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Quebec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2005/014

Atlantic Mackerel of the Northwest Atlantic in 2004

Background

This document presents an assessment of the main fishery and biology data gathered on Atlantic mackerel (Scomber scombrus L.) of NAFO Subareas 3-4 in 2004 (Figure 1). It follows the 2004/18 Stock Status Report issued in March 2004. A complete report including abundance survey results from 2004 and 2005 will be published in 2006.

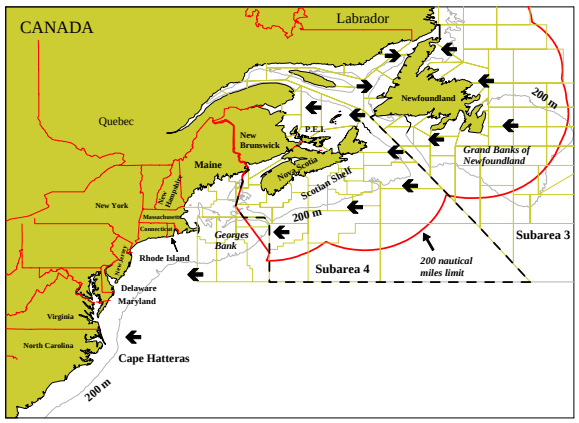

Figure 1. Distribution (←) of Atlantic mackerel (Scomber scombrus L.) in the Northwest Atlantic. The dotted line indicates the borders between Subareas 3 and 4.

Summary

- Preliminary landings from NAFO Subareas 3-4 dropped from 44,475 t in 2003 to 35,023 t in 2004. The actual value of the 2004 fishery landings should be higher since landings from Prince Edward Island, New Brunswick and Nova Scotia have not yet been accounted for.
- Between 2003 and 2004, landings by American commercial fishermen rose from 34,292 t to 52,490 t, a peak since 1960. For the entire Northwest Atlantic, preliminary mackerel landings totalled 87,980 t in 2004. Only the 1970s offshore fisheries have shown higher tonnages.
- Since 2000, the most striking feature of commercial mackerel catches has been the presence of a high abundance and very large proportion of fish from the 1999 year-class. Over the past five years, this year-class has accounted for between 56% and 77% of the total number of fish caught, which hasn't been seen since the late 1960s, i.e. since Canada began collecting biological data on mackerel.

- One- and two-year age groups were predominant in fall catches made in the Southern Gulf of St. Lawrence (using lines) and on the East coast of Newfoundland (using purse seines). The presence of small mackerel in the latter area is unusual.

The fishery

Historical overview

Mackerel landings in the Northwest Atlantic (NAFO Subareas 2-6) reached significant values in the early 1970s (between 300,000 t to 400,000 t). Landings then dropped considerably in 1977 with the introduction of the 200-nautical-mile economic exclusion zone (EEZ) (Figure 2). Owing to agreements between the United States and what was then the USSR, landings increased again in the early 1980s, peaking at close to 85,000 t in 1988. In the ensuing years, landings dropped considerably as the United States gradually reduced its mackerel quotas to eventually completely close this fishery in 1992. Since the early 2000s, catches have been increasing again due to an abundant year-class (1999) and a considerable increase in fishing effort on this species.

Since 1987, Canada has been proposing that the 200,000 t TAC for the entire Northwest Atlantic be divided equally with the United States. In light of the low biomass estimates derived from the 1996, 1998 and 2000 egg surveys, the Canadian share of the TAC was reduced from 100,000 t to 75,000 t in 2001.

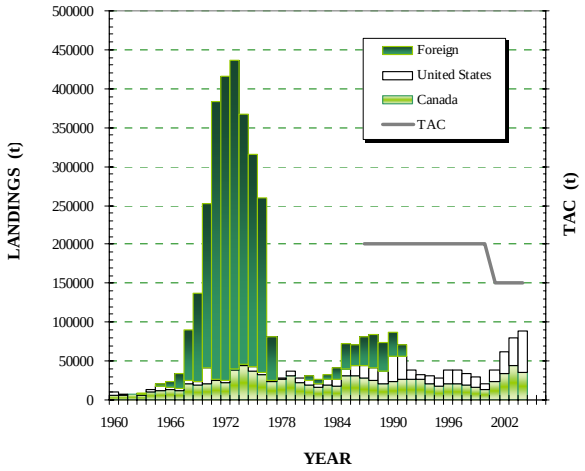

Figure 2. Annual landings (t) of mackerel and TAC (t) for the Northwest Atlantic (NAFO Subareas 2-6).

Landings in 2004

Reported mackerel landings in Eastern Canada totalled 35,023 t in 2004 (Table 1). These landings are higher than the average for recent years, and represent the second highest value since 1960. However, landing figures are incomplete since catch data for Prince Edward Island, New Brunswick and Nova Scotia are not yet available.

U.S. commercial landings reached 52,490 t in 2004, up by slightly more than 18,000 t compared with 2003. Recreational landings in the United States totalled 467 t in 2004, compared to 724 t in 2003, and no foreign vessels are reported to have fished in U.S. waters since 1992. For the entire Northwest Atlantic (NAFO Subareas 2-6), mackerel landings totalled 87,980 t in 2004, which exceeds the annual averages calculated since 1980 or 1990 (Table 1). Only the 1970s offshore fisheries have shown higher tonnages.

Of all mackerel catches reported in Canada in 2004, 32,966 t or 94% were landed in Newfoundland (Table 2), i.e. 11,548 t in Divisions 3K and 3L, and 21,418 t in Division 4R (Table 3). The purse seine was the main fishing gear used, totalling 32,966 t, followed by gillnets and jiggers, totalling 1,196 t and 860 t respectively (Table 4).

For several years, 40% of the TAC has been allocated to mobile gear over 65' (19.8 m), and 60% to mobile gear under 65' and to coastal fixed gear such as traps, gillnets, lines and weirs. In the first case, nearly 50% and 35% of the quota was reached in 2003 and 2004 respectively. These values were the highest of all historical landing series. In the second case, 66% and 55% of the quota was reached over the last two years.

Table 1. Annual mackerel landings (t) between 1990 and 2004 in NAFO Subareas 2 to 6.

YEAR	CANADA		UNITED STATES			TOTAL
	Canadian vessels	Foreign vessels	Commercial	Recreational	Other Countries	
1990	19 190	3 854	31 261	1 908	30 678	**86 891**
1991	24 914	1 281	26 961	2 439	15 714	**71 309**
1992	24 307	2 417	11 775	344	0	**38 843**
1993	26 158	591	4 666	540	0	**31 955**
1994	20 564	49	8 877	1 705	0	**31 195**
1995	17 650	0	8 479	1 249	0	**27 378**
1996	20 364	0	16 137	1 416	0	**37 917**
1997	21 309	0	15 400	1 735	0	**38 444**
1998	19 334	0	14 523	690	0	**34 547**
1999	16 561	0	12 026	1 335	0	**29 922**
2000	13 383	0	5 646	1 448	0	**20 477**
2001	23 868	0	12 336	1 538	0	**37 742**
2002	34 402	0	26 452	1 286	0	**62 140**
2003	44 475	0	34 292	724	0	**79 491**
2004*	35 023	0	52 490	467	0	**87 980**
AVERAGE:						
1960-2003	**19 050**	**3 168**	**7 888**	**1 765**	**61 283**	**93 153**
1970-2003	**21 896**	**3 595**	**9 514**	**2 085**	**73 067**	**110 158**
1980-2003	**23 080**	**522**	**12 625**	**1 920**	**10 630**	**48 777**
1990-2003	**23 320**	**585**	**16 345**	**1 311**	**3 314**	**44 875**

* Preliminary

Table 2. Annual mackerel landings (t) by Canadian province (NAFO Subareas 3 and 4) since 1995.

PROVINCE	YEAR										AVERAGE	
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004***	(1995-2003)	(1990-2003)
Nova Scotia	6 681	5 517	5 669	4 562	4 797	4 546	4 058	3 989	7 187	9	**5 223**	**6 246**
New Brunswick	2 206	2 683	1 990	1 682	1 373	972	2 199	2 182	1 734	302	**1 891**	**2 023**
Prince Edward Island	2 518	4 017	6 693	6 784	3 842	4 134	5 886	6 181	4 543	138	**4 955**	**4 449**
Quebec	3 382	4 317	5 769	4 066	5 104	1 711	2 904	4 095	4 380	1 608	**3 970**	**3 638**
Newfoundland	2 862	3 830	1 188	2 149	1 445	2 019	8 820	17 955	26 631	32 966	**7 433**	**6 939**
Not known	0	0	0	91	0	0	0	0	0	0	**10**	**6**
TOTAL	**17 650**	**20 364**	**21 309**	**19 334**	**16 561**	**13 383**	**23 868**	**34 402**	**44 475**	**35 023**	**23 483**	**23 301**

* Preliminary

Description of landings

Since 2000, mackerel landings have been characterized by the presence of a very large proportion of fish from the 1999 year-class (Figure 3). Up until now, these fish, ages 1 to 5, have accounted for between 56% and 77% of all catches in number. Such a predominance has never been observed among the year-classes sampled since the late 1960s, i.e. since Canada began collecting biological data on mackerel. These high percentages could be reflecting the predominance of this single

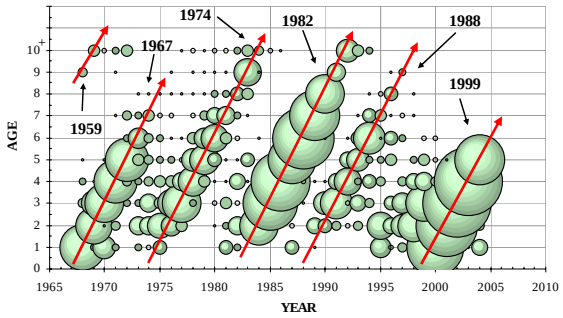

Figure 3. Catch at age (%) of mackerel from NAFO Subareas 3 and 4 for the period between 1968 and 2004 (the year-classes that dominated the fishery over several years are indicated; the 10^+ age group represents all fish older than 10 years old).

Table 3. Annual mackerel landings (t) by NAFO Division (Subareas 3 and 4) since 1995.

DIVISION AND REGION	YEAR										AVERAGE	
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*	(1995-2003)	(1990-2003)
3K	11	3	0	0	0	0	322	6 566	588	11511	**832**	**995**
3L	6	0	0	0	0	0	10	3	0	37	**2**	**54**
3P	86	60	8	65	7	19	102	135	105		**65**	**61**
4R	2 760	3 767	1 181	2 175	1 438	2 001	8 385	11 251	25938	21418	**6 544**	**5 833**
4S	30	9	1	1	2	0	17	2	0	0	**7**	**20**
4T	8 184	11 355	15 358	12 739	10 562	7 005	11 915	14 251	14106	2057	**11 719**	**10 866**
4V	1 475	1 591	838	554	762	576	125	308	60		**699**	**1 119**
4W	621	1 181	716	138	127	120	248	115	9		**364**	**836**
4X	4 478	2 399	3 208	3 662	3 663	3 663	2 743	1 771	3669		**3 251**	**3 517**
Scotian Shelf (4VWX)	**6 574**	**5 170**	**4 762**	**4 355**	**4 552**	**4 358**	**3 117**	**2 194**	**3 737**		**4 313**	**5 472**
Gulf of St. Lawrence (4RST)	**10 973**	**15 131**	**16 540**	**14 914**	**12 002**	**9 006**	**20 317**	**25 504**	**40 044**	**23 475**	**18 270**	**16 719**
East and South coasts of Newfoundland (3KLP)	**103**	**63**	**8**	**65**	**7**	**19**	**434**	**6 704**	**693**	**11 548**	**900**	**1 110**
TOTAL	**17 650**	**20 364**	**21 309**	**19 334**	**16 561**	**13 383**	**23 868**	**34 402**	**44 475**	**35 023**		

* Preliminary

Table 4. Annual mackerel landings (t) by gear type in NAFO Subareas 3 and 4 since 1995.

GEAR	YEAR										AVERAGE	
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*	(1995-2003)	(1990-2003)
Trawl	59	68	92	9	12	1	3	5	0		**28**	**421**
Purse Seine	2 720	3 607	1 116	1 572	1 348	1 840	8 022	16 907	26 313	32 966	**7 049**	**6 773**
Other Seine	0	0	9	0	0	0	0	0	0		**1**	**16**
Gillnet	4 442	6 419	6 657	7 638	5 128	5 294	6 554	5 000	4 541	1 196	**5 742**	**6 174**
Trap	4 719	3 821	3 889	3 999	4 057	3 920	3 148	2 073	3 628		**3 695**	**3 618**
Longline	0	0	0	7	3	3	20	18	13	0	**7**	**10**
Handline	899	1 231	3 029	1 998	569	90	160	169	9		**906**	**739**
Jigger	3 821	4 705	6 204	3 651	5 435	2 229	5 676	9 839	9 856	860	**5 713**	**5 253**
Weir	177	0	1	141	8	0	46	48	74		**55**	**59**
Other	812	510	313	320	0	5	237	344	40	2	**287**	**238**
TOTAL	**17 650**	**20 364**	**21 309**	**19 334**	**16 561**	**13 383**	**23 868**	**34 402**	**44 475**	**35 023**	**23 483**	**23 301**

* Preliminary

year-class in all the stock. However, in 2004, more than 30% of the catch at age was also made up of younger fish of the 1- and 2-year-old age group (Figure 4).

In 2004, the mean length and weight of fish from the 1999 year-class was respectively 361 mm and 570 g. These fish have been observed for several years in the annual length frequencies derived from sampling of the commercial line fishery in Division 4T and the commercial seine fishery in Division 4R (Figure 5). Furthermore, they can now be seen in the length frequency distributions for the gillnet fishery in Division 4T. Before 2003, the 1999 year-class was not present in this fishery owing to the high selectivity of gillnets.

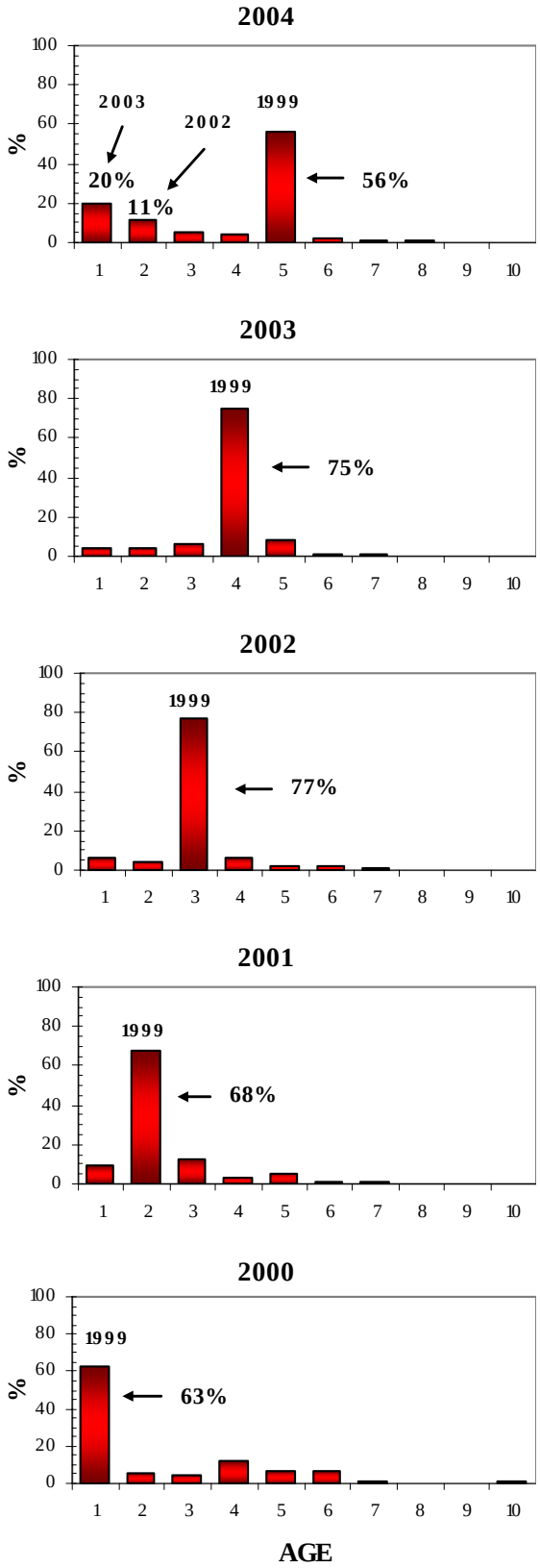

Figure 4. Catch at age (%) of mackerel from the 1999 year-class since 2000, and from the 2002 and 2003 year-classes in 2004.

Some fish from age groups 1 and 2 were caught in Division 4T during the fall line fishery (Figure 5). The same was true for 1 year-old fish caught during the seine fishery conducted off the East coast of Newfoundland (Figure 6). In fact, 70% of catches (in number) for the fourth quarter in Division 3K (5,516 t) were made up of fish from this age group, compared to 61% of the 1999 year-class in the previous quarter. The presence of smaller mackerel off the East coast of Newfoundland is unusual.

Resource status

1999 year-class

The 1999 year-class comes from a year when spawning took place earlier in the season than usual. This early spawning was deduced from a review of the mean daily values of the gonado-somatic index, which stood at only 5% on June 1, 1999 in the Southern Gulf, compared to a mean value of 12% in preceding years (Figure 7). Several fishermen also mentioned that the mackerel had arrived earlier in the Gulf of St. Lawrence in 1999. Samples from bottom trawl surveys conducted offshore Nova Scotia during the winter of 1999 indicate that ovaries were at a more advanced stage of development than in previous years. Such a degree of maturity could involve an earlier spawning in the Gulf of St. Lawrence and an even earlier one on the Scotian Shelf. It should be noted that the winter and spring of 1999 were exceptionally warm on the Scotian Shelf.

Diet and prey

Data collected in the mid-1980s showed that mackerel in the Northern Gulf of St. Lawrence fed mainly on small (< 5 mm) and large (≥ 5 mm) zooplankton (Figure 8). New estimates derived in the mid-1990s indicate that small and large zooplankton were still their main prey (90 % of their diet). However, capelin (*Mallotus villosus*) made up nearly 10% of the mackerel diet. In the early 2000s, small and large zooplankton accounted for 72% of the mackerel diet.

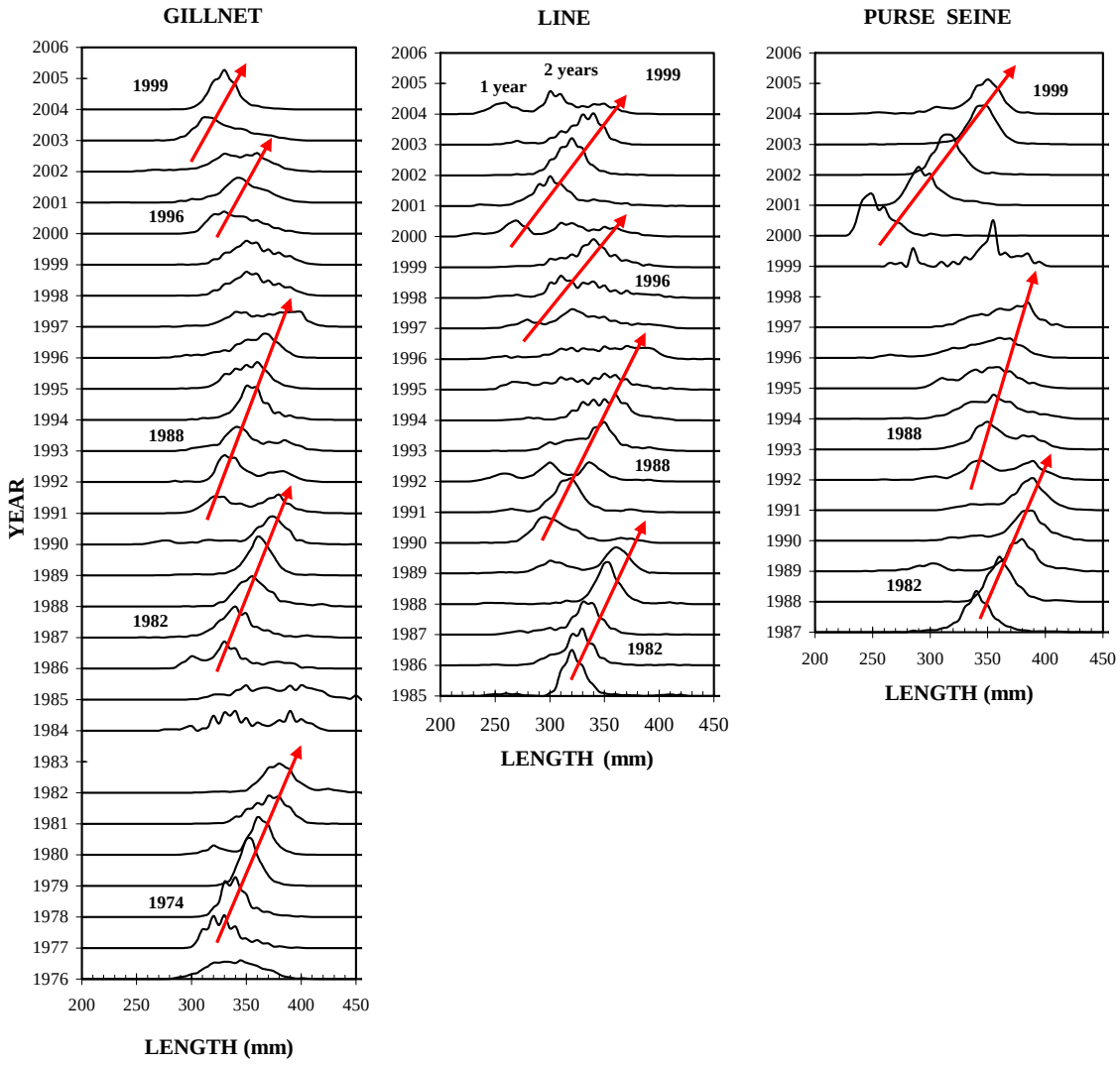

Figure 5. Annual length (mm) frequencies (%) of mackerel caught with gillnets and lines in Division 4T and with purse seines in Division 4R (the year-classes that dominated these fisheries are also indicated).

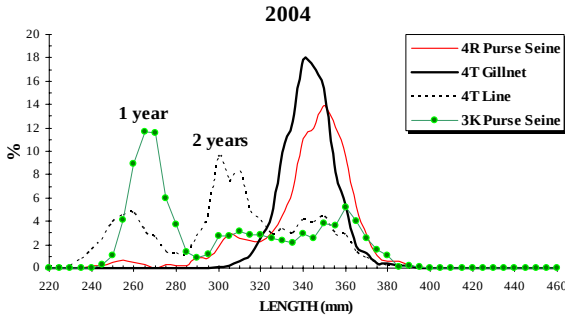

Figure 6. Length (mm) frequencies (%) of mackerel caught in 2004 in NAFO Divisions 4R, 4T and 3K (modes corresponding to age groups 1 and 2 are indicated).

During the same period, the shrimp (*Pandalus borealis*) and capelin proportions were 13% and 8% respectively.

As shown by the results of a model of the Northern Gulf of St. Lawrence marine ecosystem, the main causes of mortality for mackerel in the mid-1980s were cetaceans, large cod (*Gadus morhua*), and large demersals (Figure 9). The proportion of mackerel making up the cetacean and large cod diets during this period was 18.7% and 1.5% respectively. The same model showed that fishery related mortalities gradually increased during these three periods, from

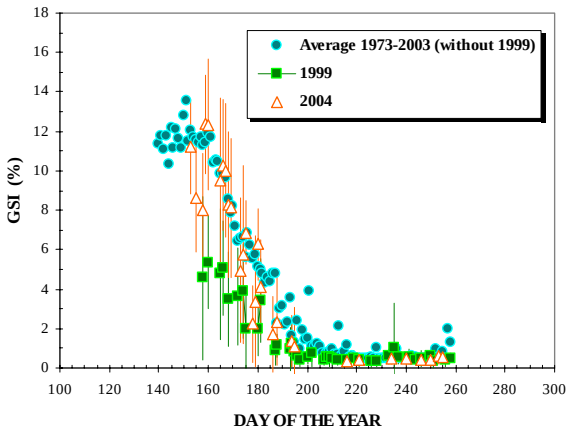

Figure 7. Daily averages of gonado-somatic index (GSI) values for 1973-2003 (excluding 1999) and for 1999 and 2004 (vertical bars represent standard deviations).

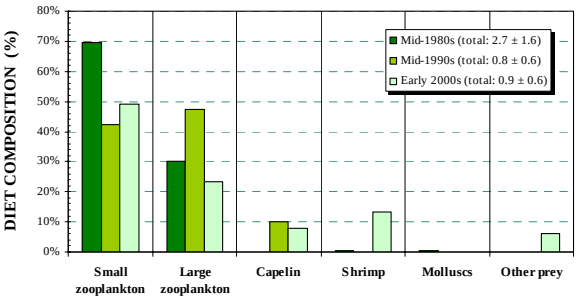

Figure 8. Mackerel diet composition (%) in the Northern Gulf of St. Lawrence from the mid-1980s to the early 2000s (C. Savenkoff and M. Castonguay, DFO, MLI, pers. comm.). Units in the legend are in t km^{-2} yr^{-1}.

2% in the early 1980s to 15% in the mid-1990s, and finally to 27% in the early 2000s.

Sources of uncertainty

Unrecorded catches

The mackerel that are caught and then used for bait do not appear in the Department's official statistics, which are based on purchase slips from sales to processing plants. Recreational fishing is very popular in summer, and these statistics aren't recorded either. Since these activities are carried out throughout Eastern Canada, the actual total number of mackerel caught is largely underestimated.

Discards of small mackerel

A disturbing observation was made during the fall of 2004 in the Southern Gulf of St. Lawrence concerning the discards of small mackerel whose length was under the minimum allowable catch size or below what industry requires. These discards, from line fisheries, caused mortalities that are difficult to calculate. Nevertheless, they were certainly significant given the fact that this type of fishery is predominant in the Southern Gulf during the fall.

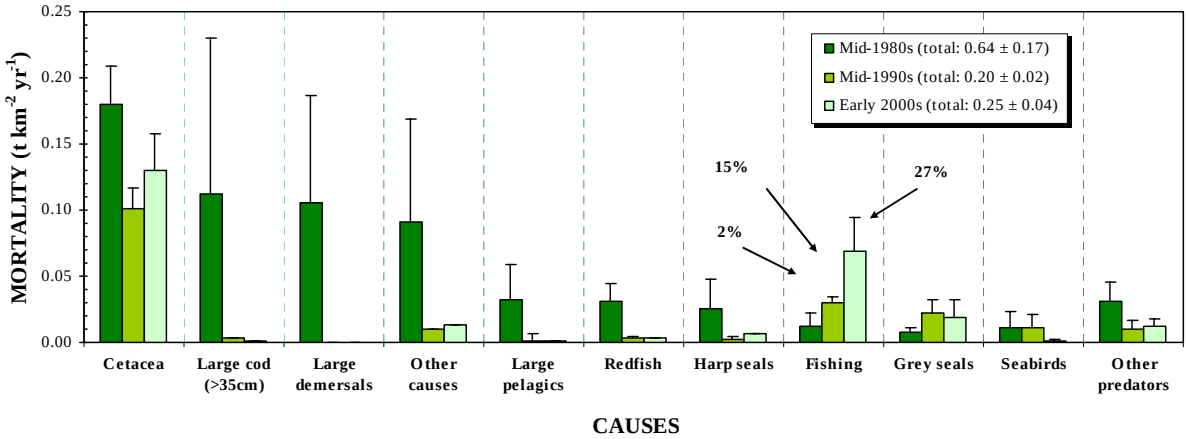

Figure 9. Main causes of mortality (t km^{-2} yr^{-1}) for mackerel estimated with a model of the Northern Gulf of St. Lawrence marine ecosystem from the mid-1980s to the early 2000s (fishery-related mortality percentages are also included) (C. Savenkoff and M. Castonguay, DFO, MLI, pers. comm.).

Management considerations

To improve the collection of statistics on the fishery occurring in the Gulf of St. Lawrence, we **recommend** that a mandatory logbook be used by all fishermen, including those who use mackerel as bait. The use of logbooks would also provide better information on the location the fishery is conducted, which would greatly facilitate analysis of the relationships between mackerel distribution and certain environmental variables. A possible alternative to the use of logbooks would be to weigh the mackerel and enter the catch data at dockside, as is currently done in Nova Scotia. However, at least for some regions of this province, this system appears to present major flaws since the official statistics are much lower than the catch figures reported by fishermen.

Recreational catches are a significant part of the overall picture, considering that this fishing is carried out by a very large number of fishermen, including tourists, all along the Atlantic coast. For the eventual management of this activity and in order to further improve catch statistics, we **recommend** that some thought soon be given to ways of estimating these catches. It should be noted that the United States produces annual estimates of recreational catches of mackerel. Considering these catches and those made by bait fishermen, which are not recorded, and the problems mentioned previously regarding the current fishery statistics collection system, **actual mackerel landings could be closer to the TAC of 75,000 t than currently identified.**

Finally, when there are discards of small mackerel in a specific area, we **recommend** that fishing activities be suspended until these smaller fish have left the area.

Precautionary approach

The Canadian precautionary approach framework was developed during national workshops held over the last few years. During these workshops, various limit reference points were studied and for the time being, a reproductive biomass target value ($\mathbf{B_{LIM}}$) was chosen. According to the conservation principles defined in the precautionary approach, the reproductive biomass of a stock should not drop any lower than this target and should also remain well above it. So far, the work carried out according to the precautionary approach on marine fish concerned the establishment of a minimum biomass limit ($\mathbf{B_{LIM}}$) calculated from stock-recruitment relationship derived from a Sequential Population Analysis (**SPA**). Because this type of analysis is not used for mackerel, other options will have to be considered. Indicators such as reproductive biomass determined from egg surveys, catch levels, age structure, maturity at age, average weight at age, growth and condition could be used as starting points for developing a management strategy that would correspond to the conservation principles defined within the precautionary approach.

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