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Pollock in Divisions 4VWX and Subarea 5

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A joint Canadian - USA assessment was first prepared for this stock in 1976. The present material updates the results of this initial assessment and provides management recommendations for 1977.

Commercial Landings

Provisional statistics indicate landings of 37,100 tons, down slightly from the 1975 figure of 39,000 tons (Table 1). The bulk of the catch (90%) was taken by Canada and the USA, with most of the remainder being taken by the FRG and the USSR (Table 2).

Percentage age composition data for Canadian and USA pollock landings (1973-1976) by quarter are given in Table 3. USA figures have been revised somewhat from those given in 1976 on the basis of additional sampling and length-at-age data. As for the 1976 assessment, age composition of the commercial catch appears to have been quite different in most quarters for the two countries; Canadian data indicates a more even age distribution throughout the year, while USA data indicates a preponderance of younger individuals in the first three quarters. The shift in the USA age composition during the fourth quarter appears associated with seasonal spawning movements into Division 5Y.

Pollock landings at age data (nos. x 10^{-3}) indicate that the 1968, 1969, and 1971 year-classes were relatively strong ones, but succeeding year-classes may be weaker (Table 4)

Cohort Analysis

Given four years of commercial removals at age data (Table 4), meaningful results can be expected for earlier years if starting values for instantaneous fishing mortality (F) in the final years are reasonably accurate. Accordingly, a cohort analysis was performed using the above catch in numbers at age data for 1973-1976 assuming instantaneous natural mortality (M)= 0.2 for all ages. The starting value for F for fully recruited year-classes was estimated by plotting a catch curve (i.e. $\log_e$ number caught versus age for each year-class) and regressing data for the fully recruited portions of each curve on time. The slope of this line provided an estimate of instantaneous total mortality (Z). Catch predictions for 1977 and 1978 were then made from the computed regressions and a cohort analysis was performed for 1976-1978 using the observed catch for 1976 and the predicted catches for the remaining two years using a starting F of Z -0.2. The F value calculated for 1976 was then taken as the starting F in a second cohort analysis. This procedure assumes that no major changes have occurred in fishing effort and stock abundance during 1973-1976, an assumption which appears justifiable on the basis of available commercial and research vessel survey data (Tables 1, 6, 7, and 10).

Results of the cohort analysis indicate a decline in stock size (age 4+) of from 106,200 tons in 1973 to 86,200 tons in 1974, followed by an increase to 104,100 tons in 1975 coincident with recruitment of the strong 1971 year-class.

Stock size subsequently decreased to 93,900 tons in 1976 and to 83,500 tons at the beginning of the current year. Weighted F values (age 4+) for 1974 and 1975 were 0.45 and 0.50, respectively, somewhat above the level of F_{max}.

Commercial and Research Vessel Survey Abundance Indices

Stratified mean catch per tow values (kg) for pollock from Georges Bank, the Gulf of Maine, and the Scotian Shelf areas for USA spring (1968-1976) and autumn (1963-1976) bottom trawl surveys are given in Table 6. Spring data appear to indicate a relatively constant level of abundance during 1975-1976, but autumn indices for Division 5Y and all areas combined rose very sharply compared to values for the preceeding year.

Canadian research vessel survey catches of pollock show a high variability from year to year (Table 10) and, as with USA surveys, pollock were more available in 1976 than in 1975. The 1971 year-class predominated in 1976 catches, all subsequent year-classes appearing weaker. Average mortality rate (Z) for the 1970-76 period was 0.46 and for the period 1972-76, Z = 0.39.

USA commercial abundance indices (MT/day fished for 51-500 GRT otter trawlers, agree with the spring survey data in indicating a relatively constant level of abundance during 1975-1976 (Table 7). Due to the relative constancy of these indices, and due to the fact that indices for almost all year-classes increased (Table 8), the increase observed for the fall 1976 survey is not thought to reflect an increase in abundance (note that a similar high index occurred in autumn of 1969). This apparent increase invalidated calculation of Z from the 1976 autumn bottom trawl indices (Table 9).

Summary and Recommendations for 1978.

The cohort analysis presented above indicates a decline in stock size since 1975 although USA commercial abundance indices and research vessel survey catch per tow values have been reasonably stable. Cohort analyses and research vessel survey data suggest that incoming 1972-1974 year-classes are weaker than preceeding ones; also, both agree in indicating that F in recent years has been higher than F_{max}.

Assuming that the 1977 TAC is fully taken, stock size at the beginning of 1978 (age 4+) will be approximately 80,000 tons, and assuming further that the 1975 and 1976 year-classes are approximately equal in strength to the preceeding three (i.e., 20×10^6 fish at age 2), fishing at F_{max} in 1978 would provide a catch of 28,100 tons; stock size at the beginning of the following year would be 78,900 tons. Alternatively, fishing at $F_{0.1}$ would provide a catch of 17,700 tons with a stock size of 90,500 tons at the beginning of the following year.

Table 1. Pollock landings (MT, round fresh) for Divisions 4VWX, Subarea 5, and Statistical Area 6, 1960-1976.

Year	4Vn	4Vs	4W	4X	Total 4VWX	5Y	5Ze	5Zw	Total 5Z	5NK	Total SA5	SA6	Total
1960	692	811	38354	20132	29989	6545	-	-	3834	18	10397	-	40386
1961	311	1053	13167	14321	29352	5017	-	-	3177	25	8219	-	37571
1962	554	738	12045	19624	32961	2560	-	-	3576	15	6151	-	39112
1963	400	274	9152	20645	30471	2168	-	-	3947	10	6125	116	36712
1964	337	137	12488	19283	32245	1754	-	-	7250	-	9004	4	41253
1965	147	1058	13134	13390	27729	1933	-	-	7065	-	8998	2	36729
1966	226	562	11040	12648	24476	953	-	-	8846	-	9799	48	34323
1967	147	510	5636	8290	14787	1728	-	-	6790	-	8523	2	23312
1968	256	757	5954	10656	17623	1416	3724	82	3806	-	5222	4	22849
1969	91	209	3938	10983	15221	4635	5025	162	5187	-	9822	-	25043
1970	130	519	2952	8194	11795	6281	5157	123	5280	-	11561	-	23356
1971	214	317	1802	9739	12072	7016	7096	142	7238	-	14312	891	27275
1972	102	495	1419	16190	20206	6419	6519	51	6570	-	12989	24	33219
1973	170	834	5871	23225	30100	5202	6235	1618	7853	-	13055	21	43176
1974	68	239	4740	20362	25409	6106	6233	5	6238	-	12344	49	37802
1975	179	620	5697	18668	25164	6015	7848	3	7851	-	13866	5	39035
1976[1]	-	-	-	-	24355	-	-	-	-	-	12767	5	37127

[1] Provisional.

Table 2. Pollock landings (MT, round fresh) for Divisions 4VWX, Subarea 5, and Statistical Area 6, 1960-1976.

Year	Canada	Fed. Rep. Germany	German Dem. Rep.	Japan	Spain	USSR	United Kingdom	U.S.A.	Other[1]	Total
1960	29,470	-	-	-	783	-	-	10,132	1	40,386
1961	26,323	-	-	-	982	-	-	10,265	1	37,571
1962	31,721	-	-	-	-	-	-	7,391	-	39,112
1963	28,999	126	-	-	-	906	28	6,653	-	36,712
1964	30,007	208	-	-	-	4,603	374	6,006	55	41,253
1965	27,316	71	-	-	1,361	2,667	11	5,303	-	36,729
1966	18,271	-	-	-	2,384	9,865	12	3,791	-	34,323
1967	17,567	-	9	-	1,779	644	1	3,312	-	23,312
1968	18,062	-	-	-	1,128	372	-	3,280	7	22,849
1969	15,968	1,188	2,195	-	1,515	227	-	3,943	7	25,043
1970	10,753	3,233	4,295	40	532	527	-	3,976	-	23,356
1971	11,757	633	6,849	15	912	2,216	-	4,890	3	27,275
1972	18,022	675	4,816	8	616	3,495	4	5,729	54	33,219
1973	26,990	1,124	948	1,570	3,113	3,092	-	6,303	36	43,176
1974	24,975	149	2	40	1,500	2,348	48	8,726	14	37,802
1975	26,548	236	96	-	709	2,004	-	9,318	124	39,035
1976[2]	23,071	1,013	24	-	397	1,972	-	10,215	435	37,127

[1] Includes Bulgaria, Cuba, Denmark, France, Italy, Iceland, and Poland.
[2] Provisional.

Table 3. Percentage age composition of Canadian and USA pollock landings for Divisions 4VWX and Subarea 5 by quarter, 1973-1976.

Year and quarter	AGE 2	3	4	5	6	7	8	9	10	11	12+
						CANADA					
1973-1	-	-	35.1	43.1	8.8	3.2	3.7	2.7	2.0	0.7	0.7
2	-	5.8	29.8	34.6	6.4	6.9	2.2	5.7	7.2	1.4	-
3	1.4	9.0	31.9	30.0	9.8	8.7	1.7	4.1	2.6	0.5	0.4
4	3.5	15.4	47.6	23.3	4.7	2.2	1.7	1.0	0.6	-	-
1974-1	-	-	4.8	56.1	22.6	4.9	6.4	-	3.1	1.1	1.1
2	-	10.7	20.3	36.7	19.7	5.8	3.0	1.5	1.6	0.7	0.1
3	4.1	48.5	22.9	16.8	4.3	1.5	1.0	0.4	0.1	0.3	0.1
4	1.9	57.7	13.4	14.9	8.0	2.4	0.9	0.2	0.3	-	0.1
1975-1	-	2.9	52.2	27.1	15.6	1.8	-	0.2	0.2	-	0.2
2	0.5	12.8	40.8	16.8	19.4	7.4	1.2	0.4	0.3	0.3	0.2
3	0.6	23.5	60.0	8.8	5.0	1.7	-	-	0.4	-	0.1
4	4.5	22.5	42.5	11.9	12.0	3.4	1.5	0.5	0.4	0.5	0.4
1976-1	-	6.2	10.0	42.4	15.1	18.2	7.7	-	-	-	-
2	-	6.9	17.4	47.4	10.1	12.4	3.1	-	-	-	1.6
3	-	29.7	35.2	25.2	5.2	1.9	0.1	-	-	-	-
4	11.5	25.8	21.1	23.9	11.4	4.8	-	-	-.1	-	-
						USA[1]					
1973-1	13.8	43.2	37.3	5.7	-	-	-	-	-	-	-
2	-	14.7	53.7	31.6	-	-	-	-	-	-	-
3	3.5	26.6	55.2	10.3	2.0	2.4	-	-	-	-	-
4	49.1	3.4	6.3	11.7	11.7	8.2	6.3	2.4	1.0	-	-
1974-1	-	18.5	50.5	26.2	3.8	0.9	-	-	-	-	-
2	2.9	76.1	20.8	1.3	-	-	-	-	-	-	-
3	16.8	74.3	8.9	-	-	-	-	-	-	-	-
4	-	4.9	9.8	22.1	19.8	15.6	14.2	5.6	2.8	3.3	1.9
1975-1	0.3	18.5	76.1	4.3	0.7	-	-	-	-	-	-
2	0.5	25.6	71.8	2.0	-	-	-	-	-	-	-
3	4.1	26.8	25.1	3.6	7.0	14.0	4.1	1.8	7.0	4.7	1.8
1976-1	-	-	7.6	20.8	15.7	33.3	16.4	0.7	1.2	1.2	3.2
2	-	33.8	43.8	22.5	-	-	-	-	-	-	-
4	-	4.3	11.2	21.3	22.6	24.1	6.2	2.4	1.4	3.9	2.7

[1]Includes only those quarters for which commercial length-frequency samples are available.

Table 4. Pollock landings at age (nos. x 10^{-3}) for Divisions 4VWX, Subarea 5, and Statistical Area 6 by country, 1973-1976.

Year	AGE 2	3	4	5	6	7	8	9	10	11	12
						CANADA					
1973	116	771	3180	2800	648	523	185	330	321	63	22
1974	240	4210	1903	2227	975	284	166	61	61	35	14
1975	213	2119	5218	1342	1208	388	87	31	38	26	26
1976	319	1827	2154	2751	729	541	129	15	22	15	44
						USA					
1973	899	750	1144	507	184	135	94	36	15	-	-
1974	352	2971	1209	483	178	116	96	38	19	22	12
1975	77	1237	2789	142	153	193	94	51	73	77	35
1976	49	1429	1682	890	235	297	110	18	14	30	31
						OTHER NATIONS[1]					
1973	42	282	1164	1025	237	192	68	121	118	23	8
1974	39	691	312	366	160	47	27	10	10	6	2
1975	25	253	623	160	144	46	10	4	5	3	3
1976	53	304	359	458	121	90	21	3	4	3	7
						TOTAL					
1973	1057	1803	5488	4332	1069	850	347	487	454	86	30
1974	631	7872	3424	3076	1313	447	289	109	90	63	28
1975	315	3609	8630	1644	1505	627	191	86	116	106	64
1976	421	3560	4195	4099	1085	928	260	36	40	48	82

[1] Calculated by prorating total landings by observed distributions at age in Canadian landings.

Table 5. Divisions 4VWX - Subarea 5 Pollock - Cohort Analysis

	2	3	4	5	6	7	8	9	10	11	12+
Catch (10^{-3})											
1973	1057	1803	5488	4332	1069	850	347	487	454	86	30
1974	631	7872	3424	3076	1313	447	289	109	90	63	28
1975	315	3609	8630	1644	1505	627	191	86	116	106	64
1976	421	3560	4195	4099	1085	928	260	36	40	48	82
Stock Size (10^{-3})											
1973	45596	15898	17999	8572	2233	1602	1025	1342	830	182	77
1974	23839	36375	11384	9771	3098	861	543	525	657	269	71
1975	(21572)	18947	22658	6223	5216	1349	300	183	332	457	163
1976	(20421)	(17377)	12247	10742	3607	2909	537	73	72	166	278
1977[1]	(20000)	16336	10969	6267	5125	1979	1549	208	28	23	247
Fishing Mortality											
1973	0.03	0.13	0.41	0.82	0.75	0.88	0.47	0.51	0.93	0.74	0.56[2]
1974	0.03	0.27	0.40	0.43	0.63	0.85	0.89	0.26	0.16	0.30	0.56[2]
1975	(0.02)	0.24	0.55	0.35	0.38	0.72	1.21	0.73	0.49	0.30	0.56[2]
1976	(0.02)	(0.26)	0.47	0.54	0.40	0.43	0.75	0.77	0.93	0.38	0.39

Year	Weighted Fs Age 4+	Stock Size (MT)
1973	0.58	106221
1974	0.45	86242
1975	0.50	104121
1976	0.49	93924
1977		83530

1 Calculated using $S \doteq e^{-Z}$

2 Mean starting F over all fully recruited year-classes

3 Mean of preceeding two year-classes

Table 6. Stratified mean catch per tow (kg) of pollock from Georges Bank, the Gulf of Maine, and the Scotian Shelf, ALBATROSS IV autumn and spring bottom trawl surveys, 1963-1975.

Year	Subdiv. 5Ze (strata 13-23 and 25)		Div. 5Y (strata 24,26-30,36-40)		Div. 4X (strata 31-35, 41 & 42)		All areas combined (strata 13-42)	
	Nos.	Wt.(kg)	Nos.	Wt.(kg)	Nos.	Wt. (kg)	Nos.	Wt.(kg)
				Autumn				
1963	0.3	1.08	2.1	8.61	1.9	6.23	1.5	5.79
1964	0.7	2.15	2.7	7.07	0.2	0.24	1.6	4.40
1965	0.3	1.13	1.1	3.70	0.5	1.69	0.8	2.46
1966	1.8	3.02	0.7	2.31	0.2	0.93	0.9	2.18
1967	0.3	0.92	0.7	2.76	0.3	0.33	0.5	1.63
1968	0.1	0.47	1.1	5.22	0.5	1.43	0.7	2.92
1969	0.2	0.35	2.3	12.27	3.7	22.11	2.0	11.22
1970	0.2	0.20	0.8	3.37	0.7	3.27	0.6	2.43
1971	1.0	1.34	0.9	5.63	1.1	2.47	1.0	3.62
1972	0.7	0.55	2.1	7.67	4.3	4.21	2.2	4.76
1973	0.3	0.45	1.4	6.05	3.4	6.27	1.6	4.48
1974	0.1	0.21	1.6	5.52	0.6	2.56	0.9	3.26
1975	0.1	0.14	1.1	3.34	0.5	1.41	0.7	1.94
1976	0.1	0.16	6.9	31.14	0.5	2.89	3.7	16.66
				Spring[1]				
1968	0.3	1.70	1.7	6.59	0.6	2.66	1.0	4.21
1969	0.4	1.28	1.3	3.25	4.2	14.57	1.7	5.44
1970	0.6	1.22	1.7	7.22	3.8	3.40	1.9	4.55
1971	0.5	1.16	1.1	4.36	3.0	7.10	1.4	4.11
1972	5.7	3.41	2.3	5.65	5.7	6.52	4.1	5.22
1973	4.6	(3.40)	1.5	(2.62)	3.7	(3.85)	2.9	(3.14)
1974	1.2	(1.90)	0.6	(2.48)	2.7	(9.34)	1.3	(3.98)
1975	1.0	(2.70)	0.7	(3.41)	2.1	(6.00)	1.0	(3.47)
1976	1.2	(4.38)	0.9	(4.52)	1.2	(2.70)	1.1	(4.03)

[1]Values in parentheses obtained by applying a 1.7-1 conversion ratio for the 41 Yankee trawl.

Table 7. Total Landings, Days Fished and Catch Rates (MT/day fished) for Pollock for USA Otter Trawlers of 51-500 GRT in Divisions 4VWX, Subarea 5, and Statistical Area 6, 1964-1976.

	Total Catch MT	Total Days Fished	All Trip Data	10%[1] Trips	50%[2] Trips
1964	5201	10196	0.5	1.9	6.3
1965	4465	9869	0.5	2.0	7.1
1966	3314	9259	0.4	2.1	7.9
1967	2579	8664	0.3	1.7	6.6
1968	2407	7121	0.3	1.6	5.8
1969	3637	5822	0.6	2.1	6.5
1970	3445	5072	0.7	2.1	5.9
1971	4128	6055	0.7	2.4	6.0
1972	4468	5522	0.8	2.6	7.7
1973	4227	5327	0.8	2.7	7.8
1974	5583	6921	0.8	2.8	7.6
1975	5380	7795	0.7	2.3	6.3
1976	6394	7976	0.8	2.2	6.6

[1]Trips for which 10% or more of the total landed weight consisted of pollock

[2]Trips for which 50% or more of the total landed weight consisted of pollock

Table 8. Stratified mean catch per tow at age (nos) for pollock in ALBATROSS IV autumn bottom trawl survey cruises in Divisions 4X and 5Y (strata 24 and 26-42).

	AGE														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
1970	0.01	.14	.06	.03	.10	.10	.10	.05	.04	.01	.03	.01	.00	.04	.05
1971	0.03	.14	.24	.07	.01	.08	.12	.05	.10	.03	.01	.01	.02	.02	.08
1972	0.00	.58	1.02	.56	.08	.09	.11	.07	.07	.06	.03	.03	.03	.02	.07
1973	0.00	.04	.88	.13	.22	.15	.16	.11	.07	.00	.18	.02	.01	.05	.07
1974	0.00	.00	.10	.34	.28	.16	.12	.11	.02	.03	.00	.04	.00	.00	.02
1975	0.01	.28	.06	.04	.13	.06	.06	.08	.06	.02	.01	.01	.00	.01	.03
1976	0.00	0.04	0.04	0.22	0.82	2.41	0.70	0.45	0.21	0.07	0.01	0.01	0.04	0.09	0.30

Table 9. Total mortality coefficients (Z) for pollock computed from catch at age data in ALBATROSS IV autumn bottom trawl surveys (strata 24 and 26-42).

Age group	70-71	71-72	72-73	73-74	74-75	75-76	Pooled avg.[1] 70-76
1	-0.539	-1.986	-0.417	-0.916	-1.792	1.946	-0.685
2	-0.154	-0.847	2.060	0.951	0.916	-1.299	0.551
3	1.099	-0.133	0.934	-0.767	0.961	-3.020	-0.272
4	0.223	-2.197	-0.629	0.318	1.540	-2.920	-1.260
5	-0.182	-0.318	-0.575	0.223	0.981	-2.457	-0.685
6	0.693	0.539	0.000	0.375	0.405	-2.015	-0.261
7	-0.693	-0.336	0.000	1.705	0.606	-0.965	-0.120
8	0.288	0.511	1.946	0.847	0.000	-0.154	0.539
9	0.000	0.000	-1.099	0.000	1.099	0.693	-0.470
10	1.099	-1.099	0.405	1.504	0.000	0.000	0.773
11	-0.693	-1.099	1.099	0.693	1.386	-1.386	0.182
12	-0.693	0.000	-0.511	0.000	0.000	-2.197	-1.153
13	-0.693	-1.253	-1.253	0.916	-1.099	-3.401	-1.404
Pooled avg. Z_{4+}[2]	0.02	-0.09	-0.22	0.73	0.83	-2.21	

[1] Computed as $\ln\left(\frac{\Sigma \text{ at age } 70\text{-}75}{\Sigma \text{ at age } 71\text{-}76}\right)$

[2] Computed as $\ln\left(\frac{\Sigma \text{ ages 4 and older}}{\Sigma \text{ ages 5 and older}}\right)$

Table 10. Estimates of population numbers at age (000's) and total mortality coefficients (Z) calculated for pollock in Canadian summer bottom trawl surveys in Div. 4VWX, 1970-75.

AGE	1970	1971	1972	1973	1974	1975	1976
1	35	-	51	-	35	-	-
2	8,867	3,631	465	1,998	209	29	157
3	2,136	3,023	986	1,859	4,679	89	990
4	1,326	837	6,146	5,649	1,162	1,624	2,837
5	967	194	1,905	2,075	1,421	1,383	4,980
6	953	89	551	330	923	1,838	1,196
7	766	158	157	76	1,047	307	2,064
8	494	54	272	191	464	460	759
9	106	36	227	290	421	147	159
10	-	111	177	11	261	20	168
11	266	-	61	128	641	37	57
12	66	-	29	56	230	-	112
13+	-	-	125	-	-	-	136
NK	135	-	51	69	-	-	71
Z(age 4+)[a]	2.07	-0.88	1.10	0.50	0.45	-0.51	
Total nos.	16,117	8,133	11,203	12,732	11,493	5,934	13,686
Biomass (mt)	29,830	9,500	28,080	28,770	36,500	21,490	51,600

[a] Calculated as $\ell n \left(\frac{\Sigma \text{ ages 4 and older}}{\Sigma \text{ ages 5 and older}} \right)$.

$\bar{Z}_{70-76} = 0.46$