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Assessment of the Cod Stock in Divisions 2J+3KL*

by

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Nominal Catch

Catches of cod from Divisions 2J3KL declined from a peak of about 800,000t in 1968 to a low of about 139,000t in 1978 with quota management coming into effect in 1973. Recent nominal catches and TAC's ('000t) are as follows:

	1978	1979	1980	1981	1982	1983	1984
TAC	135	180	180	200	230 ¹	260	266
Catch	139	167	176	161	230*	227*	

*Provisional data

Catch at age

Nominal catches by country, month and division for 1983 (Table 1) were obtained from the Department of Fisheries for Canadian based vessels and from NAFO circular letters and/or the FLASH database for others. The Canadian fishery took a major portion of the 1983 catch. Of the Canadian catch, 47% was landed by inshore gears. In recent years, the catch by inshore gears has reached the levels attained in the mid 1960's (Fig. 1).

Catch numbers, average weight, and average length at age were derived using the catch breakdown and sampling data shown in Table 2. Sampling coverage of the catch appears to be well distributed and there was adequate data to treat each division separately. The coefficient of variation for estimated catch numbers of dominant age groups was about 5% or less (Table 3) and the discrepancy between reported catch and calculated catch was about 2%. A breakdown of the catch at age by division for otter trawl, Canadian inshore and other catches is also shown (Table 4). The relationship ($\log \text{wt.} = 3.0879 \log \text{length} - 5.2106$) was applied in deriving average weight at age. The 1983 catch and average weight at age are shown along with historical results in Table 5.

Surveys

Biomass and abundance estimates (mean no. and mean wt. per tow) for research surveys in Divisions 2J, 3K, and 3L with associated confidence limits are shown in Fig. 2 to 4. Surveys in 2J and 3K during 1983 were once again conducted in the fall by the *Gadus Atlantica*. A spring survey was not conducted in Div. 3L as had been the case for the 1971-82 period. As part of a seasonal survey program research vessel surveys have been conducted in Div. 3L during the fall for the years 1981 to 1983. Fall surveys in 1981-82 were conducted by the A. T. Cameron while that for 1983 was by the W. Templeman (Tables 6 and 7). Abundance and biomass for Div. 2J (Tables 8 and 9) and 3K (Tables 10 and 11) showed an increase from 1982-83 although the confidence limits were large for Div. 2J. Biomass and abundance estimates for Div. 3L (Tables 12 and 13) were presented in a previous assessment and have been included in the present assessment for reference purposes as no new information was available for spring surveys. The 1978 year class was strong in Div. 3K and 3L with that for 1979 predominating in 2J (Tables 14 to 17). Year class strength patterns for older age groups were similar to that observed in previous years and it would appear that the 1980-81 year-classes may be strong in all Divisions.

* Subsequent to the preparation of this document for the June 1984 Meeting, some additional information became available during the meeting. This resulted in the analysis given in Appendix (pages 29-31).

Catch-effort

Catch and effort data are available by division, month, country, and gear. The multiplicative model (Gavaris, 1980) was used to account for the country-gear, seasonal and divisional differences. Data for 1962-79 was derived from NAFO(ICNAF) Statistical Bulletins and data for 1979-83 was obtained from the Department of Fisheries and Oceans, Canada. Data with less than 10 t catch and/or 10 h effort was excluded from the analysis to reduce the possible effect of truncation and rounding errors. The two series, 1962-79 and 1979-83, were analyzed separately using 1979 as the common overlapping point. Plots of the residuals indicated that data with greater catch or effort was less variable. Estimated weights, calculated according to Judge et. al. (1980, p. 132), were therefore, applied in a weighted regression for the multiplicative model. The seasonal and divisional patterns were similar in both series but more pronounced in the latter (Tables 18 and 19). The catch rate index shows a decline from the late 1960's to the mid 1970's and a subsequent increase (Table 20, Fig. 5).

Sequential population analysis

The historical partial selection was calculated by dividing the fishing mortality by the total fishing mortality for ages 8-11 in that year (Table 21). The total fishing mortality for ages 8-11 was derived from the ratio of the population numbers aged 8-10 and the population numbers aged 9-11 in the succeeding year. The partial selection of ages 4-7 used as input for 1983 in the cohort analysis was obtained by taking the average from 1975-81 after replacing values greater than 1.0 by 1.0. It was assumed that partial selection for ages 8-13 in 1983 was 1.0.

Assuming a natural mortality of 0.2, cohort analysis was performed for a range of fully recruited fishing mortalities in 1983. The fishing mortality for age 13 in 1962-82 was assumed to be equal to the total fishing mortality for ages 8-11. The relationship between the catch rate index and exploitable biomass (average) was examined to determine which fully recruited fishing mortality agreed best with the data. Exploitable biomass (average) was calculated by multiplying biomass (average) by the partial selection after substituting 1.0 for ages 8-13 and those values which were greater than 1.0. The results indicate that a fully recruited fishing mortality of 0.20 agrees best with the data (Table 22). The results from the cohort analysis using a fully recruited fishing mortality of 0.20 are shown in Table 23. Catchability defined as the ratio of catch rate index to exploitable biomass is shown in Fig. 7.

References

- GAVARIS, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. *Can. J. Fish. Aquat. Sci.*, 37: 2272-2275.
- JUDGE, G. G., W. E. GRIFFITHS, R. C. HILL, and J. C. LEE. 1980. *The theory and practice of econometrics*. John Wiley and Sons, New York, 793 p.

Table 1. Cod landings (tons) from Div. 2J, 3K, and 3L by country during 1983.

2J

Mo.	Can (N)	Can (M)	FRG	Den (F) (LL)	Norway (LL)	Port.	Poland	GDR	TOTAL
J	4359	3069							
F	9741	5359	1312				6		
M	3470	2774	480						
A	3125	1285			80				
M				54					
J	2127	722							
J	5956	461							
A	3575								
S	1548								
O	525						56		
N	110	5				126	283	7	
D	78					1655	56		
	34614	13675	1800	54	80	1781	401	7	52412

3K

Mo.	Can (N)	Can (M)	Den (F) (LL)	Norway (LL)	Port.	Poland	USSR	GDR	TOTAL
J	1730					14			
F	1660	209				19			
M	3410	1741		347		5			
A	7688	3574	479	268					
M	9136	2189	426	5		39			
J	12242	134	49			148			
J	15545	292				132			
A	6417					8	12	6	
S	4565							7	
O	1059	17			71	20			
N	548	2			1	2			
D	255	6			474	16			
	64255	8164	954	620	546	403	12	13	74967

3L

Mo.	Can (N)	Can (M)	Norway (LL)	Port.	Poland	GDR	Spain	TOTAL
J	2875	1042						
F	3965	1228						
M	2521	365			1			
A	2359	471						
M	8442	467	71	3				
J	16568	156		597				
J	21652			376				
A	9669			1105		12		
S	8043	24		170		1		
O	4024	113		505				
N	3861	513		506				
D	3514	1866		1001				
	87493	6245	71	4263	1	13	1500	99586

Table 2. Commercial sampling for Div. 2J+3KL cod in 1983.

Div.	Gear	Qtr.	Country	No. aged	Month	No. meas.	Landings (tons)			
							Country month	Total		
2J	OT	1	Can (M)		Jan.	994	3069	3069		
			Can (M)		Feb.	1367	5359	5359		
			Can (M)		Mar.	1555	2774	2774		
			Can (N)	370	Jan.	6145	4359	4359		
			Can (N)		Feb.	11445	9741	9741		
			Can (N)		Mar.	3405	3470	3470		
			FRG		Feb.	1811	1312	1800		
			Other				6			
					<u>658</u>			<u>26722</u>		<u>30578</u>
				2	Can (N)]	403	Apr.	2127	3125	4410
		Can (N)]	Jun.		3588		1988	3171		
							<u>5715</u>		<u>7581</u>	
			3	Can (N)	88	Jul.	884	494	924	
						<u>491</u>				<u>924</u>
			4	Port	390	Nov.	1646	126	126	
		Port		Dec.		6230	1655	1655		
		Poland		Dec.		250	56	395		
		Other								
				<u>390</u>			<u>8126</u>		<u>2183</u>	
			LT	2	Norway	44 ^a			80	80
Den F.	May	253			54		54			
							<u>134</u>			
	LT	3	Can (N)	456	Aug.	153	72	348		
HL			3		Can (N)*	Aug.	1841	649	1179	
Trap			3		Can (N)*	July	478	3001	3068	
Trap			3		Can (N)*	Aug.	3044	786	793	
GN			3		Can (N)*	Aug.	3687	1707	4761	
					<u>9203</u>		<u>10149</u>			
	LT	4	Can (N) ^b		Oct.	343	112	<u>494</u>		
	GN	4	Port	48	Sept.	281	138	185		
GN			4		Port	317	Oct.	565	144	144
GN			4		Port		Nov.	590	40	40
			<u>365</u>			<u>1436</u>		<u>369</u>		
	2J Total			<u>2404</u>		<u>52682</u>		<u>52412</u>		

a) Adjust using OT qtr 2 + 3 A/L Key.

b) Adjust using OT qtr 4 A/L Key.

3K	OT	1	Can (M)		Feb.	234	209	209		
			Can (M)		Mar.	660	1741	1741		
			Can (N)	368	Jan.	3643	1730	1730		
			Can (N)		Feb.	1241	1660	1660		
			Can (N)		Mar.	7601	3410	3410		
			Other					38		
					<u>368</u>			<u>13379</u>		<u>8788</u>
				2	Can (M)	409	Apr.	207	3574	3574
			Can (M)		May		330	2189	2323	
			Can (N)		Apr.		5018	7659	7659	
		Can (N)	May		7986		6928	7453		
		Other						187		
							<u>13541</u>		<u>21196</u>	
			3	Can (N)	409	Jul.	263	488	713	
		Can (M)		Jul.		281	292	424		
		Other						33		
				<u>409</u>			<u>544</u>		<u>1170</u>	

Table 2 (Cont'd.) .

Div.	Gear	Qtr.	Country	No. aged	Month	No. meas.	Landings (tons)	
							Country month	Total
		4	Can (N)		Oct.	2221	240	257
			Can (N)	351	Nov.	1584	472	594
			Port	48	Dec	1494	474	546
			Other					38
				<u>399</u>		<u>5299</u>		<u>7435</u>
	Trap	3	Can (N)		Jul	17367	6592	10568
	GN	3	Can (N)		Jul.	4716	6337	17392
	LT	3	Can (N)	757	Aug.	499	606	2431
	HL	3	Can (N)		Jul.	1472	1837	2543
	HL	3	Can (N)		Aug.	2394	3613	3613
				<u>757</u>		<u>26448</u>		<u>36547</u>
	GN	4	Can (N)		Sept.	596	716	1070
	HL	4	Can (N)	426	Sept.	4077	2786	3187
				<u>426</u>		<u>4673</u>		<u>4257</u>
	LT	1	Norway	417	Mar.	1724	347	347
								<u>347</u>
	LT	2	Norway	243	Apr.	2219	268	273
			Den (F)		Apr.	13446	479	479
			Den (F)	310	May	3418	426	426
			Den (F)		June.	632	49	49
				<u>553</u>		<u>19715</u>		<u>1227</u>
3K	Total			<u>3329</u>		<u>85323</u>		<u>74967</u>
3L	OT	1	Can (N)	330	Jan.	4755	2855	2855
			Can (N)		Feb.	7190	3880	5108
			Can (N)		Mar	4801	2484	2849
			Can (M)		Jan.	215	1042	1042
			Other					1
				<u>330</u>		<u>16961</u>		<u>17855</u>
		2	Can (N)	639	Apr.	4705	2326	2326
			Can (N)		May	7109	3899	4366
			Can (N)		Jun	1421	2267	2423
			Can (M)		Apr.	309	471	471
			Port		Jun	460	87	87
				<u>289</u>		<u>14004</u>		<u>9673</u>
				<u>928</u>				
		3	Can (N)	474	Jul.	729	1154	1154
			Can (N)		Aug.	938	1388	1388
			Can (N)		Sept.	6465	2740	2764
			Port		Jul.	773	249	249
			Other					13
				<u>554</u>		<u>8905</u>		<u>5568</u>
		4	Can (N)	420	Oct.	3226	2710	2710
			Can (N)		Nov.	9302	3615	3615
			Can (N)		Dec.	1901	3492	3492
			Can (M)		Oct.	172	113	113
			Can (M)		Nov.	662	513	513
			Can (M)		Dec.	909	1866	1866
			Port		Nov.	270	56	56
			Port		Dec.	2662	1001	1001
					<u>120</u>			
				<u>540</u>		<u>19104</u>		<u>13366</u>
	Trap	2	Can (N)	689	May	6068	1397	1402
	GN	2	Can (N)		May	2672	3048	3179
				<u>689</u>		<u>8740</u>		<u>4581</u>
	Trap	3	Can (N)	1120	Jun.	16052	9866	9866
	Trap	3	Can (N)		Jul.	11711	12099	14399
	GN	3	Can (N)		Jun.	3184	3149	3149
	GN	3	Can (N)		Jul.	2191	7327	9226
	LL	3	Can (N)		Aug.	3698	843	970
	HL	3	Can (N)		June.	3252	1232	1328
	HL	3	Can (N)		Jul.	1343	1040	1040
	HL	3	Can (N)		Aug.	2264	3359	3359
				<u>1120</u>		<u>43695</u>		<u>43337</u>

Table 2 (Cont'd.)

Div.	Gear	Qtr.	Country	No. aged	Month	No. meas.	Landings (tons)	
							Country month	Total
3L	GN	4	Can (N)	426	Sep.	332	401	587
	LL	4	Can (N)		Sep.	2038	2242	2896
	HL	4	Can (N)		Sep.	1874	2556	3282
				<u>426</u>		<u>4244</u>		<u>6765</u>
	LL	2	Norway	107	May	757	71	71
				<u>107</u>				<u>71</u>
	GN	2	Port	169	Jun.	3887	510	513
				<u>169</u>				<u>513</u>
	GN	3	Port	409	Jul.	1016	127	127
	GN	3	Port		Aug.	4704	1105	1105
	GN	3	Port		Sep.	2897	170	170
				<u>409</u>		<u>8617</u>		<u>1402</u>
	GN	4	Port	372	Oct.	2310	505	505
	GN	4	Port		Nov.	2210	450	450
				<u>372</u>		<u>4520</u>		<u>955</u>
PT	2	Spain	319	May	2575		1500	
				Jun.	1632			
3L	Total			5963		137641		99586
2J3KL	Total			11696		275646		226965

Table 3. Estimated average weight, average length, and catch numbers at age for the commercial cod fishery in Divisions 2J3KL during 1983.

AGE	AVERAGE		CATCH		
	WEIGHT (kg)	LENGTH (cm)	MEAN	STD. ERR.	C. V.
2	0.305	33.029	18	4.75	0.26
3	0.621	41.445	2454	164.34	0.07
4	0.864	46.089	13448	496.67	0.04
5	1.314	52.724	41407	741.02	0.02
6	1.744	57.885	18714	606.32	0.04
7	2.267	63.066	11835	498.13	0.04
8	2.592	65.363	14484	496.85	0.03
9	3.156	69.795	8778	386.29	0.04
10	3.491	72.103	6363	283.55	0.04
11	4.783	79.052	1011	109.42	0.11
12	7.732	93.394	243	23.45	0.10
13	9.046	97.841	91	15.71	0.17
14	9.951	97.469	41	11.63	0.28
15	10.050	103.422	29	5.99	0.21
16	10.976	105.053	11	4.58	0.43
17	12.957	110.836	7	3.35	0.37
18	15.822	118.153	7	1.58	0.22
19	11.047	104.783	3	1.40	0.64
20	15.103	116.883	3	0.39	0.15
21	14.179	114.590		0.11	0.79
22	17.410	122.446		0.18	0.64
23					
24	16.628	121.000		0.24	1.04
25					
26	16.628	121.000		0.50	1.34

Table 4. Catch at age by Division and gear for the commercial cod fishery in Divisions 2J3KL during 1983.

Age	Otter trawl			Inshore			Others 2J3KL
	2J	3K	3L	2J	3K	3L	
2		3				15	
3		98	15	31	715	1207	54
4		826	577	1265	3780	5545	95
5		2498	5300	1083	5797	16279	769
6		1618	4289	683	3711	4796	398
7		1614	2682	560	2406	2939	284
8		4450	2205	746	2524	2040	419
9		2857	1579	474	1728	853	295
10		4098	656	462	633	227	117
11		332	184	126	197	79	34
12		47	26	19	88	33	9
13		17	17	12	18	12	3
14		12	2	3	13	4	2
15		11	3	3	2	5	1
16		8	1				
17		3	2			3	
18				1	3	2	1
19				1		1	
20		2	1				

Table 5. Catch numbers and weights at age for cod in Divisions 2J3KL.

CATCH AT AGE (Numbers × 10 ⁻⁵)																		
AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
4	267	271	267	280	663	785	916	381	572	690	798	407	138	150	644	528	169	121
5	658	592	563	456	942	1009	1990	964	773	921	1166	945	355	259	346	464	396	382
6	600	1157	590	655	632	972	1450	1534	940	944	762	582	747	347	251	143	213	302
7	486	579	981	639	598	553	809	1006	788	557	560	353	613	389	180	62	83	116
8	284	288	498	671	307	388	379	493	269	241	296	273	361	356	149	38	32	36
9	207	152	202	334	240	172	224	184	100	113	118	142	186	133	113	33	15	14
10	186	114	118	147	88	161	76	115	38	43	64	76	102	77	45	20	11	8
11	106	81	84	68	47	60	54	60	19	21	30	38	55	24	19	8	4	6
12	98	41	61	37	23	34	34	42	11	12	17	22	29	13	7	3	2	2
13	80	39	48	39	18	21	19	28	5	11	14	12	10	9	4	3	1	1
4+	2974	3316	3412	3316	3558	4155	5951	4807	3513	3553	3825	2860	2596	1757	1758	1302	926	988
5+	2707	3045	3145	3036	2895	3370	5035	4426	2941	2863	3027	2453	2458	1607	1114	774	757	867
AVERAGE WEIGHT AT AGE (kg)																		
AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
4	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.77	0.70	0.74
5	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	1.02	0.99	1.12
6	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.73	1.59	1.68
7	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	2.51	2.53	2.49
8	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	3.29	3.40	3.60
9	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	3.99	4.26	4.46
10	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	4.81	4.75	5.31
11	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	5.61	5.51	5.86
12	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	6.48	7.32	7.18
13	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	8.05	8.25	9.02
AVERAGE WEIGHT AT AGE (kg)																		
AGE	1980	1981	1982	1983														
4	0.77	0.77	0.84	0.86														
5	1.15	1.15	1.21	1.21														
6	1.72	1.63	1.77	1.74														
7	2.39	2.21	2.10	2.27														
8	3.58	2.87	2.87	2.59														
9	5.02	3.82	3.09	3.16														
10	5.59	5.31	4.18	3.49														
11	6.73	6.34	6.23	4.78														
12	7.89	7.12	7.20	7.73														
13	8.73	7.46	8.05	9.05														

Table 6. Cod abundance (No. x 10⁻³) from stratified random cruises in Div. 3L.

Depth Range	Stratum No.	Stratum Area	ATC 323-325 1981	ATC 333-334 1982	W. Tempelan 7-9 1983
31-50	350	2071	4923	2332	6335
	363	1780	802	1960	13050
	371	1121	105	1010	4679
	372	2460	14256	8679	37532
	384	1120		273	6025
	Total	8552			
51-100	328	1519			
	341	1574	1930	975	1359
	342	585	381	1039	274
	343	525	897		328
	348	2120	1724	3310	1953
	349	2114	2154	1492	1622
	364	2817	963	1113	1629
	365	1041	8693	2090	578
	370	1320	173	413	727
	385	2356	44	309	318
	390	1481	37	111	111
Total	17452				
101-150	344	1494	2075	5047	1103
	347	983	2706	2915	2041
	366	1394	5197	8022	4473
	369	961	2669	1371	2525
	386	983	861	553	
	389	821		1756	
	391	282		95	635
Total	6918				
151-200	345	1432	2015	3637	2929
	346	865	5822	2337	4389
	368	334	1316	1429	
	387	718	808	3000	
	388	361		253	
	392	145		147	33
Total	3855				
31-50					
51-100					
101-150					
151-200					
Total			60550	55688	94649
Upper limit			83240	67092	123077
Lower limit			37860	44285	66220

Table 7. Cod biomass (t) from stratified random cruises in Div. 3L

Depth Range	Stratum No.	Stratum Area	ATC 323-325 1981	ATC 333-334 1982	W. Tempelan 7-9 1983
31-50	350	2071	6244	3849	8463
	363	1780	852	2009	17993
	371	1121	137	1363	6126
	372	2460	20737	6882	44364
	384	1120		1090	5941
	Total	8552			
51-100	328	1519			
	341	1574	2146	901	1949
	342	585	834	951	263
	343	525	1419		661
	348	2120	2651	4249	3125
	349	2114	3604	3174	2266
	364	2817	1932	1800	1946
	365	1041	17904	3702	961
	370	1320	300	446	1184
	385	2356	38	43	1019
	390	1481	9	58	852
	Total	17452			
101-150	344	1494	3869	7701	1682
	347	983	4550	4805	3167
	366	1394	9313	11920	8999
	369	961	7755	2290	5849
	386	983	1414	1430	
	389	821		3428	
	391	282		487	159
Total	6918				
151-200	345	1432	4703	7686	6443
	346	865	12012	4212	7746
	368	334	5948	3604	
	387	718	1334	9216	
	388	361		461	
	392	145		220	109
Total	3855				
31-50					
51-100					
101-150					
151-200					
Total			109706	87997	131267
Upper limit			153131	105967	175407
Lower limit			66281	70027	87127

Table 8. Cod abundance estimates (No. $\times 10^{-3}$) from research vessel surveys in NAFO Division 2J.

Depth Range (mtrs)	Stratum Number	Stratum area (m ²)	Gadus 3 1977	Gadus 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58 1981	Gadus 71 1982	Gadus 86-88 1983
101-200	201	1427	13336	3071	1500	5749	8355	16692	16246
	205	1823	2894	8039	1574	787	4550	21765	13547
	206	2582	6889	1634	1236	2104	6220	5868	8694
	207	2246	9745	5100	2664	3406	5479	9049	13024
Total		8078	32864	17844	6974	12046	24604	53419	51511
201-300	202	440	2097	462	396	5681	2378	2378	1833
	209	1608	10174	3531	21485	3410	10099	7681	29567
	210	774	6166	4154	2760	2982	445	4713	59785
	213	1725	6944	19617	18516	19811	2158	5807	12806
	214	1171	16716	10658	6527	10958	3956	5900	4659
	215	1270	19281	34205	9986	25692	35768	27583	7233
	228	1428	2948		6780	8254	10701	2187	2269
	234	508	1258	553	267	1506	534	2250	4698
Total		8924	65584	73180	66717	78294	66039	58499	122850
301-400	203	480	883			3081	81	1117	462
	208	448	1017	247	1480	202	303	1368	1749
	211	330	632	5450	2737	4659	1746	2415	1325
	216	384	0		202	3603	86	14	10
	222	441	50	1479	149	1258	132	0	11
	229	567	415	234	2873	1319	447	298	670
Total		2650	2997	7410	7441	14122	2795	5212	4227
101-200			32864	17844	6974	12046	24604	53419	51511
201-300			65584	73180	66717	78294	66039	58499	122850
301-400			2997	7410	7441	14122	2795	5212	4227
Total			101477	98432	81130	104461	94959	117469	180290
Upper limit			150376	131104	128646	139530	162744	151085	744785
Lower limit			52578	65761	33613	69392	27234	83853	384206

Table 9. Cod biomass estimates (t.) from research vessel surveys in NAFO Division 2J.

Depth Range (mtrs)	Stratum Number	Stratum area (mi ²)	Gadus 3 1977	Gadus 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58 1981	Gadus 71 1982	Gadus 86-88 1983
101-200	201	1427	12377	4847	3256	11319	15998	18085	16764
	205	1823	2761	16200	2669	1676	10126	39216	17742
	206	2582	5328	2074	2671	3849	13153	8533	11442
	207	<u>2246</u>	<u>16809</u>	<u>8209</u>	<u>4192</u>	<u>7738</u>	<u>12284</u>	<u>12612</u>	<u>12608</u>
Total		<u>8078</u>	<u>37275</u>	<u>31330</u>	<u>12788</u>	<u>24582</u>	<u>51561</u>	<u>78446</u>	<u>58556</u>
201-300	202	440	3074	525	749	12964	6292	5681	3798
	209	1608	15336	5384	43569	12810	22275	18351	53925
	210	774	10481	5572	5771	5810	823	10428	97578
	213	1725	6525	31627	31100	34068	5622	8073	14748
	214	1171	24370	20791	13231	25095	9669	10993	6944
	215	1270	31757	55780	19546	64301	96161	60996	12584
	228	1428	3930	12374	16972	23904	4357	2215	5370
	234	<u>508</u>	<u>2857</u>	<u>1030</u>	<u>553</u>	<u>3699</u>	<u>1192</u>	<u>4614</u>	<u>5370</u>
Total		<u>8924</u>	<u>98330</u>	<u>120709</u>	<u>126893</u>	<u>175719</u>	<u>165938</u>	<u>123493</u>	<u>197162</u>
301-400	203	480	1930			7467	230	3141	1369
	208	448	1962	438	3341	631	908	3750	3153
	211	330	1738	10285	5685	9384	4747	6490	3016
	216	384	0		484	10204	454	86	24
	222	441	43	2029	653	2780	281	0	105
	229	<u>567</u>	<u>1009</u>	<u>319</u>	<u>7394</u>	<u>3150</u>	<u>1144</u>	<u>467</u>	<u>516</u>
Total		<u>2650</u>	<u>6682</u>	<u>13071</u>	<u>17557</u>	<u>33616</u>	<u>7764</u>	<u>13934</u>	<u>8183</u>
401-500	204	354	308				3149	316	1506
	217	268	0				0	0	0
	223	180	0				0	0	0
	227	686	131				0	36	129
	235	<u>420</u>	<u>75</u>				<u>347</u>	<u>315</u>	<u>1584</u>
Total		<u>1908</u>	<u>514</u>				<u>3496</u>	<u>667</u>	<u>3219</u>
101-200		8078	37275	31330	12788	24582	51561	78446	58556
201-300		8924	98330	120709	126893	175719	165938	123493	197162
301-400		2650	6682	13071	17557	33616	7764	13934	8183
401-500		1908	<u>514</u>				<u>3496</u>	<u>667</u>	<u>3219</u>
Total			<u>142801</u>	<u>165110</u>	<u>157238</u>	<u>233917</u>	<u>228759</u>	<u>216540</u>	<u>267120</u>
Mean			142961	165109	157237	233916	228894	216679	267120
Upper limit			199808	222301	253553	314419	424737	288880	1175017
Lower limit			86113	107917	60921	153412	33051	144478	640777

Table 10. Cod abundance estimates (No.×10⁻³) from research vessel surveys in NAFO Division 3K.

Depth Range (mtrs)	Stratum Number	Stratum area (mi ²)	Gadus 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58,59 1981	Gadus 71,72 1982	Gadus 86-88 1983
201-300	620	2709	17720	26203	15206	12689	4284	17610
	621	2859	14563	25646	2739	7453	6471	4603
	624	668	13121	23166	627	3686	2470	1128
	632	447	727	2265	5078	3171	2494	8321
	634	1618	4105	18157	13651	19455	11384	14186
	635	1274	3825	1492	3706	4743	3175	1227
	636	1455	1820	2446	6051	3695	7001	2603
	637	1132	2528	5778	3909	4744	6409	8718
Total		<u>12162</u>	<u>58409</u>	<u>105153</u>	<u>50967</u>	<u>59636</u>	<u>43652</u>	<u>58396</u>
301-400	623	1027	6167	2981	7593	876	1557	5769
	625	850	1340	2488	1515	1021	2169	1276
	626	919	3191	759	1012	2235	911	1276
	628	1085	1433	2891	1008	1371	570	1955
	629	495	718	446	144	50	412	562
	630	544		388	315	225		306
	633	2179	4283	3044	2944	3106	3552	3748
	638	2059	2720	8081	3246	9158	5699	13643
	639	1463	1603	3075	741	1303	2921	4095
Total		<u>10621</u>	<u>21455</u>	<u>24153</u>	<u>18518</u>	<u>19345</u>	<u>17791</u>	<u>32630</u>
401-500	622	632				356	190	142
	627	1194				104	152	193
	631	1202				162	0	523
	640	198				0	0	
	645	204				0	5	8
Total		<u>3430</u>				<u>622</u>	<u>347</u>	<u>866</u>
201-300			58409	105153	50967	59636	43652	58396
301-400			21455	24153	18518	19345	17791	32630
Total			79865	129306	69484	79602	61791	91907
Upper limit			113311	218233	93324	104928	75262	119955
Lower limit			46420	40380	45645	54276	48320	63859

Table 11. Cod biomass estimates (t.) from research vessel surveys in NAFO Division 3K.

Depth Range (mtrs)	Stratum Number	Stratum area (mi ²)	Gadus 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58,59 1981	Gadus 71,72 1982	Gadus 86-88 1983
201-300	620	2709	32708	55286	33699	33603	9851	33248
	621	2859	25889	63106	5939	10935	11764	6750
	624	668	29936	40531	1742	7973	5365	1586
	632	447	873	3896	10165	7566	5721	13992
	634	1618	6907	29309	29404	40573	23579	22967
	635	1274	3702	2551	7902	10271	7249	3236
	636	1455	2248	5040	11959	8428	14144	6335
	637	1132	3540	10613	7871	9829	13256	17317
Total		<u>12162</u>	<u>105803</u>	<u>210332</u>	<u>108681</u>	<u>129178</u>	<u>90929</u>	<u>105431</u>
301-400	623	1027	11293	7522	15746	2175	4849	12071
	625	850	1825	5538	4626	2640	4817	3499
	626	919	6976	1940	3242	4781	2076	3932
	628	1085	2729	6206	2739	3848	1480	3841
	629	495	1136	1062	337	150	1255	1167
	630	544		1019	1174	939		847
	633	2179	6947	6379	8073	8406	8482	6558
	638	2059	4210	13362	7161	17706	10143	23310
	639	1463	2204	5734	1949	3225	8335	9295
Total		<u>10621</u>	<u>37320</u>	<u>48762</u>	<u>45047</u>	<u>43870</u>	<u>41437</u>	<u>64520</u>
401-500	622	632				1297	561	289
	627	1194				267	330	601
	631	1202				451	0	1489
	640	198				0	0	
	645	204				0	54	42
Total		<u>3430</u>				<u>2015</u>	<u>945</u>	<u>2419</u>
201-300			105803	210332	108681	129178	90929	105431
301-400			37320	48762	45047	43870	41437	64520
Total			143123	259093	153728	175023	133310	172458
Upper limit			215048	421005	201839	237798	159091	216590
Lower limit			7198	97181	105619	112247	107529	128325

Table 12. Cod abundance estimates (No.×10⁻³) from research vessel surveys in NAFO Division 3L.

Depth range (fath)	Stratum number	Stratum area (mi ²)	ATC 262 1977	ATC 276 1978	ATC 290 1979	ATC 304-5 1980	ATC 317-8 1981	ATC 329 1982
31-50	350	2,071	2,993	1,373	7,756	2,798	829	1,221
	363	1,780	4,783	2,352	7,616	1,817	3,296	1,924
	371	1,121	112	477	1,599	2,917	0	189
	372	2,460	2,247	8,969	6,135	3,293	5,032	1,477
	384	1,120	42	56	2,711	1,555	42	42
Total		8,552	10,177	13,227	25,817	12,380	9,199	4,853
51-100	328	1,519	72		296		0	342
	341	1,574	3,161	325	827	1,024	1,004	2,150
	342	585	768	747	132	417		278
	343	525	335	867	768	1,399	867	2,374
	348	2,120	875	2,361	3,687	3,456	887	2,467
	349	2,114	3,385	4,337	4,035	2,997	595	3,729
	364	2,817	967	599	4,705	2,996	952	1,304
	365	1,041	781	391	2,481	1,035		4,689
	370	1,320	66	330	817	1,486	0	248
	385	2,356	383	59	783	3,139	59	0
	390	1,481	1,223	1,056	2,223	1,223	389	139
	Total		17,452	12,016	11,072	20,754	19,172	4,753
101-150	344	1,494	7,327	11,635	15,981	7,947	29,001	9,196
	347	983	861	6,254	5,737	10,212	3,247	10,773
	366	1,394	10,461		11,118	5,232	56,749	18,521
	369	961	761	577	2,813	6,757	7,286	1,876
	386	983	1,599	639	2,749	2,066	2,693	812
	389	821	2,178	1,130	1,464	5,259	1,140	2,712
	391	282	921	201	1,117	1,757	688	191
	Total		6,918	24,108	20,436	40,979	39,230	100,804
151-200	345	1,432	5,505	5,321	1,800	6,385	15,264	2,714
	346	865	782		1,380	1,125	2,727	801
	368	334	319		56	113	1,880	639
	387	718	108	198	256	108	296	1,419
	388	361	881	257	190	41	393	989
	392	145	44	44	178	5	196	218
Total		3,855	7,639	5,820	3,860	7,777	20,756	6,780
31-50		8,552	10,177	13,227	25,817	12,380	9,199	4,853
51-100		17,452	12,016	11,072	20,754	19,172	4,753	17,720
101-150		6,918	24,108	20,436	40,979	39,230	100,804	44,081
151-200		3,855	7,639	5,820	3,860	7,777	20,756	6,780
Total			53,938	50,554	91,410	78,560	135,716	73,433
Upper Limit			67,857	70,457	112,937	93,294	266,824	94,202
Lower Limit			40,018	30,651	69,883	63,827	4,608	52,665

Table 13. Cod biomass estimates (t.) from research vessel surveys in NAFO Division 3L.

Depth range (fath)	Stratum number	Stratum area (mi ²)	ATC 262 1977	ATC 276 1978	ATC 290 1979	ATC 304-5 1980	ATC 317-8 1981	ATC 329 1982
31-50	350	2,071	5,187	2,106	13,637	7,124	2,539	4,775
	363	1,780	5,399	3,919	11,237	4,182	7,082	6,721
	371	1,121	535	1,490	2,439	8,148	0	789
	372	2,460	1,685	7,006	8,342	7,448	7,155	3,978
	384	1,120	10	19	3,521	2,480	462	231
Total		<u>8,552</u>	<u>12,996</u>	<u>14,540</u>	<u>39,176</u>	<u>29,382</u>	<u>17,238</u>	<u>16,494</u>
51-100	328	1,519	38		518		0	893
	341	1,574	3,916	1,006	2,468	3,291	2,038	8,495
	342	585	1,196	3,010	409	961		871
	343	525	438	1,789	1,190	2,936	946	4,768
	348	2,120	1,701	3,546	7,128	7,855	1,966	5,709
	349	2,114	10,746	8,879	8,800	7,282	321	10,182
	364	2,817	1,101	928	7,884	7,154	1,533	3,938
	365	1,041	1,112	532	2,953	2,442		6,056
	370	1,320	330	367	1,046	3,807	0	99
	385	2,356	422	80	1,118	6,278	413	0
	390	1,481	505	795	2,125	2,798	500	217
Total		<u>17,452</u>	<u>21,505</u>	<u>20,932</u>	<u>35,639</u>	<u>43,804</u>	<u>8,717</u>	<u>41,228</u>
101-150	344	1,494	7,784	20,366	19,398	10,172	50,712	19,583
	347	983	1,128	8,492	7,705	16,019	8,043	21,435
	366	1,394	6,211		11,509	5,912	81,497	21,817
	369	961	2,050	999	2,448	7,406	9,378	4,959
	386	983	1,228	251	2,881	2,361	4,593	1,279
	389	821	1,343	1,063	1,098	6,923	478	1,664
	391	282	634	356	1,048	2,064	1,212	95
	Total		<u>6,918</u>	<u>20,378</u>	<u>31,527</u>	<u>46,087</u>	<u>50,857</u>	<u>155,913</u>
151-200	345	1,432	13,271	10,687	4,844	11,674	29,493	6,060
	346	865	990		2,137	2,154	4,307	1,223
	368	334	404		239	796	1,761	809
	387	718	122	184	459	256	243	2,353
	388	361	1,181	181	349	108	190	1,321
	392	145	30	66	189	0	128	256
Total		<u>3,855</u>	<u>15,998</u>	<u>11,118</u>	<u>8,217</u>	<u>14,988</u>	<u>36,122</u>	<u>12,022</u>
31-50		8,552	12,996	14,540	39,176	29,382	17,238	16,494
51-100		17,452	21,505	20,932	35,639	43,804	8,717	41,228
101-150		6,918	20,378	31,527	46,087	50,857	155,913	70,832
151-200		3,855	15,998	11,118	8,217	14,988	36,122	12,022
Total			<u>70,877</u>	<u>78,118</u>	<u>129,117</u>	<u>139,030</u>	<u>218,214</u>	<u>140,578</u>
upper limit			<u>93,640</u>	<u>100,261</u>	<u>154,966</u>	<u>166,965</u>	<u>405,205</u>	<u>171,826</u>
lower limit			<u>48,114</u>	<u>55,974</u>	<u>103,267</u>	<u>111,094</u>	<u>31,224</u>	<u>109,329</u>

Table 14. Mean number of cod per standard tow from research vessel surveys in Division 2J.

Age	Gadus 3 1977	Gadus 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58 1981	Gadus 71 1982	Gadus 86-88 1983
1	0.0	0.0	0.0	0.38	0.0	1.20	2.26
2	3.79	0.60	0.35	1.66	4.70	3.50	15.99
3	10.95	8.86	1.55	1.41	3.31	20.67	19.08
4	33.03	16.35	13.04	4.81	2.59	7.27	29.39
5	15.11	33.07	19.12	21.87	4.77	5.06	18.66
6	3.32	11.32	18.41	22.33	19.22	4.84	10.03
7	1.54	2.51	2.62	13.25	17.21	14.99	5.15
8	1.39	0.91	0.83	1.92	10.88	13.18	13.99
9	1.09	0.72	0.56	0.56	2.25	8.95	6.36
10	0.60	0.52	0.32	0.40	0.57	1.50	4.03
11	0.23	0.28	0.32	0.26	0.09	0.40	.84
12	0.11	0.13	0.12	0.31	0.16	0.19	.27
13	0.05	0.16	0.05	0.10	0.17	0.11	.12
14	0.03	0.14	0.05	0.05	0.08	0.15	.10
15	0.02	0.05	0.01	0.06	0.08	0.01	.02
16	0.0	0.03	0.03	0.02	0.05	0.02	
17	0.0	0.03		0.0	0.02	0.02	.03
18	0.0	0.03		0.0	0.01	0.02	
19	0.0			0.2			
20	0.0					0.01	
>20	0.02					0.02	
Total	71.33	75.70	57.38	69.33	66.15	82.12	126.3
Upper limit	106.00	104.10	91.88	93.31	114.18	105.95	526.52
Lower limit	36.66	47.30	22.88	45.36	18.12	58.30	-273.92

Table 15. Mean number of cod per standard tow from research vessel surveys in Division 3K

Age	Gadus 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58&59 1981	Gadus 72 1982	86-88 1983
1	0.0	0.0	0.22	0.01	0.28	1.05
2	0.31	0.15	1.24	1.51	2.18	4.24
3	3.23	2.54	1.69	6.22	2.10	9.20
4	14.11	17.31	2.44	3.90	5.99	7.79
5	17.20	28.48	13.73	4.25	5.90	13.72
6	7.89	16.94	15.00	14.19	3.31	4.20
7	2.52	4.35	3.24	10.26	6.98	2.84
8	1.18	2.18	1.57	3.19	6.80	5.00
9	0.73	0.53	0.58	0.58	1.97	3.87
10	0.57	0.46	0.39	0.27	0.77	1.35
11	0.04	0.31	0.03	0.22	0.20	.47
12	0.12	0.07	0.24	0.23	0.09	.21
13	0.04	0.05	0.08	0.07	0.07	.09
13+	0.04	0.14	0.17	0.14	0.15	.29
Total	47.99	73.50	40.61	45.02	36.80	54.33
Upper limit	70.75	126.26	54.54	59.86	44.87	71.13
Lower limit	25.22	20.74	26.68	30.18	28.73	37.54

Table 16. Mean number of cod per standard tow from research surveys in Division 3L.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	.12	0.0	0.0	.16	0.0	0.0	0.0	0.0	.06	0.09	.24	.03
2	7.81	1.54	3.77	.51	1.56	2.07	0.91	0.07	.08	1.94	.67	1.72
3	22.07	5.55	12.93	5.77	3.46	18.25	4.13	3.35	.84	0.90	12.22	1.56
4	6.99	15.19	7.33	8.20	4.95	9.39	5.94	6.26	9.16	3.48	9.79	9.25
5	4.58	1.23	3.89	5.82	2.64	3.76	4.61	4.98	13.89	10.65	8.72	2.34
6	1.62	1.23	.54	2.38	2.11	2.63	2.15	3.22	6.48	8.60	14.91	2.96
7	1.70	.53	.41	.57	1.78	1.47	0.64	1.45	1.53	2.17	15.20	4.15
8	.61	.59	.28	.24	0.29	0.70	0.66	0.47	.46	0.79	4.05	3.08
9	.46	.31	.28	.17	0.16	0.12	0.44	0.40	.12	0.16	1.05	.93
10	.49	.24	.15	.09	0.05	0.03	0.15	0.23	.19	0.07	.35	.20
11	.18	.08	.12	.04	0.08	0.03	0.10	0.17	.08	0.12	.10	.07
12	.24	.06	.17	.07	0.02	0.06	0.06	0.12	.04	0.07	.10	.05
13+	1.17	.31	.41	.12	0.20	0.09	0.16	0.17	.18	0.15	.10	.26
Total	48.04	26.86	30.28	24.14	17.38	38.58	19.95	20.89	33.12	29.20	67.49	26.59
Upper limit	101.26	36.85	70.83	59.78	26.94	57.57	26.06	31.15	42.38	34.73	207.49	34.11
Lower limit	5.08	16.91	-10.18	-11.51	7.89	19.67	13.85	10.63	23.87	23.67	-72.50	19.07
# sets	57	38	29	70	55	64	102	94	141	115	78	103

Table 17. Mean number of cod per standard tow from reseach vessel surveys in Division 3L. (Fall)

Age	1981	1982	1983
1	0.40	0.40	.67
2	0.39	2.64	3.69
3	6.92	1.90	14.06
4	2.88	6.34	5.43
5	2.74	2.69	7.84
6	4.10	1.99	1.46
7	5.77	1.66	1.40
8	1.07	1.50	2.43
9	.22	.28	1.31
10	.08	.08	.46
11	.04	.05	.13
12	.03	.06	.06
13+	.13	.06	.19
Total	24.76	19.82	39.13
Upper limit	34.09	23.57	50.88
Lower limit	15.51	16.07	27.37
Dates	Sept. 22 Nov. 19	Oct. 30 Dec. 06	Oct. 13 Nov. 15
No. Sets	97	121	126

Table 18. Analysis of variance and regression coefficients from the regression of ln catch rate for cod in Divisions 2J3KL for the years 1962-79.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R.....0.769
 MULTIPLE R SQUARED.....0.592

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	4.687E0	4.687E0	
REGRESSION	26	3.885E2	1.494E1	84.869
TYPE 1	4	1.187E2	2.967E1	168.548
TYPE 2	3	3.831E1	1.277E1	72.531
TYPE 3	2	1.182E2	5.910E1	335.676
TYPE 4	17	2.283E2	1.343E1	76.276
RESIDUALS	1523	2.681E2	1.761E-1	
TOTAL	1550	6.613E2		

<u>Country/Gear</u>	<u>ln Power</u>	<u>Month</u>	<u>ln Power</u>
CAN-N OTB-4	-0.331	July	
CAN-N OTB-5	0.000	Aug.	
ESP OTB-6	0.236	Sept.	-0.639
PRT OTB-6	0.325	Oct.	
PRT OTB-7	0.655	Nov.	
		June	-0.447
		Dec.	
		May	-0.214
<u>Division</u>	<u>ln power</u>	<u>Jan.</u>	
3L	-0.288	Feb.	0.000
3K	-1.168	Mar.	
2J	0.000	Apr.	

Table 19. Analysis of variance and regression coefficients from the regression of ln catch rate for cod in Divisions 2J3KL for the years 1979-83.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R.....0.811
 MULTIPLE R SQUARED.....0.657

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.860E1	2.860E1	
REGRESSION	16	1.401E2	8.754E0	37.009
TYPE 1	5	5.319E1	1.064E1	44.975
TYPE 2	5	3.715E1	7.431E0	31.416
TYPE 3	5	2.749E1	1.375E1	58.122
TYPE 4	4	4.224E1	1.056E1	44.662
RESIDUALS	309	7.309E1	2.365E-1	
TOTAL	326	2.417E2		

<u>Country/Gear</u>	<u>ln Power</u>	<u>Month</u>	<u>ln Power</u>
PRT OTB-7	-0.688	Sept.	-1.273
PRT OTB-6	-0.370	July	-1.036
		Aug.	
CAN-N OTB-4	-0.187	June	-0.862
CAN-N OTB-5	-0.083	Oct.	
CAN-M OTB-4	0.000	May	-0.613
CAN-M OTB-5	0.392		
		Apr.	-0.273
		Dec.	
<u>Division</u>	<u>ln power</u>	Jan.	
3L	-0.870	Feb.	0.000
3K	-0.598	Mar.	
2J	0.000		

Table 20. Catch rate index series for cod in Divisions 2J3KL for 1962-79 and 1979-83, using 1979 as reference in both series. The proportion of the total catch which was used for the analysis in each year is indicated.

YEAR	TOTAL CATCH	PROP.	CATCH RATE MEAN	INDEX S. E.	EFFORT
1962	502752	0.344	1.916	0.136	262450
1963	499904	0.386	2.007	0.137	249043
1964	603585	0.321	1.873	0.125	322176
1965	555654	0.289	1.611	0.106	344924
1966	522307	0.313	1.690	0.106	309026
1967	610535	0.338	1.860	0.112	328329
1968	807470	0.273	1.774	0.102	455210
1969	748433	0.242	1.446	0.085	517482
1970	516213	0.242	1.250	0.076	412981
1971	432496	0.266	1.050	0.064	411969
1972	458170	0.145	0.935	0.059	490135
1973	354509	0.197	0.925	0.062	383413
1974	372650	0.221	1.033	0.072	360792
1975	287508	0.156	1.076	0.072	267128
1976	214220	0.174	0.878	0.067	243936
1977	172720	0.131	0.518	0.034	333279
1978	138559	0.141	0.514	0.034	269453
1979	166891	0.215	1.000	0.095	166891
1980	175782	0.273	1.179	0.113	149038
1981	170748	0.370	1.489	0.137	114671
1982	229628	0.394	1.351	0.112	169981
1983	226965	0.428	1.591	0.136	142671

Table 21. Historical partial recruitment for 1962-83. The average for the years 1975-81 was used as an estimate for cohort analysis.

SELECTIVITY COEFFICIENTS																			
AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	
4	0.15	0.16	0.14	0.07	0.21	0.18	0.28	0.09	0.27	0.32	0.41	0.45	0.14	0.13	0.30	0.26	0.12	0.09	
5	0.30	0.51	0.34	0.22	0.49	0.38	0.66	0.31	0.46	0.69	0.73	0.73	0.38	0.37	0.49	0.71	0.37	0.36	
6	0.52	0.89	0.58	0.41	0.65	0.68	0.85	0.70	0.93	1.02	0.89	0.59	0.71	0.65	0.72	0.74	0.80	0.42	
7	0.85	0.89	1.01	0.75	0.91	0.83	1.00	0.96	1.49	1.14	1.04	0.70	0.72	0.81	0.86	0.76	1.16	0.78	
8	0.92	0.98	1.04	1.00	1.01	0.93	1.07	1.09	1.09	1.07	1.09	0.97	0.97	0.99	0.90	0.88	1.04	1.06	
9	1.00	0.96	0.91	1.03	1.10	0.92	1.03	0.89	0.97	0.95	0.88	1.03	0.96	0.95	1.13	1.02	0.94	0.89	
10	1.14	1.12	1.01	0.93	0.78	1.35	0.71	0.89	0.65	0.82	0.88	1.06	1.21	1.15	1.12	1.29	0.97	0.97	
11	0.94	1.03	1.20	0.80	0.84	0.79	0.96	0.84	0.53	0.66	0.91	0.95	1.30	0.80	1.11	1.28	0.77	1.06	
12	1.23	0.67	1.07	0.75	0.71	0.95	0.76	1.54	0.55	0.56	0.80	1.35	1.12	0.98	0.57	1.05	1.01	0.67	
13	1.00	1.01	1.00	1.00	0.99	1.00	1.00	1.00	1.01	1.00	0.99	1.01	0.99	1.00	1.00	0.99	1.00	0.99	
AGE	1980	1981	1982	1983															
4	0.25	0.17	0.23	0.19															
5	0.48	0.53	0.41	0.47															
6	0.73	0.83	0.59	0.70															
7	0.64	1.15	0.93	0.84															
8	0.76	0.99	1.01	1.00															
9	1.19	1.49	0.98	1.00															
10	1.00	1.83	1.01	1.00															
11	0.75	1.52	0.82	1.00															
12	1.18	1.90	1.06	1.00															
13	0.79	1.53	1.01	1.00															

Table 22. Results from regression analyses of mid year exploitable table biomass versus catch rate index for cod in Divisions 2J3KL (1962-83).

Year	CPUE	0.15		0.20		0.25	
		Obs.	Residuals	Obs.	Residuals	Obs.	Residuals
1962	1.916	138					
1963	2.007	156					
1964	1.873	131					
1965	1.611	95					
1966	1.690	113					
1967	1.860	109					
1968	1.774	129					
1969	1.446	86					
1970	1.250	92					
1971	1.050	100					
1972	.935	95					
1973	.925	71					
1974	1.033	47					
1975	1.076	28					
1976	.878	19					
1977	.518	27	4	27	6	27	7
1978	.514	28	5	27	7	27	8
1979	1.000	36	-26	34	-25	33	-24
1980	1.179	71	-6	62	-11	57	-14
1981	1.489	102	-0.3	84	-14	73	-22
1982	1.351	114	23	90	4	76	-8
1983	1.591	147	36	110	5	88	-14
r ²		0.73		0.76		0.73	
Intercept		-19.28		-19.5		-19.68	
Slope		81.5		78.6		76.8	

Table 23. Results from cohort analysis for cod in Divisions 2J3KL using a fishing mortality of 0.20 in 1983 for fully recruited ages.

		POPULATION NUMBERS (x 10 ⁻⁵)															
AGE		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
4		5418	5779	5058	6849	8167	9252	6702	5780	5360	5893	4746	2081	1241	1260	2441	3864
5		6793	4194	4486	3900	5354	6086	6865	4658	4388	3871	4201	3164	1336	891	896	1416
6		3579	4966	2899	2164	2780	3531	4070	3820	2942	2893	2336	2384	1735	772	495	420
7		1927	2469	3017	1839	1998	1704	2012	2020	1739	1558	1514	1223	1416	745	318	178
8		1059	1138	1499	1583	937	1094	895	915	744	711	772	733	682	605	258	98
9		719	610	671	776	689	489	545	390	303	366	364	364	353	231	173	76
10		581	401	362	367	333	347	245	243	153	158	197	191	169	121	69	40
11		395	308	225	189	167	193	138	132	95	92	90	103	88	46	29	16
12		290	226	179	109	94	94	104	64	53	61	57	47	50	22	16	7
13		277	148	148	91	55	56	47	54	15	34	39	31	18	15	6	7
4+		21139	20240	18543	18866	20573	22847	21622	18077	15791	15636	14316	10322	7089	4709	4703	6122
5+		15721	14461	13485	12017	12406	13595	14920	12297	10432	9743	9569	8240	5848	3449	2262	2258
6+		8928	10267	8998	8117	7052	7509	8055	7638	6044	5872	5368	5076	4513	2558	1366	842
7+		5249	5301	6100	4953	4272	3978	3985	3819	3102	2979	3033	2492	2777	1786	871	422
AGE		1978	1979	1980	1981	1982	1983										
4		3425	3334	2055	2675	6570	3963										
5		2686	2652	2620	1576	2131	5083										
6		740	1841	1825	1892	1183	1576										
7		215	413	1234	1233	1352	840										
8		90	101	233	855	837	880										
9		46	45	50	148	605	534										
10		33	24	24	30	95	388										
11		14	17	12	15	18	61										
12		6	8	8	8	10	12										
13		3	3	5	5	5	6										
4+		7257	6436	8067	8437	12806	13342										
5+		3831	5102	6012	5762	8235	9379										
6+		1145	2450	3391	4186	4104	4296										
7+		406	610	1566	2294	2921	2720										

Table 23. Continued.

POPULATION BIOMASS (AVERAGE) ($\times 10^{-2}$ tons)																
AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
4	2622	2808	2450	3339	3892	4400	3090	2779	2516	2750	2146	925	581	587	1035	2494
5	5132	3086	3332	2911	3854	4409	4571	3286	3158	2674	2822	2093	905	593	553	1062
6	3732	4811	2864	3119	2704	3322	3600	3253	2678	2620	2115	2286	1440	630	382	529
7	2487	3226	3691	2220	2492	2086	2311	2121	1908	1858	1788	1537	1583	762	310	324
8	1725	1975	2326	2378	1460	1671	1389	1174	1129	1099	1150	1103	884	732	316	226
9	1438	1254	1330	1382	1315	932	988	668	587	720	709	672	572	355	239	205
10	1368	970	847	808	816	721	580	502	382	384	462	423	302	206	115	119
11	1137	893	601	511	479	540	363	326	289	275	248	277	179	108	58	56
12	877	763	540	328	303	281	316	139	178	204	177	126	121	53	46	30
13	1276	695	661	375	249	240	195	204	64	151	170	132	67	51	21	38
4+	21802	20380	18643	17272	17563	18601	17302	14453	12889	12734	11787	9573	6636	4077	3075	5084
5+	19173	17572	16193	13933	13672	14201	14212	11674	10373	9784	9641	8649	6055	3490	2040	2590
6+	14040	14486	12861	11022	9817	9792	9641	8388	7215	7310	6818	6556	5149	2897	1487	1527
7+	10309	9676	9996	7902	7113	6470	6042	5135	4538	4691	4703	4270	3709	2267	1106	998
AGE	1978	1979	1980	1981	1982	1983										
4	2115	2193	1390	1830	4868	3033										
5	2214	2478	2594	1572	2226	5770										
6	891	2549	2597	2622	1773	2324										
7	381	783	2468	2255	2398	1594										
8	220	260	671	2076	1799	1878										
9	143	148	196	457	1509	1390										
10	113	93	107	125	320	1117										
11	60	70	68	77	93	239										
12	31	45	51	46	55	77										
13	17	19	34	30	32	45										
4+	6186	8638	10176	11090	14984	17467										
5+	4070	6445	8786	9260	10116	14435										
6+	1856	3967	6192	7688	7890	8665										
7+	965	1418	3595	5066	6117	6341										

FISHING MORTALITY

AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
4	0.056	0.053	0.060	0.046	0.094	0.098	0.164	0.076	0.126	0.139	0.206	0.243	0.131	0.141	0.345	0.164	0.056
5	0.113	0.170	0.149	0.138	0.216	0.202	0.386	0.260	0.217	0.305	0.366	0.401	0.348	0.387	0.557	0.450	0.178
6	0.199	0.298	0.255	0.260	0.289	0.363	0.500	0.587	0.436	0.447	0.447	0.321	0.646	0.686	0.821	0.472	0.383
7	0.327	0.300	0.445	0.475	0.402	0.444	0.588	0.799	0.695	0.503	0.525	0.384	0.651	0.861	0.980	0.485	0.558
8	0.352	0.328	0.458	0.632	0.456	0.497	0.631	0.905	0.510	0.469	0.552	0.530	0.880	1.051	1.018	0.560	0.499
9	0.383	0.322	0.464	0.646	0.486	0.492	0.606	0.737	0.454	0.418	0.443	0.564	0.872	1.008	1.277	0.650	0.450
10	0.436	0.377	0.447	0.585	0.346	0.720	0.420	0.738	0.302	0.359	0.445	0.578	1.095	1.217	1.270	0.819	0.467
11	0.360	0.344	0.531	0.505	0.372	0.421	0.566	0.701	0.249	0.289	0.458	0.521	1.177	0.847	1.258	0.812	0.370
12	0.468	0.224	0.474	0.473	0.317	0.507	0.451	1.282	0.258	0.246	0.403	0.736	1.014	1.043	0.644	0.665	0.482
13	0.380	0.340	0.440	0.630	0.440	0.530	0.590	0.830	0.470	0.440	0.500	0.550	0.900	1.060	1.130	0.630	0.480
AGE	1979	1980	1981	1982	1983												
4	0.041	0.066	0.027	0.057	0.038												
5	0.173	0.126	0.086	0.102	0.094												
6	0.200	0.192	0.136	0.143	0.140												
7	0.372	0.167	0.188	0.230	0.168												
8	0.504	0.252	0.146	0.249	0.206												
9	0.425	0.310	0.244	0.243	0.200												
10	0.462	0.263	0.300	0.250	0.200												
11	0.564	0.198	0.249	0.202	0.200												
12	0.320	0.311	0.311	0.261	0.200												
13	0.470	0.260	0.250	0.250	0.200												

CATCHES OF COD INSHORE

LABRADOR - EAST COAST NEWFOUNDLAND COD STOCK (2J3KL)

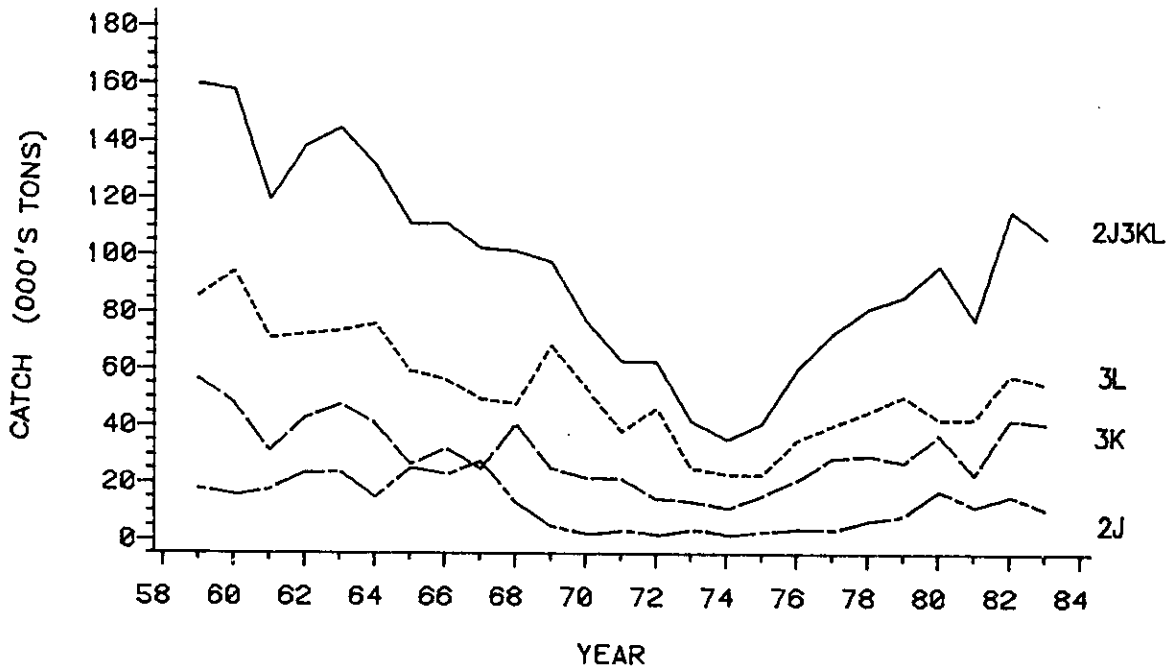


Fig. 1. Inshore cod catches from Divisions 2J3KL.

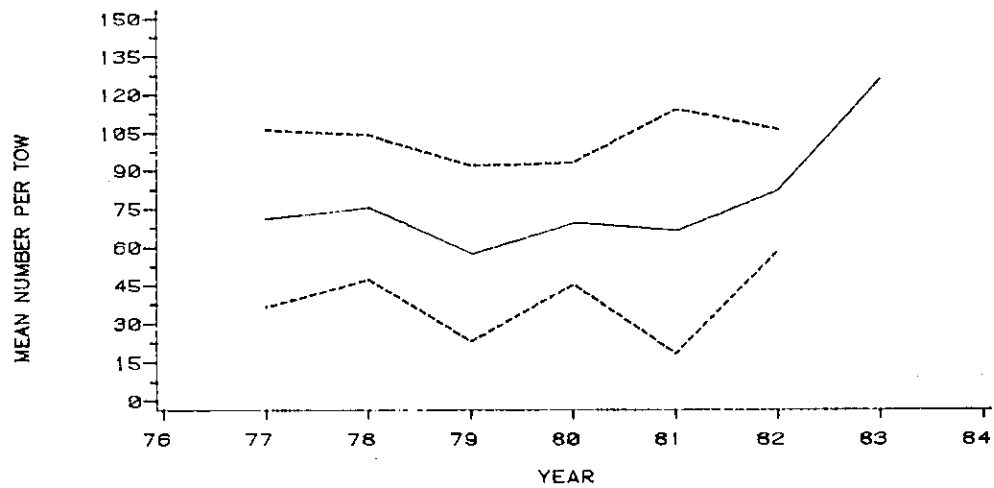
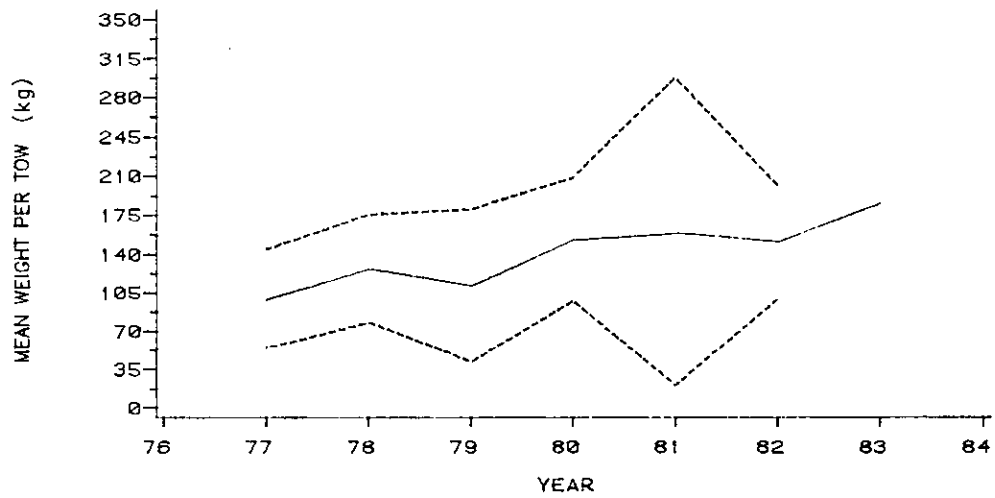


Fig. 2. Mean weight and number per tow estimates with their associated confidence limits for cod from research surveys in Division 2J. (Confidence limits for 1983 are: 526.5 and -273.9 for numbers, and 829.7 and -457.4 for weight.)

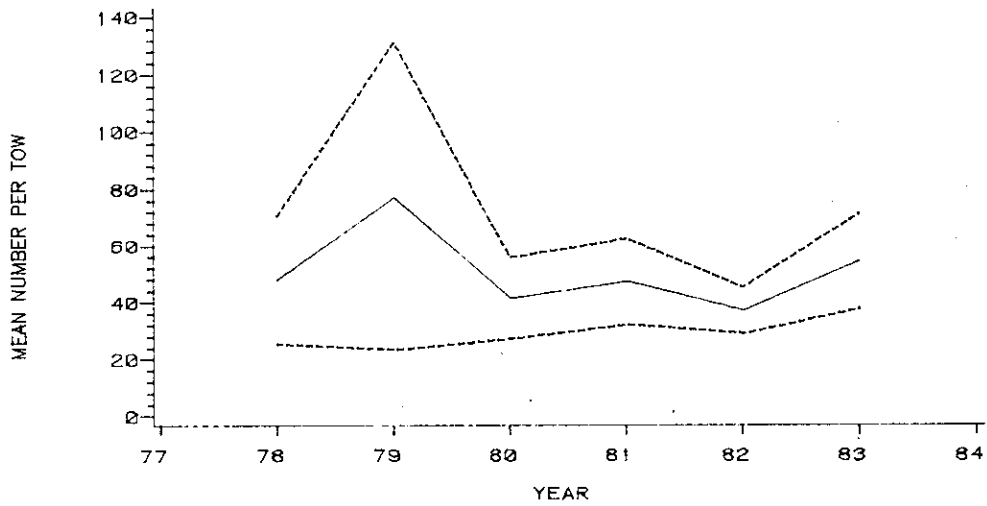
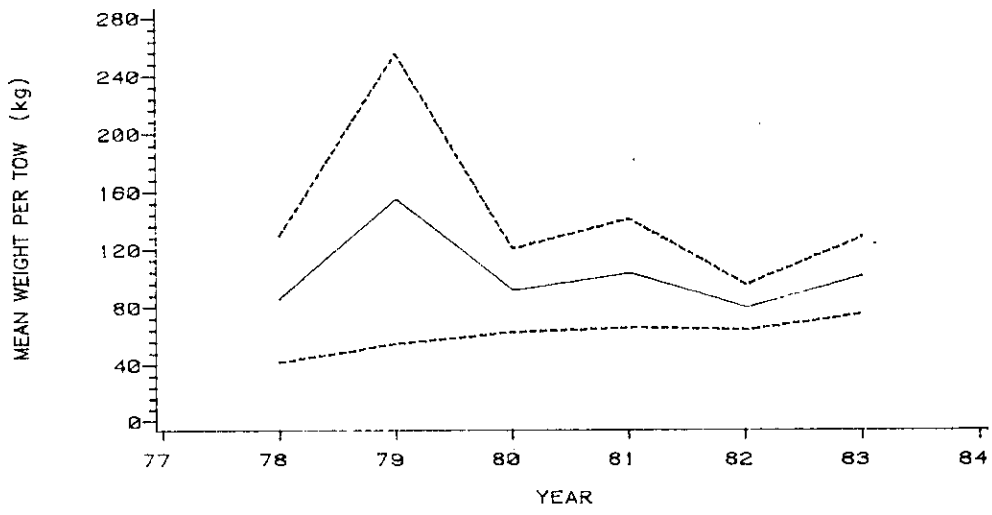


Fig. 3. Mean weight and number per tow with their associated confidence limits for cod from research surveys in Division 3K.

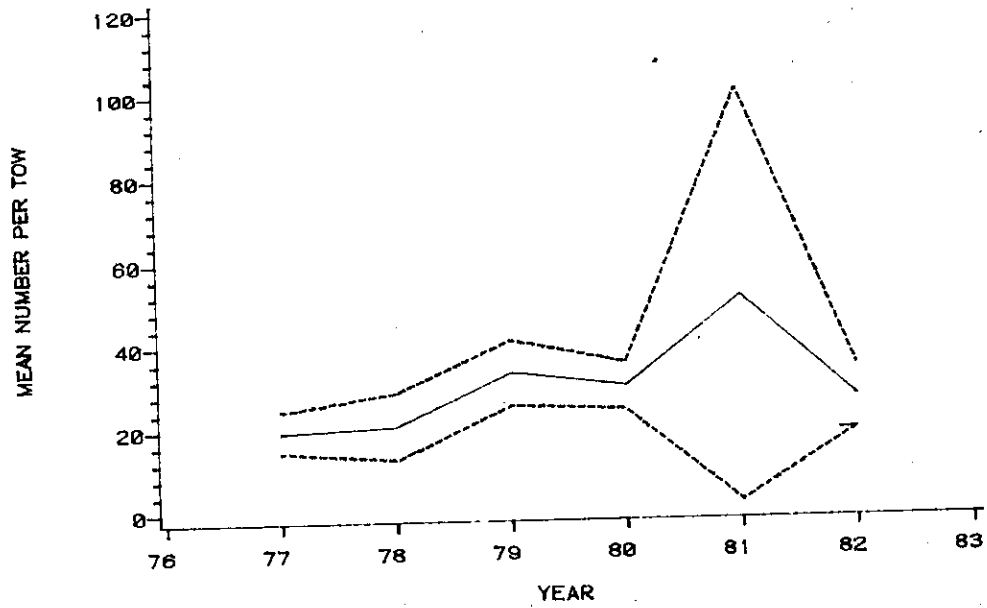
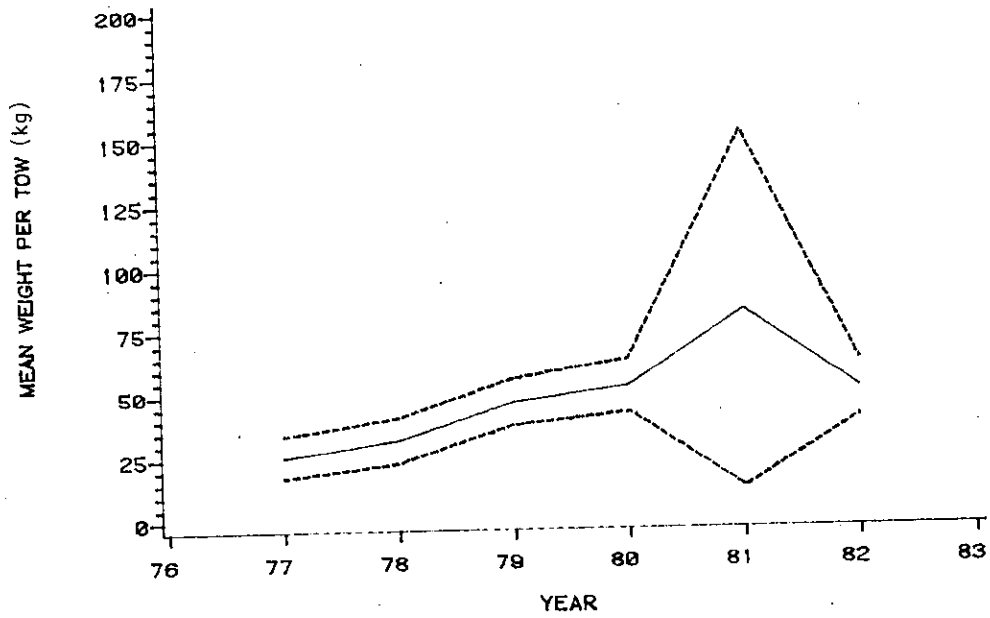


Fig. 4. Mean weight and number per tow with their associated confidence limits for cod from research surveys in Division 3L.

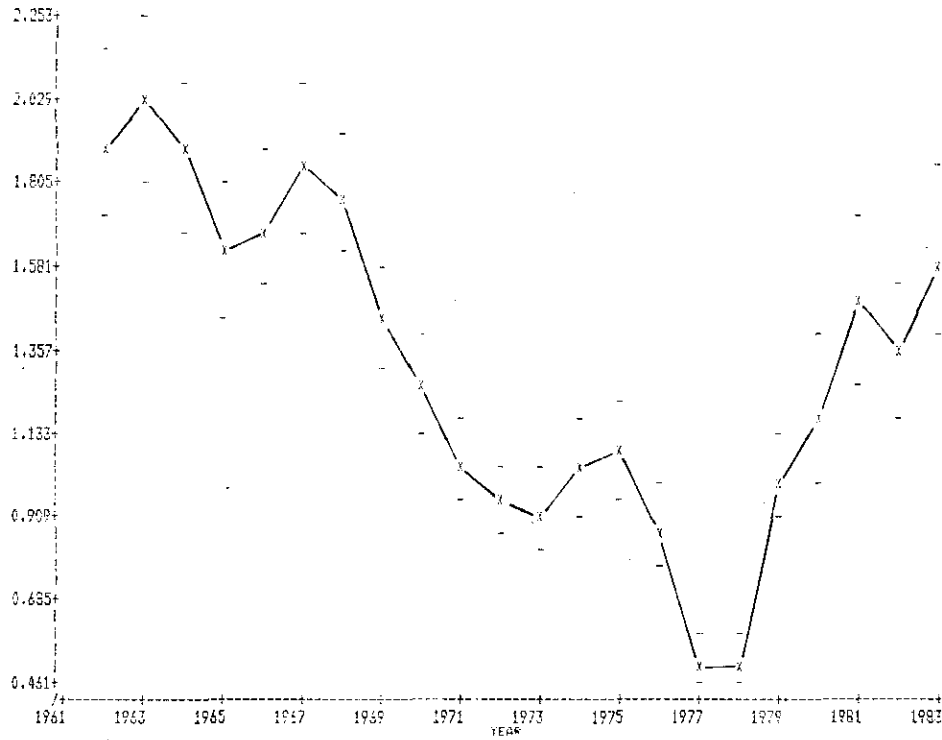


Fig. 5. Catch rate index with approximate 90% confidence interval for cod in Divisions 2J3KL.

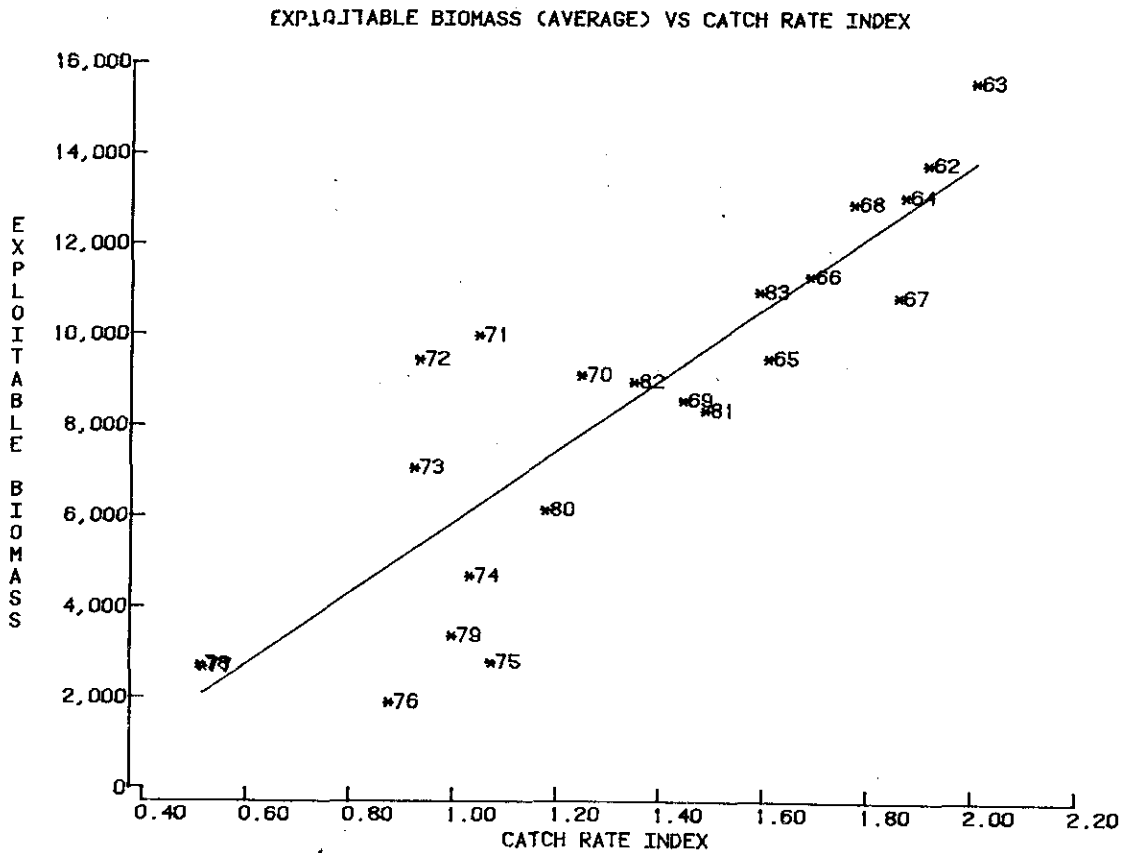


Fig. 6. Plot of the regression of exploitable biomass versus catch rate index for cod in Divisions 2J3KL using a fishing mortality of 0.20 for fully recruited ages in 1983.

2J3KL COD

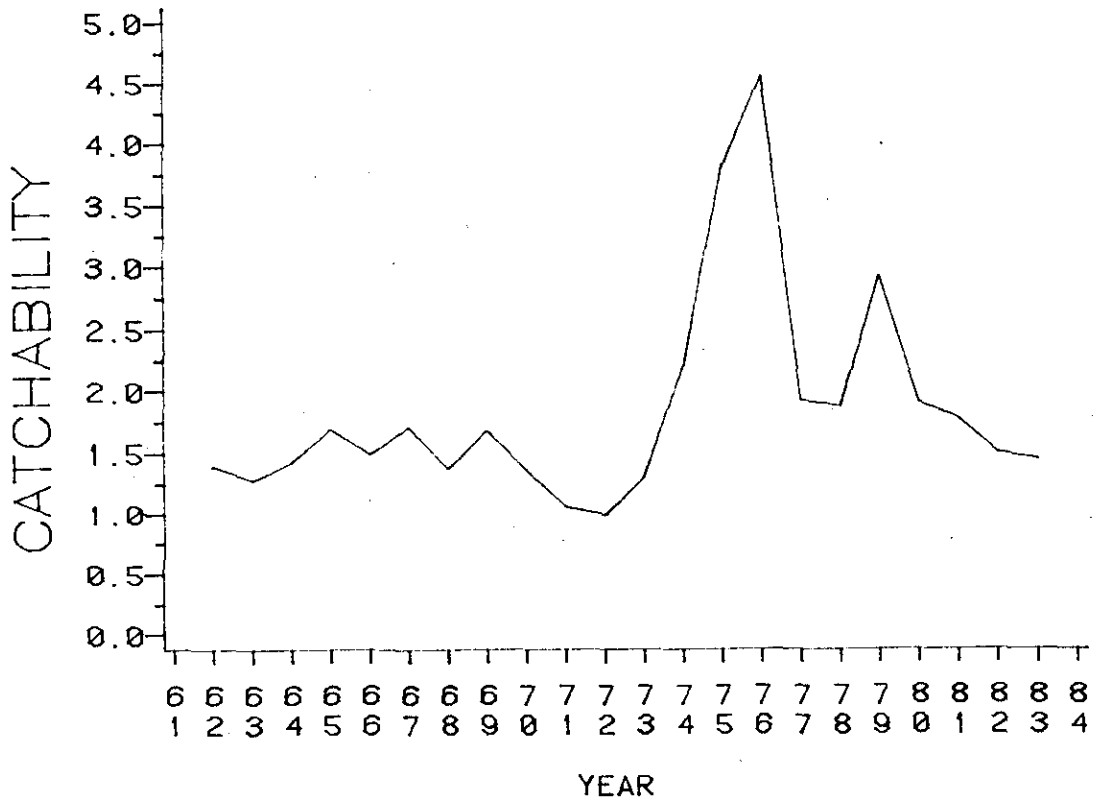


Fig. 7. Catchability (CPUE/midyear exploitable biomass) for cod in Divisions 2J3KL - exploitable biomass from cohort at $F_t=0.20$.

APPENDIX

Further Assessment of Cod Stock in Divisions 2J+3KL

A survey biomass index was obtained by combining autumn survey results from Canada and the Federal Republic of Germany. Div. 3L was omitted because of the lack of a Canadian survey in 1983. The 1977 biomass estimate for Div. 3K from Canada was calculated by taking the proportion of the 3K to 2J average biomass for the 1978-82 period. The Canadian series in the two divisions were then added and the combined series scaled to its mean. The Federal Republic of Germany mean weight per tow in Div. 2J was scaled to its 1977-83 mean then averaged with the Canadian series to produce an index of biomass. The Canadian, Federal Republic of Germany and the averaged series are shown in Table 1.

Age 4+ biomass from cohort analysis versus this survey biomass index lagged 1 year gave the highest r^2 value with a fully recruited fishing mortality estimate of 0.25 (Table 2). The fully recruited F that was accepted in the cohort analysis was 0.225 because it was the midpoint of the range of fishing mortalities derived using the above relationship and the relationship between mid-year exploitable biomass versus commercial catch rate. Tables 3 to 5 show population numbers and biomass along with fishing mortality values from a cohort analysis using $F_t = 0.225$.

Table 1. Canadian, Federal Republic of Germany and averaged survey biomass indices for 1972-83.

Year	Canada	Federal Republic of Germany	Average
1972		1.540	1.540
1973		0.900	0.900
1974		0.398	0.398
1975		0.182	0.182
1976		0.311	0.311
1977	0.724	0.320	0.522
1978	0.839	0.260	0.549
1979	1.133	1.367	1.250
1980	1.056	0.718	0.887
1981	1.100	1.826	1.463
1982	0.953	1.012	0.993
1983	1.195	1.497	1.346

Table 2. Results of regression analysis of age 4+ biomass from cohort analysis versus survey biomass index.

F_T	r^2	Slope	Intercept
0.20	0.62	7594	3225
0.25	0.72	6108	3427
0.30	0.68	5613	3647

Table 3. Population numbers from a cohort analysis for cod in NAFO Divisions 2J3KL using a fishing mortality of 0.225 in 1983 for the fully recruited ages.

POPULATION NUMBERS												
AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
4	5418	5779	5058	4849	8167	9252	6702	5790	5360	5893	4746	2081
5	4723	4194	4486	3900	5354	6086	4855	4658	4388	3871	4201	3164
6	3679	4966	2893	3164	2780	3531	4070	3920	2942	2893	2336	2384
7	1927	2469	3017	1839	1998	1704	2012	2020	1739	1558	1514	1223
8	1059	1138	1498	1583	937	1094	895	915	744	711	772	733
9	719	610	671	776	689	489	545	390	303	366	364	364
10	581	401	362	367	333	347	245	243	153	158	197	191
11	395	308	225	189	167	197	138	132	95	92	90	103
12	290	226	179	109	94	94	104	64	53	61	57	47
13	277	148	148	91	55	56	47	54	15	34	39	31
4+	21139	20240	19543	18866	20573	22847	21622	18077	15791	15636	14316	10322
5+	15721	14461	13485	12017	12406	13595	14920	12297	10432	9743	9569	8240
AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983		
4	1241	1254	2417	3734	3279	3137	1899	2431	5911	3530		
5	1336	891	891	1396	2580	2532	2459	1448	1931	4544		
6	1735	772	495	416	723	1754	1727	1760	1079	1412		
7	1414	745	318	178	211	399	1163	1153	1244	754		
8	682	605	258	98	90	96	322	766	771	791		
9	353	231	173	78	46	45	48	139	557	480		
10	187	121	69	40	33	24	24	28	88	349		
11	88	48	29	16	14	17	12	15	17	55		
12	50	22	16	7	6	8	8	10	11	11		
13	18	15	6	7	3	3	5	5	5	6		
4+	7089	4703	4673	5968	6984	8016	7566	7783	11612	11932		
5+	5849	3449	2257	2234	3705	4879	5668	5352	5700	8401		

Table 4. Mid-year population biomass from a cohort analysis for cod in Divisions 2J3KL using a fishing mortality of 0.225 in 1983 for the fully recruited ages.

POPULATION BIOMASS (AVERAGE)												
AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
4	2629	2908	2450	3339	3892	4400	3090	2779	2516	2750	3146	925
5	5132	3086	3332	2911	3854	4409	4571	3236	3158	2674	2822	2093
6	3732	4511	2864	3119	2704	3322	3600	3253	2678	2620	2115	2286
7	2487	3226	3691	2220	2492	2086	2311	2121	1908	1858	1788	1537
8	1725	1875	2326	2278	1440	1671	1289	1174	1129	1099	1150	1103
9	1438	1254	1330	1362	1315	932	988	668	587	720	709	672
10	1368	970	847	806	816	721	580	502	382	384	462	423
11	1132	893	601	511	479	540	363	328	289	275	248	277
12	877	763	540	328	303	281	316	139	178	204	177	126
13	1276	695	661	375	248	240	195	204	64	151	170	132
4+	21802	20390	18643	17272	17563	18601	17302	14453	12889	12734	11787	9573
5+	19173	17572	16197	13933	13672	14201	14212	11674	10373	9984	9641	8649
AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983		
4	581	584	1023	2404	2023	2060	1281	1661	4366	2696		
5	905	593	549	1043	2119	2357	2424	1438	2007	5129		
6	1440	630	382	523	867	2416	2444	2426	1604	2066		
7	1583	762	310	324	373	752	2313	2094	2101	1417		
8	884	732	316	226	220	251	635	1924	1640	1669		
9	572	355	239	205	143	148	186	426	1375	1236		
10	302	296	115	119	113	93	107	116	292	993		
11	177	138	58	56	60	70	68	77	85	212		
12	121	53	46	30	31	45	51	46	55	69		
13	67	51	21	38	17	19	34	30	32	45		
4+	6636	4074	3059	4968	5265	8211	8542	10238	13556	15531		
5+	6055	3490	2036	2564	3942	6151	8262	8577	9190	12835		

Table 5. Fishing mortalities from cohort analysis for cod in Divisions 2J3KL using a fishing mortality of 0.225 in 1983 for fully recruited ages.

FISHING MORTALITY													
AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
4	0.056	0.053	0.060	0.046	0.094	0.098	0.164	0.076	0.126	0.139	0.206	0.243	0.131
5	0.113	0.170	0.149	0.138	0.216	0.202	0.336	0.260	0.217	0.305	0.366	0.401	0.348
6	0.192	0.298	0.255	0.260	0.299	0.363	0.500	0.587	0.436	0.447	0.447	0.321	0.646
7	0.327	0.369	0.445	0.475	0.402	0.444	0.588	0.799	0.695	0.503	0.525	0.384	0.651
8	0.352	0.328	0.458	0.632	0.450	0.497	0.631	0.905	0.510	0.469	0.552	0.530	0.880
9	0.383	0.322	0.404	0.646	0.486	0.492	0.606	0.737	0.454	0.418	0.443	0.564	0.872
10	0.436	0.377	0.447	0.585	0.346	0.720	0.420	0.738	0.302	0.359	0.445	0.578	1.095
11	0.360	0.344	0.531	0.505	0.372	0.421	0.566	0.701	0.249	0.289	0.458	0.521	1.177
12	0.468	0.224	0.474	0.473	0.317	0.507	0.451	1.282	0.258	0.246	0.403	0.736	1.014
13	0.380	0.340	0.440	0.630	0.440	0.530	0.590	0.830	0.470	0.440	0.500	0.550	0.900
AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983				
4	0.142	0.349	0.170	0.059	0.044	0.071	0.030	0.063	0.043				
5	0.387	0.561	0.456	0.184	0.182	0.134	0.094	0.113	0.106				
6	0.686	0.921	0.478	0.394	0.211	0.204	0.147	0.158	0.158				
7	0.941	0.780	0.485	0.370	0.387	0.179	0.202	0.252	0.189				
8	1.051	1.018	0.560	0.499	0.522	0.267	0.158	0.274	0.225				
9	1.008	1.217	0.650	0.450	0.425	0.327	0.262	0.267	0.225				
10	1.217	1.270	0.819	0.467	0.462	0.263	0.323	0.274	0.225				
11	0.847	1.253	0.612	0.370	0.504	0.198	0.249	0.222	0.225				
12	1.043	0.644	0.665	0.482	0.320	0.311	0.311	0.261	0.225				
13	1.060	1.130	0.630	0.430	0.470	0.260	0.250	0.250	0.225				

