Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC
Research Document 82/13

Fishery, Biological Characteristics and Abundance of Herring in NAFO Subdivision 4S

by

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ABSTRACT

A questionnaire survey was run in 1981 in NAFO subdivision 4S to characterize the inshore herring fishery. Catch sampling was done in 1980 and 1981 to determine biological characteristics.

The results of the survey show that anchored gillnets are the only gear presently used for herring in 4S. Average number of gillnets per fisherman has increased from 4.5 to 6.4 over the past several years. Nets are generally longer (120 ft vs 90 ft) and deeper (20 ft vs 12 ft)in 4S than in the Magdalen Islands. There is no significant temporal trend in net dimensions in 4S as has been observed in the Magdalens. Average effort (net-days) per fisherman has increased from 265.8 net-days to 396.9 net-days in the past four years, which is low compared to area 4T (527.3 net-days in 1979). A C.P.U.E. index was calculated based on net surface; 4S C.P.U.E. values represent only 25% of those of the Magdalens. Weekly C.P.U.E. are maximal 2 weeks earlier in western 4S than in eastern 4S.

Gillnet catch was composed of a mixture of spring and autumn spawners. Most spring spawners average between 31 and 34 cm, while autumn spawners have a more dispersed distribution over greater lengths. Eastern and western 4S show the same age composition among spring spawners, 1974 year-class dominating with substantial numbers of 10-plus fish. Eastern 4S autumn spawners were dominated by 10-plus fish with good representation of 1973 and 1976 year-classes.

RESUME

Une enquête par questionnaire écrit a été entreprise dans la subdivision NAFO 4S en 1981, afin de décrire la pêche côtière au hareng. Un échantillonnage des captures a été réalisé en 1980 et 1981 pour déterminer les caractéristiques biologiques.

Les résultats de l'étude montrent que les filets maillants ancrés sont le seul engin de pêche présentement utilisé dans la zone 4S. Le nombre moyen de filets par pêcheur est passé de 4.5 à 6.4 au cours des dernières années. Les filets sont généralement plus longs (120 pi. vs 90 pi.) et plus profonds (20 pi. vs 12 pi.) dans 4S que ceux utilisés aux Iles-de-la-Madeleine. Il n'y a aucune fluctuation temporelle dans la taille des filets de 4S, contrairement à ce qui a été observé aux Iles-de-la-Madeleine. L'effort de pêche moyen (filets-jours) par pêcheur est passé de 265.8 filets-jours à 396.8 filets-jours lors des quatre dernières années; ces chiffres sont faibles comparés aux données de 4T (527.3 filets-jours en 1979). Un indice de prise par unité d'effort (P.U.E.) a été calculé en utilisant les surfaces des filets; les P.U.E. de 4S ne représentent que 25% de celles calculées aux Iles-de-la-Madeleine. Les P.U.E. maximales sont obtenues 2 semaines plus tôt dans la partie ouest de 4S que dans la partie est.

Les captures des filets maillants sont composées d'un mélange de frayeurs de printemps et d'automne. La majorité des frayeurs de printemps mesurent entre 31 et 34 cm tandis que ceux d'automne se distribuent également vers les plus grandes tailles. Les harengs de printemps de l'est et de l'ouest de 4S ont la même composition d'âge; la classe 1974 domine, suivie d'un important nombre de poissons de 10 ans et plus. Les frayeurs d'automne de la partie est de 4S sont dominés par les poissons de 10 ans et plus, accompagnés de substantielles quantités des classes d'âge de 1973 et 1976.

INTRODUCTION

Historically the herring fishery along the Quebec North Shore (NAFO division 4S) was for bait and local use. Variability in landings has always been high; for example, annual landings varied between 6 and 5450 barrels from 1875 to 1889 (Huntsman et al., 1954). In the mid-sixties a fish plant started processing herring at La Tabatière, and a new plant began to operate in 1981 at Baie Trinité. Landings have increased with these developments and increasing interest in the fisheries along the North Shore of the Gulf of St.Lawrence necessitate assessment of the capacity of stocks to support exploitation.

Various hypotheses have been proposed on stock relationships of North Shore herring. Huntsman et al. (1954) suggested that herring of the lower North Shore originated on the west coast of Newfoundland and "like the cod it is carried across the Channel, being in greatest quantity at Bradore and at Great Mekatina". However, only one herring tagged off the west coast of Newfoundland has been recaptured on the lower North Shore (Moores, 1979). Day (1957), based on a study of growth and vertebral counts, suggested two or more spring-spawning populations in the northwestern Gulf: one, composed of fish from Sept-Iles and Isle Verte, another comprising those from Matane, Fox River and Havre St-Pierre.

Leclerc (unpublished) made a principal component analysis of meristic and otolith morphometric data, suggesting the presence of discrete "populations" in the eastern and western part of division 4S. Otherwise, published biological data on north shore herring are rare.

Studies in 1981 were directed toward establishment of fishery characteristics and biological characteristics of exploited herring, continuing preliminary biological studies initiated in 1980. The objectives of the present paper are to summarize available data on the fishery and biology of herring in the area so as to provide preliminary advice on management.

METHODS

Yearly landings in NAFO 4S and 4R were obtained from ICNAF documents. The 4S region was then divided into three sectors corresponding to NAFO sub-areas: the northwestern Gulf, from Pointe des Monts to Rivière Moisie (subarea 4Sz); the mid northeastern shore from Kegaska to Ile Plate (sub-area 4Sv) and the far northeastern shore from Ile Plate to Blanc Sablon (subarea 4Sw) (Fig. 1). Daily landings were provided, for the northwestern sector in 1981 by Hareng du Nord Inc., a processing plant located at Baie Trinité, and in the northeastern sectors for 1980 and 1981, by Primonor Inc., a plant located at La Tabatière.

Data on the herring fishery were obtained by a mail-out survey covering all fishermen licensed in the three subareas. 102 questionnaires were analysed to describe the fishery and provide an effort index. C.P.U.E. indices were calculated from sales slips and with information provided by the questionnaires (e.g. number of gillnets, length and depth of gillnets).

Catch sampling was conducted in 1980 and 1981. Field study during 1980 was centered on a continuous sampling of gillnets set at La Tabatière between June and September. In 1981, a similar survey was conducted in the 4Sz subarea in June and July, and again, at La Tabatière between July and September. The objectives of these studies were to provide basic data on the population structure, growth, maturity and fecundity of herring in the study region. Herring captured were frozen and subsequently analysed for total length, weight, sex, gonad weight, maturity and age. Maturity stages were determined visually according to 8 stages (Boyar, 1968). Otoliths were removed for age determination and to determine whether the specimen originated from spring or fall spawning stocks. Otolith readings were made by two experienced readers using the standard method (Hunt et al., 1973). Maturity stages were classified by two methods depending on whether the samples were from the northeast or the northwest; the Quebec laboratory classification (Table 1), for the northwestern Gulf, and the St.John's method (Winters, personal communication) (Table 2) for the north eastern Gulf. This decision was necessary after comparison of otolith characteristics with maturity classification of spawning fish (stage 5, 6, 7).

However, July fish still presents a problem in 4Sw as to stage 3 and 8 differentiation; so the decision was made to classify those fish by utilizing otolith characteristics (as described by Messieh, 1972); if they were called spring it was a stage 8 while a fall fish was a stage 3.

RESULTS AND DISCUSSION

Yearly landings

Herring catches in 4S, prior to 1970, were under 100 t, rising sharply during 1970 and 1971 to a level of 600 to 900 t and peaking in 1981 to over 1000 t (Fig. 2). Catches in region 4R have been approximately 10-fold greater than in 4S for corresponding years.

In the eastern part of 4S, herring was fished, prior to 1972, mainly in September. Herring was at that time either salted or used as bait in other fisheries; in subsequent years herring has been marketed both fresh and salted. Last year a new plant began to operate at Baie Trinité, in western 4S; this fact could explain the maximum landing value in 1981.

A closer look at yearly landings and number of fishermen among subareas of 4S shows the greater importance of eastern and western regions, over the central one (Fig. 2a, 2b, 2c). The herring fished in 4Sy is strictly used for bait or local use and there is no evidence of great abundance in this subarea.

Daily landings

The herring season in eastern 4S generally extends form mid-May to mid-October and shows spring and fall highs in landings separated by a period of lower landings in June and early July (Figs. 3-6). Diversion of effort to other fisheries (particularly cod in June-July) may be as important in explaining this seasonal pattern as herring abundance. In both 4Sv and 4Sw, the fall fishery was noticeably weaker in 1981 than in 1980, while the spring fishery was generally stronger: the 4Sv subarea caught 89.2% of their herring during spring 1981 while 1980 spring landings represented 65% of total catch; 4Sw landed 81.5% of catches during the spring season of 1981 while it was 50.8% in 1980.

In western 4S, only data from the spring fishery are available (the plant closed in June), but it is evident that the first peak in landings came some two weeks earlier here than in eastern 4S (Figs. 6 & 7) thus suggesting the presence of discrete populations in two regions.

Fishery characteristics and effort

There are considerable variations in number of herring fishermen licensed through the years (Fig. 2a, 2b, 2c); Provincial regional fisheries offices listed 475 licensed fishermen in subdvision 4S in 1981. A mail-out survey was conducted; 325 questionnaires were sent, principally in the eastern and western parts of subdivision 4S. The questions were primarily designed to estimate the herring fishing effort of the gillnet fishery, and to provide basic information on spawning seasons and locations, and distribution of juveniles.

The central part (4Sy) is not considered here; none of the questionnaires sent there were mailed back and herring fishery in this region is not very important. The western questionnaires (175) were sent in May and received in July and August; the eastern ones (150) were mailed in July and received in October and November. A total of 102 questionnaires (31.4%) were filled out and mailed back.

Anchored gillnets are the only gear presently used for herring in 4S. The average number of gillnets per fisherman has increased through the past several years, showing a similar trend to that seen in the Magdalen Islands (Table 3); however nets per fisherman have increased considerably more in the Magdalen Islands (x4) than along the North Shore (x1.5). Number of nets per fisherman in 4S in 1981 was lower than in the Magdalens and number of nets per fisherman was lower (68%) in the western part of 4S than in the eastern part. This may be due to relative lack of experience of the western fishermen (4 years on the average as opposed to 7 years for the easterners).

Length distribution of gillnets shows no clear temporal trends within a given subregion over the past several years, although some fluctuations have occurred (Fig. 8). Nets are generally longer (120-150 ft) in western 4S than in eastern 4S (90-120 ft). Depth distribution of gillnets show a similar temporal pattern as observed in length frequencies (Fig. 9); however, nets are deeper (20 ft) in eastern 4S than in western 4S (15-20 ft), and for comparison gillnets in the Madgalens shows depths of 10 to 15 feets. The considerable variability of net length and depth among regions necessitates use of net surface rather than number as an effort index for comparison of C.P.U.E.'s between regions.

Similarly, there do not appear to have been significant temporal trends in stretched mesh length of nets used over the past several years, although mesh size differences between regions exist (Fig. 10). Mesh length varies from 2"-3" throughout 4S and the Magdalens. In western 4S smaller meshes (2"-2½") predominate while in eastern 4S larger meshes (2½"-3") are dominant. For comparison, in the Magdalen Islands smaller mesh (2"-2½") predominated until 1981, when mesh size increased to include 2½"-3".

Average effort (net-days) per fisherman has increased in 4S over the past 4 years similarly to number of nets per fisherman (Table 4). At the Magdalens, however, average effort per fisherman peaked in 1980, then declined in 1981, and individual effort is lower than on the North Shore. The herring season is considerably shorter at the Magdalens (spring only) than on the North Shore and has been decreasing in length during recent years. By comparison, individual effort in area 4T was substantially higher in 1978-1979 than at the Magadalens or in 4S (Table 4).

Abundance indices

Three acoustic surveys were completed in 1981 in 4S on chartered purse seiners. The cruises were made in western 4S from July 6th to July 10th and from August 27th to September 2nd; eastern 4S was surveyed from August 6th-26th. An area of 5600 km^2 was surveyed and no herring school was seen (Fig. 11). Additional seasonal coverage will be required to determine availability of herring to purse seiners in these regions; however a purse seiner survey in the southern Gulf during August 1981 located significant quantities of herring. Otherwise, to be positive, vessel cooperation was excellent since crews hoped to locate fishable areas via these charters. One huge school of juvenile capelin was located on August 8th in Old Fort area (51°12.5'N, 58°12'W) and a concentration of cod located off traditional areas was fished by boats from a north shore port.

Three C.P.U.E. indices were calculated for comparison with other areas and for determination of seasonal trends:

1) Eastern 4S daily sales slip landings were divided by corresponding effort (net-days) from questionnaire responses and the yearly average was calculated.

2) Western 4S daily sales slip landings were divided by corresponding effort (net-days) noted on sale's slip, and the yearly average was calculated.

3) C.P.U.E. indices, so obtained, were divided by the average surface (m^2) of gillnets from questionnaires responses and multiplied by 100 to give kg/100 m^2-days.

Comparison between regions was not possible with the kg/net/day indices because of significant inter-regional differences in gillnet surface and so, the standardized index (kg/100 m^2-day) was used. C.P.U.E.'s in 4S were extremely low compared with those from the Magdalens (Table 5), suggesting that the abundance of herring is relatively low.

Weekly variations

Weekly C.P.U.E. index of eastern 4S shows a strong peak for 3 weeks in May, followed by a rapid decline to a stable level of about 10 kg/net-days during summer and autumn months (Fig. 12). Thus abundance on the spring fishing grounds was considerably greater than on fall grounds. This may represent relative abundance of spring and fall fish or may result from concentration of spawning fish nearer shore in the area exploited by anchored gillnets in spring. This pattern also suggests that the high level of daily landings in the fall in eastern 4S is due to a high level of effort (relative to spring) exerted rather than to high abundance levels. Western 4S has a shorter peak period (1 week), and fishing stopped in mid-June. Highest values are two weeks earlier in western 4S than in eastern 4S.

BIOLOGICAL CHARACTERISTICS

Length frequencies

Spring spawners are mainly concentrated between 31 and 34 centimeters length classes (Fig. 13); modes are 32 cm for eastern 4S in 1980, 33 cm in 1981, both for eastern and western 4S (Fig. 13). Autumn spawners have a more dispersed length distribution in 4Svw than in western 4S where fall spawners show a unimodal distribution (33 cm) (Fig. 14).

Maturity stage

In 1980, spawning (stages 5 and 6) and spent (stages 7 and 8) fish predominated in samples from June, July and September at La Tabatière (4Svw) while August was dominated by recovering (stage 3) fish (Fig. 15). In 1981, spent and recovering fish dominated in July, August and September; surprisingly there was no evidence of dominant spawning fish (Fig. 16). Western 4S was dominated by spawning and spent fish in June while spent and recovering fish mix together in July (Fig. 17). Mature spring spawners made up the majority of the catches (86%) in western 4S while mature spring spawners represent respectively 58% and 63% in 1980 and 1981 in eastern 4S.

Age composition and catch at age

Tables 6 and 7 show the catch at age (numbers) and the age composition in the catch of spring and autumn spawners in 4S for 1980 and 1981. Those data cover only part of the fishing season in eastern 4S, because of problems with obtaining early biological samples. Spring spawners in eastern 4S were dominated in both 1980 and 1981 by the 1974 year-class with substantial numbers

of 10+ fish (Table 6). Western 4S shows the same composition among spring spawners with 1974 year-class dominant and large numbers of 10+ fish (Table 6). Autumn spawners were not analysed in western 4S because numbers were insufficient to make a reliable age-length key. The 10+ fish dominated fall spawners of eastern 4S both in 1980 and 1981 with substantial numbers of 1973 and 1976 year-class (Table 7).

DISCUSSION AND CONCLUSIONS

The inshore fishery of the North Shore is similar in some respects to that of the southern Gulf (Cleary and Worgan, 1981; Greendale and Powles, 1980; O'Boyle and Cleary, 1981) but overall is quite distinct. Only anchored gillnets are used (no drift nets or traps). Nets are substantially larger than in the southern Gulf, both in length and depth; this is particularly evident in eastern 4S. Because of this, simple effort measures (number of nets or length) cannot be used in inter-regional comparisons. The increase in effort noted throughout the southern Gulf over the past 4-5 years (in response to good prices) has also occured on the North Shore, but to a lesser degree.

Fisheries in the western and eastern parts of 4S are rather different: in the east, fishermen are on average more experienced, nets are bigger and fishing season is longer. Some of these differences are undoubtedly related to markets: in the east a fish plant has been purchasing since the mid-60's while in the west, outlets have been minimal (1 plant buying for 2 months in 1981).

What minimal information is now available suggests that abundance of herring in NAFO 4S does not justify significant expansion of effort. Gillnet C.P.U.E. is low compared to that for the Magdalens (where abundance is considered to be low), and survey cruises did not locate any concentrations of herring in 1981. On the other hand, total catches have been increasing with increased effort rather than decreasing, as in the southern Gulf, and fishermen did not report drastic declines in abundance over recent years on the questionnaires. Thus although enhanced development of herring fisheries in this area is not warranted, restriction of gillnet catches at this time could well result in loss of yield and is probably not justified. Given that the species is near its northern limit in this area and that historical catch fluctuations have been large, it is to be expected that abundance will fluctuate considerably.

Year-class strength in 4S parallels that for adjacent stocks, with 10+ fish dominating fall spawners and 1974 fish dominating spring. Abundance trends may also be expected to parallel those in adjacent areas, thus abundance may well be on the decline here.

Stock relationships remain problematical in 4S. Further tagging attempts are required, but hypotheses that eastern and western 4S are seperate groups is supported by the scanty data available, including the differing dates of arrival of spring fish in the two areas.

Further reasearch will require enhancing the sampling program. Another questionnaire, more complete, will be sent to the fishermen, to provide a better effort estimate and obtain data on dumping which is reported especially in 4sv area.

ACKNOWLEDGEMENTS

We wish to thank Ms. Isabelle D'Auteuil for the work she has done in the field last summer; and Ms. Marie-Josée Roy for her technical assistance; Mrs. Céline Trudeau and Mr. Ronald Greendale for valuable help in otolith readings and maturity determinations; and Mr. Lionel Corriveau who drafted all the figures. Finally all those who participated in field and laboratory work, thank you.

LITERATURE CITED

Boyar, H.C. 1968. Age, length and gonadal stages of herring from Georges Bank and the Gulf of Maine. ICNAF. Res. Bull. No 5: 49-61.

Cleary, L. and J. Worgan. 1981. Changes in effort, catch-per-unit-effort and biological characteristics in the inshore herring fishery at the Magdalen Islands, (1970-1981). CAFSAC Res. Doc. 81/32.

Day, L.R. 1957. Populations of herring in the northern Gulf of St.Lawrence. Bull. Fish. Res. Bd. Canada 111: 103-119.

Greendale, R. and H. Powles. 1980. La pêche côtière au hareng en Gaspésie, 1970 -1978. Rapp. Tech. Can. Sci. Halieut. Aquat. 945: 58 p.

Hunt, J.J., L.S. Parsons, J.E. Watson and G.H. Winters. 1973. Report of herring ageing workshop. ICNAF. Res. Doc. 73/2.

Huntsman, A.G., W.B. Bailey and H.B. Hachey. 1954. The general oceanography of the Strait of Belle-Isle. Fish. Res. Bd. Canada 11: 198-260.

Messieh, S.N. 1972. Use of otoliths in identifying herring stocks in the southern Gulf of St.Lawrence and adjacent waters. Fish. Res. Bd. Canada 29: 1113-1118.

Moores, J.A. 1979. Analysis of the status of the Newfoundland West Coast herring stock. CAFSAC Res. Doc. 79/5.

O'Boyle, R.N. and L. Cleary. 1981. The herring gillnet fishery in the southern Gulf of St.Lawrence, 1970-1979. Can. Tech. Rep. Fish. Aquat. Sci. 1065: 90 p.

Table 1. Maturity classification, as used by the Quebec laboratory, of spring and fall spawning herring.

MONTH	MATURITY STAGES	SPAWNING SEASON
MAY	4,5,6,7. 3,4,8	S(Spring) A(Autumn)
JUNE	4,5,6,7,8. 4,3.	S A
JULY	3,4,7,8. 4,5,6,7 (After July 15th)	S A
AUGUST	3,4,8. 4,5,6,7.	S A
SEPTEMBER	3,4, 4,5,6,7,8	S A
OCTOBER	3,4 4,5,6,7,8	S A

Table 2. Maturity classification, as made by Hunt and Winters (unpublished), of spring and fall spawning herring.

MONTH	MATURITY STAGES	SPAWNING SEASON
MAY	4,5,6,7. 3,4,8.	S(Spring) A(Autumn)
JUNE	4,5,6,7,8. 3,4.	S A
JULY	5,6,7,8. 3,4,5 (after July 15th)	S A
AUGUST	3,4,8. 4,5,6,7.	S A
SEPTEMBER	3,4. 5,6,7,8.	S A
OCTOBER	3,4. 5,6,7,8.	S A

Table 3. Average number of gillnets/fisherman in the Magdalen Islands (M.I.) and in statistical area 4S from 1970-1981, as determined by a mail-out survey.

YEAR	M.I.	4Sv	4Sw	4Sz
1970-1978	2.0 (180)*	4.3 (10)	4.6 (7)	3.0** (12)
1979	4.4 (36)	4.1 (11)	5.2 (15)	2.8 (14)
1980	7.6 (74)	5.5 (13)	5.8 (19)	3.0 (24)
1981	8.3 (65)	6.4 (13)	6.3 (23)	4.3 (58)

*: Number of fishermen.
**: For 1978 only.

Table 4. Average number of nets-days/fisherman spent fishing herring in the Magdalen Islands (M.I.) and in statistical areas 4S and 4T from 1970-1981, as determined by a mail-out survey.

YEAR	M.I.	4Sv	4Sw	4Sz	4T
1970-1978	108.7 (180)**	182.6 (8)	384.7 (5)	271.2*** (13)	441,8* (200)
1979	150.4 (36)	178.7 (10)	315.3 (11)	253.1*** (15)	527.3 (118)
1980	167.7 (74)	234.7 (12)	475.9 (12)	271.2*** (27)	—
1981	126.6 (65)	309.3 (13)	524.6 (13)	388.6 (63)	

*: For 1978 only.
**: Number of fishermen.
***: Calculated by multiplying the average number of nets-fisherman and the number of fishing days in 1981.

Table 5. 1981 C.P.U.E. index (kg/net-day and kg/100 m -day) for the herring gillnet fishery in the Magdalen Islands (M.I.) and 4S area as determined by a mail-out survey.

C.P.U.E.	M.I.	4Svw	4Sz
kg/net-day	21.1	57.1	47.2
kg/100 m -day	74.8	18.4	16.3

Table 6. Catch at age (numbers) and age composition (%) of spring spawning herring caught in 4S area.

Catch at age (1000 No)

AGE	1980	1981	
	4Svw	4Svw	4Sz
3		2.8	6.7
4	2.1	14.0	21.3
5	15.5	6.0	19.1
6	767.9	48.5	40.4
7	26.7	272.0	771.8
8	33.7	11.2	40.4
9	51.3	7.6	62.9
10	30.3	9.2	6.7
10P	81.5	29.2	153.9

Age composition (%)

AGE			
3		0.7	0.6
4	0.2	3.5	1.9
5	1.5	1.5	1.7
6	76.1	12.1	3.6
7	2.6	67.9	68.7
8	3.3	2.8	3.6
9	5.1	1.9	5.6
10	3.0	2.3	0.6
10P	8.1	7.3	13.7

Table 7. Catch at age (numbers) and age composition (%) of autumn spawning herring caught at La Tabatiere (4Svw).

Catch at age (000 No)

AGE	1980	1981
4		15.6
5	0.7	28.1
6	30.7	9.7
7	68.3	18.8
8	16.0	39.1
9	33.6	6.5
10	47.8	10.1
10P	166.7	70.0

Age composition (%)

AGE	1980	1981
4		7.9
5	0.2	14.2
6	8.4	4.9
7	18.8	9.5
8	4.4	19.8
9	9.2	3.3
10	13.1	5.1
10P	45.8	35.4

Fig. 1. NAFO Statistical subdivisions.

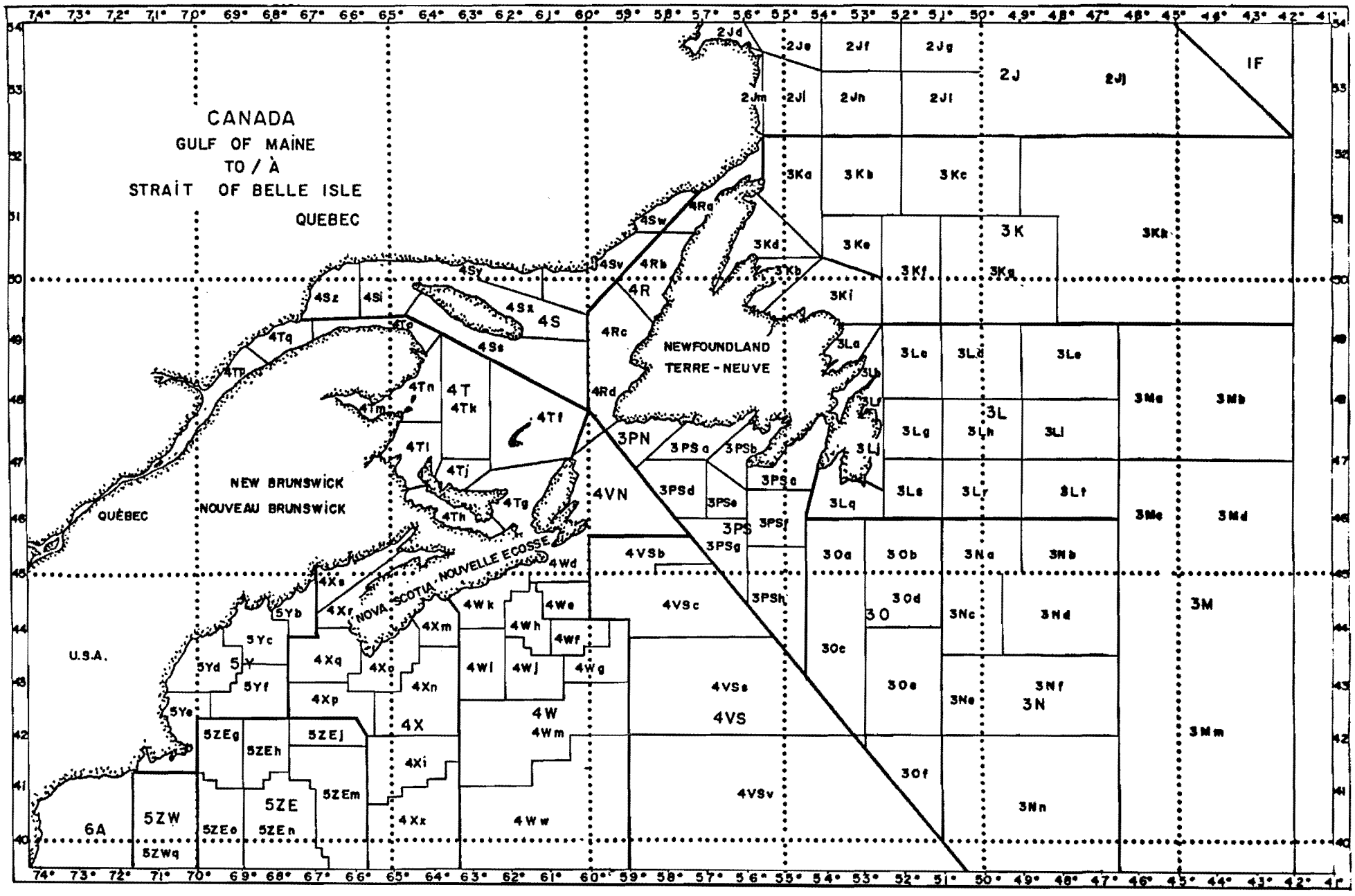


Fig. 2. Yearly landings in 4RS statistical divisions from 1962 to 1981.

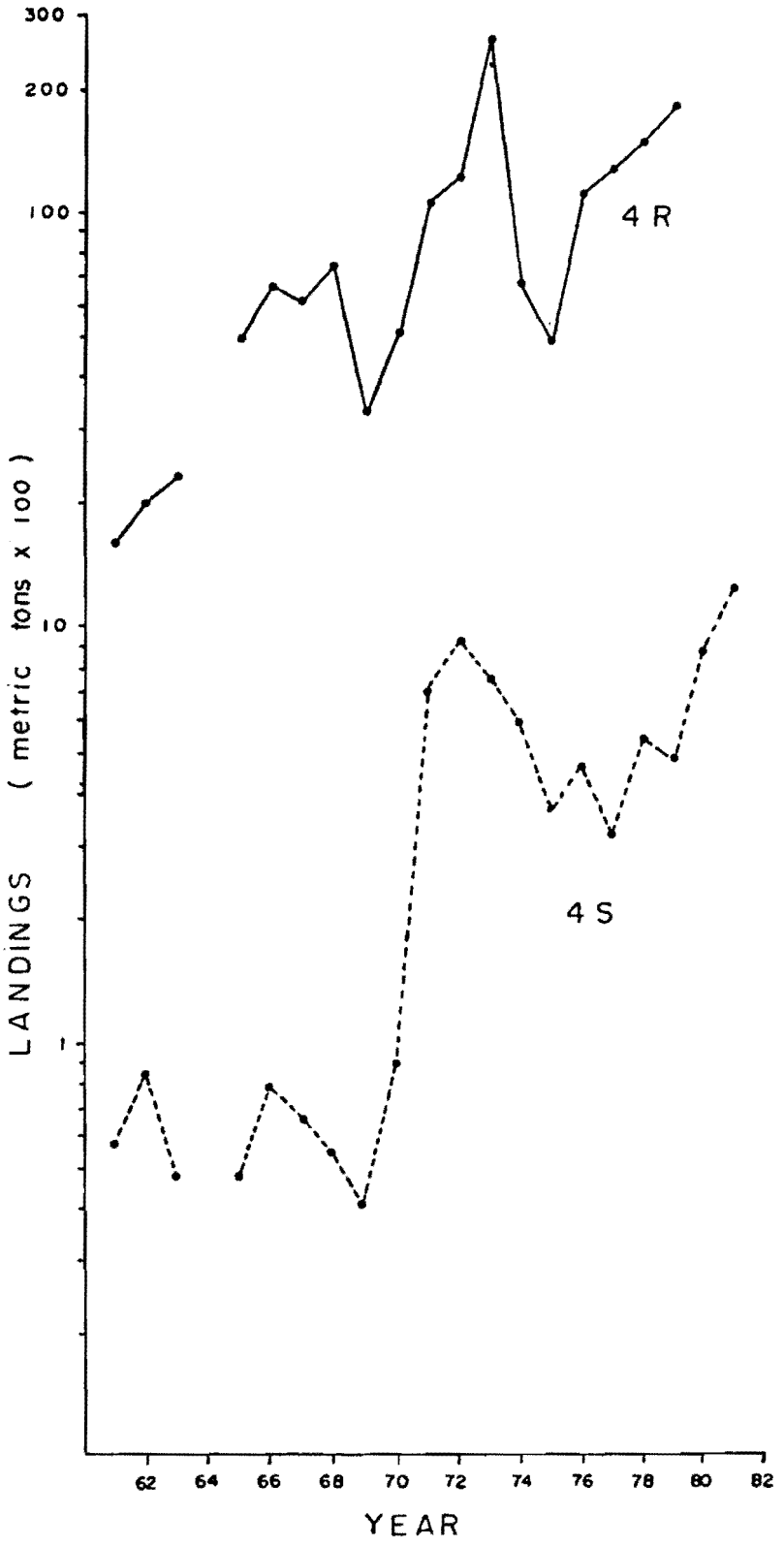


Fig. 2a. Annual landings and number of fishermen in central 4S (4Sy).

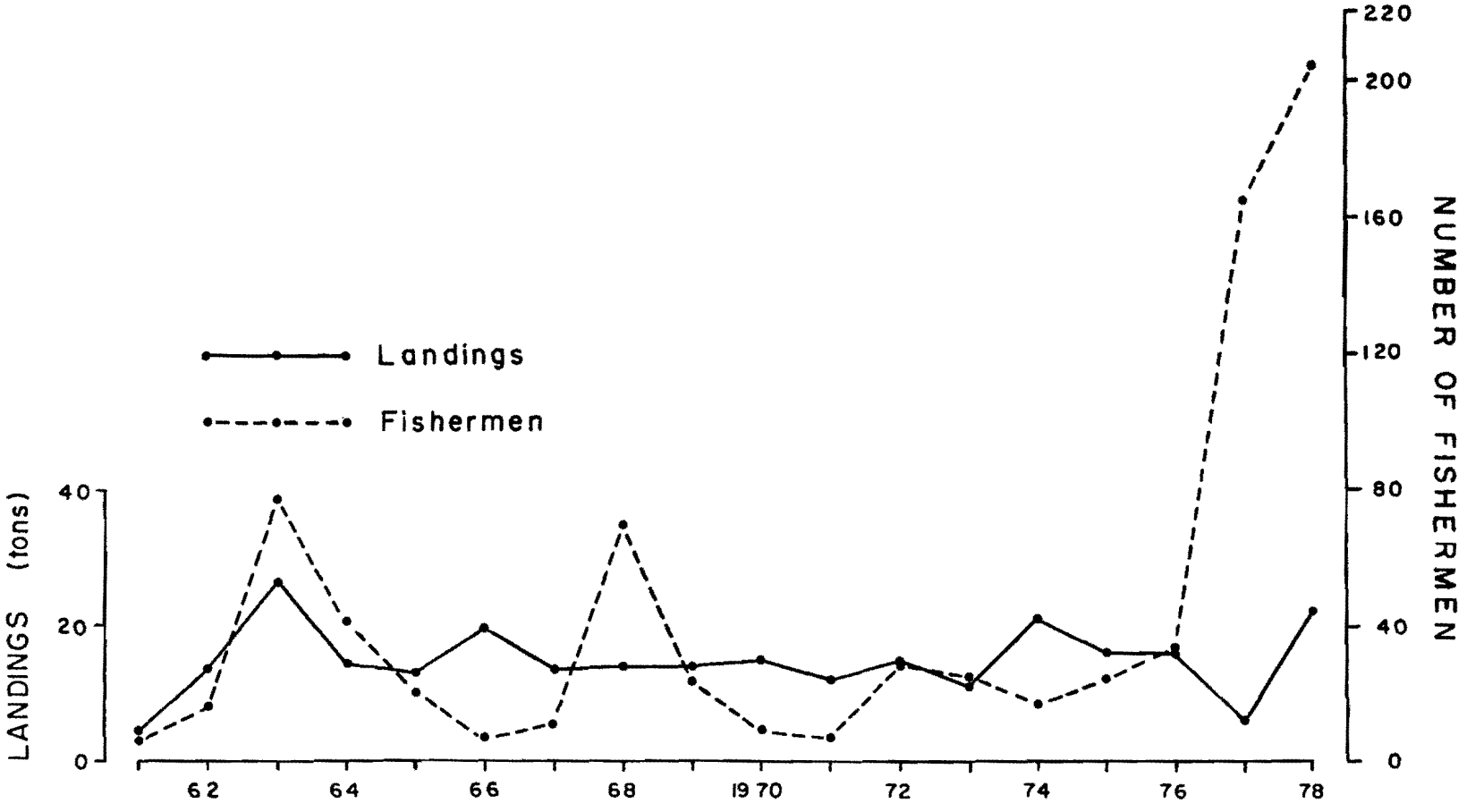
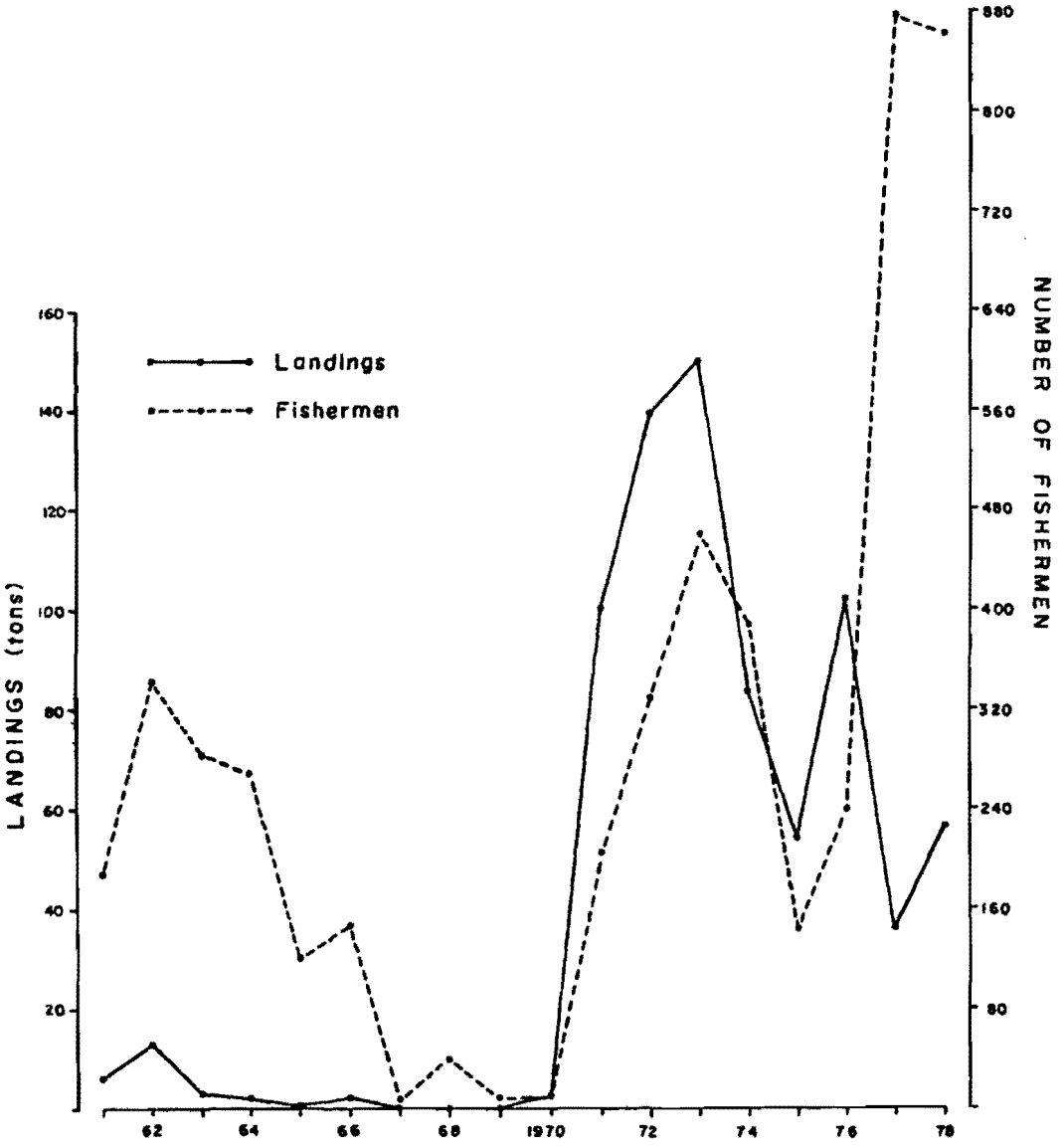


Fig. 2b. Annual landings and number of fishermen in eastern 4S (4Svw).



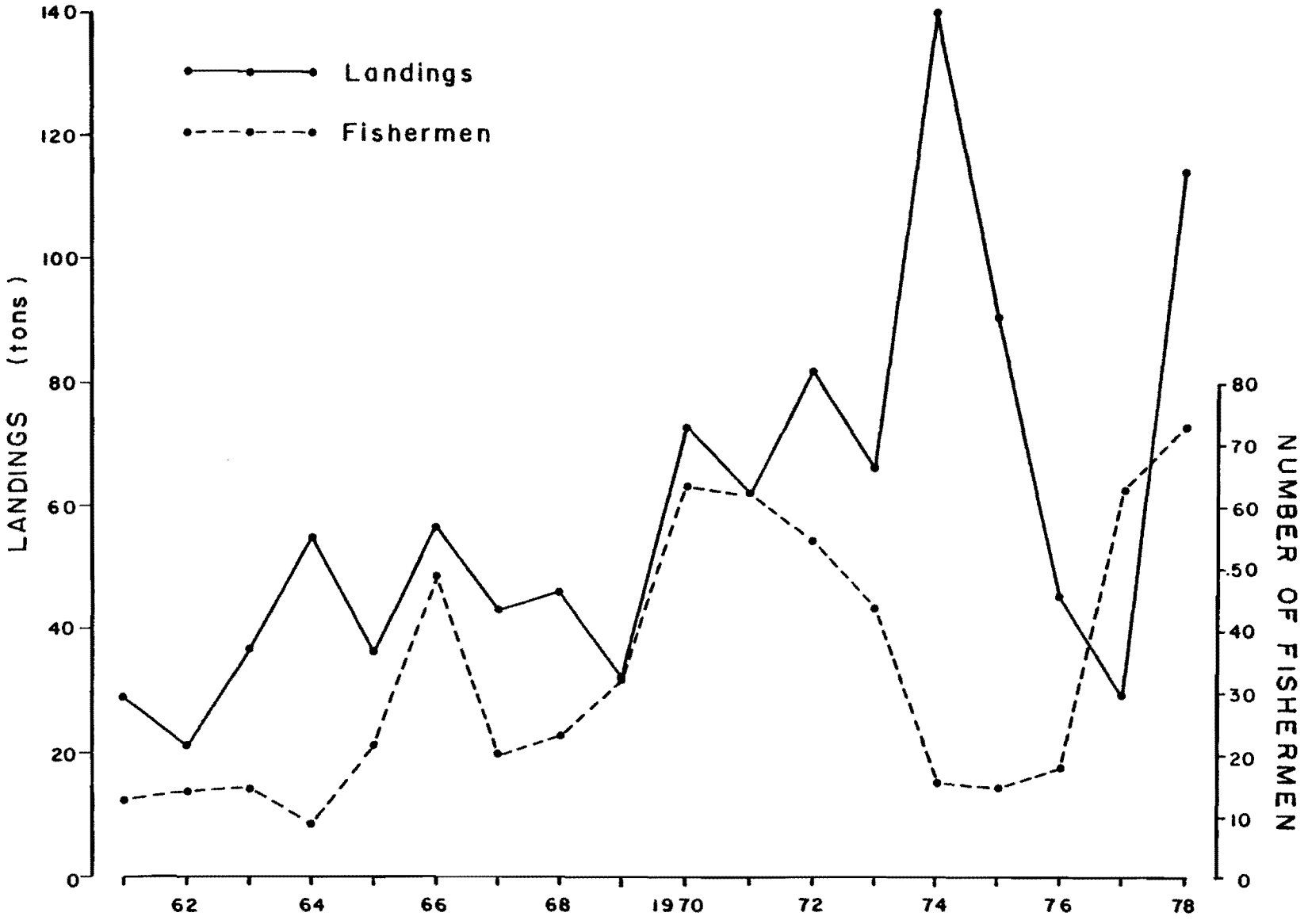


Fig. 2c. Annual landings and number of fishermen in western 4S (4Sz).

FIG. 3.

DAILY LANDINGS (Kg) 1980 FOR 4S v HERRING (Smoothed by running averages of 3)

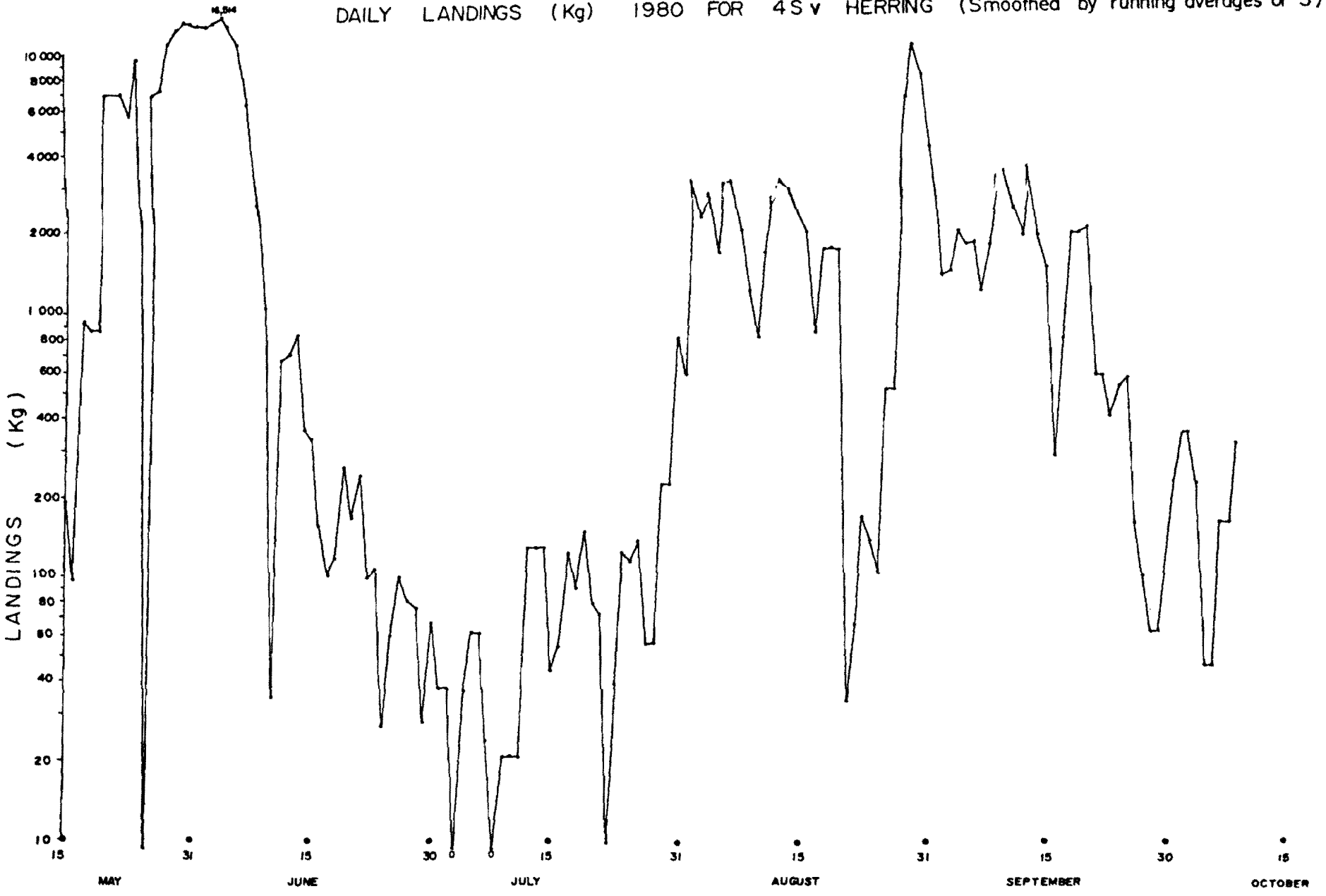


FIG. 4. DAILY LANDINGS (Kg) IN 4Sv 1981 (Smoothed by running averages of 3)

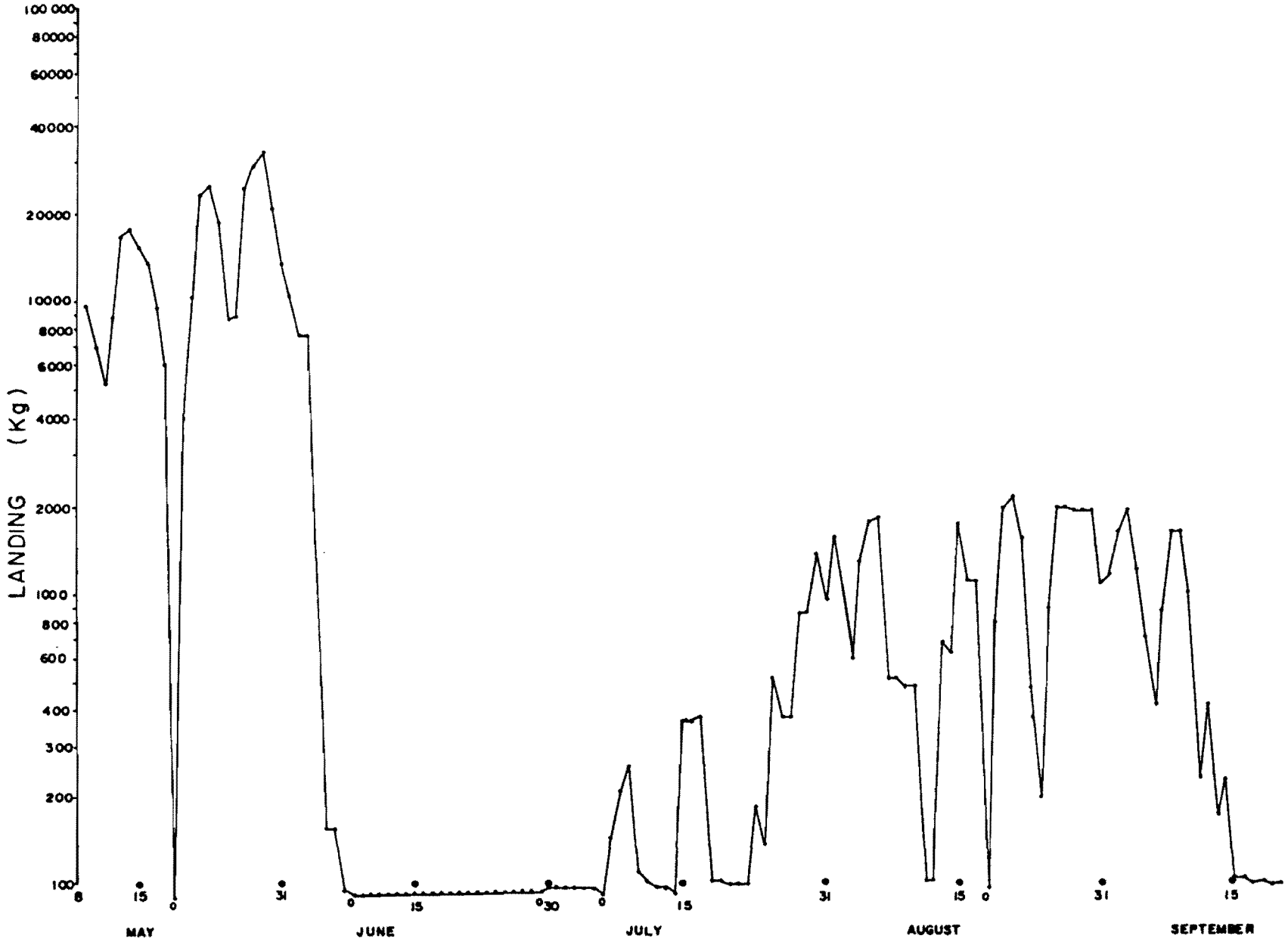


FIG. 5. DAILY LANDINGS (Kg) 1980 FOR 4 Sw HERRING (Smoothed by running averages of 3)

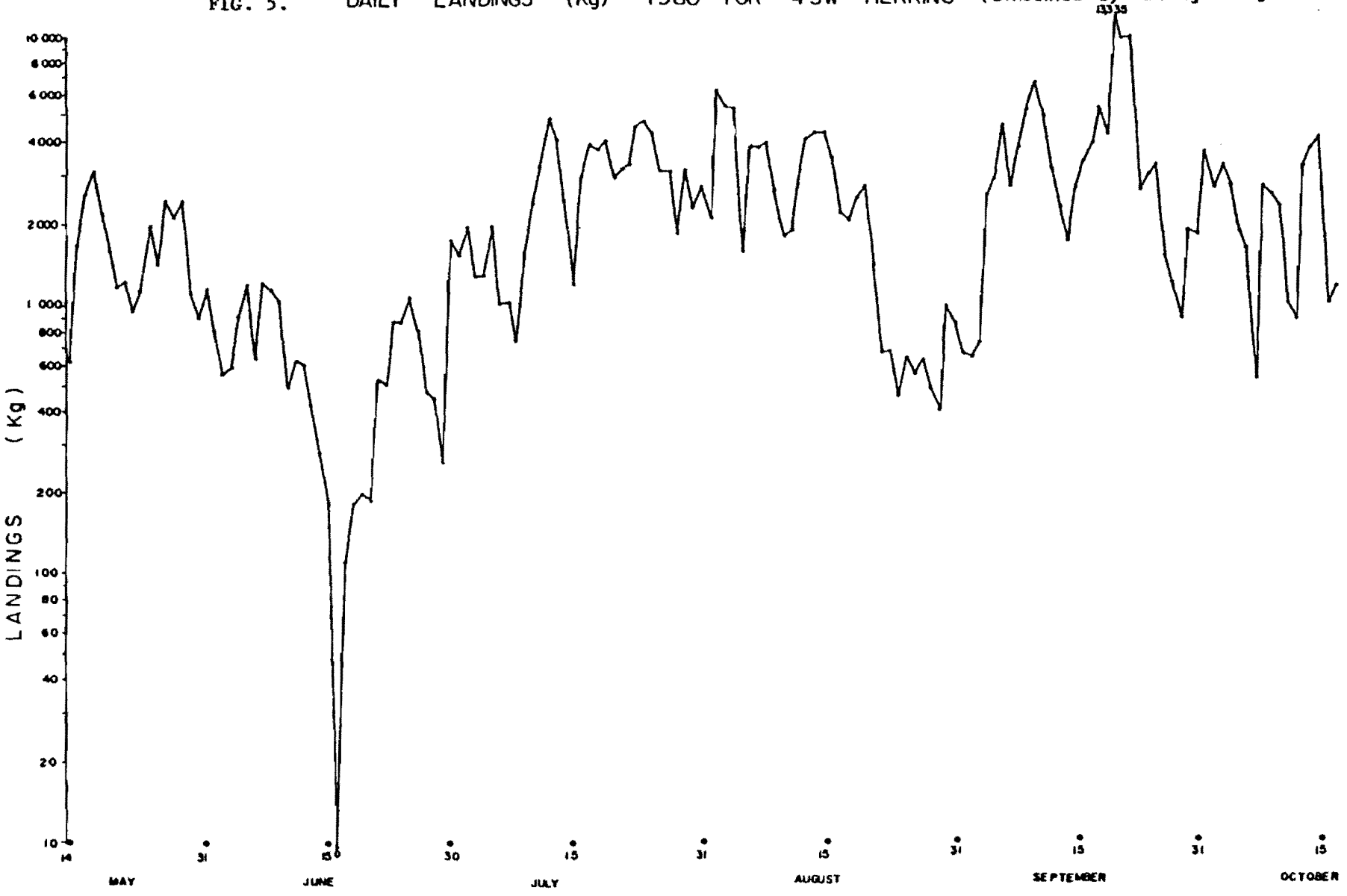
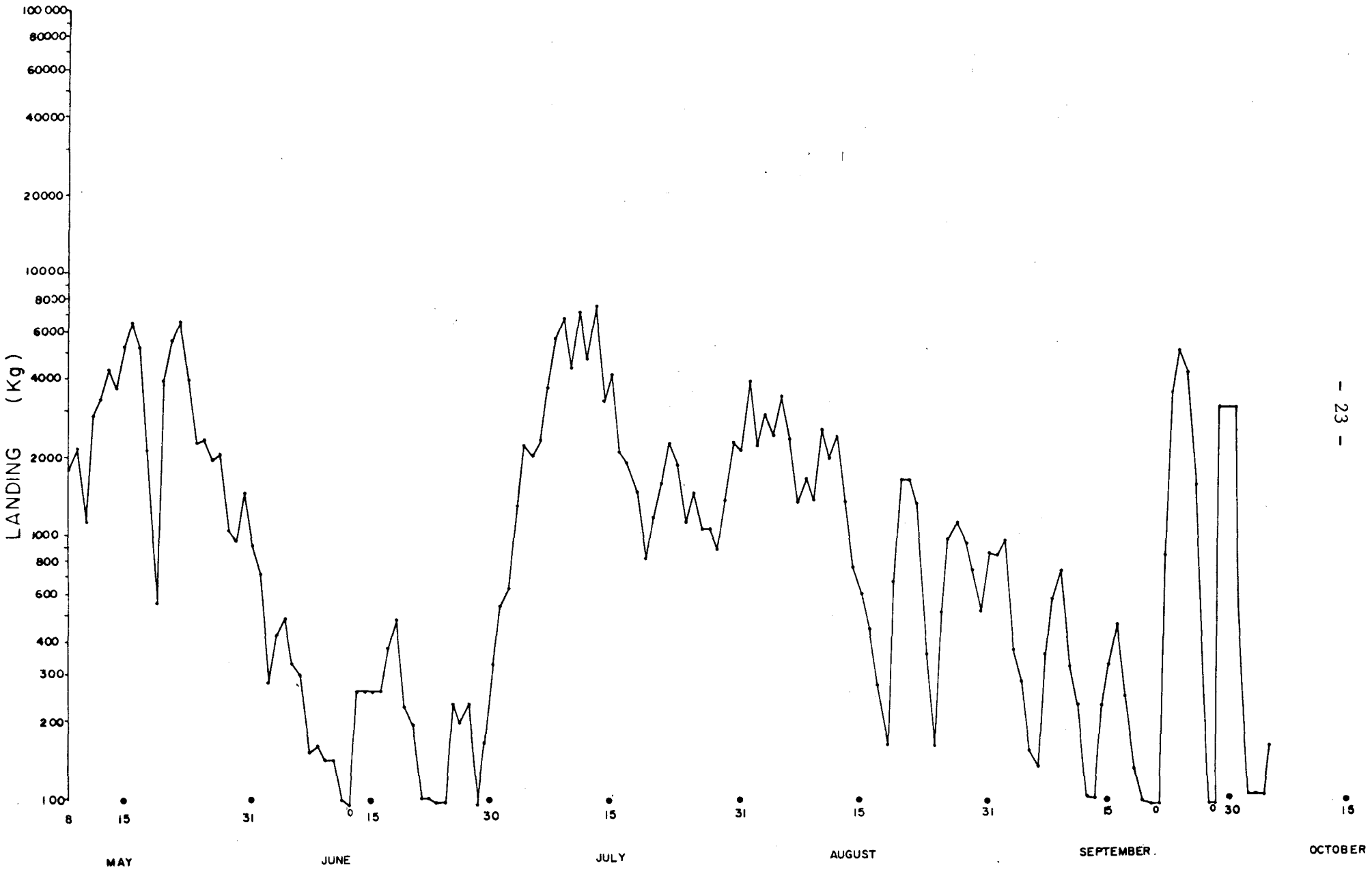


FIG. 6. DAILY LANDINGS (Kg) IN 4Sw 1981 (Smoothed by running averages)



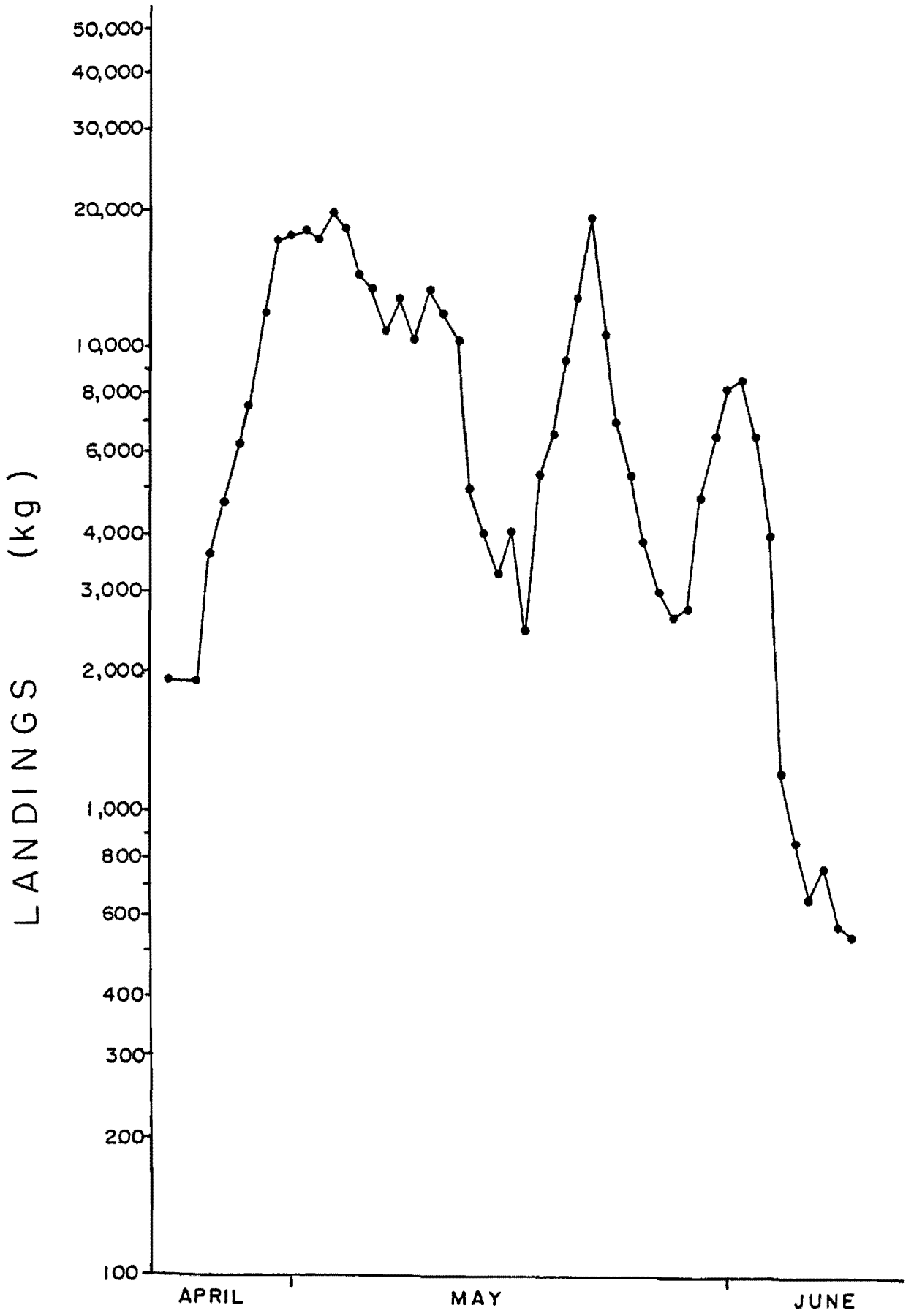
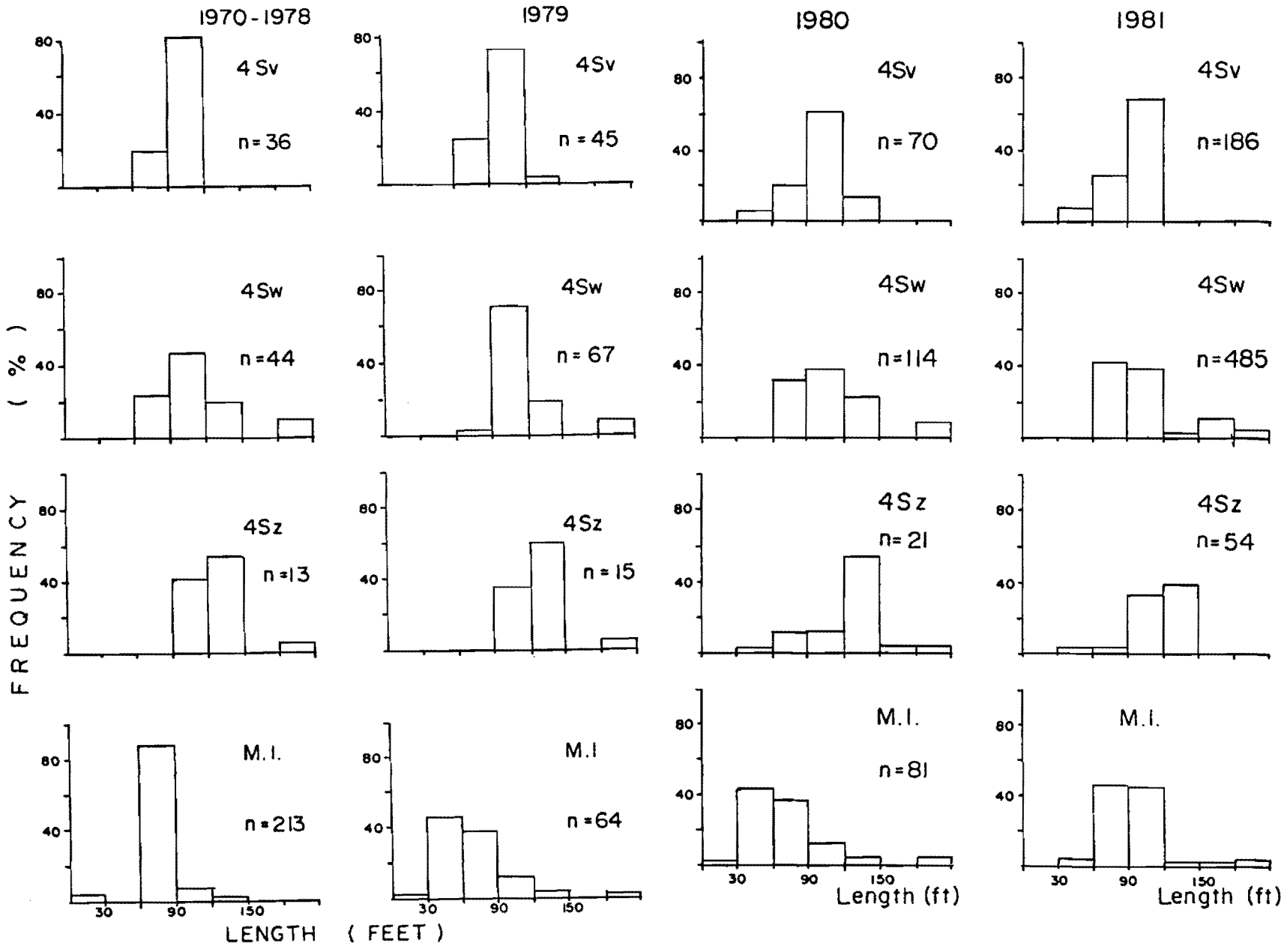


Fig. 7. Daily landings (kg) in 4Sz subarea, 1981.

Fig. 8. Length frequencies of herring gillnets used at the Magdalen Islands and in 4S area, from 1970 to 1981.



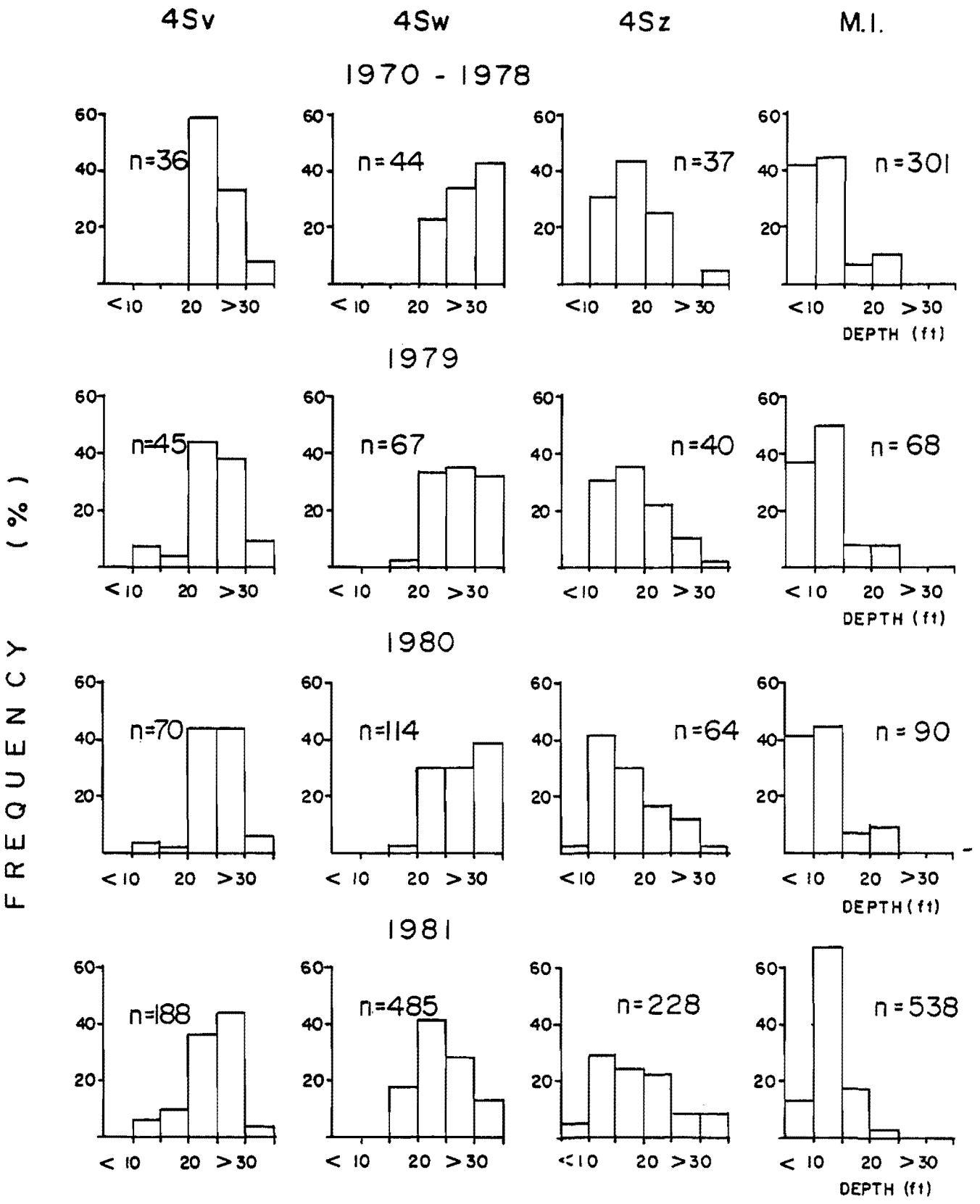


Fig. 9. Depth frequencies of herring gillnets used at the Magdalen Islands (M.I.) and in 4S area, from 1970 to 1981.

Fig. 10. Mesh size frequencies of herring gillnets used at the Magdalen Islands (M.I.) and in 4S area from 1970 to 1981.

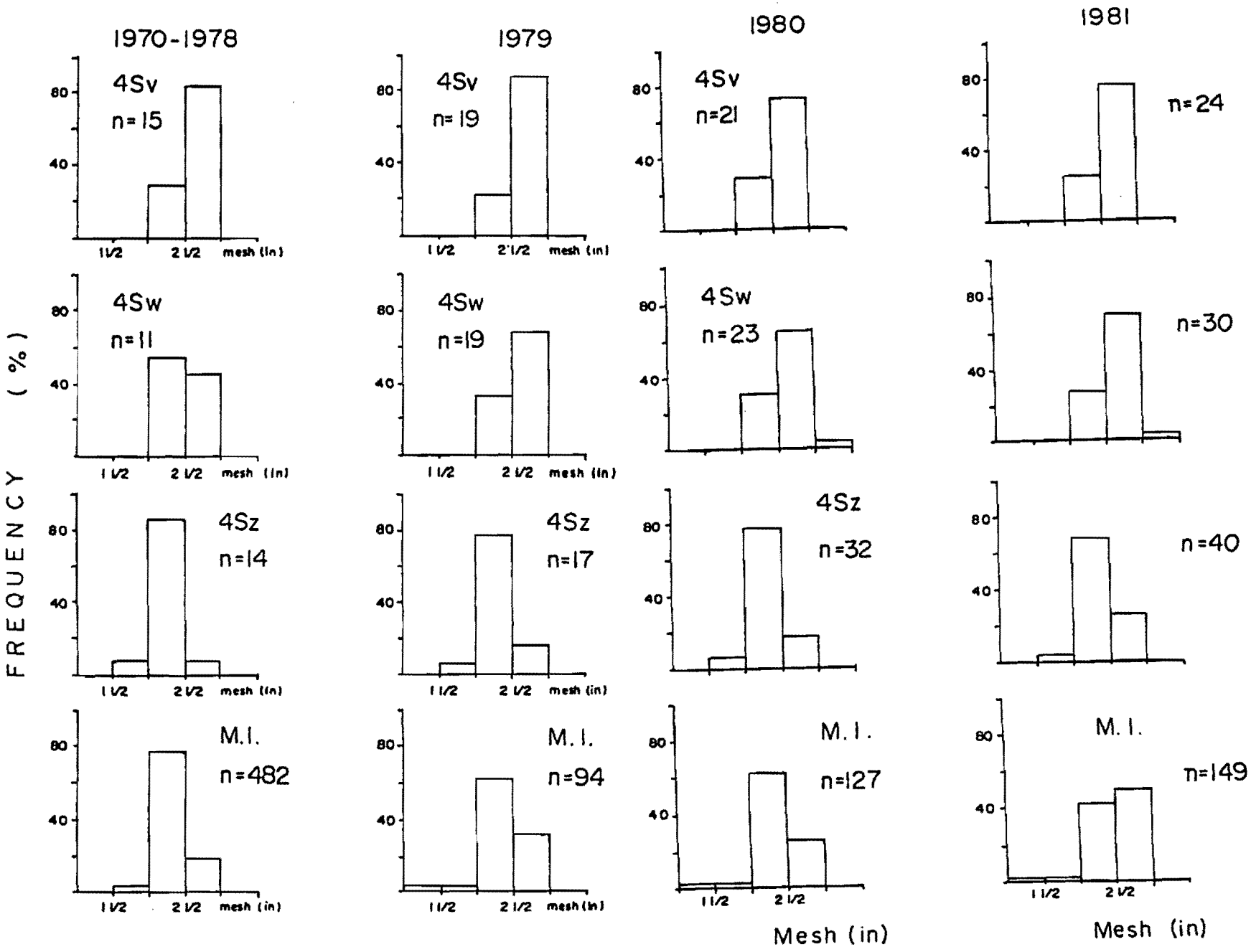
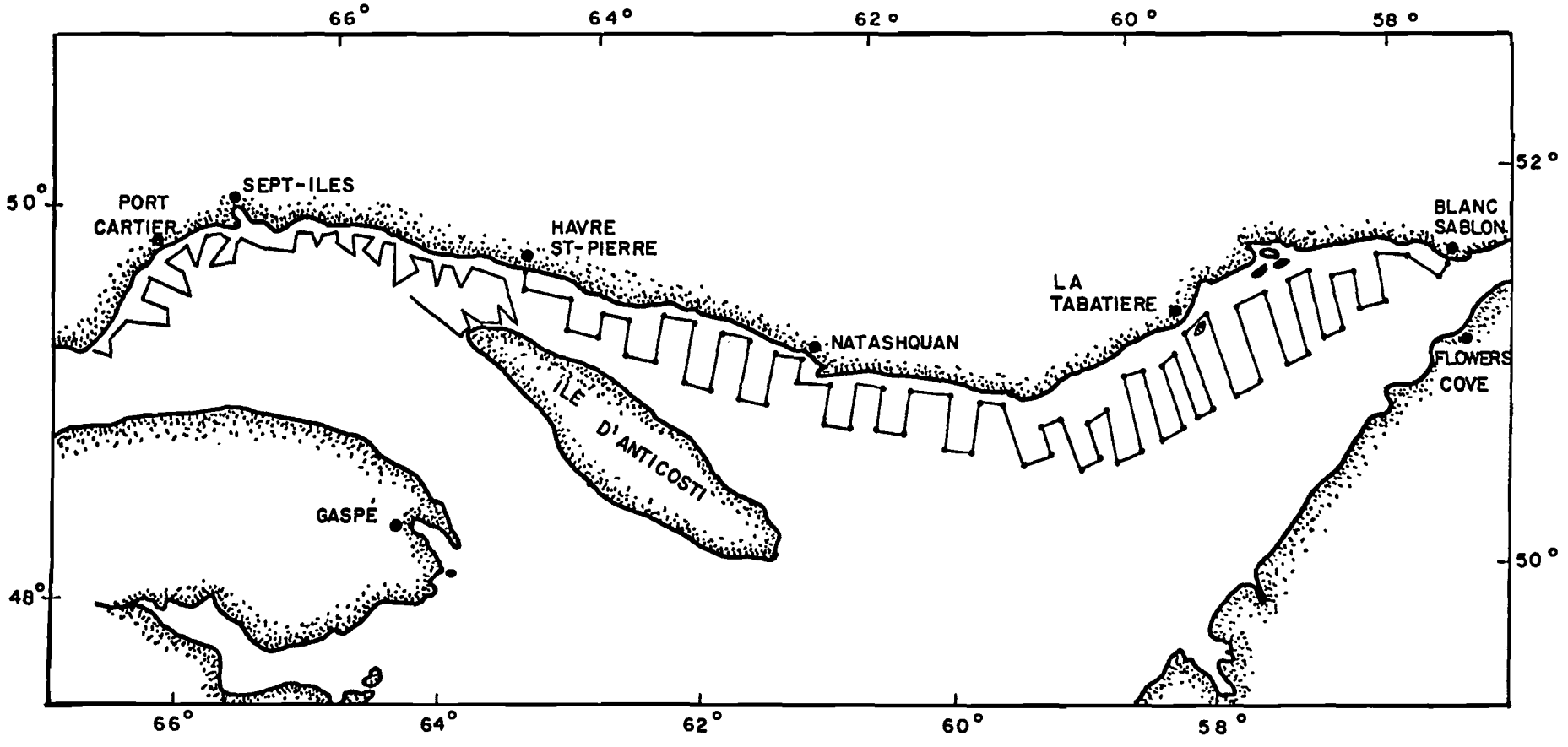


Fig. 11. SURVEYS 1981

ABUNDANCE ESTIMATION OF HERRING IN STATISTICAL DIVISION 4S



——: FIRST SURVEY : JULY 6 th TO JULY 10 th

—•—•—: SECOND SURVEY : AUGUST 6 th TO AUGUST 27 th

——: THIRD SURVEY : AUGUST 27 th TO SEPTEMBER 2 nd

Fig. 12. Weekly C.P.U.E. in 4S region, 1981.

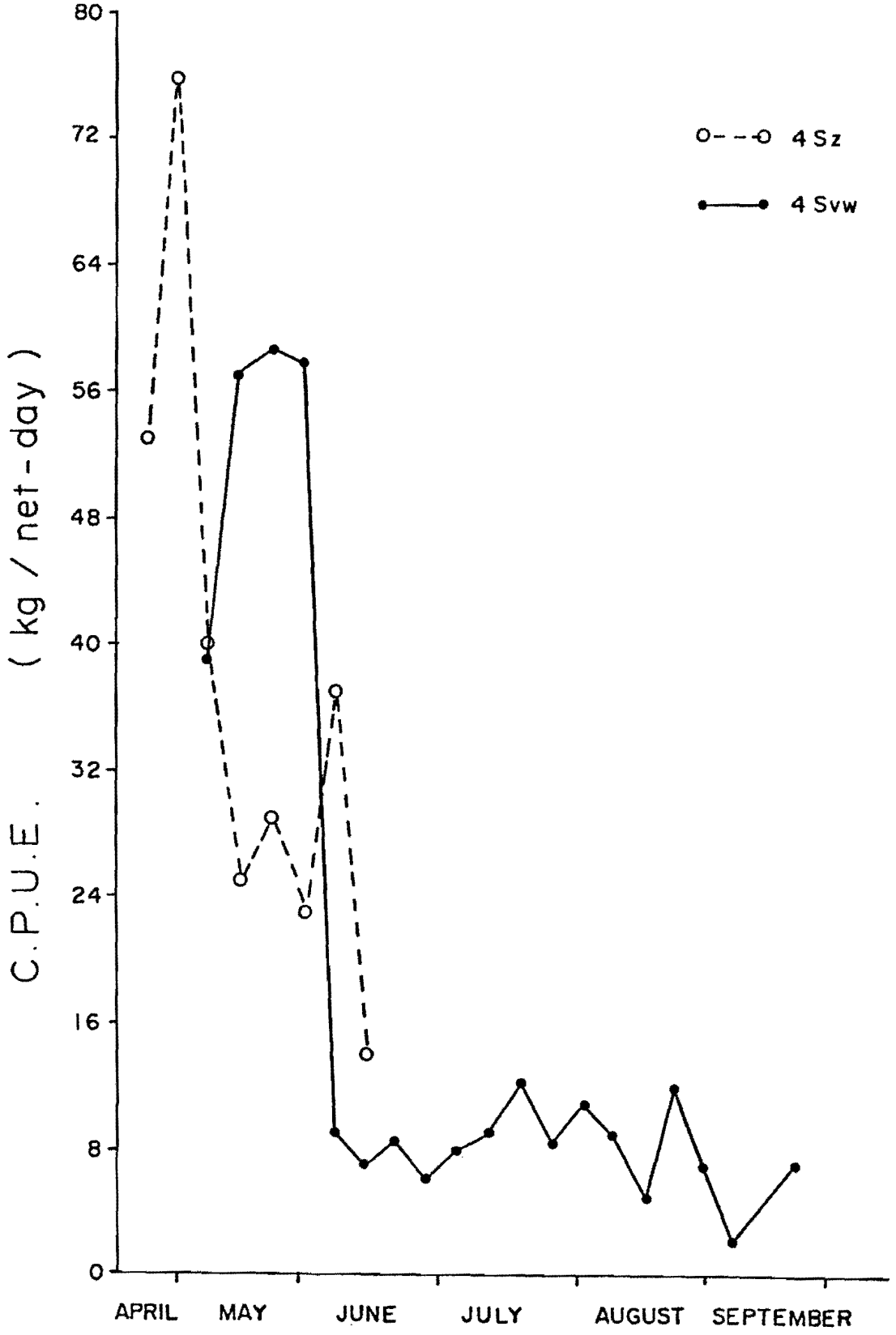


Fig. 13. Length frequencies of spring spawning herring in 4S, 1980-1981.

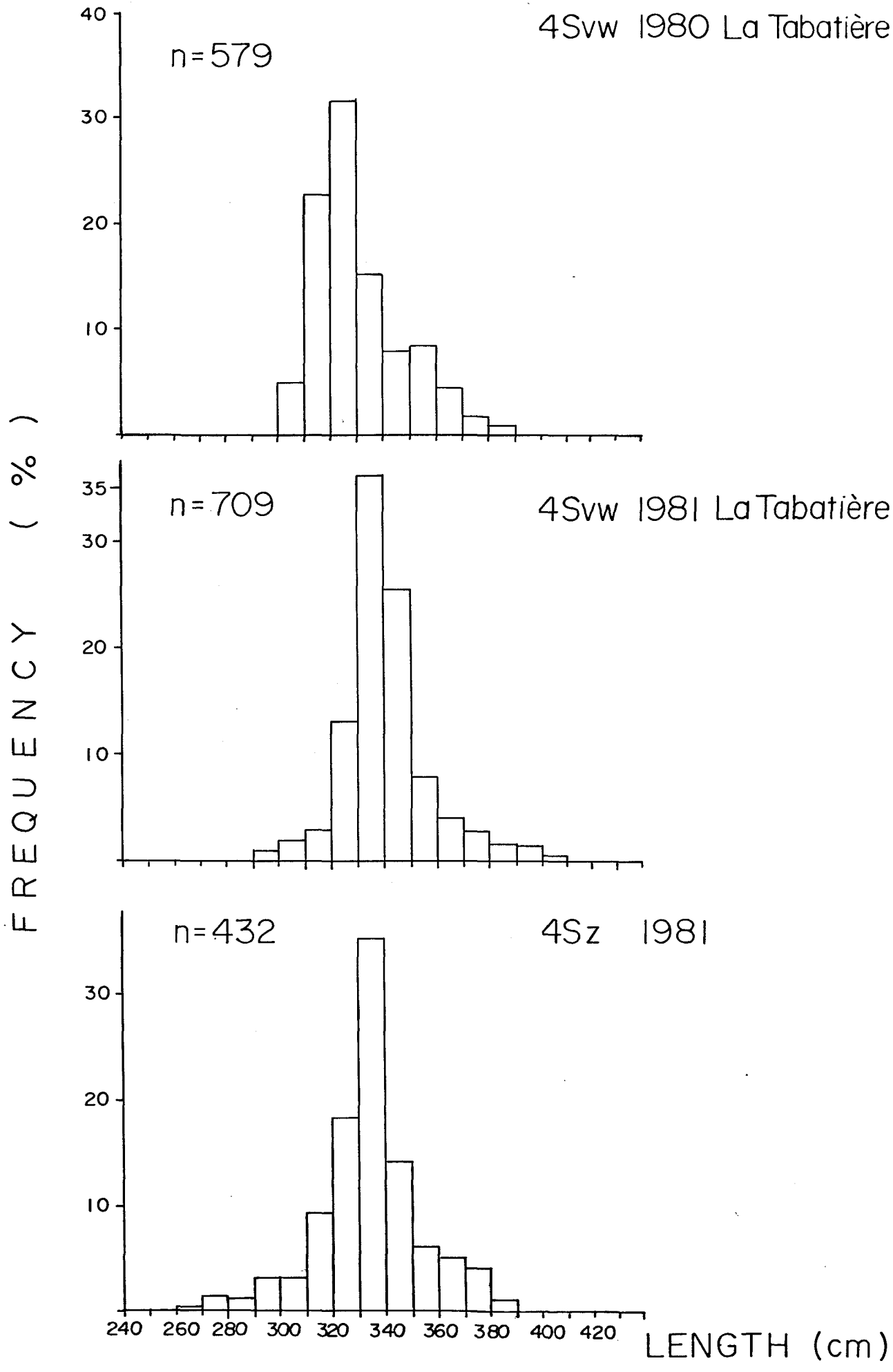


Fig. 14. Length frequencies of autumn spawning herring in 4S, 1980-1981.

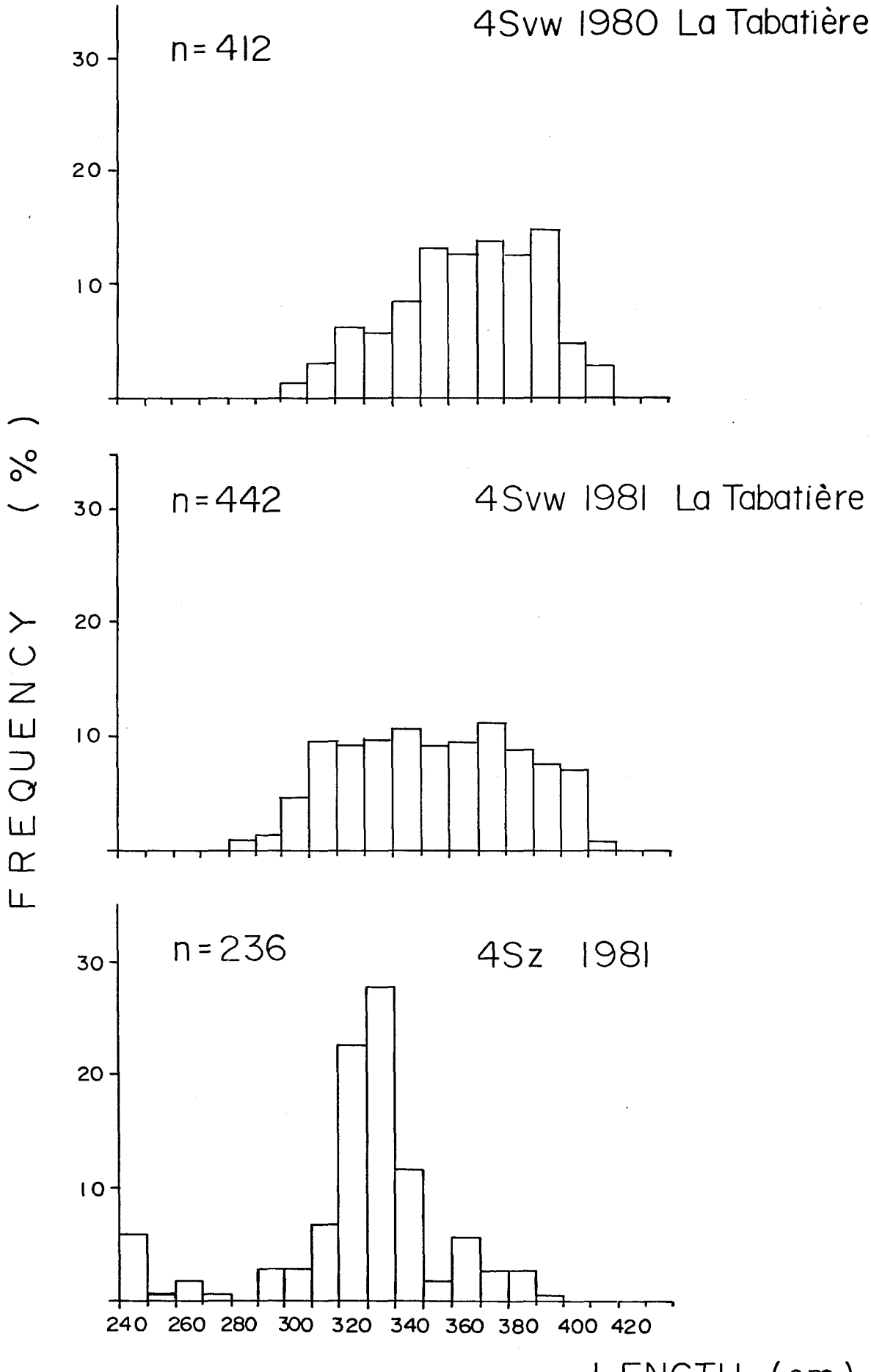


Fig. 15. Maturity frequencies at La Tabatiere (4Svw), 1980.

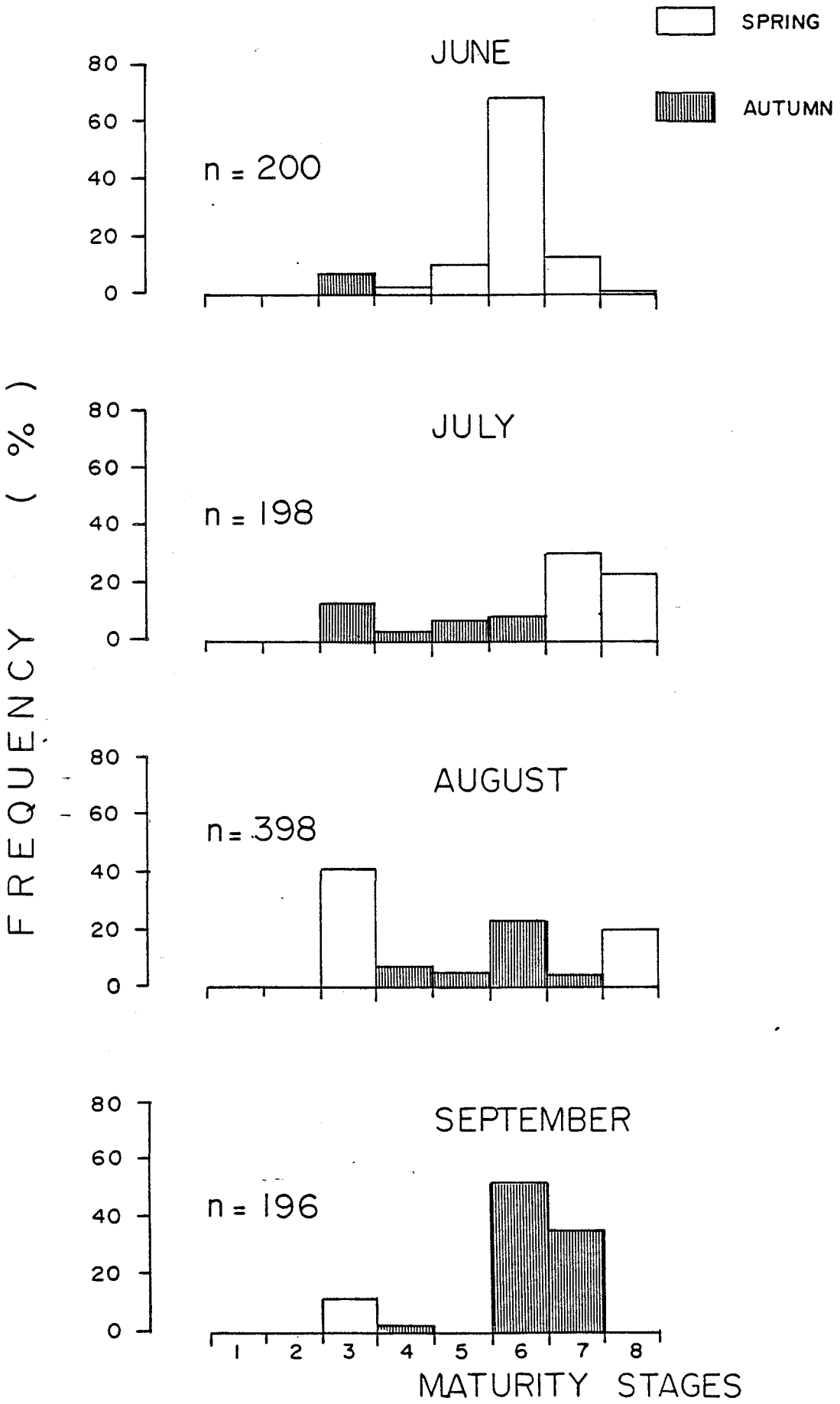


Fig. 16. Maturity frequencies at La Tabatiere (4Svw), 1981.

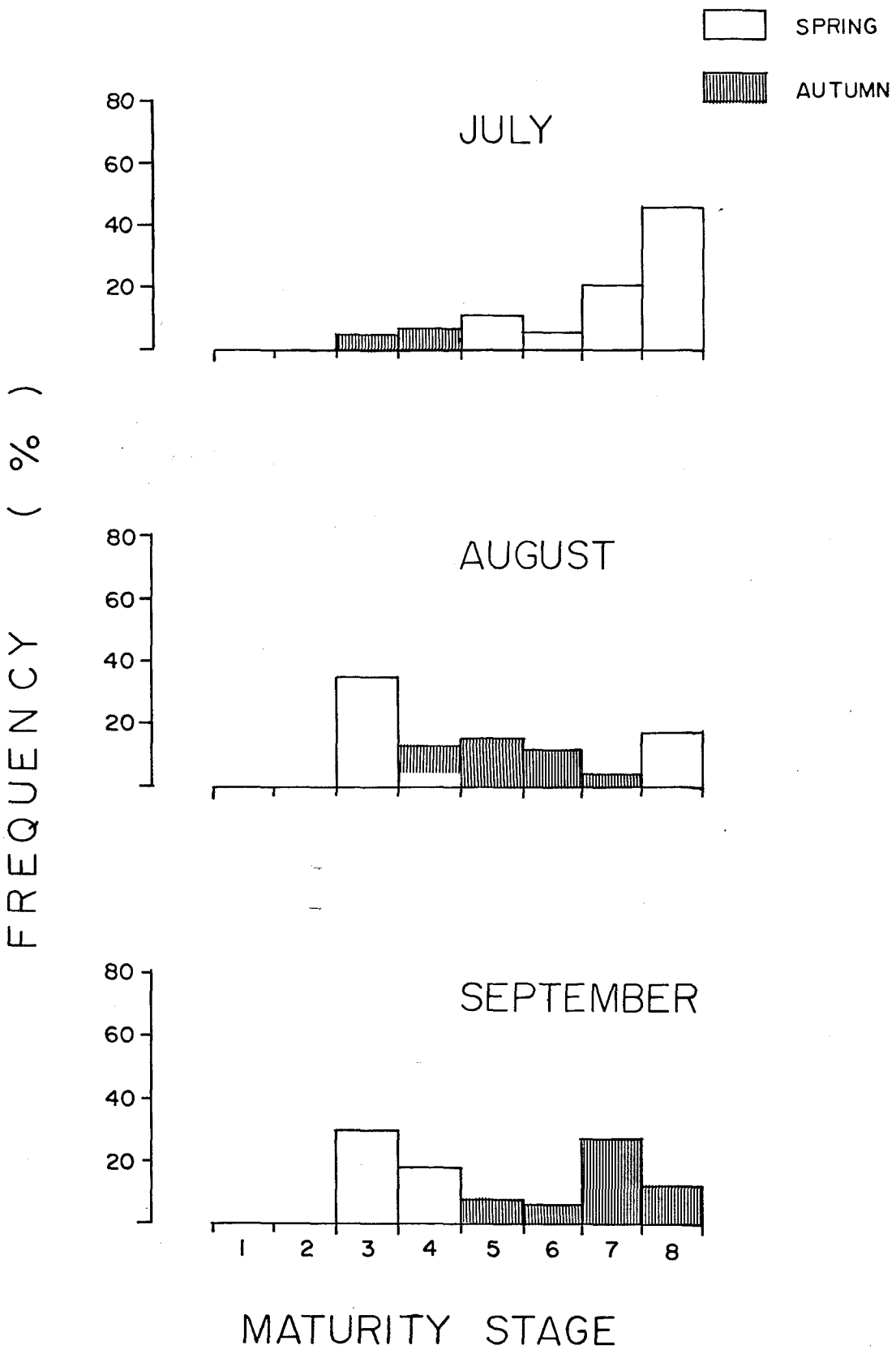


Fig. 17. Maturity frequencies in 4Sz subarea, 1981.