RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 2973
(D.c.5)

ICNAF Res.Doc. 73/37

ANNUAL MEETING - JUNE 1973

Some biological data on the herring (*Clupea harengus harengus* L.) in the Gulf of St. Lawrence, southeastern Newfoundland and Banquereau in 1972

by

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Published in ICNAF REDBOOK 1973 (III): 109-118

I - Location of samplings.

During 1972, the sampling of the herring took place from March to November, using a bottom trawl and a pelagic trawl, in the following regions (see map n° 1).

1. Close to the coasts of Newfoundland in the Gulf of St. Lawrence (division 4 R and subdivision 3 Pn) and of Nova Scotia (St. Paul Island, Cape Dauphin, subd. 4 Vn).

Cape St. George from April 16th to 17th	(bottom trawl)
Cape St. George on April 19th	(pelagic trawl)
Isle aux Morts on April 20th	(pelagic trawl)
Area around St. Paul Is. on April 21th	(pelagic trawl)
Table Pte. on July 13th	(bottom trawl)
Cape Dauphin at the end of November	(bottom trawl)

2. In open sea, off the southern coast of Banquereau, in the region of the Sable Island Gully.

Banquereau South slope on March 5th	(bottom trawl)
East Gully of Sable Island on April 24th	(pelagic trawl)
Banquereau South slope on April 26th	(bottom trawl)
East Gully of Sable Island on May 24th	(bottom trawl)

All the samplings were taken from catches varying from 1000 to 5000 kg, except those from the Banquareau South slope in March, and from the Cape Dauphin area at the end of November, in which cases the whole landing was examined, due to its limited size.

II - Work done.

The usual biological measurements were made to determine length, age, weight, sex and stage of maturity, gonad weight, gonad-somatic relation-

ship, fat content, stomach contents and the five following meristic characters : number of rays in the left pectoral ; number of gill rakers, number of dorsal rays, of keeled scales (K2) and of vertebrae.

The method used for this examination is discribed in Res. Doc. 71/40.

The separation of spring and autumn spawners was based on the stage of sexual maturity. The various stages of maturity have been noted and specified by evaluation of the gonad-somatic relationship RGS (the gonads were weighed to the closest centigram, and the herring to the closest gram). For the April sampling, the RGS of the autumn spawners is thus between 0.5 and 4.99 (stages of maturity VIII and VIII-III, while that of spring spawners varies from 5 to 24 (stages of maturity III, IV and V) (see fig. n° 1).

The Banquereau data illustrates the evolution in stages of maturation of the autumn spawners for the months of March, April and May.

Table n° 1 shows the reciprocal importance of the populations studied.

III - Age - class composition of the various populations.

1. Gulf of St. Lawrence and S W Newfoundland.

The proportion of autumn and spring spawners for the April sampling is more or less constant : about 70 % and 30 % respectively.

In the Isle aux Morts and St. Paul Island regions, the number of autumn spawners is the greater (72 to 73 %). The proportion of immature is only 1 - 8 %.

On either side of the Laurentian Channel, in the autumn spawners there is a drastic reduction in the number of herring measuring 30 cm, corresponding to the 6 year old age class (see fig. n° 2).

In the Isle aux Morts sampling, this reduction is apparent in a levelling-off of the herring between 28 and 32.9 cm long (5 to 7 years old).

Autumn spawners account for 81 % of the catches during July to the west of Table Pt. The modal size is 38 cm, and 75 % of the population are 10 years old or more.

At the end of November, very few herring were sampled at Cape Dauphin. Half of the catch was made up of immature herring between 2 and 3 years old.

2. Banquereau region.

The March, April and May catches show the same stock composition ;

made up of 93 to 97 % autumn herring. The distribution of age-classes shows the predominance of older herring (79 % are older than 8).

IV - Meristic characters.

a) Method of analysis.

A comparison of averages was used to differenciate the autumn and spring spawners within one station. For the statistical test employed, the value of P is given by FISHER and YATES Table 1 (normal distribution).

In order to compare results, we have used the distribution Table of L.S. PARSONS (see Tables 2 - 3 - 4 - 5 - 6 - 7).

The calculation of averages and variance were taken to the fifth decimal place and in the presentation of data we have rounded it off to the third decimal place.

The data for the limited spring spawners in Banquereau are noted in brackets.

b) Comparison of meristic characters for autumn and spring spawners.

1 - Numbers of pectoral fin rays and numbers of gill rakers.

The average numbers of rays in the pectoral fin and numbers of gill rakers are greater for the autumn spawners than for the spring spawners.

In all cases, the differences are significant $P \leq 0.01$.

2 - Numbers of dorsal fin rays and numbers of keeled scales K2.

The average numbers of dorsal rays among the autumn spawners is greater than that of the spring spawner, but this difference is not always significant (only half the cases show a significant difference P 0.01).

In the April sampling, the number of keeled scales varies very little between the autumn and spring spawners of S W Newfoundland ; on the other hand, the differences are significant in the other regions ($P \leq 0.01$ in the St. Paul Island Cape Dauphin region, and $P = 0.05$ in the Table Pt. region.

3 - Numbers of vertebrae.

The populations of W and S W Newfoundland show minimal non significant differences with the spring averages greater than the autumn averages. For Nova Scotia, however, the autumn and spring spawners are distinctly separated, $P = 0.5$ for the St. Paul Island region and $P \leq 0.01$ for Cape Dauphin.

c) Comparison of meristic characters for the spring population.

1 - April sampling.

Four meristic characters (number of pectoral rays $P \leq 0.01$; number of gill-rakers $P \leq 0.01$; number of keeled scales $P \leq 0.01$ and number of vertebrae $P \leq 0.01$) prove that there is no mixing between the spring spawners of St. Paul Island and those of S W Newfoundland at this time of year.

The same spring population can be found in the pelagic concentrations of Cape St. George and of Isle aux Morts. The average numbers of rays on the left pectoral, of gill rakers, of K2 and of vertebrae are practically identical.

The herring population resulting from a sampling of the bottom at Cape St. George mixes with the pelagic concentrations in S W Newfoundland.

2 - July and November samplings.

The results are shown in Tables (2 to 6).

d) Comparison of meristic characters for the autumn populations.

1 - April sampling.

The differences in meristic characters are less apparent ; only the number of rays in the left pectoral and the number of gill rakers in certain cases are significant $P \leq 0.05$.

There is very little mixing between the pelagic concentration of Cape St. George and that of Isle aux Morts ($P \leq 0.05$ for the number of rays in the left pectoral).

The large average number of vertebrae for the Isle aux Morts population (55.710) may be compared with the average of the Bay of Fortune herring (55.779) PARSONS.

Two contradictory results : the number of rays in the left pectoral ($P = 0.77$, non-significant) and the number of gill rakers (significant to $P \leq 0.05$) for the St. Paul Island concentration and the St. George's Cape concentration.

2 - In the South Banquereau region and the Sable Island Gully.

The autumn populations of these regions can be casily distinguished from the autumn populations in the Gulf of St. Lawrence and S W Newfoundland by the high average numbers of keeled scales and gill rakers.

We found the same characteristics of the autumn spawners herring type as last year (Res. Doc. 72/55).

In addition, the distribution of the number of keeled scales (K2) according to sex, shows a sexual dimorphism (see Table n° 7).

V - The stomach contents and fat content.

1. The stomach contents.

90 % of the herring caught on the bottom have empty stomachs, whereas 40 to 100 % of the herrings originating in pelagic concentration have stomachs containing food.

The stomach contents are composed mainly of Calanus finmarchicus ; 99 % for the herring in the Gulf of St. Lawrence and S W Newfoundland and 88 % for the herring in the Banquereau region.

2 - Fat content.

The determination of the fat content of the fillets was carried out in the laboratory following the BBS method. The results are shown in the general report. The lowest fat content was found in the herring caught in April, and varied with the different populations :

2.87 % for 34 autumn spawners

4.99 % for 17 spring spawners.

Conclusion.

1 - The observations made between the 17th and the 21st of April show that food and prematuration concentrations in the Gulf of St. Lawrence, S W Newfoundland and Nova Scotia are composed of a mixture of autumn and spring spawners.

2 - There are clear differences in meristic character averages between the spring pelagic concentrations on either side of the Laurentian Channel. On the other hand, the autumn spawners often show minimal differences, and are derived from mixed stocks. Within the population, the same reduction in the proportion of herring measuring 30 cm can be seen on all the length frequency curves for a thousand autumn herring.

3 - The number of Keeled scales K2 clearly separates the autumn spawners (Gulf of St. Lawrence, S W Newfoundland) from the complex stock of Banquereau.

4 - The fat content of the sample catches varied considerably according to the season and fishing area ; it goes from 2.87 percent in April in the Gulf of St. Lawrence at the Cabot straights, to 18.87 percent in July near Table Point.

5 - The pelagic concentrations seem to be connected to the presence of Calanus finmarchicus ; it is very abundant (99 %) in the stomachs of the herring of the 5000 kilogram catches in the St. Paul Island region, and diminishes to 87 % for the 340 kg catches on the East slope of the Sable Island Gully.

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Table 1. Herring - Frequency and percentage of autumn and spring spawners in the various areas (A = autumn spawners; S = spring spawners; I = immature).

Locality and spawning group		No. of specimens	Percentage Autumn	Spring	immatures
Cape St. George	A	308	62	37	1
bottom	S	185			
	I	8			
Cape St. George	A	138	69	31	
pelagic	S	62			
Isle aux Morts	A	145	72	23	5
pelagic	S	47			
	I	9			
... St. Paul	A	431	73	19	8
pelagic	S	115			
	I	54			
Table Pt	A	162	81	19	
bottom	S	38			
Cape Dauphin	A	171	39	11	50
bottom	S	46			
	I	217			
Banquereau Mar.	A	88	99	1	
South slope (bot.)	S	1			
East Gully Sable Is.	A	292	97	3	
pelagic Apr.	S	8			
Banquereau Apr.	A	194	97	3	
South slope	S	5			
East Gully Sable Is.	A	184	93	7	
bottom May.	S	14			
		2 922			

Table 2. Herring - Vertebral numbers of autumn and spring spawners (the asterisk indicates probabilities P · 0.01).

Areas	Autumn												Spring											Autumn sp.- Spring sp.-
	52	53	54	55	56	57	58	59	NO	AVE	VAR	SE	52	53	54	55	56	57	58	NO	AVE	VAR	SE	
Cape St. George (bottom)			11	121	153	20	3		308	55.620	0.498	0.040			7	73	89	15	1	185	55.622	0.508	0.053	-0.002
Cape St. George (pelagic)			4	52	70	9	2		137	55.657	0.507	0.061				19	37	5	1	62	55.806	0.421	0.083	-0.149
Isle aux Morts (pelagic)		2	1	54	70	16	2		145	55.710	0.610	0.065				16	24	7		47	55.808	0.463	0.100	-0.098
St. Paul Island (pelagic)	1	3	20	169	201	32	4		430	55.577	0.613	0.038		1	14	49	42	7	2	115	55.400	0.768	0.082	0.177 *
Table Pt. (bottom)			6	59	74	22			161	55.696	0.563	0.059			3	12	18	4	1	38	55.684	0.762	0.144	0.012
Cape Dauphin (bottom)		1	12	68	76	12	1	1	171	55.544	0.674	0.063			5	29	11			45	55.133	0.346	0.089	0.411 *
Banquereau South slope (bot.) Mar.		1	5	32	39	11			88	55.614	0.677	0.088												
East Gully Sable Is. (pelagic) Apr.			9	101	141	20	1		272	55.643	0.467	0.041												
Banquereau South slope Apr.		1	8	80	88	16	1		194	55.582	0.556	0.054												
East Gully Sable Is. (bottom) May			12	66	84	21			183	55.623	0.599	0.057				(12	14	1		27	55.592	0.328	0.112	0.031)

Table 3. Herring - Pectoral fin ray numbers of autumn and spring spawners (the asterisk indicates probabilities P ≤ 0.01).

Areas	Autumn										Spring										Autumn sp.- Spring sp.-
	16	17	18	19	20	21	NO	AVE	VAR	SE	15	16	17	18	19	20	NO	AVE	VAR	SE	
Cape St. George (bottom)	5	48	130	100	23	2	308	18.305	0.812	0.051		12	99	69	4	1	185	17.368	0.440	0.050	0.937 *
Cape St. George (pelagic)	2	13	54	51	16	2	138	18.522	0.850	0.079		7	32	21	2		62	17.290	0.504	0.091	1.232 *
Isle aux Morts (pelagic)	4	21	59	51	10		145	18.290	0.805	0.075		6	22	18	1		47	17.297	0.518	0.106	0.993 *
St. Paul Island (pelagic)	3	40	152	187	47		429	18.548	0.697	0.040		6	51	46	11	1	115	17.565	0.599	0.072	0.983 *
Table Pt. (bottom)		9	64	67	21		161	18.621	0.612	0.062		1	18	15	4		38	17.579	0.521	0.119	1.042 *
Cape Dauphin (bottom)	6	26	62	62	13	1	170	18.312	0.926	0.074	1	3	23	18			45	17.289	0.483	0.105	1.023
Banquereau South slope (bot.) Mar.		7	34	44	3		88	18.489	0.483	0.075											
East Gully Sable Is. (pelagic) Apr.		18	120	131	22	1	292	18.548	0.544	0.043											
Banquereau South slope Apr.		16	76	77	23	1	193	18.570	0.684	0.060											
East Gully Sable Is. (bottom) May	1	9	72	83	18	1	184	18.603	0.601	0.057			(5	10	8	5	28	18.464	0.999	0.192	0.139)

Table 4. Herring - Gill-raker numbers of autumn and spring spawners (the asterisk indicates probabilities P ≤ 0.01).

Areas	Autumn																Spring																Autumn sp.- Spring sp.-
	43	44	45	46	47	48	49	50	51	52	53	54	NO	AVE	VAR	SE	42	43	44	45	46	47	48	49	50	51	52	53	54	NO	AVE	VAR	SE	
Cape St. George (bottom)			4	11	31	62	59	64	47	23	4	2	307	49.261	2.946	0.098				7	13	27	40	48	34	9	6	1		185	48.530	2.588	0.119	0.731 *
Cape St. George (pelagic)			1	5	10	25	29	29	22	9	7	1	138	49.500	3.113	0.151				2	8	6	13	12	12	8	1			62	48.581	3.002	0.222	0.919 *
Isle aux Morts (pelagic)			1	5	15	23	42	24	18	13	4		145	49.296	2.835	0.140				1	2	8	12	13	6	3	2			47	48.574	2.294	0.225	0.722 *
St. Paul Island (pelagic)		5	9	39	57	81	91	69	46	18	10	5	430	48.783	3.750	0.093	1	4	8	15	26	25	20	11	2	2	1			115	46.652	3.264	0.169	2.131 *
Table Pt. (bottom)			3	3	18	24	38	40	18	14	2	1	161	49.311	2.816	0.133				1	1	9	8	10	5	3				37	48.405	2.026	0.237	0.906 *
Cape Dauphin (bottom)	1	3	11	25	20	33	26	21	21	7	2		170	48.288	4.372	0.161		1	3	10	12	15	3	1	1					46	46.196	1.805	0.200	2.092 *
Banquereau South slope (bot.) Mar.			1	2	8	14	24	11	17	8	1	2	88	49.489	3.173	0.191																		
East Gully Sable Is. (pelagic) Apr.			1	4	18	38	61	69	57	31	10	3	292	49.825	2.660	0.096																		
Banquereau South slope (bot.) Apr.				4	12	24	57	45	33	13	5	1	194	49.593	2.274	0.108																		
East Gully Sable Is. (bottom) May				3	5	17	39	50	28	25	13	4	184	50.179	2.750	0.123					1		4	1	9	6	5	1	1	28	50.357	2.979	0.332	-0.178

Table 5. Herring - Dorsal fin ray numbers of autumn and spring spawners (the asterisk indicates probabilities P ≤ 0.01).

Area	Autumn										Spring								Autumn sp.- Spring sp.-
	17	18	19	20	21	22	NO	AVE	VAR	SE	18	19	20	21	NO	AVE	VAR	SE	
Cape St. George (bottom)		18	136	137	17		308	19.497	0.479	0.039	28	98	53	4	183	19.180	0.501	0.052	0.317 *
Cape St. George (pelagic)	1	4	58	67	7		137	19.547	0.455	0.058	10	34	17	1	62	19.145	0.487	0.089	0.402 *
Isle aux Morts (pelagic)		14	56	71	4		145	19.448	0.499	0.059	6	21	19	1	47	19.319	0.527	0.107	0.129
St. Paul Island (pelagic)	1	15	185	206	23	1	431	19.552	0.453	0.032	13	62	35	4	114	19.263	0.497	0.066	0.289 *
Table Pt. (bottom)		8	68	76	8		160	19.525	0.452	0.053	3	21	13	1	38	19.316	0.438	0.109	0.209
Cape Dauphin (bottom)	1	16	65	80	7		169	19.450	0.559	0.058	3	28	15		46	19.261	0.331	0.086	0.189
Banquereau South slope (bot.) Mar.		4	46	35	2		87	19.402	0.383	0.067									
East Gully Sable Is. (pelagic) Apr.		12	142	120	13	1	288	19.476	0.445	0.039									
Banquereau South slope Apr.		12	84	85	12		193	19.503	0.501	0.051									
East Gully Sable Is. (bottom) May		11	95	73	5		184	19.391	0.414	0.047		(14	13	1	28	19.536	0.332	0.111	-0.145)

Table 6. Herring - Keeled scales K_2 numbers of autumn and spring spawners (the asterisk indicates probabilities $P \leq 0.01$).

Areas	Autumn												Spring									Autumn sp.- Spring sp.-
	12	13	14	15	16	17	18	19	NO	AVE	VAR	SE	12	13	14	15	16	NO	AVE	VAR	SE	
Cape St. George (bottom)	4	89	159	52	2			1	307	13.883	0.607	0.044	2	59	96	27	1	185	13.816	0.499	0.052	0.067
Cape St. George (pelagic)	3	49	60	23	3				138	13.812	0.665	0.070		21	32	8	1	62	13.822	0.509	0.091	-0.010
Isle aux Morts (pelagic)	2	39	73	30	1				145	13.924	0.557	0.062	2	13	24	7	1	47	13.830	0.666	0.120	0.094
St. Paul Island (pelagic)	13	105	227	81	4	1			431	13.909	0.603	0.037	9	55	42	6	2	114	13.447	0.621	0.074	0.462 *
Table Pt. (bottom)	5	39	82	35	1				162	13.926	0.603	0.061	3	13	17	3	1	37	13.622	0.742	0.143	0.304 *
Cape Dauphin (bottom)	4	49	91	25	2				171	13.836	0.550	0.057	2	25	19			46	13.370	0.327	0.085	0.466 *
Banquereau South slope (bot) Mar.	2	20	38	19	6	3			88	14.182	1.093	0.112										
East Gully Sable Is. (pelagic) Apr.	7	53	140	77	12	2	1		292	14.151	0.802	0.052										
Banquereau South slope Apr.	2	37	101	43	10	1			194	14.129	0.693	0.060										
East Gully Sable Is. (bottom) May	3	36	76	58	9	1			183	14.202	0.789	0.066		(7	11	7	3	28	14.214	0.915	0.184	-0.012)

Table 7. Herring - Keeled scales K_2 numbers of male and female.

Area and spawning group		Male											Female										Male-Female
		12	13	14	15	16	17	19	NO	AVE	VAR	SE	12	13	14	15	16	17	18	NO	AVE	VAR	SE	
Cape St. George bottom	A	2	42	75	20	2		1	142	13.880	0.716	0.071	2	46	84	32				164	13.890	0.516	0.056	-0.010
	S	2	35	51	15	1			104	13.788	0.557	0.074		24	45	12				81	13.852	0.428	0.073	-0.064
Cape St. George pelagic	A	3	28	35	9	1			76	13.697	0.614	0.090		21	25	14	2			62	13.952	0.703	0.107	-0.255
Isle aux Morts pelagic	A	1	22	40	19				82	13.939	0.552	0.082	1	17	33	11	1			63	13.905	0.571	0.096	0.034
St. Paul Island pelagic	A	3	53	107	38	2			203	13.916	0.543	0.051	10	52	120	43	2	1		228	13.903	0.660	0.054	0.013
	S	7	26	25	2	1			61	13.410	0.646	0.104	2	29	17	4	1			53	13.491	0.601	0.107	-0.081
Table Pt bottom	A	3	22	39	17	1			82	13.890	0.670	0.091	2	17	43	18				80	13.962	0.543	0.083	-0.072
Cape Dauphin bottom	A	1	18	39	12				70	13.886	0.480	0.083	3	31	52	13	2			101	13.802	0.600	0.077	-0.084
Banquereau South slope bot.	A Mar.	1	10	20	9	4	1		45	14.178	1.059	0.155	1	10	18	10	2	2		43	14.186	1.155	0.166	-0.008
East Gully Sable Is. pelagic	A Apr.	4	28	64	37	3			136	14.051	0.686	0.071	3	25	76	40	9	2	1	156	14.237	0.892	0.076	-0.186
Banquereau South slope	A Apr.	2	17	41	17	5			82	14.073	0.760	0.097		20	60	26	5	1		112	14.170	0.647	0.076	-0.097
East Gully Sable Is. bottom	A May	3	15	43	26	5	1		93	14.193	0.854	0.096		21	33	32	4			90	14.211	0.730	0.091	-0.018

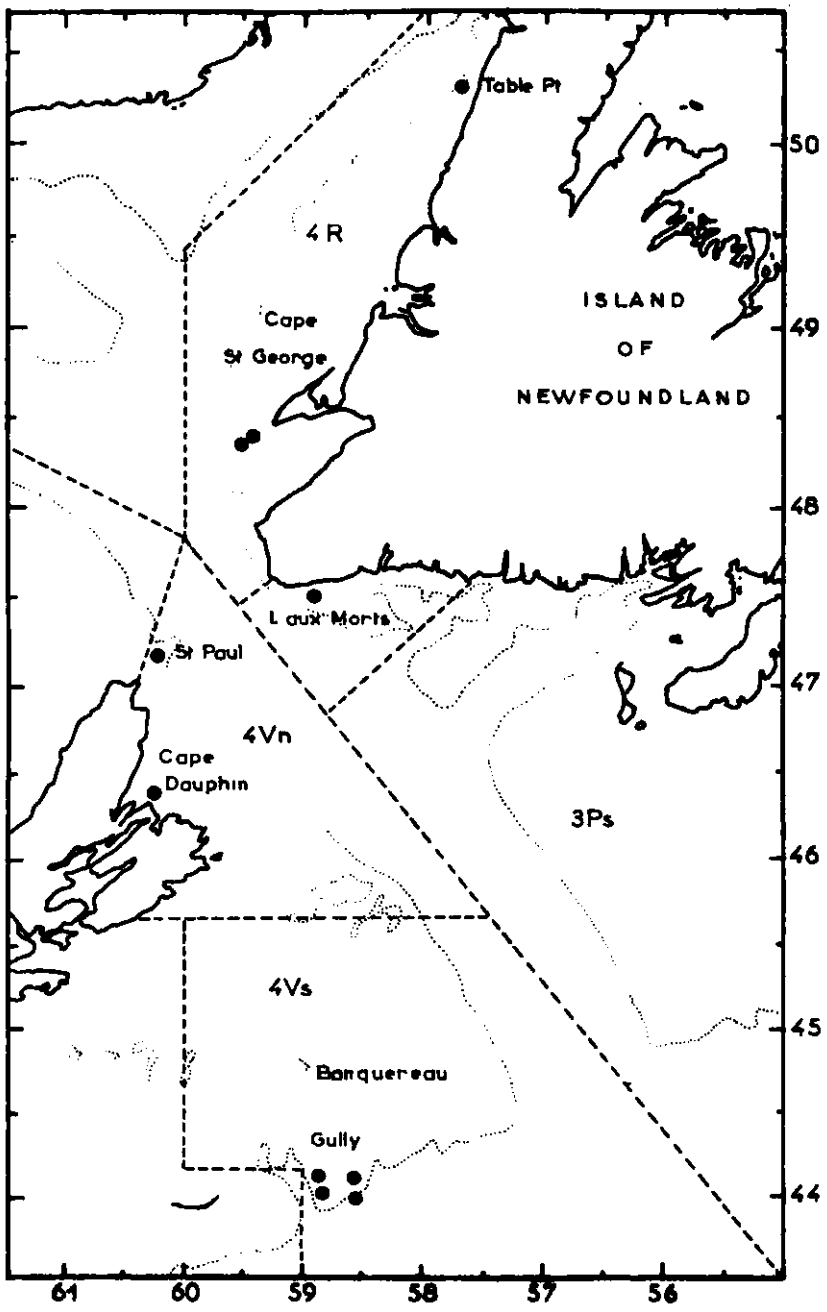

Chart 1. Location of sampling areas in Div. 4R and Subdiv. 3Pn, 4Vn and 4Vs.

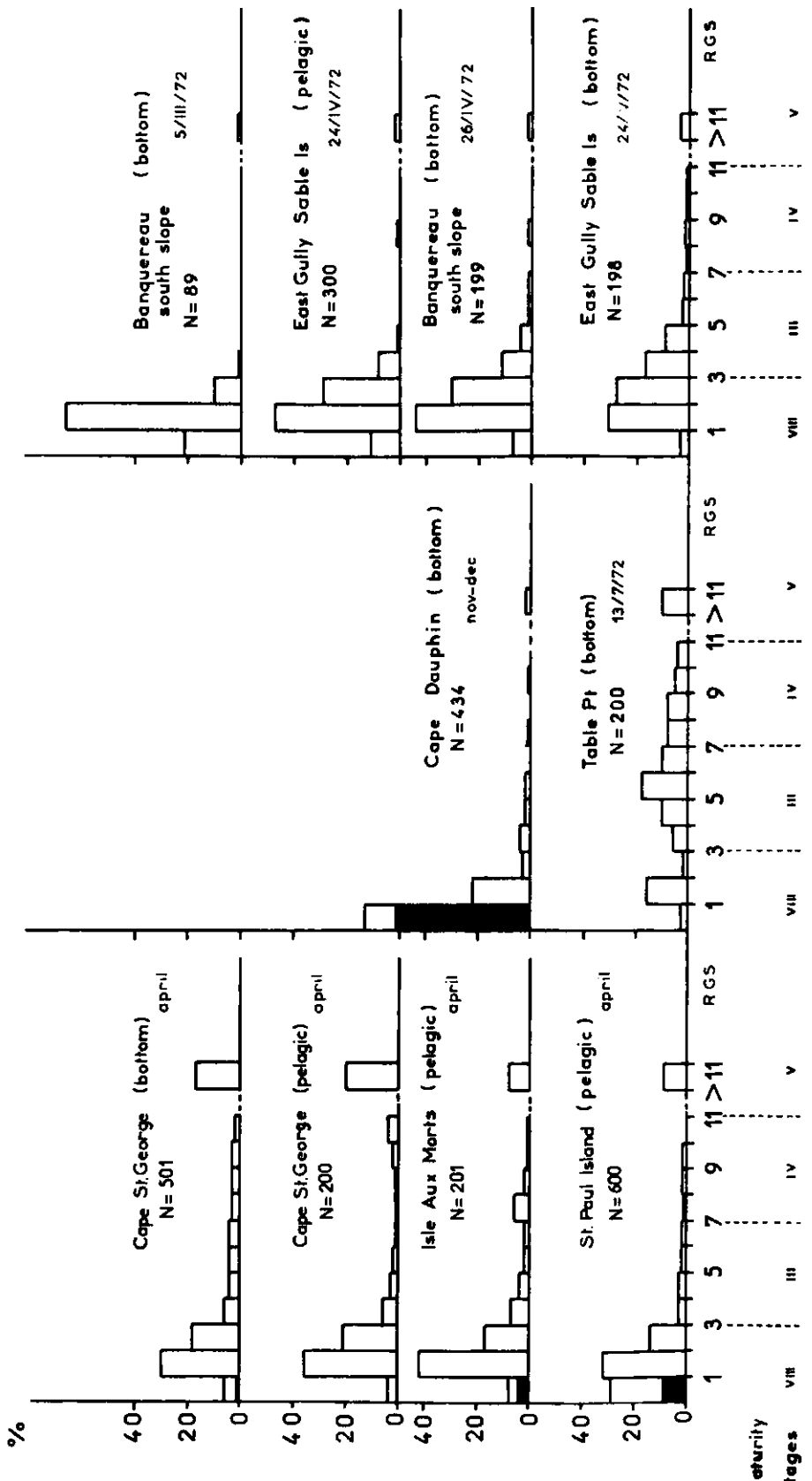

Fig. 1. Gonadal development of herring from areas (dashed line: immatures).

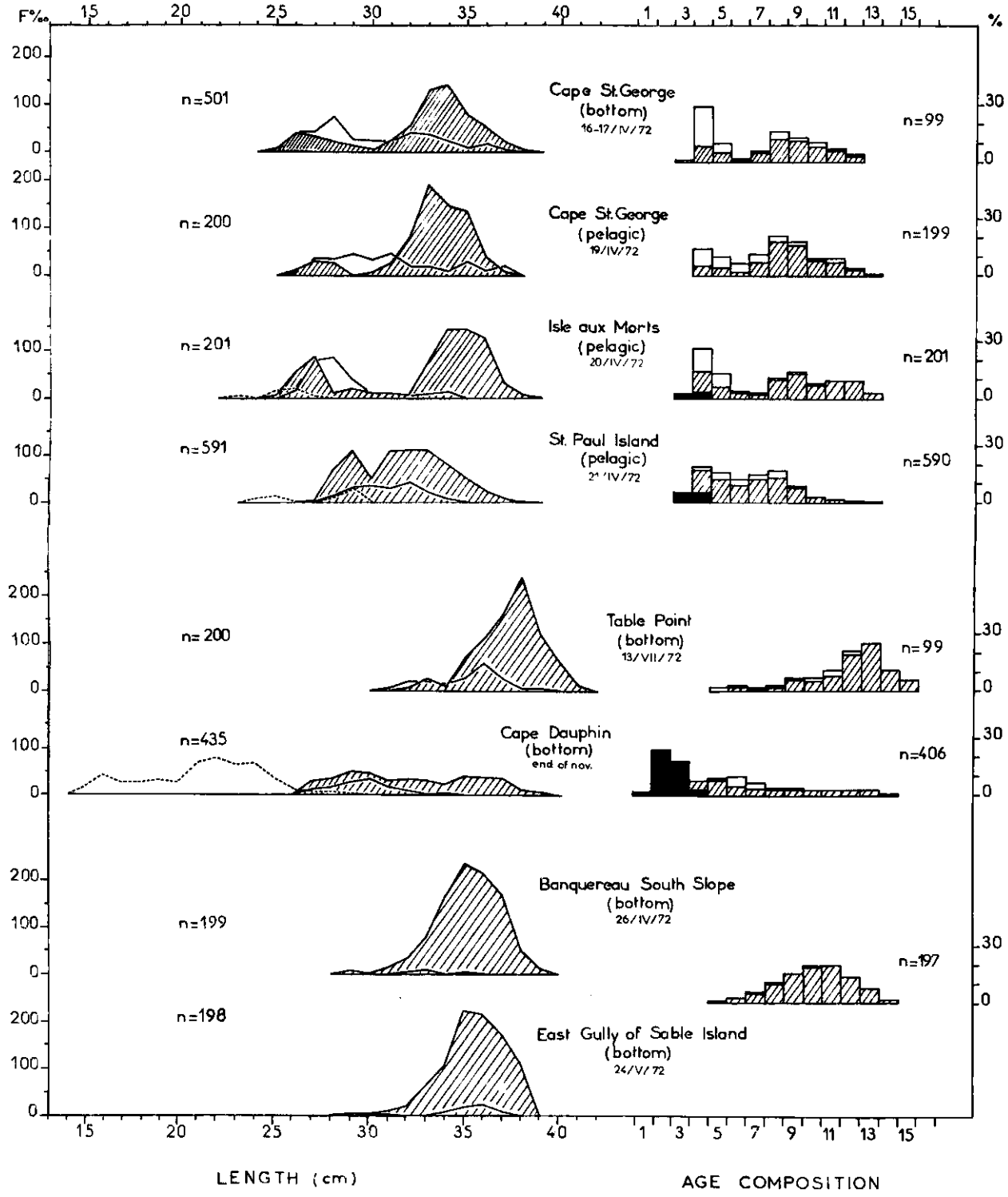

Fig. 2. Length frequencies and age composition of herring from areas (hatched portion: autumn spawners; solid portion and dashed line: immatures).