



West Coast of Newfoundland Atlantic Herring (Division 4R) in 2002

Background

Herring (*Clupea harengus harengus* L.) 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. Most herring reach sexual maturity at four years, at a length of about 25 cm. During spawning, eggs attach to the bottom, forming a carpet several centimetres thick, at specific locations which are visited every year. Unlike other pelagic species, herring populations are characterized by two spawner components. The spring component herring generally lay eggs in April and May, and the fall component herring in August and September. The two components are generally from 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 the North Shore of Quebec. Large catches are also made on the west coast of Newfoundland. This region, designated as **NAFO** (Northwest Atlantic Fisheries Organization) Division 4R, extends from unit area 4Ra in the north to unit area 4Rd in the south (Figure 1). The main gear used is the purse seine, with average annual landings of 11,045 t for large seiners (>65') and 2,927 t for small seiners (<65') over the period 1990-2001. After the seine fishery comes the gillnet fishery, whose landings average 1,356 t per year. The fishery on the west coast of Newfoundland is managed by a **TAC** (Total Allowable Catch) 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 stock to let it rebuild.

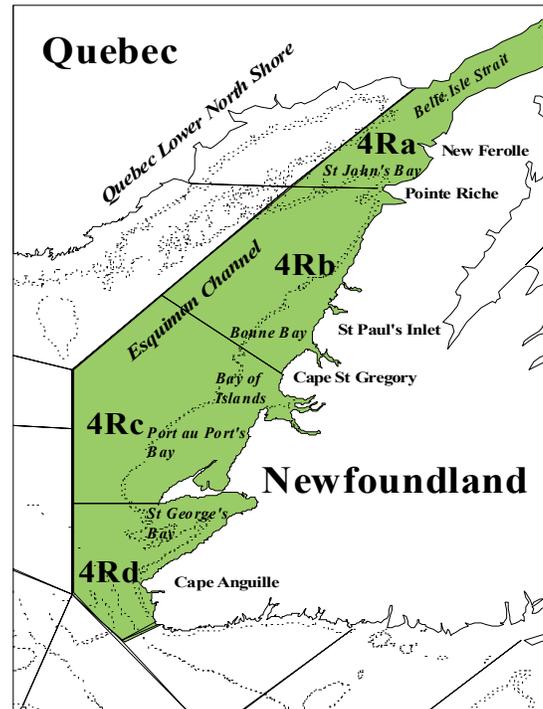


Figure 1. Map of unit areas of Division 4R on the west coast of Newfoundland (Division 4R is defined by the coloured area).

Summary

- In 2002, preliminary herring landings for the west coast of Newfoundland totalled 12,258 t, which is slightly below the 13,224 t landed in 2001 and the TAC, which has been set at 15,000 t since 2000. Most of these landings were made by large seiners in unit areas 4Rb and 4Rc.
- The condition of the spring and fall spawners has been improving since 1998. The values measured in 2002 are the highest since 1970.
- The abundance index for spring spawners from the gillnet fishery in St George's Bay has been on the rise since 1998. In 2002, this index had 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 was above average.

- According to the acoustic survey, the abundance of the spring stock fell between 1991 and 1995 but has remained relatively stable since. The abundance of the fall stock rose between 1997 and 1999 and held steady in 2002.
- Sequential Population Analyses (SPA) have been performed for the spring stock using abundance index data from the gillnet fishery and the acoustic survey, and for the fall stock using the data from the acoustic survey only. A discrepancy was observed between the gillnet index and the acoustic survey for the spring stock. Examination of these results indicated some problems with the fit of the models, in particular for the fall spawners. These analyses also indicated the presence of a retrospective pattern showing a tendency to underestimate the abundance of the two spawning stocks. Given this high level of uncertainty, the results of the SPA must be used with caution, and greater uncertainty must be ascribed to the projections derived from the risk analysis.
- The biomass of the spring spawner herring stock, according to the SPA, has risen from an all-time low of 35,011 t in 1997 to 58,921 t in 2003. The probability of exceeding $F_{0.1}$ in 2003 would be less than 50% for catches of less than 11,000 t.
- The biomass of the fall spawner herring stock, according to the SPA, has fallen from 71,412 t in 1994 (its peak value in the 1990s) to 48,481 t in 2003. The probability of exceeding

$F_{0.1}$ in 2003 would be less than 50% for catches of less than 11,600 t.

- Our ability to estimate the abundance of the two spawner stocks accurately is limited by the long (two- to three-year) intervals between the acoustic surveys, as well as by the lack of information on the fall gillnet fishery (for which no logbooks are maintained) and the sometimes inadequate geographic and temporal coverage of the commercial fishery sampling. Consequently, we are recommending a gradual increase in the TAC which should not exceed 20,000 t in 2003.

The Fishery

Nominal Catches

The various herring stocks on the west coast of Newfoundland are harvested separately during spawning gatherings or collectively when the stocks are mixed between the months of April and December. These stocks are harvested chiefly by a fleet of large (>65') and small (<65') seiners, and by large numbers of fishers using gillnets. From 1990 to 2001, total landings with all three types of gear averaged 15,479 t per year (Table 1). The average annual landings by type of gear were 11,045 t for large purse seiners, 2,927 t for small purse seiners and 1,356 t for gillnetters.

In 2002, preliminary herring landings for the west coast of Newfoundland totalled 12,258 t, slightly lower than the 13,224 t recorded in 2001 (Table 1) and the TAC, which has been held at 15,000 t since 2000. Most of these landings were made in the fall in unit areas 4Rb and 4Rc (Figures 1 and 2).

Table 1. West coast of Newfoundland herring : Landings (t) by NAFO unit area and fishing gear since 1990.

ZONE AND GEAR	YEAR													AVERAGE (1990-2001)
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002**	
4Ra	457	576	902	852	1 017	2 283	2 584	2 572	4 128	1 653	1 981	2 613	875	1 802
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	2 649	4 252
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	7 267	4 835
4Rd	5 202	16 420	8 896	11 211	2 599	3 133	1 115	1 637	611	1 201	1 471	1 589	1 467	4 590
Gillnet*	836	779	552	139	747	1 658	2 175	1 802	4 217	869	1 277	1 216	464	1 356
Small seiner	0	0	4 390	3 752	3 854	3 392	3 072	3 053	4 435	2 599	3 153	3 418	3 383	2 927
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	8 391	11 045
Others	147	63	117	108	146	148	104	354	239	93	59	246	20	152
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	12 258	15 479

* Include bar senne and cod traps

** Preliminary data

Since 1986, total landings of herring have posted a clear downward trend (Figure 2). This decline can be attributed chiefly to a decrease in the spring spawner catch, which has, however, been on the rise since 1999 (Figure 3). The annual catch of fall spawners generally exceeded that of spring spawners between 1971 and 1973 and, more recently, between 1997 and 2001.

Description of Catches

The population structure of the two spawning stocks of west coast of Newfoundland herring 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

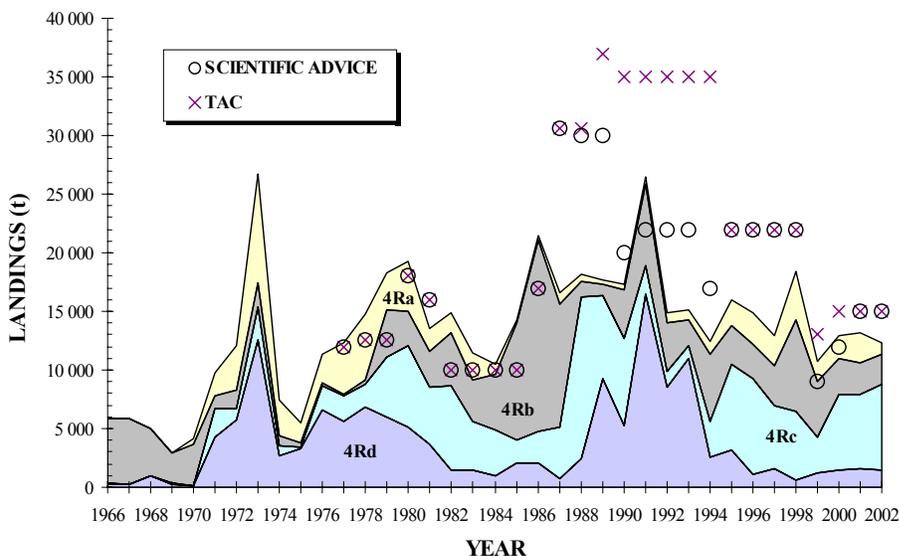


Figure 2. Commercial herring landings (t) for unit areas of NAFO Division 4R, 1966 to 2002 (TAC and scientific advice shown).

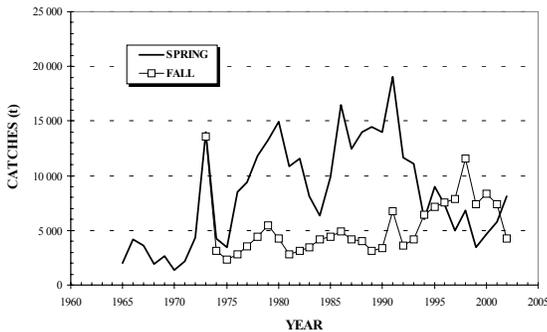


Figure 3. Annual landings (t) of spring-spawning and fall-spawning herring in NAFO Division 4R, 1965 to 2002.

dominated the fishery since the late 1960s are those from 1959, 1968, 1974, 1980, 1982, 1987, 1990, 1994 and 1996 (Figure 4A). For the fall spawners, the year-classes of 1979, 1988, 1990 and 1998 have dominated the catch since the early 1980s (Figure 4B). For this same spawner stock, the period 1973-1980 was characterized by the presence of a great many fish aged 11 or over. The abundance of these older fish might be explained by the low exploitation rates directed at this spawner stock during the period in question, or by the presence of herring from the southern Gulf of St Lawrence.

Biology of the Resource

Spawning Grounds

Historically, the main spawning grounds of the spring stock were located at the southern end of the west coast of Newfoundland, in St George’s Bay (Figure 1) and its environs. Over the past few years, however, there have been growing indications that other spawning grounds exist in the large bays farther north. Since 1998, there

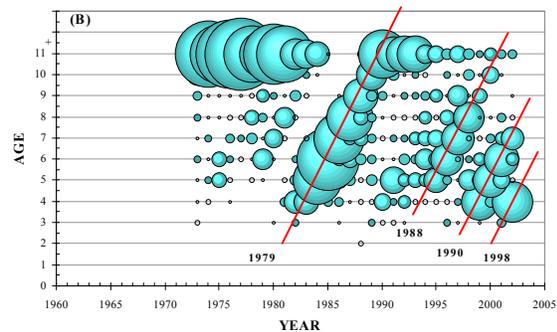
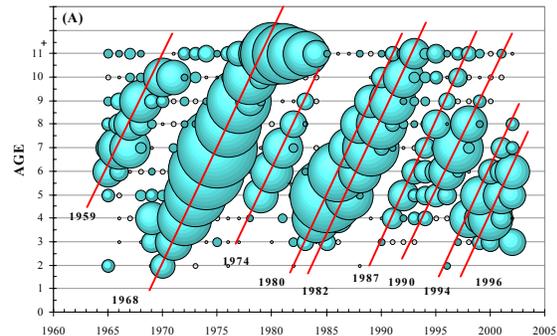


Figure 4. Catch-at-age (%) of spring spawners (A) and fall spawners (B) for year-classes sampled since 1965 (dominant year-classes are also shown).

has also been a higher proportion of spring-spawning herring in the samples from the May and June gillnet fishery in unit area 4Ra.

The fall herring spawn mainly north of Pointe Riche, in unit area 4Ra (Figure 1), from mid-July to mid-September. At other times of year, these herring can be found in the company of spring spawners in the feeding and wintering areas. The chief feeding areas are St George’s Bay in spring, near Pointe Riche and the Strait of Belle Isle in summer (Figure 1), and in the principal bays in the fall. Winter survey catches in the northern Gulf of

St. Lawrence in the 1980s and the early 1990s indicate that the herring winter in the deep waters of the Esquiman Channel (Figure 1).

Growth

In 2002, the mean weight of a 2-year-old spring herring was 0.099 kg, compared with 0.479 kg for a herring 11 years old. For fall herring, mean weights at these same ages were lower: 0.078 kg and 0.418 kg, respectively. For both spawner stocks, the mean weights measured in the 1990s and in the 2000s were lower than those measured in the 1980s (Figures 5A and 5B).

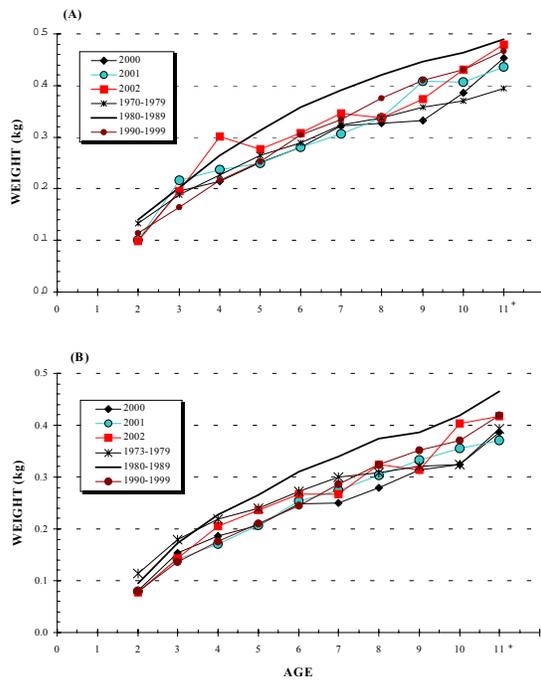


Figure 5. Mean weight-at-age (kg) of spring spawners (A) and fall spawners (B) calculated since 1970 from biological data collected at dockside (fourth quarter).

The spring herring in unit area 4Ra grow more slowly than spring herring sampled during the same months in unit area 4Rd, farther south.

Condition

In 2002, the condition of both the spring and the fall spawner stocks improved for yet another year (Figure 6). The values measured were the highest since the commercial sampling program began.

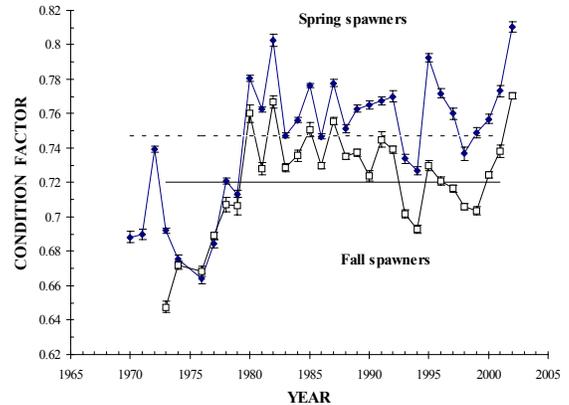


Figure 6. Mean annual condition factors (± 1 standard error) for spring and fall spawners, calculated from October to December (mean values are indicated by the horizontal lines).

Maturity

By age four, almost all of the herring in both spawner stocks reach sexual maturity (Figure 7). On average, from 2000 to 2002, the maturity percentages at ages three and four were 80% and 99%, respectively, for the spring spawners (Figure 7A), and 77% and 97% for the fall spawners (Figure 7B). For both stocks, age at sexual maturity has diminished in recent years, compared with the 1960s and 1970s.

Industry Comments

For the 2002 season, the main comments from the questionnaires filled out by the gillnet fishers each year can be summarized as follows: (1) the size

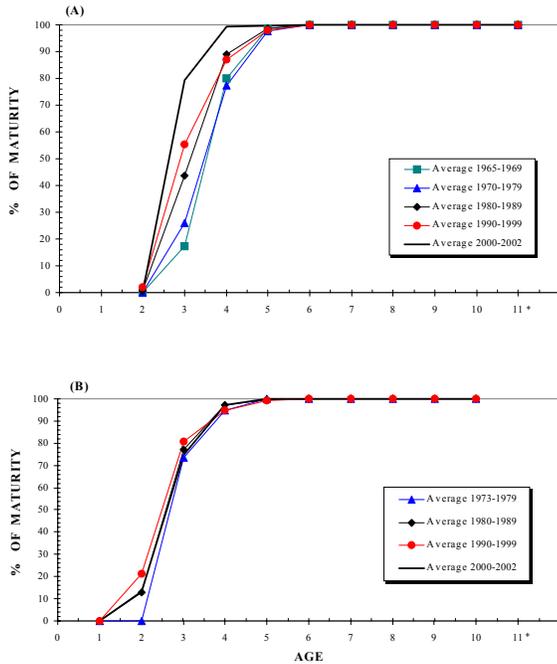


Figure 7. Mean maturity percentages at age for spring spawners (A) and fall spawners (B), calculated since 1965.

of the herring is on the rise, (2) neither gillnetting nor seining should be allowed during spawning or on spawning grounds, (3) there is a decline in the herring in areas 4Ra and 4Rd, (4) the gillnetters have market problems, (5) there are problems associated with the presence of an abundance of marine mammals (seals) and (6) overfishing in general.

At a meeting with several members of the industry, they mentioned that the herring had been very abundant in October and November 2002. The large seiners' fishing went very well, and they reached their TAC very quickly.

Resource Status

Abundance Indices

There are two relative abundance indices at present. One is associated with the commercial gillnet fishery and is based on data from index fishers and industry logbooks. The other is based on an acoustic survey conducted every two or three years in the fall. According to the most recent acoustic survey, the abundance of the spring stock fell from 1991 to 1995 and has remained relatively stable since (Figure 8). The abundance of the fall stock rose from 1997 to 1999 and remained stable in 2002.

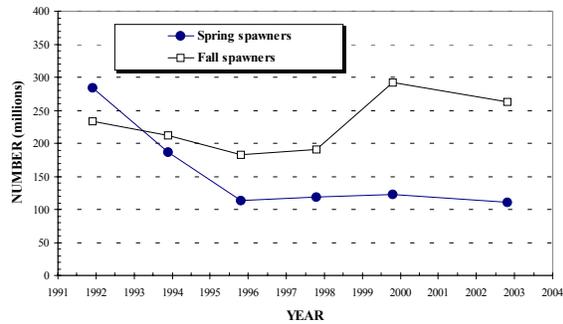


Figure 8. Abundance (millions) of spring and fall spawners calculated since 1991 from acoustic survey data.

The normalized gillnet catch rates for spring spawners declined systematically from 1985 to 1998, then rose continuously through 2002 (Figure 9). The 2002 level is similar to that reached in the late 1980s. This increase is attributable to the 1994, 1995 and 1996 year-classes, which showed above-average abundance.

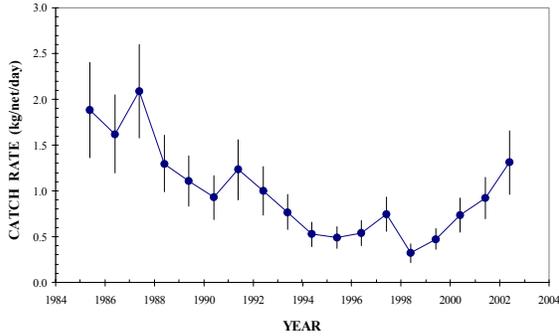


Figure 9. Normalized catch rates (kg/net/day), with 95% confidence intervals, for spring spawners, calculated from fishing and effort data from index fisher and industry logbooks.

There has not been any index fishers' abundance index for the fall spawner stock since 1993, because the low number of participants led to the program's being discontinued. There also is no commercial index, because no logbooks are maintained for this fishery, contrary to the spring stock fishery.

Analytical Assessment

Sequential Population Analyses (SPA) were performed for the spring stock using the data from the gillnet abundance index and the acoustic survey, and for the fall stock using the data from the acoustic survey alone. Examination of the results of these analyses showed a discrepancy between the gillnet index and the acoustic survey and major problems with the fit of the models, especially for the fall spawners. These analyses also indicated the presence of a retrospective pattern showing a tendency to underestimate the abundance of the two spawning stocks. Given these very high levels of uncertainty, the results of the SPA must be interpreted with caution.

For the spring spawners, the SPA indicates that the late 1960s and the early 1970s, along with the mid-1980s, were characterized by increases in abundance and spawning stock biomass (Figure 10). High recruitment was observed for the 1968, 1969, 1980 and 1982 year-classes (Figure 11). According to the SPA, fishing mortality for the oldest individuals (eight years +) exceeded the $F_{0.1}$ threshold in the mid-1960s, in 1982, in 1983 and almost all through the 1990s (Figure 12). In

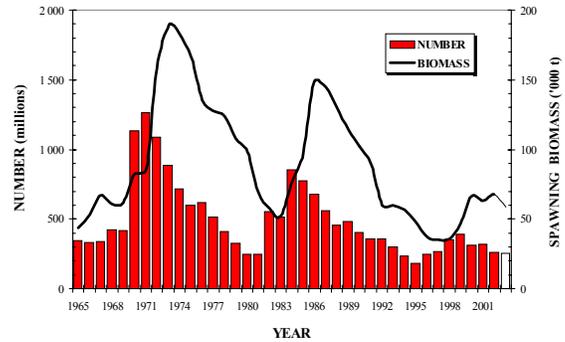


Figure 10. Spawning biomass and abundance of herring from the spring spawner stock, calculated by the SPA for the period 1965 to 2003 (data for 2003 are preliminary).

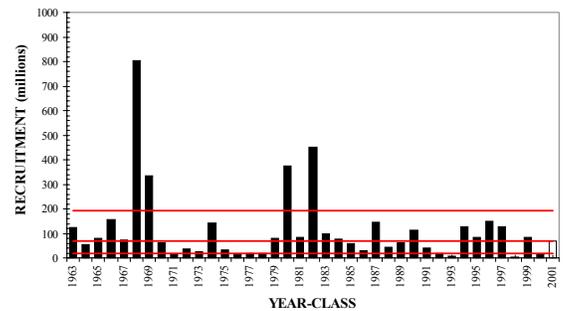


Figure 11. Estimated recruitment at age 2 of spring spawners for the 1963 to 2001 year-classes. The horizontal lines represent three levels of recruitment: low, average, and high (an average recruitment is associated to the 2001 year-class).

response to the management measures that have been applied since 1998, a substantial drop in mortality was recorded in 1999, for old as well as younger individuals. Since 2000, fishing mortality has increased slightly among herring age four and over, while it has continued to trend downward among the oldest individuals.

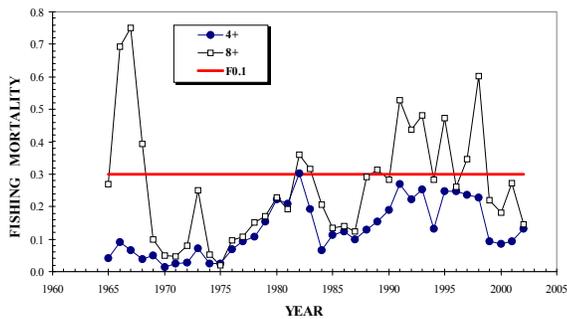


Figure 12. Instantaneous fishing mortality rates (ages 4+ and 8+ weighted by numbers at age) for spring spawning herring, 1965 to 2002.

The abundance and biomass of the fall spawners appears to have increased in 1981 and the early 1990s (Figure 13) because of the important 1979 and 1990 year-classes (Figure 14). Fishing mortality increased from 1985 to 1998, in particular, among the oldest fish (Figure 15). This has been followed by a decrease since the year 2000.

Outlook

Spring Spawners

According to the SPA, the spawning biomass of the spring herring stock rose from an all-time low of 35 011 t in 1997 to 58 921 t in 2003. The probability of exceeding $F_{0.1}$ in 2003 would be less

than 50% for catches of less than 11 000 t (Figure 16).

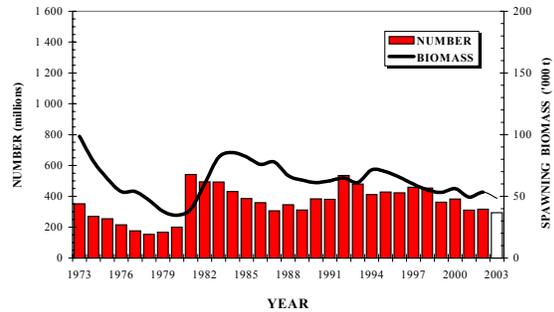


Figure 13. Spawning biomass and abundance of herring from the fall spawner stock, calculated by the SPA for the period 1973 to 2003 (data for 2003 are preliminary).

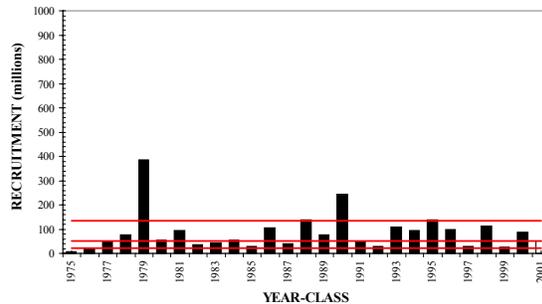


Figure 14. Estimated recruitment at age 2 of fall spawners for the 1975-2001 year-classes. The horizontal lines represent three levels of recruitment: low, average, and high (an average recruitment is associated to the 2001 year-class).

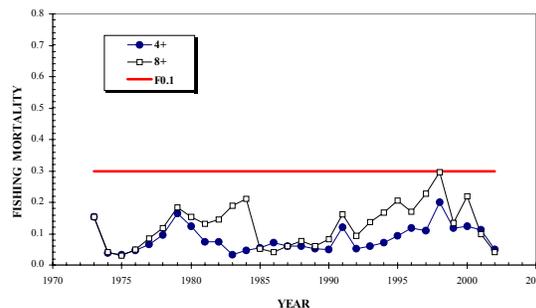


Figure 15. Instantaneous fishing mortality rates (ages 4+ and 8+ weighted by numbers at age) for fall spawning herring, 1973 to 2002.

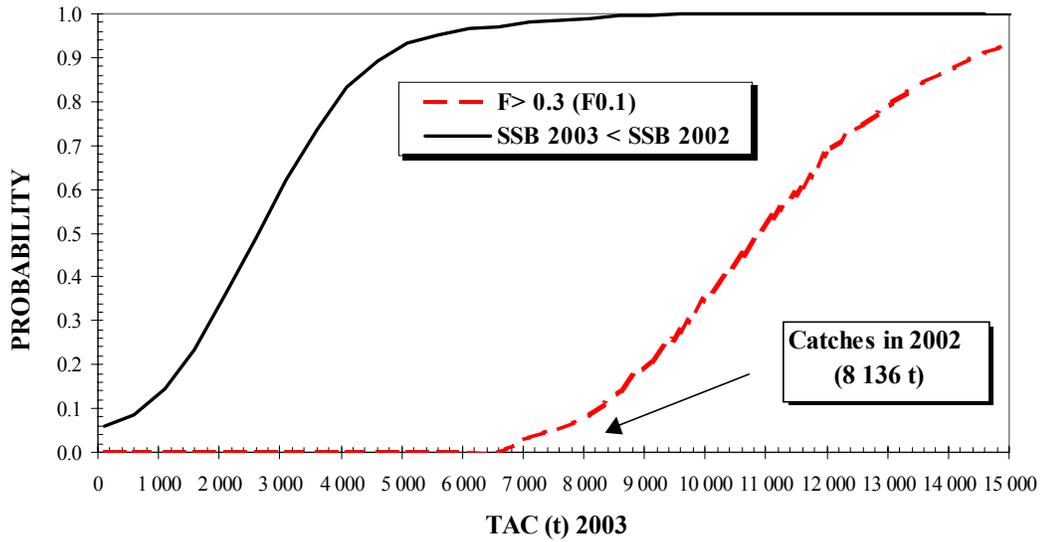


Figure 16. Risk analysis for changes in mature biomass (SSB) of spring spawning herring, by 2003 catch level (probability of exceeding $F_{0.1}$ for a given TAC is indicated by the dotted line).

Fall Spawners

According to the SPA, the spawning biomass of the fall herring stock fell from 71,412 t in 1994 (the peak value for the 1990s) to 48,481 t in 2003. The probability of exceeding $F_{0.1}$ in 2003

would be less than 50% for catches of less than 11,600 t (Figure 17).

These projections must be interpreted with a great deal of caution, because of the impreciseness of the SPA and the presence of a retrospective pattern. Our

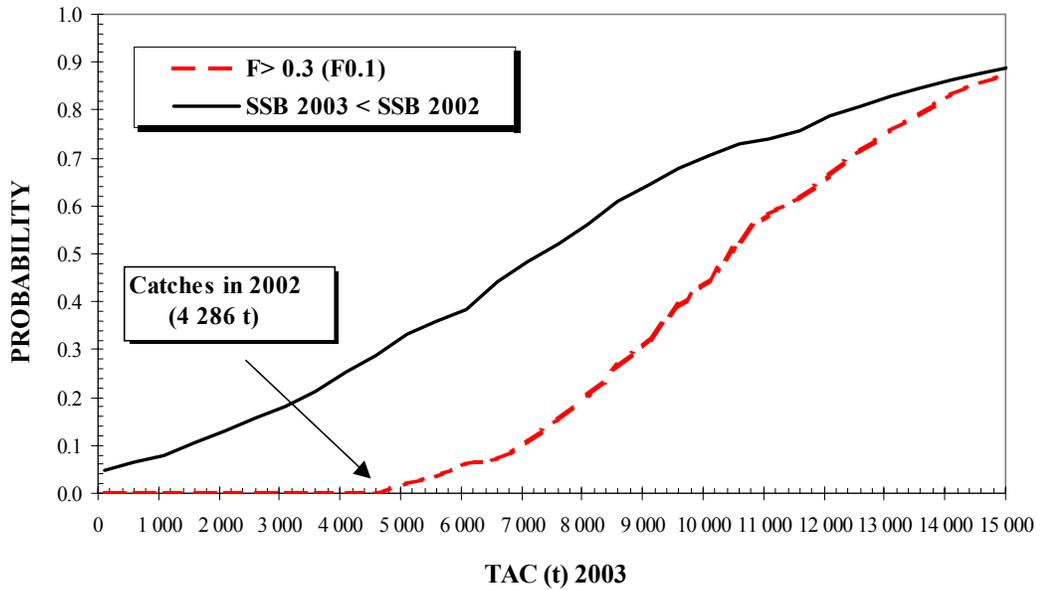


Figure 17. Risk analysis for changes in mature biomass (SSB) of fall spawning herring, by 2003 catch level (probability of exceeding $F_{0.1}$ for a given TAC is indicated by the dotted line).

ability to accurately estimate the abundance of the two spawner stocks is being reduced further and further by the long (two- to three-year) intervals between the acoustic surveys, as well as by the lack of information on the fall gillnet fishery (for which no logbooks are maintained) and the sometimes inadequate geographic and temporal coverage of the commercial fishery sampling. Consequently, we are recommending a gradual increase in the TAC which should not exceed 20,000 t in 2003.

To promote the conservation of the two spawner stocks and improve our databases, the present advice recommends: (1) maintaining the management measures in St George's Bay to continue protecting spring spawning activity, (2) dispersing the fishing effort along the entire coast and throughout the year, (3) increasing fishers' participation in the index fishers' program and the industry logbook program for the spring spawners, and lastly (4) having fall gillnet fishers maintain logbooks.

References

- Grégoire, F., L. Lefebvre and G. Guérin. 2002. Atlantic Herring (*Clupea harengus harengus* L.) on the West Coast of Newfoundland (NAFO Division 4R) in 2001. CSAS Res. Doc. 2002/058. 40 pp.
- Grégoire, F. and L. Lefebvre. 2002. Analytical Assessment and Risk Analyses for the Stock of Spring-Spawning Herring (*Clupea harengus harengus* L.) of the West Coast of Newfoundland (NAFO Division 4R) in 2001. CSAS Res. Doc. 2002/059. 61 pp.

For more information:

François Grégoire
Maurice Lamontagne Institute
850 Route de la Mer
Mont-Joli, Québec
G5H 3Z4
Tel.: 418 775-0589
Fax: 418 775-0740
E-mail: GregoireF@dfo-mpo.gc.ca

Correct citation for this publication:

DFO, 2003. West Coast of
Newfoundland Atlantic Herring
(Division 4R) in 2002. DFO –
Science, Stock Status Report
2003/008 (2003).

This report is available from the:

Regional Science Advisory Bureau,
Department of Fisheries and Oceans,
Maurice Lamontagne Institute,
P.O. Box. 1000, Mont-Joli,
Quebec, Canada
G5H 3Z4

Email: Bras@dfo-mpo.gc.ca

ISSN 1480-4913

@ Her Majesty the Queen in Right of Canada, 2003

*La version française est disponible à
l'adresse ci-dessus.*

