

Southern Gulf of St. Lawrence Herring

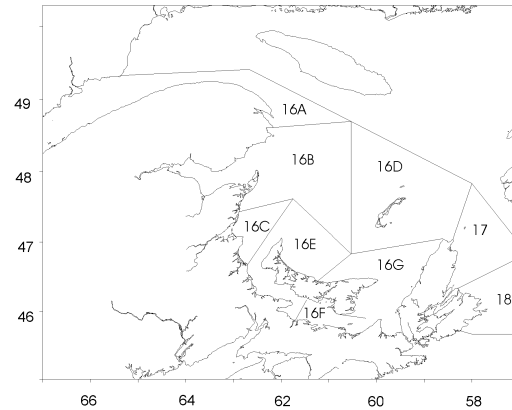
Background

Herring are a pelagic species which form schools during feeding and spawning periods. Herring in the southern Gulf of St. Lawrence consist of two components, spring spawners and fall spawners. Spring spawning occurs primarily in May but extends into June at depths <10m. Fall spawning occurs from mid-August to mid-September 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 Escuminac and southeast New Brunswick areas and the largest fall spawning population is in Chaleur Bay.

The stock area for southern Gulf of St. Lawrence herring is the area extending from the north shore of the Gaspé Peninsula to the northern tip of Cape Breton Island and includes the Magdalen Islands. Adults overwinter off the east coast of Cape Breton 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 inshore fleet harvests >97% spring spawners in the spring and fall spawners in the fall. The purse seine fleet harvests on average about 70% spring spawners 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 and harvests 60-70% fall spawners.

TAC management was initiated in 1972. Currently there are approximately 3,500 inshore licenses and 6 active seiners (>65'). These seiner catches are restricted by the requirement that no more than 10% of the catch for any day can be below 24.5 cm fork length.



Summary

Fall Spawners

- Reported 1999 landings of fall spawners were 54,441t compared to the fall spawner TAC of 60,500t.
- There were no 4T herring caught in the overwintering fishery in 4Vn. Participants in the fishery reported that this was the result of high numbers of small fish and herring being inaccessible to the gear, rather than a problem with abundance.
- Inshore catch rates were the highest since 1978. The acoustic and bottom trawl survey indices are at moderate levels. Opinions of abundance expressed during the phone survey of the inshore fleet generally indicated an increase in abundance from 1998 to 1999.
- The 1995 year-class was estimated to be the highest since 1978, while the 1994 year-class was estimated to be the second highest.
- The estimated 4+ biomass for 2000 was the highest since 1978.

- The age 7+ exploitation rate in 1999 was slightly below the target.
- The estimated catch at $F_{0.1}$ for 2000 is 71,000t.

Spring Spawners

- Reported 1999 landings of spring spawners were 17,304 t compared to the TAC of 18,500t.
- Inshore catch rates in 1999 were the lowest in the time series. These catch rates likely underestimate biomass because the fishery opened after herring had arrived on the spawning beds.
- The 1995 year-class (age 5) is near average and the 1996 year-class (age 4) is estimated to be near the second largest in the time series since 1978.
- Because of the uncertainties related to the spring gillnet catch rates, two estimates of population size were calculated. Both indicate that 4+ spawning biomass in 2000 is high. The estimates are 80,000 and 121,000 t.
- The age 4+ exploitation rate has been at or below the target rate in recent years.
- The two estimates of the $F_{0.1}$ fishing level for 2000 are 15,000 and 22,000 t. The estimate for 2000 from the previous assessment was 16,000t.
- Risk analyses indicated that it would be prudent to set the TAC for 2000 closer to the lower estimate of 15,000 t.

The Fishery

The TAC has been set separately for spring and fall spawners since 1985. The 1999 allocation of the southern Gulf of St. Lawrence herring TAC was at 77% for the inshore fleet and 23% for the seiner (>65') fleet. The TAC for fall spawners in 1999 was 60,500t, compared to 58,448t in 1998.

1999 FALL FISHERY (Statistics Branch)

Area	Allocation	Landings (t)
INSHORE		
Isle Verte	363	6
Chaleur Bay	21,209	21,672
Escuminac-West PEI	7,260	8,276
Magdalen	1,513	389
Pictou	7,503	5,957
Fisherman's Bank	7,503	8,909
Small Seiners	666	524
4Vn	605	22
Total Inshore	46,622	45,337
SEINERS (>65')		
Chaleur Bay	9,678	9,104
4Vn	4,200	0
Total Seiners	13,878	9,104
Grand Total	60,500	54,441

The 1999 TAC for spring spawners was 18,500 t. compared to 16,500 t. in 1998.

1999 SPRING FISHERY
(Statistics Branch)

Area	Allocation	Landings (t)
INSHORE		
Isle Verte (Jan-June 15)	146	79
Chaleur Bay (Jan-June 15)	897	277
Escuminac (Jan-May)	4,598	2,474
Magdalen (Jan-June 15)	1,346	2,699
Southeast NB – West PEI (Jan-May)	5,719	3,970
Pictou (Jan –June 15)	336	106
East PEI (Jan-June 15)	284	67
Bait and Roe all 4T (Jan –June 30)	776	2,320
4Vn	148	495
Total Inshore	14,250	12,487
SEINERS(>65') (All 4T)	4,252	4,817
Grand Total	18,502	17,304

The percentage of spring and fall spawners 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.

Percentage of spring and fall spawners by season and gear type for 1999

Season	Gear	Spawning Group %	
		Spring	Fall
Spring	Inshore	97	3
	Seiner	64	36
Fall	Inshore	1	99
	Seiner	25	75

The TAC and landings are separated by spawning group. The allocation for 4Vn is included with the fall spawners because over 83% of the landings in this fishery have been fall spawners since 1992.

Fall spawner landings (000s t)

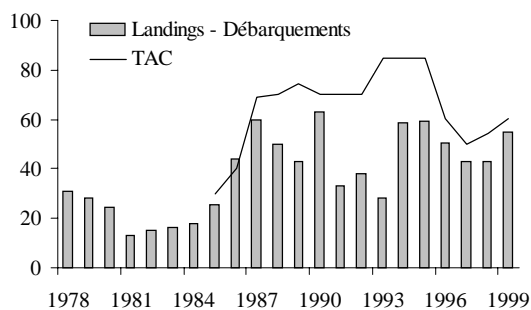
Year	1985-95	1996	1997	1998	1999
TAC	68.6	57.6	54.2	58.5	60.5
Landings	49.4	54.6	42.9	43.0	54.4

Spring spawner landings (000s t)

Year	1985-95	1996	1997	1998	1999
TAC	16.1	17.0	16.5	16.5	18.5
Landings	17.6	21.4	16.2	15.7	17.3

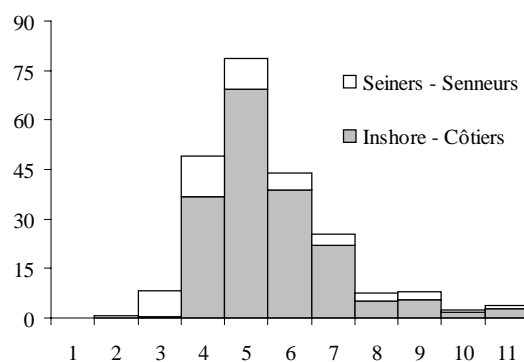
Since 1988, **landings of fall spawners** have been below the TAC. Fall inshore landings are primarily market driven. The primary market for the fall inshore fleet, which has 77% of the allocation, is the roe market. The price for roe herring in 1999 was 10 cents/pound, an increase of 3 cents/pound from 1997 and 1998. The TAC was not reached in certain areas because the market became saturated.

4T Fall Spawner landings and TAC (000 t)



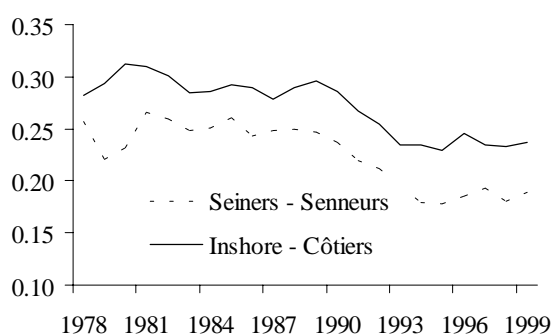
The 1994 year-class (age 5) was dominant in the 1999 catch of fall spawners. There were no 4T herring caught in the overwintering fishery in 4Vn. Participants in the fishery reported that this was the result of high numbers of small fish and herring being inaccessible to the gear, rather than a problem with abundance.

Fall Spawner 1999 Catch at Age (millions of fish)



Since 1990, the **average weight** of age 5 fall spawners has been below those observed during the 1980s. A similar pattern is observed for other ages. This decline in mean weights has leveled out since 1993. Weights at age of fall spawners in the inshore fishery are higher than for seiners largely because the inshore exploit fish containing roe on spawning grounds. Seiners catch mostly spent or maturing fish off the spawning grounds.

Fall Spawners Weight at Age 5 (kg)

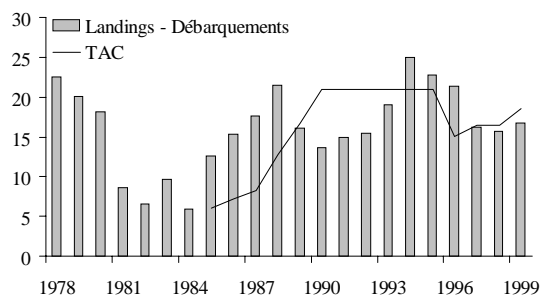


Landings of spring spawners were close to the TAC in 1999, as in 1997 and 1998. However, indications are that the fishery of 1999 was opened only after herring had arrived on the spawning beds.

The market for the spring fishery is different from that of the fall fishery. Spring herring caught by the inshore fleet are sold primarily

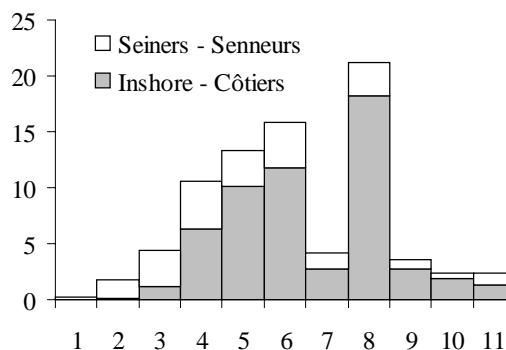
for bait and to the bloater (smoked herring) markets. The price for spring herring in 1999 was 13 cents/pound, an increase of 5 cents/pound from 1998. There is a small experimental fishery using trapnets for roe-on-kelp in Escuminac and southeast New Brunswick in May-June.

4T Spring Spawner Landings and TAC (000 t)



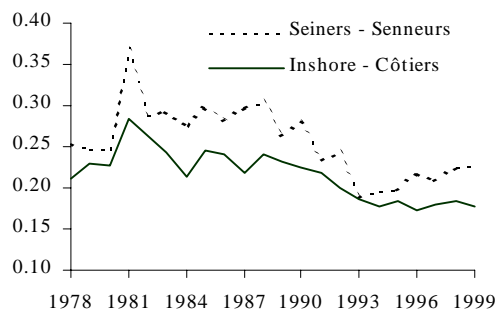
The 1991 year-class (age 8) was dominant in the 1999 **spring spawner catch**. The 1993 year-class (age 6) was the second most abundant age in the catch.

Spring Spawner 1999 Catch at Age (millions of fish)



Average **weights-at-age** of age 5 spring spawners caught since 1990 have, like most other ages, been below those observed during the 1980s. This decline in mean weights has stopped and they have started to increase for most ages. Weights-at-age of spring spawners are higher for seiners because that fishery occurs later in the year.

Spring Spawners Weight at Age 5 (kg)



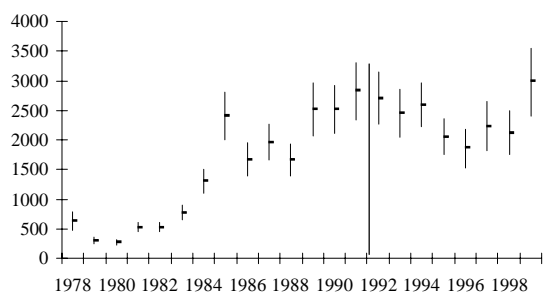
FALL SPAWNERS

Resource Status

Resource status of 4T fall spawning herring was determined using a population analysis that combines two sources of information: the fishery catch-at-age and an abundance index determined from catch rates in the inshore fishery.

The **abundance index** used to estimate stock status is based on inshore catch rates determined from purchase slips and a phone survey of 20-25% of the active inshore fishers to determine effort. This index covers the entire inshore fleet and extends from 1978 to 1999. Catch rates in 1999 were the highest in the time series.

Fall Spawner Catch Rate (kg/net/trip)



The abundance index was split into two time periods (line in graph) for the population analysis. The time periods were (1978-

1991), when a greater percentage of the fleet used 2 5/8" mesh compared to the more recent time period (1992-1999), when an increasing percentage of gillnetters have been using larger mesh.

The 1999 acoustic survey index also indicates that abundance increased from 1998 to 1999, however the estimate is near the average for the time series.

Fall Spawners Acoustic Survey (4+ numbers)



The 1999 **bottom trawl survey index** (for spring and fall spawners combined) is at intermediate levels and continues to be higher than the low levels observed in the late seventies.

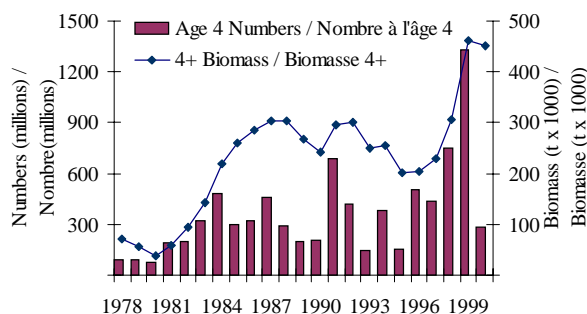
Opinions of abundance expressed by fishers during the annual phone survey of the inshore fleet indicated an increase from 1998 to 1999. In addition, quota in 1999 was reached more quickly than in recent years.

The dominance of the 1994 and 1995 year-classes in the commercial fishery and the acoustic surveys suggest that these year-classes are well above average abundance.

Estimated **population biomass** of age 4+ fall spawners in 2000 was about 450,000t, similar to that of 1999, the highest since 1978. The increase in biomass from 1998 to 1999 is due to the 1995 year-class, which is estimated to be the most abundant since

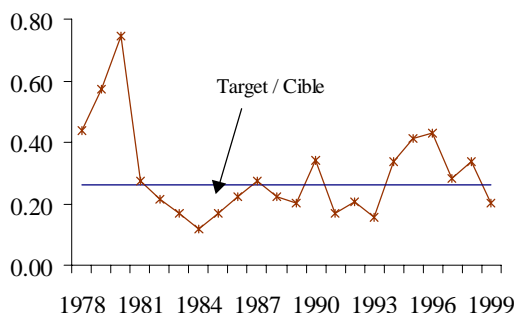
1978. The 1994 year-class is estimated to be the second highest in abundance. The 1996 year-class was not estimated and is set at the average value over the time series.

Fall Spawners Stock Size



The target **exploitation rate** for fall spawners is 26% for fully recruited age-groups (7+). Exploitation rate has been near the 26% target in recent years.

Fall Spawner 7+ Exploitation Rate



Sources of Uncertainty

Even with improvements in the estimates by splitting the catch rate index into two time series to account for the shift in mesh size, there still appears to be a tendency to overestimate 4 year-olds in the most recent year. Last year's analysis indicated that the 1994 year-class was the highest in the time series. The current analysis continues to indicate that the 1994 year-class is large, but is now estimated 15% lower than in the 1999

assessment. Therefore, the tendency to overestimate year-classes is a major source of uncertainty in this assessment. The 1995 year-class is estimated as the most abundant in the time series, nearly twice the estimates of the next largest year-classes.

A change in the exploitation pattern was also observed in the fishery in the last two years. It is unclear whether this is a permanent change. If it is, the target exploitation rate would need to be re-calculated in future years.

Outlook

The $F_{0.1}$ fall spawner fishing level for 2000 is 71,000 t. The preliminary $F_{0.1}$ level for 2001 is 69,000 t. These levels take into account the tendency to over-estimate age 4 fall spawners. This was done by discounting population numbers for that age group in 2000 by 15%. It is estimated that the 1995 year-class would account for 40% of the catch weight in 2000. Changes in the estimate of this year-class in subsequent assessments will have a major effect on future $F_{0.1}$ fishing levels.

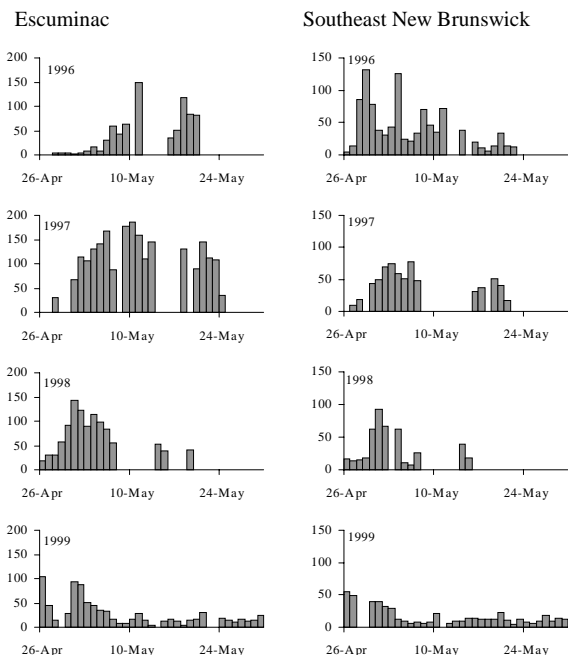
SPRING SPAWNERS

Resource Status

Resource status of the 4T spring spawning herring was determined using a similar approach to that of the fall. The analysis was complicated by the late opening of the 1999 fishery in southeast New Brunswick, Escuminac and western Prince Edward Island, which affected the CPUE index used in the population analysis. Normally, catch rates are low at the beginning of the fishery and increase as herring arrive on the spawning grounds, then decline as herring

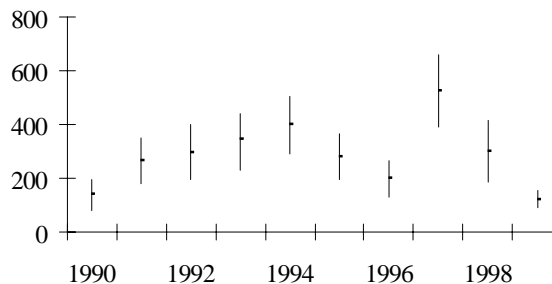
leave. In 1999, catch rates were the highest for the season at the beginning of the fishery, suggesting that the peak of the spawning run may have been missed. As a result, catch rates for the spring fishery in 1999 are likely biased downwards.

Spring Spawners Daily Catch per Unit Effort (kg/trips/nets)



The spring catch rate model included catch data for Escuminac and southeast New Brunswick from the New Brunswick market co-ordination program from 1990 to 1996 and data from dockside catch monitoring programs from 1997 to 1999. Effort was the average number of nets used in each area as determined by the phone survey. Catch rate was defined as kg/net/trip. Catch rates in 1999 were the lowest since 1990 and are considered to be under-estimated.

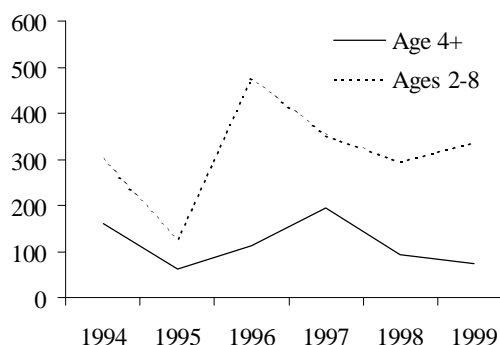
Spring Spawner Catch Rate (kg/net/trip)



Opinions of abundance obtained from fishers contacted in the **phone survey**, in the two main fishing areas (Escuminac and Southeast New Brunswick) were that herring abundance was lower in 1999 than 1998. These areas account for about 70% of the spring inshore landings. Other areas indicating a decline in abundance were western P.E.I. and Chaleur Bay. An increase was reported in the Magdalen Islands.

Abundance of spring spawner age 4+ numbers in the 1999 **acoustic survey** for years in which the same areas were surveyed (1994-1999) in Chaleur Bay was lower in 1999 than in 1998. However, the index for ages 2 to 8 indicates a slight increase from 1998.

Spring Spawners Acoustic Survey (millions of fish)



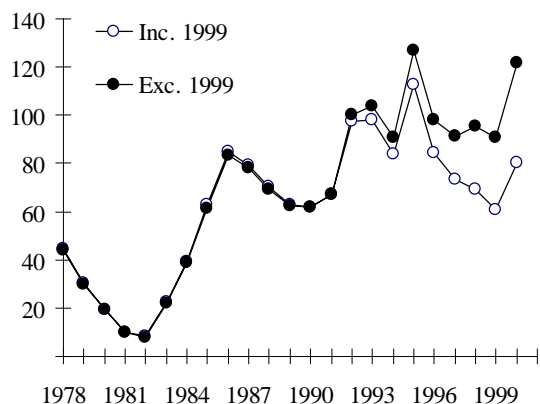
Biomass estimates from the September bottom trawl survey (spring and fall spawners combined) were similar in 1998 and 1999.

Because of the problems with the 1999 catch rate, the analysis using only the gillnet catch rate index, which was used in the past, was not considered to provide realistic estimates of population size in 2000.

Two analyses of the stock status are provided. The first included the gillnet catch rate index and the acoustic survey index. Because of the biased catch rates in 1999, this was considered to provide the lower bound of population size. The second analysis also included both indices but the estimate of gillnet catch rate in 1999 was excluded. However, because of the retrospective pattern and the exclusion of the 1999 gillnet catch rate, this was considered to provide an upper bound of population size. The precision of the population estimates for the two analyses were relatively similar.

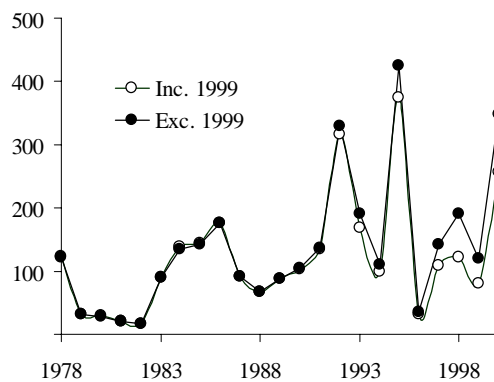
The analysis including the entire gillnet catch rate index and acoustic survey indicated that **population biomass** of age 4+ spring spawners peaked in 1995, when the largest year-class estimated since 1978 came into the fishery as four year-olds (1991 year-class). It then declined to 1999. In the last year, population biomass has increased to 80,000 t, a level comparable to 1996. The estimates of population biomass for the analysis using the two indices but excluding the 1999 gillnet catch rate showed a similar trend to the one including the 1999 gillnet catch rate with the exception that the decline after 1995 has been less pronounced. The 2000 biomass estimate (121,000 t) is near the highest observed since 1978.

Biomass estimates (4+) from the two population analyses (thousands of tonnes)



Recruitment estimates from the analysis using the two indices (including the 1999 gillnet catch rate) showed that the 1994 (age 6) and 1993 (age 7) year-classes are above average. The 1995 year-class (age 5) is near average and the 1996 year-class (age 4) is estimated to be near the second largest since 1978. The high estimate for the 1996 year-class is consistent with independent indices from the fishery and research data (acoustic survey, catches from the roe-on-kelp trap and experimental gillnets). The analysis that excludes the 1999 commercial gillnet catch rates showed a similar trend but the estimates of recent year-classes were higher.

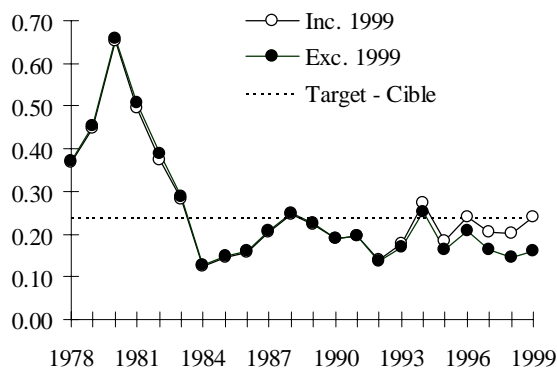
Recruitment estimates (age 4 numbers in thousands) from the two population analyses



The target **exploitation rate** at $F_{0.1}$ used for spring spawners is 24% calculated for ages

4+. The estimated exploitation rate from the analysis including the 1999 gillnet catch rate indicated that it has been at the target in recent years. The analysis excluding the 1999 gillnet catch rates gave lower exploitation rates.

Exploitation rates (age 4+) from the two population analyses



In summary, both views of the resource indicate that the 4T spring spawning herring stock remains near the highest values observed in the time-series starting in 1978.

Sources of Uncertainty

The major source of uncertainty in the estimation for spring spawners is the gillnet CPUE index for 1999. As outlined before, there are indications that the 1999 catch rates are underestimated; however the magnitude of the bias is unknown. The estimates of recent year-classes, which are well above average, are typically less precise because they have only been sampled for a few years.

Positive indicators for this stock are that the recent year-classes are above average in abundance. Several sources of information indicated that the 1996 year-class is well above average.

Negative aspects are that catches and abundance in Chaleur Bay are poor. Industry

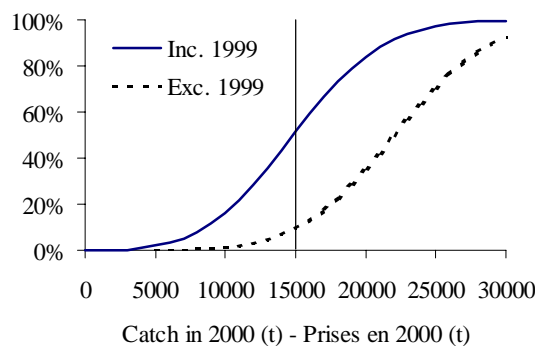
have expressed concerns regarding the abundance of spring spawners in Chaleur Bay for several years. In addition, the gillnet catch rates in the 1999 fishery were anomalous because of the late opening of the fishery.

Outlook

The $F_{0.1}$ fishing level for spring spawners in 2000 are, respectively, 15,000 t and 22,000 t for the analyses including and excluding 1999 catch rates. The corresponding preliminary estimates for 2001 are 17,000 t and 25,000 t. The preliminary estimate provided in 1999 for the 2000 fishing season was 16,000 t.

To assist decision-makers, risk analyses were conducted for the two scenarios. If the more optimistic analysis is correct, there is about a 10% probability of exceeding the target level in 2000 at a TAC of 15,000 t. If the more pessimistic scenario is correct, there is a 91% probability of exceeding $F_{0.1}$ at a TAC of 22,000 t. Even at the 1999 TAC of 18,500 t, the probability of exceeding $F_{0.1}$ would be 75% given the pessimistic scenario.

Probability of exceeding $F_{0.1}$ for the two population analyses



Given the large estimated incoming recruitment, there would be no loss in future yield by being cautious. Therefore, it would

be prudent to set the TAC for 2000 closer to the lower estimate of 15,000 t.

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