NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N186

NAFO SCR Doc. 80/IX/117
(Revised)

ANNUAL MEETING OF SCIENTIFIC COUNCIL - SEPTEMBER 1980

Distribution, Age and Growth of Silver Hake (*Merluccius bilinearis*) on the Scotian Shelf

by

A. Mari
Centro de Investigaciones Pesqueras
Calle 26, esq. 1ra.
Miramar, Habanad, Cuba

INTRODUCTION

The silver hake (*Merluccius bilinearis*) is one of the most important groundfish inhabiting the Scotian Shelf (ICNAF, Div. 4VWX). The fisheries for this species began in 1958, when the small figure of 38 t was reported. In 1961 the catches increased up to 163 000 t reaching the maximum of 299 000 t in 1973.

Since 1974, ICNAF (International Commission for the Northwest Atlantic Fisheries) enforced the catch quota system for stock inhabiting the Canadian and American Continental Shelf. Afterwards, in 1977, some restrictions in area and fishing gears were added to these regulations. It should be pointed that the International Observer Program was implemented in the same year with the objectives of assessing the quantities and species composition of the by-catch, as well as their sizes and ages, to find areas with possibilities to develop fisheries directed to silver hake with small meshed bottom trawls without damaging the stocks of by-catch species.

It is the purpose of the present paper to gather the existing information on silver hake distribution and to present the age-length keys together with the growth equation.

MATERIALS AND METHODS

Two samples of otoliths were collected, one during the summer 1977 on board the research vessel "Isla de la Juventud", and the other in 1978 from the International Observer Program, both was stratified in size and sex. Once the otoliths were removed, they were kept in identified paper envelopes. The structures were broken through the nucleus and one half was polished at the surface for age determination. When the zones were not distinctly observed due to prolonged storing of otoliths, some HNO_3 (2 %) was added for a few minutes to the polished surface, attaining a considerable improvement for observations.

The reading were carried out with an Olympus binocular stereoscope, model X with a magnification between 16X and 25X using reflected light. The polished half was place on black plastiline and the surface was covered with alcohol. For reading, ICNAF workshop methods by Hunt (1976, 1977 and 1978a) and summarize in Hunt (1979) were followed.

The Von Bertalanffy growth equation was used to describe the growth of each sex and both combined.

For studying the species distribution, data from the Soviet and Canadian cruises as well as from other ICNAF research documents were used.

RESULTS AND CONCLUSIONS

Distribution:

Silver hake is commonly found in the eastern side of North America, from the southeast of Gulf of St. Lawrence and southern Newfoundland to off South Carolina (Leim and Scott, 1966) in depths from 20 to 550 m (Sarnits and Sauskan, 1966).

Using statistical data from the Soviet fleet and the results of the research carried out by the scounting vessels of this country during the period 1962-1964. Sauskan (1964) and Sarnits and Sauskan (1966) propose a general distributional pattern for Silver hake on the Scotian Shelf as follows: in winter there is a concentration of young fish in the Scotian Gulf which is affected by the influence of the warm water from the slope. In spring the silver hake moves to the continental slope forming pre-spawing schools between La Have Bank and the Gully Deep. At the end of the summer the shallow waters around Sable Island begin a gradual warming reaching 9-12°C when the most of the spawning occurs. In fall the silver hake may be detected moving to deeper water areas again near the overwintering places. It should be noticed that the silver hake of the Scotian Shelf as other representations of the genus (Alverson and Larkins, 1969; Harts, 1948) moves from deeper waters in winter to shallower areas during the spring and summer period.

Using the fishing areas presented by Clay (1979) taken from the Fishing Atlas (Anon, 1971) and assuming that the movement of the fleet was on the main concentrations of the species, it should be noticed that the Soviet fleet moves during the summer months to the shelf slope and around Sable Island (Fig. 1).

It should be pointed that hidrological conditions in the area may limit in a great extent the operational area for the International fleet, as conditions change from one year to another. As observer in Waldron (1978 and 1979) and assuming again that the fleet apply their effort on the main commercial concentrations, it is noticiable that during 1978 the greatest silver hake commercial concentrations were on the north of the regulation line, an opposite situation as observed during 1977 from Clay (1979) it is an atipical case of distribution. Considering the results of Gómez (1979), the temperature charts from Scott (1976) and the distributional charts of the

Soviet fleet (Fig. 1), it is not a markedly atipical case for during the summer months of 1963, 1964 and 1965 the Soviet fleet operated on the area to the north of reference line, probably due to the existing hidrological conditions.

The former facts agree with Halliday (1973) who stated that "The highest catch rates were observed in the deep holes and along the Continental slope in depths greater than 100 fathoms in the Central Shelf area and to the north of Sable Island Bank".

It should be pointed out that taking into account the above mentioned existing information, it is possible to conclude that the silver hake moves through the Scotian Shelf under the influence of water temperature.

Age and Growth:

A sample of 306 silver hake otoliths collected in July of 1977 were examined from which 114 belonged to males and 192 to females.

The specimens used in the analysis ranged from 12-66 cm. The age-length key by sex derived from otoliths is presented in Table 1. These data indicate well defined age group 1 and 2 years for both males and females. Age 3 and older males (12.2 %) were poorly represented but females comprised 19.5 % of the sample. Females at age 3 showed a wide range in length (28 - 44 cm) which might be attributed to the proportion mature at age 3 (Hunt, 1978b).

The mean length-at-age shown in Table 1 were used to calculated the Von Bertalanffy parameters and the resultants curves are shown in Fig. 2.

A total of 248 otoliths were employed in 1978, from which 94 belonged to males and 154 to females. The age-length key by sex derived from the individuals (14-60 cm) analyses is presented in Table 2. Famales and males at age 2 were the most representatives with 25.3 % and 41.5 % respectively.

The representative individual for both years were females from age 1 to 9 years and males from 1 to 5 years.

The Von Bertalanffy curves derived from Table 2 are shown in Fig. 2. The asyntotic length for both years analyzed in this paper were higher than the values obtained by Hunt (1978) probably due to the lack of the older individuals in the sample.

The parameters of the equation for both years were shown in TAble 3.

In general, it was found that for each age group the females mean length exceeded the one of the males for the two years studied. Therefore covariance analysis were carried out and its results showed that regression lines were significantly different and could not be combined to give an overall relationship for the two sexes. Using the test to see if a single line could be used gave F= 4.52 (1977) and F= 6.09 (1978) with a significant level of 5 %.

REFERENCES

ALVERSON, D.L. and H.A. Larkins (1969). Status of knowledge of the Pacific hake resource. Cal.Coop.Fish.Invest.Rep. 13:24-31.

ANON. (1971). Description of the fishing zones (trawling, drift netting, purse seining) in regions along the coast of the USA and Canada. Ministry of Fisheries USSR, Main Directorate of the Fish Industry of the Western Basin, The Scientific Research Fleet of the Western Basin, Zaprtbpromrazvedka. 112 pp. (In Russian).

CLAY, D. (1979). A preliminary review of silver hake (*Merluccius bilinearis*) stock distribution and diferentiation on the Scotian Shelf. ICNAF. Res.Doc. 79/II/15. Ser. # 5341. 15 pp.

GÓMEZ, J. (1979). Temperature and salinities on the Scotian Shelf in July 1978. ICNAF. Res.Doc. 79/VI/75. Ser. No. 5417.

HALLIDAY, R.G. (1973). The silver hake fishery on the Scotian Shelf. ICNAF. Ser. No. 3065. Res.Doc. 73/103. 21 pp. Addendum I II. 4 pp. (Mimeo.).

HART, T.J. (1948). The distribution and biology of the hake. Biol.Rev. (Cambridge) Phil.Soc. 23(1):62-80.

HUNT, J.J. (1976). Report of the silver hake ageing workshop. Annu. Meet. Int.Comm.Northw.Atlant.Fish.Summ.Doc. No. 21. Ser. # 3850.

HUNT, J.J. (1977). Report of the silver hake ageing workshop. ICNAF. Summ. Doc. No. 13. Ser. No. 5073.

HUNT, J.J. (1978a). Report of the silver hake ageing workshop. ICNAF. Summ.Doc. No. 10. Ser. No. 5211.

HUNT, J.J. (1978b). Age, growth and distribution of silver hake, *Merluccius bilinearis*, on the Scotian Shelf. ICNAF. Slected Papers No. 3, :33-44.

HUNT, J.J. (1979). Age and growth studies of silver hake (*Merluccius bilinearis*) in the Northwest Atlantic ICNAF. Res.Doc. 79/VI/42. Ser. No. 5378.

LEIM, A.H. and W.B. Scott. (1966). Fishes of the Atlantic coast of Canada. Bull.Fish.Bd.Canada. No. 155. pp. 1-458.

SARNITS, A.A. and V.I. Sauskan. (1966). Hydrographic conditions and distribution of silver hake (*Merluccius bilinearis*) on Georges Bank and off Nova Scotia in 1974. ICNAF. Ser. No. 1660 (D.C.1). Res.Doc. 66-51. pp. 8. (Mimeo.).

SAUSKAN, V.I. (1964). Results of Soviet observations on the distribution of silver hake in areas of Georges Bank (5Z) and Nova Scotian (4W) in 1962-1963. ICNAF Serial No. 1357. (D.C.5). Res.Doc. No. 61. 8 pp. (Mimeo.).

SCOTT, J.S. (1976). Summer distribution of groundfish on the Scotian Shelf 1970-74. ICNAF Serial No. 4059. Res.Doc. 76/XII/163. 33 pp. (Mimeo.).

WALDROM, D.E. (1978). Catch compositions during the 1977 Scotian Shelf international fishery with emphasis on the silver hake and Squid (Illex) fisheries. ICNAF. Res.Doc. 78/II/9 (Revised). Ser. No. 5161 (D.C.5).

WALDROM, D.E. (1979). Preliminary results of joint International Observer Program to evaluate the silver hake small mesh gear line in ICNAF. Div. 4VWX. ICNAF. Res.Doc. 79/II/17. Ser. No. 5345.

Table 1. Age-length key for silver hake in Div. 4W from otolith samples, 1977.

Length (cm)	Age 1		Age 2		Age 3		Age 4		Age 5		Age 6		Age 7		Age 8		Age 9		Total		
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M+F
12	1	-																	1	-	1
13	5	3																	5	3	8
14	5	5																	5	5	10
15	5	5																	5	5	10
16	5	5																	5	5	10
17	5	5																	5	5	10
18	5	5																	5	5	10
19	5	5																	5	5	10
20	5	5																	5	5	10
21	5	5																	5	5	10
22	4	5	1	-															5	5	10
23	4	4	1	1															5	5	10
24	3	4	2	1															5	5	10
25	1	2	4	3															5	5	10
26	1	1	4	4															5	5	10
27	-	1	5	4															5	5	10
28			5	4	-	1													5	5	10
29			5	4	-	1													5	5	10
30			4	4	1	1													5	5	10
31			4	4	1	1													5	5	10
32			3	4	2	1													5	5	10
33			2	2	3	3													5	5	10
34			-	2	2	3	1	-											3	5	8
35			1	-	-	4	-	-											1	4	5
36					-	2	2	3											2	5	7
37					-	1	-	4	1	-									1	5	6
38					-	3	-	2	-	-									-	5	5
39					-	3	-	2	-	-									-	5	5
40					-	2	-	3	-	-									-	5	5
41					-	2	-	3	-	-									-	5	5
42					-	2	-	3	1	-									1	5	6
43					-	1	-	4	-	-									-	5	5
44					-	1	-	4	-	-									-	5	5
45							-	5	-	-									-	5	5
46							-	1	-	4									-	5	5
47							-	1	-	4									-	5	5
48							-	2	-	3									-	5	5
49									-	5									-	5	5
50									-	1	-	1							-	2	2
51											-	1	-	1					-	2	2
52											-	-	-	1					-	1	1
53											-	-	-	-					-	-	-
54											-	1	-	1					-	2	2
55													-	-					-	-	-
56													-	-					-	-	-
57													-	-					-	-	-
58													-	1					-	1	1
61															-	1			-	1	1
66																	-	1	-	1	1
Total	59	60	41	37	9	32	3	37	2	17	-	3	-	4	-	1	-	1	114	192	306
Mean(mm)	171	178	287	293	329	368	355	421	400	482	-	521	-	542	-	615	-	665			
%	52	31	36	19	8	17	3	19	2	9	-	2	-	2	-	+	-	+	37	63	

Table 2. Age-length key for silver hake in Div. 4W from otolith samples, 1978.

Length (cm)	Age 1		Age 2		Age 3		Age 4		Age 5		Age 6		Age 7		Age 8		Age 9		Total		
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M+F
14	1	-																	1	-	1
15	-	-																	-	-	-
16	-	1																	-	1	1
17	-	1																	-	1	1
18	2	3																	2	3	5
19	4	5	1	-															5	5	10
20	4	5	1	-															5	5	10
21	3	5	2	-															5	5	10
22	3	3	2	2															5	5	10
23	-	3	5	2															5	5	10
24	-	1	5	4															5	5	10
25			5	5															5	5	10
26			5	5															5	5	10
27			4	5	1	-													5	5	10
28			4	5	1	-													5	5	10
29			-	5	5	-													5	5	10
30			4	4	1	1													5	5	10
31			-	1	5	4													5	5	10
32			1	1	4	3	-	1											5	5	10
33					2	4	3	1											5	5	10
34					-	5	5	-											5	5	10
35					-	4	5	1											5	5	10
36					1	4	2	1											3	5	8
37					-	4	1	1											1	5	6
38					-	2	-	3											-	5	5
39							-	4	2	1									2	5	7
40							-	4	-	1									-	5	5
41							-	-	-	4	-	1							-	5	5
42							-	-	-	2	-	3							-	5	5
43							-	-	-	-	-	2							-	2	2
44							-	1	-	2	-	1	-	1					-	5	5
45							-	-	-	1	-	1	-	-					-	2	2
46							-	-	-	2	-	2	-	-					-	4	4
47							-	1	-	-	-	2	-	-					-	3	3
48									-	2	-	-	-	-					-	2	2
49									-	1	-	1	-	-					-	2	2
50											-	-	-	-					-	-	-
51											-	-	-	1					-	1	1
52											-	1	-	1					-	2	2
53											-	-	-	1					-	1	1
54											-	-	-	-					-	-	-
55											-	1	-	-					-	1	1
56											-	1	-	1					-	2	2
58															-	1			-	1	1
60																	-	1	-	1	1
Total	17	27	39	39	20	31	16	18	2	16	-	16	-	5	-	1	-	1	94	154	248
Mean(mm)	202	208	258	272	312	346	350	390	395	440	-	467	-	516	-	585	-	605			
%	18	18	42	25	21	20	17	12	2	10	-	10	-	3	-	1	-	1	38	62	

NOTE: TABLES 1 AND 2 OF THIS PAPER WERE NOT INCLUDED WITH THE ORIGINAL MANUSCRIPT. THEY WILL BE ISSUED AS AN ADDENDUM TO THIS DOCUMENT AS SOON AS RECEIVED.

Table 3. Growth parameters for 1977 and 1978.

1977	♀ + ♂	♂	♀
K	0.1453	0.5695	0.1563
t_o	-0.5250	0.0515	-0.3889
L_{oo}	87.8	42.0	84.9
1978			
K	0.0912	0.2485	0.1113
t_o	-1.518	-1.288	-1.390
L_{oo}	95.8	47.3	86.2

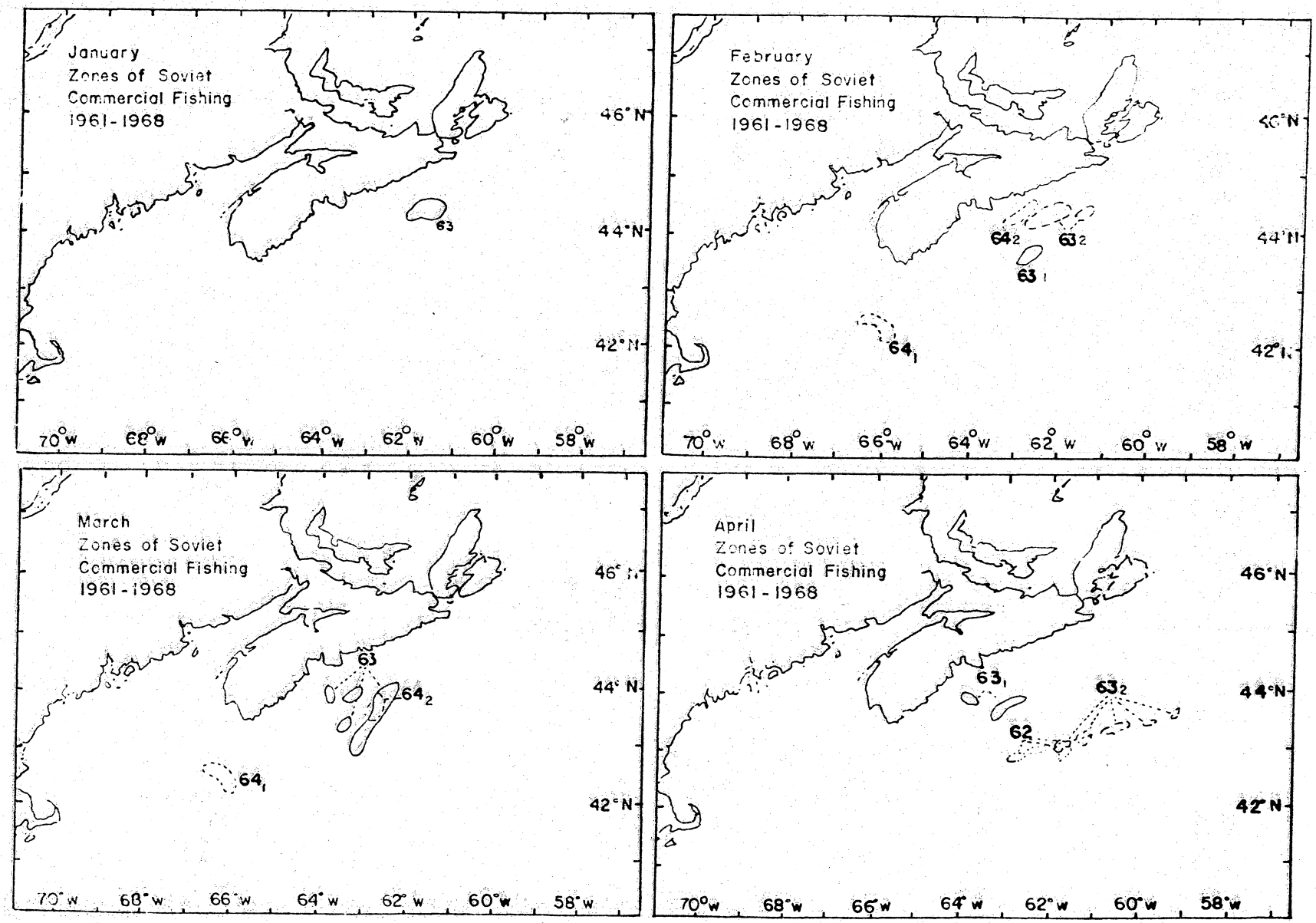

Fig. 1. Areas of Soviet commercial fishing activity by month on the Scotian Shelf, 1961-68.

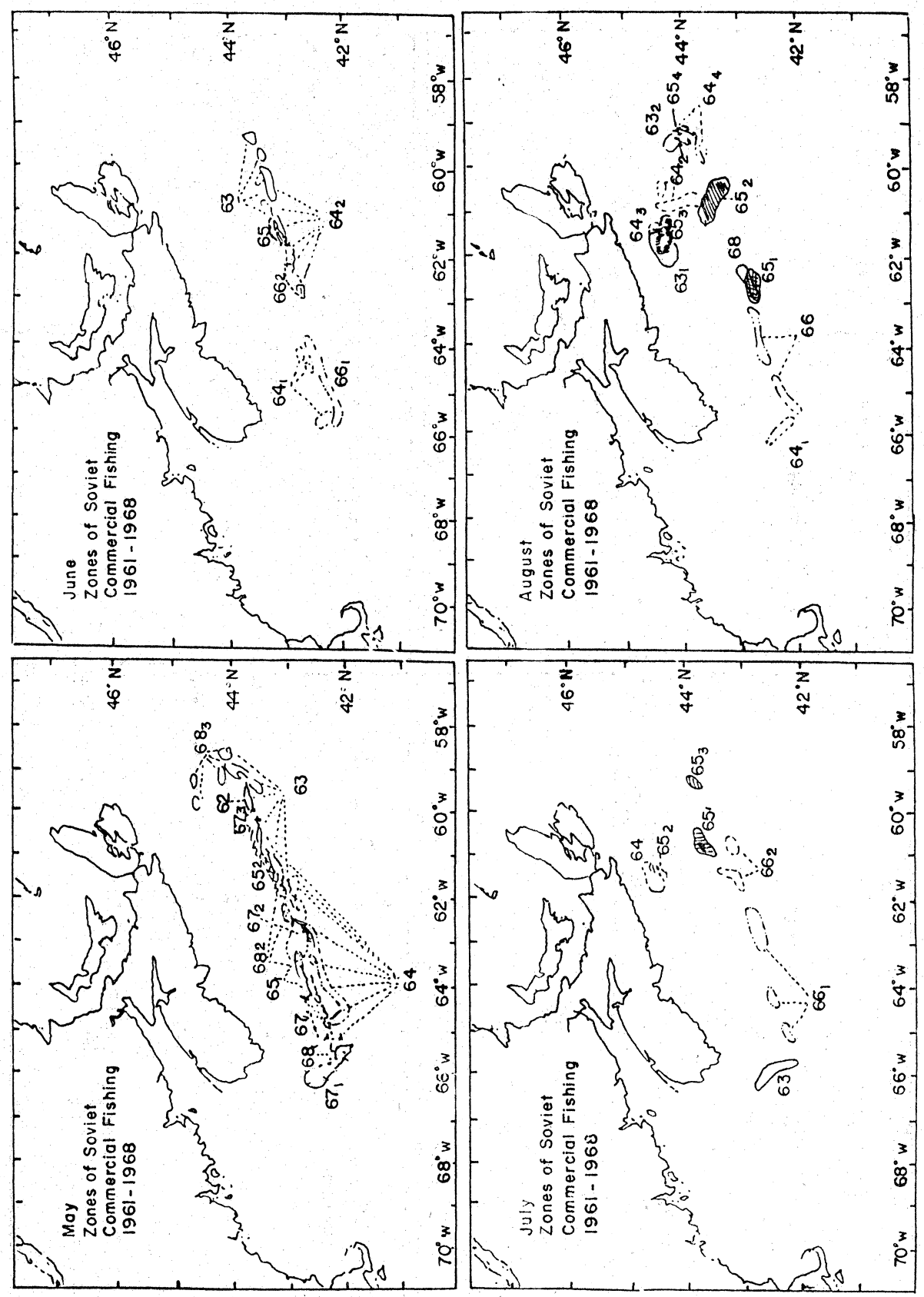

Fig. 1. (Continued)

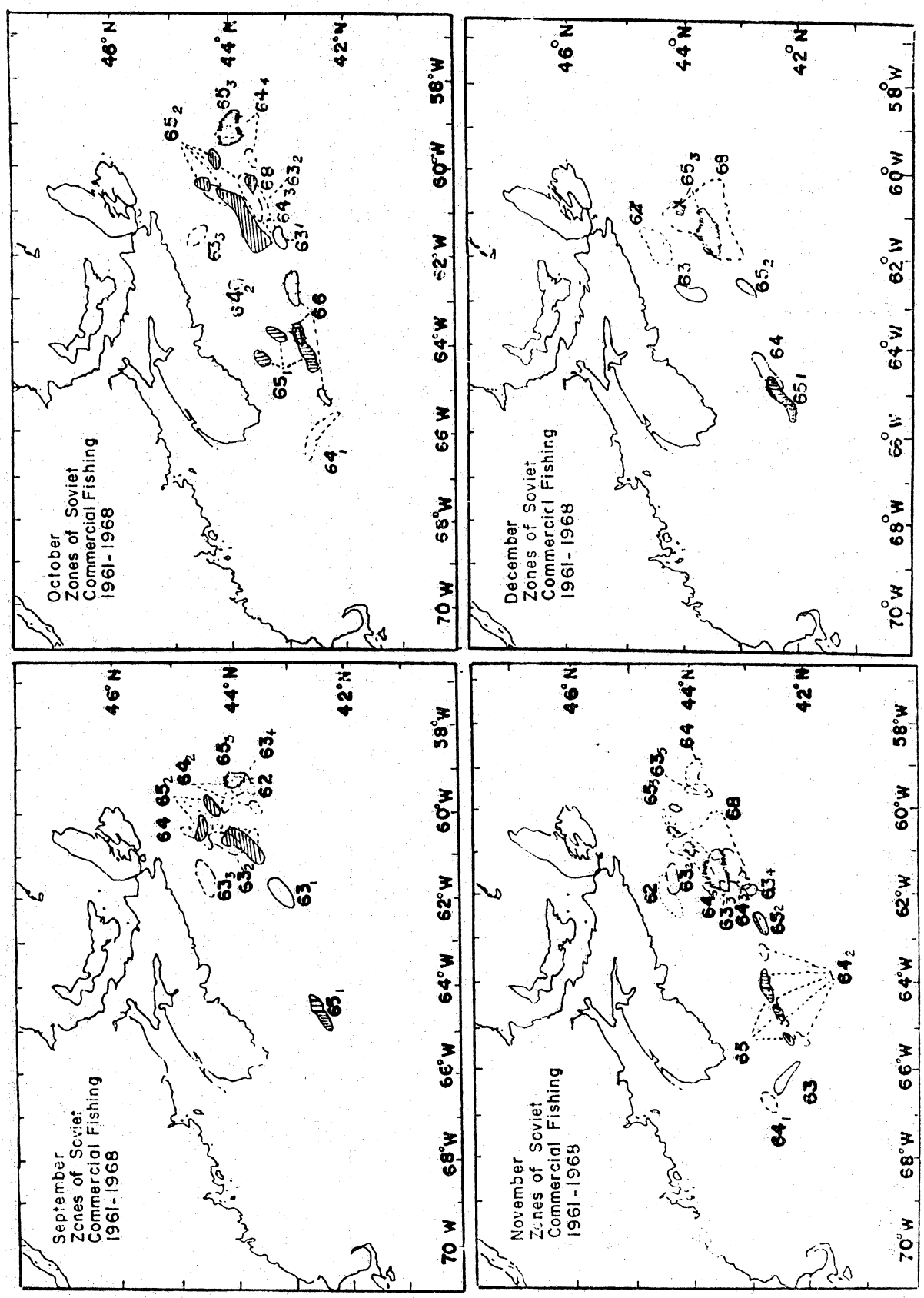

Fig. 1. (Continued)

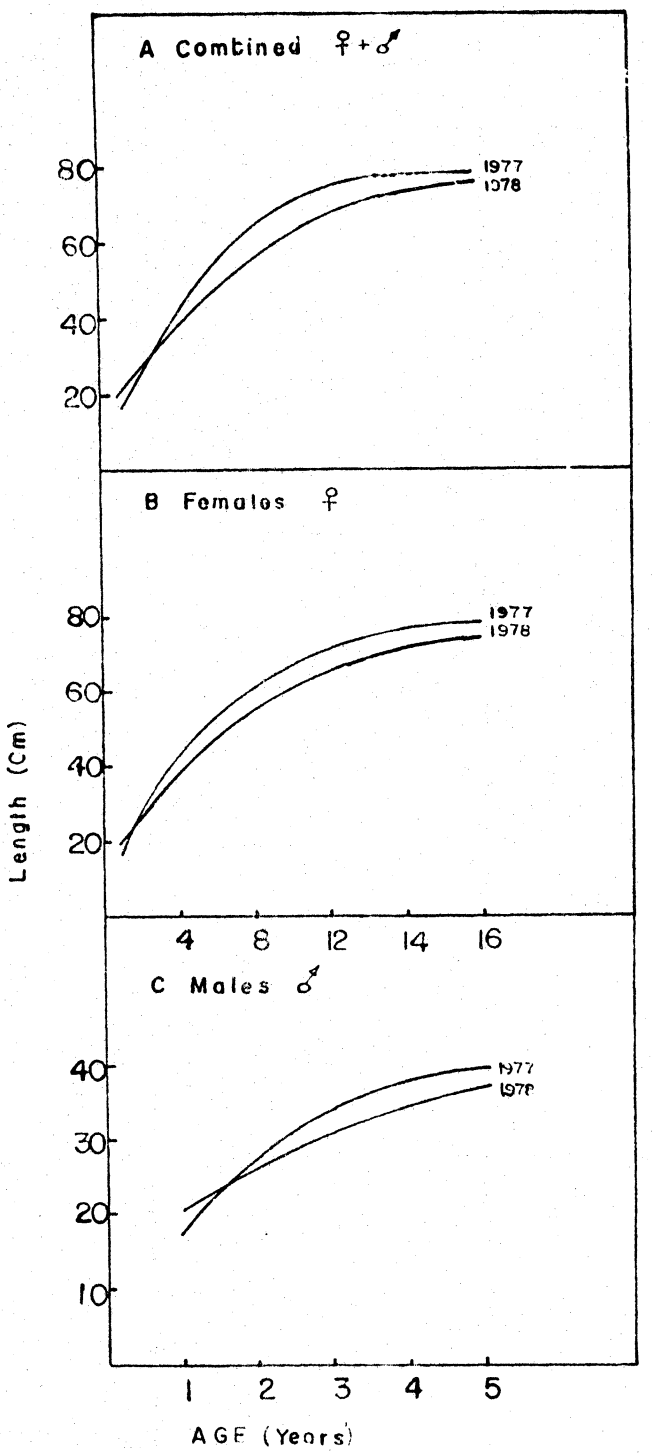

Fig. 2. Bertalanffy growth curves for silver hake on the Scotian Shelf.