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Status of the Cod Stock in Divisions 2J, 3KL

by

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Nominal Catches

Catches in this area declined from an average of about 640,000 tons in 1966-70 to about 380,000 tons in 1971-75. Recent annual catches (1977 being provisional) and TAC's are as follows:

	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
TAC (000 tons)	666	657	554	300	160
Catch (000 tons)	335	373	288	214	170

Estimation of Age Composition of the Catch

Age compositions for 1977 were derived from each yearly quarter and for each gear, ICNAF Division, and for each country separately as the sampling data permitted. Catches were composed largely of the 1972 and 1973 year-classes, as 4- and 5-year-old cod.

Effort and Fishing Mortality

Table 1 shows the mean catch (kg) per hour trawled in Divisions 3K, 3L and 3KL by Soviet research vessel surveys in the period 1971-77. By applying these research catch rates to the whole of the commercial catches in Divisions 2J3KL, the corresponding effort was calculated and the effort estimates for the years 1971-76 are included in Table 2.

Table 2 also shows effort measures derived from the Soviet and Spanish commercial catch and effort statistics for the period 1963-73. Regressions of fishing mortality (derived from VPA) and effort were calculated for each series of effort. The parameters of these regressions, including R values, are shown in Table 2. The R values are low in each case.

The fishing mortalities estimated for 1977 from 1977 effort measures ranged from .28 to .55, and since no regression was substantially superior to another, an average  $F = 0.40$  for 1977 was used in the VPA.

### Recruitment Estimates

Soviet young fish surveys in Divisions 3K, 3L and 3KL for year-classes 1959-1972 as 3-year-olds were related to estimates of abundance of the same year-classes as 4-year-olds (from VPA). The data used are shown in Table 3. Estimates of the abundance of the 1973 and 1974 year-classes were 530 million and 465 million respectively. Similar data relating the abundance of 2-year-olds from the Soviet surveys to 4-year-olds from VPA lead to an estimate of 432 million for the 1975 year-class (see Table 4).

Research surveys by the Federal Republic of Germany have clearly shown that the 1972 and 1973 year-classes were very strong in comparison with the older age groups in the catches. The 1977 survey results indicate that the 1974 and 1975 year-classes may also be stronger.

A nominal value of abundance of 500 million was used for year-classes subsequent to that of 1975.

### Partial Recruitment Patterns

The partial recruitment pattern used is given in Table 5 and represents the smoothed values of fishing mortality for 1976 derived from the VPA.

### Weight-At-Age

The weight-at-age estimates derived from the 1977 biological sampling is given in Table 6. These values are substantially higher than those used in the 1977 assessment, and may reflect changes in the area and time of capture of the catches in 1977.

### Estimation of Stock Abundance in 1977

Table 7 shows the estimate of abundance at age for the stock in 1977.

### Projection of Catches

Table 8 shows the projected catches and spawning biomass, 1978-86, at fishing mortalities of  $F = 0.20$  ( $F_{0.1}$ ),  $F = 0.16$  and  $F = 0.10$ . The catch in 1970 was about 170,000 tons and it is assumed that the 1978 TAC of 135,000 tons will be taken. For each option, catches and spawning biomass increase after 1978.

Table 9 shows the detailed computer output for the projections at  $F = 0.20$ . The spawning biomass in each year is the total of weights for ages 7-13. In the 1977 assessment, the spawning biomass included ages 7-14.

Table 1. Catch per hour trawled of cod from Soviet research vessel cruises in the period 1971-77.

YEAR	USSR Research Catch per Hour			Total Catch All Countries ('000 tons)
	3K	3L	3KL	
1971	77	138	215	432
1972	134	163	297	458
1973	33	19	52	355
1974	36	33	69	373
1975	19	20	39	288
1976	123	48	171	214
1977	36	98	134	170

Table 2. Various effort estimates and corresponding F values from VPA for cod in area 2J3KL. The effort values for the Soviet commercial fleet are in days fished, for the Spanish commercial fleet in hours fished and for the Soviet Research effort, in hours fished x 10<sup>-4</sup>.

YEAR	F	USSR	EFFORT			Spain
			USSR Research Effort			
			3K	3L	3KL	
1963	.31	10,400				453,680
1964	.45	15,700				557,077
1965	.54	13,900				596,542
1966	.39	15,400				576,555
1967	.50	17,700				588,230
1968	.50	20,500				784,586
1969	.68	19,400				868,917
1970	.36	14,600				637,367
1971	.33	15,800	561	313	201	639,165
1972	.45	14,200	342	281	154	787,704
1973	.52	13,000	1,076	1,868	683	523,014
1974	.85		1,036	1,130	541	
1975	.81		1,516	1,440	738	
1976	.69		174	446	125	

USSR

$$F = .1373 + .0206 \text{ Effort}$$

$$r = .55$$

USSR 3K

$$F = .4487 + .00020 \text{ Effort}$$

$$r = .50$$

USSR 3L

$$F = .4833 + .00014 \text{ Effort}$$

$$r = .44$$

USSR 3KL

$$F = .4526 + .00038 \text{ Effort}$$

$$r = .51$$

SPAIN

$$F = .1539 + .0048 \text{ Effort}$$

$$r = .56$$

	1977 EFFORT	1977 F
USSR	8,500	.31
USSR 3K	472	.54
USSR 3L	173	.51
USSR 3KL	127	.50
SPAIN	255,000	.28

Table 3. Estimation of the abundance of the 1973 and 1974 year-classes in area 2J3KL, from the abundance estimates in Soviet surveys of 3-year-olds and the abundance of corresponding year-classes from VPA as 4-year-olds.

Year-Class	3-year-olds (Soviet Abundance) Estimates			4-year-olds (VPA)
	3K	3L	3KL	2J3KL
1959	33	18	51	5,892
1960	16	11	27	5,207
1961	29	42	71	6,921
1962	22	56	78	8,307
1963	51	44	95	9,316
1964	11	68	79	6,737
1965	27	17	44	5,830
1966	38	61	99	5,474
1967	48	36	84	6,122
1968	46	118	164	4,875
1969	19	60	79	2,204
1970	8	8	16	1,386
1971	4	12	16	1,652
1972	8	7	15	2,333
1973	41	24	65	
1974	10	58	68	
Slope	.5856	.3762	.5568	
Intercept	2.8834	3.1016	2.6943	
r	.7452	.5508	.7000	
t	3.8711	2.2863	3.3954	
df	12	12	12	
Year-Class	<u>3K</u>	<u>3L</u>	<u>3KL</u>	<u>Average</u>
1973	6,727	4,176	5,055	5,319
1974	2,944	5,821	5,184	4,650

Table 4. Estimation of the abundance of the 1975 year-class in area 2J3KL from the abundance estimates in Soviet surveys of 2-year-olds and the abundance of corresponding year-classes from VPA as 4-year-olds.

Year-Class	2-year-olds (Soviet Abundance) Estimates			4-year-olds (VPA)
	3K	3L	3KL	2J-3KL
1960	9	3	12	5,207
1971	5	6	11	6,921
1962	2	8	10	8,307
1963	1	11	12	9,316
1964	4	22	26	6,737
1965	1	2	3	5,830
1966	4	10	14	5,474
1967	11	15	26	6,122
1968	10	68	78	4,875
1969	3	31	34	2,204
1970	1	7	8	1,386
1971	1	1	2	1,652
1972		3	3	2,333
1973	7	9	16	
1974	3	4	7	
1975	1	8	9	
Slope	.0456	.1437	.2028	
Intercept	3.6449	3.5113	3.4257	
r	.3500	.2644	.3341	
t	1.2393	.9093	1.1757	
df	11	11	11	
Year-Class	<u>3K</u>	<u>3L</u>	<u>3KL</u>	<u>Average</u>
1973	4,824	4,451	4,676	4,650
1974	4,641	3,961	3,954	4,185
1975	4,415	4,376	4,161	4,317

Table 5. The smoothed F values in 1976 by age taken from the VPA. The percentage recruitment shown was used in the projections of catch.

<u>AGE</u>	<u>Smoothed F (1976)</u>	<u>Percent Recruited</u>
4	.35	47%
5	.46	61
6	.57	76
7	.65	87
8	.70	93
9	.73	97
10	.75	100
11	.75	100
12	.75	100
13	.75	100

Table 6. Weight-at-age estimates used in the projection of catches of cod in area 2J3KL.

<u>AGE</u>	<u>Average Weight (KG)</u>	<u>Average Weight (KG) used in 1977 Assess- ment</u>
4	.766	.55
5	1.017	.88
6	1.727	1.23
7	2.512	1.66
8	3.287	2.12
9	3.994	2.64
10	4.806	3.18
11	5.607	3.76
12	6.481	4.15
13.	8.046	6.06
14	9.426	6.06

Table 7. Catch, fishing mortality and stock abundance from cohort analysis.

Age	Catch		Fishing Mortality		Stock Abundance ( $\times 10^{-5}$ )	
	1976	1977	1976	1977	1976	1977
4	644	528	.22	.19	3,626	2,452
5	346	464	.41	.24	1,118	2,390
6	251	143	.68	.30	555	606
7	180	62	.80	.35	356	230
8	149	38	.78	.38	299	132
9	113	33	.92	.39	204	112
10	45	20	.92	.40	81	66
11	19	8	.99	.40	32	27
12	7	3	.49	.40	19	10
13	4	3		.40		10

Table 8. Projected catches and spawning biomass, 1978-86, at  $F = 0.20, 0.16, 0.10$ .

Year	CATCHES			SPAWNING BIOMASS		
	$F = 0.20$	$F = 0.16$	$F = 0.10$	$F = 0.20$	$F = 0.16$	$F = 0.10$
1978	135	135	135	235	235	235
1979	197	162	102	469	469	469
1980	256	214	141	892	920	969
1981	306	262	180	1,204	1,279	1,412
1982	350	306	217	1,418	1,550	1,787
1983	388	345	252	1,654	1,845	2,198
1984	419	377	282	1,842	2,088	2,556
1985	442	402	307	1,981	2,277	2,852
1986	454	416	323	2,054	2,381	3,030



Table 9. Projection of cod catches and spawning biomass, 1977-86.

2JJKL COD PROJECTION OF CATCHES							
NATURAL MORTALITY# 0.2000			YEAR 1977				
AGE	POP. NO. (X10-3)	CATCH NO. (X10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	5300.	528.	0.117	0.766	4059.8	404.4	3860.2
5	2390.	464.	0.240	1.017	2430.6	471.9	1539.3
6	606.	143.	0.300	1.727	1046.6	247.0	367.6
7	230.	62.	0.351	2.512	577.8	155.7	132.6
8	132.	38.	0.380	3.287	433.9	124.9	73.9
9	112.	33.	0.391	3.994	447.3	131.8	62.0
10	66.	20.	0.404	4.806	317.2	96.1	36.1
11	27.	8.	0.393	5.607	151.4	44.9	14.9
12	10.	3.	0.399	6.481	64.8	19.4	5.5
13	10.	3.	0.399	8.046	80.5	24.1	5.5
TOTAL	8883.	1302.			9609.8	1720.3	6097.4
NATURAL MORTALITY# 0.2000			YEAR 1978				
AGE	POP. NO. (X10-3)	CATCH NO. (X10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	4650.	363.	0.090	0.766	3561.9	278.3	3479.4
5	3860.	396.	0.120	1.017	3925.8	403.2	2803.0
6	1539.	183.	0.140	1.727	2658.3	315.6	1095.6
7	368.	52.	0.170	2.512	923.3	131.2	253.9
8	133.	20.	0.180	3.287	435.7	65.3	90.7
9	74.	11.	0.180	3.994	295.2	44.2	50.5
10	62.	10.	0.190	4.806	298.1	46.9	42.0
11	36.	6.	0.190	5.607	202.3	31.8	24.4
12	15.	2.	0.190	6.481	96.7	15.2	10.1
13	5.	1.	0.190	8.046	44.2	7.0	3.7
TOTAL	10742.	1044.			12441.5	1338.5	7853.4
NATURAL MORTALITY# 0.2000			YEAR 1979				
AGE	POP. NO. (X10-3)	CATCH NO. (X10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	4320.	338.	0.090	0.766	3309.1	258.5	3232.5
5	3479.	357.	0.120	1.017	3538.6	363.4	2526.6
6	2803.	355.	0.150	1.727	4840.9	612.7	1975.3
7	1096.	156.	0.170	2.512	2752.1	391.1	756.8
8	254.	40.	0.190	3.287	834.5	131.3	171.9
9	91.	14.	0.190	3.994	362.1	57.0	61.4
10	51.	8.	0.200	4.806	242.9	40.0	33.9
11	42.	7.	0.200	5.607	235.5	38.8	28.1
12	24.	4.	0.200	6.481	158.3	26.1	16.4
13	10.	2.	0.200	8.046	81.3	13.4	6.8
TOTAL	12170.	1280.			16355.2	1932.3	8809.6
NATURAL MORTALITY# 0.2000			YEAR 1980				
AGE	POP. NO. (X10-3)	CATCH NO. (X10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	5000.	391.	0.090	0.766	3830.0	299.2	3741.3
5	3232.	332.	0.120	1.017	3247.5	337.6	2347.3
6	2527.	320.	0.150	1.727	4363.4	552.2	1780.5
7	1975.	281.	0.170	2.512	4961.9	705.1	1364.4
8	757.	119.	0.190	3.287	2487.5	391.4	512.4
9	172.	27.	0.190	3.994	686.5	108.0	116.4
10	61.	10.	0.200	4.806	295.0	48.6	41.1
11	34.	6.	0.200	5.607	190.0	31.3	22.7
12	28.	5.	0.200	6.481	182.4	30.1	18.9
13	16.	3.	0.200	8.046	131.7	21.7	11.0
TOTAL	13803.	1492.			20415.9	2525.2	9955.9
NATURAL MORTALITY# 0.2000			YEAR 1981				
AGE	POP. NO. (X10-3)	CATCH NO. (X10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	5000.	391.	0.090	0.766	3830.0	299.2	3741.3
5	3741.	384.	0.120	1.017	3804.9	390.7	2716.8
6	2347.	297.	0.150	1.727	4053.7	513.1	1654.1
7	1780.	253.	0.170	2.512	4472.5	635.5	1229.8
8	1364.	215.	0.190	3.287	4484.7	705.6	923.8
9	512.	81.	0.190	3.994	2046.4	322.0	346.9
10	116.	19.	0.200	4.806	559.3	92.2	78.0
11	41.	7.	0.200	5.607	230.7	38.0	27.6
12	23.	4.	0.200	6.481	147.2	24.3	15.2
13	19.	3.	0.200	8.046	151.8	25.0	12.6
TOTAL	14945.	1653.			23781.3	3045.6	10746.1

Table 9. (Cont'd)

2JJKL CUD PROJECTION OF CATCHES

NATURAL MORTALITY#		0.2000		YEAR 1982			
AGE	POP. NO. (x10-3)	CATCH NO. (x10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	5000.	391.	0.090	0.766	3830.0	299.2	3741.3
5	3741.	384.	0.120	1.017	3804.9	390.7	2716.8
6	2717.	344.	0.150	1.727	4691.8	593.8	1914.5
7	1654.	235.	0.170	2.512	4155.1	590.4	1142.5
8	1230.	193.	0.190	3.287	4042.4	636.0	832.7
9	924.	145.	0.190	3.994	3689.5	580.5	625.4
10	347.	57.	0.200	4.806	1667.2	274.8	232.5
11	78.	13.	0.200	5.607	437.4	72.1	52.3
12	28.	5.	0.200	6.481	178.7	29.5	18.5
13	15.	3.	0.200	8.046	122.5	20.2	10.2
TOTAL	15733.	1770.			26619.7	3487.2	11286.7

NATURAL MORTALITY#		0.2000		YEAR 1983			
AGE	POP. NO. (x10-3)	CATCH NO. (x10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	5000.	391.	0.090	0.766	3830.0	299.2	3741.3
5	3741.	384.	0.120	1.017	3804.9	390.7	2716.8
6	2717.	344.	0.150	1.727	4691.8	593.8	1914.5
7	1914.	272.	0.170	2.512	4809.1	683.4	1322.4
8	1143.	180.	0.190	3.287	3755.5	590.9	773.6
9	833.	131.	0.190	3.994	3325.6	523.2	563.8
10	625.	103.	0.200	4.806	3005.9	495.5	419.2
11	233.	38.	0.200	5.607	1303.8	214.9	155.9
12	52.	9.	0.200	6.481	338.9	55.9	35.1
13	18.	3.	0.200	8.046	148.7	24.5	12.4
TOTAL	16276.	1855.			29014.4	3872.0	11654.8

NATURAL MORTALITY#		0.2000		YEAR 1984			
AGE	POP. NO. (x10-3)	CATCH NO. (x10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	5000.	391.	0.090	0.766	3830.0	299.2	3741.3
5	3741.	384.	0.120	1.017	3804.9	390.7	2716.8
6	2717.	344.	0.150	1.727	4691.8	593.8	1914.5
7	1914.	272.	0.170	2.512	4809.1	683.4	1322.4
8	1322.	208.	0.190	3.287	4346.7	683.9	895.3
9	774.	122.	0.190	3.994	3089.6	486.1	523.7
10	564.	93.	0.200	4.806	2709.4	446.6	377.9
11	419.	69.	0.200	5.607	2350.7	387.5	281.0
12	156.	26.	0.200	6.481	1010.2	166.5	104.5
13	35.	6.	0.200	8.046	282.0	46.5	23.5
TOTAL	16642.	1914.			30924.6	4184.2	11900.9

NATURAL MORTALITY#		0.2000		YEAR 1985			
AGE	POP. NO. (x10-3)	CATCH NO. (x10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	5000.	391.	0.090	0.766	3830.0	299.2	3741.3
5	3741.	384.	0.120	1.017	3804.9	390.7	2716.8
6	2717.	344.	0.150	1.727	4691.8	593.8	1914.5
7	1914.	272.	0.170	2.512	4809.1	683.4	1322.4
8	1322.	208.	0.190	3.287	4346.7	683.9	895.3
9	895.	141.	0.190	3.994	3576.0	562.6	606.2
10	524.	86.	0.200	4.806	2517.1	414.9	351.1
11	378.	62.	0.200	5.607	2118.9	349.3	253.3
12	281.	46.	0.200	6.481	1821.4	300.2	188.4
13	104.	17.	0.200	8.046	840.7	138.6	70.0
TOTAL	16877.	1952.			32356.6	4416.6	12059.2

NATURAL MORTALITY#		0.2000		YEAR 1986			
AGE	POP. NO. (x10-3)	CATCH NO. (x10-3)	FISHING MORT.	MEAN WT. KG.	POP. WT. (METRIC TONS)	CATCH WT. (METRIC TONS)	RESIDUAL POP. NOS.
4	5000.	391.	0.090	0.766	3830.0	299.2	3741.3
5	3741.	384.	0.120	1.017	3804.9	390.7	2716.8
6	2717.	344.	0.150	1.727	4691.8	593.8	1914.5
7	1914.	272.	0.170	2.512	4809.1	683.4	1322.4
8	1322.	208.	0.190	3.287	4346.7	683.9	895.3
9	895.	141.	0.190	3.994	3576.0	562.6	606.2
10	606.	100.	0.200	4.806	2913.3	480.2	406.3
11	351.	58.	0.200	5.607	1968.5	324.5	235.3
12	253.	42.	0.200	6.481	1641.7	270.6	169.8
13	188.	31.	0.200	8.046	1515.7	249.8	126.3
TOTAL	16989.	1970.			33097.8	4538.8	12134.2