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An examination of the 1976 USSR assessment of the Div. 4VWX silver hake fishery

by

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This paper presents an assessment of the Div. 4VWX silver hake fishery based on the data presented by Noskov (1976). Catch data (numbers at age) were given by Noskov (1976) for 1963-1975 for Div. 4W. These data were prorated to include the total catch in Div. 4VWX (Table 1). Virtual population analysis (VPA) was performed using M=0.5 for all ages and F=1.0 for ages 3 and older in 1975, as assumed by Noskov (1976). Terminal F for those year-classes having passed through the fishery prior to 1975 was assumed to be the mean F for the fully-recruited age groups (weighted by stock size) in that particular calendar

Partial recruitment at ages 1 and 2 averaged 3% and 12% during 1963-1974 and 5% and 18% during 1968-1974 (Table 2), as indicated by fishing mortality rates calculated from VPA. Partial recruitment of 5% at age 1 and 18% at age 2 was assumed for 1975-1977. Fishing mortality at ages 1 and 2 in 1975 was assumed to be 0.05 and 0.18, respectively.

Mean weights at age (given in Table 4) used in this assessment were those presented by Noskov (1976) which were calculated from Halliday (1973). These weights were applied to the numbers caught at age to determine the calculated catch in each year. The ratio between calculated and observed catch in each year (Table 3) varied from 0.8251 to 1.2824 and averaged 1.0264 for 1963-1975. The mean weights at age were also used to calculate stock biomass in each year, and the total weight was corrected using the calculated/observed catch ratio for that predictions for 1976-1977 (Table 4).

Results of the VPA are given in Table 1 and Figures 1 and 2. Fishing mortality was high in 1963-1965 (mean of 1.28), declined to a low of 0.024 in 1968, averaged about 0.32 during 1969-1972, and then increased sharply to 1.44 in 1973. Fishing mortality dropped to 0.66 in 1974 and then increased to an estimated level of 1.0 in 1975.

Stock biomass (age 1+) decreased from about 392,000 tons in 1963 to 186,000 tons in 1966, increased rapidly to 1,261,000 tons in 1971, and decreased sharply to 335,000 tons in 1975 (Table 1, Figure 1). Catches tended to cycle with the biomass; catches decreased after 1963 as biomass decreased, increased after 1968 as biomass increased, and decreased again in 1971 and 1972 as biomass again began to decrease. However, in 1973, nearly half of the estimated biomass of 630,000 tons was removed by the fishery. This catch (299,000 tons) generated a fishing mortality (F=1.44) twice the optimal level which, according to Noskov (1976), is 0.7 (F_{opt}) for M=0.5.

Results of the VPA show that the cyclic fluctuation in biomass resulted directly from a cyclic fluctuation in recruitment. The strongest year-class during the period was produced in 1969 (5.5 billion fish at age 1) which was followed closely in size by the 1967, 1968, and 1970 year-classes which averaged 4.5 billion fish each (Table 1, Figure 2). The strength of the year-classes produced after 1970 declined steadily each year. Given the catch in 1975 of age 1 and 2 fish and assuming partial recruitment of 5% and 18%, respectively, the sizes of the 1974 and 1973 year-classes at age 1 were calculated to be 0.9 and 1.35 billion fish, respectively. The mean size of the 1962-1974 year-classes at age 1 was 2.6 billion fish.

The sizes of the 1973-1975 year-classes are quite critical in determining stock size at the beginning of 1977 and, accordingly, the 1977 TAC. Noskov (1976) assumed that the 1973 and 1975 year-classes at age 1 were equal to the mean of the 1968-1972 year-classes. In the present analysis, the mean size of the 1968-1972 year-classes is 3.64 billion fish. If the size of the 1973 year-class at age 1 is assumed equal to 3.64 billion fish, this would constitute an estimate which is 2.7 times greater than that calculated by VPA in the present analysis (1.35 billion fish). Results of the present VPA (Table 1) indicate that F=0.032 for the 1973 year-class at age 1 which represents partial recruitment of 4.9% (Table 2). If a year-class of 3.64 billion fish is assumed, the reported catch of 332×10^5 fish would have generated an F of only 0.0117 which represents partial recruitment of only 1.8%. This value is substantially below the mean of 6.0% for 1972-1973, 4.9% for 1968-1973, and 2.9% for 1963-1973. Furthermore, the resulting size of the 1973 year-class at age 2 would have been 2.18 billion fish instead of 0.80 billion as calculated in the present VPA. The reported catch of 1039x10⁵ fish (1973 year-class, age 2) would have generated an F of 0.062 (6.2% partial recruitment) instead of 0.18 (18% partial recruitment) as assumed in the present VPA. Partial recruitment of 6.2% at age 2 was observed in 1973, but the 1963-1974 and 1968-1974 means were 12.3 and 17.7%, respectively. For the purposes of prediction, the conservative approach would imply that a mean of the recent values be employed for partial recruitment instead of the lowest of the recent values.

In the present analysis the 1975 and 1976 year-classes at age 1 were assumed equal to the mean of the 1962-1974 year-classes at that age (2.6 billion fish). Following the assumption by Noskov (1976) would result in an estimate for the 1975 year-class (3.64 billion fish) which is 1.4 times larger than that used in the present analysis. Figure 2 clearly illustrates the past (1962 yearclass - present) pattern in year-class size at age 1. Results of the VPA suggest a pronounced rise and fall of year-class strength from the early 1960's to the early 1970's with the present trend being in a downward direction. The assumption made in this assessment, therefore, that the 1975 and 1976 year-classes are equal in size to the mean of the 1962-1974 year-classes, may be optimistic. The assumed size of these year-classes exceeds the sizes of the 1971-1974 year-classes which were calculated from the present VPA. This assumption tends to reverse the observed decline in the strength of recent year-classes. A more conservative approach may be to use the mean of the last several years or the lowest observed size that is known with some degree of confidence. The 1974 year-class at age 2 was assumed by Noskov (1976) to be strong and to equal the mean of the 1968-1969 year-classes. From the present analysis, this would result in 2.97 billion fish at age 2. Given the catch of 349×10^5 fish from the 1974 year-class at age 1, a year-class size of 2.97 billion fish at age 2 implies a fishing mortality of 0.009 at age 1 and a year-class size of 4.95 billion fish at age 1. This is 5.5 times greater than the 0.9 billion fish calculated in the present analysis, and would make the 1974 year-class almost as strong as the 1969 year-class, the largest on record. An F of 0.009 at age 1 in 1975 implies partial recruitment of less than 1% compared to a mean of 5% in 1968-1974 (range of 1.5 to 8.1%). Therefore, unless the fishing pattern suddenly changed in 1975 and the catch of age 1 fish in proportion to their abundance was, for some reason, substantially less than in past years, the assumption by Noskov (1976) concerning the size of the 1974 year-class would result in a considerable

Given the estimated number of fish age 2 and older present at the beginning of 1976 (1.1 billion) as calculated from VPA and assuming that the 1975 year-class at age 1 contained 2.6 billion fish (mean of 1962-1974 year-classes), an F of 1.42 for ages 3 and older (with partial recruitment of 18% at age 2 and 5% at age 1) would be required to generate the 1976 TAC of 100,000 tons (Table 4). Given the resulting estimated stock size of age 2 and older fish at the beginning of 1977 (1.8 billion fish) and assuming that the 1976 year-class at age 1 also contained 2.6 billion fish, fishing mortality of 0.7 in 1977 would result in a TAC of 47,000 tons.

overestimate of stock size.

The recommended 1977 TAC from the assessment by Noskov (1976) was 125,000 tons, assuming M=0.5 and F=0.7. The assessment by Doubleday et al. (1976) resulted in a recommended TAC of 60,000-70,000 tons. The TAC which is advised on the basis of the present assessment is lower than that recommended by Noskov (1976) mainly because of the differences in the estimated sizes of the 1973-1975 year-classes. In order to justify a TAC larger than that calculated in the present assessment, strong evidence from research vessel surveys must be presented which would support the optimistic assumption concerning the strength of the 1973-1975 year-classes.

Literature Cited

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									YEAR-CLAS	S				
	Year	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Catch (10 ⁵)	1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975	1	3	6	6	21 6	442 83 4	2045 342 44 1	2778 1702 301 16 1	689 1188 1050 107 3 4 12 1	12 86 452 182 22 6 20 13 19 12 1	10 5 123 69 9 103 29 41 5 5	1 102 20 300 45 28 8 10 2	1 2 107 786 626 93 27 35 7
F	1963 1964 1965 1966 1967 1968 1969 1970 1971 1973 1973 1974	(1.370)	(1.370)	(1.370)	(1.370)	.913 (1.189)	1.384 2.279 (1.277)	1.373 1.635 2.006 (.297)	.512 1.080 .848 .128 .014 (.024)	.118 .432 1.417 .772 .057 .137 1.200 (.399)	.002 .026 .261 .051 .024 .141 .177 .615 1.866 (1.436)	.002 .074 .074 .017 .376 .239 .948 .393 (1.436)	<.001 .036 .012 .673 .276 .392 .258 .895 (.657)	<.001 <.001 .025 .360 .817 .378 .250 .895 (.657)
Stock siz e (10 ⁵)	1963 1964 1965 1965 1967 1968 1967 1970 1971 1972 1973 1974 1975 1976	2	5	10	10	43 10	710 108 7	3296 506 60 5	8628 3136 646 168 90 54	7844 4229 1666 245 69 39 21 4	6907 4182 2471 1154 561 323 192 192 101 51 17 2	5889 3573 2174 1224 690 412 172 82 19 8 8	5778 3634 2126 1274 758 234 108 44 21 5	14130 8767 5506 3257 1379 370 154 72 18

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Table 1. Catch, fishing mortality (F), and stock sizes for silver hake in Div. 4VWX, 1963-1975, assuming M=0.5

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		_										CATCH	
1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976		Total No. (10 ⁵)) Tons
1 77 837 1952 777 146 146 21 2	8 261 3648 2758 1015 528 35 14	440 1400 2769 1531 2297 82 50	921 1603 2617 6765 362 109	201 1374 7612 1645 427	430 981 2716 1491	591 1081 2155	14 332 1039	349				6003 3417 1857 532 118 232 2759 8635 8289 7165 18985 6283 5636	123,028 81,147 50,022 10,323 2,483 3,523 46,554 169,045 128,653 114,048 299,621 95,601 110,250
<.001 .006 .110 .578 .715 .397 1.476 1.597 1.000	<.001 .012 .312 .599 .685 1.675 .678 1.000	- 013 - 069 - 261 - 316 1- 985 - 496 1- 000	.021 .064 .195 1.961 .825 1.000	.006 .069 .983 .909 1.000	.022 .089 .537 1.000	.054 .181 1.000	. 032 . 180	. 050			Wtd F 1.370 (4+) 1.189 (4+) 1.277 (4+) .297 (4+) .064 (4+) .203 (3+) .399 (3+) .400 (3+) .657 (3+) 1.000 (3+)		
25448 18629 10153 5516 1877 557 227 31 4 1	46227 28524 17090 2529 733 88 27 6	44703 26787 15273 7092 3137 261 96 21	\$5075 32696 18601 9281 792 210 47	43483 26238 14860 3374 824 184	24667 14634 8123 2879 642	14309 8223 4161 928	13537 7956 4031	9075 5236	(26000)	(26000)	Num Age 2+ 20548 12171 8423 7380 12837 24715 43317 51283 57947 55251 43015 20915 16157 11096	Stock size ber (10 ⁵) Age 1+ 27455 18060 14201 21510 38285 70942 88020 106358 101430 79918 57324 34452 25232 37096	Tons Age 1+ 391,621 264,515 202,606 185,709 301,239 578,285 758,080 1,261,209 903,049 835,949 630,749 358,066 334,506 364,750

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Year	Age 1	Age 2
1963	0.1	8.6
1964	0.2	2.2
1965	0.1	0.2
1966	0.3	12.1
1967	1.6	1.6
1968	4.2	25.0
1969	6.4	5.9
1970	5.3	17.3
1971	1.5	16.0
1972	8.1	25.3
1973	3.8	6.2
1974	4.9	28.0
Mean		
1963-1974	2.9	12.3
1968-1974	4.9	17.7

Table 2.	Partial recruitment (percentage) at age 1-2
	from VPA.

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Table 3.	Observed vs.	calculated catch	(tons) of silver
	hake in Div.	4VWX, 1963-1975.	

			Calculated
Year	Observed catch	<u>Calculated</u> catch	Observed
1052	122 020	100 405	9919
1302	123,020	100,400	.0010
1964	81,14/	70,449	.8682
1965	50,022	41,274	.8251
1966	10,323	10,960	1.0617
1967	2,483	2,704	1.0890
1968	3,523	3,683	1.0454
1969	46,564	51,067	1.0967
1970	169,045	140,587	.8317
1971	128,653	152,313	1.1839
1972	114,048	130,830	1,1471
1973	298,621	382,964	1.2824
1974	95,601	108,064	1.1304
1975	110,250	99,158	. 8994
		$\overline{\mathbf{x}}$ =	1.0264

Table 4. Predictions of catch, fihsing mortality, and stock size for silver hake in D1v. 4VWX in 1976-1977.

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1	AGE S	EL. COEFF	AVE.	WEIGHT						
2	••• •	**************************************	****	06300						
3 1.00000 .15100 4 1.00000 .21400 5 1.00000 .47800 7 1.00000 .53500 9 1.00000 .63500 PATA SET 1 YERR 1975 M= .5000 F= 1.0000 2= 1.5000 PATA SET 1 YERR 1975 M= .5000 F= 1.0000 2= 1.5000 PATA SET 1 YERR 1975 M= .5000 F= 1.0000 2= 1.5000 AGE RECRUITS (ML) CATCH (ML) CATCH (ML) CATCH (ML) 1 907.500 57.173 34.902 2.199 AGE STUCK (ML) STUCK (ML) STUCK (ML) 3.613 4 207.900 61.611 149.107 31.909 5 32.400 26.266 42.676 13.614 6 21.000 1.338 .207 .173 3 4.610.5.700 243.631 CATCH (ML) CATCH (ML) STUCK (10.1) STUCK (ML) STUCK (ML) CATCH (ML) CATCH (ML) 10 9 .400 .338 .207 .117.3 </td <td>2</td> <td>.18000</td> <td>:</td> <td>09500</td> <td></td> <td></td> <td></td> <td></td> <td></td>	2	.18000	:	09500						
4 1.00000 .21400 5 1.00000 .47900 7 1.00000 .63500 3 1.00000 .63500 7 1.00000 .63500 7 1.00000 .63500 7 YERR 1975 N= .5000 F= 1.5000 7 YERR 1975 N= .5000 F= 1.0000 .21500 7 YERR 1975 N= .5000 F= 1.0000 .21500 7 907.500 57.173 34.902 2.199 7 975.500 75.592 103.906 9.971 3 405.600 62.813 215.504 32.541 3 415.600 52.80 4.972 2.735 3 400 26.866 4.972 2.735 3 2.700 1.717 1.393 .899 9 .400 .338 .207 .175 107.4 YERR 1976 N= .5000 F= 1.4200 Z= 1.920 DRFR SET 1 YERR	3	1.00000		15100						
3 1.00000 .47900 7 1.00000 .53000 3 1.00000 .63600 9 1.00000 .63600 9 1.00000 .63600 9 1.00000 .63600 9 1.00000 .63600 9 1.00000 .63600 9 1.00000 .63600 9 .00000 .63600 9 .00000 .7173 .0000 1 .907.500 .57.173 .34.902 .199 0 .5000 .57.173 .34.902 .199 0 .5000 .57.592 .103.906 .9.971 1 .907.500 .57.773 .34.902 .199 4 .207 .1.998 .389 .3.614 5 .21.600 .5.280 4.972 .2.735 9 .2.000 .717 .1.398 .399 10 .901 .207 .175 10 .900 .63.800 .207 .175 10 .900 </td <td>4</td> <td>1.00000</td> <td>•</td> <td>21400</td> <td></td> <td></td> <td></td> <td></td> <td></td>	4	1.00000	•	21400						
5 1.00000	5	1.00000	•	31900 47900						
3 1.00000 .34500 PATA SET 1 YERR 1975 N= .5000 F= 1.0000 2= 1.5000 RGE RECRUITS (MD.) RECRUITS (WT.) CATCH (MD.) CATCH (WT.) CATCH (MD.) STOCK (WT.) 2 795.600 75.592 103.906 9.871 3 416.100 62.331 215.504 32.541 4 287.900 61.611 149.107 31.909 5 82.400 26.286 42.676 13.614 6 21.000 10.038 10.876 5.199 7 9.600 5.280 4.972 2.735 8 2.700 1.717 1.338 .389 9 .400 .338 .207 .175 TOTAL (MD.) (WT.) TOTAL (MD.) (WT.) TOTAL (MD.) RECRUITS (WT.) CATCH (MD.) CATCH (MD.) CATCH (WT.) TOTAL (MD.) RECRUITS (WT.) CATCH (MD.) CATCH (MD.) CATCH (WT.) TO 9 DATA SET 1 YEAR 1976 M= .5000 F= 1.4200 Z= 1.9200 RGE RECRUITS (MD.) RECRUITS (WT.) CATCH (MD.) CATCH (MD.) CATCH (WT.) CATCH (MD.) CATCH (MD.) CATCH (WT.) CATCH (MD.) CATCH (WT.)	5	1 00000		55000						
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Fig. 1. Catch, stock biomass, and fishing mortality for silver hake in Div. 4VWX.



Fig. 2. Abundance of age 1 and age 2+ silver hake in Div. 4VWX.

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International Commission for



the Northwest Atlantic Fisheries

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ANNUAL MEETING - JUNE 1976

An examination of the 1976 USSR assessment of the Div. 4VWX silver hake fishery

by

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Revised 1975 catch at age data (Table 5) were utilized in a new virtual population analysis (VPA). The catch in 1975 as used in the previous VPA was 110,250 tons. The revised catch used in the new VPA was 116,285 tons.

Results of the analysis indicated that at the beginning of 1976, the stock of age 2+ fish was 1.18 billion fish or 192,600 tons.

Several options were considered for the size of the 1975 and 1976 year-classes at age 1. Results of the VPA gave estimates of the sizes of the 1962-1974 yearclasses at age 1 (Table 6). These year-classes ranged in size from 5,778 x 10^5 fish (1964 year-class) to 55,253 x 10^5 (1969 year-class). The mean size was 24,035 x 10^5 , while the median was 14,927 x 10^5 . In the absence of any information concerning the size of the 1975 or 1976 year-classes, projections of catch and stock size were made assuming that they equalled (1) the poorest observed year-class (5,800 x 10^5), (2) the median year-class size (15,000 x 10^5), and (3) the mean year-class size observed during 1962-1974 (24,000 x 10^5).

In order to fully take the 1976 TAC of 100,000 tons, fishing mortality would vary from 1.49 to 1.32 depending on the size of the 1975 year-class. Biomass of age 2+ fish at the beginning of 1977 would vary from 103,400 tons to 218,800 tons. Fishing at the level of F = 0.7 in 1977 would result in a catch between 32,400 and 48,600 tons, depending on the various options concerning the sizes of the 1975 and 1976 year-classes, and leave a stock biomass of age 2+ fish in 1978, ranging from 94,400 to 302,400 tons (Fig. 5).

Assuming the lowest option on recruitment $(5,800 \times 10^5)$, fishing at F = 0.7 in 1977 would reduce the biomass of age 2+ fish from 103,400 tons in 1977 to 94,400 tons in 1978. Only at levels of F less than 0.5 in 1977 (or catches less than 24,000 tons) could the stock increase in 1978.

If recruitment is assumed equal to either the median or mean level, then the stock will achieve some increase in size in 1978 compared to 1976 and 1977 if fishing mortality in 1977 does not exceed 0.7.

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The above analysis, therefore, suggests that the TAC for 1977 could set at some level between 32,000 and 49,000 tons, depending on whether recruitment is as poor as previously observed or is as strong as the mean level observed. According to the VPA, however, a year-class as strong as the mean has not been produced since the 1971 year-class.

Table 5. Revised catch at age (10⁵ fish) in 1975 for silver hake in Div. AVWX.

Age	Number (10 ⁵)
1	368
2	1,096
3	2,273
4	1,573
5	450
6	115
7	53
8	15
9	2
Total No.	5,94 <u>5</u>
Wt (tons)	116,285

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Table 6. Size (10⁵ fish) of the 1962-1974 year-class of silver hake in Div. 4VWX at age 1 as estimated by VPA.

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Year-class	Number (10^5)
1962	6,907
1963	5,889
1964	5,778
1965	14,130
1966	25,448
1 967	46,214
1968	44,844
1969	55,253
1970	43,854
1971	25,386
1972	14,927
1973	14,262
1974	9,569
Mean	24,035
Median	14,927
Lowest	5,778
Highest	55,253



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Fig. 5

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