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Canadian Juvenile Silver Hake Abundance Estimates from Joint
Canada-USSR Surveys on the Scotian Shelf

by

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Abstract

Juvenile silver hake data from Canadian records taken during cooperative Canadian-USSR surveys from 1978-85 are tabulated and the methods used to calculate the abundance estimates are presented. Canadian data is also compared with available USSR records from 1978-83 to determine the differences in the methods used in calculating abundance estimates for assessment purposes.

Introduction

During the June, 1985 meeting the NAFO Scientific Council indicated that since the methods used by Canada and the USSR to calculate juvenile silver hake abundance indices appear to differ, these should be fully documented for the June, 1986 meeting, and the best estimation procedure investigated. This paper presents these methods for the Canadian estimates, compares them to the methods used by Soviet scientists and presents the original data by set and stratum to allow comparison with original USSR data or recalculation of estimates as may be desired by assessment scientists.

Methods

Survey design and methodology has been investigated and described previously (Koeller 1981, Koeller et al 1984, Noskov and Sherstjukov) 1984, Ivanova and Sherstjukov 1985). Canadian abundance indices were calculated as the stratified mean catch per tow using the standard formula

$$\bar{Y}_{st} = \frac{\sum_{h=1}^h (A_h \times \bar{y}_h)}{A_h}$$

where

A_h = the area of the hth stratum

\bar{y} = the mean catch in the hth stratum

For all years the stratified mean was calculated for a group of core strata (60-78) which from initial surveys were found to contain the main concentration of juveniles. No corrections were made for distance travelled during the standard 30 minute sets at 3.5 knots. In cases where only one set was achieved in any stratum the stratum mean was set to equal the catch from the single set. Note that stratified variances presented in previous reports were underestimated in these cases since strata with single sets had their variance set at zero. Canadian data in this paper has been edited and corrected since last presented (Koeller *et al* 1984), but changes to abundance estimates are minor. The 1985 data is preliminary. In 1981 the cruise was conducted by two vessels (Eklyptika and Lady Hammond) using the same gear (IYGPT) and methodology (3-step oblique tow, night tows only). However, comparative fishing experiments between these vessels indicated a ratio of 0.667 for Eklyptika:Lady Hammond juvenile silver hake catches. Consequently, all Lady Hammond catches were multiplied by this factor prior to calculating the estimates. Although a change in gear and methodology was also implemented in 1981 (near bottom tows, 24 hour operations, 13.6 m Soviet fry trawl prior to 1981, to 3-step oblique tow, night operations only, IYGPT trawl) no corrections were applied to catches since comparative fishing experiments conducted between gears and methodologies in 1983 were inconclusive (Ivanova and Sherstjukov 1984).

Results

The USSR stratum means and the abundance estimates calculated with them are given in Tables 1 and 2 (Noskov, personal communication). The same information is given for Canadian data records in Tables 3 and 4 for comparison. Differences between Tables 1 and 3 in stratum means and number of tows are mainly due to changes made to Canadian data after editing procedures, particularly reassignment of sets to strata where plotting of set locations indicated that sets actually fell inside strata other than those intended by the initial random selection.

Differences in the methods used to calculate estimates are evident from a comparison of Tables 2 and 4. Unlike Canadian estimates, USSR estimates are calculated using all available data, including strata outside the core area in years when wider coverage was achieved. They are calculated as the actual abundance of fish in the surveyed area, ie.

$$\bar{N} = \frac{\sum_{h} (A_h \times \bar{v}_h)}{g}$$

where g = the area swept by one haul
= 0.0075 nm² for the Soviet 13.6 m trawl
= 0.0104 nm² for the IYGPT

Canadian versus USSR estimates are plotted in Figure 1 for the years 1978-84. As might be expected, the ratio USSR:Canadian estimates tend to be higher in years when the core area was covered than in years when coverage was restricted to it (eg. compare points for 1978 and 1983 in (Figure 1)). Some of

the difference in ratios between years will also be due to differences in assignment of stations to strata as indicated above and to the net factors used in Soviet estimates which are specific to the trawl used. Note, however, that the ranking of year class size is identical using both methods and data sets. Canadian data records are given by set and stratum in Table 5.

Discussion

There are disadvantages to both methods of calculating abundance estimates. The Soviet method assumes complete coverage of the area occupied by juveniles from the 4VWX stock. During years where coverage was restricted to the core area it must be assumed that juvenile distribution was also restricted to it. Since this was probably not the case it is likely that the 1980, 1982 and 1983 year classes are underestimated. The use of the "swept area" method to calculate absolute abundance is also not valid if, as previously determined (Koeller 1981) fish are distributed throughout the water columns during night sets, and if a pelagic trawl set is employed throughout the water column, since the volume filtered and volume in which fish are distributed are not included in the calculations. The reported absolute abundances are therefore underestimates, although their use as an index may still be valid. Consequently, the net factors used to intercalibrate the two series are also not strictly valid since they incorporate only the wing spread rather than the effective mouth opening, or the difference in volume filtered during a standard tow. These factors also do not account for the change in methodologies applied at the same time that trawl types were changed.

The main disadvantages of the Canadian method are that it assumes that the density of fish within the core area is proportional to the size of the year class, and that no corrections are applied for the change in gear and methodology effected in 1981. The first assumption is considered reasonable since the main part of the population appears to concentrate within the core area. However, it is recommended that all future surveys cover the entire area of distribution in Divisions 4VWX.

References

- Koeller, P.A. MS 1981. Vertical distribution and optimum sampling strategy for 0-group silver hake (Merluccius bilinearis) surveys on the Scotian Shelf. NAFO SCR Doc. 81/VI/21.
- Noskov, A.S. and A.I. Sherstyukov. MS 1984. Results of comparative experiments using 13.6 m and IYGPT trawls. NAFO SCR Doc. 84/VI/65.
- Koeller, P.A., J.D. Neilson, and D.E. Waldron. MS 1984. The Canada-USSR juvenile silver hake (Merluccius bilinearis) surveys on the Scotian Shelf: abundance indices, distribution and comparison with independent estimates of juvenile abundance, 1978-83. NAFO SCR Doc. 84/VI/87.
- Ivanova, N.M. and A.I. Sherstjukov. MS 1985. Calculated estimates of differential catchability for two fry trawls (International IYGPT and the Soviet 13.6 m trawls). NAFO SCR Doc. 85/112.

TABLE 1. USSR Survey data from cooperative Canada/USSR juvenile s.hake surveys (Noskov, personal communication)

STRATUM	AREA(NM2)	1978		1979		1980		1981		1982		1983	
		n	X	n	X	n	X	n	X	n	X	n	X
47	1616	3	0	3	0								
48	1449	3	0	3	0								
*49	144	2	0	2	0								
50	383	2	3	2	0								
51	147	2	0	2	0								
53	259	4	0	4	1			2	1				
54	499	3	0	3	6			2	2253				
55	2122	7	1	7	1			6	44				
56	955	3	17	3	15			4	146				
57	811	3	1	3	3			3	1				
58	658	2	0	2	0			0	0				
59	3148	2	1	2	0			0	0				
60	1344	3	386	3	8	8	6	5	326	5	15	5	68
61	1154	4	75	4	21	6	28	3	205	5	4	5	200
62	2116	5	283	5	6	13	53	8	569	9	2	9	268
63	302	2	30	2	0	2	1	2	153	2	1	2	126
64	1297	4	13	4	15	7	23	5	634	5	12	4	83
65	2383	5	640	5	7	14	33	11	405	11	5	9	278
66	226	4	1	4	2166	4	82	2	88	2	0	2	176
70	920	3	185	3	1	6	13	3	1533	2	21	2	35
71	1004	3	91	3	93	6	16	4	548	1	55	4	221
72	1249	4	176	4	15	7	25	6	619	4	11	5	743
73	265	2	59	2	1	2	0	2	94	2	2	1	27
74	161	2	0	2	2	2	3	2	565	2	0	1	5
75	156	2	1	2	6	2	0	2	1096	1	0	2	69
76	1478	6	20	6	19	9	26	7	866	5	13	6	233
77	1232	4	274	4	123	8	15	6	851	4	13	5	225
78	233	2	20	2	34	4	27	2	413	2	0	2	60
80	655	3	6	3	6			3	133				
81	1875	6	1	6	14			8	497				

TABLE 2. Summary of USSR data presented in TABLE 1

YEAR	SETS	STRATA	K	S	TOTAL NO. (K X S)
1978	100	47-81	132	3653666	4.8228E+08
1979	100	47-81	132	927737	1.2246E+08
1980	100	60-78	132	402759	5.3164E+07
1981	98	53-81	96	11554473	1.1092E+09
1982	62	60-78	96	180828	1.7359E+07
1983	64	60-78	96	3573602	3.4307E+08
1984					
1985					

A= 3,429,904 sq.meters (1 sq.nautical mile)
k= net factor 13.6: A/(8m wing spread x 3241m)=132
IYGPT: A/(11m wing spread x 3241m x A)=96
S=SUM(STRATUM MEAN x STRATUM AREA)

TABLE 3. Canadian data from cooperative USSR/Canadian s.hake surveys

STRATUM	AREA(NM2)	n	1978		1979		1980		1981	
			n	X	n	X	n	X	n	X
47	1616	3	0.0	3	0.0					
48	1449	3	0.0	3	0.0					
50	383	2	3.0	2	0.0					
51	147	2	0.0	2	0.0					
*52	345	2	0.0	2	0.0					
53	259	4	0.0	4	0.8			2		0.0
54	499	3	0.0	3	5.7			2		2253.0
55	2122	7	0.4	7	0.6			6		44.3
56	955	3	17.3	3	15.3			4		146.8
57	811	3	0.3	3	4.0			3		1.3
58	658	2	0.0	2	0.0					
59	3148	2	1.0	2	0.0					
60	1344	3	386.0	3	7.3	6	29.3	5		325.8
61	1154	4	74.8	4	18.0	8	5.3	3		205.0
62	2116	5	315.4	5	5.6	13	53.5	8		569.6
63	302	2	30.5	2	0.0	1	0.0	2		153.0
64	1297	4	13.5	4	15.3	7	23.0	5		634.0
65	2383	5	640.4	5	6.6	15	31.4	11		405.0
66	226	4	0.5	4	2167.3	4	83.8	2		88.5
70	920	3	143.0	3	0.3	6	12.8	4		1246.3
71	1004	3	90.7	3	93.0	6	16.5	4		548.5
72	1249	4	176.5	4	15.0	7	25.1	6		619.2
73	265	2	59.0	2	1.5	3	3.0	2		94.0
74	161	2	0.0	2	2.5	2	3.0	2		565.0
75	156	2	1.0	2	6.5	2	0.0	1		778.0
76	1478	6	19.7	6	19.5	7	32.1	8		857.8
77	1232	4	274.5	4	124.0	9	13.2	12		958.3
78	233	2	20.0	2	34.0	4	26.8	2		412.5
80	655	3	6.0	3	6.3			3		133.0
81	1875	6	1.2	6	14.2			8		496.9

STRATUM	AREA(NM2)	n	1982		1983		1984		1985	
			n	X	n	X	n	X	n	X
43	1318						1	0.0		
44	3925						2	0.0		
45	1023						2	0.0		
46	491						3	0.0		
47	1616						4	0.0		
48	1449						4	3.0	2	0.0
49	144						2	0.0		
50	383						3	3.7	3	0.3
51	147						2	0.0		
*52	345						2	0.5	2	0.0
53	259						2	0.5	2	717.0
54	499						2	24.0	2	3.5
55	2122						6	87.2	6	380.3
56	955						4	54.3	4	157.0
57	811						2	4.5	2	11.5
58	658						3	0.0	3	0.3
59	3148						4	1.0	3	0.0
60	1344	5	15.2	6	74.0	5	28.4	5	36.8	
61	1154	5	4.4	5	207.0	5	15.2	5	95.2	
62	2116	9	2.0	8	287.5	9	36.2	18	246.8	
63	302	2	1.0	2	116.0	1	51.0	2	87.5	
64	1297	5	11.6	4	83.5	5	75.6	5	1169.2	
65	2383	11	5.5	9	280.7	14	85.4	11	442.4	
66	226	2	0.0	2	176.0	2	10.5	2	838.5	
70	920	2	21.5	1	33.0	2	35.5	3	78.3	
71	1004			5	185.2	4	30.8	4	43.8	
72	1249	4	10.5	5	749.0	5	17.8	6	267.7	
73	265	2	2.5	1	27.0	2	12.0	2	14.0	
74	161	2	0.0	1	5.0	2	13.5	2	35.5	
75	156	1	0.0	2	69.5	2	12.0	2	32.5	
76	1478	5	13.2	6	232.3	7	5.4	7	83.4	
77	1232	4	12.8	5	224.8	5	98.4	6	360.7	
78	233	2	0.0	2	60.5	1	0.0	2	10.0	
80	655						3	17.7	3	21.7
81	1875						4	63.0	8	277.4

Stratum marked "*" in Tables 1 and 3 are equivalent

TABLE 4. Summary of Canadian data presented in TABLE 3.

YEAR	SETS	STRATA	S	STRAT. MEAN NO./TOW
1978	55	60-78	3658465	235.7
1979	55	60-78	874039	56.3
1980	100	60-78	413218	26.6
1981	77	60-78	8985819	579.0
1982	61	60-78	127028	8.8
1983	64	60-78	3603693	232.2
1984	71	60-78	673897	43.4
1985	82	60-78	4419365	284.8

S= SUM(STRATUM MEAN x STRATUM AREA)

TABLE 5. Catches by set from Cooperative Canada/USSR juvenile s.hake surveys (from Canadian records)

STRATUM	1978								MEAN
	sets----->								
47	0	0	0						0.0
48	0	0	0						0.0
50	0	6							3.0
51	0	0							0.0
52	0	0							0.0
53	0	0	0	0					0.0
54	0	0	0						0.0
55	0	0	0	0	0	0	0	3	0.4
56	40	12	0						17.3
57	0	1	0						0.3
58	0	0							0.0
59	0	2							1.0
60	9	42	1107						386.0
61	11	243	0	45					74.8
62	62	1221	169	94	31				315.4
63	6	55							30.5
64	21	18	0	15					13.5
65	2899	96	66	0	141				640.4
66	0	2	0	0					0.5
70	45	325	59						143.0
71	71	77	124						90.7
72	31	127	392	156					176.5
73	32	86							59.0
74	0	0							0.0
75	2	0							1.0
76	12	10	2	0	21	73			19.7
77	445	575	0	78					274.5
78	19	21							20.0
80	15	0	3						6.0
81	0	0	3	4	0	0			1.2

TABLE 5. Continued

STRATUM	1979								MEAN
	sets----->								
47	0	0	0						0.0
48	0	0	0						0.0
50	0	0							0.0
51	0	0							0.0
52	0	0							0.0
53	0	0	0	3					0.8
54	0	0	17						5.7
55	3	0	0	0	0	0	0	1	0.6
56	10	7	29						15.3
57	2	1	9						4.0
58	0	0							0.0
59	0	0							0.0
60	0	10	12						7.3
61	38	18	12	4					18.0
62	3	1	6	0	18				5.6
63	0	0							0.0
64	0	10	18	33					15.3
65	32	0	0	0	1				6.6
66	2758	32	5738	141					2167.3
70	1	0	0						0.3
71	8	259	12						93.0
72	7	9	21	23					15.0
73	2	1							1.5
74	0	5							2.5
75	1	12							6.5
76	2	1	4	17	90	3			19.5
77	50	276	11	159					124.0
78	65	3							34.0
80	9	0	10						6.3
81	0	5	2	10	0	68			14.2

TABLE 5. Continued

STRATUM	1980										MEAN
	sets----->										
47											
48											
50											
51											
52											
53											
54											
55											
56											
57											
58											
59											
60	6	19	23	0	0	128					29.3
61	9	3	16	10	4	0	0	0			5.3
62	74	3	46	24	7	4	13	0	15		53.5
	256	254	0	0							
63	0										0.0
64	20	23	4	7	42	17	48				23.0
65	4	0	5	127	0	8	12	57	0		31.4
	3	24	10	217	2	2					
66	8	0	0	327							83.8
70	7	6	18	21	0	25					12.8
71	1	2	1	4	1	90					16.5
72	2	142	1	1	1	0	29				25.1
73	0	0	9								3.0
74	4	2									3.0
75	0	0									0.0
76	128	20	41	1	4	25	6				32.1
77	0	29	4	83	0	0	0	3	0		13.2
78	0	2	7	98							26.8
80											
81											

TABLE 5. Continued. *Italics indicate Lady Hammond set*

STRATUM	1981										MEAN
	sets----->										
47											
48											
50											
51											
52											
53	0	0									0.0
54	4482	24									2253.0
55	1	0	0	124	93	48					44.3
56	1	60	6	520							146.8
57	0	0	4								1.3
58											
59											
60	252	390	601	124	262						325.8
61	81	227	307								205.0
62	386	389	357	744	202	747	299	1433			569.6
63	46	260									153.0
64	2525	43	368	45	189						634.0
65	365	554	277	45	347	840	332	540	286		405.0
	576	293									
66	119	58									88.5
70	186	2800	1612	<u>387</u>							1246.3
71	703	502	515	474							548.5
72	528	428	506	1151	724	378					619.2
73	42	146									94.0
74	<u>645</u>	<u>485</u>									565.0
75	<u>778</u>										778.0
76	<u>620</u>	<u>216</u>	<u>201</u>	<u>3461</u>	<u>729</u>	<u>795</u>	<u>462</u>		378		857.8
77	<u>635</u>	<u>643</u>	<u>1313</u>	<u>1377</u>	<u>2040</u>	<u>689</u>	<u>339</u>	<u>1414</u>			958.3
	669	1293	721	367							
78	309	516									412.5
80	<u>115</u>	<u>93</u>	<u>191</u>								133.0
81	<u>13</u>	<u>36</u>	<u>237</u>	<u>79</u>	<u>184</u>	<u>1179</u>	<u>1445</u>	<u>802</u>			496.9

TABLE 5. Continued

STRATUM	1984										MEAN
	sets----->										
43	0										0.0
44	0	0									0.0
45	0	0									0.0
46	0	0	0								0.0
47	0	0	0	0							0.0
48	7	3	2	0							3.0
49	0	0									0.0
50	7	4	0								3.7
51	0	0									0.0
52	0	1									0.5
53	1	0									0.5
54	28	20									24.0
55	8	6	106	293	99	11					87.2
56	27	83	94	13							54.3
57	4	5									4.5
58	0	0	0								0.0
59	0	0	1	3							1.0
60	38	16	11	18	59						28.4
61	19	30	15	7	5						15.2
62	22	25	33	85	118	0	14	22	7		36.2
63	51										51.0
64	239	77	17	27	18						75.6
65	15	25	245	70	318	24	212	38	67		85.4
	21	12	81	52	16						
66	15	6									10.5
70	21	50									35.5
71	26	27	32	38							30.8
72	26	14	16	15	18						17.8
73	20	4									12.0
74	6	21									13.5
75	23	1									12.0
76	2	1	3	7	5	12	8				5.4
77	40	335	20	30	67						98.4
78	0										0.0
80	7	3	43								17.7
81	30	23	113	86							63.0

STRATUM	1985										MEAN
	sets----->										
47											0.0
48	0	0									0.0
50	0	0	1								0.3
51											
52	0	0									0.0
53	1417	18									717.5
54	1	6									3.5
55	166	40	70	129	1877	0					380.3
56	0	1	562	65							157.0
57	0	23									11.5
58	0	0	1								0.3
59	0	0	0								0.0
60	91	29	21	3	40						36.8
61	81	51	171	84	89						95.2
62	16	5	408	156	311	206	184	1363	554		246.8
	114	176	342	229	29	11	288	26	24		
63	146	29									87.5
64	702	637	50	4271	186						1169.2
65	617	998	420	757	456	143	238	237	107		442.4
	530	363									
66	957	720									838.5
70	91	31	113								78.3
71	39	65	54	17							43.8
72	399	501	259	208	208	31					267.7
73	12	16									14.0
74	58	13									35.5
75	14	51									32.5
76	254	142	44	95	15	3	31				83.4
77	11	624	286	183	1023	37					360.7
78	0	20									10.0
80	13	18	34								21.7
81	8	3	0	69	239	517	1089	294			277.4

FIGURE 1 CANADIAN vs USSR indices

