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Assessment of the 4T and 4Vn (Jan. Apr.) Cod Stock for 1989

by

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ABSTRACT

The 1988 provisional nominal catch was 51,795 t, an increase of approximately 1,000 t over 1987 but more than 2,000 t less than the TAC. Landings by fixed gears (8,436 t) were the lowest since 1976. The mobile gears accounted for 84 % of the landings. Several management measures (vessel allocations, trip limits and weekly closures)in addition to the fleet-period allocations were in place in 1988. The 1980 and 1982 year-classes represented approximately 25 % and 23 % of the numbers caught. Weights for ages 8 and 9 in 1988 were the lowest observed in the series. The standardized catch rate decreased from 2.777 t/h to 2.240 t/h in 1988. Discard estimates indicate a higher proportion of cod were discarded in 1988 than observed in previous years. Mean numbers per tow (age 5+) from the 1988 research surveys were approximately 50 % higher than in 1987. An analysis of research survey data over the period 1971-1988 revealed that young fish (ages 2-3) are usually found in shallow areas and older fish in deeper areas. SPA, calibrated with the adaptive framework, implied a Ft of 0.246. Yield per recruit analysis that Fo.1 is 0.2023 for this stock. Population numbers have been stable since 1983 and are at their highest level. Population biomass in recent years is the largest since the fifties. If the 1989 TAC of 54,000 t is caught, the Fo.1 and F50% catches in 1990 would be 47,602 t and 52,841 t respectively.

RESUME

Les prises nominales provisoires en 1988 se sont chiffré à 51,795 t soit une augmentation d'environ 1,000 t sur l'année précédente mais 2,000 t de moins que le TPA. Les débarquements des engins fixes (8,436 t) sont les moins élevés depuis 1976. Les captures des engins mobiles ont constitué 84 % des prises. Plusieurs mesures de gestion (allocations par navire, limite par voyage et fermetures hebdomadaires), en plus des allocations par flotte et saison, étaient en vigueur en 1988. Les classes d'âges de 1980 et 1982 représentaient 25 % et 23 % des captures en nombre. Les poids moyens des morues de 8 et 9 ans en 1988 sont les plus bas depuis 1971. Le taux de capture standardisé des chalutiers est passé de 2.777 t/h en 1987 à 2.240 t/h en 1988. Les estimés de rejets ont démontré que le pourcentage de rejet de morue est plus élevé qu'auparavant. Les nombres moyens (âges 5 et plus) par trait lors du relevé sont approximativement 50 % plus élevé qu'en 1987. Une analyse des données des relevés effectués entre 1971 et 1988 a révélé que les jeunes morues (âge 2 et 3) se retrouvent dans les eaux moins profondes alors que les morues âgées se retrouvent dans les eaux plus profondes. La calibration de l'ASP à l'aide du cadre adaptif a donné lieu a un Ft de 0.246. Une analyse de rendement par recrue a indiqué que Fo.1 est de 0.2023 pour ce stock. L'abondance de la population est stable et à son niveau le plus élevé depuis 1983. La biomasse de la population dans les années récentes est à son niveau le plus élevé depuis les années cinquante. Si le TPA de 54,000 t pour 1989 est capturé alors les captures aux niveaux Fo.1 et F50% se chiffreront à 47,602 t et 52,841 t respectivement.

INTRODUCTION

The cod stock in NAFO Division 4T and Sub-division 4Vn (Jan.-Apr.) is an important groundfish resource in the Gulf of St. Lawrence. Landings from this stock in recent years have only been surpassed by those from the cod stock in the northern Gulf (4RS, 3Pn). Except in Northumberland Strait, where cod are not present in large numbers, this species is sought by fishermen of many communities bordering the southern Gulf. In the late fall, an extensive migration occurs and by January a significant portion of the population is found in the Sydney Bight area (4Vn) (Halliday and Pinhorn, 1982). Cod return to the waters of the southern Gulf in the spring.

As many other stocks on the Canadian Atlantic coast, the 4T-Vn (Jan.- Apr.) cod stock was depleted and attained its lowest level of abundance in the mid-1970s. Since then, the stock has increased in abundance and is at the highest level observed since the fifties.

Since 1977, the fishery in 4T is conducted entirely by Canadian fishermen, mostly between April and December. In order of importance, the fishing gears used are otter trawls, Danish and Scottish seines, gillnets, longlines and handlines. The winter fishery in 4Vn is prosecuted almost entirely by otter trawlers.

Nominal catches of cod in 4T-Vn (Jan.- Apr) have varied from less than 40,000 t prior to the introduction of the otter trawler in the early fifties to a high of 104,000 t in 1956 and a low of 22,000 t in 1977 (Table 1). Between 1977 and 1980, nominal catches increased then fluctuated around an average of 60,000 t. In 1987, the TAC was reduced to 45,200 t. but was exceeded by approximately 5,000 t. Initially, the TAC for 1988 was set at 49,000 t. In mid-1988 the TAC was revised to 54,000. This value represented the Fo.1 catch for 1988 from the May 1988 assessment (Chouinard and Sinclair, 1988). The nominal catch for 1988 (51,795 t) was approximately 2,000 t lower than the TAC but over 1,000 t more than in 1987.

A) Nominal Catches and Description of the Fishery

Initial allocations of the TAC to the various sectors involved in the fishery generally followed the same proportions established in previous years (i.e. 76%-24% for mobile and fixed gears respectively) but transfers occurred later in the year. France was allocated 1,200 t in 4Vn (Table 2) as in 1987.

Several new management measures were put in place in 1988. A system of individual vessel allocation for vessels > 65' was instituted. Trip limits which were imposed in the fall of 1987 were in effect from April to December for vessels less than 65'. The limits were 20,000 lbs for vessel less than 45' in length and 45,000 lbs for vessels 45' to 65'. In the period of August 22 to October 13, the trip limit for vessels less than 45' was reduced to 5,000 lbs. In addition to trip limits. the fishery for vessels 45'-65' was open only on weekends (Friday to Sunday) from August 26 to September 29; from Friday to Monday from September 30 to October 13 and 7 days a week thereafter. Vessels less than 45' were not subjected to any weekly closures. The weekly closures were put in place to reduce glut problems at processing plants.

Nominal catch for 1988 was calculated using the provisional data supplied by the the Statistics Branches of the Scotia-Fundy, Newfoundland, Québec and Gulf regions of the Department of Fisheries and Oceans. Breakdowns of nominal catches by month, gear and country are presented in Table 3 and 4.

The fishery conducted in 4T (summer fishery) represented approximately 86% of the total nominal catch on the stock, a value comparable to 1987. The proportion taken by Quebec and Newfoundland decreased slightly over the previous year. Breakdown of catches by gear (Table 5, Figure 1) indicate that the proportion taken by Danish, Scottish and pair seiners increased from approximately 19% of the total catch in 1987 to 23% in 1988. The proportion taken by trawlers increased marginally. Landings by fixed gears are among the lowest recorded since 1965; they represented only 16% of the total landings (Table 5, Figure 1).

The reduction in the proportion of the catch by mobile gears in June is due to the closure of the fishery. The greater proportion taken in the fall (Sept. to Dec.) compared to 1987 can be attributed to an additional 5,000 t which was allocated to all fleets proportionally in mid-summer (Table 3, Figure 2). There were no closures due to over-abundance of fish less than 43 cm. in 1988.

Landings in the winter fishery (4Vn) were almost exclusively from trawlers. France did not participate in the fishery in 1988.

INPUT DATA

A) Commercial Fishery Data

i) Catch and weight at age

In 1988, sampling intensity of the commercial fishery was comparable to previous years. Most gear and quarter components were sampled with a total of nearly 67,000 fish measured and 6,400 aged (Table 6). The results of age determination comparisons (Table 7) indicated that the level of agreement in age determination between readers, and between readers and a reference collection exceeded 70%. There was no evidence of bias with respect to the differences between readers.

Quarterly age-length keys were constructed as described in Table 8. The length frequencies by gear and quarter adjusted to the corresponding landings were used with the apppropriate age-length key to obtain the catch at age by gear and quarter. Unsampled landings were estimated by multiplying the catch at age for sampled gears by the ratio of unsampled to sampled landings.

In 1988, the 1980 (age 8) and 1982 (age 6) year-classes were the most important in the mobile gears catch at age (Table 9). The 1980 year-class was also dominant in 1987 for these gears . For the fixed gears, the 1980 year-class is the most important in the catch at age. As anticipated from their selection patterns, fixed gears caught a larger proportion of fish 10 years and older than the mobile gears. There was good agreement between the predicted catch at age for 1988 from the previous assessment (Chouinard and Sinclair, 1988) and that observed (Figure 3). The catch of young fish (ages 3-6) was generally underestimated while the older age groups were overestimated in the previous assessment.

Length at age by gear and quarter indicated that the mobile gears tend to catch smaller fish at age than the fixed gears (Table 10).

Average weights at age (Table 11) (kg) were calculated using a length-weight relationship derived from the 1988 research survey data. The parameters of the power curve were a = 0.000006196 and b = 3.0977 with a correlation coefficient of 0.98 (n=3099).

Catch at age for the years 1971-1988 is presented in Table 12 with the corresponding weights at age in Table 13. The 1980 year-class which had appeared in high numbers in 1985, 1986 and 1987 accounts for almost 25% of the numbers caught in 1988. The catch of the 1982 year-class represented 23% of the catch numbers. The remainder of the catch at age matrix is the same reported in Chouinard and Sinclair (1988) except for 1982 which was recalculated because some records had been duplicated in the data file.

Weights at age for 1988 are generally higher than in 1987. The weights at age for ages 8 and 9 (1980 and 1979 year-classes) are the lowest observed in the series.

ii) Commercial Catch Rates

As in the previous assessment, a catch rate index was calculated for otter trawls only given the uncertainties about how effort is recorded for seiners. Investigation of data files had previously indicated that handling and searching time was likely included in the reported number of hours fished for these gears. It was suggested that catch per set be used but the information is only available for the most recent years. The years 1966-1988 were used. Provisional data for 1987 were obtained from DFO Statistics Branches. Observations with less than 10 units of catch or effort were removed. A multiplicative model was used to calculate a standardized catch rate index for each gear (Gavaris, 1980).

Observations were allocated to categories of gear/tonnage class/region, Division, month and year. Gears with less than 10 observations for the time series were arbitrarily eliminated from the analysis. Data for Canada (Maritimes-Quebec), Canada (Maritimes) and Canada (Quebec) were grouped for each Division, month and year because the same vessels are involved. Examination of the residuals distribution from an initial analysis indicated that weighing was not necessary.

The analysis of variance and regression coefficients from the final run are given in Table 14. The model explained 71% of the variation and each category was significant.

The overall trend is for decreasing catch rates from 1968-74 followed by increases to 1983 and a decrease in 1984. Catch rates then increased to 1987 but decreased in 1988 (Table 15, Figure 4). The observation for 1988 is consistent with the perception of the industry; trip limits were often not reached especially in the late summer and fall.

iii) Discarding practices

Observer estimates of discards of cod in 4T were available from the Quebec and the Gulf regions observer programs. The observations were made in the period of April to November. The estimates of discard rates by weight are comparable between the two programs (see summary table below). These estimates are much higher than those reported by Chouinard and Metuzals (1985) for 1984 (6%), Cliche (1981) for 1980 (4%) or from an unpublished DFO study conducted in 1976 (6%). It should be noted that a minimum size regulation of 43 cm for cod has been in effect since.

Program	Number of trips	Number of sets	Catch observed	% discard by weight	% discard by numbers
Quebec	21	185	245	14.6	19.2*
Gulf	14	94	109	17.5	n/a

* based on length frequencies from 34 sets

The discard ogive derived from the data indicates a size of 50% discarding of approximately 43 cm (Figure 5); the regulated minimum size. Chouinard and Metuzals (1985) reported a size at 50% discarding of 41 cm for 1984. It would appear that the minimum size regulation has resulted in an increase in discarding.

B) Research Survey Data

Abundance estimates

Mean numbers per tow at age 5+ estimated from the 1988 survey are approximately 50% higher than in 1987 (Table 16). The 1985 and 1986 estimates were high due to a few unusually large sets. This is reflected in the high coefficients of variation for these surveys (25% to 50%). Coefficients of variation for 1988 ranged from 10 to 30 % for the most abundant age classes (Table 17).

The 1988 survey indicates that the 1979 and 1980 year-class are still present in large numbers. These age-classes are the largest observed in the series. The 1982 and 1984 year-classes appear to be above average. The estimate of 0-group in 1986, which was the highest observed in the time series, did not translate in high numbers of 2 year-olds in 1988.

Strata 22 and 23 (Shediac Valley and Bradelle Bank areas) (Figure 6) accounted for 20% and 12% of the 1988 estimate; these two strata combined have historically accounted for 20% to 50% of the estimates. The largest set (745 kg, 1600 fish) occurred in stratum 22. Length frequencies from the RV survey from 1985 to 1988 are presented in Figure 7. The bulk of the population is found in the 30 to 50 cm range which corresponds approximately to ages 4 to 8.

Nursery Areas

Catch-at-age and by stratum from the 1971-88 September groundfish surveys in Div. 4T was analysed to determine possible nursery areas for this cod stock . A multiplicative analysis was used to determine if age groups were segregated. The model tested included year-class (YC), age (A), and stratum (S) effects as well as an age*stratum interaction.

$$\ln U = YC + A + S + A*S$$

where U = catch per tow
YC = year-class
A = age
S = strata
A*S = age-stratum interaction.

Input data consisted of mean catch per tow at age and stratum. The data were transformed as ln(U+.5). Strata with large numbers of null sets (ie: 15, 25, and 39) and ages 0, 1, and 8+ were eliminated from the analysis to reduce the number of zero observations to less than 10%.

The analysis of variance results indicated all terms were significant with a relatively weak interaction term (Table 18). The model explained 60% of the total variance. Residuals were normally distributed.

The highest concentrations of young cod (ages 2-3) were found in stratum 22 (Figure 8 and Table 19a). Strata 28, 18, and 29 also had high numbers of these age groups. These are relatively shallow, inshore strata. The age composition of catches in other strata were older, the oldest fish found in the deepest strata (16, 26, and 38). The deepest strata (15, 25 and 39) were nearly void of all ages included in the analysis. The analysis was repeated for 1980-84 and 1985-88 and resulted in similar patterns. Although ages 0-1 were not included in the analysis it is apparent from Table 19b and 19c that strata 420, 421, and 428 have high numbers of these ages. Age 9 and older cod were very generally distributed (Table 19d). This pattern is also apparent in the analysis of Tremblay and Sinclair (1985).

Relative year-class estimates from the analysis are presented in Figure 9. These indicate very low recruitment in the 1960's, increases in the 1970's and declines in the recent past. The correlation between these estimates and year-class estimates from last year's assessment was high (r^2=.91) (Figure 10) and this index may be useful in predicting recruitment for catch projections.

ESTIMATION OF STOCK PARAMETERS

C) SPA calibration - Adaptive framework

SPA was calibrated using the same formulation of the adaptive framework (Gavaris, 1988) used in the previous assessment of this stock (Chouinard and Sinclair, 1988) (Table 20). Although other formulations of the adaptive framework for this stock may give a more consistent retrospective analysis, they imply either the presence of older fish in the population not sampled by the commercial fishery or the surveys, or a constant change in catchability. The comparison of the observed and predicted catch at age (Figure 3) indicated close agreement which may indicate that although the present formulation may not be the best, it performed reasonably well.

The parameters estimated were 1) the size of age-classes 3 to 11 in 1989, 2) the slopes of the lines relating RV mean numbers per tow at age 3 to 9 and 10+ and, 3) the catchability coefficient. Constraints on the parameters were placed on the initial analysis but were removed for the final run. Parameter estimates and their standard errors are presented in Table 21. Examination of the correlation matrix of the parameters did not indicate high correlation between parameters (Table 22). The table of weighted residuals is presented in Table 23. The plots of the observed and predicted RV mean numbers per tow and OTB-CPUE derived from the analysis are in Figure 11. Plots of the weighted residuals (Figure 12) indicate that the observations for ages 9, 10 and 11 have the largest residuals. Except for the estimate of the 1985 year-class at age 4, coefficient of variations on the population estimates at age for 1989 ranged from approximately 20% to 40%.

B) Partial Recruitment (PR)

Analysis of fishing mortalities derived from the SPA for the 1984-1987 period for ages 3 to 15 using a two-way analysis of variance (APL function MULTPR) indicated full recruitment at age 9. The resulting age effect vector was standardized to the mean of ages 9 to 15 and resulted in the following partial recruitment vector (Figure 13):

Age	3	4	5	6	7	8	9	10	...
PR	0.002	0.033	0.161	0.486	0.688	0.733	1.000	1.000	...

C) Yield per recruit

Yield per recruit calculation was conducted using parameters from the 1982-1988 period. This period was considered more appropriate since the regulated cod-end mesh size was gradually increased from 114 mm prior to 1977 to 130 mm in 1981. Over 75% of the landings can be attributed to gears covered by these regulations (otter trawls and Danish and Scottish seines) and consequently data for the period after the transition is considered to represent better a " steady state " with the current conditions.

The average weight at age was calculated from the 1982 to 1988 average weights. The partial recruitment vector was derived from analysis of fishing mortalities in the period 1982-1987. Input data and the results of the calculation are presented in Table 24. The implied Fo.1 and F_{MAX} from the analysis are 0.2023 and 0.4401 slightly higher than values of 0.2 and 0.4 used previously.

ASSESSMENT RESULTS

A) Recruitment

The estimate of the 1985 year-class was 346 million fish, approximately 1.5 times the largest year-class observed (1980 year-class). Due to the relatively high coefficient of variation on the estimate, this year-class size was set to the geometric mean recruitment (age 3 numbers) from the 1968-1983 year-classes of 106 million fish. The 1984 year-class, which had been estimated to be large in the previous assessment (Chouinard and Sinclair, 1988), is again estimated to be the second largest observed. The 1979-1982 year-classes are all estimated to be above the mean (Table 25, Figure 14a).

B) Fishing Mortality and Stock Size

The fishing mortality on ages 8 and older in 1988 is estimated to be 0.246 (Table 26). It appears that the 1980 year-class is being targetted by the fishery as indicated by the higher fishing mortalities on this cohort. Total population abundance has been relatively stable since 1983 (Table 25). The proportion of fish older than 8 years of age has been increasing since 1977 from approximately 1.4 % to 17.2 % of the population (ages 3+) in 1988. The mean population biomass has also been relatively stable in recent years (Table 27).

The longer term outlook indicates that the average population biomass (ages 3+) declined from a high of 500,000 t in 1955 to approximately 100,000 t in 1975. Good recruitment and lower fishing mortalities since 1977 resulted in an increase of biomass to the present levels (Figure 14b). Fishing mortalities on the stock in 1987 and 1988 were the lowest since the early 1950's (Figure 14c). Although recent biomass estimates are similar to the biomass levels of the early 1950's, the total population numbers since 1980 are substantially higher (Figure 14d). This is attributed to a decrease in the average weights at age in recent years and a population age structure which is younger than in the early period when trawlers and other gears with a lower selectivity were being introduced in the fishery.

C) Stock Production

Production calculations (Rivard, 1982) indicated that the large catches of the mid-1950's and 1960's were well above the surplus production resulting in a reduction in the biomass of the standing stock (Figure 15a). With the recruitment of some large year-classes and the reduction of fishing mortality since the late seventies, the biomass increased. The recruitment component of production has become relatively more important in recent years (Figure 15b).

PROGNOSIS

Catch projections to 1990 were made using the 1989 beginning of the year population numbers from the non-linear least squares analysis, average weights at age from 1986-87 and a PR derived from fishing mortalities in the period 1984-87 assuming full recruitment at age 9. Input data are given below.

Age	1989 Population	Weights at age (kg)	PR
3	106000	0.358	0.002
4	86696	0.555	0.033
5	143755	0.760	0.161
6	58787	0.931	0.486
7	60366	1.106	0.688
8	38605	1.379	0.733
9	33627	1.681	1.000
10	22249	2.019	1.000
11	5033	2.423	1.000
12	2951	2.830	1.000
13	1489	3.542	1.000
14	661	4.637	1.000
15	165	12.028	1.000

Age 3 recruitment in 1988-1989 was set at the geometric mean of the 1968-82 year-classes of 106 million.

The results indicate that if the 1989 TAC of 54,000 t is caught, this will result in a terminal fishing mortality of 0.248 and a Fo.1 (0.2) catch in 1990 of 47,602 t. Fishing at Fo.1 in 1989-90 would give catches of 44,246 t and 49,154 t, respectively. The catch for 1990 using the 50 % rule (i.e. fishing at F_t= 0.224) and assuming that the 1989 TAC is caught would be 52,841 t.

TAC's are commonly split among gear sectors as a fixed percentage of the TAC. For this stock the mobile and fixed gear sectors share the TAC as 74 % - 26 % respectively. Earlier work by Fréchet and Chouinard (1987) indicated that the two sectors had different PR. Given the initial population and the expected quotas for the two sectors it is possible to split the projected catch at age as:

$$C_{i,k} = \frac{N_i \left(1 - e^{-(M + \sum_k S_{i,k}F_k)}\right) S_{i,k}F_k}{M + \sum_k S_{i,k}F_k}$$

where $C_{i,k}$ = the catch at age i by gear k
N_i = the population at age i
$S_{i,k}$ = PR at age i for gear k
F_k = the fully recruited F for the gear
M = natural mortality

Begining with initial values of F_k and weights at age for the gears ($W_{i,k}$) the values of F_k that satisfy

$$TAC = \frac{\sum_i W_i N_i (1 - e^{Z_i}) F_i}{Z_i}$$

may be found.

Partial F's for the gears were calculated (Sinclair, 1986) from the catch at age by gear for 1983-88 and the fishing mortalities given in Table 26. The PR's were found as the age effects in a multiplicative analysis of the partial F's. Year and year-class effects were tested, and while significant ($p<.05$) they did not affect the patterns. Consequently they were left out of the analysis.

The resulting PR's are shown in Figure 16 . The mobile gear PR was standardized to ages 8-10, while the fixed gear PR was standardized to ages 12-15.These partial recruitments were used with observed and projected biomass estimates for the stock to investigate trends in fishable biomass and fishing mortalities for the two gear sectors.

The results (Figure 17a and 17b) indicate that fishable biomass has been increasing steadily over the time period and that it will continue to increase to 1990. Thus both gear sectors may experience increased catch rates in the next two years. At the same time fishing mortalities exerted by the two sectors have decreased. The shortfall in catch (relative to the allocation) by the fixed gear in 1988 resulted a 1988 F of approximately the level required to take the 1989 and 1990 quotas. These results also suggest that the shortfall in fixed gear catches are the result of reductions in fishing effort and/or the availability of cod to these gears.

Mobile gear effort will have to decline by 40% over the next two years. With projected increases in catch rates for this gear sector and the required reduction in fishing effort it may be expected that the 1989-90 fishing seasons may be of short duration unless measures are taken to shift effort to times of lower availability (i.e. summer months).

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Table 1: Nominal 4TVn (Jan-Apr) cod catch and total allowable catch (TAC) for 1950 to 1988. Sources: a. 1950-1964 from Lett, b. 1965-1985 from NAFO statistics; c. 1986 to 1988 provisional from Department of Fisheries and Oceans, Statistics Branches.

YEAR	NOMINAL CATCH (t)	TAC (t)	YEAR	NOMINAL CATCH (t)	TAC (t)
1950	44023 [a]	-	69	47819	-
51	34827	-	1970	64465	-
52	41956	-	71	56375	-
53	58911	-	72	65291	-
54	63901	-	73	50635	-
1955	65227	-	74	48747	63000
56	104469	-	1975	42471	50000
57	89131	-	76	33415	30000
58	86582	-	77	22219	15000
59	70720	-	78	37892	38000
1960	66013	-	79	55996	46000
61	65583	-	1980	54634	54000
62	66664	-	81	65177	53000
63	70202	-	82	58193	60000
64	60547	-	83	61295	62000
1965	63027 [b]	-	84	55364	67000
66	54851	-	1985	62138	67000
67	41316	-	86	63441 [c]	60000
1968	46551	-	87	50596	45200
			88	51795	54000

Table 2 : Resource allocation scheme for cod in Division 4T and Subdivision 4Vn (Jan. - Apr.) for 1988.

	Area	Gear/Period	Initial Allocation (t)	Final Allocation (t)	Catch[1] (t)	Closure Date (Trip limits)
1988	4T	M.G. 65-100' Groundfish fleet only	1270	1426	1161	
		M.G. 65-100' crab vessels	290	326	262	
		M.G. 65-100' Groundfish/shrimp	1660	2164	2173	14/11/88
		Enterprise Allocation W. Nlfd	875	983	852	
		M.G. 45-64' (Jan. 1 - Apr. 21)	775	775	1017	18/04/88
		M.G. 45-64' (Apr. 22 - July 31)	11040	11040	12182	27/05/88[2]
		M.G. 45-64' (1 Aug - 1 Sept.) (by-catch)	825	825	481	
		M.G. 45-64' (Sept. 2 - Nov.9)	6305	8809[4]	8244	(45,000 lbs)
		M.G. 45-64' (Nov.10 - Dec 31)	1430	1430	2935	
		M.G. < 45' (Jan. 1 - Apr 21)	200	200	203	18/04/88
		M.G. < 45' (Apr. 22 - May 31)	3450	3450	3411	01/06/88[3]
		M.G. < 45' (1 Aug - 1 Sept) (by-catch plaice)	150	627	635	
		M.G. < 45' (Sept. 2 - Nov 9)	500	1768[4]	1758	(20,000 lbs)
		M.G. < 45' (Nov 10 - Dec 31)	200	900	939	
		F.G. < 65' (Apr.1 - June 10)	3465	1465	1286	
		F.G. < 65' (June 11 - Nov. 4)	7900	9339	6289	
		F.G. < 65' (Nov. 5 - Dec 31)	340	340	417	
	4Vn	All > 100'	5550	5550	5577	
		F.G. 65-100'	90	90	0	
		M.G. 65-100'	90	90	278	14/01/88
		F.G. 45-64'	152	37	5	
		M.G. 45-64'	490	1020	1174	
		F.G. < 45'	548	98	44	
		M.G. < 45' (Jan. 1 - Apr. 15)	130	130	121	
		M.G. < 45' (Apr. 16 - Apr.30)	75	110	164	16/04/88
		France	1200	1200	-	

Notes: [1] preliminary Canadian Atlantic Quota report
[2] 45,000 lbs trip limit
[3] 20,000 lbs trip limit
[4] season opened August 22
M.G. - Mobile Gear
F.G. - Fixed Gear

Table 3 : Provisional 4T cod catches (t round weight) during 1988 by gear type and month in Maritime Provinces, Newfoundland and Quebec.

GEAR	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL	% OF 4TVn (Jan-Apr) CATCH
MARITIMES														
Otter trawl (side)	58	67		679	1068	6	2	13	73	416	414	71	2867	5.54
Otter trawl (stern)	1120			579	3018	33	72	303	588	680	1490	1051	8934	17.25
Midw trawl (stern)		1											1	0.00
Shrimp trawl				30	14			12	1	24	3		84	0.16
Danish seine	16			1148	3382	172	170	259	309	841	2355	107	8759	16.91
Scottish seine				209	609	10	9	17	3	32	271		1160	2.24
Pair seine				78	382	16	34	21	5	1	190		727	1.40
Gillnets (set)				17	158	235	433	292	186	114	83		1518	2.93
Set lines				20	72	29	89	151	99	180	236	109	985	1.90
Handlines					1	49	53	35	11	7			156	0.30
Baited handlines					13	48	68	57	54	20	6		266	0.51
Misc.						1			20	13			34	0.07
TOTAL	1194	68	0	2760	8717	599	930	1160	1349	2328	5048	1338	25491	49.22
NEWFOUNDLAND														
Otter trawl (side)									34				34	0.07
Otter trawl (stern)			21	642	404		40	37	69		16	237	1466	2.83
TOTAL			21	642	404		40	37	103		16	237	1500	2.90
QUEBEC														
Otter trawl (side)				335	1643	10	4	216	584	559	78		3429	6.62
Otter trawl (stern)	40			583	3116	48	24	574	1107	1260	428	218	7398	14.28
Midw trawl (stern)	48	4	4		21								77	0.15
Bottom pair trawl				6	64	22	17	22	6	8	4		149	0.29
Shrimp trawl				56	3	1	1						61	0.12
Danish seine					211	1		1					213	0.41
Scottish seine				30	318	26	32	37	29	102	95		669	1.29
Gillnets (set)				9	811	569	400	341	156	95	2		2383	4.60
Set lines				30	455	317	450	305	224	338	13	10	2142	4.14
Handlines					1	17	25			4			47	0.09
Baited handlines					32	76	161	160	236	141	18		824	1.59
Misc.					4	21	7						32	0.06
Total	88	4	4	1049	6679	1108	1121	1656	2342	2507	638	228	17424	33.64
Total 4T	1282	72	25	4451	15800	1707	2091	2853	3794	4835	5702	1803	44415	85.75

Table 4 : Provisional 4Vn (Jan.-Apr.) cod catches (t round weight) during 1988 by gear type and month in Maritime Provinces, Newfoundland and Quebec.

GEAR TYPE	J	F	MONTH M	A	TOTAL	% OF 4TVn (Jan-Apr) CATCH
MARITIMES						
Otter trawl (side)	1072	704		3	1779	3.43
Otter trawl (stern)	1161	404	638	626	2829	5.46
Midw trawl (stern)		6	26	8	40	0.08
Bottom pair trawl				102	102	0.20
Danish seine	17			191	208	0.40
Scottish seine				87	87	0.17
Gillnet (set)				1	1	0.00
Set lines	3			45	48	0.09
TOTAL	2253	1114	664	1063	5094	9.83
NEWFOUNDLAND						
Otter trawl (side)				105	105	0.20
Otter trawl (stern)	357	774	727	201	2059	3.98
TOTAL	357	774	727	306	2164	4.18
QUEBEC						
Otter trawl (side)	15				15	0.03
Otter trawl (stern)	107				107	0.21
Total	122				122	0.24
TOTAL 4Vn	2732	1888	1391	1369	7380	14.25

Table 5 : Cod catch (t) by gear in 4TVn (Jan-Apr) 1965-1988

YEAR	Otter trawl	Seines	Gillnets	Longlines	Handlines	Misc.	TOTAL
			GEAR				
1965	48371	2673	3571	3189	-	5223	63027
1966	36684	2391	9414	1302	-	5060	54851
1967	23971	2225	9942	1579	2371	1228	41316
1968	28205	994	12933	395	2883	1141	46551
1969	27048	1228	9578	3710	5020	1235	47819
1970	43059	1793	9786	5490	3191	1146	64465
1971	35463	2255	9676	3008	3985	1988	56375
1972	46462	2115	7854	995	2100	5765	65291
1973	35798	2106	8129	420	2127	2055	50635
1974	34565	1741	6070	906	1266	4199	48747
1975	28408	1972	6327	139	3527	2098	42471
1976	25170	1354	4449	55	1169	1218	33415
1977	10964	3058	5931	207	1114	945	22219
1978	22539	4474	8929	155	1342	453	37892
1979	31576	8767	12022	615	1781	1235	55996
1980	32473	9977	4260	1443	723	5758	54634
1981	33963	12327	4053	5839	1055	7940	65177
1982	30627	11273	4175	3781	872	7465	58193
1983	31979	13763	3010	3070	1270	8203	61295
1984	31593	10616	6891	3738	1862	664	55364
1985	39524	11822	5287	3208	2062	235	62138
1986	35570	17594	4360	4024	1862	31	63441
1987	29618	9383	4760	4790	1999	46	50596
1988	31536	11823	3902	3175	1293	66	51795

Table 6 : Number of fish sampled from the 4TVn (Jan.-Apr.) cod fishery (Number measured/number aged)

Gear	MONTH J	F	M	A	M	J	J	A	S	O	N	D	Total
Otter Trawl	1737	1290	781	3649	7251	168	599	3052	4775	2192	4214	259	29967
	158	106	79	346	595	16	29	201	388	178	365	29	2490
Seines				1485	5085	1839	1092	2964	2314	1810	3653		20242
				200	295	230	97	225	210	175	336		1768
Gillnets				184	163	2425	2505	1014	154	40	62		6547
				35	52	414	268	77	41	22	19		928
Longlines						1359	2301	1510	1963	1102	712		8947
						222	239	122	203	152	57		995
Handlines							320	488	576	411			1795
							85	41	47	50			223
Total	1737	1290	781	5318	12499	5791	6817	9028	9782	5555	8641	259	67498
	158	106	79	581	942	882	718	666	889	577	777	29	6404

Table 7 - Summary of age determination comparisons conducted during the age reading of the 1988 otoliths. (+ or - indicates bias)

Date	Reader 1 vs Reference	Reader 2 vs Reference	Reader 1 vs Reader 2
Aug 12,1988	75		
Aug 24,1988	76		
Nov 10,1988	73		
Nov 30,1988	87		
Jan 27,1989	74		
Feb 06,1989	85	77	
Feb 09,1989		82	
Feb 14,1989			77
Feb 15,1989	95-		
Feb 21,1989		86	
Feb 23,1989			76

Table 8 : Age-length keys used in the calculation of the 1988 catch at age for 4TVn (Jan.-Apr.) cod

AGE-KEY #	FISHERY		SAMPLES	SAMPLES SIZE	CATCH (t)
1	OTB	JAN.-MAR.	L.F.: JAN.-MAR. OTB A.L.K.: JAN.-MAR. OTB	LENGTHS 3808 AGES 343	7354
2	OTB	APR.-JUNE	L.F.: APR.-JUNE OTB A.L.K.: APR.-JUNE OTB	LENGTHS 11068 AGES 957	13426
3	OTB	JULY-SEPT.	L.F.: JULY-SEPT.OTB A.L.K.: JULY-SEPT. OTB	LENGTHS 8426 AGES 618	3799
4	OTB	OCT.-DEC.	L.F.: OCT.-DEC. OTB A.L.K.: OCT.-DEC. OTB	LENGTHS 6665 AGES 572	6957
5	SNU	APR.-JUNE	L.F.: APR.-JUNE SNU A.L.K.: APR.-JUNE SNU	LENGTHS 8409 AGES 725	6903
6	SNU	JULY-SEPT.	L.F.: JULY-SEPT. SNU A.L.K.: JULY-SEPT. SNU	LENGTHS 6370 AGES 532	926
7	SNU	OCT.-DEC.	L.F.: OCT.-DEC. SNU A.L.K.: OCT.-DEC. SNU	LENGTHS 5463 AGES 511	3994
8	GNS	APR.-JUNE	L.F.: APR.-JUNE GNS A.L.K.: APR.-JUNE GNS	LENGTHS 2772 AGES 501	1800
9	GNS	JULY- DEC.	L.F.: JULY-DEC. GNS A.L.K.: JULY-DEC. GNS	LENGTHS 3775 AGES 427	2102
10	LLS	APR.-JUNE	L.F.: APR.-JUNE LLS A.L.K.: APR.-JUNE GNS APR.-JUNE LLS APR.-JUNE LHP	LENGTHS 1359 AGES 723	968
11	LLS	JULY-SEPT.	L.F.: JULY-SEPT. A.L.K.: JULY-SEPT. LLS JULY-SEPT. LHP	LENGTHS 5774 AGES 737	1318
12	LLS	OCT.-DEC.	L.F.: OCT.-DEC. A.K.L.: OCT.-DEC. GNS OCT-DEC. LLS OCT.-DEC. LHP	LENGTHS 3777 AGES 300	886
13	LHP	JULY-SEPT.	L.F.: JULY-SEPT. LHP A.L.K.: JULY-SEPT. LHP JULY-SEPT. LLS	LENGTHS 1384 AGES 737	860
14	LHP	OCT.-DEC.	L.F.: OCT.-DEC. LHP A.L.K.: OCT.-DEC. GNS OCT.-DEC. LHP OCT.-DEC. LLS	LENGTHS 987 AGES 300	196
15	UNSAMPLED CATCH				306

Table 9 : Cod (4T-Vn Jan.-Apr.) catch at age by gear and quarter in 1988. Age-Key numbers correspond to Table 8.

Age-Key	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Unsampled	
Gear	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	LLS	LLS	LLS	LHP	LHP		
Quarter	1	2	3	4	2	3	4	2	3-4	2	3	4	3	4	catch	Total
Age																
3	5	2	7	61	1	1	17				1	1	2		1	99
4	229	35	139	655	33	26	243	4	1	25	13	21	33	8	9	1474
5	533	353	881	1506	254	85	659	8	20	69	62	56	83	21	26	4414
6	1509	2541	963	1902	1489	141	994	34	58	110	118	105	102	32	60	10156
7	1057	2304	509	915	1533	117	806	57	88	90	151	100	106	28	47	7908
8	1519	3391	566	1330	1688	154	1219	123	128	179	255	144	172	35	65	10868
9	1156	2178	233	436	919	111	341	104	94	107	132	105	88	26	36	6066
10	350	437	33	84	187	35	130	107	97	50	55	23	33	5	10	1636
11	242	298	17	49	78	11	18	80	52	25	36	26	22	5	6	965
12	48	206	12	15	37	8	6	44	41	13	20	19	11	4	3	487
13	2	63	14	23	14	4	4	25	30	4	15	8	8	1	1	216
14	3	23	2	1	3	3	1	6	6	1	4		1			54
15		20	10	6	6	1	3	3	7	2	4		2			64
16+	1	7	5	1				1	1	2						18
Total	6654	11858	3191	6984	6242	897	4441	594	621	677	866	608	863	165	264	44525

Table 10 : Cod (4T-Vn Jan.-Apr.) length at age by gear and quarter in 1988. Age-Key numbers correspond to Table 8.

Age-Key	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Gear	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	LLS	LLS	LLS	LHP	LHP	Average
Quarter	1	2	3	4	2	3	4	2	3-4	2	3	4	3	4	length
Age															
3	25.[illegible]	29.00	37.72	35.41	29.69	38.00	35.10				34.88	35.79	35.51		34.83
4	36.10	37.33	41.86	40.78	37.49	43.18	40.89	36.78	36.62	39.91	40.34	42.93	39.54	43.25	40.04
5	39.75	42.82	45.59	44.26	43.60	45.45	43.04	41.87	46.28	41.82	46.04	46.01	43.42	45.37	43.61
6	45.01	45.95	48.30	47.24	46.11	47.92	45.22	52.37	48.43	46.17	49.71	50.37	48.07	49.39	46.42
7	47.87	47.75	49.53	49.06	47.44	49.63	46.23	56.45	54.78	50.36	52.01	52.13	51.29	50.45	48.21
8	49.07	48.99	50.98	49.61	49.64	50.23	47.37	55.83	55.59	50.58	53.10	53.56	52.81	51.74	49.52
9	50.91	51.04	50.29	51.74	50.92	52.26	50.01	63.04	63.25	53.80	55.42	53.89	55.26	52.52	51.64
10	56.90	53.80	54.10	55.75	56.27	60.86	50.23	70.57	75.24	60.18	57.83	58.02	57.61	53.49	57.58
11	56.18	58.36	78.16	59.95	58.97	73.25	57.45	73.81	77.61	65.04	62.53	57.12	59.60	54.65	61.08
12	77.08	58.84	56.13	60.43	62.50	76.30	58.81	74.27	91.40	71.45	64.84	55.25	60.79	55.26	65.82
13	100.91	61.08	89.54	51.24	66.70	61.22	57.67	80.42	83.71	74.11	70.58	62.13	61.65	60.97	68.94
14	85.00	60.37	123.00	88.00	83.41	77.41	62.12	98.00	90.62	90.98	85.01		66.77		76.88
15		74.97	124.50	67.71	110.65	83.52	53.00	91.23	109.70	99.41	59.11		59.87		88.34
16+	115.00	85.73	116.00	101.00				114.00	120.02	124.03					104.34
Average	47.98	48.89	49.06	47.12	48.64	50.55	46.00	64.86	65.35	51.26	53.53	52.24	51.02	50.25	48.87

Table 11 : Cod (4T-Vn Jan.-Apr.) weight at age by gear and quarter in 1988. Age-Key numbers correspond to Table 8 .

Age-Key	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Gear	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	LLS	LLS	LLS	LHP	LHP	Average
Quarter	1	2	3	4	2	3	4	2	3-4	2	3	4	3	4	weight
Age															
3	0.133	0.217	0.479	0.397	0.226	0.485	0.383				0.374	0.405	0.395		0.382
4	0.419	0.469	0.661	0.613	0.476	0.744	0.615	0.453	0.437	0.572	0.601	0.722	0.558	0.736	0.583
5	0.576	0.713	0.868	0.789	0.762	0.857	0.725	0.872	0.899	0.666	0.899	0.892	0.753	0.854	0.760
6	0.842	0.892	1.035	0.972	0.903	1.009	0.842	1.382	1.066	0.911	1.142	1.195	1.040	1.124	0.923
7	1.039	1.003	1.118	1.102	0.989	1.143	0.903	1.730	1.579	1.208	1.315	1.348	1.273	1.201	1.045
8	1.127	1.092	1.225	1.133	1.148	1.200	0.973	1.669	1.735	1.219	1.408	1.452	1.392	1.289	1.139
9	1.280	1.254	1.180	1.285	1.258	1.392	1.160	2.497	2.631	1.515	1.641	1.496	1.603	1.348	1.322
10	1.927	1.584	1.486	1.612	1.811	2.353	1.193	3.795	4.516	2.357	1.867	1.954	1.804	1.436	2.032
11	1.721	2.030	6.079	2.272	2.050	4.397	1.808	4.282	5.400	2.839	2.353	1.871	1.991	1.522	2.457
12	4.761	2.098	1.680	2.088	2.489	4.814	2.156	4.308	7.720	3.938	2.762	1.564	2.115	1.553	3.156
13	10.000	2.884	7.127	1.442	3.269	2.216	1.816	5.491	6.618	4.216	3.885	2.236	2.217	2.106	3.931
14	5.873	2.407	18.451	6.539	6.137	4.987	2.236	9.617	7.980	7.776	6.964		2.787		5.480
15		4.864	19.182	2.975	13.537	5.719	1.360	7.455	13.285	12.078	2.055		2.072		6.591
16+	14.981	6.051	16.016	10.021				14.581	17.142	19.377					12.106
Average	1.103	1.129	1.191	0.986	1.105	1.301	0.899	3.008	3.347	1.443	1.513	1.370	1.289	1.192	1.158

Table 12: 4T-Vn (Jan.-Apr.) cod catch at age ('000) for the period 1971-1988.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	6	3177	1337	2731	1556	466	546	538	142	314
4	2040	22152	6888	4980	8781	3460	3357	9854	4959	2019
5	7082	11824	14327	4774	6761	8930	4115	10627	15531	15000
6	9018	6541	5242	9404	2487	6563	2865	4463	10956	14152
7	5746	7422	3648	2986	3237	1592	1686	2589	3391	9541
8	2276	3467	2736	1795	1293	1138	406	1065	1670	1274
9	1225	919	1803	1702	1104	446	291	237	835	699
10	510	529	540	1035	791	265	180	241	291	320
11	129	354	328	266	671	135	124	104	247	124
12	346	114	97	194	150	140	55	72	64	24
13	73	49	67	85	53	45	59	44	33	16
14	117	14	46	26	74	14	11	5	15	8
15	151	46	11	6	7	10	4	13	15	11
16	61	36	23	15	66	9	5	6	8	26
3+	28780	56644	37093	29999	27031	23213	13704	29858	38157	43528

	1981	1982	1983	1984	1985	1986	1987	1988
3	96	395	33	25	165	129	67	99
4	3762	1400	1073	1198	1476	3400	880	1474
5	7277	9782	6031	3899	9915	7639	6815	4414
6	18841	8291	11662	7040	16666	21623	10065	10156
7	12863	11859	11328	8828	8148	9280	17891	7908
8	6026	7238	7223	6736	5975	3697	6540	10968
9	867	2467	5067	5062	3928	2718	1997	6066
10	432	442	2478	2871	2226	2191	1520	1636
11	190	142	105	931	942	1067	664	965
12	64	77	40	154	347	753	379	487
13	81	5	15	52	22	159	136	216
14	2	2	7	7	7	17	108	54
15	14	3	4	5	8	3	14	64
16	3	1	2	8	4	2	12	18
3+	50518	42104	45068	36816	49829	52678	47088	44525

Table 13: 4T-Vn (Jan.-Apr.) cod average weight at age (kg) for the period 1971-1987.

	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	.760	.352	.456	.601	.481	.649	.533	.400	.505
4	.815	.560	.667	.778	.737	.745	.758	.681	.706
5	1.115	.916	.920	1.078	1.142	1.071	1.249	1.030	1.004
6	1.402	1.331	1.274	1.485	1.763	1.505	1.809	1.661	1.414
7	2.146	1.516	1.683	1.959	2.363	2.170	2.437	2.261	2.213
8	3.681	2.542	2.301	2.677	2.752	2.835	3.513	2.815	3.299
9	3.836	4.922	3.574	2.893	3.221	3.220	4.242	4.354	4.064
10	5.253	5.929	5.507	4.178	3.699	3.867	4.290	4.657	7.134
11	6.010	7.117	6.004	6.065	4.457	4.750	5.074	6.495	7.021
12	4.775	8.051	7.904	7.260	6.961	5.058	5.492	6.551	6.701
13	6.821	8.830	6.150	8.290	9.202	6.238	6.743	6.250	4.698
14	7.457	10.124	6.707	6.600	6.319	10.343	8.977	5.090	8.713
15	7.914	5.599	8.918	9.122	8.390	11.472	10.795	11.566	15.415
16	17.897	11.185	6.047	11.748	6.175	14.301	9.258	10.195	17.396

	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	.564	.503	.746	.324	.448	.442	.437	.254	.382
4	.688	.674	.747	.612	.655	.575	.602	.481	.583
5	.919	.848	.960	.884	.786	.762	.816	.703	.760
6	1.206	1.132	1.155	1.138	1.082	.991	1.014	.856	.923
7	1.472	1.382	1.451	1.296	1.369	1.422	1.283	.991	1.045
8	2.643	1.832	1.736	1.557	1.613	1.666	1.743	1.256	1.139
9	2.895	3.150	2.283	1.717	2.058	1.822	1.956	1.766	1.322
10	3.566	4.122	3.270	1.946	2.266	2.122	1.866	2.159	2.032
11	7.958	4.456	4.005	4.947	3.043	2.378	2.585	2.226	2.457
12	5.805	5.603	4.142	7.462	4.880	2.810	2.223	3.112	3.156
13	10.316	6.032	6.455	8.465	5.653	8.435	3.081	3.613	3.931
14	5.813	7.080	6.924	11.358	8.619	5.844	4.409	4.023	5.480
15	9.770	3.490	4.177	12.820	11.736	11.406	15.363	12.131	8.591
16	9.355	6.760	11.099	14.760	12.808	13.547	13.531	12.628	12.106

Table 14: ANOVA and coefficient estimates from the otter trawl catch rate analysis.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R............. .843
MULTIPLE R SQUARED..... .710

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	6.667E0002	6.667E0002	
REGRESSION	43	7.761E0002	1.805E0001	71.527
TYPE 1	9	1.395E0002	1.550E0001	61.420
TYPE 2	1	4.500E0000	4.500E0000	17.835
TYPE 3	11	1.195E0002	1.087E0001	43.060
TYPE 4	22	1.739E0002	7.904E0000	31.326
RESIDUALS	1256	3.169E0002	2.523E0001	
TOTAL	1300	1.760E0003		

CATEGORY	DESCRIPTION
1	Region/Gear/Tonnage Class
	Region 2 - Maritimes and Quebec
	Region 3 - Newfoundland
	Gear 11 - Side trawler
	12 - Stern trawler
	Tonnage class
	2 - 25 - 49.9 t
	3 - 50 - 149.9 t
	4 - 150 - 499.9 t
	5 - 500 - 999.9 t
2	Division
	43 - 4T
	44 - 4Vn
3	Month
	1-12 - (Jan.-Dec.)
4	Year
	66-88 - (1966-1988)

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3125	INTERCEPT	-0.516	0.127	1300
2	44				
3	12				
4	66				
1	2112	1	-1.358	0.076	167
	2113	2	-0.948	0.071	272
	2114	3	-0.174	0.069	172
	2122	4	-0.616	0.091	63
	2123	5	-0.662	0.073	204
	2124	6	-0.344	0.072	134
	2125	7	-0.037	0.075	106
	3113	8	-0.067	0.513	1
	3114	9	-0.316	0.076	98
2	43	10	0.191	0.045	925
3	1	11	0.658	0.071	170
	2	12	0.722	0.079	122
	3	13	0.411	0.086	80
	4	14	0.006	0.068	187
	5	15	-0.223	0.068	152
	6	16	-0.379	0.077	93
	7	17	-0.367	0.086	66
	8	18	-0.582	0.083	74
	9	19	-0.559	0.082	76
	10	20	-0.508	0.080	82
	11	21	-0.288	0.073	110
4	67	22	-0.090	0.130	37
	68	23	0.239	0.130	37
	69	24	0.145	0.119	55
	70	25	0.036	0.118	60
	71	26	-0.163	0.116	68
	72	27	0.018	0.116	65
	73	28	-0.204	0.119	57
	74	29	-0.322	0.117	63
	75	30	-0.351	0.120	55
	76	31	-0.297	0.120	54
	77	32	-0.170	0.128	40
	78	33	0.170	0.128	40
	79	34	0.434	0.117	67
	80	35	0.400	0.120	61
	81	36	0.453	0.122	54
	82	37	0.538	0.119	62
	83	38	0.761	0.119	67
	84	39	0.549	0.120	61
	85	40	0.789	0.121	58
	86	41	0.821	0.120	61
	87	42	0.931	0.120	65
	88	43	0.716	0.115	86

Table 15: Standardized catch rate for otter trawlers for the 4TVn (Jan.-Apr.) cod stock.

PREDICTED CATCH RATE

STANDARDS USED VARIABLE NUMBERS: 2114 44 1

	TOTAL		CATCH RATE		
YEAR	CATCH	PROP.	MEAN	S.E.	EFFORT
1966	54851	0.194	1.092	0.123	50244
1967	41316	0.322	0.999	0.096	41359
1968	46551	0.389	1.389	0.133	33523
1969	47819	0.462	1.265	0.110	37809
1970	64465	0.355	1.134	0.096	56824
1971	56375	0.427	0.930	0.076	60621
1972	65291	0.458	1.115	0.091	58574
1973	50635	0.339	0.892	0.076	56749
1974	48747	0.310	0.793	0.066	61455
1975	42471	0.355	0.771	0.067	55097
1976	33415	0.504	0.813	0.070	41087
1977	22219	0.428	0.923	0.088	24072
1978	37892	0.439	1.296	0.121	29235
1979	55996	0.470	1.690	0.139	33137
1980	54634	0.399	1.634	0.137	33442
1981	65177	0.351	1.721	0.149	37868
1982	58193	0.372	1.875	0.155	31033
1983	61295	0.396	2.344	0.191	26147
1984	55364	0.325	1.895	0.158	29212
1985	62138	0.369	2.410	0.205	25782
1986	63441	0.316	2.489	0.211	25493
1987	50596	0.317	2.777	0.230	18221
1988	51000	0.377	2.240	0.174	22765

AVERAGE C.V. FOR THE MEAN: 0.087

Table 16: Research vessel survey mean numbers per tow at age (1971-1988) for the 4T-Vn (Jan.-Apr.) cod stock.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	.00	.00	.02	.00	.00	.00	.01	.00	.14	.24	.19	.21	.01
1	.06	.73	.07	.08	.40	2.99	.55	1.24	.17	.98	4.72	3.04	5.94
2	.57	2.07	4.69	2.31	5.42	7.33	10.19	5.11	21.67	4.61	20.50	25.17	19.66
3	6.18	4.54	9.30	10.10	4.08	31.73	15.12	23.12	22.00	31.99	19.03	16.10	42.39
4	7.48	12.13	4.31	7.08	6.18	7.98	12.75	24.91	46.65	24.03	56.76	20.63	36.50
5	7.10	5.02	6.86	2.74	5.18	5.34	4.99	14.08	28.46	41.83	47.03	23.94	19.46
6	5.52	4.18	3.23	3.31	1.82	2.25	2.65	4.28	11.60	20.53	45.89	38.14	14.04
7	3.49	2.85	2.29	1.43	1.30	.60	1.51	2.42	3.03	7.41	19.31	19.67	12.16
8	.85	1.65	1.73	1.01	.87	.44	.65	.83	1.24	1.23	10.40	9.35	8.36
9	.16	.31	1.09	1.01	.40	.25	.48	.33	.62	.60	1.38	2.89	3.98
10	.19	.23	.31	.44	.30	.23	.31	.41	.17	.25	.57	.32	2.62
11	.11	.20	.07	.18	.35	.21	.25	.48	.18	.06	.25	.12	.56
12	.09	.06	.21	.09	.08	.06	.20	.06	.15	.01	.10	.10	.11
13	.00	.03	.03	.19	.04	.06	.24	.00	.05	.01	.06	.05	.32
14	.08	.02	.05	.00	.00	.02	.00	.13	.04	.05	.05	.02	.04
15	.07	.03	.01	.04	.00	.00	.04	.03	.04	.01	.06	.00	.06
16	.16	.04	.16	.11	.00	.02	.07	.00	.02	.01	.08	.05	.00
0+	32.10	34.09	34.44	30.11	26.44	59.51	50.01	77.42	136.23	133.84	226.39	159.80	166.20
1+	32.10	34.09	34.42	30.11	26.44	59.51	50.00	77.42	136.10	133.60	226.20	159.59	166.19
2+	32.04	33.36	34.34	30.03	26.04	56.52	49.45	76.17	135.93	132.62	221.48	156.54	160.25
3+	31.47	31.29	29.65	27.72	20.62	49.19	39.26	71.06	114.26	128.02	200.97	131.37	140.59
4+	25.29	26.75	20.36	17.62	16.54	17.45	24.14	47.95	92.26	96.02	181.94	115.27	98.20
5+	17.82	14.62	16.04	10.54	10.36	9.48	11.39	23.04	45.61	72.00	125.19	94.64	61.70
6+	10.71	9.59	9.18	7.80	5.18	4.14	6.40	8.96	17.15	30.17	78.16	70.70	42.24

	1984	1985	1986	1987	1988
0	.00	1.30	2.08	.29	.64
1	2.18	3.93	6.42	.33	2.70
2	11.06	12.65	21.43	8.34	7.17
3	15.06	33.09	38.16	20.06	35.93
4	33.86	43.45	51.50	17.74	46.89
5	42.10	78.66	51.00	24.44	42.63
6	15.67	88.85	54.89	19.19	31.40
7	8.09	21.13	35.33	26.20	15.99
8	8.54	8.32	9.28	9.95	19.42
9	3.41	5.93	1.85	2.18	11.65
10	1.56	3.06	2.64	1.61	1.91
11	.54	2.00	.91	.60	.55
12	.13	.68	.58	.49	.36
13	.04	.03	.20	.20	.34
14	.13	.00	.11	.09	.12
15	.02	.00	.00	.01	.18
16	.02	.07	.12	.01	.00
0+	142.42	303.16	276.52	131.73	217.88
1+	142.42	301.85	274.43	131.44	217.24
2+	140.24	297.93	268.01	131.11	214.54
3+	129.17	285.27	246.58	122.77	207.37
4+	114.11	252.18	208.41	102.71	171.44
5+	80.25	208.73	156.92	84.97	124.55
6+	38.15	130.07	105.92	60.53	81.91

Table 17: 4T-Vn (Jan.-Apr.) research vessel survey coefficients of variation for ages 1 to 12 (1971-1988).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	53.2	31.9	46.7	44.1	66.2	36.6	30.5	43.5	41.2	36.0	33.6	26.4
2	24.9	46.5	21.8	24.4	46.8	24.9	16.5	19.7	25.2	19.1	42.9	29.9
3	10.9	19.7	18.6	12.9	52.0	18.9	17.8	21.1	15.6	26.5	18.4	31.6
4	14.5	15.3	18.5	9.1	29.4	13.5	17.2	35.7	13.4	19.5	20.0	23.1
5	15.7	21.0	17.5	8.9	26.2	22.2	22.2	37.4	12.2	21.3	20.5	22.8
6	16.0	20.4	16.4	7.0	31.7	27.5	28.5	27.8	9.7	22.2	19.3	23.1
7	15.8	18.0	16.2	7.8	28.3	31.4	34.0	23.6	8.5	20.5	17.7	19.6
8	15.5	17.9	15.0	7.4	27.2	28.4	31.7	25.4	10.2	21.9	16.1	17.3
9	23.3	16.7	16.2	7.1	26.2	33.2	30.8	44.0	13.3	25.2	13.0	15.5
10	25.9	22.1	20.9	12.9	29.6	29.3	36.3	39.3	36.2	29.5	14.3	21.3
11	35.5	24.4	21.3	18.4	31.0	31.7	33.5	71.8	23.4	33.5	14.2	33.3
12	24.0	27.0	39.6	25.6	34.7	37.4	32.7	65.5	25.6	37.4	27.6	48.4

	1983	1984	1985	1986	1987	1988
1	21.7	19.2	73.9	66.0	40.0	65.3
2	13.3	20.9	27.6	34.3	27.1	35.9
3	15.5	18.1	22.7	34.1	18.5	30.0
4	16.2	18.1	36.1	46.9	10.6	21.5
5	11.9	20.2	44.9	43.5	11.0	21.2
6	9.2	13.2	46.6	36.6	14.7	17.9
7	9.8	9.6	45.7	26.5	20.6	17.3
8	10.1	9.3	36.3	21.1	26.3	16.7
9	13.1	8.9	37.1	10.5	29.1	17.8
10	11.6	8.7	33.4	21.0	33.5	19.7
11	15.4	8.9	33.1	17.2	33.3	28.4
12	36.3	71.3	62.3	15.0	29.2	25.0

Table 18: Results from the analysis of cod mean catch per tow and strata at age from the groundfish surveys.

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: CATCH

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	147	3291.36393603	22.39023086	20.96
ERROR	2072	2213.00255533	1.06805143	PR > F
CORRECTED TOTAL	2219	5504.36649136		0.0

R-SQUARE	C.V.	ROOT MSE	CATCH MEAN
0.597955	55.9255	1.03346574	1.84793361

SOURCE	DF	TYPE I SS	F VALUE	PR > F
YC	22	1145.29144903	48.74	0.0
STRAT	20	1268.27095175	59.37	0.0
AGE	5	367.73468525	68.86	0.0
STRAT*AGE	100	510.06685001	4.78	0.0

SOURCE	DF	TYPE III SS	F VALUE	PR > F
YC	22	1152.81985003	49.06	0.0
STRAT	20	1268.20789767	59.37	0.0
AGE	5	371.23192655	69.52	0.0
STRAT*AGE	100	510.06685001	4.78	0.0

Table 19a: 4T-Vn (Jan.-Apr.) cod standardized mean catch per tow at age and by strata. Last two digit of strata numbers correspond to Figure 6.

		AGE					
		2	3	4	5	6	7
		NUM	NUM	NUM	NUM	NUM	NUM
		SUM	SUM	SUM	SUM	SUM	SUM
DEPTH	STRATA						
1	417	2.2	13.2	24.7	27.1	19.5	11.0
	418	6.8	16.2	16.4	11.7	8.5	5.3
	419	10.0	15.3	15.1	14.2	11.4	6.7
	420	4.3	7.0	9.2	10.1	8.4	5.3
	421	6.6	8.2	9.0	8.0	6.2	3.7
	422	27.6	54.4	42.3	27.6	16.7	9.4
	423	1.8	7.9	15.8	14.6	9.9	5.3
	424	0.7	6.4	14.8	18.0	13.2	7.4
	427	0.3	2.7	6.3	6.7	4.9	3.3
	428	12.0	25.6	21.6	15.1	8.6	4.7
	429	6.0	17.0	16.1	10.8	7.1	4.3
	431	3.3	8.2	11.5	10.5	7.3	4.2
	432	0.5	0.4	0.5	0.4	0.3	0.3
	433	1.6	2.5	2.7	2.4	1.9	1.2
	434	2.4	7.5	7.2	4.9	3.6	2.4
	435	3.6	7.2	5.9	5.2	4.1	2.7
	436	0.3	2.3	4.2	4.2	3.8	2.8
2	416	0.6	4.2	12.9	24.3	23.2	15.6
	426	0.1	0.8	4.1	10.1	13.4	10.8
	437	0.1	0.7	1.5	2.7	3.3	3.0
	438	0.1	1.1	3.4	6.0	7.2	6.2

Table 19b: 4T-Vn (Jan.-Apr.) cod RV mean catch per tow by year and strata for 0-group

		YEAR																	
		71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
		CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH	CATCH
		SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM
DEP	STRAT																		
1	417	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	0.0	0.0
	418	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.1	0.0	0.0
	419	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.4	0.1	0.0	0.0
	420	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.0	2.7	42.8	0.0	0.0
	421	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	3.0	0.5	0.0	5.7	.	0.0	55.8	2.2	8.9	.
	422	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	0.7	0.1	0.0	1.8
	423	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	424	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	0.0
	427	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
	428	0.0	0.0	0.0	0.0	0.0	0.0	1.0	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6
	429	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.4	0.0	0.0	0.0	0.0	2.0	0.0	0.0
	431	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	432	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.1	5.7	7.8	0.9
	433	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.1	0.0	0.0	0.0	2.9	0.4	0.3	3.1
	434	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.8	0.0	0.2
	435	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0
	436	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	416	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	0.0	0.0
	426	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	0.0	0.0
	437	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	438	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	0.0	0.0
3	415	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	0.0	0.0
	425	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	0.0
	439	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	0.0	0.0
ALL		0.0	0.0	1.3	0.0	0.0	0.0	1.0	0.0	4.5	3.0	4.6	9.5	0.3	0.0	62.9	54.2	17.0	35.2

Table 19c: 4T-Vn (Jan.-Apr.) cod RV mean catch per tow by year and strata for 1 year-old.

DEP	STRAT	YEAR 71 CATCH SUM	72 CATCH SUM	73 CATCH SUM	74 CATCH SUM	75 CATCH SUM	76 CATCH SUM	77 CATCH SUM	78 CATCH SUM	79 CATCH SUM	80 CATCH SUM	81 CATCH SUM	82 CATCH SUM	83 CATCH SUM	84 CATCH SUM	85 CATCH SUM	86 CATCH SUM	87 CATCH SUM	88 CATCH SUM
1	417	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.3	0.0	0.7	0.1	0.1	2.4	1.2	0.0	0.0	0.0	0.0
	418	0.0	0.2	0.1	0.0	0.2	8.6	2.0	1.6	0.4	0.3	0.1	0.7	6.3	7.8	0.2	1.3	0.3	0.0
	419	0.0	0.0	0.0	1.5	0.0	43.5	4.3	9.8	0.4	1.2	6.9	17.8	20.3	5.0	1.9	2.6	1.0	0.6
	420	0.0	12.1	0.1	0.0	0.0	9.7	3.6	21.0	0.0	0.4	3.0	2.2	8.1	1.1	3.1	102.5	3.5	2.5
	421	0.8	0.9	0.8	1.5	0.6	5.7	5.3	0.0	0.4	14.2	18.1	19.2	.	14.1	170.5	0.0	2.6	.
	422	0.0	3.8	0.0	0.0	0.4	16.5	0.1	0.3	0.9	0.5	36.2	4.4	26.8	9.7	6.9	25.0	1.3	6.1
	423	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.8	4.9	0.6	1.3	0.3	0.0	0.0	0.3
	424	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	0.0	2.0	0.3	1.6	0.0	0.0	0.0	0.0	0.0
	427	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	.	.	.	.	0.0
	428	0.0	1.4	0.0	0.4	0.0	4.0	0.0	.	0.0	2.5	0.0	5.3	0.4	0.0	2.2	8.3	0.1	174.9
	429	0.0	0.0	0.1	0.1	0.0	2.1	1.6	0.4	0.3	4.3	6.1	1.5	26.4	3.2	0.0	4.3	0.0	1.4
	431	0.4	0.0	0.4	0.0	0.0	0.2	0.4	0.7	0.8	0.0	5.7	2.6	5.6	0.2	0.0	1.1	0.0	1.5
	432	0.3	0.0	0.8	0.0	2.3	0.0	0.0	0.0	0.6	0.0	0.6	0.8	0.0	15.5	0.2	1.8	0.0	0.2
	433	0.0	0.0	0.0	0.1	1.0	1.6	0.2	0.4	0.0	0.0	5.2	6.8	1.7	1.2	5.3	0.5	0.0	1.6
	434	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	4.4	6.8	1.2	0.9	0.3	0.9	0.0	0.2
	435	0.5	0.0	0.1	0.0	8.3	1.1	0.0	0.0	0.0	5.1	2.0	0.0	1.1	1.8	0.3	0.0	0.5	1.3
	436	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0
2	416	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.5	0.2	5.0	0.5	0.0	0.0	0.2	0.0
	426	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	0.4	0.0	0.0	0.0	0.0
	437	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	0.0	0.6
	438	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	0.0	0.0
3	415	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	0.0	0.0
	425	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	0.0
	439	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	0.0	0.0
ALL		2.0	18.5	2.4	3.6	12.8	93.9	17.7	34.5	3.8	30.8	92.7	73.6	108.3	63.9	191.2	148.3	9.5	191.2

Table 19d: 4T-Vn (Jan.-Apr.) cod RV mean catch per tow by year and strata for 9 year-old and older.

DEP	STRAT	YEAR 71 CATCH SUM	72 CATCH SUM	73 CATCH SUM	74 CATCH SUM	75 CATCH SUM	76 CATCH SUM	77 CATCH SUM	78 CATCH SUM	79 CATCH SUM	80 CATCH SUM	81 CATCH SUM	82 CATCH SUM	83 CATCH SUM	84 CATCH SUM	85 CATCH SUM	86 CATCH SUM	87 CATCH SUM	88 CATCH SUM
1	417	0.7	0.0	1.8	2.4	1.0	0.4	0.5	0.0	0.3	2.4	2.2	2.9	5.4	7.5	3.8	2.8	3.2	24.2
	418	0.8	0.1	1.8	0.5	0.3	0.2	0.6	0.1	0.1	0.3	0.2	2.6	5.2	2.9	9.6	1.9	2.6	3.8
	419	1.3	0.4	1.4	4.0	0.5	0.8	1.1	0.0	0.4	0.3	0.7	2.8	18.4	2.7	1.9	0.7	1.9	2.2
	420	0.4	0.3	4.8	7.7	0.3	1.1	0.1	1.1	0.6	0.0	0.4	0.8	8.0	4.5	2.2	1.5	1.4	2.5
	421	0.2	1.8	0.3	0.3	0.5	0.0	0.3	0.0	1.0	0.0	1.5	1.0	.	3.4	0.7	0.2	0.6	.
	422	0.1	1.4	3.4	0.6	1.8	0.8	0.6	0.4	1.1	2.7	2.0	0.6	3.4	3.5	5.2	2.3	2.4	8.7
	423	0.1	0.1	1.0	0.6	0.1	0.5	0.1	0.8	0.4	0.3	1.5	2.9	2.6	2.3	2.9	1.8	0.9	11.8
	424	0.0	0.1	0.5	1.0	0.8	0.1	0.4	.	0.9	0.7	1.4	13.0	1.3	2.2	45.1	0.8	1.6	3.0
	427	0.4	0.2	0.0	0.4	0.0	0.0	0.0	0.2	0.3	0.2	0.7	6.0	2.6	.	.	.	.	10.5
	428	0.0	0.6	0.0	0.2	0.4	0.7	0.0	.	1.4	0.3	2.6	3.1	5.1	8.1	3.5	0.9	1.8	14.3
	429	0.1	0.2	1.2	0.8	0.6	0.1	0.4	0.3	0.5	0.3	1.6	2.8	3.6	3.7	1.5	1.2	0.6	7.2
	431	0.1	0.0	0.3	0.5	0.2	0.2	0.5	0.4	0.5	0.6	0.3	2.4	3.6	1.0	2.3	2.9	0.6	14.6
	432	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
	433	-0.0	0.0	0.0	0.5	0.4	0.0	1.9	0.0	0.6	0.0	1.5	0.0	0.3	1.8	1.0	0.3	0.1	2.7
	434	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.3	0.5	1.6	4.3	2.3	2.7	0.8	1.8	6.2
	435	0.1	0.0	0.4	0.0	0.2	0.0	0.0	0.1	0.2	0.5	0.4	0.4	2.0	2.8	4.5	0.8	1.8	0.8
	436	0.0	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.1	0.4	1.1	2.6	1.6	2.2	9.2	0.9	2.4	22.3
2	416	0.3	0.5	4.7	2.0	0.8	0.1	2.8	0.5	1.6	1.3	2.1	2.9	13.7	8.8	8.7	4.7	6.9	49.8
	426	0.0	0.2	0.6	2.6	0.2	0.2	0.1	0.1	4.2	0.8	6.2	6.0	11.4	20.0	18.1	10.9	33.4	65.7
	437	0.0	0.1	0.2	0.0	0.6	0.0	0.3	0.3	1.0	0.8	2.0	9.0	3.7	7.3	3.9	6.2	1.4	6.5
	438	0.3	0.9	0.1	1.3	0.0	0.6	0.2	0.4	0.8	1.6	6.3	6.1	11.6	8.5	3.7	4.1	3.4	23.9
3	415	0.0	0.8	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.9	0.1	0.5	0.1	0.4
	425	-0.1	0.0	0.0	0.4	0.6	0.0	0.1	.	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	439	0:0	0.1	0.2	0.5	0.2	0.0	0.7	0.8	0.4	0.0	5.3	0.7	2.1	0.9	5.5	0.6	0.5	1.3
ALL		5.0	9.5	23.0	27.3	9.5	5.8	10.7	5.5	17.2	14.6	40.6	70.4	110.1	97.4	136.1	46.9	69.4	282.4

Table 20: Summary table for the calibration of sequential population analysis using non-linear least squares for cod in 4T-Vn (Jan.-Apr.).

Parameters estimated:

- Year-class estimates $\{N_{i,1989}(i = 4,11)\}$
- Calibration constants for RV mean numbers per tow $\{k_i(i = 3,10+)\}$
- Calibration constant for CPUE $\{q\}$

Structure imposed:

- F on ages 11 to 15 in 1988 set equal to age 10
- F for oldest age set equal to weighted (by population) F on age 9-10
- Model did not include an intercept

Input data:

- Catch at age $\{C_{i,t}, (i = 3 \text{ to } 15,\ t = 71\text{-}88)\}$
- RV mean number per tow at age $\{RV_{i,t}, (i = 3 \text{ to } 10+,\ t = 71\text{-}88)\}$
- Otter trawl CPUE $\{CPUE_t,\ (t = 71\text{-}88)\}$
- Standard errors for RV and CPUE for weighting

Objective function:

- Minimize $\sum_i\sum_j \frac{(\text{Obs. Index}_{i,t} - \text{Pred. Index}_{i,t})^2}{\text{SE Index}_{i,t}}$

Summary:

- number of observations = 162
- number of parameters = 17

Table 21: Parameter estimates and standard errors for the adaptive framework

ORTHOGONALITY OFFSET......... 0.025572
MEAN SQUARE RESIDUALS 7.385261

PAR. EST.	STD. ERR.	T-STATISTIC
2.83344E0005	2.34432E0005	1.20864E0000
1.43755E0005	5.81673E0004	2.47140E0000
5.87869E0004	1.79389E0004	3.27706E0000
6.03658E0004	1.85343E0004	3.25697E0000
3.86052E0004	1.25968E0004	3.06470E0000
3.36275E0004	1.14254E0004	2.94323E0000
2.22490E0004	8.10224E0003	2.74603E0000
5.03264E0003	9.06185E0002	5.55366E0000
1.14430E-004	1.59012E-005	7.19634E0000
2.24346E-004	2.68034E-005	8.37004E0000
2.85680E-004	3.46217E-005	8.25149E0000
2.94126E-004	2.96803E-005	9.90980E0000
3.31038E-004	3.25437E-005	1.01721E0001
3.35514E-004	3.34269E-005	1.00372E0001
2.20043E-004	2.54335E-005	8.65172E0000
3.73785E-004	2.47645E-005	1.50936E0001
1.16691E-005	7.01677E-007	1.66303E0001

Table 22: Correlation matrix of the parameters for the adaptive framework

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00	.04	.00	.00	.02	.00	.01	.00	-.16	.00	.00	.00
2	.04	1.00	.03	.01	.04	.01	.02	.00	-.26	-.08	-.01	-.01
3	.00	.03	1.00	.01	.01	.03	.03	.00	-.02	-.40	-.02	.00
4	.00	.01	.01	1.00	.02	-.01	.02	.02	-.03	-.01	-.39	-.06
5	.02	.04	.01	.02	1.00	.01	.01	.03	-.16	-.02	-.01	-.16
6	.00	.01	.03	-.01	.01	1.00	-.33	-.08	-.02	-.07	.02	.01
7	.01	.02	.03	.02	.01	-.33	1.00	-.08	-.05	-.07	-.04	-.02
8	.00	.00	.00	.02	.03	-.08	-.08	1.00	-.01	-.01	-.05	-.08
9	-.16	-.26	-.02	-.03	-.16	-.02	-.05	-.01	1.00	.03	.02	.03
10	.00	-.08	-.40	-.01	-.02	-.07	-.07	-.01	.03	1.00	.01	.01
11	.00	-.01	-.02	-.39	-.01	.02	-.04	-.05	.02	.01	1.00	.03
12	.00	-.01	.00	-.06	-.16	.01	-.02	-.08	.03	.01	.03	1.00
13	.00	-.01	.00	.00	-.12	-.03	.00	-.12	.02	.01	.01	.03
14	.00	.00	.00	.00	.00	-.02	-.08	-.05	.01	.01	.01	.01
15	.00	.00	.00	.00	-.01	.03	-.04	-.17	.00	.00	.01	.02
16	.00	.00	.00	-.01	-.01	.04	-.06	-.22	.01	.01	.01	.02
17	.00	-.02	-.01	-.01	-.01	-.13	-.15	-.19	.02	.03	.02	.02

	13	14	15	16	17
1	.00	.00	.00	.00	.00
2	-.01	.00	.00	.00	-.01
3	.00	.00	.00	.00	-.01
4	.00	.00	.00	-.01	-.01
5	-.12	.00	-.01	-.01	-.01
6	-.03	-.02	.03	.04	-.13
7	.00	-.08	-.04	-.06	-.15
8	-.12	-.05	-.17	-.22	-.19
9	.02	.01	.00	.01	.02
10	.01	.01	.00	.01	.03
11	.01	.01	.01	.01	.02
12	.03	.01	.02	.02	.02
13	1.00	.01	.02	.03	.03
14	.01	1.00	.01	.02	.04
15	.02	.01	1.00	.04	.04
16	.03	.02	.04	1.00	.06
17	.03	.04	.04	.06	1.00

Table 23: Weighted residuals for the adaptive framework (3 to 10 refer to RV indices and 11 to OTB fishable biomass).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	-4.41	1.30	2.64	3.67	-.10	3.22	-.78	1.23	2.73	2.25
4	-.23	.00	-.04	.24	-.62	1.49	-3.08	-.18	3.16	.85
5	.08	-.94	-.93	-1.16	-.34	.06	-.59	-.83	1.20	1.86
6	-1.54	.13	.60	-1.11	.36	-1.08	-.45	.59	-.91	.89
7	-1.99	-1.91	.09	-.44	-.68	-1.54	-.14	.87	3.52	-.74
8	-4.18	-2.64	-.08	-.96	1.09	-1.89	.91	-.36	2.31	.50
9	-9.08	-2.81	1.66	7.19	1.06	.93	1.65	.99	3.97	2.05
10	-4.75	-3.70	1.43	1.13	1.43	2.60	6.85	4.28	5.06	.35
11	-6.17	-1.12	-1.09	1.98	.17	3.68	1.50	2.25	-1.83	1.82

	1981	1982	1983	1984	1985	1986	1987	1988
3	2.57	-.84	2.50	-.53	2.05	2.01	-.65	.00
4	3.21	.98	.67	-1.25	1.09	.97	-.75	1.10
5	2.84	.85	1.66	1.04	1.05	1.12	-1.28	2.59
6	3.29	2.69	.54	2.08	1.54	1.20	-.18	1.83
7	2.41	2.28	1.63	-1.49	1.34	1.71	.70	.19
8	3.38	1.94	2.58	3.45	.96	2.17	-1.43	1.57
9	5.55	2.54	3.58	4.35	1.75	-1.28	.03	2.68
10	12.05	3.06	6.20	-2.30	2.82	2.05	-2.09	-4.08
11	-1.28	.55	4.98	3.93	2.56	.95	-.49	-1.37

Table 24: Yield per recruit for 4T-Vn (Jan.-Apr.) cod

AGE	WEIGHT-AT-AGE	PARTIAL RECRUITMENT
1	.044	.000
2	.173	.000
3	.433	.002
4	.608	.032
5	.810	.202
6	1.023	.501
7	1.265	.760
8	1.530	.813
9	1.846	1.000
10	2.237	1.000
11	3.092	1.000
12	3.969	1.000
13	5.662	1.000
14	6.665	1.000
15	7.600	1.000
16	8.600	1.000

NATURAL MORTALITY RATE : 0.2
F0.1 COMPUTED AS .2023 AT Y/R OF .3199
FMAX COMPUTED AS .4401 AT Y/R OF .3472

YIELD PER RECRUIT ANALYSIS

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	.1000	.108	.241	2.232	1.523
	.2000	.169	.319	1.887	1.008
F0.1---	.2023	.170	.320	1.881	1.000
	.3000	.208	.342	1.647	.721
	.4000	.234	.347	1.482	.548
FMAX---	.4401	.243	.347	1.431	.499
	.5000	.254	.347	1.366	.439
	.6000	.269	.346	1.284	.364
	.7000	.282	.345	1.222	.311
	.8000	.292	.344	1.176	.272
	.9000	.301	.343	1.139	.241
	1.0000	.309	.343	1.109	.217
	1.1000	.316	.342	1.083	.197
	1.2000	.322	.342	1.062	.180
	1.3000	.328	.342	1.044	.166
	1.4000	.333	.342	1.027	.154
	1.5000	.337	.341	1.013	.144

Table 25: Population numbers (beginning of year) for the 4T-Vn (Jan.-Apr.) cod stock from 1971 to 1989. No data are available to estimate the numbers at age 3 in 1989.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	88303	34352	46426	52915	42288	119961	166512	165478	121802	124620	96850	196829
4	39096	72291	25250	36801	40852	33215	97794	135834	134995	99594	101746	79207
5	31067	30163	39143	14441	25624	25501	24063	77030	102295	106038	79714	79899
6	30931	19028	13997	19084	7503	14861	12799	15978	53451	69699	73244	58680
7	18568	17164	9660	6716	7116	3893	6229	7886	9043	33848	44260	42919
8	5934	10003	7337	4608	2797	2897	1747	3574	4114	4336	19080	24598
9	3224	2799	5052	3531	2149	1120	1342	1063	1963	1857	2397	10169
10	1626	1531	1460	2505	1351	760	514	835	656	851	888	1178
11	488	870	775	707	1115	391	383	258	466	273	408	336
12	548	282	392	338	338	305	198	201	117	158	112	162
13	145	136	128	233	101	141	123	112	100	38	108	34
14	296	52	67	44	114	35	75	48	52	52	16	15
15	418	136	30	13	13	26	16	51	34	29	35	12
3+	220643	188808	149718	141936	131360	203107	311793	408348	429087	441394	418856	494036
4+	132340	154456	103292	89021	89072	83146	145281	242870	307285	316773	322007	297207
5+	93244	82165	78041	52221	48220	49931	47487	107036	172290	217179	220260	218000
6+	62176	52001	38898	37780	22596	24429	23424	30006	69995	111142	140546	138101
7+	31245	32973	24901	18696	15093	9568	10625	14028	16544	41443	67303	79421
8+	12678	15809	15241	11979	7977	5675	4396	6142	7501	7594	23043	36502

	1983	1984	1985	1986	1987	1988	1989
3	250146	159273	170806	115725	216521	106000	
4	160793	204772	130379	139695	94631	177212	86696
5	63583	130675	166569	105410	111296	76681	143755
6	56565	46600	103460	127404	79390	84955	58787
7	40541	35759	31783	69626	84744	55892	60366
8	24408	22942	21289	18649	48608	53194	38605
9	13590	13448	12688	12024	11923	33879	33627
10	6093	6542	6430	6834	7385	7955	22249
11	565	2746	2758	3250	3613	4671	5033
12	147	367	1406	1406	1696	2357	2951
13	63	84	161	837	470	1045	1489
14	23	38	22	112	542	261	661
15	10	12	25	11	76	346	165
3+	616525	623259	647777	600983	660894	604448	454385
4+	366379	463986	476970	485258	444373	498448	454384
5+	205587	259214	346591	345563	349743	321237	367688
6+	142004	128539	180022	240153	238447	244556	223933
7+	85440	81939	76562	112749	159056	159601	165146
8+	44899	46180	44779	43124	74312	103709	104780

Table 26: Fishing mortality for the 4T-Vn (Jan.-Apr.) cod stock from 1971 to 1988.

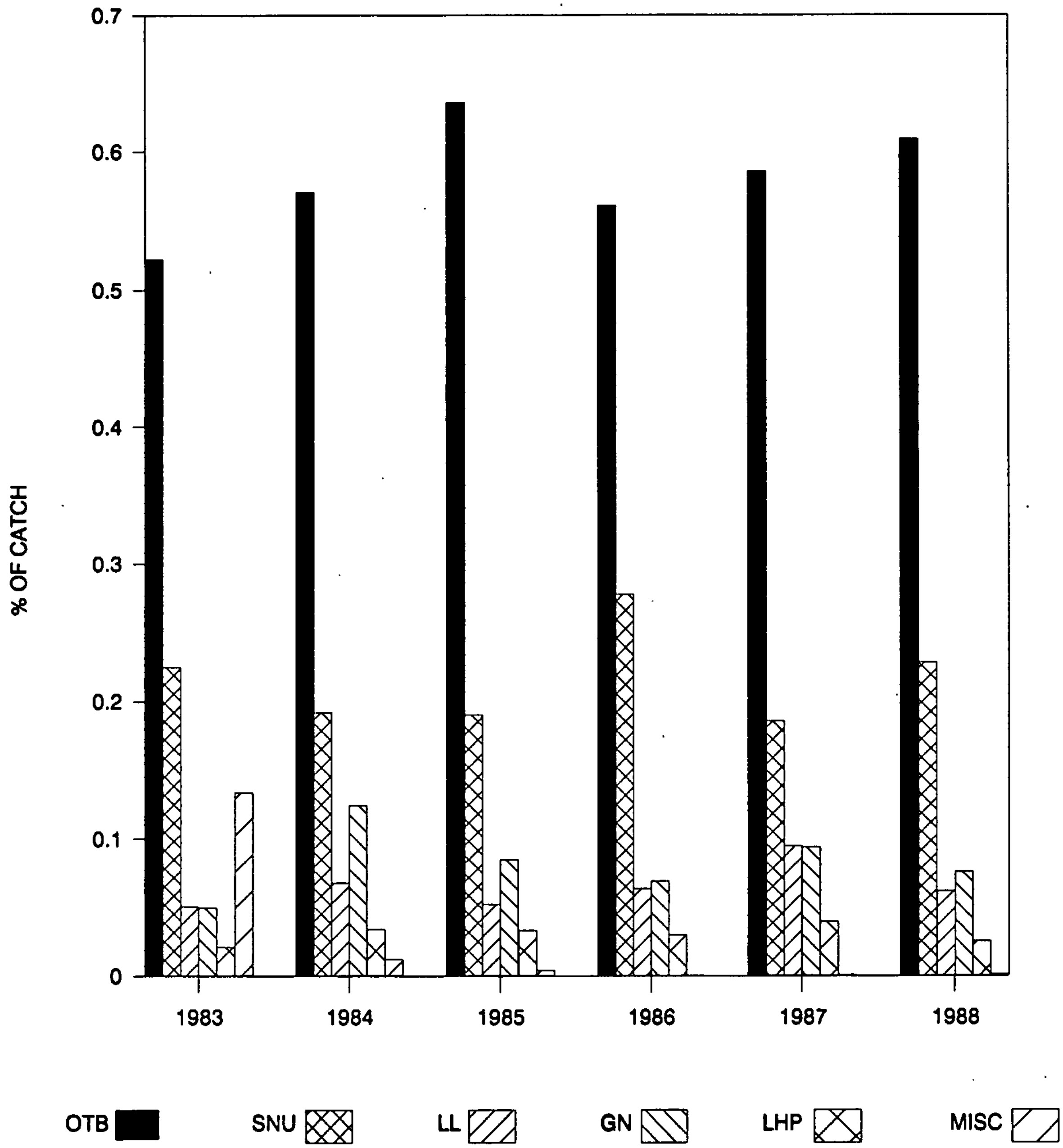
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	.000	.108	.032	.059	.042	.004	.004	.004	.001	.003	.001	.002	.000	.000	.001
4	.059	.413	.359	.162	.271	.122	.039	.084	.041	.023	.042	.020	.007	.006	.013
5	.290	.568	.518	.455	.345	.489	.209	.165	.184	.170	.106	.145	.111	.034	.068
6	.389	.478	.534	.787	.456	.670	.284	.369	.257	.254	.334	.170	.259	.183	.196
7	.419	.650	.540	.676	.699	.601	.355	.451	.535	.373	.387	.364	.369	.319	.333
8	.551	.483	.531	.563	.715	.569	.297	.399	.595	.393	.429	.393	.396	.392	.371
9	.545	.451	.502	.761	.839	.580	.274	.283	.635	.538	.510	.312	.531	.538	.419
10	.426	.481	.525	.610	1.041	.486	.490	.384	.674	.537	.771	.536	.597	.664	.482
11	.346	.598	.631	.538	1.095	.481	.443	.591	.882	.695	.724	.629	.230	.469	.474
12	1.196	.591	.320	1.008	.674	.707	.368	.504	.930	.184	1.003	.747	.358	.623	.318
13	.815	.509	.863	.517	.870	.435	.752	.569	.457	.633	1.783	.180	.307	1.153	.163
14	.575	.350	1.432	1.047	1.269	.593	.177	.123	.385	.188	.145	.162	.411	.229	.441
15	.510	.467	.514	.709	.937	.549	.332	.329	.656	.545	.583	.336	.559	.586	.445

	1986	1987	1988
3	.001	.000	.001
4	.027	.010	.009
5	.083	.070	.066
6	.208	.151	.142
7	.159	.266	.170
8	.247	.161	.259
9	.287	.205	.220
10	.437	.258	.258
11	.451	.227	.259
12	.897	.284	.259
13	.236	.386	.259
14	.183	.249	.259
15	.342	.226	.229

Table 27: Mean population biomass for the 4T-Vn (Jan.-Apr.) cod stock from 1971 to 1988.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	60823	10408	18891	28021	18071	70417	80298	59888	55714	63618	44130	132940
4	28066	30259	12903	24021	24009	21153	65945	80544	84674	61428	60918	53118
5	27382	19287	25689	11423	22562	19734	24662	66459	85297	81453	58224	64859
6	32773	18393	12632	18015	9700	14941	18352	20237	60669	67560	64226	56656
7	29715	17529	11487	8765	11093	5811	11648	13107	14171	37922	46258	47589
8	15358	18424	11975	8630	5043	5729	4836	7568	9361	8646	25941	32207
9	8720	10127	12978	6565	4304	2505	4534	3670	5408	3803	5405	18167
10	6348	6583	5718	7170	2863	2127	1591	2947	3118	2149	2342	2727
11	2258	4264	3159	3032	2786	1345	1432	1156	1999	1438	1185	915
12	1411	1572	2414	1422	1569	1016	828	946	469	762	364	433
13	620	858	485	1378	570	651	536	489	343	264	282	180
14	1535	408	221	167	377	247	559	207	343	249	98	86
15	2368	557	193	78	64	211	131	460	357	199	85	38
3+	217376	138670	118746	118689	103010	145887	215353	257678	321923	329489	309459	409917
4+	156553	128262	99855	90668	84939	75470	135055	197790	266208	265872	265329	276977
5+	128487	98003	86952	66647	60930	54317	69110	117246	181535	204444	204411	223859
6+	101105	78716	61263	55224	38368	34583	44447	50787	96237	122991	146187	159000
7+	68333	60323	48631	37209	28668	19642	26095	30550	35569	55431	81961	102344
8+	38618	42794	37144	28443	17575	13831	14448	17443	21397	17509	35703	54754

	1983	1984	1985	1986	1987	1988
3	73452	64666	68390	45808	49837	36601
4	88871	121184	67535	75225	41049	93222
5	48312	91599	111338	74898	68566	51177
6	51630	41895	84660	106093	57314	66421
7	40061	38197	35031	75041	67139	48819
8	28629	27924	27018	26208	51246	48596
9	16552	19575	17239	18614	17317	36563
10	8173	9927	9891	9430	12791	12970
11	2270	6092	4771	6177	6545	9202
12	839	1221	3083	1898	4184	5965
13	417	260	1141	2091	1284	3295
14	195	265	94	411	1756	1148
15	93	101	207	136	755	2415
3+	359493	422908	430398	442029	379784	416395
4+	286042	358241	362008	396221	329947	379794
5+	197171	237057	294473	320996	288898	286572
6+	148858	145458	183135	246099	220332	235395
7+	97228	103563	98475	140005	163018	168975
8+	57167	65366	63444	64964	95878	120156



(OTB - otter trawl, SNU - seines, LL - longlines, GN - gillnets, LHP - handlines, MISC - all other gears including unknowns)

Figure 1: Percent of 4T-Vn (Jan.-Apr.) cod catch by gear (1983-1988).

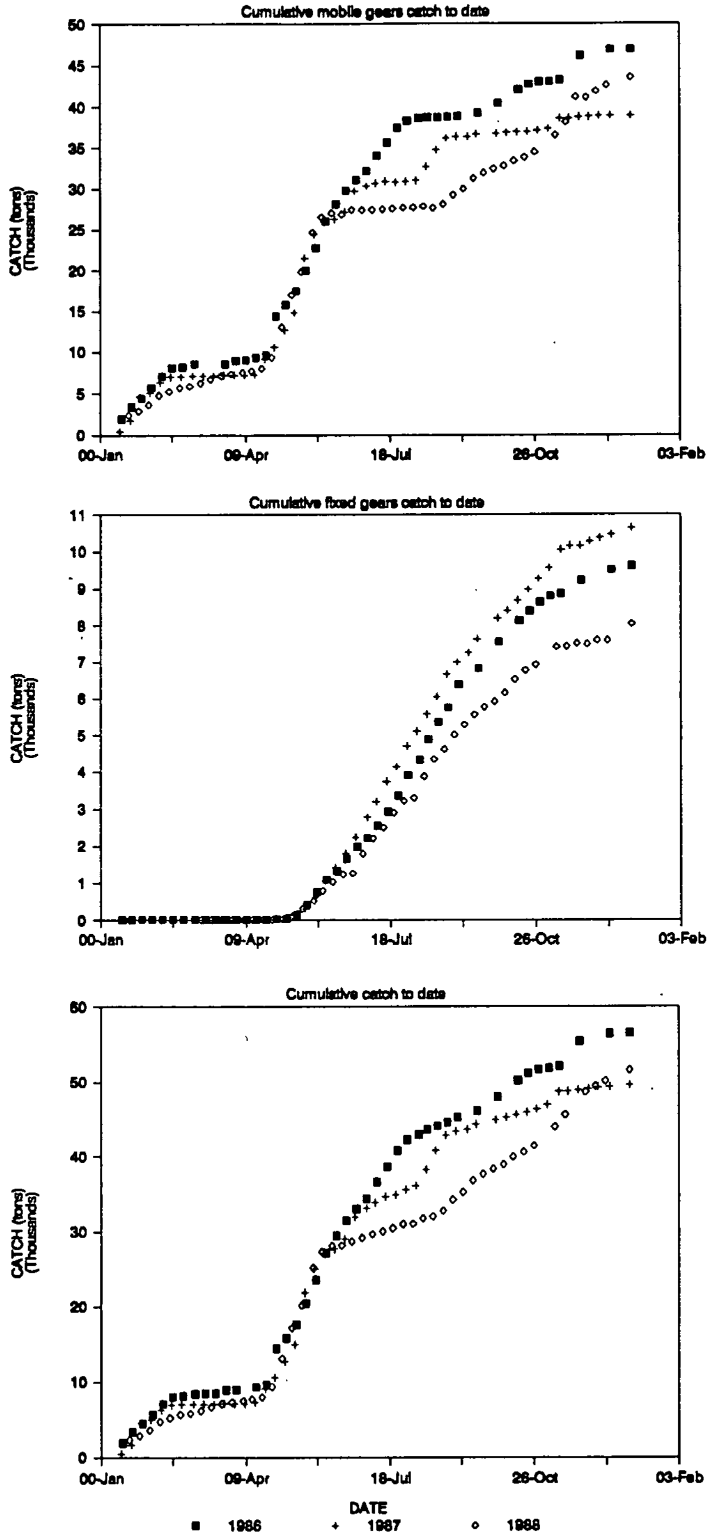


Figure 2 : Cumulative catches of cod in 4T-Vn (Jan.-Apr.). from 1986 to 1988. (Source: Canadian Atlantic Quota Report, DFO)

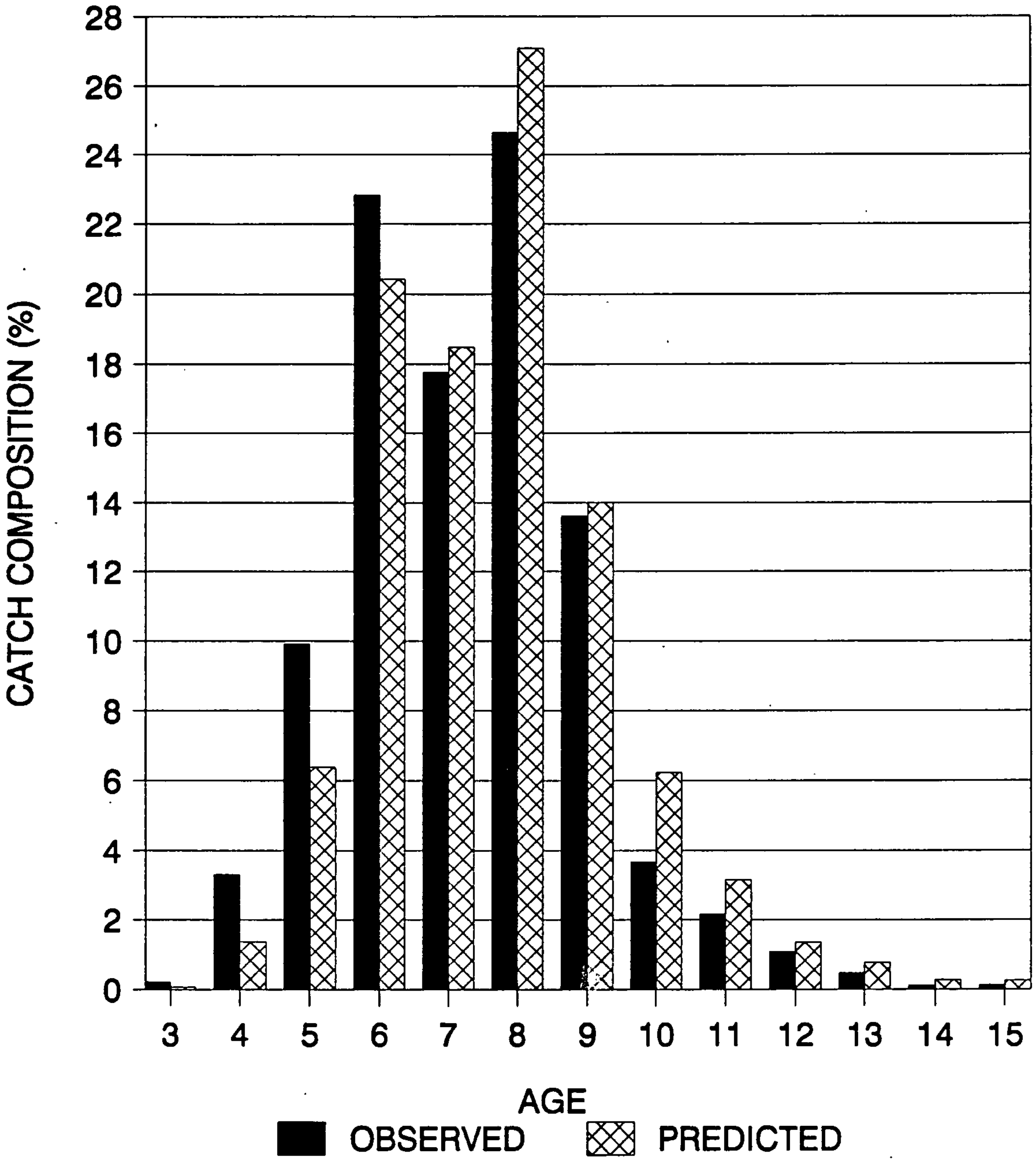


Figure 3: Age composition of observed and predicted catch at age for 1988.

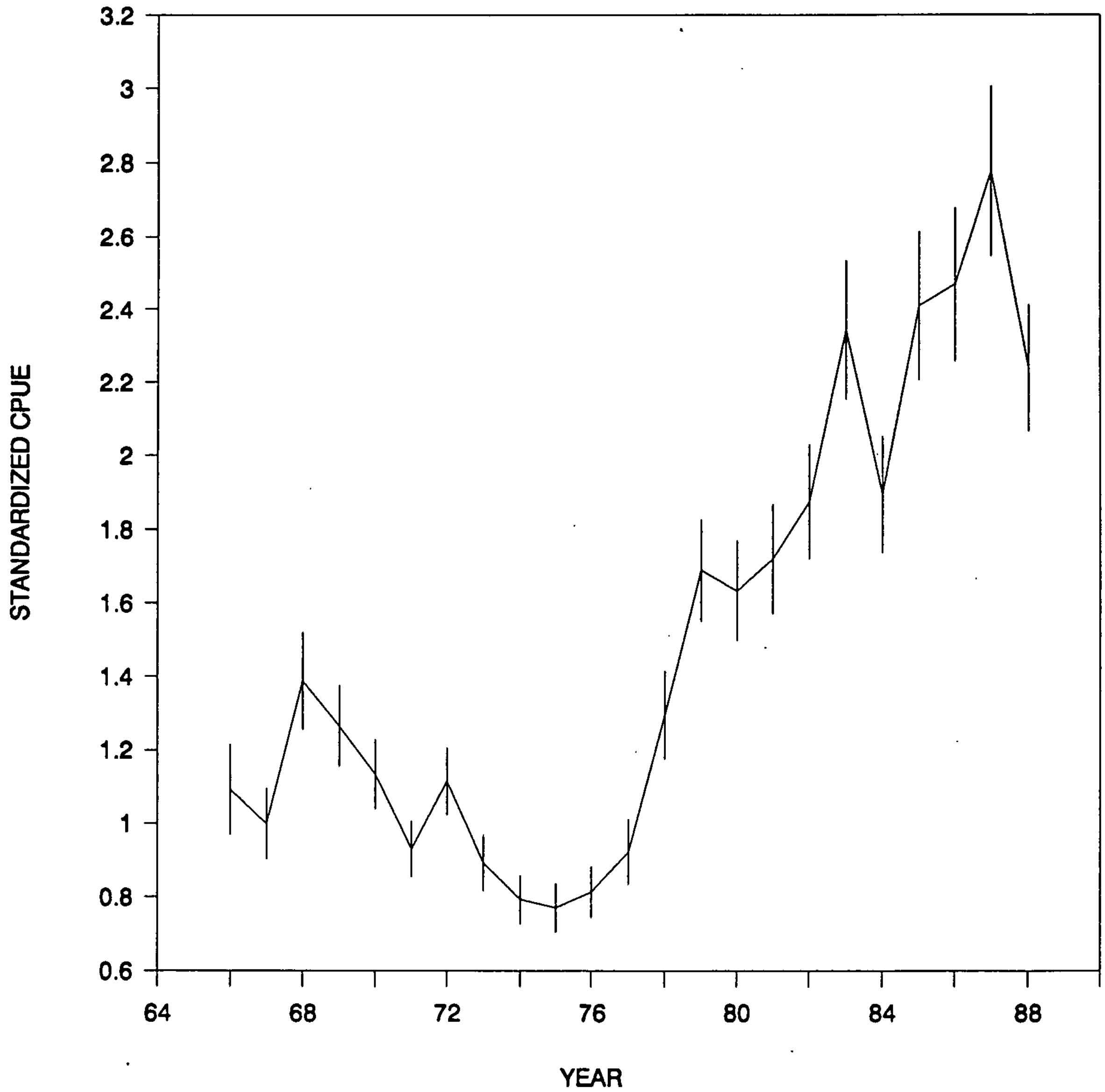


Figure 4: Standardized otter trawl catch rates (+/- 1 SE) for 4T-Vn (Jan.-Apr.) cod

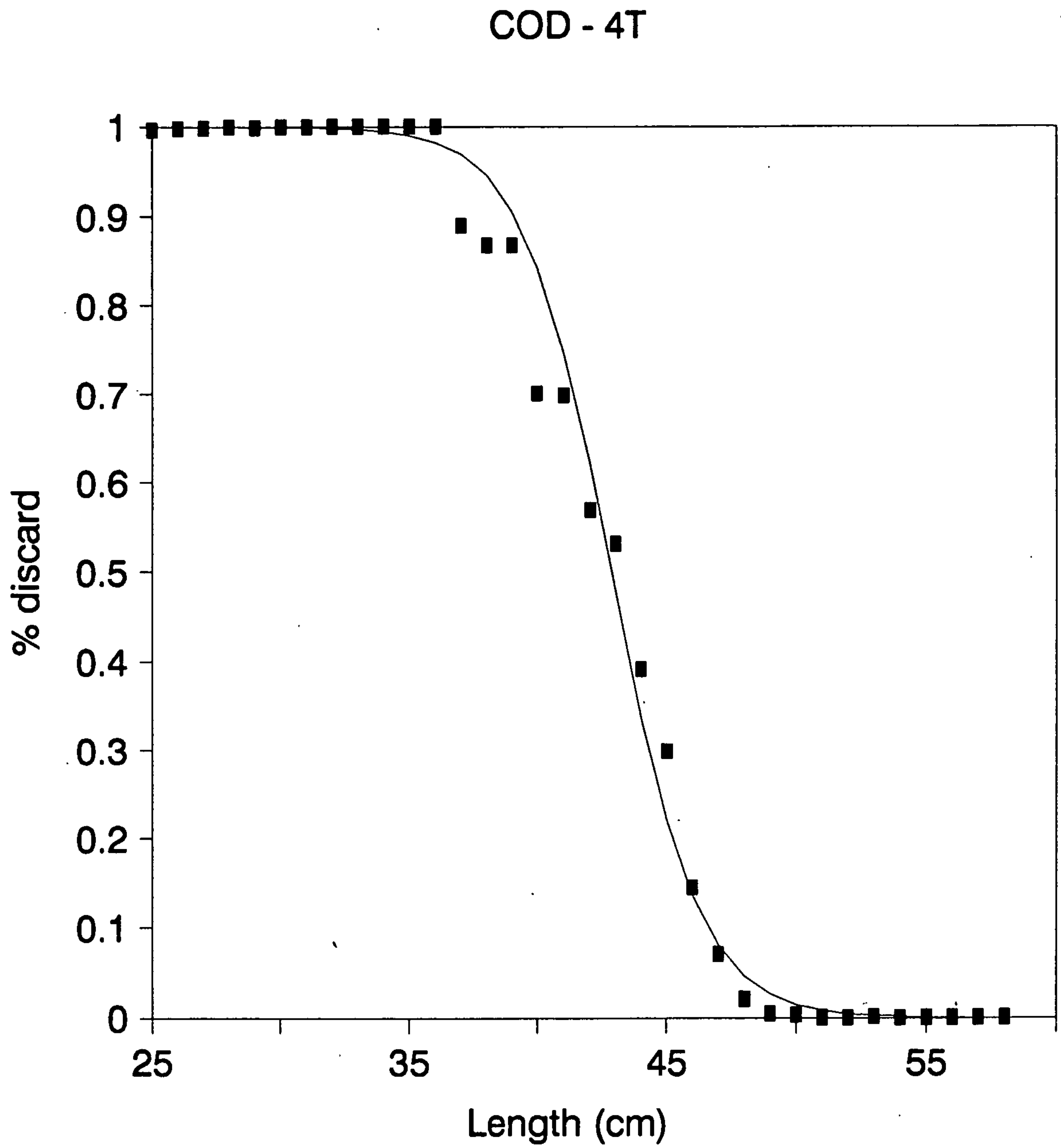


Figure 5: Discard ogive for cod in 4T from observer samples

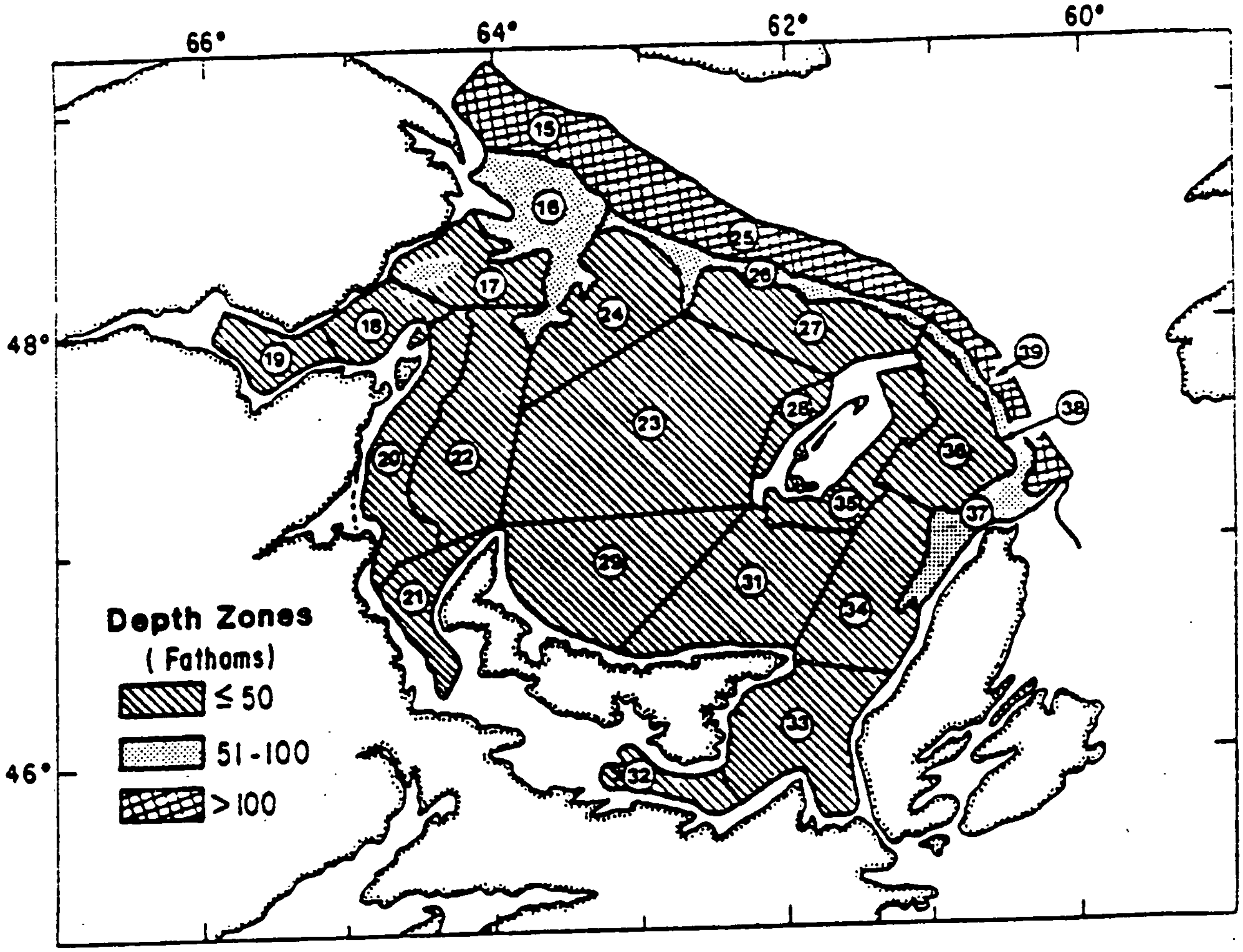


Figure 6: Stratification scheme for the southern Gulf of St. Lawrence research surveys

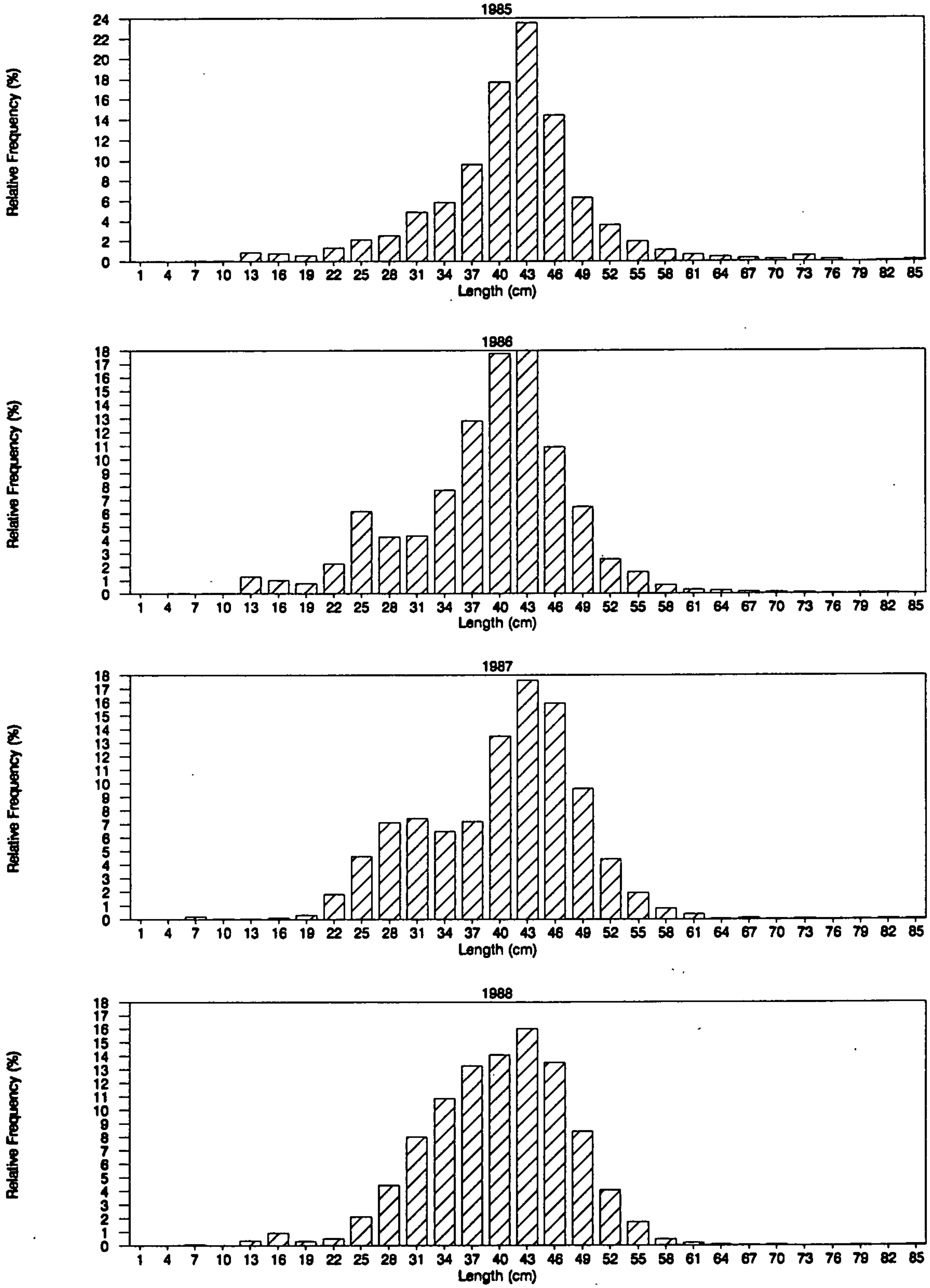


Figure 7: Length frequency distributions for cod in 4T from research vessel surveys

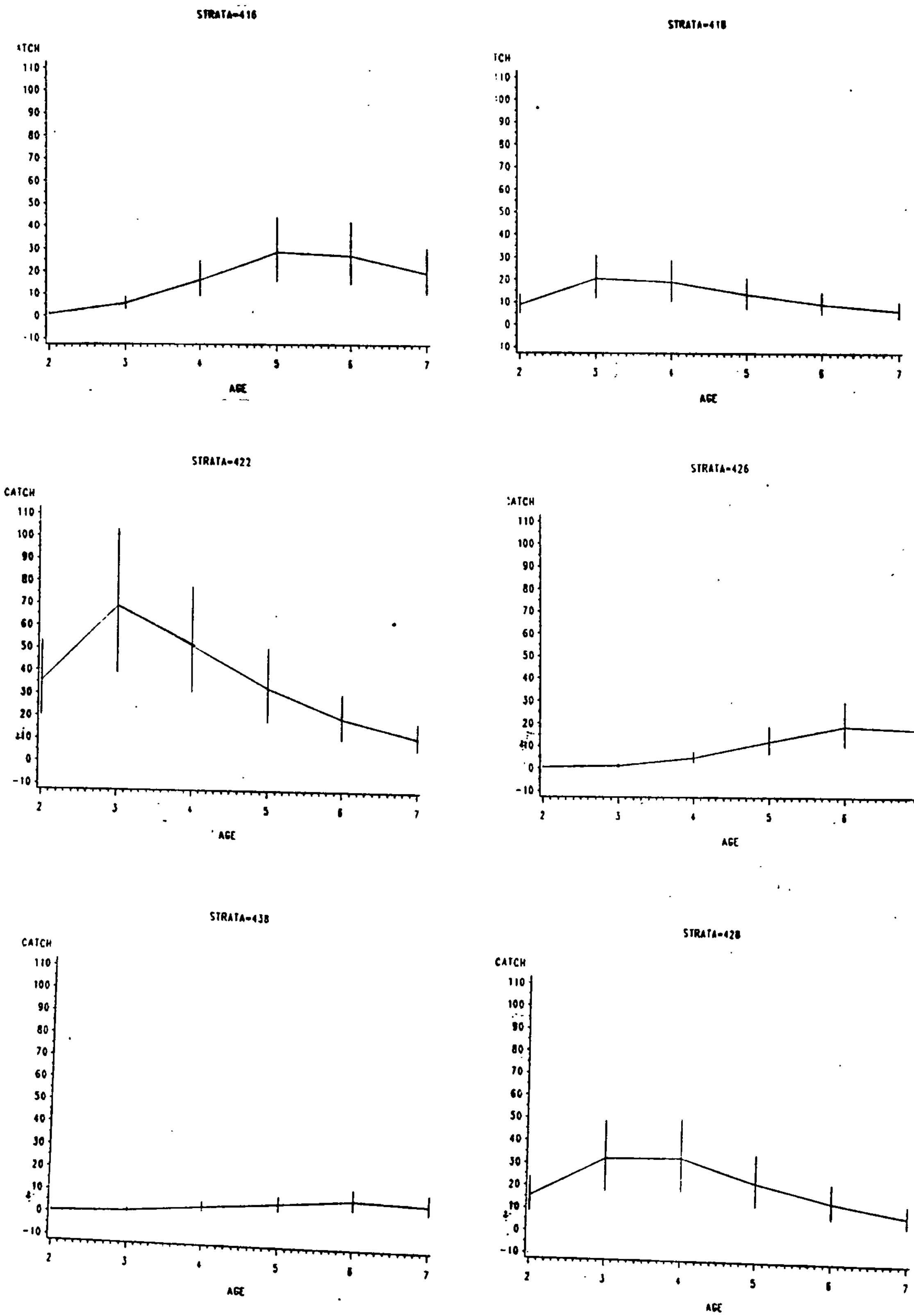


Figure 8: Standardized mean catch per tow at age for six selected strata

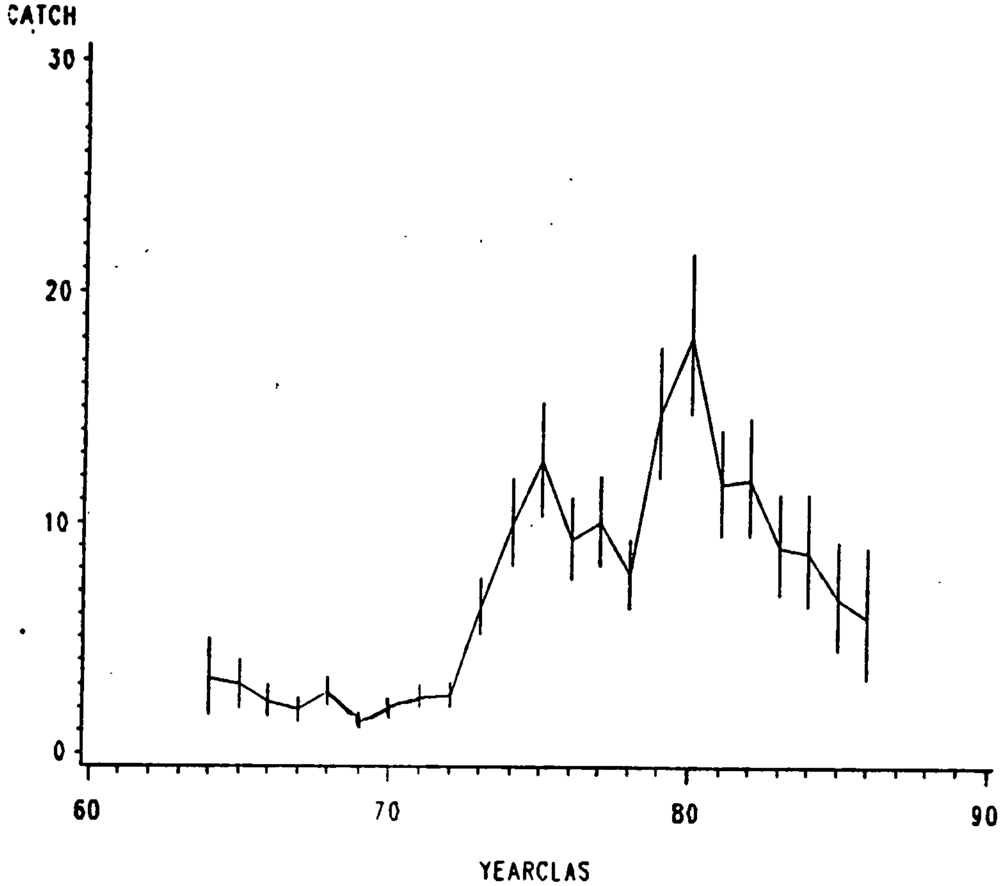


Figure 9: Standardized mean catch per tow (+/- 1 SE) for the 1964-86 year-classes

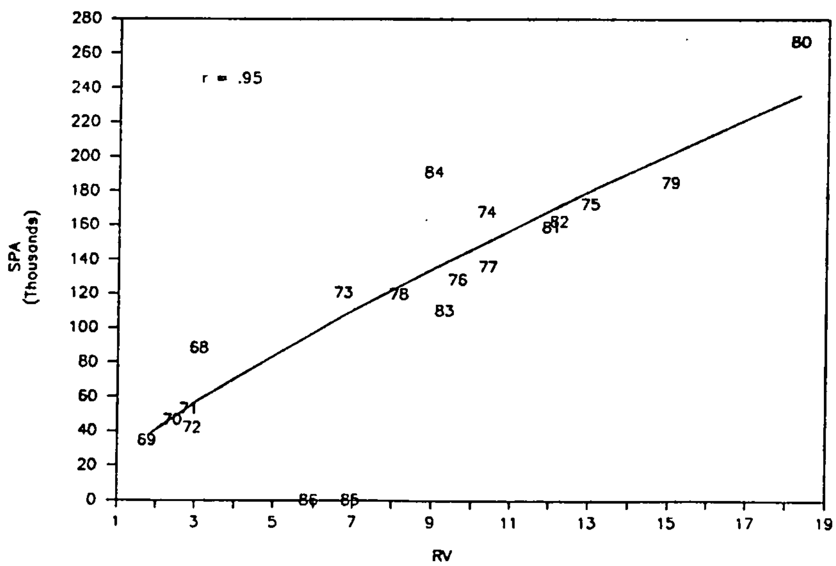


Figure 10: Comparison of year-class estimates from an analysis of mean catch per tow with estimates from the previous assessment (Chouinard and Sinclair, 1988). Only RV estimates were available for the 1985-1986 year-classes

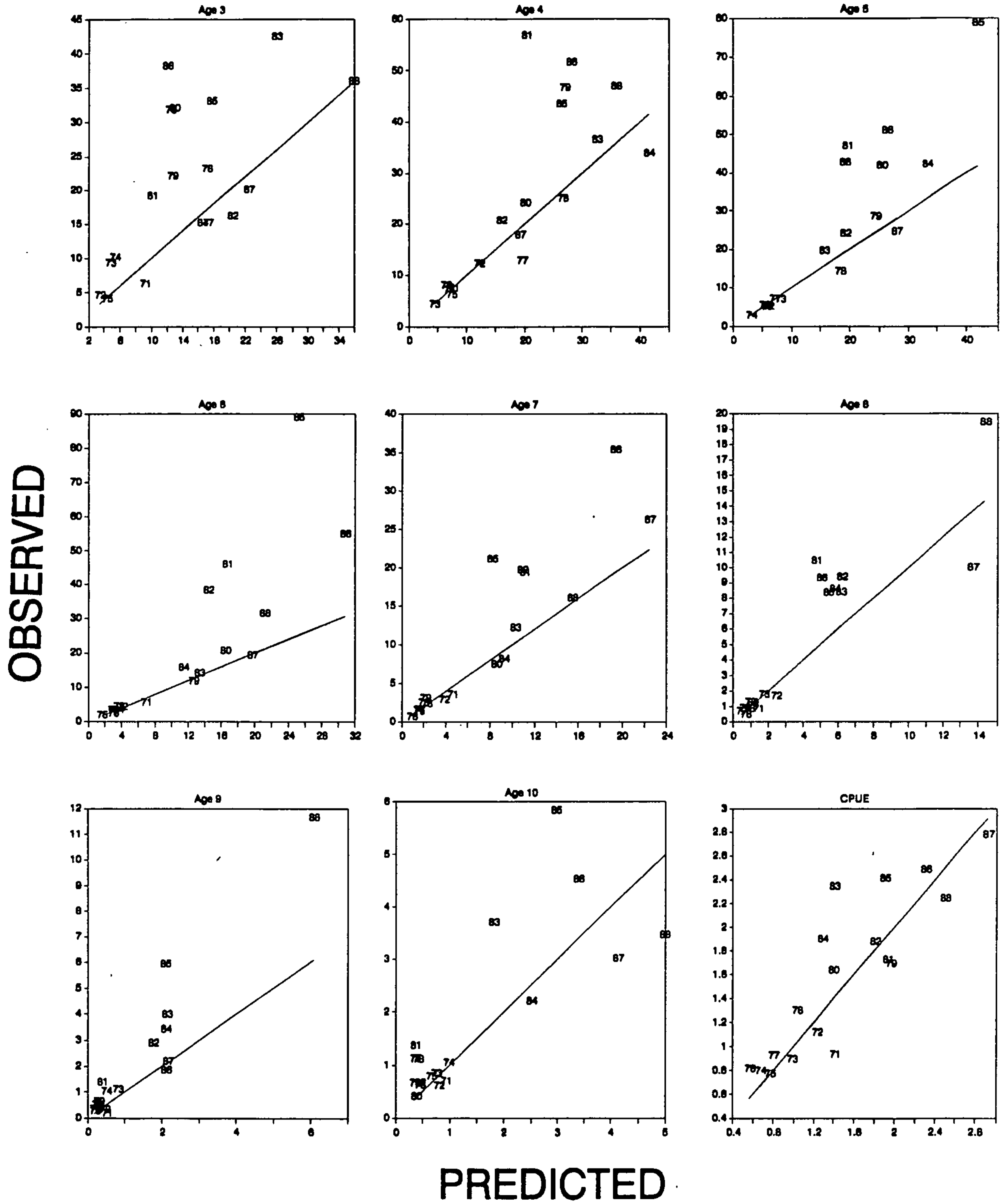


Figure 11: Observed and predicted RV mean numbers per tow at age and OTB CPUE from the adaptive famework.

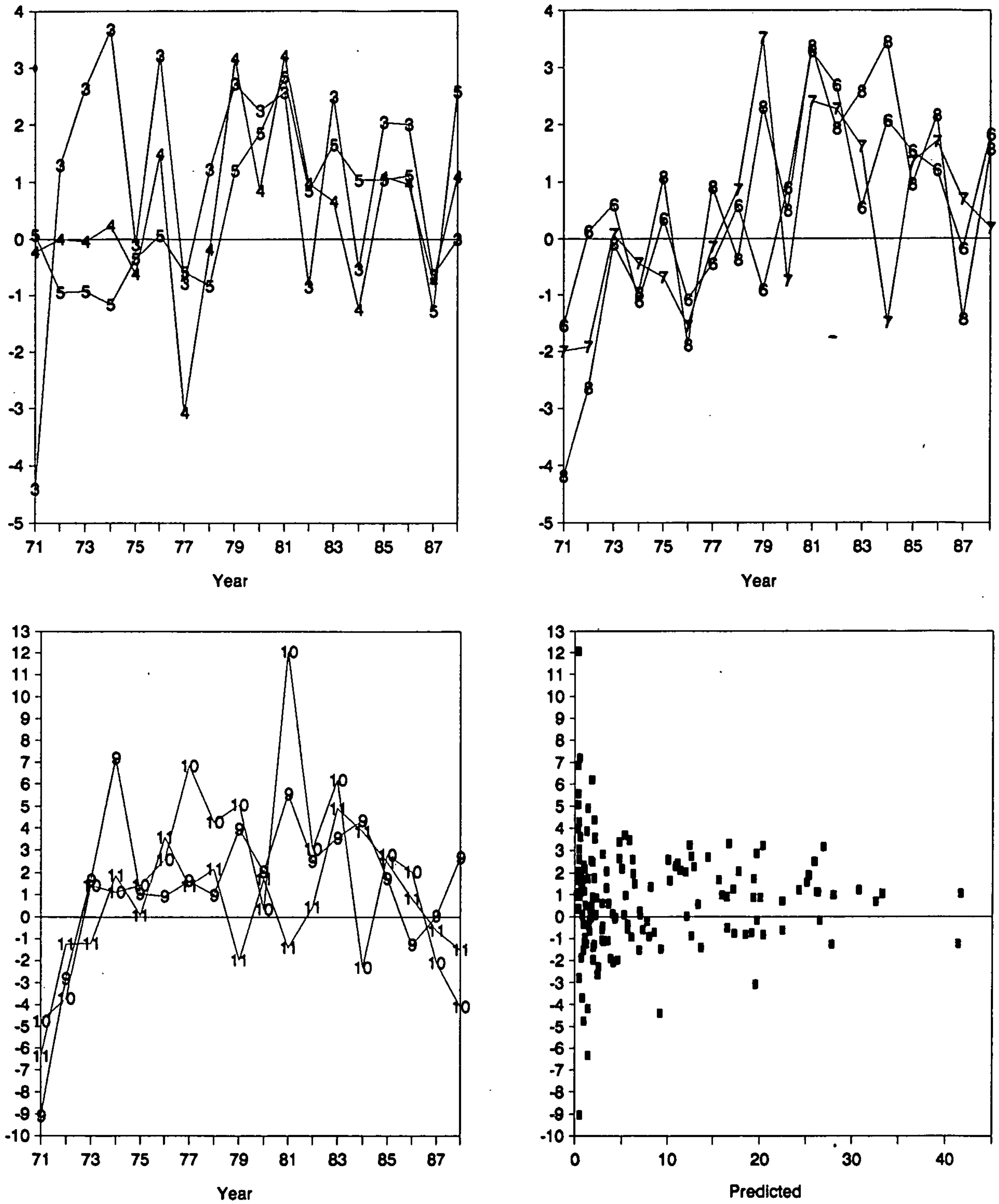


Figure 12. Weighted residuals from the calibration of SPA using the adaptive framework (3 to 10 refer to RV mean number at age; 11 to OTB CPUE).

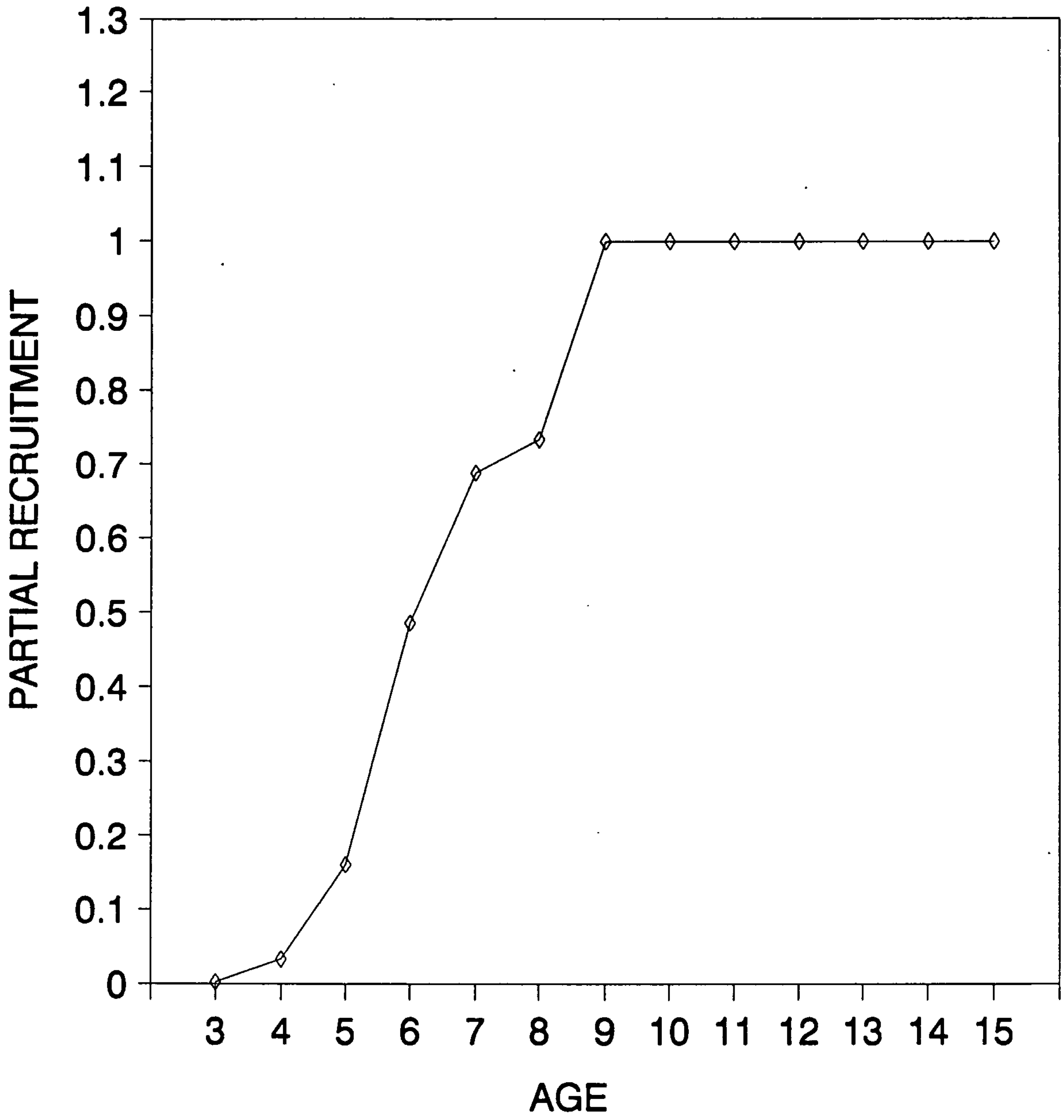


Figure 13: Partial recruitment vector for 4T-Vn (Jan.-Apr.) cod derived from analysis of variance of fishing mortalities.

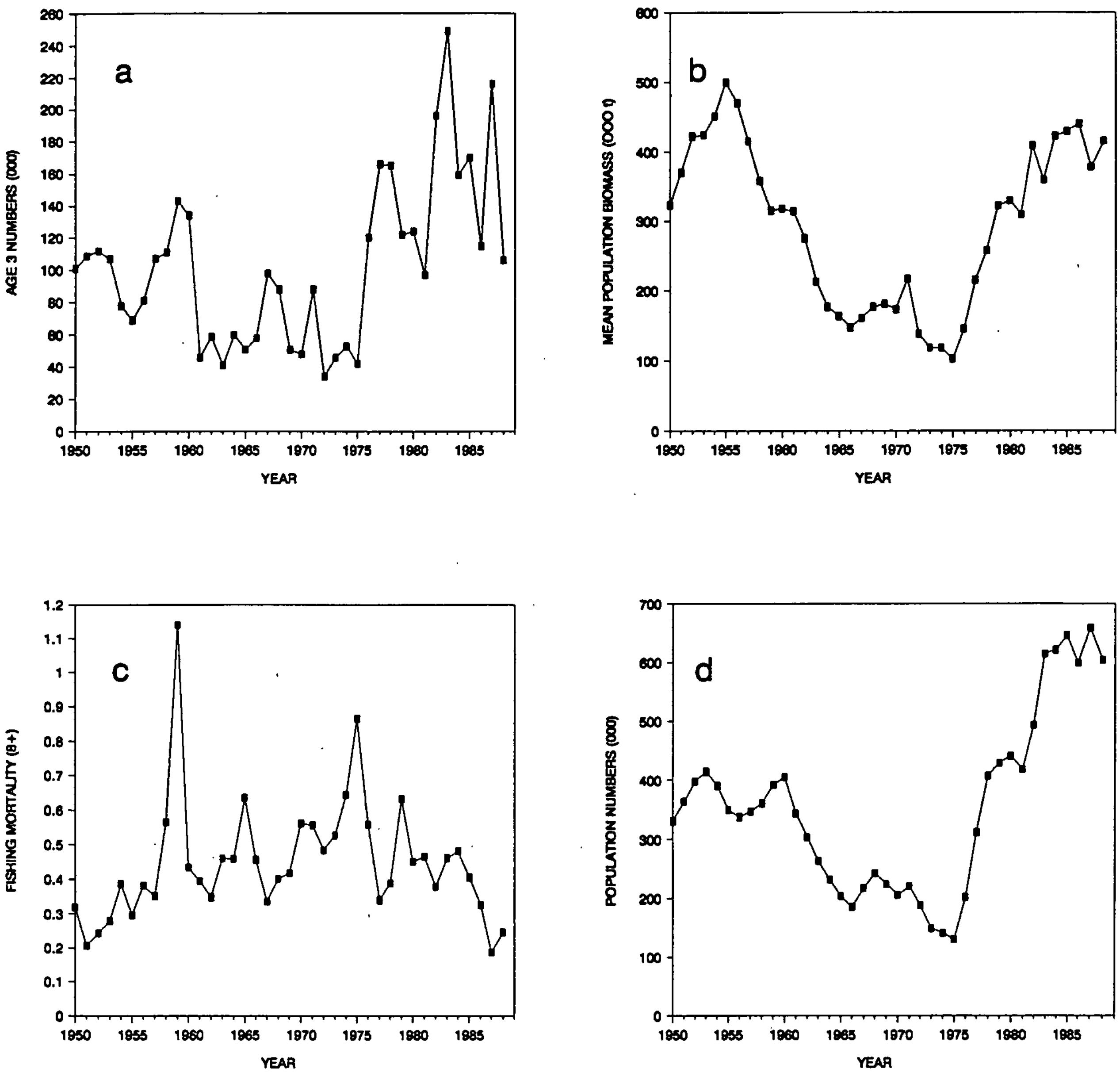


Figure 14: Recruitment (a), mean population biomass (b), fishing mortalities (c) and population numbers (d) for the 4T-Vn (Jan.-Apr.) cod stock, 1950-1988.

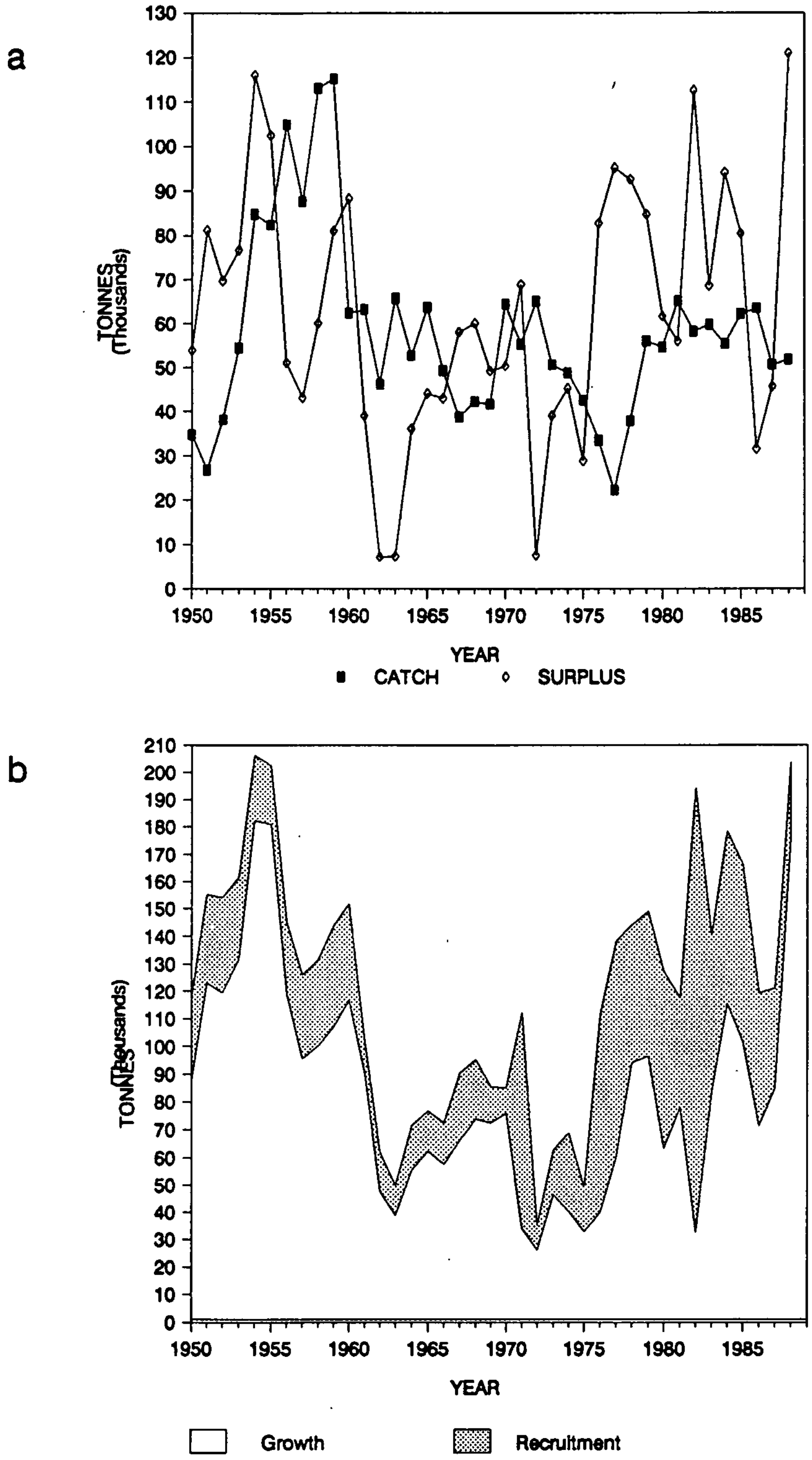


Figure 15: Catch and surplus production (a) and total production (b) for the 4T-Vn (Jan.-Apr.) cod stock, 1950-1988.

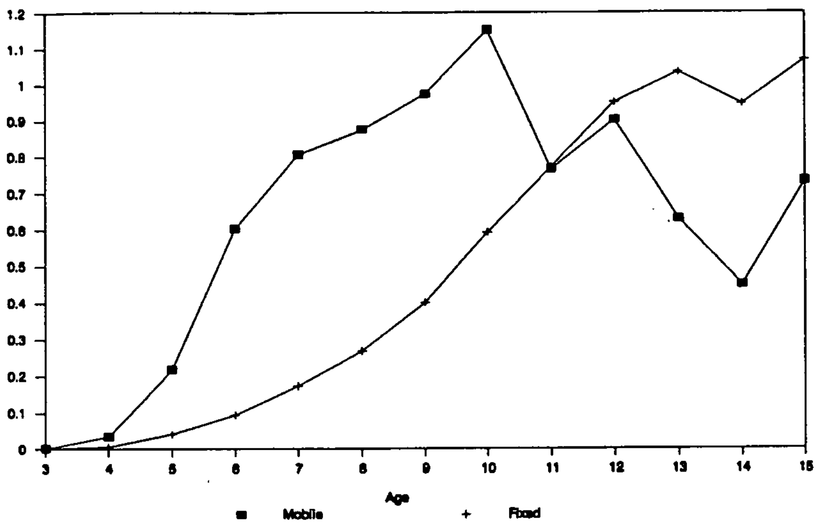


Figure 16: Partial recruitment vectors for the mobile and fixed gear components for 4T-Vn (Jan.-Apr.) cod

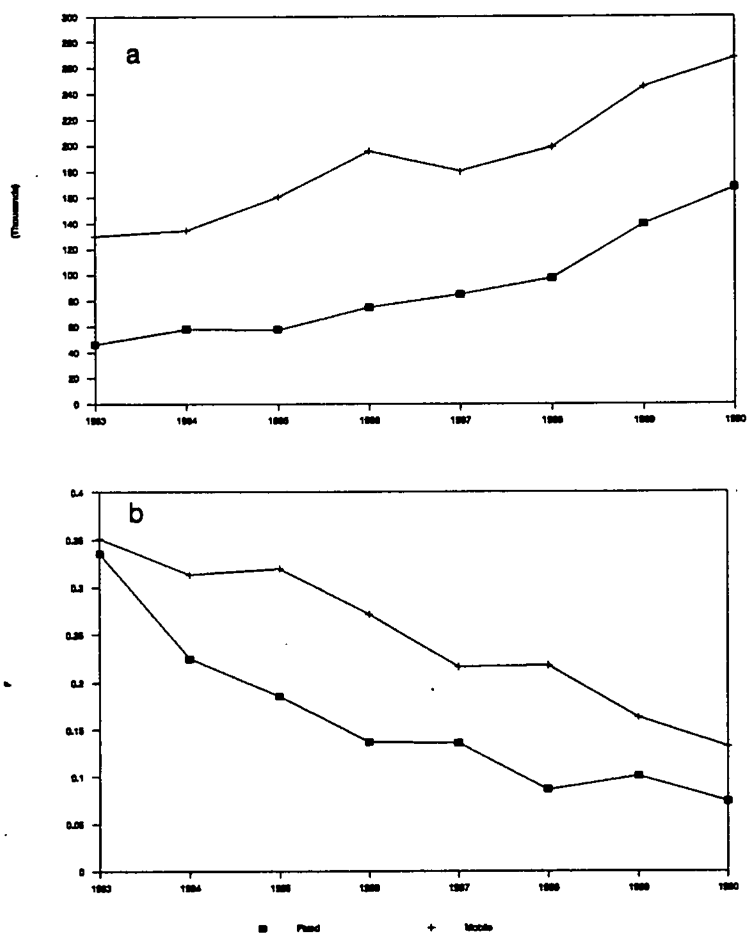


Figure 17: Trends in fishable biomass (a) and fishing mortality (b) by gear sector for cod in 4T-Vn(Jan.-Apr.)