



## ASSESSMENT OF THE QUEBEC NORTH SHORE (DIVISION 4S) HERRING STOCKS IN 2005

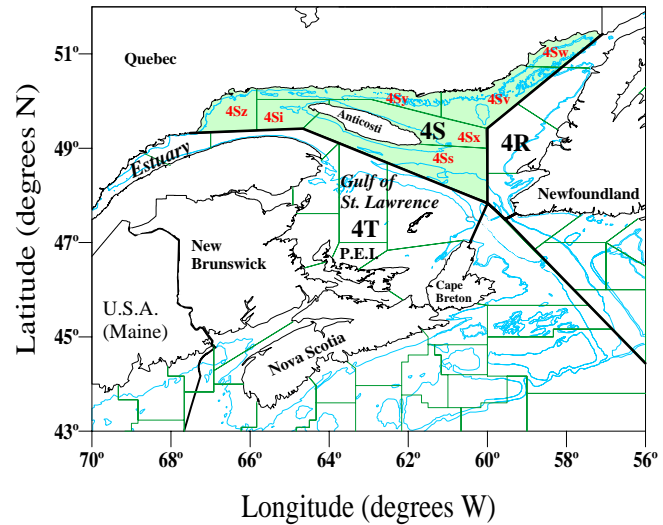


Figure 1. Map of unit areas of NAFO Division 4S (Quebec North Shore). Division 4S is identified by the coloured area.

### Context

During their annual migrations, herring are subject to a very intense commercial fishery in certain areas. In Canadian waters, the main fishery areas are located southwest of Nova Scotia, in the Bay of Fundy, in the southern Gulf of St. Lawrence and in Newfoundland. Herring landings are also made on the North Shore of Quebec. This area is associated with NAFO Division 4S and stretches west to unit area 4Sz, and east to unit areas 4Sv and 4Sw (Figure 1). The main gear used is gillnet, in the spring in area 4Sz, and later at the end of summer and in early fall in areas 4Sv and 4Sw. Declared annual landings average 356 t for all of the Quebec North Shore and for the period 1990-2004.

Because there is no acoustic survey, an analytical assessment can not be performed on the two Quebec North Shore herring spawning stocks. Consequently, it is impossible to calculate their respective abundance, fishing mortality, minimum biomass limits and a Total Allowable Catch (TAC). For the time being, these two stocks are managed using a common preventive TAC of 4,000 t.

### SUMMARY

- Herring catches on the Quebec North Shore (NAFO Division 4S) in 2005 were 414 t, up 287 t compared with 2004. Most of these landings were made in unit area 4Sw by gillnetters and trap fishermen.
- The demographic structure of the two herring spawning stocks of the Quebec North Shore is characterized by the occasional occurrence of dominant year-classes.

Some of these year-classes were observed over several consecutive years, which indicates a low exploitation rate.

- The dispersion index, which is calculated from data from bottom trawl scientific surveys, has shown an overall upward trend since 1990 with maximum values in 2000 and 2001.
- For the time being, Quebec North Shore herring stocks are managed using a common preventive Total Allowable Catch (TAC) of 4,000 t. Because of the territory's size and the actual catch levels compared to other eastern Canadian regions, herring catches could certainly be higher. However, the current available information is not sufficient to accurately determine by how much the catches could be increased.
- Finally, due to an overall lack of information concerning the species' biology, structure and spawning stock dynamics of Quebec North Shore herring, we recommend that any increase in fishing effort be made gradually and be accompanied by strict monitoring of the catches and biological characteristics.

## INTRODUCTION

### Species Biology

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 mainly on small zooplankton (< 5 mm, mostly copepods), 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 characteristics of the environment 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, Quebec North Shore herring are characterized by two spawning stocks. Spring herring generally spawn in April and May, and fall herring in August and September.

### Fishery

#### Nominal catches

Herring landings on the Quebec North Shore (NAFO Division 4S; Figure 1) saw rapid expansion through the 1970s. From less than 80 t per year for the 1960-1970 period, landings have reached an average of 628 t since 1979 (Figure 2). Herring landings on the Quebec North Shore also show significant annual variations due to fluctuating markets; the most significant one being bait. Even though the geographic size of the Quebec North Shore territory is significant, most herring landings are concentrated in only three unit areas, namely 4Sz in Division 4S WEST and 4Sv and 4Sw in Division 4S EAST (Figure 1). Average annual herring landings in these unit areas were respectively 219 t, 36 t and 71 t (Table 1). During the 1980s, the most significant landings in Division 4S EAST were made in unit area 4Sv and since the

mid-1990s, in area 4Sw (Figure 3A). In Division 4S WEST, most landings have always taken place in area 4Sz (Figure 3B).

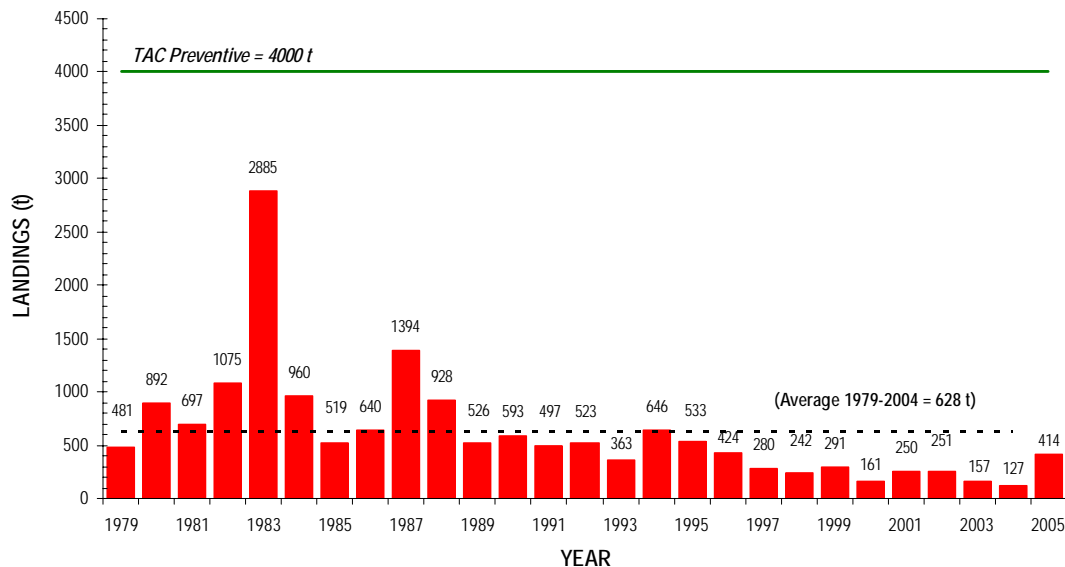


Figure 2. Herring landings and TAC (t) for NAFO Division 4S between 1979 and 2005 (the average landings for the years 1979-2004 are indicated by the horizontal dotted line).

Table 1. Annual herring catches (t) in the main unit areas on the Quebec North Shore, NAFO Division 4S.

	YEAR																AVERAGE (1990-2004)
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005 <sup>1</sup>	
<b>EAST</b>																	
4Sv	137	71	18	25	115	16	38	5	23	3	4	10	36	27	15	12	36
4Sw	39	50	70	35	139	131	164	69	55	10	63	124	82	16	24	342	71
4Sx	0	0	0	0	0	0	0	0	0	164	0	0	0	0	0	0	11
4Ss	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0
<b>TOTAL</b>	<b>176</b>	<b>121</b>	<b>88</b>	<b>60</b>	<b>254</b>	<b>147</b>	<b>202</b>	<b>74</b>	<b>79</b>	<b>178</b>	<b>67</b>	<b>134</b>	<b>119</b>	<b>43</b>	<b>40</b>	<b>354</b>	<b>119</b>
<b>WEST</b>																	
4Si	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
4Sy	41	31	52	51	58	14	3	0	0	20	0	1	0	0	0	0	18
4Sz	376	345	383	252	333	372	219	206	159	93	94	116	132	114	87	59	219
<b>TOTAL</b>	<b>417</b>	<b>376</b>	<b>435</b>	<b>303</b>	<b>391</b>	<b>385</b>	<b>222</b>	<b>206</b>	<b>162</b>	<b>113</b>	<b>94</b>	<b>117</b>	<b>132</b>	<b>114</b>	<b>87</b>	<b>59</b>	<b>237</b>

<sup>1</sup> Preliminary data

Until 2004, the most significant herring landings in unit area 4Sw occurred in statistical district 24, compared with district 23 in 2005 (Figure 4). In area 4Sz, most of the landings have occurred in district 19 since the early 2000s.

From 1984 to 1993, the proportion of landings occurring in Division 4S WEST has gradually increased compared to Division 4S EAST (Figure 5). Since then, this proportion has dropped and a minimum value was reached in 2005.

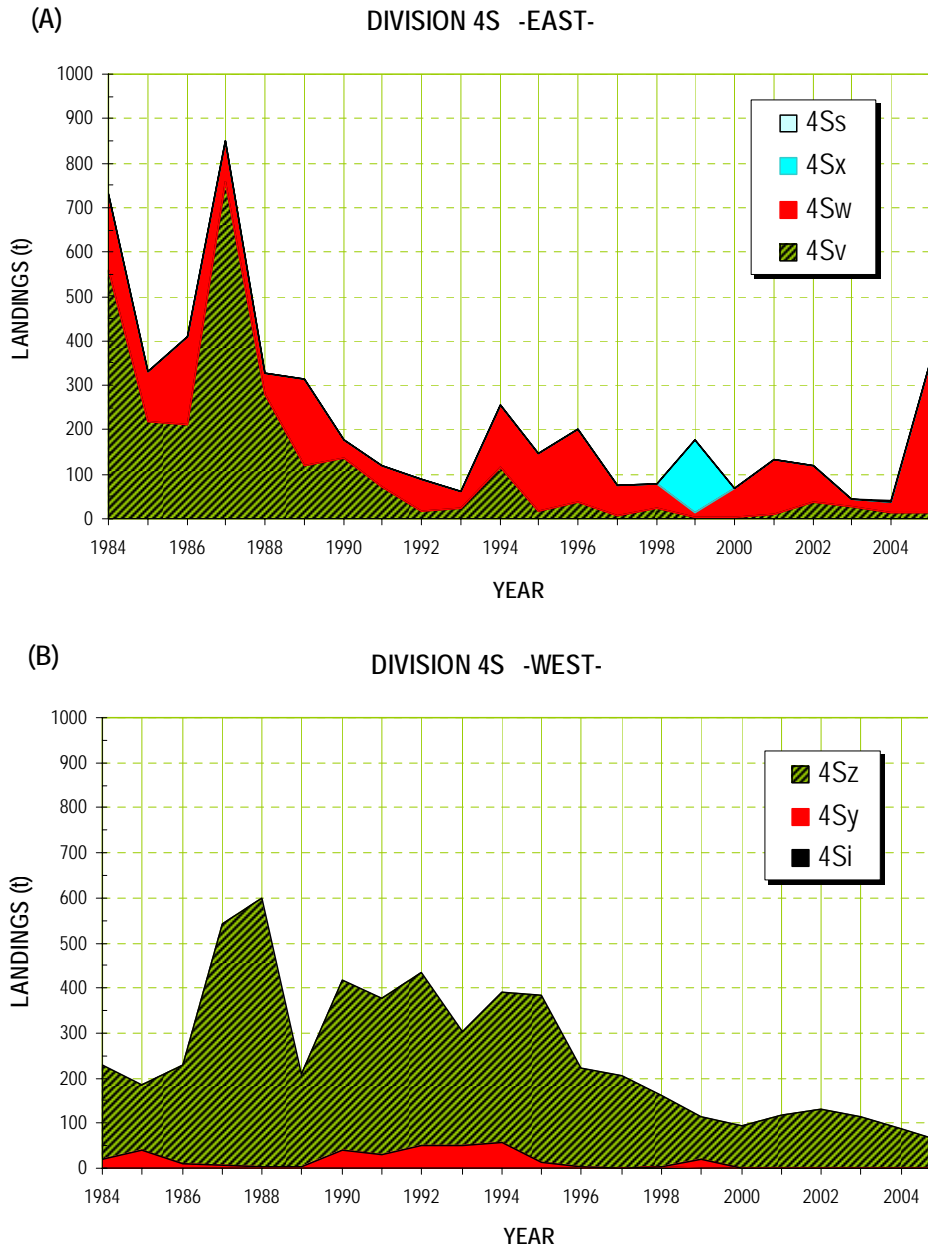


Figure 3. Cumulative commercial herring landings (t) for unit areas of NAFO Division 4S, EAST (A) and WEST (B) portions, from 1984 to 2005.

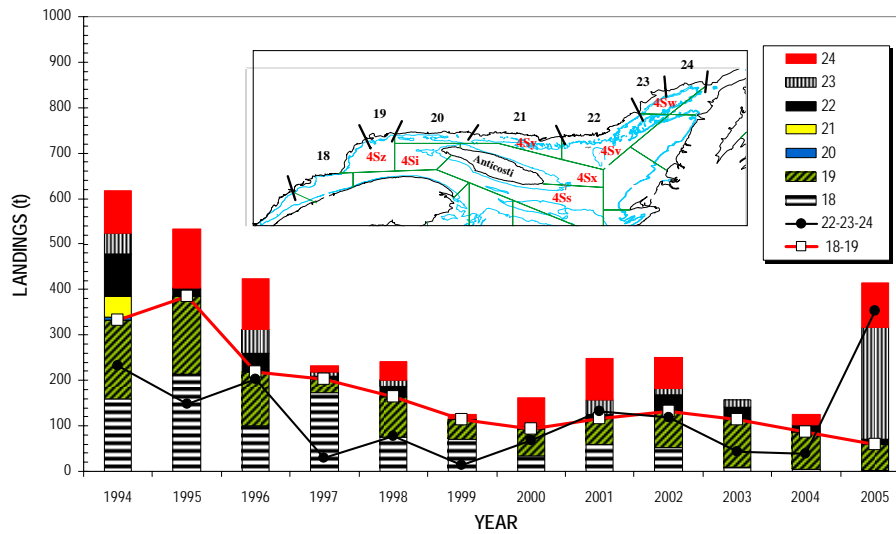


Figure 4. Commercial herring landings (t) for statistical districts of NAFO Division 4S, from 1994 to 2005.

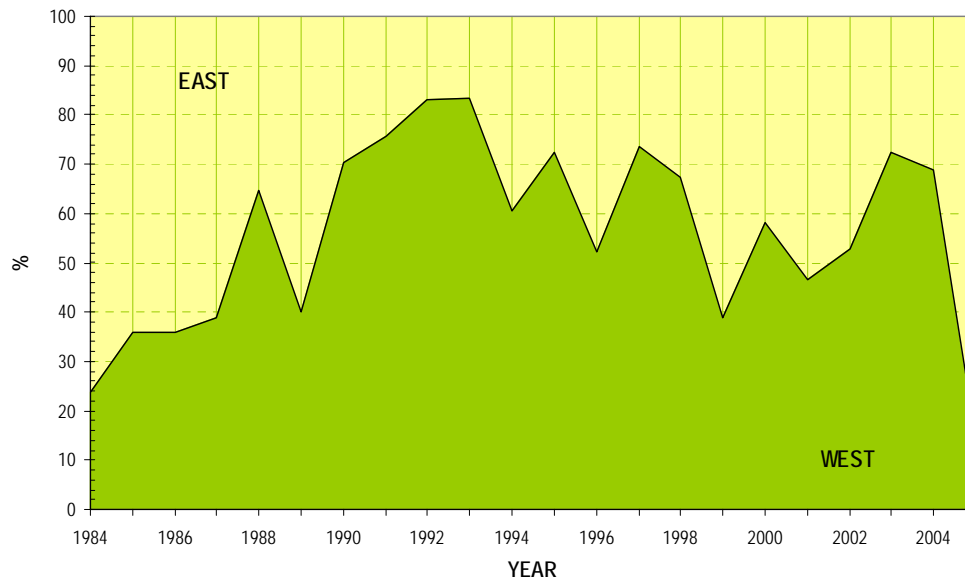


Figure 5. Percentage of herring landings between EAST and WEST portions of NAFO Division 4S, from 1984 to 2005.

### Temporal pattern of the fishery

The herring fishery on the Quebec North Shore begins in the spring in unit area 4Sz, continues in area 4Sv, and ends in late summer and early fall in area 4Sw (Figure 6). Median fishing dates, i.e. dates at which half the annual landings have been made, are May 30th (day 150 of the year) for area 4Sz, June 21th (day 172) for area 4Sv, and July 24th (day 205) for area 4Sw. Since 1994, the fishery in unit areas 4Sz and 4Sv occurred at increasingly dates as indicated by the decreasing values of median landing dates. However, no trend was observed in area 4Sw.

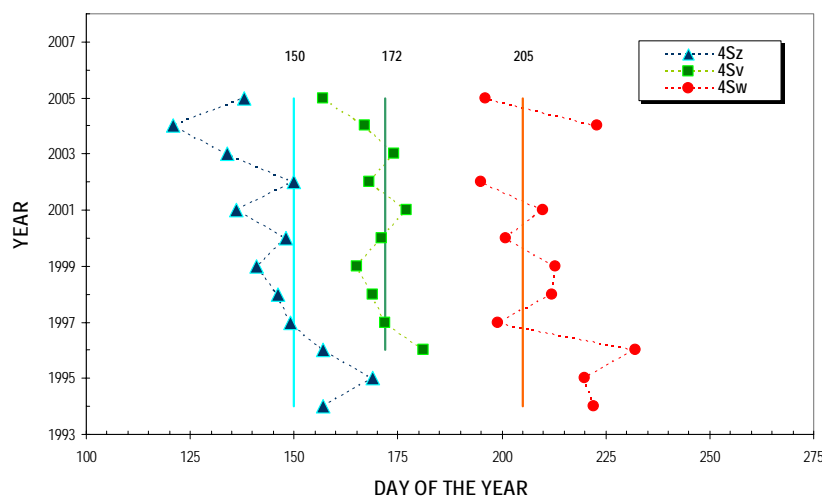


Figure 6. Temporal pattern of the herring fishery in unit areas 4Sz, 4Sv and 4Sw in NAFO Division 4S (Quebec North Shore). The symbols indicate the median landing dates; the numbers and vertical lines represent the median dates associated to each unit area when all years are combined.

Fishing gear

The main fishing gear used for catching herring on the Quebec North Shore is the gillnet. From 1990 to 2004, average annual landings with this gear were 302 t (Table 2). The second most common fishing gear is the purse senne with average annual landings of 43 t. However, in 2005, the trap became the main fishing gear with landings totalling 254 t.

Table 2. Annual herring catches (t) for the main fishing gear used on the Quebec North Shore, NAFO Division 4S.

FISHING GEAR	YEAR																AVERAGE (1990-2004)
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005 <sup>1</sup>	
<b>EAST</b>																	
Gillnet	176	105	88	56	225	147	203	28	65	13	24	133	86	43	39	93	95
Purse senne	0	0	0	4	30	0	0	45	0	164	0	0	0	0	0	7	16
Other	0	16	0	0	0	0	0	1	13	0	43	0	33	0	1	254 <sup>2</sup>	21
<b>WEST</b>																	
Gillnet	360	198	256	275	391	385	222	206	160	113	87	116	133	114	87	59	207
Purse senne	32	171	165	28	0	0	0	0	0	0	6	0	0	0	0	0	25
Other	25	7	14	0	1	0	0	0	4	1	0	0	0	0	0	0	3
<b>TOTAL</b>																	
Gillnet	536	303	344	331	616	532	425	234	225	126	111	249	218	157	126	152	302
Purse senne	32	171	165	32	30	0	0	45	0	164	6	0	0	0	0	7	43
Other	25	23	14	0	1	0	0	1	17	1	43	0	33	0	1	254	11
<b>GRAND TOTAL</b>	<b>593</b>	<b>497</b>	<b>523</b>	<b>363</b>	<b>647</b>	<b>532</b>	<b>425</b>	<b>280</b>	<b>242</b>	<b>291</b>	<b>161</b>	<b>250</b>	<b>251</b>	<b>157</b>	<b>127</b>	<b>414</b>	<b>356</b>

<sup>1</sup> Preliminary data

<sup>2</sup> Trap

## ANALYSIS

### Description of catches

#### Length frequencies

Annual length frequencies of herring sampled on the Quebec North Shore are characterized by the occurrence of modes associated with dominant year-classes (Figure 7). Since 1984, for spring spawners from unit area 4Sz, these year-classes were those from 1980, 1990, 1994 and 1997, compared with those from 1979, 1991, 1992 and 1995 for fall spawners sampled in unit areas 4Sv and 4Sw (Figure 7).

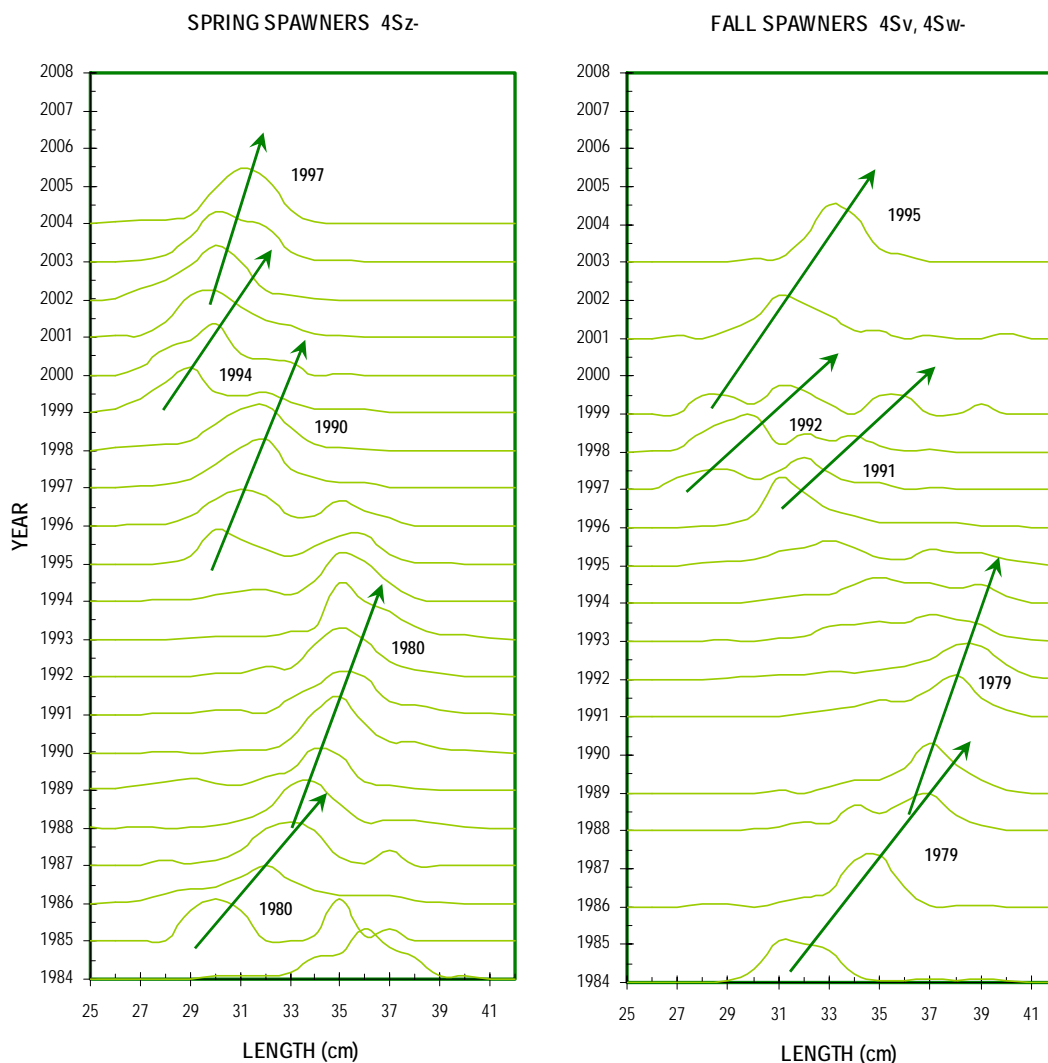


Figure 7. Length frequencies of spring (4Sz) and fall (4Sv, 4Sw) herring from the samples of the gillnet fishery on the North Shore of Quebec (NAFO Division 4S) between 1984 and 2004. The dominant year-classes are indicated.

Numbers at length

From the late 1980s to the mid-1990s, catches from the two herring spawning stocks of the Quebec North Shore were characterized by the occurrence of large size individuals (Figure 8). The occurrence of such individuals over several consecutive years is an indication of the low exploitation of these stocks. An increase in herring size is once again noticed since the mid-1990s.

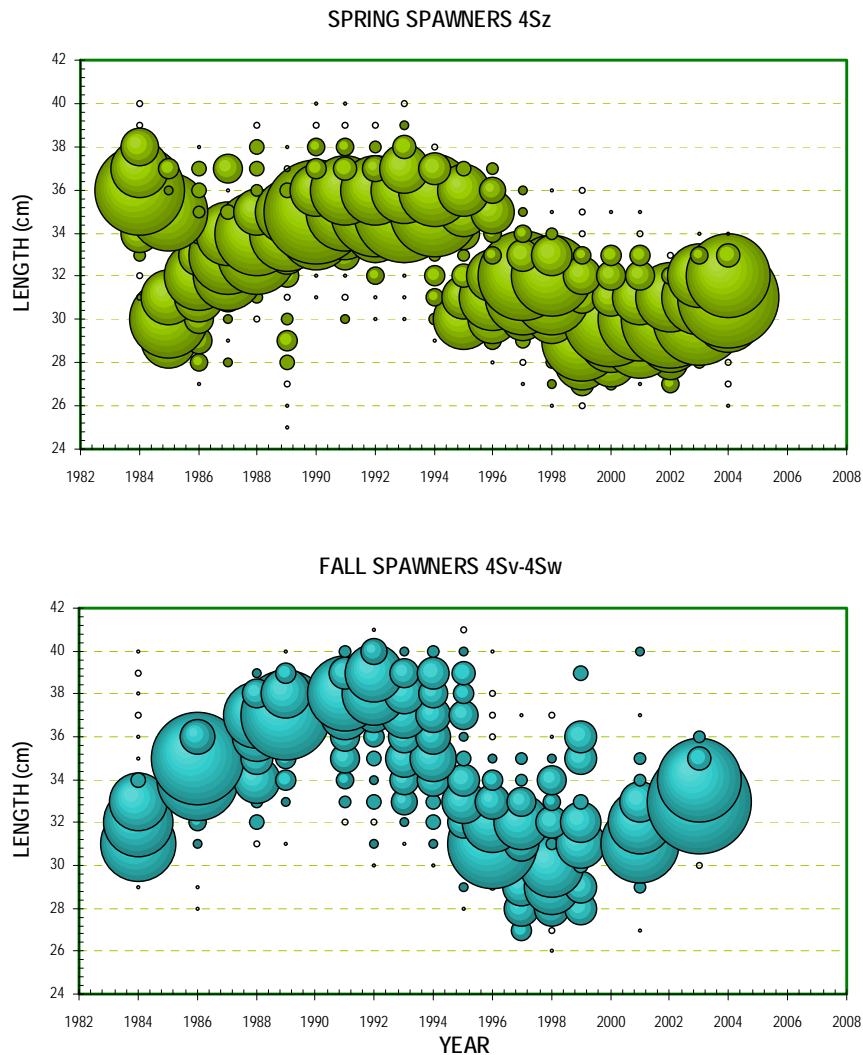


Figure 8. Numbers at length (%) of spring (4Sz) and fall (4Sv, 4Sw) spawning herring on the Quebec North Shore (NAFO Division 4S) for the period between 1984 and 2004.

Length and weight at age

During their first few years of life, growth in terms of length or weight is slower for fall spawners (Figures 9A, 9B), although it becomes slightly faster beginning at the age of five. For the same length, fall spawners are somewhat heavier than spring spawners (Figure 9C).



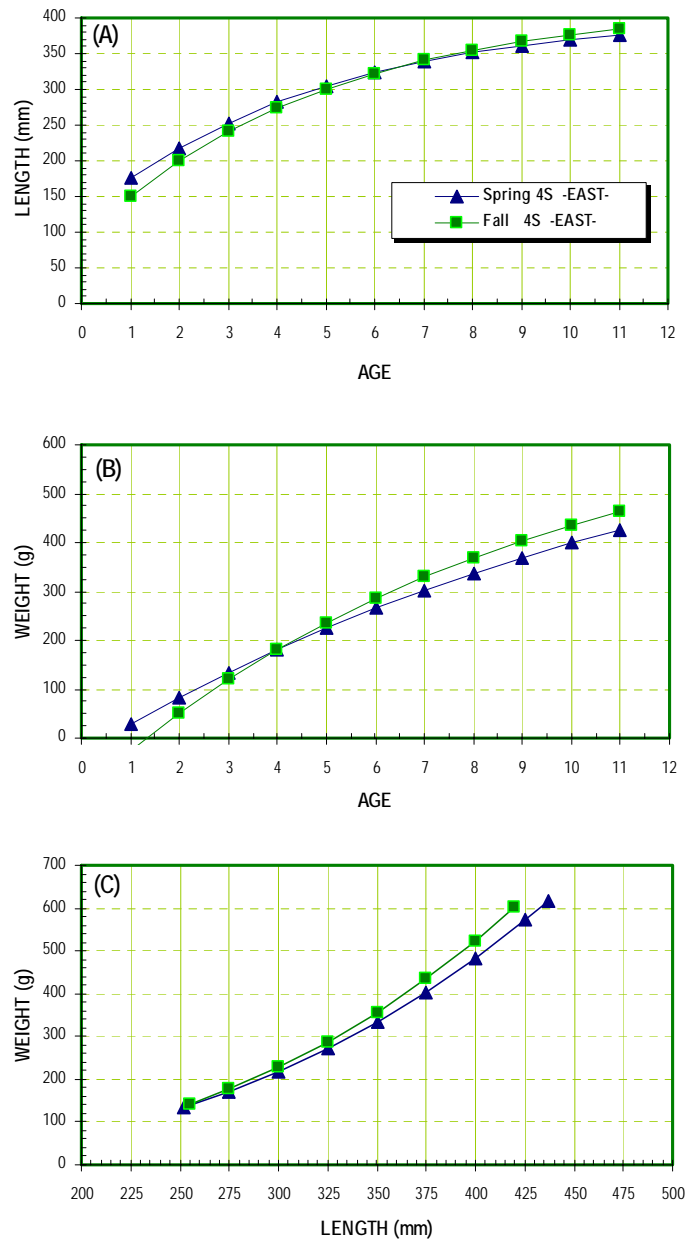


Figure 9. Relationship between length (A) and weight (B) at age, and between weight and length (C) for spring and fall spawning herring of NAFO Division 4S, EAST portion only (1984-2004).

Gonadosomatic index

In the spring, the two herring spawning stocks are distinguished by the degree of maturity of their gonads and by their gonadosomatic indices. For spring spawners (Division 4S EAST and WEST), the gonadosomatic index is between 15% and 20% from the end of April (day 110 of the year) and the end of June (day 175) (Figure 10). After spawning, which takes place quickly, the index remains at under 5% through July and August before gradually increasing in September (day 244 and later). For fall spawners, the gonadosomatic index is usually under 5%

until late June before increasing in July and reaching values of 15% and higher in August (Figure 10). Spawning occurs in late August and in September for this spawning stock.

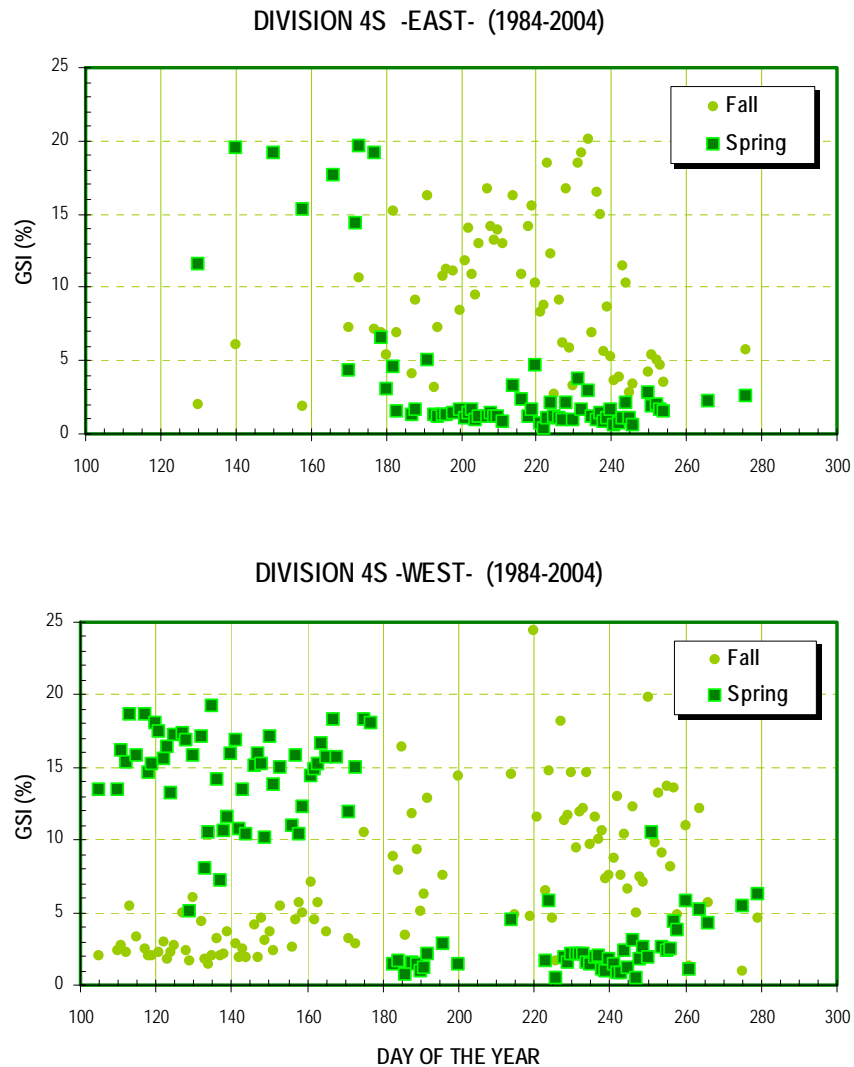


Figure 10. Mean gonadosomatic index (GSI) calculated by day for the period between 1984 and 2004. Calculations are done for each spawning group.

## Resource status

### Abundance

There is no acoustic survey to measure the abundance of the two herring spawning stocks of the Quebec North Shore. However, herring is a regular by-catch of bottom trawl abundance surveys carried out by the CCGS *Alfred Needler* and *Teleost*, which are conducted annually in the northern Gulf of St. Lawrence. Although catches by set are small, herring is caught in almost the entire sampled area covered by these surveys (Figure 11).

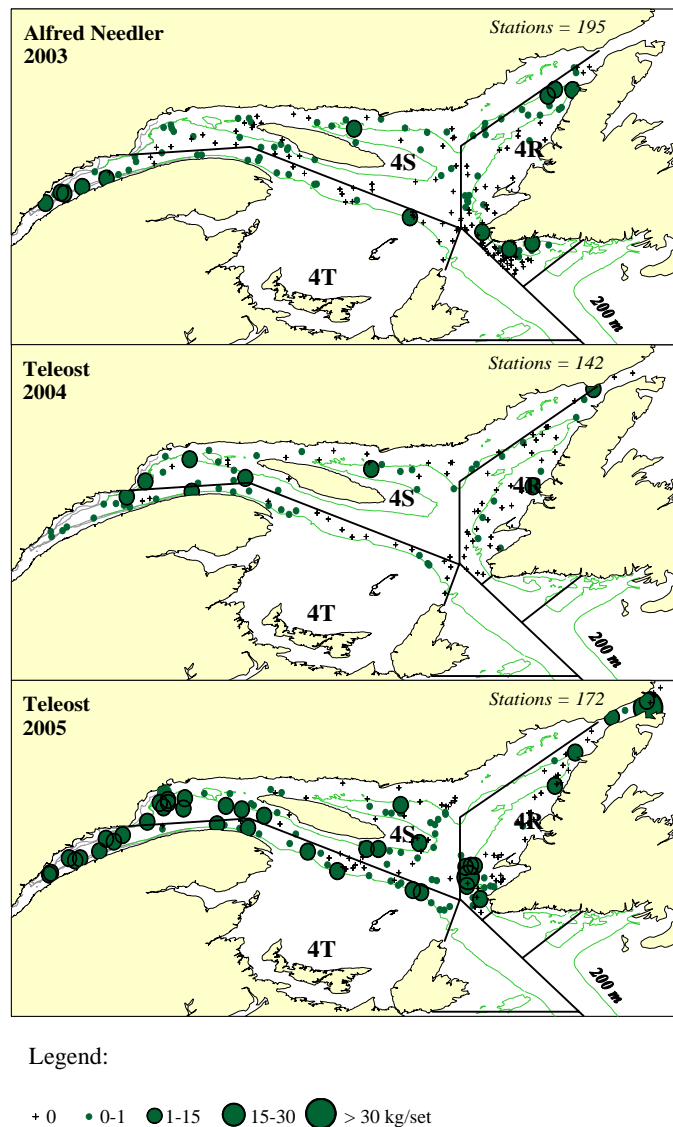


Figure 11. Herring abundance distribution (kg/set) for the last three bottom trawl surveys by the CCGS Alfred Needler and Teleost in the Estuary and northern Gulf of St. Lawrence.

Bottom trawl surveys are not appropriate for catching and measuring the abundance of a pelagic fish such as herring. Consequently, it was decided to only use presence and absence data per set to calculate, using indicator kriging, the surface associated with different probabilities of finding herring (Figure 12). These probabilities also help calculate a species dispersion index. This index has shown a clear upward trend since 1990 (Figure 13). Significant increases of this index were recorded in three occasions, in the early 1990s, in the late 1990s and since 2003. The increase since 2003 is mostly associated to an increase in probabilities of finding herring in the area west of Anticosti (Figure 12).

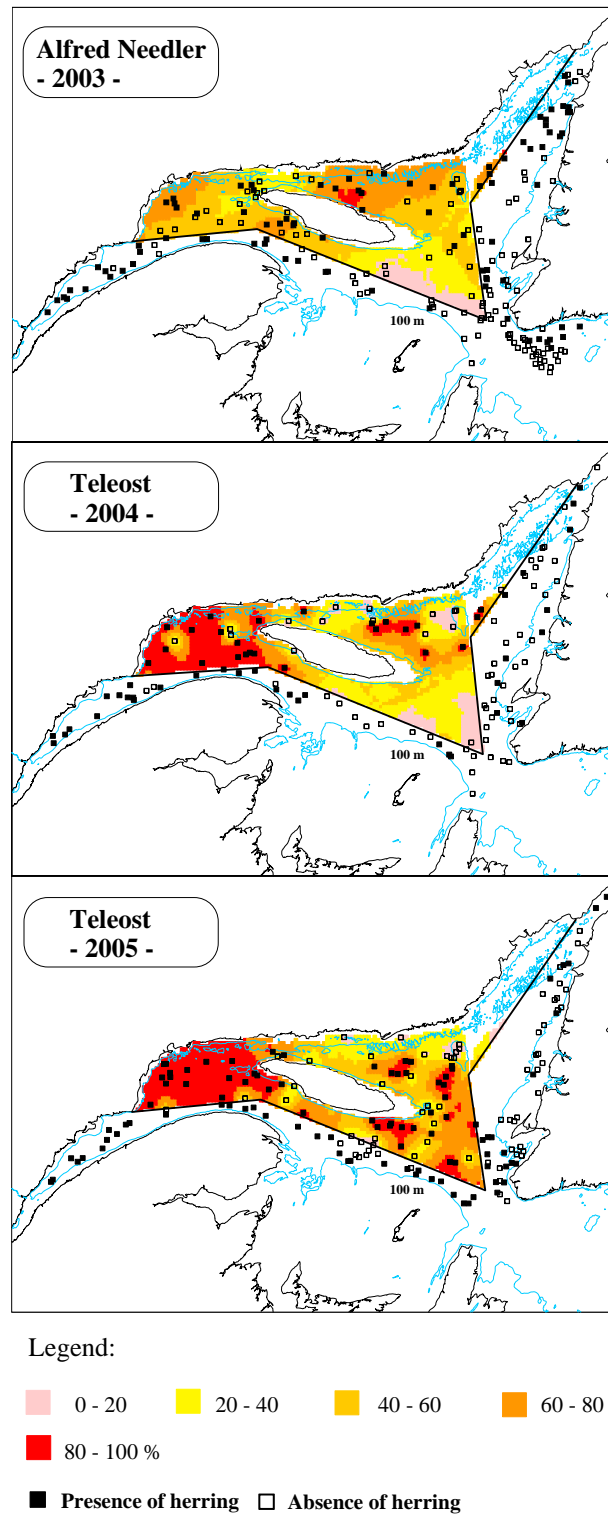


Figure 12. Herring occurrence probability surface contours (%) in NAFO Division 4S for the last three bottom trawl surveys conducted by the CCGS Alfred Needler and Teleost.

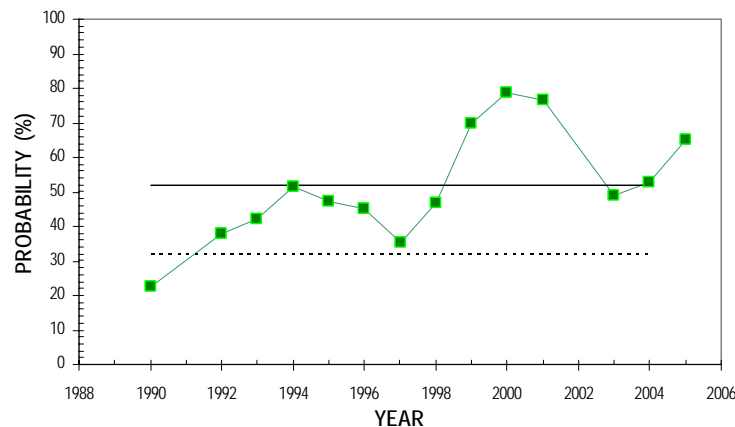


Figure 13. Mean probabilities of finding herring in NAFO Division 4S. The horizontal lines indicate upper and lower limits of the confidence interval (95%) of the 1990-2004 average.

### Analytical assessment

Without an abundance survey, there is no analytical assessment (Sequential Population Analysis or SPA) being carried out on the two herring spawning stocks of the Quebec North Shore. Consequently, it is impossible to calculate their respective abundance, fishing mortality, a minimum biomass limit and a new common TAC.

### Sources of uncertainty

The main source of uncertainty is the absence of information regarding the size of the two herring spawning stocks of the Quebec North Shore. There is also a lack of information on the number, the location and the size of spawning grounds. Furthermore, there is very little information concerning annual migration patterns, species distribution, as well as its' role in the Northern Gulf of St. Lawrence ecosystem.

## **CONCLUSION AND ADVICE**

Because of the territory's size and the actual catch levels compared to other eastern Canadian regions, herring catches could certainly be higher on the Quebec North Shore. However, the current available information is not sufficient to accurately determine by how much the catches could be increased. Consequently, we recommend that any increase in fishing effort on the two herring spawning stocks of the Quebec North Shore be made gradually and be accompanied by strict monitoring of the catches and biological characteristics.

## **SOURCES OF INFORMATION**

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