Northwest Atlantic Fisheries Organization

Serial No. N051

NAFO SCR Doc. 80/II/19
(2nd Revision)

SPECIAL MEETING OF SCIENTIFIC COUNCIL - FEBRUARY 1980

Winter Distribution of Juvenile Silver Hake from Research Cruises on the Scotian Shelf, 1966-1980

by

J. S. Scott
Department of Fisheries and Oceans, Biological Station
St. Andrews, N. B., Canada EOG 2XO

Introduction

From the years 1966 to the present, research survey cruises on the Scotian Shelf have been carried out annually (except 1973) by the A.T. Cameron in January to March and occasionally by the E.E. Prince in the period October to March (Table 1). Prior to 1966 and since 1973 the A.T. Cameron cruises have been restricted in area and objective and are not relevant to this study, while the E.E. Prince cruises in October-November produced so few silver hake that their results are not usable. We are therefore left, for this period, with a series of annual groundfish surveys in January to March in the years 1966-72, each covering a considerable part of the Scotian Shelf and, in aggregate, giving adequate coverage of the Shelf and sufficient samples of silver hake juveniles to describe the geographic and length-frequency distributions of the juveniles for January, February and March for those years.

In March 1979 extensive winter surveys were resumed, using the Lady Hammond, and results from this year, from cruises in January and March 1980 plus an autumn cruise in October-November 1978, have yielded further information on winter distribution and growth in juvenile silver hake.

The results of the above surveys as they relate to winter distribution and growth of juvenile silver hake are presented here.

Materials and Methods

The winter research surveys on the A.T. Cameron were based on a random series of ½-hour tows at pre-selected stations using a Yankee #42 bottom trawl prior to 1970 and a Yankee #36 trawl from 1970 on, both trawls with fine mesh liners. Although the stations were randomly selected, they were concentrated in areas of special interest, and certain areas, particularly the shallow water areas on top of the Banks, received relatively little attention.

The Lady Hammond surveys in 1978, 1979 and March 1980 were routine groundfish surveys, whereas the January 1980 cruise had a survey of redfish distribution as a primary objective. In 1978 the gear used was an Engel high-lift bottom trawl, while since 1979 the vessel has used a Western IIA bottom trawl, both with fine mesh cod-end liners.

Estimation of the length-frequency distributions of the juvenile silver hake was based on summing the length-frequency distributions for each month (January to March) for all years from 1966-72 and for each of the years 1978, 1979, 1980, separately, for each depth stratum as used in the present annual summer groundfish research surveys (Fig. 1). This system resulted in some extensive areas being treated as single units but it did delineate areas of known special importance in distribution of juvenile silver hake such as Emerald Basin and sections of the continental slope.

Percentage length-frequency distributions were prepared for the 1966-72 period and for each of the 1978, 1979 and 1980 surveys separately (Fig. 2). For comparison of the central and southwestern parts of the Scotian Shelf they were labelled "4WX," comprising strata 50-73 and 78, and "Browns," comprising strata 74-77 and 79-85. Representative modal lengths for each of the areas were taken from the figure.

Age determinations were not available for the early cruises and the term "juveniles" was interpreted to mean fish of 1 and 2 years of age at modal lengths of about 12 and 25 cm (Hunt 1978). The length-frequency distributions were cut off at modes in the length-frequency distributions at about 28-30 cm, eliminating most fish of ages greater than 2 group. Catch per tow for each depth stratum was estimated by dividing the total number of juveniles caught in the stratum in all years by the total number of tows

made in the stratum.

The results of the analysis are qualitative rather than quantitative, because of differences in gear used, level of effort and other factors, but they are held to reflect the density of juvenile silver hake in different areas at different times, if not actual abundance.

In conformity with usual practice, the fishes' birthdates are taken as 1st January in the year spawned, although this is rather unsuitable for fish which spawn as late in the year on the Scotian Shelf as silver hake (August-September). For the period January to March considered here, 1-group refers to fish spawned the previous fall (young-of-the-year), and 2-group to fish in their 2nd year.

Results and Conclusions

Length-frequency distributions and numbers per tow for catch of juvenile silver hake, by depth stratum, for January, February and March 1966-72 are shown in Tables 1, 2 and 3 respectively, and the 1978, 1979, January 1980 and March 1980 results in Tables 4, 5, 6, and 7 respectively. Strata in which no captures were recorded are omitted from the tables.

In January 1966-72, 1-group fish were poorly represented (Table 1) with small numbers of individuals being taken at all depth ranges but no indications of high concentration. The best catches per tow for 2-group fish were in strata 78 (243 fish per tow) in 100+ fathoms on the shelf. There was no indication of high concentration of silver hake in Emerald or LaHave Basins at this time. Modal lengths were: 1-group - 10 cm; 2-group - 21 cm (Fig. 2) with no distinction between samples from the different depth strata.

In January 1980, 1-group fish were again poorly represented (Table 6), with small numbers taken in strata 72 and 76. A concentration of mixed 1- and 2-group fish was located in stratum 76 (Roseway Basin) as well as in strata 60 and 70, both north of Emerald and LaHave Basins, and in stratum 71 (LaHave Basin). Modal lengths were 10 cm for 1-group, similar to that for 1966-72, and only 21 cm for 2-group, similar to the 1966-72 figure. The continental slope was not covered in 1980, so possible concentrations there were not located.

In February 1966-72, 1-group fish were well represented (Table 2) with best results (55 fish per tow) again in stratum 78 on the continental slope although this is based on only 1 tow in the stratum. Good catches were made in stratum 61 (Emerald Basin, >100 fathoms) where an average of 17 fish per tow was caught. One-group fish were still to be found on the shelf in shallower water (strata 62, 64, 65, 72, 76, 77), particularly in strata 72, 76 and 77, to the south and west of LaHave Basin.

February concentrations of 2-group fish were, again, mainly in strata 78 (183 fish per tow) and 61 (78 fish per tow) but a good catch per tow level (47) was shown in stratum 62, to the east of stratum 61 (Emerald Basin) although 1-group fish were poorly represented there. Two-group fish were widely distributed over the whole of the central and southwest part of the Scotian Shelf (including stratum 81 north of Browns Bank) in depths greater than 50 fathoms but were notably absent from the banks themselves.

Modal lengths in February for samples from the central part of the shelf were: 1-group - 13-15 cm; 2-group - 23-24 cm, both considerably higher than in January. The sample from stratum 81 in the southwest part of the shelf was a 2-group mode at 27 cm, considerably higher than that for the central part of the shelf.

In March 1966-72 (Table 3), 1-group fish were well represented in deep water (>100 fathoms) stratum 61 (Emerald Basin) and to a lesser degree in strata 62 and 65, to the east and south of Emerald Basin in 51-100 fathoms, but were virtually absent from catches on the continental slope, in contrast to the previous month.

In March 1979 (Table 5), 1-group fish were exceptionally well represented in stratum 54 (50-100 fathoms, south of Sable Island), and there was an exceptional concentration in stratum 82 (>100 fathoms, south of Browns Bank). Lesser concentrations were identified in strata 61 (Emerald Basin), 62 and 65 (50-100 fathoms, Western Gully), and 83 and 84 (>100 fathoms, southwest Nova Scotia).

In March 1980 (Table 7), 1-group fish were poorly represented in all areas except stratum 66 (continental slope, south of Emerald Bank) with minor catches in strata 63 (Emerald Bank), 84 and 85 (southwest Nova Scotia).

Good catches of 2+-group fish were made in March 1966-72, with highest concentrations in stratum 66 (456 fish per tow) in >100 fathoms on the

continental slope adjoining stratum 78, where best catches were recorded in the previous two months. High catch per tow figures were also shown in strata 61 (Emerald Basin) (~198 fish per tow) and to the west in 62 (230 fish per tow) as in the previous month. No catches were recorded on the western part of the shelf.

In March 1979 and 1980 (Tables 5, 7), 2-group fish were widespread over the central part of the Scotian Shelf in areas with depths over 100 fathoms but were poorly represented on the southwest part of the shelf. In 1979, major concentrations in the central area of the shelf were in stratum 54 (south of Sable Island Bank) and strata 61, 62 (Emerald Basin area). No concentrations were found off southwest Nova Scotia. Major concentrations in 1980 were in the whole central shelf area from north of LaHave Basin to the continental slope south of Emerald Bank (strata 61, 62, 63, 66, 70, 71). The only significant catch in the southwest shelf area in 1980 was in stratum 76 (Roseway Basin).

Modal lengths in March 1966-72 were: 1-group - 13 cm, within the range for February; 2-group from strata 60 and 61 - 26 cm, about the same as in January. The length-frequency distribution for stratum 66 (continental slope), however, showed a major mode, not at 26 cm in common with the other length-frequency distributions, but at 30 cm which corresponded to the 3-group mode in the others. A minor mode at 27 cm presumably corresponded to the 2-group silver hake in stratum 66. The numbers in the length-frequency distribution for each stratum were adjusted to give estimated length-frequency distributions at each age by calculating normal components of distribution as described by Hunt (1978) and determining the relative composition of the age groups. The estimated numbers of 3-group and older fish were subtracted from the total length-frequency distribution to leave only the 1- and 2-group fish numbers. The estimated length-frequency distribution for 2-group fish was then used to determine the 2-group mode and catch per tow. The 2-group mode at 27 cm was confirmed, not significantly different from that for strata 60 and 61.

Modal lengths for 1-group fish in the central shelf area in March 1979 ranged from 9-12 cm with major mode at 11 cm, and in the Browns area from 14-16 cm with major mode at 16 cm (Fig. 2). In 1980, corresponding modal lengths were 12 cm and about 14 cm, although the age-group was so poorly

represented as to make determination difficult. In 2-group fish, modal lengths in 1979 were 24-25 cm in all areas of the shelf, and in 1980 21 cm in the central shelf and 22-23 cm in the southwest.

Results of the October-November 1978 cruise (Table 4) indicate that juvenile silver hake were concentrated mainly in strata 62 (east of Emerald Basin), 61 (Emerald Basin) and 59 (northeast of Emerald Basin). The southwest part of the shelf was not sampled. Virtually no young-of-the-year fish were caught and the major modes in the length-frequency distributions were at 23 and 29 cm.

The data indicate that in 1966-72 the heaviest winter concentrations of juvenile silver hake were to be found on the edge of the continental slope in depths greater than 100 fathoms (strata 66 and 78) south of Emerald and LaHave Basins. Large but secondary concentrations were found in stratum 61 (Emerald Basin). In the 1978-80 cruises, however, the distribution varied, being centered mostly in the vicinity of Emerald, LaHave and Roseway Basins. One-group fish were concentrated south of LaHave Basin and in Roseway Basin (strata 72, 76) in January 1980, in the Emerald Basin area (strata 61, 62, 64), south of Sable Island (stratum 54) and on the edge of the Fundian Channel (strata 82, 83, 84) in March 1979, and on the shelf edge south of Emerald Bank in March 1980. Two-group fish were concentrated in Emerald Basin and its vicinity in all surveys, with important concentrations recorded in Roseway Basin and LaHave Basin in 1980.

Modal lengths do not suggest different populations in Emerald and LaHave Basins and off the edge of the shelf, but the differences in modal lengths between fish from the central part of the shelf and those from the Browns Bank area in the southwest may indicate separate populations: in March 1979 and 1980, modal lengths of age-1 fish from the Browns Bank area and the central part of the shelf were 14-16 cm and 11-12 cm respectively (Fig. 2). Differences in modal lengths from January to March suggest considerable growth in this period, from 10 to 14-16 cm in 1-group fish and 21 to 23-26 cm in 2-group fish.

Inspection of Fig. 2 shows that 1-group fish are poorly represented in almost all catches, with a general increase in proportion from January to March shown in the 1980 results, but no evidence of young-of-the-year fish in October-November 1978. This may be a result of gear selectivity, but it

is also possible that it indicates that the young-of-the-year fish are little available to the gear in October-November and become progressively more available from January to March as they assume a more demersal habit. This suggests that young-of-the-year surveys should be carried out in late winter or spring when the young fish are apparently near bottom and still concentrated in the deeper water.

Comparison of catches in March 1979 (Table 5) and March 1980 (Table 7) shows relatively low numbers of 1-group fish in 1980. It will be interesting to see if this is reflected in low abundance of 2-group fish in 1981.

The overall results of the surveys suggest that the most consistent areas for surveying juvenile silver hake is the central part of the Scotian Shelf, comprising strata 60, 61, 62 (Emerald Basin and vicinity), with stratum 71 (LaHave Basin) and strata 54, 66 and 78 (continental slope) providing intermittent high catches. In the southwest part of the Scotian Shelf area, stratum 76 (Roseway Basin) shows high potential as a sampling area, on the basis of 1979-80 surveys, and stratum 82 (southwest of Browns Bank) gave the highest number of fish per tow (2143) of all strata in all years, in March 1979.

References

Hunt, J. J. 1978. Age, growth and distribution of silver hake, Merluccius bilinearis, on the Scotian Shelf. Int. Comm. Northw. Atl. Fish. Selected Papers No. 3: 33-44.

Table 1. Length frequency distributions of juvenile silver hake in various depth strata of the Scotian Shelf from research cruises 1966-72 - January

Length (cms)	Stratum 53	54	61	63	65	66	72	77	78	Total
8		1								1
9		2						1		3
10		2			2			1		5
11								1		1
12				1	1					2
13								1		1
14				1						1
15										0
16										0
17							1			1
18							1			1
19			1							1
20				1					3	4
21					2				8	10
22		1			1				3	5
23					8				18	26
24					9				82	91
25	1				16				108	125
26				1	13				112	126
27			3		4				77	84
28	1		2		2				44	49
29	5		6		1				21	33
30					1	3			10	14
Total fish	7	6	12	4	60	3	2	4	486	
Total tows	3	2	2	1	4	1	1	1	2	
No. fish per tow	2	3	6	4	15	3	2	4	243	

Table 2. Length frequency distributions of juvenile silver hake in various depth strata of the Scotian Shelf from research cruises 1966-72 - February.

Length (cms)	Stratum 61	62	63	64	65	66	72	76	77	78	81	82	Total
6				1									1
7													0
8				2									2
9	3	1						1		1			6
10	3	1					1	2	4	1			12
11	11						1		2	4			18
12	13						2	8	6	9			38
13	22	1			3		3	1	3	22			55
14	30	1			1		2		3	3			40
15	30				2				1	7			40
16	17						1		1	5			24
17	13	2				2			4	3			24
18	10	4				4			1				19
19	18	9				7		2					36
20	26	19	2			7	1			1			56
21	59	29	10			5	1	1	1	2	1		105
22	73	58	8			4		4	1	8			156
23	155	45	7			2	1	9	1	14			234
24	164	31	5		2	4		4	2	29	1		242
25	104	15	1			2		3	1	50	1		178
26	43	13			3	2	1	2		29	11		104
27	15	7			3			2		24	17	2	70
28	10	3			1	3		2		19	12	3	53
29	15	1								3	5	4	28
30	9					6				4	3	1	23
Total fish	843	240	33	3	15	48	14	41	31	238	51	10	
Total tows	9	5	2	1	1	3	1	2	2	1	2	1	
No. fish per tow	94	48	17	3	15	16	14	21	17	238	26	10	

Table 3. Length frequency distributions of juvenile silver hake in various depth strata of the Scotian Shelf from research cruises 1966-72 - March.

Length (cms)	Stratum 60	61	62	63	64	65	66	Total
6						1		1
7						1		1
8								0
9		1	1					2
10		5	3			7		15
11		12	4			8		24
12		10	15			2		27
13		24	10		1	5	1	41
14		12	15			5		32
15		8	5			3		16
16		7	7			2	1	17
17		4	8			6		18
18		2	7			1		10
19			2			1		3
20			9					9
21		9	25			1	3	38
22		9	64			7	4	84
23		16	156			19	6	197
24	1	74	256		1	30	17	379
25		111	282		1	39	50	483
26		170	235	1		37	124	567
27		105	119			4	260	488
28		59	80			11	256	407
29		95	55			9	417	576
30	1	121	53			11	602	787
Total fish	2	854	1411	1	3	210	1771	
Total tows	1	3	5	1	1	4	2	
No. fish per tow	2	285	282	1	3	52	885	
Adjusted total fish	2	662	1298	1	3	194	913	
Adjusted no. fish per tow	1	221	230	1	3	48	456	

Table 4. Length frequency distributions of juvenile silver hake in various depth strata of the Scotian Shelf from *Lady Hammond* research cruises H009-010, October-November, 1978.

Length (cm)	Stratum 50	53	59	60	61	62	63	65	66	Total
7										
8							1			1
9							1			1
10										
11				1			1			2
12										
13										
14										
15						4				4
16				8		1				9
17				5	5	3				13
18			11	3	5	18				37
19			14	3	9	28				54
20			26	6	16	89				137
21			49	11	18	137			1	216
22		1	39	14	38	146			3	241
23		4	34	25	58	312		10	1	444
24			52	15	50	212		3	3	335
25		7	35	3	33	198		1	1	278
26		8	34	10	35	138		2	2	229
27	9	19	47	9	46	130		1	1	262
28	29	31	57	9	67	262		4	7	466
29	66	42	36	10	59	302			3	518
30	74	76	40	5	42	210				447
Total fish	178	188	474	137	481	2190	3	21	22	
Total tows	1	3	8	4	4	8	4	4	3	
No. fish per tow	178	63	59	34	120	274	1	5	7	

Table 5. Length frequency distributions of juvenile silver hake in various depth strata of the Scotian Shelf from *Lady Hammond* research cruises H013-014, March 1979.

Length (cm)	Stratum																					Total
	51	52	53	54	56	60	61	62	65	66	70	71	76	78	81	82	83	84	85	91	92	
7									5											1		6
8				12					13									1		1		27
9				32					21								9	4				66
10				57		2	14	33	18				2			33		2		1		162
11	2			116		5	16	46	7							33	9	26	4	2	1	267
12	2			76		5	39	41	4						3	100		29	2	3		304
13	4			51		5	24	80	1				22		5	200	47	81	8	3	1	532
14	5			33	1	2	22	26	3				34		19	433	140	95	19	2		834
15	1			23			8	31	1				26		12	507	224	122	8		3	966
16	1			16	1			21	2				12		12	1172	244	70	15		3	1569
17				14		2		8	4				4		15	669	77	97	11		2	903
18				9		1	4	3	2				10		10	568	93	58	6			764
19				2		6	4	18	1		1	1	14		2	367	18	23	2		2	461
20				1		4	9	41			1		24		2	69	21	8	2			182
21						10	16	53	1		9	7	24						2		1	123
22						4	18	78			9	3	16						2			130
23					3	7	41	117	2		14	14	12					4	2			216
24			1	3		4	53	167	3		13	2	24					1	1			272
25				1	3	5	65	156	2		11	10	2	2		67	1	6	3			334
26			2	4	4	7	52	111	1		15	6				67	20	4	2			295
27			3	8		2	31	81	1		16	13	4				1	2	2			164
28			5	1		2	27	74	3	1	5	16	4	1				6	5			150
29			6	3		3	16	55	1	23	17	12		4			9		4			153
30		1	17	1		4	11	44		22	11	11	2	1			10	6				141
Total fish	15	1	34	463	12	80	470	1284	96	46	122	95	236	8	80	4285	923	645	100	13	13	
Total tows	2	2	3	3	6	2	2	4	2	3	2	2	2	2	4	2	2	3	3	3	3	
No. fish per tow	8	0.5	11	154	2	40	235	621	48	15	61	48	118	4	20	2143	462	215	33	4	4	

Table 6. Length frequency distributions of juvenile silver hake in various depth strata of the Scotian Shelf from *Lady Hammond* cruise H030, January 1980.

Length (cm)	Stratum 60	70	71	72	76	Total
6	2				1	3
7					4	4
8				5	21	26
9		1	1	5	46	53
10			1	10	80	91
11				6	47	53
12				1	37	38
13				2	48	50
14	2	1	1		48	52
15	6	2	1	1	74	84
16	10	1	2	1	139	153
17	22	12	11	2	284	331
18	26	11	20	5	391	453
19	51	17	18	2	528	616
20	55	20	34	4	555	668
21	57	31	26	4	494	612
22	49	17	25		369	460
23	25	17	22		230	294
24	20	7	14		176	217
25	8	7	7	1	113	136
26	3	4	8		59	74
27	3		5		53	61
28	4		2		34	40
29	2	2	4	1	35	44
30	2	2	2		27	33
Total fish	347	152	204	50	3893	
Total tows	1	1	2	1	19	
No. fish per tow	347	152	101	50	204.9	

Table 7. Length frequency distributions of juvenile silver hake in various depth strata of the Scotian Shelf from *Lady Hammond* cruises H033-034, March 1980.

Length (cm)	Stratum																										Total
	46	50	51	52	53	56	59	60	61	62	63	65	66	70	71	72	73	74	75	76	78	81	82	84	85	92	
8																								1			1
9																											
10									3	3	2			2										5	1		16
11									1	1	4		4	1	1		1								3		16
12										2	4		30	4	1							3		5	3		52
13											5		26		1							1		2	1	1	37
14						1					4	1	27		3							1		6	5	1	49
15						1			2	2	3	1	22									4		5		1	41
16	1					2	7		4	8	1	1	16	1	7				1	1		1		3			54
17		1				4	7		1	13	6		3	5	28					3				2			73
18		2				6	16	3	18	31	4		4	9	40		1			7				1			142
19						9	14	3	26	46	5		4	11	71					12		2		1		1	205
20					1	16	9	10	31	76	14	3	8	22	65			1		18	3	1		3			281
21		1				31	1	3	43	101	17	1	8	14	44					25		1		2	1		293
22			1		1	12	5	4	33	97	13	1	16	13	34					26	3	2		5	3		269
23	1	1			2	8	2	6	26	76	9	2	8	6	18					17	10	1		10	1		204
24		1	2	1	4	3	4	1	16	50	6	2	20	10	8					5	15	3		7	1	2	161
25		6	1		14	3	1	2	16	41	8	1	19	8	8					4	16	1		8			157
26	1	6	1		10	2		2	11	37		4	20	3	8					2	12	2		5	1		127
27	1	4	4	4	14				12	36		3	17	2	8					5	16	1		2	1		130
28	1	11	3	3	14			1	9	47		5	9	5	12					5	10	1					136
29		16	7	15	23		1	4	12	47		4	12	3	16					3				4			167
30		10	4	13	14			10	13	32		1	5	4	17					5	2	1		1			132
Total fish	5	59	23	36	97	98	67	49	277	746	105	30	278	123	390		2	1	1	138	87	26		78	21	6	
Total tows	2	3	2	2	3	4	4	2	2	4	2	4	3	2	2	2	3	2	2	1	2	2	2	3	2	3	
No. fish per tow	2.5	20	12	18	32	25	17	25	139	187	53	8	93	62	195	0	1	0.5	0.5	138	44	13	0	26	11	2	

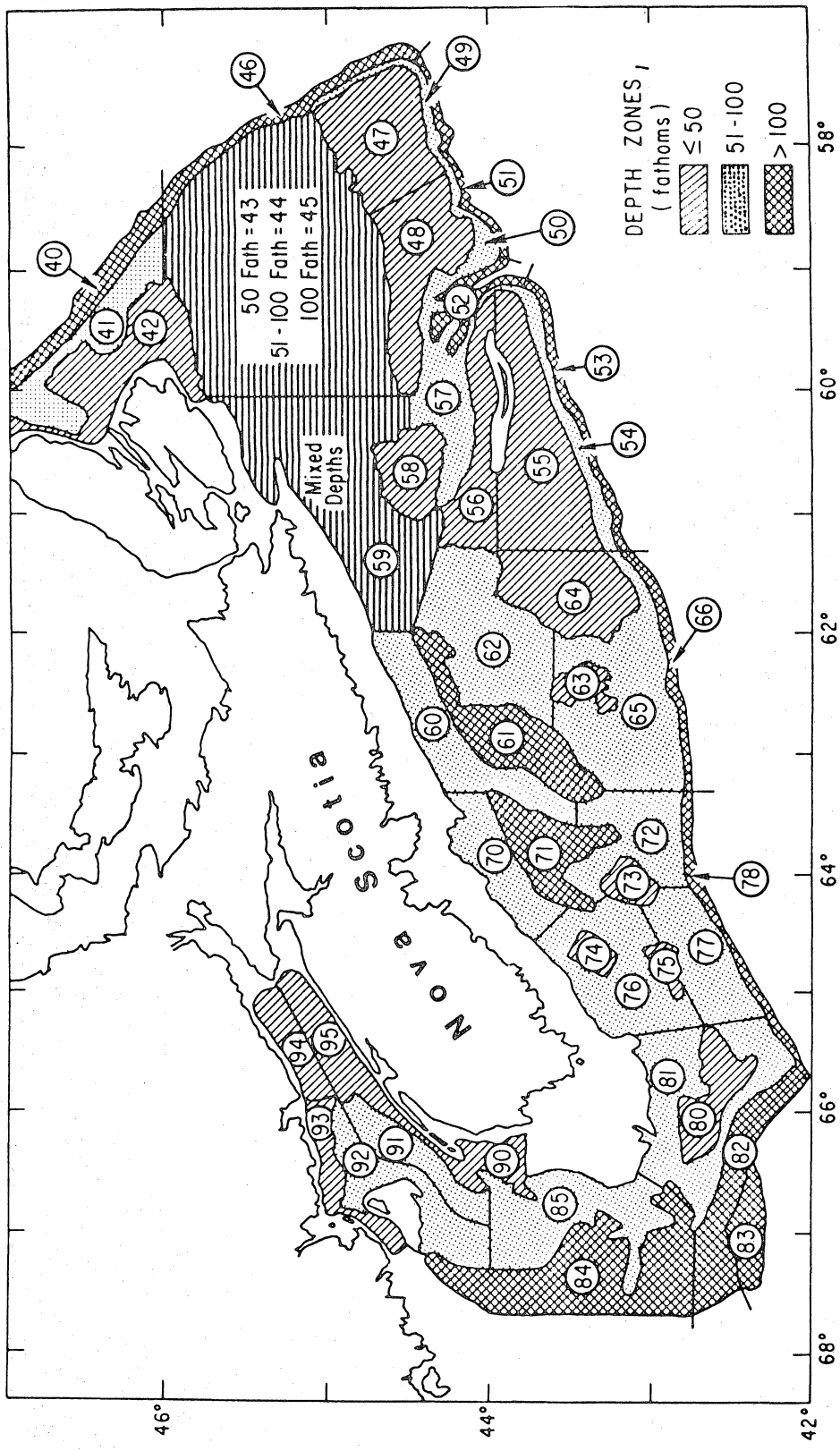

Figure 1. Depth strata of the Scotian Shelf and Bay of Fundy.

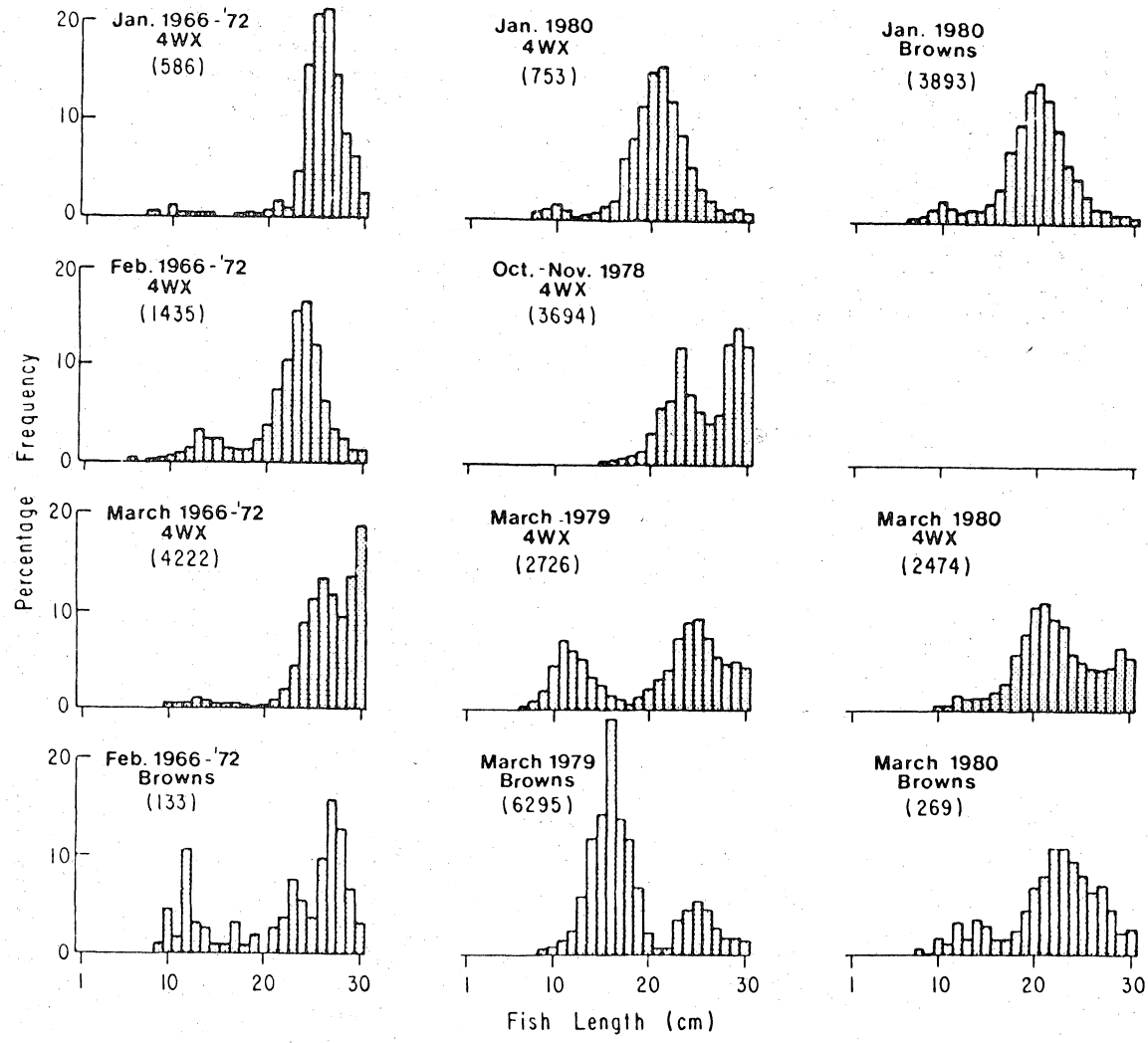

Figure 2. Percentage length-frequency distributions of juvenile silver hake from research cruises on the Scotian Shelf, 1966-80, for ICNAF Div. 4WX (central Shelf) and Browns Bank area (southwest Shelf) (numbers of fish sampled in brackets).