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Status of the Scotian Shelf Silver Hake (Whiting) Populations in 1989

by

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Introduction

Management and Current Fishery

The vessels used in this fishery are large Tonnage Class (TC) 7 vessels (greater than 2000 gross registered tons) usually between 80 and 100 meters in length. The gear most often used is a large bottom trawl with an average wing spread of 29 meters and an average head rope height of 8 meters. Using these nets, vessels have been observed to catch as much as 60 tons of silver hake in one day with one tow having as much as 25 tons of silver hake.

Catches are restricted to the seaward side of the Small Mesh Gear Line (Figure 1), and are highest during the period April to July of each year, in NAFO Div. 4W. The historical catches for this fishery have ranged from 300,000 tons in 1973 to 34,000 tons in 1983. There was a steady decrease in silver hake catch from 1973 to 1981 (Figure 2, Table 1). Nominal catches from 1977 until 1983 fluctuated between 33 and 60 thousand tons. Below are reported catches ('000 t) and the Total Allowable Catch (TAC '000 t) since 1977. More details of the 1989 fishery are presented at this meeting in a separate document.

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Advice	70	80	70	90	80	80	80	100	100	100	100	161	235	
TAC	70	80	70	90	80	80	80	100	100	100	100	120	135	135
CATCH	37	48	52	45	45	60	36	74	75	83	62	74[1]	91[1]	50[2]

[1] Preliminary
[2] As of June 1, 1990

Total catches by month are given in Table 2. Since 1976, the low level of catches against TAC is due in part to the amount of silver hake Canada allocates to other nations. A more informative method of viewing the post-1976 catches is to evaluate catch against the amount of silver hake allocated. Percentages of their total allocations caught by non-Canadian fleets have ranged from 64% to 90% (Table 3). In the most recent years the majority of the allocations were caught.

Historical catches from this fishery indicate that the major fishing season was between April and August (Table 2) with peak catches from May to July. Unlike previous years, in 1984, 1985,

1986 and 1987 the USSR started fishing in May rather than early April. Delays in fishing are reflected in the decreased catches during the months of April and May for those years (Table 2). Despite the late start for the fleet from 1984 to 1986 they still caught their allocations, as did the Cuban fleet. In 1988 & 1989 both the USSR and Cuba commenced fishing early in the season. In 1989 the fishery began in March with some vessels operating under special licence. The bulk of the fishery began in April and persisted until July with the peak from April to June. The Canadian Observer Program observed 87Kt of the reported 91Kt or 96%. The fishery was over in July. At the start of 1988, Canada was allocated 36000 t. of which 30000 t. was for development. Later in the season this was reduced to 16000 t. and the difference allocated to the USSR and Cuba who were unable to take full advantage of it. In 1989, Canada was allocated 45,000 t. In mid June this was reduced, with 6,000 going to Cuba and 20,000 to the USSR.

Commercial Sampling

As in the past, sampling for length and age of the commercial catch in 1989 was conducted by the Canadian International Observer Program (IOP). More than 425,000 lengths and 2,400 otoliths were collected from the fishery in total. This places coverage levels for 1989 and previous years above the NAFO standard.

Of the total samples, length frequency/otolith samples (300,100 lengths, 1135 otoliths; Table 4) were randomly selected and aged using the ICNAF standards (Anon., 1977) by Mr. J. Hunt of the Canadian Department of Fisheries and Oceans, St. Andrews Laboratory, St. Andrews, New Brunswick to provide a single fishing season ALK (age length key).

Catch-at-age

Results of Special Session on Input data as it relates to Catch-at-age

STACFIS, at its 1989 meeting in Dartmouth recommended that a special working group be struck to review all input data to the silver hake assessment. Differences in the catch at age matrix presented by the USSR and Canada have been noted over the years. During the special working group meeting held in Copenhagen, January 1989, silver hake commercial age length keys (sexes combined) were presented by Canada and the USSR. The Soviet keys showed a regular pattern of 2-3 age groups present at each length (Table 5). The Canadian keys displayed a more diverse distribution of ages at length especially for larger fish (Table 6). At the Copenhagen meeting, catch at age was constructed for each key using a yearly, sexes combined Canadian commercial length frequency. The resultant catches at age when Soviet and Canadian ALK's were applied to this length frequency were quite different (Table 7). This prompted the working group to comment *"The group was not able at this time to resolve why these ALKs differed, but noted that while the problem remained, a reliable analytical assessment of the silver hake stock was not possible."*

At a Canada-USSR scientific discussion held during the month of March, 1990 in Murmansk, the issue of ageing discrepancies between the two countries was again addressed. The chief USSR silver hake age reader presented the results of a re-ageing of some 800 of the 1989 otoliths. The

results showed a closer agreement with the catch at age as presented by Canada at the Copenhagen meeting. Also, the USSR side noted problems in their age determination and agreed to accept the Canadian ageing for the years 1977-1988.

Mean Length at Age

A comparison of 1977-1989 Canadian and Soviet mean length at age shows similarities over the entire age range (Figure 3). However, the standard deviation about the mean for the USSR ageing in most years is relatively constant over the age ranges (Figure 4). In comparison, the standard deviation in the Canadian mean length at age increases with age; ie: the highest variance about the mean is seen in the oldest fish. This pattern is expected for most fish species, and it's absence in the USSR results suggests possible bias in age determination.

Indices of Abundance

Commercial Catch and Effort

The data used in the calculation of the standardized catch rate are those accepted at the 1990 Copenhagen meeting, and have been adopted from the 1989 assessment (Waldron et al., 1989)

Catch Rate Standardization:

The APL program STANDARD, used to standardize catch rates, was corrected for an output error. The exact nature of the error is presented in Fanning (1990). Catch and effort from 1977-1988 were categorized in a manner similar to that used in the previous assessment. The regression results (Table 8, Figure 5) indicate there is a significant effect due to year, month, regime and country in the model. There were no significant effects due to data source (NAFO or IOP) or NAFO area.

The standardized catch rate for 1989 increased over that of 1988, and is comparable to that of 1986 & 1987 (Table 9, Figure 6). Since 1980, catch rates, although variable, continue to rise.

Abundance Surveys

Canadian Adult Surveys

The July stratified random groundfish survey is another index of adult abundance. Since 1977 three vessels have been used to conduct this survey. Analysis of comparative fishing experiments between pairs of vessels (Fanning, 1985) indicated that a conversion factor of 2.3 should be applied to the series prior to 1982. This adjustment is assumed to account for the effect of vessel and gear changes in the time series.

The survey results indicate a continual decline in total numbers since 1986 (Figure 7).

Silver hake juvenile survey

A joint USSR-Canada juvenile silver hake survey was standardized in 1981 and continues to the present. The survey index based on the core strata (60-78) (Koeller et al., 1984) is presented in Table 10. This series indicates that the 1981, 1983, 1985, 1986 and 1988 year-classes are of a similar magnitude, and are the highest in the series. The 1989 index is approximately equal to that of 1987, but still well below the numbers reported for the 1988 year class. The juvenile index corresponds with age 1 silver hake for the subsequent year (Figure 8).

Discussion

The ageing differences noted at the June 1989 STACFIS meeting persisted through the January 1990 special meeting on silver hake assessment input data. At a March, 1990 Canada-USSR scientific meeting, the USSR scientists indicated there were problems in the assignment of ages for the 1989 otoliths. It was also suggested that this problem was most likely also reflected in the 1977-1988 time series. Therefore, the USSR scientists agreed to accept the Canadian age readings for 1977-1988. Further studies on the 1989 age readings are currently underway by the USSR. A decision on which age interpretation is likely to be more correct, Canadian or USSR, is dependent upon the outcome of these studies.

Investigation of the variance around the mean USSR length at age suggests some bias in age interpretation. The variance for Canadian mean length at age better reflects growth in animal populations with larger variance at older ages. The authors suggest that the Canadian age interpretation better represents the true age of silver hake than those presented by the USSR. It still remains for STACFIS to decide on which age interpretations could be used for the assessment of stock status.

Commercial catch rates since 1982 are well above those of the late 1970's. Indeed for 1989, the CPUE has increased over that estimated for 1988. However, the high degree of variance about each estimate make it difficult to detect any difference since 1982. The July adult survey suggests a decline in the population numbers since 1986 to a level similar to that estimated for 1983. There appears to be a leveling of this trend for 1988 and 1989.

The Fall juvenile survey agrees well with the July adult survey age 1 estimates. This suggests that the fall survey is a good indicator of the relative strength of incoming recruitment. The 1989 year class is the 6th highest in the series and is similar to that of the 1987 year class. This would imply mediocre recruitment to the 1990 and 1991 fisheries for this year class.

The 1991 fishery will be composed of a strong 1988 year class which will dominate the catch, a weak 1987 year class at age 4 and an average 1989 year class at age 2. The 1989 fishery was one of the best since 1977 and was dominated by the large 1985 and 1986 year classes. These will contribute little to the 1991 fishery.

The 1990 fishery started strong but has declined to unexpected low levels early in June. This decline is usually expected in July. The decline may be due to a shift in the distribution of silver

hake brought on by a change in oceanographic features, or a reaction to an increase in the number of vessels fishing in the area (such activity may cause the schools to remain disturbed hence influence availability), or a real decline in the size of the population. Until the 1990 fishery data are analysed (or until the age interpretation question is resolved) the authors suggest a cautious approach to the management of the silver hake fishery in 1991.

Acknowledgments

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Table 1. Nominal catches for 4VWX silver hake 1970-1989 (1988-1989 preliminary).

Year

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978
Bulgaria	0	0	0	0	0	1722	3088	862	606
Canada	0	0	0	0	11	101	26	10	26
Cuba	0	0	201	0	0	1724	12572	1847	3436
France	0	0	0	0	0	0	0	15	0
FRG	0	0	10	0	296	106	97	684	0
GDR	0	0	0	0	0	0	0	0	3[1]
Ireland	0	0	0	0	0	108	106	0	0
Italy	0	0	0	0	0	0	0	38	106
Japan	129	8	63	88	67	54	78	19	161
Poland	0	0	0	0	0	0	0	295	2
Portugal	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	10	0
Spain	0	15	0	0	0	6	0	0	2
USA	0	1	0	0	0	7	1	14	0
USSR	168916	128633	113774	298533	95371	112566	81216	33301	44062
TOTAL	169045	128657	114048	298621	95745	116394	97184	37095	48404

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Bulgaria	4639	817	0	0	0	0	0	0	0	0	0
Canada	13	104	6	38	15	10	2	9	11[3]	9[3]	337[2]
Cuba	1798	2287	642	11969	7418	14496	17683	16041	20219	9016	14222[2]
France	0	0	0	2[1]	0	0	0	0	0	0	0
FRG	0	0	0	0	0	0	0	0	0	0	0
GDR	0	0	0	0	0	93	0	0	0	0	0
Ireland	9	0	0	0	0	0	0	0	0	0	0
Italy	5	0	541	37[1]	2[3]	0	0	0	0	0	0
Japan	219	239	120	937	649	530	120	67	145	0	194[3]
Poland	0	0	1[1]	31[2]	0	0	0	0	0	0	0
Portugal	0	56	2044	2[1]	378	1714	1338	0	0	0	0
Romania	1	0	0	0	0	0	0	0	0	0	0
Spain	0	40	0	0	0	0	0	0	0	0	0
USA	0	0	3	2	0	0	0	1	0	0	0
USSR	45076	40982	41243	47261	27377	57423	56337	66571	41329	65349	76752[2]
TOTAL	51760	44525	44600	60251	35839	74266	75480	82689	61704	74374	91505

[1] Observer Program Data (data not reported to NAFO)
[2] FLASH data
[3] NAFO Circular Letters and provisional reporting to NAFO.

Table 2. Scotian Shelf silver hake reported monthly catch (t) (monthly catch reported in previous year's assessment in parenthesis).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979[3]	1980	1981[3]	1982[3]	1983[3]	1984	1985	1986[1]	1987[4,1]	1988[1]	1989
Jan.	12	3	-	-	1088	2850	982	-	-	-	-	-	-	-	-	-	-	1[2]	-	-
Feb.	43	3555	43	103	261	1416	1174	2	-	6	-	-	-	-	-	-	-	-	-	-
Mar.	4335	30821	7199	12133	7345	2808	15028	3718	-	2	-	-	-	-	1[2]	-	17 (25)	3[2]	-	522
Apr.	16682	19415	12129	91367	10182	13673	10344	8142	2118	2190	1558	981	2409	6990	2614	3207	5751 (4902)	4971 (4967)	16063	36535
May	19880	11742	21303	72443	15766	14715	7860	5714	8761	13000	9809	15332	19482	16369	22079 (19529)	15491 (11323)	27723 (21382)	13068[2] (12793)	29227 (29320)	28810
June	19115	9419	16982	41948	14369	11364	7030	3284	13591	17651	13875'	13669	24786	11274	24054[2] (22000)	33319 (30483)	34810 (41594)	22190 (21611)	22202 (22211)	20532
July	34873	22118	26425	42955	10676	26874	22531	11990	14449	14417	15011	13654	12607	543	22020 (26041)	17639 (25600)	13088 (13572)	20152[2] (19247)	6880	5103
Aug.	43814	21621	14610	13394	10365	23904	8895	2805	8851	2930	4025	909	641	490	3248[2] (3411)	5766 (4891)	933 (893)	1319 (3081)	-	3
Sept.	19028	8258	11481	8656	14871	18076	6480	1046	236	903	103	41	260	156	245 (516)	54 (22)	361 (483)	- (1)	-	-
Oct.	6132	1092	3223	5493	4981	139	7625	190	285	403	84	8	7	7	2 (17)	-	(1)	-	-	-
Nov.	4115	613	452	1078	5256	26	3900	201	55	248	60	3	13	8	2 (4)	1	4	-	2[2]	-
Dec.	1016	-	-	9050	10585	549	5335	3	55	1	-	2	2	-	1 (2)	3 (10)	2 (2)	-	-	-
Total	169045	128657	114048	298621	95745	116394	97184	37095	48404	51751	44525	44599	60207	35837	74266 (74226)	75480 (75492)	82689 (82854)	61704[3]	74374 (74476)	91505[2]

1. Reported to Canada (FLASH System). Note: catch was updated and is not reflected in this column.

2. Canada did not report on a monthly basis, thus IOP data used to locate appropriate months.

3. Some countries did not report catches by months.

4. Soviet catch was not reported by month, thus was prorated to the Flash data.

Table 3. Nominal catch and allocations (t) (in parenthesis) for 4VWX silver hake. 1989 Preliminary.

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Bulgaria	862 (950)	606 (1000)	4639 (6860)	817 (1200)	0 (1000)	0 (1000)	0	0	0	0	0	0	0
Canada	10 (15190)	26 (16700)	13 (10000)	104 (20000)	6 (20000)	38 (13000)	15 (1000)	10 (1000)	2 (1000)	9 (1000)	11 (19500)	9 (16000)	337 (22000)
Cdn. Reserve							(11808)	(13000)	(8100)	(4600)			
Cuba	1847 (8910)	3436 (10300)	1798 (8070)	2287 (11200)	642 (9500)	11969 (13500)	7418 (9500)	14496 (15200)	17683 (15200)	16041 (17700)	20219 (20200)	9016 (23500)	14222[2] (24500)
EEC	0	0	0	0 (100)	0	0	0	0	0	0	0	0	0
France[4]	15	0	0 (100)[3]	0 (100)[3]	0 (100)[3]	2[1] (100)[3]	0 (100)[3]	0 (100)	0 (100)	0 (100)	0 (100)	0	0 (4000)
FRG	684	0	0	0	0	0	0	0	0	0	0	0	0
GDR	0	3[1]	0	0	0	0	0 (2000)	93 (100)	0	0	0	0	0
Italy[4]	38	106	5	0	541	37[1]	2[3]	0	0	0	0	0	0
Japan	19	161	219	239	120	937 (2000)	649 (5000)	530 (10000)[2]	128 (10000)	67 (10000)	145 (7500)	0 (7500)	194 (7500)
Poland	295	2	0	0	1[1]	31	0	0	0	0	0	0	0
Portugal	0	0	0	56	2044	2[1] (2000)	378 (3000)	1714 (4000)[2]	1338 (4000)	0	0	0	0
Romania	10	0	1	0	0	0	0	0	0	0	0	0	0
Spain	0	2	0	40	0	0	0 (4000)	0	0 (5000)	0	0	0	0
USA	14	0	0 (2)	0	3	2	0	0	0	1	0	0	0
USSR	33301 (44950)	44062 (52000)	45076 (44940)	40982 (56600)	41243 (48400)	47261 (48400)	27377 (43400)	57423 (56600)	56337 (56600)	66571 (66600)	41329 (52700)	65349 (73000)	76752[2] (77000)
Others	0	0	9 (30)	0 (900)	0 (1000)	0	0 (192)	0	0	0	0	0	0
Total Catch and TAC	37095 (70000)	48404 (80000)	51760 (70000)	44525 (90000)	44600 (80000)	60251 (80000)	35839 (80000)	74266 (100000)	75480 (100000)	82689 (100000)	61704 (100000)	74374 (120000)	91505 (135000)
Percent Sum Catch/Tac	53	61	74	50	54	75	45	74	75	83	62	62	68
Percent Sum Catch/Foreign TAC	68	76	86	64	72	90	53	86	83	87	77	72	81

1 Observed by Canadian Observers but not reported to NAFO
2 Reported to Canada (FLASH System)
3 France, St. Pierre, and Miquelon vessels only
4 EEC allocations

Table 4. Sampling used in this assessment.

Year	No. Lengths	No. Ages
1977	34379	600
1978	137468	674
1979	101908	1108
1980	247369	1462
1981	195493	987
1982	160878	1152
1983	134226	986
1984	203314	1255
1985	216912	1163
1986	197654	1289
1987	377527	1602
1988	309767	1158
1989	300100	1135

Table 5. 1989 USSR silver hake age length key

USSR	1	2	3	4	5	6	7	8	9	10	11
10											
11											
12											
13	9										
14	19										
15	21										
16	27										
17	30										
18	34										
19	43										
20	38										
21	38	2									
22	22	15									
23	7	37									
24		41									
25		47									
26		77									
27		75	2								
28		68	8								
29		42	37								
30		7	70	1							
31		4	55	4							
32			12	34							
33			8	34							
34			4	35	3						
35				7	30	3					
36				4	18	3					
37					18	3					
38					20	3					
39					12	8					
40					3	15					
41					3	15	3				
42						5	14				
43						3	11				
44						1	11	3			
45						1	10	4			
46							8	4			
47							5	9			
48							5	7			
49							1	9	1		
50								5	7		
51								1	5		
52									4		
53									5		
54									6		
55									3		
56									1		
57									2		
58											
59										2	
60											
61											
62											
63											
64											
65											
66											
67										1	
68											

Table 6. 1989 Canadian silver hake age length key

M + F	1	2	3	4	5	6	7	8	9	10	11
10											
11											
12											
13	1										
14	6										
15	16										
16	18										
17	21										
18	21										
19	18										
20	22										
21	26	1									
22	26	4									
23	20	19									
24	14	40	1								
25	1	60	1								
26		57	2								
27		53	11								
28		26	30	6							
29		12	42	10	1						
30		4	34	23	1						
31		1	22	32	2						
32			13	39	2	4	1				
33			16	27	11	5		1			
34			6	26	15	9	1				
35			3	15	21	10	2	2			
36			1	16	8	11	2	1			
37				6	9	14	2	1			
38				5	9	14	2				
39				5	8	7	4	1			
40				2	5	11	1	3			
41					3	7	2	4			
42					1	8	2	3			
43						4		2			
44						2	1	2			
45						1		1			
46							1	2		1	
47							1				
48							1		1		
49								1			
50								1			
51											1
52						1					
53											
54											
55											

Table 7. Canadian and USSR 1989 catch at age using Canadian length frequencies adjusted to catch. (Sexes combined for lengths and ages).

	Age-Length Key Used		
Age	USSR	CANADA	CAN + USSR
1	20,311	25,721	23,132
2	153,800	92,039	128,293
3	189,630	169,903	175,231
4	88,856	153,666	113,614
5	17,700	21,289	20,735
6	3,800	9,975	11,037
7	1,129	1,669	2,291
8	323	1,274	1,213
9	70	41	69
10	0	22	6
11	0	35	5

Table 8. CPUE standardization results for the 4VWX silver hake population. Includes years 1977-1989.

Key
Type 1: Data Source, NAFO or IOP
Type 2: Month
Type 3: Year
Type 4: Area
Type 5: Regime either Old or New
Type 6: Country

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... .784
MULTIPLE R SQUARED..... .614

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	7.309E0001	7.309E0001	
REGRESSION	23	2.406E0001	1.046E0000	8.861
TYPE 1	1	1.250E-001	1.250E-001	1.059
TYPE 2	6	4.525E0000	7.542E-001	6.389
TYPE 3	12	1.174E0001	9.780E-001	8.285
TYPE 4	2	7.044E-001	3.522E-001	2.984
TYPE 5	1	3.697E-001	3.697E-001	3.132
TYPE 6	1	1.276E0000	1.276E0000	10.806
RESIDUALS	128	1.511E0001	1.181E-001	
TOTAL	152	1.123E0002		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	1	INTERCEPT	0.780	0.114	152
2	5				
3	77				
4	460				
5	2				
6	1				
1	2	1	-0.141	0.137	70
2	3	2	1.006	0.365	1
	4	3	0.210	0.096	22
	6	4	-0.126	0.081	40
	7	5	-0.189	0.086	32
	8	6	-0.264	0.105	18
	9	7	-0.489	0.173	5
3	78	8	-0.313	0.116	26
	79	9	-0.158	0.120	21
	80	10	-0.467	0.148	9
	81	11	-0.335	0.149	9
	82	12	0.606	0.167	7
	83	13	-0.096	0.162	8
	84	14	0.388	0.161	8
	85	15	0.249	0.161	8
	86	16	0.710	0.189	10
	87	17	0.699	0.192	9
	88	18	0.467	0.196	9
	89	19	0.738	0.187	12
4	450	20	0.148	0.127	10
	470	21	-0.135	0.074	35
5	1	22	0.257	0.145	21
6	2	23	-0.277	0.084	33

Table 9. Standardized silver hake commercial catch rates.

PREDICTED CATCH RATE

STANDARDS USED VARIABLE NUMBERS: 1 5 460 2 1

YEAR	TOTAL CATCH	PROP.	CATCH RATE MEAN	S.E.	EFFORT
77	37095	0.702	2.300	0.263	16131
78	48404	0.879	1.683	0.182	28764
79	51751	0.827	1.965	0.212	26332
80	44525	0.920	1.439	0.189	30937
81	44599	0.833	1.641	0.219	27186
82	60207	0.958	4.200	0.603	14333
83	35837	0.921	2.083	0.289	17206
84	74266	0.967	3.380	0.468	21973
85	75480	0.981	2.942	0.408	25657
86	82689	0.427	4.623	0.881	17888
87	61704	0.926	4.573	0.876	13494
88	74482	0.863	3.621	0.704	20567
89	86729	0.984	4.757	0.880	18233

AVERAGE C.V. FOR THE MEAN: .147

Table 10. Juvenile silver hake index.

YEAR	SETS	STRATA	S	STRAT. MEAN NO./TOW	STRAT. VAR.	S.E./X
1981	77	60-78	8985819	579.0	4148.2	0.11
1982	61	60-78	127028	8.8	1.5	0.14
1983	64	60-78	3603693	232.2	597.4	0.11
1984	71	60-78	673897	43.4	50.1	0.16
1985	82	60-78	4419365	284.8	3866.5	0.22
1986	74	60-78	3073159	198.0	1437.6	0.19
1987	105	60-78	1582794	102.0	530.5	0.11
1988	116	60-78	3179086	204.8	1245.2	0.17
1989	74	60-78	2041079	131.5	360.5	0.09

S= SUM(STRATUM MEAN x STRATUM AREA)
NOTE: Stratified variance excludes strata with only 1 set
Stratified mean includes strata with only 1 set

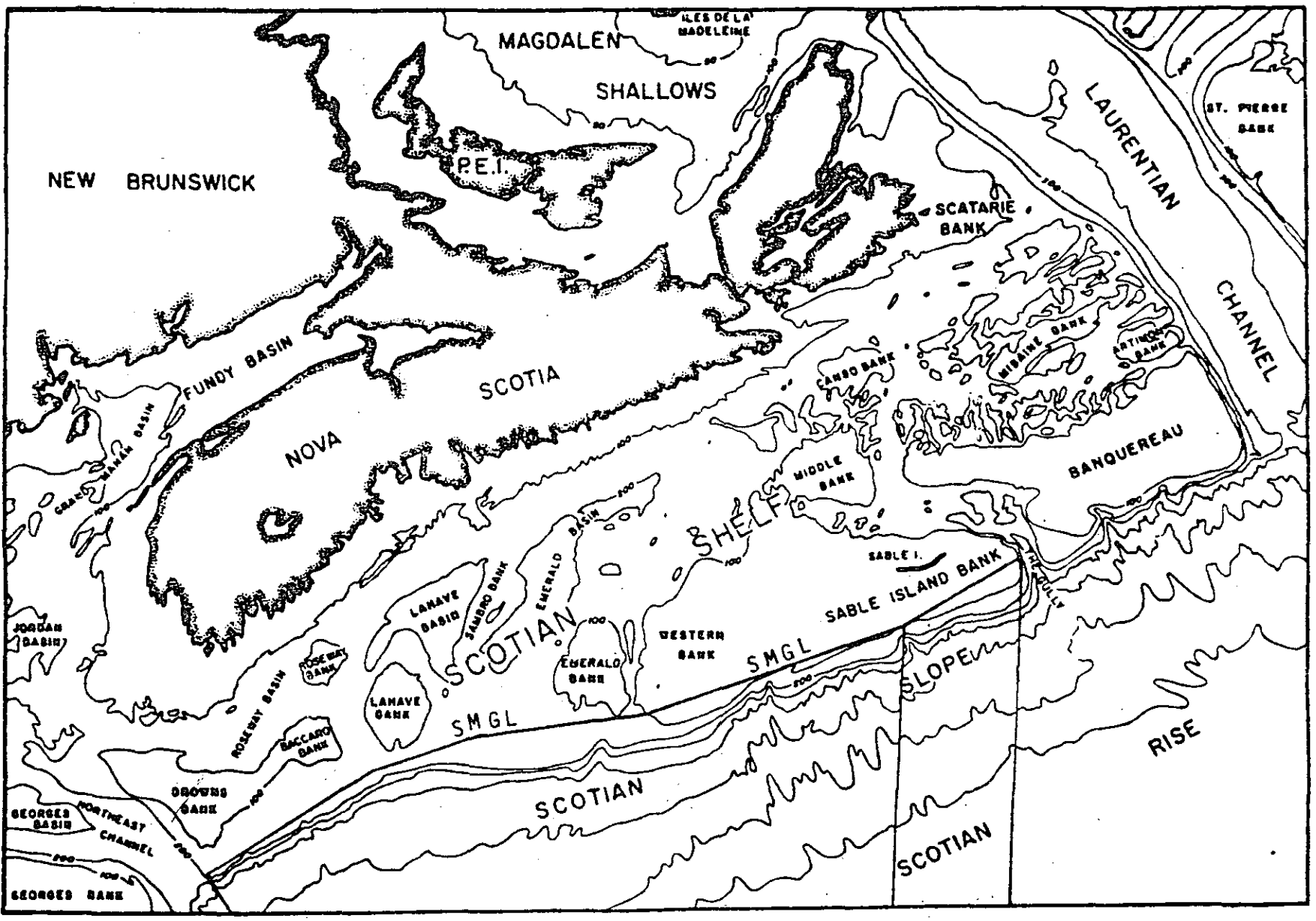


Figure 1 Bathymetric map of the Scotian Shelf and the Bay of Fundy showing the Small Mesh Gear Line (SMGL

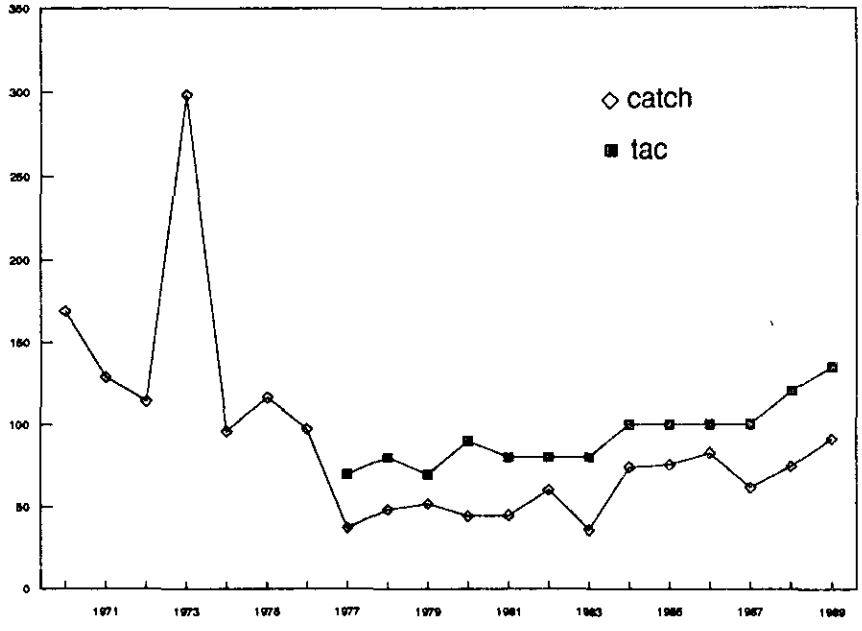
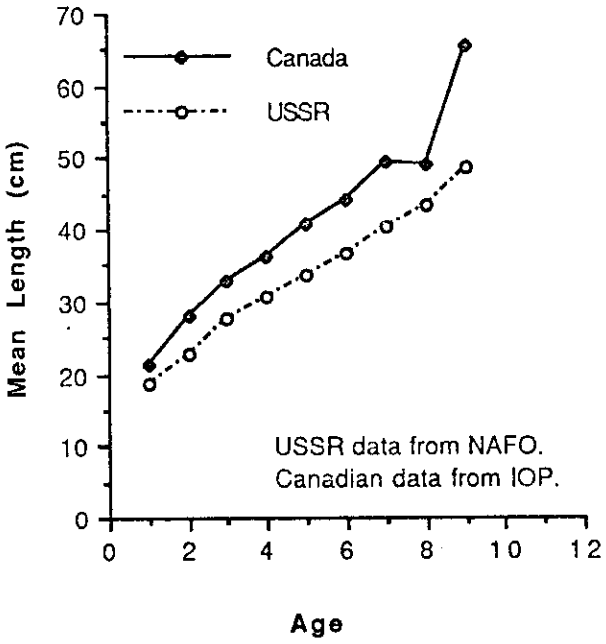


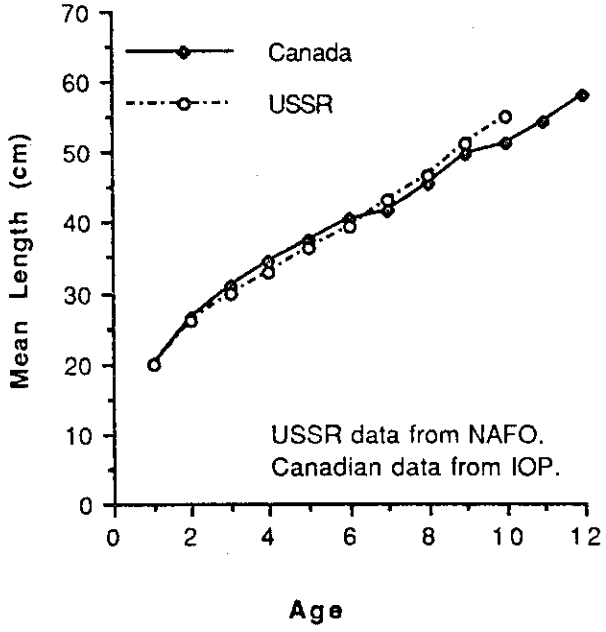
Figure 2: Catch and TAC for 4VWX silver hake

Figure 3: Mean Length at Age for Canadian and USSR Silver Hake Ageing.

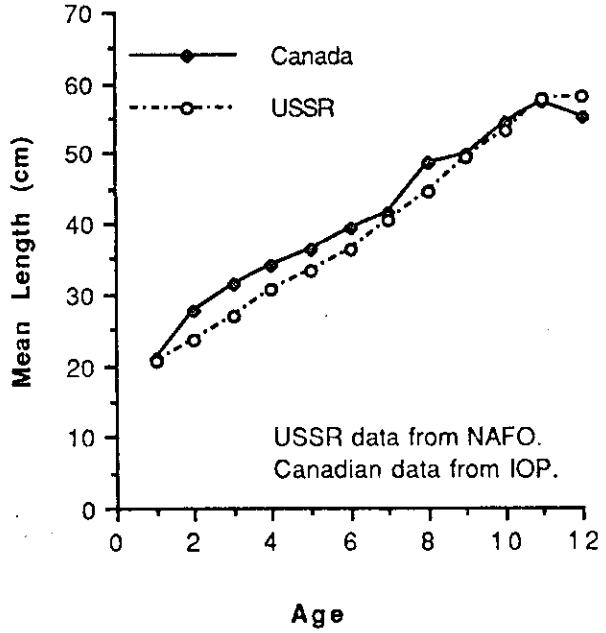
Mean Length at Age for 1977 Silver Hake, Sexes Combined



Mean Length at Age for 1978 Silver Hake, Sexes Combined



Mean Length at Age for 1979 Silver Hake, Sexes Combined



Mean Length at Age for 1980 Silver Hake, Sexes Combined

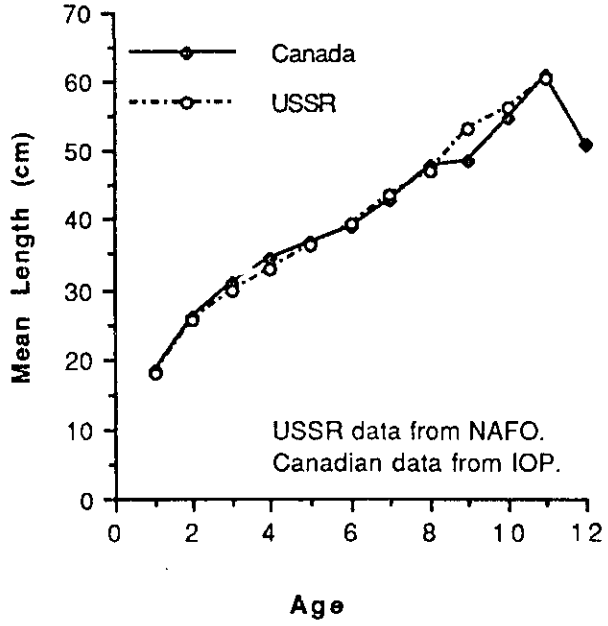
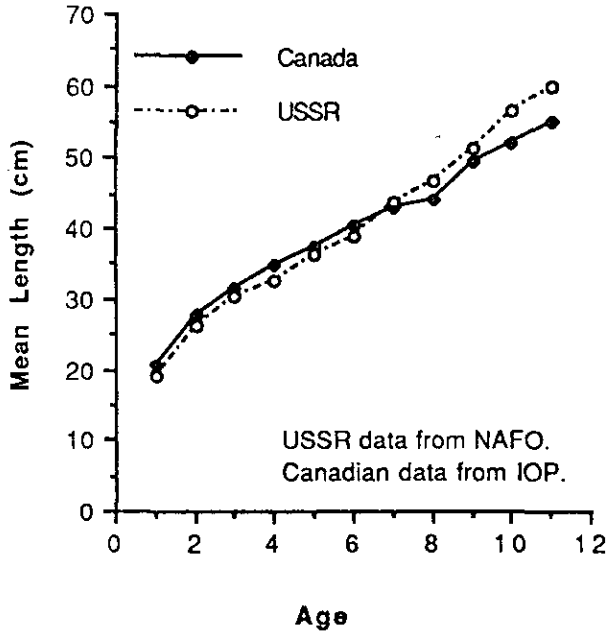
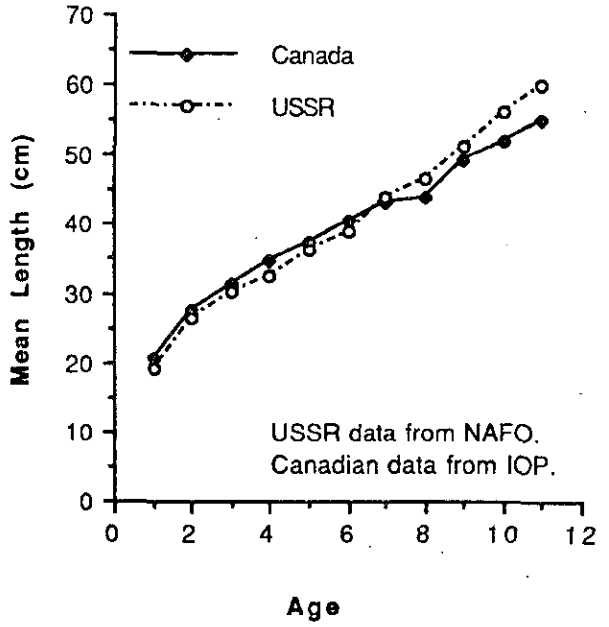


Figure 3: Mean Length at Age for Canadian and USSR Silver Hake Ageing.

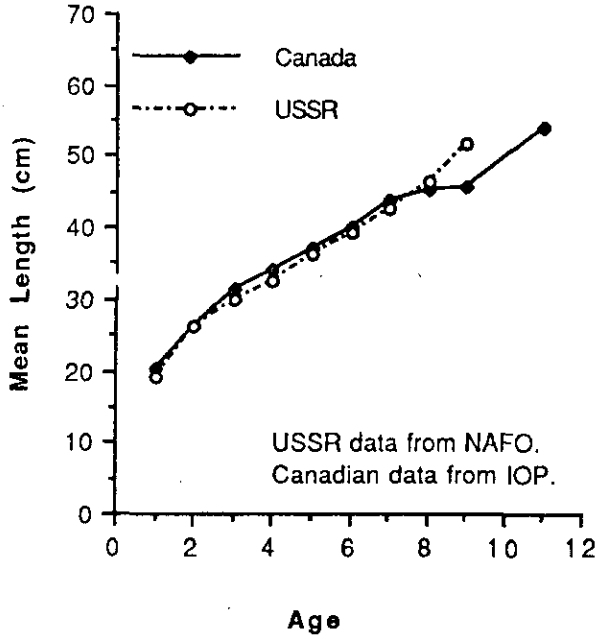
Mean Length at Age for 1981 Silver Hake, Sexes Combined



Mean Length at Age for 1982 Silver Hake, Sexes Combined



Mean Length at Age for 1983 Silver Hake, Sexes Combined



Mean Length at Age for 1984 Silver Hake, Sexes Combined

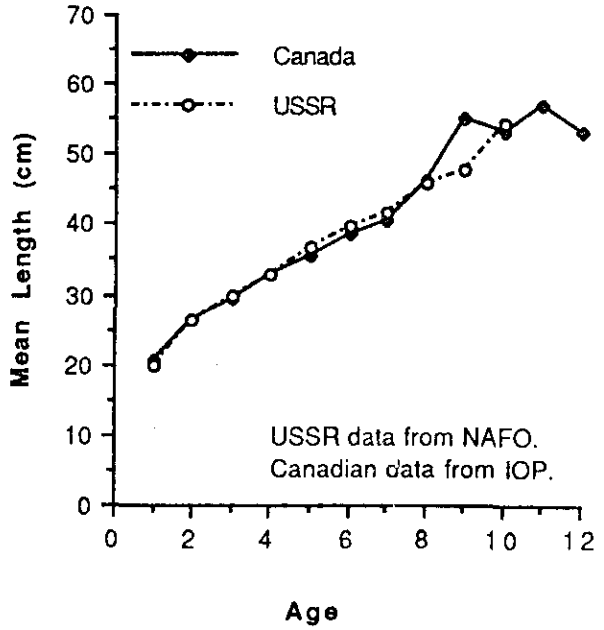
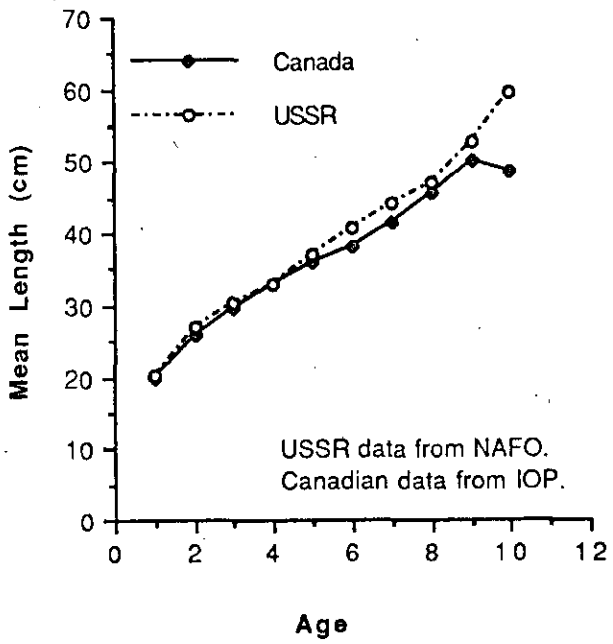
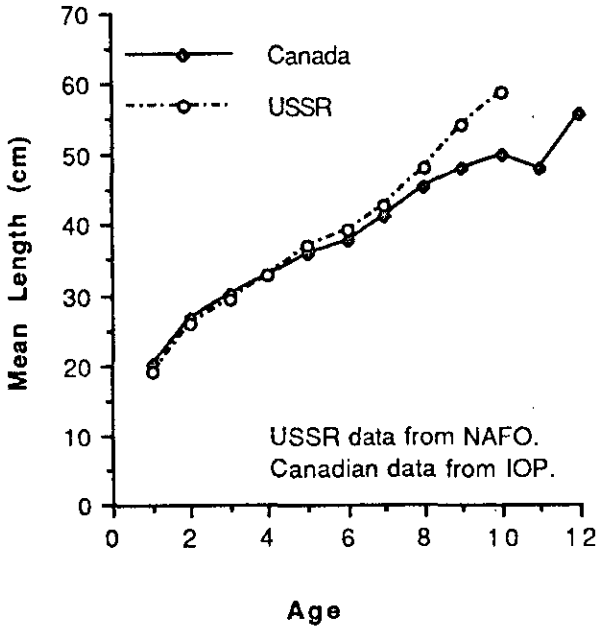


Figure 3: Mean Length at Age for Canadian and USSR Silver Hake Ageing

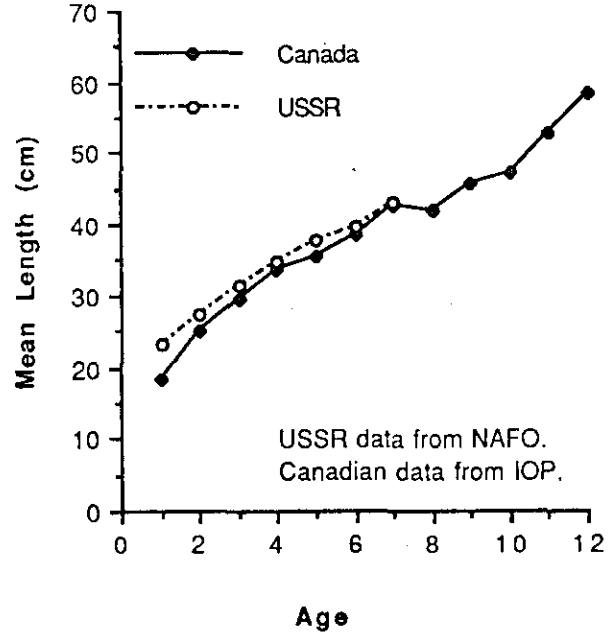
Mean Length at Age for 1985 Silver Hake, Sexes Combined



Mean Length at Age for 1986 Silver Hake, Sexes Combined



Mean Length at age for 1987 Silver Hake, Sexes Combined



Mean Length at Age for 1988 Silver Hake, Sexes Combined

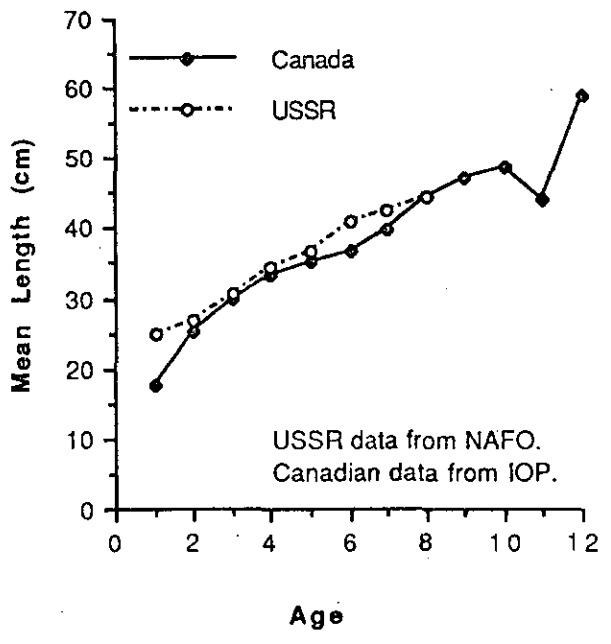


Figure 3: Mean Length at Age for Canadian and USSR Silver Hake Ageing.

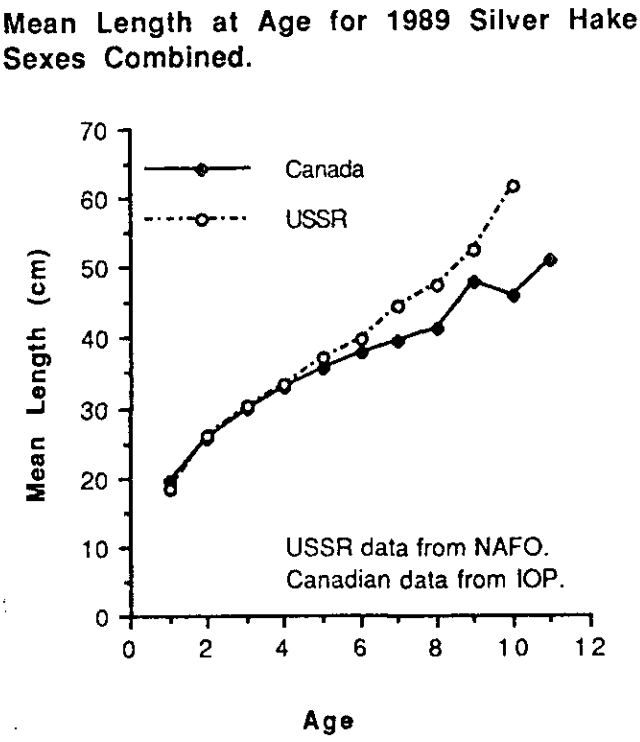
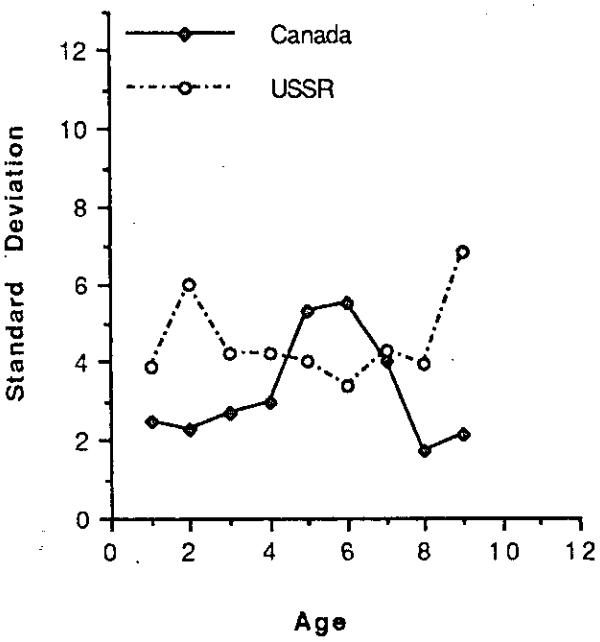
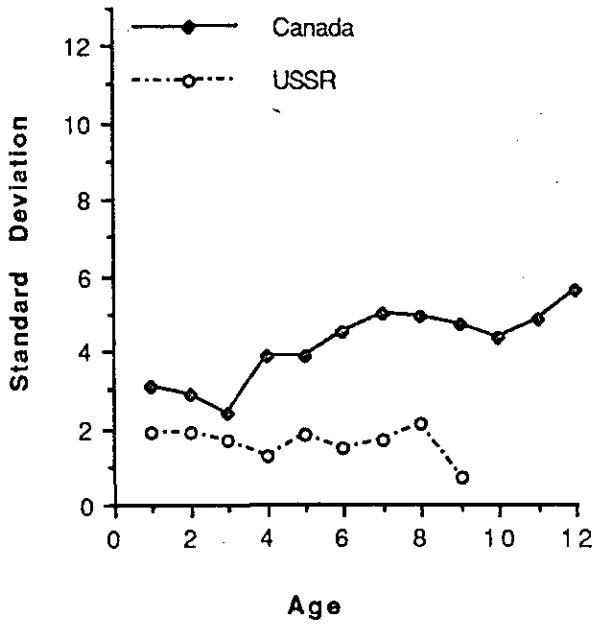


Figure 4: Standard Deviation of Mean Length at Age for Canadian and USSR Silver Hake Ageing

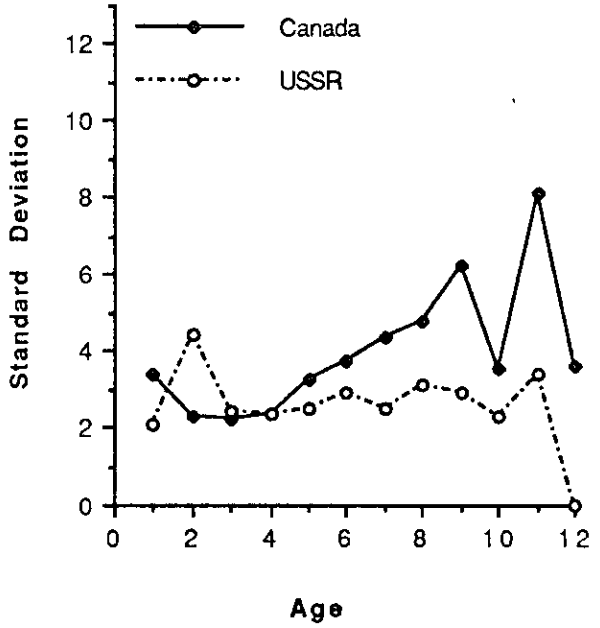
Standard Deviation of Length at Age for 1977 Silver Hake, Sexes Combined



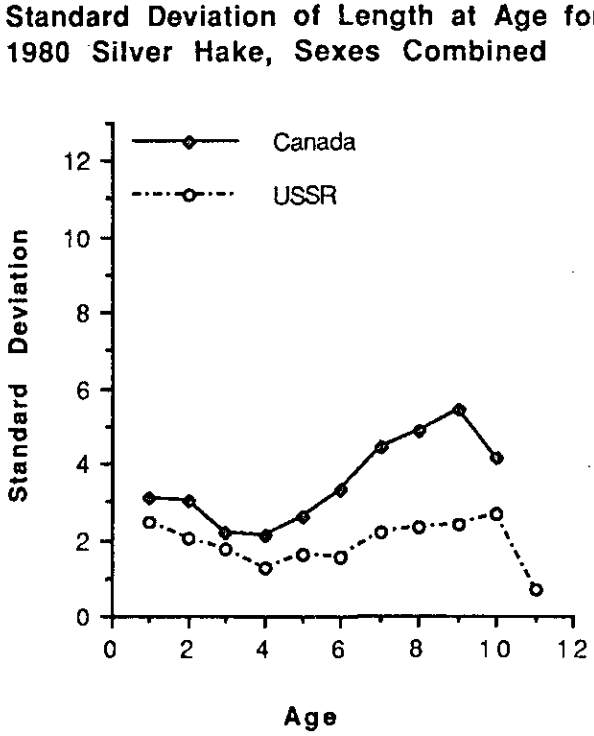
Standard Deviation of Length at Age for 1978 Silver Hake, Sexes Combined



Standard Deviation of Length at Age for 1979 Silver Hake, Sexes Combined



Standard Deviation of Length at Age for 1980 Silver Hake, Sexes Combined



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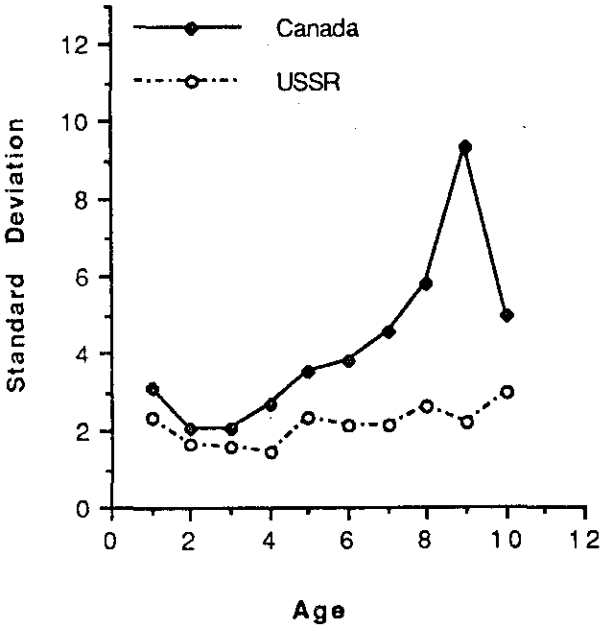
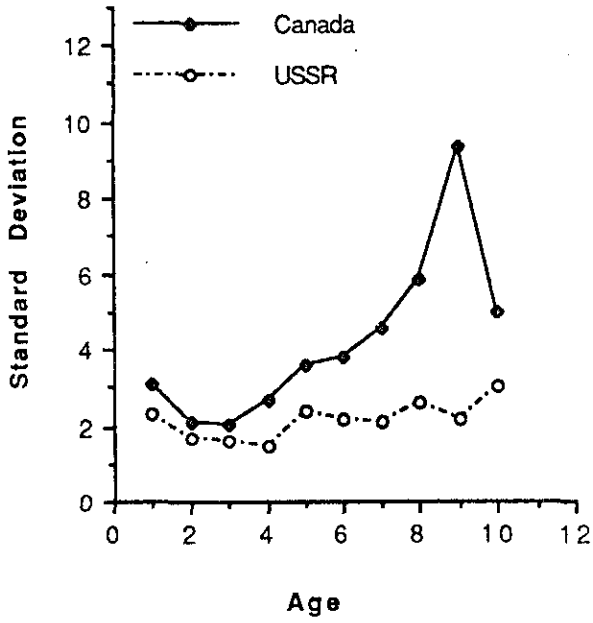
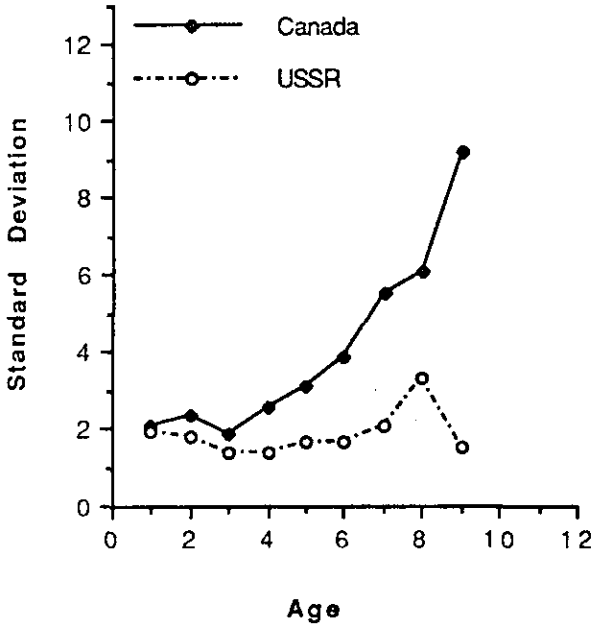
Standard Deviation of Length at Age for 1981 Silver Hake, Sexes Combined



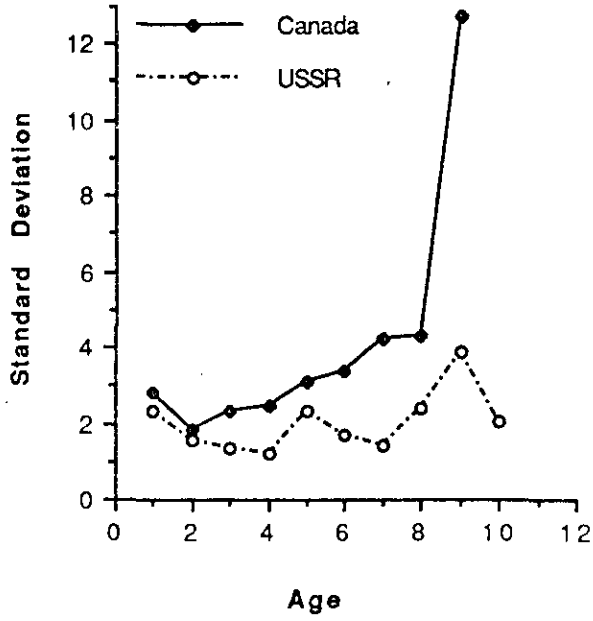
Standard Deviation of Length at Age for 1982 Silver Hake, Sexes Combined



Standard Deviation of Length at Age for 1983 Silver Hake, Sexes Combined



Standard Deviation of Length at Age for 1984 Silver Hake, Sexes Combined



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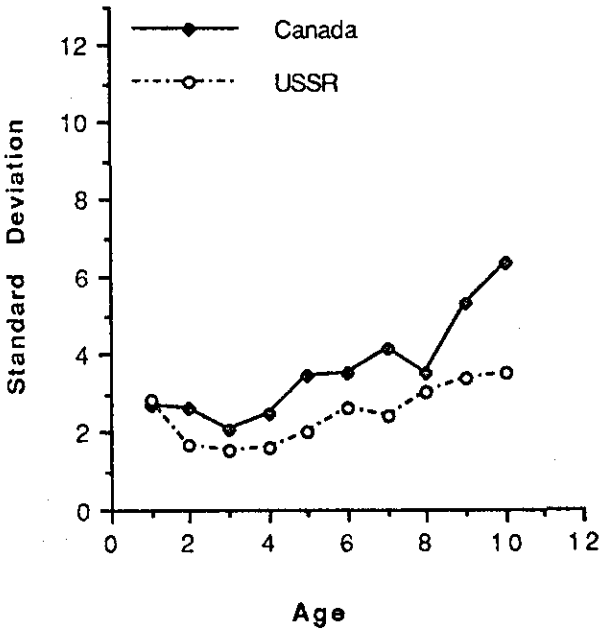
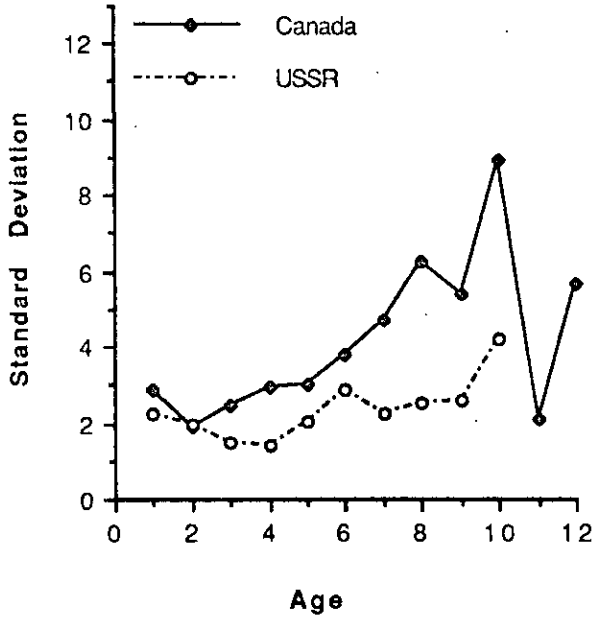
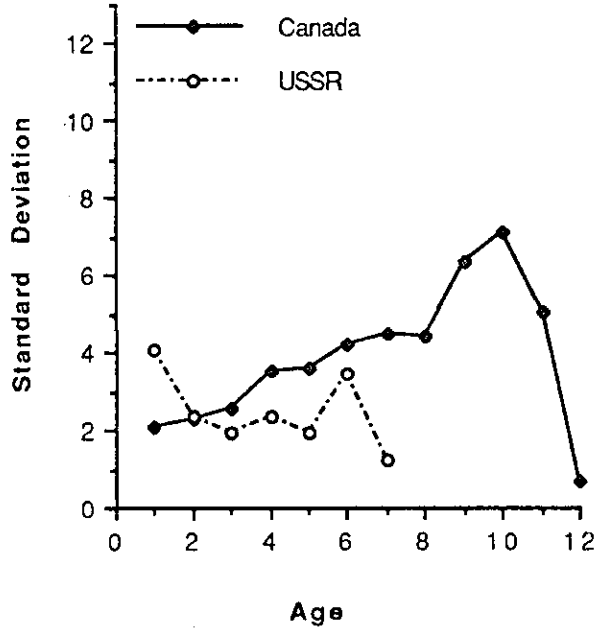
Standard Deviation of Length at Age for 1985 Silver Hake, Sexes Combined



Standard Deviation of Length at Age for 1986 Silver Hake, Sexes Combined



Standard Deviation of Length at Age for 1987 Silver Hake, Sexes Combined



Standard Deviation of Length at Age for 1988 Silver Hake, Sexes Combined

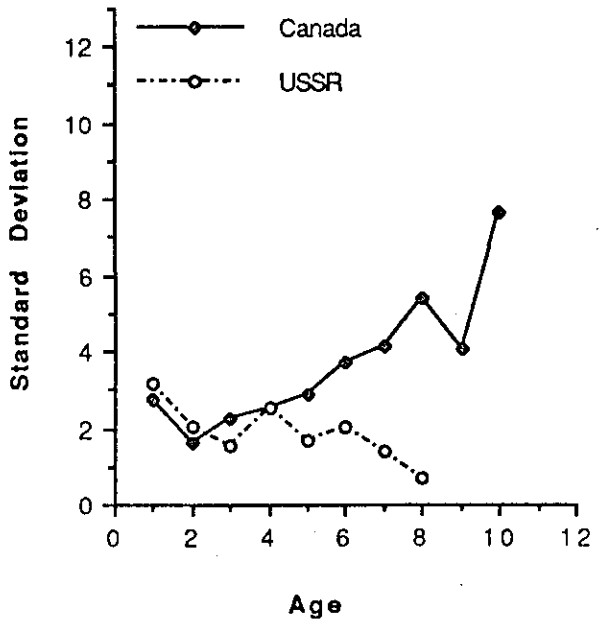


Figure 4: Standard Deviation of Mean Length at Age for Canadian and USSR Silver Hake Ageing

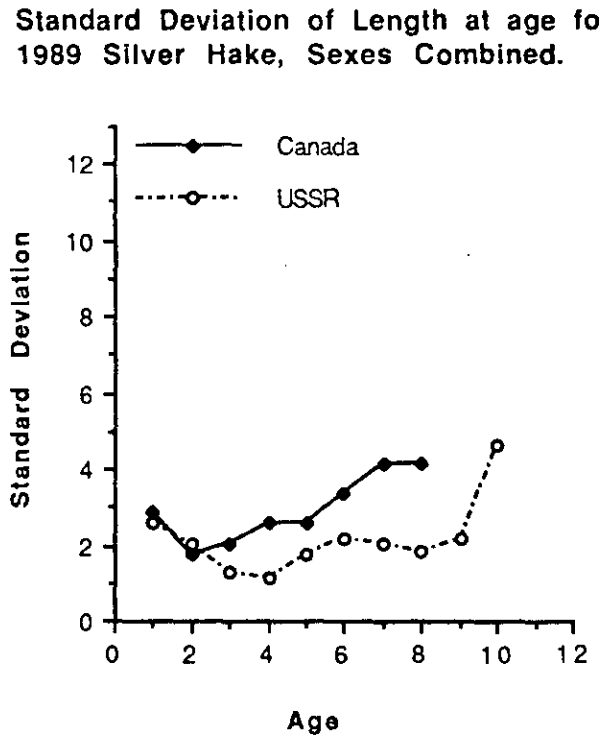


Figure 5: Residual plots from silver hake standardized catch rate analysis.

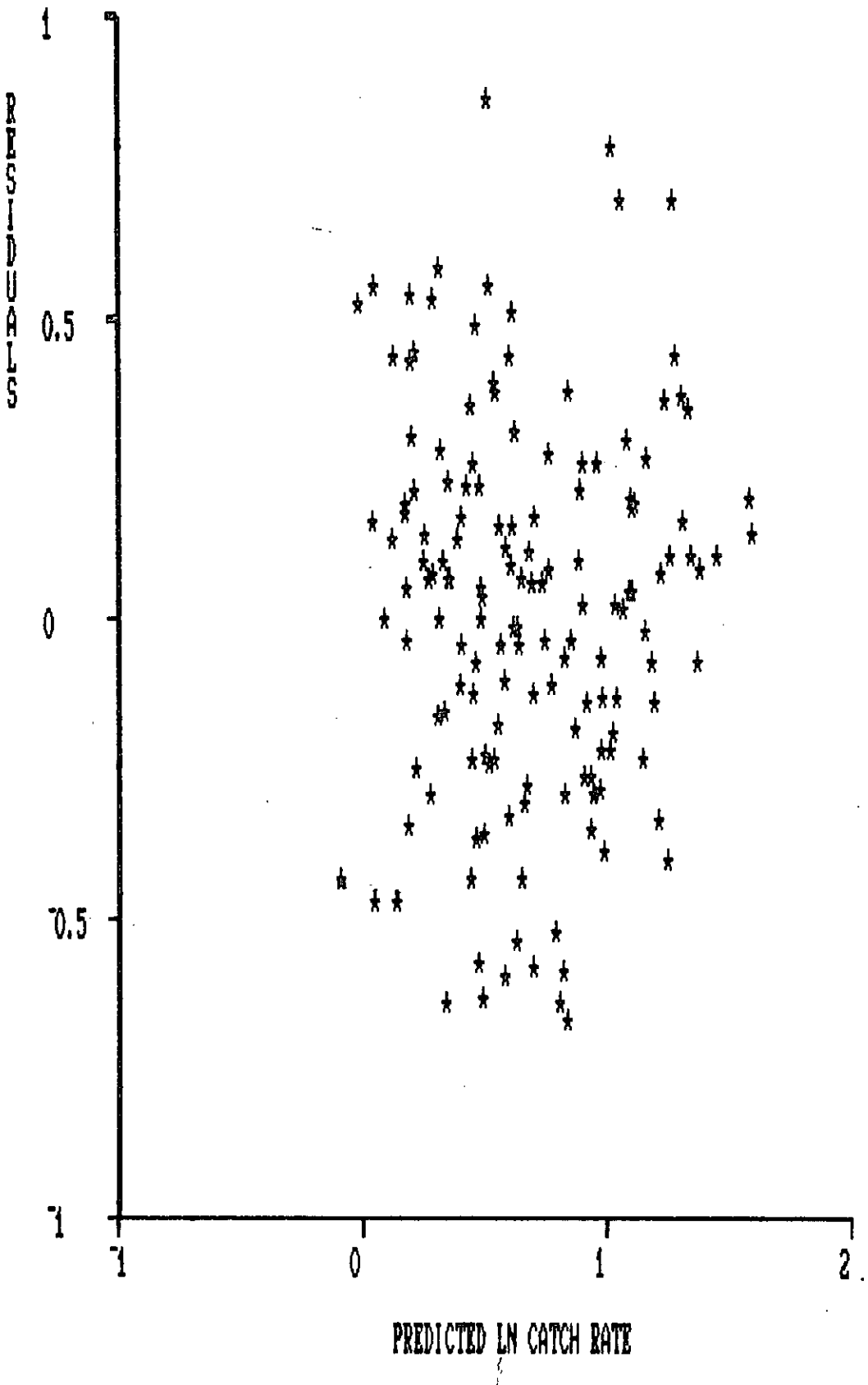


Figure 5 (Cont.): Residual plots from silver hake standardized catch rate analysis.

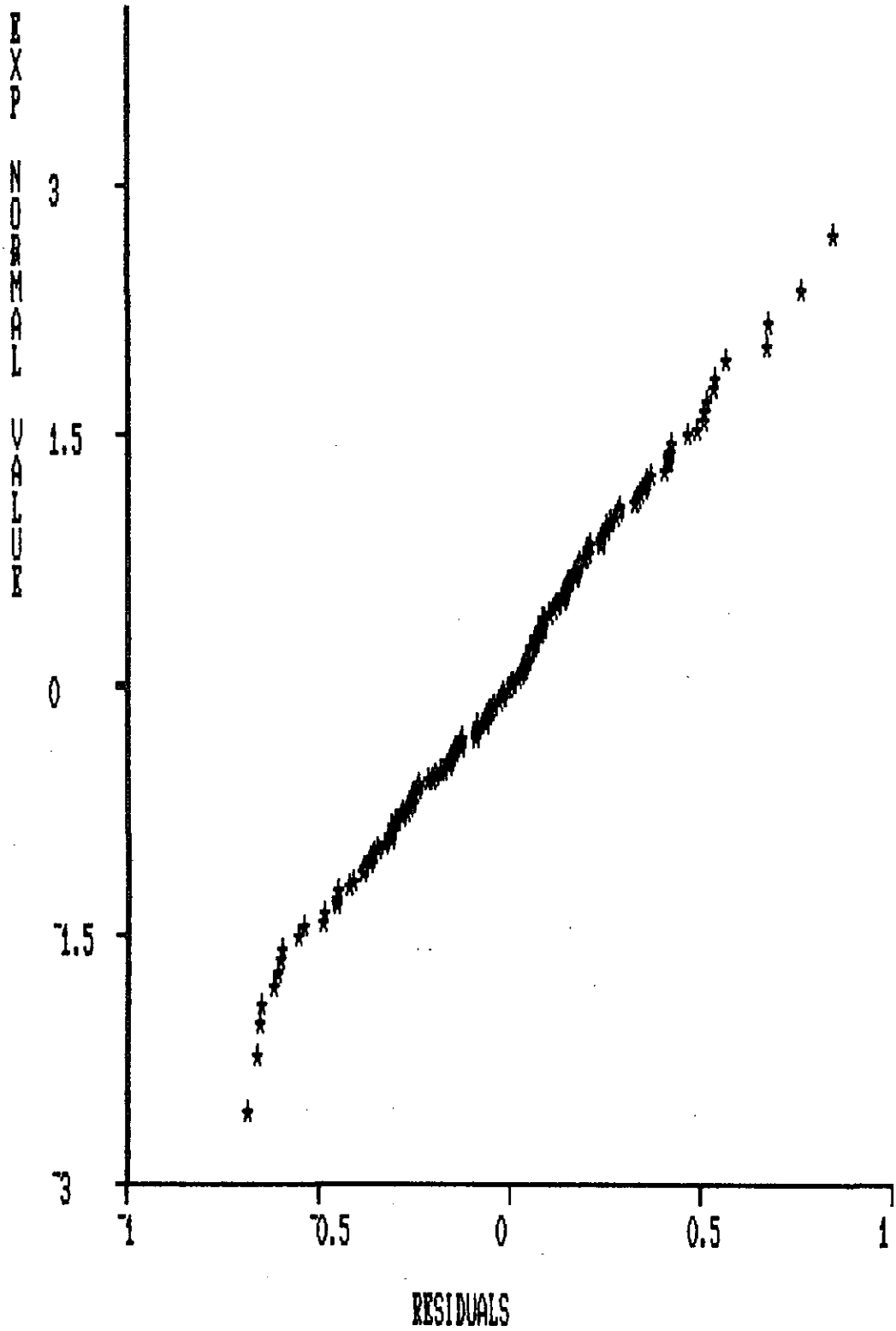
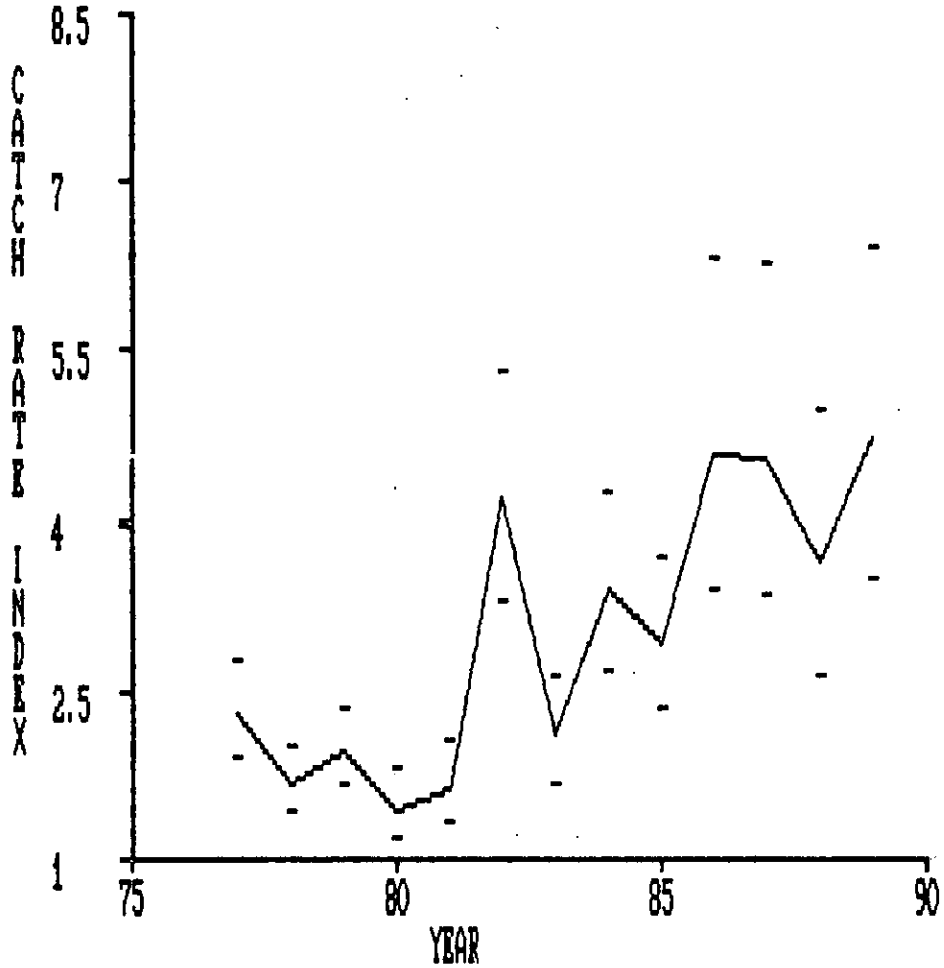


Figure 6: Silver hake standardized catch rate.



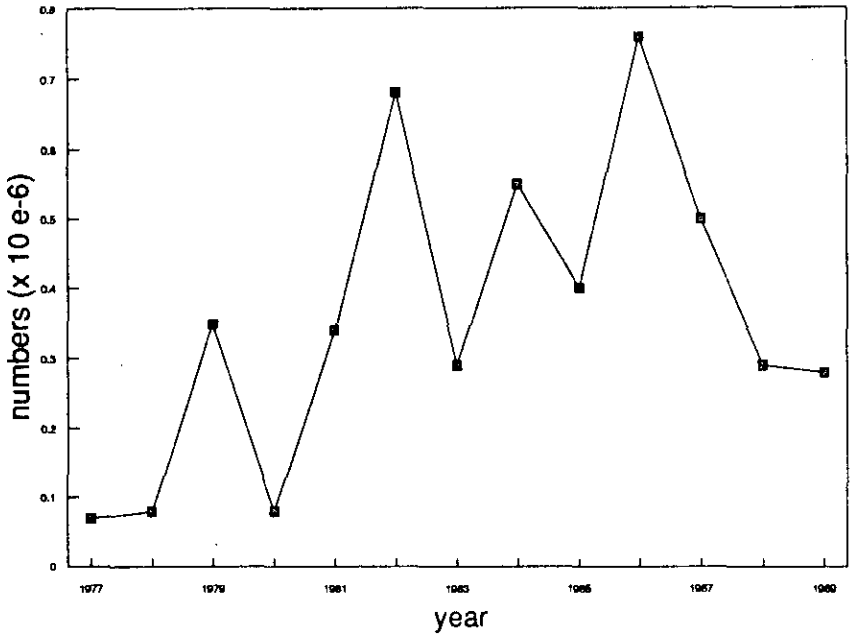


Figure 7: July R/V survey estimates of 4VWX silver hake age 1+ numbers.

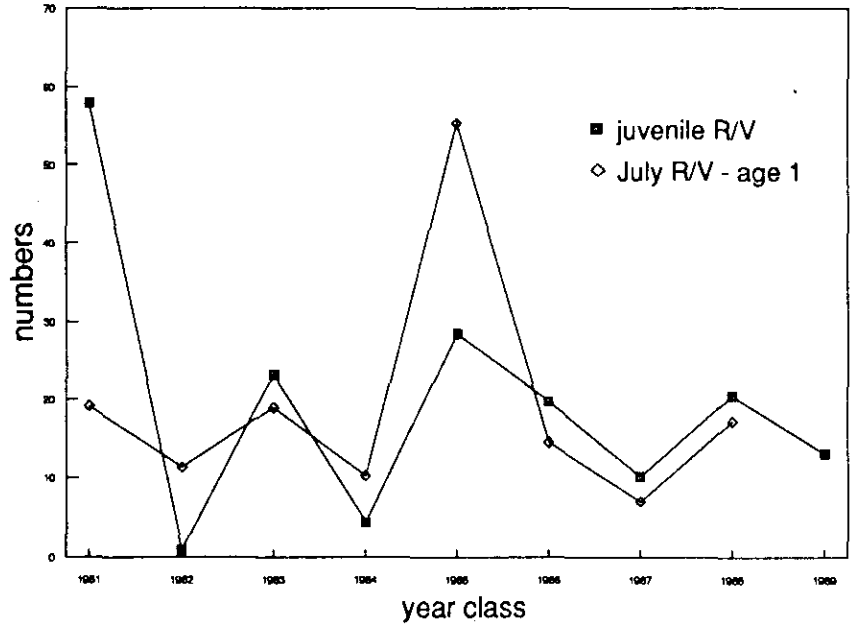


Figure 8: Silver hake stratified mean catch per tow (x0.1) plotted with the July R/V survey age 1 numbers ($x10^{-7}$) from the corresponding year class.