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The 1982 assessment of cod in NAFO Division 4T
and Subdivision 4Vn (Jan.-Apr.)

by

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Abstract

The nominal catches from the 4T-Vn (Jan.-Apr.) cod stock complex have declined from 65,000 t in 1972 to 22,000 in 1977. They have steadily increased since then to reach 59,325 t in 1981 (preliminary statistics). Stock size estimates from research surveys have increased almost exponentially in recent years and mortality rate estimates from that data set are extremely low and even negative in some instances. This indicates that the survey results have to be interpreted with caution. Commercial catch per trip for TC2 Danish seine and TC3 otter trawlers during the third quarter also indicate increases in stock size since 1976. Calibration of COHORT with these commercial catch rates and using the "Survivor" method suggested a 1981 fully recruited fishing mortality of 0.272. Population estimates at ages 3-4-5 were obtained by calibration of COHORT with the survey data, bearing in mind the suspected upward bias in the survey results. Projections at $F_{0.1}$ indicated 1983 catches of 62,000 t if the 1982 catches were equal to the 60,000 t TAC.

Résumé

Les captures nominales provenant du complexe de stock de morue de 4T-Vn (janv.-avr.) ont diminué de 65,000 t en 1972 jusqu'à 22,000 t en 1977. Depuis ce temps là les captures ont augmenté régulièrement et ont atteint

59,325 t en 1981 (données provisoires). Les effectifs estimés par navire de recherche ont augmenté presque exponentiellement au cours des dernières années et les taux de mortalité calculés à partir de ces données sont très bas et parfois même négatifs. Cette observation indique que les données des navires de recherche doivent être interprétées avec précaution. Les taux de capture (capture par voyage) des seineurs danois, (classe de tonnage 2) et des chalutiers à panneaux (classe de tonnage 3) durant le troisième trimestre, indiquent également une augmentation des effectifs depuis 1976. L'ajustement de "COHORT" avec ces taux de captures et les résultats de "Survivor" suggèrent que la mortalité par pêche sur les âges pleinement recrutés était de 0.272 en 1981. Les effectifs à 3-4 et 5 ans ont été estimés en calibrant "COHORT" avec les données des navires de recherche, en tenant compte d'une possible surévaluation des effectifs par les levées scientifiques. Les projections au niveau $F_{0.1}$ indiquent des captures de 62,000 en 1983 si les captures en 1982 sont égales au TPA de 60,000 t.

Introduction

The southern Gulf of St. Lawrence cod stock supports two major fisheries reflecting the migratory pattern of the stock. The summer fishery is concentrated in the southern Gulf of St. Lawrence (NAFO Division 4T), while the winter fishery (Jan.-Apr.) is mainly restricted to the Sydney Bight (Sub-division 4Vn). The combined fishery has historically been dominated by Canada which, since 1965, has taken at least 75% of the total nominal catches. Since 1977, the 4T fishery has been exclusively Canadian while in 4Vn, the French component has accounted for approximately 50% of the catch in recent years. Historic aspects of the fishery have been presented elsewhere (Paloheimo and Kohler 1968; Lett 1978). As have other stocks on the Canadian Atlantic coast, the 4T-Vn stock experienced very high exploitation rates in the early to mid-seventies, which led to stock decline. Contrary to neighboring stocks (e.g. 4Vs-W cod), however, young age-groups were not fished especially hard, with mature or nearly mature fish usually contributing most of the catches both in numbers and in weight. There was a succession of weak year-classes from 1965 to 1972 year-classes which, combined with the high exploitation rates mentioned above, were probably responsible for the dramatic decline observed in the first part of the 1970's.

Nominal catches

Nominal catches for 1965 to 1981 are presented in Fig. 1 and Table 1. Catch quotas were introduced in 1974 and significant restrictions were imposed on the fishery in 1976 and 1977, including reduction in TAC and exclusion of vessels greater than 100 ft from fishing in 4T. Since 1977, the TAC and catch have increased steadily, reflecting the strength of the 1973-75 year-classes. With the exception of 1978, the TAC has been overrun consistently since 1976. The largest overrun occurred in 1977 (48%). In 1981, nominal catches for 4T-Vn cod totalled 59,325 t of which 43,857 t (74%) and 15,468 t (26%) were taken, respectively, in 4T and 4Vn. Total catches, according to preliminary statistics, exceeded the TAC by 6325 t.

The percentage of the total catch taken in 4T in 1981 was slightly higher than reported in 1980 (74 vs 68%). French vessels took 49% of the catch in 4Vn (Table 2). A breakdown of the catch by fishery, gear and month is presented in Tables 2-4. In 4T, side otter trawls, fixed gillnets and Danish seines were the major gears accounting for 29.11, 28.18 and 23.12%, respectively, of the total catches (Table 3). In 4Vn, the majority of the catch (89%) was taken by large otter trawlers (Table 4).

In 4T, nominal catches were low in February, increased steadily from 1119 t in March to a peak of 7397 t in June, remained relatively constant at 4000-6000 t from July to November, and then declined sharply to 494 t in December (Table 2). Monthly trends in catches of the Maritimes, Quebec and Newfoundland components differed markedly (Table 2). Newfoundland boats were active almost exclusively in March and their catches in 4T were most likely made close to the 4Vn boundary (Table 2). Nominal catches by Quebec boats increased from 401 t in April, peaked at about 4000 t in June-July, and declined almost steadily thereafter to 791 t in November (Table 2). Maritimes boats fished in 4T from February to December and their nominal catches showed two modes, the first peaking in May (3640 t) and the second in November (4119 t) (Table 2). The decline in nominal catches during the summer months stems mostly from reduced groundfish fishing of Danish/Scottish seiners and otter trawlers (Table 3). These vessel categories direct more effort towards snow crab fishing during the summer months. The mid-summer dip in catches was not observed for gillnets, longlines and handlines. The monthly breakdown of 4Vn catches is given in Table 4.

Quarterly age frequencies from commercial samples by gear/quarter are given in Table 5 along with an indication of sampling intensity and measures of central tendency for age and length for each sample combination. It should be noted that no distinction was made between Danish and Scottish seine when the samples were collected. Seine catches (pair, Danish/Scottish) were particularly well sampled and otter trawl catches during the fourth quarter in 4T and in 4Vn were also adequately sampled. However, there was relatively poor sampling for second and third quarter otter trawl catches, longline catches (all quarters), and particularly gillnet catches for which only two samples were collected. As expected, size (age) selectivity in the component fisheries varied greatly. The modal age in the commercial samples taken from seines, handlines, and trawls (with the exception of second quarter trawls, unspecified) was 6 whereas, for longlines and gillnets, the corresponding ages were 8 and 7, respectively (Table 5).

The samples combinations of Table 5 were further amalgamated to calculate catch-at-age (Table 6). The numbers at the bottom of Table 6 refer to the key number of Table 5. Because only 97 gillnet caught fish were aged (see Table 5), the age-length key derived from Scottish/Danish seine samples (quarter 2, 3 and 4) was used to calculate the age composition of the gillnet length frequency.

Close to 43 million cod were caught in the 4T-Vn (Jan.-Apr.) cod fishery during 1981. The 1975 year-class dominated the numbers caught (37%) and together the 1973 to 1975 year-class accounted for 74% of the total number caught. The 1976 year-class contributed 13%, about the same amount as the 1973 year-class (12%). The 1977 year-class represented only 6% of the numbers caught compared with 34% and 24% for the 1974 and 1973 year-classes, respectively, at age 4. In terms of weight, the 1973 to 1975 year-class accounted for the same percentage as for numbers (74%), but the relative contribution of each is altered. The 1976 year-class represented 8% of the weight caught, while the 1973 year-class accounted for 18%.

Calculated weights-at-age for different gear/quarter combination and the year's average are given in Table 7. The 4T-Vn catch matrix for 1950 to 1981 and the estimated January weights-at-age for the same period are given respectively in Tables 8 and 9.

Stock-size indices

Research: In previous years, there was some concern that the research survey may overestimate stock size. Sinclair and Maguire (1981) attempted to account for a potential non-Gaussian distribution of catch per set, and hypothesizing a log-normal distribution, they calculated population estimates by taking the average of the log catch/set plus 1 in each stratum and re-transformed the values taking the variance into account. This did indeed lower the population estimates, but the trends since 1971 and rate of increase since 1976 were essentially identical. Since the survey data are used as a relative index of stock size, the log transformation did not solve the problem of the survey overestimating the increase in stock size since 1976. It is known that, often, high average catch/set values in a given stratum are the results of very high catches in only one or few sets. When such high catch/set occur in a large stratum, the influence of only one fishing set on the total population estimates for the entire survey area may be substantial. In an attempt to identify the "influential" sets, plots of stratum population estimates were made based on calculations from individual sets rather than from the stratum's average catch/set, (Fig. 2). These indicated that sets in strata 17-22-23-24 and 29 during the 1976 and 1978 to 1981 cruises looked anomalously large compared with previous year's catches in these strata or the other sets in the same year. Population estimates were thus recalculated excluding those sets. The sets and strata concerned are identified in Table 10.

Table 11 shows the catch/set for each stratum since 1971, while Table 12 shows the population estimates at age both unadjusted (Table 12a) and adjusted (Table 12b), by removing the large sets. Table 12 suggests that prior to 1978-79, cod were fully recruited to the research fishing gear at age 4 in the southern Gulf of St. Lawrence. However, since 1978, some year-classes appear to be fully recruited at an older age. This is especially evident between 1980 and 1981 where almost all age-groups are more abundant in 1981 than in 1980. A careful examination of Table 12a suggests that there has been essentially no mortality on the 1972 and subsequent year-classes since 1977 and even the adjusted data (Table 12b) shows similar mortality rates on these year-classes. This indicates that the research survey results have to be interpreted with caution.

Figure 3 shows the 5+ and 6+ research vessel survey population estimates (both unadjusted and adjusted) since 1971. The age 5+ show decline in population numbers from about 36 million fish in 1971 to 19 million in 1975-76, and very rapid increases thereafter, but especially since 1978. The ages 6+ show a slightly more pronounced decline from 1971 to 1975 (from 21 million to 8.5 million fish), a slight increase from 1975 to 1978 and rapid increases (about one order of magnitude) in the following years to 1981. Because of the magnitude of the increase after 1978 and due to the linear scale used, the decline from 1971 to 1975 does not look as important as it really is. The 1975-76 population estimates are only about half the 1971 estimate.

Commercial catch rates

In previous assessments (Beacham 1980; Gray 1979; Sinclair and Maguire 1981) catch rates from directed trips for Canadian otter trawlers tonnage class 3 (May to July in 4T) and tonnage classes 4-5 (January to March in 4Vn) and for Canadian Danish seiners tonnage classes 2-3 (May to July in 4T) have been presented as number of tons caught per hours fished. The Danish seine series were incomplete due to missing effort values (hours fished) for some years and for tonnage class 3 otter trawlers, the number of entries with effort values in hours fished was small. In an attempt to incorporate more catch-and-effort values in calculation of catch rates for TC 2-3 Danish seiners and TC 3 otter trawlers, quarterly catches per trip were calculated for these gear and tonnage class categories. Examination of the data indicated that third quarter catch rates showed the most consistent trends and were the most complete data sets. Catch per trip may be a biased estimator of catch rates if the number of days fished per trip is not constant. Where available, the number of days per trip is given along with catch and number of trips but, because of missing values for some years, no attempt has been made to adjust the catch rates for the number of days per trip (Tables 13-16). The data for 1970 to 1978 inclusive are for Maritimes and Quebec-based vessels, while since 1979 only Maritimes-based vessels are included. Otter trawlers TC 4-5 (Table 16) catch rates (Jan.-Mar.) are presented only for qualitative indication of stock status. Fishing success for these tonnage classes in 4Vn is very dependent on weather and ice conditions and on fish behaviour. These catch rates are thus expected to be very variable from year to year.

The third quarter tonnage class 2 Danish seiners catch rates declined from 6.7 t/trip in 1970 to 2.5 t/trip in 1976 (Table 13). The decline is not steady from year to year (Fig. 4) but the trend is evident over the period. Catch rates increased steadily after 1976 to reach 12.3 t/trip in 1981, the highest value since 1970. The number of days fished per trip (Fig. 4) does not show any consistent trend since 1978.

Tonnage class 3 Danish seiners did not contribute very much to the 4T cod fishery in the early seventies (Table 14). Their catch rates (Table 14) increased almost steadily (except a small dip in 1979) from 6.33 t/trip in 1973 to 23 t/trip in 1981. Although the increase in catch rates since 1975-76 is evident in that category as in the others, there is no indication of any noticeable decline from 1971 or 1973 to 1975-76.

Otter trawlers TC 3 third quarter catch rates (Table 15) declined from 20.4 t/trip in 1970 to 6.7 t/trip in 1974, increased slightly to 7.9-7.8 t per trip in 1975-76, then increased sharply for the next five years to reach 35.6 t/trip in 1981 (Fig. 4). The number of days fished per trip (Fig. 4) does show an increasing trend since 1978. It is most likely that the 1981 catch/trip is overestimated compared to the 1978 value, because the number of days fished per trip has increased, but the meaning in terms of relative stock size is not clear. If the fishermen were trying to achieve a certain level of catch, they would have longer trips when the stock size is low and the reverse when the stock size is high. On the other hand, good fishing success may be an incentive to stay out longer and bring back a larger catch.

Both tonnage classes 4 and 5 otter trawlers catch rates in 4Vn in Jan.-Mar. (Table 16, Fig. 5) show similar trends. They are more variable than the other data sets presented. They show a decline from 1969 to 1977, high peak in 1978, sharp decline in 1979 followed by a return to the 1978 level in 1980 and slight increase in 1981. As mentioned above, these catch rates were expected to be more variable due to the nature of that fishery.

All catch rates decline from the early seventies to the mid-seventies and increase to high values in 1980-81.

Calibration of SPA

As in the previous assessment (Sinclair and Maguire 1981) the "Survivor" program (Doubleday and Rivard 1981; Rivard 1981) was used with the unadjusted research vessel surveys population estimates to calculate the 1981 fishing mortality rates on fully recruited ages. The calibration block was from 1971 age 3 to 1980 and age 12. The calibration constant k was set to level off at age 6. The average fully recruited 1981 fishing mortality was 0.272.

Age of full recruitment to the commercial fishery for this cod stock appears to be 6 years old. Thus, in order to have to change only one parameter at a time (fully recruited fishing mortality) ages 6 and older mid-year COHORT population estimates were calibrated with the adjusted ages 6 and older R.V. population estimates. For all COHORT runs, the fishing mortality on the oldest age-group for each year was set at the average F of ages 7 to 10. Due to the potential overestimation of stock size by the research survey in recent years, but particularly in 1981, no weight was given to the 1981 value and the best agreement from 1971 to 1980 between the two data sets was sought. A COHORT run at $F_{81} = 0.25$ (Fig. 6) gave a 1980 value close to the regression line, a y -intercept near zero and a correlation coefficient of $r = 0.98$ (for 1971 to 1980). The negative intercept and the 1980 value slightly above the line suggest that $F_T 0.25$ may be a bit low. The 1981 COHORT estimate was much below the regression line.

Although the survey data has generally shown good agreement with COHORT estimates it is always desirable to confirm the survey trends with information from the commercial fishery. This is especially important in this case because of a suspected upward bias in the survey. Thus, calibration of COHORT with commercial catch rates was also attempted. Third quarter Danish seine tonnage class 2 and tonnage class 3 otter trawlers catch rates were compared with the fully recruited (6+) mid-year biomass. Exploratory COHORT runs were also made between mid-year exploited biomass and catch rates. However, the effect of the last year's partial recruitment is difficult to quantify and these relationships were not considered useful in determining stock status although, theoretically, they should be preferable to R.V. indices if the partial recruitment (P.R.) were known. COHORT runs at 1981 fully recruited fishing mortality of 0.15, 0.20, 0.272 and 0.30 were made and the results for tonnage class 2 Danish seines are shown in Table 17. The correlation coefficient increased from $r = 0.853$ at $F_T = 0.15$ to $r = 0.866$ at $F_T = 0.20$ and $r = 0.865$ at $F_T = 0.272$ then decreased to $r = 0.857$ at $F_T = 0.30$. Correlation coefficient alone thus does not allow to discriminate between F_T 's ranging from 0.15 to 0.30. The y-intercept is highly negative at $F_T = 0.15$ and becomes closer to zero as F_T increases, but is still negative at $F_T = 0.30$. The ratios in Table 17 indicate that at $F_T = 0.15$ and $F_T = 0.20$, recent biomasses are overestimated while the early seventies biomasses are somewhat underestimated when compared to the catch rates. At $F_T = 0.272$ the ratios are in fair agreement while at $F_T = 0.30$ the 1981 biomass appears underestimated. These results suggest that $F_T = 0.272$ is probably a reasonable estimate of the 1981 fishing mortality rate on the fully recruited portion of that stock.

The results of the calibration of mid-year 6+ COHORT biomass with otter trawlers TC 3 third quarter catch rates are given in Table 18. The correlation coefficient increased from $F_T = 0.15$ ($r = 0.916$) to $F_T = 0.20$ ($r = 0.919$) and decreased thereafter to $r = 0.885$ at $F_T = 0.30$. In this case again the correlation coefficients do not allow to discriminate between F_T ranging from 0.15 to 0.30. The y-intercept was essentially zero at $F_T = 0.20$ and at that fishing mortality rate, the biomass ratio for 1981 is below the catch ratio. This would suggest that $F_T = 0.20$ gives the best agreement between these two data sets. However, knowing that the number of days/trip has increased since 1978 (Fig. 4), it is unlikely that $F_T = 0.2$ accurately reflects the fishing mortality rate experience by that stock in 1981. It is known that the fishing effort has certainly not decreased in 1981 and, given the fishing mortality rates in previous years, it is unlikely that the 1981 fully recruited fishing mortality rate was below $F_T = 0.25$. Since good relationships were obtained at $F_T = 0.272$ with "Survivor" and Danish seines TC 2 catch rates, because the calibration of COHORT with the 6+ adjusted population estimates from the survey suggested at F_T above 0.25 and given the known bias in the TC 3 otter trawlers catch rates, $F_T = 0.272$ was chosen as best representing the 1981 ages 6 and older stock size.

The groundfish research vessel survey is carried out in September of each year and significant commercial catches are made before and after the survey. COHORT analysis gives population estimates at age for January 1st of each year. Thus comparing COHORT estimates at age i (Jan. 1st) with the sum (or the average) of the survey estimates at age $i-1$ and i would seem reasonable since the sum (or the average) should be an estimate of the population for the mid-point between the surveys (about March).

At $F_T = 0.272$, there is a good relationship (Fig. 7) between COHORT age 5 population estimates and the R.V. ages 4+5 population estimates for the 1967 to 1974 year-classes. The equation

$$(1) C_5 = -3663 + 1.3951 RV_{4+5}$$

where C_5 = COHORT population estimate at age 5

RV_{4+5} = the sum of the ages 4 and 5 research vessel population estimates for each year-class

predicts population estimates at age 5 for the 1975 and 1976 year-classes of 246 and 197 million fish, respectively. The fit is good ($r = 0.92$) but the lowest of these estimates is about twice the size of the highest age 5 population estimate observed since 1950 (the 1956 year-class at age 5 was estimated at 92 million and the 1974 year-class at the same age at 109 million). The estimates thus appear to be extremely high if the relationship between COHORT and survey estimates was to hold for recent years. Since there has been some concern that recent survey may be overestimating stock and year-class sizes it would seem unwise to adjust the partial recruitment on age 5 in 1981 to obtain the best fit between the COHORT and survey estimates. Because the strength of the 1976 year-class as indicated by the 1977, 1978 and 1979 surveys was of average or slightly above average size, the P.R. on age 5 in 1981 was adjusted to obtain a year-class size at age 3 of about 100 million fish (slightly above the geometric mean for the period covered by the survey). Figure 7 shows the resulting relationship between COHORT age 5 population estimates and survey ages 4+5 estimates.

The survey population estimates at ages 3+4 indicate that the 1977 year-class is stronger than any year-class observed since the initiation of the survey. That year-class still has, however, to show up in significant quantities in commercial catches although it did make a noticeable contribution to the 1981 Danish seine 4th quarter, the handline 3rd + 4th quarter and Scottish seine 3rd and 4th quarter catch-at-age (Table 6). Because of the previously mentioned uncertainties regarding the accuracy of the survey, and because of the relatively low contribution of the 1977 year-class to commercial catches, it was felt that a year-class size estimate at age 3 about equal to the highest previously observed (175 million) was probably the best estimate of the size of the 1977 year-class that could presently be obtained. The relationship between age 4 COHORT population estimates and surveys age 3+4 estimates is given in Fig. 8.

Indications from the research vessel survey are that the 1978 year-class is probably of average size. The 1981 fishing mortality rate on age 3 was thus adjusted to give a year-class estimate at age 3 of about 100 million fish. The relationship between COHORT age 3 population estimates and survey ages 2+3 estimates is shown in Fig. 9.

The partial recruitment vector for ages 3 to 5 resulting from these calibrations is:

<u>Age</u>	<u>3</u>	<u>4</u>	<u>5</u>
P.R.	.0015	.0754	.3755

with ages 6 to 15 being fully recruited.

COHORT estimates of population numbers, biomasses and fishing mortalities since 1950 are shown in Tables 19-21.

Yield-per-recruit

The adjustments to the 1981 partial recruitment values made above result in reasonable estimates of year-class sizes at age 3 for the 1976 to 1978 year-classes. However, these P.R. values are somewhat lower than P.R. estimates of recent years. This could be due to recent year-class being over-estimated or else to inaccuracies in the catch-at-age matrix for recent years. Because no major changes in fleet composition has been documented, it is felt that recent historical partial recruitment from the F matrix are more likely to represent the 1982-83 selectivities at age than the P.R. obtained from the calibration of COHORT analysis. Thus average P.R. for 1977 to 1979 were used to calculate Y/R with the average weights-at-age observed in the 1981 fishery. The results (Table 22) give a maximum yield-per-recruit of 0.641 kg per recruit at $F_{max} = 0.34$ and a yield of 0.603 kg per recruit at $F_{0.1} = 0.20$

Projections

Projections to 1983 were made (Table 23) with the 1977 to 1979 partial recruitment values, weights-at-age observed in the 1981 fishery and population estimates derived above. The 1979 and 1980 year-classes were set at 90 million fish, slightly above the geometric mean size of the 1968 to 1978 year-classes at age 3. If the 1982 TAC (60,000 t) is taken, the 1983 $F_{0.1}$ catch is 62,000 t. However, if the 1982 catch is at $F_{0.1}$ (55,000 t), the 1983 $F_{0.1}$ catch would be 63,000 t. It is estimated that the 1982 TAC (60,000 t) would result in fishing mortalities of $F_{82} = 0.22$, slightly above $F_{0.1}$.

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Table 1. Total 4TVn cod catch 1965 to 1981 (modified from Sinclair and Maguire 1981).

YEAR	CATCH(T)	TAC(T)	CATCH -TAC(T)	CATCH/TAC
1965	63027	-	-	-
1966	54851	-	-	-
1967	41314	-	-	-
1968	46551	-	-	-
1969	47819	-	-	-
1970	64459	-	-	-
1971	56375	-	-	-
1972	65291	-	-	-
1973	49608	-	-	-
1974	47255	63000	-15745	.75
1975	41231	50000	-8769	.82
1976	32729	30000	2729	1.09
1977	22219	15000	7219	1.48
1978	37880	38000	- 120	1.00
1979	51202	46000	5202	1.11
1980	57270	54000	3270	1.06
1981	59325 ¹	53000	6325	1.12

¹Preliminary.

Table 2. 4T-Vn cod catch in 4T and 4Vn during 1981. Values are given in t round weight.

Fishery	4T												TOTAL	% OF TOTAL CATCH
	J	F	M	A	M	J	J	A	S	O	N	D		
MARITIMES	-	62	68	1851	3640	3196	1988	2629	2598	3003	4119	494	23647	39.86
QUEBEC	-	-	-	401	3143	4202	3793	2510	3095	1208	791	-	19143	32.27
NEWFOUNDLAND	-	-	1051	2	14	-	-	-	-	-	-	-	1067	1.81
TOTAL	-	62	1119	2254	6797	7397	5781	5140	5693	4211	4910	494	43857	73.94

Fishery	4Vn												TOTAL	% OF TOTAL CATCH
	J	F	M	A	M	J	J	A	S	O	N	D		
MARITIMES	4372	277	444	1053	-	-	-	-	-	-	-	-	6146	10.36
NEWFOUNDLAND	-	136	1198	429	-	-	-	-	-	-	-	-	1763	2.97
FRANCE	n/a												7559	12.73
TOTAL	4372*	413*	1642*	1482*	-	-	-	-	-	-	-	-	15468	26.06

4TVn														
GRAND TOTAL	4372*	475*	2761*	3736*	6797*	7399*	5781*	5140*	5693*	4211*	4910*	494*	59325	100

*Excludes that portion of the French catch which is reflected in the total

Table 3. 1981 4T cod catch by Maritimes, Quebec and Newfoundland. Values are given in t round weight.

Gear Type	MARITIMES												TOTAL	% OF 4T CATCH
	J	F	M	A	M	J	J	A	S	O	N	D		
Danish-seines	-	-	-	585	1548	1540	743	1405	1094	1009	1891	325	10140	23.12
Otter trawls (side)	-	-	68	839	606	87	180	73	365	679	1079	-	3975	9.06
Gill nets (fixed)	-	-	-	51	753	738	643	603	420	285	54	8	3555	8.11
Longlines	-	-	-	10	52	24	45	144	350	555	573	160	1913	4.36
Scottish-seines	-	-	-	199	423	415	106	140	112	80	145	-	1619	3.69
Otter trawls (stern)	-	62	-	159	103	62	58	76	85	222	257	-	1084	2.47
Hand lines	-	-	-	4	112	261	188	179	164	128	16	2	1054	2.40
Shrimp trawls	-	-	-	-	11	-	-	-	-	43	58	-	112	0.26
Traps	-	-	-	1	19	39	-	1	-	1	-	-	61	0.14
Gill nets (drift)	-	-	-	-	-	13	11	1	6	-	-	-	31	0.07
Misc. and unknown	-	-	-	4	12	17	15	7	1	1	45	-	102	0.23
Total	-	62	68	1851	3640	3196	1988	2629	2598	3003	4119	494	23647	53.90

QUEBEC														
Gill nets (fixed)	-	-	-	74	1431	2213	2279	1318	729	383	375	-	8802	20.07
Otter trawls (side)	-	-	-	271	1629	1974	1345	771	1428	569	405	-	8391	19.13
Long lines	-	-	-	-	1	4	67	368	594	9	2	-	1045	2.38
Hand lines	-	-	-	56	82	12	102	54	333	247	9	-	894	2.04
Traps	-	-	-	-	-	-	-	-	11	-	-	-	11	0.03
Total	-	-	-	401	3143	4203	3793	2511	3095	1208	791	-	19143	43.90

NEWFOUNDLAND														
Otter trawls (side)	-	-	386	2	14	-	-	-	-	-	-	-	402	0.92
Otter trawls (stern)	-	-	665	-	-	-	-	-	-	-	-	-	665	1.52
Total	-	-	1051	2	14	-	-	-	-	-	-	-	1067	2.43

Total 4T		62	1119	2254	6797	7399	5781	5140	5693	4211	4910	494	43857	100
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Table 4. 1981 4Vn cod catches by Maritimes, Newfoundland, and France.

MARITIMES						
Gear Type	J	F	M	A	Total	% of Catch 4Vn
Otter trawls (stern)	3132	47	232	76	3487	22.54
Longlines	149	41	211	899	1300	8.40
Otter trawls (side)	1091	189	-	11	1291	8.35
Danish-seines	-	-	-	67	67	0.43
Misc. and unknown	-	-	1	-	-	0.01
Total	4372	277	444	1053	6146	39.73

NEWFOUNDLAND						
Otter trawls (side)	-	18	596	251	865	5.59
Otter trawls (stern)	-	25	526	57	608	3.93
Long lines	-	93	76	121	290	1.88
Total		136	1198	429	1763	11.40

FRANCE						
Otter trawls (stern)	NA	NA	NA	NA	7559	48.87
Total (4Vn)					15468	100.00

Table 5. Summary of commercial sampling from landings used to determine catch-at-age. Samples were grouped by quarters and gears.

Area	4T	4T	4T	4T	4T	4T	4T	4T	4T	4T	4T	4T	4T	4T	4Vn	4Vn
Key	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Gear	OTB ¹	OTB ¹	Shr ²	Shr ²	GN ¹	PrS ³	PrS ³	ScS ⁴	ScS ⁴	ScS ⁴	LL	LL	HL	HL	OTB ²	OTB ¹
Quarter	2	4	2	3	3	2	3	2	3	4	2	3	2	3	1	1
% at Age																
3	0.4	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.1	0.1	0.0	0.0
4	8.9	6.4	5.3	8.4	6.0	9.7	3.7	3.9	15.9	12.3	0.4	3.2	6.7	16.9	4.3	0.8
5	5.3	11.6	16.3	7.2	10.6	23.2	11.9	14.3	17.4	18.2	2.1	2.3	20.9	24.7	16.0	5.3
6	27.1	35.8	49.8	29.8	21.9	26.2	33.3	32.5	34.7	37.8	16.1	22.7	31.7	34.8	42.0	48.2
7	40.7	31.4	19.1	30.8	24.3	22.7	25.5	32.7	21.9	12.5	35.5	20.9	25.2	15.9	26.8	29.9
8	12.2	13.1	7.4	21.8	21.1	15.2	17.6	14.7	8.6	19.5	36.0	25.2	13.2	6.8	9.5	12.9
9	3.2	0.9	1.3	1.0	9.7	2.2	3.2	1.6	0.8	0.5	2.9	13.1	1.6	0.2	0.9	1.9
10	0.5	0.3	0.6	0.0	3.0	0.8	4.0	0.3	0.3	0.0	4.8	4.8	0.5	0.0	0.4	0.5
11	0.5	0.3	0.3	0.4	3.5	0.1	0.5	0.1	0.1	0.0	1.8	2.4	0.0	0.0	0.1	0.5
12	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	2.8	0.0	0.2	0.1	0.0
13	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.9	0.0	0.3	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.1
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mod. Lth.	52	55	49	49	52	49	49	49	49	52	58	55	49	49	49	49
Mod. Age	7	6	6	7	7	6	7	7	6	6	8	8	5	6	6	6
Avg. Lth.	52.72	53.20	51.45	51.01	59.09	50.36	55.83	49.29	49.60	50.35	60.33	65.98	49.91	48.74	48.70	51.23
Avg. Age	6.65	6.36	6.15	6.57	7.02	6.22	6.72	6.47	6.02	6.10	7.44	7.72	6.24	5.89	6.26	6.60
No. Samples	2	7	4	2	2	11	3	21	9	1	2	3	5	2	11	5
No. Aged	64	140	123	55	97	380	82	548	266	30	74	122	137	50	443	175
No. Meas.	400	1453	798	352	504	2200	600	4296	1920	200	394	539	1000	400	3696	1688

¹Unspecified; ²Coded as shrimp; ³Pair seine; ⁴Scottish seine.

Table 10. 4T-Vn cod. Sets excluded from calculations of adjusted R.V. population estimates.

<u>Year</u>	<u>Stratum</u>	<u>Set number</u>
1976	22	35
1978	23	33
1979	22	29
1980	17	50
	23	72
1981	17	53
	22	49
	23	34
	24	33
	29	39

Table 11. Average numbers caught per tow in R.V. 1971-81

S T R A T.	Y E A R										
	71	72	73	74	75	76	77	78	79	80	81
15	0	13	1	5	1	0	0	0	0	0	2
16	79	62	67	12	19	7	74	78	221	88	203
17	100	3	33	20	22	129	98	80	50	807	1430
18	121	66	185	25	29	70	117	71	146	67	16
19	62	57	41	271	5	207	121	417	708	207	161
20	22	61	114	118	21	89	112	174	105	22	92
21	45	85	62	25	57	9	60	140	162	43	296
22	113	148	113	71	140	438	50	267	506	230	744
23	29	21	25	7	5	20	40	124	146	233	279
24	14	18	6	11	12	17	32	1	199	166	526
25	7	1	0	1	21	1	1	0	0	4	1
26	16	57	9	22	1	4	6	19	83	76	260
27	39	10	4	8	1	3	26	21	42	63	33
28	3	78	63	12	35	97	23	1	482	81	337
29	11	22	69	53	73	27	101	22	115	119	200
31	34	5	17	39	23	31	99	66	112	144	121
32	14	130	9	0	91	0	0	5	13	2	1
33	6	5	1	26	25	16	70	18	41	1	60
34	4	38	3	3	10	7	10	11	53	58	93
35	10	17	14	25	100	214	16	9	11	214	38
36	19	4	3	6	3	6	4	4	20	77	57
38	1	7	4	0	18	71	3	3	24	58	31
38	31	55	3	32	1	12	13	29	132	141	107
39	0	24	2	20	1	0	6	60	4	0	49

Table 12. Population estimates from R.V. surveys (1971-1981)

A - Values not adjusted to account for large sets,

B - Values adjusted to account for large sets (see text for details).

A G E	Y E A R										
	71	72	73	74	75	76	77	78	79	80	81
1	118	1522	146	174	1052	6117	1105	2489	336	1976	9709
2	1149	4393	9522	4793	23809	15934	20630	6732	43878	9328	41508
3	12508	8887	18795	19768	6814	63330	30614	34014	44532	64773	38524
4	15131	25099	8727	14661	19095	16008	25812	27033	94435	48643	114900
5	14335	9493	13775	5637	7450	10604	10103	17009	57619	84680	95211
6	11228	8458	6554	6621	3231	4589	5358	6104	23494	41569	92909
7	6979	6109	4613	2866	2573	1333	3056	3388	6135	14994	39094
8	1727	3097	3528	2028	1873	878	1315	1329	2517	2494	21063
9	354	638	2235	2343	1345	495	969	396	1258	1210	2841
10	381	529	611	748	652	390	621	720	336	506	1162
11	218	295	145	400	690	423	503	574	371	122	513
12	127	191	461	192	364	108	404	211	615	24	209
13	633	208	439	700	261	191	614	412	0	73	502

A G E	Y E A R										
	71	72	73	74	75	76	77	78	79	80	81
1	118	1522	146	174	1052	4176	1105	2489	289	1938	6221
2	1149	4393	9522	4793	23809	12455	20630	6744	35441	8348	22348
3	12508	8887	18795	19768	6814	55857	30614	33801	40136	46076	27902
4	15131	25099	8727	14661	19095	15633	25812	24370	91687	36674	80710
5	14335	9493	13775	5637	7450	10724	10103	14718	56283	62132	65101
6	11228	8458	6554	6621	3231	4800	5358	5999	23134	30572	65715
7	6979	6109	4613	2866	2573	1412	3056	3113	6049	11682	29105
8	1727	3097	3528	2028	1873	947	1315	1232	2484	2236	16541
9	354	638	2235	2343	1345	528	969	373	1256	1109	2544
10	381	529	611	748	652	407	621	591	287	467	1110
11	218	295	145	400	690	439	503	381	348	126	505
12	127	191	461	192	364	118	404	211	557	24	223
13	633	208	439	700	261	202	614	412	0	75	376

Table 13. 4T-Vn cod. Canadian TC2 Danish seiners catch/trip (for directed trips) during the third quarter of the year in 4T. Values for Quebec seiners are included for 1970-78 inclusive.

Year	Catch	# of trips ¹	C/E	Days per trip
1970	497	74	6.7	2.959
1971	568	87	6.5	3.74
1972	602	81	7.4	2.988
1973	152	26.5	5.7	-
1974	29	6	4.8	-
1975	54	9	6.0	-
1976	15	6.1	2.5	-
1977	59	17	3.5	-
1978	46	8.2	5.6	3.537
1979	105	13.8	7.6	4.42
1980	205	25.2	8.1	3.135
1981	552	44.8	12.3	3.326

¹Fraction of trips are due to the way the effort is partitioned when more than one unit area have been fished during one trip.

Table 15. 4T-Vn cod. Canadian TC3 otter trawler catch/trip (for directed trips) during the third quarter of the year in 4T. Values for Quebec seiners are included for 1970-78 inclusive.

Year	Catch	# of trips ¹	C/E	Days per trip
1970	1268	62.1	20.42	4.09
1971	1389	104	13.36	-
1972	698	69	10.12	-
1973	612	52.6	11.63	-
1974	193	29	6.66	-
1975	452	57	7.93	-
1976	427	54.6	7.82	-
1977	783	67	11.69	4.522
1978	260	20.4	12.75	3.333
1979	135	8.9	15.17	3.82
1980	447	19.8	22.58	4.747
1981	360	10.1	35.64	4.752

¹Fraction of trips are due to the way the effort is partitioned when more than one unit area have been fished during one trip.

Table 14. 4T-Vn cod. Canadian TC3 Danish seiners catch/trip (for directed trips) during the third quarter of the year in 4T. Values for Quebec seiners are included for 1970-78 inclusive.

Year	Catch	# of trips ¹	C/E	Days per trip
1970	0	0	-	
1971	21	2	10.5	
1972	0	0	-	
1973	114	18	6.33	
1974	88	9	9.78	
1975	121	13	9.31	
1976	272	27.4	9.93	
1977	734	67.7	10.84	3.619
1978	950	72.4	13.12	3.881
1979	608	51.4	11.83	3.21
1980	1677	80.8	20.75	3.738
1981	2132	92.5	23.05	3.416

¹Fraction of trips are due to the way the effort is partitioned when more than one unit area have been fished during one trip.

Table 16. 4T-Vn cod catch per unit effort (t/hr) by Canadian otter trawls modified from Sinclair and Maguire 1981).

YEAR	Directed Trips, Jan-Mar (4Vn)								
	TC 4			TC 5					
	C	E	C/E	C	E	C/E			
1967	2918	3322	0.88	388	371	1.05			
1968	4835	4525	1.07	160	133	1.20			
1969	6019	6060	0.99	1743	1289	1.35			
1970	5888	5995	0.98	2517	1981	1.27			
1971	4130	5695	0.73	2321	2495	0.93			
1972	4902	5225	0.94	3689	3582	1.03			
1973	2924	3991	0.73	2678	2918	0.92			
1974	2965	4777	0.62	3729	5074	0.73			
1975	2323	3108	0.75	3498	4391	0.80			
1976	4536	5361	0.85	5685	6317	0.90			
1977	999	1802	0.55	1321	2247	0.59			
1978	4363	3141	1.39	4015	1998	2.01			
1979	1883	3214	0.59	3633	3406	1.07			
1980 ¹	3124	2689	1.16	4397	2223	1.98			
1981 ¹	1647	1346	1.22	2853	1396	2.04			

¹Includes Maritimes data only.

Table 17. 4T-Vn (J-A) cod. Results of calibration of COHORT 6+ mid-year biomass with TC 2 Danish seine third quarter catch per trip.

Year	Catch/ trip	ratios ¹	COHORT	Pred	ratios ¹	COHORT	Pred	ratios ¹	COHORT	Pred	ratios ¹	COHORT	Pred	ratios ¹
1970	6.7	1.05	121059	145459	.90	120838	123882	1.04	120659	106748	1.19	120612	102307	1.24
1971	6.5	1.02	112251	139084	.83	111824	119219	.96	111481	103445	1.10	111393	99357	1.14
1972	7.4	1.16	100576	169283	.75	99557	141306	.86	98745	119090	.98	98535	113332	1.01
1973	5.7	.89	70281	112575	.52	69244	99832	.60	68419	89712	.68	68204	87090	.70
1974	4.8	.75	59343	82041	.44	57863	77500	.50	56686	73894	.56	56381	72960	.58
1975	6.0	.94	45809	121300	.34	43544	106213	.37	41740	94232	.41	41272	91127	.42
1976	2.5	.39	52935	2516	.39	48840	19337	.42	45587	32695	.45	44744	36160	.46
1977	3.5	.55	76850	36406	.57	68696	44124	.59	62228	50252	.61	60553	51842	.62
1978	5.6	.88	133966	108213	.99	114594	96642	.99	99218	87453	.98	95235	85071	.98
1979	7.6	1.19	203461	175323	1.51	167174	145724	1.44	138361	122219	1.37	130896	116127	1.34
1980	8.1	1.27	286563	192771	2.12	224968	158485	1.94	176063	131258	1.74	163389	124201	1.68
1981	12.3	1.92	355242	333365	2.63	266431	261312	2.29	195905	204094	1.93	177621	189261	1.82
r			.853			.866			.865			.857		
B ₀			-80029			-41034			-10067			-2038		
B ₁			33555			24541			17383			15528		
F			.15			.20			.272			.30		

¹Ratios of yearly SPA 6+ biomass and catch rates divided by their respective 1970 to 1981 average.

Table 18. 4T-Vn (J-A) cod. Results of calibration of COHORT 6+ mid-year biomass with TC 3 otter trawlers third quarter catch per trip.

Year	Catch/ trip	ratios ¹	COHORT	Pred	ratios ¹	COHORT	Pred	ratios ¹	COHORT	Pred	ratios ¹	COHORT	Pred	ratios ¹
1970	20.4	1.39	121059	198353	.90	120838	161992	1.04	120659	133118	1.19	120612	125634	1.24
1971	13.4	.92	112251	120700	.83	111824	105902	.96	111481	94152	1.10	111393	91106	1.14
1972	10.1	.69	100576	85064	.75	99557	80162	.86	98745	76269	.98	98535	75261	1.01
1973	11.6	.79	70281	101672	.52	69244	92158	.60	68419	84603	.68	68204	82645	.70
1974	6.7	.46	59343	47007	.44	57863	52673	.50	56686	57172	.56	56381	58339	.58
1975	7.9	.54	45809	60976	.34	43544	62763	.37	41740	64181	.41	41272	64650	.42
1976	7.8	.53	52935	59766	.39	48840	61889	.42	45587	63574	.45	44744	64012	.46
1977	11.7	.80	76850	102332	.57	68696	92635	.59	62228	84939	.61	60553	82939	.62
1978	12.7	.87	133966	113991	.99	114594	101056	.99	99218	90785	.98	95235	88123	.98
1979	15.2	1.04	203461	140608	1.51	167174	120282	1.44	138161	104142	1.37	130896	99958	1.34
1980	22.6	1.54	286563	222111	2.12	224968	179152	1.94	176063	145040	1.74	163389	136198	1.68
1981	35.6	2.43	355242	365757	2.63	266431	282910	2.29	195905	217123	1.93	177621	200067	1.82
r			.916			.919			.90			.885		
B ₀			-26246			-238			20413			25767		
B ₁			10999			7945			5519			4891		
F			.15			.20			.272			.30		

¹Ratios of yearly SPA 6+ biomass and catch rates divided by their respective 1970 to 1981 average.

Table 19. AT-VH COG POPULATION NUMBERS (from COHORT analyses, see text) 31/ 5/82

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
3	100688	109518	111928	107183	77795	68868	81813	106652	110668	143733	134551	45916	59797	41329	60516	52113	61202
4	73413	82280	89545	91465	87488	63320	56091	66624	86994	90149	117194	110094	37592	48943	33607	49455	42246
5	52991	59447	66788	72378	72967	68943	49729	43777	52401	68202	70609	92361	87147	29221	38150	26637	35510
6	38096	41975	47348	52948	54195	52654	50868	34628	30314	35115	47598	49682	63023	61499	19987	25147	16246
7	26009	28744	32454	35957	38793	37993	38088	35632	22888	17032	20606	27646	32103	49889	35855	11059	12181
8	17360	18786	21609	23798	25174	25793	26409	25456	23970	11409	6189	10406	15113	19162	27507	18463	4999
9	11630	11956	13685	15301	16047	15798	17329	16896	16550	13578	2943	3497	6112	8492	9907	14141	7403
10	6525	6511	7648	8363	9276	8587	9352	9319	9411	7320	4524	1690	2160	3665	4075	4709	6570
11	3231	3367	3899	4320	4422	4201	4360	4148	4443	3216	1243	2064	926	1235	2110	2311	2186
12	1777	1830	2180	2430	2685	2427	2500	2281	2226	1988	888	666	1020	620	657	1414	984
13	919	1022	1181	1347	1414	1393	1353	1231	1126	779	523	474	197	674	383	403	775
14	591	627	741	828	891	860	906	821	748	556	251	359	218	128	459	221	194
15	350	368	429	489	522	509	531	520	472	328	155	121	137	155	71	296	134
3+1	333581	366432	399436	416807	391667	351345	339328	347984	362211	393405	407274	344978	305544	265013	233284	206369	190631
4+1	232893	256914	287508	309625	313872	282478	257516	241332	251543	249672	272723	299062	245748	223684	172768	154256	129429
5+1	159480	174635	197963	218159	226384	219157	201425	174708	164549	159523	155529	188968	208156	174741	139162	104801	87182
6+1	106488	115188	131175	145781	153417	150214	151696	130931	112148	91321	84919	96607	121008	145520	101011	78164	51672
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981		
3	105218	94445	57832	50574	74007	28848	41123	58266	60461	131888	176320	163389	100100	175165	100077		
4	48752	85512	77045	47053	41383	60590	22224	33326	46592	47349	107680	143864	133437	81837	143113		
5	28205	33520	62646	58613	35452	31641	36673	14218	24417	29187	35093	85688	108937	105029	64697		
6	19402	18113	20127	39953	34441	22409	15657	19278	8146	14475	15672	25896	61340	75141	72982		
7	9225	11735	10600	13247	21920	20107	11838	7406	6870	4543	7331	10781	16855	40427	49414		
8	6876	4802	6969	6402	7051	12403	8791	5628	2778	2753	2351	4648	6547	10633	24467		
9	2427	4059	2777	3773	3518	3450	5515	4071	2628	1144	1500	1563	2882	3749	7213		
10	4015	1619	2642	1444	1783	1761	1585	2521	1450	1217	554	984	1084	1563	2338		
11	3669	2363	933	1453	524	958	791	628	991	519	797	279	572	576	918		
12	1005	2189	1121	572	675	288	376	304	243	294	296	556	135	261	254		
13	482	476	1160	662	143	162	121	190	88	97	145	189	306	49	180		
14	415	240	156	686	326	79	49	42	89	29	48	80	122	201	14		
15	90	266	71	78	436	173	34	8	11	36	9	32	61	92	157		
3+1	229782	259340	244080	224510	221657	182869	144776	145886	154763	233531	347795	437948	432378	494722	465824		
4+1	124563	164894	186248	173936	147651	154021	103653	87620	94302	101644	171475	274559	332278	319557	365747		
5+1	75811	79382	109203	126882	106268	93431	81429	54294	47710	54295	63795	130696	198841	237720	222634		
6+1	47606	45863	46557	68270	70816	61790	44756	40076	23293	25108	28702	45008	89904	132691	157937		

Table 20. AT-VN COD POPULATION BIOMASS (JANUARY)

31/ 5/82

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
3	22151	24094	24624	23580	17115	16528	19635	22397	23240	28747	28256	8265	10763	8679	12103	11465	13464
4	74881	79811	77904	83234	69115	70286	52165	65292	78295	74824	82036	84772	25938	30834	21844	39081	30840
5	55111	67769	76138	81063	72967	80664	71112	53408	61309	70930	70609	77583	100219	17825	26324	20511	32670
6	50667	47851	70075	75187	70995	82667	82915	61637	45774	46000	68066	61109	64283	55349	14790	20621	17383
7	37714	48865	59067	69756	61681	79025	74653	69838	42572	27592	36060	42575	43981	57373	34421	11722	17784
8	28123	35882	41274	52356	49342	70672	73680	64657	52015	23161	13183	23102	28563	32768	33283	20863	7799
9	22910	25465	27371	36569	31291	52766	59787	55925	42864	32859	8534	10420	18398	22673	14068	22343	13919
10	14160	16929	18662	22579	20686	30485	35071	38116	30115	20496	12034	4986	6565	12388	16096	11207	12746
11	8240	9428	9280	10196	10126	13232	18311	18583	15107	10517	4424	7246	5370	8301	8969	8366	5509
12	7463	6973	6822	7022	7786	9925	10225	9466	10530	8529	3418	2159	4742	4077	3349	7027	5204
13	4006	3568	4027	5026	4171	7061	6546	6424	5137	6281	2489	5076	1767	3618	4343	4592	6059
14	1591	2541	3009	3744	1915	3895	4439	3195	3425	4296	1126	3339	2567	1140	3877	2941	2202
15	1250	1676	1650	2054	1090	3173	2629	2491	3349	2107	1087	1179	1433	1591	986	3104	1300
3+1	328267	370853	419903	472365	418279	520378	511168	471429	413731	356338	331323	331811	314590	256616	194453	182842	166879
4+1	306116	346759	395279	448785	401164	503850	491533	449032	390491	327591	303067	323546	303827	247937	182350	171378	153415
5+1	231234	266948	317375	365551	332049	433565	439368	383740	312196	252767	221031	238774	277888	217103	160506	133297	122575
6+1	176123	199179	241237	284488	259081	352901	368256	330332	250887	181838	150422	161191	177669	199278	134182	112786	89905
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981		
3	19991	19833	15036	11632	17022	7212	12337	15732	22975	35610	40554	55552	47047	113858	64049		
4	30714	57293	42375	22115	17795	31507	11779	18996	26092	26989	51686	94950	86734	58104	80143		
5	23974	30168	53876	46890	35807	25629	31172	12512	22708	27728	36146	94257	108937	89274	47876		
6	25222	23366	24555	53137	43051	27563	17536	26410	11568	20120	26016	41952	86489	87915	74442		
7	15590	21358	17385	25303	40333	28754	16928	13776	13464	8178	17667	23934	38430	59427	62756		
8	11757	13541	15402	18823	16641	26666	15559	13000	6474	6470	8227	13294	20821	25306	39882		
9	6505	9418	5276	9962	7704	11835	13290	10014	6964	3031	6418	5516	11325	10047	25463		
10	9555	4436	5073	6915	8219	7026	4676	7739	4089	4076	2696	4154	6471	4549	9751		
11	8769	5506	1931	4141	2416	3651	2738	3223	2645	2207	4974	1365	3332	2299	4938		
12	4564	9324	3487	1899	2564	2039	1574	1760	1028	1069	1680	3113	810	956	1489		
13	2552	3035	7230	4276	845	1000	702	1563	813	429	866	1174	1474	319	1349		
14	2468	1686	724	4314	2704	436	306	206	570	210	290	546	832	1866	142		
15	755	2853	416	489	3003	717	231	68	71	383	52	240	787	519	1795		
3+1	162416	201818	192765	209896	198102	174034	128829	124999	119460	136500	197273	340046	413488	454439	414075		
4+1	142425	181984	177729	198264	181081	166822	116492	109267	96485	100890	156719	284494	366440	340581	350026		
5+1	111711	124691	135354	176149	163286	135315	104713	90271	70393	73901	105033	189544	279707	282477	269883		
6+1	87737	94524	81478	129259	127480	109686	73541	77759	47685	46174	68887	95287	170769	193203	222007		

(from COHORT analyses)

Table 21. FISHING MORTALITY FOR 4T-VN COD

31/ 5/82

	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	0.160	0.152	0.182	0.149	0.180	0.217	0.294	0.404
6	0.082	0.057	0.075	0.111	0.155	0.124	0.156	0.214	0.377	0.333	0.343	0.237	0.034	0.340	0.392	0.525	0.366
7	0.125	0.085	0.110	0.156	0.208	0.164	0.203	0.196	0.496	0.812	0.483	0.404	0.316	0.395	0.464	0.594	0.372
8	0.173	0.117	0.145	0.194	0.266	0.198	0.247	0.231	0.368	1.155	0.371	0.332	0.376	0.460	0.465	0.714	0.523
9	0.380	0.247	0.293	0.300	0.425	0.324	0.420	0.385	0.616	0.899	0.355	0.282	0.311	0.534	0.544	0.567	0.412
10	0.462	0.313	0.371	0.437	0.592	0.478	0.613	0.541	0.874	1.573	0.585	0.402	0.359	0.352	0.367	0.567	0.383
11	0.368	0.235	0.273	0.276	0.400	0.319	0.448	0.422	0.604	1.087	0.423	0.505	0.202	0.432	0.201	0.654	0.577
12	0.353	0.238	0.281	0.341	0.456	0.385	0.509	0.506	0.850	1.135	0.427	1.018	0.214	0.280	0.289	0.401	0.513
13	0.182	0.122	0.155	0.214	0.297	0.230	0.299	0.299	0.506	0.934	0.175	0.576	0.232	0.183	0.352	0.530	0.423
14	0.273	0.181	0.216	0.262	0.359	0.282	0.355	0.355	0.624	1.079	0.527	0.766	0.141	0.385	0.238	0.302	0.567
15	0.285	0.190	0.230	0.272	0.373	0.291	0.371	0.338	0.589	1.110	0.448	0.355	0.341	0.435	0.460	0.610	0.422
6	0.179	0.118	0.147	0.185	0.257	0.200	0.259	0.272	0.498	0.765	0.394	0.314	0.175	0.386	0.446	0.591	0.405
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981		
3	0.007	0.004	0.006	0.001	0.000	0.061	0.010	0.024	0.044	0.003	0.003	0.003	0.001	0.002	0.000		
4	0.175	0.111	0.073	0.083	0.068	0.302	0.247	0.111	0.268	0.100	0.028	0.078	0.039	0.035	0.021		
5	0.243	0.310	0.250	0.332	0.259	0.504	0.443	0.357	0.323	0.422	0.104	0.134	0.171	0.164	0.102		
6	0.303	0.336	0.218	0.400	0.338	0.438	0.549	0.832	0.384	0.480	0.174	0.229	0.217	0.219	0.272		
7	0.453	0.321	0.304	0.431	0.369	0.627	0.544	0.780	0.714	0.459	0.256	0.299	0.261	0.302	0.272		
8	0.327	0.348	0.414	0.399	0.515	0.611	0.570	0.562	0.688	0.408	0.208	0.278	0.358	0.188	0.272		
9	0.205	0.229	0.454	0.550	0.492	0.578	0.583	0.832	0.570	0.526	0.221	0.166	0.412	0.272	0.272		
10	0.330	0.351	0.398	0.813	0.421	0.600	0.725	0.734	0.827	0.223	0.487	0.342	0.432	0.332	0.272		
11	0.317	0.545	0.289	0.567	0.399	0.737	0.757	0.750	1.013	0.363	0.161	0.525	0.587	0.620	0.272		
12	0.547	0.435	0.327	1.189	1.230	0.668	0.482	1.042	0.722	0.507	0.249	0.398	0.814	0.171	0.272		
13	0.497	0.918	0.326	0.509	0.394	0.993	0.858	0.563	0.896	0.492	0.397	0.237	0.217	1.063	0.272		
14	0.246	1.020	0.495	0.254	0.430	0.649	1.559	1.154	0.692	1.022	0.202	0.072	0.085	0.051	0.272		
15	0.329	0.312	0.392	0.548	0.449	0.604	0.605	0.727	0.700	0.404	0.293	0.271	0.365	0.274	0.272		
6	0.340	0.349	0.299	0.433	0.385	0.555	0.567	0.778	0.600	0.457	0.208	0.255	0.247	0.246	0.272		

Table 22. 4T-Vn cod. Parameters used in and Y/R results.

<u>Age</u>	<u>P.R.</u>	<u>Weights (kg)</u>
3	.012	.43
4	.202	.67
5	.577	.84
6	1	1.14
7	1	1.45
8	1	2.02
9	1	3.19
10	1	4.33
11	1	4.53
12	1	5.59
13	1	6.77
14	1	6.86
15	1	3.62

YIELD PER RECRUIT ANALYSIS

	<u>FISHING</u> <u>MORTALITY</u>	<u>CATCH</u> <u>(NUMBER)</u>	<u>YIELD</u> <u>(KG)</u>	<u>AVG. WEIGHT</u> <u>(KG)</u>	<u>YIELD PER</u> <u>UNIT EFFORT</u>
	0.1000	0.194	0.455	2.346	1.000
F0.1---	0.1995	0.300	0.603	2.006	0.663
	0.2000	0.301	0.603	2.005	0.662
	0.3000	0.366	0.639	1.747	0.468
FMAX---	0.3367	0.384	0.641	1.670	0.418
	0.4000	0.410	0.638	1.557	0.350
	0.5000	0.441	0.625	1.417	0.274
	0.6000	0.465	0.611	1.314	0.223
	0.7000	0.484	0.598	1.236	0.188
	0.8000	0.499	0.587	1.176	0.161
	0.9000	0.512	0.579	1.130	0.141
	1.0000	0.523	0.572	1.093	0.126

Table 23. 4T-Vn cod. Projections results.

A) 1982 catch is 60,000 tons, fishing at $F_{0.1}$ in 1983

Age	catch weight	
	1982	1983
3	93	84
4	2168	1768
5	10463	5332
6	9814	15551
7	11882	7507
8	11207	9955
9	8763	10644
10	3507	7154
11	1189	2206
12	576	883
13	193	420
14	139	118
15	6	44
Total	60,000	61,665

B) Fishing at $F_{0.1}$ in both 1982 and 1983.

Age	catch weight (t)	
	1982	1983
3	84	84
4	1971	1769
5	9544	5354
6	8987	15736
7	10881	7663
8	10263	10161
9	8025	10864
10	3211	7302
11	1089	2252
12	528	901
13	177	428
14	127	120
15	5	45
Total	54,891	62,679

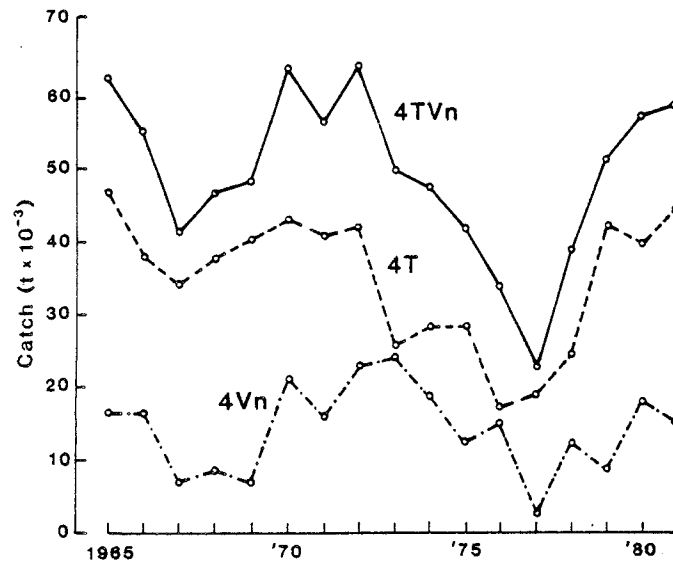


Fig. 1. Trends in 4T-Vn nominal catches for cod (1965-81).

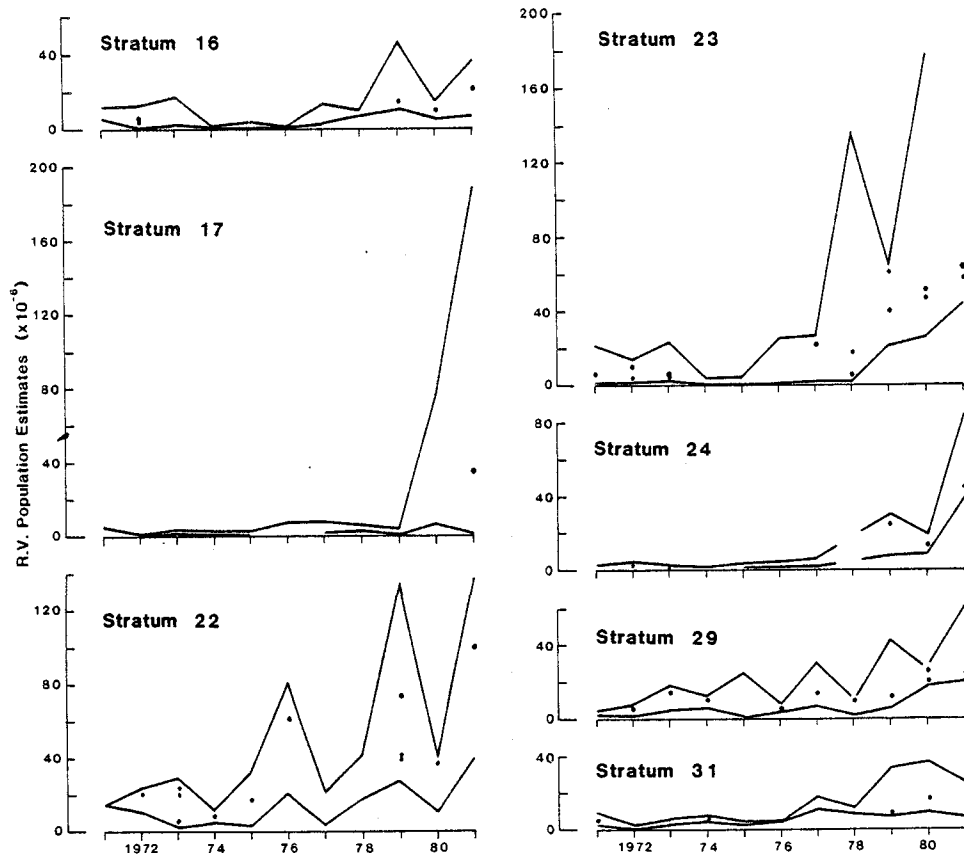


Fig. 2. R.V. population estimates for each stratum, based on individual sets, since 1971. Lines indicate the range of population estimates.

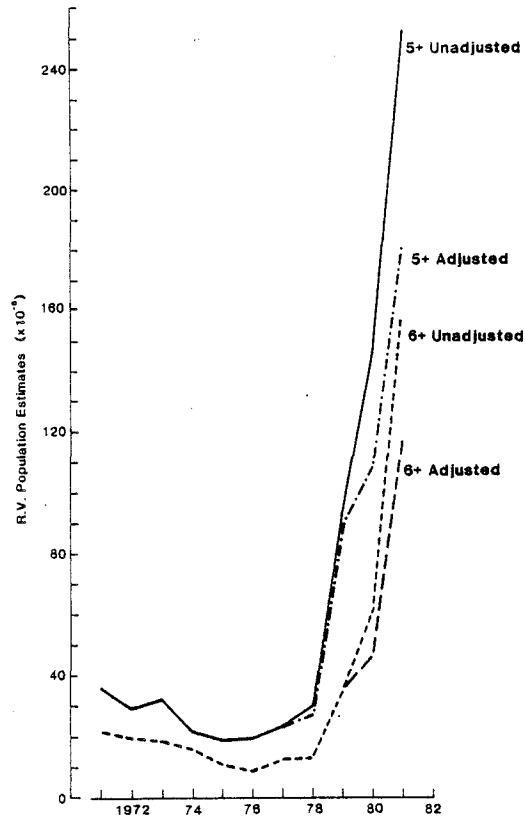


Fig. 3. Population estimates of 5 and 6 4T-Vn cod from research vessel surveys. "Adjusted" values refer to estimates based on the exclusion of sets with large catches (see text for details).

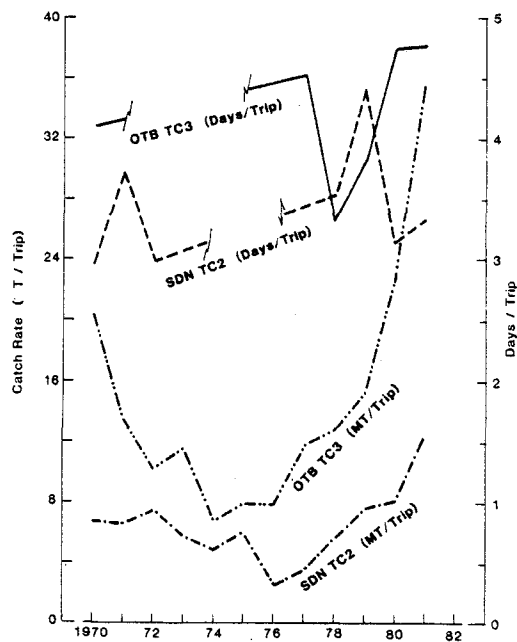


Fig. 4. Commercial catch per trip for TC2 Danish seiners and TC3 otter trawlers during the third quarter of the year. The average number of days per trip, where available, is also given.

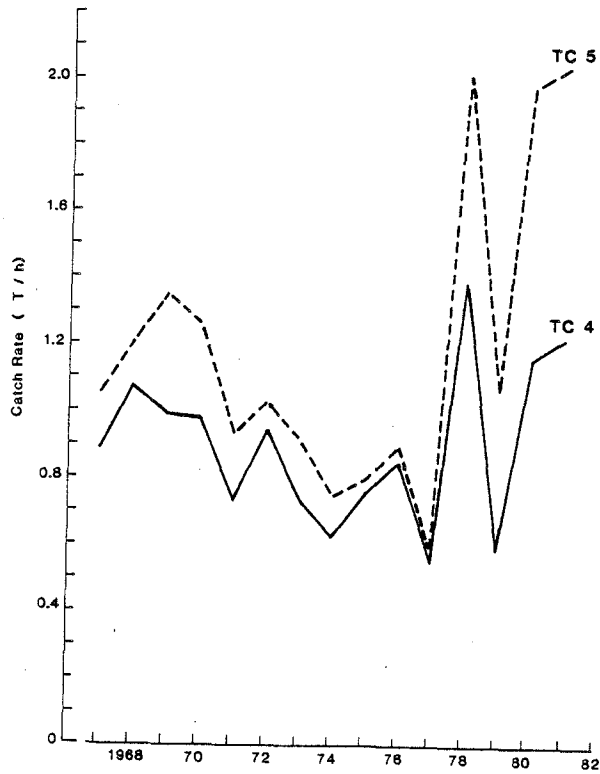


Fig. 5. Commercial catch/hour fished in during Jan.-Mar. for TC4 and TC5

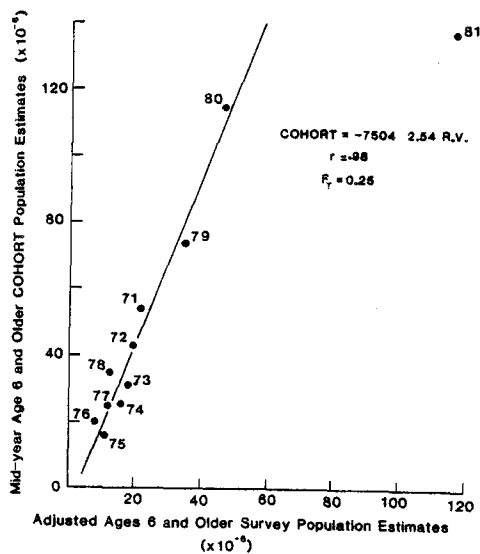


Fig. 6. Relation between adjusted age 6 and older population estimates for 4T-Vn cod from R.V. survey data and the corresponding mid-year age 6+ population estimates from COHORT analysis using a terminal F of 0.25.

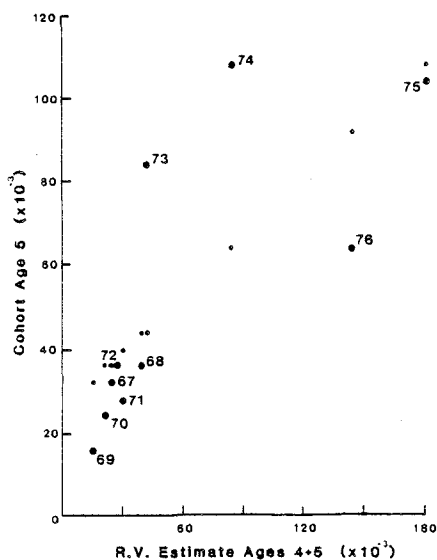


Fig. 7. Relation between age 4+5 population estimates of 4T-Vn cod from R.V. survey data and age 5 population estimates from COHORT analysis with a terminal F of 0.272.

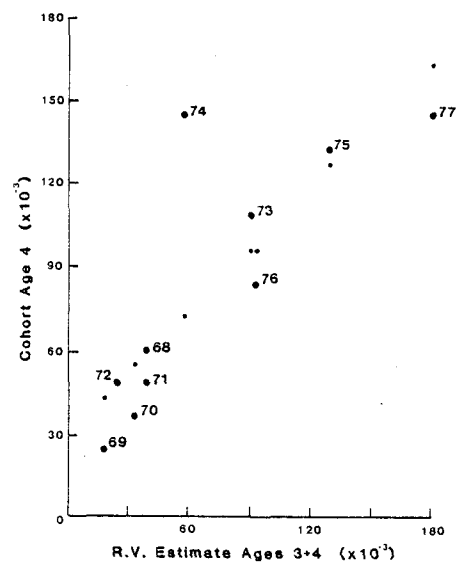


Fig. 8. Relation between 3+4 population estimates of 4T-Vn cod from R.V. survey data and age 4 population estimates from COHORT analysis with a terminal F of 0.272.

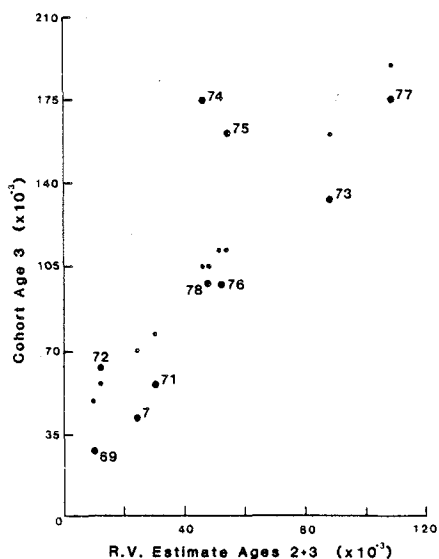


Fig. 9. Relation between 2+3 population estimates of 4T-Vn cod from R.V. survey data and age 3 population estimates from COHORT analysis with a terminal F of 0.272.