STOCK STATUS REPORT

LAURENTIAN REGION

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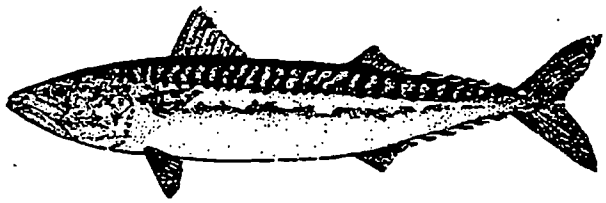
DFO, Atlantic Fisheries, Stock Status Report 96/24 June 1996

MACKEREL IN THE NORTHWEST ATLANTIC



The Atlantic mackerel (*Scomber scombrus* L.) is a member of the family Scombridae, which is distributed widely throughout the world and includes a large number of species, the most famous of which are tunas. Unlike tunas, which are able to maintain a high body temperature, and like most of the 30,000 species of bony fish, the Atlantic mackerel is an ectothermic fish. In this type of fish, body temperature does not remain constant, but varies between 1 and 2°C above the surrounding water temperature. All scombrids are of tropical origin, with the Atlantic mackerel having the most northerly distribution. In the northwest Atlantic, mackerel range from Cape Hatteras, off North Carolina, to the Gulf of St. Lawrence and the east coast of Newfoundland (Figure 1). They someti-mes occur south of Labrador. Since mackerel

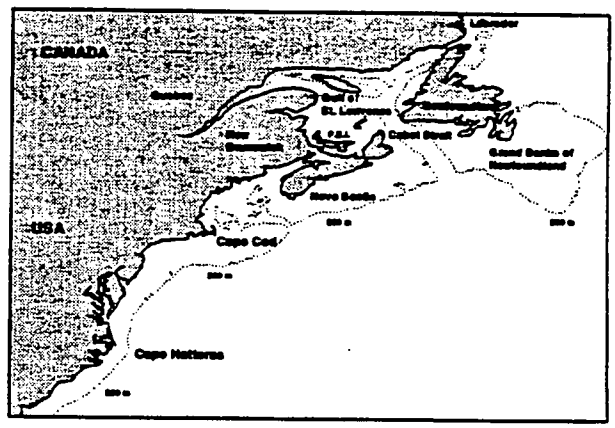


Figure 1. Main distribution of mackerel in the northwest Atlantic.

are warm-water fish, their presence along the coast of Newfoundland and Labrador depends on water temperature.

In the northeast Atlantic, mackerel are found further north because of the warm waters of the Gulf Stream. Although mackerel are present in limited numbers off southern Iceland and the northern tip of Norway, their range usually extends from the west coast of Norway to Morrocco including the North Sea and the

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the waters around England. Mackerel also occur in the Mediterranean, particularly in the northern part, between the coast of Spain and the western shores of the Black Sea.

Two stocks of mackerel are found in the northwest Atlantic, and each has its own spawning areas. The southern stock spawns in March and April along the US coast between New Jersey and Long Island, while the northern stock spawns in

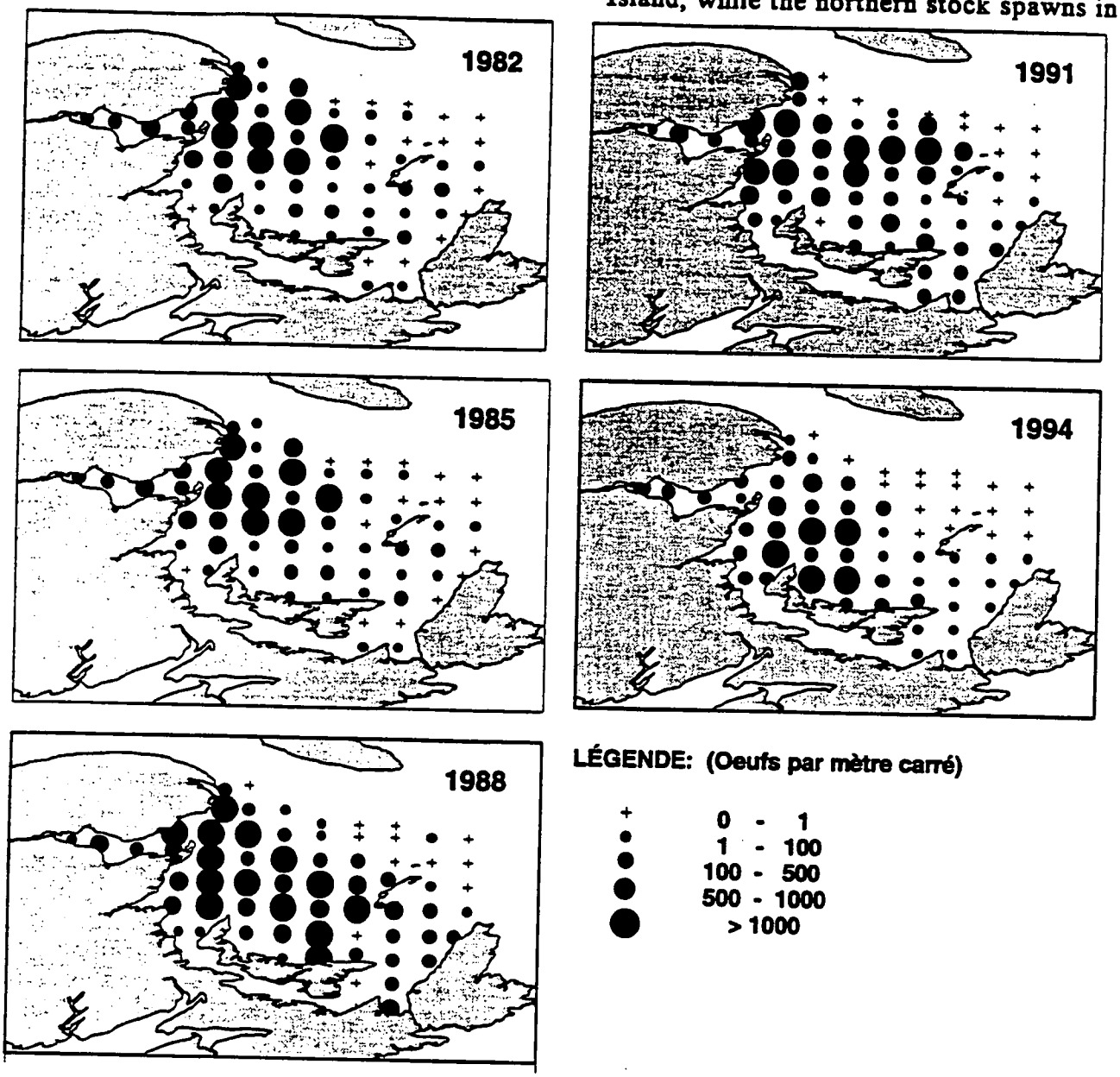


Figure 2. Mackerel eggs distribution in the Gulf of St. Lawrence, as observed for example every four years between 1982 and 1994.

June and July mainly in the Gulf of St. Lawrence, but also along the coast of Nova Scotia and, possibly, on the Grand Banks of Newfoundland. The largest egg concentrations are always found to the south of the Laurentian Channel, west of the Magdalen Islands (Figure 2).

In the Gulf of St. Lawrence, mackerel eggs are not readily confused with those of other species. Egg development time depends on water temperature. Mackerel are called multiple spawners because each female spawns several times during the spawning season. Spawning takes place at any time during the day or night. Larvae measure about 3 mm long upon hatching. Young mackerel become juveniles when they reach 50 mm in length. They also begin to form schools at this size.

Mackerel grow very quickly and can reach a length of over 20 cm by the end of the first year. Most of their growth takes place during the first six years of their life. Females grow more rapidly than males after the age of four (Figure 3).

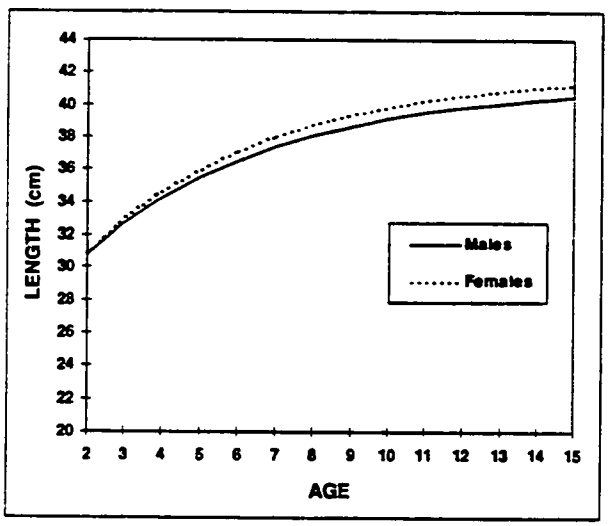
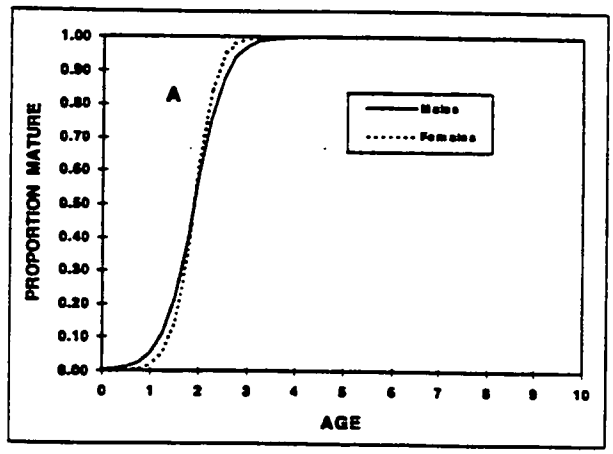


Figure 3. Length (cm) of mackerel in the Gulf of St. Lawrence - by age.



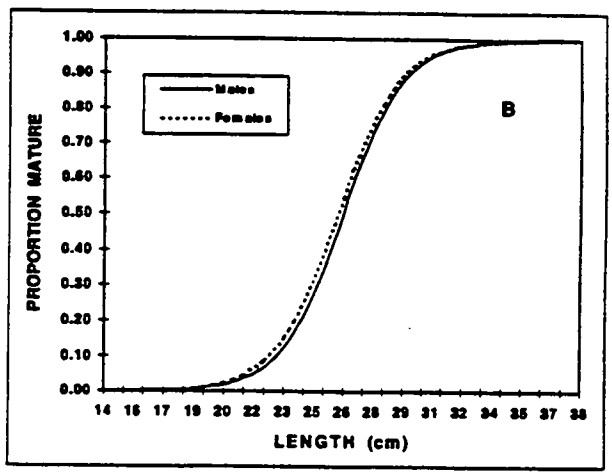


Figure 4. Maturity of mackerel caught during US groundfish surveys between 1987 and 1989 - by age (A) and length (B) (O'Brien et al. 1993).

Mackerel may live for more than 15 years, but rarely measure over 45 cm in length. Individuals from large year-classes grow more slowly. Slower growth may be observed as of the first year in the otolith, and is not offset afterwards.

The condition of mackerel is most variable at the beginning of the season. The lowest values are observed in early spring, just prior to and during spawning, while the highest are observed in the fall. Fat content is also lowest during

spawning, rising gradually thereafter to around 20% or more in the fall.

Nearly half of two-year-old mackerel and all four-year-olds are sexually mature (Figure 4a), with females maturing slightly earlier than males. Size rather than age is the determining factor. Nearly 50% of mackerel reach maturity at around 26 cm in length, and all of them at 34 cm (Figure 4b), which generally corresponds to four years of age. All individuals from the large 1959 and 1967 year-classes, in which slower growth was observed, reached maturity at age five, at a length of 33 cm.

DESCRIPTION OF THE FISHERY

It has long been acknowledged that sport and commercial mackerel catches vary widely in a given location from year to year. These fluctuations have always been a source of concern to inshore fishermen and have had a major impact on their landings. They are attributable to reproductive success and the availability of mackerel to inshore fishing gear. Even though certain mechanisms responsible for egg and early larval stage mortality are now better understood, the strength of a year-class is not known until it reaches around four or five years of age, *i.e.* when it enters the fishery.

Mackerel are fished in their overwintering grounds along the US coast and as far as the Gulf of St. Lawrence and Newfoundland. In winter and early spring, the trawl is the most effective fishing gear because mackerel are generally not concentrated in schools but are spread out near the bottom. The largest mackerel catches ever recorded in the northwest Atlantic were made at that time of the year near the US coast by a fleet of trawlers. The northern and southern stocks share certain regions in this sector. Mackerel seem to migrate in the spring mainly in response to rising water temperature. If the water takes longer to warm up near the US coast or is warmer offshore, the southern stock moves away from the coast, to the detriment of the inshore fishery. Inshore trap and gillnet fishermen from Nova Scotia are faced with a similar situation when the northern stock migrates in May and June. It is generally acknowledged that this stock moves in successive waves into the waters off the province and comes directly inshore if water temperature and food conditions are favourable. Once the mackerel reach the Gulf of St. Lawrence, they are usually fished with gillnets in the spring and lines in the late summer. Purse seines are used in the fall along the east and west coasts of Newfoundland.

The fishery in 1995

Mackerel landings for the northwest Atlantic as a whole have declined gradually since 1988 (Figure 5).

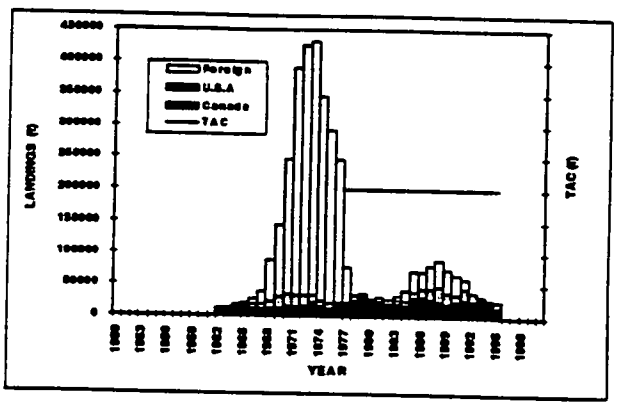


Figure 5. Mackerel landings (t) and TAC (t) in the northwest Atlantic.

Totalling nearly 90,000 t in 1988, they fell to around 24,000 t in 1995. This decrease is mainly attributable to the lower quotas allocated to the Commonwealth of Independent States fleet fishing in US waters and the complete shutdown of the fishery in 1992 (Table 1).

Table 1. Mackerel landings (t) in the northwest Atlantic

COUNTRY	YEAR							
	1988	1989	1990	1991	1992	1993	1994	1995*
Canada	25 016	21 142	23 044	26 828	25 515	27 226	20 653	14 568
United States	21 245	17 168	12 178	17 766	12 744	4 502	5 500*	9 679*
Foreign	42 858	36 823	30 678	15 714	0	0	0	0
TOTAL	89 119	75 133	65 900	60 308	38 259	31 728	26 153*	24 247*

* Preliminary statistics

Canadian landings averaged 20,081 t per year from 1965 to 1994. Based on preliminary statistics, they amounted to around 15,000 t in 1995, exceeding those of US fishermen. The largest Canadian landings were taken in divisions 4T and 4X, where they totalled 6,574 t and 3,594 t respectively. In Nova Scotia, most landings were made in St Margarets Bay, near Halifax. In general, mackerel landings by province do not fluctuate widely from year to year, except in Nova Scotia and Newfoundland (Figure 6). The substantial increase in landings in Nova Scotia between 1986 and 1992 is largely attributable to a gradual intensification of the fishing effort by foreign vessels off the Nova Scotia Shelf. In Newfoundland, however, and especially along the east coast of the province, the fluctuations in landings are related to water temperature. Since 1985, landings in the other provinces have been stable or exhibited a slight downward trend. However, when landings are analysed on a smaller geographical scale, *i.e.* by statistical district or fishing community, for example, major fluctuations may be observed. Moreover, their patterns are often different or even contrary to those that emerge on a province-wide scale. This phenomenon may be attributed to variations in the availability of mackerel to the inshore fixed gear fishery.

Catches per unit of effort by the Canadian fishery vary greatly with locality and from year to year. These fluctuations depend much more on mackerel distribution, fishing power and market demand than on real variations in abundance. Therefore, catches per unit of effort are not used as an abundance index for mackerel. Over the past few years, or more precisely, since the advent of an African market for canned mackerel, a significant relationship has emerged between catches and the line fishing effort in the fall in the Magdalen Islands. As other annual data become available, researchers will be able to study the feasibility of using these catches per unit of effort as abundance indices and analyse how they relate to spawner abundance estimates based on egg production.

Catches per unit of effort in the US sport fishery were fairly high between 1983 and 1991. They have declined, however, in recent years. Sport and commercial catches per unit of effort are not used as abundance indices owing, in the first case, to mackerel availability problems in the inshore fishery and, in the second, to market demand and the number of vessels fishing mackerel.

A notable feature of the mackerel fishery in 1995 was the presence of a large number of small fish in catches. An analysis of the catch at age data (Figure 7) revealed a high proportion of one- and two-year olds, making up nearly 60% of total catches.

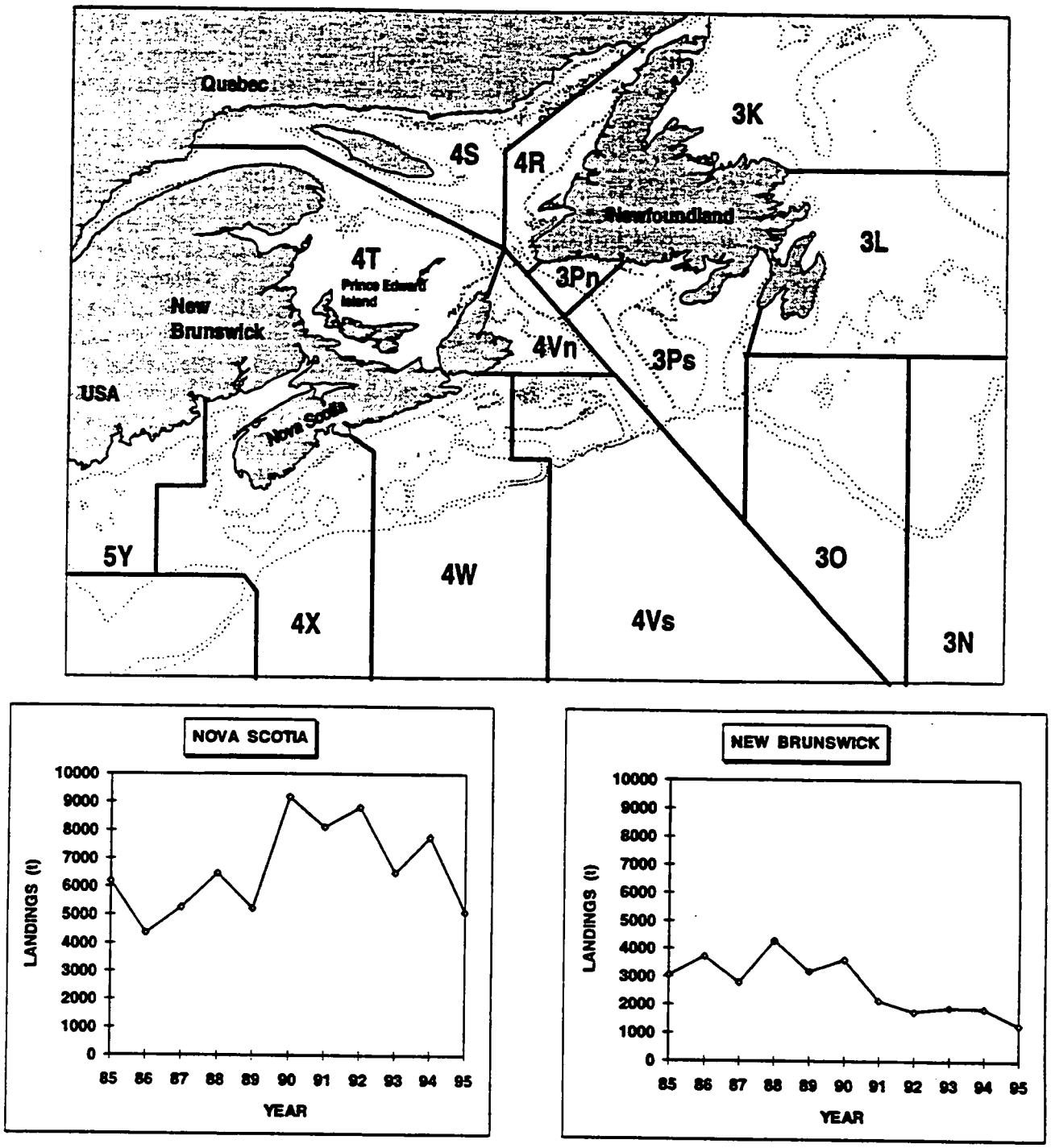
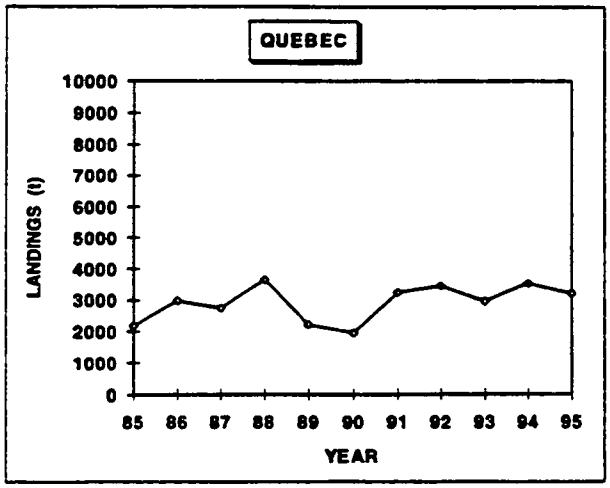
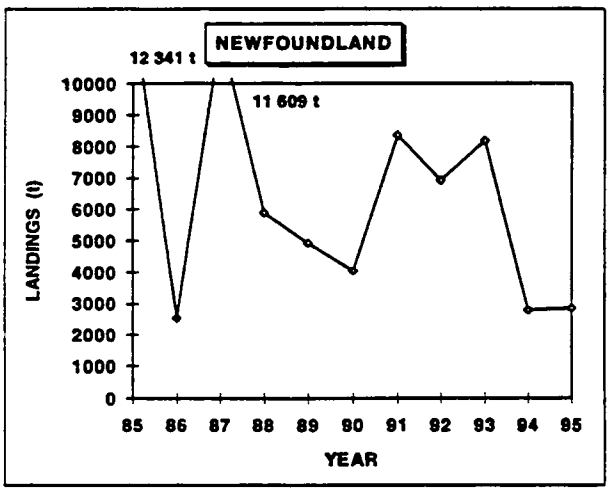


Figure 6. Mackerel landings (t) by province since 1985.





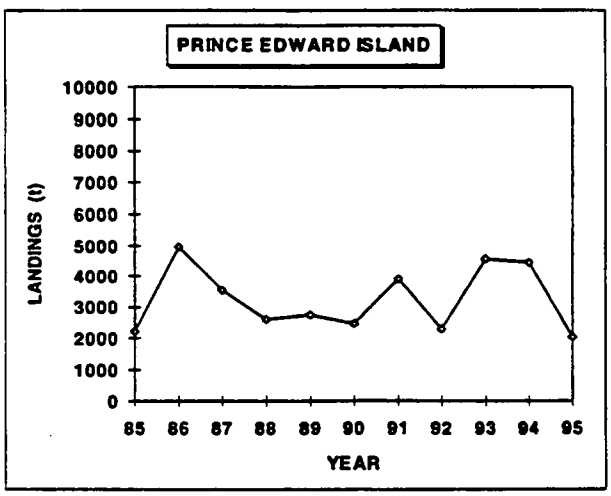


Figure 6. Continued.

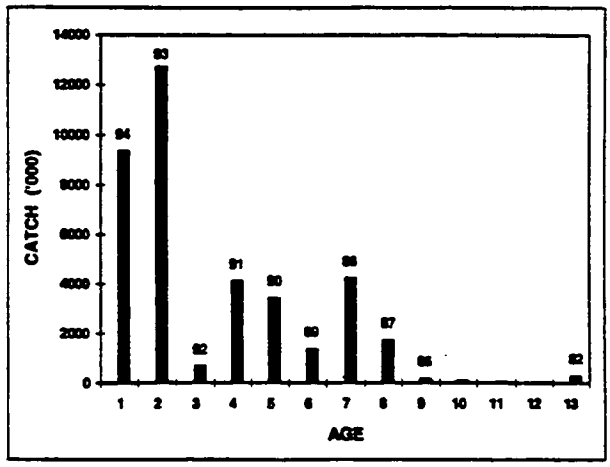


Figure 7. Mackerel caught in the Gulf of St. Lawrence - by age (the number above each bar represents the year-class or year of birth).

In general, such large proportions of small fish have only appeared in catches with the arrival of large year-classes that have subsequently sustained the fishery. For example, two-year-olds from the 1993 year-class accounted for 33% of catches as a whole in 1995, while those from the large 1967, 1974, 1982 and 1988 year-classes accounted, respectively, for 40% of total catches in 1969, 25% in 1976, 43% in 1984 and 17% in 1990.

ABUNDANCE INDICES

The indicators of stock size for mackerel are derived mainly from two surveys. The first involves plankton sampling in the Gulf of St. Lawrence every second year. This survey, which was last conducted in 1994, is used to estimate the spawning biomass of the northern stock on the basis of egg production. The second is a stratified random bottom trawl survey carried out by the Americans in the spring when the northern and southern stocks share the same territory. This survey is

conducted annually between Cape Hatteras and Georges Bank. The average catch per tow during the US survey declined from 1968 to the late 1970s (Figure 8).

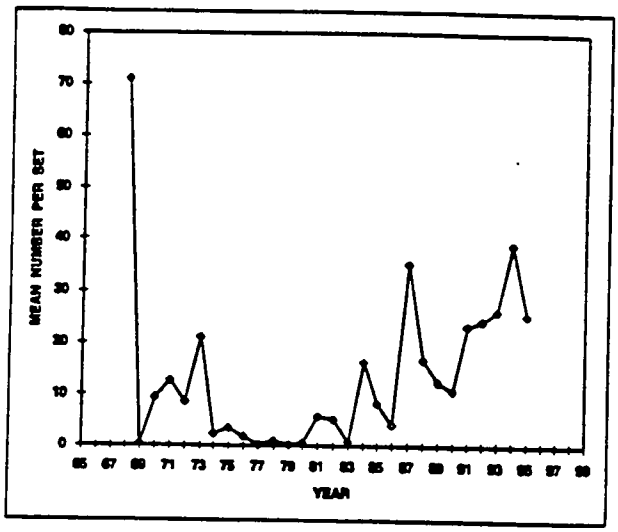


Figure 8. Indicators of stock size for mackerel in the northwest Atlantic.

It began to rise, however, in the early 1980s and has been fairly high since the beginning of the 1990s. The results of these surveys are probably rather imprecise given the highly variable availability of mackerel to groundfish trawls.

STATUS OF THE RESOURCE

Spawning stock biomass assessment

Between 1992 and 1994, the spawning biomass of the northern stock stayed constant at around 800,000 t (Figure 9).

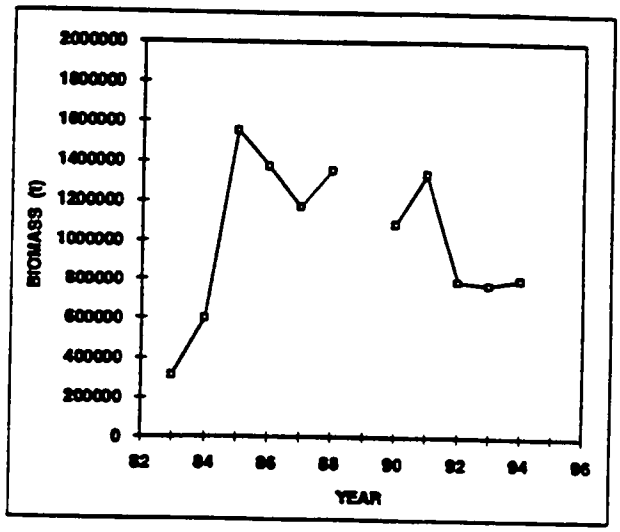


Figure 9. Mackerel spawning stock biomass based on egg production measurements during surveys in the Gulf of St. Lawrence.

This biomass assessment, derived from annual egg production, is probably the most reliable abundance index available. The method used to calculate it is used, with minor variations, in Europe, where assessments are carried out every three years. Since European catches are much larger than Canadian ones, virtual population analyses are done in years when no surveys are conducted with succes.

In 1995, spawning activities were observed in June along the south coast of Newfoundland. An analysis of mackerel gonads from commercial samples taken with capelin traps revealed that spawning was already under way at that time. In the past, juveniles have been observed in the fall on the Grand Banks of Newfoundland or off the east coast of the province, indicating that the spawning observed in Newfoundland in 1995 is not a new phenomenon. The relative intensity of these spawning activities could be

verified over the next few years using a Bongo net or midwater trawl survey.

Sequential population analysis

In 1994, the Americans did a sequential population analysis based on their groundfish survey. This analysis indicated high biomass estimates for both stocks combined, *i.e.* between 2 and 3 million tonnes. However, it also showed that the results were very variable and not very precise.

Comments from the industry

Several meetings were held with industry representatives in 1995. The comments made at these meetings were similar to those expressed the previous year. In 1995, however, attention was focused on the presence of very large numbers of small one- and two-year-old mackerel in catches in both Nova Scotia and the Gulf of St. Lawrence. The trap fishery in certain parts of Nova Scotia was disrupted by the presence of small mackerel, particularly under 25 cm (10 in.) long. A regulation stipulates that it is illegal to catch more than a certain percentage of fish this size. However, there is a lack of information on the origin of this regulation and its underlying biological principles. Despite the problems stemming from the application of the regulation in 1995, fishermen have stated very clearly that they are not opposed to the imposition of a minimum catch size.

In 1995, fishermen from Prince Edward Island, the Magdalen Islands and the east coast of Cape Breton joined the Index Fishermen Program. At the request of certain fishermen from St Margarets Bay, mackerel catches in that region over the past decade were analysed in detail. Although the study revealed fairly stable total landings, it highlighted major fluctuations and different or even opposite trends when landings were analysed on a smaller geographical scale.

CONCLUSION

The Canadian mackerel fishery is an inshore fishery whose success depends largely on the availability of mackerel near the coast. On account of their life cycle, mackerel move constantly and therefore travel long distances, passing only briefly, if at all, near certain coasts and moving to other regions to spawn, feed and overwinter. Their movements are also governed by environmental conditions. Since mackerel are warm-water fish, water temperature, like the presence of food, determines whether they occur alone or in the presence of other species. Sometimes, mackerel concentrate in schools inshore or offshore, while at other times they spread out near the surface or the bottom. These factors make it harder to catch this species and are partly responsible for the year-to-year fluctuations observed in catches in a given location. It should be noted that such fluctuations are not new. Even in the early days of the mackerel fishery, they were a source of considerable concern to inshore fishermen.

According to the most recent assessments of both the northern and southern stocks and current catch levels, stock biomass remains high. In 1995, catches included not only individuals from the abundant 1988, 1990 and 1991 year-classes, but also a substantial number of one- and two-year-old mackerel, a phenomenon

that points to the entry of two very large year-classes into the fishery. Based on these observations and current mackerel harvesting levels, the fishing effort can certainly be increased without any deleterious effects on the stock. If effort were to increase rapidly on the stock, closer monitoring of the fishery would then be required. In the meantime, research continues in an effort to improve existing abundance indices or develop new ones.

For more information:

Grégoire, F., 1996. Description de la pêche au maquereau bleu (*Scomber scombrus* L.) depuis 1985 et résultats préliminaires pour 1995. MPO Pêches de l'Atlantique. Document de recherche 96/59.

Grégoire, F., and C. Bellehumeur. 1996. Estimation géostatistique de la production quotidienne d'oeufs chez le maquereau bleu (*Scomber scombrus* L.) du golfe du Saint-Laurent. MPO Pêches de l'Atlantique. Document de recherche 96/60.

Grégoire, F., and C. Lévesque. 1996. Quelques résultats concernant les travaux en cours sur la fécondité en lots du maquereau bleu (*Scomber scombrus* L.). MPO Pêches de l'Atlantique. Document de recherche 96/61.

O'Brien, L., J. Burnett., and R.K. Mayo. 1993. Maturation of nineteen species of finfish off the Northeast coast of the United States, 1985-1990. US Department of Commerce. NOAA Technical Report NMFS 113. 66p.

Parson, L.S., and V.M. Hodder. 1970. Occurrence of juvenile and spawning Atlantic mackerel in southeastern Newfoundland coastal waters. J. Fish. Res. Bd. Can. 27:2097-2100.

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