



West Coast of Newfoundland Atlantic Herring (Division 4R) in 2003

Background

Herring (*Clupea harengus harengus*) is a pelagic fish that frequents cold Atlantic waters. Its distribution in Canada extends from the coasts of Nova Scotia to the coasts of Labrador. It travels in tight schools, feeding primarily on plankton (copepoda and euphausiacea), spawning near the coast and wintering in open sea in deeper waters. The same herring return to the same spawning, feeding and wintering sites year after year. This homing phenomenon is attributed to a learning behaviour with the recruitment of young year-classes in a population. Most herring reach sexual maturity quickly, at four years, at a length of about 25 cm. During spawning, eggs attach themselves to the sea floor, forming a carpet several centimetres thick. Unlike other pelagic species, herring populations are characterized by two spawning groups: spring herring generally spawn in April and May, and fall herring in August and September. These two spawning groups are generally considered separate stocks.

In Canadian waters, herring are also harvested commercially, mainly southwest of Nova Scotia in the Bay of Fundy, in the southern Gulf of St. Lawrence and on Quebec's North Shore. Large herring catches are also made on the west coast of Newfoundland. This region extends from Unit Area 4Ra to the north to Unit Area 4Rd to the south (Figure 1). The main gear used is the purse seine, with average annual landings totalling 10,841 t for large seiners (>65') and 2,962 t for small seiners (<65') for the 1990–2002 period. After the seine fishery comes the gillnet fishery, whose landings average 1,348 t per year. The fishery on the west coast of Newfoundland is managed by a Total Allowable Catch (TAC) for both spawning stocks combined. In addition, because of the low biomasses calculated for the past few years, severe management measures to protect the spawning grounds in St. George's Bay have been applied to the spring spawning stock to let it rebuild.

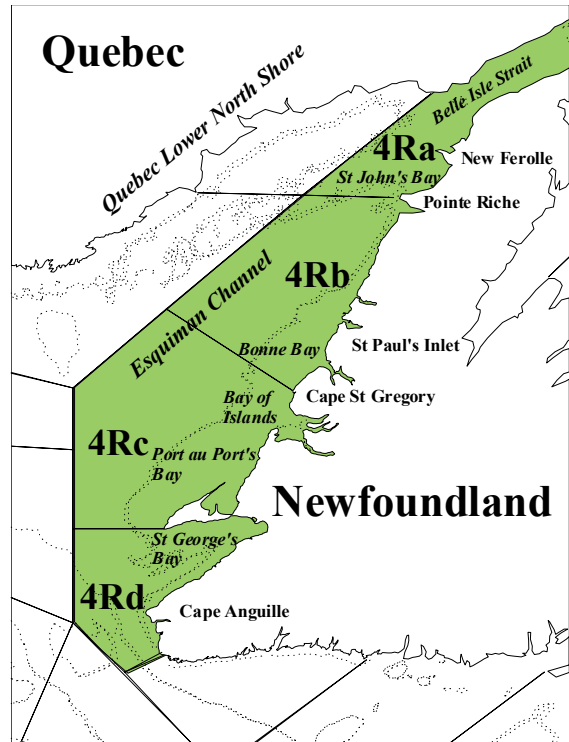


Figure 1. Map of Unit Areas of Division 4R on the west coast of Newfoundland (Division 4R is defined by the coloured area).

Summary

- In 2003, preliminary herring landings for the west coast of Newfoundland totalled 14,681 t, which is slightly above the 13,117 t landed in 2002, but lower than the TAC, which was set at 20,000 t. Most of these landings were made over a short period of time by large seiners in a very limited zone of Unit Area 4Rd.
- Worrisome biological indicators have been observed in herring. A significant drop in the mean age of the herring harvested has been observed over the last 30 years. Since 2000, 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 plummeted in 2003, following

- significant gains between 1998 and 2002.
- The abundance index for spring spawners from the gillnet fishery in St. George's Bay and Port au Port Bay has been on the rise since 1998. In 2002, the index reached the same level as that observed in the late 1980s. This increase is attributable to the 1994, 1995 and 1996 year-classes, whose abundance is above average. However, the index dropped slightly in 2003.
- A Sequential Population Analysis (SPA) was performed for spring spawners using abundance index data from the gillnet fishery and the acoustic survey. The results indicate a retrospective pattern showing a tendency to underestimate the real abundance of this stock, a tendency that now seems to be on the decline. Given these uncertainties, the SPA results and projections derived from the risk analysis must be used with caution.
- According to the SPA, the biomass of spring spawning stock rose from a record low of 32,559 t in 1997 to 74,944 t in 2002, dropping to 57,727 t in 2003. The probability of exceeding $F_{0.1}$ in 2004 would be under 50% for catches of less than 10,000 t.

- The acoustic survey provided the only abundance index for fall spawning herring. Because no survey was conducted in 2003 and because the commercial gillnet fishery has no index, no scientific advice can be given on the size of the stock and on the TAC for 2004. It is also unlikely that we will be able to provide advice on fall spawning stock in the years to come.
- Given the presence of worrisome biological indicators (drop in the mean age of the catch and maturation at an earlier age), the concentration of fishing effort in more limited areas and periods and the lack of information on fall spawning stock, we recommend that the TAC in 2004 be strictly limited at 20,000 t for both spawning stocks.

The fishery

Nominal catches

The various herring stocks on the west coast of Newfoundland are harvested separately during spawning gatherings and collectively when the stocks are mixed between April and December. These stocks are harvested mainly by a fleet of large (>65') and small (<65') seiners, and by many gillnet fishers. From 1990 to 2002,

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

AREA AND GEAR	YEAR														AVERAGE (1990-2002)
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003**	
4Ra	457	576	902	852	1 017	2 283	2 584	2 572	4 128	1 653	1 981	2 613	1 604	23	1 786
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	322	4 127
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	2 506	5 052
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	10546	4 332
Gillnet*	836	779	552	139	747	1 658	2 175	1 802	4 217	869	1 277	1 216	1 257	1 284	1 348
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	2 962
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	10 841
Others	147	63	117	108	146	148	104	354	239	93	59	246	86		147
TAC	<i>35 000</i>	<i>35 000</i>	<i>35 000</i>	<i>35 000</i>	<i>35 000</i>	<i>22 000</i>	<i>22 000</i>	<i>22 000</i>	<i>22 000</i>	<i>13 000</i>	<i>15 000</i>	<i>15 000</i>	<i>15 000</i>	<i>20 000</i>	
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	14 681	15 297

* Include bar senne and cod traps
 ** Preliminary data

landings made using the three types of gear averaged 15,297 t per year (Table 1). The average annual landings by type of gear were 10,841 t for large seiners, 2,962 t for small seiners, and 1,348 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 recently posted record highs.

In 2003, preliminary herring landings totalled 14,681 t, compared with 13,117 t in 2002 (Table 1). Seiners met their TAC quotas entirely; gillnetters' landings were limited as a result of market problems. The majority of landings were made over a short period of time, at the end of the season, in a very limited zone (St. George's Bay) in Unit Area 4Rd (Figure 1).

Total herring landings posted a downward trend between the mid-1980s and the late 1990s (Figure 2). The decline can be attributed chiefly to a decrease in the spring spawner catch (Figure 3), which was on the rise between 1997 and 2002, before declining again in 2003. Annual fall spawner

landings have been increasing since 1992, exceeding those of spring spawners between 1996 and 2001 and in 2003.

Description of catches

The population structure of the two herring spawning stocks on the west coast of Newfoundland is characterized by the periodic appearance of dominant year-classes, whose development can be tracked

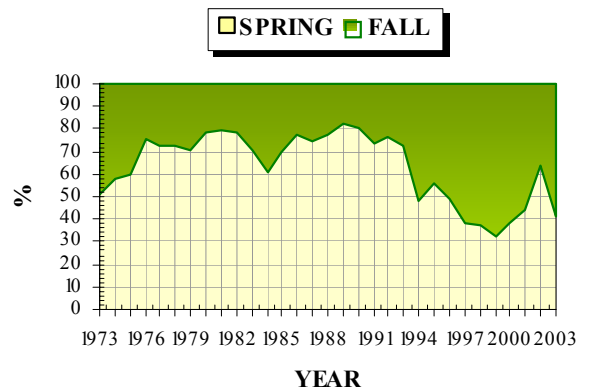


Figure 3. Annual landings contribution (%) of spring and fall herring, 1973 to 2003.

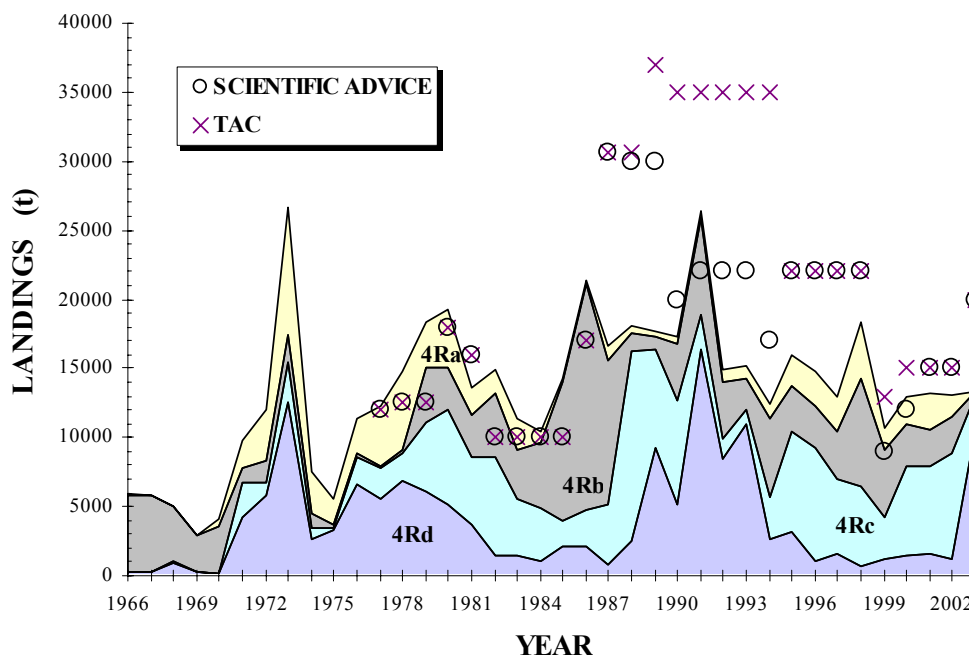


Figure 2. Cumulative commercial herring landings (t) for Unit Areas of NAFO Division 4R, 1966 to 2003 (TAC and scientific advice shown).

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, 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 or 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 consistently through 1990, and subsequently fell again (Figure 5). Data obtained in 2003 are among the lowest recorded since 1965.

Biology of the resource

Spawning grounds

Historically, the main spawning grounds of spring spawners have been located at the southern tip of the west coast of Newfoundland, in St. George’s Bay and neighbouring waters (Figure 1). Over the past few years, however, there have been many indications that other spawning grounds exist in large bays farther north. Since 1998, there has also been a higher proportion of spring spawning herring in the gillnet fishery samples taken from May and June in Unit Area 4Ra.

Fall herring spawn mainly north of Pointe Riche, in Unit Area 4Ra from mid-July to mid-September. At other times of the year, these herring can be found in the company of spring spawners in feeding and wintering areas. The main feeding areas are St. George’s Bay in spring, near Pointe Riche and in the Strait of Belle Isle (Figure 1) in summer, and the principal bays in the fall. Winter survey catches in the northern Gulf of St. Lawrence in the 1980s and early 1990s indicate that the herring winter in the deep waters of the Esquiman Channel (Figure 1).

Growth

En 2003, the mean weight of 2-year-old spring spawning herring was 0.099 kg, compared with 0.429 kg for 11-year-old

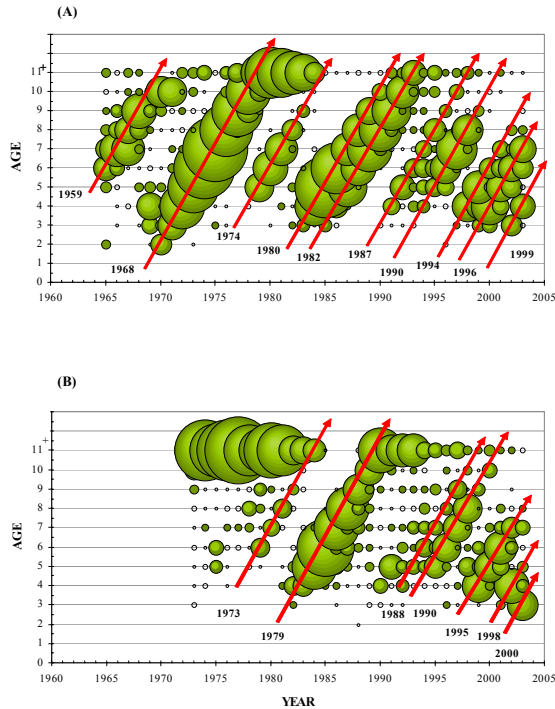


Figure 4. Catch-at-age (%) of spring spawners (A) and fall spawners (B) for year-classes sampled since 1965 (dominant year-classes are also shown).

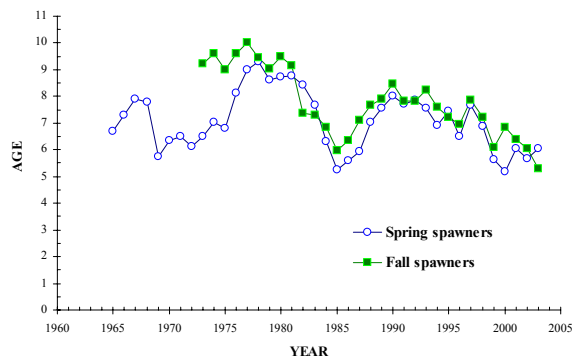


Figure 5. Mean age of spring and fall spawning herring in NAFO Division 4R, 1965 to 2003.

herring. For fall herring, mean weights at these ages were 0.089 kg and 0.387 kg, respectively. For both spawning stocks, the mean weights at age measured in the 1970s, 1990s and 2000s were lower than those measured in the 1980s (Figures 6A and 6B).

three and four were 73% and 99%, respectively, for spring spawners (Figure 8A), and 76% and 97%, respectively, for fall spawners (Figure 8B). Age at sexual maturity has dropped for both stocks in recent years, compared with that in the 1960s and 1970s.

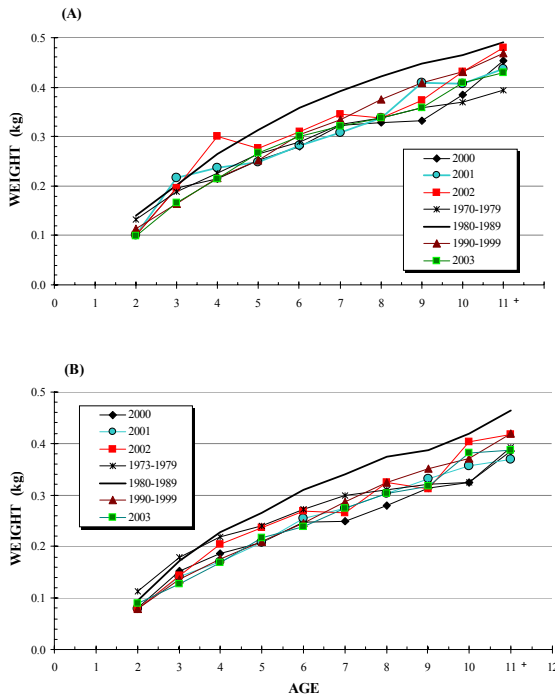


Figure 6. Mean weight-at-age (kg) of spring spawning (A) and fall spawning (B) stock calculated since 1970 using biological data collected at dockside (fourth quarter).

Condition

In 2003, the condition of both spring and fall spawning stocks declined sharply, following major gains between 1998 and 2002 (Figure 7). Values 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 groups.

Maturity

By age 4, almost all herring in both spawning stocks have reached sexual maturity (Figure 8). On average, from 2000 to 2003, the maturity percentages at ages

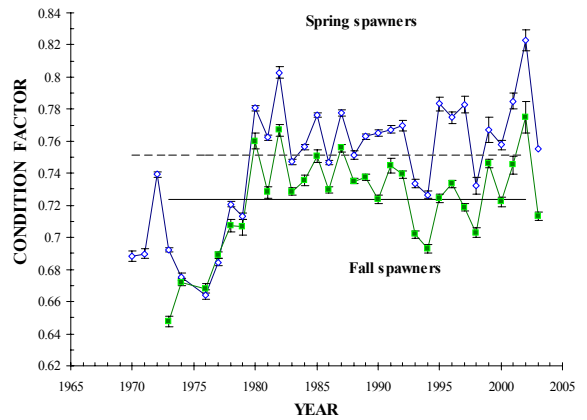


Figure 7. Mean annual condition factors (± 1 standard error) for spring and fall spawning herring, calculated from October to December (mean values are indicated by the horizontal lines).

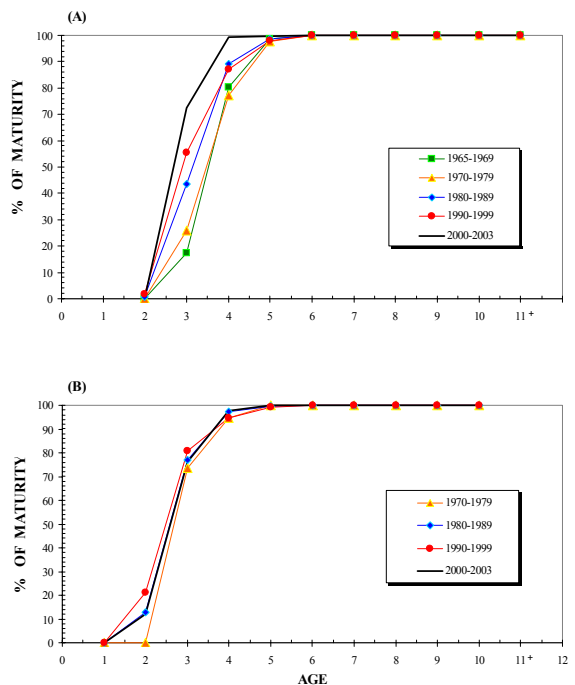


Figure 8. Mean maturity percentages at age for spring spawners (A) and fall spawners (B), calculated since 1965.

Predation

In the mid-1980s, the herring’s two main predators were redfish (*Sebastes* sp.) and large cod (>35 cm) (*Gadus morhua*) (Figure 9A). In the mid-1990s, new predation studies revealed that these two species had been replaced by cetaceans and large Greenland halibut (>40 cm) (*Reinhardtius hippoglossoides*) (Figure 9B).

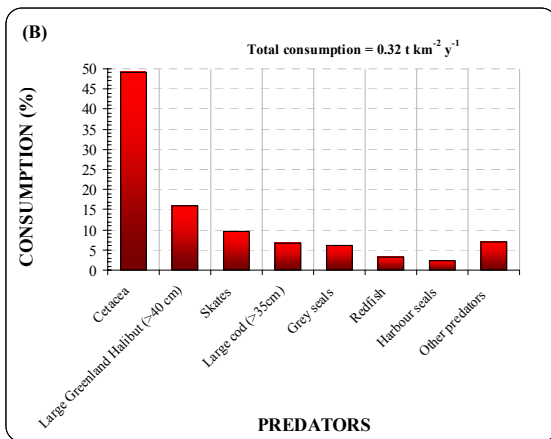
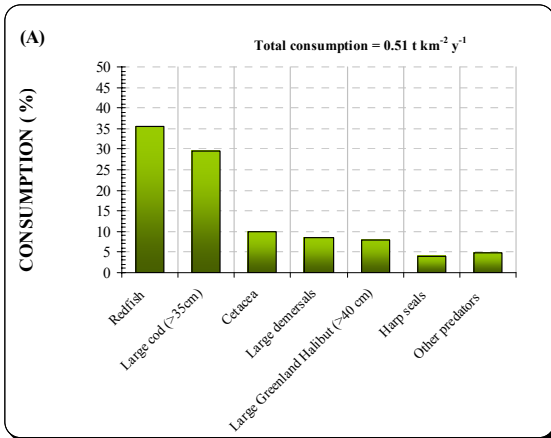


Figure 9. Consumption ($t\ km^{-2}\ year^{-1}$ as a %) of the herring’s main predators in the northern Gulf of St. Lawrence for the mid-1980s (A) and mid-1990s (B) (C. Savenkoff and M. Castonguay, DFO, MLI, pers. comm.).

Industry comments

For the 2003 season, the main comments taken from the annual questionnaire completed by gillnet fishers can be summarized as follows: (1) decline in the

abundance of herring caused by seiners and the fishery in general at spawning sites in spring and fall in Unit Areas 4Ra and 4Rb; (2) the abundance of herring in the spring in Port au Port Bay and in summer in Unit Area 4Rb; (3) the presence of small herring in the spring in Unit Area 4Rc and in the summer and fall in Unit Areas 4Ra and 4Rb; (4) the presence of large herring in the spring in Unit Area 4Rc; (5) problems caused by the presence of a large number of seals; (6) the lack of markets for the fixed gear industry.

According to some purse seiners, herring were very abundant in the fall. Seiners’ fishing effort on herring was directed only at the very end of the season because of the abundance and late presence of mackerel (*Scomber scombrus* L.). Nevertheless, the quota was met very quickly and many small herring were observed in catches from St. George’s Bay.

Resource status

Abundance indices

There are currently two relative abundance indices: one is based on an acoustic survey conducted in the fall every two or three years, and the other is associated with the commercial gillnet fishery (index fishers and industry logbooks) in St. George’s Bay and Port au Port Bay (Figure 1). According to the most recent acoustic survey, conducted in 2002, the abundance of the spring spawning stock fell between 1991 and 1995 and remained relatively stable until 2002 (Figure 10). The abundance of fall spawning stock rose between 1997 and 1999 and subsequently remained stable. The standardized gillnet catch rates for spring spawners declined between 1985 and 1998 (Figure 11), then rose continuously through 2002. This increase is attributable to the 1994, 1995 and 1996 year-classes, whose abundance is above-average. This index dropped slightly in 2003.

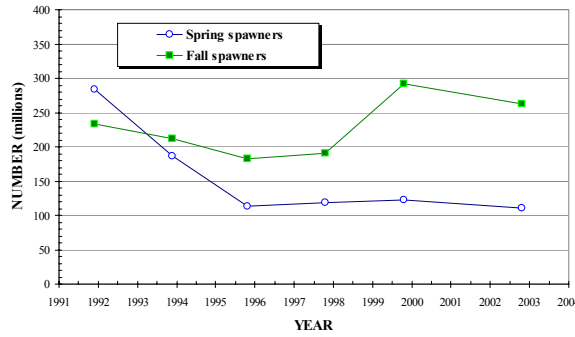


Figure 10. Abundance (millions) of spring and fall spawners calculated since 1991 using acoustic survey data.

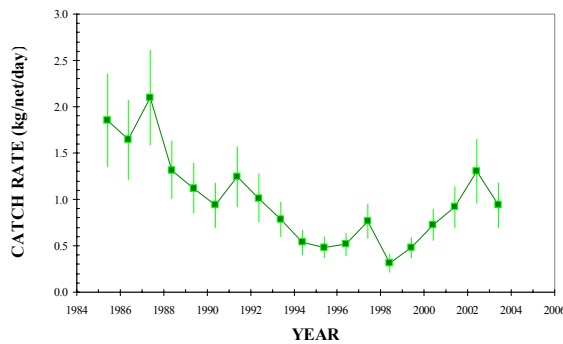


Figure 11. Standardized catch rates with 95% confidence intervals (kg/net/day) for spring spawning herring, calculated using fishery and effort data from index fisher and industry logbooks.

There has not been any index fishers' abundance index for the fall spawning stock since 1993, because the low number of participants led to the program's discontinuation. There is also no commercial index, because no logbooks are kept for this fishery, unlike in the spring stock fishery.

Analytical assessment

A Sequential Population Analysis (SPA) was performed for the spring spawning stock using the data from the gillnet abundance index and acoustic survey. The analysis of the findings showed a discrepancy between the gillnet index and the acoustic survey and major problems with the fit of the model. The analysis also

indicated the presence of a retrospective pattern showing a tendency to underestimate the abundance of this spawning stock (Figure 12A) and overestimate fishing mortality (Figure 12B). Consequently, the SPA findings and the catch projections for 2004 have to be interpreted with caution.

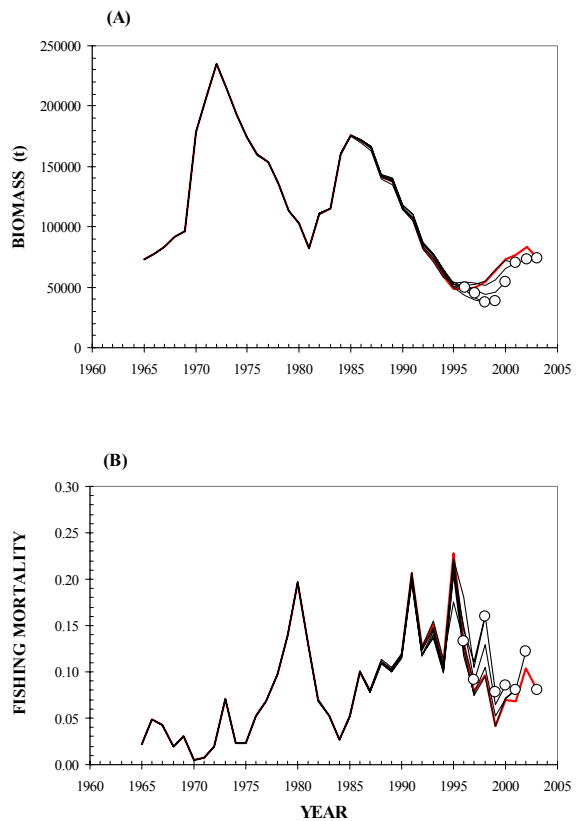


Figure 12. Retrospective pattern indicating the tendency to underestimate biomass (t) (A) and overestimate fishing mortality (B).

According to the SPA, the abundance of spring spawners increased in the early 1970s and mid-1980s (Figure 13). These periods are associated with the very high recruitment of the 1968, 1969, 1980 and 1982 year-classes (Figure 14). Fishing mortality for the oldest individuals (eight years and over) exceeded the $F_{0.1}$ threshold in the mid-1960s, in 1982, in 1983 and throughout almost all of the 1990s (Figure 15). In response to the management measures that have been applied since

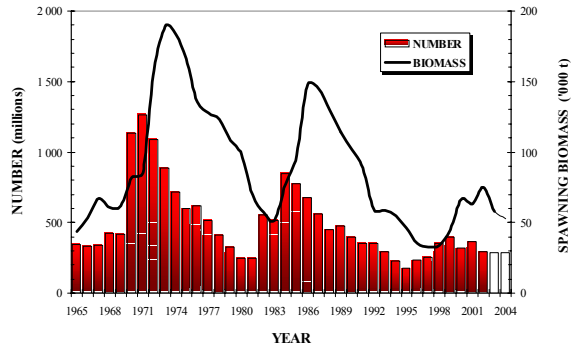


Figure 13. Spawning biomass ('000 t) and abundance of herring from the spring spawning stock, based on the SPA for 1965–2004 (data for 2003 and 2004 are preliminary).

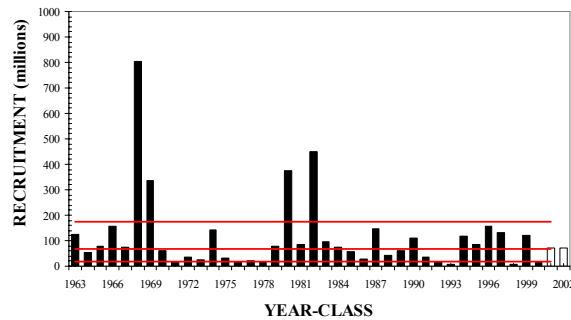


Figure 14. Estimated recruitment at age 2 of spring spawning stock for the 1963 to 2002 year-classes. The horizontal lines represent three levels of recruitment: low, average and high (an average recruitment is associated to the 2001 and 2002 year-classes).

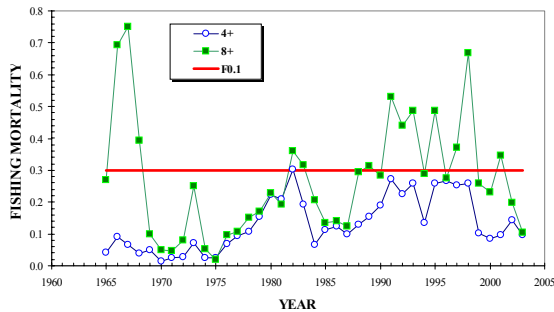


Figure 15. Instantaneous fishing mortality rates (ages 4+ and 8+ weighted by numbers at age) for spring spawning herring, 1965 to 2003.

1998, there has been a sharp drop in fishing mortality between 1998 and 1999, and since 2001. A decline in fishing mortality has also been observed among the youngest individuals (4 years and over) between 1998 and 1999 and between 2002 and 2003.

Outlook

Spring spawners

According to the SPA, the spawning biomass of the spring herring stock rose from a record low of 32,559 t in 1997 to 74,944 t in 2002, dropping to 57,727 t in 2003. Based on a risk analysis, the probability of exceeding $F_{0.1}$ in 2004 would be under 50% for catches of less than 10,000 t (Figure 16). This analysis also shows that the probability of biomass increasing between 2004 and 2005 is nil at this catch level. However, these projections have to be interpreted with a great deal of caution, given the SPA's inaccuracy.

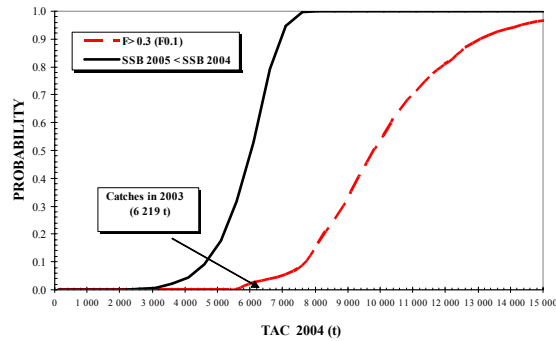


Figure 16. Risk analysis for changes in mature biomass (SSB) (t) of spring spawning herring, by 2004 catch level (probability of exceeding $F_{0.1}$ for a given TAC is indicated by the dotted line).

Fall spawners

The acoustic survey provided the only abundance index for fall spawners. Because no survey was conducted in 2003 and because the commercial gillnet fishery has no index, no scientific advice can be given

on the size of the stock and the TAC for 2004. Without an acoustic survey, it is also unlikely that we will be able to provide scientific advice on the size of the stock and TAC in the years to come.

Recommendations for 2004

Given the worrisome biological indicators, the concentration of fishing effort in limited areas and over short periods, the SPA's inaccuracy and the lack of information on fall stock, we recommend that the TAC be strictly limited to 20,000 t for both spawning stocks in 2004.

Conservation measures

To promote the conservation of both spawning herring stocks on the west coast of Newfoundland, we recommend that: (1) management measures be maintained for the ongoing protection of spring spawning activity in St. George's Bay; (2) the fishing effort be dispersed along the entire coast and over the entire year; (3) fishers' involvement in the index fishery program and industry logbook program for spring spawners be increased; (4) the utilisation of logbooks by gillnet fishers in the fall; and (5) herring catches used as bait be monitored.

For more Information

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ISSN 1480-4913 (Printed)

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**Correct citation for this
publication**

DFO, 2004. West Coast of Newfoundland
Atlantic Herring (Division 4R) in 2003.
DFO Can. Sci. Advis. Sec. Stock Status
Rep. 2004/017.