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**Eastern Scotian Shelf Haddock (4VW):
Stock Status in 1982 and Projections to 1984**

by

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Abstract

Research vessel surveys and commercial catch rates indicate that stock biomass has leveled out in the last 2-3 years. The recent trend of decreasing size-at-age continues, and again, although the quota (1982) was not caught, $F_{0.1}$ was achieved. A terminal F of 0.4 was considered appropriate for projection of catches. $F_{0.1}$ catches in 1983 and 1984 are 11,000 t and 13,000 t respectively. If the TAC (19,000 t) is taken in 1983 the projected catch for 1984 is 11,500 t.

Résumé

Les études réalisées par les navires de recherche et les prises commerciales indiquent que la biomasse des stocks s'est stabilisée ces 2-3 dernières années. La taille moyenne par groupe d'âge poursuit la tendance à la baisse observée récemment et, de nouveau, bien que le quota (1982) n'ait pas été atteint, on a de fait atteint le $F_{0.1}$. On a jugé convenable un F de dernière année de 0,4 pour les prises prévues. Les prises $F_{0.1}$ de 1983 et 1984 s'élèvent respectivement à 11 000 t et 13 000 t. Si le TPA (19 000 t) est atteint en 1983, la prise prévue pour 1984 sera de 11 500 t.

Introduction

In 1982 the TAC of 23,000 t was undercaught by about 8,000 t, and the $F_{0.1}$ catch by about 3,000 t. However, the trend of declining weight-at-age which was noted last year continued, consequently the catch in numbers was almost equal to the projected $F_{0.1}$ catch in numbers (Figure 1).

The indications are that stock abundance has stabilized in the last year or two. The quota was probably undercaught because haddock were hard to find in the early part of 1982 and because there were other more profitable stocks to fish. It also appears that the 1977 year class is weaker than projected.

Commercial Removals

1. Trends in Reported Landings

Nominal catches for the period 1954 through 1964 were between 20,000 t and 30,000 t with the exception of a catch of 38,000 t in 1959 (Table 1, Figure 2). Following a catch of 55,000 t in 1965 the fishery declined rapidly to a minimum catch of 1,360 t in 1976. Prior to 1965 approximately two-thirds of the nominal catch was attributed to Division 4W. However more recent catches have been largely confined to 4W.

Recent catches and TAC's ('000 t) have been as follows:

	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>
TAC	(a)	2	2	2	2	15	23	23
Nominal Catch	2	1	3	6	3	15	20	15*

* Provisional statistics

(a) "Lowest practicable level"

The 1983 quota was set at 19,000 t.

2. Distribution of Catch by Division, Gear, and Season

The majority of the catch (83%) continues to be reported from 4W (Table 1). The fishery continues to be dominated by trawlers (Table 2) primarily TC4 and TC5. In 1982 the catch by otter trawlers was primarily in the spring, as has been usual in the past, except 1980 (Table 3). Longliner catches were still mainly in the late summer but were a bit more evenly spread over the year than usual (Table 4).

3. Foreign Removals

Recent foreign removals are all by-catch, primarily in the USSR small-mesh fishery for silver hake (Table 1). The derivation of foreign removals in 1982 was according to White et al. (1981) (Table 5).

4. Weight-Length Relationships

In previous assessments of this stock (White et al. 1981, Mahon et al. 1982) the weight-length relationships obtained from the RV surveys were modified by excluding fish less than 30 cm in length (that is, smaller than are generally found in commercial samples). This improved the correspondence between observed and predicted weights for fish greater than 60 cm. The problem of poor estimation of weights of older fish was not as bad in 1982 and the above modification did not discernibly affect the estimates of weight-at-age. Therefore the unmodified relationship was used in all calculations (Table 6).

5. Age Composition of Reported Landings

The catch-at-age for the domestic commercial landings was calculated in three parts (Table 7) which were subsequently combined with the foreign small-mesh removals:

OTB January - June
 OTB July - December
 All other gear January - December
 Foreign removals January - December

From 1970 - 1979 the age composition of the foreign small-mesh removals was assumed to be similar to that of the Research Vessel survey in the same year. Length-frequency distributions of OBSERVER PROGRAM samples from the USSR small-mesh fishery in July 1980 and 1981 differed substantially from the RV survey length-frequency (Mahon et al. 1982). Therefore the summer RV survey age-length key was applied to the OBSERVER PROGRAM length-frequencies to obtain the age composition of the foreign removals. This procedure was repeated for 1982 (Figure 3). The values in Table 11 differ from those presented by Mahon et al. (1982) as an error was found in the computer program which produces the effort statistics (Branton and Charlton 1983, unpublished manuscript).

The removals-at-age in numbers and weight are shown in Tables 8 and 9. The weights-at-age estimated from the commercial samples are in Table 10. Nominal catch estimated from weights-at-age times numbers-at-age is compared to reported nominal catch as a check (Figure 4).

Abundance Trends

Apart from the usual technological changes which affect catch rate series, there are two specific problems which diminish the interannual comparability of CPUE estimates for 4VW haddock in the last 12 years (Table 11, Figure 5). The first is that in the mid 1970s there was little or no directed fishing and catch rates are based on very small total catches (Table 11). The second is the 1980 departure of the otter trawl fishery from its normal seasonal pattern (Table 3). The values in Table 11 differ from those presented by Mahon et al. (1982) as an error was found in the computer program which produces the effort statistics (Branton and Charlton 1983, unpublished manuscript).

The trends in the RV survey mean catch-per-standard-tow of biomass (Table 12) and of numbers-at-age (Table 13) are shown in Figures 6 and 7. In 1982 the Lady Hammond took over the regular summer groundfish survey from the A.T. Cameron. Preliminary studies by P. Koeller and S. Smith indicate that on average the catch per tow for the Lady Hammond is about 1.2 times that for the A.T. Cameron. Therefore, catch per tow for the Lady Hammond has been divided by 1.2 throughout this paper to make it comparable with the catch per tow by the A.T. Cameron. Previously, the Lady Hammond had carried out only spring and fall surveys since spring 1979. However, two summer comparative fishing experiments had been conducted (1980, 1982). These show reasonable agreement between the vessels with regard to catch in kg per standard tow of 4VW haddock (Table 12, Figure 6). The A.T. Cameron age-length keys were used to obtain a percent-at-age from the Lady Hammond length frequency. Percent-at-age agreed very well with the Cameron in 1980 and less well in 1981 (Figure 8). The mean catch-per-tow values for all surveys are in Table 14 (spring and fall included). Catch per-standard-tow at age for the two pairs of summer cruises can be compared in this Table.

RV survey mean catch-per-standard-tow at ages 1 and 2 were summed (within cohorts) for use as a recruitment index.

Estimation of Stock Abundance

The following 4 relationships were used to calculate the cohort analysis. SPA beginning of year values were adjusted to midyear using loglinear interpolation. All calculations were performed using Pope's cohort formula. Partial recruitment was updated from previous years as the historical average for the 1970-1981 period (Table 18). Natural mortality was assumed to equal 0.2.

- a) SPA numbers, ages 3+ vs RV mean catch-per-standard-tow, ages 3+
- b) SPA numbers, ages 5+ vs RV mean catch-per-standard-tow, ages 5+
- c) SPA fishable biomass vs weighted catch rate for OTB, TC4, and TC5 (Table 11)

Assuming full recruitment at age 6, partial recruitment of younger fish in each year was estimated as F-at-age divided by fully recruited F. Partial recruitment was assumed to be 1 for all fully recruited ages.

- d) SPA fishable biomass vs RV fishable biomass

Example plots of these relationships appear in Figures 9 through 12.

In each case the intercepts and R^2 values from least squares regressions were compared for terminal F values ranging from 0.3 to 0.7 (Table 15). With the above relationships we were unable to discriminate clearly among the trial levels of terminal F.

The RV age 3+ and 4+ indices indicate a terminal F of 0.6. The RV fishable biomass index gives a terminal F of 0.35, whereas the OTB TC4, TC5 index gives a terminal F of 0.40 (Table 15). The cohort analysis results at a terminal F of 0.4 were most consistent with the trend of stabilized stock size observed in the indices (Table 16).

The recruitment index indicates a very strong 1980 year class about to enter the fishery (Figure 13) and the RV survey catch at age 1 in 1982 suggests that the 1981 year class is at least as large.

Y/R and Projections

The trend of decreasing weight-at-age of 4VW haddock has continued (Table 10, Figure 14). Therefore, projections and yield-per-recruit estimates were based on the weights observed in the 1982 fishery rather than on an average over past years. If the current trend continues these will be optimistic.

In the previous three assessments of 4VW haddock $F_{0.1}$ was calculated using ages 1-11 (Waldron 1980, White *et al.* 1981, Mahon *et al.* 1982). However, although there have been few fish older than age 11 in recent catches there is historical evidence that the life span of haddock is at least 16 years. Therefore, in this assessment $F_{0.1}$ was calculated for age 1-16. Mahon and White (MS 1983) show that the mean age in the catch remains below the values observed in the 1950s. The effect of this change was to reduce $F_{0.1}$ from about 0.3 to 0.22 (Table 17). The effects of this change will be to reduce catches in the near term but to increase the average age and weight of fish in the catch at equilibrium and to increase the yield per unit effort. Since each year class will contribute significantly to the catch for a greater number of years at the new $F_{0.1}$ than at the old, $F_{0.1}$ catches should exhibit less year to year variability caused by variable recruitment.

The updated values of partial recruitment-at-age were used for the Thompson and Bell yield-per-recruit analysis and for the catch projections (Table 18). Two catch projections were run; the first assuming that the TAC is caught in 1983 (Table 19), the second with the $F_{0.1}$ catch taken in 1983 (Table 20). The results of the above analyses are summarized in Table 18.

Conclusions

Projected $F_{0.1}$ catches of 4VW haddock in 1983 are lower than those in the 1982 assessment (Mahon *et al.* 1982) for three reasons.

- 1) Weights-at-age have continued to decline.
- 2) Current estimates of stock size in 1982 are lower than those which were projected in 1982. In 1982 RV indices were high for 1980 and low for 1981. Owing to the recent history of stock recovery the high value was considered to be the more probable. The 1982 RV indices were closer to the low 1981 values indicating that the 1982 assessment had over-estimated the rate of recovery of the stock.

- 3) Older ages (12-16) were included in the estimate of $F_{0.1}$ reducing it from 0.30 to 0.22 and consequently reducing the projected catches by an approximately proportional amount in the near term. Since the yield-per-recruit is similar, long term catches should be similar, but with fewer and larger fish in the catches. Year to year variability of $F_{0.1}$ catches should be reduced.

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Table 1. Nominal catches (t) of eastern Scotian Shelf haddock (4TVW) by NAFO Division and country.

Year	4T					4Vn ²					4Vs					4W					Total Catch	TAC	
	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other			
1953	4742					3546										9357					17645		
1954	5918	1044			40	5549	405		1058	24						12323	1956		17		28334		
1955	3101	31				3339	450		1183	13						12777	1217				22111		
1956	2861					4899	147		1350	12						18273	1661		354		29557		
1957	1740	1				5869	120		747	9						19960	1533		132		30111		
1958	2599			151		3166	71		1343	6						17572	427		1593		26928		
1959	2996	1		64		1594	159		69		3456	111		2870		21156	4804		640		37920		
1960	2041					1317	6		97		1187	18		3926	1	20093	127		1024		29837		
1961	1297			273	2	1055	1		47	1	846			1526	7	22277	23	151	1441	16	28963		
1962	1132			10		1097	1		5	2	1235			1076		15566	51	2567	3224		25966		
1963	1019			46		1213	1	6	64		1061	1		2828	195	11002	60	3295	4915	866	26572		
1964	461			1		958			59	52	677	11		2057	2	9810	42	4391	2884	1889	23294		
1965	432			3	3	402			53	84	1201			1806	47	7007	8	42876	1500	96	55518		
1966	149			1		311		516	30		1494			940	9	8259	19	9985	1885	51	23649		
1967	112			9		203		95	26	31	898			839	9	7180	5	459	1046		10912		
1968	144				4	127			70	6	1128		59	1702	23	8392		195	1458	10	13318		
1969	167				3	245				112	726			631	66	8270		235	864	1	11320		
1970	160					395	2		75	1	620		34	830	16	4754	574	636	1332		9429		
1971	151					466			215	1	1133		11	1114		7940	497	464	1477		13469		
1972	60					362	3		136	19	421		3	599	37	2096	70	103	737	102	4748		
1973	21					286			76	164	233			431	9	2830	173	76	95	18	4414		
1974	17				14	161			3	1	147			174	196	907	6	102	521	78	2357	(0)	
1975	35				2	67			15	4	107	1		48	2	1393	20	52	63	59	1868	(0)	
1976	12					40				1	52	1	9		1	1198	31	15			1360	(2000)	
1977	8					189				8	144				1	2845	1	14		38	3248	(2000)	
1978	18					119			3	441			3		38	4949	82	139		109	5901	(2000)	
1979	59					194				11	650			3		2339		104		73	3433	(2000)	
1980	76					181					1836					12411		247		30	14781	(15000)	
1981	176					116				25	1793					17677		187		21	19995	(23000)	
1982	25					181					2365					12485		129		98	15283	(23000)	
1983 ¹																						(19000)	

¹ Provisional 4/83

² Catches for 1953-58 are for 4Vn and 4Vs combined.

Table 2. Nominal catches (t) of eastern Scotian Shelf haddock in 4V and 4W (4TVW) by gear type of Canada (M, Q, & Nfld.) as reported by NAFO.

Year	Otter Trawler	Longliner	Danish Seiner	Miscellaneous	Total
1960	20835	1077	23	696	22631
61	22060	448	52	1377	23937
62	16453	665	76	705	17899
63	11943	511	147	526	13127
64	10679	70	62	874	11685
1965	8033	352	66	160	8611
66	10222	233	19	130	10604
67	7855	126	25	573	8579
68	8819	296	16	364	9495
69	8603	289	30	341	9263
1970	5056	479	20	262	5817
71	8709	538	77	179	9503
72	2141	528	76	138	2883
73	2459	628	28	232	3347
74	543	493	17	162	1215
1975	593	873	10	82	1558
76	383	657	10	75	1125
77	2198	729	26	170	3123
78	4009	1069	67	364	5509
79	1745	1232	64	142	3183
1980	13063	933	176	332	14504
81	17859	1253	213	449	19774
82 ¹	12346	1567	301	842	15056

¹ Preliminary

Table 3. Nominal catches (mt) of eastern Scotian Shelf haddock in 4V and 4W by month by Canadian (MQ) otter trawlers, as reported to NAFO.

YEAR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL
1960	578	3372	4827	1328	1177	597	1427	1678	1543	1199	1665	1442	20833
1961	1387	2761	5029	6605	1389	324	508	489	859	927	1022	488	21788
1962	626	1863	4749	2401	1164	615	954	1079	1015	739	654	449	16308
1963	664	236	388	4444	1357	645	844	1079	1004	434	659	237	11991
1964	406	1531	1473	1557	1155	378	688	1082	804	359	342	638	10413
1965	347	819	1005	1114	986	350	1563	644	109	206	338	363	7844
1966	369	463	3301	1821	2151	264	247	138	136	63	262	101	9316
1967	198	294	4038	800	258	85	263	237	100	526	661	187	7647
1968	254	546	3302	782	730	901	602	114	317	391	650	408	8997
1969	888	1183	3108	1472	852	183	132	106	61	117	81	349	8532
1970	425	480	1436	1459	141	86	398	110	74	78	115	227	5029
1971	408	772	4740	1946	147	225	47	39	16	20	32	200	8592
1972	103	90	1022	280	105	221	19	56	26	18	49	128	2117
1973	93	155	1218	313	150	282	4	2	23	16	32	107	2395
1974	45	78	58	20	24	103	18	43	35	28	30	40	522
1975	25	71	68	124	65	20	85	9	40	34	20	27	588
1976	15	1	18	39	76	102	4	32	17	22	13	42	381
1977	44	90	79	57	217	37	49	114	184	180	297	796	2144
1978	118	151	669	1121	193	25	124	113	58	62	226	66	2926
1979	26	76	157	43	357	136	120	112	45	110	193	268	1643
1980	107	1165	2391	1099	316	486	744	676	411	1108	1444	1466	11413
1981	426	752	3099	3308	2006	607	513	213	105	590	346	290	12255
1982*	176	305	4207	2738	1779	1076	682	288	136	199	220	102	11908

*Preliminary

Table 4. Nominal catches (t) of eastern Scotian Shelf haddock in 4V and 4W by month by Canadian (MQ) longliners, as reported to NAFO.

YEAR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL
1960	50	122	76	66	18	-	133	80	172	25	190	145	1077
1961	3	36	23	35	6	1	8	13	63	64	159	81	492
1962	13	1	74	2	7	6	25	33	67	145	206	86	665
1963	25	3	4	49	9	17	26	30	49	85	68	52	417
1964	3	-	3	5	3	-	-	-	-	23	12	22	71
1965	17	41	27	65	23	10	5	23	28	39	53	21	352
1966	-	24	71	11	-	-	7	12	9	52	30	17	233
1967	3	1	19	10	-	3	7	5	15	29	25	9	126
1968	10	19	17	42	10	10	12	42	42	49	38	6	297
1969	1	1	8	8	4	9	25	56	39	68	53	17	289
1970	19	4	43	22	12	12	25	57	120	110	40	15	479
1971	-	14	12	33	18	26	94	61	106	107	38	29	538
1972	-	-	3	9	17	26	102	88	73	111	81	18	528
1973	1	6	115	149	47	40	39	62	56	78	59	17	669
1974	10	4	16	20	27	44	74	78	59	71	63	27	493
1975	31	37	69	78	93	81	74	138	88	105	57	24	875
1976	20	36	93	113	71	56	106	85	72	70	57	17	796
1977	15	33	55	36	42	86	65	92	72	116	100	34	746
1978	31	63	78	104	121	116	175	166	105	53	49	8	1069
1979	5	18	123	109	129	110	148	215	142	94	109	30	1232
1980	4	2	36	98	103	111	125	189	98	89	32	12	899
1981	4	28	152	37	82	69	142	168	173	196	189	82	1322
1982*	5	16	230	128	82	122	140	195	297	252	74	28	1569

* Preliminary

Table 5. Derivation of adjusted nominal catch (t) of eastern Scotlan Shelf haddock (4TVW) for 1982 by foreign countries, as determined by International Observer Program (OBS).

Country	Directed Species	Nominal catch of 4VW haddock in all fisheries (FLASH)	Observed catch of 4VW haddock in directed fisheries (OBS)	Observed catch of directed species (OBS)	Nominal catch of directed species (FLASH)	Ratio 4 + 5	Estimated by-catch of 4VW haddock in directed fishery (6 x 7)	
1	2	3	4	5	6	7	(6 x 7)	
Cuba	silver hake	43.1	49.9	7017.8	11972.6	0.0071	85.1	
Japan	silver hake squid	5.8	6.8	603.1	893.0	0.0113	10.1	
			0.2	10.0	169.2	0.0200	3.4	
USSR	silver hake	51.1	53.5	19195.6	46159.4	0.0028	<u>128.7</u>	
TOTAL								227.3

Table 6. Weight-length parameters used to calculate removals-at-age.

PERIOD	A	B	RESEARCH SURVEY
1970-1975	0.00885	3.039	Summer 1975 (Cameron)
1976	0.00553	3.160	Summer 1976 (Cameron)
1977	0.00909	3.041	Summer 1977 (Cameron)
1978	0.00580	3.152	Summer 1978 (Cameron)
1979	0.00640	3.126	Summer 1979 (Cameron)
1980 (OTB, Jan.-June)	0.00610	3.124	Spring 1980 (Hammond) ^{1,2}
1980 (OTB, July-Dec.)	0.00475	3.204	Fall 1980 (Hammond) ²
1980 (All other, Jan.-Dec.)	0.00610	3.268	Summer 1980 (Cameron)
1981 (OTB, Jan.-June)	0.10900	2.988	Summer 1981 (Cameron) ^{1,2}
1981 (OTB, July-Dec.)	0.00824	3.066	Summer 1981 (Cameron)
1981 (All other, Jan.-Dec.)	0.00824	3.066	Summer 1981 (Cameron)
1982 (Throughout)	0.01202	2.958	Summer 1982 (Hammond)

¹ Fish < 30cm excluded (see Mahon et al. 1982)

² Outlier samples excluded from Age Length Key (Mahon et al. 1982)

Table 7. Nominal catch, number of commercial samples and number of fish aged in each period and gear category for which catch-at-age was calculated (1980 and 1981).

1982		
OTB January - June	10677	(Catch)
	48	(# Samples)
	1339	(# Aged)
OTB July - December	1669	(Catch)
	13	(# Samples)
	379	(# Aged)
OTHER January - December (L.L., SND, etc.)	2710	(Catch)
	18	(# Samples)
	472	(# Aged)

Table 10. Estimated mid-year weights from commercial samples of 4W haddock (underlined values are means of observed values at that age).

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	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.148	0.148	0.148	0.148	0.148	0.148	0.089	0.133	0.082	0.107	0.080	0.080	0.060
2	0.412	0.409	0.408	0.408	0.409	0.409	0.335	0.555	0.309	0.322	0.234	0.408	0.420
3	0.659	0.688	0.719	0.721	0.652	0.814	0.666	0.910	0.682	0.724	0.705	0.689	0.670
4	0.917	0.989	1.047	1.032	1.172	1.234	1.155	1.212	1.086	1.155	1.026	0.961	0.960
5	1.229	1.296	1.396	1.380	1.600	1.576	1.580	1.511	1.537	1.598	1.363	1.257	1.190
6	1.559	1.650	1.775	1.839	2.047	1.992	2.065	1.883	2.005	2.039	1.875	1.660	1.570
7	1.984	2.007	2.178	2.174	2.515	2.454	2.436	2.307	2.452	2.459	2.363	2.155	2.070
8	2.407	2.341	2.506	2.610	2.881	2.894	2.768	2.684	2.806	2.829	2.732	2.657	2.650
9	2.846	2.657	2.931	2.957	3.134	3.252	3.129	3.074	3.259	3.215	3.244	3.016	3.100
10	3.318	3.048	3.253	3.190	3.392	3.273	3.355	3.445	3.855	3.488	3.577	3.325	3.260
11	3.738	3.320	3.450	2.943	3.594	4.621	3.743	3.858	4.246	3.769	3.689	3.626	3.820
12	4.089	3.658	<u>3.948</u>	3.650	<u>3.948</u>	3.671	3.797	4.171	<u>3.948</u>	3.705	4.294	4.530	3.910
13	4.784	3.917	<u>3.823</u>	4.761	<u>3.823</u>	4.686	3.703	4.266	<u>3.681</u>	4.261	5.370	4.516	<u>4.299</u>
14	5.374	4.469	<u>4.570</u>	5.152	<u>4.570</u>	<u>4.570</u>	<u>4.570</u>	<u>4.570</u>	5.424	4.479	<u>4.570</u>	2.519	<u>4.570</u>
15	<u>4.748</u>	4.301	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	4.639	<u>4.300</u>	5.750	<u>4.748</u>
16	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>	<u>4.748</u>

Table 11. Catch rates for Canada Maritimes otter trawlers (t/hr) January - June inclusive, and longlines (t/1000 hooks) all year. Effort is given in parentheses. The mean catch rate is weighted by effort.

Year	LL all TC	OTB - TC4	OTB - TC5	Mean OTB TC4, 5
1968	0.201 (184)	0.460 (4585)	0.616 (791)	0.483
1969	0.167 (6)	0.411 (5513)	0.569 (3577)	0.473
1970	0.235 (51)	0.268 (4168)	0.489 (1426)	0.324
1971	0.338 (68)	0.343 (598)	0.476 (5240)	0.462
1972	0.165 (79)	0.247 (1485)	0.299 (1485)	0.273
1973	0.322 (451)	0.241 (1912)	0.373 (970)	0.285
1974	0.158 (241)	0.180 (183)	0.231 (52)	0.191
1975	0.159 (1605)	0.178 (90)	0.378 (119)	0.292
1976	0.159 (1697)	0.282 (319)	0.167 (311)	0.225
1977	0.193 (1045)	0.226 (563)	0.273 (677)	0.252
1978	0.201 (2036)	0.629 (1134)	0.559 (1192)	0.593
1979	0.157 (1671)	0.300 (120)	0.482 (112)	0.388
1980	0.220 (513)	0.668 (2325)	1.494 (1590)	1.003
1981	0.176 (2168)	0.607 (5550)	0.991 (4045)	0.769
1982	0.209 (1919)	0.701 (3417)	1.211 (3512)	0.959

Table 12. Catch-(kg)-per-standard-tow by all available groundfish surveys in 4VW (A = A.T. Cameron, H = Lady Hammond).

Vessel (Season)	Year	Area (Strata)					
		4Vn 40-42	4Vs 43-46 47-52		4V* 40-52	4W 53-66	4VW** 40-66
A(SU)	1970	2.38	-	15.13	5.11	10.59	8.03
A(SU)	1971	0.00	0.19	1.50	0.52	9.01	5.18
A(SU)	1972	0.00	1.92	2.63	1.67	4.16	3.04
A(SU)	1973	0.15	0.13	0.90	0.36	5.07	2.94
A(SU)	1974	0.00	-	1.54	0.44	9.09	5.19
A(SU)	1975	0.37	0.00	2.57	0.83	12.33	7.14
A(SU)	1976	1.64	-	2.57	1.13	8.07	4.94
A(SU)	1977	3.08	0.17	7.28	2.90	28.86	17.15
A(SU)	1978	0.87	-	0.03	0.21	40.38	22.26
H(SP)	1979	0.00	0.02	10.68	30.8	22.37	13.67
A(SU)	1979	0.11	0.16	0.97	0.38	40.18	22.22
H(FA)	1979	5.53	0.38	3.18	2.41	38.78	22.37
H(SP)	1980	0.00	3.05	3.25	2.38	17.80	10.84
A(SU)	1980	0.50	0.60	2.39	1.09	60.01	33.43
H(SU)	1980	2.30	2.53	8.55	4.20	55.16	32.17
H(FA)	1980	11.48	0.13	17.94	7.93	31.29	20.75
H(SP)	1981	0.51	1.32	1.30	1.41	232.78	128.38
A(SU)	1981	4.21	1.19	1.25	1.92	31.73	18.28
H(SU)	1981	1.57	0.24	1.99	1.06	18.42	8.46
H(FA)	1981	0.69	0.23	4.52	1.58	58.84	33.00
H(SU)	1982	4.16	0.53	44.29	13.98	39.38	27.92

$$* 4V = (0.2367 \times 4Vn) + (0.4758 \times 4Vs (43-46)) + (0.2875 \times 4Vn (47-52))$$

$$** 4VW = (0.4512 \times 4V) + (0.5488 \times 4W) \text{ except H(SU) 81 where strata 60, 61, 63, 64, 65, and 66 were not sampled and } 4VW = (0.5734 \times 4V) + (0.4266 \times 4W)$$

Table 13. (a) Mean catch-per-standard-tow at age in July RV surveys for 4VW haddock (1970-1981 A.T. Cameron, 1982 Lady Hammond adjusted)

(a)

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	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	0.09	0.05	0.01	0.00	0.19	0.06	0.25	0.21	0.00	1.24	1.20	18.52	0.58
1	2.27	1.44	1.10	0.48	0.30	3.85	2.74	5.01	8.25	0.07	2.93	13.51	15.25
2	0.84	3.02	0.74	1.59	1.79	0.55	3.01	9.49	9.23	7.61	0.23	7.65	13.13
3	1.53	1.00	1.08	0.48	2.42	1.60	0.42	7.49	12.34	8.28	12.40	0.80	11.82
4	1.70	1.32	0.49	0.45	0.44	1.43	0.82	1.02	6.93	8.61	11.60	5.95	1.72
5	0.82	0.52	0.41	0.16	0.45	0.37	0.79	1.62	0.43	2.41	7.21	3.73	5.98
6	0.52	0.30	0.31	0.33	0.23	0.68	0.18	0.60	0.41	0.31	1.74	1.64	2.57
7	0.58	0.14	0.12	0.07	0.17	0.17	0.19	0.17	0.10	0.25	0.28	0.26	0.82
8	0.30	0.21	0.06	0.08	0.07	0.07	0.05	0.10	0.01	0.08	0.10	0.07	0.19
9	0.13	0.01	0.03	0.03	0.04	0.04	0.01	0.00	0.00	0.00	0.02	0.08	0.02
10	0.03	0.00	0.02	0.04	0.03	0.04	0.01	0.06	0.01	0.03	0.00	0.01	0.02
11	0.03	0.00	0.00	0.00	0.03	0.00	0.01	0.01	0.01	0.02	0.00	0.00	0.00
12+	0.04	0.00	0.00	0.00	0.00	0.02	0.05	0.02	0.00	0.01	0.00	0.00	0.02
unk	0.00	0.00	0.04	0.00	0.01	0.01	0.27	0.08	0.03	0.00	0.04	0.03	0.02

(b) Percent mean-catch-per-standard-tow

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	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	1.0	0.6	0.3	0.0	3.1	0.7	2.8	0.8	0.0	4.3	3.2	35.4	1.1
1	25.6	17.9	25.0	12.9	4.9	43.3	31.1	19.4	21.8	0.3	7.8	25.9	29.3
2	9.5	37.8	16.8	42.9	29.0	6.1	34.2	36.7	24.4	26.3	0.6	14.6	25.2
3	17.3	12.5	24.5	12.9	39.2	18.0	4.8	29.0	32.7	28.6	32.9	1.5	22.7
4	19.2	16.5	11.1	12.1	7.2	16.1	9.4	3.9	18.4	29.7	30.7	11.4	3.3
5	9.2	6.5	9.2	4.4	7.4	4.2	8.9	6.3	1.1	8.3	19.1	7.1	11.5
6	5.9	3.7	6.9	8.9	3.7	7.7	2.0	2.3	1.1	1.1	4.6	3.1	4.9
7	6.5	1.7	2.8	1.8	2.7	2.0	2.2	0.7	0.3	0.8	0.7	0.5	1.6
8	3.3	2.6	1.4	2.2	1.1	0.8	0.6	0.4	0.0	0.3	0.3	0.1	0.4
9	1.4	0.1	0.7	0.7	0.6	0.4	0.1	0.0	0.0	0.0	0.0	0.2	0.0
10	0.3	0.0	0.4	1.0	0.5	0.5	0.1	0.2	0.0	0.1	0.0	0.0	0.0
11	0.3	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
12+	0.4	0.0	0.0	0.0	0.0	0.2	0.6	0.1	0.0	0.0	0.0	0.0	0.0
unk	0.0	0.0	0.9	0.0	0.1	0.1	3.1	0.3	0.1	0.0	0.1	0.1	0.0

Table 14. Mean catch-per-standard tow in all available surveys (A=A T Cameron, H=Lady Hammond, Sp=spring, Su=summer, Fa=fall).

Age	ASu 70	ASu 71	Asu 72	Asu 73	Asu 74	Asu 75	Asu 76	Asu 77	Asu 78	HSp 79	ASu 79	HFa 79	HSp 80	ASu 80	HSu 80	HFa 80	HSp 81	ASu 81	HSu 81	HFa 81	HSu 82
0	0.09	0.05	0.01	0.00	0.19	0.06	0.25	0.21	0.00	0.00	1.24	10.56	0.00	1.20	1.74	58.63	0.00	18.52	5.17	30.94	0.70
1	2.27	1.44	1.10	0.48	0.30	3.85	2.74	5.01	8.25	0.10	0.07	0.23	4.71	2.93	4.61	8.35	27.45	13.51	6.72	33.56	18.30
2	0.84	3.02	0.74	1.59	1.79	0.55	3.01	9.49	9.23	2.46	7.61	7.72	0.25	0.23	0.16	1.27	12.45	7.65	6.70	12.09	15.75
3	1.53	1.00	1.08	0.48	2.42	1.60	0.42	7.49	12.34	4.19	8.28	12.69	8.44	12.40	14.71	7.45	6.27	0.80	0.38	1.99	14.19
4	1.70	1.32	0.49	0.45	0.44	1.43	0.82	1.02	6.93	6.53	8.61	9.07	2.51	11.60	13.23	7.72	89.25	5.95	2.65	10.85	2.06
5	0.82	0.52	0.41	0.16	0.45	0.37	0.79	1.62	0.43	3.29	2.41	1.55	2.10	7.21	7.75	3.28	35.62	3.73	1.96	5.40	7.18
6	0.52	0.30	0.31	0.33	0.23	0.68	0.18	0.60	0.41	0.61	0.31	0.38	0.77	1.74	1.74	0.92	16.24	1.64	0.82	2.79	3.08
7	0.58	0.14	0.12	0.07	0.17	0.17	0.19	0.17	0.10	0.59	0.24	0.29	0.26	0.28	0.20	0.10	5.22	0.26	0.11	0.91	0.98
8	0.30	0.21	0.06	0.08	0.07	0.07	0.05	0.10	0.01	0.16	0.08	0.04	0.16	0.10	0.07	0.02	0.85	0.07	0.04	0.28	0.23
9	0.13	0.01	0.03	0.03	0.04	0.04	0.01	0.00	0.00	0.04	0.00	0.00	0.07	0.02	0.01	0.06	0.20	0.08	0.04	0.10	0.02
10	0.03	0.00	0.02	0.04	0.03	0.04	0.01	0.06	0.01	0.05	0.03	0.00	0.01	0.00	0.00	0.01	0.05	0.01	0.02	0.00	0.02
11	0.03	0.00	0.00	0.00	0.03	0.00	0.01	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12+	0.04	0.00	0.00	0.00	0.00	0.02	0.05	0.02	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.02
unk	0.00	0.00	0.04	0.00	0.01	0.01	0.27	0.08	0.03	0.02	0.00	0.04	0.01	0.04	0.00	0.02	0.00	0.03	0.00	0.04	0.02

Table 15. R^2 * and intercept values for various relationships at various terminal F values (R^2 /intercept).

Terminal F	SPA 3+ vs RV 3+	SPA 5+ vs RV 5+	SPA Fish Bio vs OTB TC4 TC5	SPA Fish Bio vs RV Fish Bio
0.30	$\frac{0.814}{1091}$	$\frac{0.802}{-1254}$	$\frac{0.781}{-6807}$	$\frac{0.703}{122}$
0.35	-	-	$\frac{0.787}{-5007}$	$\frac{0.705}{1392}$
0.40	$\frac{0.845}{2573}$	$\frac{0.831}{-224}$	$\frac{0.788}{-3660}$	$\frac{0.704}{2311}$
0.45	-	-	$\frac{0.785}{-2617}$	$\frac{0.701}{3000}$
0.50	$\frac{0.859}{3460}$	$\frac{0.849}{394}$	$\frac{0.778}{-1785}$	$\frac{0.697}{3534}$
0.60	$\frac{0.863}{4049}$	$\frac{0.854}{807}$	$\frac{0.759}{-1785}$	$\frac{0.685}{3534}$
0.70	$\frac{0.857}{4468}$	$\frac{0.849}{1102}$		

* Most recent year included

Table 16. Cohort analysis results at $F_t = 0.4$ for 4VW haddock in 1982

POPULATION NUMBERS

14/ 5/83

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	7614	3994	7646	7474	5067	21343	35005	40194	72870	10221	38921	23468	57627
2	5303	5920	2991	5993	5822	4114	17125	28393	32875	59533	9367	30947	18048
3	6976	4223	4231	2261	3883	4564	3319	13466	23112	26767	48609	6784	25137
4	7469	5101	2689	2921	1358	2321	3371	2597	10132	18144	21487	37605	5321
5	4070	4560	2252	1553	1162	895	1234	2587	1744	6274	13773	13724	26203
6	3254	2059	1334	1020	542	545	487	789	1628	1035	4531	8395	5627
7	3385	1414	621	482	199	181	280	269	425	577	706	2202	4148
8	817	1690	327	202	100	64	91	137	135	157	425	357	732
9	204	316	343	99	25	43	25	48	62	54	116	234	166
10	79	85	14	140	19	13	28	15	27	29	40	60	97
11	45	31	35	2	22	3	7	16	5	14	20	24	22
1+	39217	29392	22484	22148	18200	34086	60972	88502	143015	122906	136996	123900	154129
2+	31502	25397	14838	14674	13133	12743	25967	48308	70144	112684	98075	100332	86502
3+	26299	19478	11847	9680	7311	8629	8842	19915	37269	53151	89707	69385	68454
4+	19323	15255	7617	6419	3428	4065	5523	6449	14158	26385	41098	62601	43316

MEAN POPULATION BIOMASS (KG)

14/ 5/83

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	996	513	1004	979	677	2835	2813	4856	5401	995	2783	1651	3654
2	1954	2055	1065	1984	2112	1513	5106	14250	9171	17366	1768	11391	6799
3	3945	2339	2540	1278	1979	3204	1956	10664	14005	17403	30240	4151	14778
4	5406	3445	2166	1969	1302	2123	3422	2591	8743	18310	17765	30325	4265
5	3628	3402	2172	1325	1305	1057	1572	3130	2088	8560	14811	12250	24847
6	3442	1979	1486	924	674	794	758	1108	2172	1754	6052	9997	7824
7	4841	1491	812	529	299	321	488	447	560	1331	1210	2876	6456
8	1270	1977	479	222	194	121	186	254	249	383	875	664	1458
9	387	260	665	143	59	112	62	113	140	150	274	469	387
10	169	172	22	205	28	33	72	32	77	84	111	126	238
11	118	54	75	3	49	9	20	46	14	44	53	60	64
1+	26155	17687	12486	9561	8678	12122	16456	37489	42720	66379	75940	73960	70771
2+	25159	17174	11482	8582	8001	9286	13643	32634	37319	65384	73158	72309	67117
3+	23205	15119	10417	6598	5889	7773	8537	18384	28149	48018	71390	60917	60318
4+	19260	12780	7876	5320	3910	4569	6581	7721	14143	30615	41151	56766	45539

FISHING MORTALITY

14/ 5/83

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.052	0.089	0.044	0.050	0.008	0.020	0.009	0.001	0.002	0.000	0.029	0.063	0.013
2	0.028	0.136	0.080	0.234	0.043	0.015	0.040	0.006	0.006	0.003	0.010	0.008	0.022
3	0.113	0.251	0.170	0.310	0.315	0.103	0.049	0.084	0.042	0.020	0.057	0.043	0.067
4	0.293	0.618	0.349	0.722	0.217	0.432	0.065	0.194	0.279	0.076	0.248	0.161	0.173
5	0.481	1.029	0.592	0.852	0.557	0.408	0.246	0.263	0.322	0.125	0.295	0.528	0.273
6	0.633	0.999	0.818	1.434	0.897	0.465	0.395	0.420	0.678	0.182	0.522	0.505	0.400
7	0.495	1.263	0.924	1.369	0.933	0.490	0.513	0.470	0.795	0.264	0.481	0.902	0.400
8	0.749	1.395	0.993	1.872	0.656	0.727	0.430	0.603	0.706	0.106	0.398	0.566	0.400
9	0.678	2.889	0.693	1.469	0.434	0.236	0.313	0.371	0.567	0.120	0.461	0.681	0.400
10	0.748	0.681	1.608	1.640	1.786	0.423	0.330	0.886	0.451	0.160	0.309	0.785	0.400
11	0.583	1.223	0.848	1.470	0.870	0.474	0.429	0.456	0.694	0.201	0.504	0.578	0.400
1+	0.256	0.588	0.260	0.397	0.179	0.080	0.034	0.035	0.044	0.026	0.119	0.177	0.102

Table 17. Calculation of $F_{0.1}$ for 4VW haddock (a) using ages 1-11
(b) using ages 1-16.

(a)

YIELD PER RECRUIT ANALYSIS

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.1000	0.152	0.270	1.779	1.000
	0.2000	0.245	0.397	1.618	0.735
$F_{0.1}$ —	0.2943	0.304	0.452	1.489	0.569
	0.3000	0.307	0.454	1.482	0.560
	0.4000	0.349	0.478	1.368	0.442
	0.5000	0.381	0.485	1.274	0.359
F_{MAX} —	0.5476	0.394	0.486	1.235	0.329
	0.6000	0.406	0.486	1.196	0.299
	0.7000	0.426	0.482	1.132	0.255
	0.8000	0.443	0.478	1.078	0.221
	0.9000	0.457	0.472	1.033	0.194
	1.0000	0.470	0.467	0.994	0.173

(b)

YIELD PER RECRUIT ANALYSIS

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.1000	0.166	0.330	1.990	1.000
	0.2000	0.256	0.444	1.732	0.674
$F_{0.1}$ —	0.2165	0.267	0.454	1.696	0.636
	0.3000	0.313	0.483	1.541	0.488
	0.4000	0.353	0.493	1.397	0.374
F_{MAX} —	0.4478	0.368	0.494	1.342	0.335
	0.5000	0.383	0.494	1.289	0.299
	0.6000	0.407	0.490	1.204	0.248
	0.7000	0.426	0.484	1.136	0.210
	0.8000	0.443	0.479	1.080	0.181
	0.9000	0.457	0.473	1.034	0.159
	1.0000	0.470	0.468	0.994	0.142

Table 18. Input for and results of catch projections for 4VW haddock ($F_T = 0.22$ in 1982).

Age	Weight (kg)	PR ¹	1982 Numbers ² ('000)
1	0.08	0.03	73000
2	0.42	0.05	59401
3	0.67	0.17	31171
4	0.96	0.43	5549
5	1.19	0.68	34395
6	1.57	1.00	8444
7	2.07	1.00	5284
8	2.65	1.00	932
9	3.10	1.00	212
10	3.26	1.00	124
11	3.82	1.00	28

Projected catches³ (t) at $F_{0.1}$

<u>1983</u>	<u>1984</u>	<u>1985</u>	
19000	11500	14500	(Assuming TAC is taken in 1983)
11000	13000	16000	($F_{0.1}$ in 1983)

¹ As in previous assessment

² Age 1 and 2 numbers set at highest observed value

³ Recruitment at geometric mean of SPA age 1 numbers, 1970-1981.

Table 19. Catch projections for 4VW haddock assuming TAC taken in 1983

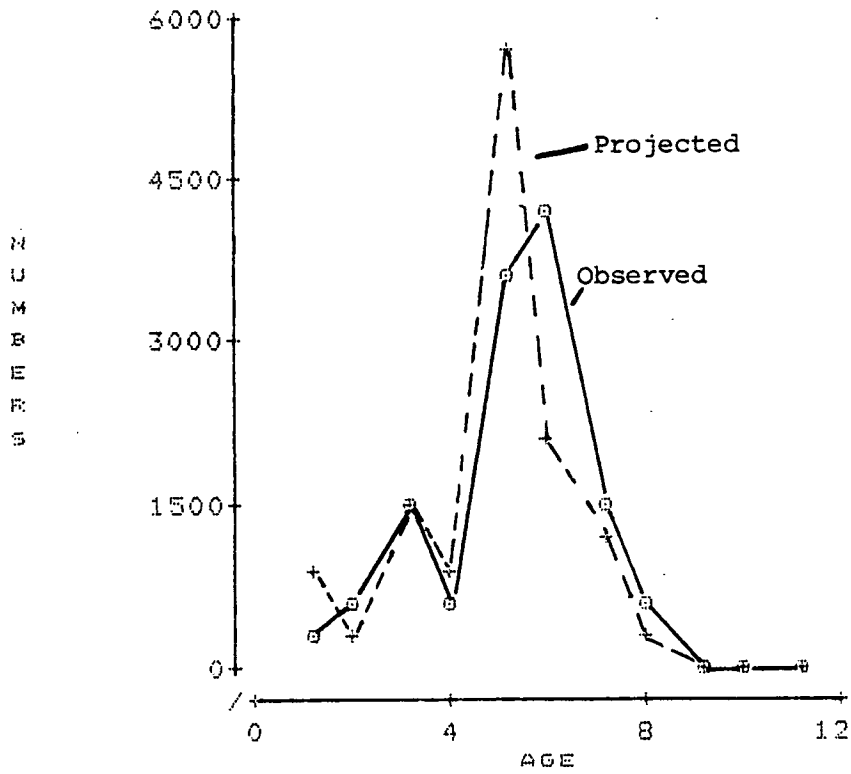
POPULATION NUMBERS 15/ 5/83						CATCH BIOMASS 15/ 5/83					
	1982	1983	1984	1985	1986		1982	1983	1984	1985	1986
1	73000	15500	15500	15500	15500	1	48	12	6	6	6
2	59041	59041	12517	12598	12598	2	147	501	56	57	57
3	25137	48023	47262	10127	10193	3	996	1983	1045	224	225
4	5321	19240	36648	37287	7999	4	736	2768	2893	2944	631
5	26203	3666	13155	27286	27762	5	6777	984	1981	4110	4182
6	6627	16332	2258	9270	19228	6	3130	7985	637	2614	5423
7	4148	3637	8808	1484	6091	7	2582	2345	3275	552	2265
8	732	2276	1962	5787	975	8	583	1879	934	2755	464
9	166	402	1228	1289	3803	9	155	388	684	718	2118
10	97	91	217	807	847	10	95	93	127	472	496
11	22	53	49	142	530	11	26	63	34	98	364
1+	200495	168260	139602	121577	105516	1+	15276	19000	11673	14550	16230
2+	127495	152760	124102	106077	90016	2+	15228	18988	11666	14544	16224
3+	68454	93719	111586	93478	77417	3+	15081	18488	11610	14487	16167
4+	43316	45696	64324	83352	67224	4+	14085	16505	10565	14263	15942

POPULATION BIOMASS (AVERAGE) 15/ 5/83						MEAN WEIGHT OF INDIVIDUALS IN CATCH					
	1982	1983	1984	1985	1986		1982	1983	1984	1985	1986
1	3946.42	837.31	839.95	839.95	839.95	1	1.2	1.3	1.3	1.4	1.6
2	22403.85	22231.84	4737.39	4768.38	4768.38						
3	14778.34	28193.28	23191.77	6040.65	6090.16						
4	4264.58	15364.64	30467.88	30998.89	6642.13						
5	24847.11	3457.18	13208.05	27396.93	27874.42						
6	7824.41	19131.05	2894.55	11883.82	24650.13						
7	6456.01	5617.54	14888.47	2507.54	10294.92						
8	1457.88	4500.53	4244.85	12523.39	2109.21						
9	387.50	928.67	3107.56	3262.68	9625.74						
10	237.74	221.90	576.44	2147.20	2254.38						
11	64.02	151.69	153.47	443.81	1653.16						
1+	86667.85	100635.63	103310.38	102813.24	96792.58						
2+	82721.43	99798.32	102470.43	101973.29	95952.63						
3+	60317.58	77566.48	97733.04	97204.91	91184.25						
4+	45539.24	49373.20	69541.27	91164.26	85104.09						

CATCH NUMBERS 15/ 5/83						FISHING MORTALITY 15/ 5/83					
	1982	1983	1984	1985	1986		1982	1983	1984	1985	1986
1	805	192	102	102	102	1	0.012	0.014	0.007	0.007	0.007
2	349	1192	134	135	135	2	0.007	0.023	0.012	0.012	0.012
3	1486	2959	1560	334	336	3	0.067	0.070	0.037	0.037	0.037
4	767	2884	3014	3067	657	4	0.173	0.180	0.095	0.095	0.095
5	5695	827	1665	3454	3514	5	0.273	0.285	0.150	0.150	0.150
6	1993	5086	406	1665	3454	6	0.400	0.417	0.220	0.220	0.220
7	1248	1133	1582	267	1094	7	0.400	0.417	0.220	0.220	0.220
8	220	709	352	1040	175	8	0.400	0.417	0.220	0.220	0.220
9	50	125	221	232	683	9	0.400	0.417	0.220	0.220	0.220
10	29	28	39	145	152	10	0.400	0.417	0.220	0.220	0.220
11	7	17	9	26	95	11	0.400	0.417	0.220	0.220	0.220
1+	12650	15153	9083	10465	10398	1+	0.079	0.113	0.076	0.102	0.118
2+	11845	14950	8981	10363	10296						
3+	11496	13768	9847	10228	10161						
4+	10009	10809	7288	9894	9825						

Table 20. Catch projections for 4VW haddock assuming F_{0.1} catch in 1983

POPULATION NUMBERS						CATCH BIOMASS					
15/ 5/83						15/ 5/83					
	1982	1983	1984	1985	1986		1982	1983	1984	1985	1986
1	73000	15500	15500	15500	15500	1	48	6	6	6	6
2	59041	59041	12598	12598	12598	2	147	265	57	57	57
3	25137	48023	47768	10193	10193	3	996	1062	1056	225	225
4	5321	19240	37887	37686	8042	4	736	1519	2991	2975	635
5	26203	3666	14325	28209	28059	5	6777	552	2158	4249	4227
6	6627	16332	2583	10094	19878	6	3130	4606	729	2847	5606
7	4148	3637	10731	1697	6632	7	2582	1353	3990	631	2466
8	732	2276	2390	7051	1115	8	583	1084	1138	3356	531
9	166	402	1496	1570	4633	9	155	224	833	874	2580
10	97	91	264	983	1032	10	95	53	154	575	604
11	22	53	60	173	646	11	26	37	41	119	443
1+	200495	168260	145602	125755	108328	1+	15276	10760	13153	15916	17380
2+	127495	152760	130102	110255	92828	2+	15228	10754	13147	15910	17374
3+	68454	93719	117503	97657	80230	3+	15081	10489	13070	15853	17318
4+	43316	45696	69735	87464	70037	4+	14085	9427	12034	15628	17092
POPULATION BIOMASS (AVERAGE)						MEAN WEIGHT OF INDIVIDUALS IN CATCH					
15/ 5/83						15/ 5/83					
	1982	1983	1984	1985	1986		1982	1983	1984	1985	1986
1	3946.42	839.95	839.95	839.95	839.95	1	1.2	1.3	1.3	1.4	1.6
2	22403.85	22346.28	4768.38	4768.38	4768.38						
3	14778.34	28645.92	28493.73	6080.16	6080.16						
4	4264.58	15995.12	31498.26	31330.93	6685.58						
5	24847.11	3680.67	14382.93	29323.46	28172.99						
6	7824.41	20937.13	3311.65	12940.90	25483.77						
7	6456.01	6147.87	18137.78	2868.87	11210.67						
8	1457.88	4925.40	5171.26	15256.54	2413.14						
9	387.50	1016.34	3785.77	3974.74	11726.49						
10	237.74	242.84	702.25	2615.81	2746.38						
11	64.02	166.01	186.97	540.67	2013.95						
1+	86667.85	104943.54	111278.93	109540.42	102141.47						
2+	82721.43	104103.59	110438.98	108700.47	101301.52						
3+	60317.58	81757.31	105670.60	103932.09	96533.14						
4+	45539.24	53111.40	77176.87	97851.92	90452.98						
CATCH NUMBERS						FISHING MORTALITY					
15/ 5/83						15/ 5/83					
	1982	1983	1984	1985	1986		1982	1983	1984	1985	1986
1	805	102	102	102	102	1	0.012	0.007	0.007	0.007	0.007
2	349	632	135	135	135	2	0.007	0.012	0.012	0.012	0.012
3	1486	1585	1576	336	336	3	0.067	0.037	0.037	0.037	0.037
4	767	1582	3116	3099	661	4	0.173	0.095	0.095	0.095	0.095
5	5695	464	1813	3571	3552	5	0.273	0.150	0.150	0.150	0.150
6	1993	2934	464	1813	3571	6	0.400	0.220	0.220	0.220	0.220
7	1248	653	1928	305	1191	7	0.400	0.220	0.220	0.220	0.220
8	220	409	429	1267	200	8	0.400	0.220	0.220	0.220	0.220
9	50	72	269	282	832	9	0.400	0.220	0.220	0.220	0.220
10	29	16	47	177	185	10	0.400	0.220	0.220	0.220	0.220
11	7	10	11	31	116	11	0.400	0.220	0.220	0.220	0.220
1+	12650	8459	9890	11118	10882	1+	0.079	0.059	0.080	0.105	0.121
2+	11845	8357	9788	11016	10781						
3+	11496	7725	9653	10881	10646						
4+	10009	6141	8077	10545	10309						



Numbers at age in the catch

1	2	3	4	5	6	7	8	9	10	11	Age
805	349	1486	767	5695	1993	1248	220	50	29	7	Projected
183	747	1508	493	3559	4095	1524	599	71	53	15	Observed

	Nominal catch (t)	Removals ('000)
Projected	18000	12800
Observed	15000	12600

Figure 1. Comparison of observed catch and projected catch for 1982

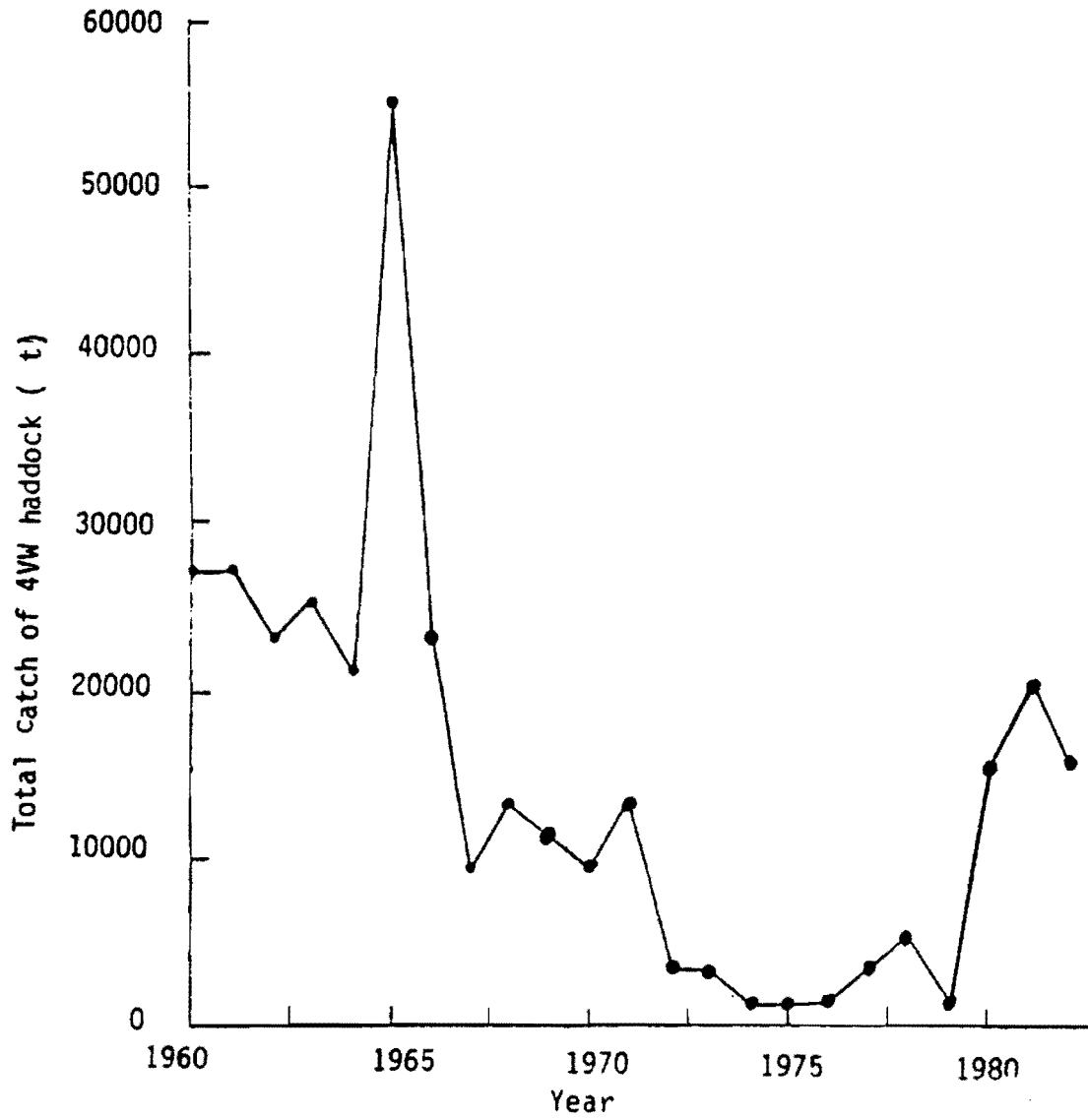


Figure 2 . Nominal catch of 4W haddock (t)

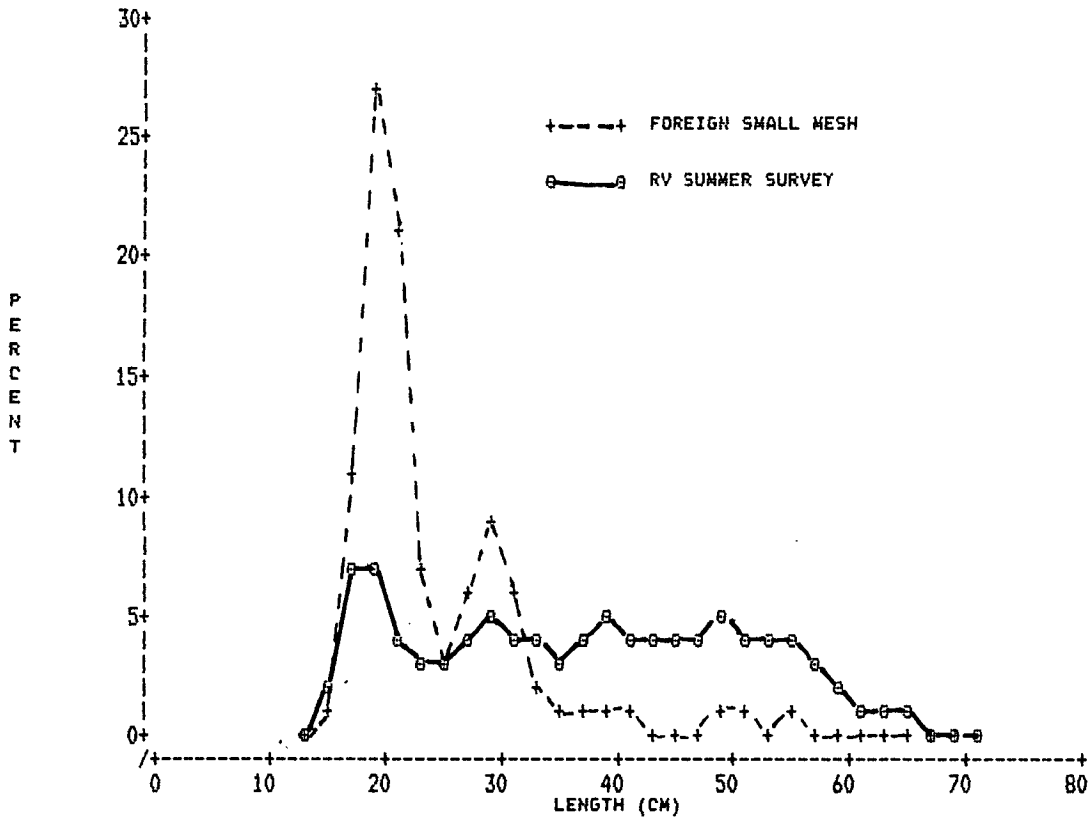


Figure 3. Comparison of length frequencies of 4W haddock caught in the summer RV survey and in the Soviet small mesh fishery (July 1982)

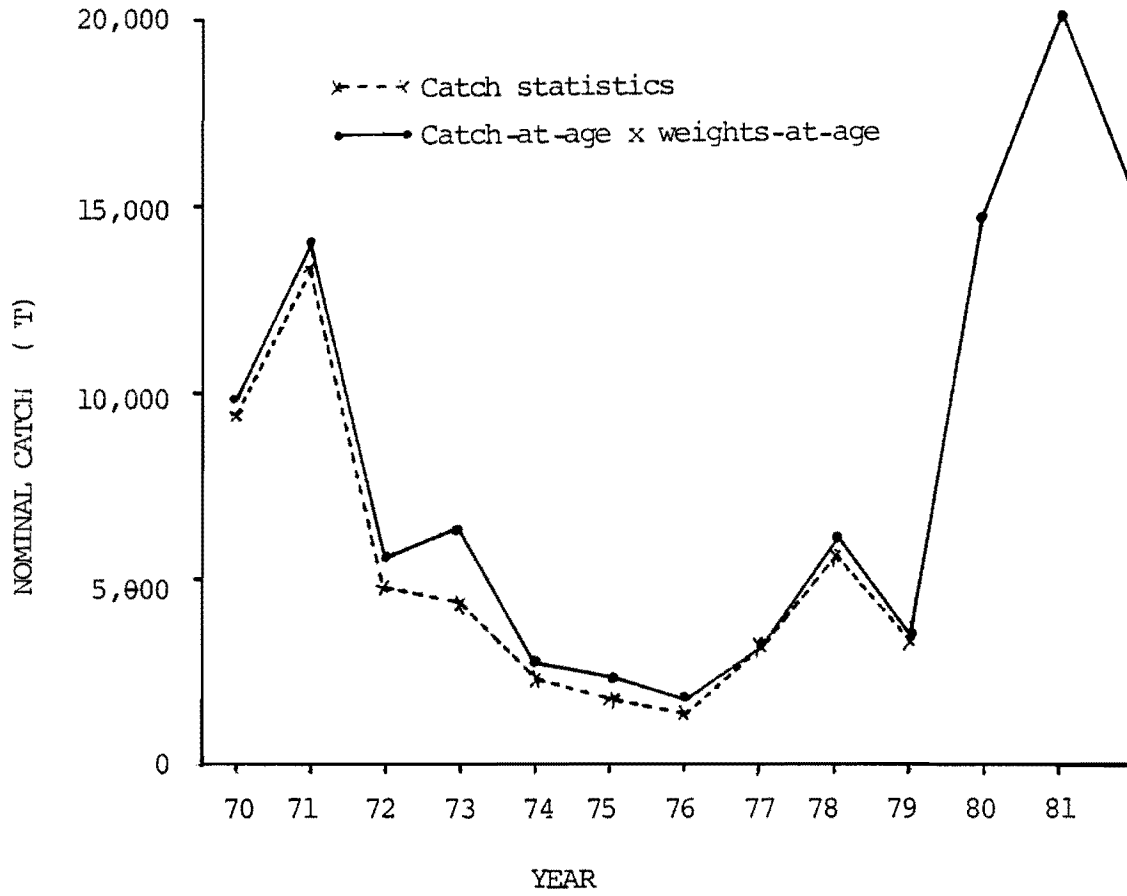


Figure 4 . Nominal catch per year from the catch statistics and estimated from catch-at-age times weight-at-age

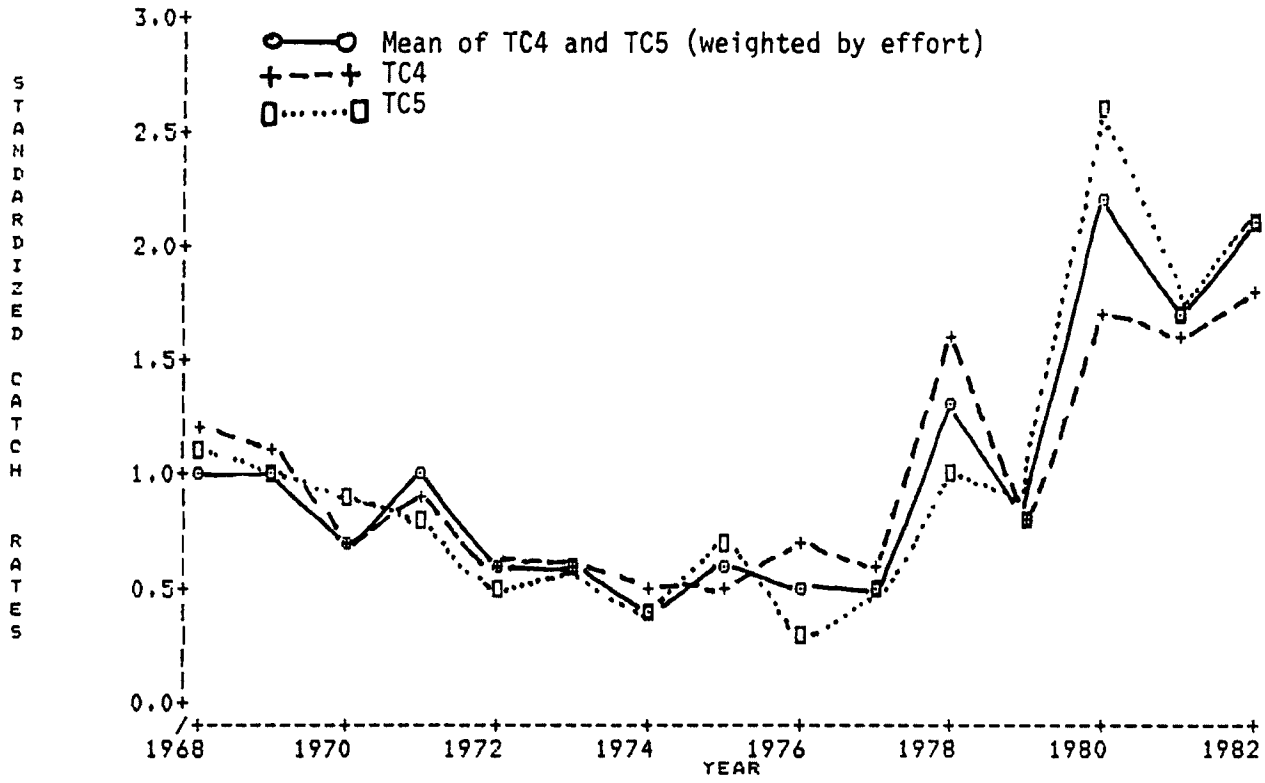


Figure 5. Catch rates for OTB TC4 and OTB TC5 (standardized to the series mean) and the standardized weighted mean

R
V
K
G
P
E
R
T
O
W

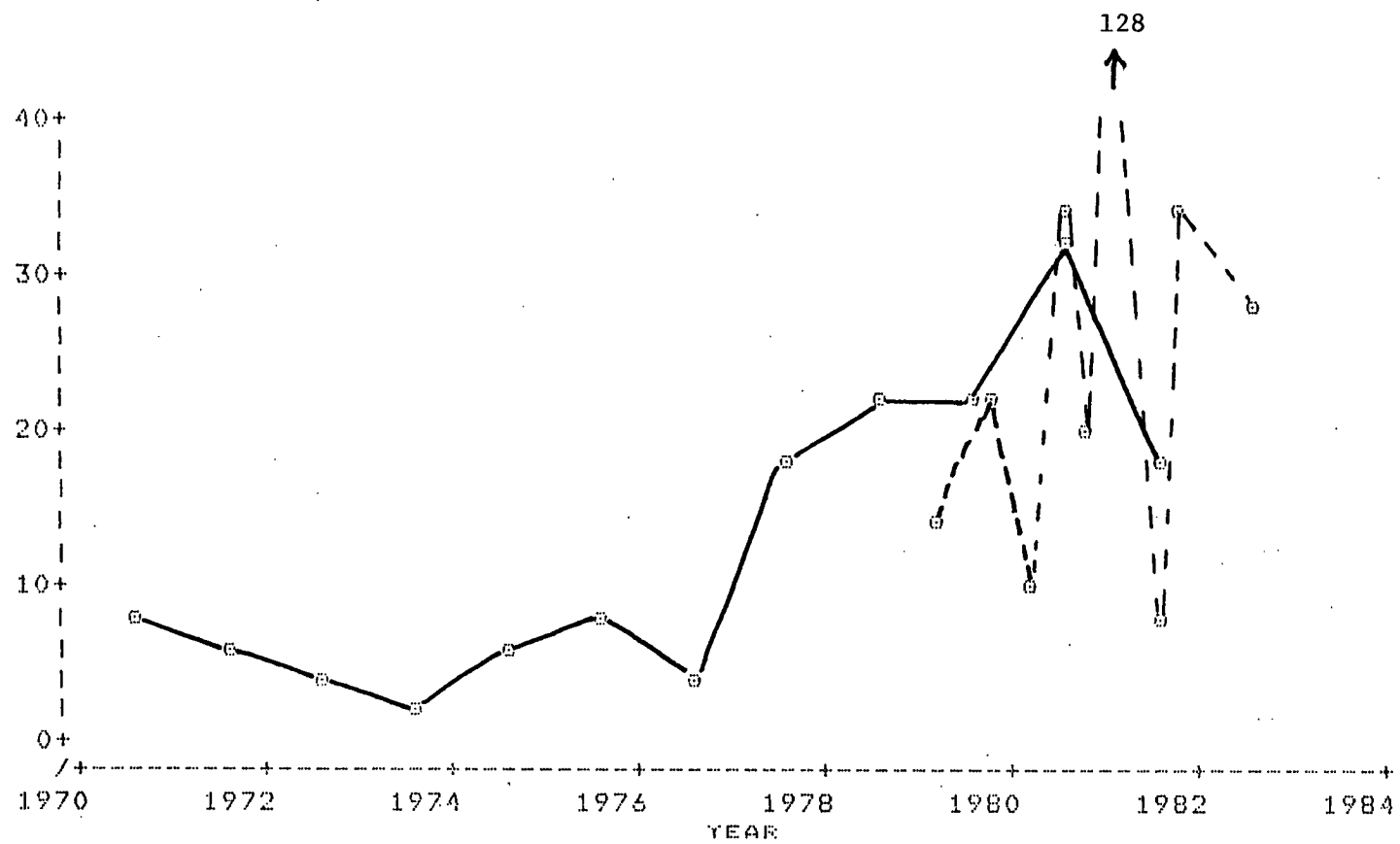


Figure 6. Mean catch per tow of 4W haddock in Lady Hammond and A. T. Cameron groundfish surveys spring, summer and fall. Lady Hammond adjusted to A.T. Cameron.

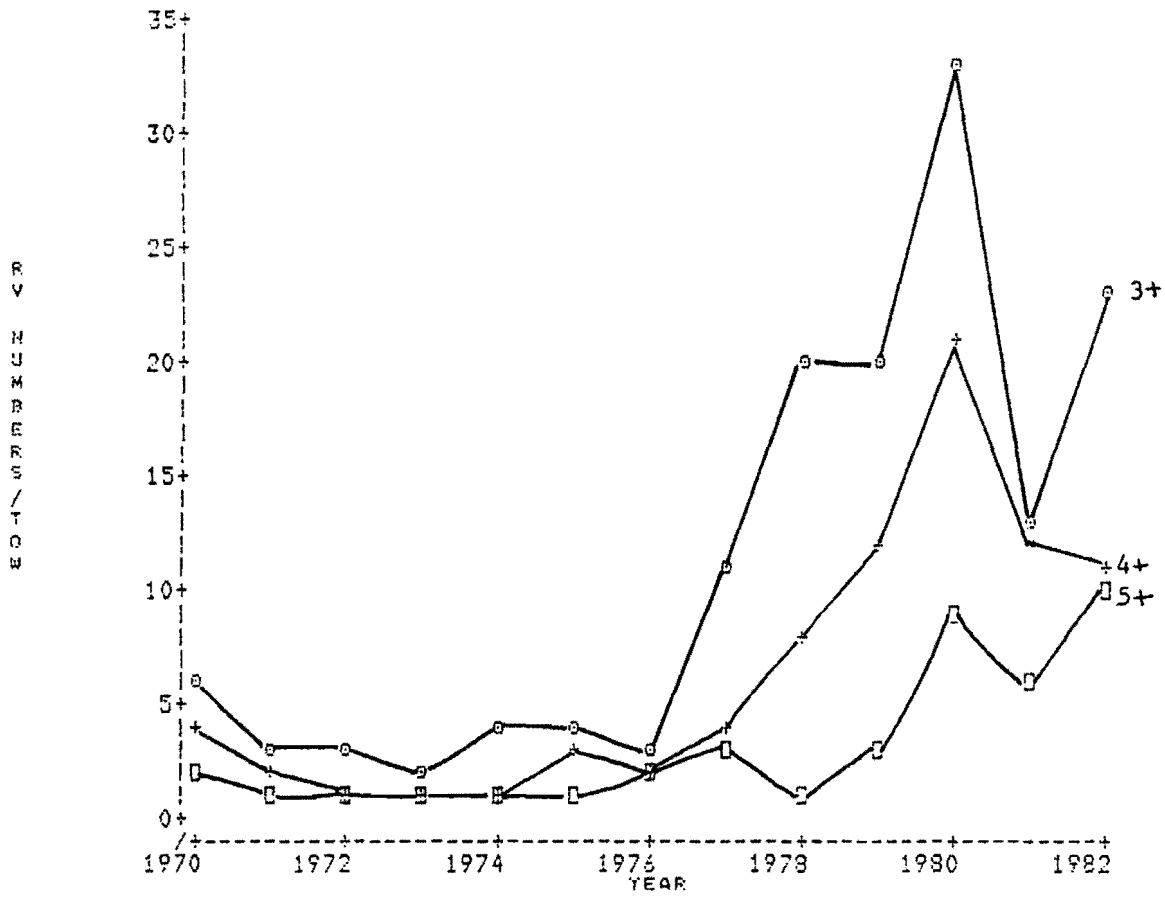


Figure 7 . RV numbers at ages 3+, 4+ and 5+ (Lady Hammond adjusted to A.T. Cameron)

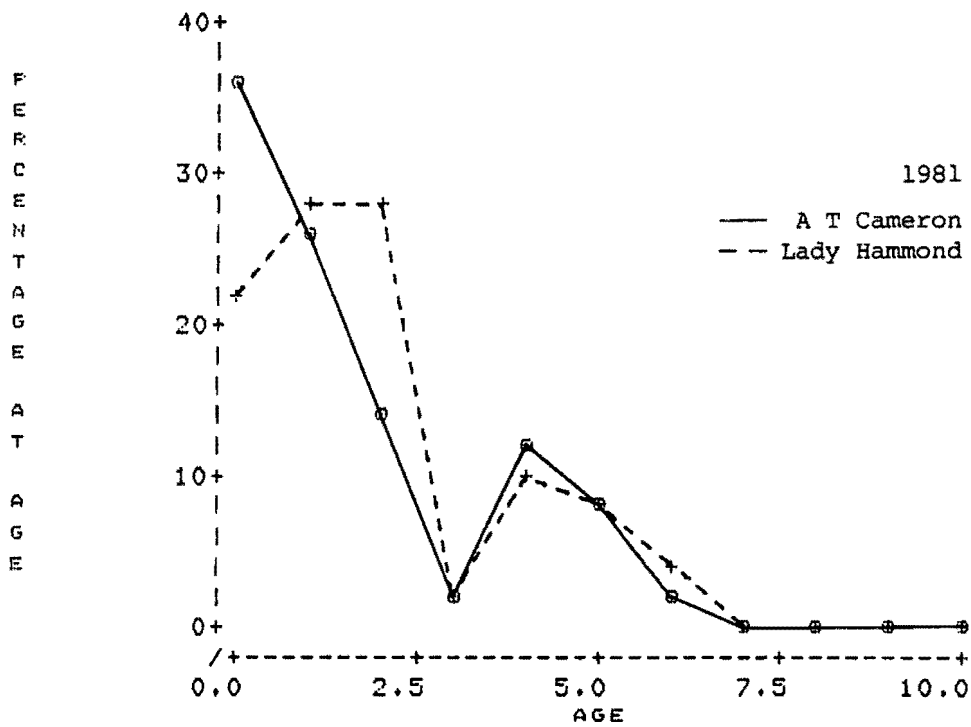
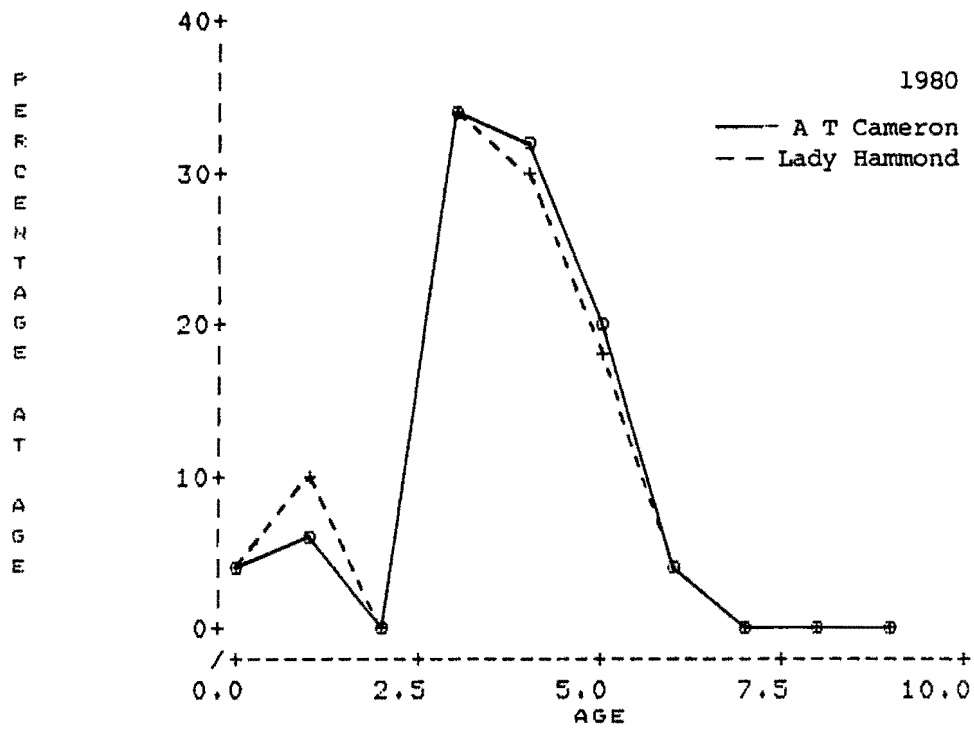
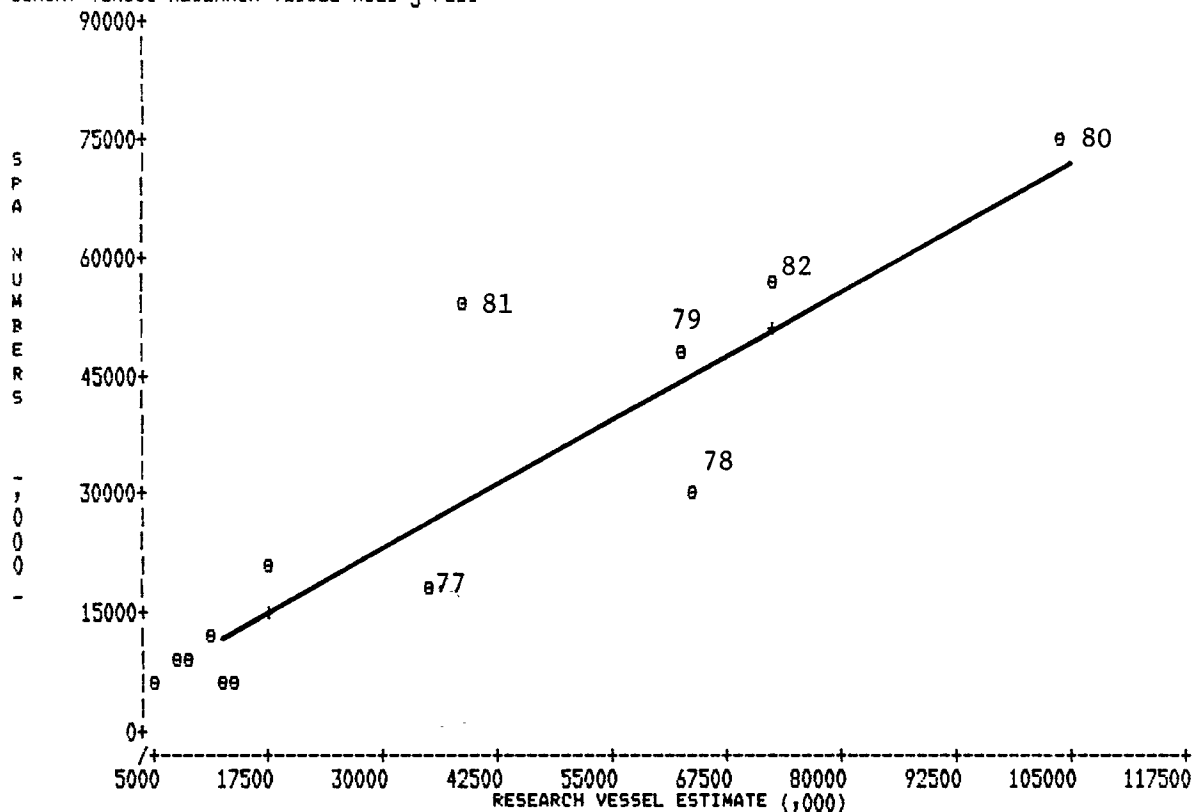


Figure 8. Comparison of age composition of 4VW from Lady Hammond and A T Cameron summer groundfish surveys.

COHORT VERSUS RESEARCH VESSEL AGES 3 PLUS



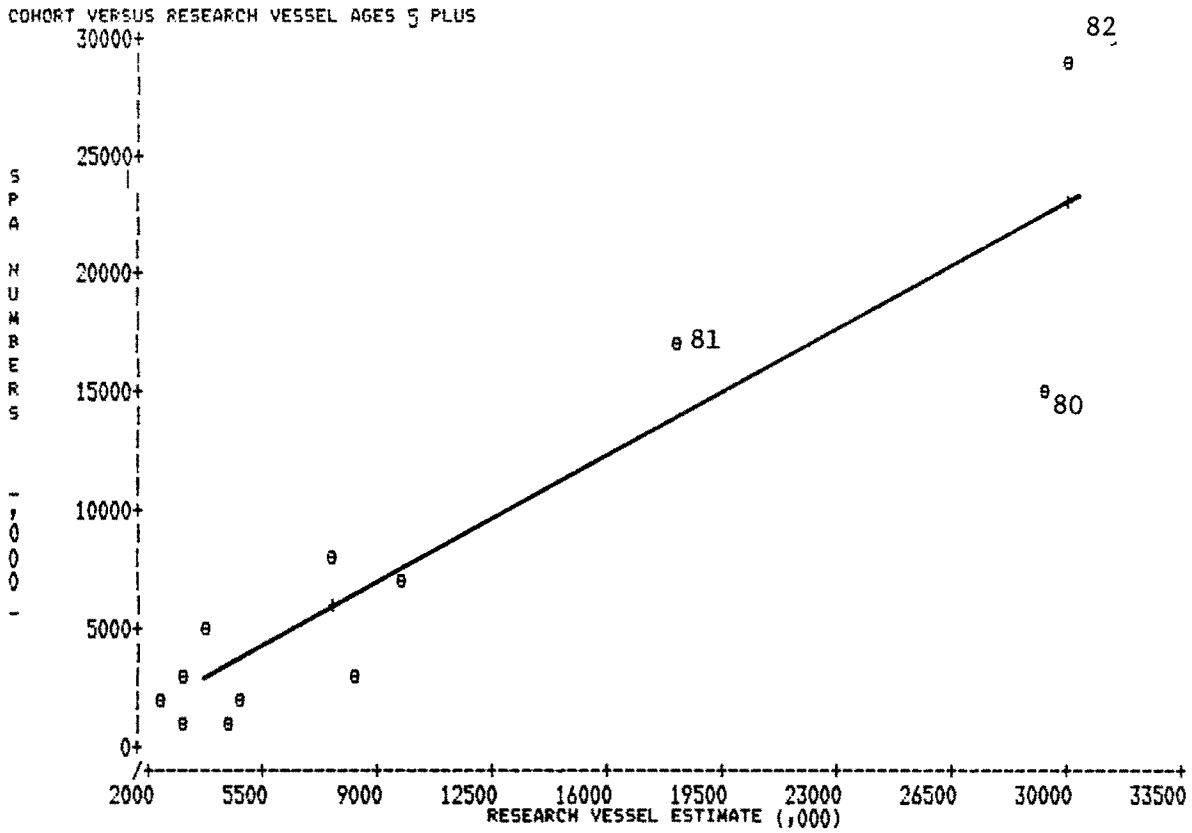
INTERCEPT = 2573 ; SLOPE = 0.689 ; R SQUARED = 0.8445

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
SPA	19952	11935	8657	5355	5431	6880	7540	16775	31253	46730	74784	54553	55831
RESEARCH	17714	10901	7977	5110	12122	13858	8770	34858	63358	62489	104318	39276	72386
ESTIMATE	14779	10085	8070	6095	10926	12122	8616	26591	46229	45630	74451	29635	52449

FULLY RECRUITED F (AGES 6 PLUS)

0.587 1.288 0.853 1.480 0.883 0.478 0.431 0.459 0.696 0.202 0.505 0.590 0.400

Figure 9. SPA vs RV estimates of age 3+ numbers



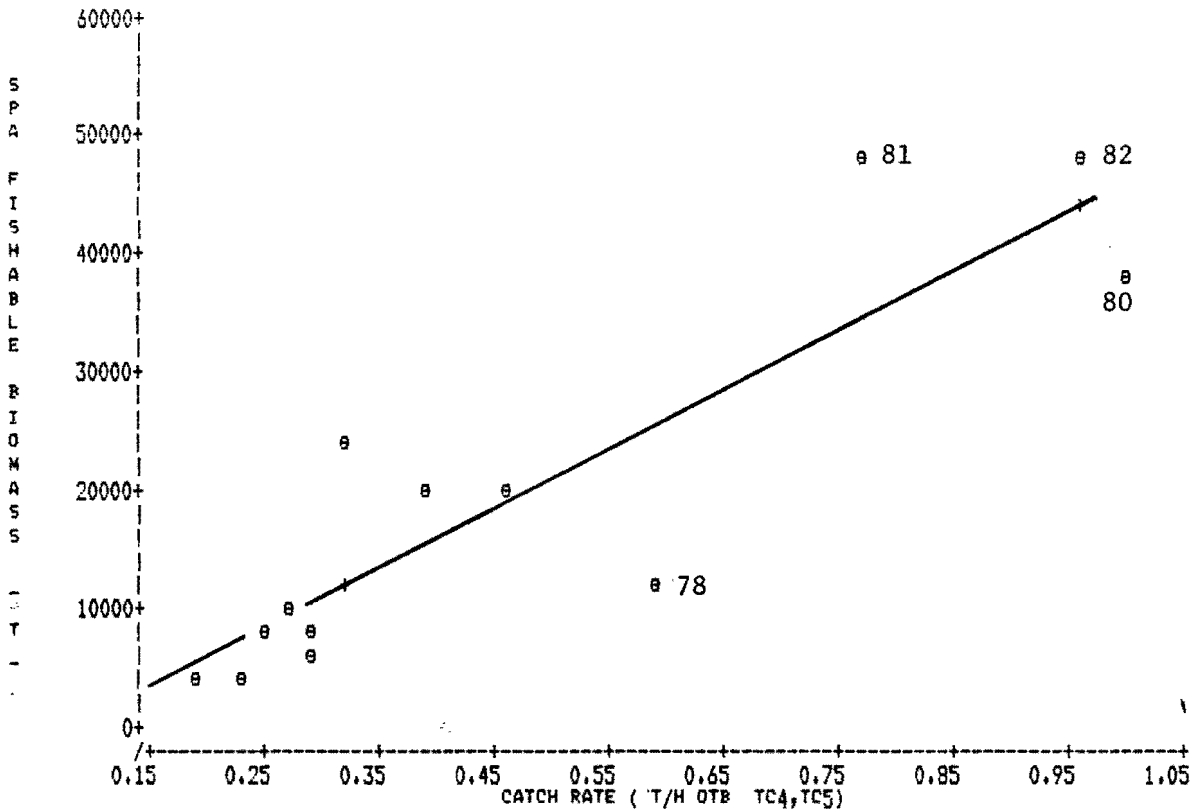
INTERCEPT = -224 ; SLOPE = 0.779 ; R SQUARED = 0.8311

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
SPA	8151	5176	3098	1760	1326	1266	1657	2970	2802	6940	14857	17154	29422
RESEARCH ESTIMATE	7603	3677	3074	2214	3198	4399	4876	8278	3137	9715	29311	18185	30074
ESTIMATE	5698	2640	2170	1500	2267	3202	3573	6223	2219	7343	22606	13940	23200

FULLY RECRUITED F (AGES 6 PLUS)

	0.587	1.298	0.853	1.480	0.883	0.478	0.431	0.459	0.696	0.202	0.505	0.590	0.400
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Figure 10. SPA vs RV estimates of 5+ numbers



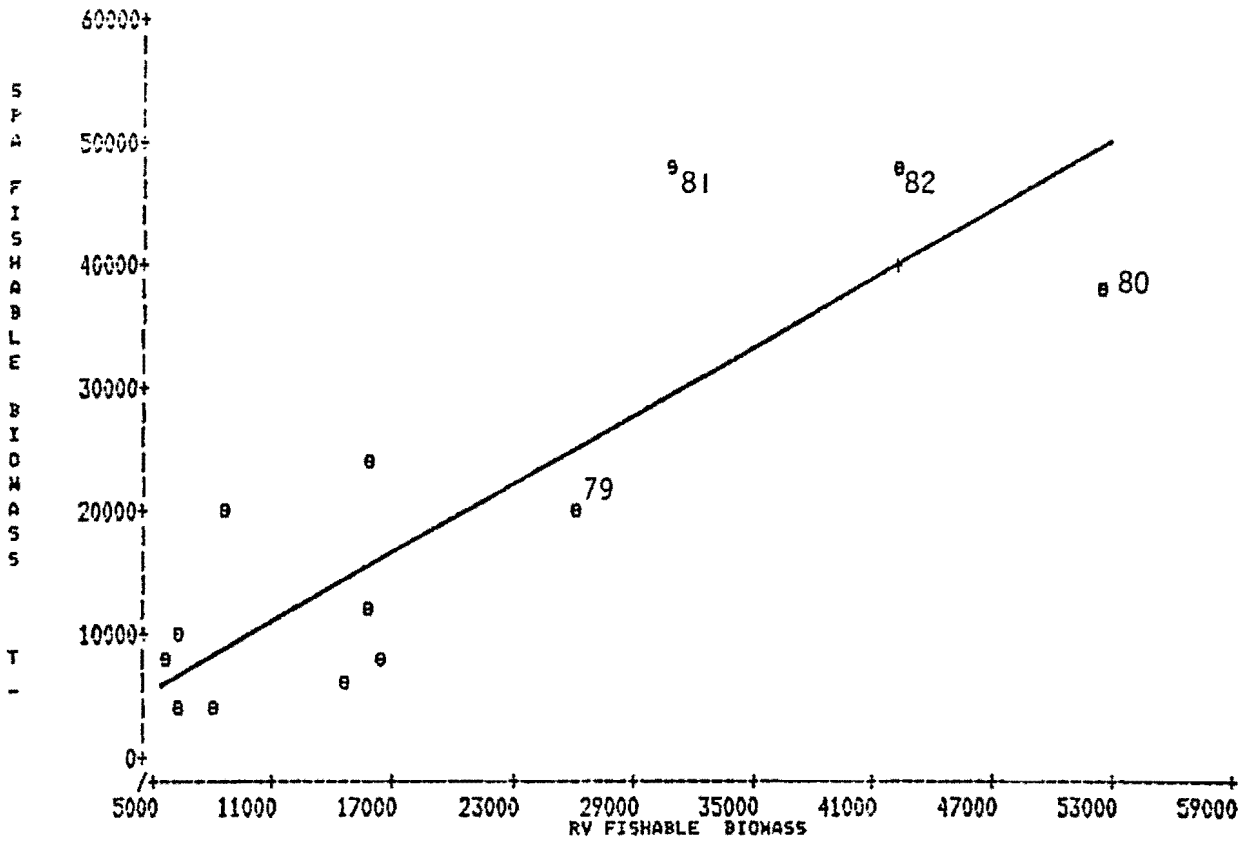
INTERCEPT = 3660.76 ; SLOPE = 49790.047 ; R SQUARED = 0.7878

YEAR	1970.00	1971.00	1972.00	1973.00	1974.00	1975.00	1976.00	1977.00	1978.00	1979.00	1980.00	1981.00	1982.00
SPA	23435.16	19819.36	9855.62	7690.87	4751.47	6728.71	4707.10	8813.71	11733.97	20840.08	37822.51	47154.59	48694.77
CATCH RATE	0.32	0.46	0.27	0.29	0.19	0.29	0.23	0.25	0.59	0.39	1.00	0.77	0.96
ESTIMATE	12487.97	19360.99	9931.93	10550.69	5863.34	10871.74	7553.46	8869.43	25871.08	15650.91	46301.74	34622.03	44112.60

FULLY RECRUITED F (AGES 6 PLUS)

0.587 1.288 0.853 1.480 0.883 0.478 0.431 0.459 0.696 0.202 0.505 0.590 0.400

Figure 11. SPA fishable biomass vs the mean catch rate from otter trawlers TC4 and 5 (weighted by effort)



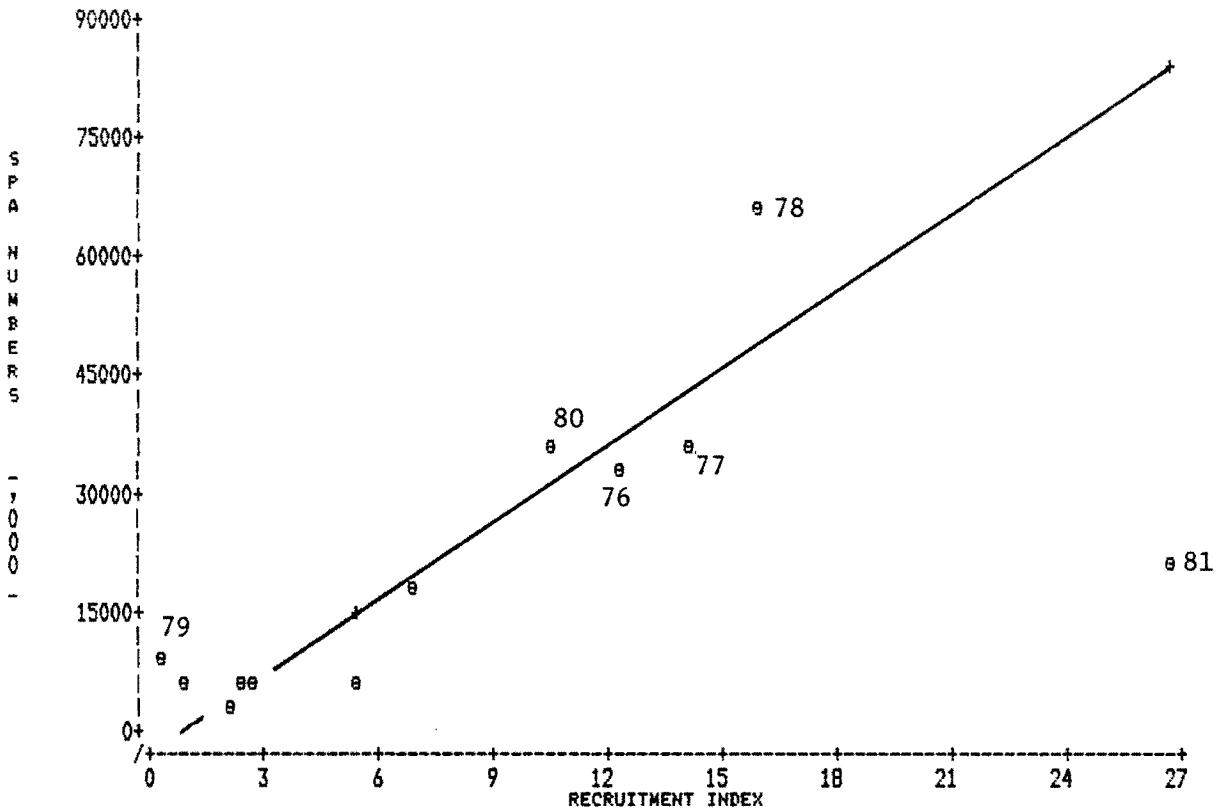
INTERCEPT = 2311 ; SLOPE = 0.890 ; R SQUARED = 0.7041

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
SPA	23435	19819	9856	7691	4751	6729	4707	8814	11734	20840	37823	47155	48695
FISHABLE B	15917	8766	5974	5326	8169	14638	6467	16469	15853	26788	52649	30668	42330
ESTIMATE	16471	10108	7625	7048	9578	15332	8064	16962	16413	25697	49147	29593	40011

FULLY RECRUITED F(AGES 6 PLUS)

0.587 1.288 0.853 1.480 0.883 0.478 0.431 0.459 0.696 0.202 0.505 0.590 0.400

Figure 12. SPA vs RV estimates of fishable biomass



INTERCEPT = -1020.733 ; SLOPE = 3219.877 ; R SQUARED = 0.8547

YEAR	1970.00	1971.00	1972.00	1973.00	1974.00	1975.00	1976.00	1977.00	1978.00	1979.00	1980.00	1981.00
SPA	6713.65	3456.51	6769.26	6596.34	4565.69	19118.17	31526.15	36350.82	65865.03	9248.10	34705.99	20580.39
INDEX	5.29	2.18	2.69	2.27	0.85	6.85	12.23	14.24	15.86	0.31	10.58	26.64
ESTIMATE	16012.42	5993.19	7646.92	6272.93	1711.89	21048.97	38350.33	44830.37	50051.05	-36.69	33034.33	84756.79

FULLY RECRUITED F

0.587 1.288 0.853 1.480 0.883 0.478 0.431 0.459 0.696 0.202 0.505 0.590 0.400
11 13

Figure 13. SPA numbers at age 1 versus RV numbers at ages 1+2 (within cohorts)

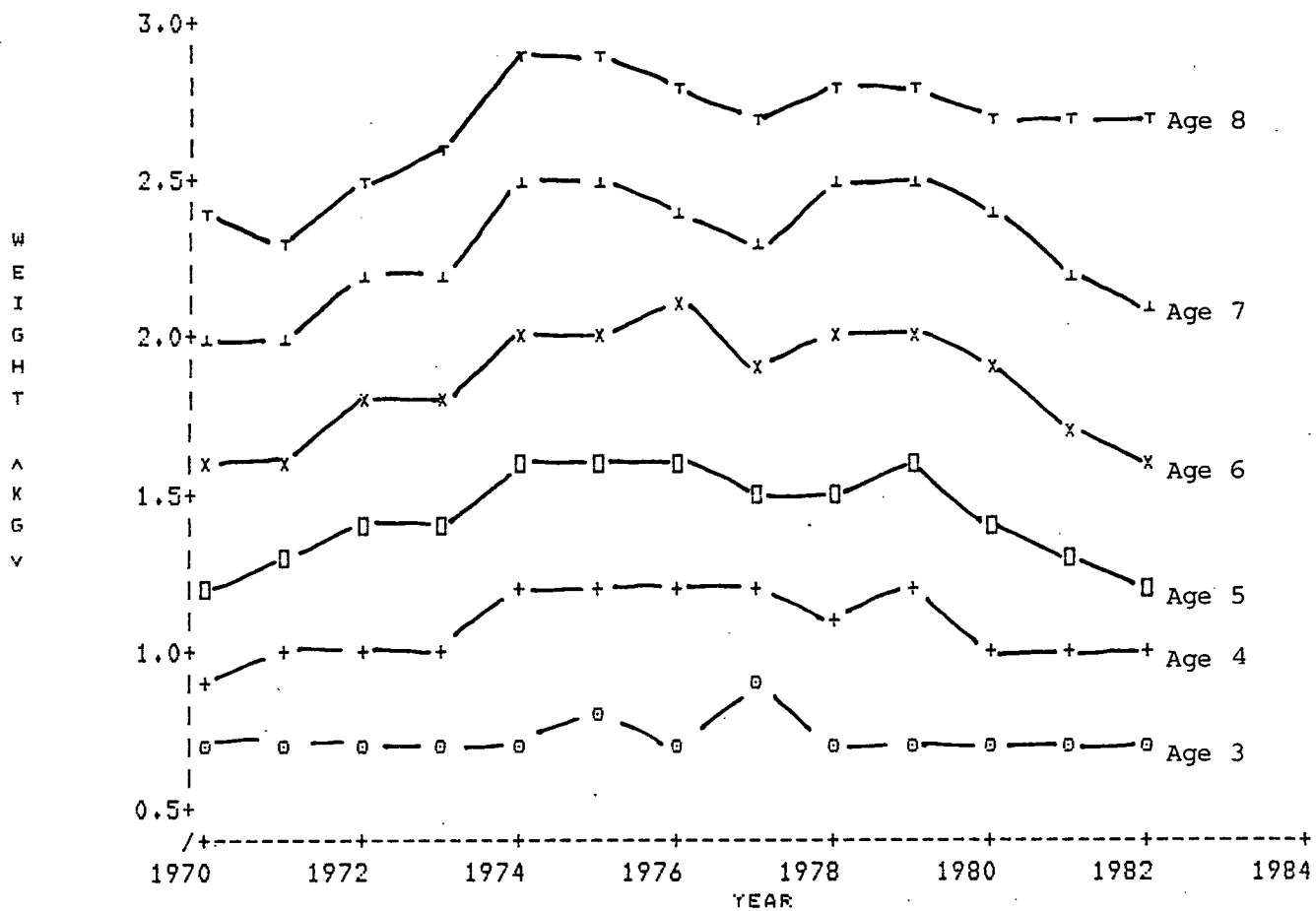


Figure 14. Weights at age through time for 4VW haddock ages 3-8 sampled from the commercial fishery