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The American Lobster, *Homarus americanus*, in the southern Gulf of St. Lawrence (Lobster Fishing Areas 23, 24, 25, 26A and 26B)

By

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Abstract

Lanteigne, M., M. Comeau, M. Mallet, G. Robichaud and F. Savoie, 1998. The American Lobster, *Homarus americanus*, In the southern Gulf of St. Lawrence - (Lobster Fishing Areas 23, 24, 25, 26A and 26B). Can. Stock Assess. Sec. Res. Doc. 98/72.

The overall catches of lobster for the southern Gulf of St. Lawrence have been slowly declining since the 1990 record landings. Catches for 1997 are ranging between 1.8 to 2.5 t of lobster per km^2 of fishing ground. The general reduction in landings and number of lobster caught since the early 1990's is observed in all Lobster Fishing Areas (LFAs) with the exception of LFA 24 which shows a steady increase.

The fishing fleet characteristics do vary widely by LFA, which may have a role in the overall fishing power. Differences are observed in the type and design of traps, and vessel particularities.

Recent research works have confirm the limited annual movement (within 10 - 15 km), the growth rate (18% for males and 15% for females) and the size at sexual maturity for females (50% of females are mature at 70 - 72 mm in carapace length). These researches have also shown that lobster throughout the southern Gulf have similar attributes. The calculations of exploitation rates using the Leslie analyses have also confirm the high levels found in earlier studies. These values are ranging between 63% to 87%.

A revised egg per recruit (E/R) analysis still suggests that the lobster stock is heavily fished and recruitment overfished, and confirms the need to increase egg production. The management changes announced in 1998 should help increase the egg production of the population and reduce the risk of recruitment declines if environmental conditions become unfavorable. Any non compliance by fishers to the new management measures will hinder all attempt to increase egg production.

Résumé

Lanteigne, M., M. Comeau, M. Mallet, G. Robichaud and F. Savoie, 1998. The American Lobster, *Homarus americanus*, In the southern Gulf of St. Lawrence - (Lobster Fishing Areas 23, 24, 25, 26A and 26B). Can. Stock Assess. Sec. Res. Doc. 98/72.

Dans son ensemble, les captures de homard dans le sud du Golfe du Saint-Laurent ont continuellement diminuées depuis les captures record de 1990. Les captures de 1997 ont se sont maintenues entre 1.8 et 2.5t de homard par km^2 de territoire de pêche. La diminution générale des débarquements et du nombre de homards capturés depuis le début des années 1990 est observée dans toutes les zones de pêche du homard (ZPH) à l'exception de la ZPH 24 où une augmentation graduelle est observée.

Les particularités de la flotte de pêche varies grandement entre les ZPH. Ces particularités peuvent jouer un rôle dans la puissance globale de pêche. Les différences sont observées au niveau des types et de la conception des casiers, ainsi qu'au niveau des navires.

Des recherches récentes ont permis de confirmer les déplacements annuels limités (à l'intérieur de 10 - 15 km), le taux de croissance (18% pour les mâles et 15% pour les femelles) et la taille à maturité sexuelle des femelles (50% des femelles sont matures à 70 - 72 mm de longueur de carapace). Ces recherches ont aussi montrées que le homard du sud du Golfe avait des attributs similaires. Les calculs de taux d'exploitation en utilisant l'analyse de Leslie ont aussi confirmés les niveaux élevés obtenus lors d'études antérieures. Ces valeurs se situent entre 63% et 87%.

Une analyse révisée du calcul des oeufs par recrue (O/R) permet de confirmer à nouveau que la population de homard est sur-exploitée et les recures sur-pêchées. Les mesures de gestion annoncées pour 1998 devraient aider à augmenter la production d'oeufs de la population et ainsi réduire le risque d'un déclin du recrutement si les conditions environnementales deviennent défavorables. Tout manque de participation des pêcheurs aux nouvelles mesures de gestion seront des empêchements à l'objectif d'augmenter la production d'oeufs.

1.0 The Lobster Fishery in the southern Gulf of St. Lawrence

1.1 History

The Canadian lobster fishery began in the mid 1800's. During a short period corresponding to the transition between the 19th and the 20th century, high lobster catches were reported in the southern Gulf of St. Lawrence. With the expanding fishing effort, these years of good catches were rapidly followed by an overall decline in landings in the early part of the 1900's (Figure 1). Annual catches decreased from 15,000 t annually in 1895 to landings fluctuating around 8,000 t between 1915 and 1975. It is only in the mid 1970's that lobster landings in the southern Gulf of St. Lawrence regained in strength, reaching record high landings of 22,000 t in 1990.

The factors responsible for the extraordinary catch increase in the last 30 years is not well understood. It is believed that the overall fishing power has substantially increased when economic and technological developments took an accelerated pace after the Second World War. However, this alone cannot explain the magnitude of the increase that was seen all over the geographical range of the American lobster, from North Carolina to Labrador. Favorable environmental factors are believed to have favored the survival of lobster recruitment over its entire distribution range.

Over the years, the lobster fishery has become and is still a major factor in the social and economic development of communities along the Atlantic coast, and especially to communities in the Gulf of St. Lawrence. In 1997, the 3,276 licence holders in Lobster Fishing Areas 23, 24, 25, 26A and 26B alone (southern Gulf of St. Lawrence) have caught 16,413 t of lobster for a landed value of more than $170 million.

1.2 Management

The southern Gulf of St. Lawrence lobster fishery management regime is based on effort control in five management areas or Lobster Fishing Areas (LFA, Figure 2). These LFAs are characterized by two major fishing seasons (spring and fall), four minimum carapace sizes at capture (minimum legal size) and three maximum number of traps permitted per fisher (Table 1). The spring fishing season occurs during the months of May and June in four LFAs (23, 24, 26A and 26B). The fall fishing season form mid-August to mid-October occurs in LFA 25 only.

Table 1. Major elements of the 1997 lobster fishery management regime for each Lobster Fishing Area.

Lobster Fishing Area (LFA)	Minimum carapace size		Fishing season	Number of license holders *	Maximum number of traps/fisher
	1997	1998			1998
LFA 23	66.7 mm	67.5 mm	May - June	749	375 **
LFA 24	63.5 mm	65.1 mm	May - June	637	300
LFA 25	66.7 mm	67.5 mm	Mid-Aug. to mid-Oct.	867	250
LFA 26A	65.1 mm	65.9 mm	May - June	767	300
LFA 26B	70.0 mm	70.0 mm	May - June	256	300

* 1997 census, ** as been changed to 350 traps/fisher in 1998

Since the implementation of regulations limiting fishing activities by LFA in 1934 and especially following the introduction of limited access to fishing licences in 1967 (DeWolf, 1974), the number of licence holders as been somewhat stabled to approximately 3,300 vessels. The number of

registered licence holders in 1984, 1988 and 1993 is presented in Table 2. Fluctuations in the number of licences in the last ten years are mainly attributed to normal changes or transfers of boat owners and by the creation and abolition of partnerships. A partnership licence is created temporarily when two licence holders joint their effort and gear (in table 2, a partnership licence is counted as one licence).

Table 2. Number of lobster fishing licence holders by year and Lobster Fishing Area.

Lobster Fishing Area (LFA)	23	24	25	26A	26B	Total
1964*		Information not available by LFA				9,380
1984	787	656	892	1,007**		3,342
1988	714	646	890	773	257	3,280
1997	749	637	867	767	256	3,276

* Calculated from data presented in Ruterford *et al.*, 1967

** Lobster Fishing Areas 26A and 26B were managed under one area.

The lobster fishing effort is also controlled by having the trap as the only fishing gear authorized, and by having a maximum gear dimension (125 cm in length, 90 cm in width et 50 cm in height). Furthermore, it is required to have an escape mechanism installed on each trap, allowing under-size lobsters to escape the fishing gear. The regulation on the escape mechanism dimension stipulates a minimum opening of 127 mm in width and 38.1 mm in height.

The minimum legal size was initially regulated at 63.5 mm ($2^{1/2}$ inches) in 1957, and was common for the entire southern Gulf. By the end of the 1980's, numerous groups from the fishing and processing sectors were requesting actions to improve the conservation aspects and the economic benefits of the resource. Actions were taken by increasing the minimum carapace size. However, not all LFAs increased their minimum legal size, which resulted in four different minimum legal sizes within the southern Gulf (Table 3).

Table 3. Changes in minimum carapace sizes (minimum legal size) in the southern Gulf of St. Lawrence since 1957.

Lobster Fishing Area (LFA)	63.5 mm	65.1 mm	65.9 mm	66.7 mm	67.5 mm	68.3 mm	70.0 mm
LFA 23	1957	1990		1991	1998		
LFA 24	1957	1998					
LFA 25	1957	1990		1991	1998		
LFA 26A	1957	1991	1998				
LFA 26B	1957	1987		1988		1989	1990

1.3 Landings

Commercial lobster catches in the southern Gulf of St. Lawrence have shown a sharp increase since 1974 from 5,594 t landed to a record high of 22,063 t in 1990 (Table 4). This represents a four folds increase during a 16 year period. However, since 1990, landings in the southern Gulf have shown a steady declining trend. In 1997, 16,413 t of lobster were landed which represent a 25% reduction from the peak landing in 1990.

The increase in catches has been observed in all LFAs, there are some variations in the year of peak landing (Figure 3). Furthermore, the declining trend is not observed with the same amplitude in all LFAs (Figure 3, Table 4).

Table 4. Lobster landings (t) by Lobster Fishing Area (LFA).

LFA	1950-59 Avg.	1960-69 Avg.	1970-79 Avg.	1980-89 Avg.	1990	1991	1992	1993	1994	1995	1996	1997
23	1,437	1,069	1,099	2,463	4,508	4,186	4,257	4,486	4,111	4,069	3,784	3,467
24	1,057	1,826	2,044	3,090	4,591	5,109	4,605	4,732	4,830	5,083	4,604	4,757
25	2,494	2,755	2,217	4,764	5,320	4,770	4,578	4,100	4,572	4,360	4,239	3,784
26A	2,751	2,440	2,037	4,389	6,363	5,844	4,594	4,686	3,480	3,536	3,720	3,481
26B	552	500	539	977	1,281	1,543	1,411	1,455	1,110	1,152	1,126	1,079
Total	8,290	8,590	7,936	15,683	22,063	21,451	19,444	19,459	18,103	18,200	17,472	16,568

Lobster catches information for the southern Gulf of St. Lawrence can be dissected further into their different size categories. These categories have been industry standards for decades and are defined as canner size (from the minimum legal size to <81mm) and market size lobster (≥ 81 mm). The ratios of these size categories (percentage of canners in weight) are providing valuable information on fluctuations of the different size groups over the years (Figure 4). In 1984, landings in all LFAs were showing relatively similar percentages of canners by weight ranging from 63% to 85% in LFA 26A and 25 respectively. With a period of good recruitment into the fishery and increasing catches, percentages of canners size lobster also increased. This increase was most evident in LFA 24 where the percentage of canners reached 91% in 1990. The LFA 25 was the area that presented the most important reduction with a decrease from 85% canner in the catch of 1995 to 76% in 1997. The percentage of canner in the other LFAs (23, 26A and 26B) stayed relatively stable.

1.4 Fishing fleet and gear characteristics

The present lobster fishing fleet of the SGSL consists of approximately 3,200 fishing enterprises or licensed fishing vessels (Table 2), using a total of 977,000 lobster traps annually. This fleet is characterized by relatively important geographical variability, which have been documented through a telephone survey conducted in the fall and winter of 1993 (Lanteigne *et al.*, in prep.). Although difficult to quantify, these particularities are important elements in the fishing power of a fleet.

The survey's results are suggesting that fishing vessels in LFA 24 and 26A are the most recent as they average 6.4 and 6.5 years respectively (Table 5). Vessels in LFA 23, 25 and 26B are averaging 9.5, 9.9 and 11.5 years respectively.

A similar trend between LFAs was also observed with the overall length of vessels ranging from 4.6 m to 14.0 m (Table 5). However, little variability was observed between LFAs with smaller boats in LFA 26B (avg.=10.1 m) and larger boats in LFA 24 (avg.=12.6 m) and LFA 25 (avg.=12.5 m). The wide range of boat length within LFA may be related to the overall particularities of the fishing grounds and the multipurpose aspect of the present lobster fishing fleet (i.e.: fishers having more than one fishing licence).

Important differences in the trap construction material are noted between LFAs (Figure 5, Table 6). The traditional wood traps were more prevalent in LFA 24 and 26B with 79.7% and 70.5% of the traps in use by the fishers respectively. The wood trap was less prevalent in LFA 23 with 33.5% of the trap in use. The prevalence of wood traps were 36.4% and 57.6% in LFA 25 and 26A respectively.

Table 5. *Basic statistics on the age and overall total length (meters) of lobster fishing vessels used in each Lobster Fishing Area (LFA), in 1993 (Lanteigne et al., in prep.).*

Lobster Fishing Areas (LFA)	23	24	25	26A	26B
Median of the vessel age frequency distribution	9	5	8	6	12
Weighted average age of vessel *(stdev)*	9.5 *(0.38)*	6.4 *(0.40)*	9.9 *(0.30)*	6.5 *(0.52)*	11.5 *(1.32)*
Minimum, maximum age of vessel	1 - 24	0.5 - 22	1 - 31	0.5 - 20	1 - 25
Minimum, maximum length (m) of vessel	5.8 - 14.0	5.5 - 13.7	5.2 - 14.0	4.6 - 13.4	7.6 - 12.8
Weighted mean length (m) of vessel *(stdev)*	11.7 *(0.13)*	12.6 *(0.06)*	12.5 *(0.10)*	11.9 *(0.14)*	10.1 *(0.28)*

Table 6. *Prevalence (%) of trap types by Lobster Fishing Area (LFA) in 1993 (Lanteigne et al. in prep.).*

Lobster Fishing Areas (LFA)	23	24	25	26A	26B
Wood traps	33.5%	79.7%	36.4%	57.6%	70.5%
Wire mesh traps	37.0%	4.3%	49.8%	26.7%	29.5%
Hybrid traps (wire mesh on wood frame)	29.1%	16.1%	13.2%	15.7%	0%
Traps made of plastic	0.5%	0%	0.6%	0%	0%

The number of wire mesh traps was the highest in LFA 25 with 49.8% of the traps in use. In the other LFAs, the prevalence of wire mesh traps was 37.0%, 29.5%, 26.7% and 4.3% in LFA 23, 26B, 26A and 24 respectively. The high proportion of wire mesh traps in LFA 25 constitutes a logical change over the wood traps. A fall fishery (mid-August to mid-October) characterizes this LFA and fishers have to cope with the proliferation and damage cause by wood borrowing worms. With the increasing environmental concerns of using chemicals for protecting wood traps, the wire mesh traps can be considered as a sensible alternative. Although fishers from some communities have indicated that the wooden trap was more efficient in their area than the wire mesh trap, it is expected that the prevalence of wood trap in LFA 25 will further decrease with the regular replacement process of worn or damage fishing equipment.

The wire meshes traps come in standards sizes and designs and are often constructed by specialized enterprises. It is somewhat different for the hybrid (wood and wire) and wood traps which are mainly constructed by fishers during wintertime. Hybrid traps type can be seen as a compromise between wood and wire traps and can be found in different sizes and designs as the wood traps. The hybrid traps are more abundant in LFA 23 with 29.1% of the traps in use but was absent in LFA 26B based on the questionnaire data.

The contrasting prevalence of the different trap types in each LFA is difficult to explain. Local traditions may still be a major factor in choosing trap types. The wood trap is still seen as the most efficient fishing gear by numerous fishers. However, all fishers do not accept this assessment of efficiency, which are mainly shared from fishers of the same community or region. Nevertheless, based on the changes from wood to wire traps in the last ten years, the overall trend is moving toward the wire mesh traps which constitute a better capital investment (less maintenance and more durable than wood traps).

Trap sizes do vary between LFAs in terms of length, width and height. The largest traps, in terms of bottom trap area, are found in LFA 25, 26A and 24 with an average of 0.7 m^2, 0.6 m^2 and 0.6 m^2 respectively (Table 7). The smallest traps are in LFA 26B and 23 with 0.5 m^2. The trap area is somewhat a reflection of the different sizes of fishing vessels, the smaller traps being found in LFAs

characterized with small vessel fleet. This is probably the result of multiple factors like the proximity of the fishing grounds, the size of the vessel to provide the most efficient trap transportation and fishing capabilities.

Table 7. *Average trap area (m^2) by type and Lobster Fishing Areas (LFA),(Lanteigne et al. in prep.).*

Lobster Fishing Areas (LFA)	23	24	25	26A	26B
Wood traps Average area (m^2)	0.5	0.6	0.7	0.6	0.5
(*stdev*)	(*0.01*)	(*0.01*)	(*0.02*)	(*0.02*)	(*0.01*)
Wire mesh traps Average area (m^2)	0.6	0.7	0.7	0.6	0.5
(*stdev*)	(*0.01*)	(*0.02*)	(*0.05*)	(*0.02*)	(*0.01*)
Hybrid traps Average area (m^2)	0.6	0.6	0.7	0.6	
(*stdev*)	(*0.01*)	(*0.02*)	(*0.01*)	(*0.02*)	--

The diameter of the trap entrances or hoop rings is also important trap design elements that do vary between LFAs (Table 8). The entrances are ranging from 8.9 to 20.3 cm in diameter in LFA 23, 24 and 26B. In LFA 25 and 26A, located in the most central portion of the Northumberland Strait, larger entrances are used, ranging from 10.2 to 25.4 cm. These differences are assumed to reflect the catch composition as larger size lobsters (market sizes) are caught in these LFAs. Fishers are known to adjust the trap entrance diameters to maximize catches for their particular fishing area.

Table 8. *Basic statistics on the trap entrance diameter (hoop rings) in centimeters (Lanteigne et al. in prep.).*

Lobster Fishing Areas (LFA)	23	24	25	26A	26B
Avg. minimum diameter in cm	11.4	11.5	13.1	12.3	12.6
(*stdev*)	(*0.15*)	(*0.18*	(*0.17*)	(*0.11*)	(*0.98*)
Avg. maximum diameter in cm	13.4	14.2	14.9	14.8	--
(*stdev*)	(*0.17*)	(*0.19*)	(*0.17*)	(*0.21*)	
Minimum diameter indicated (cm)	10.2	6.4	10.2	10.2	10.2
Maximum diameter indicated (cm)	20.3	19.1	22.8	25.4	14.0

1.5 Conservation approach

In 1994, the Fisheries Resource Conservation Council (FRCC) was requested by the federal fisheries Minister to review the current approaches to conservation and to recommend strategies for the lobster populations of the entire Canadian Atlantic coast. In November 1995, the FRCC presented their report titled "A Conservation Framework for Atlantic Lobster" (FRCC, 1995). The FRCC concluded that the present fisheries were operating at high exploitation rates, harvesting primarily immature animals and did not allow for adequate egg production. It was recommended to implement a new conservation framework, to establish seven conservation units (Lobster Production Areas) and increase egg production. A target of egg production per recruits (E/R) equivalent to 5% of that of an unfished population was recommended.

The FRCC report has presented an extensive overview of E/R values for the entire lobster fisheries on the Canadian Atlantic coast. These values were obtained with a model designed in the United States and adapted to the Canadian lobster fisheries. However, some biases in the parameters required by the model were raised by Canadian biologists, especially on the parameters related to growth, natural and molting mortality, and exploitation rates. This situation of uncertainty for some parameters were creating difficulties in assessing adequately the status of each LFA in relation with the target of 5% E/R. These concerns resulted in further research work

and refinement of the model used to calculate the E/R values. In addition, more time was given to the fishing industry to discuss the issues and to work on conservation and harvesting plans.

The official announcement from the Minister of Fisheries and Oceans on the southern Gulf of St. Lawrence lobster conservation measures was presented on April 22, 1998. However, despite general agreement by industry for the need to change, there was no agreement on the FRCC target and as a result doubling of egg per recruit was selected. This target resulted in conservation measures adapted for each LFA of the southern Gulf so that the doubling of E/R could be achieved within four years (Table 9).

Table 9. Lobster conservation measures by Lobster Fishing Area in the southern Gulf of St. Lawrence from 1998 to 2001.

	1998	1999	2000	2001
LFA 23	Increase minimum size to 67.5 mm 50% V-notching on egg bearing females*			
LFA 24	Increase minimum size to 65.1 mm	Increase minimum size to 65.9 mm	Increase minimum size to 66.7 mm	Increase minimum size to 67.5 mm
LFA 25	Increase minimum size to 67.5 mm 50% V-notching on egg bearing females*			
LFA 26A	Increase minimum size to 65.9 mm 50% V-notching on egg bearing females*		Increase minimum size to 66.7 mm	Increase minimum size to 67.5 mm
LFA 26B	50% V-notching on egg bearing females*			

* V-notching on 50% of egg bearing females caught by trap.

2.0 Biology

2.1 Distribution, life and reproductive cycles

The American Lobster habitat extends along the Atlantic coast from North Carolina to Labrador. In Canadian waters, lobsters may be fished in deep waters (i.e.: Georges Bank) but the most important concentrations are generally observed within 20 km from the shore. In the southern Gulf of St. Lawrence, lobsters are found in depths ranging from 1 to 40 meters. Although the species has a preference for hard substrate with shelters, it is often found on sandy and muddy bottoms.

The life history of the lobster can be divided into a benthic and planktonic phase. The planktonic phase follows the hatching of the eggs and occurs during the months of July and August. The larvae will go through a free-swimming period that lasts from 3 to 10 weeks depending on environmental conditions. The planktonic phase ends when the larvae settle on the substrate. Thereafter, it takes approximately 5 to 6 years of growth before they become recruited into the fishery.

The mating occurs between the months of July and September. Generally, female lobsters will follow a two year cycle of egg production, alternating molting and spawning. In a typical cycle, female are molting and mating during the same summer. The eggs are extruded one year after and carried attached on pleopods under the abdomen for nearly another year. This cycle may vary with the fluctuating environment factors and especially with the age of the female.

2.2 Movement

The first lobster tagging study in the southern Gulf of St. Lawrence was conducted in the 1930's (Templeman 1935). These studies have always been a major interest to fishers. Over the last 15 years, more than 15,000 lobster were tagged and released in the southern Gulf. These studies demonstrated that the average movement of lobster was within 10 to 15 km from their release sites (Conan *et al.* 1982; Maynard and Chiasson 1986; Comeau *et al.* 1998; Maynard *et al.* 1992; D. Maynard, pers. comm.). These observations are similar to the ones obtained in the Magdelan Islands (Templeman 1935; Montreuil 1953, 1954; Bergeron 1967; Dubé 1984). A review of past tagging studies in the southern Gulf can be found in Comeau *et al.* (1998).

Seasonal movements to shallow waters in the summer and back to deeper waters during the cold season were documented (Munro and Therriault 1983) and are well known movement patterns by fishers. The tagging studies have also shown that lobsters located on relatively large flat bottoms (i.e.: central Northumberland Strait, Caraquet Bay in New Brunswick, Malpeque Bay on Prince Edward Island) may travel more than lobsters located on a narrow or step coastal shelf (i.e.: east coast of Cape Breton, Nova Scotia).

2.3 Growth

With movement information, tagging experiments are providing valuable lobster growth data. Based on tagging data conducted in Baie des Chaleurs (Comeau *et al.* 1998), the size increments at molt were estimated at 18% and 15% for male and female lobster respectively. It is important to note that the tagging results are based on lobsters tagged in the postmolt and intermolt stages only. Lobsters tagged in premolt stage are showing lower size increment at molt that may be related to tagging trauma (Burkenroed 1951; Comeau *et al.* 1998).

Other authors (Templeman 1933, 1936; Wilder 1953, 1963; Squires 1970; Ennis 1972; Conan et al. 1982; Maynard et al. 1992) have reported the higher growth increment for male lobster compare to females. This lower growth rate is believed to be related to egg production, which has a greater stunting effect on growth than sperm production.

An overview on the growth information collected with tagging experiments in the southern Gulf of St. Lawrence since 1980 is presented in Table 10.

2.4 Size at sexual maturity

The size at which 50% of the female lobsters in the southern Gulf of St. Lawrence are sexually mature is ranging between 70 and 72 mm in carapace. These results have been obtained for different locations in the southern Gulf and for different years. This size is presently larger than the minimum legal sizes in used in the different LFAs. For males, the sexual maturity is achieved at smaller sizes and ages than females.

Between 1994 and 1997, the size at which 50 % of the female lobster reach maturity (*Lc 50%*) was estimated for various location in the LFA 23 (Table 11). Three methods were used in each location to estimate *Lc 50%* based on Aiken and Waddy (1980).

Table 10. Overview on the growth information collected with tagging experiments in the southern Gulf of St. Lawrence since 1980

	Location	N	Size range in the sample	Average molt Increment mm	%
MALES	LFA 23 Baie des Chaleurs	501	53-115	11	16.0
	LFA 23 Gulf St. Lawrence	26	57-86	10	14.1
	LFA 24	198	51-85	10	14.5
	LFA 25	173	52-85	11	16.8
	LFA 26A	84	55-102	12	17.0
	LFA 26B	914	54-93	9	13.8
FEMALES	LFA 23 Baie des Chaleurs	357	53-101	10	14.6
	LFA 23 Gulf St. Lawrence	31	60-77	9	14.0
	LFA 24	123	54-75	8	12.9
	LFA 25	150	51-81	10	16.4
	LFA 26A	153	54-104	10	13.6
	LFA 26B	1297	54-123	8	12.7
BERRIED FEMALES	LFA 23 Baie des Chaleurs	39	66-89	9	11.8
	LFA 23 Gulf St. Lawrence	3	72-78	8	10.8
	LFA 24	16	63-90	8	10.8
	LFA 25	-	-	-	-
	LFA 26A	-	-	-	-
	LFA 26B	385	67-98	8	10.8

3.0 Resource status

3.1 Fishing ground productivity

By using lobster landings and the approximate surface (km^2) of potential fishing ground in each LFA, it is possible to obtain a crude estimate of the productivity for each management area. The total potential surface of fishing ground is comprised between the 1 and 20 fathoms depth contours (Table 12). To be comparable from year to year, this calculation assumes that no major changes in the fishing ground surface (reduction or increase) had occurred during the time period considered.

The productivity by LFA can be used as a crude biomass index. In recent years, two LFAs are emerging as the most productive fishing grounds; LFA 24 and 26B (Figure 6). Since 1990, productivity values for these LFAs have increased, ranging between 1.8 and 2.5 t of lobster per km^2. During the same period, the other LFAs have shown a steady decline with values ranging between 0.7 and 1.0 t of lobster per km^2. For the entire period observed (1984 to 1997), LFA 26B have maintained the highest or second highest productivity value. This same LFA has also the smallest fishing ground area (Table 12) and when through the most important increase of the minimum legal carapace size from 63.5mm to 70mm (the largest in the southern Gulf).

Table 11. Parameters for the female sexual maturity equation obtained from different sampling sites and for different years.

Year	Location	Method	B_0	B_1	*Lc 50%* (mm)
1997	Caraquet	CG	20.9305	0.2974	70.4
1997	Caraquet	Ov5	21.8546	0.3101	70.5
1997	Caraquet	Of	17.8228	0.2543	70.1
1996	Caraquet	CG	17.3580	0.2464	70.4
1996	Caraquet	Ov5	20.8514	0.2977	70.0
1996	Caraquet	Of	17.7875	0.2545	69.9
1996	Val Comeau	CG	18.7257	0.2607	71.8
1996	Val Comeau	Ov5	26.4234	0.3657	72.3
1996	Val Comeau	Of	25.0021	0.3456	72.3
1995	Caraquet	CG	14.9749	0.2117	70.7
1995	Caraquet	Ov5	24.4479	0.3453	70.8
1995	Caraquet	Of	19.5400	0.2840	68.8
1995	Stonehaven	CG	17.7579	0.2514	70.6
1995	Stonehaven	Ov5	20.4925	0.2797	73.3
1995	Stonehaven	Of	16.2851	0.2264	71.9
1994	Caraquet	CG	16.2394	0.2260	71.9
1994	Caraquet	Ov5	16.8297	0.2392	70.4
1994	Caraquet	Of	13.7418	0.1999	68.7
1994	Anse-Bleue	CG	13.6998	0.1885	72.7
1994	Anse-Bleue	Ov5	19.0218	0.2632	72.3
1994	Anse-Bleue	Of	18.9597	0.2672	71.0

CG: *cement gland technique*
Ov5: *color of the ovary technique based on stage 5*
Of: *calculation of the ovary factor*

The logistic curve of female maturity can be calculated using: $P = 1/(1+\exp(B_0 - B_1 Lc))$

Table 12. Estimated fishing ground area (km^2) in each Lobster Fishing Area (area between the 1 and 20 fathoms depth contours).

Lobster Fishing Area (LFA)	23	24	25	26A	26B
Area in km^2	4,625	2,249	4,394	4,530	613

3.2 Size composition

Sea samplings are carried out annually in several fishing ports. Since 1993, two samples are taken: one at the beginning of the fishing season and one at the end of the fishing season. For a spring fishery, this corresponds to a sampling before June 1st and a sampling after June 1st while for the fall season, the 15th of September is the cutting point. Measures taken during sea-samplings are the sex (male, female, berried female), carapace length and frequency. It is then possible to obtain a size frequency distribution for the fishing day.

To estimate the total number of landed lobsters for a fishing season, a total of 17 sea-sampling areas were defined based on statistical districts where the sea sampling were carried out. There

were 4 areas in LFAs 23, 24 and 25, 3 areas in LFA 26A and 2 in LFA 26B. Total reported landings in weight were computed for canner and market categories by combining the landings from all fishing ports (landed ports) of a sampling area based on sale slip data. Those landings were also divided into 2 seasons, beginning and end (as described above), by using the purchased date on the sale slip. The ratio of landed lobster weight by sea-sampling lobster weight was then calculated for each sampling area and size-category/season combinations. This ratio was multiplied to the sea-sampling size-frequency with respect to season and size category, and LFAs total landing in number of lobsters were obtained by adding up the resulted values for its corresponding sampling areas.

Berried females and undersized lobsters were removed from the sea-sampling data sets before starting the calculation since those lobsters cannot be legally landed.

Absolute size frequencies for each LFA in 1992, 1995 and 1996 are presented in Figure 7. From these figures, it can be noted that LFA 25 and 26A have experienced a larger decrease in landings in the smaller size lobsters while decrease in landing in other LFAs have been more uniform throughout all the sizes.

The changes in numbers of lobsters from 1992 to 1996, for each of the canner and market size categories, are presented in Table 13. The general reduction in landings since the early 1990's is observed in all LFAs with the exception of LFA 24 which shows a steady increase in number of lobsters landed.

Table 13. Decrease in number of lobsters in each size category, in each Lobster Fishing Area, from 1992 to 1996

Lobster Fishing Area	Categories	Percentage of reduction	Average reduction (weighted)
LFA 23	canner	-16.4%	-17.0%
	market	-20.2%	
LFA 24	canner	8.3%	9.8%
	market	20.8%	
LFA 25	canner	-25.9%	-22.4%
	market	-4.8%	
LFA 26A	canner	-31.1%	-27.7%
	market	-20.9%	
LFA 26B	canner	-22.8%	-22.3%
	market	-20.7%	

3.3 Catch per unit of effort

For a LFA, the weekly catch per unit of effort was calculated as the average weekly CPUE of all the index fishers in that LFA. For a particular fisher, the weekly CPUE is given by the total landings for that week divided by the total trap hauls. The number of index fishers varied between LFAs and years (Table 14).

Table 14. Number of fishers that participated and provided daily catch information in the index fisher program.

Years	1993	1994	1995	1996	1997
LFA 23	15	28	38	38	36
LFA 24	3	6	26	30	28
LFA 25	11	37	35	32	49
LFA 26A	9	16	27	30	36
LFA 26B	1	7	13	11	12

The average weekly CPUE's for LFA 25 are different from the other LFAs both in their seasonal pattern and value (Figure 8, appendix I). For LFA 23, 24, 26A and 26B, the CPUE pattern and values are quite similar. For all LFAs, the variation in weekly CPUE between index fishers is fairly large, the coefficient of variation being in the range of 11% to122%.

3.4 Exploitation rate

Ports were combined with respect to fishing habits, the habitat and the bottom type to form 23 homogeneous fishing areas. Leslie estimates (Richer, 1975) were then calculated based on index-fishers information. When the relationship between CPUE and cumulative catch was not downward linear, a necessary (but not sufficient) condition for the validity of the Leslie analysis, the estimate was not calculated. The exploitation rate estimates for the areas and years where the method seemed to hold are presented in Table 15. Note that in LFA 25 and 26A, the underlying assumptions of the Leslie analysis were never met. Also, 1995 was an exceptional year for late ice condition, which affected lobster movements and catchability. For the years and areas where the underlying assumptions of the Leslie analysis were satisfactory met, exploitation rates varied between 63% and 87%. These values confirms the high levels found in earlier studies (DFO, 1996).

Table 15. Exploitation rate estimates and ranges (in parenthesis) using the Leslie method, for areas and years that seems to meet the underlying assumptions.

		Estimates of exploitation rate (%)			
LFA	Area (combined ports)	1994	1995	1996	1997
23	Anse-Bleue, Stonehaven, Miller Brook	-	-	-	63 (52 - 73)
23	Miscou, Pigeon-Hill	-	78 (69 - 86)	-	-
23	Ste-Marie, St-Raphael, Savoie Landing, LeGoulet	-	79 (70 - 86)	69 (58 - 79)	78 (66 - 88)
23	Tracadie, Val Comeau, Tabusintac	70 (64 - 76)	-	-	-
24	Morel, Naufrage North Lake, Red Head	72 (55 - 85)	-	69 (46 - 86)	-
24	Alberton, Seacow Pond Tignish, Northport Black Bank, Jude's Point	65 (50 - 77)	-	74 (59 - 86)	83 (76 - 89)
26B	Chéticamp, Grand Étang La Pointe, Margaree	83 (77 - 89)	-	86 (80 - 92)	-
26B	Inverness, Little Judique Harbour, Murphy's Pond, Baxter's Cove, Mabou Harbour, Port Hood	82 (77 - 86)	-	75 (58 - 88)	-

3.4 Egg production calculations (egg/recruit)

To achieve the conservation target announced by the Minister on April 22, 1998 (doubling of current E/R), calculations were conducted to obtain E/R values for the current fishery and to evaluate the changes under different management scenarios. The calculations were conducted for each LFA, with a more recent version of the model used initially in 1994 (FRCC, 1995). In addition, with new research and results on growth and exploitation rates, some of the baseline fisheries and biological parameters, required for the model, were refined. These parameters are presented in Table 16. Nevertheless, estimates of fishing mortality (F) are a source of uncertainty. Although there is confidence of the relative levels of mortality in the different areas, the absolute levels are imprecise and require further research.

The E/R calculation results for the 1997 fishing season are presented in Table 17 for each LFA. This information presenting the current E/R values (1997) and the calculations under different management scenarios have been presented to the fishing industry for discussion, during numerous meetings.

Table 16. Parameters used in the mathematical model to calculate the egg per recruit values for the different Lobster Fishing Areas (LFA).

LFA specific Parameters	LFA 23	LFA 24	LFA 25	LFA 26A	LFA 26B
Fishing mortality (F)	1.39	1.39	1.39	1.2	1.39
Fishing mortality in percentage	75%	75%	75%	70%	75%

Parameters common to all LFAs

Natural mortality (at molt)		10%
Natural mortality (other than at molt)		5%
Female sexual maturity (%) at size (*Pm*)		*Pm = 1/(1+exp(20.9545-0.2941CL))*
Double molt probability (%)	55-57 mm	10%
	58-60 mm	8%
	61-65 mm	5%
Annual molting probability (%)	Immature	100%
Sexually mature	<= 110 mm	50%
Sexually mature	111-150 mm	33.3%
Sexually mature	>= 150 mm	25%
Fecundity (number of eggs at size), (*Fec*)		$Fec = 0.00265\ CL^{3.409}$
Growth (minimal growth, average and *stdev*)		
<= 95 mm		Min.=7mm, Avg.=10mm, *stdev* =1.49mm
96-119 mm		Min.=6mm, Avg.=11mm, *stdev* =2.78mm
>= 120 mm		Min.=6mm, Avg.=11mm, *stdev* =2.78mm

Table 17. *Egg per recruit (E/R) calculations and management regime for the lobster fishery prevailing in 1997 and the expected results at the end of the four year management plan announced by the Minister (see Table 9).*

Lobster Fishing Area (LFA)	LFA 23	LFA 24	LFA 25	LFA 26A	LFA 26B
E/R calculated for year 1997	0.6%	0.3%	0.6%	0.6%	1.0%
Minimum legal carapace size in year 1997	66.7 mm 2 5/8"	63.5 mm 2 1/2"	66.7 mm 2 5/8"	65.1 mm 2 9/16"	70.0 mm 2 3/4"
Estimated E/R for year 2001	1.3%	1.0%	1.3%	1.3%	1.9%
Expected minimum legal carapace size in year 2001	68.3 mm 2 11/16"	68.3 mm 2 11/16"	68.3 mm 2 11/16"	68.3 mm 2 11/16"	70 mm 2 3/4"
Expected V- notching on berried females during the next 4 years	50%	0%	50%	50%	50%

Egg per recruit (E/R) values calculated for the 1997 fishing season range from 0.3% to 1.0% in LFA 24 and 26B respectively. These values still suggest that the lobster stock is heavily fished and recruitment overfished, and confirm the need to increase egg production. With the introduction of the new management measures in the spring of 1998, the E/R values are expected to increase.

In addition to carapace size increases, V-notching on 50% of the egg bearing females has been announced for the 1998 to 2001 fishing seasons. The notching activity was never part of the fishing industry's proposed management plan and fishers of the southern Gulf have raised concerns on the potential induced mortality and enforcement problem of a V-notching program. At the end of the 1998 lobster spring fisheries and after discussions with fishers, it has been concluded that no V-notching had been conducted. Since a portion of the predicted egg production is attributed to the V-notching measure (Figure 9), the doubling target will not be achieved without compliance to V-notching in LFA 23, 25, 26A and 26B.

4.0 Outlook

With minimum carapace size increases in all LFAs (with the exception of LFA 26B) in the spring of 1998, catches in the southern Gulf were expected to be somewhat lower than in 1997. However, based on preliminary catch and effort data, overall landings for the 1998 spring fisheries are as good if not better than in 1997. There are indications this trend may not last very long. On a large geographical scale (southern Gulf and over the entire distribution of the species), the trend has been for a steady decrease in catches since the extremely high landings of the early 1990's. The concerns about the high fishing mortality, high fishing effort, increasing fishing power and low egg production still exist.

Over the longer term, the management changes announced in 1998 should help increase the egg production of the lobster population and reduce the risk of recruitment declines if environmental conditions become unfavorable.

5.0 References

Aiken and Waddy 1980; In: The biology and management of lobsters, vol. I, Academic Press, Toronto. 463pp.

Bergeron, T. 1967. Contribution à la biologie du homard (*Homarus americanus* M. Edw.) des Îles-de-la-Madeleine. Naturaliste Can. 94: 169-207.

Burkenroad, M.D. 1951. Measurement of the natural growth rates of decapod crustaceans. Gulf Caribb. Fish. Inst. Univ. Miami, Proc. 3: 25-26.

Comeau, M., W. Landsburg, M. Lanteigne, M. Mallet, P. Mallet, G. Robichaud and F. Savoie. 1998. Lobster (*Homarus americanus*) tagging project in Caraquet (1993) - tag return from 1994 to 1997. Can. Tech. Rep. Fish. Aquat. Sci. 2216.

Conan, G.Y., Robinson, D.G., and Maynard, D.R. 1982. Growth at molt of lobsters in two areas of Northumberland Strait, Canada. Int. Counc. Explor. Sea C.M. 1982/K: 35.

DeWolf, A.G., 1974. The lobster fishery of the Maritime Provinces: economic effects of regulations. Bull. Fish. Res. Board Can. 187: 59 p.

DFO, 1996. American Lobster (*Homarus americanus*), Southern Gulf of St. Lawrence. DFO Sci. Stock Status Report. 96/115E.

Dubé, P. 1984. Analyse des déplacements du homard (*Homarus americanus*) sur les côtes des Îles-de-la-Madeleine, à partir des données de marquage et de recaptures, de 1978 à 1983. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 84/37.

Ennis, G.P. 1972. Growth per moult of tagged lobsters (*Homarus americanus*) in Bonavista Bay, Newfoundland. J. Fish. Res. Bd. Canada. 29: 143-148.

FRCC, 1995. A Conservation Framework for Atlantic Lobster. FRCC95.R.1. Minister of Supply and Services Canada, Cat. No. FS23-278/1995E. 49 pages + appendices.

Lanteigne M., 1998. Description of the 1993 lobster (*Homarus americanus*) fishing fleet in the southern Gulf of St. Lawrence and a retrospective look of the changes that took place form 1983 to 1993. In prep.

Maynard, D.R., and Chiasson, Y. 1986. Dispersion of tagged lobsters (*Homarus americanus*) in two areas of Northunberland Strait. . Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 86/72.

Maynard, D.R., Savoie, F., Landsburg, W., Roach, G., and Wade, E. 1992. The Cape Breton experiment on legal minimum lobster size increase: an intermediate report. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 92/64.

Monro, J., and Therriault, J.-C. 1983. Migrations saisonnières du homard (*Homarus americanus*) entre la côte et les lagunes des Îles-de-la-Madeleine. Can. J. Fish. Aquat. Sci.: 40: 905-918.

Montreuil, P. 1953. Recherches sur le homard des Îles-de-la-Madeleine *In* Rapport Annuel de la Station de Biologie Marine 1953. Contr. Dépt. Pêch. Québec 43: pp. 75-86.

Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Res. Board Can. 191: 382 p.

Rutherford J.B., D.G. Wilder and H.C. Frick. 1967. An Economic Appraisal of the Canadian Lobster Fishery. Bull. Fish. Res. Board Can. 157: 127 p.

Squires, H.J. 1970. Lobster (*Homarus americanus*) fishery and ecology in Port-au-Port Bay, Newfoundland 1960-65. Proc. Nat. Shellfish. Assoc. 60: 22-39.

Templeman, W. 1933. Female lobsters handicapped in growth by spawning. Fish. Res. Board. Can. Atl. Prog. Rep. 6: 5-6.

Templeman, W. 1935. Lobster tagging in the Gulf of St. Lawrence. J. Biol. Board Can. 1: 269-278.

Templeman, W. 1936. Local differences in the life history of lobster on the coast of the maritime provinces of Canada. J. Biol. Board Can. 2: 41-88.

Wilder, D.G. 1953. The growth rate of the American lobster (*Homarus americanus*). J. Fish. Res. Board Can. 10: 371-412.

Wilder, D.G. 1963. Movement, growth and survival of marked and tagged lobsters liberated in Egmont Bay, Prince Edward Island. J. Fish. Res. Board Can. 20: 305-318.

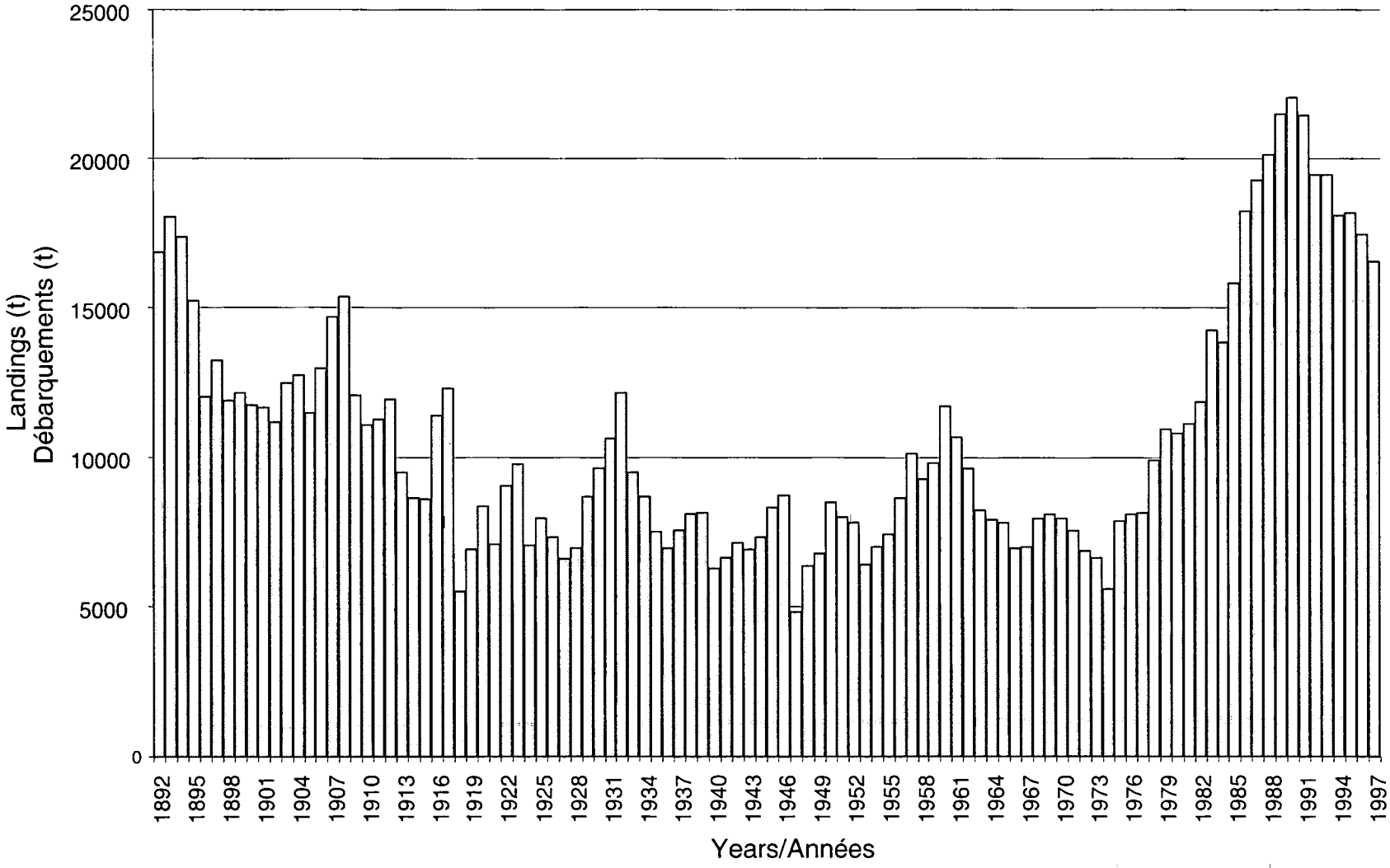

Figure 1. Lobster landings (t) in the southern Gulf of St. Lawrence from 1892 to 1997.

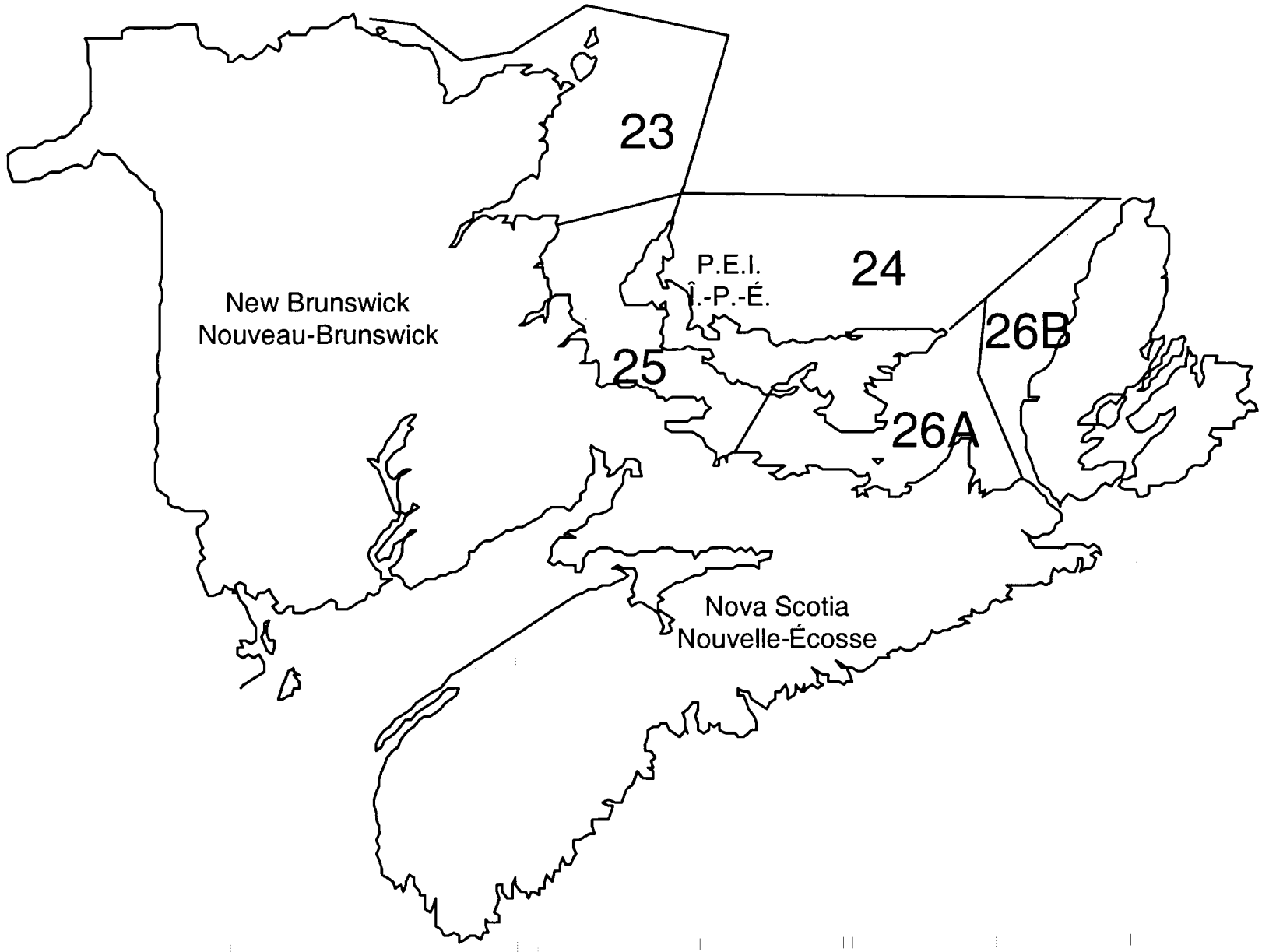

Figure 2. Lobster Fishing Areas (LFA) in the southern Gulf of St. Lawrence.

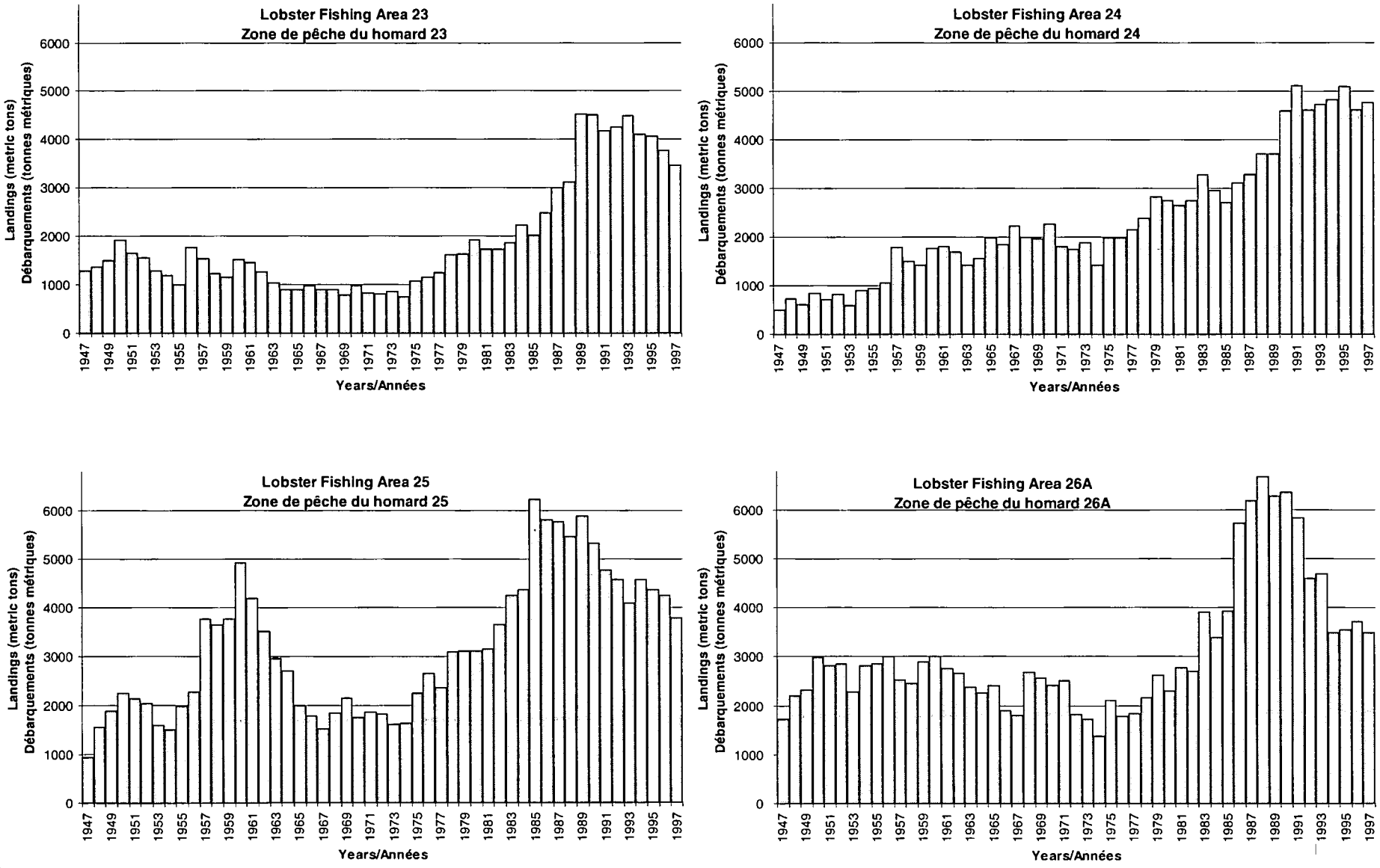

Figure 3. Lobster landings (t) by Lobster Fishing Area (LFA).

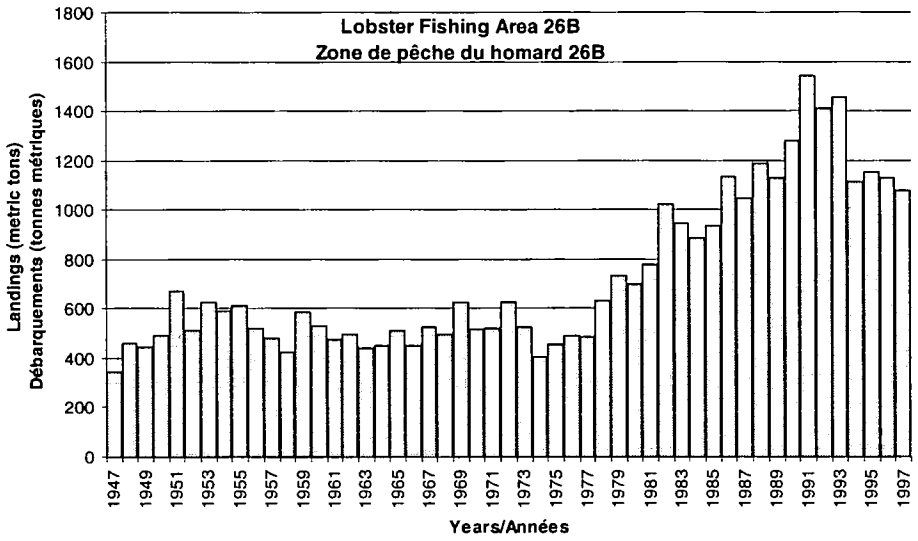

Figure 3. Lobster landings (t) by Lobster Fishing Area (LFA), continued.

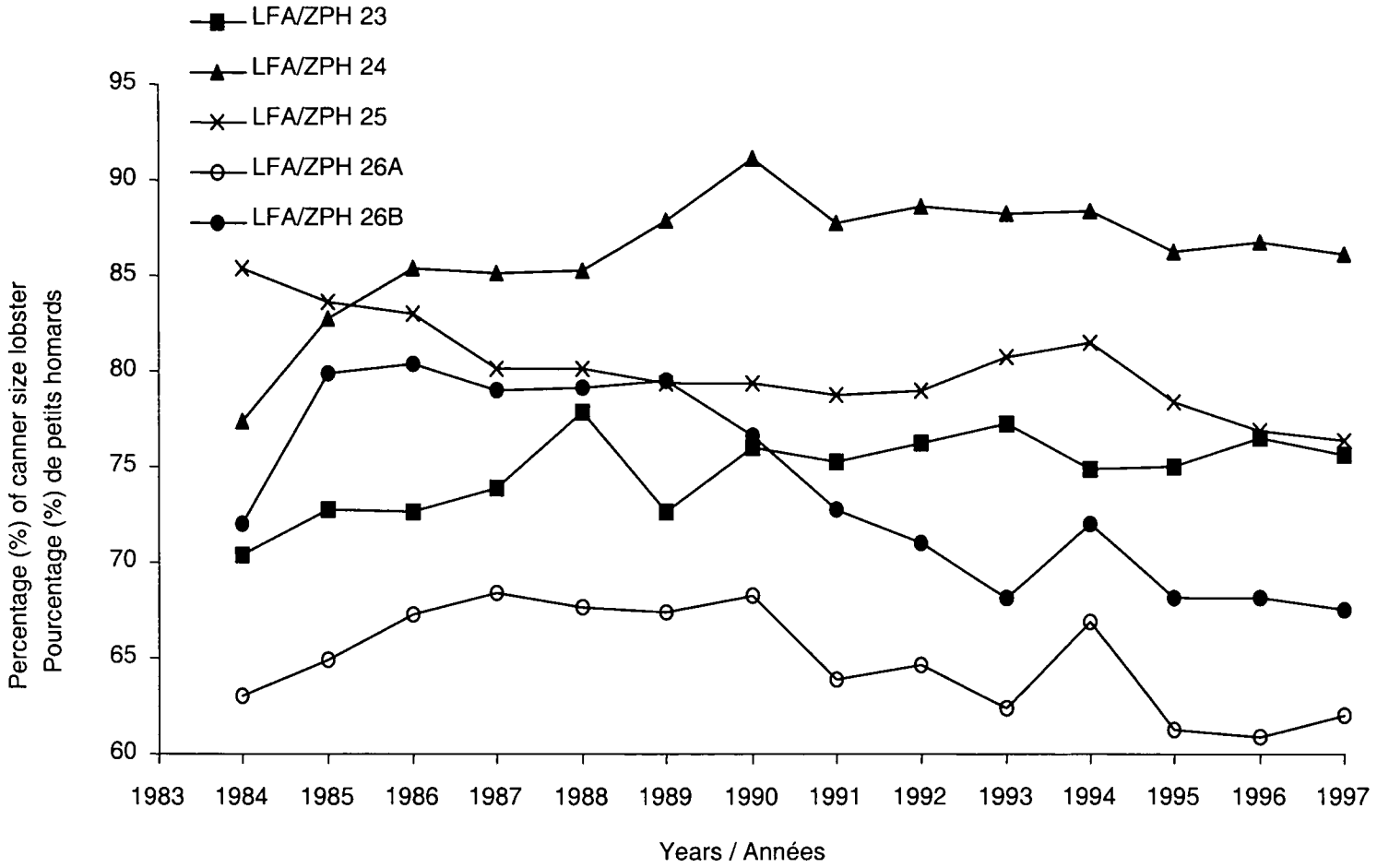

Figure 4. Percentage of canner size lobster in the commercial catches from 1984 to 1997, and by Lobster Fishing Area (LFA).

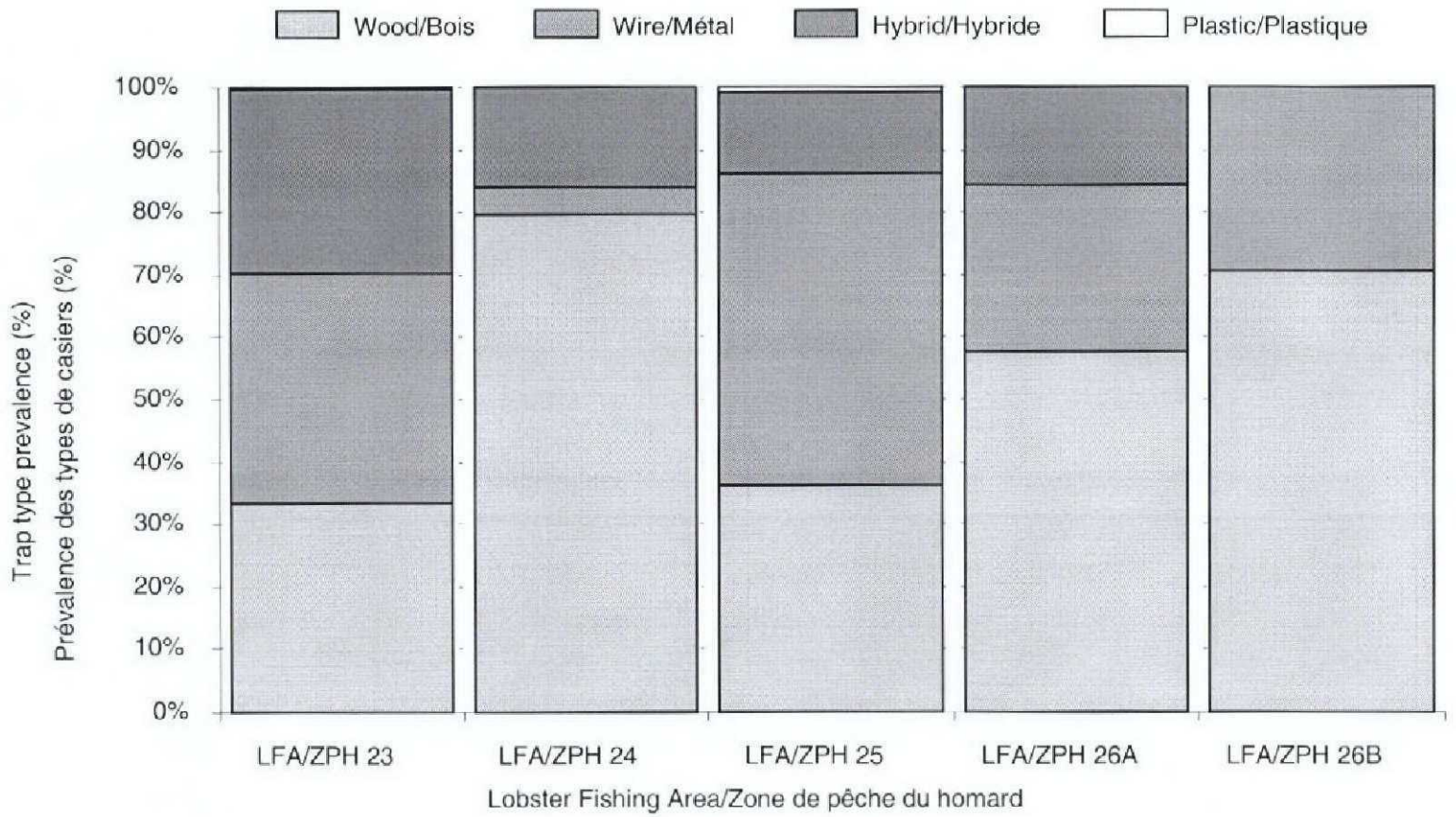

Figure 5. Prevalence of the different lobster trap types for 1993, in each Lobster Fishing Area (LFA).

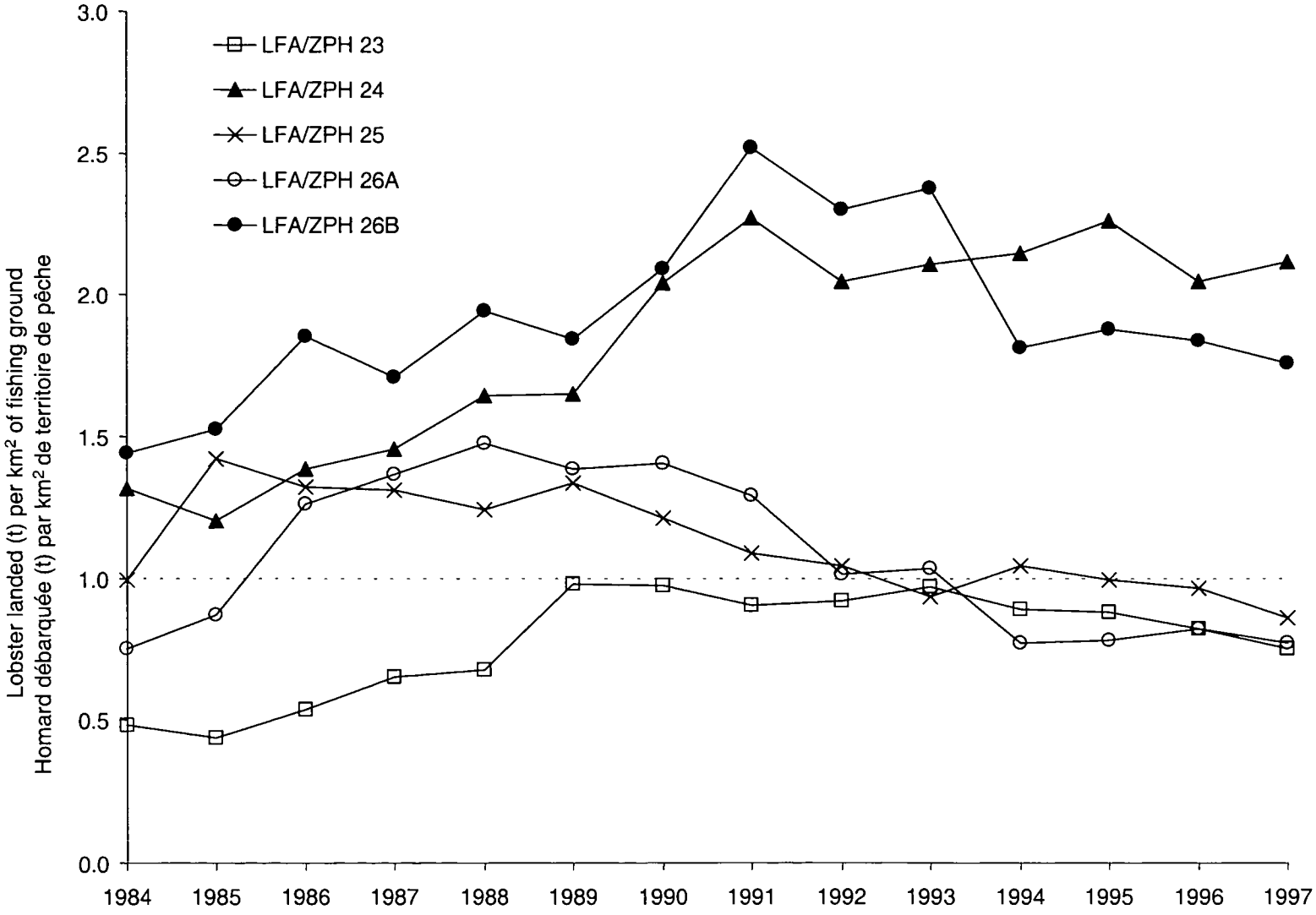

Figure 6. Lobster landed (t) per km² of estimated fishing ground from1984 to 1997, by Lobster Fishing Area (LFA).

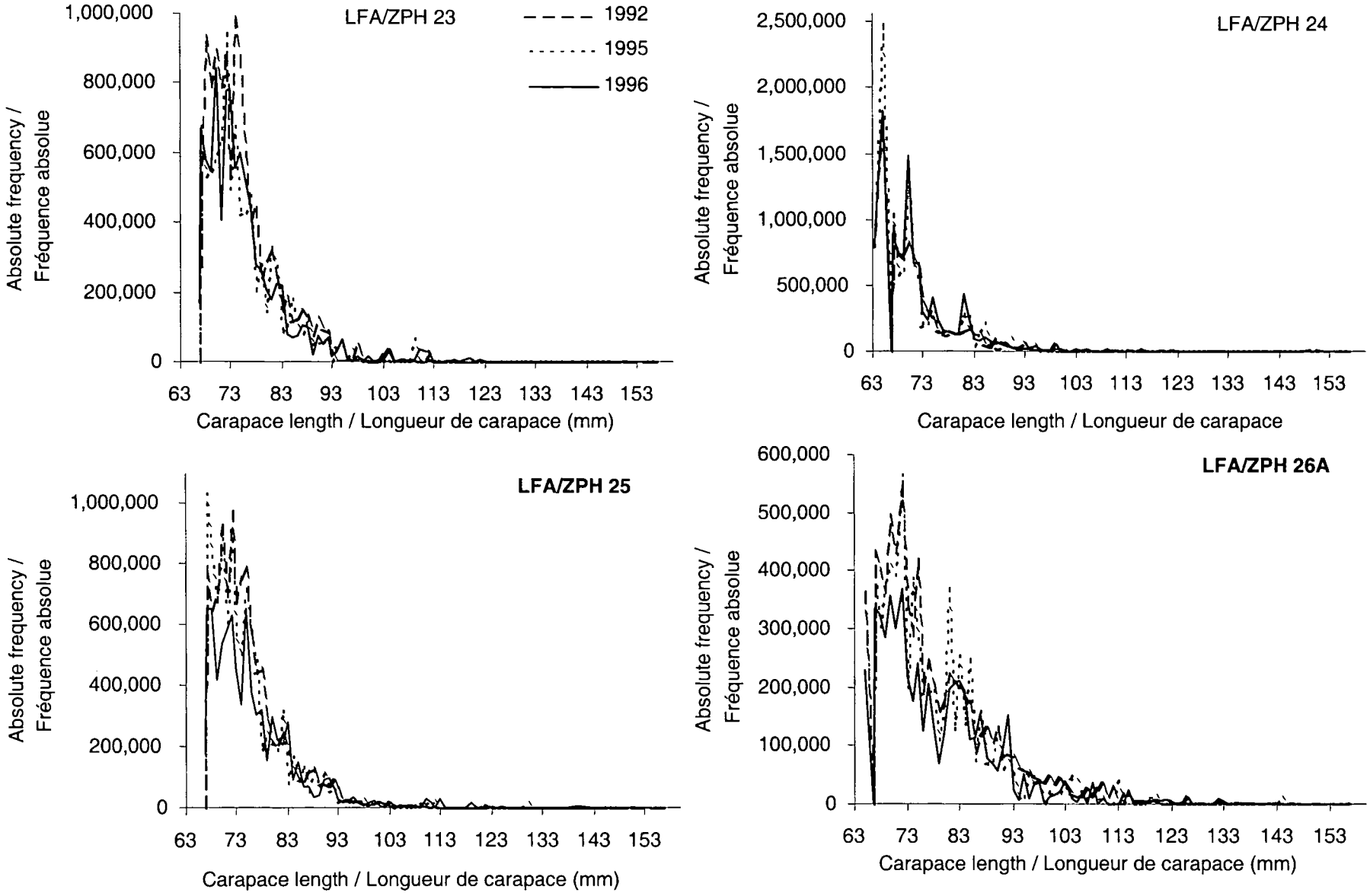

Figure 7. Size distributions for the total landings of lobsters in 1992, 1995 and 1996, by Lobster Fishing Area (LFA).

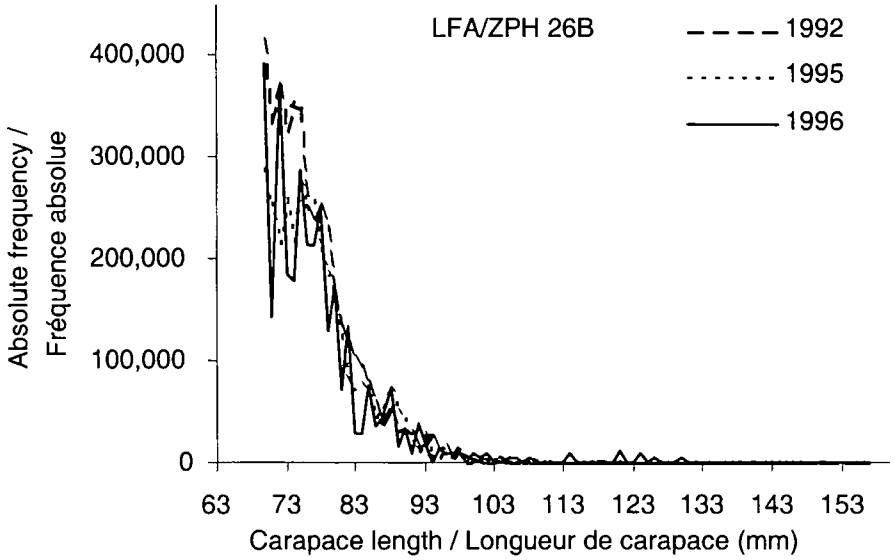

Figure 7. Size distributions for the total landings of lobsters in 1992, 1995 and 1996, by Lobster Fishing Area (LFA), continued.

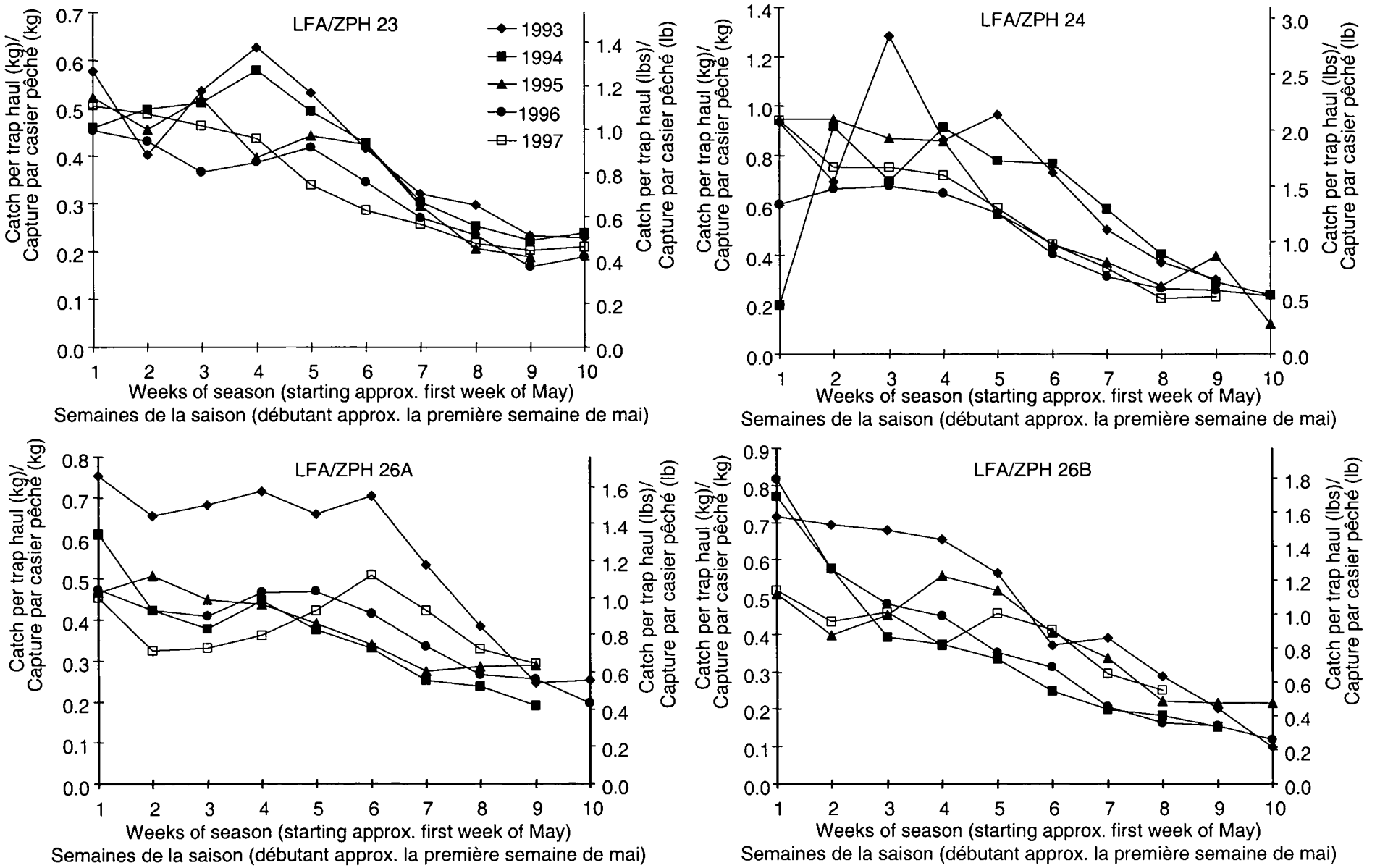

Figure 8. Average weekly catch per unit of effort (CPUE, lbs/trap haul) calculated from the index fisher logbook collected from 1993 to 1997.

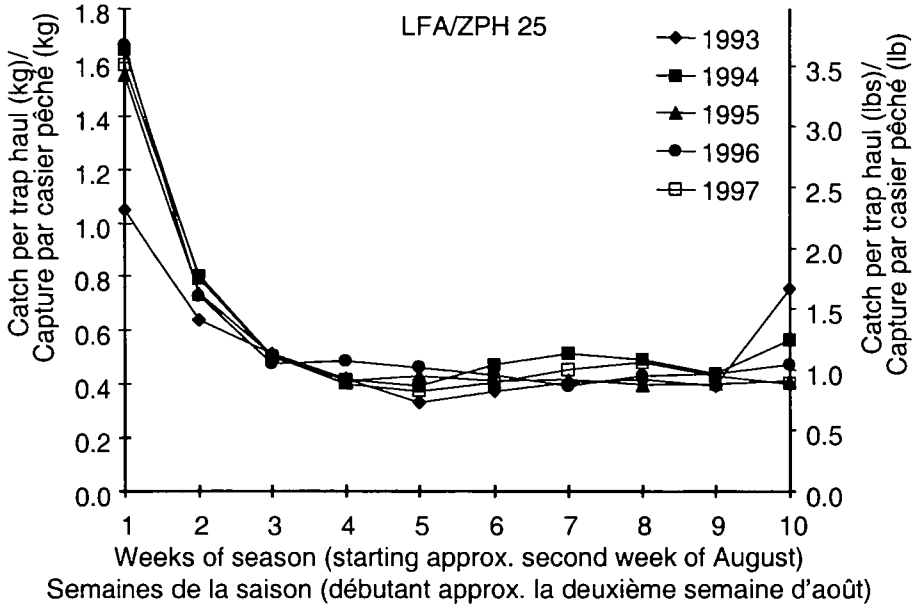

Figure 8. Average weekly catch per unit of effort (CPUE, lbs/trap haul) calculated from the index fisher logbook collected from1993 to 1997, continued.

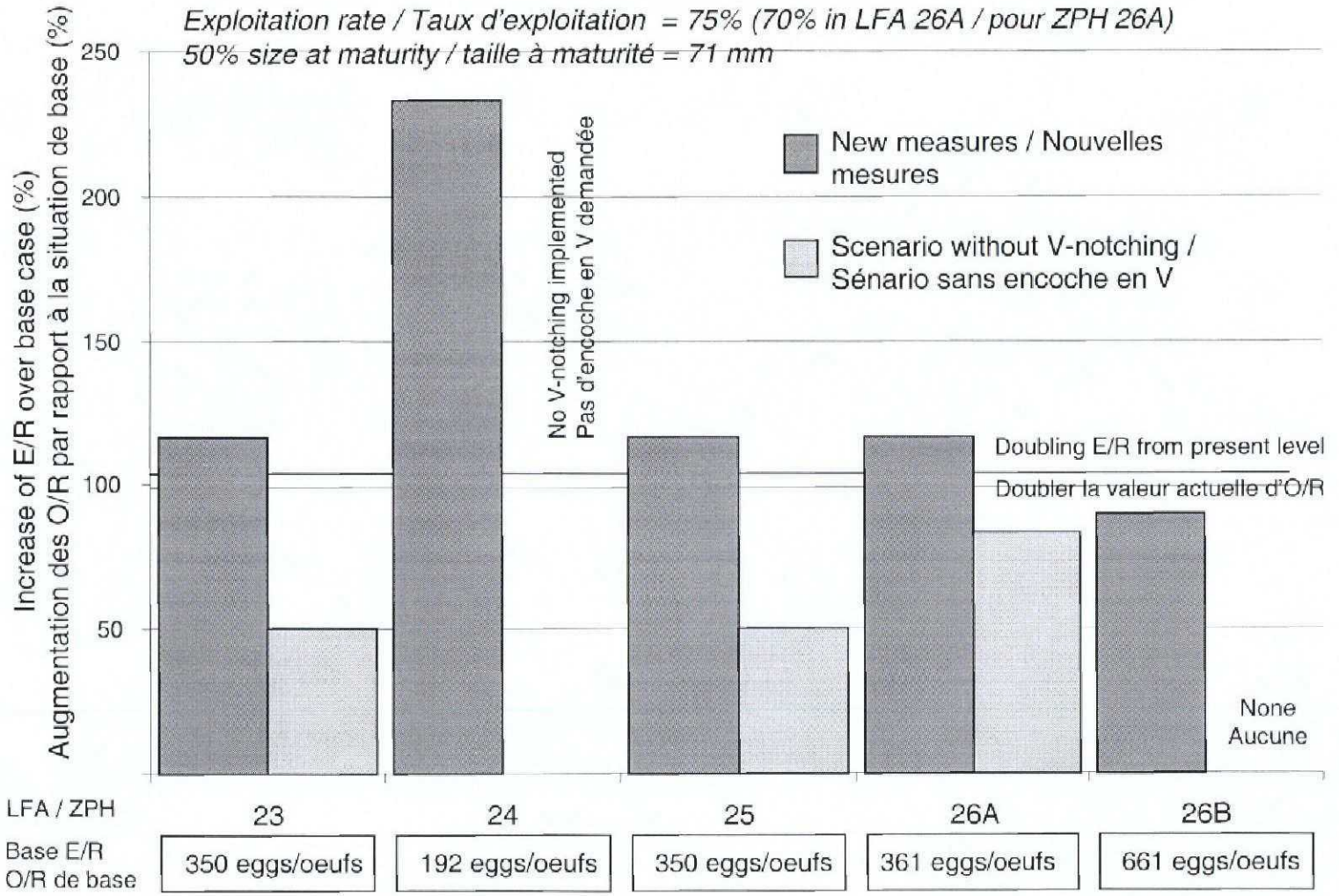

Figure 9. Comparison E/R increase with all the components of the new measures announced and without the V-notching component.

Appendix I. *Average weekly catch per unit of effort (CPUE, lbs./trap haul) calculated from the index fisher logbook data collected from 1993 to 1997.*

		Average weekly CPUE (stdev)				
LFA	Week	1993	1994	1995	1996	1997
23	1	1.27 (1.01)	1.01 (0.64)	1.15 (0.62)	1.00 (0.51)	1.11 (0.50)
	2	0.88 (0.39)	1.09 (0.44)	1.00 (0.52)	0.95 (0.54)	1.08 (0.38)
	3	1.18 (0.55)	1.12 (0.49)	1.14 (0.43)	0.80 (0.35)	1.02 (0.48)
	4	1.38 (0.37)	1.28 (0.34)	0.87 (0.40)	0.85 (0.27)	0.96 (0.29)
	5	1.17 (0.47)	1.09 (0.39)	0.97 (0.30)	0.92 (0.29)	0.75 (0.27)
	6	0.92 (0.37)	0.94 (0.28)	0.93 (0.25)	0.76 (0.27)	0.63 (0.24)
	7	0.70 (0.21)	0.67 (0.21)	0.65 (0.27)	0.60 (0.18)	0.57 (0.16)
	8	0.65 (0.32)	0.56 (0.19)	0.45 (0.21)	0.52 (0.15)	0.48 (0.13)
	9	0.51 (0.26)	0.49 (0.18)	0.41 (0.36)	0.37 (0.17)	0.44 (0.17)
	10	0.50 (0.18)	0.52 (0.29)		0.42 (0.20)	0.46 (0.27)
24	1	2.07 (-)	0.43 (0.44)	2.09 (0.66)	1.33 (0.43)	2.08 (0.67)
	2	1.53 (-)	2.02 (0.54)	2.09 (0.74)	1.47 (0.26)	1.66 (0.33)
	3	2.83 (-)	1.54 (0.53)	1.92 (0.55)	1.49 (0.61)	1.66 (0.36)
	4	1.90 (-)	2.01 (0.78)	1.89 (0.56)	1.42 (0.48)	1.59 (0.72)
	5	2.13 (0.65)	1.72 (0.39)	1.25 (0.36)	1.25 (0.47)	1.30 (0.59)
	6	1.61 (0.47)	1.69 (0.60)	0.97 (0.28)	0.88 (0.39)	0.98 (0.39)
	7	1.11 (0.38)	1.29 (0.69)	0.81 (0.24)	0.69 (0.25)	0.77 (0.25)
	8	0.82 (0.09)	0.88 (0.21)	0.60 (0.20)	0.58 (0.18)	0.49 (0.20)
	9	0.66 (0.08)	0.64 (0.18)	0.87 (1.06)	0.57 (0.45)	0.51 (0.27)
	10		0.52 (0.17)	0.26 (-)	0.52 (0.50)	
25	1	2.31 (1.44)	3.63 (1.73)	3.43 (1.42)	3.67 (1.69)	3.50 (1.76)
	2	1.41 (0.37)	1.75 (0.57)	1.62 (0.56)	1.61 (0.50)	1.77 (0.52)
	3	1.13 (0.24)	1.10 (0.38)	1.12 (0.43)	1.05 (0.34)	1.11 (0.37)
	4	0.92 (0.29)	0.91 (0.30)	0.91 (0.37)	1.06 (0.34)	0.89 (0.32)
	5	0.73 (0.24)	0.86 (0.29)	0.94 (0.34)	1.02 (0.33)	0.82 (0.27)
	6	0.83 (0.30)	1.04 (0.35)	0.90 (0.31)	0.95 (0.28)	0.89 (0.30)
	7	0.90 (0.19)	1.13 (0.44)	0.92 (0.26)	0.86 (0.25)	1.00 (0.34)
	8	0.91 (0.22)	1.08 (0.65)	0.88 (0.30)	0.95 (0.30)	1.06 (0.44)
	9	0.86 (0.18)	0.96 (0.58)	0.89 (0.30)	0.97 (0.34)	0.95 (0.41)
	10	1.66 (0.57)	1.24 (0.66)	0.90 (0.53)	1.04 (0.45)	0.88 (0.30)
26A	1	1.66 (0.65)	1.35 (0.50)	1.03 (0.62)	1.04 (0.47)	1.00 (0.81)
	2	1.44 (0.50)	0.93 (0.61)	1.12 (0.46)	0.93 (0.43)	0.72 (0.42)
	3	1.50 (0.53)	0.83 (0.52)	0.99 (0.40)	0.90 (0.37)	0.73 (0.37)
	4	1.58 (0.63)	0.99 (0.74)	0.97 (0.34)	1.03 (0.46)	0.80 (0.36)
	5	1.45 (0.69)	0.83 (0.53)	0.86 (0.29)	1.04 (0.39)	0.93 (0.35)
	6	1.55 (0.61)	0.73 (0.36)	0.75 (0.24)	0.92 (0.32)	1.12 (0.50)
	7	1.18 (0.47)	0.56 (0.25)	0.60 (0.19)	0.74 (0.29)	0.93 (0.28)
	8	0.85 (0.39)	0.52 (0.26)	0.63 (0.23)	0.59 (0.19)	0.72 (0.20)
	9	0.54 (0.15)	0.42 (0.18)	0.64 (0.35)	0.56 (0.31)	0.65 (0.25)
	10	0.56 (0.31)			0.43 (0.29)	

a dash (-) indicates that variance could not be calculated since only one logbook was available

Appendix I. *Average weekly catch per unit of effort (CPUE, lbs./trap haul) calculated from the index fisher logbook data collected from 1993 to 1997 (continued).*

		Average weekly CPUE (stdev)				
LFA	Week	1993	1994	1995	1996	1997
26B	1	1.58 (-)	1.70 (0.27)	1.12 (0.54)	1.80 (0.44)	1.14 (0.38)
	2	1.53 (-)	1.27 (0.31)	0.88 (0.29)	1.27 (0.32)	0.96 (0.24)
	3	1.50 (-)	0.86 (0.28)	0.99 (0.31)	1.06 (0.29)	1.01 (0.29)
	4	1.44 (-)	0.82 (0.16)	1.22 (0.31)	0.99 (0.27)	0.81 (0.24)
	5	1.24 (-)	0.74 (0.15)	1.14 (0.26)	0.77 (0.25)	1.01 (0.30)
	6	0.82 (-)	0.55 (0.09)	0.89 (0.22)	0.68 (0.24)	0.91 (0.18)
	7	0.86 (-)	0.44 (0.06)	0.74 (0.26)	0.46 (0.13)	0.65 (0.15)
	8	0.64 (-)	0.40 (0.06)	0.49 (0.20)	0.36 (0.09)	0.55 (0.15)
	9	0.44 (-)	0.33 (0.06)	0.48 (0.21)	0.34 (0.19)	
	10	0.22 (-)		0.48 (0.29)	0.26 (0.16)	

a dash (-) indicates that variance could not be calculated since only one logbook was available