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Quebec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2005/016

West Coast of Newfoundland Atlantic Herring (Division 4R) in 2004

Background

This document presents an assessment of the main fishery and biology data gathered for the two spawning herring stocks of the west coast of Newfoundland (Clupea harengus harengus L.) in NAFO Division 4R (Figure 1) in 2004. It follows the 2004/17 Stock Status Report published in March 2004, which presented the results of a complete analytical assessment of the spring-spawning herring stock.

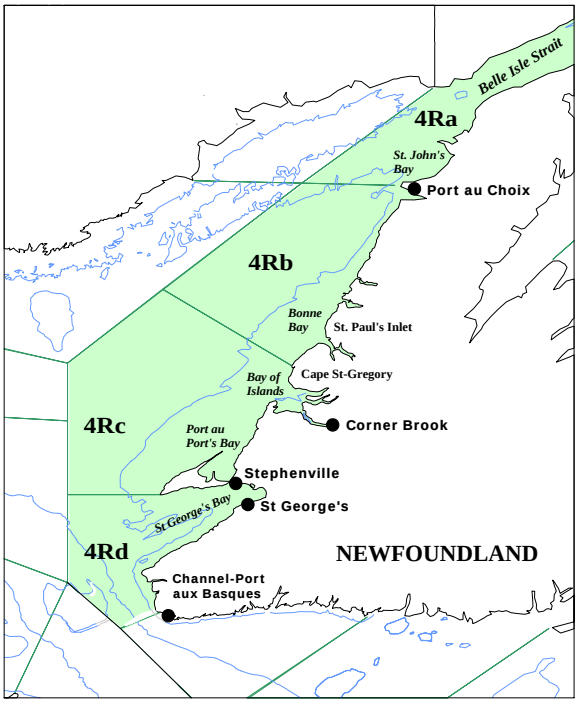

Figure 1. Map of Unit Areas of NAFO Division 4R on the west coast of Newfoundland (Division 4R is identified by the coloured area).

Summary

- Preliminary landings of herring for the west coast of Newfoundland have dropped from 15,131 t in 2003 to 14,477 t in 2004. Most of these landings were made in the fall by purse seine fishermen in Unit Areas 4Rc and 4Rd.
- For three years now, herring catches from the spring-spawning stock were characterized by the 1996, 1997 and 1999 year-classes. These year-classes alone accounted for 67 % of the catches made in 2004. For fall spawners, the 1996 and 2000 year-classes accounted for 53 % of the catches.
- Worrisome biological indications have been observed in herring of the west coast of Newfoundland. A significant drop in the mean age of the herring harvested has been observed over the last 30 years. Between 2000 and 2003,

an increase in the proportion of mature fish at 3 and 4 years of age has been observed in spring-herring catches, indicating maturation at an increasingly younger age. The condition of spring and fall spawners has increased slightly in 2004 after having dropped dramatically in 2003.

- The abundance index for spring spawners from the gillnet index fishery in the St. George's Bay and Port au Port Bay has been on the rise since 1998. In 2002, this index reached the same level as that observed in the late 1980s due to the 1994, 1995 and 1996 year-classes, whose abundance is above average. However, this index has been dropping since 2003.
- In 2004, only two logbooks were completed on a voluntary basis by gillnet fishermen. This lack of cooperation greatly limits our ability to monitor the evolution of the two spawning herring stocks of the West Coast of Newfoundland.
- A Sequential Population Analysis (**SPA**) was conducted using abundance index data from the gillnet fishery and the acoustic survey for the spring spawner stock. The **SPA** diagnostics indicate that this type of analysis is no longer possible without also using an acoustic survey.
- The acoustic survey provided the only abundance index for fall-spawning herring. Because no survey has been conducted since 2002 and because there is no gillnet fishery index, no detailed scientific advice can be given regarding stock size and allowable catch levels for 2005.
- Without acoustic surveys or other indices measuring the abundance of young age groups in particular, we can no longer conduct analytical assessments for these two spawning stocks. Future scientific advice will be based essentially on biological indicators provided by the analysis of commercial samples and relative abundance indices based on commercial fishery data. To ensure minimum information, we **recommend** that the utilisation of logbooks be mandatory for all gillnet fishermen and that the commercial sampling program be maintained.
- To promote the conservation of both spawning herring stocks on the west coast of Newfoundland, we **recommend** that the fishing effort be distributed along the entire coast and over the entire year.

The fishery

Historical outlook

The two herring stocks of the west coast of Newfoundland are harvested separately during spawning gatherings or collectively when the stocks are mixed between April and December. These stocks are mainly harvested by a fleet of large (>65') and small (<65') seiners, and by many gillnet fishermen. From 1990 to 2003, landings made using the three types of gear averaged 15,285 t per year (Table 1). The average annual landings were 10,859 t for large seiners, 2,915 t for small seiners, and 1,368 t for gillnetters. Herring is also harvested for bait. These catches are not accounted for and could be substantial, especially since the crab (*Chionoecetes opilio*) and lobster (*Homarus americanus*) fisheries have recently shown record highs.

Landings in 2004

Preliminary herring landings in 2004 totalled 14,477 t, compared with 15,131 t in 2003 (Table 1). Seiners met their TAC quotas almost entirely, whereas gillnetters' landings were limited as a result of market problems. The majority of landings were made at the end of the year, and in a very limited sector (Port au Port Bay and St. George's Bay) in Unit Areas 4Rc and 4Rd (Figure 1).

Total herring landings showed a downward trend between the mid-1980s and the late 1990s (Figure 2). The decline can be mainly attributed to a decrease in spring spawner

Table 1. Herring of the west coast of Newfoundland: surveyed landings (t) by NAFO Unit Area, fishing gear and TAC since 1990.

AREA AND GEAR	YEAR															AVERAGE
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004**	(1990-2003)
4Ra	457	576	902	852	1 017	2 283	2 584	2 572	4 128	1 653	1 981	2 613	1 604	1 290	185	**1 751**
4Rb	4 191	6 948	4 147	2 218	5 711	3 273	2 952	3 451	7 729	4 766	2 995	2 643	2 621	714	560	**3 883**
4Rc	7 434	2 493	1 391	1 030	3 052	7 321	8 173	5 300	5 891	3 088	6 469	6 379	7 660	2 594	5 860	**4 877**
4Rd	5 202	16 420	8 896	11 211	2 599	3 133	1 115	1 637	611	1 201	1 471	1 589	1 232	10533	7872	**4 775**
Gillnet*	836	779	552	139	747	1 658	2 175	1 802	4 217	869	1 277	1 216	1 257	1 630	405	**1 368**
Small seiner	0	0	4 390	3 752	3 854	3 392	3 072	3 053	4 435	2 599	3 153	3 418	3 382	2 307	2 972	**2 915**
Large seiner	16 301	25 594	10 277	11 309	7 634	10 814	9 473	7 751	9 468	7 147	8 427	8 344	8 392	11 090	11 100	**10 859**
Others	147	63	117	108	146	148	104	354	239	93	59	246	86	104	0	**144**
TAC	***35 000***	***35 000***	***35 000***	***35 000***	***35 000***	***22 000***	***22 000***	***22 000***	***22 000***	***13 000***	***15 000***	***15 000***	***15 000***	***20 000***	***20 000***	
GRAND TOTAL	**17 284**	**26 436**	**15 336**	**15 308**	**12 381**	**16 012**	**14 824**	**12 960**	**18 359**	**10 708**	**12 916**	**13 224**	**13 117**	**15 131**	**14 477**	**15 285**

* Include bar seine and cod traps

** Preliminary data

catches (Figure 3), which have been rising since 1999. Annual fall-spawner landings have been increasing since 1992, exceeding those of spring spawners between 1996 and 2001 and in 2003 (Figure 3).

Description of landings

The population structure of the two spawning herring stocks of the west coast of Newfoundland is characterized by the periodic appearance of dominant year-classes, whose development can be tracked through catch-at-age or annual length frequencies. For spring spawners, the year-classes that have dominated the fishery since the late 1960s are those from 1959, 1968, 1974, 1980, 1982, 1987, 1990, 1994, 1996 and 1999 (Figure 4A). For fall spawners, the year-classes of 1973, 1979,

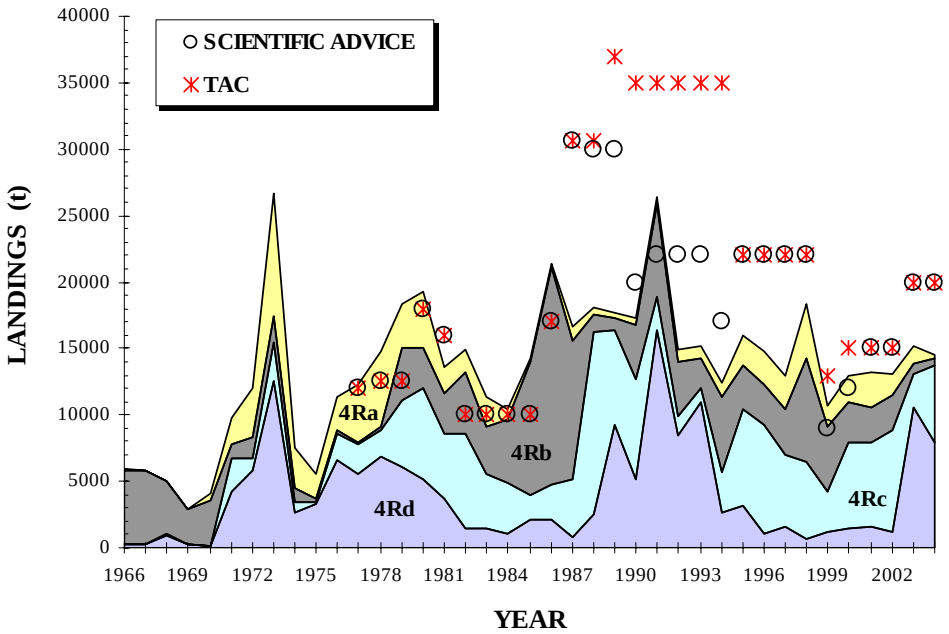

Figure 2. Cumulative commercial herring landings (t) for Unit Areas of NAFO Division 4R, 1966 to 2004 (TAC and scientific advice shown).

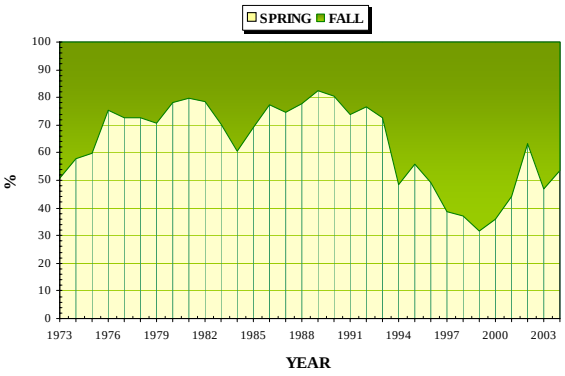

Figure 3. Annual landings contribution (%) of spring and fall-spawning herring, 1973 to 2004.

1988, 1990, 1995, 1998 and 2000 have dominated the catch since the early 1980s (Figure 4B). Between 1973 and 1980, fall spawning stock was characterized by the presence of a large number of fish aged 11 or over. The abundance of these older fish might be attributable to the low harvesting rates during the period in question and to the presence of herring from the southern Gulf of St. Lawrence in commercial samples.

The mean age of spring and fall spawners dropped between the mid-1970s and 1985, rose through 1990, and subsequently fell again (Figure 5). Data obtained in 2003 are among the lowest recorded since 1965. The mean age of spring and fall spawners has increased since 2000 and 2003 respectively. Nevertheless, the 2004 values are still lower than those recorded in the 1970s.

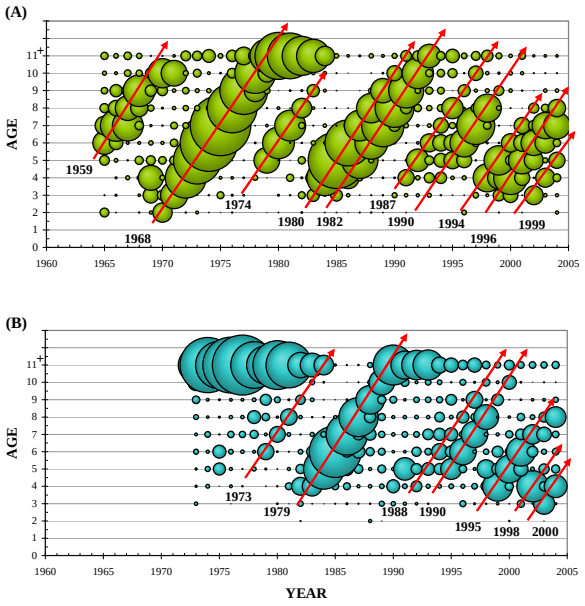

Figure 4. Catch-at-age (%) of spring spawners (A) and fall spawners (B) for year-classes sampled since 1965 (dominant year-classes are also shown).

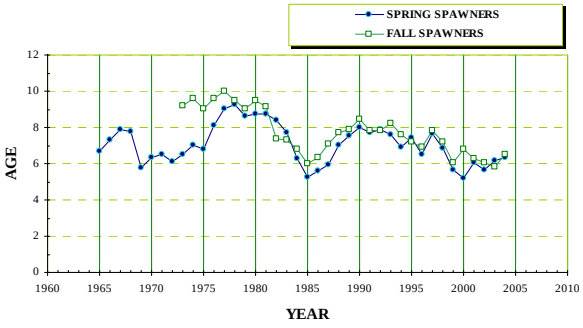

Figure 5. Mean age of spring and fall-spawning herring caught in NAFO Division 4R, 1965 to 2004.

Biology of the resource

Growth

In 2004, the mean weight of 2-year-old spring-spawning herring was 0.105 kg, compared with 0.434 kg for 11-year-old herring. For fall herring, mean weights at these ages were 0.067 kg and 0.408 kg, respectively. These values are all superior to those recorded in 2003. For both spawning groups, the mean weights at age measured in the 1970s, 1990s and 2000s were lower than those measured in the 1980s (Figures 6A and 6B).

Condition

In 2003, the condition of both spring and fall spawners declined sharply, following major gains between 1998 and 2002 (Figure 7). Levels recorded in 2002 were the highest since the commercial sampling program began. The decline in the condition of stocks in 2003 was observed in all age

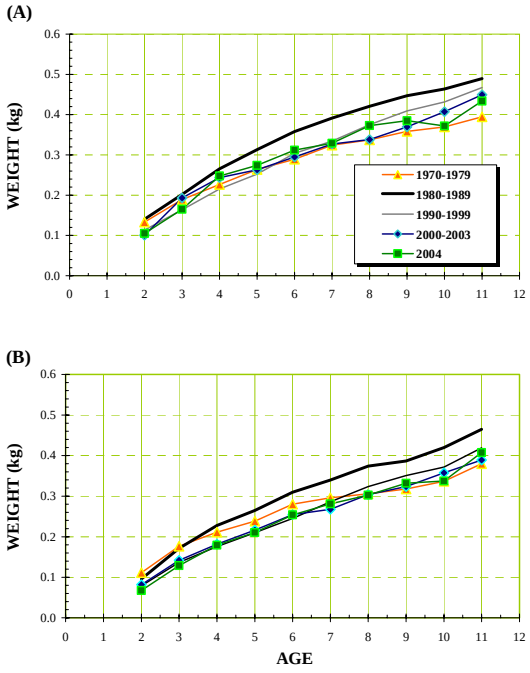

Figure 6. Mean weight-at-age (kg) of spring-spawning (A) and fall-spawning (B) stock calculated since 1970 using biological data collected at dockside (fourth quarter).

groups. However, a small increase was observed in 2004.

Maturity

By age 5, almost all herring in both spawning groups reach sexual maturity (Figure 8). On average, from 2000 to 2003, the maturity percentages at ages three and four were 69% and 99%, respectively, for spring spawners (Figure 8A), and 12% and 78%, respectively, for fall spawners (Figure 8B). In recent years, age at sexual maturity has dropped for spring spawners compared with that in the 1970s and 1980s.

Feeding and predation

In the mid-1980s, the data showed that herring in the northern Gulf of St. Lawrence fed mainly on small (< 5 mm) zooplankton (Figure 9), mostly copepods. New estimates made in the mid-1990s and early 2000s indicated that small and large zooplankton (euphausids, amphipods) represent the two main prey for herring. During these three

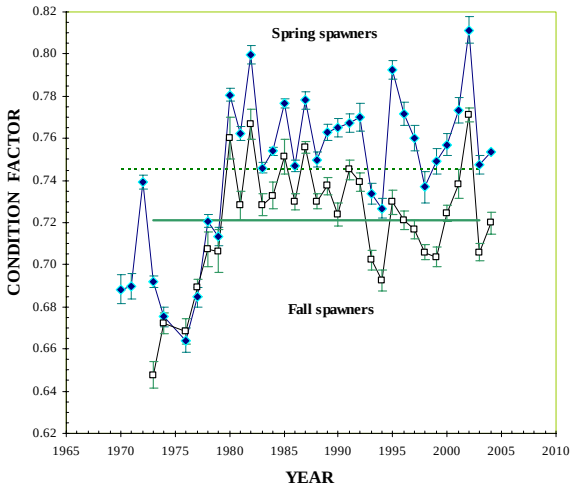

Figure 7. Mean annual condition factors (± 2 standard errors) for spring and fall-spawning herring, calculated from October to December (mean values are indicated by the horizontal lines).

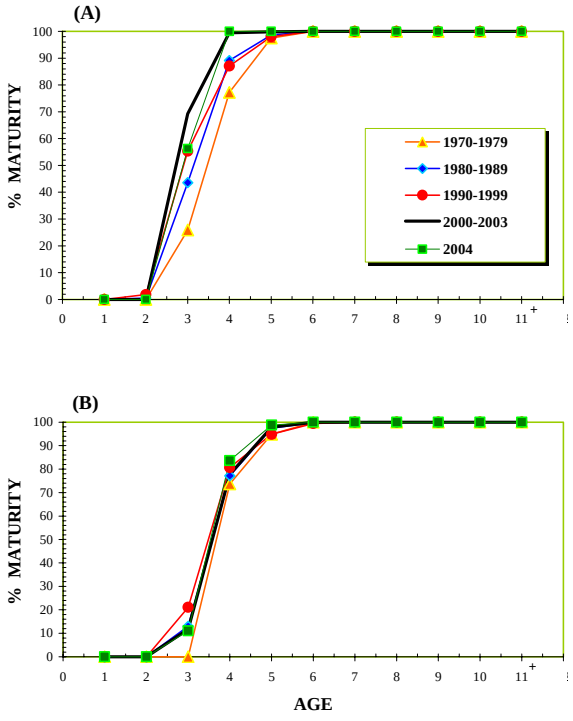

Figure 8. Mean maturity percentages at age for spring spawners (A) and fall spawners (B), calculated since 1970.

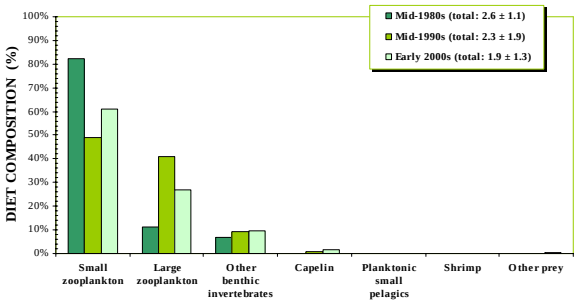

Figure 9. Diet composition (%) of herring in the Northern Gulf of St. Lawrence from the mid-1980s to the early 2000s (C. Savenkoff and M. Castonguay, DFO, MLI, pers. comm.).

periods, benthic invertebrates accounted for approximately 10% of the herring diet.

Results from a model of the northern Gulf of St. Lawrence marine ecosystem indicate that the main causes of mortality for herring during the mid-1980s were redfish (*Sebastes* sp., 24% of total mortality), large cod (*Gadus morhua*, 20%) and the fishery (24%) (Figure 10). Cetaceans and the fishery were the two main causes of mortality (32% and 30% respectively) in the mid-1990s and early 2000s (20% and 34% respectively).

Resource status

Abundance indices

The first index measuring the abundance of the two spawning stocks came from an acoustic survey conducted in the fall every two or three years between 1991 and 2002. This survey no longer exists due to a lack of financial resources. The second index, still existing, concerns the standardized catches per unit effort (CPUEs) associated with a commercial gillnet fishery conducted on the spring spawning stock in St. George's Bay and Port au Port Bay (Figure 1). This index can be split in two according to whether the CPUEs are derived from index fishermen only (Figure 11A) or from the same fishermen plus a certain number of fishermen who completed logbooks on a voluntary basis (none in 2004) (Figure 11B). In both cases, the general trends were the same. The abundance of spring spawners would have decreased between 1985 and 1998. This decline would have been followed by an increase through 2002 due to the 1994, 1995 and 1996 year-classes, whose abundance is above-average. A drop has been recorded since 2002, more noticeably in the case of CPUEs calculated using all the logbooks (Figure 11B).

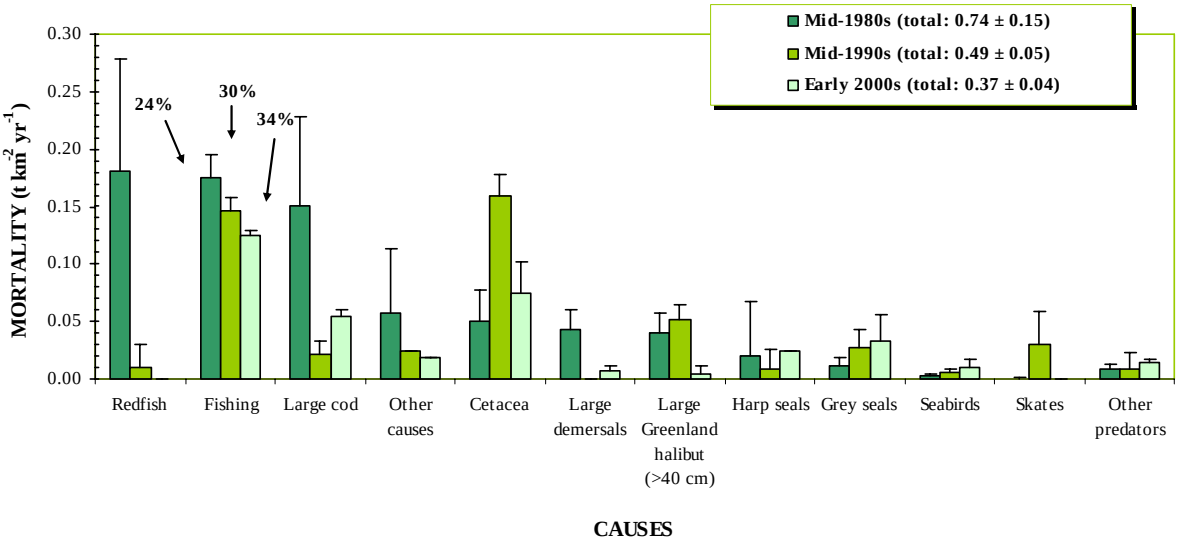

Figure 10. Main causes of herring mortality (t km^{-2} yr^{-1}) calculated using a model of the Northern Gulf of St. Lawrence marine ecosystem from the mid-1980s to the early 2000s (fishery-related mortality percentages are also included) (C. Savenkoff and M. Castonguay, DFO, MLI, pers. comm.).

The index fishermen' abundance index for the fall spawning stock also no longer exists since 1993 as the low number of participants led to the program's discontinuation. There is also no commercial index, because of the lack of logbooks (only 2 logbooks were completed in 2004).

Dispersion index

A dispersion index is calculated by indicator kriging using per-tow herring presence and absence data collected from bottom trawl surveys in the northern Gulf of St. Lawrence. This index, which represents the mean probability of finding herring, increased between 1990 and 1996 and between 1998 and 2000 (Figure 12). However, a drop in dispersion was recorded since 2001. This drop can also be observed by examining surface charts associated with very high probabilities of finding herring (Figure 13).

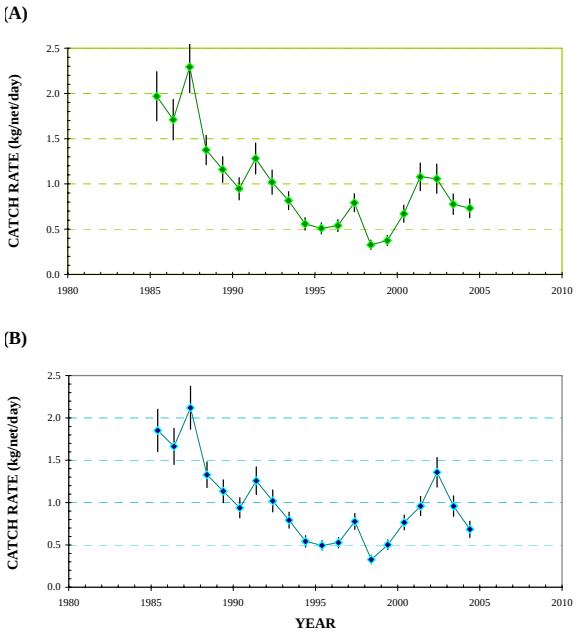

Figure 11. Standardized catch rates with 95% confidence intervals (kg/net/day) for spring-spawning herring, calculated using fishery and effort data from the index fishermen logbooks (A) and from the same logbooks plus the logbooks completed on a voluntary basis (B).

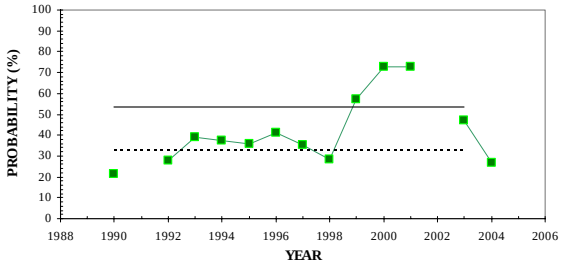

Figure 12. Mean probabilities (%) of finding herring in NAFO Division 4R. The horizontal lines indicate upper and lower limits of the confidence interval (95%) from the 1990s' average.

Outlook

Analytical assessment

A Sequential Population Analysis (**SPA**) was conducted for the spring-spawning stock using data from the gillnet abundance index (1985-2004) and acoustic survey (1991-2002). The diagnostics of this analysis showed serious adjustment problems and a significant discrepancy regarding projected numbers and biomasses for 2005 and 2006. Furthermore, the analysis indicated the presence of a retrospective pattern showing a tendency to overestimate the actual abundance of this spawning stock over recent years and underestimate it over previous years.

Without acoustic surveys or other indices measuring the abundance of younger age groups in particular, it will no longer be possible to conduct analytical assessments on these two spawning stocks. Moreover, for the first time since the beginning of the 1990s, it's no longer possible to give a detailed scientific advice on stocks size and the allowable catch levels. Future scientific advice will be essentially based on biological indicators provided by the analysis of commercial samples and relative abundance indices based on commercial fishery data.

Conservation measures

To promote the conservation of both spawning herring stocks of the west coast of Newfoundland, this advice **recommend**

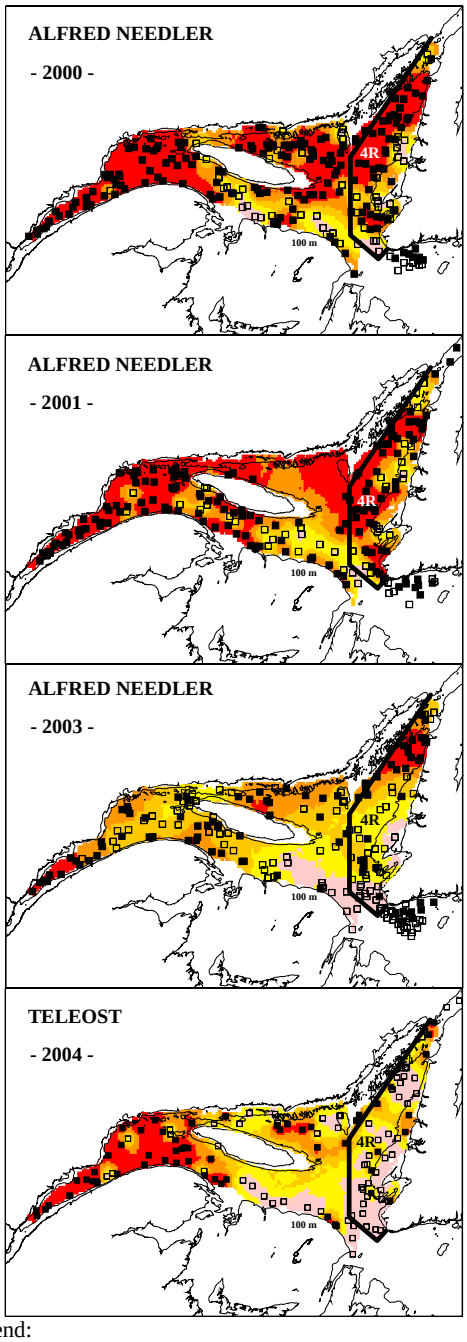

Figure 13. Herring presence probability surface contours (%) for the bottom trawl surveys conducted in the Estuary and Northern Gulf of St. Lawrence since 2000. Station positions, herring presence or absence, Division 4R, and the 100 m isobath are indicated.

that: (1) management measures be maintained to ensure protection of spring spawning activity in St. George's Bay; (2) fishing effort be distributed along the entire coast and over the entire year; (3) fishermen' involvement in the index fishery program and in the industry logbook program for spring spawners be increased; (4) the utilisation of logbooks by gillnet fishermen in the fall, and finally, (5) herring catches used as bait be monitored.

Precautionary approach

The Canadian precautionary approach framework was developed during national workshops held over the last few years. During these workshops, various limit reference points were studied and for the time being, a reproductive biomass target value ($\mathbf{B_{LIM}}$) was chosen. According to the conservation principles defined in the precautionary approach, the reproductive biomass of a stock should not drop any lower than this target and should also remain well above it. So far, the work carried out according to the precautionary approach on sea fish concerned the establishment of a minimum biomass limit ($\mathbf{B_{LIM}}$) calculated from a stock-recruitment relationship derived from a Sequential Population Analysis (**SPA**).

The minimum biomass limits for both herring stocks of the west coast of Newfoundland have been defined as being 20% of the maximum biomasses from the entire historical series. However, since it is no longer possible to conduct **SPA**s for these two stocks due to the absence of acoustic surveys, other options will have to be considered. Indicators such as catch levels, age structure, mean age, maturity at age, average weight at age, growth and condition could be used as starting points for developing a management strategy that would correspond to the conservation principles defined within the precautionary approach.

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