Atlantic Mackerel of the Northwest Atlantic

Background

In the northwest Atlantic, mackerel (Scomber scombrus L.) occur from Cape Hatteras, off North Carolina, to the Gulf of St. Lawrence and the east coast of Newfoundland (Figure 1). There are two groups or spawning stocks of mackerel in the region, each with its own spawning area. The southern stock spawns in March and April along the New Jersey coast. Although spawning does occur along the coast of Nova Scotia, the northern stock spawns mainly in the southern Gulf of St. Lawrence in June and July. Spawning takes place each year after a long migration that begins some months earlier in the Georges Bank area.

There are more than 15,000 mackerel fishermen in the Maritimes and Quebec. It is chiefly an inshore fishery and the most commonly used gear types are gillnets, handlines, purse seines and traps, in decreasing order of importance. Their utilisation depends on the area and time of year.

Overall, Canadian landings are stable from year to year, averaging just over 21,000 t annually since 1990. Regionally, however, there are major variations, as migration routes change, while fishing grounds remain the same. Changes in migration patterns are caused mainly by mackerel's sensitivity to certain environmental conditions, particularly water temperature.

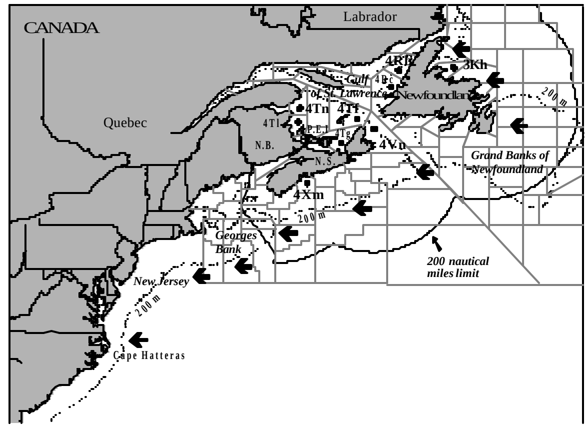

Figure 1. Distribution (¬) of Atlantic mackerel (Scomber scombrus L.) in the northwest Atlantic and main fishing sites (·).

Summary

- In 2000, the most noticeable feature of the mackerel fishery in the Gulf of St. Lawrence was the presence in the catches of a very large number of small fish. In fact, nearly 63 % of all catches were made up of fish just one year of age, that is, from the 1999 year-class. The lack of market outlets for these fish, with an average size of 270 mm, resulted in a considerable reduction in fishing effort and correspondingly landings.
- Until 1984, the **condition** of the mackerel upon their arrival in the Gulf of St. Lawrence was relatively good compared to that noted between 1985 and 1998 and in 2000. Furthermore, annual variations in condition are similar to the fluctuations in the mean temperature of the **C**old **I**ntermediate **L**ayer of water (**CIL**).
- A review of the **gonadosomatic index** reveals that, in 1998 and 1999, spawning took place earlier than during the period 1973 to 1997. The spawning activities were completed by the end of June, rather than late July as in other years. In 2000, the situation returned to normal

with an index that showed a maximum value as of early June.

- According to the 2000 abundance survey, the spawning biomass was 213,662 t for the first pass and 66,001 t for the second one, or an average of 139,832 t. Although this is considered as a relative index, the values obtained since 1996 are lower than those observed during earlier years. These low abundance values may be attributable to the absence in recent years of one or more **dominant year-classes**. However, a possible lack of synchronism between spawning and the date of the surveys may have led to assessment errors.
- This lack of synchronism is corrected for using the **D**aily **F**ecundity **R**eduction **M**ethod (**DFRM**), which permits a spawning biomass estimate to be derived from a measure of daily egg production and the seasonal decline in the reproductive potential of females. From the two sampling passes conducted in the 2000 survey, mackerel spawning stock biomass was estimated at 562,533 t and 169,510 t respectively, for an average of 366,022 t compared with 243,980 t in 1998 and 443,095 t in 1996.
- **V**irtual **P**opulation **A**nalysis (**VPA**) was conducted on an exploratory basis by using Canadian catch at age and spawning biomass values from the egg survey as a calibration index. Preliminary **VPA** results suggest that methods of analysing the egg survey data, in some years, significantly overestimate the true size of the stock. As evidenced by annual variations in the date on which the **gonadosomatic index** reaches 50 % and the pattern of some cumulative landings, an overestimate of this type may have been obtained in the surveys conducted in the early 1990s.
- In light of these findings and the basic principles of the **precautionary approach**, it no longer appears prudent to maintain a Canadian **TAC** (**T**otal **A**llowable **C**atch) of 100,000 t.

Main attributes of the stock

ATTRIBUTE	RECENT TREND	CURRENT SITUATION
Condition Factor (June)	Above mean (1973-1999) prior to 1985 and below it from 1985 to 1998.	1999 value again above mean; 2000 value below mean. Strongly associated with **CIL** temperature.
Gonadosomatic Index (GSI)	Between 1973 and 1997, a peak of about 12 % was reached around June 1 and spawning was over (**GSI** = 1 %) near the end of July.	In 1998, spawning earlier than usual. In 1999, on June 1, a maximum **GSI** of about 4 % and spawning over by the end of June. In 2000, back to normal.
Weight and length at age	Below mean (1973-1998) during the 1970s and above it in the 1980s. Growth of year-classes is inversely proportional to their abundance.	Below this mean in the 1990s, but above it in 2000. Slower growth seen in year-classes from late 1990s.
Annual length frequencies	A principal mode that shifts through the years and is associated with the dominant year-classes.	Lack of such a mode throughout the 1990s.
Gear selectivity	Mode corresponding to dominant year-classes appears earlier in length frequencies associated with handline catches.	In 2000, such a mode (1999 year-class) was found in length frequencies of handline catches.
Dominant year-classes	Last dominant year-classes were those of 1959, 1967, 1969, 1974, 1982 and 1988.	In 2000, 63 % of the catch at age was made up of fish only one year old. This is the highest value since 1973.
Egg survey	Spawning biomass increased between 1983 and 1988 before shrinking and then stabilizing between 1990 and 1994. Fluctuations in total biomass associated with the arrival of dominant year-classes and their entry into the population. During the 1980s and until 1994, high egg concentrations as measured by kriging were found in the middle of the Gulf of St. Lawrence.	Values obtained in 1996, 1998 and 2000 are very low and on the same order as in 1983. The lower abundance seen recently may be due to the lack of strong recruitment or by assessment errors caused by a lack of synchronism between spawning and the survey. In 1996 and 1998, high egg concentrations were found farther south, near the southwestern tip of the Magdalen Islands. In 2000, they were once again found in the middle of the Gulf.

Mackerel biology

The Atlantic mackerel (*Scomber scombrus L.*) is a member of the family **Scombridae**, which is distributed widely throughout tropical and temperate waters the world over and includes a large number of species, the best known of which are tunas. The Atlantic mackerel is the species of the genus *Scomber* that has the most northerly geographic range. Furthermore, unlike the two other species belonging to this genus, the Atlantic mackerel does not have a swim bladder, so it must swim continually. The lack of the swim bladder also allows it to change depth rapidly. On their long annual migrations, mackerel sometimes travel in very dense schools, especially in the spring and fall. The schools tend to be composed of identical-sized individuals that swim at the same speed.

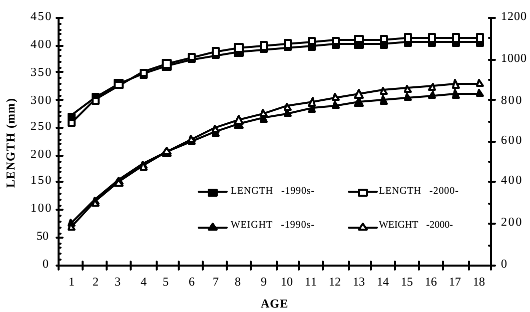

Figure 2. Length (mm) and weight (g) at age of Atlantic mackerel sampled in Canadian coastal waters between 1990 and 1999 (1990s) and in 2000.

Although spawning does occur along the shores of Nova Scotia, the mackerel that frequent Canadian waters spawn mainly in the southern Gulf of St. Lawrence in June and July. The largest egg concentrations are found south of the Laurentian Channel, west of the Magdalen Islands. Mackerel are considered **multiple spawners**, because each female spawns several times, and the spawning is **asynchronous**, meaning that it may occur at any time of the day or night. Egg development time depends on water temperature. Larvae measure about 3 mm upon hatching. At 50 mm in length, young mackerel become **juveniles** and begin to form schools. Some of these schools are located in inshore waters, possibly due to the migration of juveniles from spawning areas toward the coast. Little is known about the size of the **juvenile** contingent that participates in this migration or the importance of coastal habitats for **juveniles**. Although mackerel feed primarily on plankton, the adult diet includes small fish and squid. Mackerel grow very quickly, measuring about 270 mm long and weighing 200 g by the end of the second year (age 1+) of growth (Figure 2).

Most growth takes place in the first few years, with females growing more rapidly than males as of the age of four. Atlantic mackerel may live for more than 15 years, but rarely exceed 450 mm in length. Growth rates may vary from year to year and from one year-class to another. Fish from **dominant year-classes** grow more slowly (Figure 3).

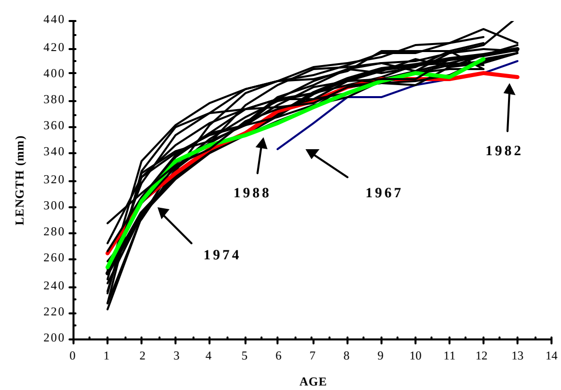

Figure 3. Mean length (mm) at age for year-classes of mackerel since the late 1960s (the 4 largest classes are indicated).

The **condition** of mackerel is at its lowest in early spring, whereas the highest values are seen in the fall. Up to and including 1984, the **condition** of mackerel on arrival in the Gulf of St. Lawrence was above the mean for 1973 to 1999 (Figure 4). Between 1985 and 2000, except in 1999, the annual values were below this mean. Annual variations in **condition** are very similar to the fluctuations in the mean temperature of the **CIL** (**C**old **I**ntermediate **L**ayer) (Figure 4). The potential relationships between mackerel

condition and water temperatures are not well known. However, it is assumed that the decline in **condition** could have an impact on the **natural mortality** of mackerel.

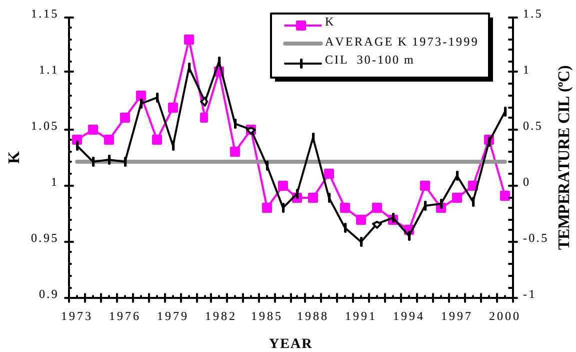

Figure 4. Mean annual condition factor K (Fulton) calculated in June, and mean temperature (ºC) of the 30-to-100 m layer associated to the CIL (Dr Denis Gilbert, Maurice Lamontagne Institute, Mont-Joli, pers. comm.).

During spawning, mackerel reach their lowest **fat content** about 5 % which gradually rises thereafter to 20 % or more in the fall. Interannual variations occur in **fat content**, along with variations in length and weight.

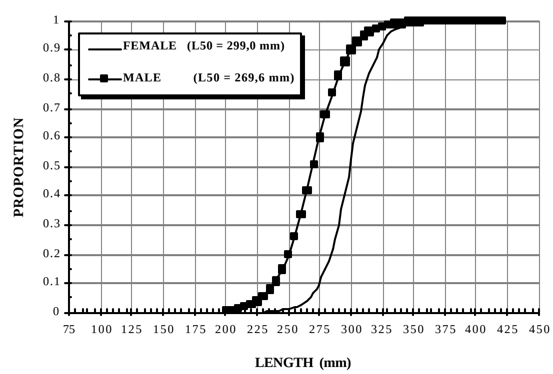

Figure 5. Maturity at length of mackerel sampled in St. Margaret's Bay, NS, 1996 (L50 is the length at which 50 % of the fish are sexually mature).

In comparison with other species, mackerel reach **sexual maturity** quickly, with 50 % of females and males being sexually mature at a length of 299 mm and 270 mm respectively (Figure 5). All mackerel reach maturity by the time they are 340 mm long, and nearly half of two-year-old mackerel are mature. Size rather than age is the determining factor. All fish in **dominant year-classes**, like those of 1959 and 1967, in which growth was slower, reached maturity at age five and a length of 330 mm.

The fishery

General

Landings of mackerel in the northwest Atlantic, which ranged from 300,000 t to 400,000 t in the early 1970s (Figure 6), declined sharply when the 200-nautical-mile exclusive economic zone was instituted. As a result of agreements with the United States and the Commonwealth of Independent States, catches rebounded considerably in the early 1980s, peaking at nearly 90,000 t in 1988. A gradual reduction in quotas set by the United States, ending with the complete closure of this fishery in 1992, explains the major reduction in landings that occurred in later years.

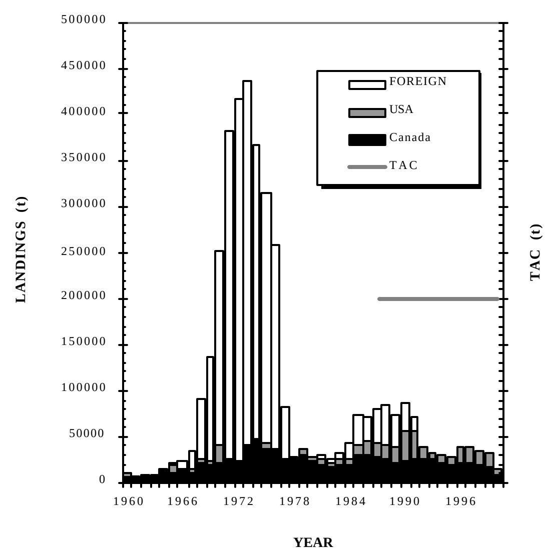

Figure 6. Annual mackerel landings (t) and TAC (t) for the northwest Atlantic (Canada has proposed a TAC of 200,000 t shared equally with the United States).

Canadian landings

Mackerel landings in Canadian waters are generally stable from year to year, averaging just over 21,000 t in recent years (Table 1). Nova Scotia is the Atlantic province with the highest landings, which average 6,829 t annually. In terms of landings, the most important unit areas are 4Tl, 4Tf and 4Xm (Figure 1) with annual mean landings of 3,999 t, 3,414 t and 3,119 t respectively (Table 2). On a smaller geographic scale, for example, statistical district or fishing community, landings may fluctuate significantly from one year to the next. The fluctuations are due to great variability in seasonal migration patterns, although fishing grounds usually remain the same.

The most commonly used gear types in Canada are gillnets and handlines, which account for mean annual landings of 6,575 t and 4,498 t respectively (Table 3). Gillnets are used mostly in spring and handlines in

Table 1. Annual mackerel catches (t) in the Maritimes and Quebec since 1990.

PROVINCE	YEAR											Average
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000***	(1990-1999)
Nova Scotia	9 182	8 115	8 831	7 144	7 792	6 681	5 517	5 669	4 562	4 797	2 710	**6 829**
New Brunswick	3 614	2 137	1 748	1 989	1 879	2 206	2 683	1 990	1 682	1 373	223	**2 130**
Prince Edward Island	2 458	3 922	2 299	4 580	4 441	2 518	4 017	6 693	6 784	3 842	1 459	**4 156**
Quebec	1 971	3 256	3 480	3 175	3 529	3 382	4 317	5 769	4 066	5 104	609	**3 805**
Newfoundland	4 041	8 341	6 915	9 343	2 775	2 862	3 830	1 188	2 149	1 445	3 794	**4 289**
Not determinated	0	0	0	0	0	0	0	0	91	0	0	**9**
TOTAL	**21 266**	**25 771**	**23 273**	**26 232**	**20 417**	**17 650**	**20 364**	**21 309**	**19 334**	**16 561**	**8 795**	**21 218**

* Preliminary

Table 2. Annual mackerel catches (t) in the main NAFO unit areas and subdivision (4Vn).*

UNIT AREA	YEAR											Average
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000****	(1990-1999)
3Kh	179	35	270	1 964	9	5	0	0	0	0	1 948	**246**
4Rb	626	2 596	1 434	2 371	1 605	663	868	217	650	751	1 106	**1 178**
4Rc	263	4 578	3 185	915	799	1 326	2 100	617	1 388	679	653	**1 585**
4Tf	1 986	3 086	3 190	2 674	3 286	2 925	3 805	5 257	3 268	4 662	270	**3 414**
4Tg	548	884	278	415	756	600	844	2 861	2 510	826	165	**1 052**
4Tl	3 331	3 885	2 455	4 797	4 285	2 977	4 651	5 332	4 769	3 511	1 357	**3 999**
4Tn	945	921	794	826	650	728	688	698	1 035	952	235	**824**
4Vn	2 396	2 384	1 277	1 579	1 671	1 475	1 591	835	554	757	33	**1 452**
4Xm	2 542	2 646	4 021	2 799	4 647	4 141	2 342	3 123	1 886	3 045	1 656	**3 119**
TOTAL	**12 817**	**21 013**	**16 903**	**18 340**	**17 708**	**14 841**	**16 888**	**18 941**	**16 059**	**15 184**	**7 423**	**16 869**
Others	8 449	4 758	6 371	7 892	2 709	2 809	3 476	2 368	3 275	1 377	1 372	**4 348**
GRAND TOTAL	**21 266**	**25 771**	**23 273**	**26 232**	**20 417**	**17 650**	**20 364**	**21 309**	**19 334**	**16 561**	**8 795**	**21 218**

* See Figure 1

** Preliminary

Table 3. Annual mackerel catches (t) by the main fishing gear types used on the East Coast of Canada.

GEAR	YEAR											Average
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000***	(1990-1999)
Trawl	2 616	977	2 050	605	0	59	68	92	9	12	0	**649**
Purse Seine	3 707	8 453	6 798	9 556	3 229	2 720	3 607	1 116	1 572	1 348	3 793	**4 211**
Other Seines	150	17	50	234	0	0	0	9	0	0	0	**46**
Gillnet	7 933	7 284	5 646	8 276	6 322	4 442	6 420	6 657	7 637	5 128	1 982	**6 575**
Trap	1 877	2 907	4 327	31	5 356	4 719	3 821	3 889	3 999	4 057	2 454	**3 498**
Longline	16	1	28	402	0	0	0	0	7	3	0	**46**
Jigger	472	448	544	4 144	338	899	1 231	3 029	1 998	569	17	**1 367**
Handline	4 427	5 679	3 550	2 985	4 523	3 821	4 705	6 204	3 651	5 435	548	**4 498**
Weir	62	4	265	0	3	177	0	1	141	8	0	**66**
Others	6	0	15	4	645	813	510	313	320	0	0	**263**

* Preliminary

fall. Traps are also important, accounting for mean annual landings of 3,498 t. They are used chiefly in spring in Nova Scotia. Fall catches by purse seiners on the west coast of Newfoundland are also significant. The success of this fishery is strongly dependent on the water temperatures and prevailing winds in this region. These conditions likewise determine fishing success on the east coast of Newfoundland. For example, in the fall of 2000, 1,948 t of mackerel was taken in unit area 3Kh (Figure 1), which represents one of the largest landings made in this region since 1993 (Table 2).

Characteristics of the catches

The demographic structure of the mackerel population is characterized by the periodic arrival of a **dominant year-class**. Its development can be followed by examining catch at age or annual length frequency distributions. In the latter case, each of these classes is clearly associated with a principal mode, which gradually shifts over the years to larger sizes. This is the case, for example, of the **dominant year-classes** of 1974, 1982 and 1988, which are observed in the length frequency distributions associated with the spring gillnet fishery (Figure 7A), and the 1982 and 1988 year-classes, which are linked to the length frequency distributions of the fall handline fishery (Figure 7B). In the latter case, the mode associated with the 1999 year-class is already present.

Highlights of the 2000 fishing season

The most noteworthy aspect of the 2000 fishing season was the presence of a very large number of small mackerel in the catches. These individuals alone, which were just one year old and 270 mm long on average, made up 63 % of the total catch at age. This is the highest value observed since 1973 (Figure 8). Since there are no market outlets for these small fish and they were very abundant throughout the Gulf of St. Lawrence, many fishermen simply halted their fishing activities and this led to a sharp decline in landings.

The 1999 year-class could prove to be a **dominant year-class**. The advent of such a year-class cannot be predicted and much less explained with present knowledge. However, certain indicators do exist. For example, a review of **satellite maps** and of thermograph data from index fishermen showed that the water temperatures recorded at the beginning of the 1999 season were higher than in preceding years. These conditions promoted the presence of larger numbers of mackerel near some shores and

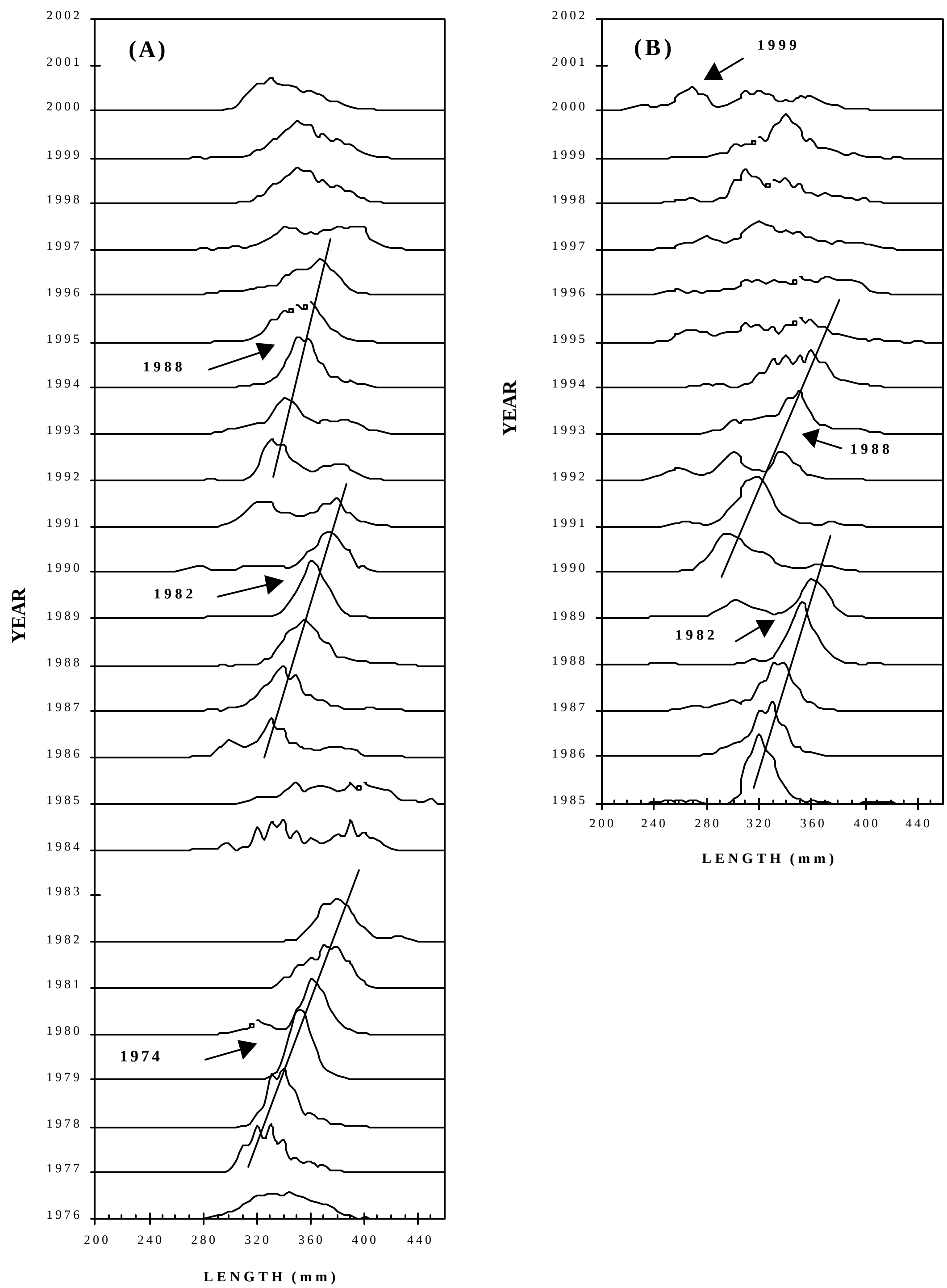

Figure 7. Annual length frequency distributions of mackerel caught by gillnets (A) and handlines (B) in the Gulf of St. Lawrence (Division 4T) (the strong year-classes that dominated these two fishery sectors are shown).

also explained the earlier arrival of mackerel in the Gulf of St. Lawrence. The 1999 fishing season was even opened prior to the normal starting date of June 1, in response to requests from many fishermen. An analysis of mean daily **gonadosomatic index** values showed that spawning took place earlier in 1998 and especially in 1999 than during the 1973-1997 period (Figure 9). Nonetheless, the situation returned to normal in 2000.

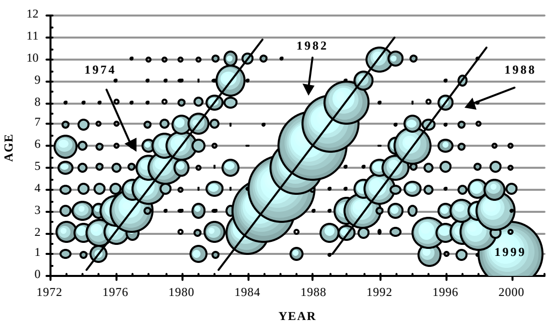

Figure 8. Canadian catch at age (%) for the period between 1973 and 2000 (the largest-ever catch of one-year-old fish was recorded in 2000; the dominant year-classes are also shown).

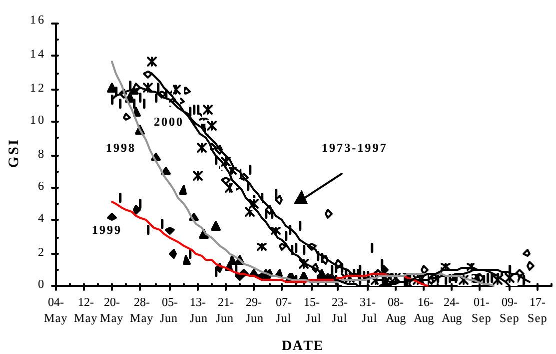

Figure 9. Mean daily gonadosomatic index (GSI) values, 1973 to 2000. Polynomial curves were adjusted to fit the data.

The industry

Over the past few years, mackerel fishermen and processors have expressed concern about the following: (1) In 2000, the presence of a large number of small mackerel in the Gulf of St. Lawrence was viewed as a collapse of the stock rather than the advent of **dominant year-class**; (2) The lack of market outlets for these small fish resulted in a substantial decline in fishing activity; (3) The fishery that takes place in winter and spring in US waters; (4) The drift gillnet fishery on Bradelle Bank in the spring; (5) The fall handline fishery, which is expanding more and more; (6) The abundance of mackerel in certain locations but not throughout the Gulf of St. Lawrence or along the shores of Nova Scotia; (7) The large numbers of seals found around fishing gear, especially gillnets and traps; (8) The risk of overharvesting the resource; (9) a **TAC** of 100,000 t that seems too high; and (10) The obvious lack of financial resources to run joint projects with DFO.

Resource status

The abundance of mackerel that spawn in the southern Gulf of St. Lawrence is calculated on the basis of a biennial egg survey. During this survey, samples are taken twice with plankton nets at stations distributed at regular intervals along parallel transects. For each of these passes, a mean number of eggs is first computed per unit surface area, and then this value is extrapolated to the entire sampled area to obtain daily egg production. Until recently, mean egg densities were calculated using a stratified random sampling plan. Now, densities are calculated by taking into account the geographic position and spatial variation of eggs. This **geostatistical approach** coupled with **kriging** has improved the accuracy of the estimated mean densities. Daily egg production values are used to calculate total or annual egg production based on a model that describes daily egg production during spawning. Annual production figures are converted into spawning biomasses by taking account of certain biological characteristics of the females.

Abundance survey

During the first pass, from June 18 to 26, the largest egg concentrations were found in the area west of the Magdalen Islands (Figure 10A). Examination of the **satellite map** taken during that pass showed that this region had high surface water temperatures. Even higher water temperatures were observed during the second pass, conducted between June 26 and July 3 (Figure 10B). In this pass, the largest egg concentrations were found near the Gaspé Peninsula. Examination of the **satellite maps** and data collected using a probe attached to the nets showed that the water temperatures warmed up very rapidly during the survey.

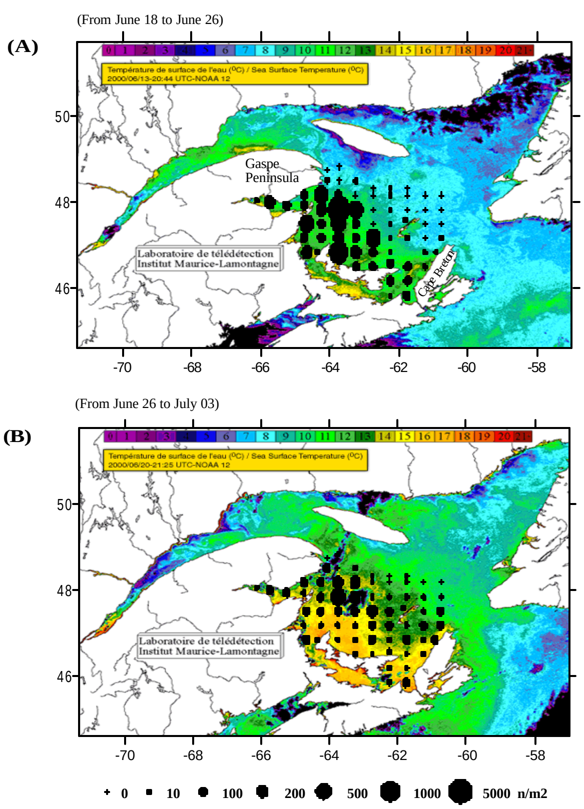

Figure 10. Distribution of mackerel eggs (number per square metre) during the first (A) and the second (B) pass of the 2000 survey in the southern Gulf of St. Lawrence.

In 2000, the number of stations found to have substantial egg concentrations was lower than in 1998. In addition, the area with very high egg concentrations, determined by **kriging**, was located in the middle of the Gulf in 2000 (Figure 11), as in the surveys done between 1983 and 1994, rather than in the region southwest of the Magdalen Islands as was the case in 1996 and 1998. The spawning biomass was estimated at 213,662 t for the first pass and 66,001 t for the second one, for a mean of 139,832 t. This value represents a drop of 134,324 t and 32,157 t in comparison with 1998 and 1996 (Figure 12).

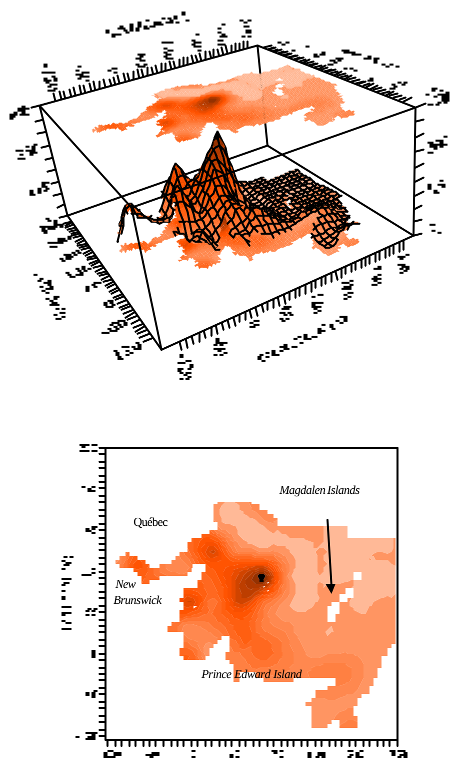

Figure 11. Surface kriged (3D and 2D representations) for mackerel egg densities recorded during the first sampling pass of the 2000 survey in the southern Gulf of St. Lawrence (the longitudes and latitudes have been transformed into Cartesian co-ordinates).

Daily Fecundity Reduction Method

The model used to convert daily egg production into annual production values is sensitive to mistiming between the survey and spawning. For example, the spawning biomass values will be overestimated if the survey takes place before peak spawning, with the reverse situation likewise being true. This problem could be avoided by a series of surveys covering the entire spawning period, as is done in Europe for mackerel abundance assessments.

The **D**aily **F**ecundity **R**eduction **M**ethod (**DFRM**) was devised to address this type of problem. This approach makes it possible to compute spawning biomass based on daily rather than total or annual egg production, taking into account the seasonal decline in female reproductive potential. The decline is measured on the basis of the seasonal diminution in the number of vitellogenic or mature oocytes and the number of females with active ovaries.

With this method, spawning biomass in 2000 was estimated at 562,533 t for the first pass and 169,510 t for the second one (Figure 12), for a mean value of 366,022 t. This value is higher than the 243,980 t computed using the same method in 1998, but smaller than the 443,095 t calculated in 1996. Compared with the traditional method, the biomass values computed with the **DFRM** should represent absolute rather than relative values. By contrast, the biomass obtained in the second pass of the 2000 survey may be underestimated, since it appears that this pass was conducted around the very end of the spawning period. With the likely advent of the **dominant year-class** of 1999, it will be interesting to compare these two methods once again.

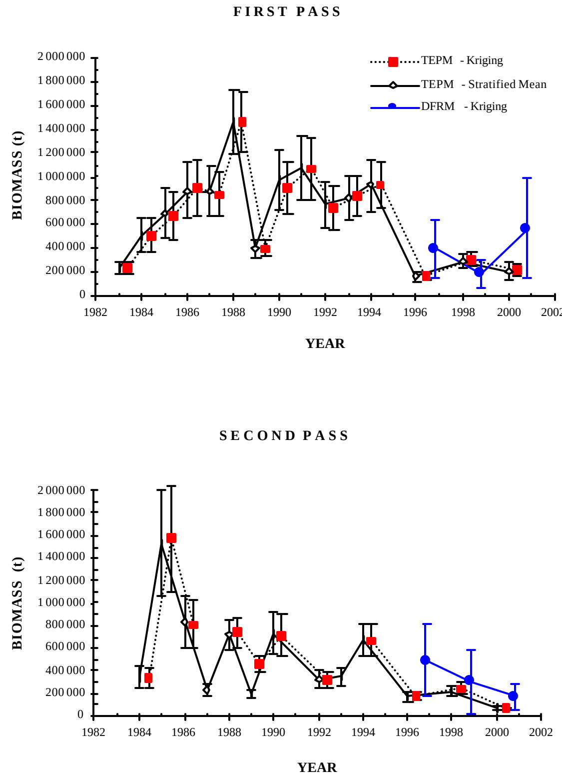

Figure 12. Spawning biomasses (t) of mackerel computed using two different methods (TEPM: Total Egg Production Method; DFRM: Daily Fecundity Reduction Method) and two different statistical approaches (stratified mean and kriging).

Analytical assessment

Studies to determine a suitable **VPA** (**V**irtual **P**opulation **A**nalysis) formula for the mackerel of the Gulf of St. Lawrence continued last year. It is difficult to apply **VPA** to mackerel mainly because of the following characteristics: (1) the very nature of the abundance index, which is not age disaggregated; (2) errors in estimating the spawning biomass, which are linked to the possible lack of synchronism between spawning and the survey; (3) the catch at age, which is underestimated as are landings; (4) **natural mortality**, which is set at 0.2 for all ages and all years; and (5) the absence of key biological data such as weight at age for some months.

As in 1998, the preliminary results suggest that the biomasses estimated by **VPA** were strongly correlated with those derived from the survey and that the latter may overestimate the true abundance of mackerel some years. In fact, as is suggested by the date on which the **gonadosomatic index** reaches 50 % of its highest value and the profile of cumulative landings at the entrance to the Gulf, overestimation of this kind would have been greatest in the early 1990s.

Outlook

The results of the most recent egg sampling surveys strongly suggest that the number of mackerel frequenting Canadian waters is now at a level as low as that seen in the early 1980s. Although greater fishing effort could be directed at this stock, maintaining a Canadian **TAC** of 100,000 t may not be a very prudent approach at this time. The current situation is very different from that of the 1970s when some very strong year-classes helped to sustain catches of several hundred thousand tonnes of mackerel over a number of years. Nonetheless, the presence of a very large number of one-year-old fish in the catches made in 2000 could signal the arrival of a **dominant year-class** (1999) and, consequently, a reversal of the situation. The true strength of this year-class may be confirmed once the fish that comprise it are fully recruited to the fishery or during the next abundance survey, to be done in 2002. The fish of this year-class will then be three years old and most of them will be sexually mature.

Sources of uncertainty

Catches of mackerel used as bait do not appear in DFO's official statistics, which are based on processing plant purchase slips. **Recreational fishing**, which is very popular in summer, is not counted either. As these activities are common in several parts of the Maritimes and Quebec, real mackerel catches are underestimated considerably.

All fishing areas have not always been covered systematically by DFO's commercial sampling program over the years. As a result, the biological data collected and used as the basis for estimating abundance and monitoring the population may not reflect the true situation of the stock.

Management considerations

To improve fishery statistics, a mandatory **logbook** should be distributed to all fishermen, including fishermen who use mackerel as bait. The **logbooks** would also help to determine where the fish are, and greatly facilitate the study of relationships between mackerel distribution and certain environmental variables.

Recreational mackerel catches are probably high, considering that many fishermen (tourists) fish for this species all along the Atlantic coast. With an eye to future management of this activity and in order to improve the validity of fishery statistics we should soon start thinking about how to estimate these catches.

Finally, the minimum legal size, currently set at 250 mm, should be more realistic and more in line with mackerel biology. This value is well below the sizes of 299 mm and 270 mm computed from the **sexual maturity** curves for females and males. We recommend that the size linked to females be applied as soon as possible.

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