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STATUS OF THE WEST COAST OF NEWFOUNDLAND HERRING  
STOCK IN 1983

by

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ABSTRACT

Herring landings in NAFO division 4R decreased from 26,688 t in 1973 to 8,726 t in 1983. Quotas set since 1977 have been exceeded every year except in 1981 and 1983.

Catch rates from the purse seiner fishery are difficult to interpret, but seem to indicate a decline in the fall spawner biomass between 1978 and 1981. Catch rates from the inshore fishery suggests that the spring spawner biomass has been stable since 1981 while the fall spawner biomass has declined continuously between 1977 and 1981 and has fluctuated since then.

According to the catch at age matrices spring spawners have generally dominated the catch since 1966. In 1983, about 40% of the spring spawner catch consisted of the 1979 and 1980 year-classes. In the fall spawner catch, herring of ages 11+ have dominated since at least 1966.

Cohort analysis showed that the spring spawner population dropped from  $1.3 \times 10^9$  fish in 1971 to  $.25 \times 10^9$  fish in 1983. Besides, since the appearance in the fishery of the 1974 year-class, recruitment at age 2 has been well below the historical average. The results of the cohort analysis for fall spawners indicate a twelve fold decrease in total population numbers between 1966 and 1983. During this period fishing mortality rates were below  $F_{0.1}$ . Recruitment at age 2, generally lower for fall spawners than for spring spawners, has also been weaker in recent years for both spawning components.

Projections for future catches and population estimates show that if 9,000 t of spring spawners are caught in 1985 the population biomass will slightly decrease from 53,000 t to 50,000 t. Fishing the fall spawners at  $F_{0.1}$  will yield less than 2,000 t in 1985 with a decline in total biomass from 14,000 t in 1984 to 12,000 t in 1985.

## RÉSUMÉ

Les débarquements de hareng dans la Division 4R de l'OPANO sont passés de 26,688 t en 1973 à 8,726 t en 1983. Les TPA imposés depuis 1977 ont été dépassés chaque année sauf en 1981 et 1983.

Les taux de capture obtenus pour la pêche au seigneur sont difficiles à interpréter pour diverses raisons, mais semblent indiquer un déclin de la biomasse des reproducteurs d'automne entre 1978 et 1981. Les taux de capture calculés à partir des données de la pêche côtière montrent que la biomasse des reproducteurs de printemps est stable depuis 1981 tandis que celle des reproducteurs d'automne aurait continuellement décliné entre 1977 et 1981 pour ensuite fluctuer.

Selon la matrice des captures à l'âge, les reproducteurs de printemps sont généralement dominants dans la capture depuis 1966. Toujours chez les harengs de printemps, les classes d'âge de 1979 et 1980 représentaient environ 40% de la capture en 1983. Chez les reproducteurs d'automne, ce sont les poissons de plus de 11 ans qui dominent dans la capture depuis 1966.

L'analyse de cohorte des reproducteurs de printemps a démontré que cette population est passée de  $1.3 \times 10^9$  harengs en 1971 à  $.25 \times 10^9$  harengs en 1983. De plus, depuis la venue de la classe d'âge de 1974 dans la pêche commerciale, le recrutement à l'âge de 2 ans a été constamment inférieur à la moyenne historique de recrutement. La population des reproducteurs d'automne a décliné par un facteur de 12 entre 1966 et 1983, et ce, même si la mortalité par la pêche était inférieure à  $F_{0.1}$ . De plus, le recrutement à l'âge 2 pour cette population, généralement inférieur au recrutement des reproducteurs de printemps, a été plus faible au cours des dernières années.

Les résultats des projections de captures et biomasses résiduelles montrent que la capture de 9,000 t de harengs de printemps en 1985 aura pour conséquence de diminuer légèrement la population de 53,000 t en 1984 à 50,000 t en 1985. Une mortalité par pêche de  $F_{0.1}$  pour les reproducteurs d'automne permettra de capturer moins de 2 000 t de ces harengs en 1985 et entraînera également une légère baisse de biomasse de 14,000 t en 1984 et 12,000 t en 1985.

## INTRODUCTION

Total landings from the west coast of Newfoundland, NAFO division 4R, peaked in 1973, decreased sharply a year later when the number of seiners in the commercial fleet was greatly reduced, increased until 1980 and dropped continuously thereafter (Table 1, Figure 1). Quotas have been in effect since 1977, when the west coast of Newfoundland was defined as a herring management area. In order to prevent overexploitation of local stocks, the quotas for this area were broken down into three subareas: 1) St. George's Bay 2) Cape St. George to Cape St. Gregory and 3) Cape St. Gregory to Cape Norman (Moore and Winters, 1978) (Figure 2). Quotas set since 1977 have been exceeded every year except in 1981 and 1983.

The fishing pattern of the herring fleet has varied greatly over time. Before 1971, most of the catch was reported in area M while from 1971 to 1978 landings from area K were the most important (Figure 3). More recently, the proportion of the total catch reported in the latter area has slowly diminished while increasing in area L.

These herring stocks have been exploited by both fixed gears, mainly anchored gillnets, and mobile gears, mainly purse seines. However the proportion of the total catch taken by each gear component in each fishing area has been extremely variable, and complete disappearance of one or the other fishery has occurred in some years (Table 2, Figure 4).

## HISTORICAL TRENDS

The purse seine fleet, being very mobile, can direct its fishing effort wherever the fishing success is expected to be optimum. Therefore the fishing pattern of the fleet has fluctuated considerably over time (Figure 5). For instance, in the southern fishery (areas K+L) during the 70's most of the catch was reported in area K. But as the fishing success decreased in St. George's Bay in the early 80's, more and more catches were reported from area L. Finally, in 1983, no fish were landed from St. George's Bay and all catches were taken in area L. In the northern fishery (areas M+N), Moore and Winters (1980) noted that "the fishing pattern of the seiner fleet in 1979 was slightly different... with the bulk of the catch being taken south of Pt Riche rather than in St. John Bay as occurred since 1976". Since then the shift in fishing pattern has become more pronounced with the result that in 1983 catches from area M were 4 times higher than in area N. The overall result of these changes in fishing patterns is that more and more of the total purse seine catch is taken in the central part of the west coast (areas L + M) rather than at the extremities.

The fishery made up of all gears other than purse seines (mostly gillnets) has also gone through remarkable changes since 1966. In the late sixties, the predominance of this fishery in the southern areas rapidly

declined (Figure 6). From 1971 to 1978 most of the catch was reported from area N (Figure 6) but after 1975, the development of a major spring gillnet fishery south of Cape St. Gregory (Moore and Winters, 1980) resulted in more catches being reported from area L, and a little later from area K. Consequently since 1979, almost equal proportions of the total catch have been taken from the southern and northern zones.

#### THE 1982 AND 1983 FISHERIES

Total allowable catches (TAC) of 10,000 t were set in 1982 and 1983. While the TAC was slightly overrun in 1982, total catches did not exceed 9,000 t in 1983. In both years purse seine catches in St-George's Bay were below the allocations, with no catches at all in 1983 (Table 3), due to the dominance of fish below market size. During the same period, the Port au Port and Cape St. Gregory purse seine allocations were overrun in 1982 and 1983. However the 1983 fishery was slightly different in that catches from Cape St. Gregory were taken in area N as well as area M (Table 4), and the fishery lasted until December instead of November as in the previous year. The fixed gear allocation, all areas, was overrun in 1982 but not reached in 1983, although the fishing season in each area lasted longer.

#### COMPARISONS BETWEEN HISTORICAL AND RECENT CATCH COMPOSITION

According to Tremblay et al. (1983), the spring fishery, concentrated on the southern part of the coast, has exploited primarily spawning and pre-spawning concentrations of herring. In 1983 the spring fishery also took place almost exclusively in areas K and L (Figure 7). However most of the herring caught were at maturity stages 3 and 4 (maturing), rather than 5 and 6 (spawning) as expected (Figure 8, semester 2), and the catch was comprised of both spring and fall spawner fish instead of spring spawners only as in the previous year (Table 5).

The fall fishery has historically taken place further north (areas M and N) and has been directed towards mixed spring and fall spawners (Tremblay et al., 1983). Again, in 1983, most of the fall catch was reported from areas M and N (Figure 7). In area M spring and fall spawner fish were found in approximately equal proportions in the gillnet catches (Table 5). Most of these fish were either in maturing (Stages 3 and 4) or recovering- resting (stages 7 and 8) stages of gonad development. However, the situation was quite different in area N: Fall spawners dominated the gillnet catches, both in 1982 and 1983 (Table 5), and spawning fish (maturity stages 5 and 6) were an important proportion of the catch during the third quarter of the year. It thus seems that the gillnet fishery in area N is more of a fall spawner directed fishery rather than a mixed fishery. Since gillnet catches in area N are much more important than in area M, we conclude that the overall fall gillnet fishery is not entirely mixed and that this could be of some importance in future management decisions.

As stated earlier, the contribution of the purse seine fishery to the total catches in areas M and N has varied considerably over time. Consequently, the total catch composition of the fall fishery will also vary according to the purse seiner fishing patterns. An analysis of historical data is thus necessary to evaluate the impact of the purse seine fall fishery on each spawning stock.

### POPULATION ABUNDANCE INDICES

Catch rate indices have been calculated for the gillnet and purse seine fisheries for each of the four fishing areas. An index was also derived from the January bottom trawl survey data in division 4R.

#### Gillnet fishery

Monthly gillnet catch rates (expressed in t/slip) were calculated using the information on all purchase slips available in 1983 (Table 7). Similar data were available for the period 1978-1982 (Moore *et al.*, 1982; Tremblay *et al.*, 1983). In an attempt to find catch rate indices representative of each spawning component, the gillnet catch composition by month and area fished was examined (Table 8). As a result, two catch rate indices were selected: one for areas K + L in April and May for the spring spawners, and the other for area N in August for fall spawners. Mean catch per landing, weighted on corresponding gillnet catches for areas K and L, were calculated (Table 9). This index is however biased because it does not take into account the number of nets fished per trip. In an attempt to minimize the bias, the catch rates were adjusted for gang size. The number of nets per gang size for 1978-1981 were based on surveys carried out on the Newfoundland east coast. No survey was done in 1982 and 1983, so gang size was assumed to be constant for those two years. These catch rates were used to fine tune cohort analyses on the two spawning stocks.

Abundance indices for the spring fishery (spring spawners according to the 1982-1983 sampling data) in areas K and L dropped suddenly in 1981, a year earlier than the purse seiner catch rate and have remained almost stable since then (Figure 10). In the area N fall fishery the catch rates have followed a continuous decline between 1977 and 1981, which is similar to what was found for the purse seine catch rates and confirm the decrease in available abundance of fall spawners.

### Purse seine fishery

Log-books of catch and effort data for the purse seiner fleet have been analysed for trends in abundance. Historical catch and effort data were most consistently available for the months of April and May in areas K and L for the spring fishing season and for the months of November and December in areas M and N for the fall fishing season. Consequently, catch rates, weighted on corresponding purse seiner catch, were calculated for those selected months and areas (Table 6).

Historical trends in c/set and c/night are very similar (Table 6, Figure 9). Since 1980 the spring catch rates are in general much higher than the fall catch rates; the weighted average c/set and c/night between 1980-1983 are respectively 2.5 and 2 times higher in the spring fishery than in the fall fishery. In the spring fishery catch rates were more or less stable between 1975 and 1980, and have fluctuated since then. In the fall fishery, catch rates dropped steadily between 1978-1981, increased sharply in 1982 and went down again in 1983. If we assume that the spring fishery catch is mainly comprised of spring spawners and the fall fishery catch is of both spring and fall spawners, the drop in catch rate noted in the fall fishery between 1978 and 1981 could indicate a decrease in the fall spawner biomass.

The validity of seiners catch rates as representative of the fish population abundance has often been discussed (Powles, 1981; Pope, 1978; Ulltang, 1978; Cleary, 1982). Besides, log-book coverage was rather limited in 1982 and 1983. Consequently the data were not used to fine tune cohort analyses, but are presented here as additional information on trends in abundance.

### Bottom trawl survey

Data from the January survey are available only for 1983 and 1984. The catch rate has dropped from 1.28 herring/tow in 1983 to 0.89 herring/tow in 1984.

This trawl survey is designed to obtain basic data on groundfish stocks. Any catch of herring is incidental and catch rates should be accepted with caution.

### AGE COMPOSITION OF THE COMMERCIAL CATCH

Catch at age data from 1966 to 1981 were taken from Tremblay *et al.* (1983). The 1982 catches at age were updated with the final 1982 landings statistics (Tremblay, pers. comm).

### Spring spawner catch

From 1966 to 1983 spring spawners (SS) have generally dominated the catch (Table 10). The average proportion of SS in the catch before 1979 was of 63% compared to 77% after 1979. The 1968 year-class is the largest ever observed in the spring spawner catch and completely dominated the catch from 1970 to 1978. Since then, only the 1974 year-class has significantly contributed to the spring spawner fishery (from 1979 to 1982) (Table 11). In 1983 about 40% of the catch consisted of the 1979 and 1980 year-classes. Consequently, the mean age of spring spawners in the catch dropped to 7 years old in 1983 (which is the lowest average seen since 1975). The proportion of fish younger than 4 years old has increased from a mean of 1.4% between 1978 and 1982 to 18% in 1983.

### Fall spawner catch

Herring of ages 11<sup>+</sup> have always dominated the fall spawner catch since 1966. The 1973 year-class contributed more than 15% to the annual catch between 1979 and 1982. The 1978 year-class was 17% and 13% of the 1982 and 1983 catches respectively, while the 1979 year-class provided 24% of the 1983 catch. The mean age of fall spawners in the catch has therefore decreased in recent years, from 10 years old in 1976 to 7 years old in 1983. The proportion of fish younger than 4 years old is negligible, being less than 1%.

### LENGTH FREQUENCIES OF THE COMMERCIAL AND RESEARCH CATCHES

In 1982 and 1983 commercial purse seine catches from the fall fishery were sampled by observers on board the vessels. Length frequencies of herring landed as well as discarded are shown in figure 11. In both years the dominant lengths of landed fish were between 340 and 380 cm, the smallest length group being 220-240 cm. The length distributions of the discarded catch were bimodal with peaks at 80-100 cm and 260-280 cm in 1982 and at 140-160 and 260-280 cm in 1983. From these data it seems evident that purse seiners discarded most of the herring less than 320 cm.

Length frequencies of herring caught during the bottom trawl survey in 1983 also demonstrate that fish smaller than 220 cm were available. The modes observed correspond very closely to those found in the landed catch (360-380 cm) and in the discarded catch (260-280 cm) from the commercial purse seine fishery.

The comparison of the commercial and research length frequency data shows very clearly that the purse seine fishery is very selective related to the size of the fish landed. In other words, fish smaller than around 320 cm, although not abundant in the commercial purse seine samples collected at the wharf or fish plant, are nonetheless available to the fishery.



NATURAL MORTALITY RATE

An estimate of 0.2 for the instantaneous natural mortality rate (M) was assumed for the present analysis. This value was used in the 1982 assessment (Tremblay et al., 1983) and is consistent with that for other herring stocks (Lea, 1930; Runnstrom, 1936; Beverton, 1963). The possibility of fluctuations with time in the natural mortality rate cannot be excluded, but since no accurate calculations of such a change could be done, M was assumed constant.

PARTIAL RECRUITMENT

Partial recruitment vectors for the 1983 assessment were estimated with two sets of data: 1) the age composition of the 1983 catch compared with the age composition of the catch as projected from the 1982 assessment analysis (Tremblay et al., 1983) 2) the age composition of the catch from a gillnet survey conducted in 1983 on the west coast of Newfoundland.

Partial recruitment values used in the 1982 assessment to project future catches were calculated from mean historical F's (Tremblay et al., 1983). These values were:

	Ages	2	3	4	5	6	7	8+
pr	SS	.02	.30	.42	.58	.63	.77	1.00
	FS	.001	.05	.17	.39	.65	1.00	1.00

The results of the projections for 1983 were compared with the actual 1983 age composition of the catch (Figure 12). From this comparison it is obvious that the catch of spring spawners of ages 3 and 4 were underestimated while the catch of fish of ages 9 and 11+ were overestimated. In the fall spawner catch, herring of age 4 were also underestimated but fish of age 5 were overestimated. All other catches were predicted rather accurately. Consequently the partial recruitment values to be adjusted are for ages 3, 4, 9 and 11+ for spring spawners, and ages 4 and 5 for fall spawners.

The results of the experimental gillnet survey were also used to refine the partial recruitment estimates. The age composition of the spring and fall spawner 1983 catches was divided by the age composition of the fish caught during the survey (assuming that the latter represents the population available to the fishery). The results are as follows:

	Ages	2	3	4	5	6+
pr	SS	.02	.24	1	1	1
	FS	--	.13	.45	.52	1

The two sets of data agree in showing that spring and fall spawners of age 4 recruit at a rate higher than what was used in the 1982 assessment.

Based on this information a new vector of partial recruitment was created and used in the trial runs of cohort analysis:

	Ages	2	3	4	5	6+
pr	SS	.02	.35	.50	.58	1
	FS	.001	.05	.29	.40	1

#### WEIGHTS AT AGE

Mean weights at age for 1983 were calculated as the straight averages of weights for the 1st and 2nd quarter of the year (Table 12), as was done for previous years (Tremblay et al. 1983). The historical data were not available for the calculation of weighted averages.

#### COHORT ANALYSES

Cohort analyses were run separately for spring and fall spawners. Average F's for ages 7+ (weighted on population numbers) were input as last age F for each run.

Terminal F's, 0.15 and 0.3 for spring and fall spawners respectively were selected by choosing the analyses which showed the best relationship between fishable biomass and gillnet catch rates (Table 13 and 14, Figures 13 and 14). Recruitment at age 2 was estimated to be the geometric mean of the observed recruitment from 1966 to 1979.

According to the present analysis, the spring spawner population numbers reached a historical low of  $.25 \times 10^9$  fish in 1983 after a decline from  $1.3 \times 10^9$  fish in 1971 (Table 15). This decline in abundance was observed although fishing mortality rates for both 5+ and 7+ have been kept below  $F_{0.1}$ . However, since the appearance in the fishery of the 1974 year-class, recruitment at age 2 has been well below the historical average (1966-1976:  $164,054 \times 10^3$  fish VS 1977-1982:  $31,619 \times 10^3$  fish).

The results of the cohort analysis run for fall spawners indicate a twelve fold decrease in total population numbers between 1966 and 1983 (Table 16). Fishing mortality rates were below  $F_{0.1}$  until 1983, when it reached the highest observed value of  $F = 0.3$ . Recruitment at age 2, generally lower for fall spawners than for spring spawners, has also been weaker in recent years (1966-1976:  $27,956 \times 10^3$  fish VS 1977-1982:  $15,030 \times 10^3$  fish).

## CATCH PROJECTIONS AND BIOMASS ESTIMATES

Projections for future catches and population estimates were calculated assuming that the 1984 TAC will be taken, and that proportion of spring and fall spawners will be similar to what was observed in the 1983 catch. Weights at age were the 1983 weights for the first half of the year adjusted for the annual growth. For projection purposes, the 1979 to 1981 year-classes were set at the geometric mean level of recruitment between 1966-1979. All projections were calculated with a full recruitment  $F = 0.3$ . Biomass estimates (numbers at age from cohort analysis times the weights at age) from 1966 to 1985 are presented to show any abundance trends over time.

### Spring spawners

Assuming a terminal  $F = 0.15$  in 1983, fishing the spring spawner population at  $F = 0.192$  in 1984 and  $F_{0.1} = 0.3$  in 1985 will yield 9,000 t in 1985 with a slight decrease in population biomass from 53,000 t in 1984 to 50,000 t in 1985 (Table 17). The total biomass, estimated to be 234,000 t in 1972, will continue to decline (Table 18) and the mature biomass in 1985 will be 19% of the highest historical value observed (162,400 t in 1974).

### Fall spawners

The fall spawner population fished at  $F = 0.3$  in 1983  $F = 0.55$  in 1984 and  $F_{0.1} = 0.3$  in 1985 will result in a catch of less than 2,000 t in 1985 (Table 19), with a decrease in total biomass from 14,000 t in 1984 to 12,000 t in 1985. After a continuous decline since 1966 the total and mature biomass are expected to stabilize if fishing is maintained at this rate (Table 20). Mature biomass in 1985 (6,200 t) is estimated to be 3% of the maximum observed since 1966.

CONCLUSION

The status of the Newfoundland west coast herring stock is difficult to assess. Some basic information on abundance indices and partial recruitment is lacking; however, some overall trends are apparent. First, although there are some small fish available to the fishery, no recent year-class has been strong enough to contribute substantially to the fishery over many consecutive years. Recruitment at age 2 since 1976, has been much lower than the historical recruitment. Moreover, the "abundance" of small fish observed in St. George's Bay for the past few years is not a guarantee of improved recruitment in the near future. Second, the mature biomass for both spring and fall spawners has dropped considerably over the last 10 years, even though fishing mortality rates were kept below  $F_{0.1}$ .

From the present review, it is evident that the west coast of Newfoundland herring stocks are reaching low levels of abundance. Therefore, until recruitment improves, caution should be taken when fishing these stocks.

REFERENCES

- Beverton, R.J.H. 1963. Maturation, growth and mortality of clupeid and engraulid stocks in relation to fishing. Rapp. P.-V. Réun. Cons. int. Explor. Mer 154: 270-278.
- Cleary, Lynn. 1982. Assessment of the 4T herring stock. CAFSAC Res. Doc. 82/47.
- Lea, E. 1930. Report on age and growth of the herring in Canadian waters. Rapp. Cons. Explor. Mer 65: 100.
- Moore, J.A. and G.H. Winters. 1978. The Newfoundland west coast herring stocks. CAFSAC Res. Doc. 78/2.
- Moore, J.A. and G.H. Winters. 1980. An assessment of the status of the Newfoundland west coast herring stock. CAFSAC Res. Doc. 80/51.
- Moore, J.A., G.H. Winters and M.F. Dawson. 1982. An examination of the status of the west coast herring stock with a re-evaluation of the historical data base. CAFSAC Res. Doc. 82/49.
- Pope, J.G. 1978. Some consequences for fisheries management of aspects of the behaviour of pelagic fish. ICES Symp. Biol. Basis Pel. Fish. Stock Management, Pap. 12: 1-27.
- Powles, H. 1981. What does purse seine catch per unit of effort measure? A simple fishery model. CAFSAC Res. Doc. 81/36.
- Runnstrom, S. 1936. A study of the life history and migrations on the Norwegian spring herring based on an analysis of the winter rings and summer zones on the scale. Fiskeridir Skr. Havund ersok 5(2): 1-103.
- Tremblay, D., H. Powles and J.A. Moore. 1983. Status of the 4R herring stock in 1982. CAFSAC Res. Doc. 83/33.
- Ulltang, O. 1978. Catch per unit of effort in the Norwegian purse seine fishery for Atlanto-Scandian (Norwegian spring spawning) herring. FAO Fish. Tech. Pap. 155: 91-101.

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Table 1. Total herring catches (t) from NAFO division 4R by fishing area, 1966-1983.

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Year	Areas				Total catch	TAC
	K	L	M	N		
1966	216	103	5529	18	5866	
1967	216	66	5540	13	5835	
1968	156	59	3978	11	4204	
1969	277	46	2549	40	2912	
1970	79	27	3473	301	3880	
1971	3830	2424	1076	1963	9293	
1972	4921	862	1544	3628	10955	
1973	12537	2862	2067	9222	26688	
1974	2611	856	942	2842	7251	
1975	3613	113	242	1027	4995	
1976	6565	2067	226	1251	10109	
1977	5569	2203	156	4358	12286	12000
1978	6808	1984	365	6453	15610	12500
1979	6032	5043	3996	3250	18321	12500
1980	5097	6943	2967	4113	19120	18000
1981	3638	4900	3088	1967	13593	16000
1982	2399	4345	2464	1676	10884	10000
1983	1411	3155	2226	1934	8726	10000

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Table 2. Total herring catches (t) from NAFO division 4R by fishing area and gear type, 1966-1983

Year	K		L		M		N		Combined		Total
	Purse seine	Other <sup>1</sup>	Purse seine	Other	Purse seine	Other	Purse seine	Other	Purse seine	Other	
1966		216		103	5490	39		18	5490	376	5866
1967		216		66	5464	76		13	5464	371	5835
1968		156		59	3776	202		11	3776	428	4204
1969	241	36		46	2344	205		40	2585	327	2912
1970	28	51	12	15	2939	534		301	2979	901	3880
1971	3287	543	2239	185	725	351	356	1607	6607	2686	9293
1972	4743	178	727	135	1330	214	--	3628	6800	4155	10955
1973	12112	425	2740	122	1763	304	3453	5769	20068	6620	26688
1974	2453	158	756	100	439	503	1071	1771	4719	2532	7251
1975	3495	118	--	113	--	242	--	1027	3495	1500	4995
1976	6067	498	1956	112	--	226	184	1067	8206	1903	10109
1977	5289	280	2008	195	--	156	2167	2191	9464	2822	12286
1978	6252	556	1037	947	--	365	2636	3817	9925	5685	15610
1979	4387	1645	2773	2270	2829	1167	--	3250	9989	8332	18321
1980	3480	1617	3702	3241	2001	966	427	3686	9610	9510	19120
1981	2269	1369	3277	1623	2037	1051	342	1625	7925	5668	13593
1982	934	1465	2762	1583	1888	576	0	1676	5584	5300	10884
1983	0	1411	2240	915	1906	320	465	1469	4611	4115	8726

<sup>1</sup> Includes shrimp trawl, bar seine, gillnet and trap.



Table 3. A comparison of catch (t) and quotas for NAFO division 4R herring stocks in 1982 and 1983 (allocations in brackets\*).

1982				
Fishing area		Purse seine	Other	Total
St-George's Bay	(K)	934 (2200)	1465 (1000)	2399 (3200)
Port-au-Port	(L)	2762 (1650)	1493 (1500)	4255 (3150)
Cape St.Gregory North(M + N)		1888 (1650)	2136 (2000)	4024 (3650)
Total		5584 (5500)	5094 (4500)	10678 (10000)

1983				
Fishing area		Purse seine	Other	Total
St-George's Bay	(K)	0 (1925)	1411	1411
Port-au-Port	(L)	2240 (1925)	915	3155
			(2250)	(6100)
Cape St.Gregory North(M + N)		2372 (1650)	1789 (2250)	4161 (3900)
Total		4612 (5500)	4115 (4500)	8727 (10000)

\* Allocations are officially established for "mobile" and "fixed" gears.

Table 4. Herring catches (t) from NAFO division 4R by month, gear type and fishing area in 1982 and 1983.

		K			L			M			N		
YEAR	MONTH	PURSE SEINE	GILLNET	OTHER GEAR	PURSE SEINE	GILLNET	OTHER GEAR	PURSE SEINE	GILLNET	OTHER GEAR	PURSE SEINE	GILLNET	OTHER GEAR
82	J	-	-	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	-	-	-	-	-	-	-	-
	M	-	-	-	-	-	-	-	-	-	-	-	-
	A	-	12	-	1 364	38	-	-	-	10	-	-	1
	M	8	1 319	3	1 291	1 135	1	-	44	1	-	2	-
	J	-	44	-	107	133	-	-	29	9	-	28	-
	J	-	33	-	-	3	-	-	55	9	-	532	-
	A	-	15	-	-	5	-	-	12	1	-	350	-
	S	-	20	-	-	29	-	-	49	-	-	51	-
	O	323	20	-	-	29	-	-	49	-	-	51	-
	N	603	16	-	-	227	10	1 455	249	28	-	621	-
	D	-	3	-	-	2	-	433	80	-	-	83	-
		-	-	-	-	-	-	-	-	-	8	-	
TOTAL		934	1 462	3	2 762	1 572	11	1 888	518	58	-	1 675	1
83	J	-	1	-	-	2	-	-	-	-	-	-	-
	F	-	2	-	-	1	-	-	-	1	-	-	-
	M	-	15	-	-	5	-	-	-	54	-	-	4
	A	-	887	1	1 585	393	46	-	29	52	-	9	3
	M	-	429	1	590	358	-	-	48	-	-	5	-
	J	-	29	-	65	44	-	-	9	1	-	43	-
	J	-	25	-	-	36	-	-	23	-	-	233	10
	A	-	12	-	-	26	-	-	6	-	-	540	3
	S	-	3	-	-	-	-	-	6	-	-	233	-
	O	-	5	-	-	1	-	284	23	-	-	74	-
	N	-	-	-	-	2	-	1 338	29	-	357	159	16
	D	-	1	-	-	1	-	284	39	-	108	137	-
TOTAL		-	1 409	2	2 240	869	46	1 906	212	108	465	1 433	36

Table 5. Proportion (%) of spring and fall spawner herring in the commercial samples per fishing area and gear type in 1982 and 1983.

Area	Gear	1982			1983		
		Spring	Fall	(n)*	Spring	Fall	(n)
K	GN	--	--	--	61	39	(56)
	PS	99	1	(204)	--	--	--
L	GN	100	--	(144)	--	--	--
	PS	89	11	(373)	59	41	(1313)
M	GN	52	48	(151)	42	58	(274)
	PS	77	23	(524)	47	53	(975)
N	GN	3	97	(147)	29	71	(981)
	PS	--	--	--	50	50	(276)

\* Sample size

Table 6. Purse seine catch rates for the spring fishery in areas K and L and for the fall fishery in areas M and N, 1969-1983. (Sample size in parentheses).

K-L

	CATCH/ SET	CATCH/ SUCCESSFUL SET	CATCH/ NIGHT	CATCH/ SUCCESSFUL NIGHT
1969	-	-	-	-
70	-	-	-	-
71	11.88 ( 8 )	22.50 ( 6 )	15.00 ( 9 )	33.75 ( 4 )
72	32.52 ( 79 )	33.99 ( 74 )	53.33 ( 37 )	59.95 ( 32 )
73	50.41 ( 59 )	51.40 ( 58 )	131.26 ( 24 )	137.27 ( 23 )
74	32.02 ( 39 )	34.19 ( 36 )	34.36 ( 36 )	51.17 ( 24 )
75	79.66 ( 19 )	79.66 ( 19 )	91.77 ( 17 )	119.34 ( 13 )
76	100.26 ( 77 )	105.09 ( 69 )	98.36 ( 68 )	165.73 ( 38 )
77	67.63 ( 79 )	71.16 ( 76 )	105.82 ( 59 )	113.68 ( 53 )
78	47.17 ( 109 )	48.51 ( 106 )	86.31 ( 61 )	99.35 ( 53 )
79	72.56 ( 69 )	90.10 ( 53 )	85.90 ( 57 )	100.65 ( 49 )
80	102.63 ( 44 )	121.76 ( 37 )	98.41 ( 44 )	151.69 ( 28 )
81	198.20 ( 79 )	231.70 ( 51 )	185.00 ( 71 )	264.53 ( 41 )
82	17.68 ( 17 )	60.75 ( 9 )	36.05 ( 8 )	64.84 ( 6 )
83	103.33 ( 6 )	103.33 ( 6 )	124.00 ( 5 )	124.00 ( 5 )

APRIL - MAY

M-N

	CATCH/ SET	CATCH/ SUCCESSFUL SET	CATCH/ NIGHT	CATCH/ SUCCESSFUL NIGHT
	88.25 ( 4 )	117.67 ( 3 )	117.67 ( 5 )	96.60 ( 5 )
	24.11 ( 17 )	31.01 ( 15 )	53.48 ( 24 )	108.10 ( 16 )
	-	-	30.00 ( 11 )	165.00 ( 2 )
	-	-	-	-
	131.05 ( 22 )	149.46 ( 20 )	128.21 ( 26 )	176.88 ( 18 )
	500.00 ( 1 )	500.00 ( 1 )	2500 ( 2 )	500.00 ( 1 )
	-	-	-	-
	38.33 ( 6 )	57.50 ( 4 )	32.86 ( 7 )	57.50 ( 4 )
	-	-	35.00 ( 3 )	35.00 ( 3 )
	135.00 ( 7 )	135.00 ( 7 )	137.64 ( 11 )	150.80 ( 10 )
	76.81 ( 26 )	95.20 ( 20 )	100.49 ( 20 )	120.02 ( 16 )
	75.90 ( 34 )	80.05 ( 32 )	72.48 ( 36 )	126.27 ( 20 )
	13.82 ( 6 )	20.04 ( 4 )	8.75 ( 4 )	27.64 ( 3 )
	86.07 ( 14 )	135.00 ( 2 )	109.55 ( 11 )	133.89 ( 9 )
	38.08 ( 38 )	68.87 ( 24 )	56.14 ( 27 )	104.84 ( 16 )

NOVEMBER - DECEMBER

Table 7. Monthly gillnet catch rates (t/landing), unadjusted for changes in gang size per fishing area in 1983. (Catches in parentheses).

Area	April	May	June	July	August	September	October	November	December
K	1.05 (507)	1.28 (210)	--	1.29 (1)	--	--	--	--	--
L	0.64 (475)	0.51 (249)	0.42 (11)	1.65 (13)	2.11 (13)	--	--	--	--
M	0.57 (21)	0.67 (53)	0.17 (8)	0.38 (34)	0.07 (2)	--	0.38 (23)	0.97 (25)	1.13 (13)
N	--	0.66 (6)	0.44 (81)	0.45 (508)	0.76 (670)	0.46 (444)	0.33 (177)	0.78 (195)	1.91 (28)

Table 8. Fixed gillnet catch composition and monthly catches\* (t) for April and May, 1982-1983, in fishing areas K and L, and for July to November, 1977-1983, in fishing area N.

AREA	YEAR	MONTH	% SPAWNING TYPE		CATCH
			FS	SS	
K	1982	April	—	—	12
		May	0	100	1 319
	1983	April	—	—	887
		May	39	61	429
L	1982	April	0	100	38
		May	0	100	1 135
	1983	April	—	—	394
		May	—	—	358
N	1977	July	67	33	377
		August	98	2	800
		September	72	28	226
		October	43	57	369
		November	21	79	546
	1978	July	66	34	839
		August	(96)	(4)**	1 278
		September	(62)	(38)**	670
		October	(38)	(62)**	727
		November	21	79	482
	1979	July	60	40	783
		August	89	11	1 010
		September	61	39	307
		October	47	53	270
		November	(26)	(74)**	533
1980	July	67	33	846	
	August	100	0	1 692	
	September	54	46	525	
	October	24	76	129	
	November	37	63	244	
1981	July	—	—	209	
	August	—	—	648	
	September	—	—	227	
	October	—	—	203	
	November	—	—	169	
1982	July	97	3	532	
	August	—	—	350	
	September	—	—	51	
	October	—	—	622	
	November	—	—	83	
1983	July	70	30	233	
	August	98	2	540	
	September	68	32	233	
	October	69	31	74	
	November	60	40	158	

\* Data for 1977-80 is from table 7 of Moores et al. (1981). CAFSAC Res. Doc. 81/9. Adjustments were made to 1977, 1978 and 1980 data.

\*\* Average monthly percent.

Table 9. Fixed gillnet catches (t), catch rates (t/landing) and gang size used to calculate abundance indices of spring and fall spawner herring.

YEAR	K				L				K + L*		N		STANDARDIZED GANG SIZE
	April		May		April		May		April + May		August		
	C	C/E	C	C/E	C	C/E	C	C/E	C	C/E	C	C/E	
1977											800	.77	1.00
1978	41	.25	437	.66	199	1.35	491	1.15	1 168	.97	1 278	.66	1.10
1979	619	.51	838	.70	943	1.32	1 117	1.18	3 517	.99	1 010	.69	1.27
1980	616	.25	853	.77	1 445	1.41	1 652	1.41	4 566	1.13	1 692	.64	1.45
1981	481	.66	817	1.10	889	.75	601	.92	2 788	.87	648	.56	1.45
1982	12	.09	1 319	1.05	38	.54	1 135	.66	2 504	.86	350	.58	1.45
1983	887	1.05	429	1.28	394	.64	358	.51	2 068	.93	540	.76	1.45

\* Average weighted by catches.

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
SS 1	0	0	0	0	0	0	372	0	0	0	0	29	0	0	4	0	0	4
2	189	1	103	240	3 011	0	375	4 384	137	96	511	11	0	143	320	51	0	23
3	390	8	296	1 093	1 458	3 238	254	910	235	738	997	664	40	30	992	317	433	2 764
4	298	337	336	1 910	438	271	7 843	1 177	108	345	982	533	2 097	176	85	1 832	510	3 388
5	586	70	583	965	660	544	1 341	30 697	294	190	229	516	210	10 967	327	97	1 960	1 297
6	2 052	296	206	314	261	572	1 577	2 820	10 512	1 283	319	287	749	575	14 894	318	420	647
7	4 127	3 545	616	173	201	453	1 879	3 139	254	8 261	2 745	346	287	1 039	412	8 773	1 811	215
8	2 158	3 039	1 304	439	234	1 194	1 113	3 018	857	237	15 428	4 160	2 266	456	1 304	250	5 000	810
9	1 670	1 429	2 282	975	1 015	98	1 099	1 796	689	360	764	16 333	8 617	2 710	258	593	957	1 306
10	303	860	508	372	1 012	908	476	1 502	195	140	2 851	926	15 951	7 042	991	215	574	736
11+	505	969	433	446	1 755	1 062	4 400	6 271	2 143	671	3 134	5 547	4 380	14 466	21 735	15 134	9 112	4 551
Total	12 278	10 554	6 667	6 927	10 045	8 340	20 729	55 714	15 424	12 321	27 960	29 352	34 597	37 604	41 322	27 580	20 777	15 741
FS 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	104	0	0	17	0	31	29	0	0	0	0	0	0	0	16	0	0	7
3	181	28	226	300	890	0	102	810	16	96	59	3	15	19	215	28	43	58
4	639	51	131	642	176	81	113	769	269	174	47	61	53	70	83	337	954	2 133
5	277	529	201	355	142	368	403	1 102	388	1 110	102	113	452	288	143	158	562	1 132
6	274	306	1 037	692	250	590	755	2 596	284	327	338	302	311	2 542	253	82	337	961
7	277	116	294	519	493	2 144	1 218	2 028	288	78	470	746	1 130	626	1 542	191	121	447
8	1 007	322	223	158	173	3 562	1 275	2 525	222	112	108	388	1 841	1 396	224	717	316	185
9	1 105	927	288	122	128	1 899	2 097	5 196	293	67	158	214	589	2 038	691	120	879	408
10	926	1 128	1 208	164	228	1 273	1 254	8 047	336	63	52	99	379	552	282	98	260	724
11+	2 781	3 155	2 568	1 411	2 171	14 105	9 513	17 386	4 202	2 229	3 969	7 213	5 681	6 824	5 027	2 716	2 168	2 901
Total	7 571	6 562	6 176	4 380	4 651	24 053	16 759	40 459	6 298	4 256	5 303	9 139	10 451	14 355	8 476	4 447	5 640	8 956
Total FS + SS	19 849	17 116	12 843	11 307	14 696	32 393	37 488	96 173	21 722	16 577	33 263	38 491	45 048	51 959	49 798	32 027	26 417	24 697
% SS	61.9	61.7	51.9	61.3	68.3	25.8	55.3	57.9	71.0	74.3	84.1	76.3	76.8	72.4	83.0	86.1	78.7	63.7
% FS	38.1	38.1	48.1	38.7	31.7	74.2	44.7	42.1	29.0	25.7	15.9	23.7	23.2	27.6	17.0	14.9	21.3	36.3

Table 10. Catches at age ( $\times 10^{-3}$ ) and proportion of spring and fall spawners in NAFO division 4R herring landings, 1966-1983. (SS = spring spawners; FS = fall spawners).



Table 11. Age compositions (%) and mean ages\* of spring and fall spawners in NAFO division 4R herring landings, 1966-1983. (SS = spring spawners; FS = fall spawners)

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
SS 1	0.00	0.00	0.00	0.00	0.00	0.00	1.79	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.01	0.00	0.00	0.02
2	1.54	0.01	1.54	3.46	<u>29.98</u>	0.00	1.81	7.87	0.89	0.78	1.83	0.04	0.00	0.38	0.77	0.18	0.00	0.14
3	3.18	0.08	4.44	15.78	14.51	<u>38.82</u>	1.23	1.63	1.52	5.99	3.57	2.26	0.12	0.08	2.40	1.15	2.08	17.56
4	2.43	3.19	5.04	27.57	4.36	3.25	<u>37.84</u>	2.11	0.70	2.80	3.51	1.82	6.06	0.47	0.21	6.64	2.45	21.93
5	4.77	0.66	8.74	13.93	6.57	6.52	6.47	<u>55.10</u>	1.91	1.54	0.82	1.76	0.61	<u>29.16</u>	0.79	0.35	9.43	8.24
6	16.71	2.80	3.09	4.53	2.60	6.86	7.61	5.06	<u>68.15</u>	10.41	1.14	0.98	2.16	1.53	<u>36.04</u>	1.15	2.02	4.11
7	33.61	33.59	9.24	2.50	2.00	5.43	9.06	5.63	1.65	<u>67.05</u>	9.82	1.18	0.83	2.76	1.00	<u>31.81</u>	8.72	1.37
8	17.58	28.79	19.56	6.34	2.33	14.32	5.37	5.42	5.56	1.92	<u>55.18</u>	14.17	6.55	1.21	3.16	0.91	<u>24.07</u>	5.15
9	13.60	13.54	34.23	14.08	10.10	1.18	5.30	3.22	4.47	2.92	2.73	<u>55.65</u>	24.91	7.21	0.62	2.15	4.61	8.30
10	2.47	8.15	7.62	5.37	10.07	10.89	2.30	2.70	1.26	1.14	10.20	3.15	<u>46.11</u>	18.73	2.40	0.78	2.76	4.67
11+	4.11	9.18	6.49	6.44	17.47	12.73	21.23	11.26	13.89	5.45	11.21	18.90	12.66	<u>38.47</u>	52.60	54.87	43.86	28.91
< 4	4.72	0.09	5.98	19.24	44.49	38.82	4.83	9.50	2.41	6.77	5.40	2.40	0.12	0.46	3.18	1.33	2.08	17.72
mean age	7.1	8.0	7.9	5.8	5.9	6.2	6.5	6.0	6.9	6.8	8.0	8.9	9.2	8.6	8.7	9.0	8.8	7.0
FS 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	1.37	0.00	0.00	0.39	0.00	0.13	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.08
3	2.39	0.43	3.66	6.85	19.14	0.00	0.61	2.00	0.25	2.26	1.11	0.03	0.14	0.13	2.54	0.63	0.76	0.64
4	8.44	0.78	2.12	14.66	3.78	0.34	0.67	1.90	4.27	4.09	0.89	0.67	0.51	0.49	0.98	7.58	<u>16.91</u>	<u>23.82</u>
5	3.66	8.06	3.25	8.11	3.05	1.53	2.40	2.72	6.16	26.08	1.92	1.24	4.32	2.01	1.69	3.55	9.96	<u>12.64</u>
6	3.62	4.66	16.79	15.80	5.38	2.45	4.51	6.42	4.51	7.68	6.37	3.30	2.98	<u>17.71</u>	2.98	1.84	5.98	10.73
7	3.66	1.77	4.76	11.85	10.60	8.91	7.27	5.01	4.57	1.82	8.86	8.16	10.81	4.36	<u>18.19</u>	4.30	2.15	4.99
8	13.30	4.91	3.61	3.61	3.72	14.81	7.61	6.24	3.52	2.63	2.04	4.25	17.62	9.72	2.64	<u>16.12</u>	5.60	2.07
9	14.60	14.13	4.66	2.79	2.75	7.90	12.51	12.84	4.65	1.57	2.98	2.34	5.64	14.20	8.15	2.70	<u>15.59</u>	4.55
10	12.23	17.19	19.56	3.74	4.90	5.29	7.48	19.89	5.34	1.48	0.98	1.08	3.63	3.85	3.33	2.20	4.61	8.08
11+	36.73	48.08	41.58	32.21	46.68	58.64	56.76	42.97	66.72	52.37	74.84	78.93	54.36	47.54	59.31	61.07	38.44	32.40
< 4	3.76	0.43	3.66	7.24	19.14	0.13	0.78	2.00	0.25	2.26	1.11	0.03	0.14	0.13	2.73	0.63	0.76	0.72
mean age	8.7	9.5	8.9	7.4	8.1	9.7	9.7	9.4	9.7	8.4	9.9	10.2	9.4	9.2	9.5	9.4	8.2	7.5

\*Assuming ages 11+ to be 11.

Table 12. Average weights (g) at age (first half of the year) for spring and fall spawner herring in NAFO division 4R.

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
SPRING SPAWNERS																		
2	76	76	76	76	76	-	76	88	76	72	71	64	-	87	98	72	-	-
3	150	150	150	150	150	150	196	157	150	149	135	122	167	125	158	176	155	131
4	196	196	196	196	196	196	203	194	196	196	177	194	172	234	221	234	248	228
5	225	225	225	225	225	215	210	204	225	233	227	219	247	241	261	308	270	276
6	257	257	257	257	257	250	275	250	240	237	238	250	279	287	291	329	337	281
7	278	278	278	278	278	278	277	309	299	270	259	252	289	319	341	367	358	370
8	296	296	296	296	296	296	279	324	313	300	290	267	292	334	351	394	365	445
9	322	322	322	322	322	322	317	351	318	334	310	289	314	340	367	416	393	441
10	333	333	333	333	333	334	346	370	333	339	319	297	328	357	375	412	406	484
11+	363	363	363	363	363	370	363	389	371	392	380	338	344	389	409	463	432	498
FALL SPAWNERS																		
2	50	50	50	50	50	50	50	-	-	-	-	-	-	-	50	-	-	-
3	120	120	120	120	120	-	120	161	120	114	91	120	120	114	122	126	154	-
4	174	174	174	174	174	174	174	181	215	164	156	163	174	165	224	212	223	175
5	226	226	226	226	226	226	226	254	225	221	190	224	228	239	229	257	301	224
6	253	253	253	253	253	272	238	293	235	248	240	231	252	270	287	288	326	300
7	284	284	284	284	284	308	239	306	284	273	255	258	315	321	321	368	389	318
8	307	307	307	307	307	328	275	315	307	278	307	277	319	348	357	400	424	369
9	319	319	319	319	319	362	280	324	319	305	319	319	323	361	380	436	443	405
10	337	337	337	337	337	378	287	349	376	372	337	337	337	370	381	486	501	450
11+	405	405	405	405	405	448	376	362	415	432	393	382	418	415	497	524	530	495

Table 13. Correlation coefficients and intercept values for the relationships between the January spring spawner fishable biomass VS spring gillnet rates catch rates for areas K + L in April and May, adjusted for gang size at different terminal F's in 1983.

Fishable biomass VS CPUE	TERMINAL F's			
	0.05	0.10	0.15	0.20
r	.819	.899	.908	.909
bo	63 776	1 933	-18 655	-28 937
Less 1983 point				
r	.808	.890	.913	.923
bo	62 045	9 143	-8 468	-17 262

Table 14. Correlation coefficients and intercept values for the relationships between fall spawner mean fishable biomass VS fall gillnet catch rates for area N in August, adjusted for gang size at different terminal F's in 1983.

Fishable biomass VS CPUE	TERMINAL F's		
	0.10	0.20	0.30
r	.835	.859	.864
bo	16 759	1 826	-3 151
Less 1983 point			
r	.937	.967	.973
bo	19 476	4 372	-661





Table 17. Catch and population estimates for spring spawner herring in NAFO division 4R, 1983-1985, assuming a fishing mortality rate  $F = 0.3$  in 1985

Age	POPULATION						FISHING MORTALITY		
	Numbers $\times 10^{-3}$			Biomass (t)			1983	1984	1985
	1983	1984	1985	1983	1984	1985			
2	55 364	55 364	55 364	4 153.43	4 153.43	4 153.43	0.000	0.001	0.001
3	45 594	45 530	45 302	6 223.41	6 214.60	6 183.48	0.069	0.089	0.138
4	36 862	34 835	34 117	8 757.18	8 275.67	8 105.03	0.107	0.137	0.213
5	17 150	27 125	24 877	4 931.85	7 800.62	7 154.04	0.087	0.111	0.174
6	5 112	12 871	19 866	1 496.77	3 768.47	5 816.65	0.150	0.192	0.300
7	1 699	3 602	8 696	654.91	1 388.82	3 352.45	0.150	0.192	0.300
8	6 400	1 197	2 434	2 967.49	555.06	1 128.51	0.150	0.192	0.300
9	10 319	4 510	809	4 741.61	2 072.36	371.64	0.150	0.192	0.300
10	5 815	7 272	3 047	2 932.70	3 667.16	1 536.64	0.150	0.192	0.300
11	2 133	4 098	4 913	1 106.97	2 126.42	2 549.27	0.150	0.192	0.300
12	474	1 503	2 769	245.99	780.07	1 436.65	0.150	0.192	0.300
13	1 454	334	1 016	754.38	173.35	527.03	0.150	0.192	0.300
14	10 445	1 024	226	5 420.07	331.60	117.12	0.150	0.192	0.300
15	16 838	7 361	692	8 736.90	3 819.46	359.16	0.150	0.192	0.300
16	664	11 865	4 973	344.39	6 156.79	2 580.50	0.150	0.192	0.300
17	1 888	468	8 016	979.88	242.69	4 159.64	0.150	0.192	0.300
18	356	1 331	316	184.50	690.51	163.97	0.150	0.192	0.300
19	150	251	899	77.90	130.01	466.52	0.150	0.192	0.300
20	1 549	106	169	803.58	54.89	87.84	0.154	0.192	0.300
	220 266	220 647	218 500	55 513.91	52 601.99	50 249.55			

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Age	Numbers $\times 10^{-3}$			Biomass (t)		
	1983	1984	1985	1983	1984	1985
2	23	29	46	2	2	3
3	2 764	3 503	5 315	377	478	725
4	3 388	4 043	5 965	805	961	1 417
5	1 297	2 597	3 611	373	747	1 039
6	647	2 046	4 690	189	599	1 373
7	215	573	2 053	83	221	791
8	810	190	575	376	88	266
9	1 306	717	191	600	329	88
10	736	1 156	719	371	583	363
11	270	651	1 160	140	338	602
12	60	239	654	31	124	339
13	184	53	240	95	28	124
14	1 322	163	53	686	84	28
15	2 131	1 170	163	1 106	607	85
16	84	1 886	1 174	44	979	609
17	239	74	1 893	124	39	982
18	45	211	75	23	110	39
19	19	40	212	10	21	110
20	201	17	40	104	9	21
	15 741	19 358	28 828	5 540	6 345	9 005

Table 18. Population biomass estimates (t) for spring spawner herring in NAFO division 4R, 1966-1985.

BIOMASS (first half of the year)																				
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	2575	4432	11979	3955	66721	25550	3849	1419	2452	2838	10663	1823	458	1726	3221	5596	5239	3986	3986	3986
3	7985	4136	7162	19344	6359	107407	53948	6457	1385	3917	4345	14945	3893	617	2546	4686	9856	7804	5964	5935
4	4160	8473	4423	7610	20500	6544	118414	43673	6438	1440	3691	4937	17147	4458	887	2877	5335	11781	7942	7779
5	20110	3849	7895	4089	6763	18326	5689	95979	41231	6244	1295	3545	5027	19213	4029	988	2271	4733	7486	6866
6	12767	18670	3583	7248	3600	6003	19056	5242	85782	35494	5181	1116	3567	4728	16107	4061	856	1437	3617	5582
7	12002	10791	16460	3122	6340	3122	5303	17090	4370	76443	31457	4418	981	3123	4422	11685	3515	629	1333	3218
8	7504	9357	8457	14184	2675	5473	2451	4527	13284	3521	65055	25887	4100	842	2483	4036	6617	2848	533	1083
9	3682	6054	7449	7153	12505	2314	4456	2171	2769	11347	2912	49044	23744	3212	606	1919	3207	4551	1989	357
10	1447	2615	4696	5619	5762	10313	2005	3890	1145	2206	8769	2079	40725	19318	1981	460	1315	2815	3520	1475
11+	2535	3101	4271	7379	10788	13317	19228	16998	13859	12264	11478	14137	11735	43252	47393	36407	22208	17904	14114	11947
2*	74767	71478	76375	79703	142013	198369	234399	197446	172715	155714	144846	121931	111377	100489	83675	72715	60419	58488	50484	48228
5*	60047	54437	52811	48794	48433	58868	58188	145897	162440	147519	126147	100226	89879	93688	77021	59556	39989	34917	32592	30528

Table 19. Catch and population estimates for fall spawner herring in NAFO division 4R, 1983-1985, assuming a fishing mortality rate F = 0.3 in 1985

Age	POPULATION			FISHING MORTALITY					
	Numbers x 10 <sup>-3</sup>			Biomass (t)					
	1983	1984	1985	1983	1984	1985	1983	1984	1985
2	17 601	17 608	17 608	916.86	917.23	917.23	0.000	0.001	0.000
3	14 415	14 404	14 404	2 312.75	2 311.03	2 311.12	0.004	0.008	0.004
4	11 778	11 749	11 697	2 147.33	2 142.18	2 132.66	0.222	0.407	0.222
5	11 023	7 723	6 403	2 572.48	1 802.34	1 494.23	0.120	0.220	0.120
6	4 071	8 004	5 074	1 272.29	2 501.79	1 585.95	0.300	0.550	0.300
7	1 893	2 469	3 781	627.30	817.98	1 252.55	0.300	0.550	0.300
8	784	1 148	1 166	301.26	441.50	448.31	0.300	0.550	0.300
9	1 728	475	542	729.22	200.55	228.87	0.300	0.550	0.300
10	3 067	1 048	224	1 437.78	491.44	105.25	0.300	0.550	0.300
11	1 317	1 860	495	679.37	959.26	255.33	0.300	0.550	0.300
12	381	799	879	196.60	412.06	453.08	0.300	0.550	0.300
13	568	231	377	292.72	119.25	194.62	0.300	0.550	0.300
14	754	344	109	388.84	177.54	56.32	0.300	0.550	0.300
15	580	457	163	299.27	235.84	83.86	0.300	0.550	0.300
16	123	352	216	63.35	181.52	111.39	0.300	0.550	0.300
17	110	75	166	56.80	38.42	85.74	0.300	0.550	0.300
18	233	67	35	120.15	34.45	18.15	0.300	0.550	0.300
19	606	141	32	312.38	72.87	16.27	0.300	0.550	0.300
20	7 616	367	67	3 927.68	189.47	34.42	0.300	0.550	0.300
	78 647	69 323	63 439	18 654.43	14 046.73	11 785.36			

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Age	Numbers x 10 <sup>-3</sup>			Biomass (t)		
	1983	1984	1985	1983	1984	1985
2	7	13	7	0	1	0
3	58	106	58	9	17	9
4	2 133	3 585	2 118	389	654	386
5	1 132	1 388	658	264	324	153
6	961	3 098	1 198	300	968	374
7	447	955	893	148	317	296
8	185	444	275	71	171	106
9	408	184	128	172	78	54
10	724	406	53	339	190	25
11	311	720	117	160	371	60
12	90	309	207	46	159	107
13	134	89	89	69	46	46
14	178	133	26	92	69	13
15	137	177	38	71	91	20
16	29	136	51	15	70	26
17	26	29	39	13	15	20
18	55	26	8	28	13	4
19	143	55	7	74	28	4
20	1 798	142	16	927	73	8
	8 956	11 995	5 987	3 190	3 655	1 713

Table 20. Population biomass estimates (t) for fall spawner herring in NAFO division 4R, 1966-1987.

BIOMASS (first half of the year)																				
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	4419	1658	827	784	1136	1271	1565	836	692	1687	502	180	323	552	1086	2107	262	880	880	880
3	31831	8672	3258	1626	1538	2232	2493	4121	1643	1291	2513	986	353	603	1102	2238	5312	662	2218	2218
4	13269	37760	10291	3832	1883	1685	2649	3062	4348	1836	1433	3678	1170	395	966	1527	3238	4936	2056	2047
5	10609	13980	40144	10917	3944	1966	1776	3140	2960	3605	1712	1675	4199	1304	434	888	1684	2469	1730	1434
6	12453	9660	12692	36747	9924	3852	1616	1778	2145	2584	2965	1683	1517	3960	1208	410	875	1221	2401	1522
7	14016	11375	8800	11398	33595	9822	2643	1492	744	1970	2100	2530	1793	1492	3117	1183	424	602	785	1202
8	41958	12328	10035	7706	9944	31620	6647	2505	662	524	1792	1750	2348	1266	1156	2622	1043	289	424	430
9	24986	35404	10395	8473	6510	9543	21197	6038	1348	477	460	1493	1558	1574	651	1068	2090	700	192	220
10	31318	21275	30340	8903	7291	6272	5701	20970	3969	1189	411	349	1226	1264	658	378	950	1380	472	101
11	64919	82607	86996	99695	89806	88297	60549	50089	57878	51287	38413	29561	24093	18545	16256	12256	9137	6083	2323	1257
2+	249778	186629	213778	190081	165571	156560	106836	94031	76389	66450	52301	43885	38580	30955	26634	24677	25015	19222	13481	11311
5+	200259	234719	199402	183839	161014	151372	100129	86012	69706	61636	47853	39041	36734	29405	23480	18805	16203	12744	8327	6166



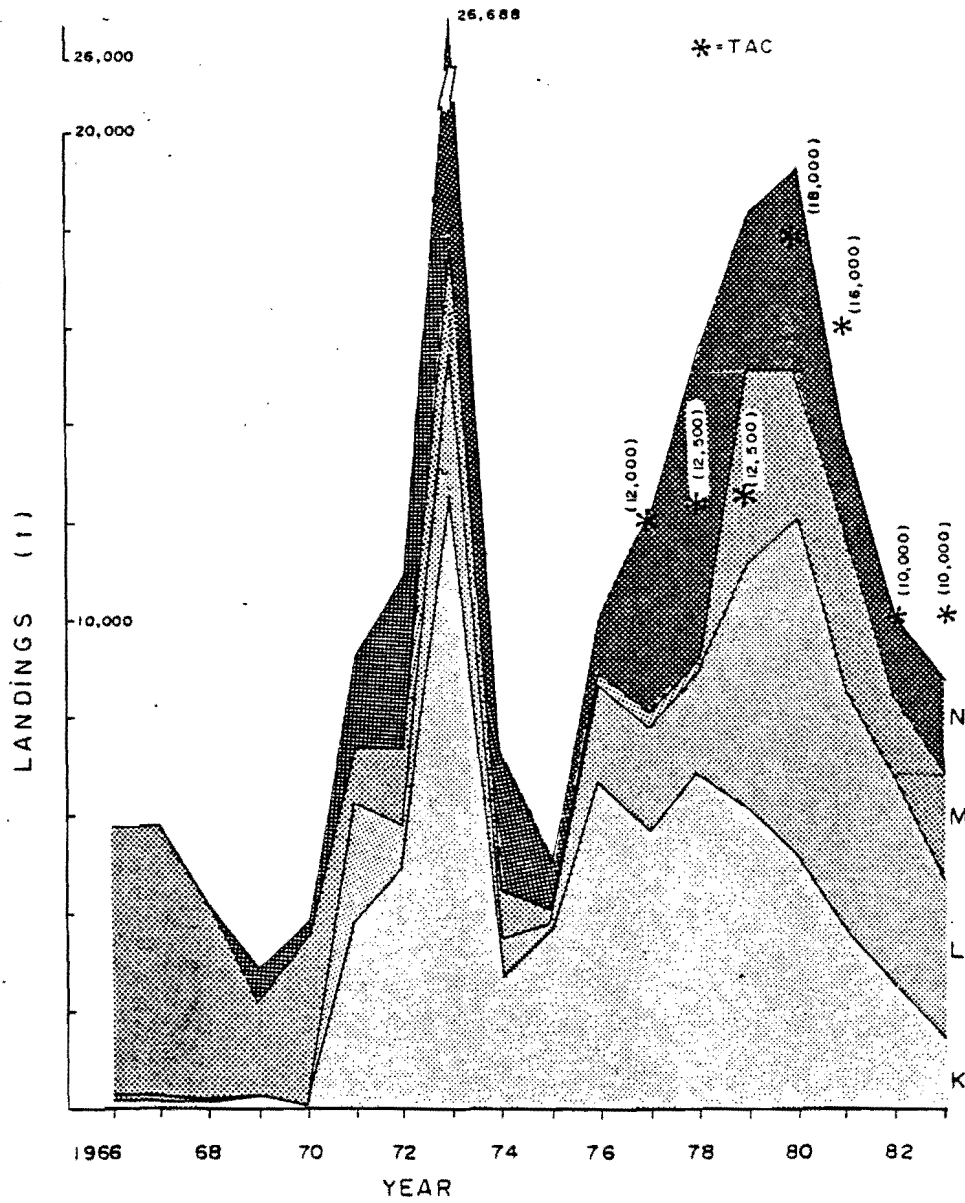


Figure 1. Commercial herring landings (t) from NAFO division 4R by fishing area, 1966-1983.

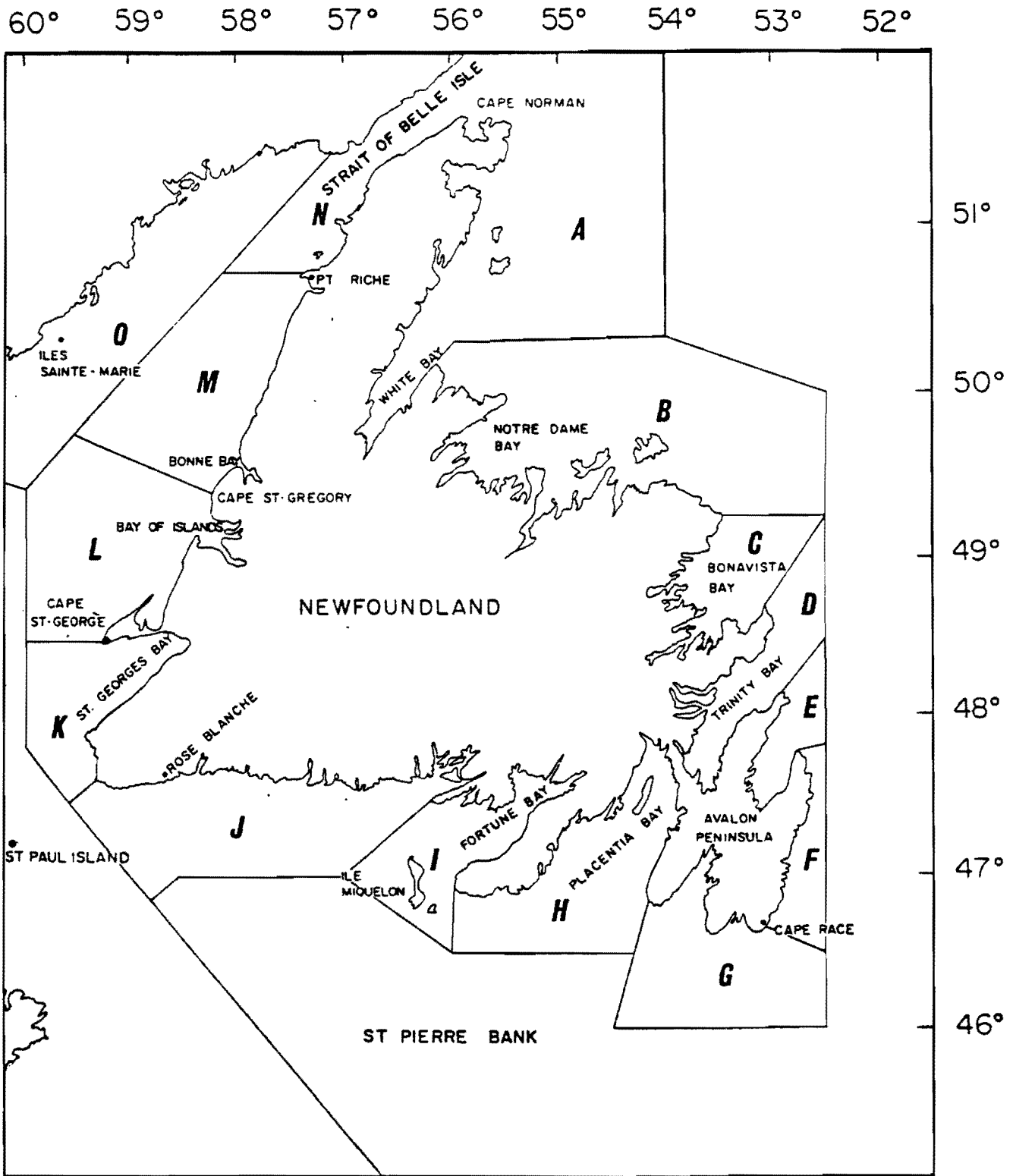


Figure 2. Newfoundland fishing areas.

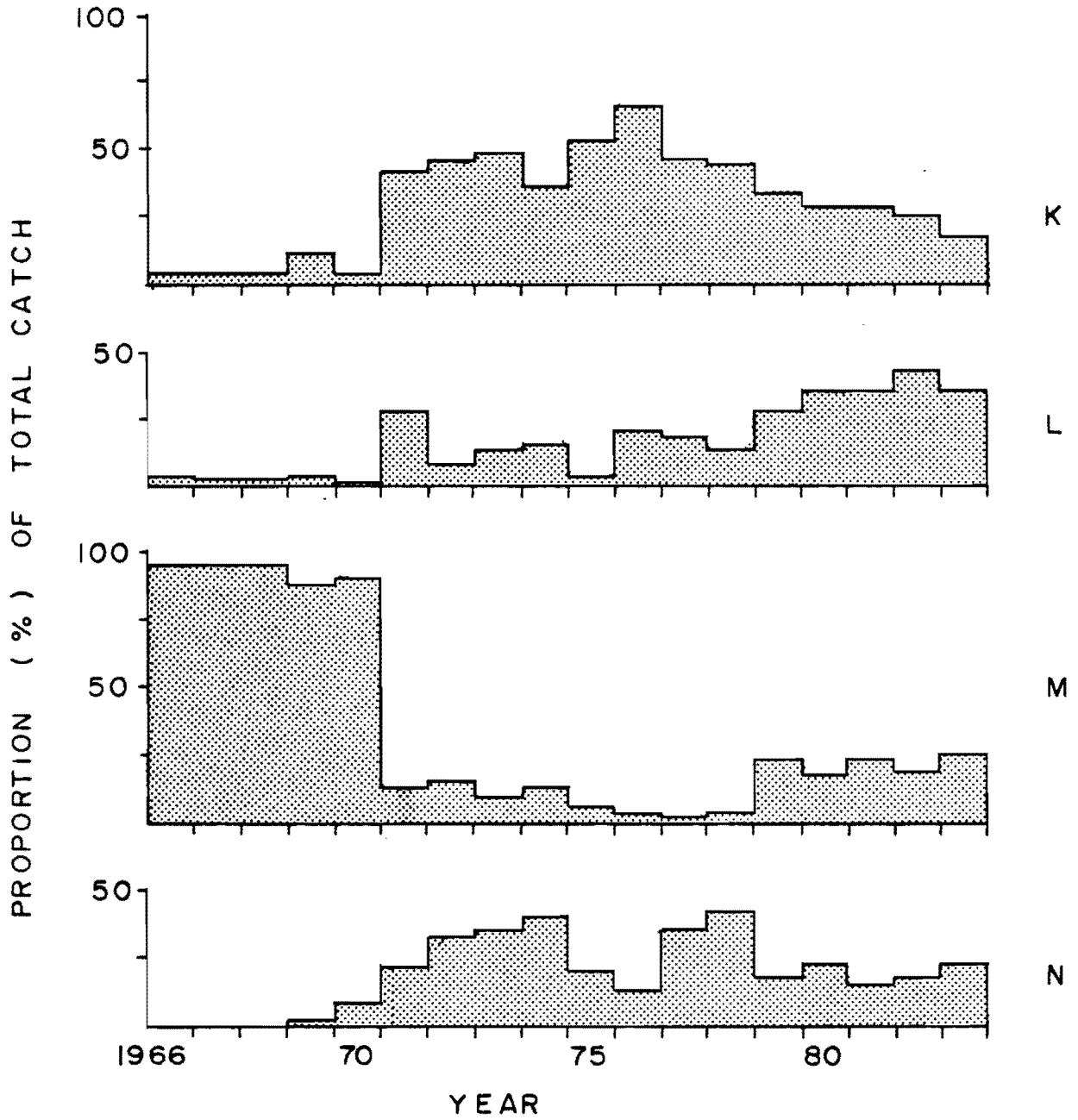


Figure 3. Proportions of the total annual herring catches separated by fishing areas, 1966-1983.

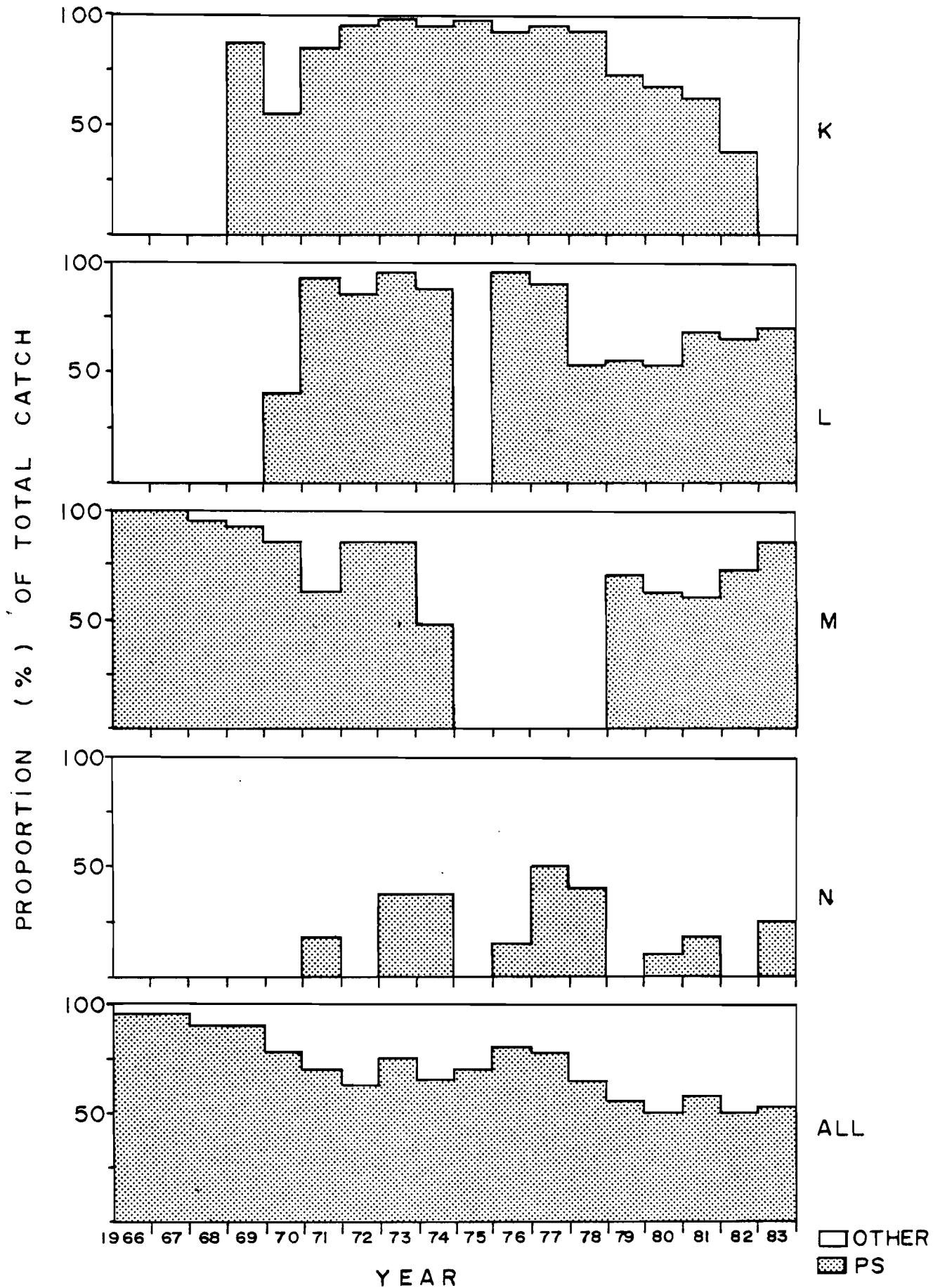


Figure 4. Proportions of the annual herring catches taken by purse seines and by all other gears separated by fishing areas, 1966-1983.

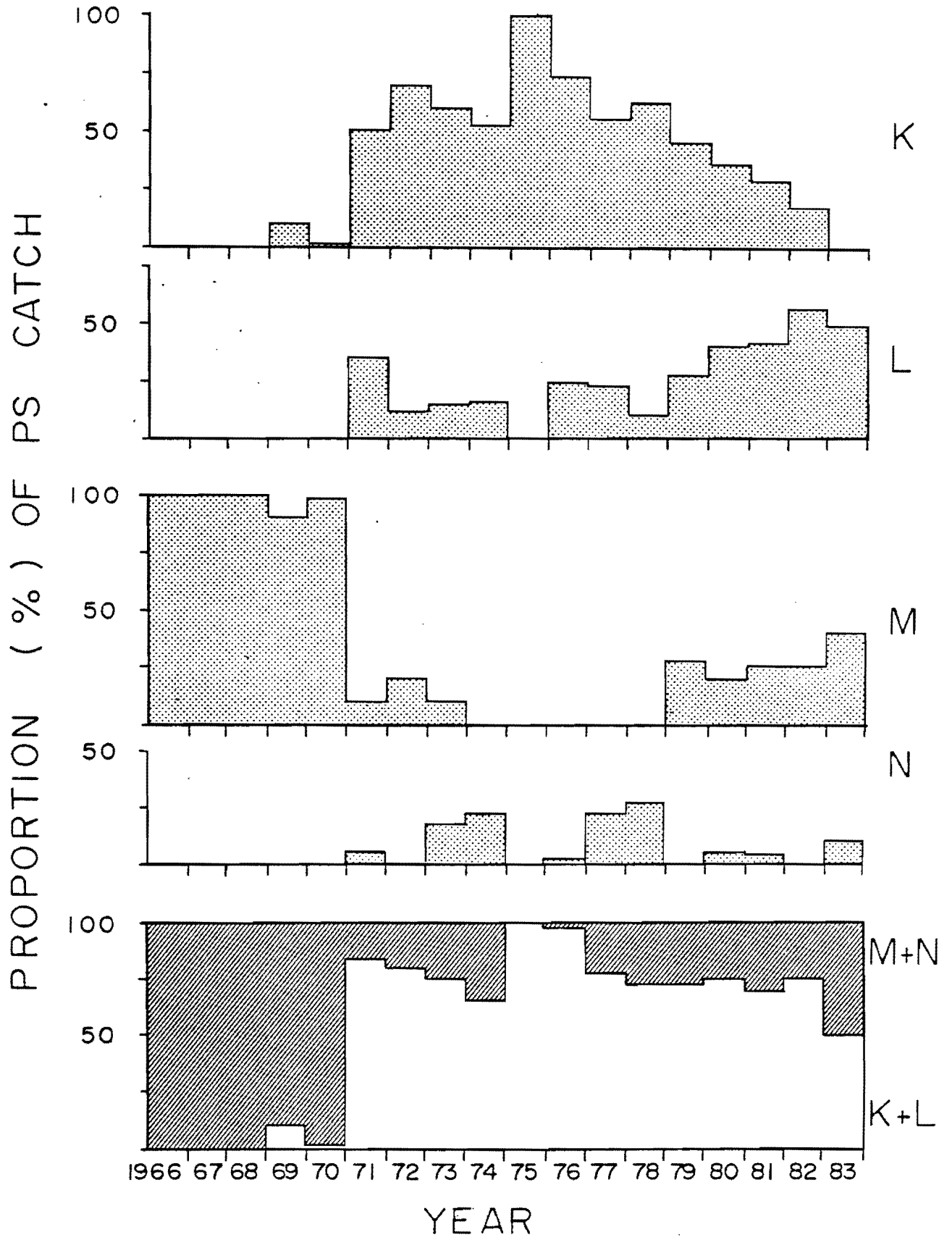


Figure 5. Proportions of the annual herring purse seine catches separated by fishing areas, 1966-1983.

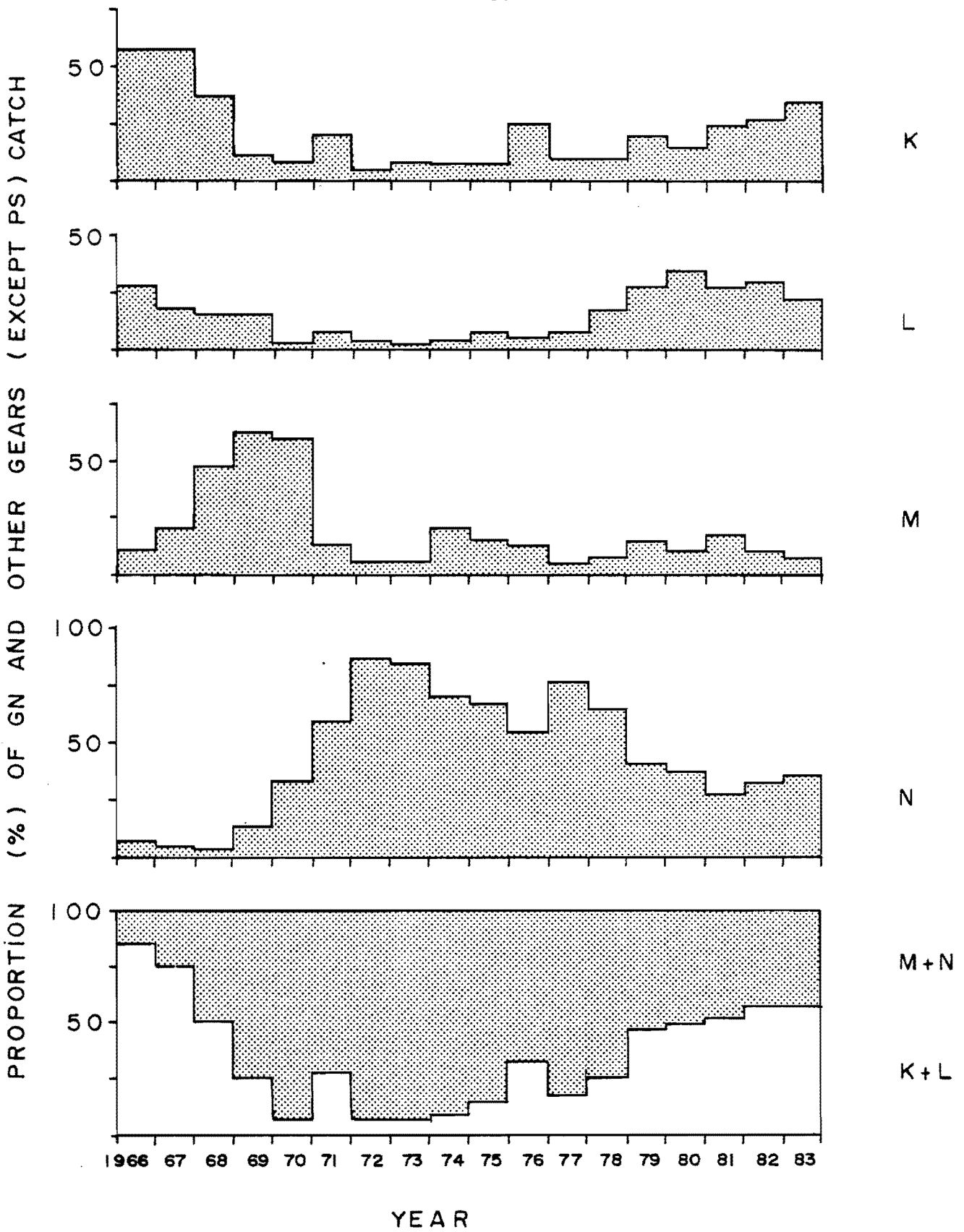


Figure 6. Proportions of the annual herring catches taken by all gears except purse seines separated by fishing areas, 1966-1983.

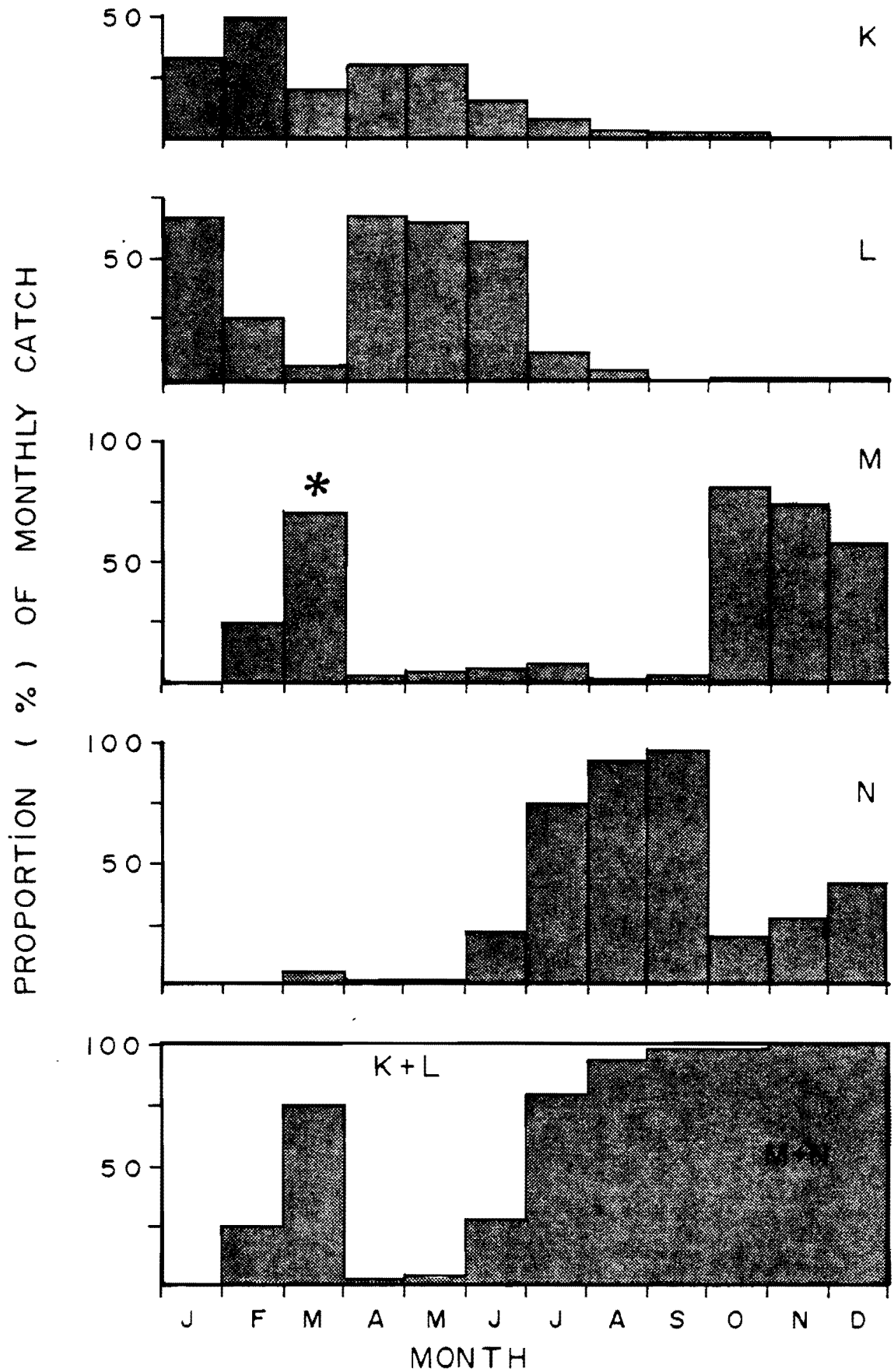


Figure 7. Monthly distribution of catches per fishing areas in 1983.  
\* 78 t were caught in March, of which 53 t were taken by traps.

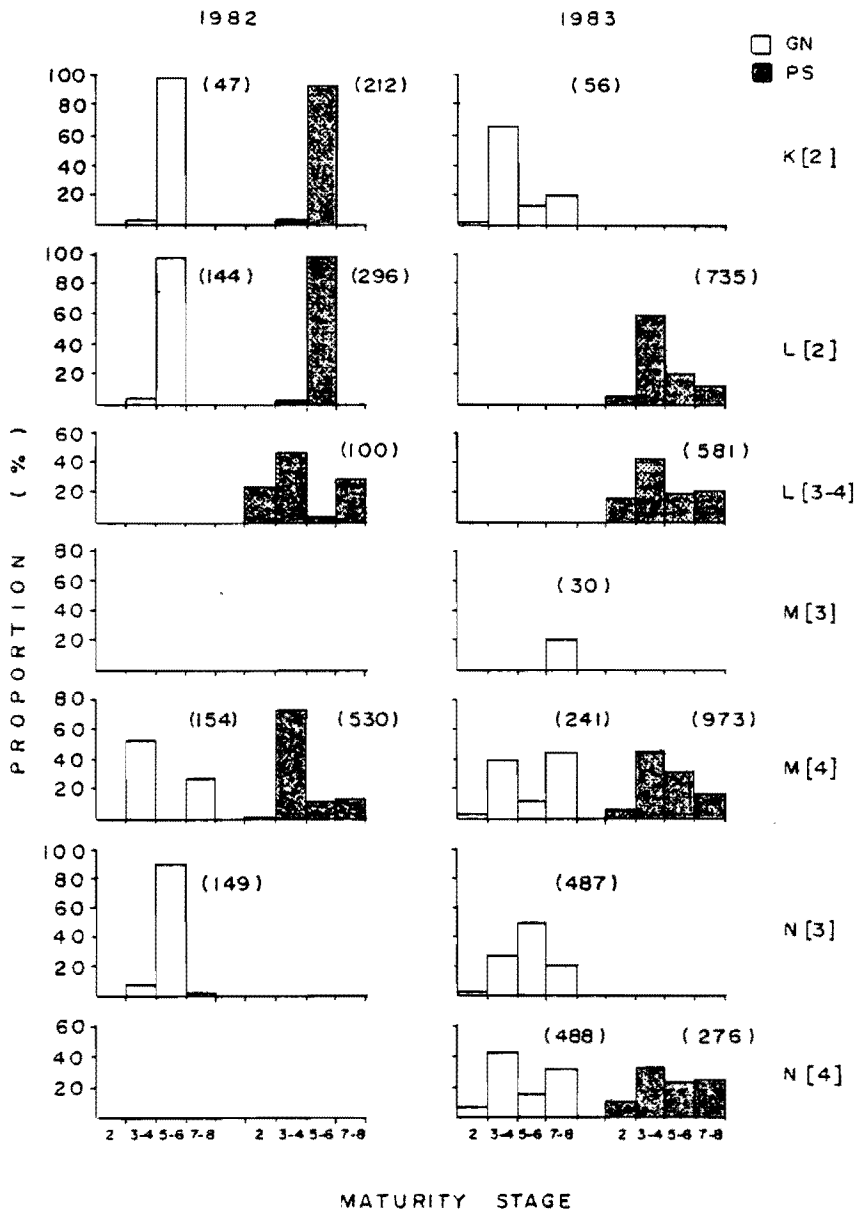


Figure 8. Maturity stages of herring caught by gillnets and purse seines for each fishing area. The number in brackets is the semester. The number in parentheses is the sample size.



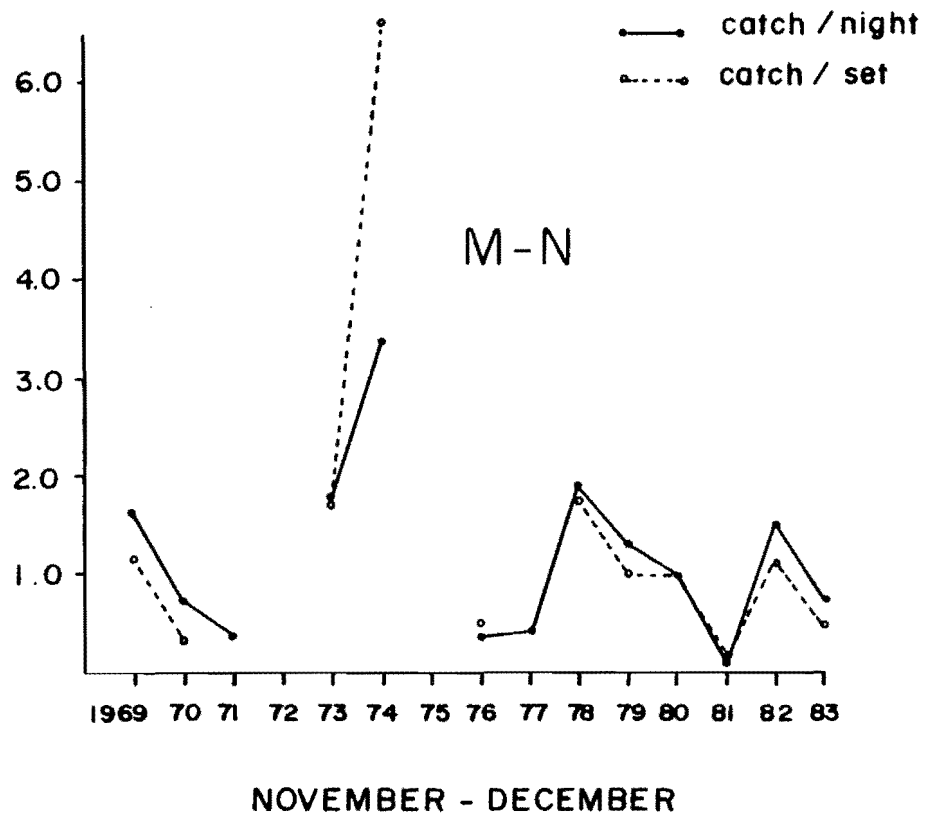
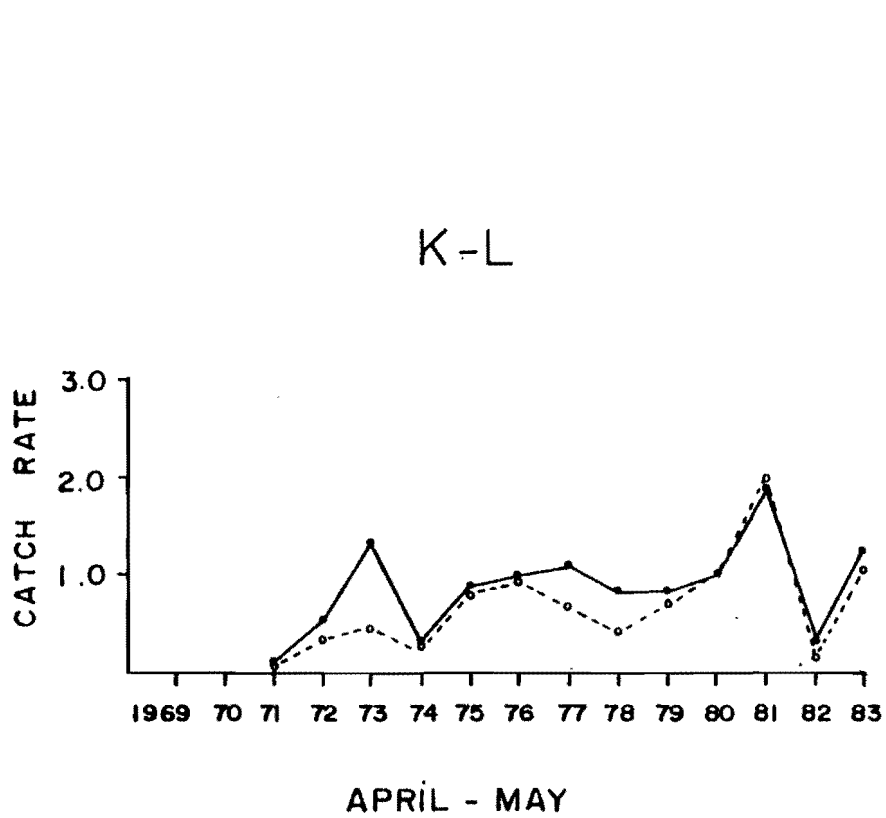


Figure 9. Purse seine catch rates, standardized to 1980, from the spring and fall fisheries in NAFO division 4R, 1969-1983.

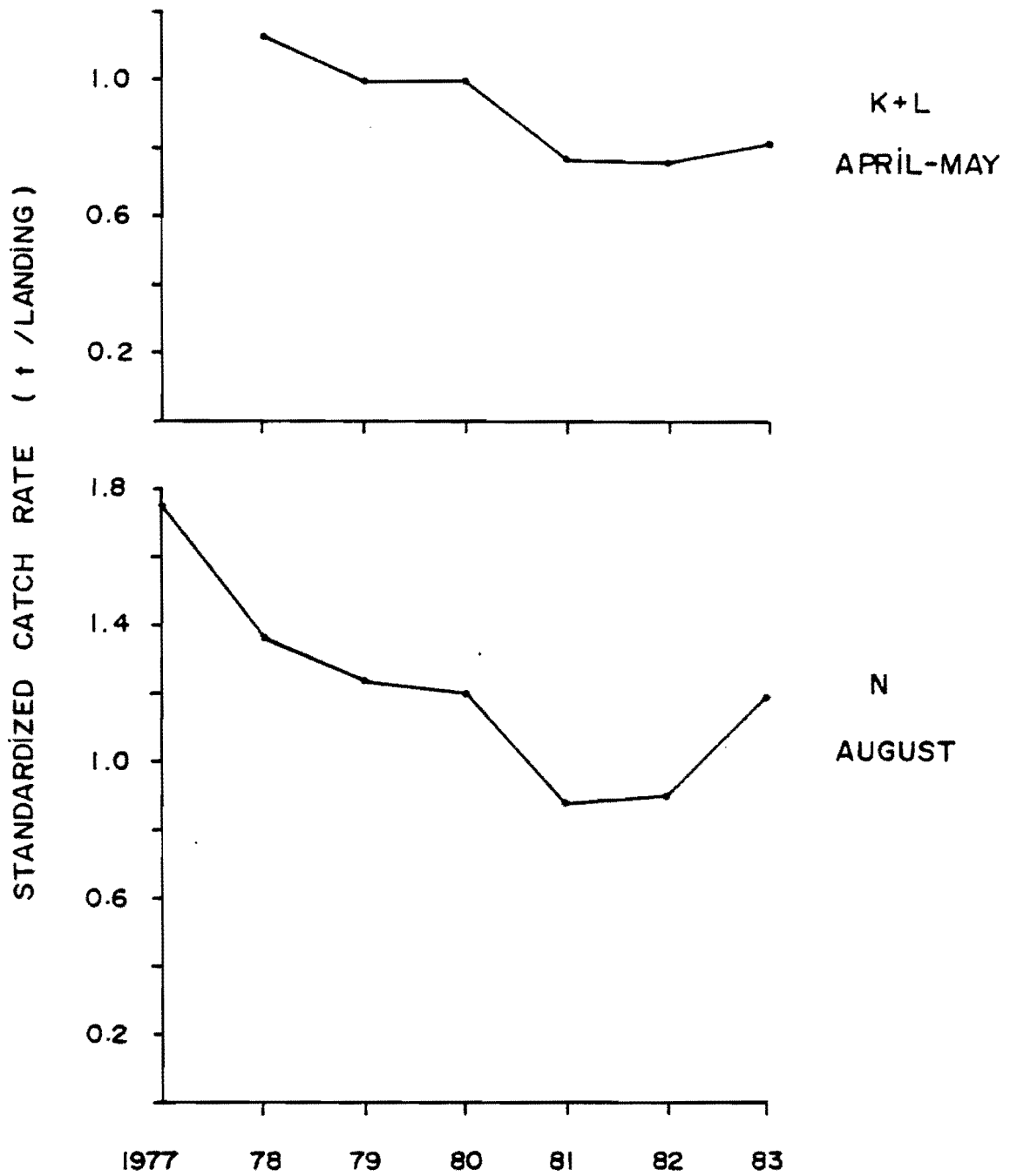


Figure 10. Gillnet catch rates, standardized to 1980, from the spring and fall fisheries in NAFO division 4R, 1977-1983.

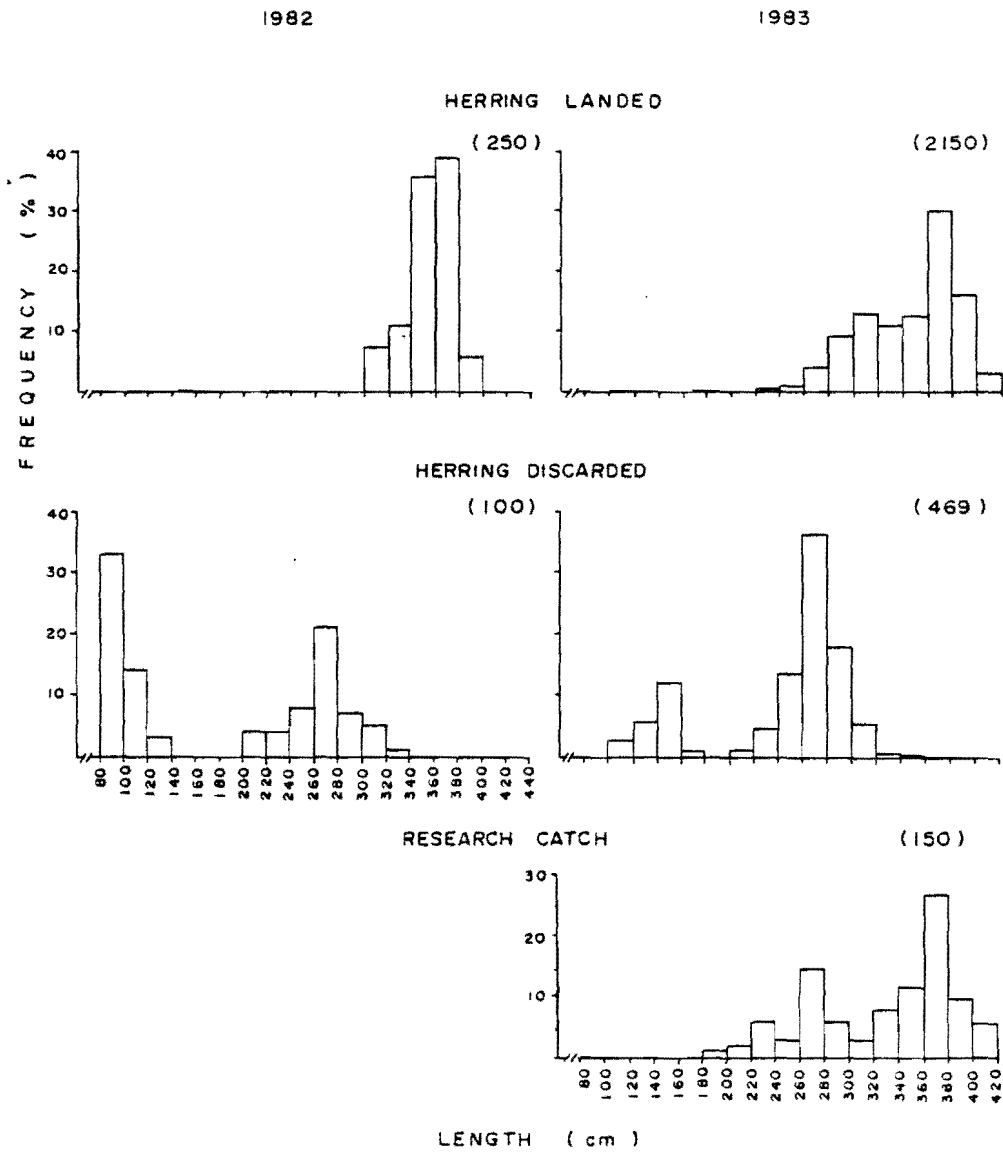


Figure 11. Herring length frequencies from the purse seine commercial catch samples in 1982 and 1983 and from the bottom trawl research survey in 1983 in NAFO division 4R.

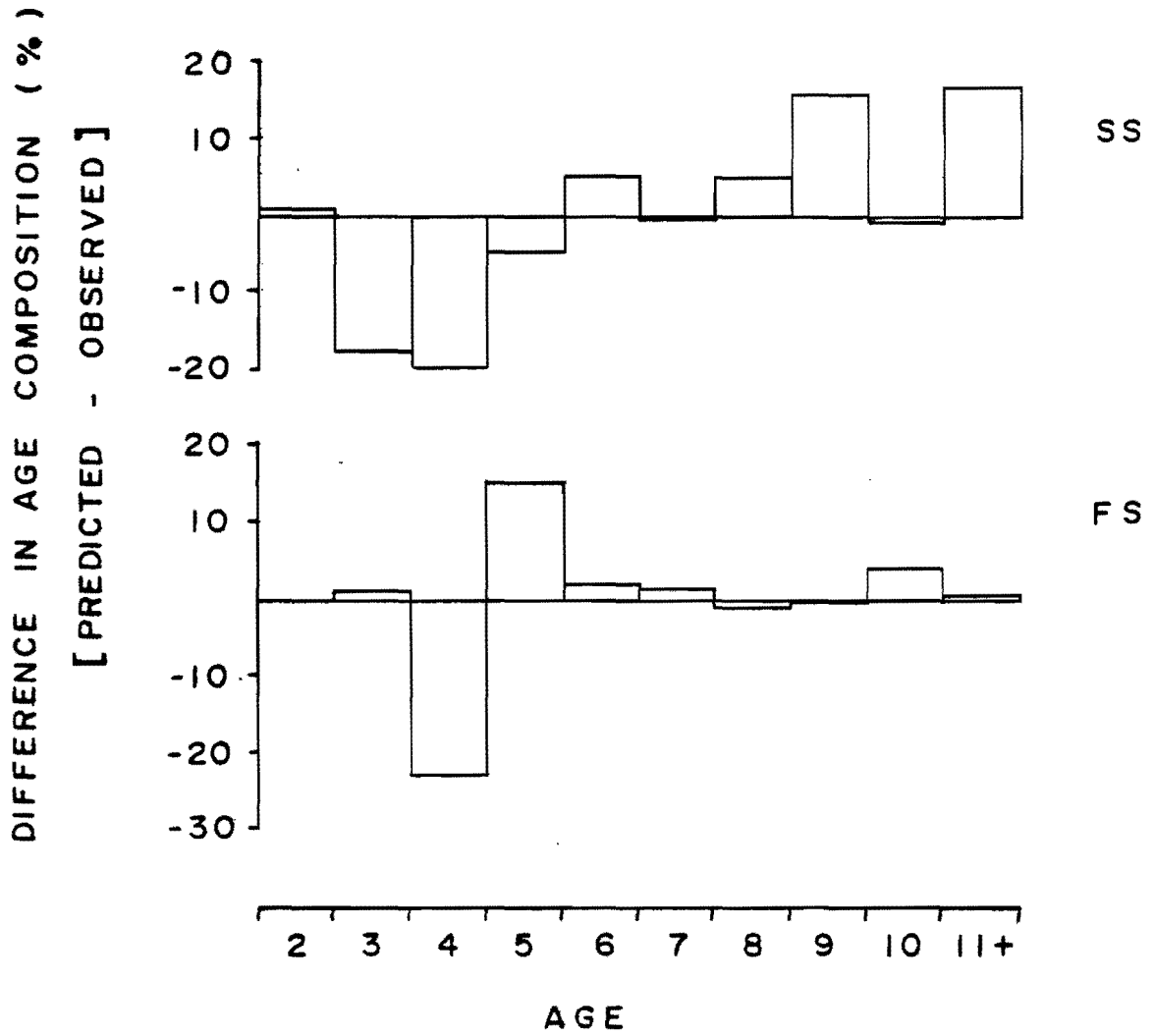


Figure 12. Difference between the predicted and observed age composition of the commercial herring catch in NAFO division 4R.

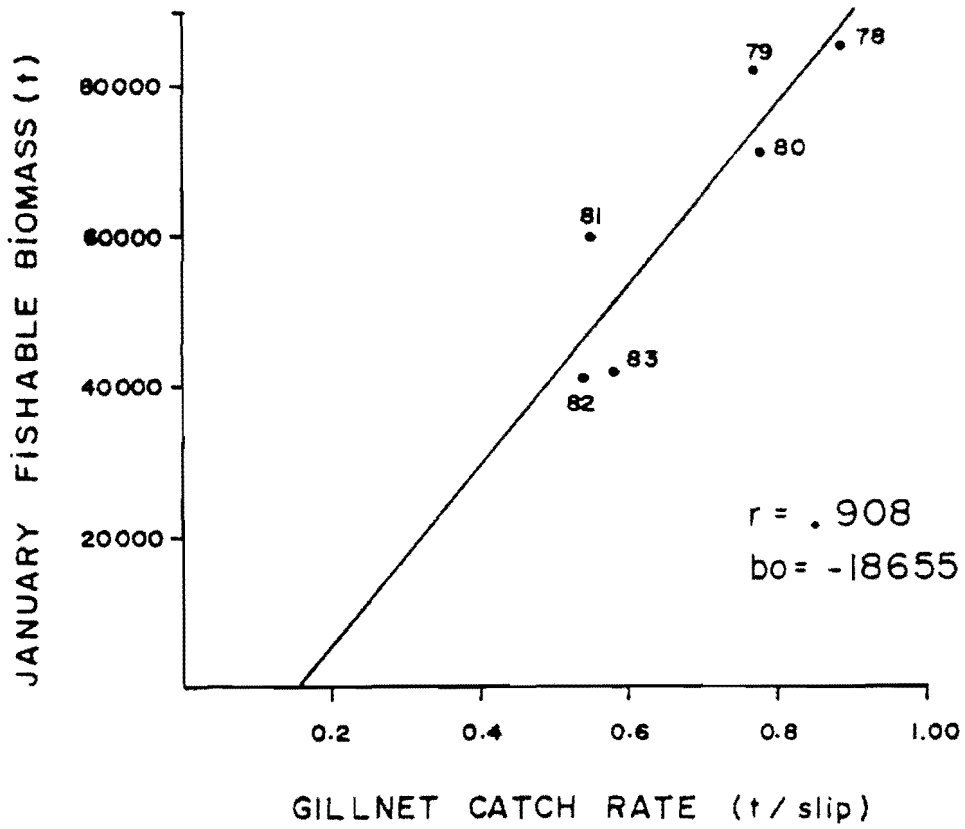


Figure 13. Relationship between the January spring spawner fishable biomass and the adjusted gillnet catch rates for areas K and L in April and May, 1978-1983.

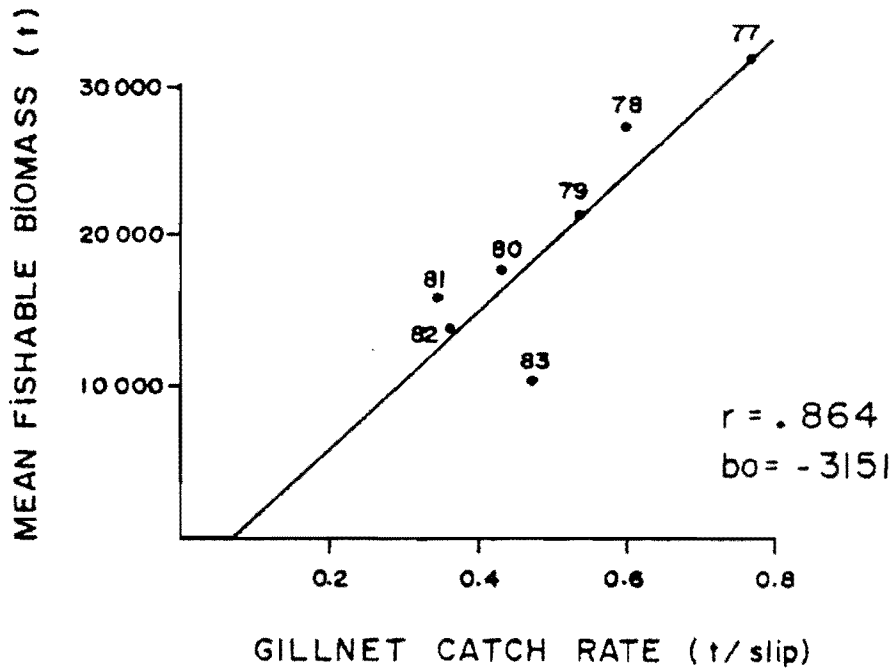


Figure 14. Relationship between the mean fall spawner fishable biomass and the adjusted gillnet catch rates for area N in August, 1977-1983.