

4TVn (Jan-Apr) Cod Assessment

by

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Abstract

The seasonal distribution of the catch by gear type for this management unit was described. The catch was taken relatively evenly throughout the year. The total 4Vn catch between January and April was 18,231 t, 47% of which was taken by French vessels. The total catch in 4T between March and December was 39,039 t. The overall 1980 reported landings for this management unit (57,270 t) continued to increase after the historical low of 22,000 t recorded during 1977. A combined commercial catch rate index indicates minimum catch rates between 1974 to 1976 with a steady increase of approximately 150% to 1980. The research vessel survey data were re-analysed to produce log transformed population-at-age estimates as well as the routine stratified estimates. The total population estimate, by either method, has leveled off in 1980 subsequent to the strong increase since 1977. The survey indicates an uninterrupted series of good year-classes from 1973 to 1977. The catch numbers-at-age for 1979 and 1980 were generated using the appropriate commercial samples. The 4T coverage was particularly poor in 1980, the worst since 1975.

Estimates of population numbers from ages 3 to 9 at the end of 1980 were calculated using the survivor method. The mean fishing mortalities for ages 6 to 9 were 0.28 and 0.31 using respectively the transformed and untransformed survey data. VPA analyses were run using a mature F of 0.28 and an asymptotic partial recruitment vector (fully recruited at age 6). Partial recruitment at younger ages were adjusted using both the results of the survivor program (for ages 4 and 5) and a recruitment predictor (age 3). The VPA results were compared with both the combined commercial catch rate index and the research vessel population estimates. The correlations exceeded 0.94. The results indicate a reduction in partial recruitment at younger ages (3, 4 and 5) since the 1978 fishery. The year-classes from 1973 to 1977 inclusive have been exceptional, with that for 1977 almost double any year-class prior to 1973. The 5+ biomass is estimated to have climbed

to above 250,000 t. The 1982 projected yield at $F_{0.1}$ (0.2), assuming a catch of 53,000 t in 1981, is 65,000 t.

Résumé

La distribution saisonnière des prises par type d'engin dans cette unité de gestion montre une repartition relativement uniforme tout au long de l'année. Les prises totales dans la division 4Vn pour la période de janvier à avril ont atteint 18 231 t dont 47% ont été rapportées par la flotte française. Les prises totales dans la division 4T pour la période de mars à décembre furent de 39 039 t. Les débarquements totaux enregistrés en 1980 pour l'ensemble de l'unité de gestion (57 270 t) continuèrent à augmenter depuis le creux historique de 1977. L'indice combiné des taux de capture par la flotte commerciale indique un minimum entre 1974 et 1976 suivi d'une augmentation régulière jusqu'en 1980. Les données des relevés par les navires de recherche ont été analysées de nouveau pour donner des estimations de population par âge transformées sous forme logarithmique, ainsi que des estimations stratifiées routinières. L'estimation de population totale, obtenue par l'une ou l'autre méthode, a atteint un plateau en 1980 après la forte augmentation observée depuis 1977. Les relevés montrent une série ininterrompue d'importantes classes d'âge de 1973 à 1977. Des échantillons commerciaux appropriés ont permis de calculer les nombres par âge capturés en 1979 et 1980. La échantillonnage scientifique de 4T a été particulièrement pauvre en 1980, le pire depuis 1975.

On a fait appel à la méthode des survivants pour estimer les nombres de sujets d'âges 3 à 9 dans la population à la fin de 1980. Les mortalités moyennes par la pêche aux âges 6 à 9 étaient de 0,28 et 0,31, selon qu'on utilise respectivement les données transformées et non transformées des relevés. Des analyses de population virtuelle (APV) ont été effectuées avec un F d'âges pleinement recrutés de 0,28 et un vecteur de recrutement partiel asymptotique (plein recrutement à l'âge 6). Le recrutement partiel des âges plus jeunes a été ajusté en utilisant à la fois les résultats du programme SURVIVOR (pour les âges 4 et 5) et un indice de recrutement (âge 3). Les résultats de l'APV ont été comparés avec l'indice combiné des taux de capture commerciaux et les estimations de populations découlant des relevés par navire de recherche. Les indices de corrélations dépassent 0,94. Les résultats indiquent que le recrutement partiel des jeunes âges (3, 4 et 5) a diminué depuis 1978. Les classes d'âge de 1973 à 1977 ont été exceptionnelles, celle de 1977 étant presque le double de toute autre née avant 1973. On estime que la biomasse d'âge 5+ a bondi à plus de 250 000 t. Le rendement prévu pour 1982 avec un $F_{0.1} = 0,2$, à supposer des prises de 53 000 t en 1981, est de 65 000 t.

Catch Description

The catch was taken relatively evenly throughout the year, both within 4Vn during overwintering and on the Magdalen Shallows (4T) during the spring to autumn months (Fig. 1a).

The total catch in 4Vn between January and April was 18,231 t, the highest since 1975 (Fig. 2). The French vessels took 47%, with essentially all the remainder being taken by the larger Canadian otter trawls (tonnage classes 4 and 5). The total catch in 4T between March and December was 39,039 t, a slight decline in relation to 1979 but higher than any other year since 1973 (Fig. 2). The smaller otter trawls and Danish seines (tonnage classes 2 and 3) were the most important gear types in the 4T fishery but gillnets and hand and longlines accounted for approximately 20% of the catch (Fig. 1b). The overall 1980 reported landings for this management unit (57,270 t) continued to rise as the component stock(s) rebuild (Table 2, Fig. 2b). The TAC for 1980 was 54,000 t and this appears to have been exceeded by about 3,000 t. However, these landings statistics for 1980 are still preliminary particularly those for Quebec. The catches by gear-type for 1980 are shown in Table 1 (a,b,c), and the total annual catch since 1965 in Table 2.

Catch Per Unit Effort

The commercial CPUE indices that have been used in recent assessments were updated. The 4Vn indices calculated for Canadian otter trawls (tonnage classes 4 and 5) were high in 1980 but not as high as the somewhat anomalous 1978 values (Table 3a). Both indices for the Danish seiners, tonnage classes 2 and 3, increased to respectively 0.40 and 0.61 t/hour (Table 3b). The latter value is the highest in the time series. The otter trawl (tonnage class 3) CPUE was also high, but was a slight decrease from 1979 (Table 3a).

The trends since 1967 for the five commercial CPUE indices are shown in Figure 3. Although there is considerable year-to-year variability for any one series, the overall trend of increasing catch rates since 1978 is evident (with the exception of tonnage class 4 otter trawls in the winter fishery). The May to July indices within 4T were combined by taking an unweighted average of the three indices (Table 3c). Missing values were filled by averaging the nearest values. The combined index indicates minimum catch rates between 1974 to 1976 with a steady increase of approximately 150% to 1980.

The research vessel survey data was re-analysed to produce the routine stratified population-at-age estimates and log transformed estimates. The results are shown in Tables 4a and b. The total RV population abundance, by either method, has leveled off in 1980 subsequent to the strong increase since 1977. The 1977 year-class-at-age 3 is again by far the strongest in the time series, as was previously indicated in the 1979 survey. The Z values indicate some "availability" changes in the survey, being unrealistically low during

1978-79. The year-class strength indices (from 1970 to 1978) from the surveys are shown in Table 4c.

The survey estimates indicate an uninterrupted series of good year-classes from 1973 to 1977. The 1978 year-class (from the age 1+2 indices only) appears to be at best of moderate strength (ranking 4th or 9th in the respective series).

There is a good correspondence between the research vessel indices and the May to July commercial CPUE indices, with an r value as high as 0.99 between the combined index and the 4+ RV numbers. The winter fishery indices do not correlate well with either the summer CPUE indices or the RV population numbers. The trends since 1971 in the combined CPUE index and 4+ numbers (ln transformed) are shown in Figure 4.

Generation of Numbers-at-age in the Catch

The extent of the sampling of commercial landings since 1971 is summarized in Table 5. The coverage of the Canadian winter fishery (the large otter trawls) is relatively good, for example 17 samples representing less than 10,000 t in 1980. The catch by other gear components however is much less satisfactory. For example there is only a single sample representing the otter trawl catches in 4T between September and December, when a significant portion of the catch was taken. The 4T coverage was particularly bad in 1980, the worst since 1975.

The numbers-at-age for 1979 were re-generated. The new results indicate respectively an 86% and 10% increase in the age 4 and 5 fish in the catch relative to the previous assessment. The 1980 catches-at-age were generated on a quarterly basis by gear-type where possible. When not possible gear-types within a quarter were combined. The catch matrix from 1950 to 1980 is shown in Table 6. The 1950 to 1977 numbers were taken from Lett (1978) and the 1978 numbers from Gray (1979). Eighty-seven percent of the 1980 catch comprised the 1973 to 1975 year-classes. Thus if the sampling is adequate the strong 1976 and 1977 year-classes (as indicated by the RV survey) are not being selected for by the overall fishery.

Survivor

Estimates of the population numbers, from age 3 to 9, were derived using both the routine RV population estimates (Table 4a) and the log transformed estimates in the "survivor" program (Rivard 1980). The results are summarized in Tables 7a and b. The calibration block excluded the 1980 and the age 9 vectors. The coefficients of variation were relatively low using both RV survey matrices. The major difference between the two survivor runs is the relative strength of the 1975 year-class, 110 million using the untransformed data and 80 million using the transformed. There were only two outliers in the

residuals in each of the runs. The mean fishing mortalities for ages 6 to 9 were respectively 0.28 and 0.31 for the "transformed" and "untransformed" cases. These values compare favorably with the 1979-80 Z estimates shown in Tables 4a, b.

VPA Input Parameters

The initial partial recruitment vector (Table 8) was calculated from the fishing mortalities-at-age generated from survivor (i.e F at age 3, 4 and 5 divided by average of F's for ages 6 to 9). This assumes an asymptotic PR vector. The Fs for older ages were estimated by iteration using the average F each year of ages 6 to 12. The fully recruited F for 1980 was that estimated from the "survivor" run using the transformed RV survey population estimates. Natural mortality was 0.2. The weights-at-age for 1980 are shown in Table 8. The time series of weights-at-age for the winter fishery from 1950 to 1980 are shown in Table 9. The values from 1950 to 1977 were taken from Lett (1978), for 1978 from Gray (1979) and for 1979 and 1980 from this year's catch-at-age analysis.

VPA Results

The results of the VPA run using the above input parameters are shown in Tables 10a, b, and c. The VPA 4+ populations numbers in relation to the log transformed and untransformed RV population estimates are shown in Fig. 5. There is the suggestion of curvilinearity in the relationships, and the 1978 VPA population estimate is high in relation to the survey estimates. The relationship between 5+ VPA and the log transformed RV 5+ numbers looks linear, but again the VPA 1978 5+ estimates is relatively high (Fig. 6). The correlations for all four comparisons exceed 0.94. Fishable biomass (partial recruitment x mid-year population biomass) is related to the combined May to July CPUE index in Figure 7. There is not a suggestion of curvilinearity in this case. The VPA year-class strengths from 1970 to 1976 are compared to the two age 1+2+3 RV survey recruitment indices in Figure 8. There is a considerably tighter relationship using the log transformed index. The GM regressions are:

$$Y = 9814 + 2.20 X \quad r = 0.88 \text{ (untransformed survey)}$$

$$Y = -16,692 + 9.96 X \quad r = 0.96 \text{ (transformed survey)}$$

The predicted sizes of the 1977 year-class are respectively 254 and 264 million. The other index (RV age 1+2), which permits prediction of the 1978 year-class, was also considered. The relationships between these RV indices and VPA year-class strengths (Fig. 9) were weaker.

The GM regressions are:

$$Y = 16.84 + 0.00748 X, r = 0.80 \text{ (untransformed survey)}$$

$$Y = 24.67 + 0.0239 X, r = 0.69 \text{ (transformed survey)}$$

where X is VPA estimate of year-class strength at age 3 ($\times 10^{-3}$) and Y is the appropriate RV index ($\times 10^{-1}$). The predictions for the 1977 and 1978 year-classes in millions are:

	<u>1977</u>	<u>1978</u>
Regression 1.	363	89
Regression 2.	201	127

The predicted value for the 1977 year-class from the log transformed RV age 1+2+3 indice regression (264×10^6) was chosen. This results in a reduction of the partial recruitment at age 3 from 0.01 to 0.0036. The suggested changes in partial recruitment over the past three assessments are:

<u>Age</u>	<u>Gray (1979)</u>	<u>Beacham (1980)</u>	<u>Survivor</u>	<u>This VPA</u>
3	0.02	0.005	0.01	0.004
4	0.40	0.07	0.08	0.08
5	0.75	0.80	0.54	0.54
6+	1	1	1	1

The year-class strengths from 1947 to 1978 as well as the 5+ population biomasses from 1950 to 1980 are shown in Figure 10. This assessment indicates that the year-classes from 1973 to 1977 inclusive have been exceptional, with that for 1977 almost double any year-class prior to 1973. The 5+ biomass is estimated to have climbed to above, 250,000 t in 1979, reaching the levels estimated in the early 60's but still considerably below the peak values estimated for the mid 50's.

Yield Per Recruit

A Thompson-Bell yield per recruit analysis was carried out using both the present weight-at-age and PR conditions as well as more "average" conditions. The following input values were considered:

Age	RUN 1		RUN 2		RUN 3	
	Wt ¹	PR ³	Wt ²	PR ³	Wt ²	Pr ⁴
3	0.54	0.004	0.25	0.004	0.025	0.02
4	0.69	0.08	0.72	0.08	0.72	0.40
5	0.90	0.54	0.98	0.54	0.98	0.75
6	1.20	1	1.31	1	1.31	1
7	1.51	1	1.71	1	1.71	1
8	2.65	1	2.21	1	2.21	1
9	3.13	1	2.64	1	2.64	1
10	4.15	1	3.24	1	3.24	1
11	8.27	1	3.72	1	3.72	1
12	6.40	1	4.41	1	4.41	1
13	11.11	1	6.25	1	6.25	1
14	5.52	1	6.52	1	6.52	1
15	10.10	1	7.23	1	7.23	1

$$F_{0.1} = 0.177$$

$$F_{0.1} = 0.215$$

$$F_{0.1} = 0.201$$

- 1 1980 mean weights-at-age for the overall fishery
- 2 1950 to 1980 mean weights-at-age for the winter fishery (4Vn)
- 3 Final partial recruitments in this assessment
- 4 Partial recruitment used by Gray (1979) representing a period of low adult biomass.

Run 1 represents present conditions to the degree that the present analysis is correct. Runs 2 and 3 represent long-term average weight-at-age distributions and two extremes in the partial recruitment pattern. The 1979 and 1980 assessments used $F_{0.1}$ values of respectively 0.200 and 0.195.

Projections

A three year projection was run. The input parameters were:

- (i) the 1977 year-class set at 175×10^6 fish (the highest on record but lower than the VPA estimate)
- (ii) weights-at-age as estimated for the 1980 overall fishery
- (iii) partial recruitment estimated for the 1980 fishery
- (iv) the 1978 and 1979 year-classes equal to the geometric mean of VPA estimated 1964 to 1976 year-class strengths (78.5 million)

Assuming the 1981 TAC of 53,000 t is taken, the catch at $F_{0.1} = 0.20$ in 1982 is calculated to be 65,000 t (Table 11).

References

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Table 1a. 4TVn Cod Catch during 1980 in 4T

Gear Type	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
<u>MARITIMES AND NFLD.</u>													
Fixed gillnets	-	-	-	4	167	346	626	648	343	272	83	-	2489
Drift gillnets	-	-	-	-	7	11	3	6	2	17	-	-	46
Handlines	-	-	-	-	73	160	127	119	57	77	106	2	721
Longlines	-	-	-	3	50	40	51	45	86	115	181	54	625
Traps	-	-	-	-	8	22	4	29	1	-	-	-	64
Misc & unknown	-	-	-	-	96	22	46	95	61	38	13	-	371
Otter trawls (side)	407	-	-	646	612	117	72	94	322	560	336	496	3662
Otter trawls (stern)	-	-	-	162	430	43	110	83	66	202	269	319	1684
Purse-seine	-	-	-	-	-	16	-	-	-	-	-	-	16
Pair-seine	-	-	-	66	77	127	23	-	-	-	6	-	299
Danish-seine	15	-	-	195	2033	1159	650	1022	464	703	1666	745	8652
Scottish-seine	-	-	-	-	269	180	107	150	37	84	122	3	952
<u>Maritimes and Nfld</u>													
<u>TOTAL</u>	422	-	-	1076	3822	2243	1819	2291	1439	2068	2782	1619	19581
<u>QUEBEC</u>													
Inshore	-	-	-	-	-	-	-	-	-	-	-	-	8346
Offshore	-	-	-	-	-	-	-	-	-	-	-	-	11112
Quebec Total	-	-	-	-	-	-	-	-	-	-	-	-	19458
												Total combined	39039

Table 1b. 4TVn Cod Offshore Landings by Quebec Vessels during 1980.

Gear-type	J	F	M	A	M	J	J	A	S	O	N	D	Gear Totals
Gillnets (set)					237	382	355	408	263	61			1706
Shrimp trawl				3	12	9	15	23	16	40	8		126
Otter trawl (side)			16	57	1222	2025	1575	870	853	1214	629		8461
Otter trawl (stern)					38	86	75	27	32	35			293
Longlines					17	17	40	20	97	159	43		393
Danish seine							13	26	8	2			49
Mid-water trawl				63			6	15					84
Monthly Totals			16	123	1526	2519	2079	1389	1269	1511	680		11,112

Table 1c. Catch of 4TVn Cod in 4Vn between January and April 1980.

Gear Type	January	February	March	April	Gear Totals
Handlines	2	-	-	-	2
Longlines	58	106	12	250	426
Otter trawls (side)	963	1863	27	28	2881
Otter trawls (stern)	3553	2529	68	115	6265
Danish seine	-	-	-	7	7
Canadian Totals	4576	4498	107	400	9581
French (all gears)	598	3584	2790	1678	8650
Combined Totals	5174	8082	2897	2078	18,231

Table 2. 4TVn Cod Total Catch 1965 to 1980.

<u>YEAR</u>	<u>CATCH (t)</u>	<u>TAC(t)</u>
1965	63027	-
66	54851	-
67	41314	-
68	46551	-
69	47819	-
70	64459	-
71	56375	-
72	65291	-
73	49608	-
74	47255	63000
75	41231	50000
76	32729	30000
77	22219	15000
78	37880	38000
79	51202	46000
80	57270	54000

Table 3a. 4TVn cod catch per unit effort (t/hr) by Canadian Otter Trawlers

YEAR	<u>Directed Trips (May-July)</u>			<u>Directed Trips (Jan-Mar)</u>					
	<u>TC 3</u>			<u>TC4</u>			<u>TC5</u>		
	C	E	C/E	C	E	C/E	C	E	C/E
1967	1654	7436	0.22	2918	3322	0.88	388	371	1.05
1968	1603	7001	0.23	4835	4525	1.07	160	133	1.20
1969	1824	7209	0.25	6019	6060	0.99	1743	1289	1.35
1970	2491	9618	0.26	5888	5995	0.98	2517	1981	1.26
1971	3312	12786	0.26	4130	5695	0.73	2321	2495	0.93
1972	4433	15748	0.28	4902	5225	0.94	3689	3582	1.03
1973	1570	9164	0.17	2924	3991	0.73	2678	2918	0.92
1974	371	4211	0.09	3664	5444	0.67	3967	5355	0.75
1975	1981	9924	0.20	2370	3108	0.76	3519	4456	0.79
1976	707	4631	0.15	5919	6752	0.88	6395	6914	0.92
1977	1396	7428	0.19	940	1692	0.56	1332	2277	0.59
1978	2747	11009	0.25	4458	3219	1.38	4084	2010	2.03
1979	1512	2228	0.68	1168	1820	0.64	3151	2406	1.31
1980	483	865	0.56	3124	2689	1.16	4397	2223	1.98

Table 3b. 4TVn cod catch per unit effort for Canadian Danish Seiners

	Directed trips (May, June, July)					
	TC2 (t/hr)			TC3 (t/hr)		
	C	E	C/E	C	E	C/E
1967	1290	6505	0.20	20	56	0.36
1968	486	2701	0.18	-	-	-
1969	55	127	0.43	63	191	0.33
1970	343	1615	0.21	93	259	0.36
1971	505	4286	0.12	90	221	0.41
1972	292	1232	0.24	153	476	0.32
1973	135	474	0.28	165	481	0.34
1974	-	-	-	-	-	-
1975	-	-	-	-	-	-
1976	-	-	-	268	1507	0.18
1977	20	226	0.29	561	2488	0.23
1978	405	1422	0.28	1580	4442	0.36
1979	402	1530	0.26	2409	4954	0.49
1980	531	1338	0.40	2937	4828	0.61

Table 3c. Combined CPUE series for otter trawls (tonnage class 3) and Danish seiners during May to July in 4T.

<u>YEAR</u>	<u>CPUE (t/hr)</u>
1967	0.29
1968	0.25
1969	0.34
1970	0.28
1971	0.26
1972	0.28
1973	0.26
1974	0.22
1975	0.24
1976	0.21
1977	0.24
1978	0.30
1979	0.48
1980	0.52

Table 4a. Research vessel survey numbers-at-age (Stratified estimates), 4TVn Cod.

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	119	1523	146	175	882	6117	1105	2365	337	1977
2	1149	4393	9522	4794	12259	15935	20631	9707	43878	9329
3	12509	8888	18796	19768	9132	63330	30614	43924	44533	64773
4	15132	25099	8727	14661	14544	16009	25812	47326	94436	48644
5	14336	9494	13775	5638	11835	10605	10104	26747	57620	84681
6	11229	8459	6555	6622	4100	4589	5359	8141	23494	41570
7	6980	6110	4613	2867	2949	1334	3057	4593	6135	14994
8	1728	3098	3528	2029	2001	878	1316	1570	2518	2495
9	355	639	2235	2343	911	495	969	628	1259	1211
10	382	530	611	748	648	390	622	785	336	506
11	219	296	146	401	771	424	504	911	371	122
12	128	191	462	192	199	109	405	110	616	25
13+	633	208	440	700	92	192	614	301	0	74
TOTAL ¹	64891	68922	69550	60932	60318	120400	101105	147102	275528	270394
4+	51116	54119	41087	36196	38047	35020	48756	91107	186781	194317
5+	35985	29020	32361	21536	23503	19011	22945	43782	92346	145674
6+	21649	19527	18586	15898	11669	8407	12842	17035	34727	60994
7+	10421	11069	12032	9277	7569	3818	7483	8895	11233	19424
	71/2	72/3	73/4	74/5	75/6	76/7	77/8	78/9	79/80	
Z 4+/5+	0.57	0.51	0.65	0.43	0.69	0.42	0.11	-0.01	0.25	
Z 5+/6+	0.61	0.45	0.71	0.61	1.03	0.39	0.30	0.23	0.41	
Z 6+/7+	0.67	0.48	0.69	0.74	1.12	0.12	0.37	0.42	0.58	

¹ The numbers-at-age have been rounded downwards such that the column totals do not equal the sum of the individual estimates.

Table 4b. Research vessel survey numbers-at-age (\ln transformed stratified estimates) 4TVn Cod.

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	85	396	107	102	309	1229	550	597	215	816
2	655	1157	2979	1850	2053	4567	7036	2610	6776	4075
3	6777	3736	5827	5733	2922	11546	13508	10827	13346	20809
4	7070	10353	3748	5581	6108	5114	12624	15304	36057	20532
5	6336	4265	5361	3283	5727	3991	5067	9280	27306	34586
6	5181	3979	3052	3819	2260	2170	2894	3522	13584	19690
7	3701	3231	2284	1825	1783	825	1710	2290	4309	8390
8	1238	1847	1943	1391	1289	590	817	989	1904	1729
9	294	511	1316	1603	679	376	663	424	979	870
10	287	412	450	591	486	298	412	500	253	379
11	175	253	128	340	532	315	358	418	308	106
12	122	167	334	158	170	96	305	82	465	23
13+	479	144	333	536	75	155	380	206	0	63
TOTAL ¹	32395	30444	27856	26806	24387	31268	46317	47042	105497	112062
4+	24879	25157	18945	19122	19104	13927	25224	33009	85162	86363
5+	17809	14804	15198	13542	12996	8813	12601	17706	49105	65832
6+	11474	10540	9837	10259	7270	4822	7535	8426	21799	31247
7+	6293	6562	6785	6441	5011	2653	4641	4905	8216	11557
		<u>71/2</u>	<u>72/3</u>	<u>73/4</u>	<u>74/5</u>	<u>75/6</u>	<u>76/7</u>	<u>77/8</u>	<u>78/9</u>	<u>79/80</u>
Σ 4+/5+		0.52	0.50	0.34	0.39	0.77	0.10	0.35	-0.40	0.26
Σ 5+/6+		0.52	0.41	0.39	0.62	0.99	0.16	0.40	-0.21	0.45
Σ 6+/7+		0.56	0.44	0.42	0.72	1.01	0.04	0.43	0.03	0.63

¹ The numbers-at-age have been rounded downwards such that the column totals do not equal the sum of the individual estimates.

Table 4c. Recruitment indices from the research vessel survey, 4TVn Cod

<u>Stratified estimates</u>		
<u>Year-class</u>	<u>Ages (1 + 2)</u>	<u>Ages (1 + 2 + 3)</u>
1970	4512	23308
1971	11045	30813
1972	4940	14072
1973	12434	75764
1974	16817	47431
1975	26748	70672
1976	10812	55345
1977	46243	111016
1978	9666	-
<u>ln transformed estimates</u>		
1970	1242	7069
1971	3375	9108
1972	1957	4879
1973	2155	13701
1974	4876	18384
1975	8265	19092
1976	3160	16506
1977	7373	28182
1978	4290	-

Table 4d. Correlations between catch-rate indices for 4TVn Cod (1971 to 1980)

	Otter Trawl (3)	Otter Trawl (4)	Otter Trawl (5)	RV 4+	RV(ln) 4+	RV 5+	RV (ln) 5+
Combined May to July Indice	0.96	0.29	0.75	0.99	0.99	0.97	0.98
Otter trawl (3) May to July		0.15	0.65	0.95	0.96	0.87	0.91
Otter trawl (4) Jan to Mar			0.81	0.31	0.21	0.36	0.25
Otter trawl (5) Jan to Mar				0.78	0.70	0.75	0.70

Table 5. Extent of Canadian sampling of commercial landings of cod in Division 4T and Subdivision 4Vn (Jan-Apr) 1971-80.

Year	Jan - April Trawl			May - August Trawl			September-December Trawl			No. of Samples	Seine		No. of Samples	Line		Gillnet		
	No. of samples	Number measured	No. Aged	No. of Samples	Number measured	No. Aged	No. of Samples	Number Measured	No. Aged		Number Measured	No. Aged		Number Measured	No. Aged	No. of Samples	Number Measured	No. Aged
1971	6	1780	280	4	785	133	1	200	38	8	1898	254	1	142	38	2	179	58
1972	7	2360	334	7	1574	255	4	887	137	5	1248	160	1	200	0	2	400	90
1973	7	2161	320	4	801	151	5	1107	177	3	600	107	3	577	80	10	1841	516
1974	15	4849	711	3	700	117	4	894	126	3	600	109	0	0	0	8	1552	316
1975	13	4191	697	10	1855	361	5	1659	233	3	538	88	2	400	85	7	1313	254
1976	18	6166	884	12	2929	523	1	78	23	22	4468	755	11	2188	440	7	1212	270
1977	4	1163	203	11	2217	377	6	1205	202	35	7076	1219	15	2871	592	6	1227	256
1978	12	3855	497	12	2212	407	2	431	66	24	4809	843	6	1200	183	3	580	101
1979	12	3866	457	9	1799	307	13	3435	496	21	4231	697	12	2400	455	4	736	159
1980	17	5315	693	5	1012	78	1	217	36	9	1819	265	1	200	32	3	482	98

Table 6. 4TVn cod catch matrix (1950 to 1980)

	<u>50</u>	<u>CATMAT</u>	<u>53</u>	<u>54</u>	<u>55</u>	<u>56</u>	<u>57</u>	<u>58</u>	<u>59</u>	<u>60</u>	<u>61</u>	<u>62</u>	<u>63</u>	<u>64</u>	<u>65</u>	<u>66</u>	<u>67</u>	<u>68</u>	<u>69</u>	<u>70</u>	<u>71</u>	<u>72</u>	<u>73</u>	<u>74</u>	<u>75</u>	<u>76</u>	<u>77</u>	<u>78</u>	<u>79</u>	<u>80</u>	
3	173	133	192	294	412	324	396	359	506	535	75	1	16	255	100	464	1498	700	310	327	26	2	1541	378	1229	2379	332	547	370	131	332
4	728	638	1034	2120	2968	2336	2372	2372	3341	3535	3967	3304	1720	2123	970	5504	7055	7068	8140	4936	3395	2476	14294	4396	3170	9902	4059	2733	9779	4664	2548
5	1559	1462	1915	5596	7832	6165	6727	6109	8607	9107	8983	13921	10887	4352	6728	6148	10689	5503	8086	12530	14972	7313	11326	11878	3862	6096	9089	3134	9743	15527	14376
6	2703	2113	3104	5037	7049	5549	6648	6037	8606	9000	12515	9475	1889	16021	5863	9292	4505	4586	4674	3571	11925	8941	7193	5982	9851	2350	4996	2266	4804	10824	13379
7	2772	2127	3065	4713	6596	5191	6331	5750	8101	8571	7144	8313	7870	14742	12038	4481	3423	3040	2916	2516	4194	6127	8479	4492	3631	3173	1513	1496	2519	3500	9539
8	2495	1874	2643	3799	5319	4186	5223	4743	6683	7071	1736	2661	4290	6390	9261	8524	1841	1735	1276	2136	1905	2567	5128	3455	2188	1250	834	400	1021	1781	1649
9	3327	2365	3141	3593	5029	3959	5381	4887	6885	7286	795	777	1480	3180	3760	5534	2262	407	753	917	1444	1237	1370	2204	2081	1033	423	269	216	880	808
10	2183	1582	2146	2680	3751	2952	3878	3522	4961	5250	1812	506	589	984	1133	1845	1890	1021	434	785	727	554	719	740	1186	738	220	193	258	344	400
11	901	638	843	942	1319	1038	1424	1293	1823	1929	388	741	153	392	347	1004	867	901	899	212	569	156	452	380	300	571	143	107	103	230	241
12	478	351	483	636	890	701	902	819	1153	1221	279	385	178	137	149	423	357	383	698	283	360	432	127	130	178	113	106	59	165	68	37
13	138	106	153	235	329	259	316	287	405	428	76	188	37	102	103	150	242	171	259	292	239	42	92	63	74	47	34	43	36	54	29
14	128	94	130	173	243	191	245	222	314	332	93	174	26	37	88	52	76	82	139	55	139	103	34	35	26	40	17	8	5	9	9
15	79	58	80	106	148	117	150	136	192	203	51	33	36	50	24	124	42	23	65	21	30	144	72	14	4	5	11	2	7	17	20

Table 7(a). Results of "surviyor" using the untransformed stratified research vessel survey estimates of population numbers-at-age.

<u>Estimated survivors for 1980 (weighted)</u>				
Age	Survivors	CV%	F (1980)	\bar{F} (fully recruited)
3	213554	30	0.0014	
4	106688	22	0.021	
5	110140	21	0.111	
6	45221	23	0.236	
7	17913	26	0.391	0.31
8	3927	26	0.320	
9	2040	25	0.305	

Residuals (outliers are in brackets)

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	-0.395	0.234	0.606	0.344	-0.274	(0.806)	-0.302	-0.266	0.098	-0.000
4	-0.074	0.166	0.090	0.146	-0.097	0.107	-0.342	-0.093	0.246	-0.070
5	0.025	-0.207	0.013	0.035	0.226	0.020	-0.130	-0.122	0.326	0.299
6	-0.217	0.024	0.121	0.038	0.278	-0.145	-0.127	0.062	0.152	0.406
7	-0.108	-0.217	0.090	0.073	0.195	-0.243	0.035	0.157	0.321	0.218
8	-0.045	-0.230	-0.032	0.011	(0.569)	-0.254	0.291	-0.174	0.102	-0.015
9	-0.001	0.020	0.329	0.275	-0.393	-0.139	0.340	-0.068	0.124	-0.074

Table 7(b). Results of "survivor" using the ln transformed stratified research vessel survey estimates of population numbers-at-age.

<u>Estimated survivors for 1980 (weighted)</u>				
Age	Survivors	CV%	F(1980)	\bar{F} (fully recruited)
3	200856	28	0.0015	
4	105482	21	0.022	
5	80094	21	0.150	
6	46887	22	0.229	
7	17230	26	0.403	
8	4515	26	0.284	0.28
9	2958	22	0.220	

Residuals (outliers are in brackets)

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	0.028	0.356	0.423	0.116	-0.378	0.195	-0.067	-0.321	-0.021	0.000
4	0.053	0.178	0.089	0.042	-0.094	-0.135	-0.098	-0.302	0.501	0.021
5	-0.110	-0.315	-0.232	0.127	0.164	-0.296	-0.107	-0.400	0.315	0.462
6	-0.292	-0.077	0.007	0.143	0.264	-0.271	-0.119	-0.074	0.388	0.389
7	-0.094	-0.186	-0.020	0.192	0.238	-0.220	0.017	0.052	(0.646)	0.430
8	0.086	-0.164	-0.022	0.121	(0.550)	-0.240	0.228	-0.124	0.350	0.263
9	0.000	-0.040	0.233	0.410	-0.008	-0.160	0.275	-0.105	0.304	0.038

Table 8. Weights-at-age and partial recruitments for the 1980 4TYn Cod Fishery.

Age	Weights-at-age (kg)		4TVn Overall Fishery	Research Vessel Cruise	Partial Recruitment Vector
	4Vn Jan-April Samples	4T May-Aug. Samples (Otter Trawls)			
1	-	-	-	0.03	-
2	-	-	-	0.11	-
3	0.65	0.68	0.54	0.35	0.01
4	0.71	0.77	0.69	0.61	0.08
5	0.85	0.99	0.90	0.95	0.54
6	1.17	1.23	1.20	1.24	1.00
7	1.47	1.50	1.51	1.61	1.00
8	2.38	2.73	2.65	2.95	1.00
9	2.68	4.14	3.13	3.69	1.00
10	2.91	2.75	4.15	4.57	1.00
11	3.99	-	8.27	5.57	1.00
12	3.67	-	6.40	6.05	1.00
13	6.51	-	11.11	9.84	1.00
14	9.26	-	5.52	10.52	1.00
15	5.66	-	10.10	7.69	1.00
16	13.11	-	10.42	4.53	1.00

Table 9. January weights-at-age from 1950 to 1980 (estimated from 4Vn 1st quarter commercial samples).

Age	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
3	0.22	0.22	0.22	0.22	0.22	0.24	0.24	0.21	0.21	0.2	0.21	0.18	0.18	0.21	0.2	0.22	0.22	0.19	0.21	0.26	0.23	0.23	0.25	0.3	0.27	0.38	0.27	0.23	0.34	0.47	0.65
4	1.02	0.97	0.87	0.91	0.79	1.11	0.93	0.98	0.9	0.83	0.7	0.77	0.69	0.63	0.65	0.77	0.73	0.63	0.67	0.55	0.47	0.43	0.52	0.53	0.57	0.56	0.57	0.48	0.66	0.65	0.71
5	1.04	1.14	1.14	1.12	1	1.17	1.43	1.22	1.17	1.04	1	0.84	1.15	0.61	0.69	0.77	0.92	0.85	0.9	0.86	0.8	1.01	0.81	0.85	0.88	0.93	0.95	1.03	1.1	1	0.85
6	1.33	1.14	1.48	1.42	1.31	1.57	1.63	1.78	1.51	1.31	1.43	1.23	1.02	0.9	0.74	0.82	1.07	1.3	1.29	1.22	1.33	1.25	1.23	1.12	1.37	1.42	1.39	1.66	1.62	1.41	1.17
7	1.45	1.7	1.82	1.94	1.59	2.08	1.96	1.96	1.88	1.62	1.75	1.54	1.37	1.15	0.96	1.06	1.46	1.69	1.82	1.64	1.91	1.84	1.43	1.43	1.86	1.96	1.8	2.41	2.22	2.28	1.47
8	1.62	1.91	1.91	2.2	1.96	2.74	2.79	2.54	2.17	2.03	2.13	2.22	1.89	1.71	1.21	1.13	1.56	1.71	2.82	2.21	2.94	2.36	2.15	1.77	2.31	2.33	2.35	3.5	2.86	3.18	2.38
9	1.97	2.13	2	2.39	1.95	3.34	3.45	3.31	2.59	2.42	2.9	2.98	3.01	2.67	1.42	1.58	1.88	2.68	2.32	1.9	2.64	2.19	3.43	2.41	2.46	2.65	2.65	4.28	3.53	3.93	2.68
10	2.17	2.6	2.44	2.7	2.23	3.55	3.75	4.09	3.2	2.8	2.66	2.95	3.04	3.38	3.95	2.38	1.94	2.38	2.74	1.92	4.79	4.61	3.99	2.95	3.07	2.82	3.35	4.87	4.22	5.97	2.91
11	2.55	2.8	2.38	2.36	2.29	3.15	4.2	4.48	3.4	3.27	3.56	3.51	5.8	6.72	4.25	3.62	2.52	2.39	2.33	2.07	2.85	4.61	3.81	3.46	5.13	2.67	4.25	6.24	4.9	5.82	3.99
12	4.2	3.81	3.13	2.89	2.9	4.09	4.09	4.15	4.73	4.29	3.85	3.24	4.65	6.58	5.1	4.97	5.29	4.54	4.26	3.11	3.32	3.8	7.08	4.19	5.79	4.23	3.63	5.68	5.6	6	3.67
13	4.36	3.49	3.41	3.73	2.95	5.07	4.84	5.22	4.56	8.06	4.76	10.7	8.96	5.37	11.33	11.4	7.82	5.29	6.37	6.23	6.46	5.93	6.19	5.81	8.23	9.26	4.44	5.97	6.22	4.82	6.51
14	2.69	4.05	4.06	4.52	2.15	4.53	4.9	3.89	4.58	7.73	4.49	9.29	11.76	8.91	8.44	13.33	11.35	5.94	7.02	4.65	6.29	8.3	5.54	6.25	4.91	6.44	7.16	6	6.83	6.82	9.26
15	3.57	4.55	3.85	4.2	2.09	6.23	4.95	4.79	7.1	6.42	7.03	9.73	10.47	10.25	13.83	10.47	9.73	8.38	10.73	5.86	6.29	6.89	4.13	6.85	8.09	6.55	10.56	6	7.42	12.92	5.66

Table 10a. Population numbers-at-age estimates for 4TVn.

POPULATION NUMBERS														30/ 4/81
	50	51	52	53	54	55	56	57	58	59	60	61	62	63
3	100268	108664	110807	106416	76915	68168	80849	105919	109738	142002	133398	45511	59267	40980
4	72622	81936	88846	90548	86860	62600	55518	65836	86395	89389	115778	109150	37260	48509
5	52639	58800	66508	71807	72220	68436	49144	43314	51761	67718	69995	91210	86381	28954
6	37976	41690	46822	52723	53743	52069	50471	34175	29959	34629	47238	49213	62139	60913
7	25816	28654	32226	35534	38624	37650	37628	35333	22547	16803	20267	27434	31767	49170
8	17163	18637	21541	23621	24846	25685	26149	25108	23751	11202	6117	10192	15002	18936
9	11563	11805	13570	15255	15918	15559	17260	16710	16289	13445	2902	3450	5954	8431
10	6513	6480	7537	8286	9260	8522	9182	9304	9295	7180	4522	1662	2126	3545
11	3258	3375	3884	4244	4381	4225	4331	4050	4464	3192	1251	2081	907	1212
12	1807	1858	2190	2422	2628	2403	2527	2269	2156	2024	901	676	1040	605
13	939	1050	1205	1358	1412	1354	1338	1261	1124	738	573	487	211	691
14	605	644	764	849	901	860	875	812	774	558	224	401	231	140
15	361	380	443	509	540	519	532	497	465	353	162	100	173	165
3+	331531	363975	396343	413572	388248	348050	335806	344587	358717	389233	403328	341566	302457	262250
4+	231263	255311	285536	307156	311333	279883	254957	238668	248979	247231	269929	296055	243190	221271
5+	158641	173375	196689	216608	224473	217282	199439	172832	162584	157842	154151	186905	205930	172761
6+	106001	114575	130182	144801	152253	148846	150295	129519	110824	90124	84157	95696	119549	143807
	64	65	66	67	68	69	70	71	72	73	74	75	76	77
3	60032	51732	60636	104296	93558	55866	50663	72656	31205	41838	57565	51542	137203	148855
4	33321	49060	41935	48292	84758	76318	45444	41456	59484	24158	33913	46020	40052	112033
5	37800	26405	35206	27982	33172	62055	58031	34144	31707	35855	15823	24907	28773	29132
6	19786	24892	16092	19233	17959	19892	39535	34061	21378	15812	18705	9484	14914	15405
7	35480	10937	12059	9130	11625	10505	13072	21667	19856	11054	7590	6539	5653	7731
8	27028	18258	4946	6800	4750	6898	6339	6941	12239	8676	5032	2973	2523	3269
9	9775	13828	7338	2401	4008	2743	3731	3481	3384	5435	4012	2164	1317	1318
10	4056	4637	6369	3978	1599	2604	1423	1762	1741	1545	2478	1430	850	699
11	2019	2303	2146	3519	2340	920	1428	517	946	783	604	970	513	498
12	640	1340	988	981	2071	1111	562	660	284	371	302	227	287	292
13	372	390	718	489	460	1070	655	141	158	119	187	89	85	140
14	474	212	185	371	247	147	614	322	78	47	41	87	31	39
15	81	309	127	84	230	79	71	378	172	34	8	11	35	10
3+	230864	204304	188746	227557	256779	240208	221569	218187	182631	145726	146259	146444	232237	319422
4+	170832	152573	128110	123261	163221	184341	170906	145531	151426	103888	88694	94902	95034	170567
5+	137511	103512	86175	74969	78463	108023	125462	104076	91942	79730	54781	48882	54982	58534
6+	99711	77107	50969	46987	45291	45968	67431	69932	60235	43875	38959	23975	26208	29402
	78	79	80	81										
3	175101	157888	164001	78511										
4	121378	143026	129149	215846										
5	89257	90556	112889	101569										
6	21027	64295	60164	79359										
7	10571	12896	42896	37229										
8	4984	6391	7415	26543										
9	2316	3162	3633	4588										
10	837	1702	1799	2248										
11	399	454	1084	1113										
12	312	234	166	671										
13	186	108	130	103										
14	76	120	40	80										
15	25	58	90	25										
3+	426468	480889	623456											
4+	251368	323002	359457											
5+	129989	179975	230307											
6+	40732	89419	117418											

Table 10b. January 1st estimates of population biomass for 4TVn Cod.

POPULATION BIOMASS														30/ 4/81
	50	51	52	53	54	55	56	57	58	59	60	61	62	63
3	22059	23906	24378	23411	16921	16360	19404	22243	23045	28400	28014	8192	10668	8606
4	74074	79478	77296	82399	68620	69486	51632	64519	77755	74193	81045	84045	25710	30561
5	54745	67032	75819	80424	72220	80070	70276	52843	60560	70427	69995	76616	99338	17662
6	50508	47527	69296	74866	70404	81748	82268	60832	45238	45364	67551	60532	63382	54821
7	37433	48712	58651	68936	61412	78313	73751	69252	41937	27221	35467	42249	43520	56545
8	27804	35598	41144	51966	48699	70377	72956	63774	51539	22740	13029	22626	28354	32381
9	22779	25144	27139	36459	31041	51967	59547	55311	42187	32538	8416	10280	17921	22512
10	14134	16849	18391	22373	20649	30253	34432	38054	29744	20103	12027	4903	6462	11981
11	8307	9451	9244	10017	10032	13310	18192	18143	15178	10438	4454	7303	5259	8142
12	7590	7080	6853	6999	7621	9828	10334	9418	10198	8683	3468	2191	4834	3779
13	4094	3665	4111	5067	4164	6864	6477	6580	5127	5952	2728	5213	1893	3710
14	1627	2610	3103	3838	1936	3896	4290	3157	3545	4311	1006	3723	2711	1245
15	1290	1729	1705	2137	1128	3234	2635	2379	3302	2265	1137	976	1807	1695
3+	326444	368781	417130	468891	414848	515706	506194	466506	409356	352635	328336	328848	311861	253840
4+	304385	344875	392752	445479	397927	499346	486790	444263	386311	324235	300323	320636	301192	245234
5+	230311	265396	315456	363081	329307	429860	435158	379744	308555	250042	219278	236611	275483	214673
6+	175566	198364	239637	282656	257087	349790	364882	326901	247995	179615	149284	159995	176144	197011
	64	65	66	67	68	69	70	71	72	73	74	75	76	77
3	12006	11381	13340	19816	19647	14525	11652	16711	7801	12551	15542	19586	37045	34237
4	21659	37776	30613	30424	56788	41975	21359	17826	30932	12804	19330	25771	22830	53776
5	26082	20332	32389	23785	29855	53367	46425	34485	25683	30476	13924	23163	27335	30006
6	14642	20412	17219	25003	23167	24268	52581	42577	26295	17709	25626	13467	20730	25572
7	34061	11594	17606	15430	21157	17228	24968	39868	28394	15808	14117	12817	10175	18633
8	32704	20631	7717	11628	13394	15244	18638	16381	26314	15357	11624	6928	5928	11443
9	13881	21848	13795	6435	9300	5211	9850	7623	11607	13098	9869	5735	3489	5640
10	16020	11037	12356	9469	4383	5000	6819	8123	6949	4557	7607	4033	2847	3402
11	8580	8338	5407	8409	5452	1904	4069	2385	3603	2708	3101	2590	2181	3109
12	3266	6662	5228	4454	8824	3455	1867	2507	2008	1554	1747	961	1042	1658
13	4213	4450	5615	2589	2933	6667	4234	839	976	690	1540	824	379	836
14	3999	2826	2103	2203	1737	682	3861	2677	433	296	202	560	222	236
15	1122	3232	1234	702	2467	463	445	2602	709	230	64	70	375	61
3+	192234	180518	164623	160347	199104	189989	206768	194604	171703	127839	124293	116506	134578	188609
4+	180227	169137	151283	140531	179457	175464	195115	177893	163901	115287	108750	96920	97533	154372
5+	158569	131361	120670	110107	122669	133489	173757	160067	132970	102483	89420	71149	74704	100596
6+	132487	111029	88281	86322	92814	80122	127332	125582	107287	72007	75496	47985	47369	70590
	78	79	80											
3	59534	74207												
4	80110	92967	91696											
5	98182	90556	95956											
6	34063	90656	70392											
7	23469	29403	63057											
8	14254	20324	17649											
9	8177	12427	9738											
10	3531	10159	5234											
11	1953	2640	4324											
12	1746	1403	611											
13	1156	522	849											
14	520	817	375											
15	186	747	509											
3+	326881	426828												
4+	267346	352621	360388											
5+	187237	259654	268692											
6+	89034	169097	172737											

"Fishable" Biomass (t x 10⁻³)

1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
90	105	97	90	87	98	69	54	45	62	70	102	142	188

Table 10c. Fishing mortality-at-age estimated from VPA for 4TVn Cod.

FISHING MORTALITY																			30/ 4/81
	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
3	0.002	0.001	0.002	0.003	0.006	0.005	0.005	0.004	0.005	0.004	0.001	0.000	0.000	0.007	0.002	0.010	0.028	0.007	0.004
4	0.011	0.009	0.013	0.026	0.038	0.042	0.048	0.041	0.044	0.045	0.039	0.034	0.052	0.049	0.033	0.132	0.205	0.176	0.112
5	0.033	0.028	0.032	0.090	0.127	0.104	0.163	0.169	0.202	0.160	0.152	0.184	0.149	0.181	0.218	0.295	0.405	0.243	0.311
6	0.082	0.057	0.076	0.111	0.156	0.125	0.157	0.216	0.378	0.336	0.343	0.238	0.034	0.340	0.393	0.525	0.367	0.303	0.336
7	0.126	0.085	0.111	0.158	0.208	0.165	0.205	0.197	0.499	0.810	0.487	0.404	0.317	0.398	0.464	0.594	0.373	0.454	0.322
8	0.174	0.117	0.145	0.195	0.268	0.198	0.248	0.233	0.369	1.151	0.373	0.338	0.376	0.461	0.470	0.712	0.523	0.328	0.349
9	0.379	0.249	0.293	0.299	0.425	0.327	0.418	0.387	0.619	0.890	0.357	0.284	0.319	0.532	0.516	0.575	0.412	0.206	0.231
10	0.457	0.312	0.374	0.437	0.585	0.477	0.619	0.534	0.869	1.547	0.576	0.406	0.362	0.363	0.366	0.571	0.393	0.331	0.353
11	0.361	0.233	0.272	0.279	0.400	0.314	0.446	0.430	0.591	1.065	0.415	0.494	0.205	0.438	0.209	0.646	0.583	0.330	0.545
12	0.343	0.233	0.277	0.340	0.463	0.385	0.495	0.502	0.872	1.062	0.415	0.963	0.209	0.286	0.295	0.424	0.503	0.556	0.460
13	0.176	0.118	0.150	0.211	0.296	0.236	0.300	0.288	0.501	0.992	0.158	0.548	0.214	0.177	0.362	0.545	0.461	0.482	0.944
14	0.265	0.175	0.207	0.253	0.351	0.280	0.367	0.357	0.588	1.038	0.604	0.643	0.133	0.343	0.228	0.314	0.594	0.278	0.943
15	0.275	0.184	0.221	0.260	0.358	0.284	0.370	0.357	0.600	0.980	0.424	0.447	0.260	0.403	0.392	0.578	0.450	0.358	0.371
3+	0.206	0.139	0.167	0.205	0.283	0.226	0.295	0.286	0.472	0.775	0.334	0.383	0.202	0.306	0.306	0.455	0.407	0.312	0.406
	69	70	71	72	73	74	75	76	77	78	79	80							
3	0.006	0.001	0.000	0.056	0.010	0.024	0.052	0.003	0.004	0.002	0.001	0.001							
4	0.074	0.086	0.068	0.306	0.223	0.109	0.270	0.118	0.027	0.093	0.037	0.022							
5	0.251	0.333	0.268	0.496	0.451	0.312	0.313	0.425	0.126	0.128	0.209	0.151							
6	0.220	0.401	0.340	0.460	0.534	0.851	0.317	0.457	0.177	0.289	0.205	0.280							
7	0.305	0.433	0.371	0.628	0.587	0.737	0.752	0.348	0.239	0.303	0.353	0.280							
8	0.415	0.400	0.518	0.612	0.571	0.644	0.615	0.449	0.145	0.255	0.365	0.280							
9	0.456	0.550	0.493	0.584	0.585	0.831	0.735	0.434	0.254	0.108	0.364	0.280							
10	0.401	0.812	0.422	0.600	0.738	0.738	0.825	0.334	0.361	0.412	0.251	0.280							
11	0.292	0.572	0.401	0.736	0.753	0.778	1.018	0.365	0.269	0.333	0.803	0.280							
12	0.328	1.180	1.232	0.671	0.484	1.022	0.780	0.517	0.251	0.858	0.384	0.280							
13	0.356	0.509	0.394	1.004	0.861	0.566	0.855	0.572	0.410	0.239	0.784	0.280							
14	0.528	0.286	0.431	0.644	1.589	1.154	0.696	0.909	0.252	0.075	0.086	0.280							
15	0.345	0.621	0.540	0.613	0.608	0.800	0.720	0.415	0.242	0.366	0.389	0.280							
3+	0.306	0.476	0.421	0.570	0.615	0.659	0.611	0.411	0.212	0.266	0.325	0.229							

Table 11. Catch projections through 1982 under assumptions described in text.

Catch Biomass			
	1980	1981	1982
3	179	31	31
4	1758	1416	638
5	12938	8633	9638
6	16055	15686	15041
7	14404	9246	13266
8	4370	11569	10906
9	2529	2362	9184
10	1660	1534	2105
11	1993	1514	2055
12	237	706	788
13	322	188	824
14	50	73	63
15	202	41	90
	56697	53000	64628

Fishing Mortality			
	1980	1981	1982
3	0.002	0.001	0.001
4	0.022	0.016	0.016
5	0.151	0.108	0.108
6	0.280	0.200	0.200
7	0.280	0.200	0.200
8	0.280	0.200	0.200
9	0.280	0.200	0.200
10	0.280	0.200	0.200
11	0.280	0.200	0.200
12	0.281	0.200	0.200
13	0.281	0.200	0.200
14	0.284	0.200	0.200
15	0.280	0.200	0.200

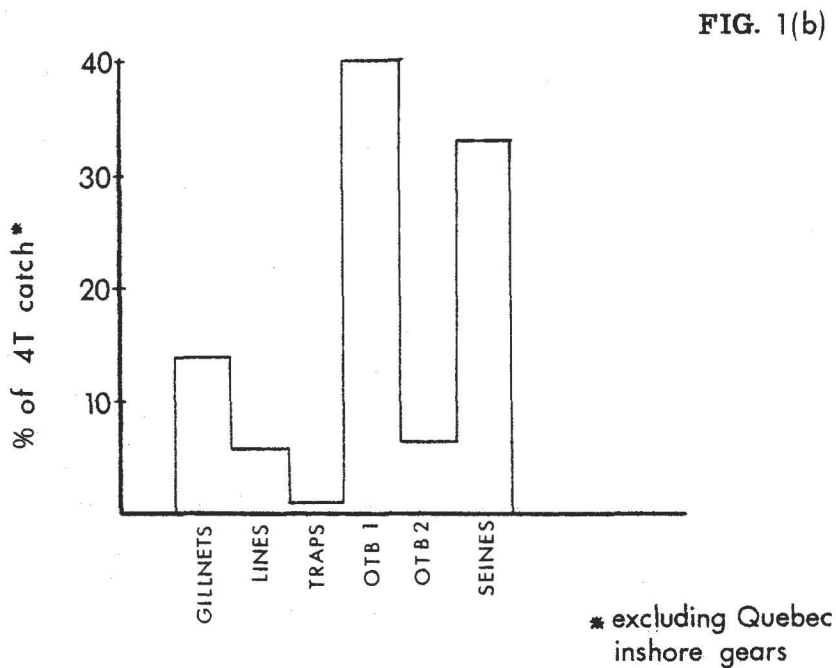
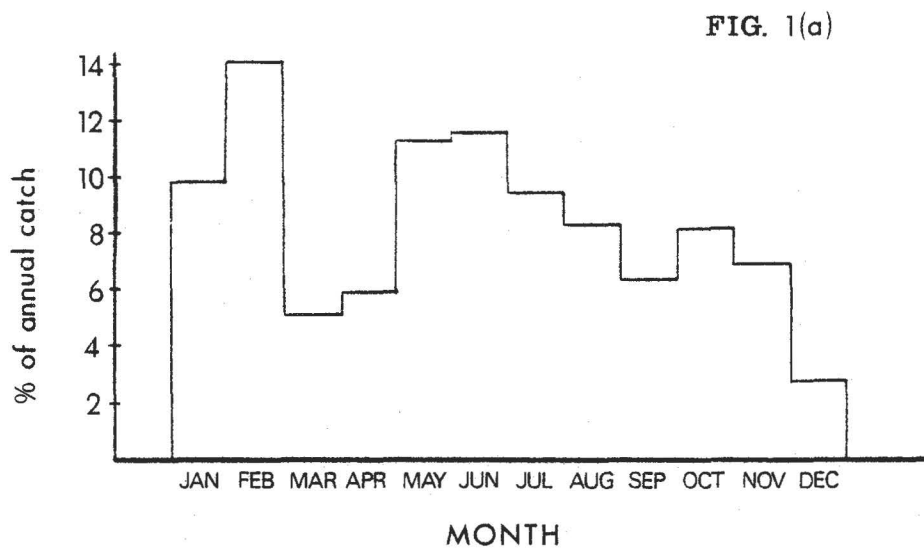


Figure 1a. Monthly distribution of catch (%) of 4TVn cod.

1b. Relative contribution (%) of various gear types to the landings of cod in 4T.

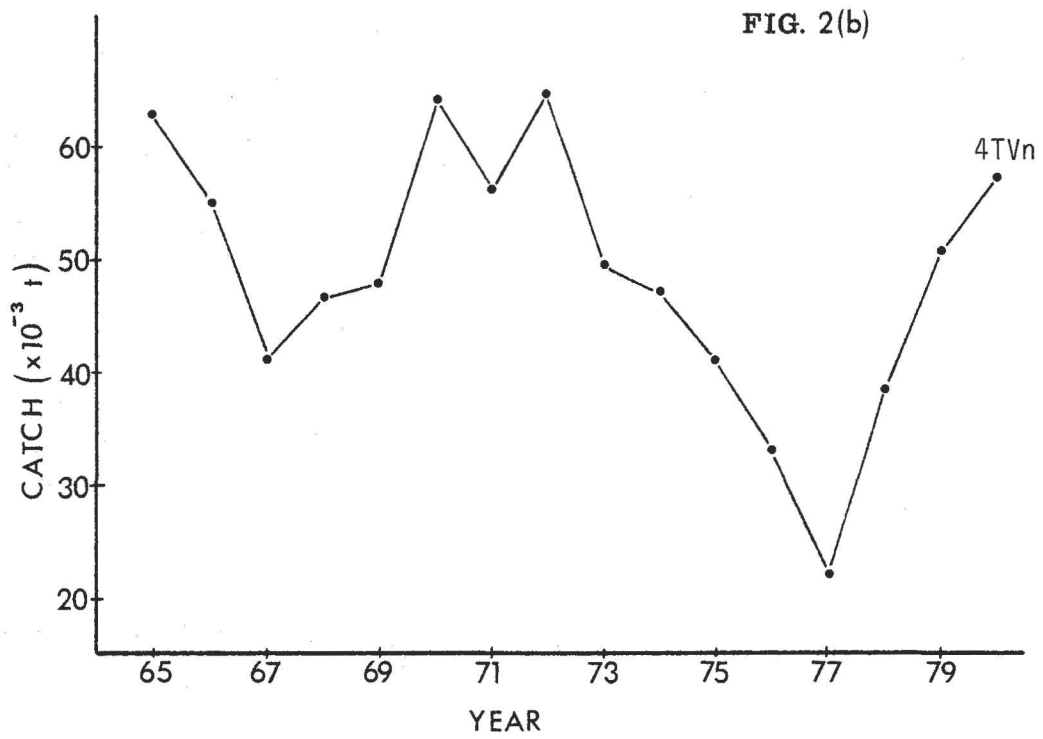
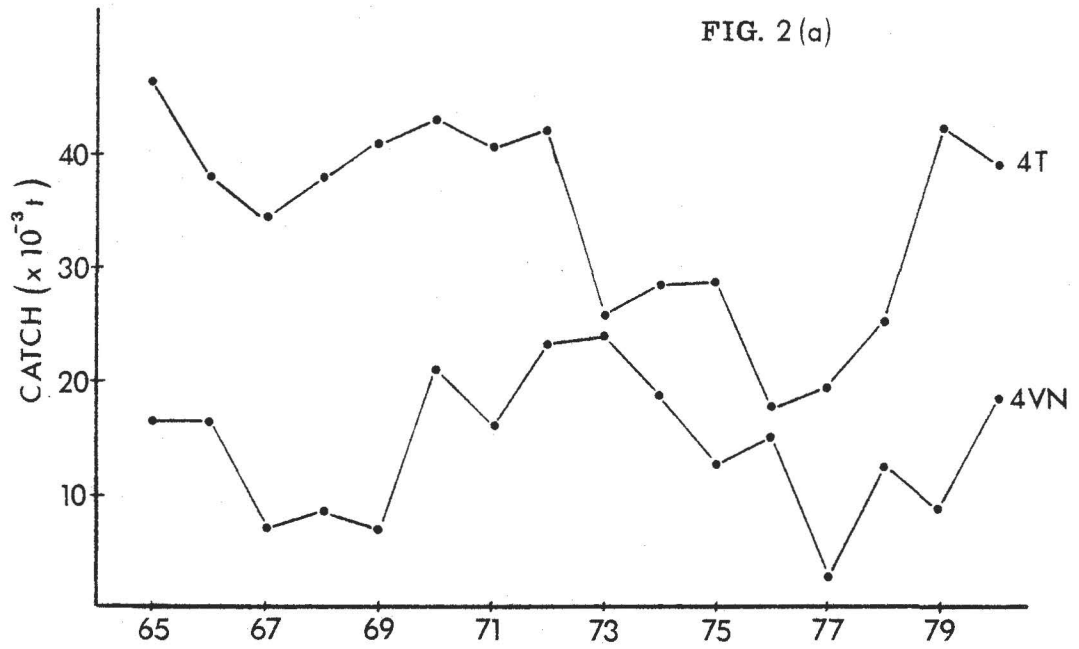


Figure 2. Trends in landings of 4TVn cod from 1965 to 1980.

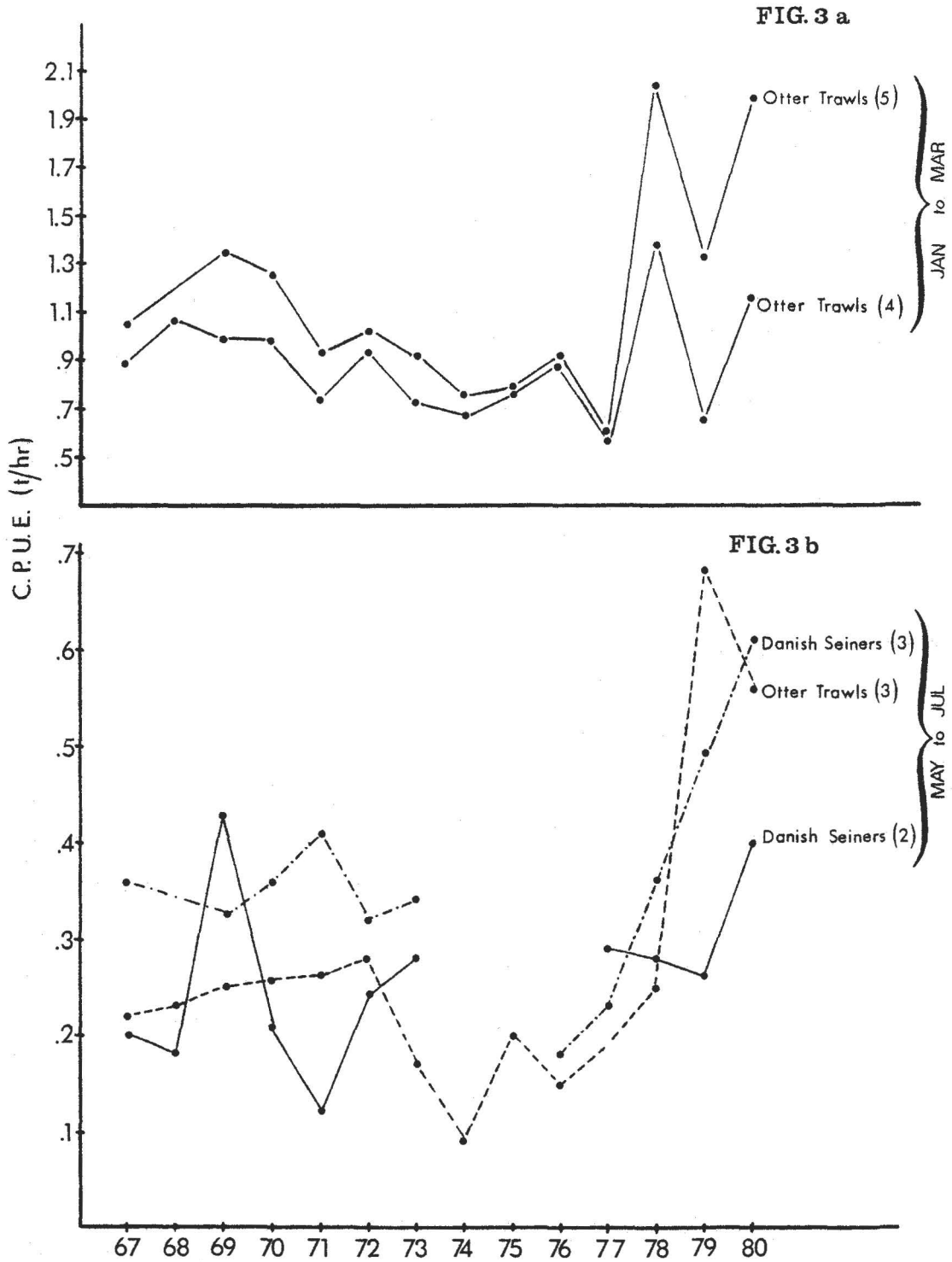


Figure 3. Trends in catch per unit of effort for several gear types participating in the 4TVn cod fishery (1967-1980).

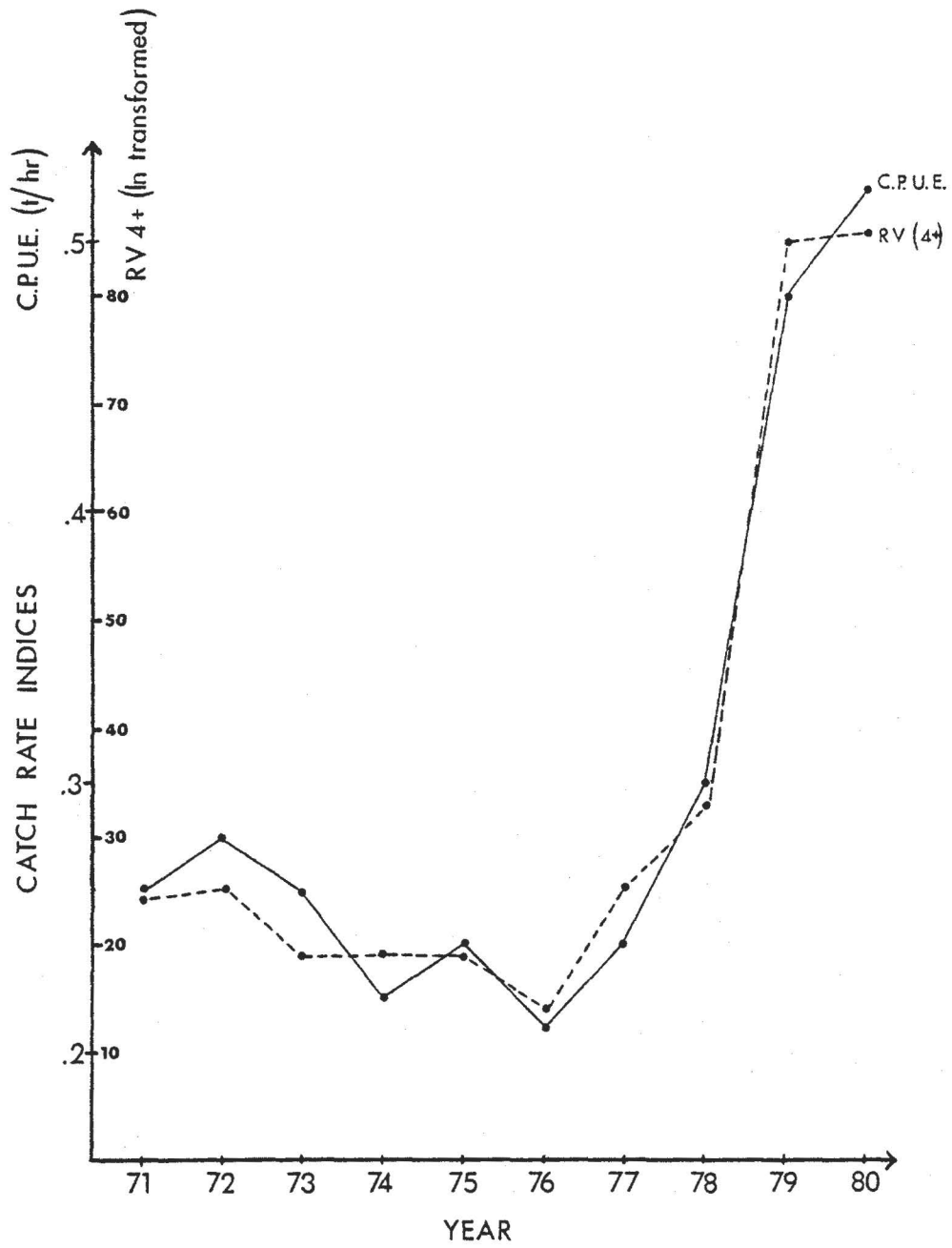


Figure 4. Trends in a combined CPUE index for the 4TVn cod fishery and 4+ numbers of cod estimated from the research vessel survey (1971 to 1980).

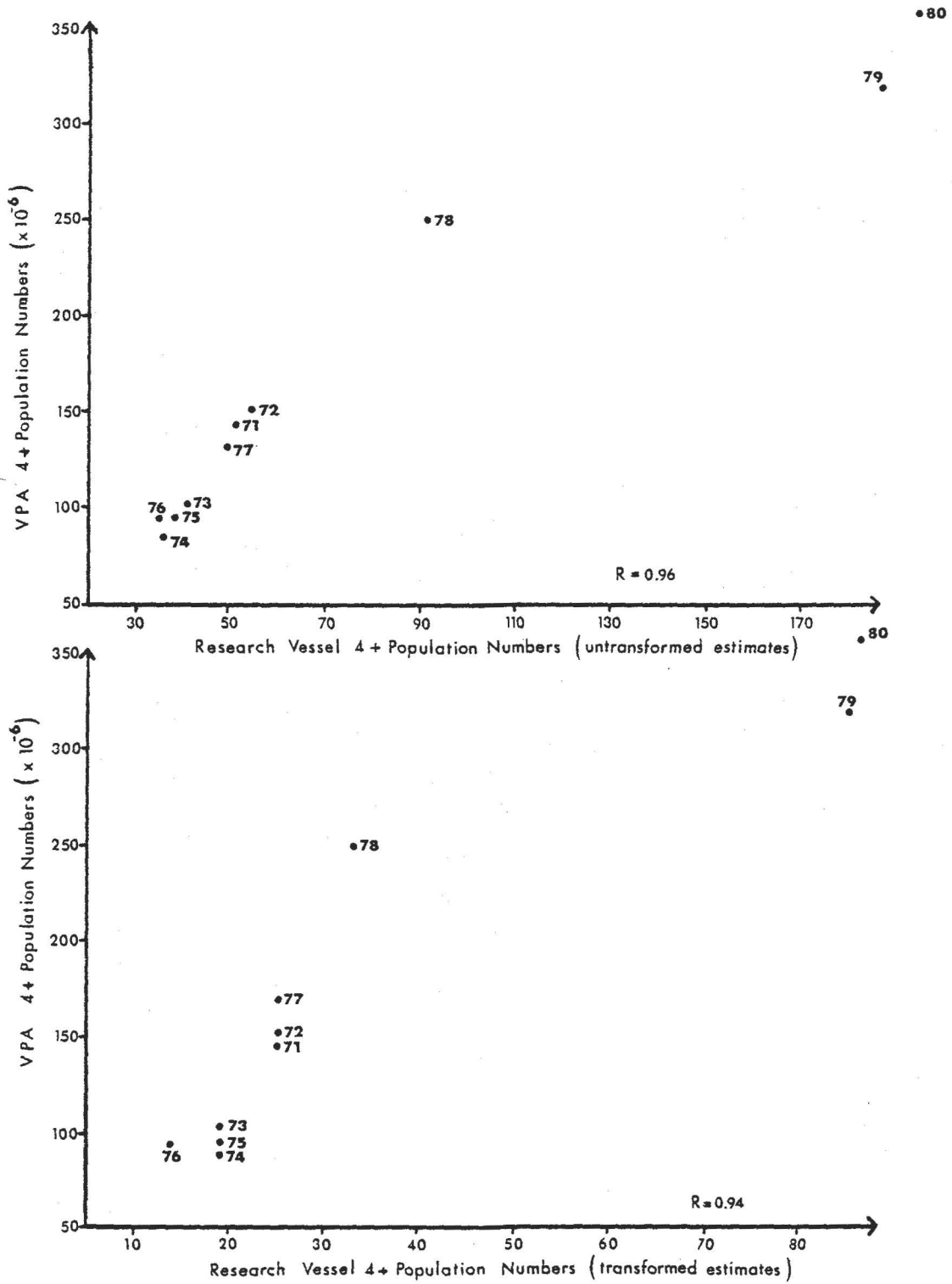


Figure 5. Relationship between VPA 4+ numbers and research vessel 4+ numbers.

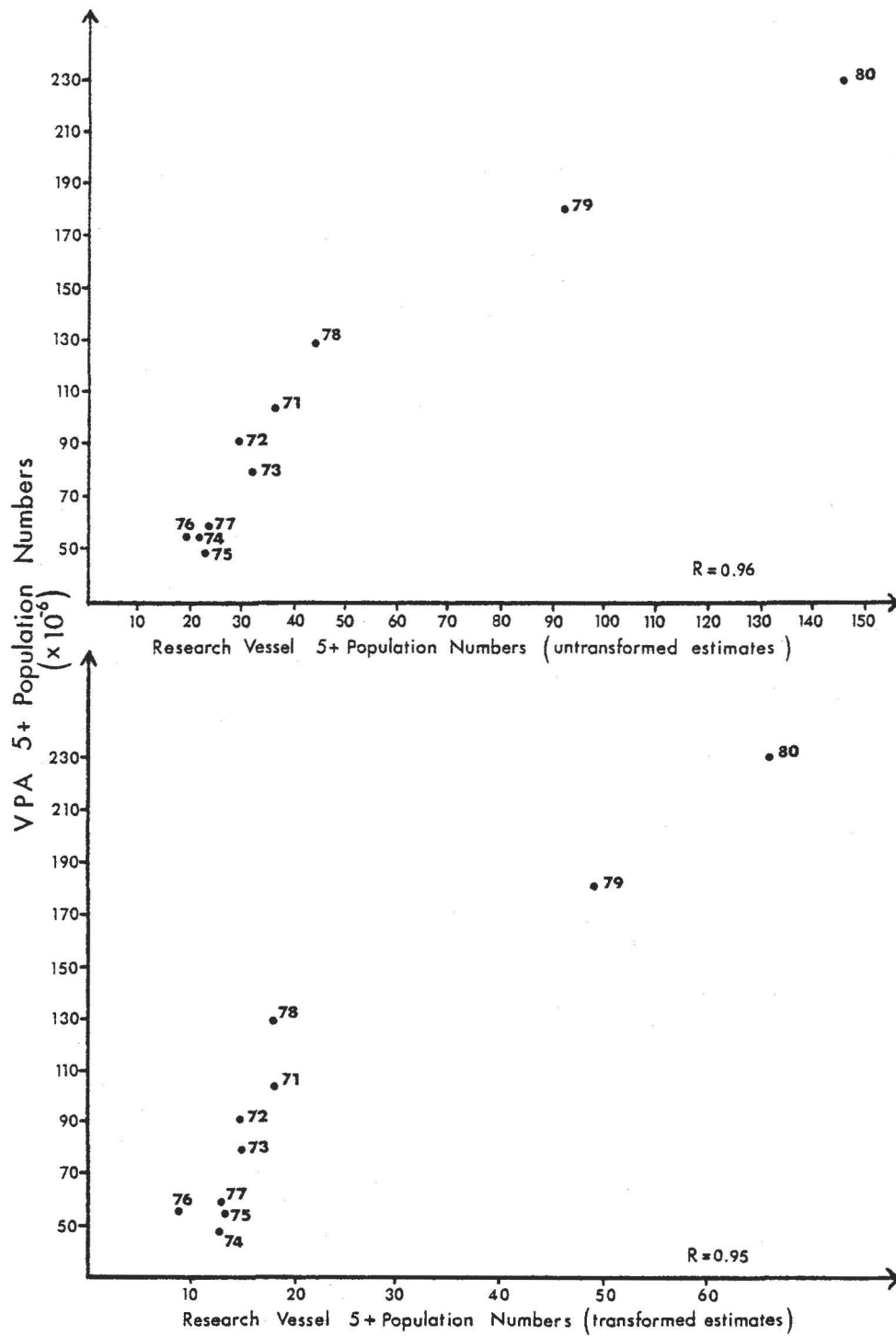


Figure 6. Relationship between VPA 5+ numbers and research vessel 5+ numbers.

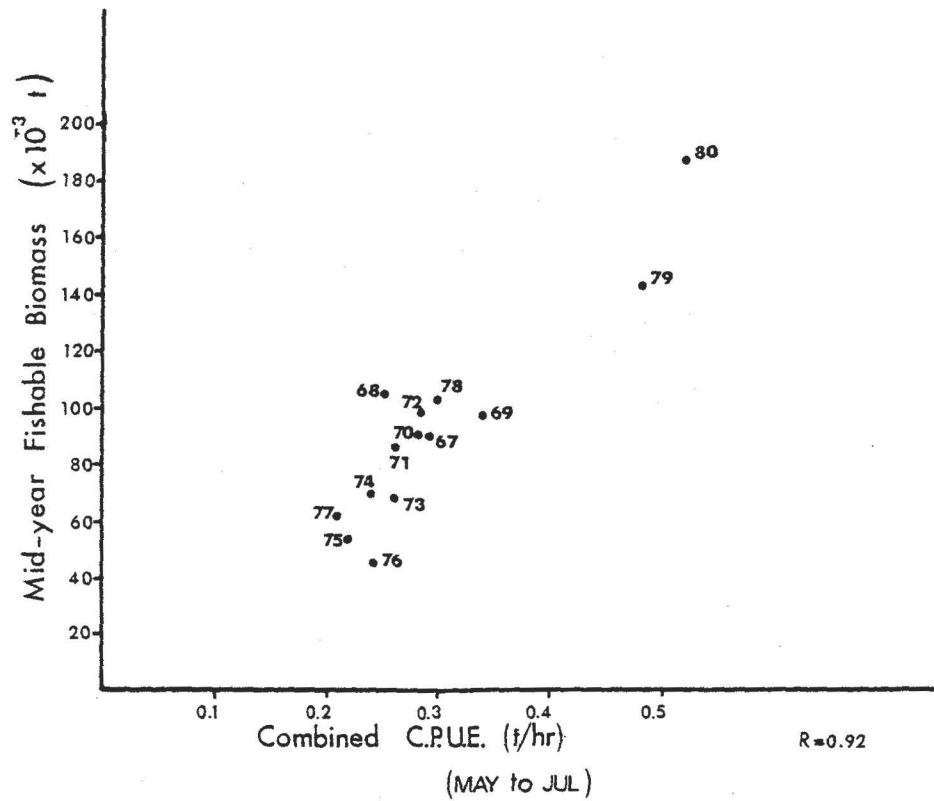


Figure 7. Relationship between mid-year fishable biomass from VPA and the combined CPUE index.

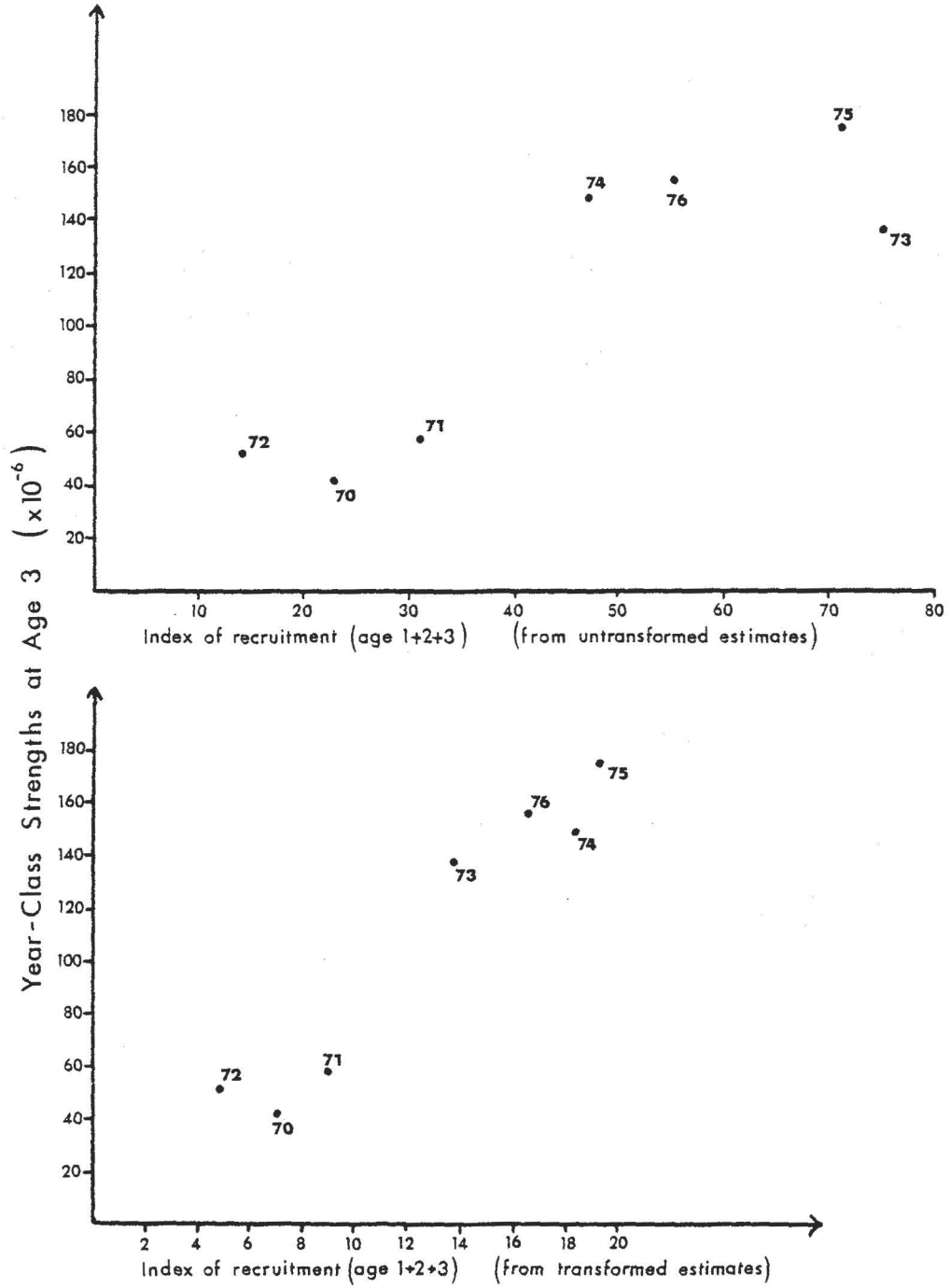


Figure 8. Relationships between VPA year-class strength estimates at age 3 and indices of recruitment.

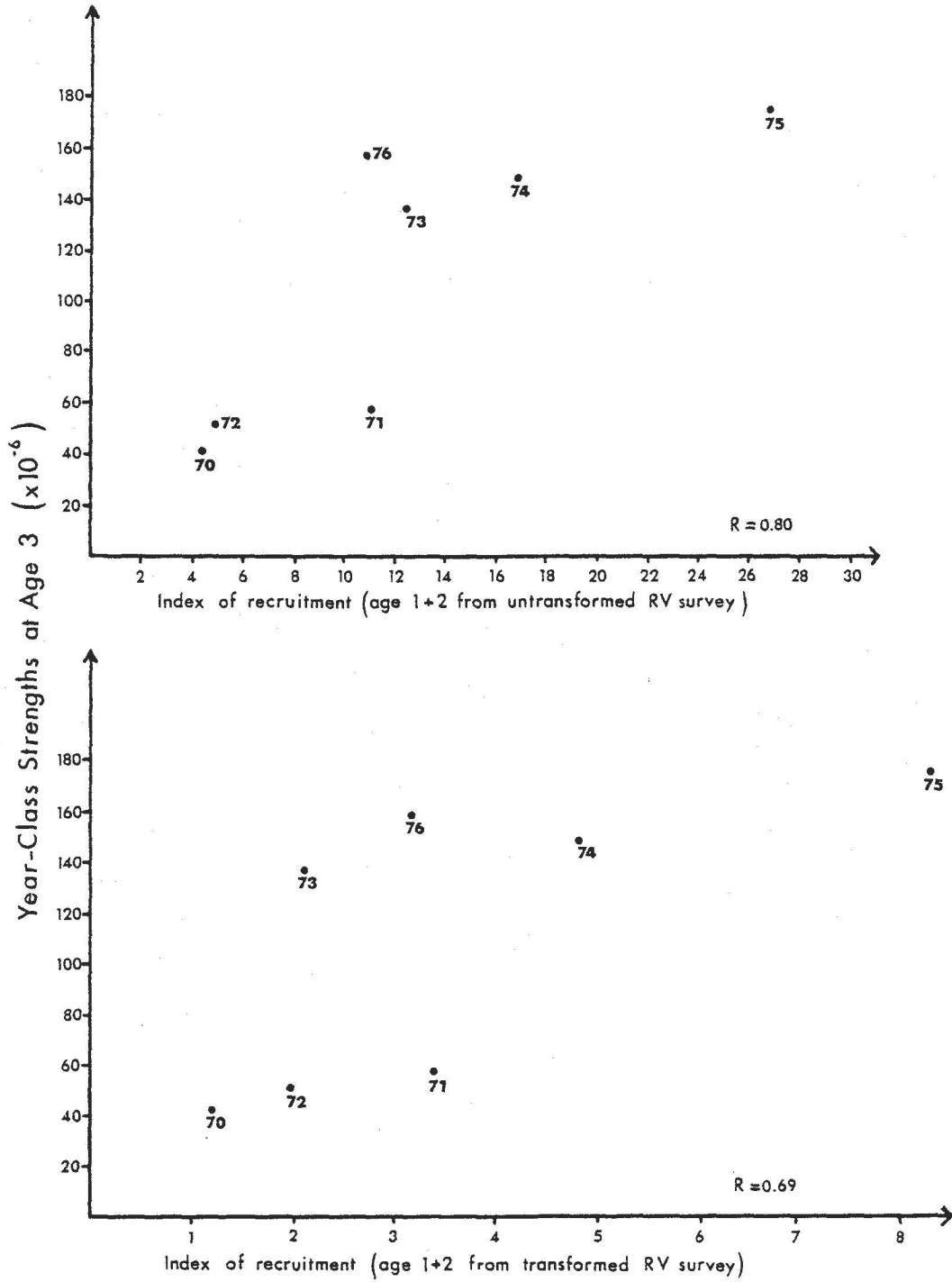


Figure 9. Relationships between VPA year-class strength estimates at age 3 and indices of recruitment.

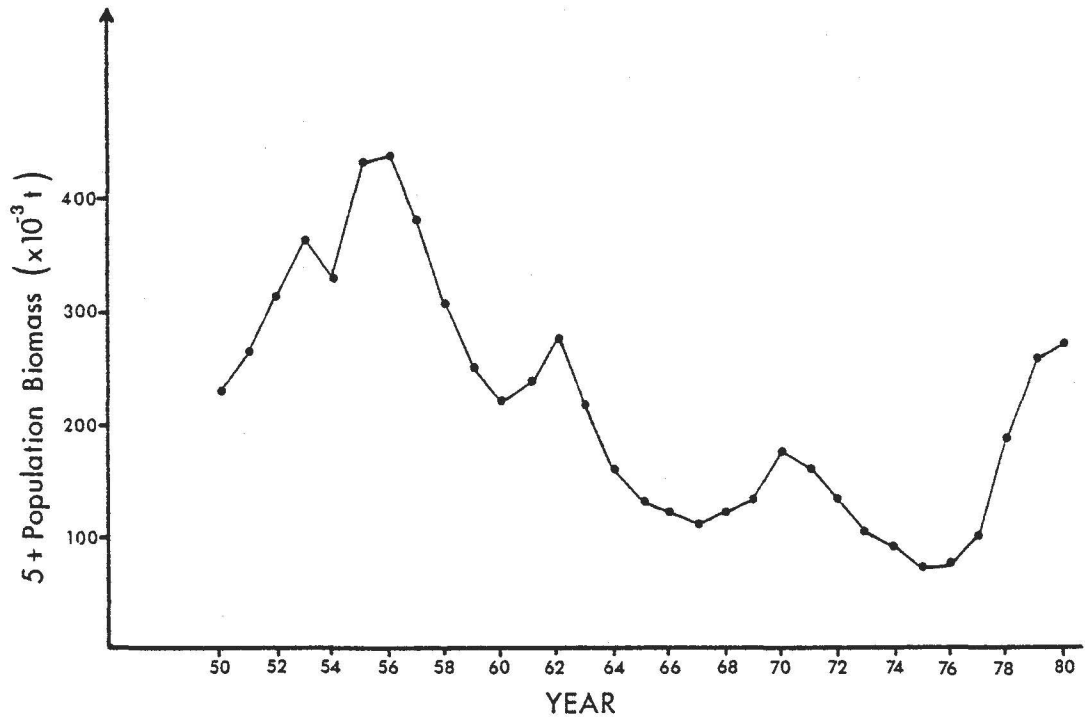
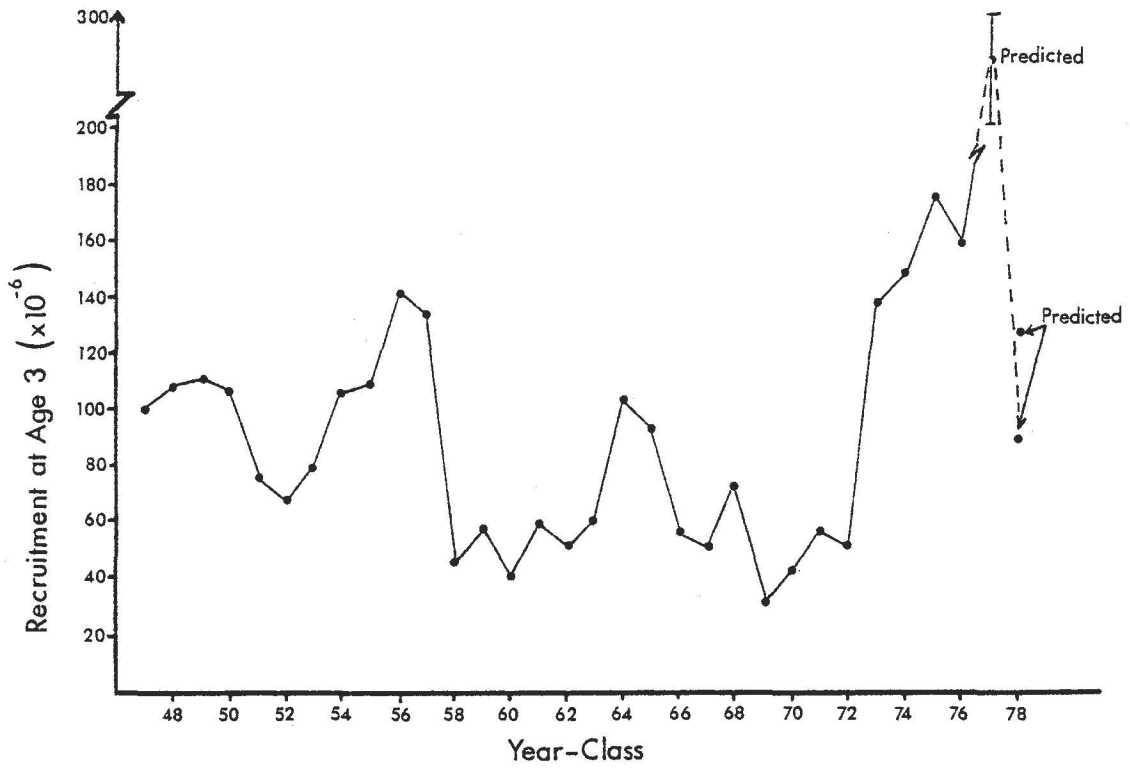


Figure 10. Distribution of VPA estimates of year-class strengths at age 3 (upper) and 5+ population biomass (lower).