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THE SILVER HAKE FISHERY ON THE SCOTIAN SHELF

by

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INTRODUCTION

This first analysis of the silver hake fishery on the Scotian Shelf is based largely on Soviet biological samples from the commercial fishery available from ICNAF Sampling Yearbooks, supplemented by the results of Canadian research vessel surveys conducted in July of 1970–72. For stratification scheme and methodology of Canadian surveys see Halliday and Kohler (ICNAF Res. Doc. 71/35).

LANDINGS

The USSR is the only major exploiter of silver hake on the Scotian Shelf. Landings increased from 2 metric tons in 1961 to 123,000 tons in 1963, subsequently declining to 2,500 tons in 1967 (Table 1). Landings then increased to 169,000 tons in 1970, declined slightly to 128,700 tons in 1971 and preliminary reports indicate landings of 113,774 tons in 1972 (USSR statistical submission to ICNAF Secretariat for 1972). The bulk of these landings came from Div. 4W.

DISTRIBUTION AND STOCK STRUCTURE

Canadian research vessel survey catches in July 1970–72 indicate that silver hake are widely distributed on the Scotian Shelf except in the cold water area to the north of Banquereau and in the head of the Bay of Fundy (Fig. 1). Highest catch rates were in the deep holes and along the continental slope in depths greater than 100 fath in the central shelf area (the

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Scotian Gulf) and to the north of Sable Island Bank. A small concentration was also located in the Fundian Channel between Browns and Georges Banks. These areas of the shelf are freque inundated with incursions of warm "Slope Water".

Major spawning concentrations occur on the west bar of Sable Island Bank. It is likely that silver hake caught in Div. 4V are taken from the eastern fringe of the Sable Island Bank Stock. As the Div. 4W-4X dividing line runs through the centre of the Scotian Gulf which is a major area of concentration of the Sable Island Stock, it is likely that much of the landings recorded from Div. 4X are also from the Sable Island Stock. Concentrations of silver hake do occur and are fished in the Browns Bank area. This may be a small separate stock or part of the Georges Bank or Gulf of Maine stocks. It does at any rate appear to be small and is included with the Sable Island Stock in this analysis. It was possible to compare size and age composition of commercial catches between Div. 4X and Div. 4VW only in 1970 (Fig. 2). In that year there was little difference in sizes and ages removed, and growth rates are also virtually identical.

AGE COMPOSITION AND NUMBERS OF REMOVALS

Age composition of landings in the years 1962–71 were derived from Soviet length-frequency data from Sampling Yearbooks and age-length keys available from the Secretariat. The length-frequencies were weighted by quarterly landings in each Division when possible. However, the incompleteness of the data frequently required grouping of Divisions and quarters. It is assumed that there are no discards in this fishery and thus landings and catches are synonymous.

In the 1962–67 period removals were almost entirely composed of fish aged 2–6 yrs (Table 2). In 1968–71 fish 7–9 yrs old and also 1 yr olds formed a significant part of removals. Peak contribution to the fishery occurred at age 3 or 4 possibly depending on the relative strengths of year classes.

Removals increased from 54 million in 1962 to 525 million in 1963, declined to 11 million in 1967, increased to 1,014 million in 1970, then declined to 743 million in 1971.

MORTALITY

Virtual population analysis (VPA) indicates that fishing mortality (F) (assuming M = 0.50) of fully recruited age groups (age 4+) ranged from 1.53–2.39 in 1963–65, declined to 0.05 in 1968, and increased to 0.53 in 1969 (Table 3).

POPULATION NUMBERS

Population numbers estimated by VPA of age 2+ fish declined from 1,869 million to 406 million in 1966 increasing to 3,017 million in 1969 (Table 4).

The 1962-1964 year classes were poor, numbering 200–300 million fish at age 2. The 1966 and 1967 year classes were very strong, numbering about 1,500 million fish at age 2.

GROWTH

Mean lengths at age for all 1962–71 commercial sampling data combined are:

Age	Length (cm)
1	21.3
2	24.3
3	27.9
4	31.0
5	35.0
6	39.6
7	41.8
8	43.2
9	46.2
10	48.5

von Bertalanffy growth parameters were calculated for ages 4–9 (i.e. those fully recruited age groups well represented in the fishery) giving:

L_α = 52.67 cm (W_α = 1.18 kg from Table 5)

K = 0.229

t_o = 0.141 yrs.

YIELD PER RECRUIT

Beverton and Holt yield per recruit curves were calculated using growth parameters cited above and others as follows:

Age at recruitment to the exploited area, t_ρ = 1.0 yr.

Mean age at recruitment to the fishery, $t_{\rho 1}$ = 3.25 yrs.

Maximum age of significant contribution to the fishery, t_λ = 10 yrs.

The value of t_λ was chosen from inspection of the age composition of removals and $t_{\rho 1}$ was chosen by calculation of percentage recruitment at age from virtual population analysis F values assuming full recruitment at age 4 (Table 3).

If M = 0.50, the yield per recruit curve is almost flat topped, F_{max} occurring at 2.7 but F_{opt} (as defined by Gulland) at 0.60 (Fig. 3). If M = 0.70, F_{opt} = 0.90. If M = 0.30, F_{opt} = 0.40 and F_{max} = 0.80.

Thus, when removals were high in 1963–65 F was above F_{opt} and when removals were low in 1966-68, F was below F_{opt}.

If mean age at recruitment is actually as high as 3.25 yrs then no benefits can be expected in the silver hake fishery by increasing mesh size (Figs 4 and 5).

CURRENT STATUS OF THE FISHERY

As VPA describes the fishery only through 1969 an attempt was made to describe the events of 1970 and 1971 from catch per unit effort (cpe) and Canadian research vessel survey data.

Although the cpe in Div. 4W of Soviet stern trawlers of over 1,800 gross tons is biased by diversion of effort to other species at times of low silver hake abundance they agree moderately well with estimates of "available biomass" from VPA (Table 6). Cpe and "available biomass" are linearly related if 1968 data are excluded from the 1965–69 data series (Fig. 6A). "Available biomass" in 1970 and 1971, estimated from this line, was 205,000 and 147,000 tons respectively. Values of F calculated from catch to biomass ratios for 1962–69 are linearly related to F from VPA, although slightly higher (Fig. 6B). Interpretation of this line gives F values on the VPA axis for 1970 and 1971 of 2.10 and 2.80 respectively. Thus, F in 1970-71 was again well above F_{opt}.

Silver hake have a low catchability coefficient in relation to the #36 Yankee otter trawl used in Canadian research vessel surveys, and a high variability can be expected from survey population estimates. These estimates suggest that abundance declined between 1970 and 1971 but to a greater extent than indicated by commercial cpe data, then increased in 1972 (Table 7).

However, although population estimates from surveys have a high variability, relative length and age compositions are much less variable. Research vessel catch length frequencies are bimodal with peaks at about 20 cm and 28 cm (Fig. 7). From the growth data of Nicky (1969, ICNAF Res. Bull., 6: 107-117) for New England silver hake, those fish less than 24 cm forming the mode at 20 cm are most likely virtually all age 1 fish. The proportion of fish of 24 cm and less in research vessel surveys is similar in 1970, 1971 and 1972, ranging from 26–42% of the catch (Table 8) and from 22.2 million to 36.9 million fish, suggesting that the year classes of 1969–71 are of comparable magnitude.

The large landings of 1970–72 indicate that age 3 and 4 year old fish in those years belonged to strong year classes. In 1970 these were the 1966 and 1967 year classes which VPA indicated to be the strongest on record. However, 1968 and 1969 year classes must also have been fairly strong to support the large fisheries in 1971 and 1972. If the 1970 and 1971 year classes are indeed comparable in strength to that of 1969, then substantial landings should also be possible in 1973 and perhaps 1974.

ADDENDUM

The USSR Research Report for 1972 (ICNAF Summary Doc. 73/22) gives the percentage age composition of 1972 commercial catches. These have a mean age of 3.3 yrs which is equivalent to a mean length of 27.1 cm (from the von Bertalanffy growth equation calculated above) and a mean weight of 0.138 kg (from Table 5). Thus landings of 113,800 tons is approximately equivalent to removal of 824.6 million fish, slightly higher than the 743 million removed in 1971. The age composition of these removals was:

Age	Removals ($\times 10^{-6}$)
1	4.9
2	183.1
3	324.9
4	197.1
5	91.5
6	16.5
7	6.6

Recalculating the VPA with 1972 data included reduce- the estimated value of F = 0.53 for fully recruited age groups (4+) in 1969 to F = 0.42 and estimates 1970 values for age 4 at F = 1.17 (Table 9).

Revised population estimates ($\times 10^{-6}$) for 1969 and those for 1970 are:

Age	1969	1970
2	1762.9	1282.9
3	1022.4	1057.7
4	338.1	555.1
5	87.5	145.2
6	19.5	25.8
Σ_{2-6}	3,230.4	3,066.7
Σ_{4-6}	445.1	726.1

This is a marginal increase in 1969 population numbers of age 2+ fish from 3,016.6 million and indicates that 1970 population numbers were about the same as in 1969. The 1968 year class at age 2 was strong and comparable in size to those of 1966 and 1967.

F = 1.17 in 1970 is considerably lower than the estimate of 2.10 from Fig. 6 but still higher than F_{opt}.

TABLE 1 : Silver hake landings from ICNAF Div. 4VWX by Division and country (metric tons round).

	ICNAF DIVISION					C O U N T R Y					
Year	4Vn	4Vs	4W	4X	Total	Canada	France(SP)	Japan	Spain	USSR	USA
1960	-	-	-	187	187	-	-	-	-	-	187
1961	-	-	-	2	2	-	-	-	-	-	2
1962	-	-	8,825	29	8,854	-	-	-	-	8,825	29
1963	168	-	116,388	6,472	123,028	-	-	-	-	123,023	5
1964	32	-	62,905	18,210	81,147	-	-	-	-	81,147	-
1965	180	2	49,461	379	50,022	5	3	-	-	49,987	27
1966	40	-	3,860	6,423	10,323	-	-	-	-	10,323	-
1967	-	-	1,834	643	2,477	-	-	-	-	2,476	1
1968	2	237	3,150	58	3,447	5	-	-	-	3,441	1
1969	-	1,226	43,543	1,554	46,323	-	-	-	-	46,323	-
1970	-	5,116	158,938	4,991	169,045	-	-	88	-	168,957	-
1971	11	3,000	119,452	6,190	128,653	-	-	8	11	128,633	1

Table 2 : Silver hake Div. 4VWX – estimated numbers removed from the population ($x10^{-3}$).

	Calendar Year									
Age	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	-	-	-	-	-	-	585	14,034	149,395	99,320
2	11,441	16,622	9,212	2,284	15,575	87	5,043	11,809	59,013	79,316
3	29,536	228,497	184,688	66,452	17,928	1,919	6,663	76,757	350,498	281,038
4	10,834	218,795	155,526	96,795	13,028	6,632	3,173	98,657	349,164	229,755
5	2,071	55,919	21,690	28,804	4,736	1,919	1,303	32,573	92,601	44,783
6	19	5,289	8,505	4,150	429	251	707	6,344	8,786	4,742
7	-	-	-	-	22	12	270	441	2,296	1,682
8	-	-	-	-	-	-	95	217	2,188	1,453
9	-	-	-	-	-	-	-	-	90	975
10	-	-	-	-	-	-	-	-	2	-
Total	53,901	525,122	379,621	198,485	51,718	10,821	17,839	240,832	1,014,033	743,064

Table 3 : Silver hake Div. 4VWX – fishing mortality, F, from virtual population analysis. (M = 0.50) (Mean F's are weighted by population numbers.)

	Calendar Year									
Age	1962	1963	1964	1965	1966	1967	1968	1969	$\bar{F}_{62-69}$	% recruitment
1	-	-	-	-	-	-	.01	.01	-	-
2	.02	.03	.04	.02	.10	.01	.01	.01	.02	2
3	.07	.54	.73	.62	.20	.02	.02	.11	.27	27
4	.10	1.73	1.47	2.14	.33	.14	.04	.47	1.00	100
5	.20	1.61	1.45	3.19	.99	.10	.05	.87	1.22	100
6	.03	1.92	3.15	3.46	.94	.17	.07	.52	1.27	100
$\bar{F}_{2-6}$	.04	.59	.75	.93	.19	.02	.01	.11	$\bar{F}_{2-6} = 0.24$	
$\bar{F}_{4-6}$	.11	1.71	1.53	2.39	.43	.13	.05	.53	$\bar{F}_{4-6} = 1.05$	

Table 4 : Silver hake Div. 4VWX – Population numbers from virtual population analysis. (M = 0.50) ($x10^{-3}$)

	Calendar Year							
Age	1962	1963	1964	1965	1966	1967	1968	1969
2	1,142.9	746.6	305.6	209.2	213.1	918.1	1,560.1	1,669.0
3	558.6	680.1	439.7	178.2	124.5	135.3	550.9	936.1
4	151.8	316.2	242.2	128.5	58.2	64.4	97.2	327.8
5	14.4	83.3	34.0	34.2	9.2	25.6	34.3	64.2
6	.8	7.3	10.1	4.8	.9	2.0	13.3	19.5
Σ_{2-6}	1,868.5	1,833.5	1,031.6	554.9	405.9	1,145.4	2,255.8	3,016.6
Σ_{4-6}	167.0	406.8	286.3	167.5	68.3	92.0	144.8	411.5

Table 5 : LENGTH-WEIGHT TABLE

SILVER HAKE CRUISE A200-201 DIVS. 4V 4W 4X
MALES AND FEMALES COMBINED OVER 15 CM.

B= 3.272602 A=0.002819390 LOG A=-2.549844 NO.SAMPLED= 835

MINIMUM OBSERVED LENGTH 16. CM. MAXIMUM OBSERVED LENGTH 73. CM.

LENGTH (CM.)	COMPUTED WT. GRAMS	LBS.	OBS.WT. GRAMS	LENGTH (CM.)	COMPUTED WT. GRAMS	LBS.	OBS.WT. GRAMS
1.	0.	0.00	0.(0)	41.	535.	1.18	566.(6)
2.	0.	0.00	0.(0)	42.	579.	1.28	531.(4)
3.	0.	0.00	0.(0)	43.	625.	1.38	648.(3)
4.	0.	0.00	0.(0)	44.	674.	1.49	625.(2)
5.	1.	0.00	0.(0)	45.	725.	1.60	800.(2)
6.	1.	0.00	0.(0)	46.	779.	1.72	0.(0)
7.	2.	0.00	0.(0)	47.	836.	1.84	750.(3)
8.	3.	0.01	0.(0)	48.	896.	1.97	700.(1)
9.	4.	0.01	0.(0)	49.	958.	2.11	1000.(3)
10.	5.	0.01	0.(0)	50.	1024.	2.26	1060.(5)
11.	7.	0.02	0.(0)	51.	1092.	2.41	1025.(1)
12.	10.	0.02	0.(0)	52.	1164.	2.57	1250.(1)
13.	12.	0.03	0.(0)	53.	1239.	2.73	925.(1)
14.	16.	0.04	0.(0)	54.	1317.	2.90	1300.(1)
15.	20.	0.04	0.(0)	55.	1399.	3.08	1400.(1)
16.	25.	0.05	26.(17)	56.	1483.	3.27	1575.(1)
17.	30.	0.07	27.(34)	57.	1572.	3.47	1600.(1)
18.	36.	0.08	37.(44)	58.	1664.	3.67	0.(0)
19.	43.	0.10	45.(52)	59.	1760.	3.88	1700.(1)
20.	51.	0.11	52.(69)	60.	1859.	4.10	2000.(1)
21.	60.	0.13	62.(36)	61.	1963.	4.33	0.(0)
22.	70.	0.15	72.(34)	62.	2070.	4.56	1600.(1)
23.	81.	0.18	82.(29)	63.	2181.	4.81	2100.(1)
24.	93.	0.20	91.(18)	64.	2296.	5.06	0.(0)
25.	106.	0.23	111.(22)	65.	2416.	5.33	0.(0)
26.	120.	0.27	124.(40)	66.	2540.	5.60	0.(0)
27.	136.	0.30	143.(59)	67.	2668.	5.88	0.(0)
28.	154.	0.34	159.(67)	68.	2800.	6.17	0.(0)
29.	172.	0.38	175.(41)	69.	2937.	6.48	0.(0)
30.	192.	0.42	196.(46)	70.	3079.	6.79	0.(0)
31.	214.	0.47	213.(30)	71.	3225.	7.11	0.(0)
32.	238.	0.52	227.(36)	72.	3376.	7.44	0.(0)
33.	263.	0.58	258.(35)	73.	3532.	7.79	2900.(1)
34.	290.	0.64	293.(29)	74.	3693.	8.14	0.(0)
35.	319.	0.70	315.(19)	75.	3859.	8.51	0.(0)
36.	349.	0.77	344.(13)	76.	4030.	8.88	0.(0)
37.	382.	0.84	371.(7)	77.	4206.	9.27	0.(0)
38.	417.	0.92	428.(7)	78.	4388.	9.67	0.(0)
39.	454.	1.00	443.(7)	79.	4574.	10.08	0.(0)
40.	493.	1.09	491.(3)	80.	4767.	10.51	0.(0)

NUMBER OF FISH SAMPLED AT LENGTH IN BRACKETS

CORR.SUM OF X SQRD.= 11.464875 CORR.SUM OF Y SQRD.= 128.401376

SUMX= 1161.140144 SUMY= 1736.282048 SSREG= 122.787991

Table 6 : Silver hake landings from ICNAF Div. 4VWX, catch per hour in Div. 4W by USSR stern trawlers greater than 1,800 gross tons, total effort (hours) in USSR stern trawler units, and "available biomass" calculated from VPA with M = 0.5. (CPE = 12 month mean of monthly values. Landings and "available biomass" in metric tons.)

Year	Landings	Catch/hour	Effort	Available biomass
1960	187	-	-	-
1961	2	-	-	-
1962	8,854	-	-	68,500
1963	123,028	-	-	162,100
1964	81,147	-	-	102,500
1965	50,022	0.67	74,660	58,400
1966	10,323	0.22	46,923	25,600
1967	2,477	0.29	8,541	30,000
1968	3,447	0.15	22,980	66,300
1969	46,323	0.98	47,268	139,900
1970	169,045	1.58	106,991	(205,000)[1]
1971	128,653	1.13	113,852	(147,000)[1]

[1]Estimated from relationship of catch/hour and "available biomass" in 1965-67 and 1969.

Table 7 : Silver hake — A. estimated population biomass (metric tons) and kg/tow. B. estimated population numbers ($x10^{-6}$) and no./tow, from Canadian research vessel surveys, July 1970-72.

A

Strata	ICNAF Div.	1970		1971		1972	
		Biomass	kg/tow	Biomass	kg/tow	Biomass	kg/tow
40-42	4Vn	-	-	-	-	-	-
43-52	4Vs	340	0.84	+	+	40	0.10
40-50	4V	340	0.84	+	+	40	0.10
53-66	4W	17,400	10.14	3,410	1.99	12,010	7.00
70-95	4X	5,780	3.14	4,470	2.43	3,210	1.74
40-95	4VWX	23,520	4.90	7,880	1.59	15,260	3.09

B

Strata	ICNAF Div.	1970		1971		1972	
		Popn. no.	no./tow	Popn. no.	no./tow	Popn. no.	no./tow
40-42	4Vn	-	-	-	-	-	-
43-52	4Vs	1.2	2.95	0.1	0.25	0.1	0.20
40-50	4V	1.2	2.95	0.1	0.25	0.1	0.20
53-66	4W	104.2	60.77	20.9	12.21	70.8	41.26
70-95	4X	37.3	20.23	32.3	17.51	17.0	9.21
40-95	4VWX	142.7	29.32	53.3	10.78	87.9	17.72

Table 8 : Silver hake Div. 4VWX – estimated population numbers by size group from Canadian research vessel surveys, July 1970-72.

Year	Strata	Div.	≤24 cm (x10^{-6})	>24 cm (x10^{-6})	Total (x10
1970	40-52	4V	-	1.2	1.2
	53-66	4W	24.9	79.3	104.2
	70-95	4X	12.0	25.3	37.3
	40-95	4VWX	36.9 (26%)	105.8	142.7
1971	40-52	4V	-	0.1	0.1
	53-66	4W	5.5	15.5	20.9
	70-95	4X	16.7	15.5	32.2
	40-95	4VWX	22.2 (42%)	31.1	53.3
1972	40-52	4V	+	0.1	0.1
	53-66	4W	21.0	49.8	70.8
	70-95	4X	8.5	8.4	17.0
	40-95	4VWX	29.5 (34%)	58.3	87.8

Table 9 : Silver hake Div. 4VWX – fishing mortality, F, revised after inclusion of 1972 data, from VPA. (M = 0.50. Mean F's are weighted by population numbers.)

Age	1962	1963	1964	1965	1966	1967	1968	1969	1970	$\bar{F}_{68-70}$	% recruitment
1	-	-	-	-	-	-	.01	.01	.08	.03	4
2	.02	.03	.04	.02	.05	.01	.01	.01	.06	.02	2
3	.07	.54	.73	.62	.20	.01	.02	.10	.44	.22	27
4	.10	1.73	1.47	2.14	.33	.14	.03	.38	1.21	.81	100
5	.20	1.61	1.45	3.19	.99	.10	.05	.54	1.13	.80	100
6	.03	1.92	3.15	3.46	.94	.17	.07	.52	.39	.36	100
$\bar{F}_{2-6}$	.04	.59	.75	.93	.16	.02	.01	.10	.45		
$\bar{F}_{4-6}$	.11	1.71	1.53	2.39	.43	.13	.04	.42	1.17		

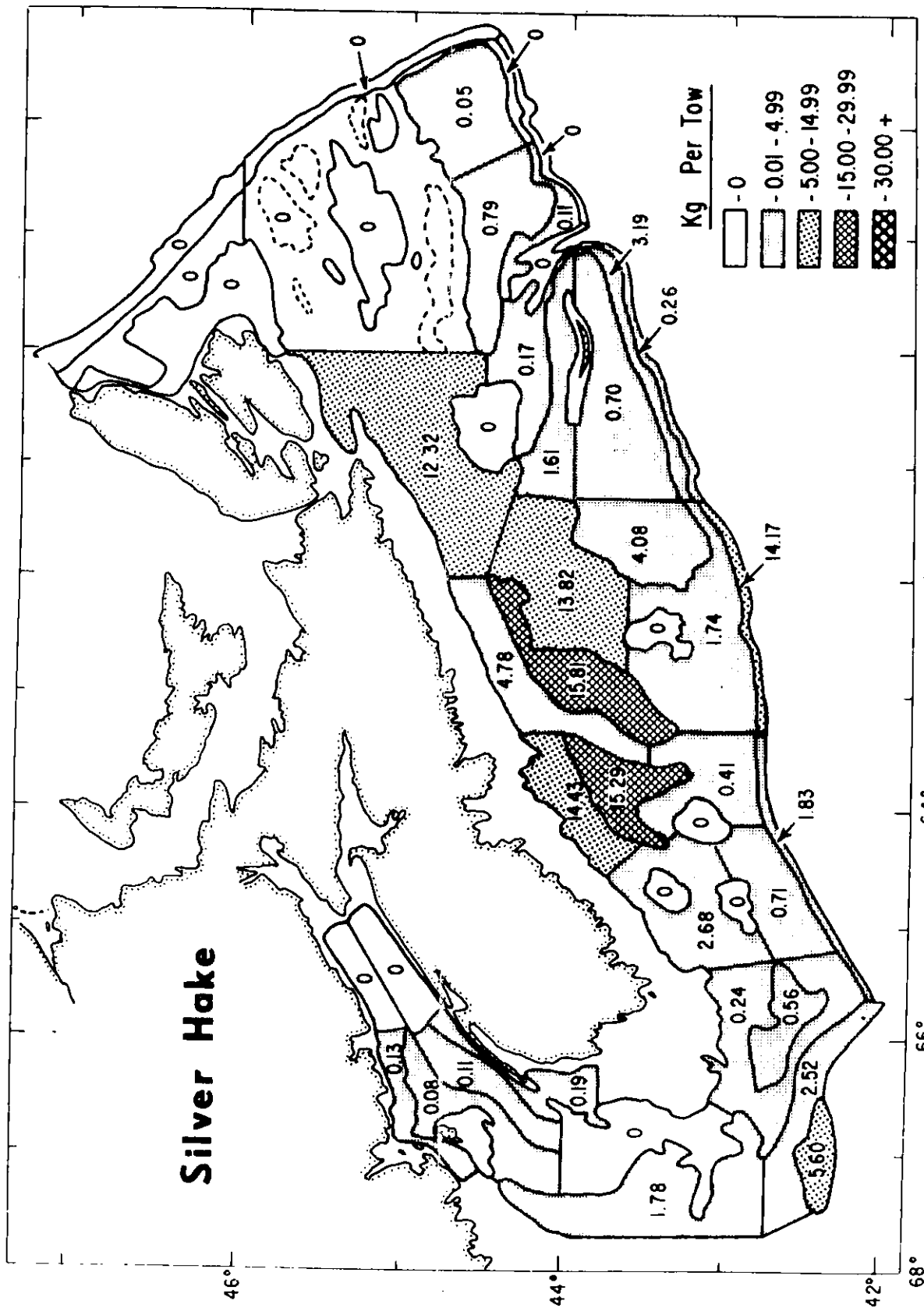
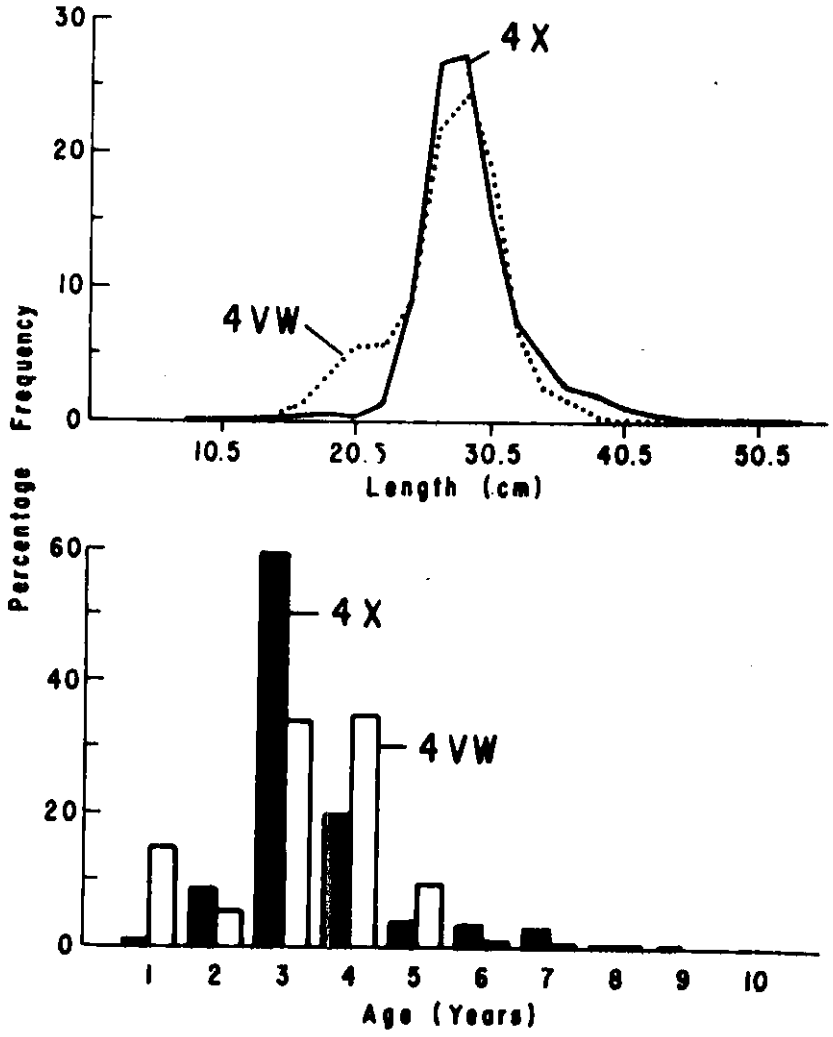


Fig. 1. Silver hake : distribution and abundance from Canadian research vessel survey : 1970-72.



Mean length at age (cm)

Age	3	4	5	6	7
4X	27.8	30.8	34.2	36.3	39.8
4VW	27.0	29.4	33.0	37.5	39.5

Fig. 2. Silver hake : size and age composition of Soviet commercial catches and mean length at age in Div. 4X and Div. 4VW in 1970.

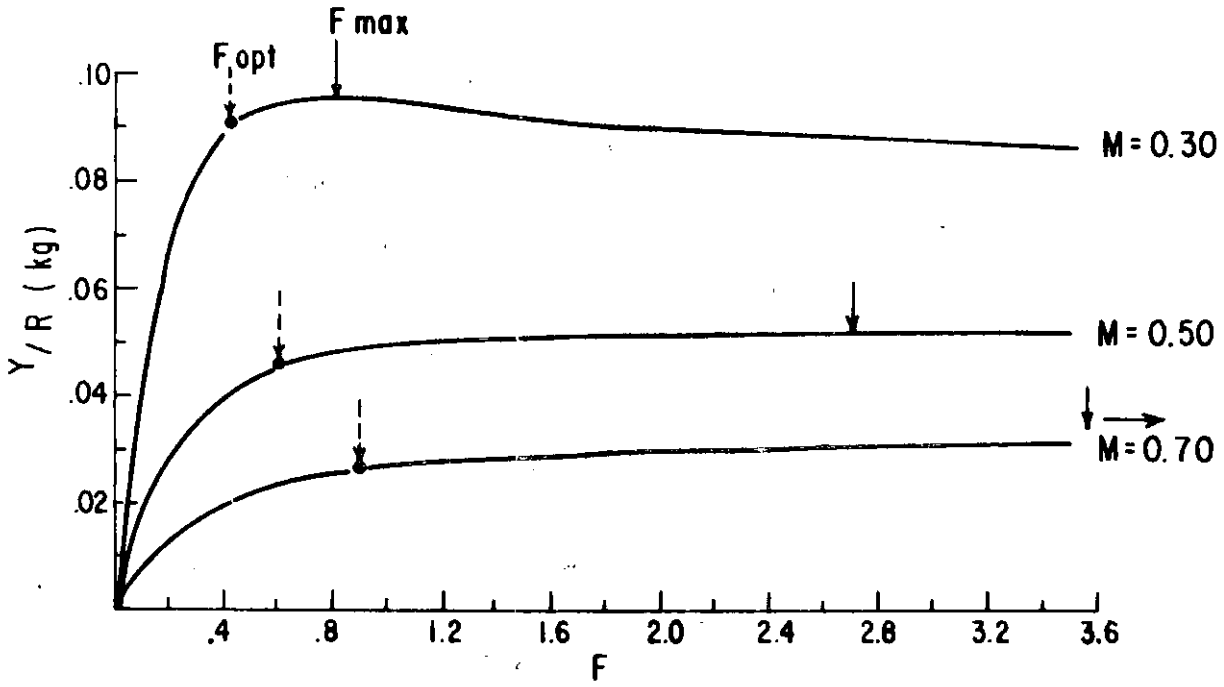


Fig. 3. Silver hake : yield per recruit for t_{p1} = 3.25 yrs. Dots with broken arrows indicate F_{opt}, solid arrows indicate F_{max}.

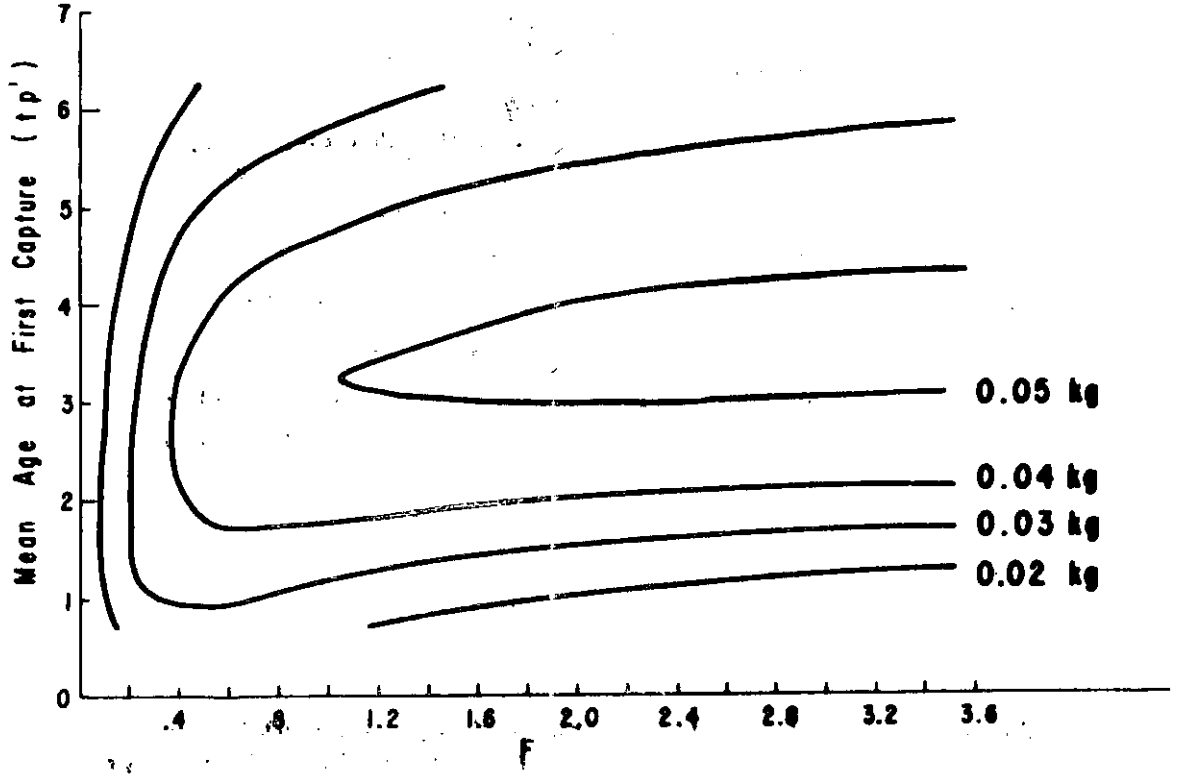


Fig. 4. Silver hake : yield isopleth diagram for M = 0.50.

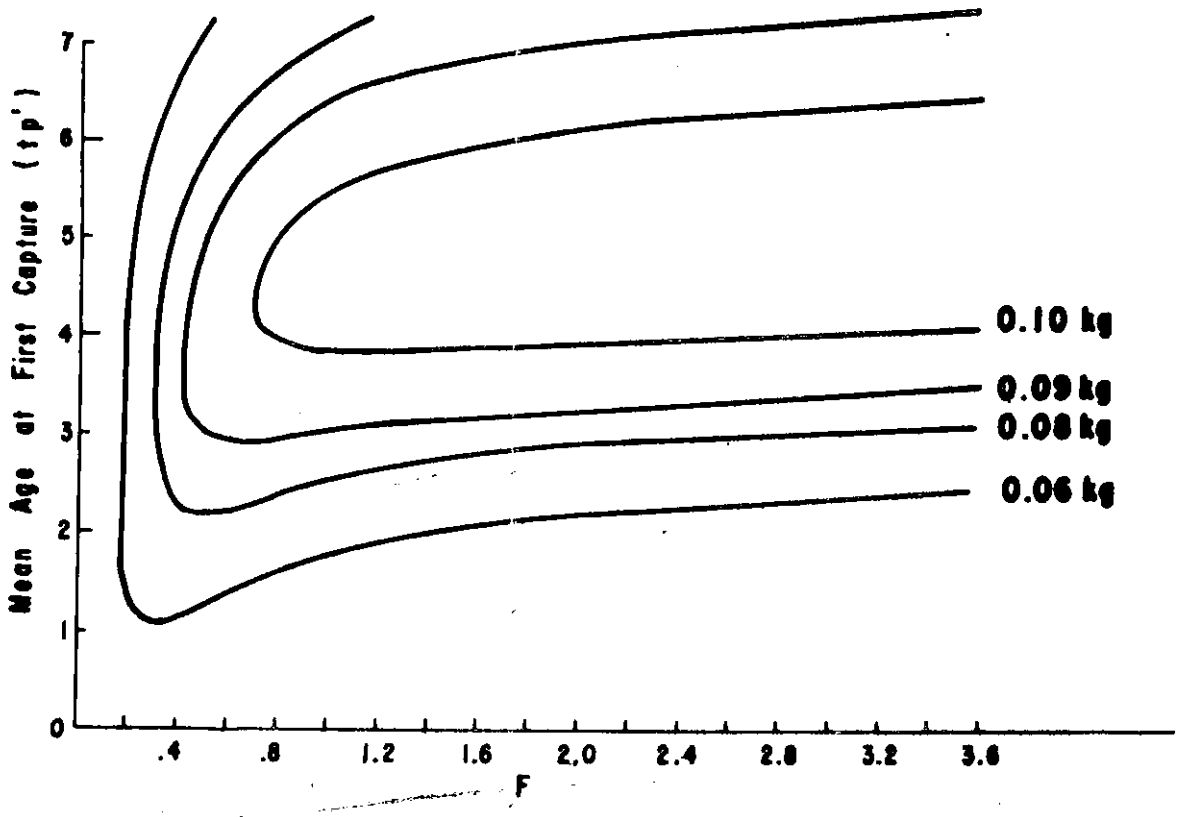


Fig. 5. Silver hake : yield isopleth diagram for M = 0.30.

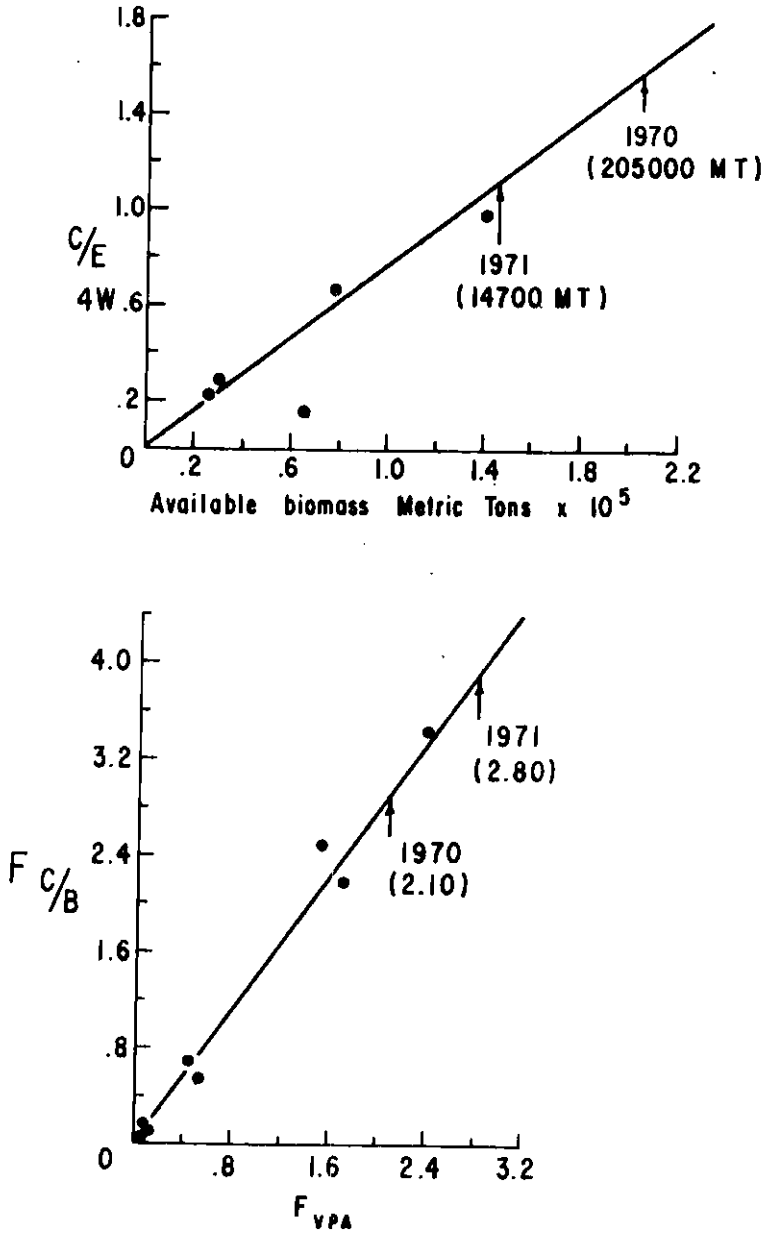


Fig. 6. Silver hake : A.(upper graph) relationship of cpe in Div. 4W of Soviet stern trawlers of over 1,800 gross tons and "available biomass" from virtual population analysis. B.(lower graph) relationship of F calculated from the catch/biomass ratio and F from VPA.

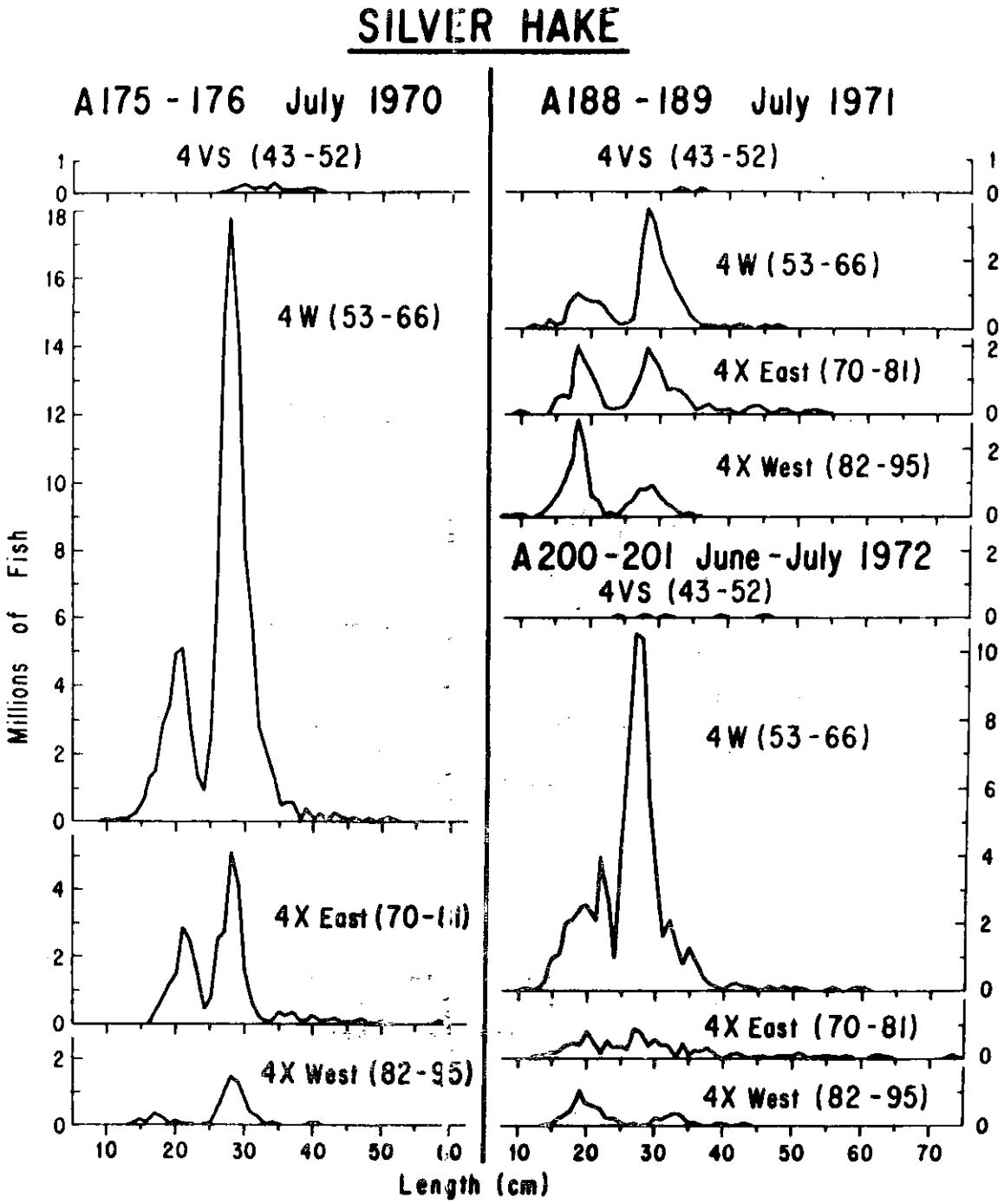


Fig. 7. Silver hake : length composition of Scotian Shelf population by Division estimated from Canadian research vessel surveys, 1970-72.

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ADDENDUM II

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Silver Hake in Subarea 4

by

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Table 10 presents projected numbers and catches through 1974. A value of M = 0.50 was used. Full recruitment at age 5, 50% recruitment at age 3 and 5% recruitment at age 2; the 1970-71 recruitment pattern.

Mean weight at age was derived from mean length at age (page 3) and length-weight Table 5 giving:

Age	Weight (grams)
2	95
3	151
4	214
5	319
6	478

Population numbers and F for 1970 are available from VPA. The observed catches at age in 1970, when multiplied by mean weights at age total 167,000 tons compared to actual catches of 169,000 tons, and in 1971 amount to 116,000 tons compared to 129,000 tons indicating good agreement. From the population numbers and F in 1970, population numbers in 1971 were calculated, and from these and known catches, F in 1971 was obtained. Again population numbers in 1971 and F in 1971 were used to calculate population numbers at the beginning of 1972. The preliminary breakdown of 1972 catch by age-group given in Addendum I does not compare well with estimated population numbers for 1972 and indicates greater removals of 5-year-olds than there were in the population. Thus the F in 1972 was adjusted by interaction to generate the catch in weight for 1972 maintaining the same proportional distribution of F among age-groups as in 1970-71.

Population numbers and F in 1972 were used to obtain population numbers in 1973. Assuming effort (and hence F) in 1973 is the same as in 1972, catch will be about 104,000 tons. These calculations are based on the assumption that the 1969-71 year-classes are as strong as those of 1966-68 and will recruit $1,500 \times 10^{-6}$ individuals at age 2. It is important to record that this assumes recruitment of six successive year-classes of a strength greater than any previously recorded in the fishery.

Assuming recruitment in 1974 of a 1972 year-class which is also as strong as those of 1966-71, fishing at about F_{opt} implies catches of 55,000 tons in 1974. If F remains at the 1972 level then catches may be about 103,000 tons.

If the 1972 year-class is as poor as the 1963 and 1964 year-classes, i.e. 200×10^{-6} individuals, the corresponding catches at F_{opt} - 52,000 tons, and at 1972 F = 95,000 tons.

TABLE 10

Age	P_n 1970	C_n 1970	F_{1970}	C_ω 1970	
2	1,282.9	77.0	.06	5,605	
3	1,057.7	350.5	.44	52,926	
4	535.1	349.2	1.21	74,729	
5	145.2	92.6	1.13	29,539	
6	25.8	8.8	.89	4,206	
			$\bar{F}_{4-6} = 1.17$		167,000 tons (Actual catch = 169,000 tons)
	P_n 1971	C_n 1971	F_{1971}	C_ω 1971	
2	1,500.0	79.3	.07	7,534	
3	732.8	281.0	.64	42,431	
4	413.2	221.5	1.13	49,177	
5	100.4	44.8	.80	14,291	
6	28.4	4.7	.23	2,247	
			$\bar{F}_{4-6} = 1.06$		116,000 tons (Actual catch = 129,000 tons)
	P_n 1972	C_n 1972	F_{1972}	* F and C adjusted to equal catch weight C_ω 1972	
2	1,500.0	91.5	.08	8,693	
3	848.3	349.4	.71	52,759	
4	234.4	152.1	1.50	32,549	
5	81.0	47.4	1.23	15,121	
6	27.4	8.8	.51	4,286	
			$\bar{F}_{4-6} = 1.40$		113,000 tons
	P_n 1973	C_n 1973	F_{1973}	C_ω 1973	
2	1500.0	91.5	.08	8,693	
3	839.8	346.0	.71	52,246	
4	253.0	164.2	1.50	35,139	
5	31.7	18.5	1.23	5,902	
6	14.4	4.6	.51	2,199	
			$\bar{F}_{4-6} = 1.45$		104,000 tons

TABLE 10 (contd)

Age	P_N 1974	C_n 1974	F_{opt}
2	1500.0	34.5	.03
3	837.8	175.0	.31
4	256.4	97.5	.66
5	34.2	11.5	.54
6	5.6	0.4	.22

$\bar{F}_{4-6} = 0.64$

Age	P_N 1974	C_n 1974	F_{1972}	C_ω 1974
2	1500.0	91.5	.08	8,693
3	837.8	346.8	.71	52,367
4	256.4	162.5	1.56	34,775
5	34.2	20.0	1.23	6,380
6	5.6	1.8	.51	860

$\bar{F}_{4-6} = 1.46$

C_ω 1974
3,278
26,878
20,451
3,669
430

55,000 tons

(52,000 tons if 1972 y.c. in 200×10^6 at age 2)

103,000 tons

(95,000 tons if 1972 y.c. in 200×10^6 at age 2)