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Assessment of cod in NAFO Division 4T and subdivision 4Vn (Jan.-Apr.) for 1983

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ABSTRACT

Provisional nominal catches for 1982 were 58,181 t, slightly below the 60,000 t TAC but significantly down from the previous year (65,177 t). Research vessel population estimates are lower in 1982 than in 1981 but still higher than the values for 1971 to 1980. Standardized commercial catch rates have increased regularly since 1976 and the 1982 values is the highest observed since 1968. Commercial sampling of gillnet catches in 1982 was poor and this may be the reason for a relative absence of ages 8 and older cod in the catch compared to 1981. Partial recruitments were adjusted to take this fact into account and SPA was calibrated with the standardized catch rate and the research vessel survey population estimates. Best agreement was found for $F_t = 0.275$. Fishing at $F_{0.1} = 0.2$ in 1983 and 1984 would give catches of 59,000 t and 68,000 t respectively. If the TAC is caught (62,000 t), the 1984 $F_{0.1}$ catch would be 67,000 t.

RESUME

Les données préliminaires indiquent des captures nominales de 58 181 t en 1982, légèrement en-dessous du TPA de 60 000 t. Toutefois, les captures de 1982 sont significativement plus faibles que celles de 1981 (65 177 t). Les effectifs estimés à l'aide des navires de recherche sont plus faibles en 1982 qu'en 1981 mais ils sont quand-même plus élevés que les valeurs de 1971 à 1980. Le taux de capture standardisé de bateau commerciaux a augmenté régulièrement depuis 1976 et la valeur pour 1982 et la plus haute enregistrée depuis 1968. L'échantillonnage commercial des captures des filets maillants a été très limité en 1982. C'est peut-être la raison de l'absence relative des groupes d'âges de 8 ans et plus dans la capture comparé à 1981. Les recrutements partiels ont été ajusté en conséquence. L'ASP a été calibrée à l'aide du taux de capture standardisé et des estimés des effectifs par navire de recherche. Les meilleurs résultats ont été obtenus à $F_t = 0,275$. Si on pêche à $F_{0,1} = 0,2$ en 1983 et 1984, les captures seront respectivement de 59 000 et 68 000 t. Si le TPA est atteint en 1983 (62 000 t), les capturés à $F_{0,1}$ en 1984 seraient de 67 000 t.

NOMINAL CATCHES

Since 1950, nominal catches of cod in NAFO Division 4T and Subdivision 4Vn (Jan.-Apr.) have fluctuated between 105 000 t in 1956 and 22 000 t in 1977 (table 1 and figure 1). The catches increased from nearly 35 000 t in 1951 to almost 105 000 t in 1956 and then declined to a level between 60 000 and 70 000 t for the period 1959 to 1965. The yield remained below 50 000 t from 1967 to 1969 and then oscillated between 56 000 t and 65 000 until 1972. Thereafter, the catches decreased steadily to 22 000 t in 1977. Nominal catches have increased more or less regularly since then to 65 000 t in 1981 but decreased slightly to 58 181 t in 1982.

In the mid to late sixties, most of the catch was taken from June to September (table 2, figure 2) but from 1967 to 1974 the catches in January to April became progressively more important. In 1974 and 1976, close to 60% of the catches were taken in January to April, mostly in NAFO Subdivision 4Vn. Since 1978 the catches are more evenly distributed throughout the year, but the catches during the summer months (June to September) are slightly more important.

The catches from the southern Gulf of St.Lawrence cod stock complex can be classified according to three gear categories:

1) otter trawlers;

2) seines and pair trawlers;

3) inshore and fixed gear (including gillnets, longlines, handlines, traps and other miscellaneous gears).

Figure 3 shows that the inshore and fixed gears have generally been the major contributors to the catches from May to October while the otter trawlers have usually been the sole exploiters in the January to March-April season since 1974. The catches by the second category (seines and pair trawlers) have become increasingly more important during the second half of the year since 1976 (figure 3).

During the 1982 fishing season (table 3a), a total of 43 477 t were caught in NAFO Division 4T. Maritimes based vessels caught 25 058 t (58%) (table 3a), Quebec based vessels caught 18 342 t (42%) while Newfoundland boats caught 77 t (less than 1%). Less than 3% of the 4T cod catches were taken between January and April. In NAFO Subdivision 4Vn (Jan.-Apr.) a total of 14 704 t was caught. Maritimes based vessels caught 6 429 t (44%), Newfoundland based vessels 1 530 t (10%) and French vessels took 6 745 t (45%).

In 4T, the Maritimes catches (table 3b) were made by Danish and Scottish seines (11 222 t or 45%), by otter trawlers (7 423 t or 30%), by gillnets (3 374 t or 13%), by longlines (1 990 t or 8%) and by various other gears including handlines and traps (table 3b). The small Newfoundland catch was mainly caught by otter trawlers (76 t). At the time of writing, Quebec catches were not broken down by gear or by month for vessels less than 25 GRT. That catogory accounted for 43% (7 844 t) of the Quebec catches. The remainder (table 3b) was caught by otter trawlers (8 174 t or 45%), by longliners (1 381 t or 7%) and by gillnetters (727 t or 4%). It is likely that a major portion of the 7 844 t not broken down by gear has probably been caught by gillnetters.

In NAFO Subdivision 4Vn, most of the catches were made by otter trawlers (table 3c).

CATCH AND WEIGHTS-AT-AGE

The 1950 to 1979 catch-at-age was taken from Maguire and Waiwood (1982). The 1980-81 catch-at-age was recalculated for updated nominal catches using a slightly different procedure than in previous years. When few age readings were available for a given gear-quarter combination, suitable age-length keys were combined with the original samples to obtain between 3-400 age readings. The appropriate length frequencies were then aged with that combined age-length key. The same procedure was applied to estimate the 1982 catch-at-age. Table 4 shows the age frequencies for 1980-81 from Maguire and Waiwood and those estimated in this analysis. Generally, the recalculated age frequencies have a smoother pattern than the previous ones, but there is no striking differences except that more fish are assigned to the 1974 and 1973 year-classes. Table 5 shows the 1950 to 1982 catch-at-age and figure 4 the 1950 to 1982 commercial age frequencies. The 1950 to 1960 catch-at-age was originally taken from Lett (1978) by Sinclair and Maguire (1981). Lett (1978) stated that "Catch-at-age between 1950 and 1960 should be regarded cautiously since sampling information is only available for the winter trawl fishery for the entire period (Paloheimo and Kohler, 1968). Long and hand lines and some gillnets made up a substantial proportion of the fishery during this period in addition to an inshore otter trawl fleet of small vessels. In years when samples were available for these gear types they were weighted into the overall catch-at-age frequency accordingly, but in years when samples were lacking an average catch-at-age frequency for that gear type was used.". However it was not until figure 4 was drawn that it was realized that only two age-frequencies had been used to breakdown the catches for 1950-59: one for 1950-52 and another one for 1953-1959. Although catch-at-age and age frequencies are given for 1950-1982 in table 5 and figure 4 the SPA presented later should be interpreted with extreme caution since it is doubtful that the catch-at-age prior to 1960 gives valuable information on the age structure of the stock. However, an examination of the sampling records shows that it should be possible to obtain yearly age-frequencies for that period. Although the gear and time coverage are not always adequate, it is surely possible to improve the estimates given on table 5 and figure 4.

The 1974 to 1977 year-classes (y.c) accounted for close to 90% of the 1982 catches in numbers. The 1975 y.c. was dominant, followed closely by the 1977 y.c. which finally appeared in the commercial fishery after showing up for several years in the research vessel surveys (Maguire and Waiwood, 1982). The 1976 y.c. was third in terms of catch numbers followed by the 1974 y.c.

Average weights-at-age (Maguire and Waiwood, 1982) for this fishery are available only for the beginning of the year (table 6a). An estimate of mid-year weights-at-age was calculated using a procedure similar to the one described by Rivard (1982) to estimate beginning of year weights from mid-year weights. For the body of the table, i.e. except for the oldest age (all years) and the most recent year (all ages), mid-year weights-at-age were estimated by the following equation:

$$W_{t+0.5,\, i+0.5} = e^{(\ln W_{t,i} + \ln W_{t+1,\, i+1}) \div 2} \qquad (1)$$

where t indexes the years and i the ages.

For the oldest age and for the most recent year:

$$W_{t+0.5,\, i+0.5} = e^{2\,(\ln W_{t,i} - \ln W_{t-0.5,\, i-0.5}) \div 2} \qquad (2)$$

For the oldest age of the first year and the youngest age of the most recent year, $W_{t-0.5,i-0.5}$ do not exist so the values for the next year-class, youngest and oldest respectively, were used.

The mid-year weights have been calculated after the annual CAFSAC May meeting and as such they were not used in the analysis. They are presented here for future reference (table 6b) only although they are no satisfactory substitute to estimated weights in the fishery.

Figure 5 shows the beginning of year average weights-at-age for 1950-1982, 1977-1982 and for 1982. The lines show no sign of levelling off. The average weights for the more recent period (1977-1982) are generally higher than the long term average. The 1982 weights are lower than the 1977-1982 average for ages 3 and 6 to 10, almost equal for ages 4-5 and larger for ages 11 to 15.

STOCK SIZE INDICES

Research vessel surveys

Concern was expressed in previous assessments that the research vessel survey population estimates could have increased more rapidly than stock size (Sinclair and Maguire, 1981; Maguire et Waiwood, 1982). Logarithmic transformations of catch per set and exclusion of extreme values have been tried with no apparent improvement of the estimates (Sinclair and Maguire, 1981; Maguire and Waiwood, 1982). The population estimates for 1982 were down from 1981 and when the series was examined, sets in certain strata were found to be anomalously large in 1981. Consequently, for these strata, the estimates were recalculated by replacing the highest value by the second highest value to calculate the stratum mean following a technique known as "windzorising". The results are shown in table 7 and figure 6. The age 1 and older population estimates were between 60 and 70 million fish from 1971 to 1975, rose to 100-120 million in 1976-1978, increased sharply thereafter to reach close to 410 million in 1981 and then declined to 314 million in 1982. The age 4 and older population estimates declined from 54 million in 1972 to 45 million in 1976, a slow increase to 57 million in 1978 followed and then the estimate rose sharply to 320 million in 1981. The 1982 estimate was 195 million. Ages 6 and older declined by a factor of three from 22 million in 1971 to 8 million in 1976, increased slowly to 13 million in 1978 and then increased by one order of magnitude over three years to reach 141 million in 1982. The 1982 estimate is down at 82 million. An examination of figure 6 in light of ancillary information from the fishery suggests that 1981, even windzorised, could still be perceived as anomalously high since there is no indication the 1982 commercial catch rates were down from 1981. The results of the research vessel surveys can nevertheless be taken as indicating a large increase in population size from 1978 to 1982.

Commercial catch per unit of effort

Commercial catch per unit of effort for Canadian otter trawlers and Danish-scottish seiners involved in the 4T-Vn (Jan.-Apr.) cod fishery were standardized with a multiplicative model (Gavaris, 1980) for 1968 to 1982. Three category types appear in the model:

1) Province-gear - tonnage class;
2) Months;
3) Years.

The analysis of variance of an unweighted regression combining CAN-M Danish seiners tonnage class 4 with tonnage class 2 and 3 otter trawlers in one category is shown in table 8. The resulting catch rates standardized to tonnage class 4 CAN-M otter trawlers fishing in January are shown in table 9

and figure 7. The standardized catch rates went from slightly above 0.5 t/hour in 1968-69 to about 0.3 t/hour in 1973. They remained at that level until 1976. The catch rates increased from 1977 onwards to 0.757 t/hour in 1982. The series shows the 1981 value slightly lower than the 1980 value, an observation corresponding to ancillary information from the fishery. This series shows the 1982 abundance to be a little more than twice the 1976 abundance while the 6+ numbers from the survey indicated an 8 fold increase from 1976 to 1982.

SEQUENTIAL POPULATION ANALYSIS

Cohort analysis (CA) (Pope, 1972) was calculated using M =0.2. The fishing mortality on the oldest age for every year was estimated as the weighted (by population numbers) average of the fishing mortalities on ages 7 to 10. CA was recalculated with that average until the difference between two successive runs was less than 0.001.

A comparison of percentage at age in the commercial catch and in the research vessel surveys for 1977 to 1982 indicated full recruitment at age 7 and the following partial recruitment for younger ages:

Age	3	4	5	6	7	8
PR	0.014	.142	.402	.658	1.0	1.0

These values are slightly lower than those used by Maguire and Waiwood (1982) on ages 4 to 6.

Preliminary runs of SPA with that partial recruitment vector and assuming full recruitment for older ages revealed anomalously high fishing mortality values at ages 8 and older in 1981. Examination of the commercial catch length frequencies and catch-at-age for 1980-81 and 1982 showed a relative absence of older fish in 1982 compared to 1981. No gillnet samples were collected in 1982, although significant gillnet catches were reported (table 3b). It thus appeared that the 1982 catch of ages 9 and older fish was underestimated due to poor sampling. Consequently, partial recruitment (P.R.) values that would give an approximately flat-topped P.R. vector on ages 8 and older in 1981 were sought. The results are given below:

Age	9	10	11	12	13	14	15
PR	.45	.45	.25	.35	.15	.10	.40

It should also be mentioned that an important proportion of the otoliths collected in 1982 were aged by a different age reader than in previous years. After a first reading of all otoliths was completed, a subsample was aged by the person who used to read the otoliths and a poor agreement was found. The cause of the disagreement was identified and all otoliths were read again (results used here). Percentage agreement after this second reading has not been verified.

As mentioned earlier, mid-year average weights-at-age were not available at the time the analysis was done. Since commercial catch rate should be compared with mean biomass (i.e. mean numbers times mid-year weights) an estimate was obtained by multiplying mean numbers by beginning of year weights. This should only produce a different scaling if growth in the first two quarters is reasonably constant from year to year.

The results of the comparison of exploited biomass with standardized catch rates are shown in table 10a for $F_T = 0.15$ to $F_T = 0.35$ with increments of 0.05. The correlation coefficients are above 0.9 for all F_T but the maximum is obtained at $F_T = 0.30$. At the lower F_T, the intercept has a large negative value which converges towards zero as F_T increases. However, it would be necessary to use a F_T above 0.5 to obtain an intercept near zero. At $F_T = 0.15$ all the points for 1973 to 1982 are above the regression line. At $F_T = 0.20$ all the points for 1976 to 1982 are above the regression line. Overall, a $F_T = 0.30$ appears to result in the most satisfactory relationship when the correlation coefficient, the residuals and the intercept are considered.

SPA mean 6+ numbers were compared with the research vessel surveys 6+ population estimates for $F_T = 0.15$ to $F_T = 0.30$ with increments of 0.05. The correlation coefficients (table 10b) are essentially the same at all F_T's ($r = 0.92$), the intercept becomes larger as F_T increases. At $F_T = 0.15$ and $F_T = 0.20$, the SPA 6+ numbers increase from 1981 to 1982 while the research vessel survey shows a decrease. As F_T is increased, the residuals for 1981 and 1982 become smaller. It is difficult to select a best F_T for this data set, but an F_T between 0.25 and 0.30 would appear to give good results.

Finally, SPA mean 4+ numbers were compared with R.V. 4+ numbers, again at $F_T = 0.15$ to $F_T = 0.30$ with increments of 0.05. The correlation coefficient (table 10c) is highest ($r = 0.925$) at $F_T = 0.15$ and decreases to $r = 0.87$ at $F_T = 0.30$. The intercept becomes larger as F_T increases. At the highest starting fishing mortality ($F_T = 0.30$), the slope of the line is 0.944, suggesting that the research vessel surveys estimate higher population numbers than SPA does. This does not agree with previous studies of the R.V. results (Scott, et al., in press) and $F_T = 0.30$ appears too high for this relationship. Again, it is difficult to select a best F_T, but the results suggest a F_T in the range of 0.20 to 0.25.

The three relationships investigated showed a range of possible F_T, however it appears that a $F_T = 0.275$ would be a fair compromise when the results of the three relationships are considered. Population numbers, population biomass and fishing mortality values are shown in tables 11 to 13 for $F_T = 0.275$. The results indicate that in recent years the stock has reached its highest levels since 1950.

PROJECTIONS

Projections to 1984 (table 14) were made with the 1982 population estimates from the SPA run at $F_T = 0.275$, a 1980 year-class of 190 million fish (equal to the largest observed), a flat top partial recruitment vector on ages 7 and older, and the average 1980-82 weights-at-age in the fishery given below:

Age	3	4	5	6	7	8	9	10	11	12	13	14	15
wt(kg)	.53	.69	.90	1.16	1.44	2.03	2.69	3.5	5.57	5.32	8.39	6.80	6.01

If the 1983 TAC (62 000 t) is caught, the 1984 $F_{0.1} = 0.20$ catch would be 67 000 t. Fishing at $F_{0.1}$ in both 1983 and 1984 would yield catches of 59 000 t and 68 000 t respectively.

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Table 1. Total nominal catches of cod in NAFO Division 4T and Subdivision 4Vn (Jan.-Apr.). The 1950 to 1966 values are from Lett (1978), those from 1967-1981 were extracted from NAFO tapes and those for 1982 are preliminary data from various sources.

YEAR	NOMINAL CATCH	TAC	CATCH/TAC
1950	44 023		
51	34 827		
52	41 956		
53	58 911		
54	63 901		
1955	65 227		
56	104 469		
57	89 131		
58	86 582		
59	70 720		
1960	66 013		
61	65 583		
62	66 664		
63	70 202		
64	60 547		
1965	63 027		
66	54 851		
67	41 316		
68	46 551		
69	47 819		
1970	64 465		
71	56 375		
72	64 617		
73	49 396		
74	47 170	63 000	.749
1975	41 231	50 000	.825
76	32 779	30 000	1.093
77	22 219	15 000	1.481
78	37 892	38 000	.997
79	55 996	46 000	1.217
1980	54 634	54 000	1.012
81	65 177	53 000	1.230
82[1]	58 181[1]	60 000	.970

[1] Provisional data.

Table 2. Monthly nominal catches (tons) of cod in NAFO Division 4T and Subdivision 4Vn (Jan.-Apr.).

YEAR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN	TOTAL
67	2 883	1 633	1 795	3 678	3 073	6 069	6 754	6 141	3 925	2 507	1 445	1 413		41 316
68	3 437	2 005	1 393	5 591	4 469	4 315	7 255	6 635	5 354	2 889	1 419	1 789		46 551
69	3 327	3 099	3 598	3 182	2 823	5 277	8 899	7 278	4 054	2 417	2 066	1 799		47 819
1970	4 104	4 942	11 720	7 114	4 098	5 657	9 146	6 789	4 369	3 668	1 689	1 169		64 465
71	2 694	5 688	5 927	6 829	4 544	6 303	8 276	5 894	4 538	2 591	1 587	1 504		56 375
72	8 734	8 026	7 787	6 211	7 783	7 113	5 044	4 747	3 319	2 002	1 623	2 228		64 617
73	8 099	6 813	7 470	3 675	2 245	3 718	4 505	4 438	2 926	2 188	1 556	1 763		49 396
74	13 622	9 476	2 740	2 799	1 987	2 270	3 204	2 532	2 168	1 648	2 118	2 606		47 170
1975	5 376	5 903	2 927	2 147	6 419	3 276	3 665	2 883	2 423	2 123	1 308	2 781		41 231
76	9 343	4 454	3 744	2 240	2 664	2 060	2 886	1 987	1 751	825	468	357		32 779
77	819	863	919	266	2 750	2 795	3 596	3 296	2 104	2 114	2 594	103		22 219
78	5 523	6 080	943	837	5 993	3 656	4 811	3 834	2 499	2 560	939	217		37 892
79	1 276	5 182	2 304	2 630	7 895	6 351	6 264	4 977	3 056	4 314	7 200	4 547		55 996
1980	5 248	8 373	3 293	4 141	5 896	5 870	4 834	4 859	3 210	3 832	3 460	1 618		54 634
81	8 661	3 677	3 976	4 541	7 844	8 313	6 237	5 995	5 599	4 653	5 186	495		65 177
82[1]	4 040	6 073	3 056	2 525	4 634	6 468	4 600	4 065	3 486	3 534	4 493	3 363	7 844	58 181

[1] Provisional

Table 3a. 4T-Vn cod nominal catches in 4T and 4Vn during 1982.

FISHERY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN	TOTAL
							4T							
Maritimes	57	60	27	745	3 529	4 598	1 846	2 291	2 173	2 551	3 870	3 311		25 058
Quebec				98	1 105	1 797	2 754	1 774	1 313	983	623	51	7 844	18 342
Newfoundland				3		73						1		77
TOTAL	57	60	27	846	4 634	6 468	4 600	4 065	3 486	3 534	4 493	3 363	7 844	43 477
							4 Vn							
Maritimes	1 953	2 980	32	1 464										6 429
Newfoundland	190	792	333	215										1 530
France	1 840	2 241	2 664											6 745
TOTAL	3 983	6 013	3 029	1 679										14 704
							4 TVn							
GRAND TOTAL	4 040	6 073	3 056	2 525	4 634	6 468	4 600	4 065	3 486	3 534	4 493	3 363	7 844	58 181

Table 3b. 1982 4T cod nominal catches by Maritimes, Quebec and Newfoundland.

GEAR TYPE	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN	TOTAL
MARITIMES														
Gillnets (anchored					422	655	735	677	569	239	41	7		3 345
Gillnets (drift)					4	8	15	2						29
Handlines					54	188	152	184	129	110	54	1		872
Fix					6	55	1	1	51	4	3			121
Shrimp trawl									5	21				26
Otter trawl (side)	41			91	1 666	1 106	150	104	137	454	888	565		5 202
Otter trawl (stern)		60		111	149	62	53	77	22	177	695	789		2 195
Longlines				8	83	94	62	83	260	260	577	563		1 990
Danish seines			27	500	979	1 977	526	877	890	1 184	1 457	1 315		9 732
Scottish seines	16			35	164	446	139	277	98	89	155	71		1 490
Miscellaneous					2	7	12	9	12	13				55
TOTAL	57	60	27	745	3 529	4 598	1 845	2 291	2 173	2 551	3 870	3 311		25 057
NEWFOUNDLAND														
Otter trawl (stern)				3		73								76
Longlines												1		1
TOTAL				3		73						1		77
QUEBEC														
Shrimp trawl				2	2		6		147	2				159
Otter trawl				96	852	1 369	2 369	1 299	841	710	587	51		8 174
Gillnets					50	206	86	160	170	54	1			727
Longlines					164	212	293	315	155	207	35			1 381
Traps					37	10				10				57
Unknown													7 844	7 844
TOTAL				98	1 105	1 797	2 754	1 774	1 313	983	623	51	7 844	18 342
TOTAL 4T	57	60	27	846	4 634	6 468	4 600	4 065	3 486	3 534	4 493	3 363	7 844	43 477

Table 3c. 1982 4Vn cod nominal catches by Maritimes, Newfoundland and France.

GEAR TYPE	JANUARY	FEBRUARY	MARCH	APRIL	TOTAL
		MARITIMES			
Otter trawls (stern)	594	1 168	---	40	1 802
Otter trawls (side)	1 348	1 812	27	1 015	4 202
Longlines	11	---	4	362	377
Danish Seines	---	---	1	47	48
TOTAL	1 953	2 980	32	1 464	6 429
		NEWFOUNDLAND			
Otter trawls (side)	148	742	333	173	1 396
Otter trawls (stern)	42	50	---	42	134
TOTAL	190	792	333	215	1 530
		FRANCE			
Otter trawls (stern)	1 840	2 241	2 664	---	6 745
TOTAL 4Vn	3 983	6 013	3 029	1 679	14 704

Table 4. 4T-Vn (Jan.-Apr.) cod. Comparison of the 1980-81 age frequencies from Maguire and Waiwood (1982) with those estimated in this analysis.

AGE	1980			1981		
	MAGUIRE AND WAIWOOD	THIS ANALYSIS	RATIO	MAGUIRE AND WAIWOOD	THIS ANALYSIS	RATIO
3	8	7	.88	1	1	1.00
4	59	42	.71	62	52	.84
5	331	329	.99	134	126	.94
6	309	325	1.05	371	352	.95
7	220	227	1.03	251	271	1.08
8	38	33	.87	124	148	1.19
9	19	21	1.11	37	26	.70
10	9	9	1.00	12	15	1.25
11	6	4	.67	5	6	1.20
12	1	1	1.00	1	1	1.00
13	1	1	1.00	1	1	1.00
14	0	0	1.00	0	0	1.00
15	0	0	1.00	1	0	--

TABLE 5. 4T-VN(JAN-APR) COD CATCH AT AGE FOR 1950 TO 1982. 22/ 8/83

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
3	173	133	192	294	412	324	396	359	506	535	75	1	16	255	100	464	1498
4	728	638	1034	2120	2968	2336	2372	2372	3341	3535	3967	3304	1720	2123	970	5504	7055
5	1559	1462	1915	5596	7832	6165	6727	6109	8607	9107	8983	13921	10887	4352	6728	6148	10689
6	2703	2113	3104	5037	7049	5549	6648	6037	8606	9000	12515	9475	1889	16021	5863	9292	4505
7	2772	2127	3065	4713	6596	5191	6331	5750	8101	8571	7144	8313	7870	14742	12038	4481	3423
8	2495	1874	2643	3799	5319	4186	5223	4743	6683	7071	1736	2661	4290	6390	9261	8524	1841
9	3327	2365	3141	3593	5029	3959	5381	4887	6885	7286	795	777	1480	3180	3760	5534	2262
10	2183	1582	2146	2680	3751	2952	3878	3522	4961	5250	1812	506	589	984	1133	1845	1890
11	901	638	843	942	1319	1038	1424	1293	1823	1929	388	741	153	392	347	1004	867
12	478	351	483	636	890	701	902	819	1153	1221	279	385	178	137	149	423	375
13	138	106	153	235	329	259	316	287	405	428	76	188	37	102	103	150	242
14	128	94	130	173	243	191	245	222	314	332	93	174	26	37	88	52	76
15	79	58	80	106	148	117	150	136	192	203	51	33	36	50	24	124	42
3+	17664	13541	18929	29924	41885	32968	39993	36536	51577	54468	37914	40479	29171	48765	40564	43545	34765
4+	17491	13408	18737	29630	41473	32644	39597	36177	51071	53933	37839	40478	29155	48510	40464	43081	33267
5+	16763	12770	17703	27510	38505	30308	37225	33805	47730	50398	33872	37174	27435	46387	39494	37577	26212
6+	15204	11308	15788	21914	30673	24143	30498	27696	39123	41291	24889	23253	16548	42035	32766	31429	15523

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	700	310	327	26	2	1541	378	1229	2379	332	547	370	131	292	40	624
4	7068	8140	4936	3395	2476	14294	4396	3170	9902	4059	2733	9779	4664	1779	2508	1667
5	5503	8086	12530	14972	7313	11326	11878	3862	6096	9089	3134	9743	15527	13806	6023	11220
6	4586	4674	3571	11925	8941	7193	5982	9851	2350	4996	2266	4804	10824	13630	16845	8887
7	3040	2916	2516	4194	6127	8479	4492	3631	3173	1513	1496	2519	3500	9519	12939	12526
8	1735	1276	2136	1905	2567	5128	3455	2188	1250	834	400	1021	1781	1398	7066	7327
9	407	753	917	1444	1237	1370	2204	2081	1033	423	269	216	880	861	1264	1988
10	1021	434	785	727	554	719	740	1186	738	220	193	258	344	380	740	338
11	901	899	212	569	156	452	380	300	571	143	107	103	230	174	277	102
12	383	698	283	360	432	127	130	178	113	106	59	165	68	32	61	50
13	171	259	292	239	42	92	63	74	47	34	43	36	54	28	29	6
14	82	139	55	139	103	34	35	26	40	17	8	5	9	18	15	2
15	23	65	21	30	144	72	14	4	5	11	2	7	17	13	18	4
3+	25620	28649	28581	39925	30094	50827	34147	27780	27697	21777	11257	29026	38029	41931	47825	44741
4+	24920	28339	28254	39899	30092	49286	33769	26551	25318	21445	10710	28656	37898	41639	47785	44117
5+	17852	20199	23318	36504	27616	34992	29373	23381	15416	17386	7977	18877	33234	39859	45277	42450
6+	12349	12113	10788	21532	20303	23666	17495	19519	9320	8297	4843	9134	17707	26053	39253	31230

TABLE 6A, 4T-VN(JAN-APR) COD CALCULATED BEGINNING OF YEAR AVERAGE WEIGHTS-AT-AGE 22/ 8/83

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
3	0.22	0.22	0.22	0.22	0.22	0.24	0.24	0.21	0.21	0.20	0.21	0.18	0.18	0.21	0.20	0.22	0.22
4	1.02	0.97	0.87	0.91	0.79	1.11	0.93	0.98	0.90	0.83	0.70	0.77	0.69	0.63	0.65	0.77	0.78
5	1.04	1.14	1.14	1.12	1.00	1.17	1.43	1.22	1.17	1.04	1.00	0.84	1.15	0.61	0.69	0.77	0.92
6	1.33	1.14	1.48	1.42	1.31	1.57	1.63	1.79	1.51	1.31	1.43	1.23	1.22	0.90	0.74	0.82	1.07
7	1.45	1.70	1.82	1.94	1.59	2.08	1.96	1.96	1.86	1.62	1.75	1.54	1.37	1.15	0.96	1.06	1.46
8	1.82	1.91	1.91	2.20	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
9	1.97	2.13	2.00	2.39	1.95	3.34	3.45	3.31	2.59	2.42	2.90	2.98	3.01	2.67	1.42	1.58	1.88
10	2.17	2.60	2.44	2.70	2.23	3.55	3.75	4.09	3.20	2.80	2.66	2.95	3.04	3.38	3.95	2.38	1.94
11	2.53	2.80	2.38	2.36	2.29	3.15	4.20	4.48	3.40	3.27	3.56	3.51	5.80	6.72	4.25	3.62	2.52
12	4.20	3.81	3.13	2.89	2.90	4.09	4.09	4.15	4.73	4.29	3.85	3.24	4.65	6.58	5.10	4.97	5.29
13	4.36	3.49	3.41	3.73	2.95	5.07	4.84	5.22	4.56	8.06	4.76	10.70	8.96	5.37	11.33	11.40	7.82
14	2.69	4.05	4.06	4.52	2.15	4.53	4.90	3.89	4.58	7.73	4.49	9.29	11.76	8.91	8.44	13.33	11.35
15	3.57	4.55	3.85	4.20	2.09	6.23	4.95	4.79	7.10	6.42	7.03	9.73	10.47	10.25	13.83	10.47	9.73

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.19	0.21	0.26	0.23	0.23	0.25	0.30	0.27	0.38	0.27	0.23	0.34	0.47	0.65	0.64	0.39
4	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	0.56	0.70
5	0.85	0.90	0.86	0.80	1.01	0.81	0.85	0.88	0.93	0.95	1.03	1.10	1.00	0.85	0.74	0.94
6	1.30	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	1.02	1.23
7	1.69	1.82	1.64	1.91	1.84	1.43	1.43	1.86	1.96	1.80	2.41	2.22	2.28	1.47	1.27	1.56
8	1.71	2.82	2.21	2.94	2.36	2.15	1.77	2.31	2.33	2.35	3.50	2.86	3.18	2.38	1.63	1.77
9	2.68	2.32	1.90	2.64	2.19	3.43	2.41	2.46	2.65	2.65	4.28	3.53	3.93	2.68	3.53	2.78
10	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	4.17	3.26
11	2.39	2.33	2.07	2.85	4.61	3.81	3.46	5.13	2.67	4.25	6.24	4.90	5.82	3.99	5.38	5.83
12	4.54	4.26	3.11	3.32	3.80	7.08	4.19	5.79	4.23	3.63	5.68	5.60	6.00	3.67	5.87	8.90
13	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	7.50	8.79
14	5.94	7.02	4.65	6.29	8.30	5.54	6.25	4.91	6.44	7.16	6.00	6.83	6.82	9.26	10.29	10.62
15	8.38	10.73	5.86	6.29	6.89	4.13	6.85	8.09	6.55	10.56	6.00	7.42	12.92	5.66	11.45	15.09

TABLE 6B, 4T-VH(JAN-APR) COD ESTIMATED MID-YEAR AVERAGE WEIGHTS-AT-AGE, 22/ 3/83

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
3	0.46	0.44	0.45	0.42	0.49	0.47	0.48	0.43	0.42	0.37	0.40	0.35	0.34	0.37	0.39	0.40	0.37
4	1.08	1.05	0.99	0.95	0.96	1.26	1.07	1.07	0.97	0.91	0.77	0.94	0.85	0.66	0.71	0.84	0.77
5	1.09	1.30	1.27	1.21	1.25	1.38	1.60	1.36	1.24	1.22	1.11	0.93	1.02	0.67	0.75	0.91	1.09
6	1.50	1.44	1.69	1.50	1.65	1.75	1.79	1.82	1.56	1.51	1.48	1.30	1.08	0.93	0.89	1.09	1.34
7	1.66	1.80	2.00	1.95	2.09	2.41	2.23	2.06	1.94	1.86	1.97	1.71	1.53	1.18	1.04	1.29	1.55
8	1.86	1.95	2.14	2.07	2.56	3.07	3.04	2.56	2.29	2.43	2.52	2.58	2.25	1.56	1.38	1.46	2.04
9	2.26	2.28	2.32	2.31	2.63	3.54	3.76	3.25	2.69	2.54	2.92	3.01	3.19	3.25	1.84	1.75	2.12
10	2.46	2.49	2.40	2.49	2.65	3.86	4.10	3.73	3.23	3.16	3.06	4.14	4.52	3.79	3.78	2.45	2.15
11	3.12	2.96	2.62	2.62	3.06	3.59	4.17	4.60	3.82	3.55	3.40	4.04	6.18	5.85	4.60	4.38	3.33
12	3.83	3.60	3.42	2.92	3.83	4.45	4.62	4.35	6.17	4.52	6.42	5.39	5.00	8.63	7.62	6.23	5.29
13	4.20	3.76	3.93	2.83	3.66	4.98	4.34	4.89	5.94	6.02	6.65	11.22	8.93	6.73	12.29	11.37	6.82
14	3.50	3.95	4.13	3.07	3.66	4.74	4.84	5.26	5.42	7.37	6.61	9.86	10.98	11.10	9.40	11.39	9.75
15	3.64	5.92	3.75	4.27	1.42	10.61	5.17	4.74	9.59	7.60	6.70	14.32	11.12	9.57	17.23	11.66	8.31

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.36	0.34	0.35	0.31	0.35	0.36	0.41	0.39	0.47	0.36	0.39	0.47	0.58	0.60	0.67	0.23
4	0.75	0.76	0.66	0.69	0.59	0.66	0.68	0.73	0.73	0.77	0.73	0.81	0.74	0.72	0.73	0.73
5	1.05	1.05	1.07	1.00	1.11	0.95	1.08	1.12	1.14	1.26	1.29	1.25	1.08	0.93	0.95	1.22
6	1.54	1.45	1.53	1.56	1.34	1.33	1.44	1.64	1.60	1.83	1.92	1.92	1.44	1.22	1.26	1.59
7	2.18	2.01	2.20	2.12	1.99	1.59	1.82	2.08	2.15	2.51	2.63	2.66	2.33	1.55	1.50	1.93
8	1.99	2.31	2.42	2.54	2.85	2.28	2.09	2.47	2.48	3.17	3.51	3.35	2.92	2.90	2.13	2.09
9	2.71	2.11	3.02	3.49	2.96	3.18	2.72	2.63	2.98	3.59	4.25	4.59	3.38	3.34	3.39	3.63
10	2.35	2.38	2.34	4.70	4.19	3.72	3.89	2.86	3.46	4.57	4.88	4.96	4.88	3.96	4.93	3.13
11	3.19	2.69	2.62	3.29	5.71	4.00	4.48	4.66	3.11	4.91	5.91	5.42	4.62	4.84	6.92	6.89
12	5.38	5.15	4.48	4.44	4.85	6.41	5.87	7.32	4.33	4.66	5.94	5.20	6.25	5.25	7.18	11.45
13	6.09	5.44	6.26	7.32	5.73	6.22	5.34	7.28	8.14	5.16	6.39	6.51	6.68	8.18	8.92	10.76
14	7.98	6.41	5.41	6.58	5.85	6.16	7.11	5.67	8.25	6.55	6.67	9.39	6.21	10.30	12.46	12.64
15	7.20	14.42	5.35	7.32	7.21	2.91	7.62	9.20	7.57	13.52	5.49	8.25	17.77	5.16	12.73	18.27

TABLE 7. 4T-VN(JAN-APR) COD R,V, SURVEY POPULATION ESTIMATES WITH THE 1981 VALUE WINDZORISED. 22/ 3/83

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	118	1522	146	174	1052	6117	1105	2489	336	1976	9531	4570
2	1149	4393	9522	4793	23809	15934	20630	6732	43878	9328	41369	63888
3	12508	8887	18795	19768	6814	63330	30614	34014	44532	64773	36360	50123
4	15131	25099	8727	14661	19095	16008	25812	27033	94435	48643	98286	36848
5	14335	9493	13775	5637	7450	10604	10103	17009	57619	84680	80975	76019
6	11228	8458	6354	6621	3231	4589	5358	6104	23494	41569	81280	37826
7	6979	6109	4613	2866	2573	1333	3056	3338	6135	14994	35047	27804
8	1727	3097	3528	2028	1873	878	1315	1329	2517	2494	19337	13372
9	354	638	2235	2343	1345	495	969	396	1258	1210	2716	1885
10	381	529	611	748	652	390	621	720	336	506	1146	586
11	218	295	145	400	690	423	503	574	371	122	507	190
12	127	191	461	192	364	108	404	211	615	24	209	88
12+	633	208	439	700	261	191	614	412	0	73	363	190
1+	64888	68919	69551	60931	69209	120400	101104	100411	275526	270392	407146	313389
2+	64770	67397	69405	60757	68157	114283	99999	97922	275190	268416	397595	308819
3+	63621	63004	59883	55964	44348	98349	79369	91190	231312	259088	356226	244931
4+	51113	54117	41088	36196	37534	35019	48755	57176	186780	194315	319866	194808
5+	35982	29018	32361	21535	18439	19011	22943	30143	92345	145672	221580	157960
6+	21647	19525	18586	15898	10989	8407	12840	13134	34726	60992	140605	81941

Table 8. 4T-Vn (Jan.-Apr.) cod analysis of variance of a multiplicative model.

Multiple R = 0.788

Multiple R^2 = 0.620

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F-VALUE
Intercept	1	848.7	848.7	
Regression	33	516.6	15.7	53.79
Province-gear-tonnage class	8	186.8	23.4	80.25
Months	11	95.4	8.7	29.81
Years	14	71.1	5.1	17.44
Residuals	1 087	316.3	0.291	
TOTAL	1 121	1 682		

Table 9. 4T-Vn (Jan.-Apr.) cod catch rates standardized to CAN-M TC4 otter trawlers fishing in January.

YEAR	TOTAL CATCH	PROPORTION	CATCH RATE		RELATIVE EFFORT
			Mean	S.E.	
1968	46 551	0.385	0.512	0.055	90 911
1969	47 819	0.456	0.524	0.054	91 247
1970	64 459	0.342	0.477	0.048	135 025
1971	56 375	0.409	0.372	0.038	151 665
1972	65 291	0.369	0.411	0.042	159 001
1973	49 608	0.298	0.304	0.032	163 376
1974	47 255	0.278	0.306	0.032	154 352
1975	41 231	0.321	0.310	0.033	132 912
1976	32 729	0.489	0.318	0.033	102 834
1977	22 219	0.465	0.348	0.037	63 856
1978	37 880	0.358	0.465	0.051	81 442
1979	51 202	0.583	0.534	0.052	95 911
1980	57 270	0.481	0.621	0.062	92 160
1981	65 177	0.476	0.619	0.061	105 341
1982	58 181	0.412	0.757	0.078	76 818

Average coefficient of variation for the mean = 0.103

Table 10a. 4T-Vn (Jan.-Apr.) cod results of calibration of SPA mean exploited biomass and standardized catch rate.

YEAR	CATCH RATE	EXB	PRED	EXB	PRED	EXB	PRED	EXB	PRED	EXB	PRED
1968	0.512	102 453	192 395	102 382	161 524	102 341	142 978	102 312	130 602	102 293	121 741
1969	0.524	90 591	201 592	90 523	168 310	90 482	148 317	90 455	134 976	90 436	125 425
1970	0.477	111 581	165 571	111 410	141 731	111 307	127 404	111 239	117 842	111 190	110 996
1971	0.372	104 414	85 099	104 121	82 351	103 945	80 682	103 828	79 564	103 744	78 762
1972	0.411	97 435	114 988	96 907	104 406	96 590	98 036	96 379	93 782	96 228	90 734
1973	0.304	71 521	32 983	70 748	43 895	70 284	50 424	69 975	54 774	69 754	57 886
1974	0.306	56 251	34 516	55 421	45 026	54 921	51 314	54 588	55 503	54 351	58 500
1975	0.310	45 130	37 582	43 684	47 288	42 813	53 094	42 231	56 961	41 815	59 728
1976	0.318	63 980	43 713	60 205	51 812	57 919	56 654	56 383	59 878	55 286	62 184
1977	0.348	77 086	66 705	70 705	68 778	66 836	70 003	64 236	70 815	62 379	71 394
1978	0.465	168 241	156 374	148 679	134 944	136 779	122 064	128 840	113 468	123 168	107 312
1979	0.534	214 666	209 256	182 289	173 965	162 836	152 767	149 852	138 622	140 568	128 495
1980	0.621	313 550	275 933	254 964	223 166	219 782	191 479	196 308	170 338	179 530	155 204
1981	0.619	333 010	274 400	261 251	222 035	218 149	190 589	180 345	169 609	168 582	154 590
1982	0.757	421 360	380 163	316 020	300 077	252 816	251 995	210 680	219 918	180 583	196 955
B_0		-200 003		-128 024		-84 846		-56 051		-35 441	
B_1		766 401		565 524		444 969		364 556		306 996	
r		.908		.922		.930		.931		.923	
F		.15		.20		.25		.30		.35	

Table 10b. 4T-Vn (Jan.-Apr.) cod results of calibration of SPA mean 6+ numbers and research vessel surveys 6+ numbers.

YEAR	6+ RV	SPA 6+	PRED	SPA 6+	PRED	SPA 6+	PRED	SPA 6+	PRED
1971	21 647	53 906	57 176	53 731	49 957	53 626	45 625	53 556	42 737
1972	19 525	43 420	52 790	43 146	46 662	42 982	42 984	42 873	40 532
1973	18 586	31 481	50 849	31 206	45 203	31 042	41 815	30 932	39 557
1974	15 898	25 819	45 293	25 434	41 029	25 204	38 470	25 050	36 764
1975	10 989	16 701	35 145	16 098	33 405	15 736	32 360	15 494	31 663
1976	8 407	20 590	29 808	19 310	29 395	18 540	29 146	18 026	28 980
1977	12 840	29 929	38 972	27 036	36 279	25 299	34 664	24 141	33 586
1978	13 134	42 906	39 579	37 738	36 736	34 635	35 030	32 565	33 892
1979	34 726	111 016	84 211	93 346	70 270	82 738	61 904	75 662	56 327
1980	60 992	178 280	138 504	145 713	111 064	126 113	94 597	113 050	83 618
1981	140 605	242 099	303 068	189 834	234 710	158 466	193 688	137 551	166 339
1982	81 941	260 955	181 807	195 717	143 599	156 573	120 671	130 478	105 385
B_0		12 431		16 338		18 682		20 245	
B_1		2.067		1.553		1.245		1.039	
r		.919		.921		.921		.918	
F		.15		.20		.25		.30	

Table 10c. 4T-Vn (Jan.-Apr.) cod results of calibration of SPA mean 4+ numbers and research vessel surveys 4+ numbers.

YEAR	4+ RV	SPA 4+	PRED	SPA 4+	PRED	SPA 4+	PRED	SPA 4+	PRED
1971	51 113	118 744	157 147	118 341	140 781	118 099	130 966	117 938	124 427
1972	54 117	114 098	163 133	113 542	145 191	113 207	134 432	112 985	127 263
1973	41 088	77 117	137 170	76 230	126 062	75 698	119 401	75 343	114 964
1974	36 196	68 350	127 422	66 444	118 880	65 301	113 758	64 538	110 346
1975	37 534	81 845	130 088	77 500	120 844	74 892	115 301	73 152	111 609
1976	35 019	91 176	125 077	83 453	117 152	78 816	112 400	75 723	109 235
1977	48 755	207 384	152 448	181 081	137 319	165 303	128 246	154 787	122 202
1978	57 176	340 725	169 228	292 041	149 683	262 851	137 960	243 411	130 151
1979	186 780	458 441	427 486	380 587	339 969	333 915	287 473	302 838	252 491
1980	194 315	488 972	442 501	391 658	351 032	333 305	296 166	294 436	259 603
1981	319 866	595 735	692 682	459 200	535 368	377 286	441 003	322 687	378 117
1982	194 808	525 280	443 483	393 960	351 756	315 168	296 734	262 640	260 069
B_0		55 296		65 736		72 001		76 179	
B_1		1.993		1.468		1.154		.944	
r		.925		.912		.895		.873	
F		.15		.20		.25		.30	

TABLE 11. 4T-VN(JAN-APR) COD POPULATION NUMBERS FROM SPA WITH FT=0.275. 22/ 8/83

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
3	100717	109563	111918	107119	77841	68782	81812	106818	110788	144057	134519	45927	59796	41326	60487	52127	61208
4	73361	82304	89582	91457	87436	63358	56020	66624	87130	90248	117460	110067	37601	48942	33604	49432	42258
5	52957	59405	66807	72408	72960	68901	49759	43719	52401	68313	70690	92578	87126	29229	38150	26635	35491
6	38183	41947	47313	52964	54219	52648	50833	34653	30267	35114	47690	49748	63201	61481	19992	25147	16244
7	26202	28816	32431	35928	38806	38013	38084	35603	22909	16993	20605	27721	32157	50035	35840	11063	12181
8	17734	18944	21668	23779	25151	25803	26425	25452	23946	11426	6158	10406	15174	19207	27626	18451	5003
9	11982	12262	13814	15349	16031	15779	17338	16909	16546	13559	2957	3471	6112	8542	9943	14239	7394
10	6823	6799	7899	8468	9315	8575	9337	9326	9422	7317	4508	1701	2138	3665	4116	4739	6650
11	3453	3611	4135	4525	4508	4233	4349	4135	4449	3225	1240	2051	935	1218	2110	2345	2210
12	1955	2012	2379	2623	2853	2497	2526	2272	2216	1993	895	665	1009	627	642	1414	1011
13	1083	1168	1329	1511	1572	1530	1410	1252	1119	771	527	480	196	665	390	391	775
14	724	762	861	950	1024	989	1019	869	766	550	244	363	223	127	452	226	185
15	445	477	539	587	621	619	637	612	511	343	150	115	139	159	70	291	138
3+	335619	368068	400676	417668	392338	351727	339550	348245	362470	393909	407643	345294	305807	265223	233423	206498	190748
4+	234902	258506	288758	310550	314497	282945	257738	241427	251681	249852	273124	299367	246011	223897	172937	154371	129539
5+	161540	176202	199176	219093	227061	219587	201718	174803	164551	159604	155664	189300	208410	174955	139333	104940	87281
6+	108584	116797	132369	146685	154101	150687	151958	131084	112151	91291	84974	96722	121285	145726	101183	78304	51790

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	105266	94185	57014	50838	73532	28636	41597	60705	53350	148996	189659	190736	120089	179840	58661	179296
4	48758	85551	76832	46383	41599	60201	22051	33715	48589	41527	121687	154784	155827	98202	146976	47991
5	28214	33524	62678	58438	34903	31818	36355	14076	24735	30821	30326	97156	117878	123360	78791	118065
6	19386	18120	20131	39979	34298	21959	15802	19017	8030	14735	17010	21993	70729	82461	88506	59059
7	9223	11722	10607	13250	21941	19991	11470	7525	6656	4448	7544	11876	13660	48114	55181	57221
8	6875	4801	6959	6407	7054	12420	8695	5327	2875	2579	2273	4823	7444	8017	30779	33470
9	2431	4059	2776	3765	3522	3452	5529	3993	2381	1223	1357	1499	3025	4483	5299	18807
10	4007	1622	2642	1443	1776	1764	1587	2532	1386	1015	619	867	1032	1680	2892	3195
11	3735	2357	935	1453	524	952	794	630	1000	467	632	332	477	533	1032	1698
12	1025	2242	1116	574	675	288	371	306	244	302	253	421	179	182	279	594
13	489	493	1204	658	144	161	120	186	90	98	152	154	195	85	120	173
14	415	245	169	722	322	80	49	42	85	31	49	85	93	111	44	73
15	82	266	75	89	465	171	35	8	11	34	10	33	65	68	74	22
3+	229905	259187	243137	223998	220755	181894	144455	148061	149432	246275	371570	484760	490693	547138	468635	519663
4+	124639	165002	186123	173160	147223	153258	102857	87356	96082	97279	181911	294023	370603	367297	409974	340367
5+	75882	79451	109291	126777	105624	93057	80807	53641	47494	55753	60224	139239	214776	269095	262998	292376
6+	47668	45927	46613	68338	70720	61239	44452	39565	22759	24931	29897	42083	96898	145735	184206	174311

TABLE 12A, 4T-VII(JAN-APR) COD BEGINNING OF YEAR POPULATION BIOMASS FROM SPA WITH FT=0.275. 22/ 8/83

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
3	22158	24104	24622	23566	17125	16508	19635	22432	23266	28811	28249	8267	10763	8679	12097	11468	13466
4	74829	79835	77936	83225	69074	70327	52099	65291	78417	74906	82222	84751	25945	30834	21843	38062	30848
5	55075	67721	76160	81097	72960	80614	71156	53338	61309	71046	70690	77766	100194	17829	26323	20509	32652
6	50784	47819	70024	75209	71027	82657	82857	61682	45703	45999	68196	61190	64465	55333	14794	20620	17381
7	37993	48987	59025	69701	61701	79067	74644	69782	42610	27529	36060	42690	44055	57540	34407	11727	17784
8	28729	36183	41386	52314	49296	70701	73726	64647	51964	23195	13116	23102	28679	32844	33428	20850	7805
9	23604	26117	27629	36684	31261	52703	59817	55969	42855	32812	8574	10342	18397	22806	14119	22497	13900
10	14805	17678	19273	22864	20774	30440	35013	38145	30151	20488	11992	5019	6501	12388	16258	11278	12901
11	8805	10110	9842	10680	10324	13333	18267	18526	15127	10547	4416	7201	5424	8184	8969	8488	5570
12	8213	7665	7446	7581	8273	10215	10333	9431	10480	8550	3446	2153	4692	4127	3276	7026	5349
13	4721	4078	4533	5635	4638	7758	6827	6537	5105	6213	2508	5141	1754	3572	4413	4459	6059
14	1948	3085	3495	4294	2202	4482	4991	3380	3506	4252	1095	3369	2626	1129	3817	3009	2094
15	1589	2170	2073	2466	1298	3854	3154	2932	3625	2200	1054	1123	1460	1633	972	3043	1340
3+	333252	375552	423445	475316	419953	522659	512519	472092	414117	356548	331618	332115	314955	256897	194717	183037	167150
4+	311094	351449	398823	451749	402828	506152	492884	449660	390851	327736	303369	323848	304191	248219	182620	171569	153684
5+	236265	271614	320887	368524	333754	435824	440785	384369	312434	252830	221148	239097	278247	217385	160777	133507	122836
6+	181190	203893	244726	287427	260794	355211	369629	331031	251125	181785	150457	161331	178052	199556	134454	112997	90184

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	20000	19779	14824	11693	16912	7159	12479	16390	20273	40229	43621	64850	56442	116896	37543	70284
4	30717	57319	42258	21800	17887	31305	11687	19217	27210	23670	58410	102158	101288	69724	82307	33594
5	23982	30172	53903	46751	35252	25772	30902	12387	23004	29280	31236	106872	117878	104856	58306	110981
6	25202	23375	24559	53171	42873	27010	17698	26053	11403	20482	28237	35629	99728	96480	90277	72642
7	15587	21334	17395	25308	40372	28587	16403	13996	13046	8006	18180	26366	31144	70728	70079	89264
8	11757	13538	15379	18838	16646	26703	15390	12304	6700	6060	7955	13793	23673	19080	50170	59243
9	6514	9417	5274	9939	7714	11841	13324	9822	6310	3241	5806	5291	11887	12016	18704	52282
10	9536	4444	5073	6912	8186	7040	4681	7774	3908	3400	3013	3660	6159	4889	12058	10415
11	8926	5491	1936	4140	2414	3629	2747	3230	2670	1984	3943	1626	2774	2128	5552	9898
12	4654	9552	3471	1905	2563	2036	1554	1773	1032	1097	1436	2355	1071	668	1638	5290
13	2585	3139	7503	4248	854	999	700	1531	830	433	905	956	940	551	904	1523
14	2467	1722	786	4540	2674	443	306	204	549	221	295	582	636	1026	450	773
15	690	2853	440	558	3205	704	237	68	69	355	59	245	842	386	853	330
3+	162617	202135	192799	209802	197553	173228	128108	124751	117005	138460	203097	364382	454462	499427	428840	516518
4+	142616	182356	177975	198110	180640	166069	115629	108361	96732	98231	159475	299531	398020	382531	391297	446234
5+	111899	125037	135718	176310	162753	134765	103942	89143	69523	74561	101065	197373	296732	312807	308990	412640
6+	87917	94865	81815	129559	127501	108992	73041	76756	46519	45281	69829	90502	178854	207951	250684	301659

TABLE 12B. 4T-VN(JAN-APR) COD ESTIMATED MEAN BIOMASS FROM SPA WITH FY=0.275. 22/ 8/83

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
3	42130	43416	45345	40415	34765	29378	35868	42013	41819	48756	49012	14670	18248	13793	21495	18843	20382
4	71318	78117	79651	78090	74798	70913	52850	63421	74825	72948	80152	92360	21564	28563	21213	35415	27385
5	51435	69012	75854	76160	78002	82043	66612	49652	53461	69982	66108	71234	74836	16339	23467	19073	29125
6	50042	53274	70083	68396	75333	78892	76441	51633	35965	41211	54621	52333	61043	44164	13365	19571	16680
7	37239	45179	55791	58929	66507	76771	69937	60613	32075	19828	29427	35522	38461	44504	27278	9820	14657
8	27547	31749	39157	40702	51434	65461	64772	53043	41851	15201	11807	20860	25928	21926	27928	17623	7286
9	20702	22617	25385	27893	31353	43451	48537	41667	30460	20854	6644	8280	15261	19686	12910	17451	11694
10	12442	13327	14533	15619	17078	24036	26178	24573	18699	10810	9534	5296	7391	10675	11903	8119	10880
11	8315	8739	8713	9483	10419	11868	13357	14161	11681	6450	3134	5935	4763	5267	7992	6939	5218
12	5851	5937	6533	5994	8142	8465	8388	7084	8449	4980	4278	2066	4124	4308	3861	6623	3801
13	3836	3790	4433	3545	4600	6266	4851	4836	4758	2754	2924	3765	1418	3715	3689	3128	3929
14	2071	2542	2953	2379	2944	3790	3867	3542	2853	2269	1135	2304	2080	1063	3436	2029	1235
15	1326	2389	1683	2047	694	5325	2596	2303	3475	1499	734	1257	1202	1135	883	2306	859
3+	334257	380088	430114	429652	456070	506659	474253	418541	360370	317544	319509	315882	276319	215139	179420	166942	153131
4+	292126	336672	384770	389237	421305	477281	438385	376527	318551	268787	270497	301212	258071	201346	157926	148098	132749
5+	220808	258555	305119	311147	346507	406368	385535	313107	243726	195839	190345	208852	236506	172783	136713	112684	105364
6+	169373	189543	229265	234987	268504	324325	318924	263455	190266	125857	124237	137618	161670	156444	113246	93610	76239

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	33919	28960	18008	14486	23048	9173	15514	21162	21963	48557	66870	81185	62838	98255	35573	37238
4	30622	55809	44586	27815	21535	31433	12133	21110	28470	27303	79176	110076	103291	63888	95766	31249
5	23871	27517	53988	45301	31134	21796	28873	12041	21950	29179	33504	103672	107212	97741	65306	123602
6	23433	20406	25113	47030	35435	21420	16102	19295	9694	19659	27432	33627	84506	82781	90482	77880
7	14786	18319	18294	20867	33279	21586	14557	10061	9229	8131	15968	25211	24666	60065	65107	87876
8	10644	8556	12558	12235	14340	19382	12607	9052	4803	6034	6534	12921	17047	19026	51735	55674
9	5417	6965	6146	9233	7517	7634	10438	6489	4774	3186	4649	5742	7734	12134	14106	58328
10	7321	2970	4652	4262	5539	4516	4028	4722	2924	3696	2249	3234	3687	5262	11054	8550
11	9334	4468	1939	3338	2250	2464	2292	1895	1816	1715	3068	1341	1415	1900	5488	10262
12	3908	8603	3885	1379	1740	1232	1573	1291	692	1016	1184	1525	786	783	1594	5888
13	2152	1647	5900	3442	624	586	396	940	449	364	735	788	995	507	845	1656
14	2675	922	674	3845	1396	334	163	128	458	121	270	702	497	941	393	823
15	452	3000	307	474	2506	339	183	50	52	336	44	217	896	284	747	322
3+	168534	188143	196051	193710	180343	141894	118862	108236	107274	149298	241684	380241	415569	443567	438196	499349
4+	134615	159182	178042	179223	157295	132721	103347	87074	85311	100741	174814	299056	352731	345312	402623	462111
5+	103993	103373	133456	151408	135760	101288	91214	65965	56841	73438	95638	188979	249440	281424	306857	430861
6+	80123	75856	79468	106107	104626	79492	62341	53924	34891	44258	62134	85307	142228	183682	241551	307259

TABLE 13. 4T-VN(JAN-APR) COD ESTIMATED FISHING MORTALITIES AT AGE FROM SPA WITH FT=0.275. 22/ 8/83

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
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	0.027
4	0.011	0.009	0.013	0.026	0.038	0.042	0.048	0.040	0.043	0.044	0.038	0.034	0.052	0.049	0.032	0.131	0.204
5	0.033	0.028	0.032	0.089	0.126	0.104	0.162	0.168	0.200	0.159	0.151	0.182	0.149	0.180	0.217	0.295	0.405
6	0.081	0.057	0.075	0.111	0.155	0.124	0.156	0.214	0.377	0.333	0.343	0.236	0.034	0.340	0.392	0.525	0.366
7	0.124	0.085	0.110	0.157	0.208	0.164	0.203	0.197	0.496	0.815	0.483	0.403	0.315	0.394	0.464	0.594	0.372
8	0.169	0.116	0.145	0.194	0.266	0.198	0.246	0.231	0.369	1.152	0.373	0.332	0.375	0.458	0.463	0.715	0.522
9	0.367	0.240	0.289	0.299	0.426	0.325	0.420	0.385	0.616	0.901	0.353	0.284	0.311	0.530	0.541	0.561	0.413
10	0.436	0.297	0.357	0.430	0.589	0.479	0.614	0.540	0.872	1.575	0.587	0.399	0.363	0.332	0.363	0.563	0.377
11	0.340	0.217	0.255	0.261	0.391	0.316	0.449	0.424	0.603	1.082	0.424	0.509	0.199	0.440	0.201	0.641	0.568
12	0.315	0.214	0.254	0.312	0.423	0.371	0.502	0.508	0.856	1.130	0.422	1.022	0.217	0.276	0.296	0.401	0.527
13	0.152	0.106	0.136	0.189	0.263	0.207	0.284	0.292	0.511	0.951	0.174	0.566	0.234	0.186	0.346	0.551	0.423
14	0.217	0.147	0.183	0.225	0.304	0.240	0.309	0.332	0.604	1.100	0.547	0.756	0.138	0.390	0.242	0.294	0.607
15	0.217	0.144	0.178	0.221	0.303	0.233	0.299	0.280	0.530	1.029	0.466	0.376	0.333	0.422	0.468	0.627	0.407
7+	0.225	0.149	0.184	0.225	0.310	0.240	0.310	0.292	0.543	1.036	0.460	0.396	0.328	0.419	0.458	0.620	0.422

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.007	0.004	0.006	0.001	0.000	0.061	0.010	0.023	0.051	0.002	0.003	0.002	0.001	0.002	0.001	0.004
4	0.175	0.111	0.074	0.084	0.068	0.304	0.249	0.110	0.255	0.114	0.025	0.072	0.034	0.020	0.019	0.039
5	0.243	0.310	0.250	0.333	0.263	0.500	0.448	0.361	0.318	0.394	0.121	0.117	0.157	0.132	0.088	0.111
6	0.303	0.336	0.218	0.400	0.340	0.449	0.542	0.850	0.391	0.470	0.159	0.276	0.185	0.202	0.236	0.181
7	0.453	0.321	0.304	0.430	0.369	0.633	0.567	0.762	0.748	0.471	0.247	0.267	0.333	0.247	0.300	0.275
8	0.327	0.348	0.414	0.398	0.515	0.609	0.578	0.605	0.655	0.442	0.216	0.267	0.307	0.214	0.293	0.275
9	0.205	0.229	0.454	0.551	0.491	0.577	0.581	0.858	0.653	0.482	0.247	0.173	0.388	0.239	0.306	0.124
10	0.331	0.351	0.398	0.814	0.423	0.598	0.724	0.729	0.888	0.274	0.423	0.399	0.460	0.287	0.333	0.124
11	0.310	0.548	0.288	0.567	0.399	0.743	0.753	0.748	0.997	0.413	0.207	0.420	0.762	0.448	0.352	0.069
12	0.533	0.422	0.329	1.182	1.230	0.670	0.490	1.028	0.717	0.490	0.298	0.569	0.546	0.213	0.277	0.096
13	0.489	0.870	0.312	0.514	0.389	0.994	0.862	0.579	0.866	0.486	0.376	0.300	0.365	0.461	0.304	0.041
14	0.246	0.984	0.446	0.239	0.436	0.635	1.564	1.171	0.730	0.937	0.199	0.067	0.113	0.197	0.493	0.028
15	0.366	0.312	0.366	0.463	0.414	0.618	0.583	0.734	0.726	0.443	0.251	0.266	0.337	0.243	0.299	0.245
7+	0.365	0.357	0.360	0.478	0.429	0.623	0.589	0.739	0.745	0.445	0.251	0.274	0.346	0.245	0.299	0.242

Table 14a. 4T-Vn (Jan.-Apr.) cod, projections to 1984 fishing at $F_{0.1}$ = 0.20 in 1983. Mean biomass was calculated with the estimated average weights in the fishery for 1980-82.

AGE	POPULATION NUMBERS		MEAN POPULATION BIOMASS		CATCH BIOMASS		FISHING MORTALITY	
	1983	1984	1983	1984	1983	1984	1983	1984
3	190 000	91 564	91 908	44 292	257	124	.003	.003
4	146 231	155 124	90 473	95 975	2 569	2 726	.028	.028
5	37 787	116 372	29 576	91 085	2 378	7 323	.080	.080
6	86 547	28 547	85 304	28 138	11 226	3 703	.132	.132
7	40 350	62 121	47 810	73 607	9 562	14 721	.200	.200
8	35 585	27 047	59 382	45 135	11 876	9 027	.200	.200
9	20 815	23 853	46 181	52 922	9 236	10 584	.200	.200
10	13 605	13 953	39 249	40 250	7 850	8 050	.200	.200
11	2 311	9 120	10 614	41 883	2 123	8 377	.200	.200
12	1 298	1 549	5 689	6 792	1 138	1 358	.200	.200
13	442	870	3 055	6 014	611	1 203	.200	.200
14	136	296	762	1 659	152	332	.200	.200
15	58	91	287	452	57	90	.200	.200
3+	575 164	530 507	510 290	528 204	59 035	67 618		
4+	385 164	438 943	418 382	483 912	58 778	67 494		
5+	238 933	283 819	327 909	387 937	56 209	64 768		
6+	201 146	167 448	298 333	296 852	53 831	57 445		

Table 14b. 4T-Vn (Jan.-Apr.) cod, projections to 1984 catching the 62 000 t TAC in 1983. Mean biomass was calculated with the estimated average weights in the fishery for 1980-82.

AGE	POPULATION NUMBERS		MEAN POPULATION BIOMASS		CATCH BIOMASS		FISHING MORTALITY	
	1983	1984	1983	1984	1983	1984	1983	1984
3	190 000	91 564	91 901	44 292	271	124	.003	.003
4	146 231	155 100	90 405	95 960	2 709	2 725	.030	.028
5	37 787	116 191	29 514	90 944	2 503	7 312	.085	.080
6	86 547	28 422	85 014	28 014	11 803	3 687	.139	.132
7	40 350	61 674	47 566	73 077	10 035	14 615	.211	.200
8	35 585	26 752	59 079	44 643	12 465	8 929	.211	.200
9	20 815	23 593	45 945	52 344	9 693	10 469	.211	.200
10	13 605	13 800	39 048	39 811	8 238	7 962	.211	.200
11	2 311	9 020	10 560	41 425	2 228	8 285	.211	.200
12	1 298	1 532	5 660	6 718	1 194	1 344	.211	.200
13	442	860	3 040	5 948	641	1 190	.211	.200
14	136	293	759	1 641	160	328	.211	.200
15	58	90	286	447	60	89	.211	.200
3+	575 164	528 891	508 778	525 265	62 000	67 059		
4+	385 164	437 327	416 876	480 973	61 729	66 935		
5+	238 933	282 227	326 471	385 012	59 020	64 209		
6+	201 146	166 037	296 956	294 069	56 517	56 898		

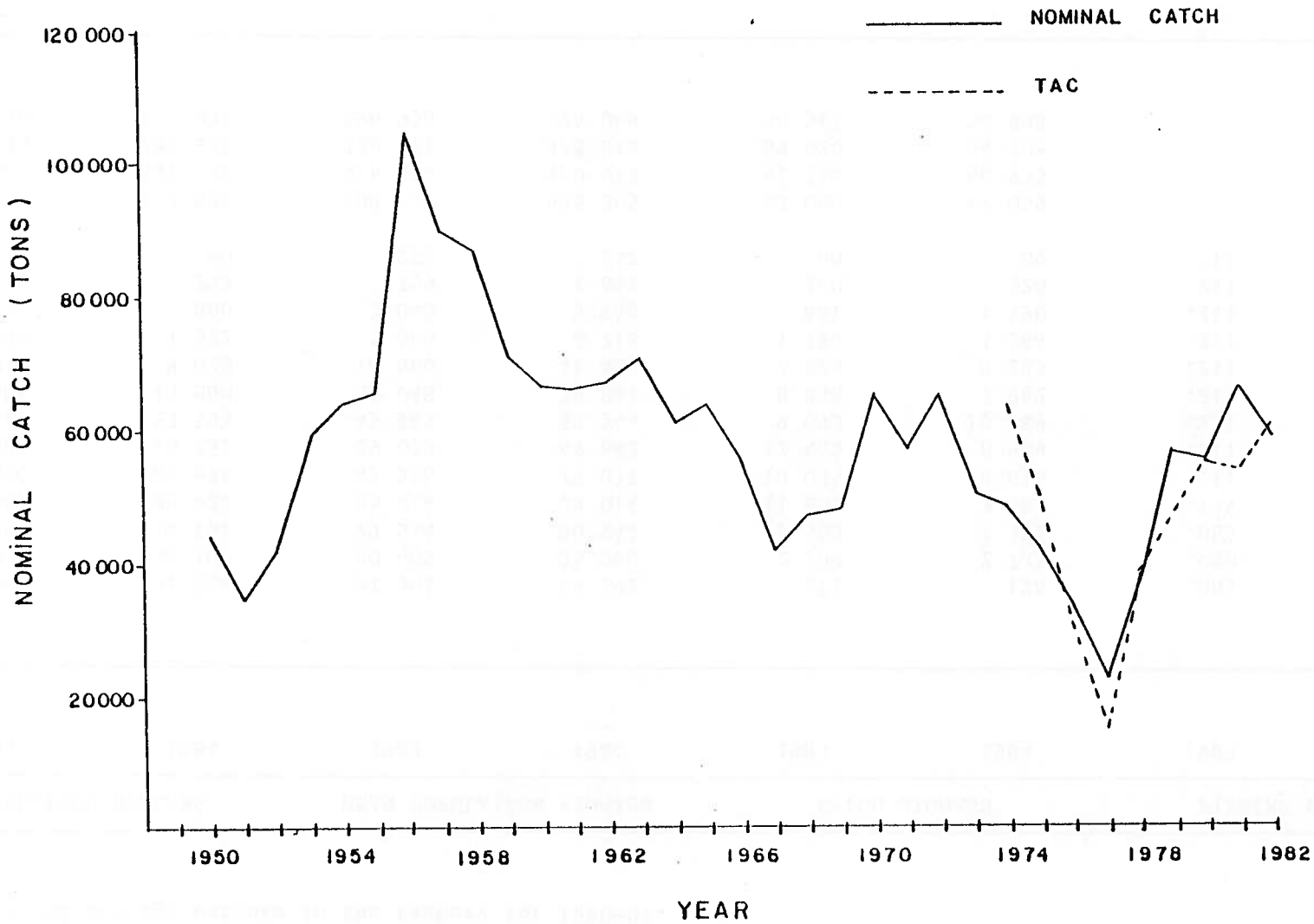

Figure 1. 4T-Vn (Jan.-Apr.) cod total nominal catches for 1950 to 1982. TAC since implemented are also shown.

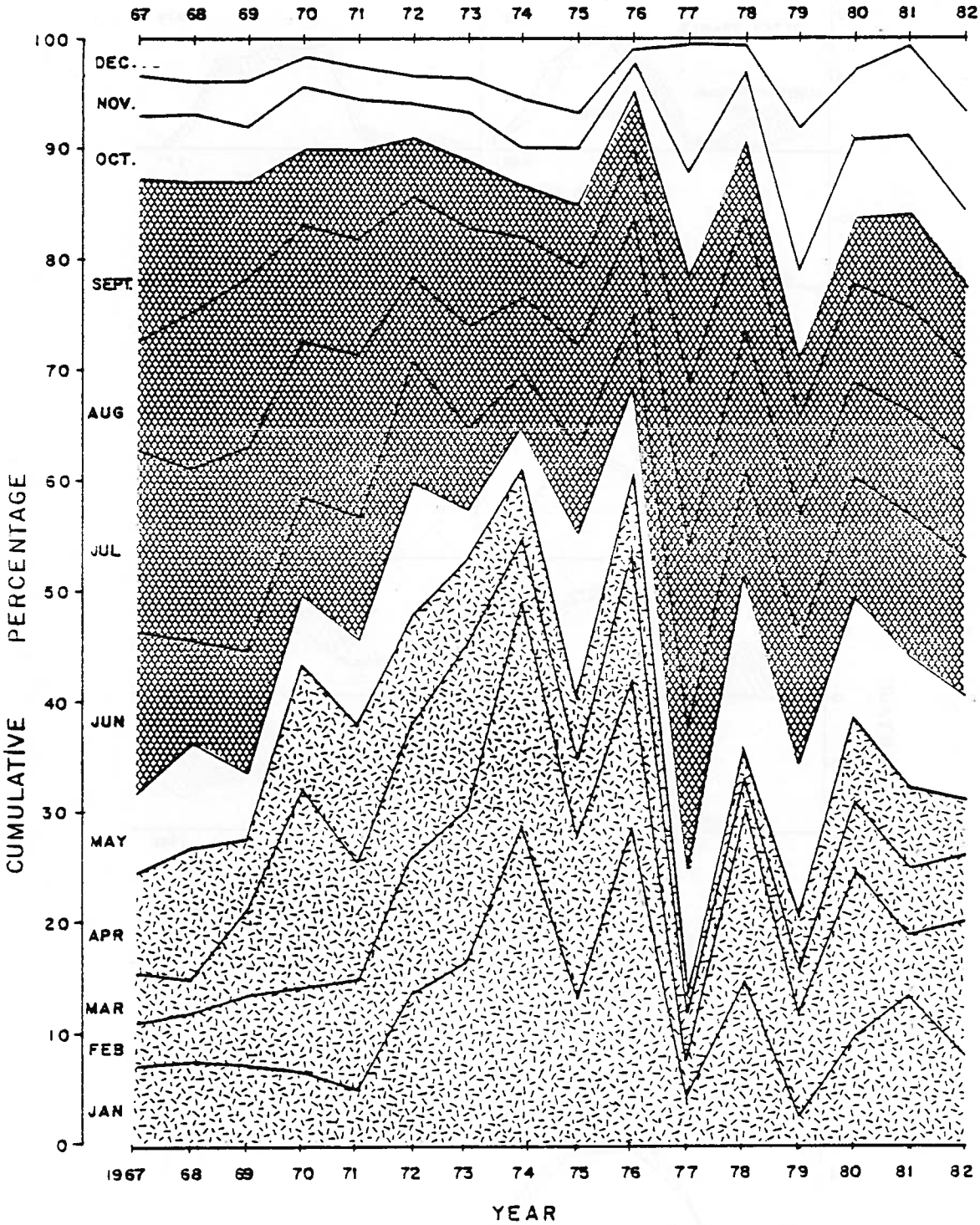

Figure 2. 4T-Vn (Jan.-Apr.) cod cumulative monthly percentage of nominal catches.

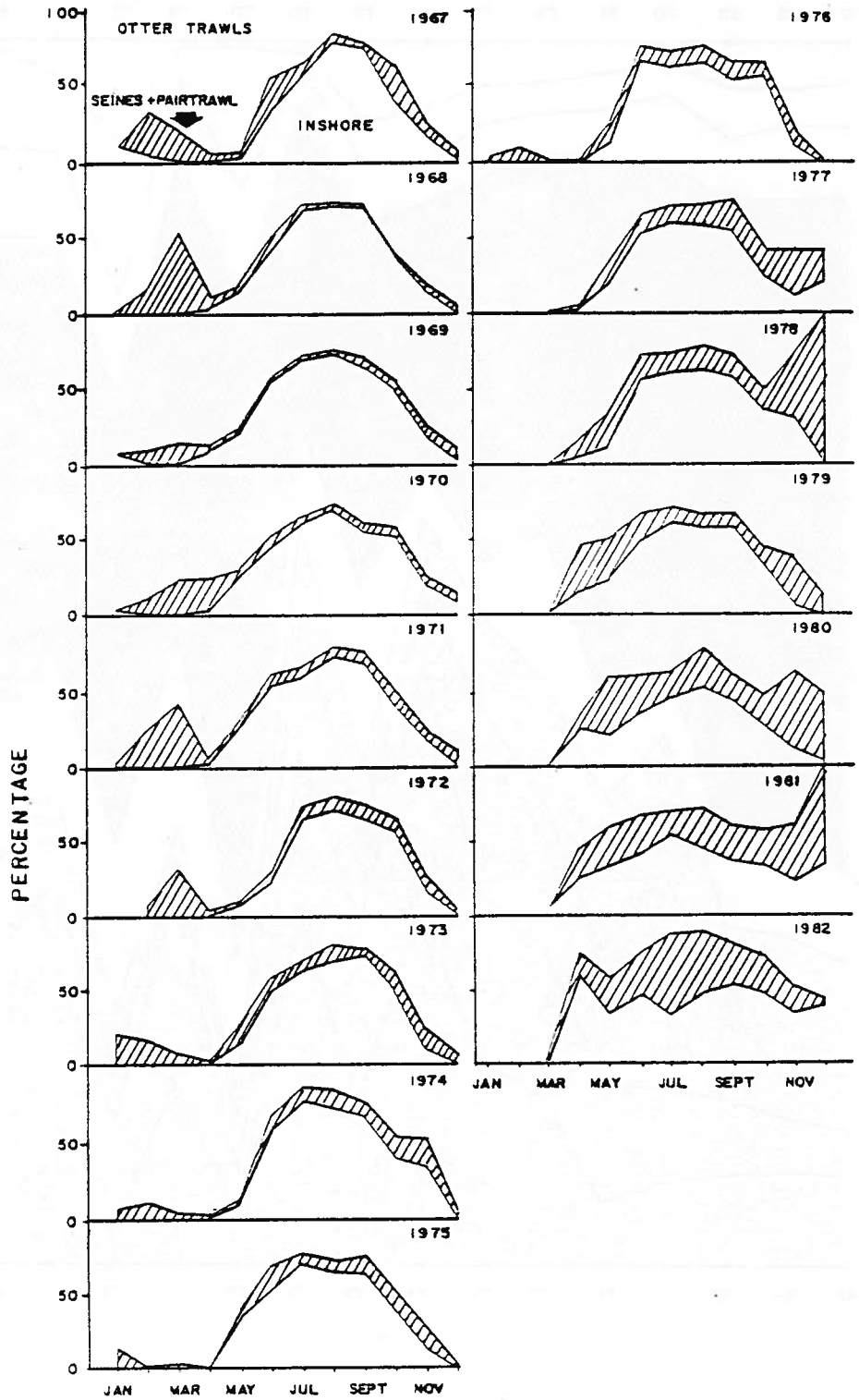

Figure 3. 4T-Vn (Jan.-Apr.) cod percentage of nominal catches by gear type and by month.

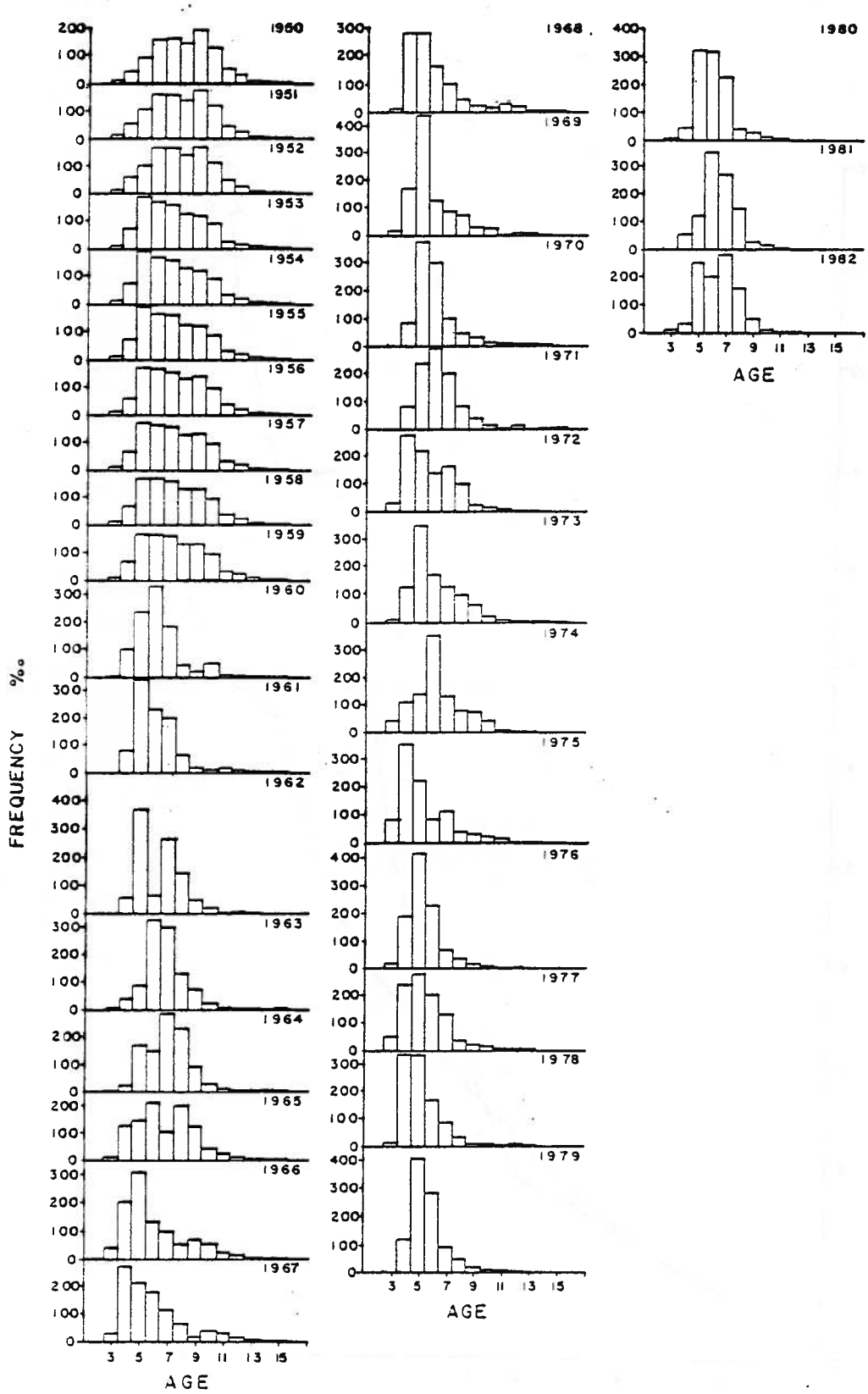

Figure 4. 4T-Vn (Jan.-Apr.) cod commercial age frequencies for 1950 to 1982.

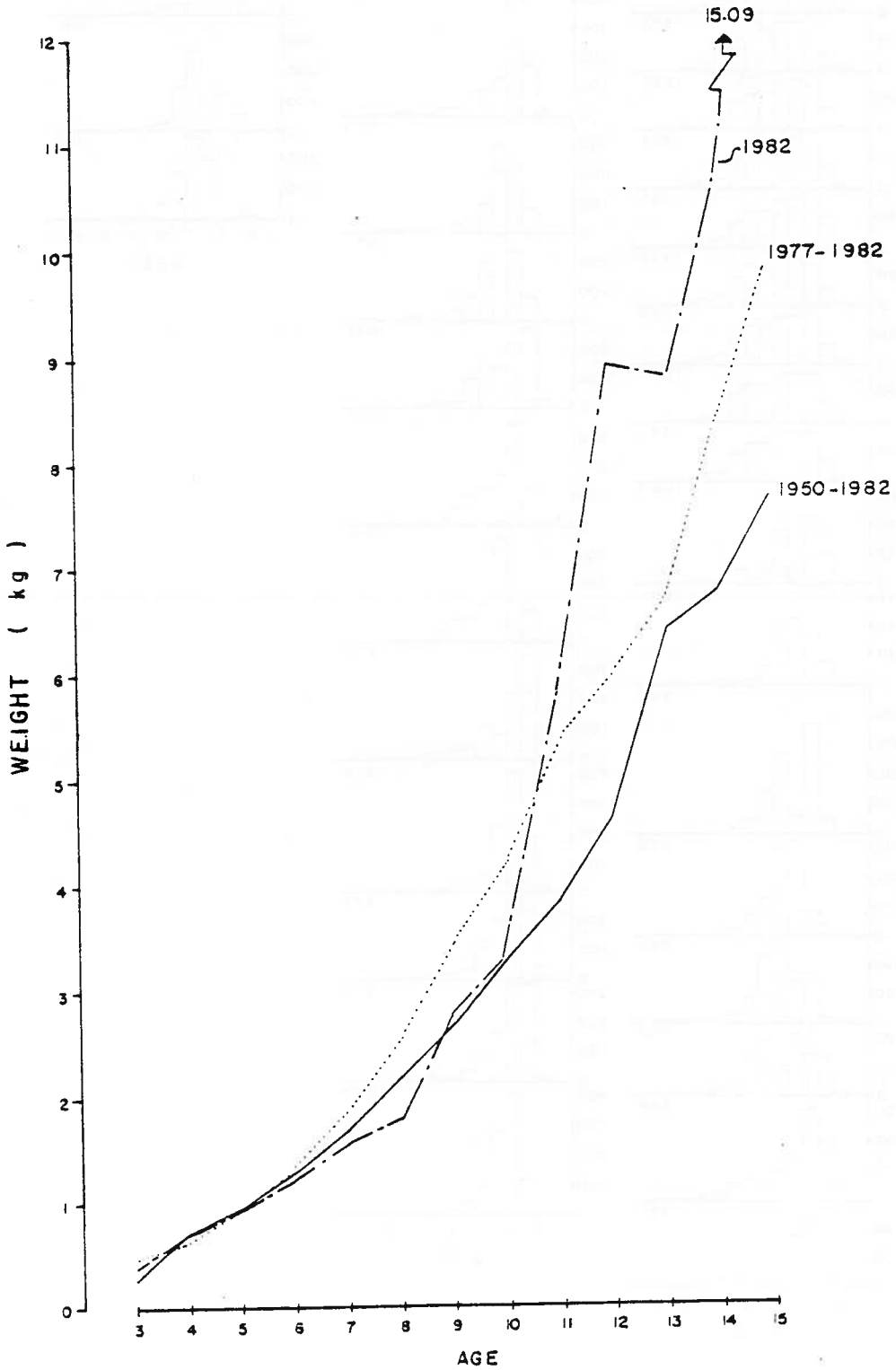

Figure 5. 4T-Vn (Jan.-Apr.) cod average beginning of year weights-at-age for: 1950 to 1982, 1977 to 1982 and 1982.

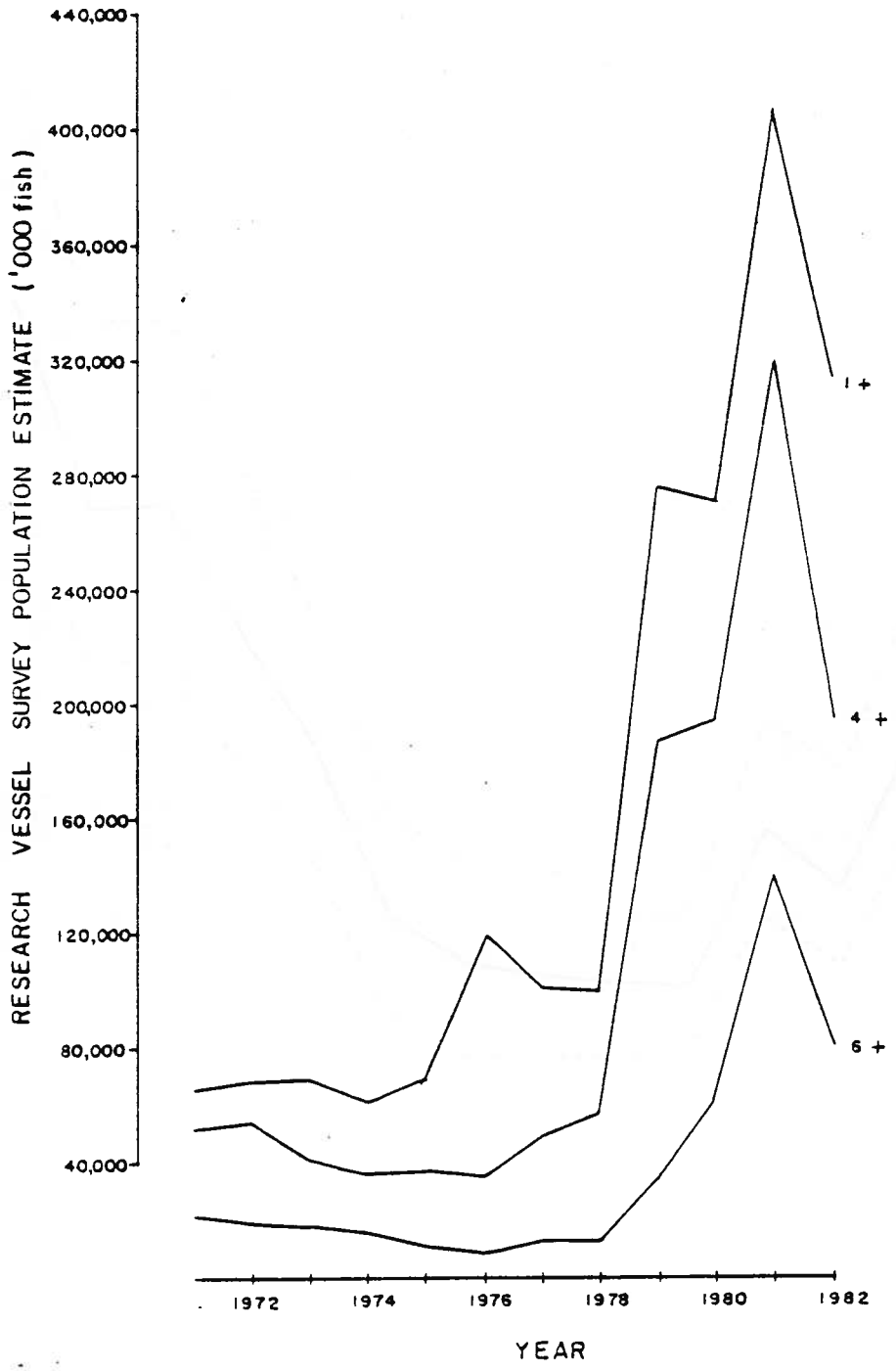

Figure 6. 4T-Vn (Jan.-Apr.) cod R.V. population number estimates for 1971 to 1982 (1981 value windzorized).

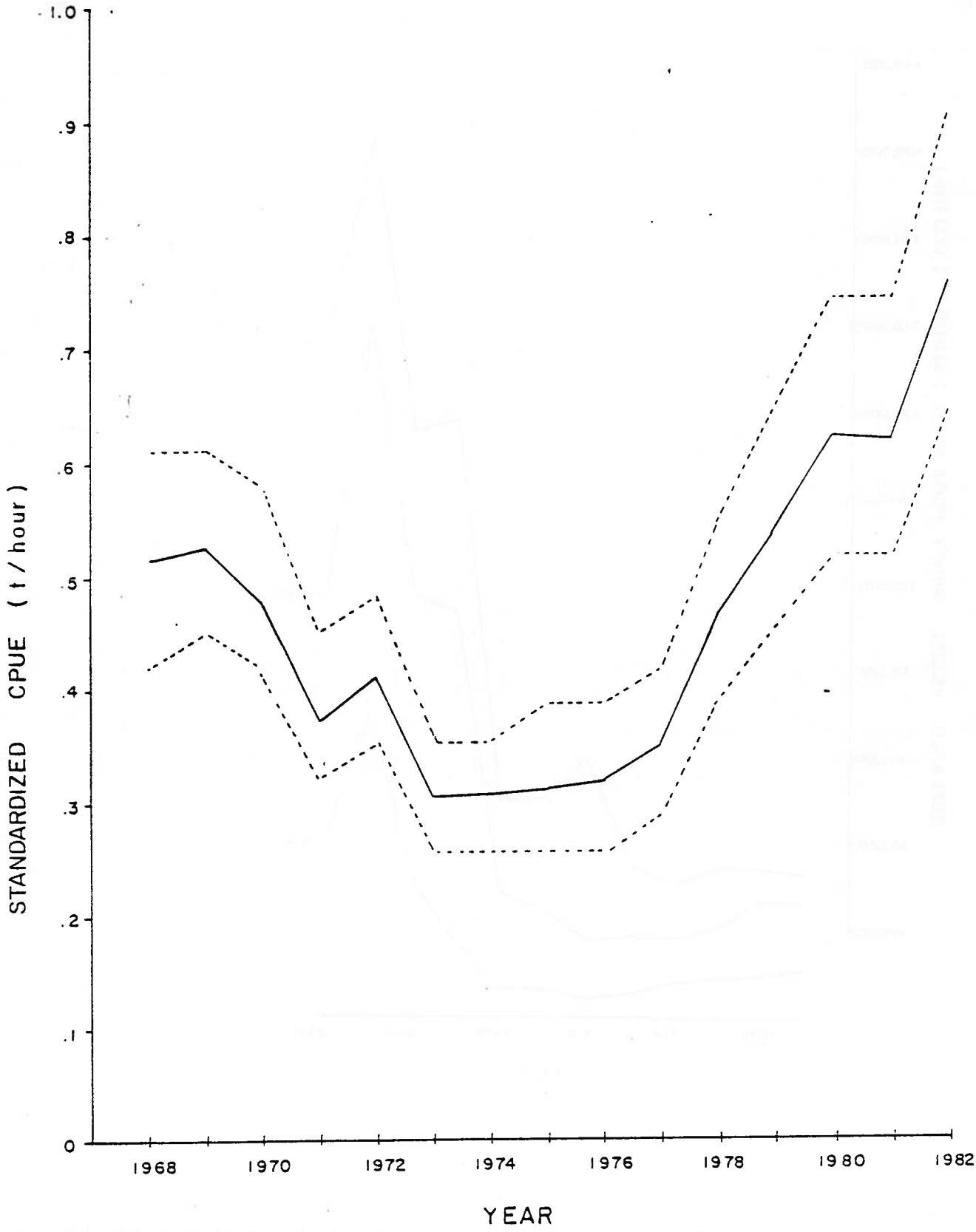

Figure 7. 4T-Vn (Jan.-Apr.) cod standardized commercial catch rate for 1968 to 1982 with approximate 90% confidence interval.