An assessment of the southern Gulf of St. Lawrence herring stock complex

by

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ABSTRACT

Herring landings in NAFO Division 4T decreased from 175,000 t in 1970 to 40,000 t in 1980. Between 1972 and 1980, TAC's were in effect, but catches reached the TAC's level only in 1973. In 1981 and 1982, TAC's of 15,000 t and 16,000 t, with major allocations in inshore gears, were overrun.

Catch rates from the purse seiner fall fishery indicated a general decline in available abundance during the seventies, and a small increase since 1980-1981. Catch rates from the inshore fishery are more confusing, with some indices showing a slight increase from 1980 to 1982, while others are still decreasing.

The catch at age matrices show that the spring spawner fishery is supported essentially by one year-class, with the mean age of a fish caught being 3 years old, and the proportion of fish younger than 5 reaching 80% in 1982. In the fall spawner fishery, three year-classes contribute to the catch, the mean age of a fish is 5, and 15% of the fish caught are less than 5 years old.

Cohort analysis run with fall spawner herring data showed that no strong recruitment is expected in the near future. The fishing mortality rate for fully recruited fish in 1982 was estimated to be 0.70, and $F_{0.1} = 0.382$. The herring biomass (weights for the first quarter of the year) has dropped from over 900,000 t in 1969 to around 45,000 t in 1982. Fishing at $F_{0.1}$ would allow the total biomass to remain at the 45,000 t level in 1985, but the mature biomasse would still be less than 25,000 t.

Estimates of population abundance and fishing mortality rates for the spring spawner component of the stock could not be obtained. The analysis was confounded by the effect of the increasing use of small mesh gillnets in the spring fishery in the mid to late 1970's. However qualitative information on the distribution of the fishery, together with the concentration of the fishery on a very small number of age groups in the last three years indicate that the biomass remains low.

RESUME

Les débarquements de hareng rapportés dans la Division 4T de l'OPANO sont passés de 175,000 t en 1970 à 40,000 t en 1980. Les TPA imposés de 1972 à 1980 n'ont été atteints qu'une seule fois en 1973. Par contre, les TPA de 1981 et 1982 (15,000 t et 16,000 t) dont la majeure partie était allouée aux engins côtiers ont été dépassés.

Les taux de capture obtenus pour la pêche d'automne au seineur indiquent un déclin de la biomasse disponible au cours des années 1970, suivi d'une légère augmentation depuis 1980-1981. Les taux de capture de la pêche côtière sont plus difficiles à interpréter: certains indices augmentent de 1980 à 1982, d'autres diminuent.

Selon la matrice des captures à l'âge, la pêche des reproducteurs de printemps s'exerce essentiellement sur une classe d'âge; l'âge moyen des harengs capturés est de 3 ans, et 80% des captures ont moins de 5 ans. Chez les reproducteurs d'automne, trois classes d'âge contribuent à maintenir la pêche. L'âge moyen des captures est de 5 ans, et 15% des harengs ont moins de 5 ans.

L'analyse de cohorte effectuée sur les données de la pêche au hareng frayant l'automne a permis de constater qu'il n'y aurait pas de forte classe d'âge recrutée dans un avenir immédiat. Le taux de mortalité par pêche chez les individus pleinement recrutés est passé à 0.70 en 1982 et $F_{0.1} = 0.382$. La biomasse de hareng (calculée avec les poids à l'âge obtenus pour le premier semestre de l'année) est passée de plus de 900,000 t en 1969 à environ 45,000 t en 1982. Une exploitation du stock au niveau $F_{0.1}$ permettrait à la biomasse de demeurer au niveau de 45,000 t en 1985, mais la biomasse mature serait encore inférieure à 25,000 t.

L'usage croissant des filets maillants de petites mailles dans la pêche de printemps entre le milieu et la fin des années 1970 a rendu très difficile l'interprétation des données relatives à cette pêche. Conséquemment aucun estimé de l'abondance des reproducteurs de printemps et de la mortalité par la pêche qu'ils ont subie n'a pu être obtenu. Cependant, des données qualitatives sur les aires de pêche ainsi que la concentration de la pêche sur un nombre très restreint de classes d'âge au cours des trois dernières années indiquent que la biomasse demeure à un faible niveau.

LANDINGS

Landings from the Southern Gulf of St.Lawrence herring stock were historically reported primarily in the spring by fixed inshore gears (Figures 1 and 2). By the mid 1960's, the stock was also exploited by a purse seiner fishery, mainly in the winter, and all along its migratory route (Winters and Hodder, 1975). The result was a slow shift from a spring inshore fishery to year-round fishery dispersed over all the Southern Gulf and Southwest Newfoundland.

Accurate catch statistics have always been difficult to obtain; most of the herring used for bait is not reported, and fishing restrictions have led, in some instances, to underreporting by the fishermen. However, the problems associated with data collection are well documented (O'Boyle and McMillan, unpublished data) and catch statistics for the Southern Gulf herring stock are available from different sources: NAFO Statistical Bulletins, Fisheries Technical report etc.

The partitioning of herring catches from the west coast of Newfoundland to both the Southern Gulf of St.Lawrence stock complex (4T) and west coast of Newfoundland stock complex was recently revised (Moores, 1983). It was concluded that all purse seiner catches from St.George's Bay prior to 1969, as well as 1971 catches in area K 40-1, 1972 catches in area K 40-1 and K 40-2 should be assigned to the Southern Gulf of St.Lawrence stock (Figure 3). Besides, purse seiner catches reported in NAFO subdivision 3Pn were also from the 4T herring stock, and from 1968 to 1972 represented between 23 and 37 percent of the total catch. However, this percentage has dropped below 1% since 1973. All landings from 4T herring stock are included in the present analysis, and catches reported in NAFO division 4T are shown in Table 1.

Until recently purse seiners were the gear taking most of the landings: up to 81 percent of the total catch in division 4T, and before 1974 as much as 97% in subdivision 3Pn. The proportion of total landings attributed to the inshore fishery decreased from 1966 to 1980 while the seiner fleet was active. However, in 1981 and 1982, most of the catch was attributable to inshore gears, because of quota and allocation restrictions (Tables 2 and 3).

CATCH SAMPLING

Sampling of the herring landings was performed by St.Andrews and Quebec laboratories. The numbers of fish aged is shown on Table 4. Ages were read in St.Andrews and Quebec City.

POPULATION ABUNDANCE INDICES

Because of the schooling behaviour of herring, catch rates are not expected to be directly proportional to stock abundance. In fact, Paloheimo and Dickie (1964) suggested that in some circumstances the catchability would be inversely related to stock abundance. However, over the long term, catch rates may show a general trend in stock abundance and, although no order of magnitude of the trend can be calculated precisely, catch rates represent valuable information on trends in biomass. Consequently, catch rate indices for the inshore and offshore fishery for different areas of the Southern Gulf were used to detect fishable biomass trends. (It should be remembered that until 1981 any data pertinent to the inshore fishery is related only to a low proportion of the total herring catch).

PURSE SEINER FISHERY

Log-book records of catch and effort data for the purse seiner fleet operating in the spring, along the "Edge", and in the fall in Southern Gulf area, have been analysed for trends in abundance. The spring catch rates expressed in tons per set (Table 5, Figure 4) dropped continuously between 1969 and 1972, and then remained more or less stable until 1980. The catch per night index fluctuates too much to show any trend in available abundance. However, these catch rates may not reflect the overall abundance of the stock: this fishery did not exploit a stationary herring population, but schools which were migrating from overwintering and spawning areas, and the seiner fleet had in the most recent years changed its area of fishing (Valdron and Sinclair, pers. comm.).

The purse seiner fall fishery occurs between the months of June and December, with the exact fishing time varying from one year to the next. However, fishing always occurred during the months of September and October from 1970 to 1981, from September to November between 1974-1979 and in October only in 1982. In order to minimize the effect of seasonal fluctuations on the calculation of the abundance indices, the catch rates were derived for two limited periods of fishing: September to November, and October only. Data were obtained from purse seiner log books and, in 1981 and 1982, additional information was provided by an observer program held during the fall fishery.

The catch rates for the September to November fishery declined between 1969 and 1975, increased in 1976 and then remained stable until 1978 (Table 5, Figure 4). This abundance index dropped to the lowest historical point in 1980, and increased again in 1981. When only the October fishery is considered, even more fluctuations are noted in the catch rate. After a slight increase in catch rates from 1974 to 1977, the abundance index declined substantially up to 1981 and then increased again in 1982. Catch rates provided by the observers were higher than those calculated with the logbook data. In 1981 and 1982, quota restriction could have induced underreporting and consequently any abundance index calculated with underestimated catches will be biased downwards.

The validity of seiner catch rates as representative of the fish population abundance has often been discussed (Powles, 1981; Pope, 1980; Ulltang, 1978). Several factors reduce the reliability of the indices: fishing fleet behavior, increase in searching powers, learning capacity etc. Further, data recorded in seiner log-books are often inaccurate and difficult to analyse. Important details like the fact that seiners voluntarily stop fishing whenever the herring caught has fed on "redfeed", or is too small to be sold to fish plants, are most of the time not recorded, and anyway impossible to quantify, leading to uncertainties in catch rates.

GILLNET FISHERY

The gillnet fishery is now responsible for most inshore landings. In the past few years, many studies have been conducted to evaluate the fishing effort from the gillnetters. These studies have also provided catch rate series from different fisheries in the Southern Gulf (Figure 5).

Southern Gulf purchase slip survey

Messieh (1981) calculated gillnet catch rates from spring and fall fisheries in the Southern Gulf, using the information on all the purchase slips available. The catch rates for Caraquet, Escuminac, North Prince Edward Island and Pictou fishery are presented here (Table 6, Figure 6).

During the spring fishery, the catch rates for both Caraquet and Escuminac dropped between 1978 and 1981, when they reached the lowest value ever calculated. However both catch rates also increased in 1982, indicating greater availability of the stock fished. The Prince Edward Island fishery catch rate has been continuously increasing from 1980 to 1982, and has now reached the highest level of 2.96 t/successful trip since 1973.

The behaviour of the fall fishery is different from the spring fishery. The catch rate in Caraquet has been increasing since 1980, after a continuous decline since 1974. The Escuminac fishery shows in 1982 the lowest catch rate in the time series, and the Pictou catch rate seems stable.

Messieh's overall index is biased upward because it does not take into account the trips made with no catch recorded and the number of nets fished per trip. In an attempt to minimize errors, the data used by Messieh were modified to include the average number of nets used by the fishermen in Caraquet and Escuminac areas (Table 7). Data on the number of nets were obtained from a questionnaire survey conducted in 1982 by the Quebec laboratory.

The overall trend in catch rate is simular to that for the uncorrected series for the spring fishery, with an increase in 1982. The index for the fall fishery in Caraquet is also similar to the uncorrected series, but in Escuminac it shows a stable situation instead of a decline of available abundance.

An overall catch rate was calculated using total gillnet landings, the number of succcessful trips and the number of nets fished in the Caraquet-Escuminac-north PEI spring fishery and in the Caraquet-Shippagan fall fishery (Table 8). This index of abundance was considered to best represent population trends and to be the most error-free available, and consequently was used in attempts to fine-tune cohort analysis.

Magdalen Islands surveys

A catch rate index for the spring inshore fishery was calculated with data from questionnaires sent to all fishermen licensed for herring fishing. The results show that after a decrease from 69.5 lb/net-day in 1970 to 45.4 lb/net-day in 1974, the catch rates remained more or less stable until 1979 and then reached the lowest values of 17.9 lb/net-day in 1982 (Table 6, Figure 6). This drop in catch rate followed a period of dredging in one of the major spawning area of the Islands, the Grande Entrée lagoon.

Pictou gillnet survey

In Pictou, Nova Scotia, over 90% of the herring catch is taken in the fall fishery. The catch rate for that fishery is calculated by dividing the landings by the number of fishing boats using gillnets. This catch rate increased between 1968 (25.6 t/boat) and 1971 (73.3 t/boat), declined until 1977 (8.6 t/boat), and then increased to reach 27.9 t/boat in 1982 (Table 6, Figure 6). This index does not compensate for either number of nets per boat or number of days fished.

TRAP FISHERY

The herring trap fishery in the Magdalen Islands offers several advantages over other commercial fisheries for the study of herring catch rates. Firstly, the effort of the trap fishery has remained relatively constant over the last decade and is more easily quantifiable than for any other gear. Traps are fixed gear and there has been no marked increase either in their numbers or in their efficiency due to changes in design (size, shape, mesh size) or fish search techniques (Spénard, 1979). Secondly, since no discarding of fish is

practiced by trap fishermen (H. Cyr, personal communication) and since there is a commercial trap fishery for which landing data are available, an estimate of catch and ultimately catch per unit effort (CPUE) can be easily obtained. Thirdly, traps are less size selective than gillnets and thus sampling of the herring population is more representative.

In the Magdalen Islands, traps historically reported most of the catch. This gear exploits only spring spawning herring. The trap fishery can thus provide a reliable abundance index for the spring spawners since the fishing effort of this fixed gear has been very stable over time: traps have remained in the same emplacements without being moved to concentrate on area where fish are abundant. However the catch is subject to the migration and behavior of herring as well as the timing of the fishery in relation to the spawning period. Catch rates were calculated by dividing the reported trap landings by the number of traps in operation. This index (Table 6, Figure 7) clearly indicates a sharp decline in available abundance between 1970 and 1981. However, the fishery was a little more successful in 1982, when 6 traps were set and caught 19 t of fish.

AGE COMPOSITION OF THE COMMERCIAL CATCH

Catch at age data were provided by Dr G. Winters up to 1981 (Table 9). In the early seventies, fish between the age of 3 and 10 contributed to the fishery, with an average age of 8 years. Later, the range of ages found in the catch decreased slowly and the mean age of the catch dropped smoothly from 8 to 4. Concurrently, fish older than 5, considered sexually mature, were scarcer in the catch, and in 1982 the fishing pressure was directed almost exclusively on herring of age 3, 4 and 5.

The proportion of spring and fall spawners in the total catch has changed over the years. Up to 1972, fall spawners were dominant in the catch. In the mid seventies, the fishery was sustained by spring spawners, but recently fall spawners again have contributed the most to the catch. The age composition matrix for spring spawners shows that the 1974 year-class has contributed substantially to the fishery in recent years (Table 10). Fish of age one have been caught from 1977 to 1981. The mean age of the catch has gone from 8 years in 1969 to 3 years in 1982, even with the apparently strong 1974 year-class supporting the fishery from 1977 to 1979. The proportion of fish younger than 4 years old has gradually increased from 26% in 1978 to 80% in 1982. This increase is not due to the presence of one young dominant year-class, but rather to an increase in proportion of the catch of two and three-year-olds. Although the 1977 year-class represented a high (42%) proportion of the total catch in numbers in 1980, this year-class was replaced in importance in the 1981 catch by the 1978 year-class and in the 1982 catch by the 1979 year-class. The spring spawner fishery has been supported by age 3 fish since 1981.

In the fall spawner catch (Table 11), the 1970 year-class supported most of the fishery between 1974 and 1978. The 1977 year-class represented 38% of the total catch in number in 1980 and 60% in 1981. In 1982, the 1978 year-class also contributed substantially (32%) to the catch. Fish of age one have been seen in 1979-80. The mean age of the catch has dropped, going from 9 years in 1969 to 4 years in 1981. However, the mean age increased slightly in 1982. The proportion of fish younger than 4 years old has increased to 40% in 1980, due to the presence of the 1977 year-class. The fall spawner fishery has been supported by three year-classes in recent years.

The shift in population age structure towards younger age classes could result from heavy fishing pressure, as in the case of the Pacific sardine (Murphy, 1966). Since the seiner fleet has the capacity to search for schools of herring, and since there is no market for fish smaller than 10 inches, it appears probable that no more larger older fish were available to the fishery, forcing the seiners to catch younger fish (the mean age in the purse seiner catch was 3 years old in 1981 and 4 years old in 1982). Besides, in 1981 and 1982, although most of the catch (80%) was taken by gillnetters, the mean age of the total catch was still low and the proportion of young fish still high compared to the early 1970's. This could also reflect the fact that larger older fish are scarce in the population.

Since fish older than 11 years represented up to 43% of the fall spawner catch in 1969, and 38% of the spring spawner catch in 1970, numbers of 11+ fish were broken down into numbers up to age 21. To do so, the following assumption was made: the ratio of number of fish at age 10 to the number of fish 10+ in 1969 equals the ratio of fish 11 to 11+ in 1970, and so on. The numbers prorated in this way were used in the cohort analysis.

PARTIAL RECRUITMENT

Since the fishery changed from predominantly offshore to predominantly inshore gears in 1981, partial recruitment could not be estimated from historical data. Consequently, a selectivity vector was calculated for fish ages 2 to 11 and used as partial recruitment. The selectivity vector was derived as follows:

The selectivity ogive for the major gillnet mesh sizes used (2½ inches to 2¾ inches) was obtained from Olsen (1959). The proportion of each gillnet mesh size used in 6 different areas of the southern Gulf (Cape Breton, Northumberland Strait in Nova Scotia and in New Brunswick, Chaleur Bay in New Brunswick, north and south of PEI) during the spring and fall fishery was calculated. Total gillnet landings for these same areas and seasons were broken down according to the proportion of the different mesh sizes employed, and used as a weighting factor in the calculation of a "combined" selectivity ogive.

Since mainly mature fish are available to the gillnet fishery, the selectivity vector for the 1982 fishery had to be adjusted for the proportion of mature fish available to the dominant gear. In order to do so, the proportion of fully mature fish amongst the spring spawners in the purse seine fall catch of 1981, and amongst the fall spawners in the purse seine fall catch of 1982 was considered as representative of the population maturity at age composition in 1982, with one year lag in the age of spring spawners. The selectivity factor for gillnets was thus multiplied by the proportion of mature fish in the population to give an "adjusted selectivity vector". The resulting vector was then combined (weighed with the appropriate catch at age) to the purse seiner selectivity ogive (Winters, pers. comm.) to give an estimate of partial recruitment:

	age	3	4	5	6	7	8	9	10	11+
SS	pr	0.64	0.87	1.00	0.95	0.72	0.50	0.36	0.21	0.16
FS	pr	0.23	0.72	0.96	1.00	0.90	0.79	0.66	0.55	0.42

Thus, spring spawner herring recruit to the commercial fishery at 5 years old while fall spawners are not fully recruited before the age of 6. This may be explained by the fact that most (52%) of the gillnets used during the spring fishery, when spring spawner herring are caught, have a mesh size of 2¼ inches, while in the fall fishery, when fall spawner fish are caught, over 75% of the nets have a mesh size greater than 2 5/8 inches.

COHORT ANALYSIS

Cohort analysis was run for fall spawner herring with a range of terminal F's. Fishing mortality rates due to the gillnet fishery only were calculated by multiplying the F's at age by the proportion of gillnet catch at age over the total catch at age. The resulting fishing rates were used to calculate the annual partial recruitment of the fish to the gillnet fishery. The partial recruitment vector multiplied by the total biomass gave an estimate of the biomass available to the gillnet fishery. The fall spawner biomass was then correlated with the fall gillnet catch rates. Based on the best regressions of "mature" biomass (ie ages 4+ and ages 5+) versus gillnet catch rates and gillnet selected biomass versus gillnet catch rages, the average 1982 mortality for fish of ages 5, 6 and 7, which are mostly fully recruited, is estimated to be 0.7 (Figures 8 and 9). Results of the cohort analysis showed that the 1967 year-class was the strongest seen since 1969 (Table 12). Moderately strong (over 1,000 000 fish) year-classes showed up in the late seventies, following 3 years of very poor recruitment in 1973-1974 and 1975. The total population numbers are at the lowest level observed, and in 1982 represented 8% of the population estimates in 1969-1970.

Cohort analysis was also attempted for spring spawner herring. However reliable estimates of the parameters could not be obtained because of the confounding effect of the increasing use of small mesh gillnets in the spring fishery in the mid to late 1970's.

FALL SPAWNER YIELD PER RECRUIT

A Thompson and Bell yield per recruit relationship was calculated using the partial recruitment values derived from the selectivy ogives for ages 3 to 21. Partial recruitment at age 2 was calculated from cohort analysis and average weights at age from 1980 - 1981 were used in the model (Table 13). $F_{0.1}$ calculated was 0.382. This value of $F_{0.1}$ is higher than $F_{0.1}$ = 0.30 used in the assessments of the east coast of Newfoundland (Wheeler and Winters, 1981), southeast Newfoundland (Moores et al. 1981) and NAFO Division 4WX herring stocks (Sinclair et al. 1982).

PROJECTIONS OF THE CATCH AND BIOMASS OF FALL SPAWNER HERRING

Projections were done with the population number estimates in 1982, the partial recruitment values used in the cohort analysis and a recruitment value at age 2 of 115,000,000 fish (geometric mean of recruitment from 1969 to 1978). Catches in 1983 were estimated to 17,000 t, and projections for 1984 and 1985 were calculated at $F_{0.1}$ The results showed that catches of 8,000 t in 1984 and 10,000 t in 1985 will allow the 4T popultion biomass to increase from 57,000 t in 1983 to 65,000 t in 1985 (Table 14).

Biomass estimates at age were calculated using the weights at age from samples for the first quarter of the year (Table 14). The biomass was over 900,000 t in 1969, decreased to a low of 45,000 t in 1982, and is projected to remain at this level in 1985 (Table 15). However the mature biomass will still be below 25,000 t.

CONCLUSION

The history of the 4T herring stock complex is similar to the history of many herring stocks of the European waters, which have undergone strong declines: the Atlanto-Scandian, North Sea, Celtic sea and West of Scotland herring. After reaching peak values, total catch decreased in spite of management regulations (Saetersdal, 1980). Catch rates from the purse seine fishery, although very variable, showed a general decline in available abundance; and in the southern Gulf, the inshore gear catch rates, in many cases decreased from 1977 to 1981. In the North Sea, none of the gears under study showed a decline in abundance of the magnitude observed, and many of the gears did not show a systematic decline at all (Pope, 1980). Recruitment was low for many years (Saetersdal, 1980) and in some cases fishing pressure was high on immature fish (Dragesund et al., 1980). Fishing mortality on adult stock increased as the adult biomass decreased (Jakobsson, 1980) and in some cases the stock collapsed.

The total biomass of the Southern Gulf of St.Lawrence herring stock complex was estimated to be less than 125,000 tons in 1981, 10% of the 1969 estimated biomass. The fall spawner biomass is now estimated to be around 45,000 t (weights for the first quater of the year), and the concentration of the fishery on a very small number of age groups in the last 3 years indicate that the biomass remains low. Only a few year-classes are now being exploited and no sign of exceptionally good recruitment is evident. In the event of poor recruitment going on in the near future, a stock collapse would still be possible. Consequently a fishing pressure equal to $F_{0.1} = 0.382$ could be too high, and until the stock shows evident signs of recovery no fishing at all would be advisable.

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Table 1: Herring landings* (t) in NAFO division 4T, 1967 to 1982.

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1967	1742	-	-	409	25220	8764	5679	10718	4620	1358	3095	1131	62736
1968	546	442	806	6455	24239	2566	15847	19768	22350	5284	13057	770	112130
1969	-	-	73	9329	17701	6568	35476	46987	22448	4169	11543	121	154415
1970	-	55	-	21211	15782	2545	51002	36860	24959	18506	3831	746	175497
1971	-	-	42	10644	11895	4809	41521	23067	36282	5163	1053	370	134846
1972	-	-	-	400	6102	2583	11034	9092	14453	7777	2108	41	53590
1973	-	-	-	1876	12801	4221	2135	7737	9436	2079	69	3	40357
1974	-	-	-	1302	14474	1190	2958	3143	7282	3081	1714	9	35153
1975	-	-	-	4028	20229	1428	289	2398	4646	8986	2256	305	44565
1976	-	-	-	8461	14406	961	193	1082	1807	5244	6973	326	39453
1977	-	-	-	7625	8338	8850	244	2125	1148	7166	8726	602	44824
1978	240	-	-	2046	13363	883	526	2487	10095	13672	6981	2848	53141
1979	-	-	-	14072	6158	1113	680	1766	6381	5071	9904	2598	47743
1980	80	-	15	10458	9220	1032	910	2224	1952	9011	5001	540	40443
1981	-	-	13	1736	4566	729	1588	5119	3986	2171	1246	-	21154
1982**				220	5453	1229	775	4915	7880	3391	69	-	23932

* From ICNAF statistical bulletin no 17 to 28
** Provisional

Table 2: Herring landings (t) in NAFO division 4T, in 1981.

Gear	January	February	March	April	May	June	July	August	September	October	November	December	Total
OTB	-	-	-	-	20	1	1	35	89	8	-	-	154
SDN	-	-	-	-	-	-	-	34	-	-	-	-	34
PS (a)	-	-	-	-	-	-	1	-	-	1861	1158	-	3020
	-	-	-	-	-	-	-	-	-	2450	1933	-	4385
GNS	-	-	-	675	2607	414	596	4307	3305	188	51	-	12143
LHP	-	-	-	-	-	1	2	10	-	-	-	-	13
FPN	-	-	-	1	4	2	1	9	-	-	-	-	17
MISC	-	-	13	1060	1935	311	987	724	592	114	37	-	5773
TOTAL(b)	0	0	13	1736	4566	729	1588	5119	3986	2171	1246	0	21154
										2760	2021		22519

(a) Recorded landings: 3020 t; fishermen pers. comm.: 4385 t.

(b) Total including the recorded Purse seiner landings: 21154 t.
Total including the communicated purse seiner landings: 22519 t.

Table 3: Preliminary herring landings (t) in NAFO division 4T, in 1982.

Gear	January	February	March	April	May	June	July	August	September	October	November	December	Total
FIX	-	-	-	-	71	15	1	-	17	-	-		104
GN	-	-	-	220	5342	1162	774	4894	7856	282	69		20599
HL	-	-	-	-	-	-	-	1	5	-	-		6
NK	-	-	-	-	30	-	-	20	2	-	-		52
PS	-	-	-	-	10	52	-	-	-	3109	-		3171
TOTAL	-	-	-	220	5453	1229	775	4915	7880	3391	69		23932

Table 4. Distribution by month, province, gear and area of the herring sampled for ages in NAFO Division 4T in 1982.

Province	Gear	Statistical district	Fishing area	April	May	June	July	August	Sept.	October	Total
New Brunswick	Purse seiner	65	437							96	96
			438							596	596
		67	437							50	50
			438							147	147
	Gillnet	65						24	583		607
Québec	Gillnet	10						111			111
		14			394	98		190	89		771
		17			105						105
			431	1230	1261						2491
	Trap	14							89		89
			431		693						693
	Gillnet		432					290			290
			433		793						793
			436		396			73			469
			437	468	195		72	671			1406
			438		100		200	195			495

Table 5. Purse Seiner catch rates for 4T herring.

Year	Spring "edge"		Sept.-Oct.-Nov.	October	
	t/set	t/night	t/set*	t/set	t/night
1967	73.1	169.3			
1968	38.1	72.2		68.1	48.7
1969	41.6	75.5	110.2	--	--
1970	38.7	74.2	90.9	62.6	77.5
1971	35.1	85.5	56.7	40.1	70.3
1972	25.9	67.4	45.1	56.2	79.6
1973	40.2	126.3	41.5	146.0	146.0
1974	33.2	97.1	37.9	23.4	40.5
1975	56.6	102.8	34.5	35.0	45.5
1976	34.9	78.2	40.6	40.1	57.1
1977	32.1	60.5	44.4	50.2	78.4
1978	33.2	51.4	44.3	31.9	50.9
1979	32.0	102.4	24.5	20.2	13.9
1980	35.7	76.2	18.7	24.2	31.8
1981			26.6	18.4(22.3)**	24.2(29.0)**
1982				35.2(44.7)**	48.9(62.7)**

* Winters, pers. comm.
** ( ) from the observers' program

Table 6: Catch rates for the spring and fall inshore herring fishery in NAFO Division 4T.

	SPRING FISHERY					FALL FISHERY			
	Caraquet*	Escuminac*	Magdalen Islands		North PEI*	Caraquet*	Escuminac*	Pictou	
	t/s. trip	t/s. trip	lb/n-days	t/trap	t/s. trip	t/s. trip	t/s. trip	mt/s. trip*	t/boat*
1968									25.65
1969									28.71
1970			69.46	204.83					44.24
1971			68.69	328.82					73.34
1972			59.19	123.32					62.24
1973	3.80	2.11	52.13	90.91	1.02	3.11	3.29	1.60	45.53
1974	2.29	1.62	45.40	80.18	0.37	7.14	3.77	0.99	17.42
1975	1.12	1.61	58.48	58.96	1.16	6.79	4.66	1.32	22.63
1976	2.28	2.10	53.51	40.31	0.57	5.50	7.44	1.12	15.21
1977	3.97	2.33	47.22	72.00	0.54	6.18	3.55	1.22	8.64
1978	4.74	2.70	51.91	33.61	1.21	4.20	4.90	1.06	11.75
1979	2.28	1.73	59.77	7.33	1.69	2.75	7.75	1.00	32.96
1980	3.18	1.19	50.84	2.10	0.97	1.78	5.39	0.62	23.45
1981	0.77	0.88	46.58	1.00	1.07	2.37	5.34	1.15	25.54
1982	1.53	2.47	17.85	3.2	2.96	4.52	1.26	0.74	27.86

* Spring fishery: May-June; fall fishery: August-September; 1973 to 1980 data from Messieh, 1981, 1981 data from Randall, pers. comm. and 1982 data from Messieh, pers. comm.
** Data from Crawford, pers. comm.

Table 7. Catch rates (t/successful trip-net) for the spring and fall inshore herring fishery in NAFO Division 4T.

	SPRING FISHERY		FALL FISHERY	
	Caraquet	Escuminac	Caraquet	Escuminac
1973	0.72 (5)*	0.06 (29)	0.44 (7)	--
1974	0.44 (5)	0.05 (27)	0.95 (8)	--
1975	0.19 (6)	0.05 (33)	0.95 (7)	--
1976	0.36 (6)	0.06 (34)	0.62 (9)	--
1977	0.47 (8)	0.07 (32)	0.66 (9)	--
1978	0.55 (9)	0.07 (33)	0.37 (11)	--
1979	0.24 (10)	0.04 (39)	0.23 (12)	--
1980	0.27 (12)	0.03 (39)	0.16 (11)	0.18 (25)
1981	0.06 (13)	0.03 (41)	0.22 (11)	0.18 (23)
1982	0.14 (11)	0.06 (41)	0.41 (11)	0.19 (22)

* ( ) number of nets, rounded.

Table 8. Gillnet catch rates* used for fine tuning the cohort analysis.

	Spring**	Fall***
1973	0.093	0.381
1974	0.057	0.728
1975	0.057	0.889
1976	0.061	0.591
1977	0.075	0.478
1978	0.077	0.360
1979	0.046	0.185
1980	0.041	0.133
1981	0.036	0.182
1982	0.064	0.343

* Calculated as:

Total gillnet landings (O'Boyle and Cleary, 1981) divided by the total number of successful trips (Messieh, 1981, Randall and Messieh, pers. comm.) times the number of nets per trip (O'Boyle and Cleary, 1981, Cleary, unpublished data).

** For the months of April, May and June and districts 63-64-65-66-67-68-69-70-73-75-76-77-78-80-82-83-92

*** For the months of July, August, September, October, November, and districts 63-64-65-66-67-68.

Table 9. Catch-at-age, prorated to age 21, for spring and fall spawner herring in NAFO Division 4T, 1969-1982.

Age group	Catch-at-age in numbers $x10^{-6}$													
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.5	8.1	2.1	0.2	0.0
2	2.5	2.2	8.1	5.8	3.3	9.3	1.7	17.4	3.5	15.8	24.6	21.6	5.8	1.2
3	39.1	50.6	98.8	7.3	5.0	13.7	29.0	9.4	63.3	33.9	19.5	70.4	25.7	39.0
4	37.9	99.6	99.6	43.1	7.0	19.5	23.3	31.2	15.3	95.3	40.3	14.7	38.2	25.2
5	31.7	42.8	48.9	56.9	39.6	7.4	28.7	12.6	14.4	19.1	60.3	24.9	6.7	25.1
6	120.3	42.0	69.1	25.8	25.9	25.7	23.8	33.6	7.2	11.1	13.1	22.6	3.2	5.4
7	144.8	193.0	96.4	31.8	12.9	13.5	23.4	5.0	23.0	4.8	5.3	7.0	5.0	2.3
8	46.9	138.8	128.6	30.1	17.8	6.6	7.5	11.4	2.7	15.3	3.8	2.5	1.6	1.2
9	99.1	53.1	72.8	27.9	9.7	11.2	5.5	4.9	8.0	1.8	5.4	1.5	0.9	0.7
10	249.4	101.1	35.9	16.4	11.8	4.8	9.0	2.4	3.3	4.6	1.4	0.6	0.2	0.2
11	89.6	180.0	51.7	9.3	4.7	7.6	5.6	12.5	1.6	2.2	2.9	0.7	0.2	0.0
12	266.0	267.9	86.3	11.2	1.8	2.4	8.2	6.0	8.1	0.6	1.6	1.6	0.2	0.0
13	0.0	0.0	150.9	14.3	2.3	1.3	3.2	7.5	4.4	2.6	0.5	0.5	0.5	0.0
14	0.0	0.0	0.0	42.7	3.4	1.5	1.4	4.2	5.9	2.2	1.8	0.2	0.1	0.0
15	0.0	0.0	0.0	0.0	7.6	1.8	1.7	1.3	2.8	3.5	1.6	0.6	0.1	0.0
16	0.0	0.0	0.0	0.0	0.0	5.4	2.1	1.6	1.0	1.1	2.5	0.5	0.2	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	5.4	2.2	1.2	0.6	0.7	0.7	0.2	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	1.7	0.6	0.4	0.2	0.2	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.9	0.4	0.1	0.1	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.6	0.1	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.6	0.2	0.0
Total*	1127.3	1171.1	947.1	322.6	152.8	131.7	179.5	167.2	172.8	219.9	196.6	173.8	89.5	100.5
Mean age	9.0	9.0	8.1	7.9	7.2	6.7	6.7	7.0	6.3	5.2	5.1	4.3	4.3	4.1
Proportion (%)														
Fish 5	92.9	87.0	78.2	82.6	90.0	67.7	69.9	65.3	51.3	33.3	52.9	37.3	21.9	34.7
Fall S.	70.5	72.9	77.9	81.1	58.8	56.5	41.5	40.6	36.9	46.1	53.4	46.1	56.9	61.9
Spring S.	29.5	27.1	22.1	18.9	41.2	43.5	58.5	59.4	63.1	53.9	46.6	53.9	43.1	38.1

*Total might be different from the summation of the numbers at age because of rounding.

Table 10. Catch-at-age* and age composition for spring spawner herring in NAFO Division 4T, 1969-1982.

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
	CATCH-AT-AGE ($x10^{-6}$)													
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.5	8.0	2.0	0.2	0.0
2	0.1	0.0	3.2	0.1	1.6	4.6	1.6	17.3	3.3	14.3	21.7	20.3	5.7	1.0
3	17.2	8.4	65.7	2.1	1.7	8.7	26.8	9.1	60.3	14.7	13.3	39.8	16.4	29.6
4	18.0	40.6	6.8	27.5	2.5	3.3	19.2	29.3	7.4	67.7	5.7	5.3	7.6	5.5
5	12.3	12.6	13.6	5.8	31.7	1.7	3.2	7.2	10.8	4.8	32.9	2.9	1.2	1.3
6	29.3	16.6	9.3	5.0	6.1	21.9	16.8	2.4	3.6	7.1	2.1	14.7	0.8	0.3
7	25.1	32.6	8.8	3.3	3.9	3.8	20.1	0.5	0.6	1.3	3.0	3.1	4.1	0.2
8	8.5	35.6	14.3	3.9	6.0	4.1	2.5	9.4	0.5	1.2	0.7	1.9	0.7	0.3
9	48.6	10.2	15.0	4.5	2.3	6.0	3.3	1.1	6.6	0.2	0.2	0.7	0.7	0.1
10	155.4	39.3	5.0	4.9	2.3	0.9	5.3	1.6	0.5	3.7	0.7	0.3	0.1	0.0
11	16.0	108.9	16.5	0.3	2.7	0.7	1.7	9.9	0.9	0.1	2.2	0.5	0.1	0.0
12	1.8	12.5	45.7	0.9	0.2	0.9	1.4	3.2	5.8	0.1	0.1	1.4	0.2	0.0
13	0.0	0.0	5.3	2.5	0.5	0.1	1.7	2.6	1.9	0.9	0.1	0.1	0.5	0.0
14	0.0	0.0	0.0	0.3	1.3	0.2	0.2	3.1	1.5	0.3	0.5	0.1	0.0	0.0
15	0.0	0.0	0.0	0.0	0.2	0.3	0.4	0.4	1.8	0.2	0.2	0.3	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.7	0.2	0.3	0.1	0.1	0.1	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.1	0.4	0.0	0.1	0.1	0.1	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.1	0.0	0.1	0.1	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total**	332.3	317.3	209.2	61.1	63.0	57.3	105.0	99.3	109.1	118.6	91.7	93.7	38.6	38.3
Mean age	8.4	8.5	7.2	6.1	6.2	5.9	5.7	6.1	5.0	4.2	4.0	3.9	4.1	3.3
	Age composition (%)													
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.3	8.7	2.1	0.5	0.0
2	0.0	0.0	1.5	0.2	2.5	8.0	1.5	17.4	3.0	12.1	23.7	21.7	14.8	2.6
3	5.2	2.6	31.4	3.4	2.7	15.2	25.5	9.2	55.3	12.4	14.5	42.5	42.5	77.3
4	5.4	12.8	3.3	45.0	4.0	5.8	18.3	29.5	6.8	57.1	6.2	5.7	19.7	14.4
5	3.7	4.0	6.5	9.5	50.3	3.0	3.0	7.3	9.9	4.0	35.9	3.1	3.1	3.4
6	8.8	5.2	4.4	8.2	9.7	38.2	16.0	2.4	3.3	6.0	2.3	15.7	2.1	0.8
7	7.6	10.3	4.2	5.4	6.2	6.6	19.1	0.5	0.5	1.1	3.3	3.3	10.6	0.5
8	2.6	11.2	6.8	6.4	9.5	7.2	2.4	9.5	0.5	1.0	0.8	2.0	1.8	0.8
9	14.6	3.2	7.2	7.4	3.7	10.5	3.1	1.1	6.0	0.2	0.2	0.7	1.8	0.3
10	46.8	12.4	2.4	8.0	3.7	1.6	5.0	1.6	0.5	3.1	0.8	0.3	0.3	0.0
11	4.8	34.3	7.9	0.5	4.3	1.2	1.6	10.0	0.8	0.1	2.4	0.5	0.3	0.0
12	0.5	3.9	21.8	1.5	0.3	1.6	1.3	3.2	5.3	0.1	0.1	1.5	0.4	0.0
13	0.0	0.0	2.5	4.1	0.8	0.2	1.6	2.6	1.7	0.8	0.1	0.1	1.2	0.0
14	0.0	0.0	0.0	0.5	2.1	0.3	0.2	3.1	1.4	0.3	0.5	0.1	0.1	0.0
15	0.0	0.0	0.0	0.0	0.3	0.5	0.4	0.4	1.6	0.2	0.2	0.3	0.1	0.0
16	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.7	0.2	0.3	0.1	0.1	0.3	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.1	0.4	0.0	0.1	0.1	0.3	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.0	0.0	0.1	0.1	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.1	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
< 4	5.2	2.6	32.9	3.6	5.2	23.2	27.0	26.6	60.1	25.7	46.9	66.3	57.8	79.9

* Data from 1969 to 1981 from Writers, pers. comm. and Moores pers. comm.
**Total might be different from the summation of the numbers at age because of rounding.

Table 11. Catch-at-age* and age composition of fall spawner herring in NAFO Division 4T, 1969-1982.

CATCH-AT-AGE ($x10^{-6}$)

Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
2	2.4	2.2	4.9	5.7	1.7	4.7	0.1	0.1	0.2	1.5	2.9	1.3	0.1	0.2
3	21.9	42.2	33.1	5.2	3.3	5.0	2.2	0.3	3.0	19.2	6.2	30.6	9.3	9.4
4	19.9	59.0	92.8	15.6	4.5	16.2	4.1	1.9	7.9	27.6	34.6	9.4	30.6	19.7
5	19.4	30.2	35.3	51.1	7.9	5.7	25.5	5.4	3.6	14.3	27.4	22.0	5.5	23.8
6	91.0	25.4	59.8	20.8	19.8	3.8	7.0	31.2	3.6	4.0	11.0	7.9	2.4	5.1
7	119.7	160.4	87.6	28.5	9.0	9.7	3.3	4.5	22.4	3.5	2.3	3.9	0.9	2.1
8	38.4	103.2	114.3	26.2	11.8	2.5	5.0	2.0	2.2	14.1	3.1	0.6	0.9	0.9
9	50.5	42.9	57.8	23.4	7.4	5.2	2.2	3.8	1.4	1.6	5.2	0.8	0.2	0.6
10	94.0	61.8	30.9	11.5	9.5	3.9	3.7	0.8	2.8	0.9	0.7	0.3	0.1	0.2
11	73.6	71.1	35.2	9.0	2.0	6.9	3.9	2.6	0.7	2.1	0.7	0.2	0.1	0.0
12	264.2	255.4	40.6	10.3	1.6	1.5	6.8	2.8	2.3	0.5	1.5	0.2	0.1	0.0
13	0.0	0.0	145.6	11.8	1.8	1.2	1.5	4.9	2.5	1.7	0.4	0.4	0.1	0.0
14	0.0	0.0	0.0	42.4	2.1	1.3	1.2	1.1	4.4	1.9	1.3	0.1	0.1	0.0
15	0.0	0.0	0.0	0.0	7.4	1.5	1.3	0.9	1.0	3.3	1.4	0.3	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	5.3	1.5	0.9	0.8	0.8	2.4	0.4	0.1	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	5.2	1.1	0.8	0.6	0.6	0.6	0.1	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	1.0	0.6	0.4	0.2	0.2	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.8	0.4	0.1	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.6	0.1	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.6	0.2	0.0
Total**	795.0	853.8	737.9	261.5	89.8	74.4	74.5	67.9	63.7	101.3	104.9	80.1	50.9	62.2
Mean age	9.2	8.7	8.3	8.3	7.9	7.4	8.1	8.3	8.5	6.4	6.1	4.8	4.4	4.7

Age composition (%)

1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
2	0.3	0.3	0.7	2.2	1.9	6.3	0.1	0.1	0.3	1.5	2.8	1.6	0.2	0.3
3	2.8	4.9	4.5	2.0	3.7	6.7	3.0	0.4	4.7	19.0	5.9	38.2	18.3	15.1
4	2.5	6.9	12.6	6.0	5.0	21.8	5.5	2.8	12.4	27.2	33.0	11.7	60.1	31.7
5	2.4	3.5	4.8	19.5	8.8	7.7	34.2	8.0	5.7	14.1	26.1	27.5	10.8	38.3
6	11.4	3.0	8.1	8.0	22.0	5.1	9.4	45.9	5.7	3.9	10.5	9.9	4.7	8.2
7	15.1	18.8	11.9	10.9	10.0	13.0	4.4	6.6	35.2	3.5	2.2	4.9	1.8	3.4
8	4.8	12.1	15.5	10.0	13.1	3.4	6.7	2.9	3.5	13.9	3.0	0.7	1.8	1.4
9	6.4	5.0	7.8	8.9	8.2	7.0	3.0	5.6	2.2	1.6	5.0	1.0	0.4	1.0
10	11.8	7.2	4.2	4.4	10.6	5.2	5.0	1.2	4.4	0.9	0.7	0.4	0.2	0.3
11	9.3	8.3	4.8	3.4	2.2	9.3	5.2	3.8	1.1	2.1	0.7	0.2	0.2	0.0
12	33.2	29.9	5.5	3.9	1.8	2.0	9.1	4.1	3.6	0.5	1.4	0.2	0.1	0.0
13	0.0	0.0	19.7	4.5	2.0	1.6	2.0	7.2	3.9	1.7	0.4	0.5	0.1	0.0
14	0.0	0.0	0.0	16.2	2.3	1.7	1.6	1.6	6.9	1.9	1.2	0.1	0.2	0.0
15	0.0	0.0	0.0	0.0	8.2	2.0	1.7	1.3	1.6	3.3	1.3	0.4	0.1	0.0
16	0.0	0.0	0.0	0.0	0.0	7.1	2.0	1.3	1.3	0.8	2.3	0.5	0.2	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	7.0	1.6	1.3	0.6	0.6	0.7	0.2	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	1.6	0.6	0.4	0.2	0.4	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.8	0.4	0.1	0.1	0.1
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.6	0.1	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.7	0.3	0.0
< 4	3.1	5.2	5.1	4.2	5.6	13.0	3.1	0.6	5.0	20.4	8.8	40.0	18.5	15.4

* Data from 1969 to 1981 from Writers, pers. comm. and Moores, pers. comm.
**Total might be different from the summation of the numbers at age because of rounding.

Table 12. Population number estimates and fishing mortality rates for fall spawner herring, using a $F_{5-7} = 0.70$

POPULATION NUMBERS $x10^6$

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	477	134	83	311	62	42	91	134	146	60	188	92	81	125
3	258	388	108	64	249	49	30	75	110	120	48	152	74	67
4	328	191	280	58	47	201	36	22	61	87	81	34	97	52
5	354	250	103	145	33	35	150	25	17	43	47	35	19	51
6	720	272	178	52	72	20	23	100	16	10	22	13	8	11
7	429	507	200	91	24	41	13	13	53	10	5	8	4	5
8	199	243	270	84	49	12	25	8	6	23	5	2	3	2
9	254	128	105	118	45	29	7	16	5	3	6	1	1	2
10	336	162	66	34	75	30	19	4	10	2	1	1	0	1
11	877	190	77	26	17	53	21	13	2	5	1	0	0	0
12	333	651	91	31	13	12	37	14	8	1	3	0	0	0
13			302	38	16	9	9	24	9	4	1	1	0	0
14				116	20	12	7	6	15	5	2	0	0	0
15					56	15	8	4	4	9	2	1	0	0
16						39	11	6	3	2	4	1	0	0
17							27	7	4	2	1	1	0	0
18								18	5	2	1	0	0	0
19									11	3	1	0	0	0
20										6	2	1	0	0
21											3	1	1	0
Total	4565	3116	1863	1168	778	599	514	489	485	397	424	344	288	316

FISHING MORTALITY

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	0.006	0.018	0.067	0.020	0.031	0.133	0.001	0.001	0.002	0.028	0.017	0.016	0.001	0.002
3	0.099	0.128	0.416	0.094	0.015	0.120	0.085	0.004	0.031	0.195	0.154	0.252	0.149	0.169
4	0.069	0.417	0.457	0.352	0.111	0.093	0.136	0.098	0.155	0.430	0.644	0.368	0.431	0.528
5	0.062	0.143	0.476	0.494	0.302	0.200	0.208	0.268	0.273	0.462	1.053	1.211	0.382	0.705
6	0.150	0.109	0.465	0.577	0.360	0.232	0.403	0.424	0.288	0.554	0.803	1.071	0.377	0.734
7	0.369	0.430	0.662	0.423	0.532	0.300	0.325	0.493	0.623	0.505	0.735	0.763	0.311	0.661
8	0.240	0.635	0.630	0.420	0.310	0.272	0.249	0.335	0.479	1.093	1.240	0.424	0.389	0.580
9	0.248	0.461	0.933	0.248	0.199	0.217	0.410	0.304	0.415	0.791	2.236	1.486	0.242	0.484
10	0.370	0.545	0.725	0.470	0.150	0.152	0.237	0.255	0.385	0.517	1.033	0.889	0.739	0.404
11	0.097	0.535	0.702	0.476	0.136	0.155	0.225	0.261	0.371	0.563	1.033	0.997	0.628	0.308
12	2.100	0.568	0.679	0.453	0.142	0.144	0.226	0.250	0.389	0.497	1.078	0.997	0.739	0.308
13			0.761	0.424	0.130	0.150	0.209	0.253	0.370	0.560	0.994	0.997	0.739	0.308
14				0.520	0.122	0.131	0.221	0.223	0.379	0.537	1.208	0.733	0.739	0.308
15					0.157	0.120	0.187	0.257	0.345	0.548	1.020	1.083	0.504	0.308
16						0.161	0.169	0.192	0.383	0.515	1.044	0.965	1.011	0.308
17							0.235	0.180	0.260	0.557	0.960	0.825	0.790	0.308
18								0.253	0.248	0.318	0.934	1.068	0.739	0.308
19									0.361	0.321	0.364	0.637	0.628	0.308
20										0.501	0.426	0.144	0.246	0.308
21											0.864	1.015	0.357	0.308
F_{5-7}	0.194	0.227	0.534	0.498	0.398	0.244	0.312	0.395	0.395	0.507	0.864	1.015	0.357	0.700

Table 13. Average weights at age for fall spawner herring, for the first quarter of the year*.

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	-	-	-	-	-	-	-	-	-	-	-	50	-	-
2	(40)	(40)	(40)	(40)	(40)	47	(40)	35	(40)	(40)	37	76	-	93.6
3	63	88	93	53	100	126	115	111	99	128	83	109	143.4	150.6
4	149	133	142	168	170	190	169	184	166	191	168	172	241.6	154.9
5	171	188	189	194	206	235	215	217	202	231	217	224	273.4	188.9
6	197	202	129	238	242	255	248	253	229	260	262	257	316.7	236.9
7	225	221	234	253	269	283	272	276	260	288	288	300	326.1	323.7
8	236	244	248	262	292	314	288	283	276	315	312	329	347.8	237.0
9	247	255	264	277	295	327	314	300	287	313	329	346	394.0	285.0
10	254	262	272	287	313	331	325	323	285	322	333	375	327.5	-
11	281	290	297	312	342	354	362	349	324	363	380	386	426.8	389.0

* 1969 to 1981 data from Winters, pers. comm.

Table 14. Projections of the catch and biomass of fall spawner herring, assuming a catch of 17,000 t in 1983 and a fishing mortality $F_{0.1}$ = 0.382 in 1984 and 1985

POPULATION NUMBERS x10^6

	1982	1983	1984	1985
2	115	115	115	115
3	67	94	94	94
4	52	46	63	71
5	51	25	20	39
6	11	21	9	11
7	5	4	7	5
8	2	2	2	4
9	2	1	1	1
10	1	1	0	1
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
	307	311	312	342

POPULATION BIOMASS

	1982	1983	1984	1985
2	11741.48	11741.48	11741.48	11741.48
3	10682.76	15124.01	15121.02	15139.55
4	13786.50	12093.35	16509.59	18561.06
5	14211.53	7015.60	5491.79	10824.45
6	3608.41	7009.56	2973.41	3798.17
7	1914.06	1696.22	2813.45	1987.63
8	874.23	785.76	604.06	1585.67
9	731.66	436.66	347.02	399.16
10	311.41	406.96	218.84	243.53
11	42.69	186.26	223.14	158.85
12	42.69	25.67	104.84	155.61
13	21.32	25.67	14.45	73.12
14	21.32	12.82	14.45	10.08
15	42.69	12.82	7.21	10.08
16	21.32	25.67	7.21	5.03
17	21.32	12.82	14.45	5.03
18	42.69	12.82	7.21	10.08
19	85.43	25.67	7.21	5.03
20	21.32	51.39	14.45	5.03
21	33.50	12.82	28.93	10.08
	58258.34	56714.35	56264.57	64729.05

Table 14. (continued)

CATCH NUMBERS $x10^6$

	1982	1983	1984	1985
2	0	0	0	0
3	9	16	7	7
4	20	20	14	15
5	24	13	6	11
6	5	11	3	3
7	2	2	2	1
8	1	1	0	1
9	1	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
	62	65	32	40

CATCH BIOMASS

	1982	1983	1984	1985
2	20	23	10	10
3	1508	2551	1154	1156
4	5174	5250	3615	4064
5	6591	3710	1537	3030
6	1722	3805	861	1100
7	848	860	746	527
8	353	364	143	376
9	257	178	70	81
10	94	144	38	42
11	10	53	30	21
12	10	7	14	21
13	5	7	2	10
14	5	4	2	1
15	10	4	1	1
16	5	7	1	1
17	5	4	2	1
18	10	4	1	1
19	21	7	1	1
20	5	15	2	1
21	15	4	4	1
	16670	17000	8234	10446

Table 14. (continued)

FISHING MORTALITY

	1982	1983	1984	1985
2	0.002	0.002	0.001	0.001
3	0.169	0.205	0.088	0.088
4	0.528	0.642	0.275	0.275
5	0.705	0.856	0.367	0.367
6	0.734	0.892	0.382	0.382
7	0.661	0.803	0.344	0.344
8	0.582	0.705	0.302	0.302
9	0.485	0.589	0.252	0.252
10	0.404	0.491	0.210	0.210
11	0.309	0.375	0.160	0.160
12	0.309	0.375	0.160	0.160
13	0.309	0.375	0.160	0.160
14	0.309	0.375	0.160	0.160
15	0.309	0.375	0.160	0.160
16	0.309	0.375	0.160	0.160
17	0.309	0.375	0.160	0.160
18	0.309	0.375	0.160	0.160
19	0.308	0.375	0.160	0.160
20	0.309	0.375	0.160	0.160
21	0.309	0.375	0.160	0.160

Table 15. Population biomass in tons (first quarter of the year) for fall spawner herring in NAFO Division 4T, from 1969 to 1985

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	19068	5353	3331	12428	2466	1959	3654	4704	5852	2416	6974	7015	0	11735
3	16229	34153	10004	3378	24921	6165	3434	8292	10885	15307	3992	16535	10668	10027
4	48830	25415	39699	9764	8072	38199	6006	4132	10108	16675	13530	5808	23317	8131
5	60527	47058	19479	28115	6894	8178	32238	5509	3367	9864	10091	7757	5232	9696
6	141853	54993	22912	12481	17524	5164	5787	25222	3641	2701	5770	3414	2674	2533
7	96451	112091	46779	23100	6487	11708	3575	3525	13881	2811	1407	2423	1215	1535
8	47004	59209	66991	22115	14298	3643	7228	2200	1762	7385	1505	631	1073	530
9	62800	32722	27797	32613	13394	9618	2272	4807	1308	1013	2117	396	405	488
10	85244	42567	18018	9731	23544	10088	6297	1271	2759	793	401	212	70	0
11+	339888	243895	139660	65813	42254	49794	43646	32061	19930	14786	8109	2481	966	299
TOTAL	917894	657456	394670	219538	15985	144515	114137	91723	73493	73751	53896	46672	45620	44974
Age 4+	882597	617950	381335	203732	132467	136391	107049	78727	56756	56028	42930	23122	34952	23212

	1983	1984	1985
2	10797	10797	10797
3	14195	14170	14210
4	7132	8398	10929
5	4785	2357	6368
6	4919	1125	1677
7	1359	1185	859
8	475	204	503
9	290	139	149
10	282	99	101
11+	309	249	242
Total	44543	38723	45835
4+	19551	13756	20828

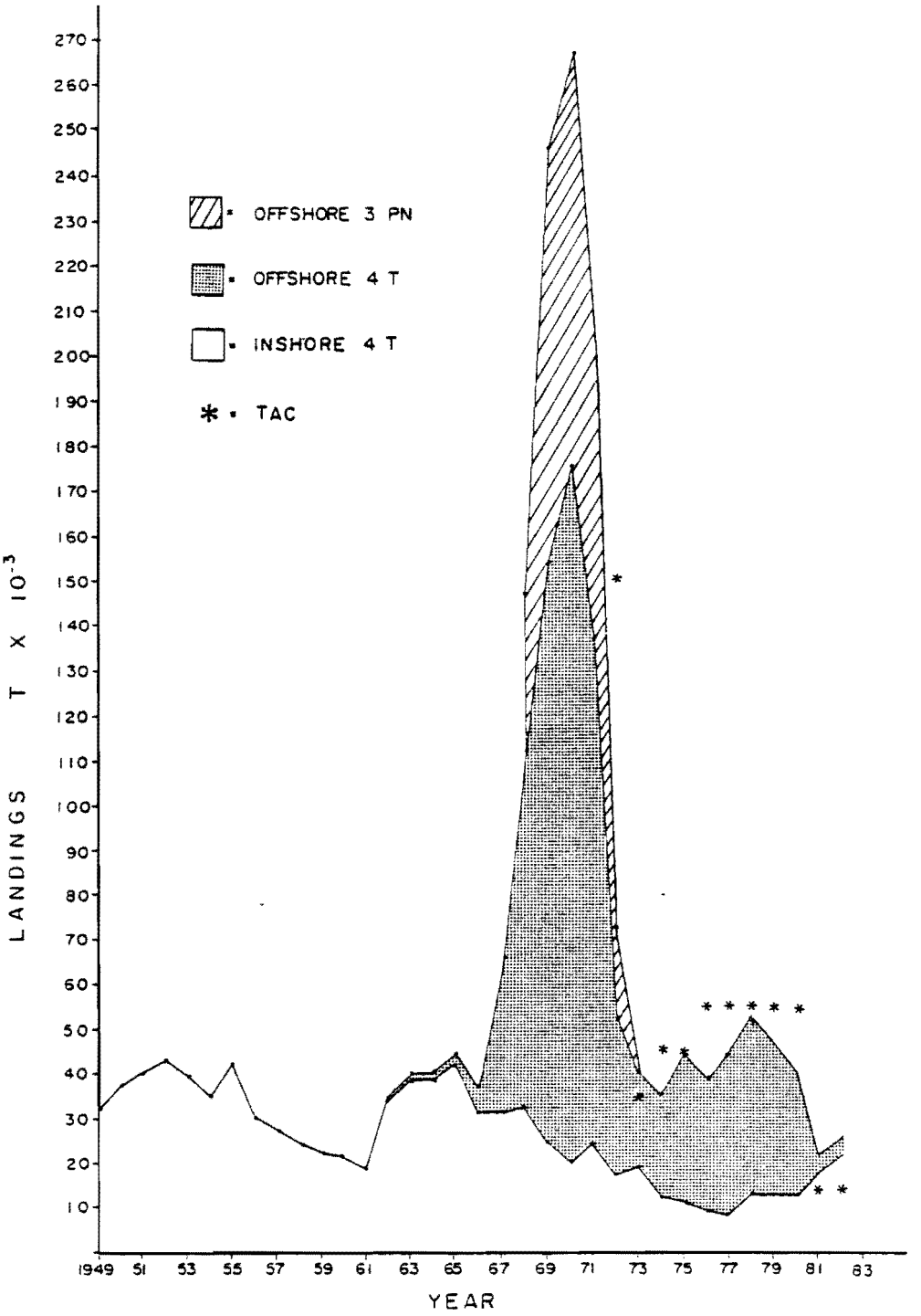

FIGURE 1. Commercial landings of 4T-3Pn herring, from the inshore and offshore fishery.

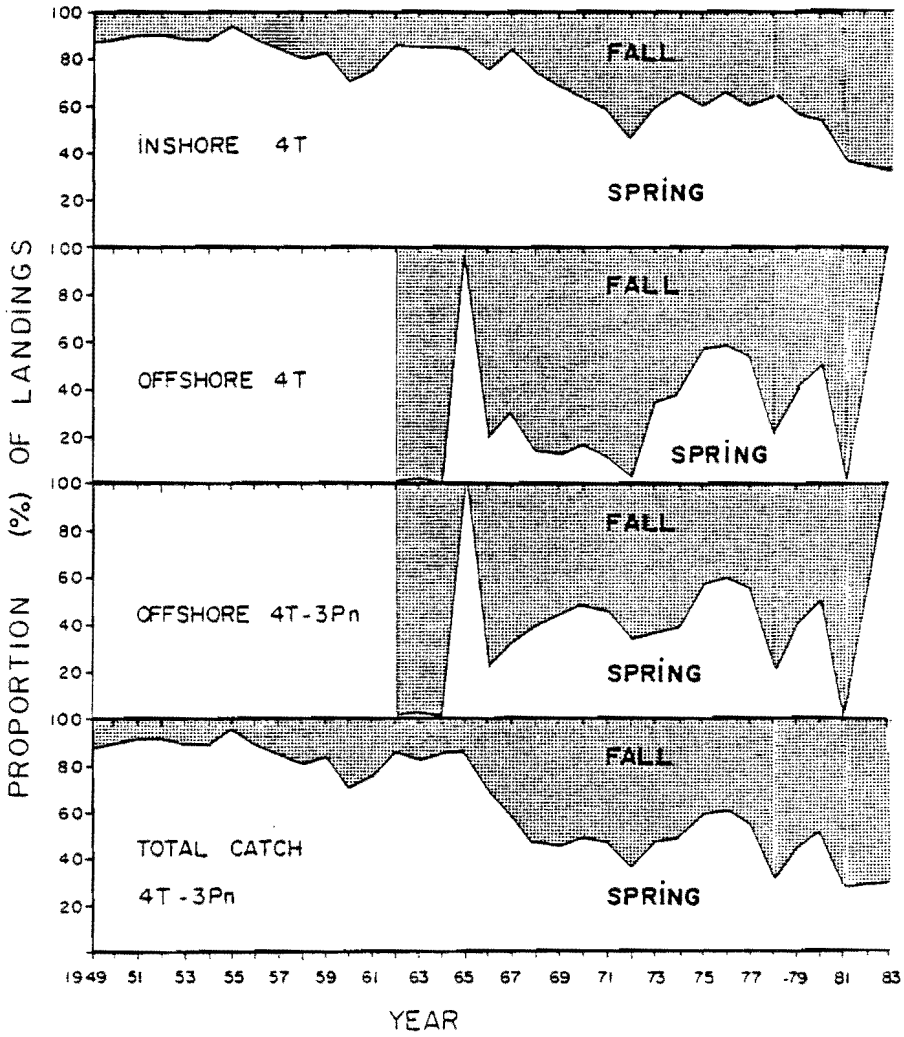

FIGURE 2. Proportion of herring caught during the spring and fall fishing seasons in NAFO division 4T and subdivision 3Pn.

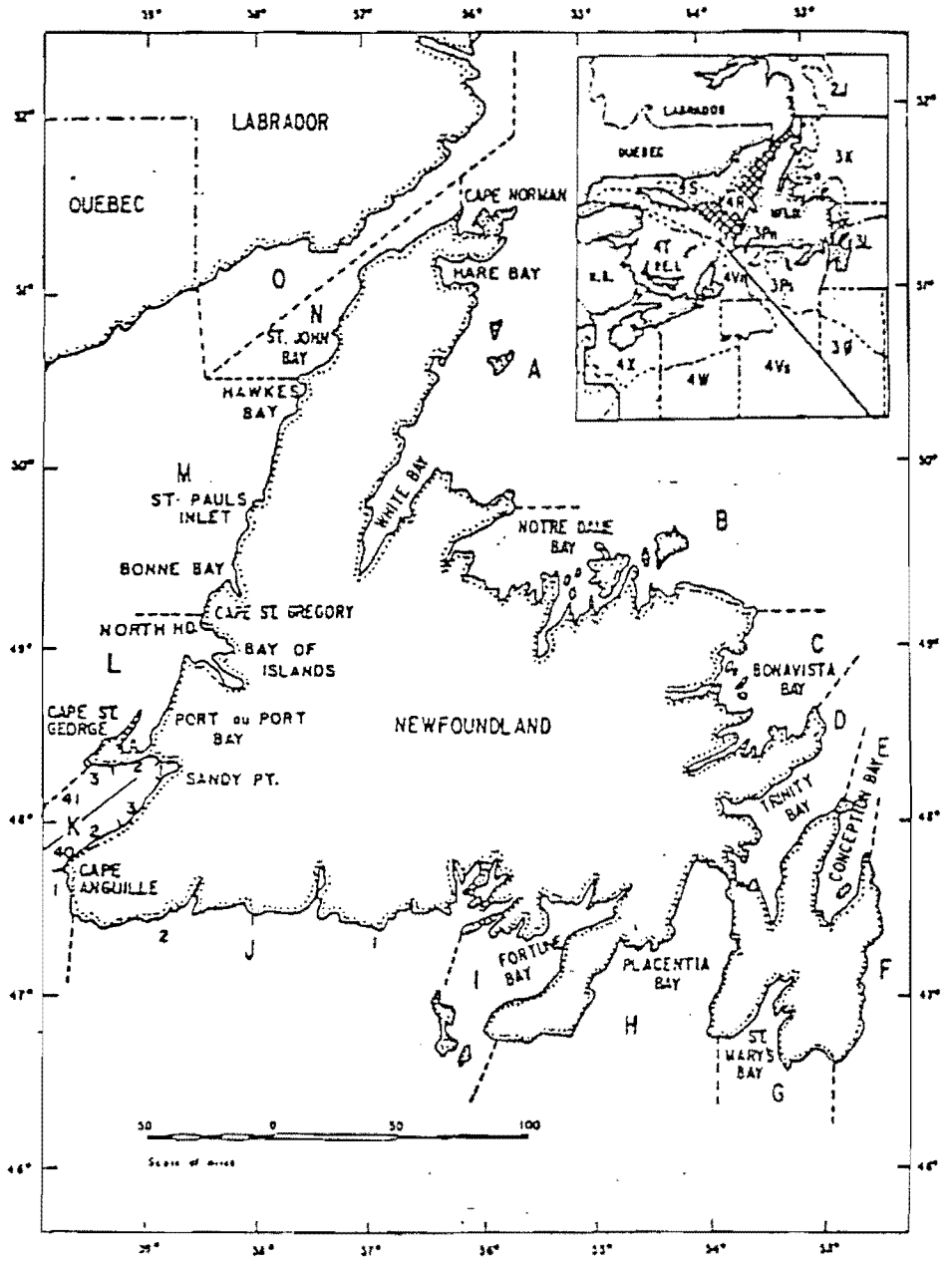

FIGURE 3. Map of the Newfoundland fishing areas.

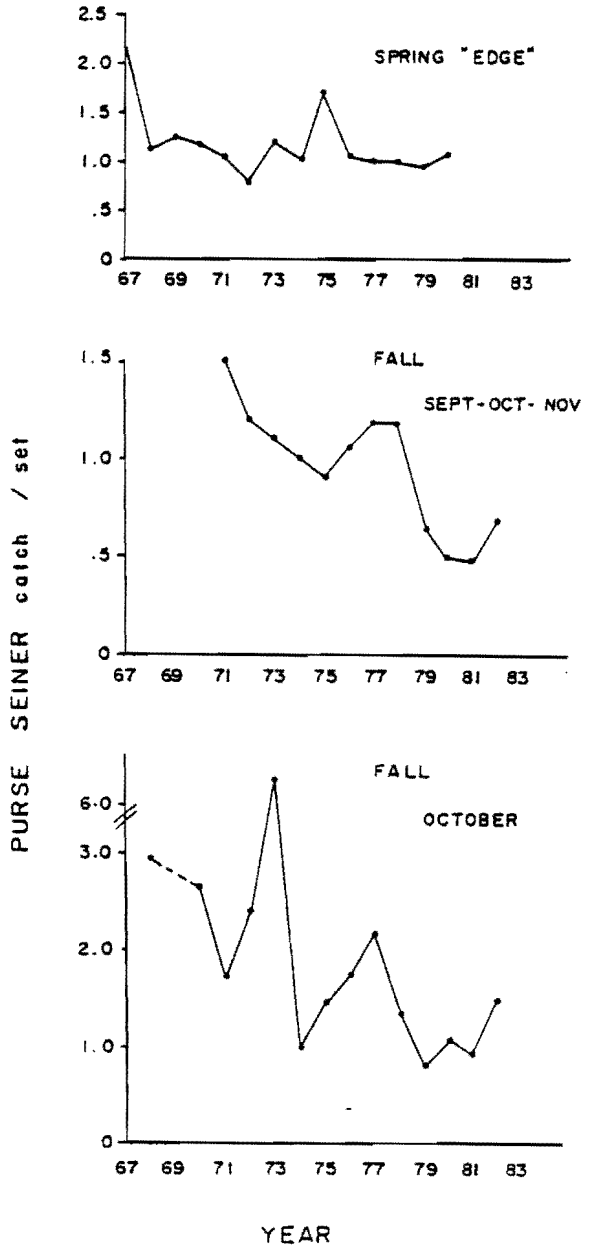

FIGURE 4. Herring catch rates, standardized to 1974, from the purse seiner Fishery, in the spring and fall seasons in the southern Gulf of St. Lawrence.

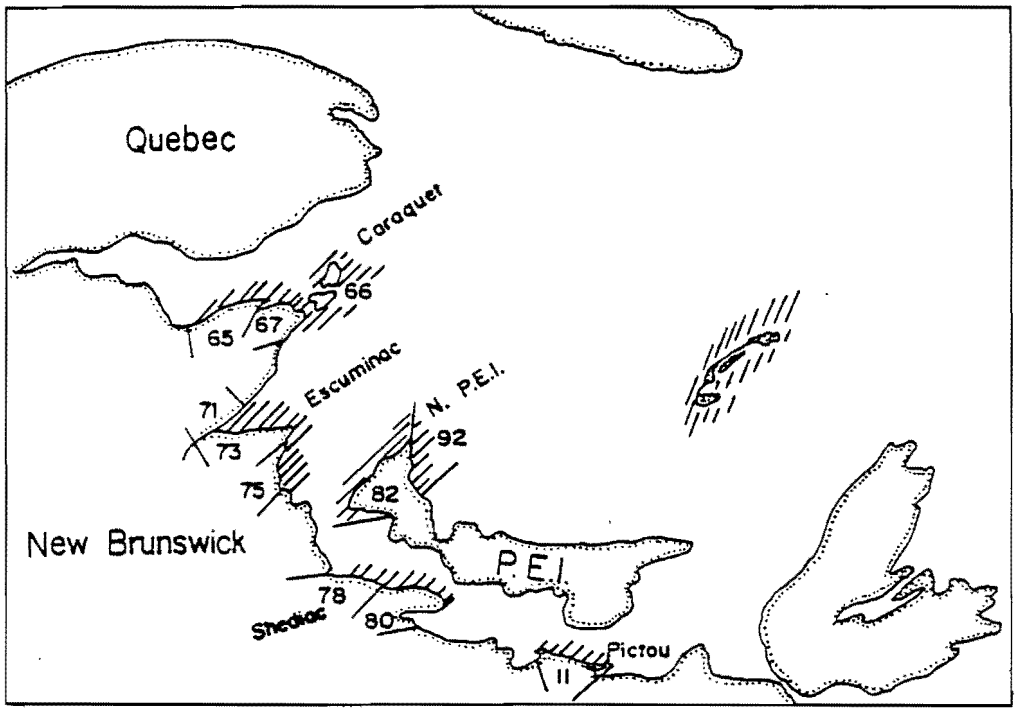

FIGURE 5. Map of southern Gulf of St. Lawrence showing the areas where the major gillnet landings are made each year, and for which catch rates were calculated.

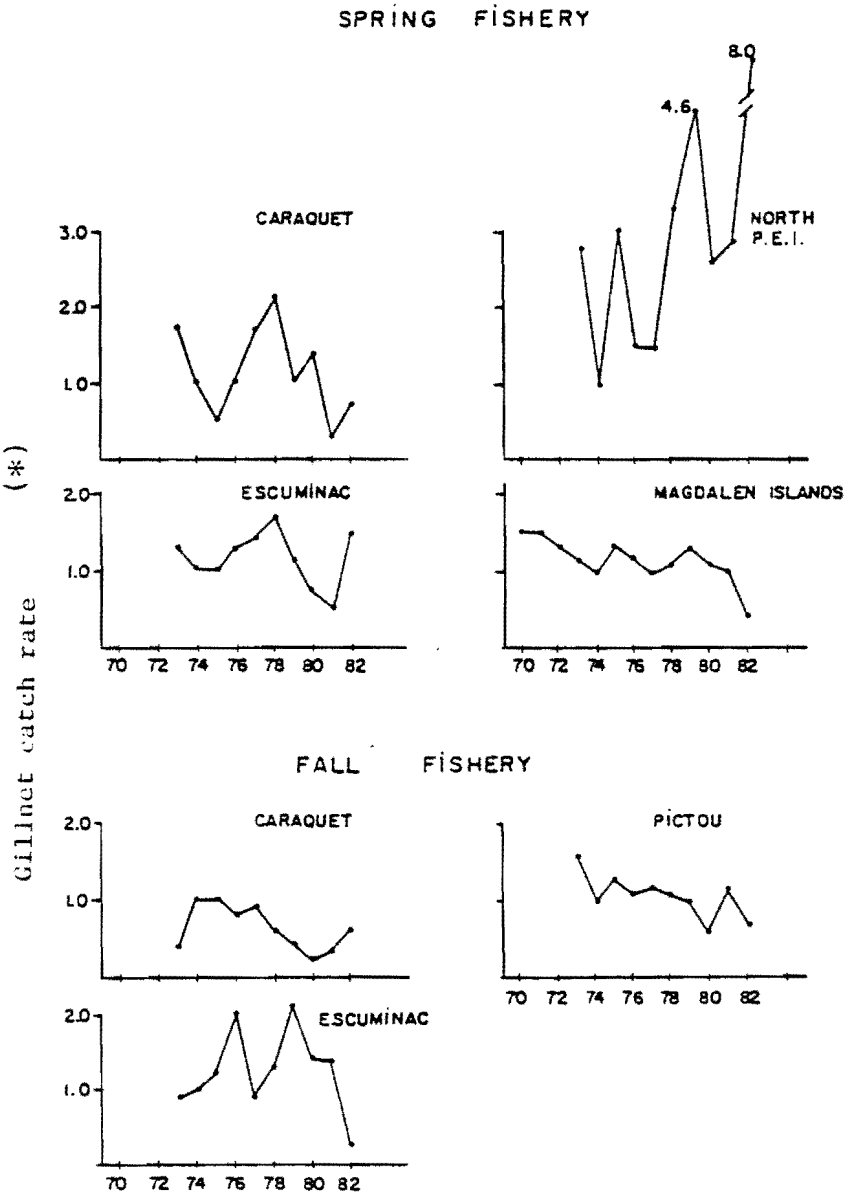

Figure 6. Herring catch rates (standardized to 1974) from the gillnet spring and fall fishery in the Southern Gulf of St. Lawrence.
*units shown on table 6.

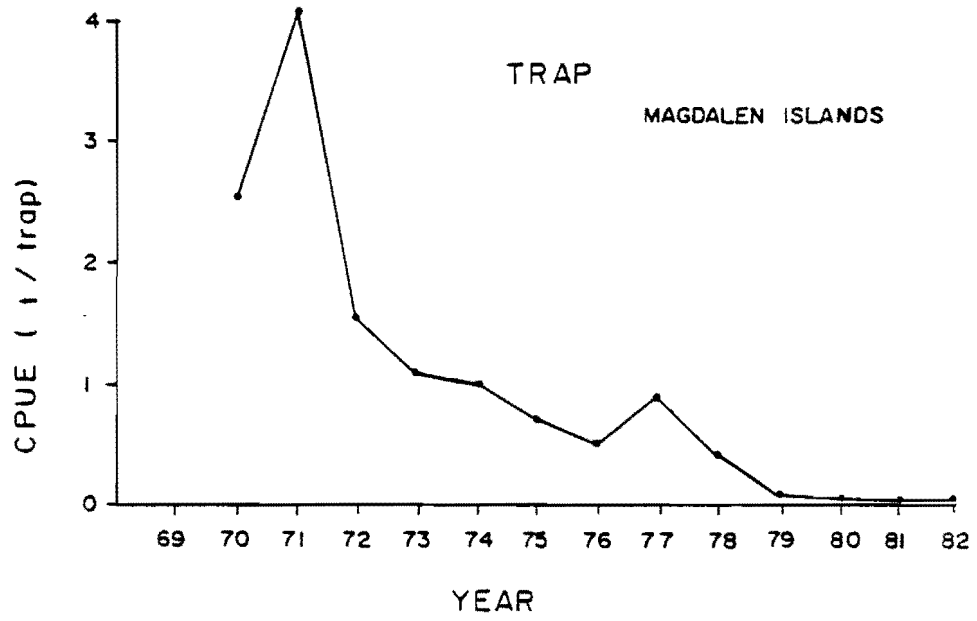

FIGURE 7. Herring catch rates (standardized to 1974) from the Magdalen Islands trap fishery.

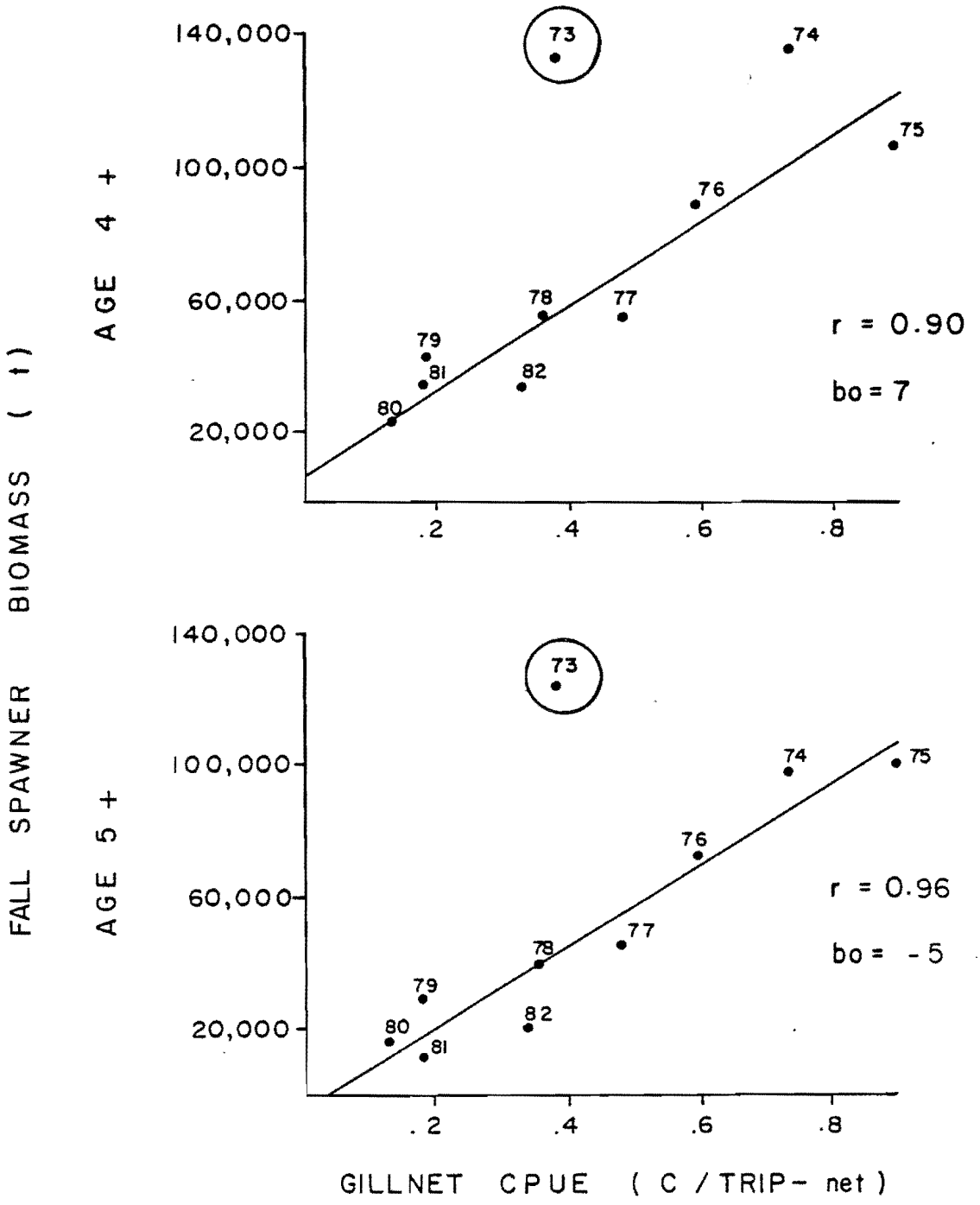

Figure 8. Relationship between the fall spawner biomass ages 4+ and 5+ and gillnet catch rates for the fall spawner fishery. The 1973 point is excluded from the regression.

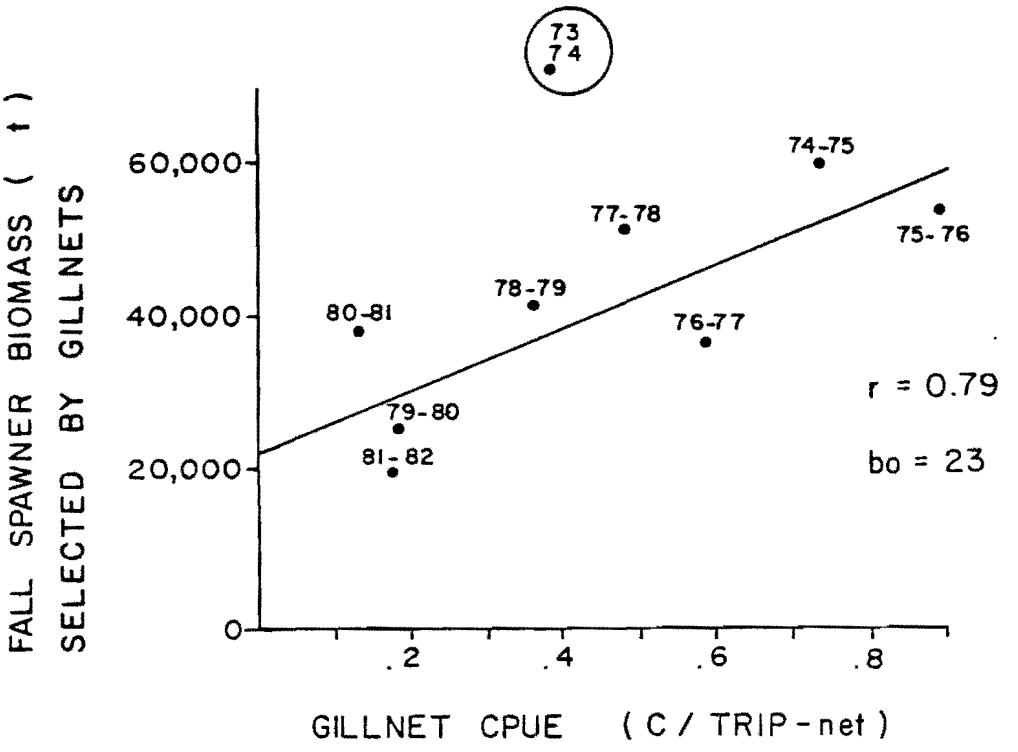

Figure 9. Relationship between the January fall spawner biomass selected by gillnets and the gillnet catch rates for the fall spawner fishery from the previous year. The 1973-74 point was excluded from the regression.