ASSESSMENT OF THE WEST COAST OF NEWFOUNDLAND (DIVISION 4R) HERRING STOCKS IN 2011

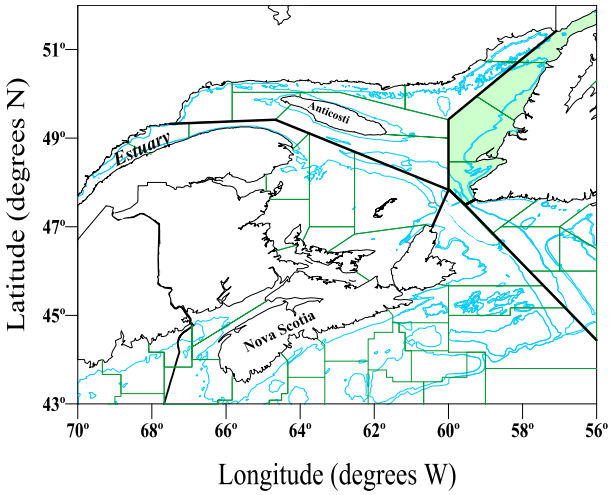

Figure 1. Map of unit areas of NAFO Division 4R (west coast of Newfoundland). Division 4R is identified by the coloured area.

Context

Herring are a pelagic species that perform significant annual migrations associated with spawning, feeding and wintering. Herring are part of a commercial fishery and in Canadian waters, the main fishing areas are south-western Nova Scotia and the Bay of Fundy (complex of stock 4VWX), the southern Gulf of St. Lawrence (4TVn stocks), the northern Gulf of St. Lawrence (4S stocks), and the west (4R stocks), east and south-east coasts (3KLPs stocks) of Newfoundland. On the west coast of Newfoundland (NAFO Division 4R) (Figure 1), the average annual landings of herring have been about 16,000 t since 1975. The main fishing gear is the purse seine with average annual landings of near 11,000 t. In order of important gears, the purse seine is followed by the "tuck" seine (modified bar seine), the gillnet, and the trap.

The west coast of Newfoundland herring fishery is managed by a Total Allowable Catch (TAC) associated with both spawning stocks. The current TAC of 20,000 t was set during the last analytical assessments. The TAC is split between the various fleets as follows: 55% for large seiners (> 65 '), 22% for small seiners (<65') and 23% for fixed gear.

A first series of acoustic surveys was conducted between 1991 and 2002. A second series of surveys began in the fall of 2009 following the recommendations of the Fisheries Resource Conservation Council (FRCC). In a few years' time, this series will allow for the return of an analytical assessment as well as the updating of reference points. They will help develop a strategic framework for fisheries consistent with the precautionary approach. This framework aims to reduce the risk of serious or irreversible damage to commercially exploited stocks.

The last assessment of the two herring spawning stocks on the west coast of Newfoundland was done in 2010. The Fisheries and Aquaculture Management Branch has requested a scientific advice on these stocks for the 2012 and 2013 fishing seasons. At a meeting held on May 17, 2012, the status of these stocks was reviewed. This paper presents the results and conclusions from that meeting.

SUMMARY

- In 2011, herring catches from the west coast of Newfoundland (NAFO Division 4R) totalled 20,501 t for a TAC of 20,000 t. The quota allotted for the large seiners was reached whereas the quotas for the small seiners and fixed gear were exceeded. Catches from the bait fishery are not recorded and could be significant.

- Herring catches on the west coast of Newfoundland are currently composed of older fish. The 2002 and 2000 year-classes were dominant for spring-spawning and fall-spawning herring catches, respectively, over the 2000s.

- The age at 50% maturity was higher in 2010 and 2011 whereas an increase in the length at 50% maturity has been observed since the beginning of the 1990s.

- The condition index showed a significant decrease in 2011. Although the possible causes of this change were not analyzed, such decreases have been observed in the past.

- Based on the acoustic survey, the total biomass index of spring-spawning herring varied between 5,801 t and 14,624 t from 2009 to 2011. These figures are significantly lower than the 34,550 t measured in the 2002 survey. In 2002, spring-spawning herring accounted for 32% of the total biomass compared to 12% in 2011.

- According to the same survey, the total biomass index of fall-spawning herring varied between 66,216 t and 121,888 t from 2009 to 2011, and is mainly composed of a single year-class. Biomasses for 2010 and 2011 are higher than those from 2002, but there is a high degree of uncertainty associated with their estimate.

- In the absence of significant reconstruction signs among spring spawners, it is recommended that the management measures implemented in the late 1990s to protect the spawn of this stock remain in place.

- Herring catches are now composed in large part of fall spawners. In recent years, catches of about 20,000 t have been supported by the dominant 2000 year-class. With the anticipated decline of this year-class, and without strong recruitment, it is unlikely that catches of this magnitude can be sustained in the medium term.

- Under these conditions, the current catch level (20,000 t) should not be increased for 2012 and 2013 to limit the increase in the exploitation rate.

INTRODUCTION

Species Biology

Atlantic 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 in order to feed, to spawn near the coast and to overwinter 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. At spawning, eggs attach themselves to the sea floor, forming a carpet of a few centimetres thick. The egg incubation time and larval growth are linked to ambient environmental characteristics such as water temperature. Most herring reach sexual maturity at four years of age, at a length of about 25 cm. Compared with other herring populations, the west coast of Newfoundland herring are characterized by two spawning stocks. Spring herring generally spawn in April and May, and fall herring in August and September.

ANALYSIS

The 2011 Fishery

Herring landings on the west coast of Newfoundland have been rising since 1999 (Figure 2). In 2011, they totalled 20,501 t compared with 19,205 t in 2010, and with an annual average (2000-2010) of 16,529 t (Table 1). A total of 6,452 t were caught in unit area 4Rb, compared with 6,278 t, 5,046 t and 2,725 t for unit areas 4Rd, 4Rc and 4Ra (Table 1).

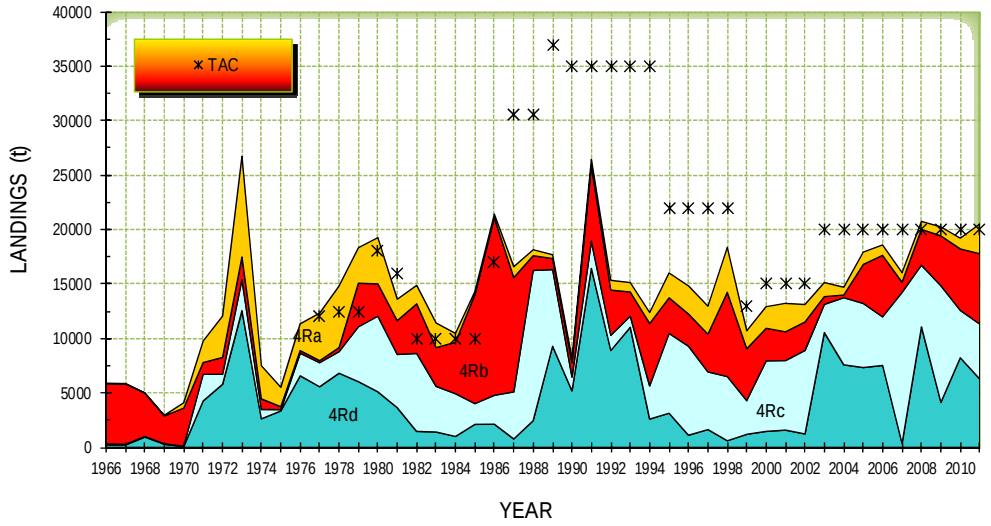

Figure 2. Herring cumulative commercial landings (t) and TACs (t) for unit areas of the west coast of Newfoundland (NAFO Division 4R), from 1966 to 2011.

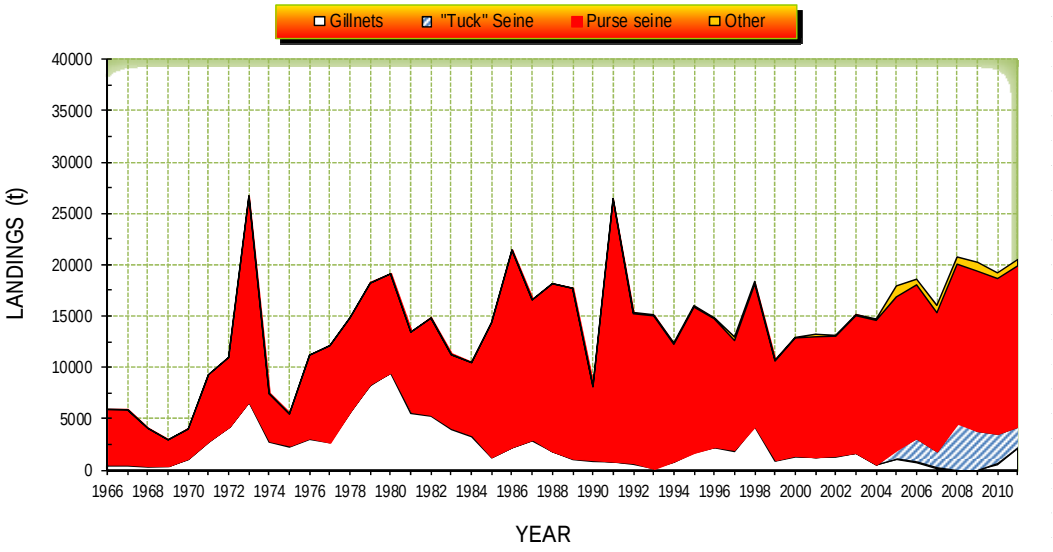

Figure 3. Herring cumulative commercial landings (t) per fishing gear for the west coast of Newfoundland (NAFO Division 4R), from 1966 to 2011.

Table 1. Annual herring catches (t) in the unit areas of the west coast of Newfoundland (NAFO Division 4R).

UNIT	AVERAGE	YEAR												AVERAGE
AREA	(1990-1999)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*	(2000-2010)
4Ra	1 694	1 981	2 613	1 604	1 290	713	1 138	955	885	731	822	984	2 725	1 247
4Rb	4 253	2 995	2 643	2 621	713	252	3 573	5 647	914	3 286	4 575	5 651	6 452	2 988
4Rc	3 900	6 469	6 379	7 660	2 594	6 162	5 890	4 457	13 861	5 668	10 707	4 342	5 046	6 744
4Rd	5 183	1 471	1 589	1 232	10 534	7 575	7 327	7 524	375	11 058	4 133	8 228	6 278	5 550
Unknown	912	0	0	0	0	0	0	0	0	0	0	0	0	0
TAC		*15 000*	*15 000*	*15 000*	*20 000*	*20 000*	*20 000*	*20 000*	*20 000*	*20 000*	*20 000*	*20 000*	*20 000*	
TOTAL		12 916	13 224	13 117	15 131	14 702	17 928	18 583	16 035	20 743	20 237	19 205	20 501	16 529

* Preliminary data

On the west coast of Newfoundland, most herring landings are associated with the purse seine (Figure 3). In 2011, landings by large seiners (>65') totalled 10,259 t compared to 5,463 t by small seiners (<65'), 2,117 t by gillnet, 2,050 t by the "tuck" seine and 611 t by trap (Table 2). The "tuck" seine, which is a modified bar seine, has been used in the herring fishery since 2005. It is considered a fixed gear.

In 2011, the quota allotted for large seiners' fleet was reached whereas the quotas for other fleets were exceeded. Between 1990 and 2004, fixed gear took on average only 30% of their quota. The arrival of the "tuck" seine in this fishing fleet increased the average for the 2005-2010 period to 86%.

Table 2. Annual herring catches (t) for the main fishing gear used on the west coast of Newfoundland (NAFO Division 4R).

FISHING	AVERAGE	YEAR												AVERAGE
GEAR	(1990-1999)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*	(2000-2010)
Gillnet	1 378	1 277	1 216	1 257	1 629	499	1 031	702	132	3	0	525	2 117	752
"Tuck" seine	0	0	0	0	0	0	909	2 286	1 545	4 498	3 779	2 953	2 050	1 452
Other seine	1	0	96	13	0	2	530	53	8	0	0	0	0	64
Trap	150	59	150	73	104	127	534	498	706	700	872	560	611	398
Small seiner (<65')	3 612	3 153	3 418	3 382	2 307	2 974	3 918	3 941	2 688	4 356	4 416	4 950	5 463	3 591
Large seiner (>65')	10 801	8 427	8 344	8 392	11 091	11 100	11 007	11 102	10 955	11 185	11 171	10 217	10 259	10 272
TOTAL		12 915	13 224	13 117	15 131	14 701	17 928	18 582	16 034	20 743	20 238	19 205	20 500	

* Preliminary data

In 2011, catches by large seiners were mostly made in the unit area 4Rb and catches by small seiners in areas 4Rd and 4Rc (Figure 4). The "tuck" seine was used mainly in 4Rd and 4Rc compared to the gillnet and the trap in 4Ra. The herring purse seine and "tuck" seine fishery is practiced mainly in the fall. Spring fishing activities were strongly reduced at the end of the 1990s following the implementation of management measures to protect the spawn of spring-spawning herring. In the fall, the herring fishery follows the mackerel fishery.

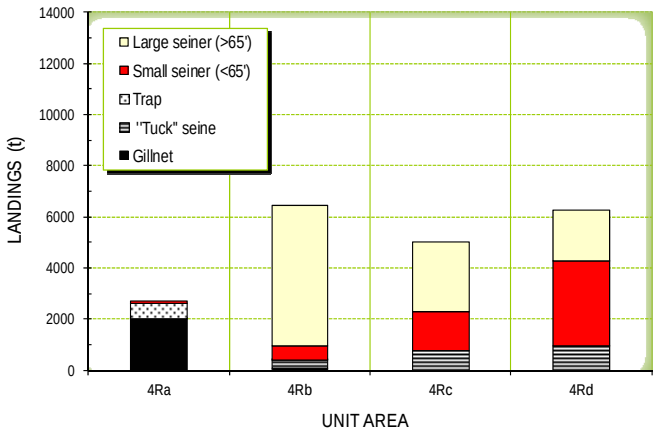

Figure 4. Herring landings (t) in 2011 per fishing gear for unit areas of the west coast of Newfoundland (NAFO Division 4R).

Biological Data

Length frequency analysis indicates that herring stocks on the west coast of Newfoundland are characterized by the periodic occurrence of dominant year-classes. These dominant year-classes are identified by the occurrence of a main mode that shifts toward longer lengths over the years. For spring spawners, the most recent of these year-classes was 2002 (Figure 5A) compared to the 2000 year-class of fall spawners (Figure 5B). From 2005 to 2007, this year-class alone accounted for more than 50% of catches (in number). This proportion decreased from 44% in 2008 to 18% in 2010. In 2011, herring in the 11^{+} age group, which are included in this year-class, accounted for 14% of catches.

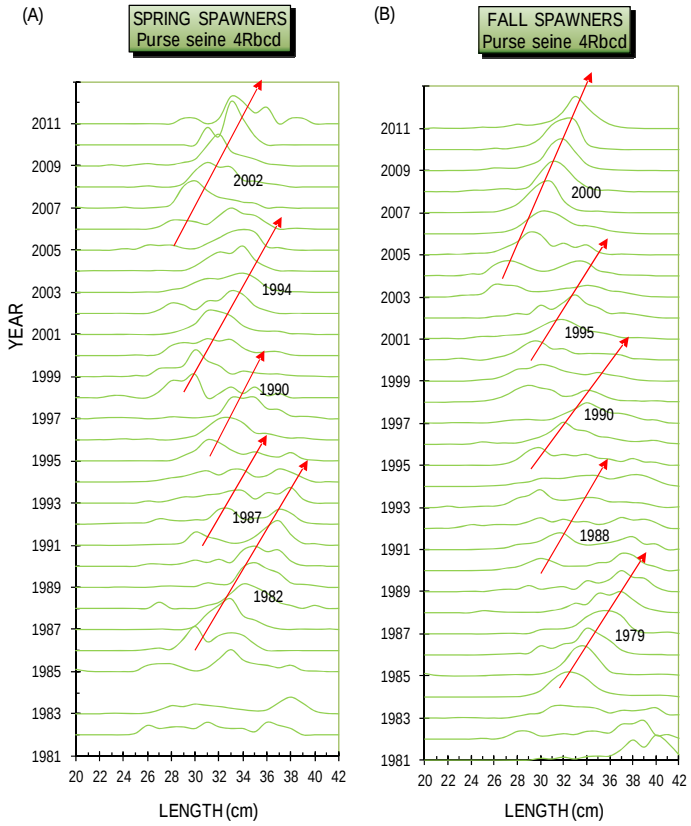

Figure 5. Annual length (cm) frequencies (%) of spring (A) and fall (B) spawning herring caught in the fall with the purse seine in unit areas 4Rbcd (some dominant year-classes are indicated).

For spring spawners, the proportion of mature fish at length has varied little over the years (Figure 6A). Lengths at 50% of maturity (L_{50}) were 273 mm in the 1980s compared to 266 mm and 274 mm in the 2000s and 2010s. For fall spawners, the proportion of mature fish at length increased slightly from the 1980s to the 1990s before subsequently decreasing (Figure 6B). The length at 50% maturity was 288 mm in the 1980s. This length increased from 270 mm in the 1990s to 285 mm in the 2010s. For both spawning stocks, the age at 50% of maturity (A_{50}) was higher in 2010 and 2011 compared to the 2000s.

Both herring spawning stocks showed similar annual variations in their condition indices (Figures 7A and 7B). These indices increased at a high rate from the mid-1970s to the early 1980s. They were relatively stable until 1992; however, significant annual variations were observed thereafter. These two indices showed a upward trend from 2003 to 2010 followed by a significant decrease such that the values measured in 2011 are under the lower limit of the average for the 1970-2010 period. Such decreases have been observed in the past.

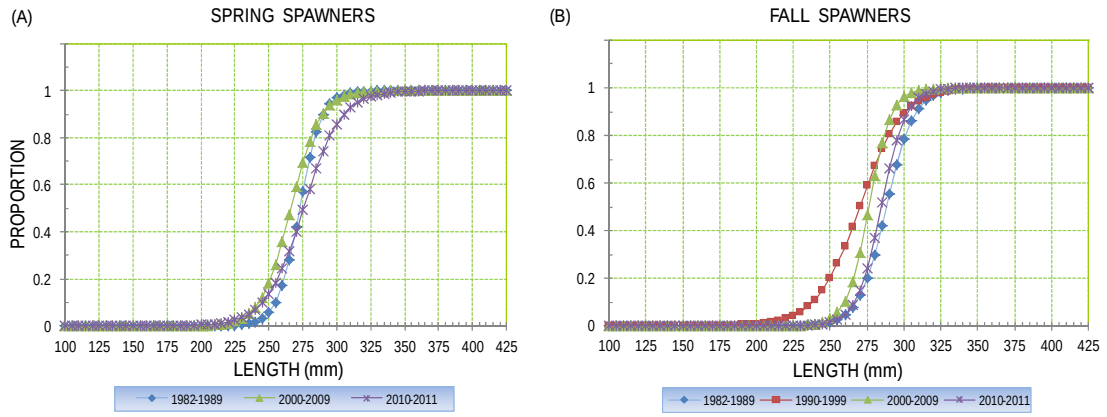

Figure 6. Proportion of maturity at length by year period for spring (A) and fall (B) spawning herring stocks of the west coast of Newfoundland (NAFO Division 4R). For spring spawners, calculations were made using biological samples taken in the second quarter until 2002 and in the fourth quarter starting in 2003. For fall spawners, all calculations were done using biological samples taken in the third quarter.

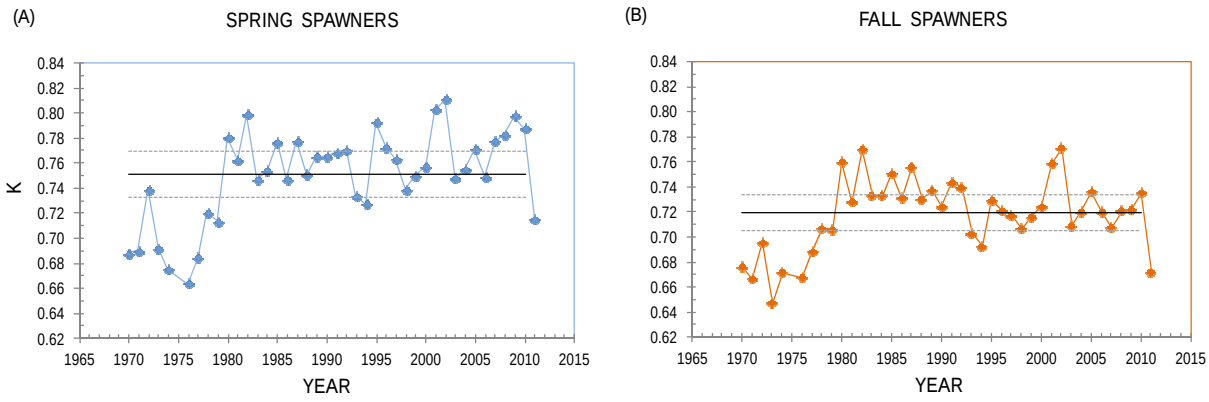

Figure 7. The average annual condition for spring (A) and fall (B) herring spawners (calculated using samples taken in the fourth quarter) on the west coast of Newfoundland (NAFO Division 4R). The horizontal lines show the 1970-2010 averages ± 0.5 x standard deviation.

Resource Status

Acoustic Survey

A first series of acoustic surveys was conducted between 1991 and 2002. A second series of surveys began in the fall of 2009 following the FRCC recommendations. The first surveys from this new series should be conducted on an annual basis to enable the fastest possible return of an analytical assessment as well as the updating of reference points.

The 2011 acoustic survey took place between October 18 and November 8. Quebec's Lower North Shore was covered first, followed by unit areas 4Ra and 4Rb. These areas correspond to strata 10 and 9 (Figure 8).

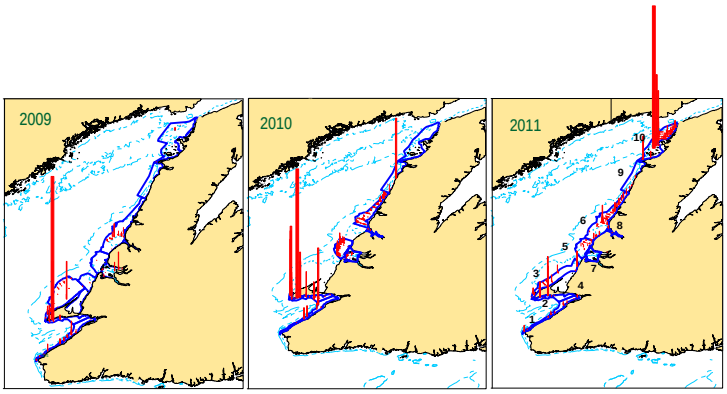

Figure 8. Herring density distribution (kg/m^2) along the west coast of Newfoundland in the fall of 2009, 2010 and 2011 (completed strata and transect numbers are indicated; scale densities expressed by the height of the bars differ from one survey to the other).

As with the acoustic surveys conducted in 2002 and 2010, a significant signal (kg/m^2) was measured in 2011 in strata 10 (in 2010, this strata was only partially covered owing to poor weather conditions). Significant signals were also measured in strata 2, located in the northern side of St. George's Bay.

The total biomass index of spring-spawning herring fell considerably between 1991 and 1993 (Figure 9A). After gaining some stability, this index fell again, decreasing from 34,550 t in 2002 to 5,801 t in 2009,and to 11,363 t and 14,624 t in 2010 and 2011. In 2002, spring herring accounted for 32.1% of the total biomass of the two spawning stocks compared to 8.1% in 2009, 8.5% in 2010 and 11.7% in 2011 (Figure 10). The mean size of herring used to calculate the biomass index was 335 mm in 2002 compared to 328 mm in 2009, 330 mm in 2010 and 333 mm in 2011 (Figure 11A).

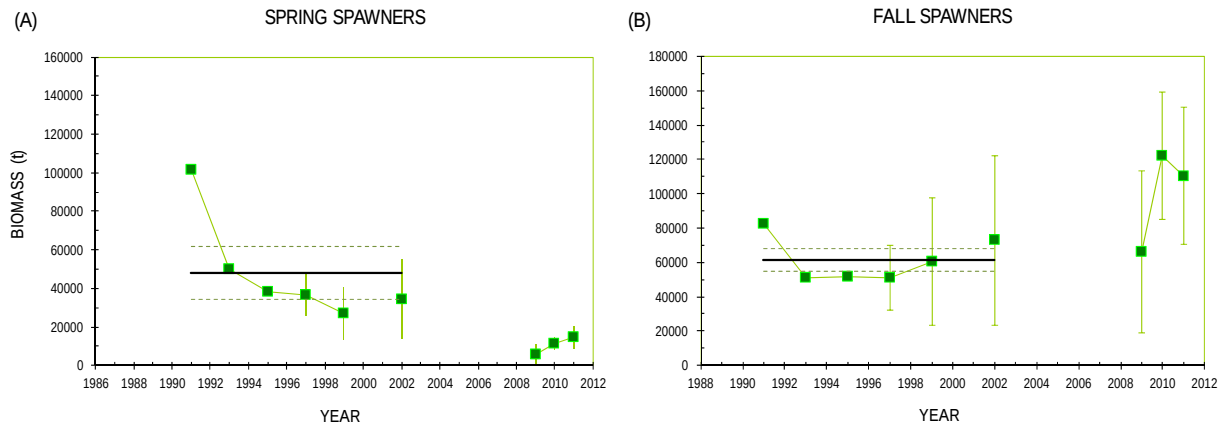

Figure 9. Total biomass index (t) (with 95% confidence intervals for the last six surveys) of spring (A) and fall (B) spawning herring stocks on the west coast of Newfoundland (NAFO Division 4R) estimated by the acoustic survey. The horizontal lines represent the 1991-2002 average ± 0.5 x standard deviation.

The total biomass index of fall-spawning herring also fell between 1991 and 1993 (Figure 9B). In 2009, this index was estimated at 66,216 t compared to 72,916 t in 2002. From 2010 to 2011,

the index decreased from 121,888 t to 110,428 t. The mean size of herring used to calculate the biomass index was 329 mm in 2002 compared to 326 mm in 2009, 330 mm in 2010 and 329 mm in 2011 (Figure 11B).

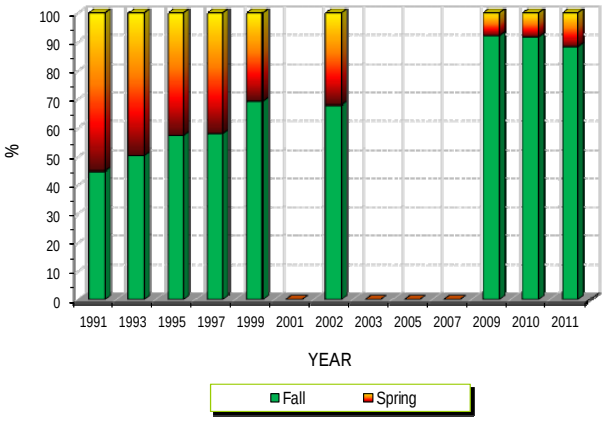

Figure 10. Percentage of spring- and fall-spawning herring observed in the biological samples used to calculate the biomass indices from the acoustic survey results.

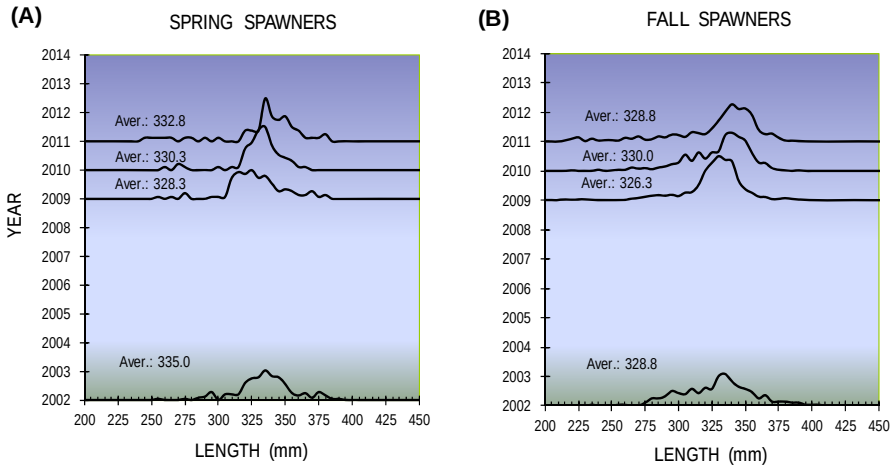

Figure 11. Length frequencies (mm) of spring- (A) and fall- (B) spawning herring used to calculate biomass indices from the acoustic survey results.

Analytical Assessment

Exploratory analyses were conducted using data from the last three acoustic surveys. Adjustment problems occurred for the analytical models owing to the low number of surveys.

Sources of Uncertainty

The main source of uncertainty is the lack of statistics for the gillnet bait fishery. There are currently more than 300 licenses for bait in St. George's Bay, Port au Port Bay and Bay of Islands. This bait fishery is practiced during the lobster fishery season and therefore targets spring-spawning herring, whose abundance is always at very low levels.

CONCLUSION AND ADVICE

Acoustic survey results from the fall of 2011 indicate a very small increase in spring-spawning herring stock. Given the absence of reconstruction signs, it is recommended that the management measures implemented to protect the spawn of this spawning component remain in place. It is further recommended that the spring bait fishery, which specifically targets this component, be closely monitored (using log-books) in order to estimate catches. Survey results also indicate a slight decrease in the abundance of fall-spawning herring.

In recent years, catches of about 20,000 t have been supported by the dominant 2000 year-class of fall spawners. This year-class alone has ensured stability in the herring fishery on the west coast Newfoundland over the past few years. With the decline of this year-class, and without strong recruitment, it is unlikely that catches of about 20,000 t can be sustained in coming years.

The dispersal of fishing effort along the coast and throughout the year is recommended in order to support the conservation of the two spawning stocks.

Without abundant recruitment, the current catch level (20,000 t) should not be increased for 2012 and 2013. Catch at age should be monitored closely until the next acoustic survey, which is scheduled for fall 2013.

SOURCES OF INFORMATION

This Science Advisory Report is from the April 17, 2012 on the "Assessment of the 4R herring stocks in 2011". Additional publications from this meeting will be posted as they become available on the Fisheries and Oceans Science Advisory Schedule at: http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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