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An Assessment of the West Coast of Newfoundland (NAFO Division 4R) Herring Resource up to 1992

by

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ABSTRACT

Herring stocks are exploited in NAFO division 4R from April to December, by both fixed and mobile gears. Landings reached only 15,300 mt in 1992, despite a TAC of 35,000 mt, mainly due to limited markets. Spring spawners have been predominant in the annual catches since 1973. Since 1985, the 1980 and 1982 spring- spawning year-classes have comprised > 68% of the annual catch in numbers. The 1979 year-class has been the single most important autumn-spawning cohort in the catch since 1983. The 1986 and 1987 autumn- and spring-spawning year-classes, respectively, have contributed strongly since 1990. The spring-spawning gillnet catch-rate indices decreased substantially in 1992, while the autumn-spawning indices increased dramatically, indicating that the 1986 autumn-spawning cohort is well above average, while the spring-spawning 1987 cohort appears much less substantial. The spring-spawner cohort analysis indicated that the 5+ mid-year biomass has declined since 1987, and the weighted 6+ terminal F was estimated at 0.4 in 1992. Cohort analysis for the autumn spawners resulted in unconverged population numbers, although this signified that the autumn-spawning stock has not undergone as high an exploitation rate in recent years as the spring-spawning component.

RÉSUMÉ

Les stocks de hareng de la division 4R de l'OPANO sont exploités d'avril à décembre, à l'aide d'engins fixes et mobiles. Malgré un TPA de 35 000 t, les débarquements de hareng n'ont atteint que 15 300 t en 1992, particulièrement à cause des marchés restreints. Les reproducteurs de printemps dominent les captures depuis 1973. Les classes d'âge de 1980 et 1982 ont représenté plus de 68% de la capture des reproducteurs de printemps en nombre depuis 1985. Depuis 1983, la classe d'âge de 1979 a dominé les captures des reproducteurs d'automne. Les classes d'âge de 1986 et de 1987 des stocks reproducteurs d'automne et de printemps, respectivement, ont contribué fortement depuis 1990. Les indices d'abondance des reproducteurs de printemps ont démontré une diminution d'abondance significative en 1992, pendant que les indices du groupe d'automne ont connu une augmentation dramatique en 1992, qui indiquent que la classe d'âge de 1986 est plus forte que la moyenne, tandis que celle de 1987 est beaucoup moins substantielle. L'analyse de cohorte pour les reproducteurs de printemps a indiqué que la biomasse 5+ a diminué depuis 1987, et que le F terminal 6+ a été de 0,4 en 1992. L'analyse de cohorte pour les reproducteurs d'automne a produit des estimations d'effectifs non-convergentes. Ceci indique que le stock d'automne n'a pas subit un taux d'exploitation aussi élevé que les reproducteurs de printemps ces dernières années.

INTRODUCTION

Atlantic herring (*Clupea harengus* L.) in NAFO Division 4R (Figure 1) have been assessed by CAFSAC as a single management unit since the stock limits were defined in 1977 (Moores and Winters, 1977). The 4R herring management unit was defined essentially on the basis of tagging studies conducted between 1975 and 1980 (Moores and Winters, 1984). These studies indicated that herring tagged during the pre-spawning, spawning and overwintering seasons along the west coast of Newfoundland were primarily (99.2%) recaptured within Division 4R. This division was therefore considered to be "an appropriate reference for [herring] stock assessment purposes" (Moores and Winters, 1984). Although there were indications from sampling and tagging data that herring concentrations exploited in Bay St. Georges in the spring fishery between 1967 and 1972 were possibly a mixture of west coast and southern Gulf stocks, Moores (1983) concluded that herring caught in this area since 1973 were primarily of west coast origin.

As in previous assessments, the spring- and autumn-spawning components of the west coast of Newfoundland herring resource have been reviewed separately.

DESCRIPTION OF THE FISHERY AND HISTORICAL FISHING PATTERNS

Total herring landings from the west coast of Newfoundland were relatively small from 1966 to 1970, ranging between 3,000 and 6,000 mt (Table 1, Figure 2). A marked increase in catches began in 1971, peaking at 27,000 mt in 1973, as plant processors shifted from fish meal production to barrelled products for human consumption subsequent to the decline of the North Sea herring stocks. Landings in 4R decreased sharply in 1974 and 1975 as the purse seine fleet shifted its activities to the overwintering herring concentrations in NAFO subdivision 4Vn. Again, landings steadily increased between 1976 and 1980, this trend being reversed in 1981, mainly due to depressed markets. Augmented sales to eastern block countries in 1985 stimulated another increasing trend in landings which peaked at 21,400 mt in 1986, but which has levelled off at between 15,300 mt and 19,400 mt in the last six years.

The herring stocks in 4R are exploited mainly by large (>85') purse seiners, small (<65') purse seiners and to a much lesser extent by fixed gillnetters from April to December on both spawning and overwintering concentrations. Since 1985, the proportion of the total catch taken by the purse seines has been in excess of 80%, and reached 96% in 1992 (Figure 3).

From 1984 to 1987, the majority of the purse seine catches were taken in areas 4Rb and 4Rc from October to December (Table 2a) from overwintering concentrations of mixed spring and autumn spawners (Table 3). This fishery contributed to over 80% of the purse seine landings in 1986 and 1987. In recent years, the traditional barrelled-product market for Newfoundland herring has been slowly replaced by an expansion in over-the-side sales (OSS) to the Russians, and by the development of a spring frozen-round market for the Japanese and Koreans. This, along with some quota sharing with the purse seine fleet based in the southern Gulf of St. Lawrence, explains the considerable increase in landings from the spring fishery in 4Rc and 4Rd (from approximately 2,000 mt in 1987 to 12,400 mt in 1991). This spring fishery accounted for 75 and 66% of the total purse seine catch in 1990 and 1991, respectively (Figure 4a), up from 50-55% in the previous two years.

In 1992, however, catches decreased by 3,000 mt in the spring fishery. Although there are both spring and autumn spawners in the Bay St. Georges area, spring spawners are preferred for the oriental frozen-round market. Adequate concentrations of this spawning group were difficult to locate in the spring of 1992 (R. Dumphy, purse seine fleet manager, Barry's Fisheries Ltd, pers. comm.). Equally, the traditional fall Bonne Bay fishery was curtailed in 1992, as the usual large concentrations of herring left the bay area a month earlier than usual (end of November rather than the end of December), resulting in a shortfall of approximately 1,500 mt compared to 1991. Curiously, this earlier-than-usual winter migration was also observed for the herring stocks in the Sydney Bight (4TVn) and Chedabucto Bay (4WX) areas at approximately the same time (R. Dumphy, ibid., pers. comm.).

Concurrent with changes to the fishing pattern of the large purse seine fleet has been an increase in the activity of the smaller (<65') purse seiners along the west coast. These vessels, which have traditionally fished capelin, have been issued "experimental" herring licences under the inshore allocation since 1989. Annual landings from this gear sector had not exceeded 800 mt until 1992, when they landed 2,200 mt.

Total gillnet landings (Table 1), and therefore the proportion of the total catch taken by gillnets (Figure 3), have dwindled since 1980. Due to a limited market demand for gillnetted herring, less than 10% of the total 4R landings have been reported from the fixed gear sector since 1985, with the exception of 1987 (17%). The inshore fishery is now almost exclusively oriented toward supplying bait for the active lobster fishery. Since 1989, the late fall (October-December) fishery has been extremely limited, although this was at least in part due to exceptionally poor weather conditions over the past several years. Since 1991, the market for gillnetted herring has been essentially moribund, with recorded landings below 550 mt.

From 1979 to 1989, almost equal proportions of the total gillnet catch was taken from spawning concentrations spring spawners (Table 4) in Bay St. Georges and Port-au-Port Bay (4Rd,4Rc) in April and May, and north of Pointe Riche (4Ra,4Rb) from July to September (Table 2b; Figure 4b). A late fall fishery on mixed spring- and autumn-spawner concentrations (Table 4) has also occurred, although sporadically, in areas 4Ra to 4Rc throughout this period. Since 1990, gillnet landings in Bay St. Georges and Port-au-Port Bay have been marginal (Table 2b).

Gillnet fishermen in the Bay St. Georges/Port-au-Port areas have complained that for the past two or three years, the spring- spawning herring are not coming in to spawn in the numbers seen over the past decade. Comments collected from written questionnaires sent to all licensed inshore herring fishermen, as well as comments from index-fishermen, showed a general consensus on this observation in the Bay St. Georges/ Port-au-Port area (Figure 5a) and equally in the southern portions of unit area 4Rb (Figure 5b). However, north of Pointe Riche in unit area 4Ra (the major autumn-spawning area), opinions are shared between those who feel that the abundance of herring is high, and those who feel stocks are decreasing (Figure 5c).

MANAGEMENT PLAN

Total allowable catches (TAC) have been in effect since 1977. Since 1981, 45% of the

TAC has been allocated to the fixed gear sector and 55% to the mobile gear sector, although transfers from the fixed gear sector to the mobile fleet have been allowed since the early 1980's. In addition, the purse seine quota has been proportioned among the five active vessels and the gillnet allocation has been divided evenly between the regions north and south of Cape St. Gregory. Since 1989, an additional inshore allocation has been made for the experimental, small-purse-seine fishery. The allocation for this gear sector has come from the inshore (fixed gear) quota and has increased from 2,000 to 3,800 mt from 1989 to 1992. Large purse-seine allocations to the OSS programme have also increased, from 8,000 mt in 1990 to 10,000 mt in 1991, although this decreased to 7,000 mt in 1992. The TAC has not been exceeded since 1986 (Table 1; Figure 2).

COMMERCIAL FISHERY DATA

a) Age Composition of the Commercial Catch:

Random samples from the commercial fishery were collected by port samplers, and by index gillnet fishermen hired to keep detailed catch and effort data on herring caught throughout the fishing season, covering most of the major commercial landings (Annex 1). These samples were frozen and sent to the Maurice Lamontagne Institute (MLI) in Mont-Joli, Quebec for analyses (length, weight, gonad weight, maturity stage, and otolith collection for age determination).

Individual herring were assigned as either spring or autumn spawners by relating the maturity stage, estimated from a gonadosomatic index model (McQuinn, 1989), to the date of capture, using the 4R maturity cycle chart (McQuinn, 1987a). In the case of immature fish, otolith characteristics were used as described by Cleary *et al.* (1982). Ages were determined from the otoliths as the number of winter rings for spring spawners and the number of winter rings plus one for autumn spawners (Cleary *et al.*, 1982). All herring age 11 or more were aggregated into an 11+ age-group. As in previous years, the 1991 catch at age (Table 5) was generated (CATΔAGE v1.0, Anon, 1986) for spring and autumn spawners as described by McQuinn (1987b), weighting the age compositions by the corresponding landing as grouped in Annex 1.

b) Spring-Spawner Catch at Age:

Spring spawners have dominated the catch in every year since 1973 (Table 5), averaging 73% of the catch in numbers. This percentage was over 80% of the catch in numbers between 1988 and 1990 due to the active spring fishery in Bay St. Georges, which traditionally exploits pre-spawning and spawning concentrations. However in 1991, only 71% of the total removals consisted of spring spawners (Table 5) primarily due to a higher catch of autumn spawners in the Bay St. Georges spring fishery (Table 3). Typically herring schools at the head of Bay St. Georges near the spawning beds are predominately spring spawners, while the autumn spawners are concentrated near the mouth of the bay or north of Cape St. Georges (4Rc). In 1991, the purse seine fleet increased their fishing effort in April near the mouth of the bay (Figure 6) thus encountering more autumn spawners. In 1992, the market was oriented more towards spring spawners, therefore fishing effort was more near the spawning grounds at the head of the Bay (Figure 6).

The 1968 year-class was the largest ever observed in the spring-spawner catch and

completely dominated from 1973 (the beginning of the time series) to 1982 (Table 6). In 1985, the 1980 year-class was the single most important cohort since the 1968 year-class, contributing to 63% of the catch in numbers, and again 51% in 1986. Since 1987, the 1982 year-class has also contributed strongly to the spring-spawner catch, maintaining the mean age of the spring spawners (assuming ages 11+ to be 11) at 8 years old in 1990. In 1991, the 1987 year-class represented 18% of the spring-spawner catch, lowering the mean age of the catch to 7.7 years old. The 1987 cohort has recruited strongly along the Newfoundland east coast (Wheeler *et al.*, 1992).

c) **Autumn-Spawner Catch at Age:**

Herring of the 11+ age group have historically dominated the autumn-spawner catch (Table 6). In 1983, the 1979 year-class strongly recruited into the fishery and contributed to more than 24% of the catch in numbers at age 4. In 1990, the 1986 year-class strongly recruited to the autumn-spawner purse seine catch at age, but only became a significant contributor to the gillnet fishery in 1992 (Table 7). This cohort was the largest single year-class in 1991 and the strongest since the 1979 year-class.

d) **Length Frequencies:**

The strength of the 1986 autumn-spawning and the 1987 spring-spawning year-classes will be the most important factor affecting the 4R herring fishery for the near future. The length distribution of the purse seine catches showed the presence of these recruiting year-classes as juveniles in the Bonne Bay fishery (4Rb) since 1990 (Figure 7) although at the time the relative strength of each was unknown. These recruiting year-classes were caught further and further south from 1991 to 1992, and have become dominant in the Bonne Bay fall fishery. This indicates that the autumn-spawner 1986 year-class has been expanding southward over the past three years. However, the spring- spawning 1987 year-class has only been seen in the catches in Bay St. Georges (4Rd) and Port-au-Port (4Rc) in 1992, indicating that this year-class has not influenced the catches in southern regions to the same extent as the 1986 autumn-spawning cohort has in the north.

Index gillnet fishermen have been hired since 1984 to complete daily logbooks, recording their catch and effort as well as their location, mesh-size, size of nets and water depth, and to supply biological samples. Several of these fishermen fish in the vicinity of the major spring-spawning sites in the Bay St. Georges/Port-au-Port area (Figures 9 and 10). The length distributions of spring spawners from their individual captures showed the dominance of the 1980 and 1982 year-classes since 1987 (Figures 11 and 12). As is usually the case, incoming year-classes recruit to the gillnet fishery 1 to 2 years later than to the purse seiners (Figure 8), due to the large mesh size (2.5 to 3.0 in) common in this fishery (Konan, 1991). However, the 1987 year-class has only been seen in significant numbers in the catches in Bay St. Georges (4Rd) and Port-au-Port (4Rc) in 1992 and even then, not equally for each fisherman.

POPULATION ABUNDANCE INDICES

Abundance indices were estimated, for both spring and autumn spawners from detailed logbooks of daily catch and effort compiled by index gillnet fishermen, as well as from commercial

landing data collected by Statistics Branch of DFO.

a) **Logbook Data:**

Annual gillnet catch rates were estimated from the index- fisherman logbook data covering most of the fishing season (Table 8) and standardized using a multiplicative model (Gavaris, 1980). The category types for the model were year, month and fishing site to account for spatial and temporal variability (Table 9 and 10). Prior to these analyses, catches were proportioned to spring and autumn spawners using the percent spawning-stock composition determined from the commercial samples (Table 4).

b) **Commercial Data:**

Annual gillnet catch rates were also estimated from all available purchase slips from 1981 to 1992 using a multiplicative model (Table 11). Prior to these analyses, catches were proportioned to spring and autumn spawners as per the logbook data. In addition, slips which represented a weekly sum of landings rather than a daily trip were excluded, and slips representing several trips by the same fisherman on the same day were combined.

The estimated number of nets fished/day between 1982 to 1992 were obtained from written surveys sent between 1984 to 1992 to all licensed fishermen along the west coast. In addition, estimates of the numbers of nets fished by each fishermen were also available between 1981 and 1983 from the licence application forms. In order to weigh the mean number of nets used in the multiplicative model by the number of landings of each fisherman, the purchase slip and questionnaire files were merged. This involved matching the Commercial Fishing Vessel number from the questionnaires with the individual purchase slips to produce a combined data set where effort was the number of nets/fisherman/day rather than a daily trip. In addition, where no match was possible, the mean number of nets/unit area calculated from the questionnaires was used.

A multiplicative model was then fitted to these catch and effort data to yield standardized annual catch rates for each spawning stock (Gavaris, 1980). The category types for the model were month, unit area and year (Tables 12 and 13).

c) **Trends in Catch Rates:**

Spring-spawner catch rates from the logbook data show the recruitment and subsequent decline of the 1980 and 1982 spring-spawning year-classes to the gillnet fishery (Figure 13a; Table 14). Similarly, the passage of the 1979 year-class is equally obvious in the autumn-spawning series (Figure 13b). Furthermore, the recruitment of the 1986 autumn-spawning and 1987 spring-spawning year-classes is also unmistakable. Although the general patterns are similar, the annual estimates from the commercial data series follow these year classes less well than the logbook series (Figure 13, Table 15). This is perhaps not surprising given that the input data from the logbooks was better controlled and is less susceptible to biases related to estimates of daily catches than the commercial data. One signal is however clear from both data sets, the spring-spawning indices decreased substantially in 1992, while the autumn-spawning indices increased dramatically. This is the strongest

indication yet that the 1986 autumn-spawning cohort is well above average, while the spring-spawning 1987 cohort appears much less substantial, as it has already started to decline in importance at age five in the gillnet catch.

SEQUENTIAL POPULATION ANALYSES

a) Estimation of Parameters:

Natural Mortality Rate:

A value of 0.2 was assumed for the instantaneous natural mortality rate (M) in the present analyses. This value was used in previous assessments (McQuinn, 1989) and is consistent with estimates made for other herring stocks (Runnström, 1936; Beverton, 1963; Cushing, 1981).

Fishing Mortality for the Oldest Ages:

The fishing mortalities for the oldest ages (F_o) were estimated as described by McQuinn (1986) (FISH▲HER v1.0, Anon, 1986). This method assumes that the F for age 10 is equal to the F for ages 11+ and requires only a F value for age group 11+ in the last year as input. The resulting F vector was used to start the cohort analysis at age 10. The 11+ population numbers are then concatenated to the population matrix.

Mean Weight at Age:

The annual mean weights at age for each spawning stock were estimated as the average of the weight at age of each sample (McQuinn, 1987b), weighted by the corresponding landings as grouped in Annex 1 (WEIGHT▲AGE v1.0). These weight-at-age matrices (Table 16) were used to calculate the catch- and population-biomass-at-age matrices.

b) Age by Age Calibration of Cohort Analyses:

Cohort analyses were calibrated age by age using the adaptive framework (Gavaris, 1987). The formulation involved estimating mean population numbers (N) at ages 4 through 10 in 1992 and the age-specific catchability coefficients (q) by predicting the logbook gillnet catch rates at age (in numbers), using the minimization of the residual sums of squares in the natural log scale as the objective criteria. Gillnet catch-rate-at-age matrices were calculated for each spawning stock by dividing the gillnet catch at age by the annual gillnet effort from the multiplicative model. An initial calibration showed the intercepts to be non-significant. A summary of the formulation used in the calibration is as follows:

Parameters:

- year-class estimates:	$N_{i,t}$	i=4-10; t=1992
- calibration constants:	q_i	i=4-10
- number of parameters:	14	

Structure:

- F for oldest age-group (11+) = F at age 10 (CALCΔFΔOLD)
- model did not include an intercept term (non-significant)

Input Data:

- Catch at age:	$C_{i,t}$	i=2-11+; t=1973-92
- logbook catch rates:	$CPUE_{i,t}$	i=4-10 ; t=1984-92
- number of observations:	63	
- natural mortality (M):	0.2	

Objective function:

- minimize $\sum_i \sum_t [(\text{obs. ln } CPUE_{i,t})-(\text{pred. ln } CPUE_{i,t})]^2$

ASSESSMENT RESULTS AND DISCUSSION

The estimated spring-spawner population numbers in 1992 for ages 6 through 10 and the age-specific catchability coefficients for ages 4 to 10 from the ADAPT formulation were all statistically significant (Table 17a) with a mean square residual of 0.519. However, the population number estimates for ages 4 and 5 were not significantly different from zero, and thus were not deemed reliable. The correlation matrix and standardized residuals indicated that the model fit was adequate (Tables 18 and 19).

The spring-spawner analysis indicated that the 5+ mid-year biomass dropped more or less steadily between 1973 and 1983 (Figure 14, Table 22), primarily due to poor recruitment since the appearance of the 1968 year-class (Table 23), and rose by more than four times by 1987 with the recruitment of the 1980 and 1982 year-classes. Again the stock biomass declined until 1992, when the recruitment of the 1987 year-class caused a halt to this downward trend.

The weighted 6+ terminal F in 1992 was estimated at 0.397 (Table 26a) indicating an exploitation rate on these age groups was higher than the target F of 0.3. Fishing mortalities on these older ages have increased over that past five years relative to the previous five years and were estimated to be above 0.3 since 1990. This was not unexpected given the increased importance of the spring Bay St. Georges fishery which concentrates on pre-spawning herring.

It is obvious from Figure 14 that this stock is in need of a strong recruitment pulse to reverse the steady decline in the mature biomass. Although the 1987 year-class has now recruited to both the purse seine and the gillnet fisheries, several indicators concur that this year-class may not be sufficiently strong to support this fishery at present exploitation rates over the next few years and that this spawning stock is not rebuilding:

- although the cohort analysis estimated this year-class to be almost as strong as the 1980 or 1982 year-classes, the estimate was non-significant, putting in doubt the dependability of this value;
- the decline in the two gillnet catch rate indices in 1992;
- the generalized observation from the fixed gear sector that spring spawning in Bay St. Georges/Port-au-Port is more restricted in both time and space than over the past decade; and

- the recognition by the mobile fleet that the pre-spawning herring in spring Bay St. Georges fishery are harder to locate.

In addition, it should be noted that when the 1980 and 1982 year-classes where recruiting to the fishery, they were picked up by the purse seiners in Bay St. Georges as three and four year olds (McQuinn and Lambert, 1991). This did not occur with the 1987 cohort, as they have been seen only sparingly even at age five (Figure 7).

The estimated autumn-spawner population numbers in 1992 for ages 6 through 10 and the age-specific regression coefficients for ages 4 to 10 from the ADAPT formulation were all statistically significant (Table 17b) with a mean square residual of 0.513. However, the population number estimates for ages 4 and 5 were not significantly different from 0, and thus were not deemed reliable. The correlation matrix and standardized residuals indicated that the model fit was adequate (Tables 20 and 21), however, an examination of the fishing mortality matrix showed that the cohort analysis was not converged, the fully recruited Fs being ≤ 0.1 since 1985 (Table 26b). Although the resulting population number and biomass estimates are presented here (Tables 24 and 25), it was felt that the cohort analysis was unreliable for the autumn-spawning component.

The cohort analysis results do nonetheless indicate that the autumn-spawning stock has not undergone as high an exploitation rate in recent years as the spring-spawning component. Both the logbook and the commercial catch rates indices indicate that the 1986 year-class is of substantial importance, as both abundance estimates in 1992 are the highest in their respective series. The questionnaire responses also indicate that the situation with this spawning component north of Point Riche (the major spawning zone) is relatively good. Finally, the presence of this cohort in the late fall purse seine fishery since 1990, and its dominance since 1991, also points to a strong recruiting pulse.

PROGNOSES

The present analyses point to an increase in the fishing effort and mortality on the spring-spawning stock in recent years and, according to the gillnet catch rates, as well as auxiliary information from both the inshore and the offshore gear sectors, a decrease in the amount of spring spawners in the Bay St. Georges/Port-au-Port spawning grounds. Parallel to this decline in the southern spawning areas was a decrease in the percentage of spring spawners in the mixed Bonne Bay fishery.

The non-significant population number estimates for ages 2 through 5 prevented the calculation of any worthwhile projections from the cohort analysis results. Since these ages will be the most important contributors to the fishery in 1994, using estimates of average recruitment for these ages in a forecast would not be useful for basing management decisions. Further, it was felt that the analysis would benefit from the addition of the 1993 spring-spawner index-fishermen catch rate to the time series to confirm the abundance trend of this component. In the interim, industry should be aware that our present view of the spring-spawning resource suggests that caution should be exercised. More definitive statements regarding stock status and conservation measures should be forthcoming after analyses of the results of the 1993 fishing season.

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Table 1. Herring catches (t) by gear type and fishing area and total allowable catches from NAFO Division 4R from 1966 to 1992.

YEAR	4Rd				4Rc				4Rb				4Ra				COMBINED				TAC
	Purse seine	Gill-net	Other gears*	Total	Purse seine	Gill-net	Other gears*	Total	Purse seine	Gill-net	Other gears*	Total	Purse seine	Gill-net	Other gears*	Total	Purse seine	Gill-net	Other gears*	Total	
1966	0	216	0	216	0	103	0	103	5491	39	0	5530	0	45	0	45	5491	403	0	5894	
1967	0	215	0	215	0	66	0	66	5464	76	0	5540	0	40	0	40	5464	397	0	5861	
1968	0	156	789	945	0	59	0	59	3776	67	136	3979	0	11	0	11	3776	293	925	4994	
1969	241	36	6	283	0	46	0	46	2344	201	4	2549	0	68	1	69	2585	351	11	2947	
1970	28	51	3	82	12	15	17	44	2939	534	4	3477	0	407	92	499	2979	1007	116	4102	
1971	3287	543	427	4257	2239	185	24	2448	725	338	21	1084	356	1598	11	1965	6607	2664	483	9754	
1972	4743	178	866	5787	727	135	64	926	1330	214	0	1544	0	3628	146	3774	6800	4155	1076	12031	
1973	12112	429	0	12541	2740	122	0	2862	1763	305	2	2070	3453	5760	15	9228	20068	6616	17	26701	
1974	2465	159	0	2624	756	101	4	861	439	479	47	965	1071	1972	5	3048	4731	2711	56	7498	
1975	3221	116	3	3340	0	112	16	128	0	240	26	266	0	1764	22	1786	3221	2232	67	5520	
1976	6067	499	3	6569	1956	111	2	2069	0	226	20	246	184	2143	140	2467	8207	2979	165	11351	
1977	5289	272	7	5568	2009	193	3	2205	0	158	31	189	2155	2028	183	4366	9453	2651	224	12328	12000
1978	6252	522	33	6807	1037	931	16	1984	0	288	81	369	1834	3795	22	5651	9123	5536	152	14811	12500
1979	4387	1642	3	6032	2774	2267	2	5043	2829	1048	121	3998	0	3258	7	3265	9990	8215	133	18338	12500
1980	3499	1558	41	5098	3703	3224	17	6944	2002	879	88	2969	428	3810	5	4243	9632	9471	151	19254	18000
1981	2269	1368	2	3639	3277	1622	0	4899	2037	913	140	3090	342	1600	27	1969	7925	5503	169	13597	16000
1982	0	1463	3	1466	5575	1572	11	7158	3973	519	58	4550	0	1695	1	1696	9548	5249	73	14870[2]	10000
1983	0	1410	2	1412	3269	873	46	4188	3223	226	108	3557	787	1438	34	2259	7279	3947	190	11416[2]	10000
1984	0	1006	1	1007	3023	902	0	3925	4166	554	2	4722	15	790	4	809	7206	3252	7	10465[2]	10000
1985	1720	398	0	2118	1733	164	0	1897	9718	348	4	10070	0	295	6	301	13171	1205	10	14386[2]	10000
1986	1854	273	0	2127	1586	1069	0	2655	15830	468	0	16298	0	337	0	337	19270	2147	0	21417[2]	17000
1987	222	550	0	772	3183	1137	0	4320	10164	327	5	10496	164	829	0	993	13733	2843	5	16581	30600
1988	2019	435	0	2454	13197	592	0	13789	1093	256	0	1349	44	509	0	553	16353	1792	0	18145	30600
1989	9111	177	0	9288	6589	444	0	7033	947	69	0	1016	13	337	0	350	16660	1027	0	17415	37000
1990	5156	97	0	5253	7495	79	0	7574	3404	181	6	3591	28	323	133	484	16084	677	140	16903[1]	35000
1991	11871	37	0	11918	1557	31	0	1588	5342	59	0	5401	98	323	54	377	18877	450	54	19381[1]	35000
1992	8696	27	1	8724	1523	37	0	1560	4091	47	1	4139	346	440	115	901	14655	552	117	15324[1]	35000

* Includes shrimp trawl, bar seine, cod trap, midwater trawl and otter trawl.
[1] Preliminary
[2] Purse seine landings adjusted according to industry records

Table 2.a. Herring landings (t) by purse seines in NAFO division 4R by unit area and month from 1984 to 1992.

YEAR	AREA	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1984	4Ra											15		15
	4Rb				24						1090	1763	1289	4166
	4Rc	309			2714									3023
	4Rd													
	Total	309			2738	.					1090	1778	1289	7204
1985	4Ra													
	4Rb								482		526	5577	3133	9718
	4Rc					1464	99				170			1733
	4Rd					1720								1720
	Total					3184	99		482		696	5577	3133	13171
1986	4Ra													
	4Rb										3091	10608	2131	15830
	4Rc					1400		186						1586
	4Rd				185	1669								1854
	Total				185	3069		186			3091	10608	2131	19270
1987	4Ra											164		164
	4Rb					25			14		748	4426	4951	10164
	4Rc					1319	596			153	565	379	171	3183
	4Rd					222								222
	Total					1566	596		14	153	1313	4969	5122	13733
1988	4Ra							22	22					44
	4Rb									71	312	437	273	1093
	4Rc				639	5342	70		6		990	1985	4165	13197
	4Rd				1308	711								2019
	Total				1947	6053	70	22	28	71	1302	2422	4438	16353
1989	4Ra								13					13
	4Rb				33						81	347	486	947
	4Rc				35		51		6	514	776	3080	2127	6589
	4Rd				379	8587	145							9111
	Total				447	8587	196		19	514	857	3427	2613	16660
1990	4Ra						14	14						28
	4Rb						138				379			3404
	4Rc					6536	450	205	27	17	261	2888		7495
	4Rd					4799	335				23			5156
	Total					11335	798	357	27	17	662	2888		16084
1991	4Ra							62	36					98
	4Rb					8	42	113	18	45	501	3285	1330	5342
	4Rc					490	87	127		107	130	161	463	1567
	4Rd				6090	5567	214							11871
	Total				6090	6065	345	303	54	152	631	3446	1793	18877
1992	4Ra						86	258	2					346
	4Rb						18				87	3986		4091
	4Rc					23	779	43		51	56	567	4	1523
	4Rd					8297	124				2	273	1	8696
	Total					8320	1007	301	2	51	145	4825	5	14655

Table 2.b. Herring landings (t) by gillnets in NAFO division 4R by unit area and month from 1984 to 1992.

YEAR	AREA	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1984	4Ra	19				1	47	99	154	131	225	122	11	809
	4Rb				64	117	82	3	2	59	76	138	13	554
	4Rc				248	208	47	24	15	7	199	106	48	902
	4Rd				253	673	30	21	9	8	8	3	1	1006
	Total	19			565	999	206	147	180	205	508	369	73	3271
1985	4Ra					1	4		20	152	2	112	4	295
	4Rb				1	22	38	2	11	6	26	234	8	348
	4Rc				2	93	28	11	9	4	11	1	5	164
	4Rd					324	28	19	5	11	10		1	398
	Total				3	440	98	32	45	173	49	347	18	1205
1986	4Ra					65	84	19	48	28	68	14	11	337
	4Rb				6	48	46	14	9	8	136	171	30	468
	4Rc				132	319	105	21	10	8	141	319	14	1069
	4Rd				100	83	49	21	10	10				273
	Total				238	515	284	75	77	54	345	504	55	2147
1987	4Ra					19	21	14	142	65	192	353	23	829
	4Rb	1		1	15	22	23	11	7	5	87	135	20	327
	4Rc				146	580	96	77	52	13	55	117	1	1137
	4Rd				146	319	30	22	8	8	13	4		550
	Total	1		1	307	940	170	124	209	91	347	609	44	2843
1988	4Ra					14			18	5	208	225	38	508
	4Rb				11	15	23	7	4	2	60	114	21	257
	4Rc				34	61	227	186	10	4	7	18	45	592
	4Rd				108	113	43	142	8	8	11	1		434
	Total				153	203	293	335	40	19	286	358	104	1791
1989	4Ra					4	34	13			4	182	100	337
	4Rb		1	2	8	16	24	8	2	1	7			69
	4Rc				10	213	101	108		11		1		444
	4Rd				2	107	36	19	7	5		1		177
	Total		1	2	20	340	195	148	9	17	11	184	100	1027
1990	4Ra					4	9	3	13	49	28	216		323
	4Rb				10	13	23	14	3	1	1	117		181
	4Rc					4	19	46	3	2	5			79
	4Rd					34	11	40	9	2	1			97
	Total				10	55	62	102	28	54	35	333		679
1991	4Ra						21	169	40	23	24	45		323
	4Rb									1	12	46		59
	4Rc								6	19	5			31
	4Rd				2	4	1		9	12	6	4		37
	Total				2	4	22	169	56	56	47	95		450
1992	4Ra					9	16	179	34	12	107	84		440
	4Rb			2	3	15	20	1			3	3		47
	4Rc					22	2	5	3	1	2	2		37
	4Rd					15	3	3	2	1	1	2	1	27
	Total			2	3	62	41	188	39	14	113	91	1	552

Table 3. Proportion (%) of spring- and fall-spawning herring in the purse seine catch by month and fishing area, NAFO Division 4R from 1973 to 1992.

SPAWNING GROUP	FISHING AREA																								
	4Rd			4Rc									4Rb								4Ra				
SPRING	APR	MAY	NOV	JAN	APR	MAY	JUN	JUL	SEP	OCT	NOV	DEC	JAN	APR	JUIN	AUG	SEP	OCT	NOV	DEC	JUL	AUG	OCT	NOV	DEC
1973	51.3				36.7	64.7							91.3					91.0	90.8						76.7
1974	68.3	39.1																		92.6					
1975	98.0	84.7																							
1976	90.4	97.8				52.3																			87.7
1977	95.4	99.0				32.4																	47.3	89.3	
1978	82.4				81.9																			85.8	84.4
1979	86.2				43.2	26.0													93.3					91.6	86.7
1980	95.2				98.0							73.4							88.2						
1981	96.4	92.0			97.3													87.3	63.5	55.7					
1982					99.8	98.0			65.0									78.8	77.7						
1983					61.0	54.5				73.8									79.8	68.9				74.7	62.7
1984				76.4	43.9									40.9				76.9	64.5	60.5				62.0	
1985		92.0				66.0	49.7			82.6						23.8		71.0	70.0	67.7					
1986	77.0	100.0				93.6		78.0										77.3	74.8	71.0					
1987		97.0			100.0	93.0	100.0		65.3	84.7						0.0		74.5	76.9	72.1				28.0	
1988	83.6	99.5				34.0	100.0							37.5			62.0	41.3	65.8	72.1	28.0	2.0			
1989		91.3				34.0			79.5	66.9								68.5	70.1	70.1					
1990		89.8						78.0		88.0								74.0	55.3	66.0					
1991		71.6						72.0	48.0	66.0		80.0						56.3	65.3	63.4					
1992		94.7	72.7			100.0	100.0		28.6		68.2				47.7			32.0	49.9						
FALL																									
1973	48.7				63.3	35.3							8.7					9.0	9.2						23.3
1974	31.7	60.9																		7.4					
1975	2.0	15.3																							
1976	9.6	2.2				47.7																			12.3
1977	4.6	1.0				67.6																	52.7	10.7	
1978	17.6				18.1																			14.2	15.6
1979	13.8				56.8	74.0													6.7					8.4	13.3
1980	4.8				2.0							26.6							11.7						
1981	3.6	8.0			2.7													12.7	36.5	44.3					
1982					0.2	2.0			35.0									21.2	22.3						
1983					39.0	45.5				26.2									20.2	31.1				25.3	37.3
1984				23.6	56.1									59.1				23.1	35.5	39.5				38.0	
1985		8.0				34.0	50.3			17.4						76.2		29.0	30.0	32.3					
1986	23.0	0.0				6.4		22.0										22.7	25.2	29.0					
1987		3.0			0.0	7.0	0.0		34.7	15.3						100.0		25.5	23.1	27.9				72.0	
1988	16.4	0.5				66.0	0.0							62.5			38.0	58.7	34.2	27.9	72.0	98.0			
1989		8.7				66.0			20.5	33.1								31.5	29.9	29.9					
1990		10.2						22.0		12.0								26.0	44.7	34.0					
1991		28.4						28.0	52.0	34.0		20.0						43.7	34.7	36.6					
1992		5.3	27.0						71.4		31.8				52.3			68.0	50.1						

Table 4. Proportion (%) of spring- and fall-spawning herring in the gillnet catch by month and fishing area, NAFO division 4R from 1973 to 1992.

SPAWNING GROUP	FISHING AREA 4Rd			4Rc						4Rb							4Ra							
SPRING	APR	MAY	JUN	APR	MAY	JUN	JUL	SEP	OCT	MAY	JUN	JUL	SEP	OCT	NOV	DEC	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973												32.3		29.0	81.2				14.4				62.4	
1974											99.0					86.5				14.3			50.0	
1975		90.0									55.3	12.0												
1976		100.0									98.0								5.3				76.7	
1977											83.3	18.0				86.0		66.0	32.2	8.0	25.7	56.6	78.0	
1978		99.0								85.7	98.0							52.0	33.6				78.9	
1979	84.0			92.8						95.0					84.0				38.7	11.7	44.0	56.0		
1980	96.4			91.1						100.0					81.8		63.3	55.6	34.1	3.0	42.9	72.0	66.0	
1981				95.8						82.4	91.0							37.0	24.9	0.7			43.8	
1982					97.2										64.9				2.7					
1983		95.7											80.0	46.1	41.8				39.6	1.4	46.3	56.9	56.3	68.2
1984		94.1			78.5				84.0					60.2		44.9				8.6	27.9	63.0	36.0	52.7
1985		97.7			86.5	90.0													80.0		9.5	15.7		28.0
1986	84.4	98.4		50.0	83.7			66.0	80.0						54.4				16.8	10.1	32.0	44.1	27.1	
1987	92.0	99.4		52.0	84.7	88.6								52.2						14.2	26.0	49.5	37.5	
1988	98.0	99.6	96.0	73.5	78.3	81.4	76.0								68.1				28.0	11.8	27.0	41.3	52.8	42.0
1989		99.0	91.1	86.0	85.3	79.6								71.0	56.7				22.3	11.6	23.3	44.0	40.0	
1990		96.9	99.3		92.0	88.5	34.5								44.0				15.5	17.8	10.8	18.0	32.5	
1991		95.9	96.0		88.8	59.2							32.0	44.0	70.0				4.5	27.0	38.1	50.0	43.4	
1992		93.2	76.0		74.8	70.4	52.0											26.0	10.0	8.3	1.0	10.2		
FALL																								
1973												67.7		71.0	18.8				85.6				37.6	
1974											1.0					13.5				85.7			50.0	
1975		10.0									44.7	88.0												
1976		0.0									2.0								94.7				23.3	
1977											16.7	82.0				14.0		34.0	67.2	92.0	74.3	43.4	22.0	
1978		1.0								14.3	2.0							48.0	66.4				21.1	
1979	16.0			7.2						5.0					16.0				61.3	88.2	56.0	44.0		
1980	3.6			8.9						0.0					18.2		36.7	44.4	65.9	97.0	57.1	28.0	34.0	
1981				4.2						17.6	9.0							63.0	75.1	99.3			56.3	
1982					2.8										35.1				97.3					
1983		4.3											20.0	53.9	58.2				60.4	98.6	53.7	43.1	43.7	31.8
1984		5.9			21.5				16.0					39.8		55.1				91.4	72.1	37.0	64.0	47.3
1985		2.3			13.5	10.0													20.0	90.5	84.3		72.0	
1986	15.6	1.6		50.0	16.3			34.0	20.0						45.6				83.2	89.9	68.0	55.9	72.9	
1987	8.0	0.6		48.0	15.3	11.4								47.8						85.8	74.0	50.5	62.5	
1988	2.0	0.4	4.0	26.5	21.7	18.6	24.0								31.9				72.0	88.2	73.0	58.7	47.2	58.0
1989		1.0	8.9	14.0	14.7	20.4								29.0	43.3				77.7	88.4	76.7	56.0	60.0	
1990		3.1	0.7		8.0	11.5	65.5								56.0				84.5	82.2	89.2	82.0	67.5	
1991		4.1	4.0		11.2	40.8							68.0	56.0	30.0				95.5	72.1	61.9	50.0	56.6	
1992		6.8	24.0		25.2	29.6	48.0											74.0	90.0	91.7	99.0	89.8		

Table 5. Spring- and fall-spawner catch at age ($x10^3$) and proportion of spring spawners in NAFO division 4R herring landings from 1973 to 1992 (all gears).

SPRING SPAWNERS

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0	0	0	0	45	0	0	3	13	0	4	39	48	265	323	183	0	0	0	0
2	1833	141	57	484	10	0	167	300	40	594	34	198	362	323	455	734	305	100	480	90
3	435	261	996	680	534	47	25	854	417	2374	2965	433	4587	2348	329	519	574	2056	1706	1243
4	1063	130	420	846	541	1987	214	106	2114	693	3562	7773	787	13762	2781	417	763	610	7036	1708
5	27872	371	100	201	409	207	10828	355	129	2452	1131	3809	21642	3349	15257	2400	461	412	934	8377
6	2570	9445	1063	350	304	679	617	13872	354	421	1091	595	3993	28781	3507	14830	3036	983	631	997
7	3222	318	8431	2802	348	241	1075	407	8872	2153	293	814	445	5241	12952	4004	18705	5002	2072	998
8	3232	851	317	15567	4362	2162	547	1344	188	6488	713	209	381	465	1736	14606	3072	16049	4939	2783
9	2598	774	336	759	15959	8208	2772	247	515	704	2990	672	255	167	182	2734	10910	3782	15660	2168
10	4789	490	244	3136	1694	15260	7404	1427	283	950	798	755	380	260	37	480	779	6472	1649	11882
11+	5696	2175	665	3588	6003	5062	14032	20574	13181	12863	7975	4226	1764	1661	806	2123	1380	2130	4762	4064
1+	53310	14955	12629	28413	30210	33851	37681	39488	26106	29692	21556	19523	34645	56621	38365	43030	39985	37594	39869	34310

FALL SPAWNERS

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	15	0	101	15	0	15	35	0	484	43	38	50	0
3	1798	20	19	48	3	10	7	181	33	567	83	55	235	426	156	207	599	463	719	337
4	1180	393	40	272	169	27	116	136	524	1824	2330	668	1340	1431	487	511	539	1391	949	1446
5	1114	530	865	290	134	545	345	86	245	956	1356	6259	1907	2671	1354	481	923	387	4279	1446
6	2626	325	925	422	404	393	2689	176	90	509	1309	1147	9678	2292	2009	1240	807	312	628	1235
7	1527	592	107	561	721	1108	520	1729	295	140	506	908	902	8421	1728	1740	749	466	1082	776
8	2631	258	157	325	405	1689	1287	250	1234	377	159	220	622	794	5927	1667	828	323	609	542
9	3830	308	147	253	342	503	1847	675	153	972	467	146	115	384	474	4165	961	1027	485	777
10	8265	313	218	88	293	341	468	308	124	315	618	268	36	66	163	705	2873	442	1658	389
11+	17653	5610	3371	4818	6646	6051	6286	5243	3369	2609	2824	3091	468	227	196	777	983	4223	5543	3925
1+	40626	8348	5848	7076	9116	10668	13564	8799	6067	8371	9667	12762	15333	16745	12494	11977	9305	9072	16002	10873

TOTAL (SPRING AND FALL)

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
TOTAL REMOVALS	93937	23303	18477	35489	39326	44520	51245	48288	32173	38062	31223	32286	49978	73366	50859	53475	49292	46666	55871	45183
% SPRING SPAWNERS	56.8	64.2	68.4	80.1	76.8	76.0	73.5	81.8	81.1	78.0	69.0	60.5	69.3	77.2	75.4	80.5	81.1	80.6	71.4	75.9

Table 6. Age composition (%) and mean age* of (A) spring and (B) fall spawners in NAFO division 4R herring landings from 1973 to 1992. Dominant year-classes have been underlined.

A) SPRING SPAWNER AGE COMPOSITION (%)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0	.0	.0	.0	.1	.0	.0	.0	.1	.0	.0	.2	.1	.5	.8	.4	.0	.0	.0	.0
2	3.4	.9	.5	1.7	.0	.0	.4	.8	.2	2.0	.2	1.0	1.0	.6	1.2	1.7	.8	.3	1.2	.3
3	.8	1.7	7.9	2.4	1.8	.1	.1	2.2	1.6	8.0	13.8	2.2	13.2	4.1	.9	1.2	1.4	5.5	4.3	3.6
4	2.0	.9	3.3	3.0	1.8	5.9	.6	.3	8.1	2.3	16.5	39.8	2.3	24.3	7.2	1.0	1.9	1.6	17.6	5.0
5	52.3	2.5	.8	.7	1.4	.6	28.7	.9	.5	8.3	5.2	19.5	62.5	5.9	39.8	5.6	1.2	1.1	2.3	24.4
6	4.8	63.2	8.4	1.2	1.0	2.0	1.6	35.1	1.4	1.4	5.1	3.0	11.5	50.8	9.1	34.5	7.6	2.6	1.6	2.9
7	6.0	2.1	66.8	9.9	1.2	.7	2.9	1.0	34.0	7.3	1.4	4.2	1.3	9.3	33.8	9.3	46.8	13.3	5.2	2.9
8	6.1	5.7	2.5	54.8	14.4	6.4	1.5	3.4	.7	21.9	3.3	1.1	1.1	.8	4.5	33.9	7.7	42.7	12.4	8.1
9	4.9	5.2	2.7	2.7	52.8	24.2	7.4	.6	2.0	2.4	13.9	3.4	.7	.3	.5	6.4	27.3	10.1	39.3	6.3
10	9.0	3.3	1.9	11.0	5.6	45.1	19.6	3.6	1.1	3.2	3.7	3.9	1.1	.5	.1	1.1	1.9	17.2	4.1	34.6
11+	10.7	14.5	5.3	12.6	19.9	15.0	37.2	52.1	50.5	43.3	37.0	21.6	5.1	2.9	2.1	4.9	3.5	5.7	11.9	11.8

MEAN AGE* OF INDIVIDUALS IN CATCH

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
MEAN AGE	6.5	7.0	6.8	8.1	9.0	9.3	8.6	8.7	8.8	8.4	7.7	6.3	5.3	5.6	5.9	7.0	7.6	8.0	7.7	7.9

B) FALL SPAWNER AGE COMPOSITION (%)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0
2	.0	.0	.0	.0	.0	.0	.0	.2	.0	1.2	.2	.0	.1	.2	.0	4.6	.5	.4	.3	.0
3	4.4	.2	.3	.7	.0	.1	.1	2.1	.5	6.8	.9	.4	1.5	2.5	1.3	1.8	6.4	5.1	4.5	3.1
4	2.9	4.7	.7	3.8	1.9	.2	.9	1.5	8.6	21.8	24.1	5.2	8.7	8.5	3.9	5.0	5.8	15.3	5.9	13.3
5	2.7	6.4	14.8	4.1	1.5	5.1	2.5	1.0	4.0	11.4	14.0	49.0	12.4	15.9	10.8	4.7	9.9	4.3	26.7	13.3
6	6.5	3.9	15.8	6.0	4.4	3.7	19.8	2.0	1.5	6.1	13.5	9.0	63.1	13.7	16.1	9.8	8.7	3.4	3.9	11.4
7	3.8	7.1	1.8	7.9	7.9	10.4	3.8	19.7	4.9	1.7	5.2	7.1	5.9	50.3	13.8	12.1	8.0	5.1	6.8	7.1
8	6.5	3.1	2.7	4.6	4.4	15.8	9.5	2.8	20.3	4.5	1.6	1.7	4.1	4.7	47.4	14.4	8.9	3.6	3.8	5.0
9	9.4	3.7	2.5	3.6	3.8	4.7	13.6	7.7	2.5	11.6	4.8	1.1	.7	2.3	3.8	36.4	10.3	11.3	3.0	7.1
10	20.3	3.8	3.7	1.3	3.2	3.2	3.5	3.5	2.0	3.8	6.4	2.1	.2	.4	1.3	4.8	30.9	4.9	10.4	3.6
11+	43.5	67.2	57.6	68.1	72.9	56.7	46.3	59.6	55.5	31.2	29.2	24.2	3.1	1.4	1.6	6.4	10.6	46.5	34.6	36.1

MEAN AGE* OF INDIVIDUALS IN CATCH

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
MEAN AGE	9.2	9.6	9.0	9.6	10.0	9.5	9.0	9.5	9.2	7.4	7.3	6.8	6.0	6.3	7.1	7.7	7.9	8.5	7.8	7.8

* assuming ages 11+ to be 11.

Table 7. Spring- and fall-spawner gillnet catch at age (x10^3) in NAFO division 4R herring landings from 1973 to 1992.

SPRING-SPAWNER GILLNET CATCH AT AGE

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	3	0	0	21	1	0	0	0	0	0	0	0	0
3	7	10	0	13	13	3	0	71	59	319	842	13	1	3	0	4	8	30	3	0
4	145	0	89	0	4	368	42	50	805	145	1770	1416	33	296	125	30	46	26	82	14
5	2148	76	10	0	39	82	2980	123	53	879	468	1486	1220	143	1714	600	58	35	7	50
6	228	1781	219	15	53	132	441	5485	163	106	513	242	391	2909	602	1436	349	75	4	18
7	1225	111	878	581	141	63	606	225	4038	340	57	469	67	662	2388	561	996	78	22	31
8	769	383	89	1790	1041	751	337	620	83	2495	19	67	75	78	418	1139	165	433	31	66
9	784	130	66	123	1680	1659	1597	146	192	229	1200	236	44	55	26	132	396	53	90	22
10	467	89	48	540	325	4228	3403	927	113	256	249	271	62	45	18	27	51	112	14	87
11	2830	1210	172	1336	1712	2408	6726	8291	3484	4144	3151	1892	290	261	175	98	53	36	47	26
1+	8603	3789	1573	4398	5007	9695	16131	15942	8988	8912	8290	6094	2183	4452	5466	4026	2121	880	300	316

FALL-SPAWNER GILLNET CATCH AT AGE

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	3	0	0	0	0	16	24	0	0	0	0	0	0	0	1	0
4	32	106	6	0	39	9	11	43	342	405	1229	83	4	3	36	2	8	43	15	30
5	179	190	200	11	30	296	260	73	201	523	531	2319	49	102	178	102	32	70	55	32
6	766	49	586	178	90	193	1289	153	24	164	627	329	1211	189	354	251	63	119	63	178
7	331	207	46	191	467	463	218	1342	245	81	143	397	134	1596	473	202	108	79	82	80
8	639	38	134	228	228	708	504	120	876	199	78	74	93	135	1909	169	187	132	88	136
9	683	198	108	161	239	156	527	603	46	554	169	64	26	84	194	679	174	228	55	148
10	1862	80	201	88	140	147	315	272	71	220	199	95	2	31	74	89	182	51	68	51
11+	6941	2719	2683	2826	2647	3624	3018	4552	2396	1529	581	442	115	160	54	68	55	654	495	678
1+	11434	3586	3964	3684	3884	5595	6142	7159	4201	3708	3582	3803	1633	2299	3273	1561	809	1376	921	1334

Table 8. Frequency of observations of logbook catch and effort data by fisherman and year herring in NAFO Division 4R.

MONTH	Frequency	Percent	Cumulative Frequency	Cumulative Percent
4	87	3.2	87	3.2
5	835	30.7	922	33.9
6	488	18.0	1410	51.9
7	182	6.7	1592	58.6
8	754	27.8	2346	86.3
9	316	11.6	2662	98.0
10	33	1.2	2695	99.2
11	22	0.8	2717	100.0

FISHING AREA	Frequency	Percent	Cumulative Frequency	Cumulative Percent
FISCHELL	172	6.3	172	6.3
SANDY POINT	361	13.3	533	19.6
ST-GEORGES	149	5.5	682	25.1
BARACHOIS BROOK	128	4.7	810	29.8
LOURDES	188	6.9	998	36.7
BLACK DUCK BROOK	220	8.1	1218	44.8
BLUE BEACH	207	7.6	1425	52.4
BARRD HARBOUR	30	1.1	1455	53.6
CASTOR RIVER	78	2.9	1533	56.4
BARTLETT HBR	37	1.4	1570	57.8
FERROLE POINT	21	0.8	1591	58.6
WHALE ISLAND	18	0.7	1609	59.2
BLUE COVE	128	4.7	1737	63.9
CURRENT ISLAND	67	2.5	1804	66.4
FORRESTER POINT	212	7.8	2016	74.2
EDDIES COVE E	701	25.8	2717	100.0

YEAR	Frequency	Percent	Cumulative Frequency	Cumulative Percent
84	126	4.6	126	4.6
85	218	8.0	344	12.7
86	259	9.5	603	22.2
87	349	12.8	952	35.0
88	411	15.1	1363	50.2
89	364	13.4	1727	63.6
90	368	13.5	2095	77.1
91	310	11.4	2405	88.5
92	312	11.5	2717	100.0

Table 9. Analysis of variance and regression coefficients for the 1984 to 1992 logbook spring-spawning 4R herring catch rate data (catch/(surface*hours)).

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	4711.142012	157.038067	79.58	0.0001
Error	2213	4366.940984	1.973313		
Corrected Total	2243	9078.082996			

R-Square	C.V.	Root MSE	CATRATE Mean
0.518958	-14.19370	1.404746	-9.896974

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MONTH	7	191.8769028	27.4109861	13.89	0.0001
FISHING AREA	15	932.7786941	62.1852463	31.51	0.0001
YEAR	8	166.2823488	20.7852936	10.53	0.0001

Parameter		Estimate	T for HO: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		-18.55344784 B	-15.81	0.0001	1.17327681
MONTH	4	4.05136322 B	3.53	0.0004	1.14848022
	5	4.24522763 B	3.74	0.0002	1.13501234
	6	3.41325592 B	3.01	0.0027	1.13577506
	7	3.03263781 B	2.75	0.0060	1.10262374
	8	2.80168230 B	2.56	0.0106	1.09478476
	9	2.93390224 B	2.67	0.0076	1.09889786
	10	2.48977095 B	2.21	0.0271	1.12615130
	11	0.00000000 B		.	
FISHING AREA	BARACHOIS BK.	5.48036118 B	10.30	0.0001	0.53194504
	BARRD HARBOUR	4.00322835 B	3.71	0.0002	1.08040473
	BARTLETT HBR	4.20901833 B	8.04	0.0001	0.52340672
	BLACK DUCK BK	5.11368624 B	9.86	0.0001	0.51839832
	BLUE BEACH	5.65427289 B	10.92	0.0001	0.51759398
	BLUE COVE	4.55545718 B	10.42	0.0001	0.43730908
	CASTOR RIVER	3.01630410 B	6.45	0.0001	0.46795503
	CURRENT IS	5.10505559 B	11.18	0.0001	0.45657558
	EDDIES COVE E	4.53723652 B	10.89	0.0001	0.41645851
	FERROLE POINT	4.81872632 B	9.21	0.0001	0.52306054
	FISCHELL	6.89038167 B	13.12	0.0001	0.52536993
	FORRESTER PT	4.66330652 B	10.98	0.0001	0.42480158
	LOURDES	4.49360929 B	8.70	0.0001	0.51644149
	SANDY POINT	6.01544336 B	11.62	0.0001	0.51784518
	ST-GEORGES	6.52564098 B	12.30	0.0001	0.53050786
	WHALE ISLAND	0.00000000 B		.	
YEAR	84	-0.33634015 B	-1.73	0.0842	0.19467676
	85	0.65552043 B	4.64	0.0001	0.14122362
	86	0.32528548 B	2.37	0.0180	0.13739917
	87	0.51265342 B	3.89	0.0001	0.13182850
	88	0.17940671 B	1.47	0.1418	0.12207560
	89	0.03593888 B	0.30	0.7655	0.12046925
	90	-0.39668791 B	-3.18	0.0015	0.12462205
	91	0.25335074 B	1.95	0.0510	0.12973217
	92	0.00000000 B		.	

Table 10. Analysis of variance and regression coefficients for the 1984 to 1991 logbook fall-spawning 4R herring catch rate data (catch/(surface*hours)).

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	3474.672451	115.822415	57.15	0.0001
Error	2213	4484.812812	2.026576		
Corrected Total	2243	7959.485264			

R-Square	C.V.	Root MSE	CATRATE Mean
0.436545	-13.85999	1.423579	-10.27114

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MONTH	7	178.8024333	25.5432048	12.60	0.0001
FISHING AREA	15	903.2249031	60.2149935	29.71	0.0001
YEAR	8	612.1782099	76.5222762	37.76	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		-16.85954472 B	-14.18	0.0001	1.18900584
MONTH	4	4.80232119 B	4.13	0.0001	1.16387682
	5	3.78262481 B	3.29	0.0010	1.15022839
	6	3.51407343 B	3.05	0.0023	1.15100133
	7	4.25516469 B	3.81	0.0001	1.11740559
	8	4.27949885 B	3.86	0.0001	1.10946152
	9	3.84576248 B	3.45	0.0006	1.11362976
	10	3.08846793 B	2.71	0.0069	1.14124856
	11	0.00000000 B	.	.	
FISHING	BARACHOIS BK	1.45787054 B	2.70	0.0069	0.53907633
AREA	BARRD HARBOUR	3.76638531 B	3.44	0.0006	1.09488870
	BARTLETT HBR	4.25430259 B	8.02	0.0001	0.53042354
	BLACK DUCK BK	3.12983749 B	5.96	0.0001	0.52534801
	BLUE BEACH	3.76723108 B	7.18	0.0001	0.52453288
	BLUE COVE	4.35164743 B	9.82	0.0001	0.44317167
	CASTOR RIVER	2.80960481 B	5.92	0.0001	0.47422846
	CURRENT IS.	4.77494342 B	10.32	0.0001	0.46269646
	EDDIES COVE E	4.38194190 B	10.38	0.0001	0.42204158
	FERROLE POINT	4.49787286 B	8.49	0.0001	0.53007272
	FISCHELL	3.67127795 B	6.90	0.0001	0.53241307
	FORRESTER PT	4.53383521 B	10.53	0.0001	0.43049650
	LOURDES	2.64744920 B	5.06	0.0001	0.52336494
	SANDY POINT	2.11821891 B	4.04	0.0001	0.52478745
	ST-GEORGES	2.47340606 B	4.60	0.0001	0.53761988
	WHALE ISLAND	0.00000000 B	.	.	
YEAR	84	-1.51726450 B	-7.69	0.0001	0.19728661
	85	-0.23565221 B	-1.65	0.0998	0.14311688
	86	-0.45604161 B	-3.28	0.0011	0.13924115
	87	-0.65749163 B	-4.92	0.0001	0.13359581
	88	-1.31848187 B	-10.66	0.0001	0.12371216
	89	-0.84740182 B	-6.94	0.0001	0.12208427
	90	-1.76841321 B	-14.00	0.0001	0.12629274
	91	-1.07403174 B	-8.17	0.0001	0.13147137
	92	0.00000000 B	.	.	

Table 11. Frequency of observations of commercial catch and effort data by fisherman and year herring in NAFO Division 4R.

MONTH	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2	0.0	2	0.0
2	4	0.0	6	0.0
3	23	0.1	29	0.1
4	2934	14.8	2963	14.9
5	3993	20.1	6956	35.0
6	601	3.0	7557	38.0
7	2372	11.9	9929	49.9
8	2753	13.8	12682	63.8
9	1705	8.6	14387	72.3
10	3467	17.4	17854	89.8
11	1900	9.6	19754	99.3
12	133	0.7	19887	100.0

SUBAREA	Frequency	Percent	Cumulative Frequency	Cumulative Percent
4RA	10103	50.8	10103	50.8
4RB	2522	12.7	12625	63.5
4RC	3832	19.3	16457	82.8
4RD	3430	17.2	19887	100.0

YEAR	Frequency	Percent	Cumulative Frequency	Cumulative Percent
81	5498	27.6	5498	27.6
82	4975	25.0	10473	52.7
83	3426	17.2	13899	69.9
84	2484	12.5	16383	82.4
85	340	1.7	16723	84.1
86	420	2.1	17143	86.2
87	739	3.7	17882	89.9
88	720	3.6	18602	93.5
89	137	0.7	18739	94.2
90	465	2.3	19204	96.6
91	415	2.1	19619	98.7
92	268	1.3	19887	100.0

Table 12. Analysis of variance and regression coefficients for the 1981 to 1992 commercial spring-spawning 4R herring catch rate data (catch/net).

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	46142.12532	2006.17936	1010.96	0.0001
Error	16334	32413.58564	1.98442		
Corrected Total	16357	78555.71095			

R-Square	C.V.	Root MSE	CATRATE Mean
0.587381	-37.21946	1.408696	-3.784837

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MONTH	9	15777.40111	1753.04457	883.40	0.0001
SUBAREA	3	224.74462	74.91487	37.75	0.0001
YEAR	11	3081.48671	280.13516	141.17	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		-2.932883415 B	-17.13	0.0001	0.17119283
MONTH	3	0.211729319 B	0.65	0.5187	0.32811096
	4	-0.017738236 B	-0.12	0.9030	0.14557102
	5	0.425641237 B	2.96	0.0030	0.14362402
	6	-1.213521956 B	-8.21	0.0001	0.14785884
	7	-2.773332108 B	-20.04	0.0001	0.13841937
	8	-3.642184881 B	-26.30	0.0001	0.13847914
	9	-2.604489111 B	-18.59	0.0001	0.14008100
	10	-0.498023890 B	-3.64	0.0003	0.13681606
	11	-0.506865085 B	-3.67	0.0002	0.13819841
	12	0.000000000 B	.	.	
SUBAREA	4RA	-0.605529794 B	-10.15	0.0001	0.05964515
	4RB	-0.553126315 B	-9.69	0.0001	0.05708391
	4RC	-0.166504185 B	-4.27	0.0001	0.03899649
	4RD	0.000000000 B	.	.	
YEAR	81	0.336883414 B	3.60	0.0003	0.09369927
	82	0.278745591 B	3.08	0.0021	0.09043054
	83	0.923968776 B	10.09	0.0001	0.09153335
	84	0.814326575 B	8.82	0.0001	0.09233551
	85	0.894020070 B	7.53	0.0001	0.11865893
	86	1.719306618 B	15.19	0.0001	0.11320276
	87	1.620708230 B	15.84	0.0001	0.10228784
	88	0.880333553 B	8.67	0.0001	0.10158640
	89	1.614014663 B	10.78	0.0001	0.14974023
	90	0.895780201 B	8.19	0.0001	0.10932942
	91	2.010145028 B	17.93	0.0001	0.11209299
	92	0.000000000 B	.	.	

Table 13. Analysis of variance and regression coefficients for the 1981 to 1992 commercial autumn-spawning 4R herring catch rate data (catch/net).

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	17213.94212	748.43227	492.11	0.0001
Error	16334	24841.99072	1.52088		
Corrected Total	16357	42055.93284			

R-Square	C.V.	Root MSE	CATRATE Mean
0.409311	-31.62153	1.233238	-3.899995

Source	DF	Type III SS	Mean Square	F Value	Pr > F
MONTH	9	3105.371036	345.041226	226.87	0.0001
SUBAREA	3	92.462999	30.821000	20.27	0.0001
YEAR	11	1903.954028	173.086730	113.81	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		-2.148551703 B	-14.34	0.0001	0.14987018
MONTH	3	-2.561987329 B	-8.92	0.0001	0.28724362
	4	-1.891581071 B	-14.84	0.0001	0.12743966
	5	-2.051630627 B	-16.32	0.0001	0.12573516
	6	-1.561880567 B	-12.07	0.0001	0.12944252
	7	-0.221605643 B	-1.83	0.0675	0.12117877
	8	0.082120958 B	0.68	0.4982	0.12123109
	9	-0.472932788 B	-3.86	0.0001	0.12263343
	10	-0.745032078 B	-6.22	0.0001	0.11977515
	11	-0.219493846 B	-1.81	0.0697	0.12098533
	12	0.000000000 B	.	.	
SUBAREA	4RA	0.397989128 B	7.62	0.0001	0.05221615
	4RB	0.269400842 B	5.39	0.0001	0.04997391
	4RC	0.072049803 B	2.11	0.0348	0.03413934
	4RD	0.000000000 B	.	.	
YEAR	81	-1.048851817 B	-12.79	0.0001	0.08202871
	82	-1.325970658 B	-16.75	0.0001	0.07916711
	83	-1.373191366 B	-17.14	0.0001	0.08013256
	84	-0.706045681 B	-8.73	0.0001	0.08083481
	85	-0.504127786 B	-4.85	0.0001	0.10387956
	86	-0.127848009 B	-1.29	0.1971	0.09910297
	87	-0.632803039 B	-7.07	0.0001	0.08954754
	88	-1.133569103 B	-12.75	0.0001	0.08893347
	89	-0.106713395 B	-0.81	0.4156	0.13108958
	90	-0.755434403 B	-7.89	0.0001	0.09571207
	91	-1.117426090 B	-11.39	0.0001	0.09813143
	92	0.000000000 B	.	.	

Table 14. Predicted mean logbook catch rate estimates for spring- and fall-spawning herring in NAFO Division 4R.

	SPRING SPAWNERS		FALL SPAWNERS	
YEAR	CATCH RATE	STANDARD ERROR	CATCH RATE	STANDARD ERROR
84	0.58521	0.10400	0.44755	0.08058
85	1.59136	0.19461	1.62644	0.20154
86	1.14470	0.13245	1.30581	0.15310
87	1.38136	0.15314	1.06817	0.12000
88	0.99081	0.10113	0.55207	0.05710
89	0.85793	0.09190	0.88378	0.09593
90	0.55639	0.06178	0.35169	0.03957
91	1.06529	0.12290	0.70389	0.08229
92	0.82694	0.09482	2.06058	0.23942

Table 15. Predicted mean commercial catch rate estimates for spring- and fall-spawning herring in NAFO Division 4R.

	SPRING SPAWNERS		FALL SPAWNERS	
YEAR	CATCH RATE	STANDARD ERROR	CATCH RATE	STANDARD ERROR
81	0.37498	0.01895	0.57162	0.02530
82	0.35388	0.01632	0.43334	0.01750
83	0.67464	0.03094	0.41336	0.01660
84	0.60457	0.02814	0.80547	0.03283
85	0.65299	0.05628	0.98370	0.07426
86	1.49128	0.11888	1.43370	0.10009
87	1.35286	0.08545	0.86607	0.04790
88	0.64533	0.03914	0.52496	0.02788
89	1.33631	0.16433	1.45936	0.15725
90	0.65495	0.04622	0.76583	0.04732
91	1.99477	0.15761	0.53298	0.03688
92	0.26694	0.02450	1.62793	0.13085

Table 16. Annual weight at age (weighted by landings) for (A) spring- and (B) fall- spawning herring in NAFO Division 4R from 1973 to 1992.

(A)

ANNUAL SPRING SPAWNER WEIGHT AT AGE (KG)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	.101	.129	.077	.069	.064	.103	.115	.117	.085	.095	.142	.134	.109	.142	.165	.153	.149	.120	.154	.103
3	.158	.172	.156	.122	.156	.184	.121	.201	.196	.216	.190	.206	.168	.171	.235	.192	.193	.180	.159	.115
4	.224	.223	.197	.193	.208	.228	.234	.247	.262	.263	.263	.239	.247	.230	.250	.223	.233	.257	.203	.214
5	.222	.236	.242	.241	.247	.275	.268	.298	.327	.290	.305	.297	.283	.268	.289	.261	.301	.270	.276	.246
6	.268	.262	.243	.252	.278	.305	.319	.321	.344	.357	.337	.348	.329	.315	.349	.302	.307	.301	.318	.276
7	.303	.300	.279	.269	.262	.313	.343	.354	.385	.386	.385	.379	.373	.338	.370	.338	.350	.343	.332	.366
8	.322	.324	.301	.299	.290	.318	.357	.380	.415	.395	.424	.406	.404	.413	.390	.371	.384	.373	.374	.368
9	.333	.351	.335	.315	.313	.340	.366	.398	.430	.423	.434	.431	.434	.415	.428	.385	.399	.409	.401	.399
10	.350	.335	.350	.334	.332	.362	.373	.389	.429	.434	.492	.437	.425	.449	.422	.457	.408	.417	.408	.411
11	.367	.384	.382	.382	.353	.393	.409	.430	.472	.454	.475	.485	.477	.459	.515	.490	.488	.461	.440	.422

(B)

ANNUAL FALL SPAWNER WEIGHT AT AGE (KG)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	.100	.122	.122	.122	.122	.122	.122	.122	.144	.166	.105	.078	.050	.105	.110	.115	.115	.088	.068	.068
3	.105	.171	.120	.107	.250	.161	.218	.222	.204	.150	.205	.164	.155	.157	.187	.139	.139	.164	.102	.158
4	.156	.218	.188	.155	.229	.238	.216	.242	.280	.252	.218	.209	.202	.214	.235	.216	.216	.201	.217	.189
5	.231	.259	.266	.282	.250	.282	.281	.360	.328	.306	.268	.249	.258	.240	.272	.259	.259	.238	.203	.227
6	.274	.265	.297	.271	.255	.316	.308	.341	.358	.328	.309	.293	.292	.280	.319	.281	.281	.273	.297	.276
7	.297	.284	.352	.287	.301	.345	.355	.404	.406	.449	.338	.343	.326	.317	.334	.310	.310	.322	.319	.295
8	.329	.307	.323	.277	.321	.367	.381	.419	.436	.441	.374	.359	.347	.340	.363	.354	.354	.355	.361	.346
9	.334	.355	.370	.308	.308	.366	.405	.461	.485	.444	.430	.429	.374	.356	.364	.377	.377	.373	.381	.384
10	.346	.378	.391	.426	.330	.390	.408	.468	.498	.485	.462	.450	.444	.363	.392	.398	.398	.399	.415	.420
11	.382	.422	.465	.454	.421	.471	.458	.534	.515	.507	.503	.494	.432	.465	.513	.428	.428	.432	.426	.442

Table 17. Parameter estimates, standard errors, T-statistics and mean square residuals from the (a) spring-spawning and (b) autumn spawning cohort analyses as estimated from the adaptive framework.

a) Spring Spawners:

PARAMETER NO.	PARAMETER EST.	STD. ERR.	T-STATISTIC
1. age 4 no.	5.37664E0004	4.03468E0004	1.33261 §
2. age 5 no.	1.46438E0005	7.84341E0004	1.86702 §
3. age 6 no.	1.22863E0004	5.49807E0003	2.23466
4. age 7 no.	7.38556E0003	2.88498E0003	2.56001
5. age 8 no.	9.26766E0003	3.19800E0003	2.89796
6. age 9 no.	8.35330E0003	3.23189E0003	2.58465
7. age 10 no.	2.77510E0004	8.90823E0003	3.11521
8. age 4 coef.	2.30186E-003	6.54722E-004	3.51579
9. age 5 coef.	7.36125E-003	1.97292E-003	3.73115
10. age 6 coef.	1.53762E-002	3.98465E-003	3.85885
11. age 7 coef.	3.02723E-002	7.71112E-003	3.92579
12. age 8 coef.	3.15666E-002	8.04868E-003	3.92196
13. age 9 coef.	2.71574E-002	6.85112E-003	3.96394
14. age 10 coef.	3.05079E-002	7.65032E-003	3.98779

MEAN SQUARE RESIDUALS 0.519233

b) Fall Spawners:

PARAMETER NO.	PARAMETER EST.	STD. ERR.	T-STATISTIC
1. age 4 no.	3.05562E0005	2.36486E0005	1.29209 §
2. age 5 no.	4.59195E0004	2.51240E0004	1.82772 §
3. age 6 no.	4.22397E0004	1.96511E0004	2.14949
4. age 7 no.	1.54675E0004	6.19478E0003	2.49686
5. age 8 no.	8.15073E0003	3.08912E0003	2.63853
6. age 9 no.	1.06435E0004	3.60953E0003	2.94872
7. age 10 no.	7.02135E0003	2.29961E0003	3.05328
8. age 4 coef.	4.53767E-004	1.34241E-004	3.38023
9. age 5 coef.	4.60361E-003	1.27998E-003	3.59663
10. age 6 coef.	1.25864E-002	3.35443E-003	3.75218
11. age 7 coef.	1.76772E-002	4.57399E-003	3.86473
12. age 8 coef.	2.19577E-002	5.54217E-003	3.96193
13. age 9 coef.	2.61910E-002	6.47097E-003	4.04747
14. age 10 coef.	1.71374E-002	4.16423E-003	4.11539

MEAN SQUARE RESIDUALS 0.512722

§ estimates are non-significant

Table 18. Parameter correlation matrix for 4R spring-spawning herring as estimated from cohort analyses using the adaptive framework.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.000	.108	.094	.084	.070	.050	.036	-.366	-.069	-.049	-.036	-.028	-.017	-.010
2	.108	1.000	.128	.114	.094	.068	.050	-.295	-.296	-.067	-.048	-.037	-.023	-.013
3	.094	.128	1.000	.135	.111	.081	.059	-.257	-.258	-.258	-.057	-.044	-.028	-.016
4	.084	.114	.135	1.000	.127	.095	.069	-.231	-.228	-.224	-.235	-.051	-.033	-.019
5	.070	.094	.111	.127	1.000	.115	.079	-.191	-.187	-.183	-.196	-.253	-.039	-.021
6	.050	.068	.081	.095	.115	1.000	.094	-.137	-.137	-.137	-.154	-.205	-.253	-.025
7	.036	.050	.059	.069	.079	.094	1.000	-.099	-.100	-.101	-.109	-.127	-.166	-.271
8	-.366	-.295	-.257	-.231	-.191	-.137	-.099	1.000	.189	.134	.098	.076	.047	.027
9	-.069	-.296	-.258	-.228	-.187	-.137	-.100	.189	1.000	.133	.097	.075	.047	.027
10	-.049	-.067	-.258	-.224	-.183	-.137	-.101	.134	.133	1.000	.095	.074	.047	.027
11	-.036	-.048	-.057	-.235	-.196	-.154	-.109	.098	.097	.095	1.000	.081	.053	.030
12	-.028	-.037	-.044	-.051	-.253	-.205	-.127	.076	.075	.074	.081	1.000	.067	.035
13	-.017	-.023	-.028	-.033	-.039	-.253	-.166	.047	.047	.047	.053	.067	1.000	.045
14	-.010	-.013	-.016	-.019	-.021	-.025	-.271	.027	.027	.027	.030	.035	.045	1.000

Table 19. Standardized residuals (obs. - pred.) from the adaptive framework for 4R spring-spawning herring

	1984	1985	1986	1987	1988	1989	1990	1991	1992
4	-.20	-.31	-.69	.03	-.75	.67	.30	.95	.00
5	.63	1.00	-.74	.18	.66	-.62	-.07	-.14	-.89
6	-.18	1.10	.55	.26	-.47	.11	-.38	-.87	-.13
7	1.03	.35	.48	.04	-.15	-.70	-1.17	-.17	.29
8	-1.69	1.88	-.22	.35	-.31	-.57	-.68	.22	1.03
9	-.43	.52	1.14	-.88	-.05	-.23	-.44	.24	.13
10	-.05	.63	-.26	.17	-.56	-.26	-.57	.42	.49

Table 20. Parameter correlation matrix for 4R autumn-spawning herring as estimated from cohort analyses using the adaptive framework.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.000	.124	.112	.107	.097	.093	.083	-.380	-.098	-.076	-.059	-.043	-.028	-.013
2	.124	1.000	.152	.143	.130	.125	.112	-.326	-.321	-.102	-.079	-.057	-.037	-.018
3	.112	.152	1.000	.166	.152	.145	.132	-.294	-.298	-.284	-.092	-.067	-.044	-.021
4	.107	.143	.166	1.000	.169	.160	.147	-.281	-.275	-.263	-.251	-.074	-.048	-.023
5	.097	.130	.152	.169	1.000	.170	.156	-.254	-.253	-.241	-.237	-.227	-.051	-.025
6	.093	.125	.145	.160	.170	1.000	.165	-.245	-.240	-.230	-.217	-.203	-.190	-.026
7	.083	.112	.132	.147	.156	.165	1.000	-.219	-.218	-.212	-.203	-.189	-.175	-.160
8	-.380	-.326	-.294	-.281	-.254	-.245	-.219	1.000	.258	.200	.155	.112	.073	.035
9	-.098	-.321	-.298	-.275	-.253	-.240	-.218	.258	1.000	.198	.153	.111	.072	.035
10	-.076	-.102	-.284	-.263	-.241	-.230	-.212	.200	.198	1.000	.146	.107	.069	.034
11	-.059	-.079	-.092	-.251	-.237	-.217	-.203	.155	.153	.146	1.000	.103	.066	.032
12	-.043	-.057	-.067	-.074	-.227	-.203	-.189	.112	.111	.107	.103	1.000	.061	.030
13	-.028	-.037	-.044	-.048	-.051	-.190	-.175	.073	.072	.069	.066	.061	1.000	.028
14	-.013	-.018	-.021	-.023	-.025	-.026	-.160	.035	.035	.034	.032	.030	.028	1.000

Table 21. Standardized residuals (obs. - pred.) from the adaptive framework for 4R autumn-spawning herring

	1984	1985	1986	1987	1988	1989	1990	1991	1992
4	.84	-.63	-.77	.98	-1.62	.75	.13	.33	.00
5	.17	.42	.01	.60	.03	.35	-.65	-.60	-.32
6	-.87	.95	.47	-.09	.32	-.20	-.57	-.47	.47
7	-.33	.29	.55	.77	-.61	.40	-1.52	.10	.36
8	-.88	.42	-.29	.18	.01	.35	-.81	-.32	1.34
9	.18	.29	-.23	-.47	-.65	1.23	-.80	-.54	.99
10	.97	-.30	.50	-.32	-.44	-.26	-.72	-.16	.73

Table 22. Mid-year population biomass (mt), estimated from cohort analysis, for spring-spawning herring in NAFO division 4R from 1973 to 1992.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	1456	4020	1738	8943	1827	1439	2047	2048	6159	32624
3	7054	1780	3959	2256	16528	4290	1384	2902	2751	12780
4	44993	8069	1628	3862	3020	19652	4471	2303	2922	2937
5	85345	38562	7148	1546	3862	3150	18456	4611	2472	2147
6	7513	76394	32467	6078	1415	3805	2937	15283	4258	2170
7	14742	6259	64563	29090	5097	1230	3313	2493	10604	3799
8	5805	12076	5068	54524	25091	4973	1077	2671	2255	6047
9	3368	4248	9985	4262	42766	22822	4035	805	2003	1814
10	6957	2062	3250	8069	3473	35727	18000	2628	623	1472
11	8692	10471	9673	10548	13081	12871	37410	41869	31983	20852
2+	185925	163941	139478	129178	116160	109961	93130	77615	66030	86641
3+	184469	159922	137739	120235	114332	108522	91083	75567	59871	54016
4+	177414	158142	133781	117979	97804	104232	89699	72665	57120	41236
5+	132421	150073	132153	114117	94785	84580	85228	70362	54198	38300

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	
2	10896	50648	8606	5340	3711	4401	37788	8918	7742	5164	†
3	53404	12916	51899	11009	7165	3471	4411	37501	9686	4665	†
4	12240	54284	12631	57388	12719	5515	3344	4703	34253	10373	$
5	2611	10448	50789	11027	55886	10284	5996	2998	3997	32577	$
6	1363	2114	8474	40763	10793	43984	9265	4792	2788	3054	
7	1784	917	1674	6021	30434	7600	37353	7624	4065	2433	
8	2666	1444	532	1369	4008	21038	5903	26917	5270	3056	
9	3139	1967	1188	318	998	2693	14086	4123	18448	2996	
10	1445	1516	1356	913	207	805	1492	8335	2106	10189	
11	13941	9412	7045	5966	5555	4202	3159	3035	6554	4763	
2+	103489	145668	144192	140115	131476	103994	122797	108946	94910	79272	
3+	92594	95019	135586	134775	127764	99593	85009	100028	87168	74108	
4+	39190	82103	83687	123765	120599	96122	80599	62527	77482	69442	
5+	26950	27819	71057	66377	107881	90607	77254	57824	43229	59069	

Table 23. Population numbers at age ($x10^3$), estimated from cohort analysis, for spring-spawning herring in NAFO division 4R from 1973 to 1992.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	16015	34409	24951	143304	31551	15424	19721	19275	80080	379078
3	49308	11453	28044	20376	116890	25823	12628	15994	15510	65527
4	221587	39977	9141	22060	16067	95218	21100	10316	12322	12321
5	424648	180458	32613	7104	17296	12665	76160	17082	8350	8176
6	31024	322453	147411	26611	5635	13790	10182	52557	13664	6720
7	53858	23075	255456	119728	21470	4338	10677	7778	30478	10867
8	19909	41180	18604	201521	95489	17264	3334	7768	5999	16925
9	11175	13376	32945	14945	150906	74233	12178	2235	5145	4741
10	21988	6798	10251	26670	11550	109111	53351	7463	1606	3746
11	26151	30171	27949	30519	40924	36195	101107	107624	74846	50740
2+	875664	703350	587366	612837	507777	404061	320437	248092	248000	558843
3+	859648	668941	562414	469533	476226	388637	300717	228817	167921	179765
4+	810340	657488	534370	449157	359337	362814	288089	212823	152411	114237
5+	588753	617511	525229	427097	343269	267596	266989	202507	140089	101916

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	
2	84797	417923	87357	41546	24857	31692	280806	82442	55500	55526	†
3	309825	69395	341987	71194	33722	19940	25312	229629	67407	45005	†
4	51501	250980	56425	275845	56165	27312	15838	20204	186144	53645	$
5	9461	38942	198452	45484	213390	43467	21998	12276	15990	146035	$
6	4475	6723	28437	142896	34209	160904	33361	17593	9679	12247	
7	5121	2677	4966	19669	90951	24835	118107	24566	13515	7353	
8	6949	3927	1455	3663	11362	62745	17006	79773	15587	9191	
9	7987	5044	3026	847	2579	7732	39051	11144	50790	8293	
10	3245	3833	3522	2247	543	1947	4044	22100	5702	27414	
11	32428	21470	16329	14373	11923	9474	7161	7272	16461	12490	
2+	515789	820916	741955	617764	479700	390047	562682	507000	436776	377199	
3+	430992	402994	654598	576218	454843	358354	281876	424558	381276	321673	
4+	121167	333598	312611	505024	421121	338414	256564	194929	313869	276667	
5+	69666	82618	256186	229179	364956	311103	240727	174725	127724	223022	

† geometric mean
$ estimates are non-significant

Table 24. Mid-year population biomass (mt), estimated from cohort analysis, for autumn-spawning herring in NAFO division 4R from 1973 to 1992.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	1629	1952	4486	1275	654	1786	5125	7706	46492	8027
3	2621	2274	1572	3222	2140	707	2613	7629	10560	39730
4	2797	4148	2054	1659	5647	1670	775	2369	7832	10640
5	2786	3550	4064	2506	2138	5643	1605	1022	2598	6888
6	3137	2378	3193	3195	1798	2177	4901	1501	808	2061
7	1557	2056	2497	2309	2806	1877	1887	4380	1404	796
8	4558	936	1757	1580	1972	2577	1351	1647	3252	1141
9	4353	3258	844	1328	1361	1719	1769	851	1460	2262
10	20974	2854	2841	745	1098	1298	1400	967	478	1136
11	49553	57097	52233	43209	31782	27831	21079	18771	13432	9809
2+	93964	80503	75542	61029	51396	47285	42506	46844	88316	82490
3+	92336	78551	71056	59754	50742	45499	37380	39137	41824	74463
4+	89715	76277	69484	56532	48602	44793	34767	31508	31264	34734
5+	86918	72130	67430	54873	42954	43123	33993	29139	23432	24094

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	
2	8512	3418	2313	3225	4522	10993	8886	36208	2887	2887	†
3	8106	10825	5595	5925	4701	4692	10898	10386	34293	5491	†
4	47047	6756	10939	6275	7188	4425	5928	12737	11205	52299	§
5	8896	43549	6674	10358	6219	6386	4229	5221	10340	9428	§
6	5444	7631	40347	5491	10585	4952	5559	3435	5242	10527	
7	1597	4581	6634	33287	4742	7912	4155	4996	3213	4120	
8	500	1242	3538	5423	28731	3612	6897	3682	4452	2542	
9	778	414	989	2792	4511	22592	2634	5695	3135	3691	
10	1561	494	297	753	2392	3885	18181	1967	4845	2659	
11	7776	6258	3710	3341	3781	4607	6695	20392	16605	15794	
2+	90217	85168	81036	76870	77371	74057	74061	104718	96215	106551	
3+	81705	81750	78723	73645	72850	63064	65176	68510	93328	106551	
4+	73599	70925	73128	67720	68148	58372	54277	58125	59035	101060	
5+	26552	64169	62189	61445	60960	53947	48349	45388	47830	48761	

Table 25. Population numbers at age ($x10^3$), estimated from cohort analysis, for autumn-spawning herring in NAFO division 4R from 1973 to 1992.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	17998	17685	40638	11554	5925	16177	46431	69810	356820	53440
3	27684	14735	14479	33271	9459	4851	13245	38014	57142	292139
4	19775	21038	12047	11837	27197	7742	3962	10837	30959	46754
5	13351	15123	16869	9827	9446	22114	6315	3139	8750	24873
6	12659	9923	11901	13029	7783	7612	17612	4858	2492	6942
7	5800	7988	7830	8907	10285	6007	5877	11987	3818	1959
8	15298	3367	6005	6314	6786	7769	3915	4341	8249	2859
9	14422	10144	2523	4774	4876	5189	4832	2041	3328	5637
10	67083	8342	8027	1932	3680	3682	3793	2285	1061	2587
11	143277	149482	124163	105216	83509	65334	50917	38866	28815	21397
2+	337347	257827	244481	206662	168945	146477	156898	186178	501434	458587
3+	319349	240142	203843	195108	163020	130300	110468	116368	144614	405147
4+	291665	225406	189364	161837	153560	125449	97223	78354	87472	113007
5+	271890	204368	177318	150000	126364	117707	93261	67517	56513	66253

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	
2	89337	48742	51012	33949	45429	106054	85719	456058	46925	46925	†
3	43662	73129	39907	41751	27764	37194	86391	70142	373355	38373	†
4	238671	35672	59823	32461	33798	22589	30265	70189	57008	305026	§
5	36629	193299	28601	47767	25282	27231	18032	24290	56207	45816	§
6	19499	28762	152597	21691	36692	19474	21860	13929	19537	42146	
7	5223	14780	22511	116178	15685	28223	14822	17167	11121	15427	
8	1477	3818	11280	17614	87499	11278	21533	11458	13633	8127	
9	2000	1065	2927	8672	13703	66275	7726	16880	9088	10611	
10	3736	1215	740	2292	6753	10790	50492	5456	12890	7002	
11	17069	14004	9500	7949	8138	11893	17284	52154	43099	39518	
2+	457302	414487	378896	330324	300742	341001	354123	737723	642864	512047	
3+	367965	365745	327884	296374	255313	234947	268405	281664	595940	512047	
4+	324303	292616	287978	254623	227549	197753	182014	211522	222585	473674	
5+	85632	256944	228154	222163	193752	175164	151749	141333	165577	168647	

† geometric mean
§ estimates are non-significant

Table 26. Instantaneous fishing mortality matrix and average for ages 6+ (unweighted and weighted), estimated from cohort analysis, for (a) spring-spawning and (b) autumn-spawning herring in NAFO division 4R from 1973 to 1992.

A)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	.135	.005	.003	.004	.000	.000	.009	.017	.001	.002	.000	.001	.005	.009	.020	.025	.001	.001	.010	.002
3	.010	.025	.040	.038	.005	.002	.002	.061	.030	.041	.011	.007	.015	.037	.011	.030	.025	.010	.028	.031
4	.005	.004	.052	.043	.038	.023	.011	.011	.210	.064	.080	.035	.016	.057	.056	.016	.055	.034	.043	.036
5	.075	.002	.003	.032	.026	.018	.171	.023	.017	.403	.142	.114	.128	.085	.082	.065	.023	.038	.067	.065
6	.096	.033	.008	.015	.061	.056	.069	.345	.029	.072	.314	.103	.169	.252	.120	.109	.106	.064	.075	.094
7	.068	.015	.037	.026	.018	.063	.118	.060	.388	.247	.065	.410	.104	.349	.171	.179	.192	.255	.186	.162
8	.198	.023	.019	.089	.052	.149	.200	.212	.035	.551	.120	.061	.341	.151	.185	.274	.223	.251	.431	.403
9	.297	.066	.011	.058	.124	.130	.290	.130	.117	.179	.534	.159	.098	.245	.081	.448	.369	.470	.417	.338
10	.273	.083	.027	.139	.176	.167	.166	.236	.215	.326	.315	.244	.127	.136	.077	.273	.238	.387	.381	.641
11	.273	.083	.027	.139	.176	.167	.166	.236	.215	.326	.315	.244	.127	.136	.077	.273	.238	.387	.381	.441
6+	.165	.036	.025	.072	.103	.147	.166	.257	.224	.332	.300	.206	.149	.250	.152	.171	.216	.271	.354	.415
wt	.222	.054	.024	.090	.109	.135	.188	.175	.194	.326	.270	.223	.159	.203	.118	.289	.252	.350	.359	.397

B)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.000	.000	.000	.001	.000	.005	.001	.000	.001	.000
3	.075	.001	.001	.002	.000	.002	.001	.005	.001	.002	.002	.001	.007	.011	.006	.006	.008	.007	.002	.010
4	.068	.021	.004	.026	.007	.004	.033	.014	.019	.044	.011	.021	.025	.050	.016	.025	.020	.022	.019	.005
5	.097	.040	.058	.033	.016	.028	.062	.031	.031	.043	.042	.036	.077	.064	.061	.020	.058	.018	.088	.035
6	.260	.037	.090	.036	.059	.059	.185	.041	.041	.085	.077	.045	.073	.124	.062	.073	.042	.025	.036	.033
7	.344	.085	.015	.072	.081	.228	.103	.174	.089	.082	.113	.070	.045	.083	.130	.071	.057	.030	.114	.057
8	.211	.089	.029	.059	.068	.275	.451	.066	.181	.157	.127	.066	.063	.051	.078	.178	.043	.032	.051	.076
9	.347	.034	.067	.060	.081	.113	.549	.455	.052	.211	.299	.165	.044	.050	.039	.072	.148	.070	.061	.084
10	.146	.042	.030	.052	.092	.108	.146	.161	.138	.144	.201	.278	.056	.032	.027	.075	.065	.093	.153	.063
11	.146	.042	.030	.052	.092	.108	.146	.161	.138	.144	.201	.278	.056	.032	.027	.075	.065	.093	.153	.116
6+	.171	.044	.035	.052	.087	.125	.187	.157	.130	.141	.144	.110	.068	.081	.072	.080	.062	.067	.108	.072
wt	.239	.059	.034	.059	.083	.166	.279	.203	.120	.148	.188	.171	.053	.050	.060	.094	.076	.064	.106	.079

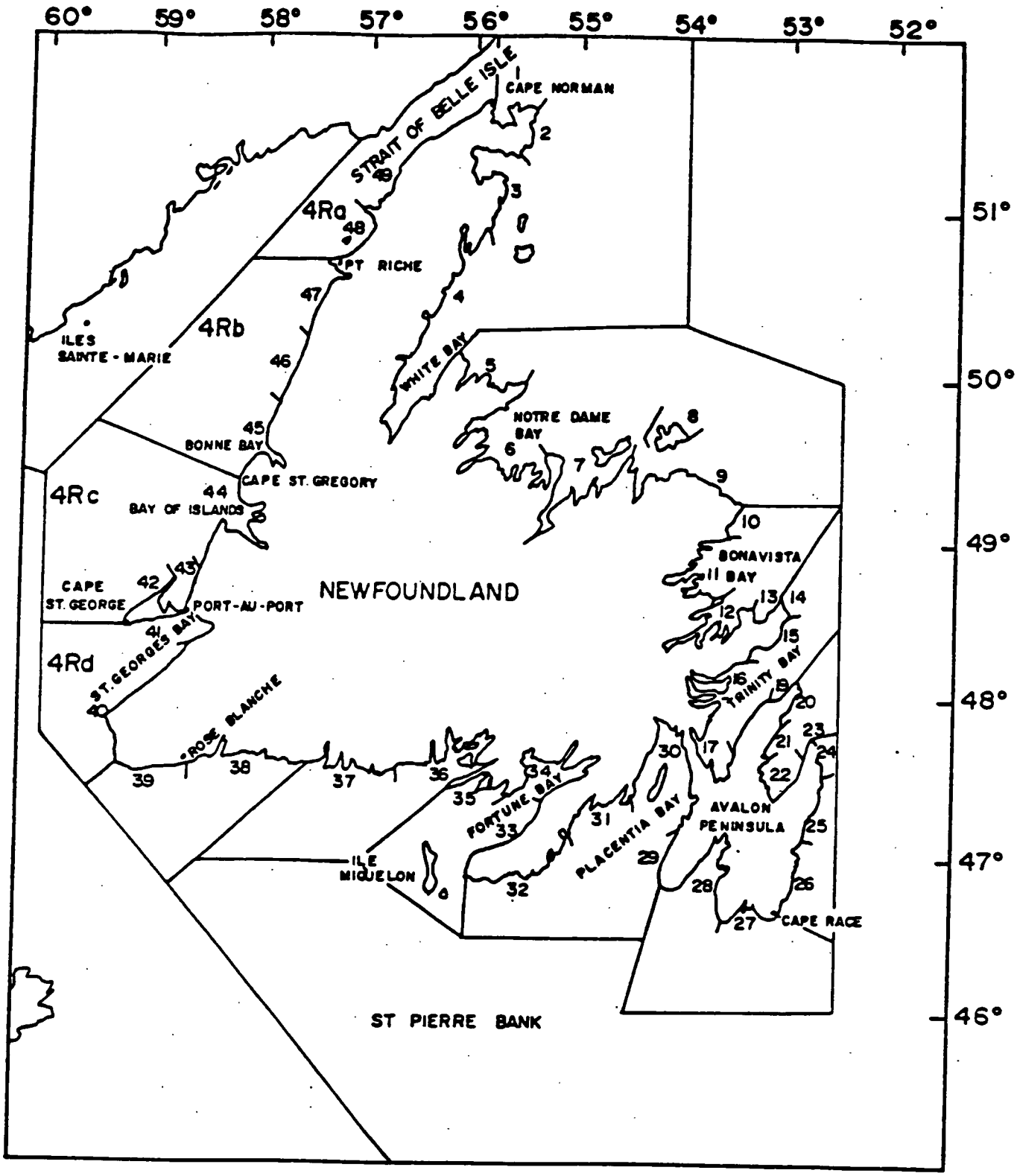


Figure 1. West coast of Newfoundland unit areas and statistical districts.

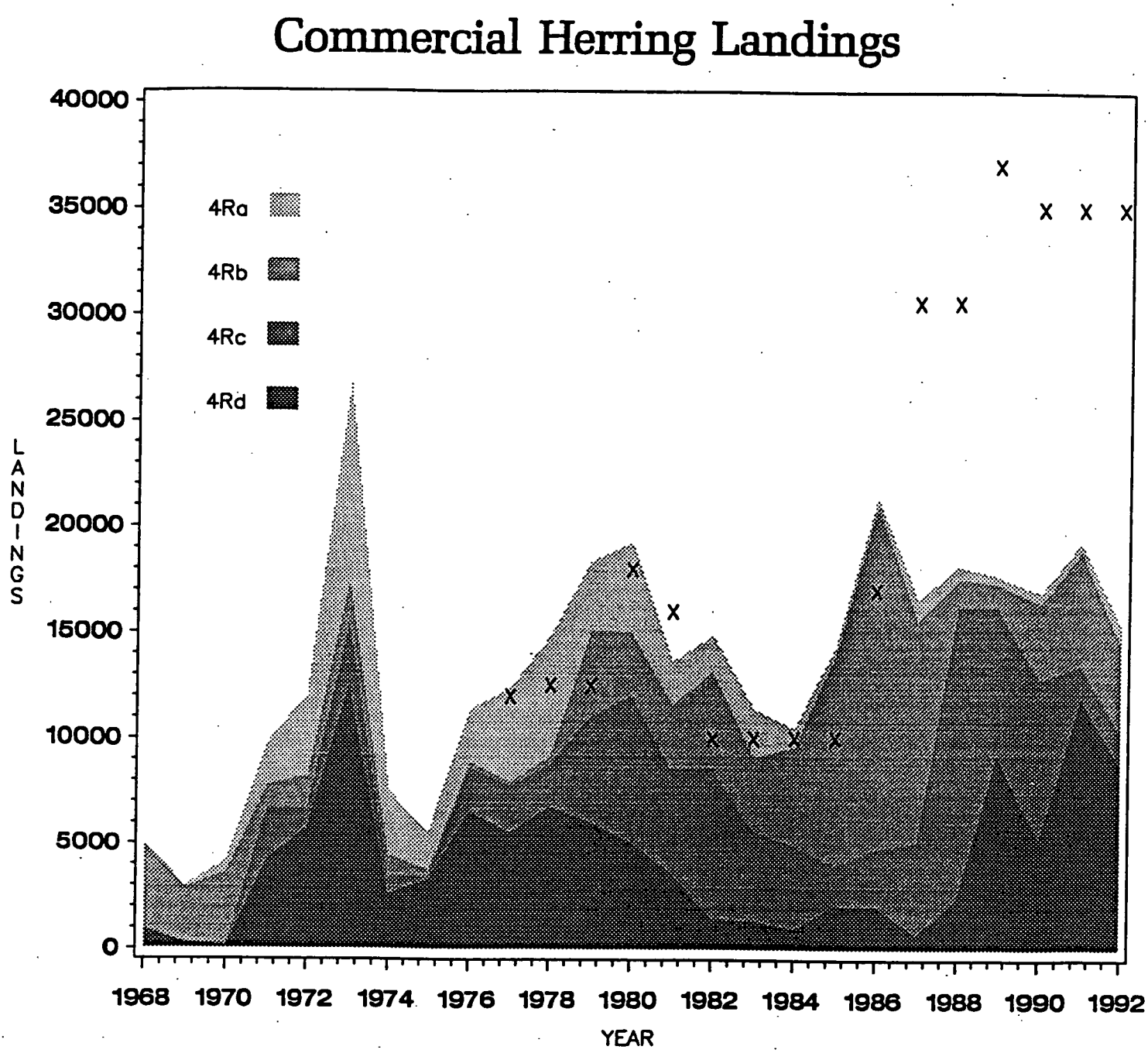


Figure 2. Cumulative commercial herring landings (t) by fishing area in NAFO Division 4R from 1968 to 1992. "X"indicates annual TAC.

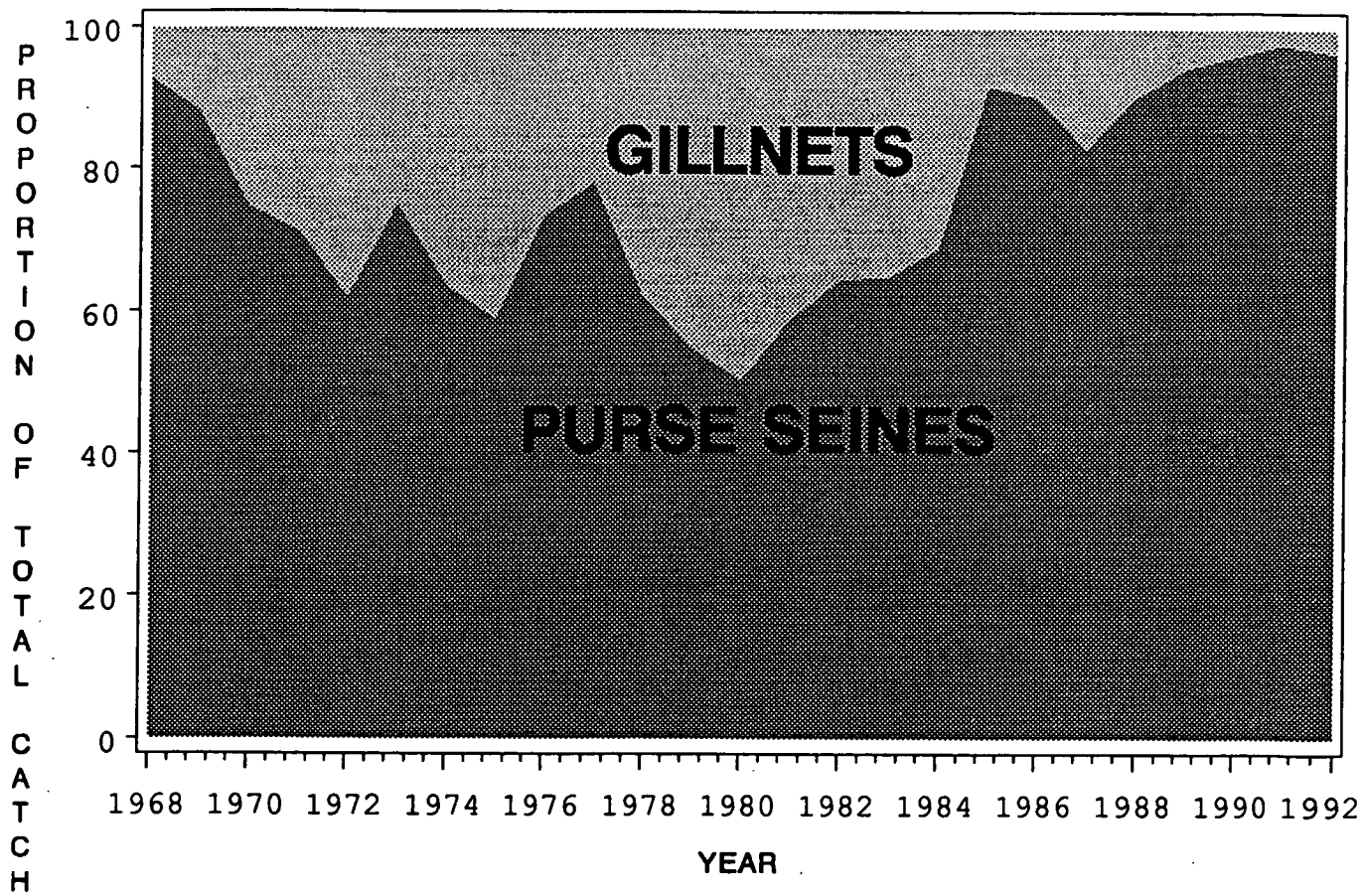


Figure 3. Proportion of total herring landings taken by gillnets and purse seines in NAFO Division 4R from 1968 to 1992.

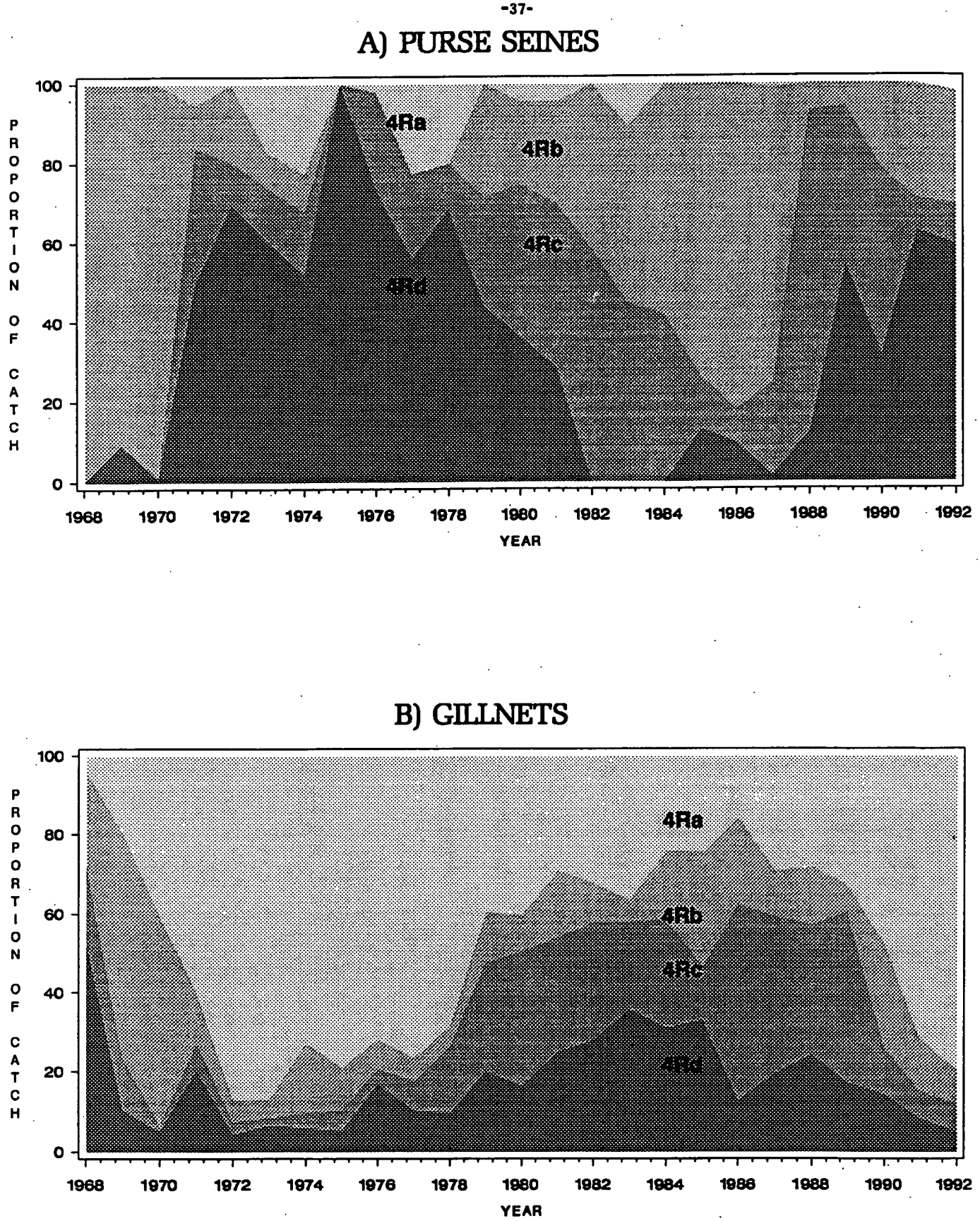


Figure 4. Proportion of (a) purse seine and (b) gillnet herring landings by fishing area in NAFO Division 4R from 1968 to 1992.

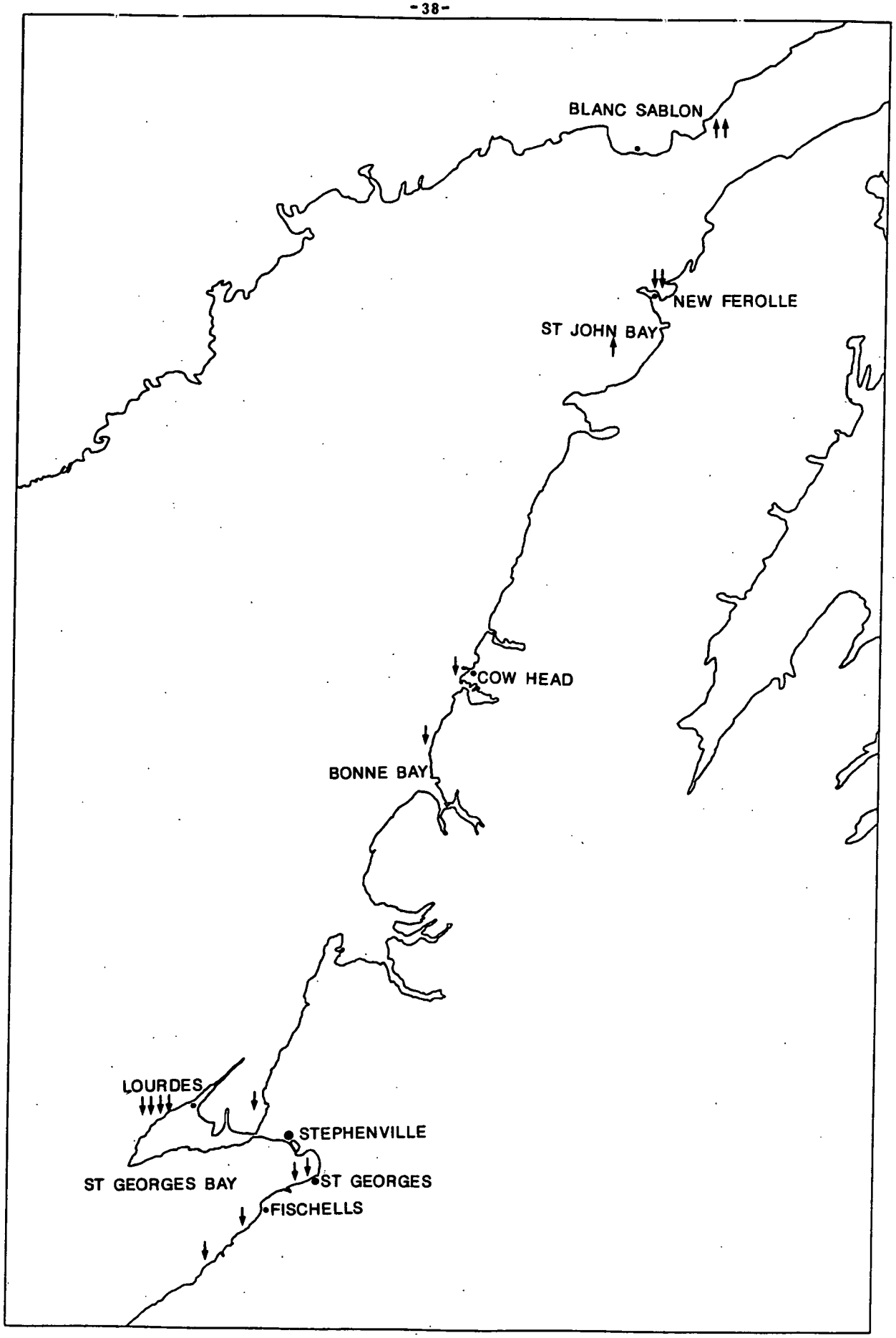


Figure 5. Distribution of unsolicited comments concerning the state of herring spawning in unit areas (a) 4Rd and 4Rc (b) 4Rb and (c) 4Ra from written questionnaires to inshore fishermen. [↑ = stock in good shape; ↓ = spawning in decline].

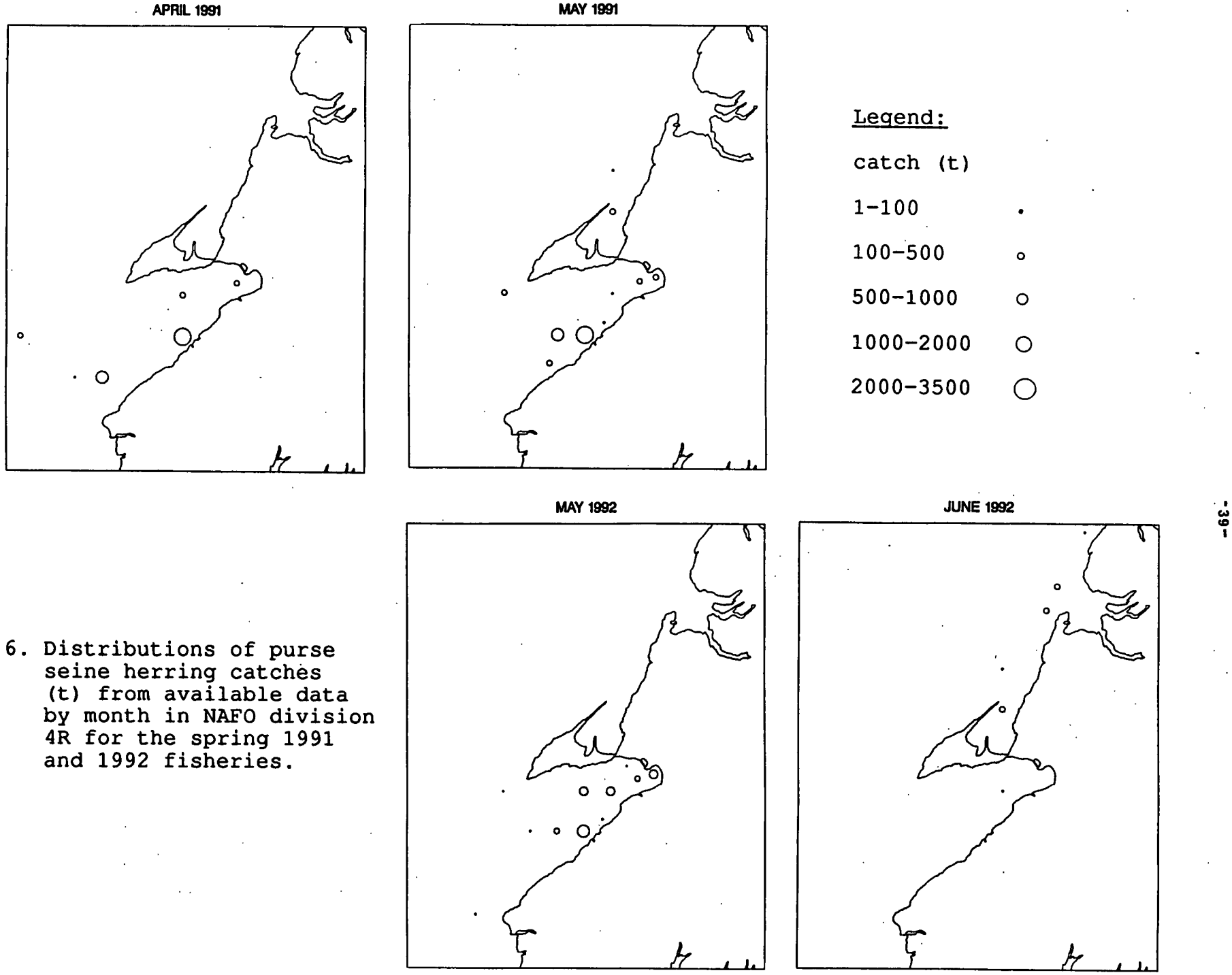


Figure 6. Distributions of purse seine herring catches (t) from available data by month in NAFO division 4R for the spring 1991 and 1992 fisheries.

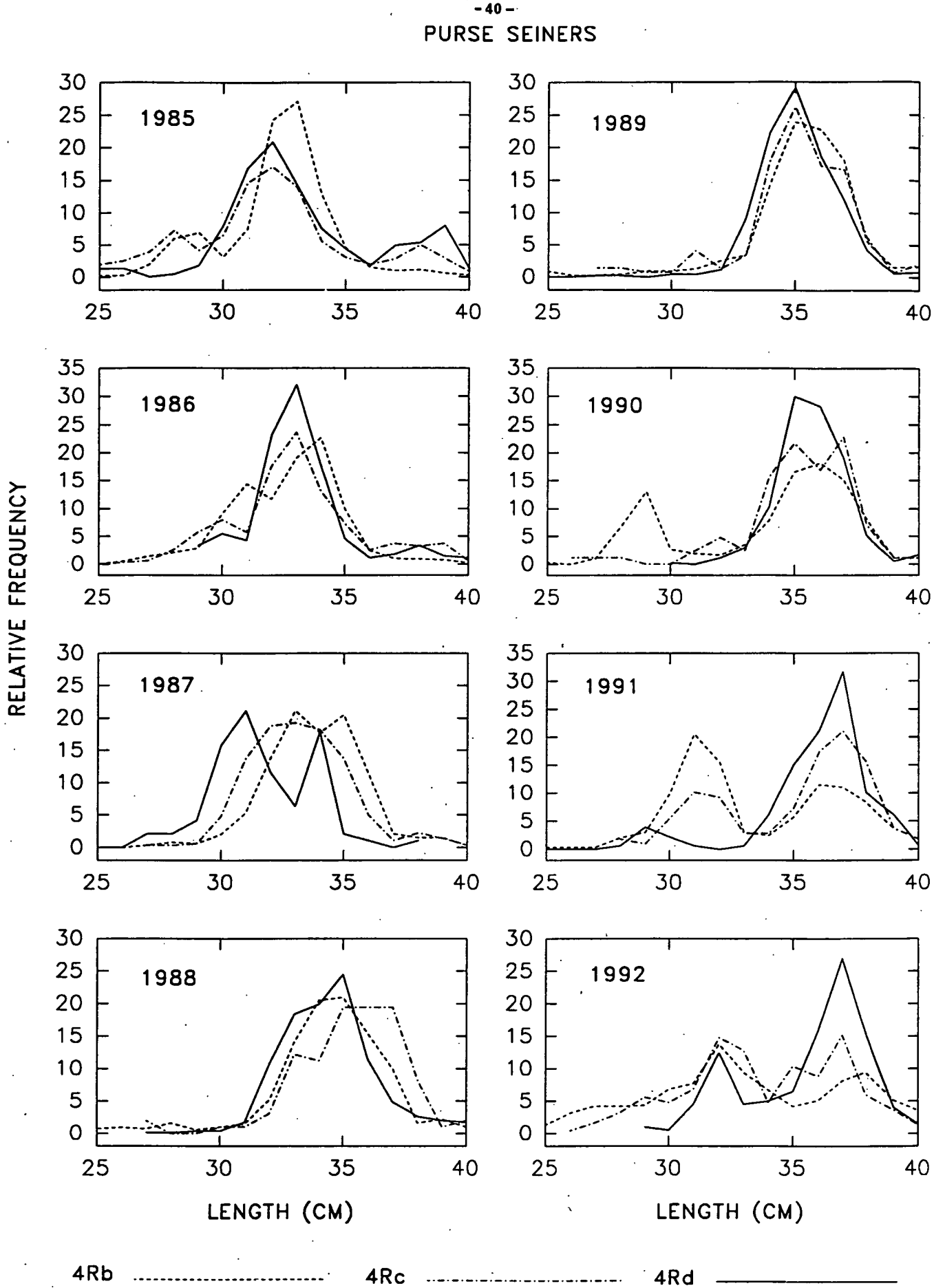


Figure 7. Length frequency distributions of 4R herring by unit area from purse seine samples between 1985 and 1992.

GILLNET

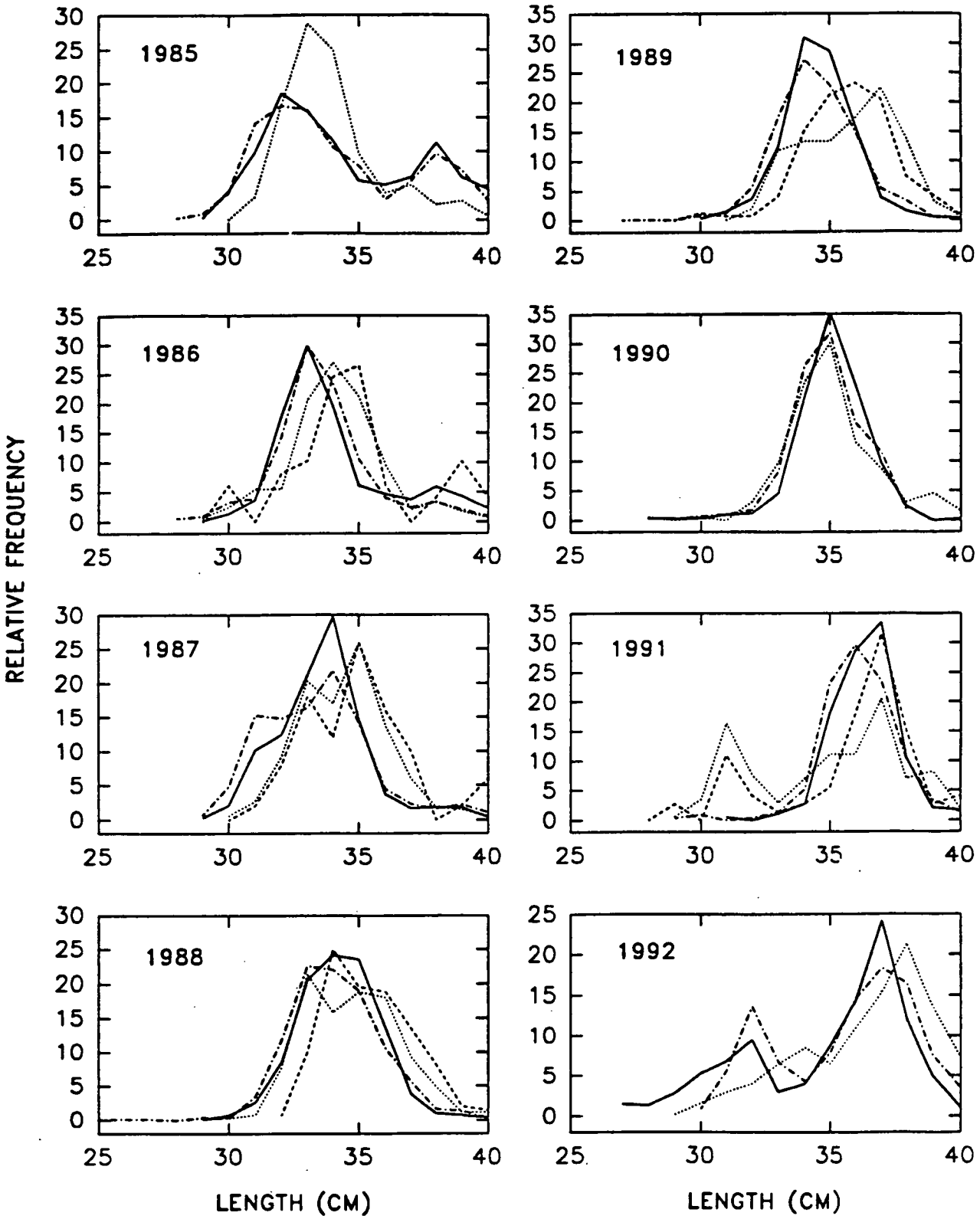


Figure 8. Length frequency distributions of 4R herring by unit area from gillnet samples between 1985 and 1992.

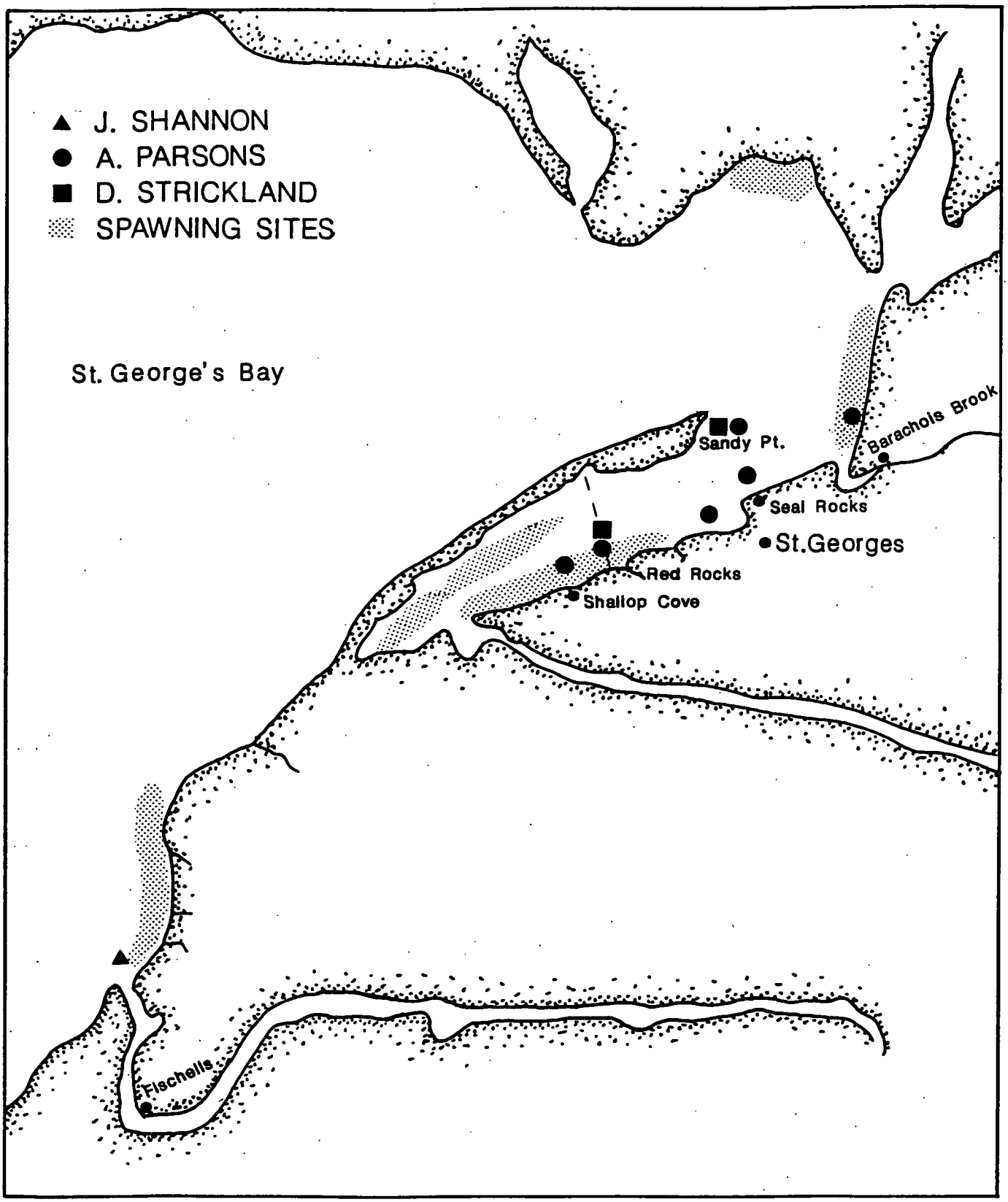


Figure 9. Location of the major spawning sites of spring herring and fishing sites of index fishermen in St. Georges Bay.

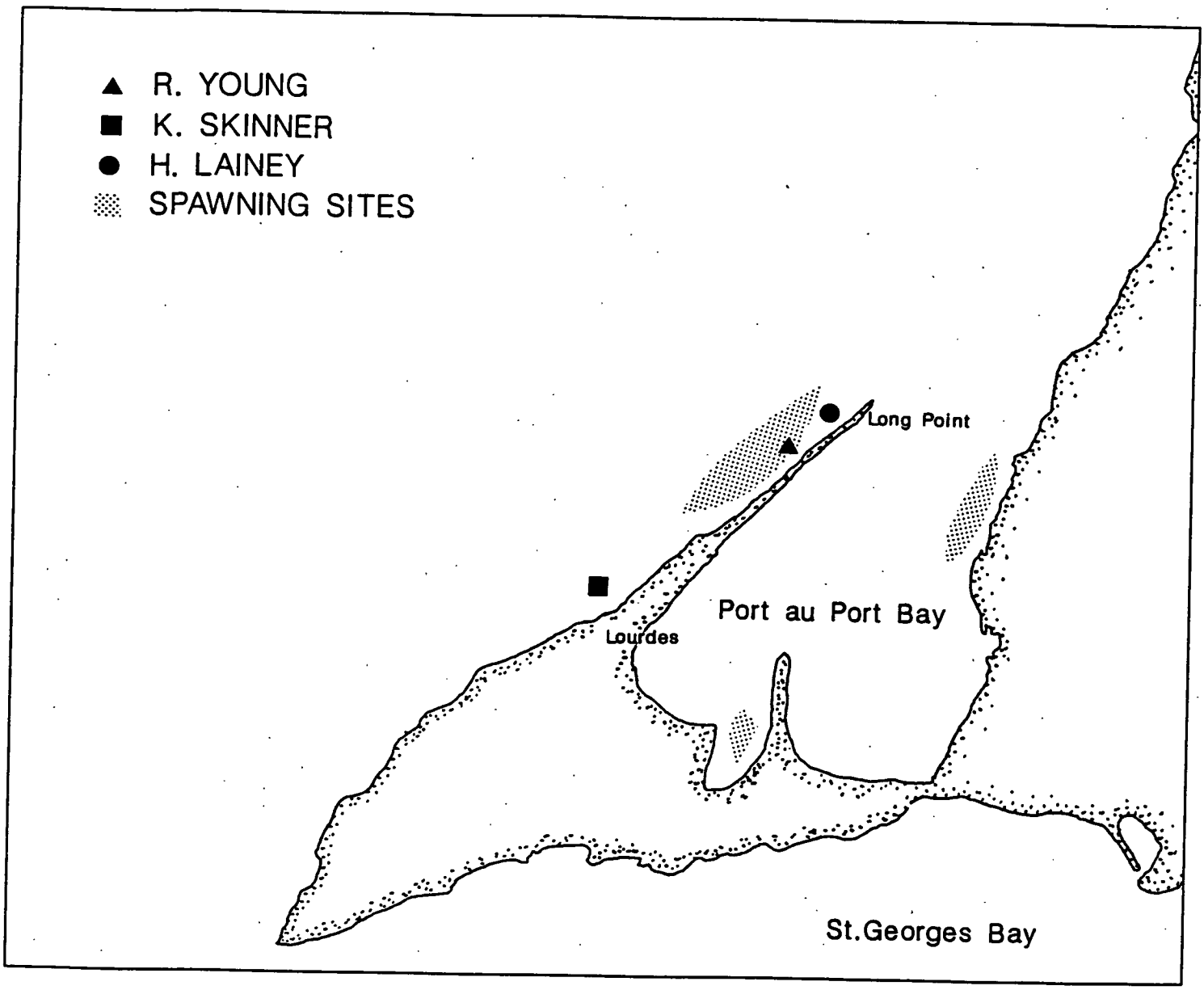


Figure 10. Location of the major spawning sites of spring herring and fishing sites of index fishermen in and around Port-au-Port Bay.

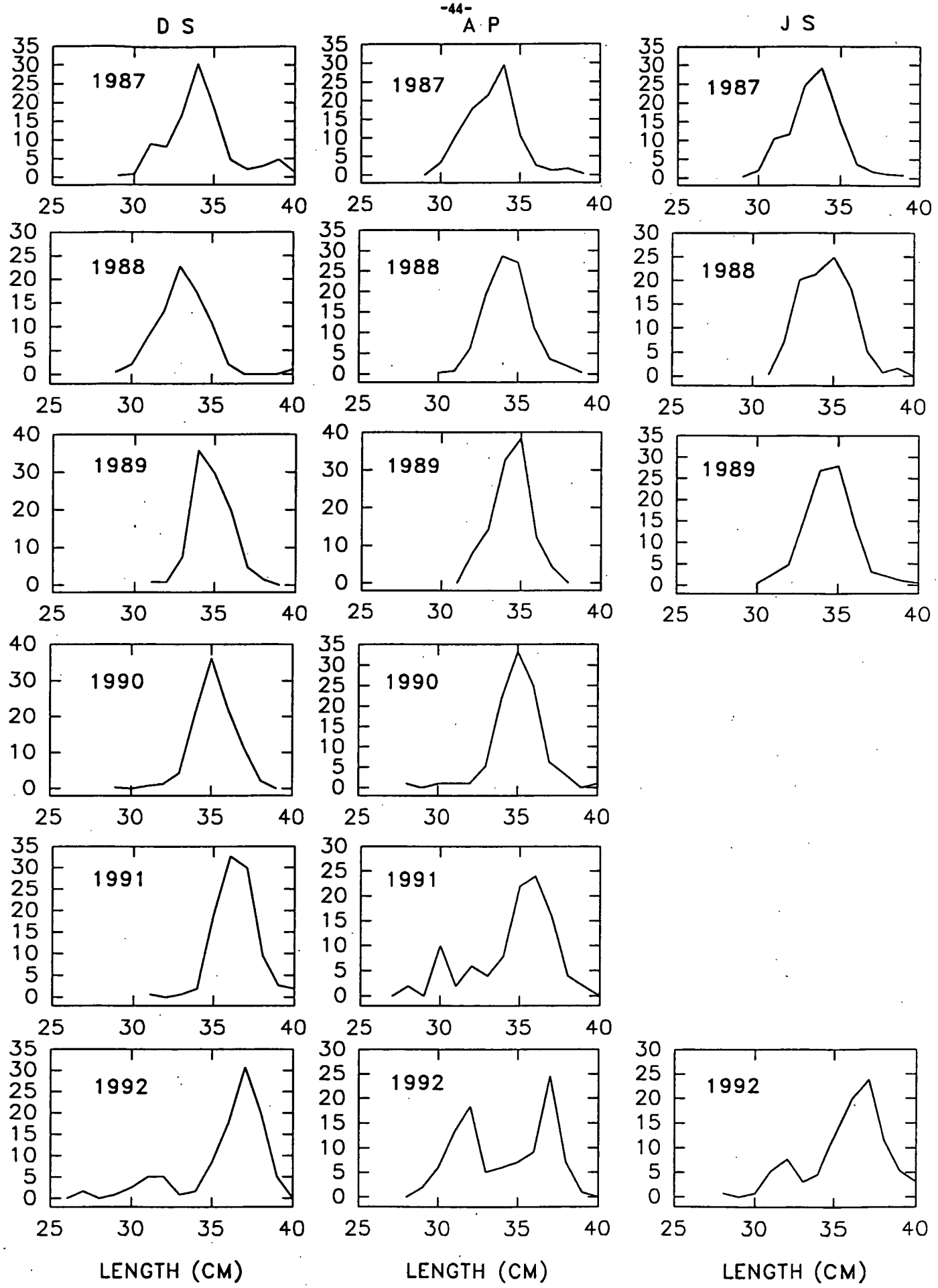


Figure 11. Length frequency distributions of 4R spring-spawning herring from index fishermen in St. Georges Bay between 1987 and 1992.

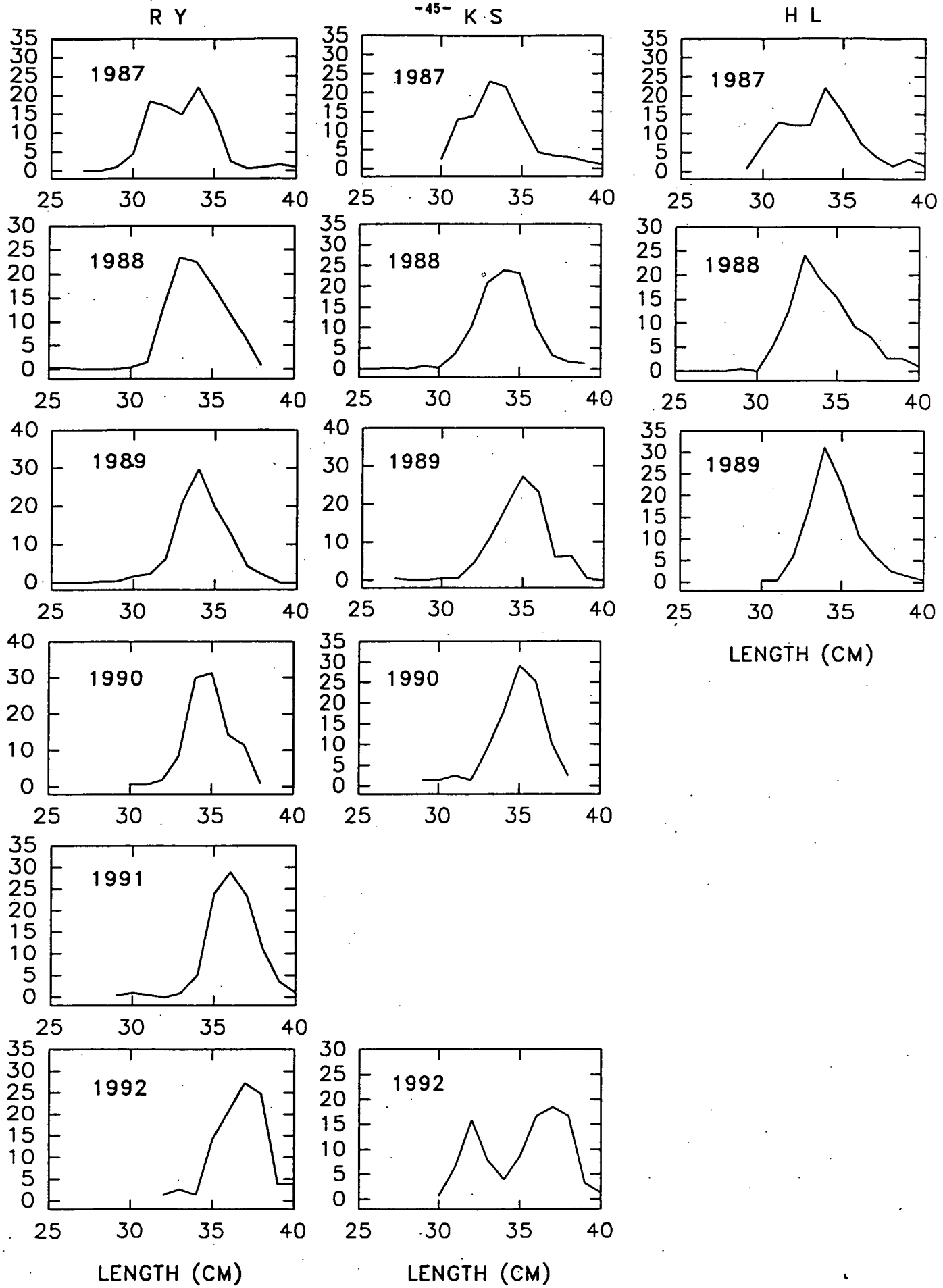
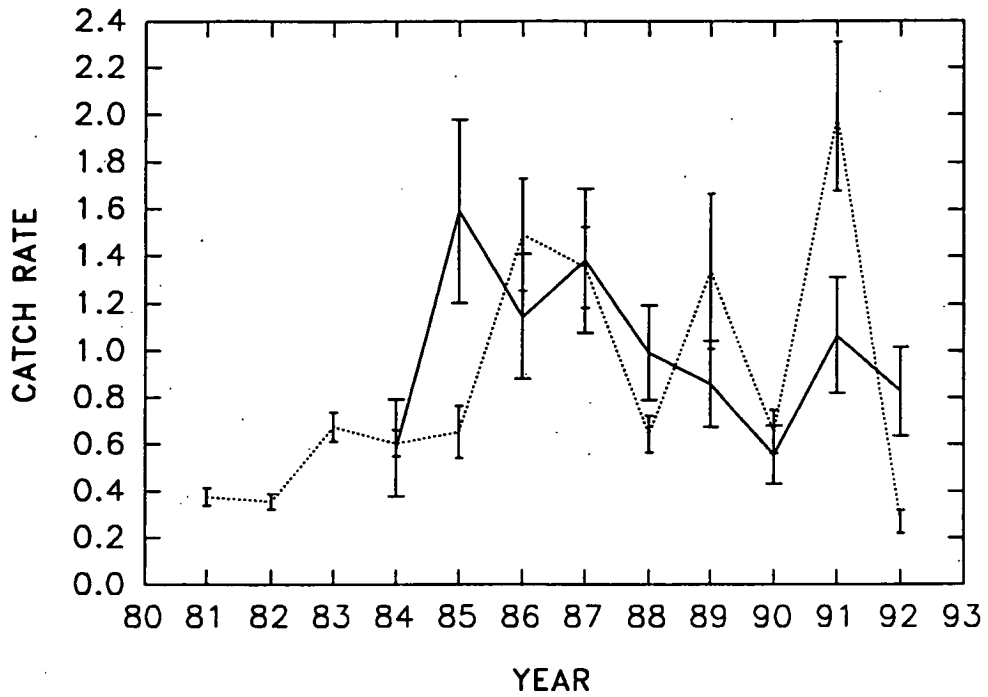


Figure 12. Length frequency distributions of 4R spring-spawning herring from index fishermen in and around Port-au-Port Bay between 1987 and 1992.

A) Spring Spawners



B) Autumn Spawners

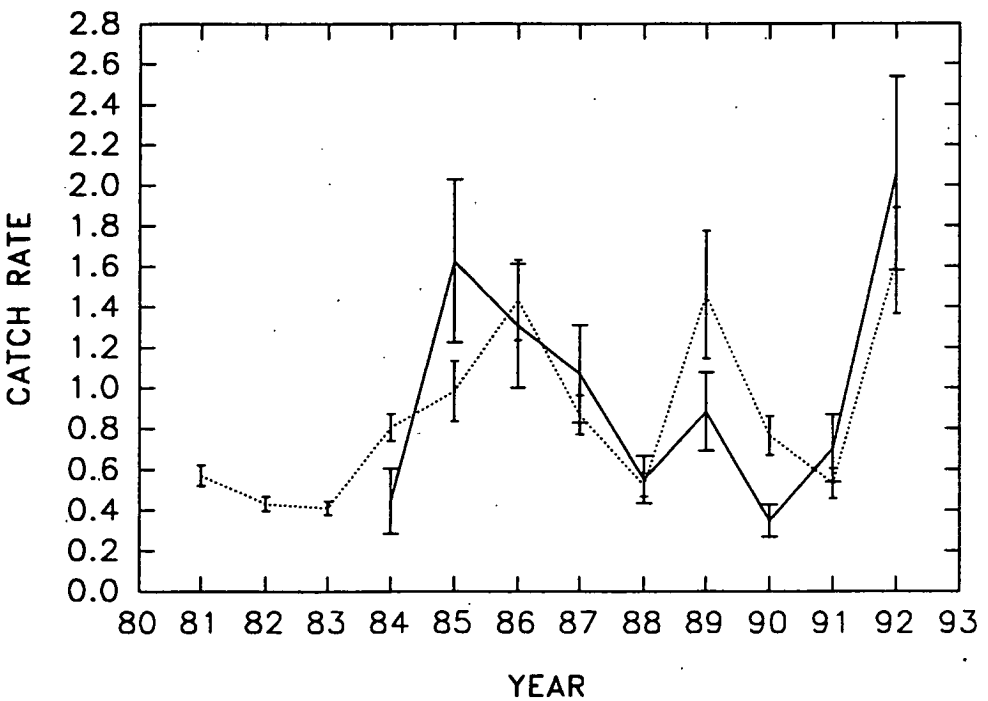


Figure 13. Gillnet catch per unit effort and 2 S.E. (standardized to the mean of each series from 1984 to 1992) for (a) spring-spawning and (b) autumn-spawning herring in NAFO division 4R as calculated from index-fisherman logbook (—) and commercial (···) data.

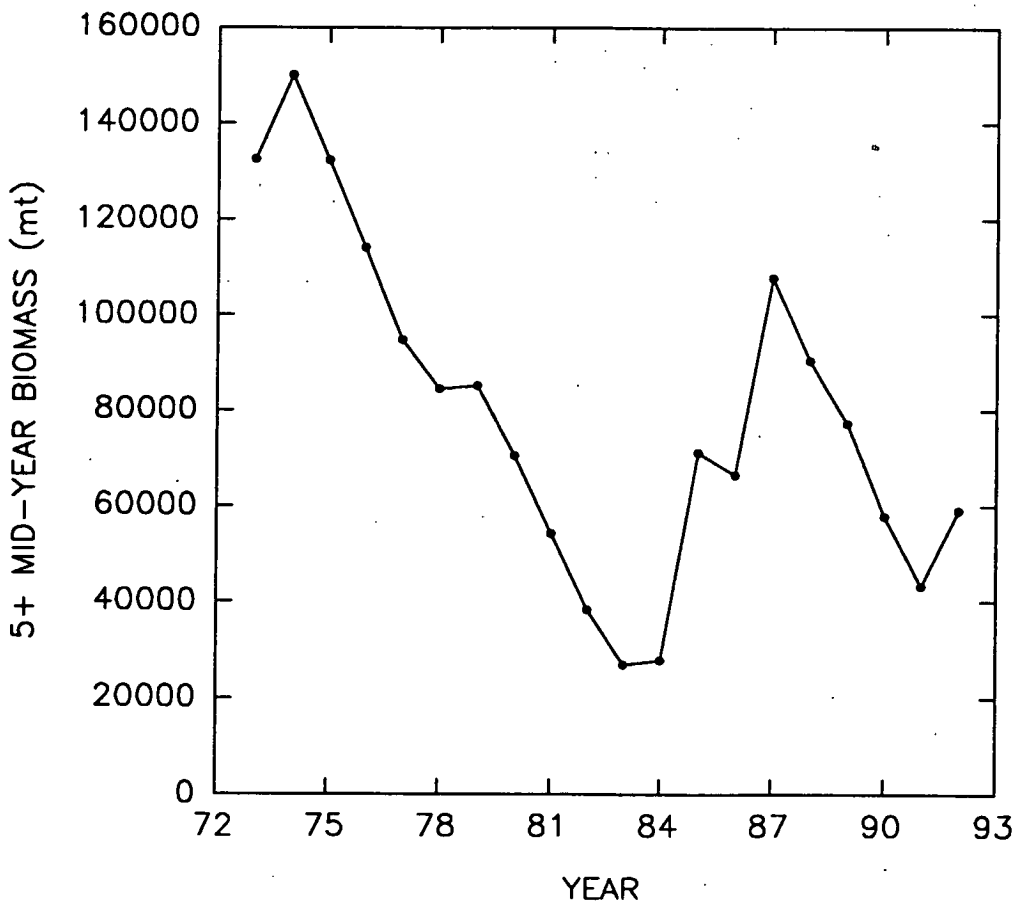


Figure 14. Mid-year population biomass (5+) for 4R spring-spawning herring from 1973 to 1992.

Annex 1. Number of herring otoliths read (**bold print**) and commercial landings (t) in NAFO division 4R by gear, area and month in 1992. (Boxed areas indicate sample-landing combinations for the weighting of the catch at age)

GEAR	AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
GN	4Ra					1 9	**49** 27	2 **149** 265	3 **91** 52	4 **86** 12	5 **48** 107	84	
	4Rb			6 2	3	15	20	1	1		3	3	
	4Rc					**141** 22	7 **125** 2	8 **49** 5	3	1	2	2	
	4Rd					9 **227** 15	10 **140** 3	4	2	1	1	2	
PS	4Ra						1 86	258	2				
	4Rb					**48**	**40** 18				2 **50** 87	3 **382** 3985	
	4Rc					4 **45** 23	5 **136** 779	43		6 **49** 51	7 56	**150** 567	4
	4Rd					8 **148** 8297	124				9 2	**91** 272	1