf 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 2005** (Figure 13) was similar to that in 2004, and remains near the lowest in the series that starts in 1990.

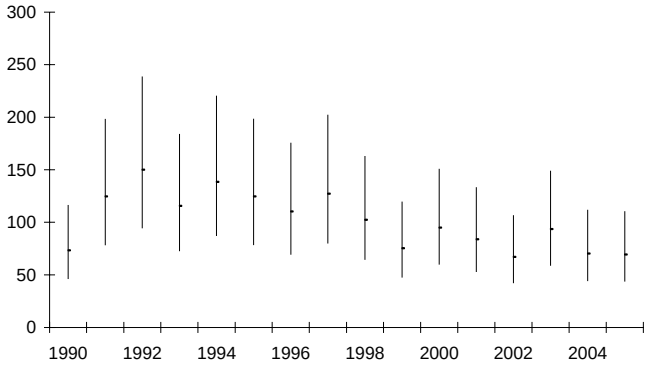


Figure 13. Spring Spawner CPUE index (kg/net/trip).

The 2005 **acoustic survey abundance** (Figure 14) of the age 4+ spring spawner component was slightly higher than in 2004, but combined abundance for ages 2 to 8 was lower. The 2005 acoustic index remains near the lowest in the series.

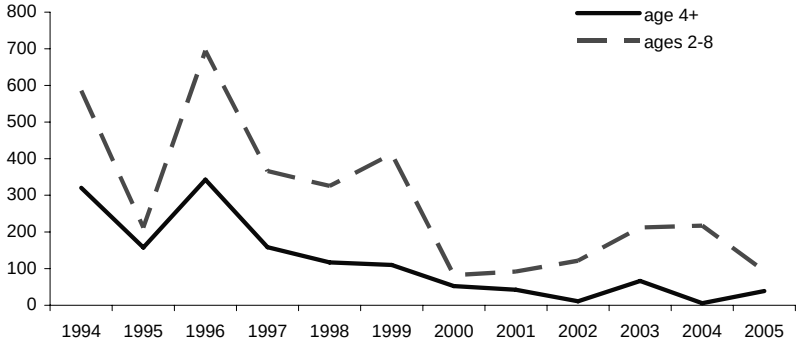


Figure 14. Spring Spawner Component Acoustic Survey Index (millions of fish).

The population analysis showed no retrospective pattern. Although two indices were used, more weight was given to the CPUE index which is more internally consistent.

Recruitment estimates (age 4) from the analysis (Figure 15) indicate that most year-classes after 1991 were below average. The 1997, 1999 and 2001 year-classes appear to be slightly above average. The 1998 year-class is below average as is the 2000 year-class (age 5 in 2005) which is estimated as the lowest observed since the 1978 year-class. The analysis indicates that both spawning **population abundance and biomass** (Figure 16) of the 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 - 10 spawning biomass is estimated to be about 50,600t at the beginning of 2006. The target **exploitation rate** at $F_{0.1}$ for the spring spawner component is about 27% over fully recruited ages 6 to 8. The estimated exploitation rate (Figure 17) has been close to the target in recent years. The exploitation rate in 2005 was below the target. The lower catches and estimated improved recruitment in 2005 contribute to the slight increase in biomass for 2006.

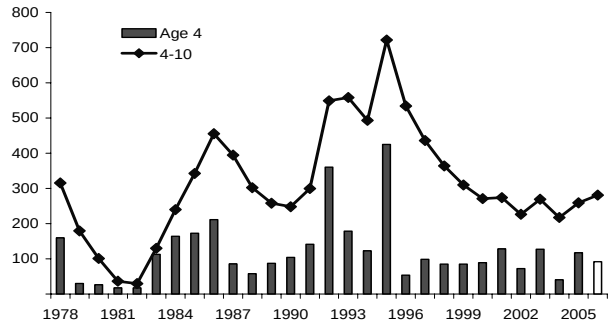


Figure 15. Spring Spawner Component Population Numbers (millions of fish). Age 4 in 2006 is the geometric mean of 1978-2005.

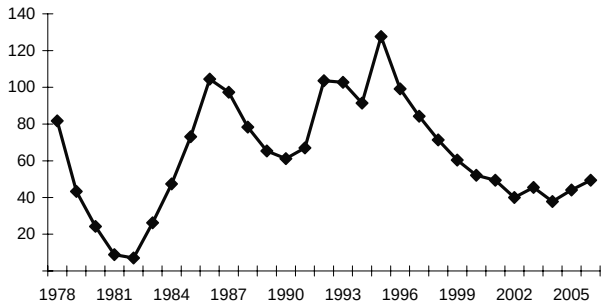


Figure 16. Spring Spawner Component Age 4 to 10 Biomass (000t).

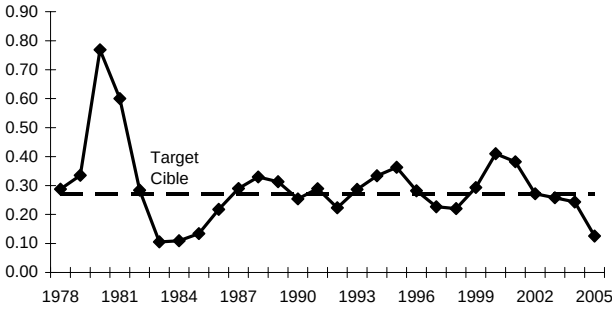


Figure 17. Spring Spawner Exploitation Rates (ages 6 to 8).

Sources of Uncertainty

Recent gillnet catch rates remain near the lowest in the time series that starts in 1990 and are a **source of uncertainty**. Views from fishermen from the traditionally important areas in terms of landings (e.g. 16 C and E) are that catch rates may represent an overestimate. In particular, the amount of effort used may be underestimated as trips with no catch do not have to be reported. There are no recruitment estimates for ages 2 to 4 for 2006.

Conclusions and Advice

The **risk analyses** (Figure 18) conducted were: 1) the probability of exceeding $F_{0.1}$, 2) the probability of a 5% increase in biomass, and 3) the probability of a 10% increase in biomass. The estimate of the $F_{0.1}$ catch for the spring spawner component in 2006 is 12,600t. The risks associated with different catch levels can be examined. For example, the 50% probability of a 5% increase in biomass corresponds to a catch of 7,500t. For a 10% increase in biomass, a catch of slightly less than 5,000t would be required.

The upper stock reference (USR) biomass level for spring spawning herring is 54,000 t. Below this level of biomass, the application of the precautionary approach requires that the exploitation rate be reduced below $F_{0.1}$ and harvest strategies that promote rebuilding be adopted. The current estimate of ages 4-10 biomass (50,000 t) is below the USR. Given the current state of spawning stock biomass, catch levels below 7500 t (5% increase) are advised.

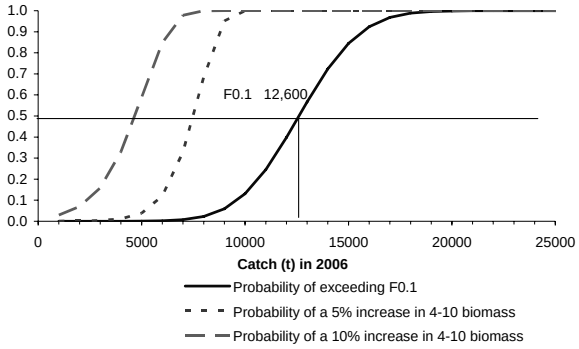


Figure 18. Spring Spawner Component Risk Analysis.

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 very large declines, as reflected by catches, in some areas. Specifically, landings in the Escuminac gillnet fishery (herring fishing area 16C) were only 7% of their allotted quota. This area was the location of an important spawning ground and historically supported a large spring fishery. Given the current state of the spring spawner component, harvesting strategies that promote rebuilding should be strongly considered.

SOURCES OF INFORMATION

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