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Canadian Atlantic Fisheries Scientific Advisory Committee

CAFSAC Research Document 84/81

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Comité scientifique consultatif des pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 84/81

Analysis of Eastern Scotian Shelf Haddock (4VW)

by

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Abstract

Research surveys indicate that stock biomass has levelled out, or is increasing very slowly. Commercial catch rates on the other hand are down in 1983 and 1984 from the high levels in 1980-1982. The catch was again substantially less than the quota. A terminal fishing mortality of 0.4 was used for catch projections. The projections are that $F_{0.1}$ catch in 1985 will be 14,000 t if the TAC is taken in 1984, or 15,500 t if the $F_{0.1}$ is taken in 1984. Either way this catch will be predominantly of 5 year old fish. It is clear both from the poor tuning relationships and the historical underestimation of stock size that this assessment is essentially an informed guess. To summarize: partial recruitment is important for projections but the inability to predict catch composition in 1983 suggests either an unstable partial recruitment or substantial errors in ageing in 1982 and 1983; there are severe problems in the tuning relationships; and there is little idea of a 'typical' year-class size due to the short time series. To improve this assessment, it will be necessary to: investigate the effect of input errors on the SPA by looking further at the possibility of ageing errors, and by considering the possibility of density dependent changes in natural mortality; and develop a historical catch-at-age back to the early 1950s to obtain a better perspective of year-class size.

Résumé

Les relevés de recherche indiquent que la biomasse du stock a atteint un plateau, ou alors n'augmente que très lentement. Les taux de prises commerciales par contre ont baissé en 1983 et 1984 par rapport aux niveaux élevés atteints en 1980-1982. Les prises ont à nouveau été substantiellement moindres que le quota. Pour établir les projections de prises, on a utilisé une mortalité par pêche de la dernière année de 0,4. Selon ces projections, les prises $F_{0,1}$ en 1985 seront de 14 000 t si le TPA est atteint en 1984, ou de 15 500 t si les prises atteignent le $F_{0,1}$ en 1984. D'une façon ou d'une autre, ces prises seront avant tout des poissons de 5 ans. Il est évident tant à cause du mauvais ajustement des relations qu'à cause de la sous-évaluation historique de la dimension du stock que ces projections sont fondamentalement des hypothèses. Pour résumer: le recrutment partiel est important pour établir des projections, mais l'incapacité de prévoir la composition des prises en 1983 suggère soit un recrutement partiel instable soit des erreurs substantielles dans les âges en 1982 et 1983; il existe des problèmes graves dans l'ajustement des relations; et l'on n'a qu'une faible idée de la dimension "typique" d'une classe d'âge à cause de la courte série chronologique. Pour mieux fonder ces évaluations, il faudra étudier l'effet des erreurs d'entrée sur l'ASP en réexaminant la possibilité d'erreurs dans les âges et en considérant la possibilité de changements dus à la densité dans la mortalité naturelle; il faudra aussi établir les prises par âge en remontant jusqu'au début des années 1950 pour obtenir une meilleure idée de la dimension des classes d'âge.

Introduction

The TAC in 1983 was initially set at 19,000 t but was reduced to 15,000 t after the 1983 assessment (Mahon et al. 1983). The catch (9,000 t) was substantially less than even this reduced TAC.

Trends in Reported Landings

In the early 1960s catches began to decline and reached a minimum in 1976 (Table 1, Figure 1). They increased again rapidly to 1981 then declined again in 1982 and 1983. Recent catches and TACs ('000 t) have been as follows:

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
TAC	*	2	2	2	2	15	23	23	15	15
Nominal Catch	2	1	3	6	3	15	20	15	9	-

* lowest practicable level

In 1982 an anomalously cold winter was thought to have affected the distribution of haddock in the spring. In 1983 avoidance of small haddcok of the 1981 year-class is a likely reason for low catches. In 1984 there is again a shortfall, probably for the latter reason (Table 2).

Distribution of Catch

The majority of catch continues to be in 4W (Table 1). This is mainly by large otter trawlers (Table 3), although longliners and other gear took a greater proportion than usual.

As usual most of the otter trawler catch is in spring (Table 4) and longliner catch in summer and fall (Table 5).

Small Mesh Gear Removals

Small mesh gear removals are all by-catch, primarily in the USSR silver hake fishery. Since 1977 observers on these vessels have been recording by-catch levels and size composition for haddock.

From 1977 to the present the observed by-catch ratios have been applied to the reported silver hake catch to estimate the haddock by-catch (Table 6). From 1970 to 1977 the average of the 1977-1979 by-catch ratios was used. The estimated by-catch is substantially higher than reported catch (Table 6).

Age Composition of Landings

The catch-at-age for non-small mesh gear landings was calculated in three parts for 1977 to 1983 and in two parts from 1970 to 1976 (Table 7).

The catch-at-age presented in this assessment differs from the previous assessment (Table 8) (Mahon et al. 1983) in the following ways. First, pair trawl catches, mainly Spanish, have been included with otter trawl (OTB) catches, leaving primarily Danish and Scottish seine and longline catches in the category "other". Secondly, new weight-length relationships have been calculated and used as described in the next paragraph.

Analysis of weight/length relationships from RV surveys 1970 to 1981 showed that there was seasonal variation in condition (Figure 2). Consequently, weight/length relationships were estimated for each RV survey (fish smaller than 30 cm excluded) and the relationship most closely matching the peak period of catch was used (Table 7). Condition was estimated as the observed weight of a fish divided by the predicted weight at that length estimated from random subsamples of all the weights and lengths. The weight-length parameters from three such subsamples (n = 5911, 5975, 5959) differed very little (intercepts = 0.00728, 0.00685, 0.00730; slopes = 3.0895, 3.1054, 3.0872). Therefore, averages of these parameters were used to predict average weight-at-length for calculating condition.

The catch for small mesh removals from 1970-1976 was assumed to be similar in age structure to the research vessel summer survey catch in those years. From 1977 on, length-frequencies of haddock by-catch in the USSR small mesh fishery were available from the International Observer Program. These were applied to the summer research vessel age-length keys to estimate the age composition of the catch (Table 9, 10). Weight-length relationships from these surveys (all lengths included) were used. Catch-at-age for small mesh and other gears were combined (Tables 11-14).

The weights-at-age in the commercial catch are in Table 15. Mean weights-at-age from the RV summer surveys are in Table 16.

Comparison of the observed catch-at-age for 1983 with that projected by the 1983 assessment (Mahon et al. 1983) shows an unexpectedly high proportion of age 5 fish in the observed catch (Figure 3). This suggests a change in the partial recruitment pattern in 1983 from that used in the catch projections in the previous year. However, it should be noted that problems with ageing 4VW haddock in 1983 were encountered in early 1984. These were considered to be rectified (J. Hunt, MFD, pers. comm.).

Abundance Indices

The summer RV survey series (Halliday and Koeller 1981) has previously been used to calibrate the cohort analysis. In 1981 the 12 year A.T. Cameron series ended. In 1982 the survey was carried out by the Lady Hammond. A conversion factor of 0.833 was used to bring the Lady Hammond estimates into line with the A.T. Cameron. In 1983 the Alfred Needler was used. Comparative fishing experiments suggest no difference between the Lady Hammond and the Alfred Needler (P. Fanning, MFD, Pers. Comm.) therefore the same conversion factor was applied to the Alfred Needler estimates and these were appended to the time series used in 1982 (Tables

17-20; Figures 4 and 5).

Catch rates by Canada Maritimes otter trawlers show a substantial decline in 1983 and remain low in 1984 (Table 21). A multiplicative catch rate standardization was carried out (Table 22 and 23; Figure 6) (Gavaris 1980). The regression was weighted by catch. This series shows an increasing trend from 1972 through 1982 with a sharp decline to similar levels in 1983 and 1984. This decline in commercial catch rates in the last two years is not reflected in the survey catch per tow in kg. This is likely due to the relatively high abundance of partially recruited (to the commercial fishery) age classes.

Estimation of Stock Abundance

There is considerable doubt as to the validity of recent estimates for stock abundance of 4VW haddock:

1) There are trends in the residuals of the tuning relationships which invalidate the model's assumption of a linear relationship between the SPA estimates and the abundance indices.

2) A substantial proportion of catch comes from partially recruited ages (33%, 56%, 58%, 71% in 1983, 1982, 1981, 1980, respectively). Therefore, the estimation of the partial recruitment pattern is critical to the projections, as much or more so than estimating terminal fully recruited fishing mortality.

3) In retrospect, past assessments have been biased towards over-estimating stock size. The quotas have not been caught for several years.

The following 3 relationships were used in an attempt to calibrate the cohort analysis.

a) SPA numbers, ages 5+ vs RV mean catch-per-standard-tow, ages 5+

b) SPA fishable biomass vs RV fishable biomass

c) SPA fishable biomass vs standardized catch rate

All calculations were performed using Pope's cohort formula (Rivard 1982). Natural mortality was assumed to equal 0.2. 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.

Owing to the apparent change in partial recruitment in 1983, partial recruitment at ages 1-5 was recalculated as follows. The cohort analysis was calibrated using ages 5+ of the RV survey. Using the fully recruited terminal F estimated by the above calibration procedure, the terminal Fs of ages 5-1 were reset successively so as to maximize the correlation coefficient (last point included) for the age specific relationships of SPA vs RV numbers. The resulting partial recruitment pattern can be found in

Table 24.

For relationships a and b the RV values were averaged within cohorts between summer surveys and compared to the beginning of year SPA values. The purpose of averaging in this way was to reduce the variability inherent in the survey data, and to use a closer temporal match between the SPA and surveys than is afforded by the past practice of comparing SPA midyear estimates obtained by log linear interpolation, with RV summer estimates. The fact that the calibration relationships were substantially improved by this procedure suggests that the temporal matching of SPA and indices is important. However, it is noteworthy that in averaging it is necessary to drop the 1970 values from the SPA. The fact that these have always been outliers in the calibration relationships no doubt contributed to the improved fit.

Plots of these relationships at a terminal F of 0.4 are in Figures 7-9. The SPA estimate numbers, fishing mortalities, and partial recruitment values are in Table 24.

Using the above relationships, for which the R^2 values and intercepts are in Table 25, it was difficult to distinguish among the trial values of terminal F. The relationships between R^2 and F_t were very flat topped making it difficult to discriminate between a wide range of terminal F values. This is particularly disturbing considering the apparent good fit of the regression lines to the data and the relatively high vlaues of R^2.

As would be expected, the decline in commercial catch rates in 1983 leads to a relatively high estimate of F_t (0.55). The survey 5+ numbers and fishable biomass gave F_t values of 0.45 and 0.35 respectively. The reasons for the discrepancy between these two survey indices is less obvious. However, the partially recruited ages 3 and 4 do contribute significantly to the fishable biomass. A further problem in calibrating the SPA was that there are distinct trends in the residuals for all three relationships (Figure 10). In all three instances, the SPA estimates are less than predicted by the abundance indices in the middle years of the time span. F_t appears to be in the range of 0.3-0.55. Given the uncertainty, a value of 0.4 appears most appropriate, but may be too low. In any case it is the partially recruited F values which are important to the projections.

Yield Per Recruit

A Thompson and Bell yield-per-recruit analysis (Rivard 1982) using the available 1983 weights-at-ages 1-14, with age 13 interpolated and ages 15 and 16 set equal to age 14, gave an $F_{0.1}$ value of 0.22. This is the same as observed in the previous assessment.

Projections

Two projections (Rivard 1982) were made using the input parameters shown in Table 26 (Table 27). If the TAC is taken in 1984 fishing at

$F_{0.1}$ in 1985 would yield a catch of 14,000 t. If only the $F_{0.1}$ catch (9,000 t) is taken in 1984 then fishing at $F_{0.1}$ would yield a catch of 15,500 t in 1985.

Discussion

The rapid recovery of this stock which took place in the late 1970s has slowed, and if commercial catch rates are to be believed the stock may even have declined slightly in fishable biomass in 1983 and 1984.

Recruitment, however, continues to be good. At present this is only relative to the very poor recruitment in the early 1970s when the stock was very low. Without a more extensive historical analysis we are unable to compare the current 'good' recruitment to that in the 1950s and early 1960s when stock biomass was at similar or higher levels. This historical analysis is in progress, but involves estimating the age composition of the substantial amounts of haddock caught by the USSR in the early and mid-1960s. There are no samples for these removals and it is necessary to use RV age composition to reconstruct the age composition of Soviet removals.

In spite of the recovery of the 4VW haddock stock, a retrospective view suggest that fishing mortalities have routinely been substantially in excess of F_{MAX} (Figure 11). Furthermore, recent assessments have consistently underestimated terminal fishing mortality and thence overestimated abundance in the most recent year. The reason for the consistent underestimation is unclear at present. In the face of the insensitivity of the tuning criteria to the input F_t there has been a degree of latitude for "judgement" of the appropriate F_t.

The poor match in age structure of observed and predicted catch-at-age for 1983 could have two causes. First, it is possible that ageing errors persist in the data. Second, the partial recruitment pattern in 1983 could be substantially different from that in previous years. Depending on the relative distributions of age classes, the direction of effort at the recruiting 3 and 4 year olds could have raised fishing mortality on the 5 years olds above normal levels.

The time trends in the tuning relationships are a serious violation of the model assumptions. Thus the approach of maximising R^2 or minimising the sum of squares of residuals in recent years would lead to substantial errors. Since the pattern in the residuals is similar for both the RV surveys and the commercial catch rates, the fault probably lies in the input to the SPA i.e. catch-at-age and/or natural mortality parameters.

Finally, Table 27b shows that half the catch biomass in 1985 will be from one age class (age 5). The magnitude of this catch is very dependent on our estimate of the size of that year-class at age 3 in 1983. This estimate is very sensitive to the partial recruitment at age 3 in 1983.

Summary

It is clear both from the poor tuning relationships and the historical underestimation of stock size that this assessment is essentially an informed guess. To summarize:

- partial recruitment is important for projections but the inability to predict catch composition in 1983 suggests either an unstable partial recruitment or substantial errors in ageing in 1982 or 1983;
- there are severe problems in the tuning relationships; and
- there is little idea of a 'typical' year-class size due to the short time series.

To improve this assessment, it will be necessary to:

- investigate the effect of input errors on the SPA by looking further at the possibility of ageing errors, and by considering the possibility of density dependent changes in natural mortality; and
- develop a historical catch-at-age back to the early 1950s to obtain a better perspective of year-class size.

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

	4T					4Vn*					4Vs					4W						
Year	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other	Canada	USA	USSR	Spain	Other	Total	TAC
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				5769	120		747	9						19960	1533		132		30011	
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	12	13320	
1969	167				3	245				112	726			631	69	8270		235	864	1	11323	
1970	160					395	2		75	1	620		34	830	20	4754	574	636	1332		9436	
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				2	286			76	164	233			431	9	2830	173	76	95	18	4414	
1974	17				14	161			3	1	147		30	174	196	907	6	102	521	78	2357	(0)
1975	35				2	67			15	4	107	1		48	3	1393	20	52	63	59	1869	(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	81					188				42	1841					12448		209		31	14840	(15000)
1981	177					119				25	1796					17684		187		21	20009	(23000)
1982	25					181					2365					12485		51		49	15156	(23000)
1983	36					200				22	1532				12	7265		169		157	9393	(15000)
1984																						(15000)

* Catches for 1954-58 are for 4Vn and 4Vs combined.

Table 2. Recent Canadian fishery allocations and the respective reported catch (t) of 4VW haddock. Information from Canadian Atlantic Quota Reports.

Year	Fleet	Allocation	Reported Catch	%	**	Closure Date
1977	All Vessels	1700	2086	123		
1978	All Vessels	1700	5040	296		
1979	All Vessels	1700	2650	156		
1980	All 125'	3400	3302	97		
	All 125'	11500	11175	97		Apr. 2/80
1981	All 125'	4550	4352	96	(63)	
	All 125'	18300	15233	83	(79)	May 6/81
1982	All 100'	16600	9365	56	(53)	
	MG 65'-100'	750	583	78	(72)	Jul. 23/82
	MG 65'	4000	3097	77	(71)	Aug. 28/82
	FG 65'	1650	1410	85	(39)	
1983	All 100'	11650	5906	51	(48)	
	MG 65'-100'	500	395	79	(66)	
	MG 65'	1450	1318	91	(80)	
	FG 65'	1400	1418	101	(43)	
1984	All 100'	11850	4142*		(35)	
	MG 65'-100'	330	192*		(58)	
	MG 65'	1920	943*		(49)	
	FG 65'	900	460*		(51)	

* Landings to date: 1984/09/05

** Numbers in brackets indicate percentage of allocation landed as of first week of September.

Table 3. Canadian (M, Q, & Nfld.) nominal catches (t) of eastern Scotian Shelf haddock in 4V and 4W (4TVW) by gear.

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	12346	1567	301	842	15056
83	6969	1254	538	236	8997

Table 4. Nominal catches (t) of eastern Scotian Shelf haddock in 4V and 4W by month by Canadian (MQ) otter trawlers.

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	12256
1982	176	305	4207	2738	1779	1076	682	288	136	199	220	102	11908
1983	72	191	1400	2079	1386	738	274	212	164	199	143	31	6889

Table 5. Nominal catches (t) of eastern Scotian Shelf haddock in 4V and 4W by month by Canadian (MQ) longliners.

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
1983	17	12	49	90	68	139	138	138	155	180	174	94	1254

Table 6. Estimation of small mesh removals of haddock in 4VW in silver hake directed fisheries by Cuba, Bulgaria, Romania, and the USSR 1970 to 1982. In 1983 Japan and Portugal carried out directed fisheries for silver hake.

Year	Nominal Catch of Silver Hake (t)	IOP By-Catch Ratio (%)	Reported Catch of Haddock (t)	Estimated By-Catch Of Haddock (t)
1970	164,013	0.82*	670	1345
1971	122,616	0.82*	475	1005
1972	108,828	0.82*	106	892
1973	269,420	0.82*	76	2209
1974	87,497	0.82*	132	717
1975	98,994	0.82*	109	812
1976	90,483	0.82*	24	742
1977	30,019	0.64	33	192
1978	45,966	1.25	229	575
1979	50,374	0.51	176	257
1980	37,709	0.75	229	283
1981	37,554	0.80	201	300
1982	58,132	0.40	94**	233
1983	34,259	1.64	326**	562

* Mean of 1977-1979 weighted by-catch observed.

** FLASH

Table 7. Grouping of catch by gears and time period for estimation of removals-at-age. Trawlers are primarily stern and side bottom trawls but also pair trawls, other is primarily longline, Danish seine, and Scottish seine.

Year	Period	Gears	No. of Samples	Number Aged	Number Measured	Catch (t)	a	b	Cruise
1970	Jan - Dec	Trawlers	11	405	2172	7986	0.0062	3.136	Cameron #170 March 1970
	Jan - Dec	Other	3	107	602	779	0.0112	2.989	Cameron #175/176 July 1970
1971	Jan - Dec	Trawlers	24	966	5930	12174	0.0052	3.168	Cameron #184 March 1971
	Jan - Dec	Other	5	197	966	820	0.0088	3.035	Cameron #188/189 July 1971
1972	Jan - Dec	Trawlers	7	255	1661	3802	0.0036	3.261	Cameron #196 March 1972
	Jan - Dec	Other	1	29	200	817	0.0133	2.943	Cameron #200/201 July 1972
1973	Jan - Dec	Trawlers	8	299	1831	3407	0.0036	3.261	Cameron #196 March 1972
	Jan - Dec	Other	3	100	652	927	0.0096	3.017	Cameron #212/213 July 1973
1974	Jan - Dec	Trawlers	1	37	364	1545	0.0089	3.035	Cameron #225/226 July 1974
	Jan - Dec	Other	2	70	459	680	0.0089	3.035	Cameron #225/226 July 1974
1975	Jan - Dec	Trawlers	4	136	1048	778	0.0045	3.204	Cameron #219 March 1974
	Jan - Dec	Other	1	30	200	982	0.0094	3.023	Cameron #236/237 July 1975
1976	Jan - Dec	Trawlers	3	106	850	424	0.0191	2.837	Cameron #250/251 July 1976
	Jan - Dec	Other	3	89	478	912	0.0191	2.837	Cameron #250/251 July 1976
1977	Jan - June	Trawlers	3	105	616	548	0.0103	2.983	Cameron #259 March 1977
	July - Dec	Trawlers	11	319	2419	1684	0.0108	2.996	Cameron #265/266 July 1977
	Jan - Dec	Other	4	133	885	982	0.0108	2.996	Cameron #265/266 July 1977
1978	Jan - June	Trawlers	18	582	5776	3453	0.0019	3.425	Cameron #274 March 1978
	July - Dec	Trawlers	2	55	507	649	0.0103	3.000	Cameron #279/280 July 1978
	Jan - Dec	Other	5	164	1068	1536	0.0103	3.000	Cameron #279/280 July 1978
1979	Jan - June	Trawlers	3	80	650	847	0.0063	3.117	Hammond #13/14 March 1979
	July - Dec	Trawlers	6	189	1324	878	0.0050	3.187	Hammond #26/27 Oct-Nov 1979
	Jan - Dec	Other	12	347	2675	1528	0.0057	3.155	Cameron #292/293 July 1979
1980	Jan - June	Trawlers	24	759	5527	7077	0.0069	3.091	Hammond #33/34 March 1980
	July - Dec	Trawlers	22	619	5021	6122	0.0049	3.197	Hammond #42/43 October 1980
	Jan - Dec	Other	6	180	1421	1412	0.0117	2.970	Cameron #306/307 July 1980
1981	Jan - June	Trawlers	29	642	7450	15709	0.0070	3.102	Hammond #48/49 March 1981
	July - Dec	Trawlers	14	374	3062	2067	0.0087	3.049	Hammond #64/65 October 1981
	Jan - Dec	Other	15	407	2793	2025	0.0093	3.037	Cameron #321/322 July 1981
1982	Jan - June	Trawlers	48	1339	11563	10702	0.0059	3.143	Hammond #71/72 March 1982
	July - Dec	Trawlers	13	379	2682	1657	0.0055	3.155	Needler #2/3 October 1982
	Jan - Dec	Other	18	472	3337	2676	0.0123	2.954	Hammond #80/81 July 1982
1983	Jan - June	Trawlers	39	694	9253	6068	0.0093	3.006	Hammond #94/95 March 1983
	July - Dec	Trawlers	17	133	3642	936	0.0085	3.045	Needler #17/18 October 1983
	Jan - Dec	Other	15	131	2676	2060	0.0116	2.961	Needler #12/13 July 1983

TABLE 8, DIFFERENCES IN NON SMALL MESH REMOVALS (OLD-NEW) 22/ 9/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	-1	0	-2	0	0	21	-6	0	1	0	0	0
3	7	-38	-9	-10	-11	-4	5	15	57	-2	-13	-2	-2
4	21	-98	-17	-38	-4	-6	-26	80	-174	-22	-43	-5	5
5	20	-99	-7	-9	-7	0	-36	30	10	-20	-48	13	69
6	23	-35	0	-7	-5	2	-35	-36	20	-1	-33	7	36
7	21	-28	-4	-4	-2	1	-21	-21	9	-5	-5	7	28
8	7	-30	1	-1	-1	0	-7	-24	1	-2	-3	1	6
9	2	-8	-4	0	0	0	-1	-5	2	1	-1	-1	2
10	1	-1	0	-2	0	0	-2	-7	1	-2	0	0	1
11	0	-1	0	0	0	0	0	-1	0	0	0	0	2
12	0	0	0	0	0	0	0	-4	0	0	0	-1	2
13	0	-1	0	0	0	0	0	-2	0	0	0	-1	2
14	0	0	0	0	0	0	0	-1	0	0	-1	-3	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0
1+	102	-339	-39	-74	-30	-7	-103	19	-75	-53	-145	14	150

TABLE 9, SMALL MESH REMOVALS AT AGE(,000) 22/ 9/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	306	268	306	487	59	279	431	213	714	1	332	870	530	497
2	127	636	280	1134	233	61	407	197	426	258	374	241	413	462
3	245	216	352	418	318	223	64	49	219	97	137	22	74	305
4	307	247	148	378	65	206	120	9	122	54	59	59	7	82
5	138	102	116	109	64	48	128	13	19	28	26	32	18	52
6	87	60	75	239	30	72	29	7	17	7	9	18	9	77
7	77	28	35	60	24	18	30	3	3	6	2	3	3	30
8	52	43	21	60	11	7	6	1	1	1	0	1	0	10
9	18	2	9	10	5	4	2	0	0	0	0	1	0	2
10	5	0	3	20	7	4	2	0	0	0	0	0	0	1
11	5	0	0	0	8	0	2	0	1	0	0	0	0	0
12	4	0	0	0	0	1	4	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	2	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1+	1374	1602	1344	2914	825	923	1226	492	1523	453	940	1247	1055	1518

TABLE 10, DIFFERENCE IN SMALL MESH REMOVALS (OLD-NEW) 22/ 9/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	41	41	-11	-159	-21	107	-137	-176	-572	0	683	418	275
2	2	14	-81	-44	-9	-6	-84	-128	-268	-123	-302	-97	-83
3	-11	-2	-63	-91	-16	-63	-19	6	-8	51	65	-3	-30
4	-46	36	-16	-70	-10	-63	-32	-1	-4	99	-17	1	-1
5	-13	10	-6	3	-7	-11	-43	-1	-12	15	-7	0	6
6	-7	4	7	-13	-2	-4	-10	-3	-10	-2	-3	-4	2
7	12	1	-2	-13	-3	-1	-9	-2	-2	-1	-1	-1	0
8	-6	3	-5	-3	-3	0	-1	0	0	1	0	0	0
9	1	1	0	9	0	0	-1	0	0	0	0	0	1
10	-1	0	2	5	-3	0	-1	0	0	0	0	0	0
11	-1	0	0	0	-4	0	-1	0	0	0	0	0	0
12	2	0	0	0	0	1	2	0	0	0	0	0	0
13	0	0	10	0	1	1	29	1	0	0	0	0	0
14	-2	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0
1+	-28	108	-165	-375	-78	-38	-306	-304	-876	39	418	313	170

TABLE 11, REMOVALS AT AGE (,000) FOR 4VW HADDOCK 10/10/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	306	268	306	487	59	279	431	213	714	1	332	870	530	497
2	129	667	288	1178	233	61	676	283	433	268	376	318	433	462
3	679	888	671	646	975	470	157	965	811	423	2372	262	1518	979
4	1743	2188	751	1467	254	805	249	335	2412	1120	4335	5072	763	3063
5	1400	2740	924	811	464	282	323	513	436	675	3238	5081	5621	2013
6	1365	1208	668	723	298	185	189	283	715	159	1702	3010	1956	1737
7	1163	944	345	342	114	63	132	117	203	149	249	1178	1219	562
8	389	1177	191	159	47	30	36	80	61	16	129	139	214	251
9	88	277	159	60	8	8	8	19	23	5	39	105	48	32
10	38	39	9	99	17	4	10	15	8	6	9	30	28	12
11	19	21	18	2	16	1	3	6	2	2	7	10	5	13
12	14	25	0	4	0	1	7	7	0	0	2	3	7	6
13	6	5	0	3	0	1	1	3	1	0	1	4	0	0
14	6	2	0	1	0	0	0	1	1	1	1	4	0	0
15	0	2	0	0	0	0	0	0	0	1	1	0	1	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 12, PERCENT REMOVALS AT AGE FOR 4VW HADDOCK 10/10/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	4.2	2.6	7.1	8.1	2.4	12.7	19.4	7.5	12.3	0.1	2.6	5.4	4.3	5.2
2	1.8	6.4	6.6	19.7	9.4	2.8	30.4	10.0	7.4	9.5	2.9	2.0	3.5	4.8
3	9.2	8.5	15.5	10.8	39.2	21.5	7.1	34.0	13.9	15.0	18.5	1.6	12.3	10.2
4	23.7	20.9	17.3	24.5	10.2	36.8	11.2	11.8	41.4	39.6	33.9	31.5	6.2	31.8
5	19.1	26.2	21.3	13.6	18.7	12.9	14.5	18.1	7.5	23.9	25.3	31.6	45.5	20.9
6	18.6	11.6	15.4	12.1	12.0	8.5	8.5	10.0	12.3	5.6	13.3	18.7	15.8	18.0
7	15.8	9.0	8.0	5.7	4.6	2.9	5.9	4.1	3.5	5.3	1.9	7.3	9.9	5.8
8	5.3	11.3	4.4	2.7	1.9	1.4	1.6	2.8	1.1	0.6	1.0	0.9	1.7	2.6
9	1.2	2.7	3.7	1.0	0.3	0.4	0.4	0.7	0.4	0.2	0.3	0.7	0.4	0.3
10	0.5	0.4	0.2	1.7	0.7	0.2	0.4	0.5	0.1	0.2	0.1	0.2	0.2	0.1
11	0.3	0.2	0.4	0.0	0.6	0.0	0.1	0.2	0.0	0.1	0.1	0.1	0.0	0.1
12	0.2	0.2	0.0	0.1	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.1	0.1
13	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
14	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 13, NOMINAL CATCH AT AGE (T) FOR 4VW HADDOCK

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	33	32	30	56	7	44	40	35	63	0	39	73	39	32
2	43	224	80	409	95	15	249	122	131	80	63	111	104	79
3	434	555	393	420	627	401	83	893	528	285	1677	178	948	503
4	1591	2015	717	1433	285	968	303	413	2579	1309	4463	4835	729	2530
5	1802	3567	1241	1114	768	443	519	778	661	1052	4406	6434	6762	2331
6	2136	1965	1224	1350	588	396	384	541	1405	322	3143	5049	3144	2471
7	2410	1821	755	759	282	155	300	273	525	363	578	2580	2630	963
8	1010	2711	459	411	132	83	84	202	165	47	344	376	596	476
9	275	795	472	196	24	24	26	52	74	16	123	324	150	87
10	153	135	35	314	60	14	25	50	29	20	32	101	98	41
11	68	77	70	6	53	4	10	19	9	8	26	36	20	37
12	58	92	0	16	0	4	25	19	0	0	7	10	29	19
13	25	16	0	12	0	3	5	5	4	2	3	19	0	0
14	30	11	0	7	0	0	0	0	3	2	0	5	0	0
15	0	10	0	0	0	0	0	0	0	4	2	3	3	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1+	10070	14027	5476	6504	2922	2553	2054	3402	6175	3509	14907	20133	15253	9569

TABLE 14, PERCENT NOMINAL CATCH AT AGE FOR 4VW HADDOCK

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0.3	0.2	0.5	0.9	0.2	1.7	1.9	1.0	1.0	0.0	0.3	0.4	0.3	0.3
2	0.4	1.6	1.5	6.3	3.2	0.6	12.1	3.6	2.1	2.3	0.4	0.6	0.7	0.8
3	4.3	4.0	7.2	6.5	21.5	15.7	4.0	26.2	8.5	8.1	11.2	0.9	6.2	5.3
4	15.8	14.4	13.1	22.0	9.8	37.9	14.8	12.1	41.8	37.3	29.9	24.0	4.8	26.4
5	17.9	25.4	22.7	17.1	26.3	17.4	25.3	22.9	10.7	30.0	29.6	32.0	44.3	24.4
6	21.2	14.0	22.3	20.8	20.1	15.5	18.7	15.9	22.8	9.2	21.1	25.1	20.6	25.8
7	23.9	13.0	13.8	11.7	9.7	6.1	14.6	8.0	8.5	10.3	3.9	12.8	17.2	10.1
8	10.0	19.3	8.4	6.3	4.5	3.2	4.1	5.9	2.7	1.3	2.3	1.9	3.9	5.0
9	2.7	5.7	8.6	3.0	0.8	0.9	1.3	1.5	1.2	0.4	0.8	1.6	1.0	0.9
10	1.5	1.0	0.6	4.8	2.0	0.5	1.2	1.5	0.5	0.6	0.2	0.5	0.6	0.4
11	0.7	0.6	1.3	0.1	1.8	0.1	0.5	0.6	0.1	0.2	0.2	0.2	0.1	0.4
12	0.6	0.7	0.0	0.3	0.0	0.2	1.2	0.6	0.0	0.0	0.0	0.0	0.2	0.2
13	0.2	0.1	0.0	0.2	0.0	0.1	0.2	0.1	0.1	0.0	0.0	0.1	0.0	0.0
14	0.3	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
15	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 15, WEIGHTS AT AGE IN THE COMMERCIAL CATCH FOR 4VW HADDOCK 22/ 9/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0.108	0.119	0.098	0.115	0.122	0.159	0.092	0.165	0.088	0.102	0.117	0.084	0.073	0.064
2	0.332	0.335	0.280	0.348	0.407	0.245	0.369	0.433	0.303	0.298	0.168	0.349	0.240	0.171
3	0.638	0.625	0.586	0.651	0.643	0.852	0.526	0.925	0.651	0.674	0.707	0.680	0.624	0.514
4	0.913	0.921	0.955	0.976	1.124	1.202	1.217	1.235	1.069	1.169	1.030	0.953	0.956	0.826
5	1.288	1.302	1.344	1.374	1.656	1.572	1.607	1.515	1.517	1.558	1.361	1.266	1.203	1.158
6	1.565	1.627	1.832	1.866	1.978	2.137	2.027	1.908	1.964	2.026	1.846	1.678	1.608	1.422
7	2.072	1.930	2.187	2.218	2.468	2.447	2.271	2.345	2.581	2.443	2.318	2.190	2.157	1.714
8	2.595	2.303	2.407	2.593	2.789	2.800	2.327	2.506	2.687	2.962	2.662	2.708	2.783	1.897
9	3.137	2.867	2.971	3.248	2.841	3.037	3.194	2.811	3.276	3.273	3.128	3.082	3.145	2.771
10	4.044	3.435	3.862	3.174	3.435	3.131	2.611	3.328	3.497	3.440	3.402	3.410	3.525	3.260
11	3.553	3.752	3.830	3.630	3.396	4.120	3.102	3.196	3.841	4.208	3.654	3.664	4.496	2.842
12	4.105	3.738	0.000	4.089	0.000	3.984	3.890	2.592	0.000	0.000	4.112	2.724	4.270	3.498
13	4.477	3.041	0.000	4.390	0.000	3.760	3.620	1.875	4.610	4.652	2.708	4.177	0.000	0.000
14	5.196	4.881	0.000	6.410	0.000	0.000	0.000	0.000	4.910	4.241	0.000	1.126	0.000	3.873
15	0.000	6.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.970	4.230	5.620	4.870	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 16, MEAN WEIGHTS AT AGE (KG) IN SUMMER RV SURVEYS 22/ 9/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	0.004	0.004	0.000	0.000	0.007	0.004	0.005	0.067	0.000	0.000	0.000	0.005	0.013	0.000
1	0.108	0.119	0.098	0.115	0.122	0.159	0.092	0.165	0.088	0.102	0.117	0.084	0.073	0.064
2	0.326	0.328	0.281	0.340	0.407	0.245	0.328	0.272	0.304	0.292	0.167	0.285	0.235	0.171
3	0.664	0.634	0.499	0.678	0.725	0.837	0.564	0.752	0.612	0.479	0.449	0.508	0.541	0.372
4	0.988	0.924	0.968	1.121	1.067	1.154	1.143	1.151	1.120	1.031	0.908	0.901	0.823	0.803
5	1.406	1.279	1.274	1.396	1.563	1.640	1.533	1.701	1.686	1.470	1.302	1.297	1.184	1.239
6	1.767	1.584	1.863	1.987	2.082	2.089	1.865	2.010	2.005	1.979	1.914	1.765	1.581	1.463
7	2.152	1.836	2.318	2.068	2.032	2.265	2.430	2.472	2.663	2.245	2.401	2.250	1.880	1.692
8	2.747	2.356	2.159	2.713	2.403	2.544	2.608	3.036	1.932	2.844	3.025	2.485	2.256	2.035
9	3.148	2.164	2.151	4.088	2.123	2.468	2.898	0.000	0.000	0.000	2.454	2.826	3.452	2.466
10	3.402	0.000	3.473	3.749	3.421	3.131	1.708	3.481	4.235	3.717	0.000	3.198	0.000	2.016
11	4.077	0.000	0.000	0.000	3.121	0.000	2.898	0.000	3.542	3.190	0.000	0.000	0.000	0.000
12	3.930	0.000	0.000	0.000	0.000	3.984	4.184	0.000	0.000	0.000	0.000	0.000	0.000	2.979
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	5.541	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.190	0.000	0.000	0.000	3.873
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 17. RESEARCH TRAWL SURVEY CATCH AT AGE PER STANDARD TOW FOR 4VW HADDOCK 10/10/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
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	0.57	0.12
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	15.00	18.16
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	12.91	12.10
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	11.63	25.07
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	1.69	9.46
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	5.89	2.46
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	2.52	2.12
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	0.80	0.72
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	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	0.05
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	0.05
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	0.02
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	0.01
13	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	0.00

TABLE 18. PERCENT NUMBERS AT AGE IN RESEARCH TRAWL SURVEY CATCHES 10/10/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
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	0.2
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	25.7
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	17.1
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	35.5
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	13.4
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	3.5
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	3.0
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	1.0
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	0.3
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	0.1
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	0.1
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	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	0.0
13	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	0.0

Table 19. Mean catch per standard tow at age in all available surveys for 4VW haddock (A = A.T. Cameron, H = Lady Hammond, N = Alfred Needler; SU = summer, SP = spring, FA = fall). Hammond and Needler adjusted to Cameron using a factor of 0.833.

AGE	ASU70	ASU71	ASU72	ASU73	ASU74	ASU75	ASU76	ASU77	ASU78	HSP79	ASU79	HFA79	HSP80	ASU80	HSU80	HFA80	HSP81	ASU81	HSU81	HFA81	HSP82	HSU82	NSU83
0	0.09	0.05	0.01	0.00	0.19	0.06	0.25	0.21	0.00	0.00	1.24	8.65	0.00	1.20	1.42	48.06	0.00	18.52	4.24	25.36	0.00	0.69	0.12
1	2.27	1.44	1.10	0.48	0.30	3.85	2.74	5.01	8.25	0.08	0.07	0.19	3.86	2.93	3.78	6.85	22.50	13.51	5.50	27.51	27.67	18.00	18.16
2	0.84	3.02	0.74	1.59	1.79	0.55	3.01	9.49	9.23	2.02	7.61	6.33	0.21	0.23	0.13	1.04	10.20	7.65	5.49	9.91	24.94	15.49	12.10
3	1.53	1.00	1.08	0.48	2.42	1.60	0.42	7.49	12.34	3.43	8.28	10.40	6.92	12.40	12.06	6.11	5.14	0.80	0.31	1.63	12.25	13.95	25.07
4	1.70	1.32	0.49	0.45	0.44	1.43	0.82	1.02	6.93	5.36	8.61	7.44	2.06	11.60	10.84	6.33	73.16	5.95	2.17	8.89	1.52	2.03	9.46
5	0.82	0.52	0.41	0.16	0.45	0.37	0.79	1.62	0.43	2.70	2.41	1.27	1.72	7.21	6.35	2.69	29.20	3.73	1.61	4.42	9.83	7.06	2.46
6	0.52	0.30	0.31	0.33	0.23	0.68	0.18	0.60	0.41	0.50	0.31	0.31	0.63	1.74	1.42	0.75	13.31	1.64	0.67	2.29	2.70	3.03	2.12
7	0.58	0.14	0.12	0.07	0.17	0.17	0.19	0.17	0.10	0.49	0.24	0.24	0.22	0.28	0.16	0.08	4.28	0.26	0.09	0.75	2.11	0.96	0.72
8	0.30	0.21	0.06	0.08	0.07	0.07	0.05	0.10	0.01	0.13	0.08	0.03	0.13	0.10	0.06	0.01	0.70	0.07	0.03	0.23	0.47	0.23	0.19
9	0.13	0.01	0.03	0.03	0.04	0.04	0.01	0.00	0.00	0.03	0.00	0.00	0.06	0.02	0.01	0.05	0.17	0.08	0.03	0.08	0.25	0.02	0.05
10	0.03	0.00	0.02	0.04	0.03	0.04	0.01	0.06	0.01	0.04	0.03	0.00	0.01	0.00	0.00	0.01	0.04	0.01	0.02	0.00	0.06	0.02	0.05
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	0.04	0.00	0.02
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	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.01
UK	0.00	0.00	0.04	0.00	0.01	0.01	0.27	0.08	0.03	0.02	0.00	0.03	0.00	0.04	0.00	0.01	0.00	0.03	0.00	0.03	0.00	0.02	0.00

Table 20. Catch-(kg)-per-standard-tow by summer groundfish survey in 4VW (A = A.T. Cameron, H = Lady Hammond, N = Alfred Needler).

Vessel (Season)	Year	Area (Strata) 4Vn 40-42	4Vs 43-46	4Vs 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	10.86	31.31	22.74	13.90
A(SU)	1979	0.11	0.16	0.97	0.38	40.18	22.22
H(FA)	1979	5.62	0.39	3.23	2.45	39.43	22.74
H(SP)	1980	0.00	3.10	3.30	2.42	18.10	11.02
A(SU)	1980	0.50	0.60	2.39	1.09	60.01	33.43
H(SU)	1980	2.34	2.57	8.69	4.27	56.08	32.71
H(FA)	1980	11.67	0.13	18.24	8.06	31.81	21.10
H(SP)	1981	0.52	1.34	1.32	1.43	236.66	130.52
A(SU)	1981	4.21	1.19	1.25	1.92	31.73	18.28
H(SU)	1981	1.59	0.24	2.02	1.08	18.73	8.60
H(FA)	1981	0.70	0.23	4.60	1.61	59.82	33.55
H(SP)	1982	-	0.00	18.14	14.43	40.74	34.73
H(SU)	1982	4.23	0.54	45.03	14.21	40.04	28.39
N(FA)	1982	4.94	-	-	4.94	50.83	46.17
H(SU)	1983	1.67	1.91	9.07	2.43	62.09	34.73
N(SU)	1983	1.81	0.79	26.06	8.30	53.77	33.26
N(FA)	1983	19.25	0.59	50.05	19.23	144.42	87.93
N(SU)	1984	4.96	1.17	35.44	11.92	55.69	35.94

Note: Catch per standard tow values for Lady Hammond and Alfred Needler divided by 1.22 to be comparable with A.T. Cameron.

Table 21. 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
1983	0.153	(1579)	0.466	(2272)	0.755	(2467)	0.616
1984	0.205	(444)*	0.497	(189)	0.667	(1769)	0.651

* Jan-July only

Table 22. Details of multiplicative catch rate standardization.

	Categories	Breakdown
1.	Gear	OTB 1 OTB 2 LL
2.	Tonnage Class	2-5
3.	Season	Quarters
4.	Year	1968-1984
5.	Area	4V 4W

The reference variables were the first in each category. The catch rates (Figure 6) are standardized to OTB 2, TC 5, 2nd Quarter, 4W.

Table 23. Analysis of variance and regression coefficients for the multiplicative catch rate standardization for 4VW haddock.

Multiple R 0.829
Multiple R Squared 0.688

ANALYSIS OF VARIANCE

Source of Variation	DF	Sums of Squares	Mean Squares	F-Value
Intercept	1	1.206E2	1.206E2	
Regression	25	1.206E2	4.823E0	40.353
Type 1	2	8.662E0	4.331E0	36.233
Type 2	3	9.897E0	3.299E0	27.601
Type 3	3	2.168E1	7.227E0	60.462
Type 4	16	5.061E1	3.163E0	26.466
Type 5	1	2.991E-1	2.994E-1	2.505
Residuals	458	5.474E1	1.195E-1	
Total	484	2.959E2		

REGRESSION COEFFICIENTS

		Variable	Coefficient	Std. Error	No. Obs.
Intercept			-1.222	0.147	484
Gear	OTB2	1	0.202	0.056	262
	LL	2	-0.350	0.122	96
TC	3	3	0.399	0.109	77
	4	4	0.519	0.111	177
	5	5	0.792	0.108	152
Quarter	2nd	6	-0.272	0.037	165
	3rd	7	-0.616	0.068	92
	4th	8	-0.492	0.060	82
Year	1969	9	-0.183	0.082	27
	1969	10	-0.419	0.098	25
	1969	11	-0.364	0.082	25
	1969	12	-0.736	0.143	12
	1969	13	-0.422	0.135	15
	1969	14	-0.306	0.601	3
	1969	15	-0.205	0.250	14
	1969	16	-0.302	0.220	13
	1969	17	0.039	0.123	29
	1969	18	0.207	0.103	36
	1969	19	0.156	0.192	17
	1969	20	0.488	0.076	57
	1969	21	0.328	0.076	55
	1969	22	0.519	0.078	56
	1969	23	0.097	0.089	42
	1969	24	0.182	0.115	27
Area	4W	25	0.027	0.075	420

(a) POPULATION NUMBERS 4/10/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	8133	4448	8103	7752	4681	20247	29315	34822	44797	17373	45824	91831	104587	85901
2	5459	6382	3400	6357	5906	3780	16324	23611	28317	36031	14222	37217	74397	85149
3	7176	4352	4621	2523	4139	4625	3039	12754	19075	22792	29257	11304	30183	60520
4	7652	5261	2759	3176	1482	2507	3361	2346	9568	14884	18277	21807	9018	23338
5	4130	4688	2327	1580	1273	984	1324	2526	1618	5651	11172	11042	13265	6693
6	3270	2115	1359	1070	559	622	550	791	1604	930	4016	6217	4443	5775
7	3402	1442	638	508	221	189	342	279	392	666	618	1748	2367	1868
8	824	1733	326	210	107	78	97	160	123	136	411	280	365	834
9	203	322	354	95	29	44	37	47	58	45	98	219	103	105
10	80	86	13	146	23	16	29	23	22	27	33	44	84	42
11	49	32	35	3	30	3	9	15	5	10	17	18	10	44
1+	40377	30861	23936	23420	18450	33093	54428	77374	105578	98546	123945	181728	238821	270268

(b) FISHING MORTALITY 4/10/84

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0.042	0.069	0.043	0.072	0.014	0.015	0.016	0.007	0.018	0.000	0.008	0.011	0.006	0.006
2	0.027	0.123	0.098	0.229	0.045	0.018	0.047	0.013	0.017	0.008	0.030	0.009	0.006	0.006
3	0.110	0.256	0.175	0.332	0.302	0.119	0.059	0.087	0.048	0.021	0.094	0.026	0.057	0.018
4	0.290	0.616	0.358	0.715	0.210	0.439	0.085	0.172	0.327	0.087	0.304	0.297	0.098	0.156
5	0.469	1.038	0.577	0.838	0.516	0.381	0.314	0.254	0.354	0.142	0.386	0.710	0.632	0.400
6	0.619	0.998	0.783	1.375	0.887	0.399	0.479	0.504	0.679	0.209	0.632	0.766	0.666	0.400
7	0.474	1.286	0.911	1.361	0.846	0.463	0.558	0.619	0.854	0.283	0.591	1.366	0.842	0.400
8	0.738	1.389	1.038	1.792	0.674	0.546	0.530	0.810	0.799	0.136	0.428	0.796	1.047	0.400
9	0.652	3.011	0.686	1.227	0.395	0.216	0.280	0.574	0.557	0.124	0.590	0.756	0.714	0.400
10	0.736	0.697	1.433	1.384	1.860	0.370	0.455	1.326	0.541	0.272	0.377	1.338	0.456	0.400
11	0.566	1.228	0.829	1.400	0.846	0.413	0.500	0.574	0.710	0.229	0.607	0.866	0.734	0.400
1+	0.245	0.575	0.255	0.397	0.183	0.085	0.049	0.045	0.071	0.033	0.134	0.130	0.073	0.044

(c)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0.074	0.053	0.051	0.051	0.016	0.037	0.033	0.012	0.025	0.000	0.013	0.012	0.008	0.016
2	0.047	0.095	0.118	0.163	0.052	0.043	0.093	0.023	0.024	0.036	0.049	0.011	0.009	0.015
3	0.194	0.197	0.210	0.236	0.350	0.288	0.118	0.150	0.068	0.090	0.154	0.029	0.077	0.045
4	0.508	0.474	0.429	0.507	0.244	1.058	0.170	0.294	0.458	0.378	0.499	0.333	0.133	0.390
5	0.823	0.800	0.692	0.595	0.599	0.918	0.626	0.436	0.496	0.616	0.635	0.796	0.853	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 24. Cohort analysis of 4VW haddock (top) population numbers (middle) fishing mortality (bottom) partial recruitment

Table 25. Calibration of SPA versus research survey and commercial abundance indices.

F_t	R^2 of Relationship (* maximum)		
	SPA 5+ vs RV 5+ numbers	SPA fishable biomass vs RV fishable biomass	SPA fishable biomass vs standardized catch rate
0.25	0.847	0.911	
0.30	0.874	0.926	0.570
0.35	0.890	0.927*	0.595
0.40	0.897	0.918	0.610
0.45	0.900*	0.903	0.618
0.50	0.899	0.886	0.622
0.55	0.895	0.867	0.622*
0.60			0.620

Table 26. Input to catch projections for 4VW haddock.

Age	Population numbers ('000)	Weights-at-age (kg)	Partial recruitment
1	45000[1]	0.064	0.029[3]
2	75000[2]	0.171	0.018[3]
3	60520	0.514	0.05
4	23338	0.826	0.39
5	6693	1.158	1
6	5775	1.422	1
7	1868	1.714	1
8	834	1.897	1
9	105	2.771	1
10	42	3.260	1
11	44	2.842	1

[1] Set to highest observed prior to 1980.

[2] Set to highest previously observed.

[3] Adjusted to produce the preset population numbers-at-ages 1 and 2.

Post 1983 age 1 recruitment was set to the GM of SPA age 1 numbers from 1970 to 1981 (17.3 million).

Table 27a. Catch projection with TAC taken in 1984

POPULATION NUMBERS 84/10/06

	1983	1984	1985	1986	1987
1	45000	17302	17302	17302	17302
2	75000	36394	14007	14073	14073
3	60520	60988	29596	11423	11476
4	23338	48666	49003	23966	9250
5	6693	16348	34411	36821	18009
6	5775	3673	9191	22610	24193
7	1868	3169	2065	6039	14856
8	834	1025	1782	1357	3968
9	105	458	576	1171	892
10	42	58	257	379	769
11	44	23	32	169	249
1+	219219	188104	158224	135310	115037
2+	174219	170802	140922	118008	97734
3+	99219	134407	126915	103935	83661
4+	38699	73420	97319	92512	72185

CATCH BIOMASS 84/10/06

	1983	1984	1985	1986	1987
1	32	11	7	7	7
2	79	38	9	9	9
3	503	529	151	58	58
4	2530	4979	3020	1477	570
5	2331	5407	7156	7657	3745
6	2471	1493	2349	5777	6182
7	963	1552	636	1860	4575
8	476	556	607	462	1352
9	87	362	287	583	444
10	41	54	151	222	451
11	37	19	17	86	127
1+	9549	15000	14388	18198	17519
2+	9518	14989	14381	18192	17513
3+	9439	14951	14373	18183	17504
4+	8936	14422	14222	18125	17446

POPULATION BIOMASS 84/10/06

	1983	1984	1985	1986	1987
1	2885.91	1109.62	1109.62	1109.62	1109.62
2	12803.72	6213.09	2391.25	2402.46	2402.46
3	31088.65	31328.94	15203.33	5867.79	5895.29
4	19274.45	40192.13	40470.69	19793.29	7639.30
5	7747.74	18923.90	39834.33	42624.11	20846.48
6	8214.52	5224.74	13073.58	32160.99	34413.37
7	3202.29	5433.27	3540.20	10352.50	25467.14
8	1582.08	1944.85	3380.24	2573.96	7526.97
9	290.94	1267.90	1597.13	3244.08	2470.28
10	136.93	188.00	838.76	1234.76	2508.02
11	125.03	65.88	92.13	480.33	707.11
1+	87352.25	111892.33	121531.26	121843.89	110986.04
2+	84466.35	110782.70	120421.64	120734.27	109876.41
3+	71662.63	104569.61	118030.39	118331.81	107473.95
4+	40573.98	73240.67	102827.06	112464.02	101578.67

FISHING MORTALITY 84/10/06

	1983	1984	1985	1986	1987
1	0.012	0.011	0.007	0.007	0.007
2	0.007	0.007	0.004	0.004	0.004
3	0.018	0.019	0.011	0.011	0.011
4	0.156	0.147	0.086	0.086	0.086
5	0.400	0.376	0.220	0.220	0.220
6	0.400	0.376	0.220	0.220	0.220
7	0.400	0.376	0.220	0.220	0.220
8	0.400	0.376	0.220	0.220	0.220
9	0.399	0.376	0.220	0.220	0.220
10	0.394	0.376	0.220	0.220	0.220
11	0.397	0.376	0.220	0.220	0.220

CATCH NUMBERS 84/10/06

	1983	1984	1985	1986	1987
1	497	176	103	103	103
2	462	222	50	50	50
3	979	1029	294	113	114
4	3063	6029	3657	1789	690
5	2013	4671	6182	6615	3235
6	1737	1050	1651	4062	4346
7	562	906	371	1085	2669
8	251	293	320	244	713
9	32	131	104	210	160
10	12	16	46	68	138
11	13	7	6	30	45
1+	9621	14529	12783	14369	12264
2+	9124	14354	12680	14266	12160
3+	8662	14131	12630	14216	12110
4+	7683	13102	12337	14102	11996

Table 27b. Catch projection with $F_{0.1}$ catch taken in 1984

POPULATION NUMBERS 84/10/06

	1983	1984	1985	1986	1987
1	45000	17302	17302	17302	17302
2	75000	36394	14073	14073	14073
3	60520	60988	29679	11476	11476
4	23338	48666	49386	24034	9293
5	6693	16348	36568	37110	18059
6	5775	3673	10741	24027	24383
7	1868	3169	2413	7057	15787
8	834	1025	2082	1586	4637
9	105	458	674	1368	1042
10	42	58	301	443	899
11	44	23	38	198	291
1+	219219	188104	163258	138673	117242
2+	174219	170802	145956	121371	99940
3+	99219	134407	131883	107298	85867
4+	38699	73420	102204	95822	74391

CATCH BIOMASS 84/10/06

	1983	1984	1985	1986	1987
1	32	7	7	7	7
2	79	22	9	9	9
3	503	311	151	58	58
4	2530	2999	3044	1481	573
5	2331	3400	7604	7717	3755
6	2471	939	2745	6140	6230
7	963	976	743	2173	4862
8	476	349	710	540	1580
9	87	228	335	681	519
10	41	34	176	259	527
11	37	12	19	101	148
1+	9549	9276	15543	19166	18268
2+	9518	9269	15536	19160	18261
3+	9439	9247	15528	19151	18253
4+	8936	8936	15377	19093	18194

POPULATION BIOMASS 84/10/06

	1983	1984	1985	1986	1987
1	2885.91	1109.62	1109.62	1109.62	1109.62
2	12803.72	6213.09	2402.46	2402.46	2402.46
3	31088.65	31328.94	15246.04	5895.29	5895.29
4	19274.45	40192.13	40787.30	19848.89	7675.11
5	7747.74	18923.90	42330.73	42957.57	20905.04
6	8214.52	5224.74	15278.56	34176.51	34682.60
7	3202.29	5433.27	4137.29	12098.55	27063.15
8	1582.08	1944.85	3950.35	3008.09	8796.46
9	290.94	1267.90	1866.50	3791.22	2886.91
10	136.93	188.00	980.23	1443.01	2931.02
11	125.03	65.88	107.66	561.35	826.37
1+	87352.25	111892.33	128196.75	127292.56	115174.04
2+	84466.35	110782.70	127087.13	126182.94	114064.41
3+	71662.63	104569.61	124684.67	123780.48	111661.96
4+	40573.98	73240.67	109438.63	117885.19	105766.67

FISHING MORTALITY 84/10/06

	1983	1984	1985	1986	1987
1	0.012	0.007	0.007	0.007	0.007
2	0.007	0.004	0.004	0.004	0.004
3	0.018	0.011	0.011	0.011	0.011
4	0.156	0.086	0.086	0.086	0.086
5	0.400	0.220	0.220	0.220	0.220
6	0.400	0.220	0.220	0.220	0.220
7	0.400	0.220	0.220	0.220	0.220
8	0.400	0.220	0.220	0.220	0.220
9	0.399	0.220	0.220	0.220	0.220
10	0.394	0.220	0.220	0.220	0.220
11	0.397	0.220	0.220	0.220	0.220

CATCH NUMBERS 84/10/06

	1983	1984	1985	1986	1987
1	497	103	103	103	103
2	462	130	50	50	50
3	979	605	294	114	114
4	3063	3632	3686	1794	694
5	2013	2937	6569	6666	3244
6	1737	660	1930	4316	4380
7	562	569	434	1268	2836
8	251	184	374	285	833
9	32	82	121	246	187
10	12	10	54	80	162
11	13	4	7	35	52
1+	9621	8917	13622	14957	12655
2+	9124	8814	13519	14854	12552
3+	8662	8683	13468	14804	12502
4+	7683	8079	13174	14690	12388

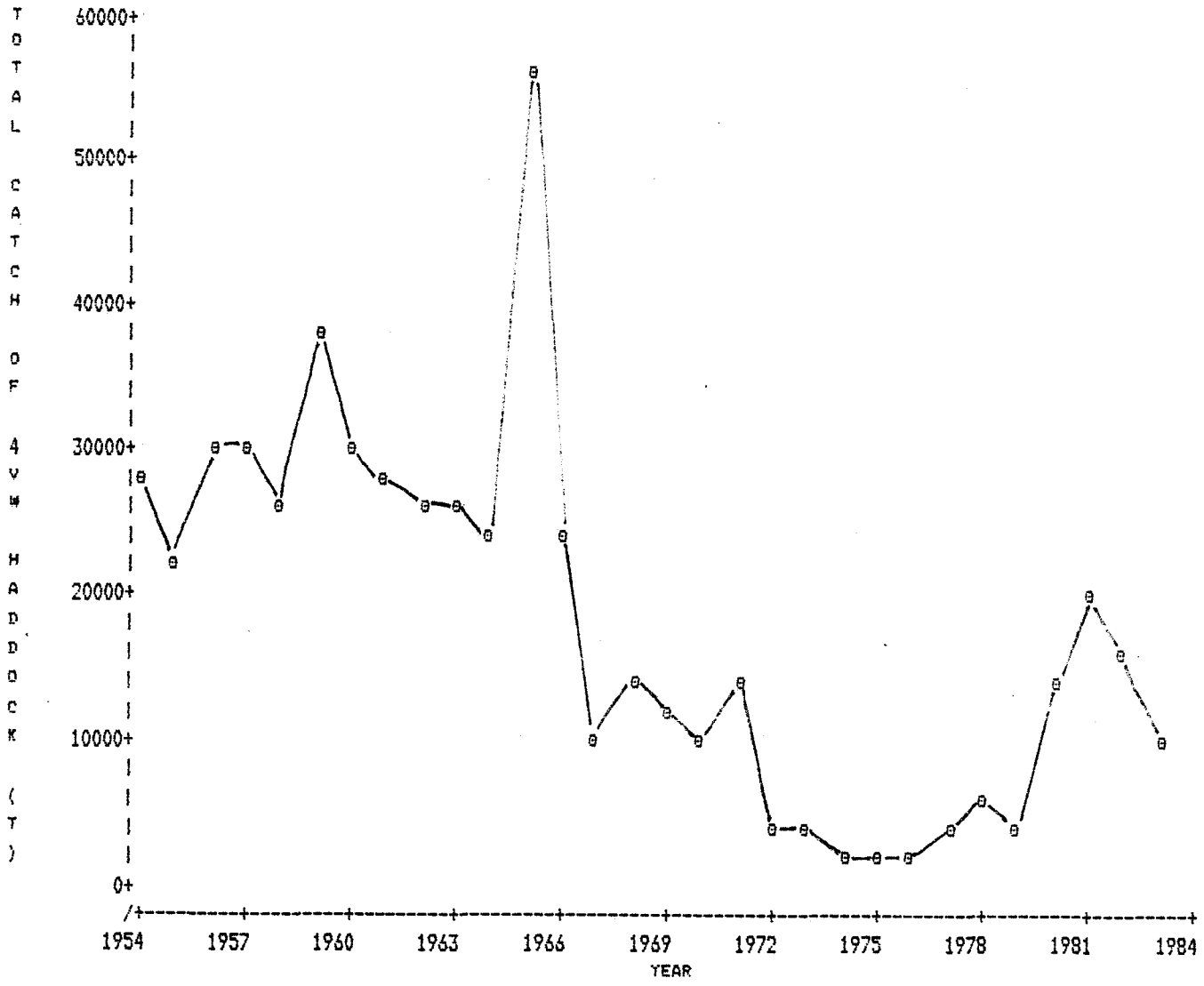
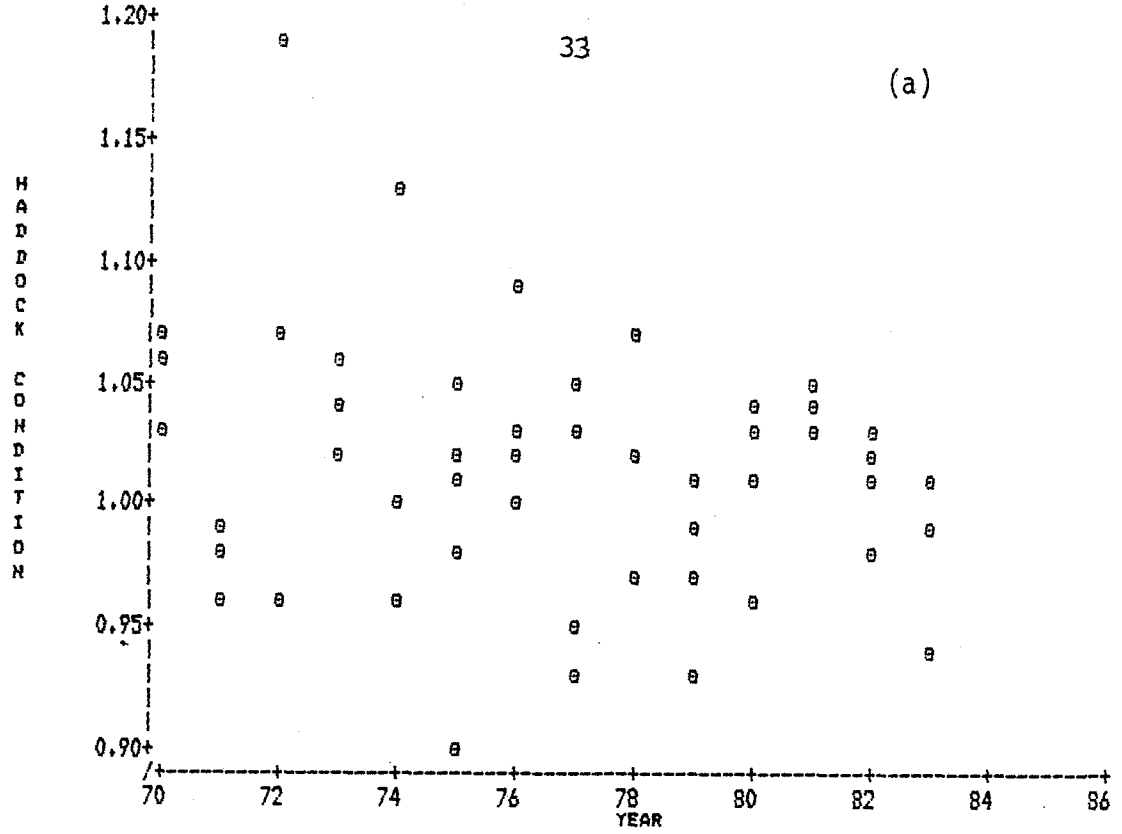


Figure 1. Nominal catch of 4VW haddock (t)



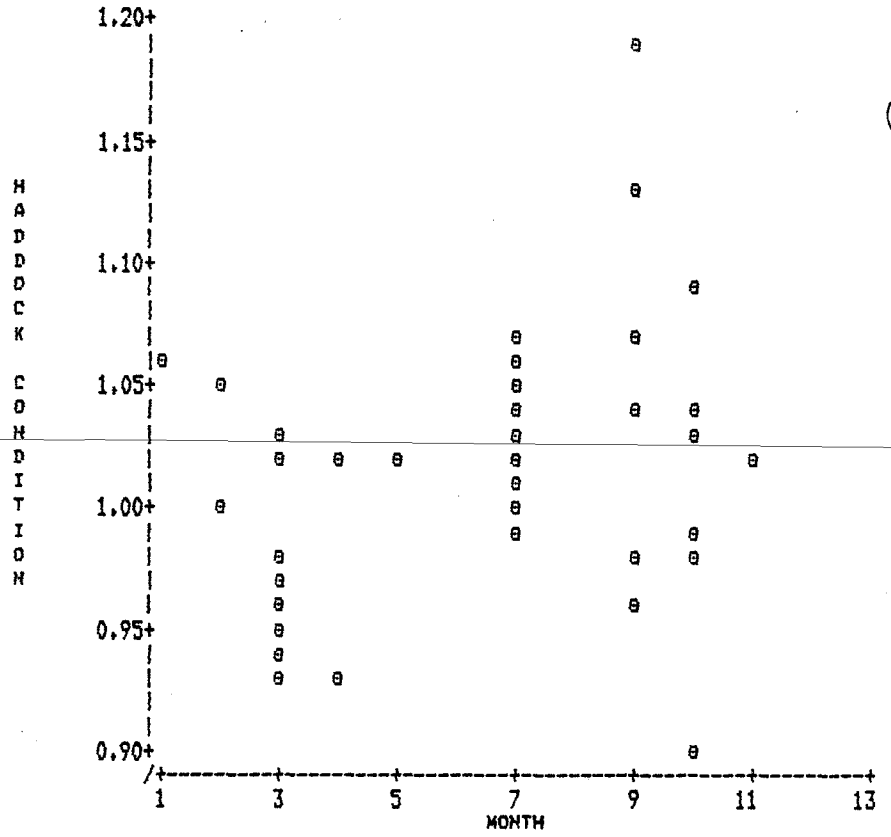


Figure 2. Haddock condition factor in RV surveys (a) average condition in each survey in each year, (b) average condition in each month for surveys in all years (1970-1982)(the condition factor was calculated as the observed weight versus the weight estimated for a fish of that length using an overall weight-length relationship)

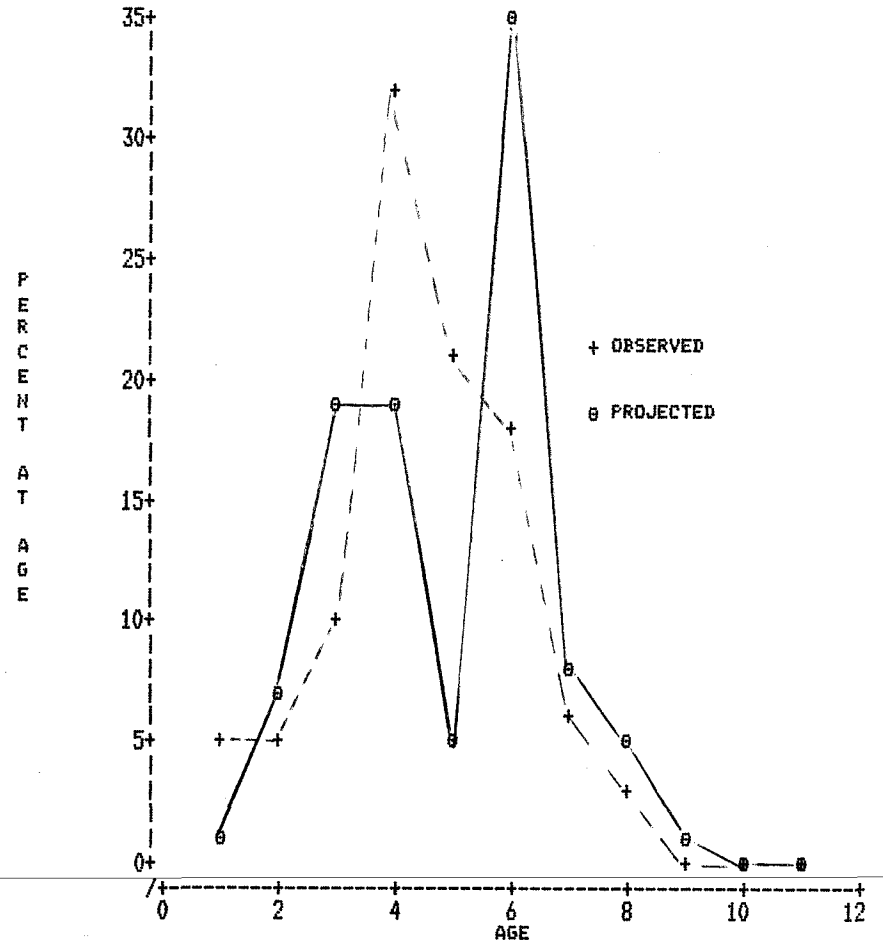


Figure 3. The observed percent catch at age in numbers in 1983 versus that projected by the previous assessment.

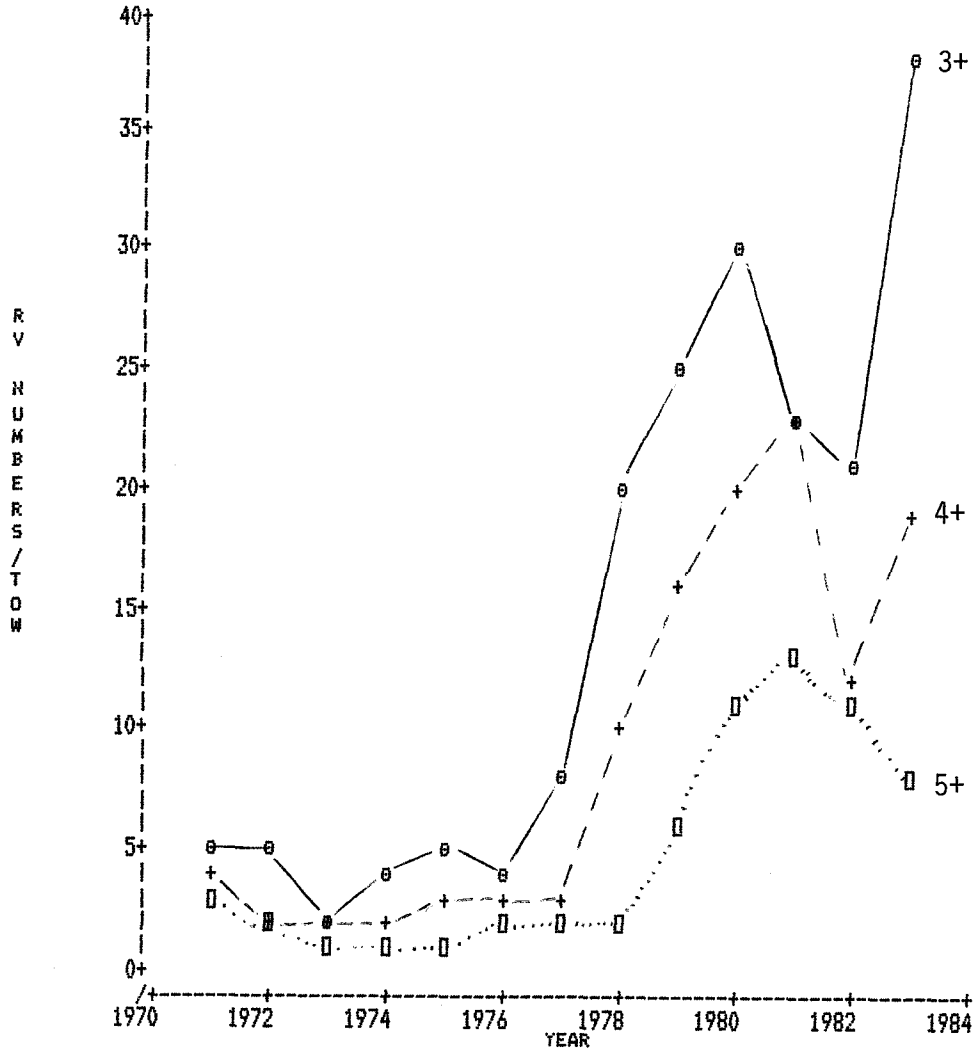


Figure 4. Trends in mean catch per tow at age for 4VW haddock in RV surveys averaged across years within cohorts (see text)

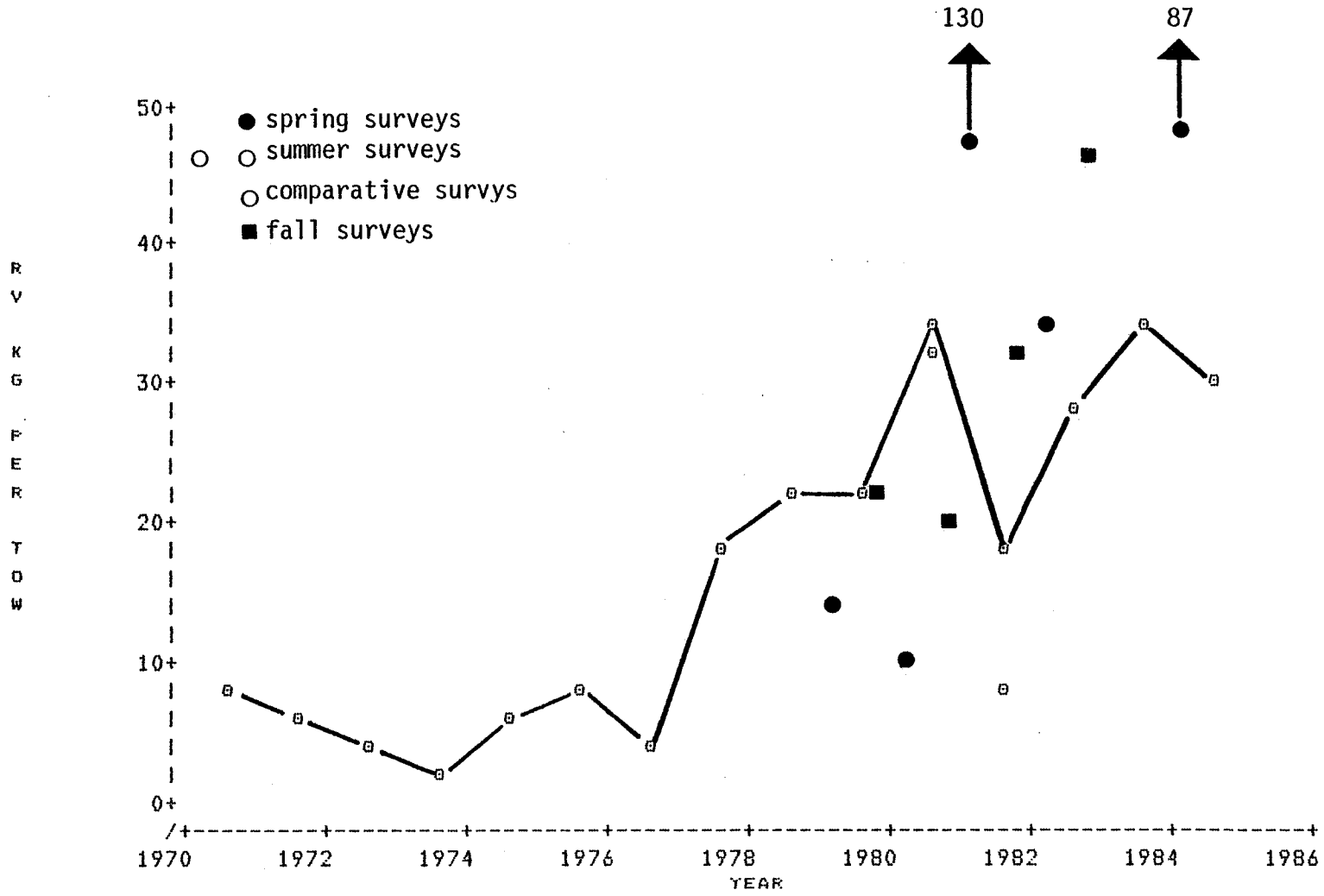
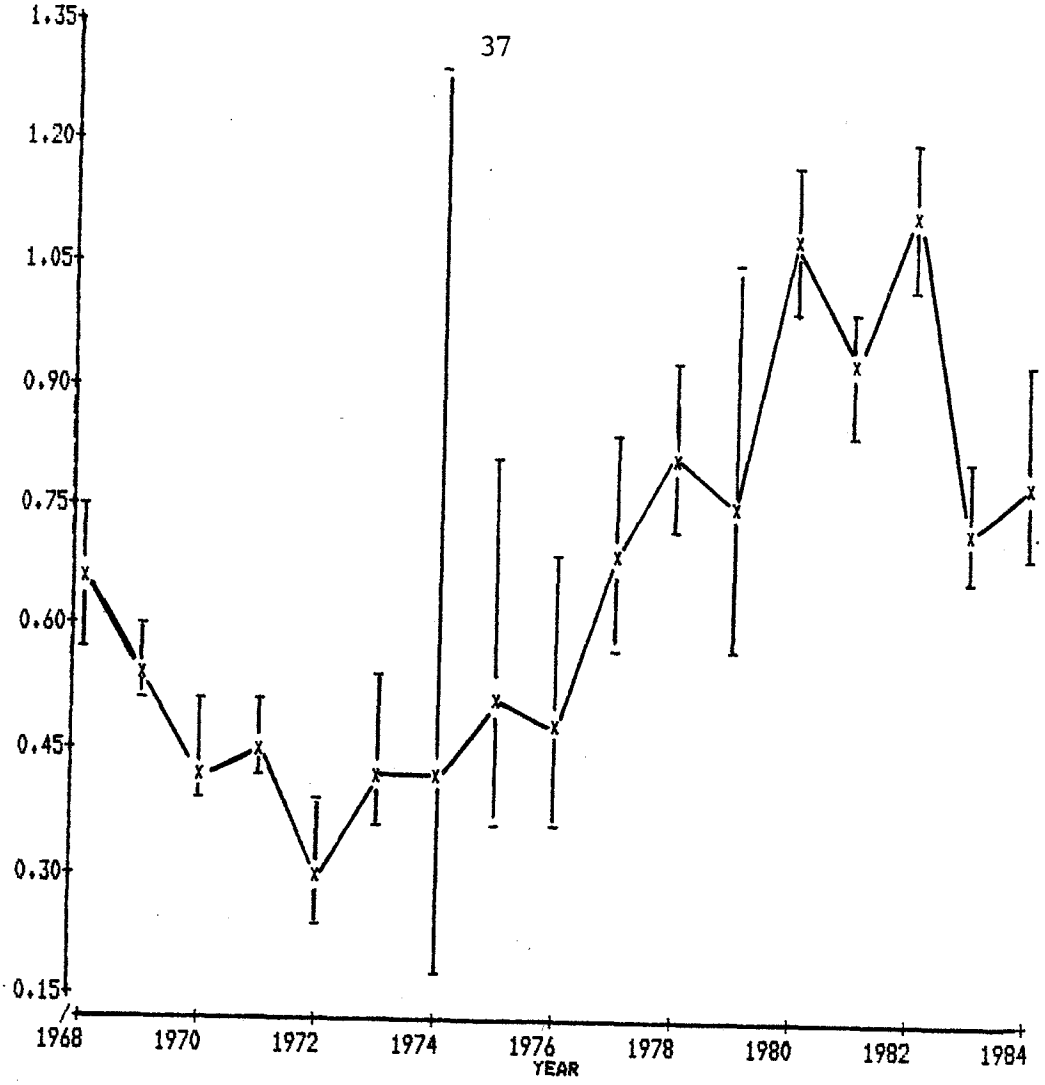


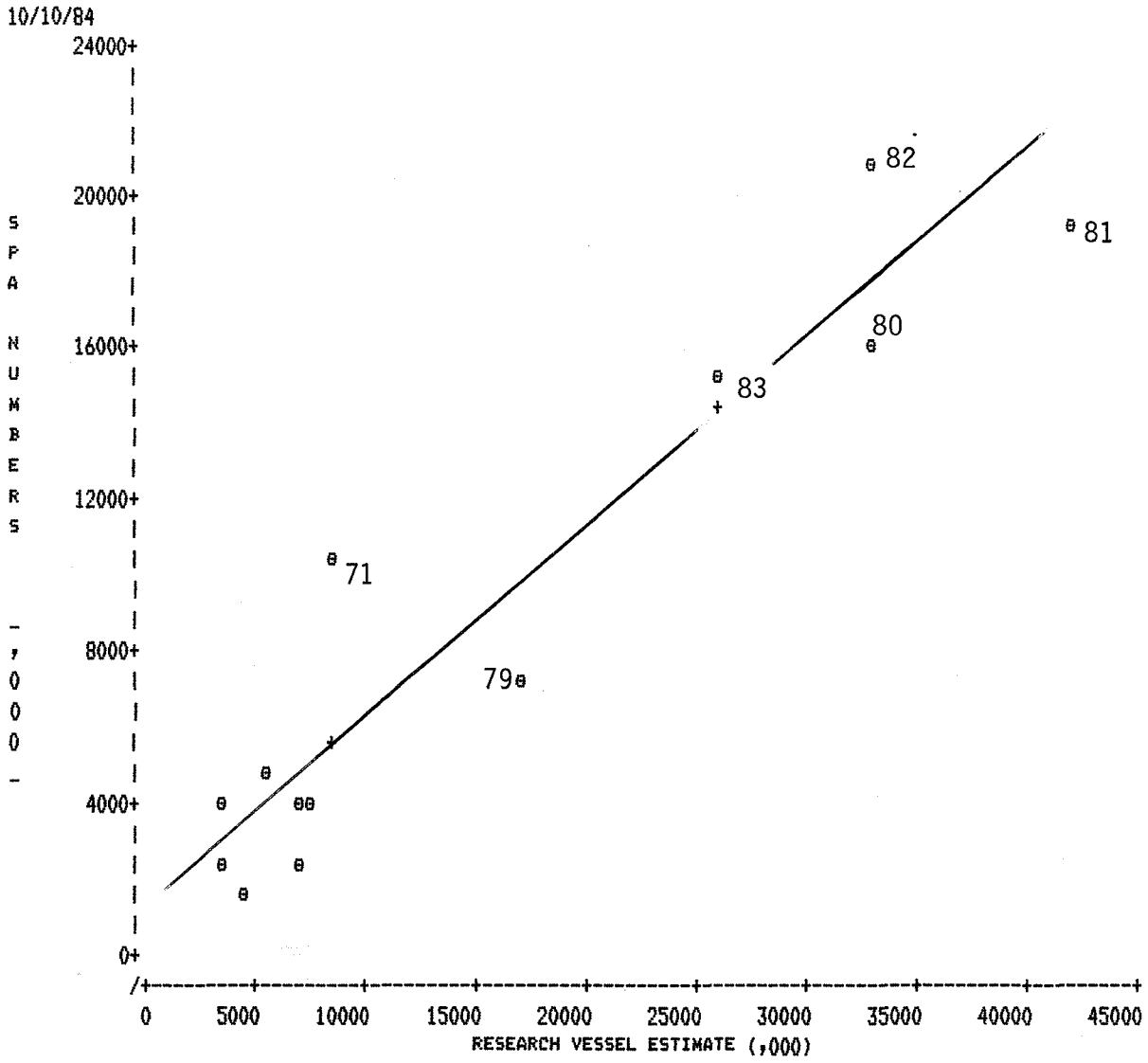
Figure 5. Trends in mean catch per tow (kg) of 4VW haddock in all RV surveys



YEAR	TOTAL CATCH	PROP.	CATCH RATE MEAN	S.E.	EFFORT
1968	13332	0.283	0.660	0.050	20206
1969	11323	0.404	0.550	0.036	20585
1970	9436	0.234	0.434	0.037	21759
1971	13469	0.346	0.459	0.030	29347
1972	4748	0.170	0.314	0.042	15119
1973	4414	0.212	0.431	0.053	10247
1974	2357	0.016	0.407	0.224	5797
1975	1869	0.131	0.523	0.126	3571
1976	1360	0.232	0.479	0.100	2842
1977	3248	0.395	0.684	0.077	4750
1978	5901	0.344	0.811	0.070	7276
1979	3433	0.125	0.760	0.139	4514
1980	14840	0.551	1.076	0.061	13786
1981	20009	0.443	0.918	0.043	21802
1982	15166	0.591	1.111	0.052	13650
1983	9393	0.462	0.728	0.043	12910
1984	5299	0.328	0.791	0.071	6702

AVERAGE C.V. FOR THE MEAN:0.131

Figure 6. The standardized catch rate and effort for 4VW haddock



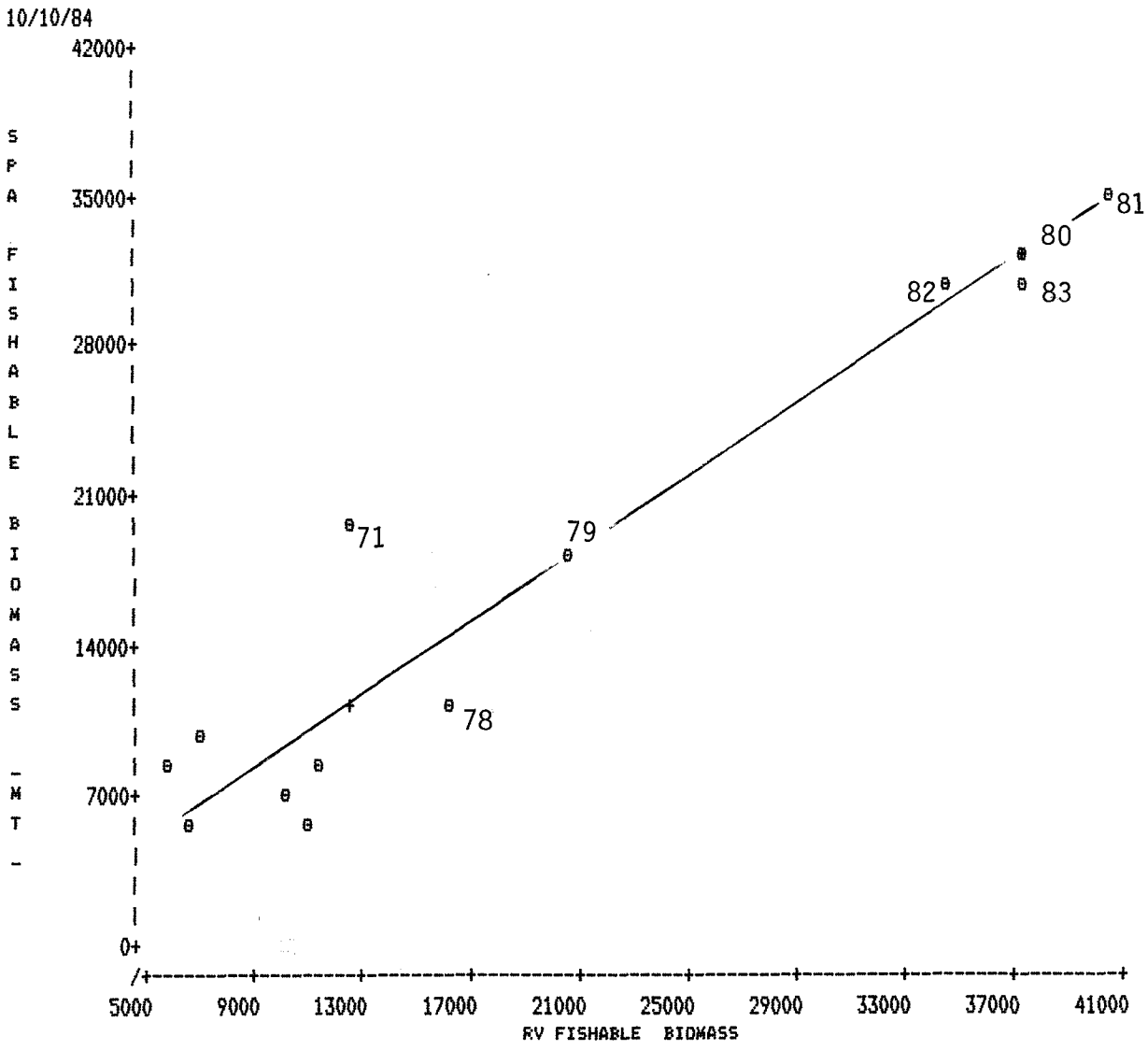
INTERCEPT = 1262 ; SLOPE = 0.487 ; R SQUARED = 0.8974

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
SPA	10418	5053	3611	2241	1935	2388	3842	3821	7467	16364	19568	20637	15361
RESEARCH	8302	5432	3348	3408	4473	6857	7436	7167	17213	32958	41816	33132	26190
ESTIMATE	5305	3907	2892	2922	3440	4601	4883	4753	9645	17313	21628	17398	14017
RESIDUALS	5112	1146	719	-680	-1505	-2213	-1041	-931	-2178	-950	-2059	3238	1343

FULLY RECRUITED F (AGES 6 PLUS)

0.570 1.299 0.835 1.409 0.861 0.415 0.502 0.583 0.712 0.230 0.609 0.893 0.740 0.400

FIGURE 7. SPA BEGINNING OF YEAR NUMBERS VS RV NUMBERS AVERAGED ACROSS YEARS (AGES 5+)



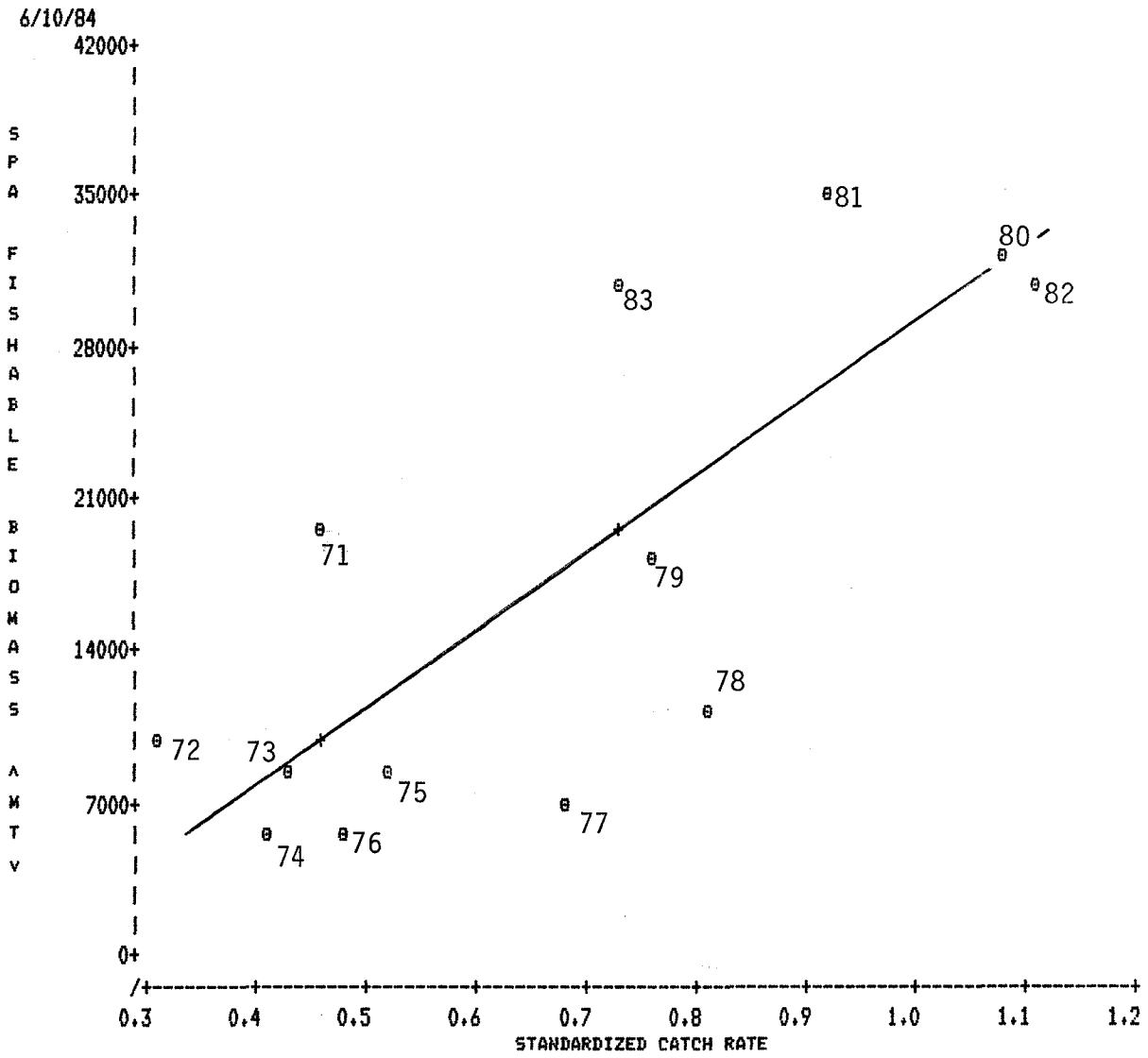
INTERCEPT = 1261 ; SLOPE = 0.814 ; R SQUARED = 0.9177

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
SPA	19495	9921	8105	4945	8105	5208	7412	11827	17966	32841	34406	30359	30520
FISHABLE B	12608	6856	5688	6678	11363	10921	10294	16070	20665	37365	40622	34717	37552
ESTIMATE	11528	6844	5893	6698	10514	10154	9643	14347	18089	31687	34340	29531	31840
RESIDUALS	7967	3077	2212	-1754	-2409	-4946	-2232	-2520	-123	1154	66	828	-1320

FULLY RECRUITED F(AGES 6 PLUS)

0.570 1.299 0.835 1.409 0.861 0.415 0.502 0.583 0.712 0.230 0.609 0.893 0.740 0.400

FIGURE 8 , SPA BEGINNING OF YEAR FISHABLE BIOMASS VS RV FISHABLE BIOMASS AVERAGED BETWEEN YEARS



INTERCEPT = -5754.81 ; SLOPE = 34011.930 ; R SQUARED = 0.6100

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
SPA	19495	9921	8105	4945	8105	5208	7412	11827	17966	32841	34406	30359	30520
CATCH RATE	0.46	0.31	0.43	0.41	0.52	0.48	0.68	0.81	0.76	1.08	0.92	1.11	0.73
ESTIMATE	9855	4927	8897	8075	12045	10521	17503	21831	20110	30857	25460	32035	18992
RESIDUALS	9640	4994	-792	-3130	-3941	-5313	-10091	-10005	-2144	1984	8946	-1676	11527

FULLY RECRUITED F(AGES 6 PLUS)

0.570 1.299 0.835 1.409 0.861 0.415 0.502 0.583 0.712 0.230 0.609 0.893 0.740 0.400

FIGURE 9. SPA FISHABLE BIOMASS VS STANDARDIZED COMMERCIAL CATCH RATE

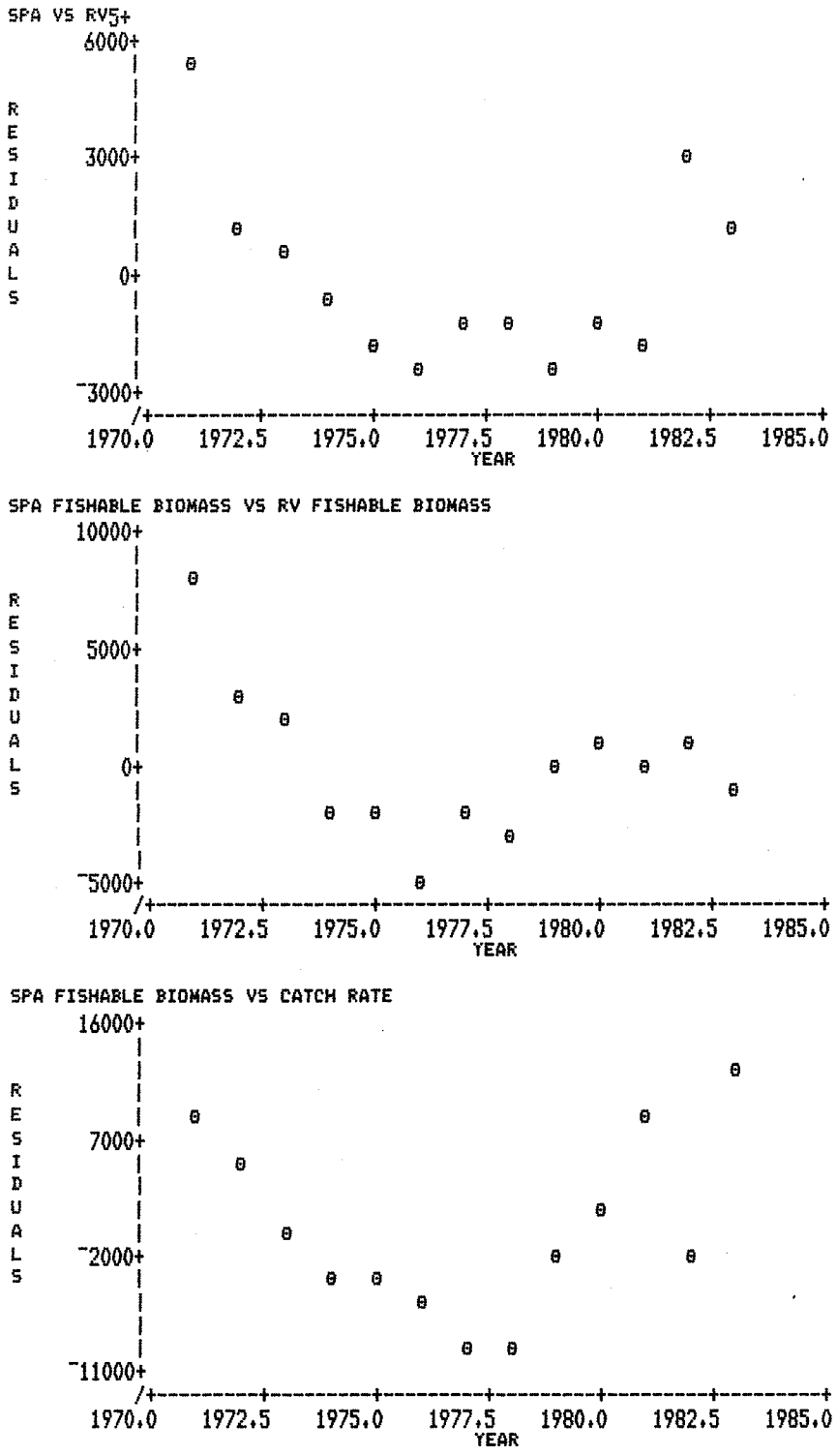


Figure 10. The time trends in the residuals of the relationships used in calibrating the cohort analysis

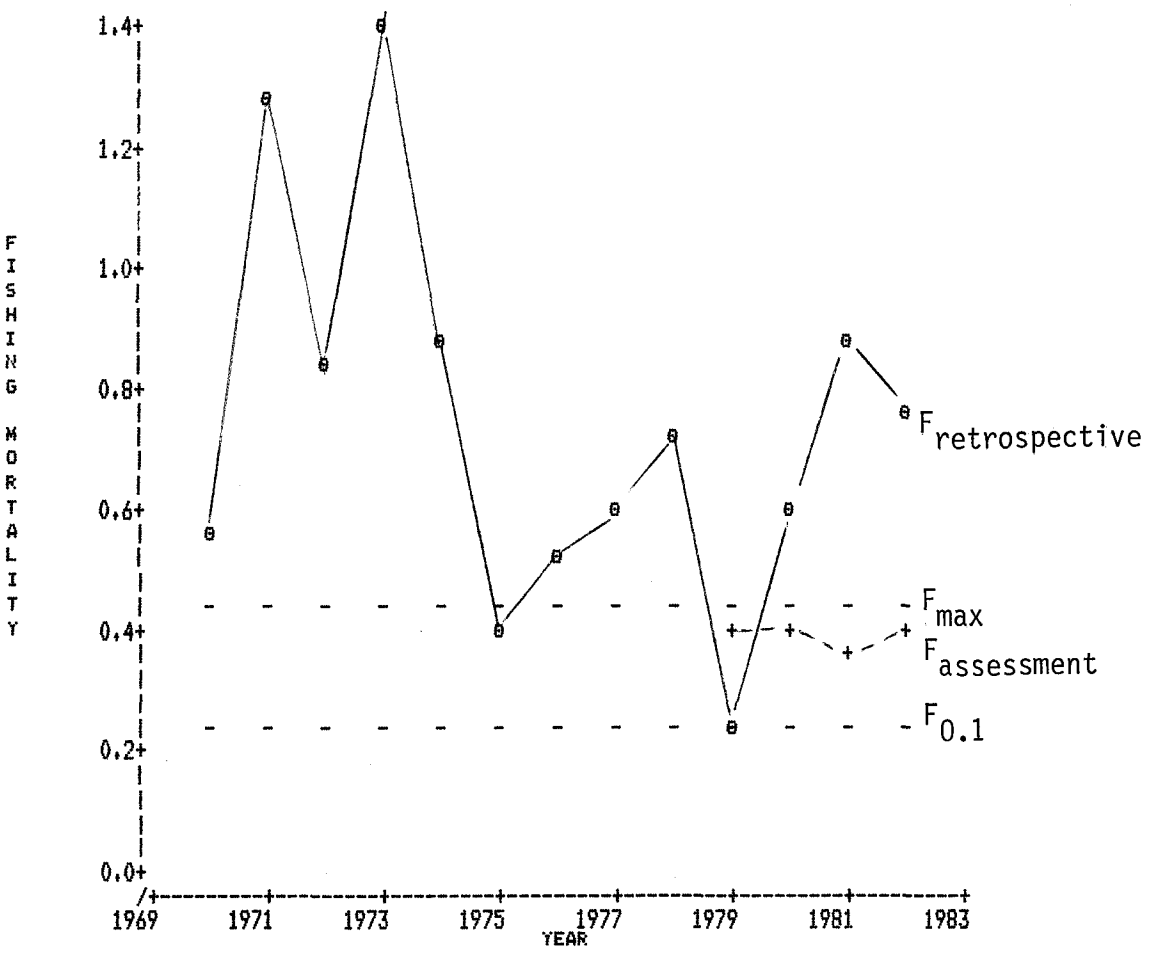


FIGURE 11. COMPARISON OF FISHING MORTALITY IN PAST YEARS WITH F MAX AND F 0.1