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Status of the 1990 Cod Fishery in 4X

by

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Abstract

The 1990 nominal catch of 4X cod was 23,197 t. The TAC of 22,000 t was exceeded only slightly under CHP management, although the catch statistics are believed to be almost as accurate as those of 1989. Due to the presence of the strong 1985 and 1987 year-classes and that of the above-average 1986 year-class, stock biomass is at an all-time high, having recovered from the record-low levels of 1985. Calibration of the SPA with the ADAPT framework indicated a terminal 5+ fishing mortality of 0.32. This estimate is well below the long-term mean, but is consistent with the catch restrictions on the small mobile gear fishery and the size of the 1985-1987 year-classes. An analysis of retrospective F's in this stock indicates that previous assessments have provided consistent estimates of terminal F. The fishable biomass of 4X cod will remain relatively high through 1991 and 1992 as the strong year-classes move through the fishery. However, subsequent stock status will continue to depend heavily upon the strength of the incoming year-classes.

Résumé

En 1990, les prises nominales de morue dans la division 4X ont été de 23 197 t. Le TPA de 22 000 t n'a été que légèrement dépassé dans le cadre de la gestion morue/aiglefin/goberge. Ajoutons que les données statistiques sur les prises sont jugées presque aussi précises que celles de 1989. À cause de la présence des fortes classes d'âge de 1985 et 1987 et d'une classe d'âge supérieure à la moyenne, soit celle de 1986, la biomasse du stock, qui était tombée à son plus bas en 1985, a grimpé à un niveau record. L'étalonnage de l'ASP à l'aide de la méthode ADAPT a indiqué une mortalité terminale due à la pêche à l'âge 5+ de 0,32. Cette estimation est bien inférieure à la moyenne à long terme, mais correspond aux restrictions sur les prises imposées aux petits bateaux pêchant aux engins mobiles et à la grosseur des classes d'âge de 1985 et de 1987. Une analyse rétrospective des valeurs F dans ce stock révèle que les évaluations antérieures ont fourni des estimations cohérentes de la mortalité terminale. La biomasse exploitable de morue dans la division 4X demeurera assez élevée en 1991 et en 1992, alors que les fortes classes d'âge s'intégreront à la pêche. Toutefois, la situation subséquente du stock dépendra grandement de la force des classes d'âge à venir.

Nominal Catches

Historically, the cod fishery in Division 4X (Figure 1) has been prosecuted by the Canadian inshore fleet. Between 1947 and 1961, nominal catches for the Division averaged 15,000 t, with less than 3,000 t estimated as having come from the offshore grounds. The introduction of large Canadian and foreign trawlers in 1962 resulted in a rapid increase in catches, which peaked at 35,543 t in 1968 (Table 1). Imposition of quotas on 4X haddock by ICNAF in 1970 substantially reduced cod catches (to approximately 22,000 t), emphasizing the by-catch nature of many cod catches. Since 1976, the fishery has been nearly 100% Canadian and catches increased to almost 33,000 t; however, there was a marked decline in catches after 1982 to about 20,000 t, where it has remained since 1985 (Figure 2). The 1990 nominal catch was 23,197 t.

Both the fixed (< 65') and mobile (< 65') gear categories exceeded their allocations in 1990 (Table 2). The fishery by MG<65' was closed or restricted several times during the year, in part due to overruns under the trimester quota system, and despite management under CHP (whereby the quotas for cod, haddock, and pollock were pooled) (Table 3). The TAC for the stock as a whole was increased by 10000 t (from 12000 to 22000 t) in mid-July.

The accuracy of the 4X cod catch statistics was reasonably good in 1990, although perhaps not so much so as in 1989. In 1987 and 1988 in particular, substantial quantities of cod were either unreported during the year or incorrectly reported as other species such as white hake. Comments by fishermen, industry representatives, and port samplers all indicate that 1989 catch statistics were relatively accurate, due both to enhanced enforcement and the presence of CHP management. The 1990 catch statistics are believed to be accurate for the fixed gear fleet throughout the entire year. However, MG<65' appear to have under-reported landings during two periods: in mid-February and for a 7-week period in September and October. During the former, the first trimester's allocation had been greatly exceeded, and some C1's (MG<45') are believed to have fished 4X cod under the guise of a 4VsW cod licence. Beginning in September, much of the DFO enforcement was reallocated to the tuna fishery, at which point there were widespread reports (from both industry and the port technicians) of large-scale non-reporting of cod and haddock. Some 4X cod were also misreported as being caught in 5Z. While only rough approximations are possible, the catch by MG<65' was probably under-reported by 1000-2000 t in 1990. The small mobile gear sector has misreported 4X cod to 5Y in previous years (documented in Campana and Simon, MS 1985), necessitating adjustment of reported catches for stock assessment purposes. The problem has not been significant since 1986; nevertheless, the adjustment procedure was continued for the current assessment.

In addition to misreporting, two other practises may have affected the accuracy of the 1990 catch statistics. In response to trip limits and high catch rates in the Bay of Fundy, some of the small mobile gear fleet were reported to have dumped unknown quantities of cod in both January, and in particular, April. Trans-shipping of cod from draggers to small fixed gear and lobster boats was also reported, particularly in late August and September.

The introduction of an "experimental" fishery on Georges Bank may have had some effect on the size composition of the 4X cod catch by MG<65'. Georges Bank was opened to the small mobile gear fleet on June 1 under the condition that 130 mm square mesh be used (as opposed to 130 mm diamond mesh). A large majority of the small mobile gear fleet adopted the new mesh, and subsequently reported that catches of small cod and haddock had decreased substantially. As a result, many of the fishermen that fished both 4X and Georges Bank did not change their gear between trips. Reports from industry stated that most of the small mobile gear fleet was using 130 mm square mesh in 4X by the fall.

A breakdown of nominal catches by gear, tonnage class, and unit area over recent years is presented in Table 4. Landings have been split relatively evenly between otter trawlers and fixed gear since about 1983. Longline/handline catches increased somewhat in 1990 (Fig. 3), apparently due to the relative absence of dogfish on Browns Bank in the summer relative to the previous five summers. Catches by TC-1 vessels accounted for 47% of the total in 1990, with gillnets (GN) accounting for over 1700 t of that catch. Catches in each of the fixed gear categories peaked in the summer months, while that of the mobile gear was greatest in the first quarter (Figure 4).

Stock Abundance Indices

Research Vessel Surveys

Random stratified surveys of the Scotian Shelf have been conducted since 1970; Strata 70-95 comprise the offshore and Bay of Fundy region of 4X (Figure 5). Inshore regions are not surveyed due to the prevalence of rough bottom. Surveys between 1970 and 1981 were carried out by the A.T. Cameron, while the Lady Hammond was used in 1982 and the Alfred Needler in subsequent years. All research vessel (RV) data have been presented in terms of Alfred Needler trawlable units (41' wingspread). As per the recommendation of the Statistics, Sampling and Surveys Subcommittee of CAFSAC, RV data prior to 1983 were multiplied by an inter-vessel conversion factor of 0.8.

Age-structured survey population indices were based on 2-8 sets in each stratum (Table 5). The 1990 indices of number and weight per tow were somewhat higher than those of the long-term mean, and appeared to be distributed among strata in a pattern similar to that of other years (Tables 6, 7; Figs. 6, 7). As has been observed in previous years, both small (<43 cm) and large (>43 cm) cod were found in the same areas, with peak abundances near the mouth of the Bay of Fundy and on the offshore banks (Figs. 6, 7). Survey 3-7 numbers and biomass have increased from a 1987 low to a level which is considerably above that of the long-term mean (Table 8; see also Fig. 13). Both age 5+ population numbers (Fig. 8) and a total biomass index (Fig. 9) were above the long-term mean. Coefficients of variation around the age-structured survey estimates were uniformly low (Table 9).

With respect to incoming recruitment, the 1987 year-class (age 3) has appeared strong in each

of the last three survey years, while the 1986 year-class may be above average (Table 8; Fig. 10). The age 2 estimate for the 1988 year-class suggests that it is not particularly strong.

Commercial Catch Rates

Given the historic misreporting problem in the region, the multiple closures and fishery restrictions in recent years, and the low number of C/E observations per gear category (Campana and Hamel, MS1989), the use of commercial C/E as an index of 4X cod abundance is not considered appropriate.

Age Composition of the Catch

In previous assessments, quarterly age-length keys were computed for each of the major gear types (pooled among tonnage classes) for the period 1948-88. Details of key construction and sample aggregation policy are described elsewhere (Campana and Simon, MS 1986). Seventy four samples went into the construction of comparable keys for 1990. Length-weight relationships were derived from seasonal RV data on an annual basis; in years where spring or fall surveys were not conducted, seasonal means were applied.

Quarterly landings data, sample information, and the calculated numbers at age for each of the major gear categories in 1990 are presented in Table 10. Catch numbers-at-age for the miscellaneous gear category was computed quarterly, through a pro-rated comparison of miscellaneous landings with the sum of OT, LL, and GN landings. Foreign catches were treated similarly, but were pro-rated only on the basis of OT landings (since all foreign catches employed trawl gear). The data for previous years has been presented elsewhere (Campana and Simon, MS 1986, 1987, 1988; Campana and Hamel MS 1989, 1990).

Total catch numbers and percent catch numbers-at-age for the period 1948-90 are presented in Tables 11 and 12. A comparison of the 1990 catch composition and that predicted last year for 1990 indicates good agreement with the exception of the 1985 and 1987 year-classes (Fig. 11). This discrepancy was anticipated last year when, in a cautionary approach, the Subcommittee declined to use optimistic recruitment estimates for both the 1985 and 1987 year-classes (the latter was set to the GM). Fish of ages 3-5 made up 86% of the catch numbers and 74% of the catch weight in 1990 (Tables 12, 13). Catch composition curves indicate that age 5 fish were fully recruited to the fishery. No recent trends in mean weight-at-age in the catch (Table 14; Fig. 12) were noted, although there have been long-term trends (Table 14).

Estimation of Stock Size

Calibration of the SPA

The SPA was calibrated against RV population numbers through use of the ADAPT framework (Gavaris MS 1989). As was done in previous assessments, the SPA-RV regression slopes and population numbers at ages 3-7 were estimated. All data were ln transformed. The ADAPT

formulation used is summarized in Table 15.

The calibration model reached a stable optimum when fitted; the parameters remained constant after removal of the penalty function and were uncorrelated among themselves (Table 16). All parameters were significantly different from 0. Use of a model without an SPA-RV intercept was justified through fitting of a slope-intercept model; none of the intercepts were significantly different from 0, but 4 of the 5 slopes remained so. Examination of the age-by-age weighted calibration plots indicated that the model fit the data well. The residuals were usually randomly distributed across year, predicted values, and SPA population numbers. A comparison of the predicted and observed population numbers for ages 3-7 is presented in Figure 13.

The estimate of terminal F (5+) = 0.32 was smaller than that of previous years, but was consistent with the catch restrictions on the small mobile gear fishery and the size of the 1985 year-class. To determine if the accuracy of the 1989-1990 catch statistics (compared to the relative inaccuracy of the 1987-88 statistics) influenced the results, the SPA was recalibrated assuming the 1987-88 nominal catches by MG < 65' were 50% of the true value and that 1984-86 and 1990 catches were 80% of the true value. The simulation resulted in about a 10% increase in terminal F and a corresponding decrease in the 1990 population. While the degree of misreporting assumed in the simulation was somewhat arbitrary, the results indicated that our perception of current stock status would not be unduly influenced by recent, moderate changes in catch reporting practices.

The results of the calibration indicated that the 1985 and 1987 year-classes were among the largest of the 43-year time series. The 1986 year-class was estimated as being above average in size.

Assessment Results

Population numbers and fishing mortalities corresponding to $F_t = .32$ are presented in Tables 17 and 18. Fishing mortalities during the last two years have been lower than any others over the last 14 years, and well below the long-term mean of 0.55 (Fig. 14). However, the relatively low values of F for 1989 and 1990 can be ascribed almost entirely to the catch restrictions on the small mobile gear fishery and the strength of the 1985 and 1987 year-classes. An analysis of retrospective F's for this stock indicates that previous assessments have provided consistent estimates of F_t (Fig. 15). The mean weight in the catch is well below that expected of both F_{max} and $F_{0.1}$ (Fig. 16).

Biomass has increased to record levels as two strong year-classes and one of above-average strength have entered the fishery (Table 19; Fig. 17). The influence of the very weak 1984 year-class has now largely dissipated. The 1985 and 1987 year-classes are believed to be the two strongest year-classes on record since that of 1963 (Fig. 18).

Prognosis

The fishable biomass of 4X cod will remain relatively high through 1991 and 1992 as the strong 1985 and 1987 year-classes move through the fishery. Subsequent stock status will continue to depend heavily upon the strength of the incoming year-classes. However, even average recruitment levels will result in a decline in fishable biomass after 1992.

Given the importance of incoming recruitment to this stock, and in light of the speed with which new year-classes enter the fishery, a measure of incoming recruitment would greatly enhance the accuracy and precision of catch projections for 4X cod. Last year's assessment noted the apparent correlation between the year-class strengths of 4X and $5Z_{j,m}$ cod (Campana and Hamel MS 1990). Biological bases for such a correlation would include large-scale environmental influences on recruitment and the documented movement of tagged Georges Bank cod into 4X waters (Wise 1963). The correlation in recruitment was quantified in this year's assessment. First of all, the internal consistency of the various U.S. RV surveys for the 1978-1988 year-classes of $5Z_{j,m}$ cod (Spring, ages 1 and 2; Autumn, ages 0 and 1) was confirmed by correlation analysis. Principle component analysis removed the coherent signal from each of the 4 indices (Table 20). The first principle component was then regressed against the corresponding year-classes of 4X cod; only the 1978-1986 year-classes were used to ensure that the year-class strengths were in a reasonably converged part of the F matrix. The resulting regression was statistically significant (Table 20; Fig. 19), indicating that 4X cod year-class strength was related to the 5Z cod RV indices during the 1978-1986 period. While it would be premature to apply the regression to predict the strengths of the 1988 and 1989 4X cod year-classes, a continued parallelism in year-class strengths would suggest that the 1988 and 1989 cohorts in 4X may be at least of average size.

Catch projections were made on the basis of the existing multi-year management plan. Catches of 26000 t in each of 1991 and 1992 correspond to fishing mortalities of 0.31 and 0.28 in 1991 and 1992, respectively. These values are similar to that of F_{MAX}. Population biomass under this management plan would increase slightly from the 1990 level of 116,000 t to 130,000 t in January 1993.

The use of square mesh gear (130 or 140 mm) by MG < 65' initiated in 1990 suggests that a decline in partial recruitment may follow. However, there is insufficient information upon which to base a recalculation of partial recruitment.

Expected annual yield (long-term) at $F_{0.1}$ is 21,000 t for this stock (Campana and Hamel MS 1989).

Conclusions

Stock status as indicated by this assessment confirms the trends noted in last year's assessment. Biomass has increased to record-high levels in response to the entry of two strong year-classes

and one of above-average strength into the fishery. However, the rapid increase in biomass was not detected for two years after it had begun. The lag in detection was not due to any particular deficiency in the assessment, but rather to the rapid growth and the young age at which new year-classes enter and begin to dominate the fishery. In the absence of predictions of incoming recruitment, late detection is likely to continue, making it difficult to react to shifts in population growth until after they have become pronounced. As an example, during the 3 years it generally takes to feel confident of a trend in the data, a recruiting year-class of 4X cod will go from a partial recruitment of 10% to fully recruited. Thus, the fishery will often respond to a population shift well before it can be detected in the assessment. Research to define early predictors of incoming 4X cod recruitment, such as the possible correlation with 5Z cod recruitment, appears to be warranted.

Historic assessments of this stock have always reported overexploitation (Halliday, MS 1971, MS 1974; Sinclair, MS 1980; de Lafontaine, MS 1981; Gagne et al., MS 1983; Campana and Simon, MS 1984). This view of the fishery was substantiated in 1985 when the first analytical assessment of the 4X stock complex was presented (Campana and Simon, MS 1985). Extension of the SPA back to 1948 revealed a long history of overexploitation (Campana and Simon, MS 1986, MS 1987, MS 1988; Campana and Hamel, MS 1989, MS 1990). The relative long-term stability of the stock is thus testament to its resilience. Resilience is further demonstrated by the rapid shift in stock status over the past 6 years, from a near record-low biomass in 1985 to a record-high biomass in 1990. There has been no apparent relationship between stock and recruitment to this point (Campana and Hamel, MS 1989; Campana et al., 1989). Given the high rate of exploitation, the status of this stock is inexorably linked to the strength of the recruiting year-classes.

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Table 1. 4X cod nominal catches (t) by country.

	Canada										%	
Year	M&Q	Nfld	Spain	USSR	USA	FRG	France	Japan	Other	Total	Canada	TAC
1948	17761				1999					19760	89.9	
49	14282				1799					16081	88.9	
1950	19088				1581					20669	92.4	
51	16543				1639					18182	91.0	
52	16570				1651					18221	90.9	
53	12903				1461					14364	89.8	
54	14406				2523		19			16948	85.0	
55	13432				1378					14810	90.7	
56	14849				1663					16512	89.9	
57	13619				1083					14702	92.6	
58	11103				1110					12213	90.9	
59	12866				862					13728	93.7	
1960	12123				1605					13728	88.3	
61	12424		2	9	1263					13698	90.7	
62	14656		3	80	1157					15896	92.2	
63	15849		1	684	1301	9				17844	88.8	
64	20767			2922	1413	338			15	25455	81.6	
65	24221		144	1553	871	125				26914	90.0	
66	24244		803	4961	966				5	30979	78.3	
67	27813		2536	667	1445					32461	85.7	
68	30770		2829	1061	859		24			35543	86.6	
69	24056		8217	1	448		3		1	32726	73.5	
1970	18001		3647	10	499			152		22309	80.7	
71	20180		2615	337	239			6		23377	86.3	
72	20490		1547	30	323	2				22392	91.5	
73	20002		1519	562	136			5		22224	90.0	
74	19005		1640	119	385	15	5		2	21171	89.8	
75	19493		900	207	480	3			5	21088	92.4	
76	16138		175		339				3	16655	96.9	
77	22002			4	760		185			22951	95.9	
78	23719	10		6	276	2		3	1	24017	98.8	
79	28647	28			46			1		28722	99.8	
1980	30735	355	2	94	75			10	6	31277	99.4	
81	31043	47			125			5		31220	99.6	
82	32701	9			234			1		32945	99.3	30000
83	28963			11	286			1		29261	99.0	30000
84	25068			5	189					25262	99.2	30000
85	21370				9					21379	100.0	30000
86	19869				43					19912	99.8	20000
87	18671				11					18682	99.9	17500
88	19766				4					19770	100.0	14000
89*	19581				4					19585	100.0	12500
1990*	23054			5	138					23197	99.4	22000
91												26000

Sources: 1948-53 ICNAF Suppl. Ann. Proc. 11 (Appendix) (1962).
1954-66 NAFO Statistical Bulletins.
1967-90 MFD Statistics: Foreign catches from NAFO Statistical Bulletins.

* = Preliminary

Table 2. Canadian quota allocation and reported Maritime landings (t) by gear category for cod in 4X and 5Y. Landings are derived from Atlantic quota reports (FG = fixed gear; MG = mobile gear).

Year	Gear	4X Allocation	4X Reported Landings	5Y Allocation	5Y Reported Landings
1981	All gear	Unlimited	30742	192	599
1982	All gear	30000	31520	200	871
	FG < 65'	20250	20505	-	-
	MG < 65'	6000	7942	200	871
	FG 65-100'	200	168	-	-
	MG 65-100'	400	150	-	-
	> 100'	3150	2494	-	-
1983	All gear	30000	25610	1500	2578
	FG < 65'	20250	14892	700	176
	MG < 65'	8000*	9167	700	2394
	FG 65-100'	200	54	-	-
	MG 65-100'	400	192	-	-
	> 100'	3150	1305	100	8
1984	All gear	30000	24088	1500	1404
	FG < 65'	20250	12206	700	164
	MG < 65'	6000	10201	700	1240
	FG 65-100'	200	5	-	-
	MG 65-100'	400	88	-	-
	> 100'	3150	1588	100	0
1985	All gear	30000	20810	1500	1474
	FG < 65'	17000	9843	500	78
	MG < 65'	8900	9683	900	1392
	FG 65-100'	200	6	-	-
	MG 65-100'	400	38	-	-
	> 100'	3500	1240	100	4
1986	All gear	20000	18190	1500	686
	FG < 65'	9381*	8646	700	103
	MG < 65'**	8619*	8381	700	583
	FG 65-100'	130	0	-	-
	MG 65-100'	270	37	-	-
	> 100'	1600	1126	100	0
1987	All gear	17500	17531	1500	449
	FG < 65'	9690	9654	700	257
	MG < 65'**	5870	6360	700	161
	FG 65-100'	48	48	-	-
	MG 65-100'	160	98	-	-
	> 100'	1732	1371	100	31
1988	All gear	14000	19158	1500	803
	FG < 65'	7915	10888	700	203
	MG < 65'**	4340	7598	700	600
	FG 65-100'	70	0	-	-
	MG 65-100'	190	10	-	-
	> 100'	1485	662	100	0
1989[1]	All gear	12500	19365	965	341
	FG < 65'	7390	10027	750	261
	MG < 65'**	4050	8513	215	80
	FG 65-100'	55	0	-	-
	MG 65-100'	120	30	-	-
	> 100'	885	795	-	-
1990[1]	All gear	22000[2]	22509	1500	316
	FG < 65'	13000	14708	750	148
	MG < 45'**	3940	3865	215	168
	MG 45-64'**	3190	3399	535	0
	FG 65-100'	51	0	-	-
	MG 65-100'	157	25	-	-
	> 100'	1662	512	-	-
1991	All gear	26000		1500	
	FG < 65'	13000		750	
	MG < 45'	3940[3]		215	
	MG 45-64'	3190[3]		535	
	FG 65-100'	140		-	
	MG 65-100'	300		-	
	> 100'	1430		-	

* Adjusted in mid-year ** Fishery closed or restricted several times during the year

[1] Preliminary [2] Initially set at 12000 t, increased by 10000t on July 25/90. [3] Quota reserve for MG < 65' = 4000 t.

Table 3. Restrictions and closures of the 4X cod fishery in 1990.

Vessel class	Date	Restrictions and options.	
C-1 specialist	Feb. 13	:10000 lbs CHP*, 1 trip per week.	
(MG < 45')		no license conditions issued for period Feb 13-19.	
SWNS	Mar. 6	:no license conditions issued beyond Mar 6.	
SWNB	Apr. 16	:15000 lbs CHP until May 7.	
	May 10	:no license conditions to be issued.	
	May 17	:15000 lbs CHP total until June 11.	
	June 15	:OPTION 1: C = 10% P	
		H = 10% P	4 trips until Dec 31
		P = 20000 lbs	
		:OPTION 2: C = 5000 lbs	
		H = 20% CP	4 trips until Dec 31
		P = 10000 lbs	
	Aug. 23	:C = 5000 lbs	
		H = 20% CP	4 trips until Dec. 31
		P = 10000 lbs	
	Sept. 19	:C = individual trip limits	week to week basis
		H = 20% CP	until Nov. 30
		P = individual trip limits	
C-1 generalist	Feb. 13	:3300 lbs CHP, 2 trips or 10% bycatch only	
(MG < 45')	Apr. 20	:3300 lbs CHP, 2 trips/week or 10% bycatch only. License conditions	
SWNS		valid for a 7 day period. Until Aug. 31.	
SWNB	Aug. 23	:Until further notice no more license conditions of 2 trips of 3300 lbs	
		will be issued. 10% bycatch only until Sept 5.	
	Sept. 19	:CHP = 3300 lbs, 2 trips/week on week to week basis or 10% bycatch,	
		license conditions valid for a 14 day period, until Oct. 3.	
	Oct. 3	:10% bycatch only. Until Oct. 31.	
	Nov. 1	:CHP = 3300 lbs. 2 trips/week. Until Nov. 28. or 10% bycatch only.	
		Until Nov. 28.	
C-2	Feb. 13	:20000 lbs CHP, 1 trip until Feb. 19.	
(MG 45'-64')	Feb. 19	:No license conditions issued beyond Feb. 19.	
SWNS	Apr. 16	:20000 lbs CHP. Until June 11.	
SWNB	May 10	:No license conditions to be issued.	
	May 17	:20000 lbs CHP. Until June 11.	
	June 15	:C = 30%P	
		H = 20%P	4 trips until Dec. 31.
		P = 15000 lbs	
	Aug. 23	:C = 3300 lbs, 30%P	
		H = 20%P	4 trips until Dec. 31.
		P = 15000 lbs	
	Sept. 19	:C = individual trip limits	week to week basis
		H = 20%CP	until Nov. 30.
		P = individual trip limits	
C-3	July 31	:C = 10%	
(MG < 45')		H = 10%	1 trip for month of August
EAST NS		P = 15000 lbs	
	Sept. 19	:C = 10%	
		H = 10%	only 1 trip since Aug. 1
		P = 15000 lbs	
C-4	May 10	:no license conditions to be issued.	
(MG 45'-64')	July 31	:C = 10%	
EAST NS		H = 10%	1 trip for month of August.
		P = 15000 lbs	

* CHP : Cod Haddock Pollock Source: Canadian Atlantic Quota Reports.
Remarks: MG < 45' spec. and MG 45'-64' under trimester quota system.

Table 4. Nominal catch (t) of 4X cod by Maritime vessels. Underlined catches represent the dominant TC for a gear/unit area.

Year	Unit[B] Area	OBT					LL/LHP[A]				GN		Misc.	Total	5Y[C]
		1	2	3	4	5	1	2	3	4	1	2			
1987	M	11	92	49	35	81	809	113	-	-	1277	41	151	2679	
	N	-	152	275	301	586	6	201	47	-	-	3	52	1623	
	O	14	182	116	8	47	3651	293	64	-	329	45	37	4786	
	P	1	237	325	65	201	33	161	68	-	-	8	49	1148	
	Q	112	383	260	30	10	371	59	-	-	-	-	34	1259	
	R	126	252	74	-	-	385	-	-	-	18	8	3	866	
	S	82	328	75	-	-	522	16	-	-	175	19	2	1219	
	U	-	1071	2226	45	3	5	1259	297	22	1	42	112	5083	
	Total	346	2697	3400	484	928	5782	2122	476	22	1800	166	440	18663	449
1988	M	4	67	85	-	146	537	77	1	-	446	9	80	1452	
	N	-	161	229	49	104	1	368	64	-	3	40	49	1068	
	O	57	218	123	31	38	4205	143	41	-	199	132	28	5215	
	P	2	456	255	18	99	49	238	98	-	-	54	1	1270	
	Q	96	262	112	49	36	327	103	55	-	2	-	39	1081	
	R	184	52	26	-	-	463	11	-	-	7	-	1	744	
	S	87	293	66	-	-	424	36	-	-	146	45	8	1105	
	U	18	2300	2437	7	-	9	2136	406	-	-	140	29	7482	
	Total	448	3809	3333	154	423	6015	3112	665	-	803	420	235	19417	348
1989	M	7	14	15	1	-	554	70	19	-	618	1	69	1368	
	N	-	199	227	33	80	1	266	69	40	1	25	78	1019	
	O	66	576	230	-	91	4081	126	28	-	260	41	8	5507	
	P	-	797	1017	15	494	1	350	129	-	-	-	16	2819	
	Q	25	398	499	3	25	196	93	8	-	-	88	22	1357	
	R	143	225	302	-	-	436	1	-	-	1	-	3	1111	
	S	150	134	74	-	-	334	6	-	-	193	24	1	916	
	U	11	1504	1567	3	-	63	1421	343	-	-	253	9	5174	
	Total	402	3847	3931	55	690	5666	2333	596	40	1073	432	206	19271	310
1990	L	-	9	-	-	-	-	-	-	-	-	-	-	9	
	M	12	13	18	33	-	771	128	64	-	762	1	28	1830	
	N	-	118	116	2	14	-	303	59	103	-	23	4	742	
	O	57	731	270	10	44	6135	150	41	-	332	65	43	7878	
	P	11	380	442	19	86	4	471	188	-	-	31	19	1651	
	Q	54	797	592	4	12	380	149	16	-	36	88	58	2186	
	R	159	163	293	13	-	939	1	-	-	86	-	30	1684	
	S	186	141	121	-	-	554	16	-	-	484	208	5	1715	
	U	9	1082	1600	13	-	78	1974	312	59	4	218	10	5359	
	Total	488	3434	3452	94	156	8861	3192	680	162	1704	634	197	23054	190

A LHP = handline

B See Figure 1 for location of unit area; U = unspecified

C Catch reported in area 5Y by OTB tonnage class 2 and 3.

Table 5 NUMBER OF SETS PER STRATUM IN RV SURVEYS

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
70	0	2	2	2	3	2	2	2	2	2	2	2	2	2	2
71	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
72	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2
73	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
74	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
75	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
76	2	2	2	2	2	3	2	4	2	0	2	2	2	2	2
77	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2
78	2	2	3	2	3	3	3	3	2	3	3	3	3	3	3
80	4	4	4	2	3	3	4	4	3	4	3	3	4	4	4
81	5	3	4	5	4	3	4	2	5	4	3	4	4	4	4
82	2	2	2	2	2	2	3	2	2	3	2	2	2	2	2
83	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2
84	2	2	3	3	3	3	3	3	2	3	3	3	4	3	3
85	2	2	2	3	3	3	3	3	3	3	2	3	4	3	3
90	2	2	2	2	2	3	3	3	3	2	3	3	3	3	3
91	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
92	3	2	4	3	3	3	3	3	3	3	3	3	3	3	3
93	0	2	3	3	3	3	3	3	3	3	3	2	3	3	3
94	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
95	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2

	1985	1986	1987	1988	1989	1990
70	2	2	3	3	2	2
71	2	2	2	2	2	2
72	2	2	4	4	5	6
73	2	2	2	2	2	3
74	2	2	2	2	2	2
75	2	2	2	2	2	2
76	2	2	4	4	4	4
77	2	2	5	4	4	5
78	3	3	2	2	2	2
80	4	4	4	4	4	8
81	4	4	6	7	6	8
82	2	2	3	3	3	3
83	2	2	2	2	2	2
84	3	3	4	4	4	3
85	3	3	6	7	6	2
90	3	3	4	4	4	4
91	3	3	4	4	4	3
92	3	3	4	4	4	3
93	3	3	3	3	3	3
94	2	2	2	2	2	2
95	2	2	2	2	2	2

TABLE 6. MEAN NUMBERS PER TOW BY STRATUM IN RV SURVEYS

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
70	.0	3.5	.6	3.9	.0	.4	.0	2.3	.0	.8	.0	.0	.0	1.6	.0
71	.0	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	.0	.0	1.2
72	3.7	2.4	.0	.0	3.6	2.6	8.8	2.2	1.5	4.2	8.4	14.7	2.3	4.6	5.2
73	2.9	7.0	2.9	5.8	6.8	5.6	9.2	8.6	8.0	4.2	2.0	4.6	1.7	12.1	2.7
74	7.3	2.6	4.0	16.8	5.9	8.0	9.9	9.2	1.9	11.4	2.1	15.1	5.4	24.1	.0
75	22.8	9.1	9.4	9.4	10.2	2.6	9.4	5.4	7.4	7.5	7.3	10.7	5.7	.0	9.4
76	49.5	65.3	21.8	3.6	9.8	9.4	14.0	3.9	2.7	.0	7.4	5.2	.4	24.3	10.3
77	1.3	3.8	1.0	4.2	4.0	2.4	6.0	4.1	5.2	3.7	2.4	1.4	3.7	5.7	12.4
78	.0	.0	.0	.0	.2	.2	1.2	.8	6.1	1.1	.6	5.0	.3	.0	1.1
80	6.1	12.9	7.4	10.7	4.1	7.6	6.2	24.7	9.1	11.1	14.5	11.7	3.0	20.9	8.2
81	9.4	1.3	9.0	8.4	14.0	10.5	1.5	2.3	3.7	5.7	3.4	1.6	4.5	8.5	17.0
82	3.1	.0	.0	.0	1.5	9.8	1.3	2.6	1.8	3.0	3.1	.5	3.0	.5	2.4
83	.3	.0	7.0	.0	.0	.0	.0	1.3	.9	.0	.6	1.2	.4	.0	1.0
84	.0	.8	.5	.8	1.3	.4	2.8	.3	.0	2.2	.0	1.0	.4	.0	2.4
85	6.8	1.7	1.2	6.0	.9	4.8	.9	12.4	2.0	3.5	5.7	9.6	6.9	2.3	13.1
90	10.7	6.1	10.5	4.4	19.3	37.8	4.1	15.2	14.0	10.4	6.2	31.9	16.3	10.8	13.7
91	1.9	3.0	9.5	4.9	2.9	4.8	13.2	16.1	14.8	60.0	16.3	14.5	7.6	18.3	46.9
92	2.4	2.7	6.3	1.4	5.2	11.1	4.7	11.5	3.7	13.4	1.2	10.4	26.0	11.0	3.1
93	.0	.3	1.9	1.4	3.9	9.9	8.4	1.5	6.3	6.3	7.2	7.1	13.6	9.9	24.7
94	1.1	5.8	2.4	4.8	.8	16.4	12.6	3.9	2.9	1.6	12.4	3.4	.4	.0	13.9
95	2.5	7.7	14.9	4.7	18.0	9.8	7.4	24.0	.0	26.7	36.9	19.8	4.9	.9	21.6

	1985	1986	1987	1988	1989	1990
70	.0	3.6	.0	.3	.0	2.1
71	.0	.0	.0	.6	.0	.5
72	15.6	1.0	1.3	2.6	.2	3.6
73	10.1	4.5	2.6	4.5	2.0	25.3
74	13.1	15.9	1.1	5.2	9.0	4.4
75	18.2	6.2	7.3	7.7	21.1	4.5
76	1.5	3.9	.8	6.0	23.2	8.0
77	4.0	7.9	6.5	11.4	10.2	2.7
78	1.0	.0	.0	.0	.0	.4
80	4.2	11.8	16.0	286.3	12.8	13.5
81	2.3	3.4	3.7	34.5	11.4	11.4
82	.0	.0	.4	3.2	5.5	3.9
83	.5	.0	.0	.0	.0	1.8
84	.0	.0	2.5	1.1	.2	.3
85	7.5	5.9	4.0	8.9	7.8	19.7
90	120.9	30.7	15.0	58.0	57.6	15.9
91	32.4	10.6	8.6	20.0	4.6	29.1
92	22.2	9.7	3.0	37.7	4.6	12.7
93	40.6	9.3	5.9	10.3	41.2	2.2
94	4.1	1.0	10.9	2.1	2.1	5.6
95	35.3	7.2	5.7	7.5	4.4	6.6

TABLE 7. MEAN WEIGHT (KG) PER TOW BY STRATUM IN RV SURVEYS

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
70	.0	8.9	.9	12.7	.0	2.3	.0	6.5	.0	.3	.0	.0	.0	1.6	.0
71	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
72	10.6	4.6	.0	.0	4.9	6.6	14.4	2.2	2.9	8.0	19.2	7.9	1.6	6.5	5.7
73	3.2	10.6	7.8	12.4	7.5	8.3	25.0	28.7	13.4	17.3	5.3	3.8	2.2	7.5	3.3
74	19.9	10.3	14.3	19.2	12.8	14.5	27.8	26.0	5.7	29.4	9.9	33.7	16.5	38.5	.0
75	70.1	26.5	22.5	16.1	23.0	14.0	14.1	8.7	15.3	20.9	10.8	31.9	15.2	.0	19.3
76	121.1	52.5	51.2	7.1	32.1	22.3	26.2	9.0	10.5	.0	12.1	16.0	.0	38.5	19.0
77	3.0	9.6	1.2	8.5	7.0	3.1	9.3	17.7	4.9	7.9	15.6	2.8	10.8	10.8	22.7
78	.0	.0	.0	.0	.2	.4	2.4	2.2	10.7	2.8	3.5	19.7	2.0	.0	1.0
80	17.3	17.7	15.9	30.4	11.3	11.3	11.0	43.4	18.0	28.8	48.3	15.9	9.8	35.1	15.9
81	25.7	3.5	26.8	18.1	23.9	25.0	3.3	5.0	7.4	32.0	9.1	4.1	13.1	14.4	17.8
82	12.8	.0	.0	.0	2.3	39.7	5.2	11.1	4.6	14.0	14.3	1.1	3.7	1.0	6.8
83	3.2	.0	15.6	.0	.0	.0	.0	6.1	6.1	.0	5.2	8.6	.4	.0	5.2
84	.0	3.9	1.3	3.0	13.1	1.1	9.9	.6	.0	7.4	.0	2.1	.7	.0	6.5
85	19.8	6.5	5.4	18.4	2.5	19.1	.9	26.9	6.7	8.7	21.6	28.0	15.2	7.0	18.6
90	17.7	10.8	27.3	7.4	42.2	59.9	6.2	30.8	43.0	12.9	21.4	42.0	41.5	25.3	19.3
91	10.6	9.7	38.9	14.0	10.4	13.4	65.8	37.3	42.5	64.0	44.6	40.9	22.1	34.1	74.9
92	12.0	14.8	25.5	4.9	17.4	42.0	16.7	47.1	13.3	45.2	5.7	45.7	101.2	48.4	13.7
93	.0	.0	6.5	3.2	7.4	28.1	30.7	4.2	33.4	9.2	25.0	28.2	40.3	36.1	44.2
94	.6	6.0	12.9	13.7	4.7	32.6	33.8	13.1	8.0	6.2	.4	3.1	1.1	.0	30.5
95	17.8	8.5	36.6	14.6	32.8	14.9	18.5	50.2	.0	52.3	16.8	47.5	7.5	1.4	33.4

	1985	1986	1987	1988	1989	1990
70	.0	6.2	.0	.3	.0	1.5
71	.0	.0	.0	.0	.0	.0
72	16.0	.0	1.8	1.9	.0	3.2
73	20.6	9.3	9.3	10.8	4.4	40.7
74	30.3	44.9	2.2	8.2	20.6	5.9
75	23.5	4.6	4.9	10.3	43.8	14.7
76	2.4	6.4	3.4	10.8	19.6	17.9
77	7.5	19.0	17.9	22.4	7.8	7.6
78	6.8	.0	.0	.0	.0	.4
80	12.3	40.4	14.4	265.4	28.5	25.5
81	4.4	5.8	8.0	47.1	11.4	21.4
82	.0	.0	1.1	9.7	13.4	12.4
83	1.0	.0	.0	.0	.0	5.1
84	.0	.0	8.7	2.2	.7	.3
85	26.9	10.4	12.1	11.4	16.7	49.2
90	153.0	60.5	21.0	62.6	77.5	40.8
91	93.4	29.5	45.0	53.9	11.1	114.0
92	39.9	32.1	20.1	100.1	16.4	56.6
93	78.0	17.4	21.0	18.1	71.5	5.3
94	6.2	1.0	17.8	7.2	2.6	10.3
95	45.9	14.9	14.4	7.3	16.4	15.3

Table 8 STRATIFIED MEAN NUMBER PER TOW FROM MID-YEAR RV

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	.01	.00	.00	.01	.06	.00	.00	.00	.01	.00	.93	.03
1	.48	.18	.15	.06	.21	.52	.08	.13	.10	1.39	.10	1.13
2	.76	3.58	.73	1.07	.49	1.43	.64	1.09	.54	1.75	.45	1.22
3	1.19	1.99	1.62	.57	2.29	.82	1.43	2.16	.88	.89	1.43	1.16
4	2.09	.32	1.28	1.13	.54	1.50	1.18	1.32	1.26	1.01	.58	1.30
5	.92	.74	.36	.36	.82	1.27	1.04	.40	.68	.91	.53	.68
6	1.22	.34	.25	.14	.48	.50	.42	.65	.25	.51	.72	.44
7	.53	.47	.11	.08	.06	.40	.21	.18	.19	.23	.23	.24
8	.26	.02	.27	.03	.00	.08	.12	.11	.05	.16	.11	.20
9	.09	.00	.20	.09	.02	.05	.03	.02	.04	.03	.06	.05
10	.05	.01	.08	.02	.01	.00	.03	.01	.00	.03	.00	.05
11	.01	.00	.01	.01	.02	.06	.01	.01	.00	.04	.04	.01
12	.00	.00	.01	.00	.00	.01	.00	.01	.00	.00	.00	.00

	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.04	.09	.00	.04	.02	.00	.18	.20	.01
1	.37	.09	.52	.31	.48	.24	1.66	.50	.30
2	.91	.68	3.44	5.57	.64	1.49	6.06	3.89	.41
3	.90	2.62	2.25	2.67	1.67	.37	10.24	2.12	3.48
4	.94	1.50	1.50	.95	.81	.72	1.77	1.66	1.64
5	.78	.93	1.23	.97	.23	.38	1.08	.28	1.57
6	.44	.58	.45	.50	.40	.17	.33	.31	.19
7	.12	.24	.32	.34	.29	.14	.13	.03	.27
8	.13	.00	.04	.19	.14	.20	.19	.02	.04
9	.11	.05	.04	.10	.06	.05	.04	.05	.03
10	.03	.02	.02	.01	.01	.03	.00	.03	.00
11	.02	.00	.00	.00	.00	.04	.00	.01	.01
12	.01	.00	.00	.00	.00	.00	.00	.00	.02

TABLE 9 COEFFICIENT OF VARIATION FOR RV STRATIFIED MEAN NO/TOW

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	1.00	.00	.00	1.02	.93	.00	.00	.00	1.01	.00	.86	1.00	.90	.75
1	.33	.37	.47	.67	.69	.32	.63	.38	.60	.80	.68	.69	.51	.72
2	.64	.82	.66	.25	.33	.28	.40	.27	.34	.38	.43	.28	.30	.37
3	.66	.83	.45	.26	.26	.26	.40	.25	.33	.29	.29	.28	.27	.24
4	.66	.55	.32	.25	.32	.26	.40	.24	.24	.25	.29	.21	.24	.18
5	.57	.46	.29	.31	.19	.29	.27	.31	.23	.25	.19	.25	.23	.42
6	.50	.40	.28	.25	.33	.33	.24	.27	.19	.26	.21	.19	.25	.35
7	.46	.28	.42	.43	.82	.46	.38	.35	.29	.48	.24	.30	.18	.38
8	.47	.52	.22	.38	.00	.67	.47	.52	.50	.75	.31	.31	.30	.00
9	.51	.00	.47	.54	.74	.59	.51	.45	.29	.85	.57	.49	.48	.59
10	.69	1.01	.39	.60	.63	.00	.35	.70	.00	.68	.00	.52	.56	.38
11	1.04	.00	.58	.50	.69	1.00	.98	.80	.00	.72	.93	1.01	.49	.00
12	.00	.00	.58	.95	.00	.59	.00	.96	.00	.00	.00	.97	1.01	.00

	1984	1985	1986	1987	1988	1989	1990
0	.00	.72	.99	1.07	.53	.60	1.00
1	.52	.44	.67	.64	.42	.33	.41
2	.43	.47	.37	.25	.65	.37	.34
3	.45	.42	.32	.26	.52	.29	.28
4	.32	.34	.30	.25	.55	.27	.21
5	.30	.26	.35	.33	.38	.26	.29
6	.27	.27	.26	.40	.39	.38	.50
7	.31	.36	.32	.35	.55	.42	.30
8	.71	.54	.32	.30	.59	1.00	.55
9	.62	.55	.67	.62	.62	.67	.62
10	.99	1.03	1.01	.65	.00	.43	.00
11	.00	.00	.00	.67	.00	1.00	.50
12	.00	.96	.00	.00	.00	.00	.69

Table 10 Input data used in the construction of the 1990 catch-at-age matrix. A) Quarterly landings used in calculation of numbers-at-age (foreign landings are annual), B) Number of samples available for key construction, C) Length-weight parameters (A/B) and D) Numbers-at-age ('000) by gear type.

(A)

Otter Trawl				Longline and Handline				Gillnet				Miscellaneous				
1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	Foreign
3006	2065	1543	1200	1936	2672	6191	2096	145	403	1504	286	39	74	43	41	143

(B)

Gear	Jan-Mar	Apr-June	July-Sept	Oct-Dec
OT	14	10	6	4
LL	9	3	11	7
GN	1	5	2	2

(C)

Jan-Mar	Apr-June	July-Sept	Oct-Dec
.0081/3.0503	.0084/3.041	.0073/3.0736	.0063/3.1152

(D)

Age	OT	LL	GN	MISC	FOREIGN
1	0	0	0	0	0
2	65	35	0	1	1
3	1025	1069	50	19	19
4	1054	1209	131	21	19
5	744	1525	296	22	14
6	99	361	114	4	2
7	62	252	48	3	1
8	16	52	6	1	0
9	7	35	0	0	0
10	3	30	1	0	0
11	2	9	0	0	0
12	0	9	2	0	0
13	0	0	0	0	0
14	1	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0

TABLE 11 CATCH NUMBERS AT AGE (THOUSANDS) 26/ 4/91

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
1	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0
2	36	489	660	295	763	120	260	54	105	0	160	0	0	11	2
3	806	1475	1947	2626	1265	860	482	1279	622	211	831	326	0	265	792
4	1617	1431	3274	1898	2927	734	2024	662	2395	365	1257	1986	275	409	2057
5	1639	930	1441	1465	1189	1407	909	1236	731	1442	585	1726	966	1940	2734
6	676	908	773	500	557	450	1051	521	584	234	805	1093	804	901	1183
7	270	67	732	468	361	222	358	583	505	602	84	417	273	320	513
8	364	105	40	277	170	74	139	190	470	288	168	409	336	97	237
9	363	150	51	82	254	175	129	58	116	341	149	87	196	79	81
10	265	162	91	26	30	219	136	34	40	288	94	0	107	41	55
11	103	52	13	107	21	73	91	60	78	0	23	25	51	18	6
12	50	16	67	71	13	16	35	32	78	94	10	16	13	9	0
13	51	30	6	16	28	0	31	16	47	136	7	0	30	0	12
14	74	9	1	16	6	27	23	4	9	64	0	0	0	0	3
15	26	23	31	7	0	0	13	0	0	0	7	0	0	0	3
16	0	0	1	0	0	0	2	4	0	0	0	0	0	0	0

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	32	15	17	11	456	272	553	358	331	101	766	410
3	396	106	1498	1909	1601	1690	2557	1341	1302	2446	1857	2193	1556	1693
4	1972	751	2576	4703	6321	2575	2047	1398	1031	3071	2432	2088	2955	2476
5	1576	3104	2903	3372	3690	6149	2277	1565	1324	1903	1952	1814	1022	1401
6	1083	2550	2194	1753	1271	2554	2014	980	1062	953	676	1171	679	467
7	927	852	701	1108	480	459	595	435	452	165	295	267	365	190
8	301	768	271	357	388	191	195	78	388	122	75	209	88	122
9	222	385	78	44	142	246	140	215	165	141	159	116	58	74
10	39	78	41	65	36	59	229	52	159	67	68	109	35	18
11	41	27	23	26	46	40	25	17	32	4	52	98	26	7
12	33	83	7	24	11	31	8	26	72	2	15	39	14	2
13	17	8	9	5	2	6	8	0	87	1	7	9	8	4
14	7	0	1	0	1	6	5	0	0	4	8	13	0	1
15	4	0	0	0	0	3	10	0	43	0	15	20	0	2
16	0	10	0	3	5	10	20	0	7	18	0	17	1	0

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	2	0	0	0	0	0	4	39	0	0	0	0	10	0
2	1609	285	326	885	886	982	766	804	888	147	1055	439	519	102
3	3063	1803	1294	4773	4063	2549	3896	2381	1594	3129	784	2996	2305	2181
4	1683	2274	3405	1952	4424	4476	2112	3243	1488	2204	2140	1665	3763	2435
5	1606	1991	2632	2476	1684	3332	2376	1845	2458	906	1016	1534	709	2601
6	775	2188	1217	1288	1017	873	1148	923	1159	985	472	686	615	580
7	272	636	703	426	535	398	620	444	491	343	478	211	158	366
8	257	199	218	242	299	301	251	159	174	164	230	207	83	76
9	101	55	99	86	165	140	136	54	66	82	111	96	54	42
10	81	49	79	51	65	99	71	50	44	37	56	59	17	35
11	36	9	23	12	27	52	52	31	26	15	31	35	7	11
12	39	16	13	16	18	27	9	22	8	15	8	9	6	12
13	10	6	3	4	20	18	18	6	8	9	7	10	2	1
14	25	2	7	1	6	0	5	2	2	0	4	2	0	2
15	2	1	0	1	2	4	0	4	1	2	3	1	1	0
16	12	1	7	3	6	0	2	15	4	0	2	1	0	0

TABLE 12 PERCENT NUMBERS AT AGE 26/ 4/91

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.01	.08	.07	.04	.10	.03	.05	.01	.02	.00	.04	.00	.00	.00	.00	.00	.00
3	.13	.25	.21	.33	.17	.20	.08	.27	.11	.05	.20	.05	.00	.06	.10	.06	.01
4	.25	.24	.36	.24	.39	.17	.36	.14	.41	.09	.30	.33	.09	.10	.27	.30	.09
5	.26	.16	.16	.19	.16	.32	.16	.26	.13	.35	.14	.28	.32	.47	.36	.24	.36
6	.11	.16	.08	.06	.07	.10	.18	.11	.10	.06	.19	.18	.26	.22	.15	.16	.29
7	.04	.01	.08	.06	.05	.05	.06	.12	.09	.15	.02	.07	.09	.08	.07	.14	.10
8	.06	.02	.00	.04	.02	.02	.02	.04	.08	.07	.04	.07	.11	.02	.03	.05	.09
9	.06	.03	.01	.01	.03	.04	.02	.01	.02	.08	.04	.01	.06	.02	.01	.03	.04
10	.04	.03	.01	.00	.00	.05	.02	.01	.01	.07	.02	.00	.04	.01	.01	.01	.01
11	.02	.01	.00	.01	.00	.02	.02	.01	.01	.00	.01	.00	.02	.00	.00	.01	.00
12	.01	.00	.01	.01	.00	.00	.01	.01	.01	.02	.00	.00	.00	.00	.00	.00	.01
13	.01	.01	.00	.00	.00	.00	.01	.00	.01	.03	.00	.00	.01	.00	.00	.00	.00
14	.01	.00	.00	.00	.00	.01	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00
15	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.00	.00	.00	.00	.04	.04	.08	.04	.04	.01	.10	.06	.17	.03	.03	.07	.07
3	.14	.14	.11	.12	.24	.21	.19	.26	.23	.27	.21	.25	.32	.19	.13	.39	.31
4	.25	.35	.45	.18	.19	.22	.15	.33	.31	.25	.39	.36	.18	.24	.34	.16	.33
5	.28	.25	.26	.44	.22	.25	.20	.21	.25	.22	.13	.20	.17	.21	.26	.20	.13
6	.21	.13	.09	.18	.19	.15	.16	.10	.09	.14	.09	.07	.08	.23	.12	.11	.08
7	.07	.08	.03	.03	.06	.07	.07	.02	.04	.03	.05	.03	.03	.07	.07	.03	.04
8	.03	.03	.03	.01	.02	.01	.06	.01	.01	.03	.01	.02	.03	.02	.02	.02	.02
9	.01	.00	.01	.02	.01	.03	.02	.02	.02	.01	.01	.01	.01	.01	.01	.01	.01
10	.00	.00	.00	.00	.02	.01	.02	.01	.01	.01	.00	.00	.01	.01	.01	.00	.00
11	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
15	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.07	.07	.08	.11	.02	.16	.06	.06	.01
3	.19	.34	.24	.19	.39	.12	.38	.28	.26
4	.34	.18	.32	.18	.27	.33	.21	.46	.29
5	.25	.21	.18	.29	.11	.16	.19	.09	.31
6	.07	.10	.09	.14	.12	.07	.09	.07	.07
7	.03	.05	.04	.06	.04	.07	.03	.02	.04
8	.02	.02	.02	.02	.02	.04	.03	.01	.01
9	.01	.01	.01	.01	.01	.02	.01	.01	.01
10	.01	.01	.00	.01	.00	.01	.01	.00	.00
11	.00	.00	.00	.00	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00	.00	.00	.00	.00
15	.00	.00	.00	.00	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.00	.00	.00	.00	.00

TABLE 13 PERCENT CATCH WEIGHT AT AGE 26/ 4/91

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.00	.04	.03	.01	.04	.01	.01	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
3	.05	.12	.11	.17	.10	.09	.04	.09	.04	.01	.08	.01	.00	.02	.04	.01	.00
4	.12	.20	.28	.17	.30	.12	.20	.09	.25	.03	.15	.17	.03	.05	.14	.13	.03
5	.17	.16	.20	.21	.17	.34	.15	.26	.11	.24	.13	.23	.16	.37	.26	.18	.22
6	.10	.20	.13	.11	.10	.12	.27	.16	.14	.05	.29	.18	.21	.27	.21	.18	.28
7	.06	.02	.13	.13	.11	.09	.10	.22	.16	.13	.04	.15	.12	.13	.16	.23	.11
8	.11	.04	.02	.08	.05	.04	.05	.07	.15	.10	.09	.17	.15	.04	.10	.11	.16
9	.12	.07	.02	.03	.07	.05	.04	.03	.04	.16	.10	.06	.13	.05	.04	.08	.12
10	.09	.08	.04	.01	.01	.09	.04	.02	.01	.12	.07	.00	.09	.03	.03	.02	.03
11	.05	.03	.01	.04	.01	.04	.04	.02	.04	.00	.02	.02	.06	.02	.00	.03	.01
12	.03	.01	.03	.03	.01	.01	.01	.02	.03	.04	.00	.01	.01	.01	.00	.02	.03
13	.03	.02	.00	.01	.02	.00	.02	.01	.02	.07	.01	.00	.04	.00	.01	.01	.00
14	.06	.00	.00	.01	.01	.01	.02	.00	.00	.04	.00	.00	.00	.00	.00	.00	.00
15	.02	.02	.02	.00	.00	.00	.01	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.00	.00	.00	.00	.01	.01	.01	.01	.01	.00	.02	.01	.07	.01	.01	.02	.02
3	.05	.06	.05	.04	.10	.09	.05	.16	.11	.10	.09	.12	.17	.11	.06	.21	.16
4	.16	.24	.32	.11	.12	.14	.08	.28	.24	.14	.30	.31	.14	.17	.23	.13	.28
5	.26	.26	.28	.39	.23	.24	.16	.21	.28	.21	.15	.24	.17	.19	.27	.23	.15
6	.28	.19	.13	.24	.25	.24	.18	.18	.11	.22	.20	.12	.15	.31	.17	.19	.12
7	.13	.14	.08	.07	.10	.13	.12	.04	.07	.06	.11	.07	.07	.11	.13	.09	.10
8	.06	.06	.08	.04	.05	.03	.12	.04	.03	.06	.04	.06	.09	.05	.05	.05	.07
9	.03	.01	.03	.05	.04	.06	.07	.04	.07	.04	.03	.05	.04	.01	.03	.03	.04
10	.02	.02	.01	.02	.06	.02	.07	.02	.04	.04	.02	.01	.03	.02	.03	.02	.02
11	.01	.01	.01	.01	.01	.01	.02	.00	.02	.05	.02	.01	.02	.00	.01	.00	.01
12	.00	.01	.00	.01	.00	.02	.04	.00	.01	.03	.01	.00	.03	.00	.01	.01	.01
13	.00	.00	.00	.00	.00	.00	.05	.00	.01	.01	.00	.00	.01	.00	.00	.00	.01
14	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00	.00	.02	.00	.00	.00	.00
15	.00	.00	.00	.00	.00	.00	.03	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.01	.00	.00	.01	.00	.01	.00	.00	.01	.00	.00	.00	.00

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.02	.02	.03	.03	.01	.05	.02	.02	.00
3	.10	.17	.14	.10	.21	.06	.20	.19	.14
4	.25	.13	.26	.14	.22	.25	.16	.44	.24
5	.29	.21	.20	.29	.12	.17	.21	.10	.36
6	.11	.16	.14	.19	.20	.10	.14	.13	.10
7	.07	.12	.10	.11	.09	.14	.06	.04	.09
8	.06	.07	.05	.06	.06	.10	.08	.04	.03
9	.04	.05	.02	.02	.04	.05	.05	.03	.02
10	.03	.03	.02	.02	.02	.04	.03	.01	.02
11	.02	.02	.02	.01	.01	.02	.02	.01	.01
12	.01	.00	.01	.01	.01	.01	.01	.00	.01
13	.01	.01	.00	.00	.01	.01	.01	.00	.00
14	.00	.00	.00	.00	.00	.00	.00	.00	.00
15	.00	.00	.00	.00	.00	.00	.00	.00	.00
16	.00	.00	.01	.00	.00	.00	.00	.00	.00

TABLE 14 MEAN WEIGHT AT AGE (KG) 26/ 4/91

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
1	.47	.47	.47	.50	.47	.47	.47	.77	.47	.47	.47	.47	.47	.47
2	.62	1.15	.82	.71	.87	.99	.95	.78	.63	.79	.66	.49	.66	.32
3	1.08	1.28	1.11	1.14	1.34	1.42	1.28	1.07	1.23	.63	1.11	.52	1.04	.86
4	1.41	2.20	1.63	1.58	1.81	2.40	1.67	1.95	1.91	1.18	1.39	1.15	1.23	1.58
5	2.03	2.82	2.64	2.51	2.49	3.41	2.71	3.02	2.60	2.29	2.64	1.72	2.28	2.65
6	2.82	3.54	3.18	3.82	3.25	3.86	4.24	4.43	4.36	2.93	4.16	2.19	3.50	4.14
7	4.38	4.34	3.42	4.98	5.44	5.64	4.72	5.51	5.69	3.07	5.69	4.56	5.92	5.71
8	5.61	6.17	8.26	4.94	5.57	6.83	6.41	5.39	5.58	4.96	5.96	5.39	6.22	5.91
9	6.41	7.39	6.07	6.00	4.61	4.23	5.78	7.13	6.57	6.60	7.85	8.45	9.03	9.49
10	6.65	7.55	8.72	8.09	5.15	5.58	5.01	8.85	5.55	5.79	8.92	11.81	11.85	11.49
11	8.71	8.29	10.57	6.82	5.89	6.81	7.50	5.52	8.10	5.54	10.10	11.13	15.77	13.27
12	10.54	11.58	9.95	7.00	15.64	6.47	5.91	9.46	6.93	6.15	5.53	4.98	6.88	16.78
13	10.50	11.50	5.43	11.17	11.74	13.53	8.92	9.76	7.62	6.86	12.57	13.29	16.78	11.90
14	14.72	8.46	16.80	13.05	16.78	4.57	11.42	9.15	6.91	8.99	11.89	14.22	14.22	16.85
15	13.49	10.81	9.99	11.67	15.73	16.15	12.44	12.34	15.73	11.22	11.21	15.73	15.73	15.73
16	17.42	17.42	15.52	15.52	15.52	15.52	15.52	15.52	15.52	15.52	15.52	15.52	15.52	17.42

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47	.47
2	.28	.66	.68	.64	.50	.53	.78	.77	.65	.61	.69	.73	.60	.69
3	.76	.69	.85	.89	1.05	1.02	.95	1.26	1.37	.87	1.40	1.26	1.09	1.23
4	1.14	1.26	1.30	1.64	1.59	1.61	1.55	1.83	2.00	1.70	2.02	2.19	1.55	2.14
5	1.57	2.13	2.03	2.41	2.42	2.39	2.23	3.23	3.00	2.73	2.45	3.10	2.62	3.15
6	3.00	3.01	3.20	3.52	3.30	3.35	3.39	4.03	4.85	3.87	4.13	3.62	4.38	6.13
7	5.23	4.63	3.83	4.93	4.03	5.26	5.44	5.50	6.07	6.19	4.96	4.90	5.53	6.63
8	7.23	6.50	5.98	5.74	5.40	6.47	6.85	8.90	6.84	7.05	6.83	7.63	6.56	8.97
9	7.55	7.10	9.08	11.31	6.95	7.64	7.95	9.26	5.14	9.11	6.14	9.54	8.62	9.41
10	7.99	7.94	9.45	10.63	7.82	9.48	9.75	8.05	8.04	10.18	6.36	11.28	8.90	13.52
11	7.66	11.41	12.75	14.47	8.09	9.27	11.12	14.88	12.84	13.44	16.55	10.42	11.27	13.30
12	11.65	9.71	11.47	9.28	11.35	13.08	13.22	13.70	17.38	12.77	15.01	10.55	15.41	13.54
13	12.32	10.02	15.52	13.29	8.43	17.38	14.74	16.35	13.29	14.33	17.49	16.78	15.31	12.66
14	16.92	13.66	14.22	14.22	14.22	16.78	15.72	16.78	16.03	15.02	17.93	16.80	11.82	16.62
15	16.92	11.17	15.50	15.50	15.57	15.86	16.92	15.24	16.67	15.72	16.87	16.78	17.01	15.32
16	16.78	16.78	16.78	16.83	16.78	16.92	17.50	17.93	16.95	16.55	15.81	15.45	15.41	14.01

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.47	.48	.47	.47	.47	.47	.47	.36	.38	.37	.38	.47	.47	.50	.47
2	.60	1.04	.84	.83	.71	.75	.81	.85	.95	.82	.80	.91	.96	.92	.92
3	1.19	1.26	1.57	1.27	1.41	1.25	1.33	1.33	1.50	1.41	1.29	1.46	1.35	1.57	1.49
4	2.14	1.86	1.91	2.04	2.17	1.99	1.85	1.85	2.00	1.97	1.90	2.16	1.88	2.28	2.26
5	3.00	2.34	2.39	3.11	2.98	2.80	2.84	2.61	2.73	2.52	2.63	3.17	2.71	2.76	3.22
6	4.42	4.28	3.54	4.15	4.75	3.60	4.13	4.21	3.82	3.53	3.96	3.89	4.01	4.02	3.89
7	6.07	5.76	4.17	5.34	6.71	5.64	5.46	5.58	5.42	4.96	5.02	5.55	5.25	4.98	5.61
8	8.56	7.75	6.16	7.26	6.93	7.25	7.08	8.05	7.61	6.89	7.47	7.89	8.07	8.45	7.97
9	10.83	9.08	6.18	8.65	9.57	8.38	8.38	10.26	9.34	8.09	9.51	9.13	10.12	9.97	9.99
10	12.01	9.44	9.22	11.24	9.81	11.21	9.07	11.42	11.69	9.86	9.20	11.90	10.99	11.89	12.47
11	16.17	10.75	6.56	10.65	11.86	12.29	10.63	11.59	13.27	12.41	11.90	12.95	12.17	15.24	14.03
12	12.47	15.41	7.23	12.00	14.11	12.41	14.16	15.10	14.15	14.52	14.38	15.53	16.25	16.38	16.15
13	14.90	15.83	6.90	16.72	11.57	15.35	13.99	16.13	14.34	12.31	15.07	14.10	18.61	17.19	17.83
14	16.32	16.65	13.32	13.56	9.32	15.35	16.14	16.14	15.10	12.28	13.19	16.67	19.15	19.00	19.68
15	17.93	15.54	16.92	15.35	17.52	14.51	16.54	16.57	16.74	16.20	20.33	22.20	19.94	19.52	20.53
16	15.59	16.01	16.92	16.57	17.37	16.69	16.76	15.98	17.01	14.62	17.42	21.03	26.30	25.84	21.38

Table 15. Input values for the ADAPT calibration.

The adaptive framework was used to estimate stock size according to the following formulation:

Parameters of the ADAPT framework

- Year-class estimates: - $N_{i,1990}$ i = 3-7

- Calibration coefficients for summer RV stratified mean number per tow
  - K_i i = 3-7

Structure Imposed

-Error for catch assumed negligible;
-Population numbers in 1990 at ages 1 and 2 set to the geometric mean; ages 5+ assumed to be fully recruited;
-F on oldest age group calculated as a weighted F for ages 5-7;
-Model did not include an intercept term;
-M = 0.2.

Input

- $C_{i,t}$ i = 1-13; t = 1970-90
- $RV_{i,t}$(mean number/tow) i = 3-7; t = 1970-90

Objective function

- Minimize

$$\sum_i \sum_t \left((lnRV_{i,t}) - (lnK_i N_{i,t}) \right)^2$$

where the summation is for t = 1970 to 1990 and i = 3 to 7.

Summary

-Number of observations = 105
-Number of parameters = 10

Table 16 ADAPTIVE FRAMEWORK 2 INDEX TUNING
4X COD 5/01/91 08:57

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.022582
MEAN SQUARE RESIDUALS 0.258434

PAR. EST.	STD. ERR.	T-STATISTIC
2.92729E0004	1.45601E0004	2.01048E0000
1.26132E0004	4.41700E0003	2.85561E0000
1.20329E0004	3.27431E0003	3.67494E0000
1.29892E0003	3.52990E0002	3.67977E0000
1.33081E0003	4.08724E0002	3.25601E0000
1.41099E-004	1.64473E-005	8.57881E0000
1.72924E-004	1.98853E-005	8.69608E0000
2.12296E-004	2.44165E-005	8.69476E0000
2.71307E-004	3.14080E-005	8.63814E0000
2.56487E-004	2.97642E-005	8.61730E0000

Parameter Correlation Matrix

	1	2	3	4	5	6	7	8	9	10
1	1.000	.033	.027	.013	.011	-.222	-.011	-.008	-.007	-.008
2	.033	1.000	.042	.021	.018	-.149	-.177	-.012	-.011	-.012
3	.027	.042	1.000	.011	.040	-.121	-.150	-.200	-.120	-.198
4	.013	.021	.011	1.000	.044	-.057	-.078	-.116	-.204	-.046
5	.011	.018	.040	.044	1.000	-.050	-.067	-.099	-.143	-.199
6	-.222	-.149	-.121	-.057	-.050	1.000	.049	.034	.031	.034
7	-.011	-.177	-.150	-.078	-.067	.049	1.000	.044	.041	.044
8	-.008	-.012	-.200	-.116	-.099	.034	.044	1.000	.058	.061
9	-.007	-.011	-.120	-.204	-.143	.031	.041	.058	1.000	.057
10	-.008	-.012	-.198	-.046	-.199	.034	.044	.061	.057	1.000

Standardized Residuals for RV index (s.e.=1 for log model)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	.136	.217	.161	-.651	.410	-.847	-.045	.160	-.695
4	.885	-.973	.063	.138	-.351	.322	-.278	.066	-.133
5	.448	.214	-.375	-.734	.330	.909	.368	-1.088	-.234
6	.910	.102	-.337	-.763	.095	.306	.122	.232	-1.071
7	.506	.685	-.263	-.675	-.823	.703	.010	-.152	-.216

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	-.381	-.467	-.568	-.473	.356	.975	.987	.196	-.715	1.213	.032	.000
4	-.245	-.587	-.180	-.347	.320	.157	.508	.190	-.305	1.184	-.406	-.026
5	-.039	-.338	-.009	-.062	.223	.551	.250	-.449	-.057	.513	-.217	-.204
6	-.050	.254	.055	.011	.321	.021	.243	-.077	-.292	.388	-.375	-.095
7	-.275	-.104	-.048	-.430	.339	.604	.559	.545	-.248	.243	-1.071	.111

TABLE 17. POPULATION NUMBERS ('000)

POPULATION NUMBERS 13/ 5/91

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
1	17509	24810	12414	15891	8772	18385	9066	14122	16469	18140	16042	23158	29081	18708
2	13487	14335	20313	10163	13010	7182	15052	7423	11558	13483	14852	13134	18960	23809
3	9085	11010	11294	16034	8054	9961	5771	12088	6028	9368	11039	12015	10753	15523
4	8536	6709	7679	7484	10751	5449	7377	4289	8740	4372	7478	8286	9542	8804
5	6908	5526	4199	3325	4411	6153	3806	4208	2913	4989	3250	4986	4987	7563
6	1601	4172	3683	2134	1397	2535	3765	2294	2327	1723	2780	2131	2520	3209
7	842	699	2594	2316	1294	640	1668	2131	1407	1376	1199	1548	756	1336
8	1003	445	512	1461	1472	733	323	1041	1218	694	582	906	890	372
9	885	491	269	383	946	1052	533	139	681	572	308	325	371	425
10	522	396	267	174	239	545	703	319	61	452	159	117	187	127
11	150	188	177	136	119	169	248	452	230	14	109	45	96	56
12	119	30	107	133	14	78	72	121	316	118	11	68	15	33
13	68	52	10	27	45	0	49	27	70	188	11	0	41	0
1+	60715	68863	63517	59661	50524	52881	48433	48655	52016	55490	57822	66719	78198	79964

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	22595	33517	42668	20586	16312	16131	14207	20429	19411	15184	20618	24202	20387	25394
2	15317	18499	27441	34934	16854	13355	13207	11632	16726	15892	12432	16880	19815	16691
3	19483	12539	15146	22467	28572	13785	10919	10802	9111	13448	12512	9854	13521	16132
4	12469	15235	9907	12304	17039	21665	9838	7411	6531	6245	9833	8030	6388	9086
5	6838	8347	10689	7432	7742	9695	12018	5724	4215	4082	4180	5272	4374	3341
6	4437	3124	5409	5943	3458	3287	4598	4276	2627	2035	2144	1700	2550	1939
7	1812	2562	1578	2120	2880	1245	1541	1454	1678	1264	705	893	780	1028
8	804	1020	1259	521	1102	1355	585	847	652	981	626	428	464	397
9	216	444	562	336	181	579	758	306	516	463	452	403	283	190
10	276	104	162	112	205	108	345	398	124	228	230	242	185	127
11	66	176	49	62	55	109	56	230	119	55	43	128	137	53
12	29	48	107	16	30	21	47	9	165	81	16	31	58	23
13	19	24	10	13	7	3	7	10	0	112	2	11	12	12
1+	84361	95639	114988	106845	94437	81339	68127	63529	61875	60071	63792	68074	68954	74414

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	24668	17196	32461	29556	20950	27117	13599	14539	20716	10073	40552	27250	44212	19397	19922
2	20791	20196	14077	26577	24199	17152	22202	11133	11900	16926	8247	33201	22310	36198	15871
3	12973	16651	15079	11267	21464	19011	13241	17288	8422	9015	13054	6619	26228	17869	29167
4	11800	9089	10861	10714	8054	13254	11888	8535	10629	4742	5939	7857	4710	18763	12544
5	4765	7420	5919	6835	5691	4828	6848	5683	5076	5768	2536	2868	4496	2350	11957
6	1810	2633	4622	3044	3215	2419	2428	2592	2503	2487	2499	1257	1428	2293	1282
7	973	1060	1455	1805	1391	1466	1060	1199	1083	1214	987	1155	601	548	1320
8	512	625	621	615	841	754	717	508	420	485	550	497	512	301	306
9	246	309	279	329	306	469	347	314	189	200	240	302	199	232	171
10	103	134	161	179	180	172	234	157	134	105	104	122	146	76	140
11	72	68	37	87	75	100	83	103	64	64	46	51	49	66	47
12	20	53	23	22	50	50	57	20	37	25	30	24	14	8	47
13	6	15	8	4	6	27	25	23	9	10	13	10	13	3	1
1+	78739	75449	85602	91034	86421	86820	72730	62094	61183	51115	74795	81212	104918	98103	92777

Table 18

FISHING MORTALITY 13/ 5/91

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.003	.038	.037	.033	.067	.019	.019	.008	.010	.000	.012	.000	.000	.001	.000
3	.103	.160	.211	.200	.191	.100	.097	.124	.121	.025	.087	.030	.000	.019	.046
4	.235	.269	.637	.329	.358	.159	.361	.187	.361	.097	.205	.308	.032	.053	.201
5	.304	.206	.477	.667	.354	.291	.306	.393	.325	.385	.222	.482	.241	.333	.583
6	.629	.275	.264	.300	.581	.219	.369	.289	.325	.163	.386	.837	.435	.372	.349
7	.438	.112	.374	.253	.368	.485	.271	.360	.506	.661	.081	.353	.509	.308	.375
8	.513	.302	.091	.235	.136	.118	.644	.225	.556	.612	.384	.693	.540	.342	.394
9	.605	.411	.234	.269	.352	.204	.313	.622	.209	1.077	.766	.352	.875	.232	.535
10	.822	.604	.476	.182	.149	.587	.240	.127	1.267	1.220	1.057	.001	1.005	.446	.249
11	1.417	.365	.086	2.041	.222	.656	.520	.160	.468	.008	.271	.926	.878	.448	.116
12	.632	.872	1.176	.884	4.217	.262	.770	.345	.320	2.146	4.242	.300	4.334	.350	.004
13	.601	.289	.297	.289	.333	.270	.347	.290	.403	.532	.337	.580	.522	.345	.357
6+	.613	.295	.305	.311	.354	.281	.351	.293	.412	.610	.364	.610	.542	.346	.358

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.001	.001	.001	.001	.044	.018	.039	.032	.022	.006	.052	.022	.092
3	.036	.008	.077	.077	.137	.188	.303	.178	.113	.243	.233	.198	.113	.156	.227
4	.154	.087	.263	.364	.389	.341	.364	.270	.201	.423	.408	.448	.445	.264	.229
5	.234	.387	.565	.657	.546	.833	.579	.528	.444	.700	.526	.613	.413	.393	.273
6	.483	.736	.524	.822	.557	.951	.735	.531	.860	.676	.579	.708	.489	.336	.393
7	.511	.908	.454	.554	.555	.399	.602	.337	.503	.299	.455	.475	.497	.243	.334
8	.396	1.120	.857	.444	.381	.447	.294	.141	.575	.242	.214	.691	.281	.305	.605
9	.806	1.413	.297	.313	.317	.444	.704	.618	.499	.424	.575	.602	.411	.407	.450
10	.541	.754	.516	.433	.462	.208	1.011	.618	1.467	.387	.373	1.048	.361	.211	1.094
11	.299	.934	.528	.765	.633	1.578	.130	.176	1.058	.121	.590	1.569	.776	.113	.895
12	1.395	1.946	.647	2.021	.829	1.317	3.954	.192	3.601	.174	.742	1.384	1.111	.102	1.737
13	.496	.854	.514	.639	.497	.691	.637	.414	.701	.480	.490	.690	.465	.301	.436
6+	.502	.876	.519	.654	.501	.733	.659	.426	.756	.498	.497	.708	.469	.303	.452

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.000	.000	.000	.000	.000	.000	.002	.000	.000	.000	.000	.001	.000
2	.023	.014	.041	.059	.050	.079	.078	.060	.020	.036	.022	.016	.007
3	.142	.136	.282	.269	.239	.286	.375	.217	.308	.140	.135	.154	.086
4	.263	.433	.312	.460	.538	.320	.411	.426	.528	.358	.495	.251	.240
5	.465	.554	.655	.487	.772	.620	.513	.637	.502	.497	.473	.406	.273
6	.741	.583	.585	.625	.506	.673	.523	.724	.572	.537	.758	.352	.680
7	.660	.563	.413	.516	.537	.849	.603	.593	.485	.612	.491	.383	.363
8	.437	.498	.383	.577	.624	.791	.543	.505	.400	.717	.594	.365	.317
9	.245	.405	.374	.494	.590	.651	.385	.452	.479	.526	.759	.301	.317
10	.413	.675	.382	.537	.626	.692	.533	.619	.506	.717	.598	.290	.317
11	.312	.351	.199	.357	1.203	.815	.748	.581	.447	1.114	1.576	.131	.317
12	1.487	1.123	.431	.510	.733	.637	1.100	.472	.868	.433	1.359	1.603	.317
13	.662	.558	.490	.567	.552	.727	.545	.644	.523	.598	.671	.350	.317
6+	.672	.560	.495	.569	.556	.730	.547	.648	.526	.602	.683	.352	.476

Table 19

TABLE 19. MID-YR SPA POPULATION BIOMASS (T) 16/ 5/91

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
1	7411	10502	5255	7201	3713	7782	3838	9854	6971	7679	6790	9802	12310	7919
2	7614	14658	14904	6417	9893	6403	12801	5227	6568	9666	8823	5875	11391	6904
3	8459	11811	10298	15003	8950	12194	6402	11038	6320	5284	10700	5580	10101	11972
4	9741	11809	8499	9194	14898	11006	9407	6945	12749	4464	8549	7445	10473	12287
5	10993	12828	8042	5576	8422	16580	8086	9586	5894	8650	6994	6231	9195	15536
6	3073	11748	9381	6421	3151	7996	12163	8028	7890	4235	8753	2899	6530	10116
7	2729	2605	6744	9277	5365	2610	6273	8987	5740	2834	5944	5425	3204	5983
8	4018	2157	3668	5853	6968	4287	1397	4575	4768	2358	2627	3229	3912	1695
9	3898	2717	1325	1833	3353	3663	2412	674	3671	2131	1550	2108	2052	3272
10	2175	2055	1691	1173	1041	2102	2848	2410	177	1397	810	1254	1287	1071
11	649	1190	1629	369	572	772	1325	2096	1361	70	880	303	926	547
12	849	212	577	569	50	404	272	879	1705	280	14	267	22	421
13	491	470	44	238	410	2	338	210	400	912	110	1	494	1
1+	62099	84761	72056	69124	66788	75802	67562	70510	64215	49961	62545	50419	71897	77725

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	9564	14187	18061	8714	6905	6828	6014	8647	8217	6427	8727	10245	8629	10749
2	3887	11041	16908	20396	7634	6411	9332	7979	9754	8605	7683	11010	10696	10118
3	13180	7677	11624	17520	26123	11941	8569	10675	10402	10011	14131	10086	12128	17015
4	11753	16134	11194	16195	20673	26327	11779	10358	10444	8723	14800	13202	7278	14337
5	7437	14442	16413	12494	12571	16365	16698	12860	8995	8221	6756	11626	7829	7876
6	10243	6825	11237	14874	7146	7732	9252	11203	9029	4852	5906	4278	7341	8589
7	7208	8498	3654	7674	8145	4592	6307	5504	7878	5617	2751	3207	3135	4909
8	4378	4994	4179	1845	4391	6645	2949	5943	3779	4810	3457	2673	2014	2829
9	1156	1985	2533	2996	984	3453	4441	1868	1813	3036	2066	2673	1676	1339
10	1777	582	987	850	1186	751	2764	1857	681	1128	1107	2079	943	1313
11	435	1583	377	642	284	684	290	2910	1269	418	609	922	722	452
12	308	234	505	100	137	170	321	31	2374	267	195	213	449	176
13	178	172	94	119	39	41	73	115	1	1053	23	130	123	110
1+	71505	88355	97765	104418	96219	91939	78790	79949	74635	63168	68210	72343	62965	79811

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	10441	7481	13740	12511	8868	11478	5756	4743	7128	3378	13966	11535	18715	8721	8432
2	11163	18263	10645	19936	15251	11395	16008	8228	9904	12292	5909	27050	19281	29846	13246
3	13020	17135	20077	12178	24064	18906	14262	18207	9602	10367	13225	8204	30042	23676	37834
4	20249	13713	16640	16157	13666	19265	15546	12328	15935	6952	8000	13029	6365	34367	22920
5	10789	13854	10343	14936	11394	9792	12452	10135	9911	9833	4786	6547	8872	4867	30692
6	6200	8500	10615	8755	10573	5938	7190	7277	6811	5726	6887	3461	3689	7078	3315
7	4771	4728	4070	6741	6978	5910	4094	4147	4035	4157	3585	4389	2279	2066	5660
8	3441	3327	2831	3216	4413	3797	3457	2595	2257	2397	3089	2569	2854	1945	1903
9	1996	2063	1393	2135	2231	2834	2007	2173	1334	1189	1654	1958	1294	1817	1335
10	1016	709	1111	1340	1335	1368	1448	1189	1111	708	687	947	1105	717	1367
11	1005	447	188	715	729	945	472	747	552	555	406	370	276	853	512
12	216	360	80	146	527	445	529	208	295	264	261	279	114	62	595
13	74	174	35	50	49	287	242	238	89	84	137	98	160	38	19
1+	84382	90753	91770	98816	100078	92359	83464	72213	68963	57902	62593	80436	95046	116054	127830

Table 20. PCA of US R.V. indices of 5Zj,m cod (Spring age 1 and 2, Autumn age 0 and 1) for the 1978-1988 yearclasses, followed by regression of first PC on SPA numbers at age 1 for 4X cod (for the 1978-1986 yearclasses only).

Principal Components Analysis

Component Number	Percent of Variance	Cumulative Percentage
1	68.34047	68.34047
2	21.91352	90.25399
3	6.06300	96.31699
4	3.68301	100.00000

Variable: WORKAREA.PCOMP

(1,1)	-0.568637
(2,1)	-0.058999
(3,1)	-1.03829
(4,1)	2.93661
(5,1)	-0.134563
(6,1)	-1.30123
(7,1)	0.227081
(8,1)	-1.51118
(9,1)	3.28413
(10,1)	-1.54679
(11,1)	-0.288145

Variable: WORKAREA.WEIGHTS (length = 4 4)

(1,1)	0.536896	(1,2)	-0.253189	(1,3)	0.796617	(1,4)	0.114192
(2,1)	0.437571	(2,2)	-0.680298	(2,3)	-0.458332	(2,4)	-0.368319
(3,1)	0.462116	(3,2)	0.641761	(3,3)	-0.0197939	(3,4)	-0.611719
(4,1)	0.553825	(4,2)	0.247454	(4,3)	-0.393627	(4,4)	0.690726

Regression Analysis - Linear model: Y = a+bX

Dependent variable: -2 DROP SPA1 Independent variable: -2 DROP PCOMP[;1]

Parameter	Estimate	Standard Error	T Value	Prob. Level
Intercept	22478.2	2570.83	8.74359	5.14599E-5
Slope	3955.81	1546.81	2.55739	0.0376951

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	Prob. Level
Model	3.8318E0008	1	3.8318E0008	6.5403E0000	.03770
Error	4.1011E0008	7	5.8587E0007		
Total (Corr.)	7.9329E0008	8			

Correlation Coefficient = 0.694999 R-squared = 48.30 percent
Stnd. Error of Est. = 7654.23

Table 21 Catch Projections

PR

	1990
1	.000
2	.053
3	.358
4	.739
5	1.000
6	1.000
7	1.000
8	1.000
9	1.000
10	1.000
11	1.000
12	1.000
13	1.000
14	1.000
15	1.000
16	1.000

MEAN WT, 1984-90

1	.43
2	.90
3	1.44
4	2.06
5	2.82
6	3.87
7	5.25
8	7.76
9	9.45
10	11.14
11	13.14
12	15.34
13	15.64
14	15.64
15	15.64
16	15.64

POPULATION NUMBERS 1

	1990	1991	1992
1	19922	19922	19922
2	15871	16311	16309
3	29167	12902	13137
4	12544	21912	9465
5	11957	8079	14300
6	1282	7451	4866
7	1320	532	4487
8	306	752	320
9	171	182	453
10	140	102	110
11	47	84	61
12	47	28	50
13	1	28	17
14	0	0	17
15	0	0	0
16	0	0	0
1+	92777	88285	83515
2+	72854	68363	63593
3+	56983	52052	47284
4+	27816	39150	34147

CATCH BIOMASS 13

	1990	1991	1992
1	0	1	1
2	92	216	199
3	3139	1753	1649
4	5026	8347	3345
5	7334	5487	9036
6	2246	6952	4224
7	1926	673	5283
8	588	1406	557
9	400	415	959
10	387	274	274
11	152	265	181
12	179	103	173
13	13	106	59
14	0	1	59
15	0	0	1
16	0	0	0
1+	21483	26000	26000
2+	21483	25999	25999
3+	21391	25783	25800
4+	18252	24030	24151

POPULATION BIOMASS (AVERAGE)

	1990	1991	1992
1	7809	7808	7808
2	12892	13189	13196
3	36500	15965	16323
4	20942	36807	16034
5	26866	17871	31991
6	3303	22643	14955
7	5305	2192	18705
8	1854	4580	1972
9	1263	1352	3396
10	1222	892	971
11	480	863	641
12	565	335	614
13	12	345	208
14	0	5	210
15	0	0	3
16	0	0	0
1+	119013	124846	127027
2+	111204	117038	119218
3+	98312	103849	106022
4+	61812	87884	89699

FISHING MORTALITY

	1990	1991	1992
1	.000	.000	.000
2	.007	.016	.015
3	.086	.110	.101
4	.240	.227	.209
5	.273	.307	.282
6	.680	.307	.282
7	.363	.307	.282
8	.317	.307	.282
9	.317	.307	.282
10	.317	.307	.282
11	.317	.307	.282
12	.317	.307	.282
13	1.092	.307	.282
14	.000	.307	.282
15	.000	.307	.282
16	.000	.307	.282
1+	.113	.135	.126

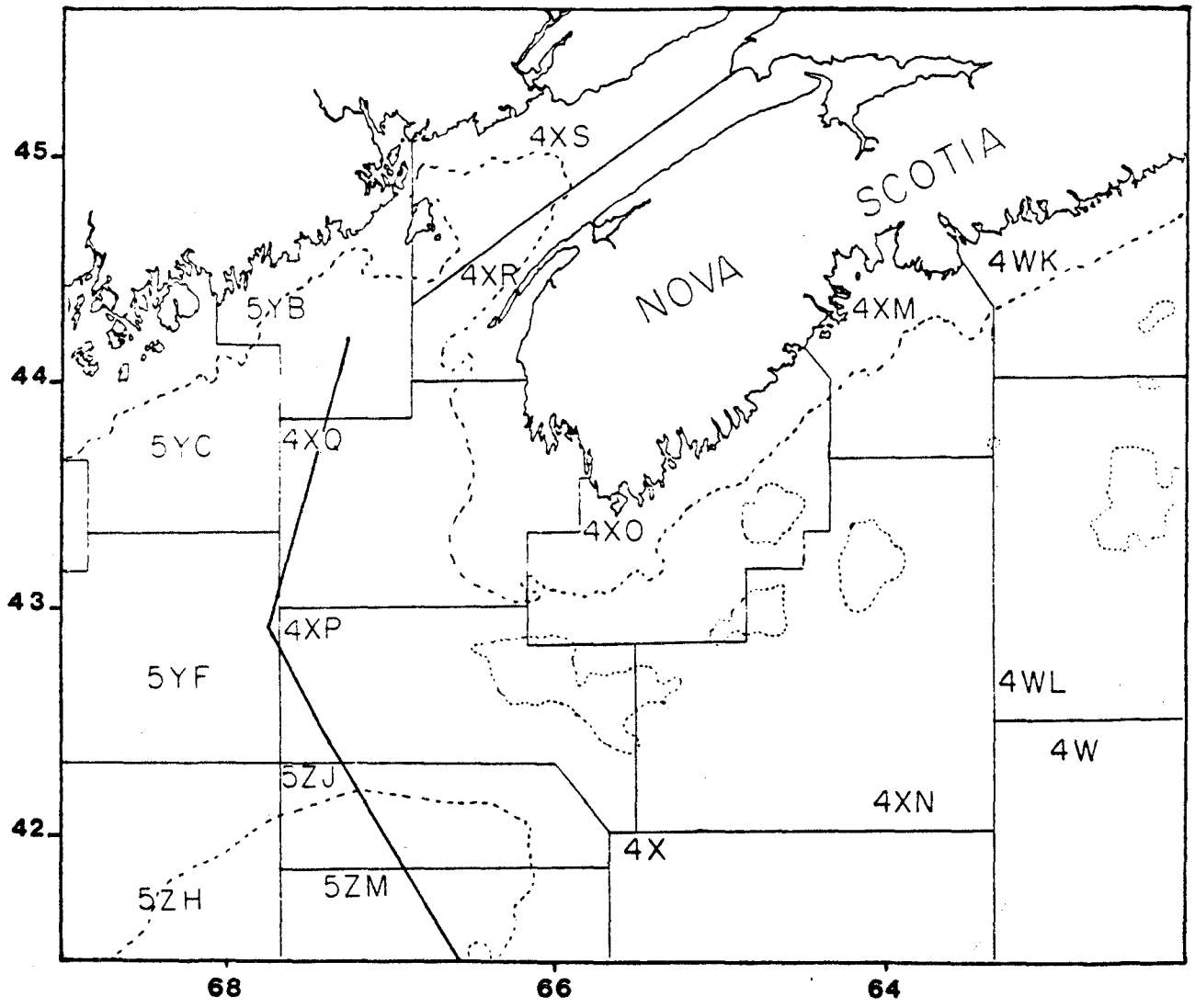


Figure 1. Unit areas in NAFO Division 4X in reference to the ICJ Canada-US boundary.

FIG. 2. 4X COD NOMINAL CATCH AND TAC

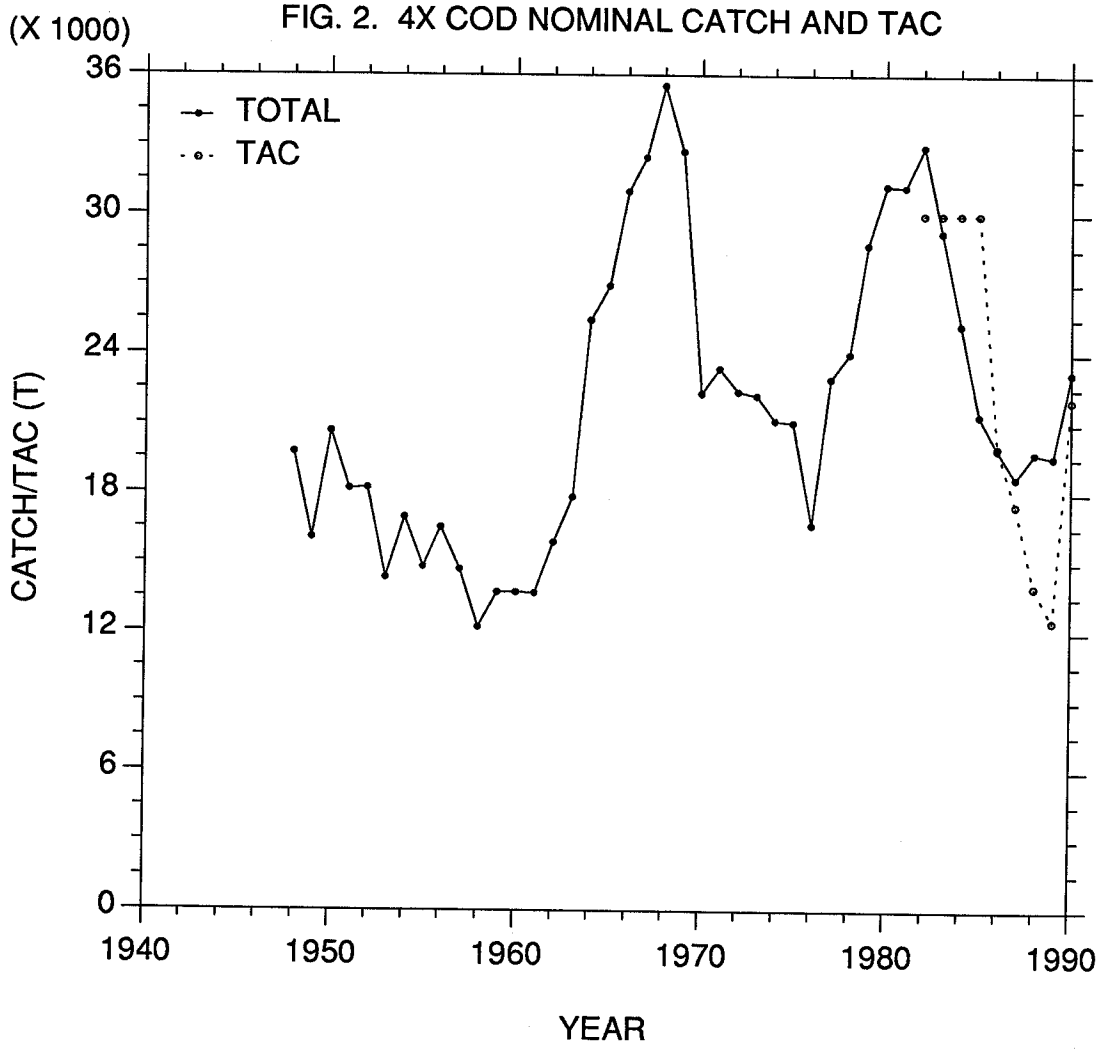


FIG.3. NOMINAL CATCH BY MAJOR GEAR CATEGORY.

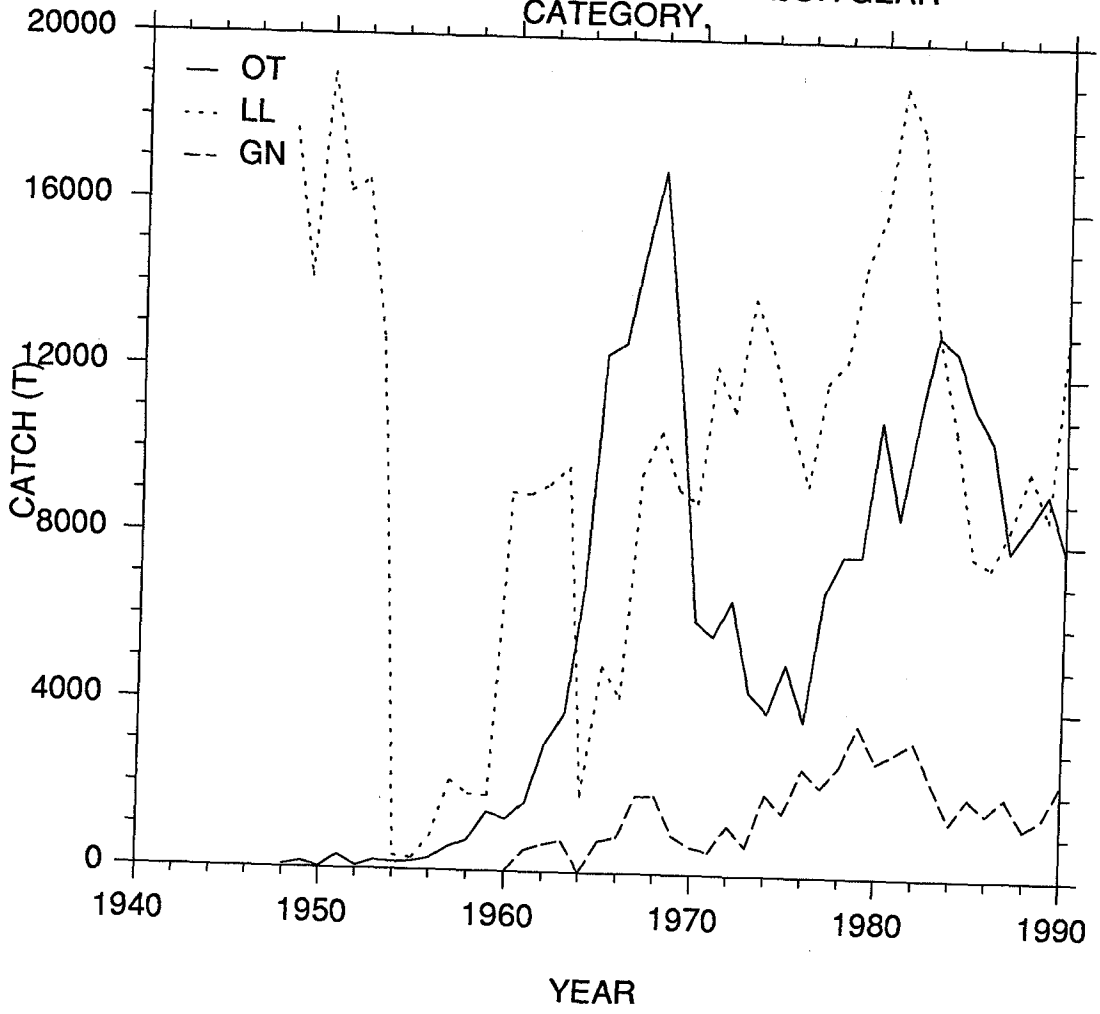
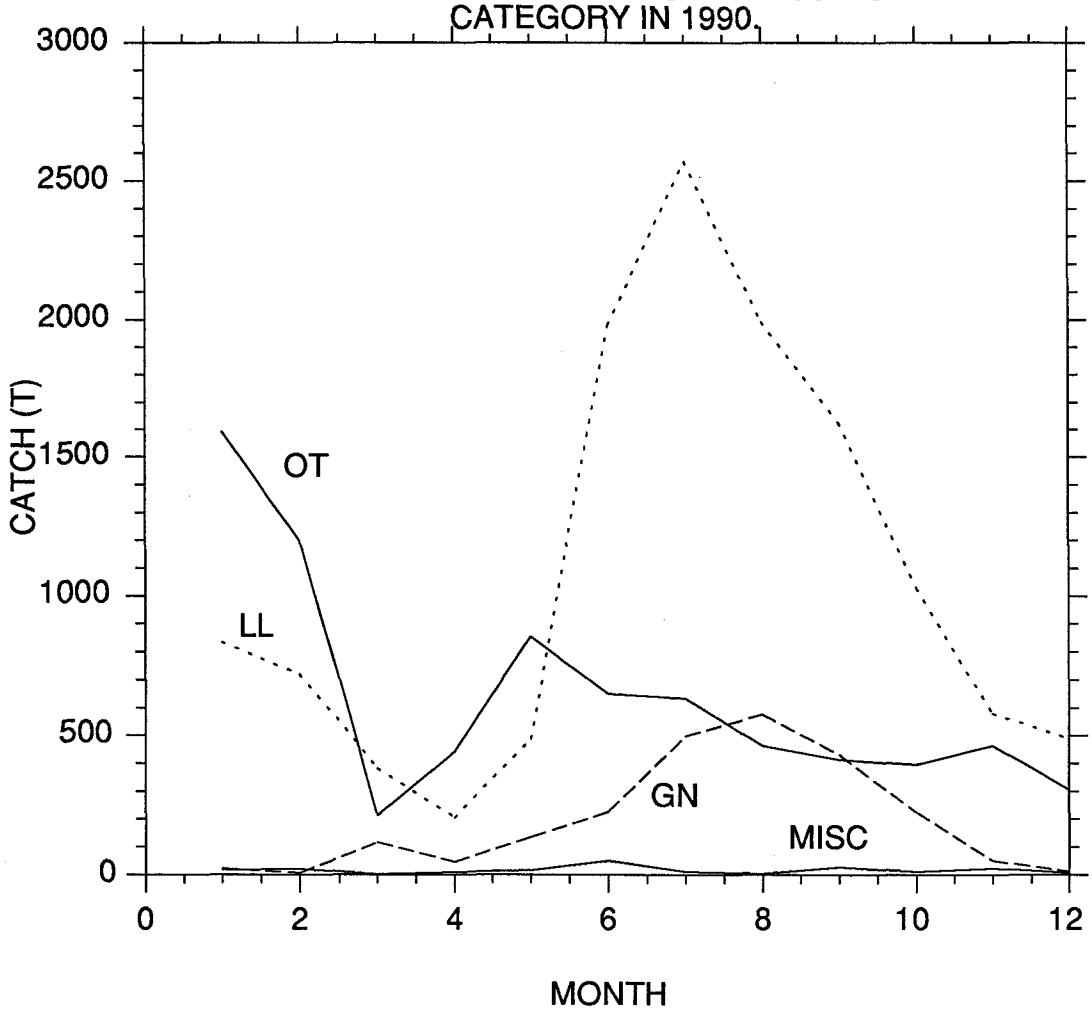


FIG.4. MONTHLY CATCHES BY MAJOR GEAR CATEGORY IN 1990.



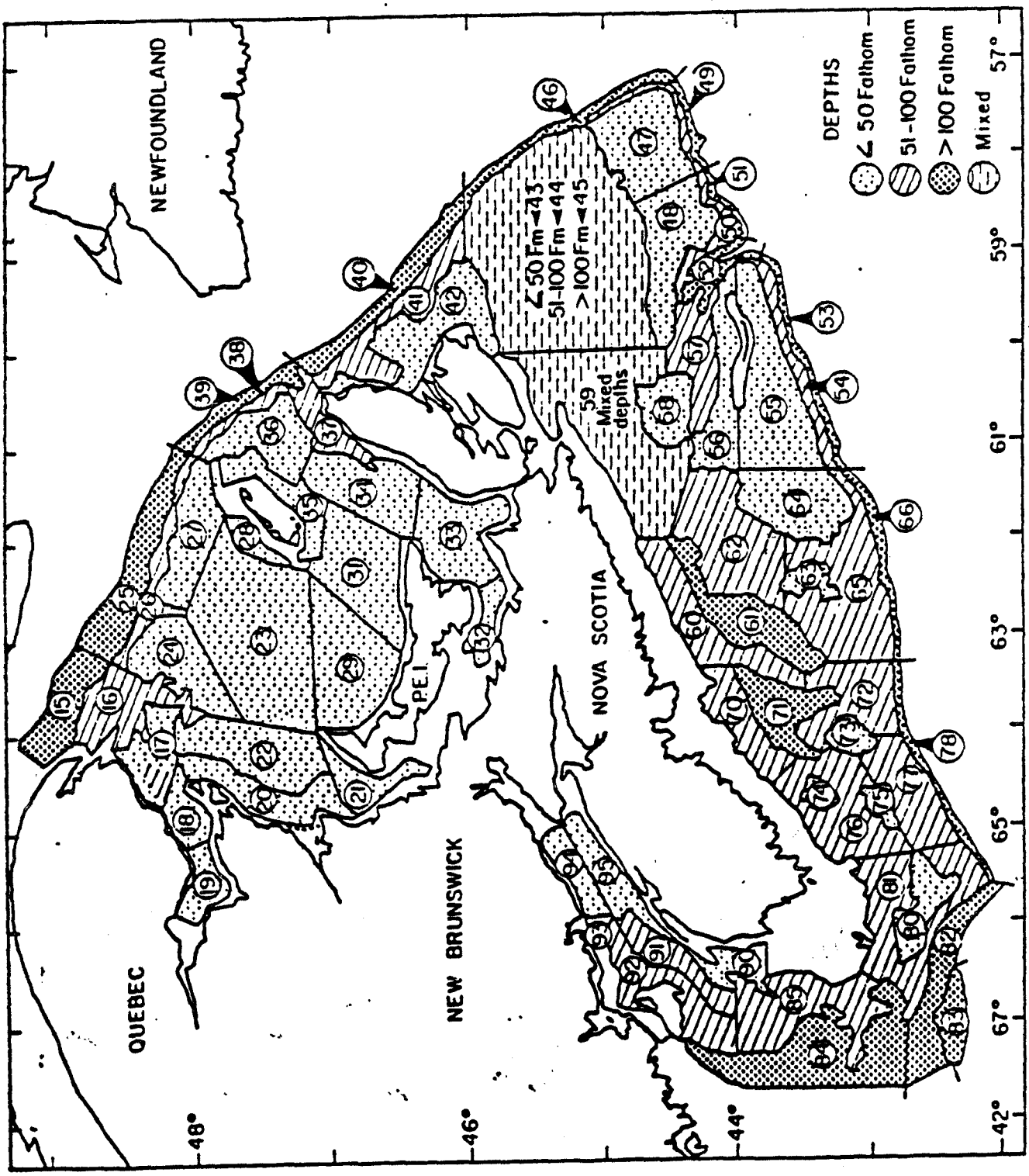


Figure 5. Stratification scheme used for the research groundfish surveys.

FIG.6. Distribution of small (<43 cm) 4X cod (numbers/standard tow) in the 1990 summer RV survey.

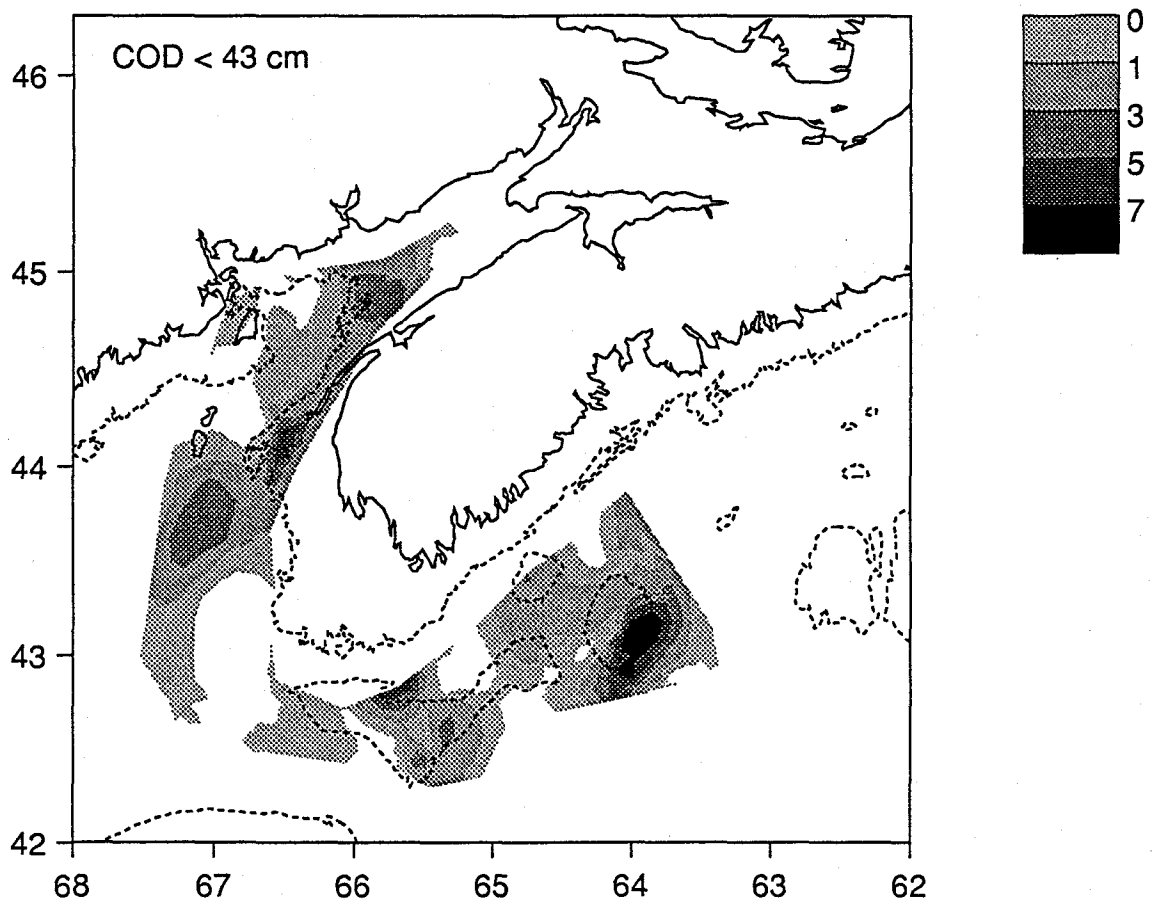


FIG.7. Distribution of large (>43 cm) 4X cod (numbers/standard tow) in the 1990 summer RV survey.

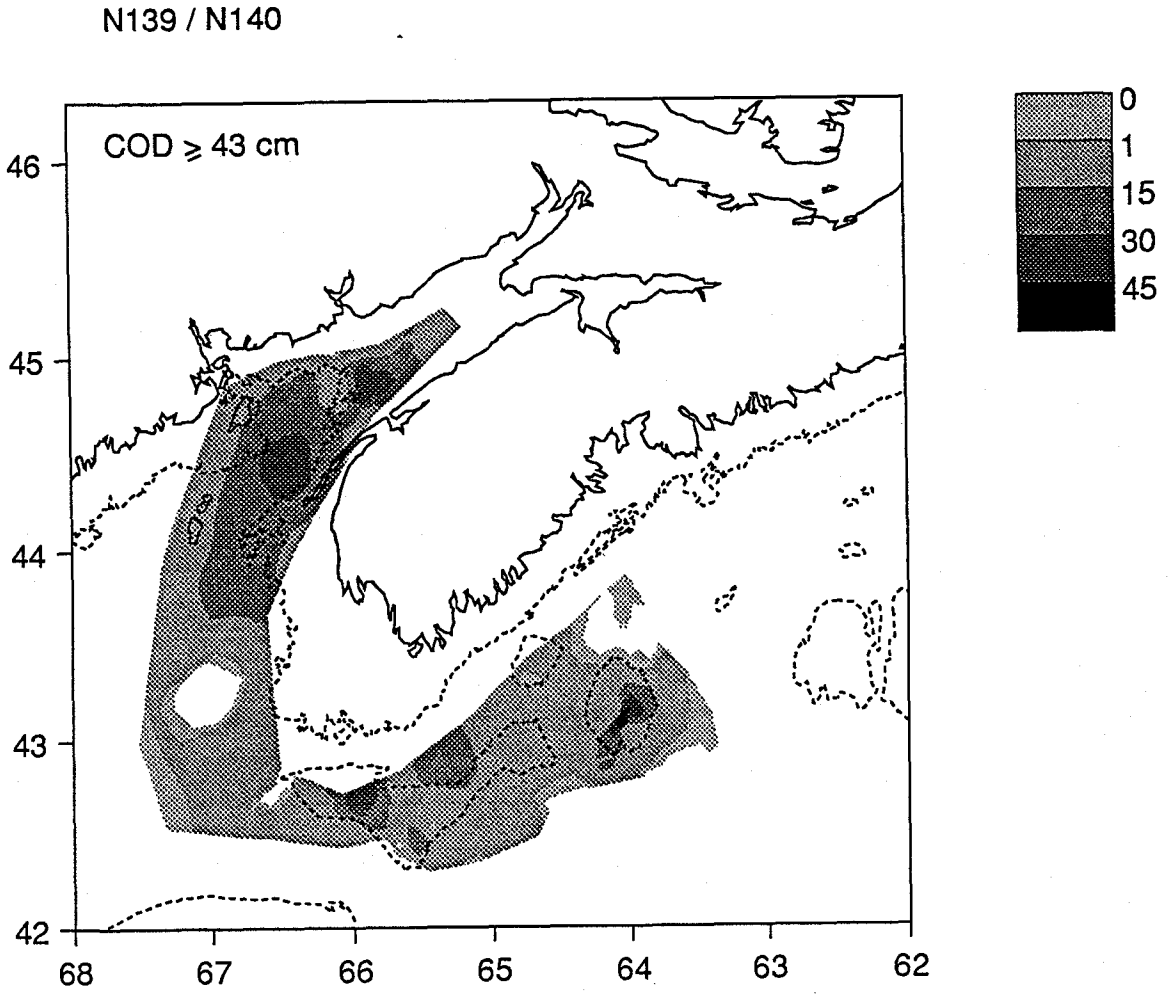


FIG. 8 RV 5+ NUMBERS PER TOW.

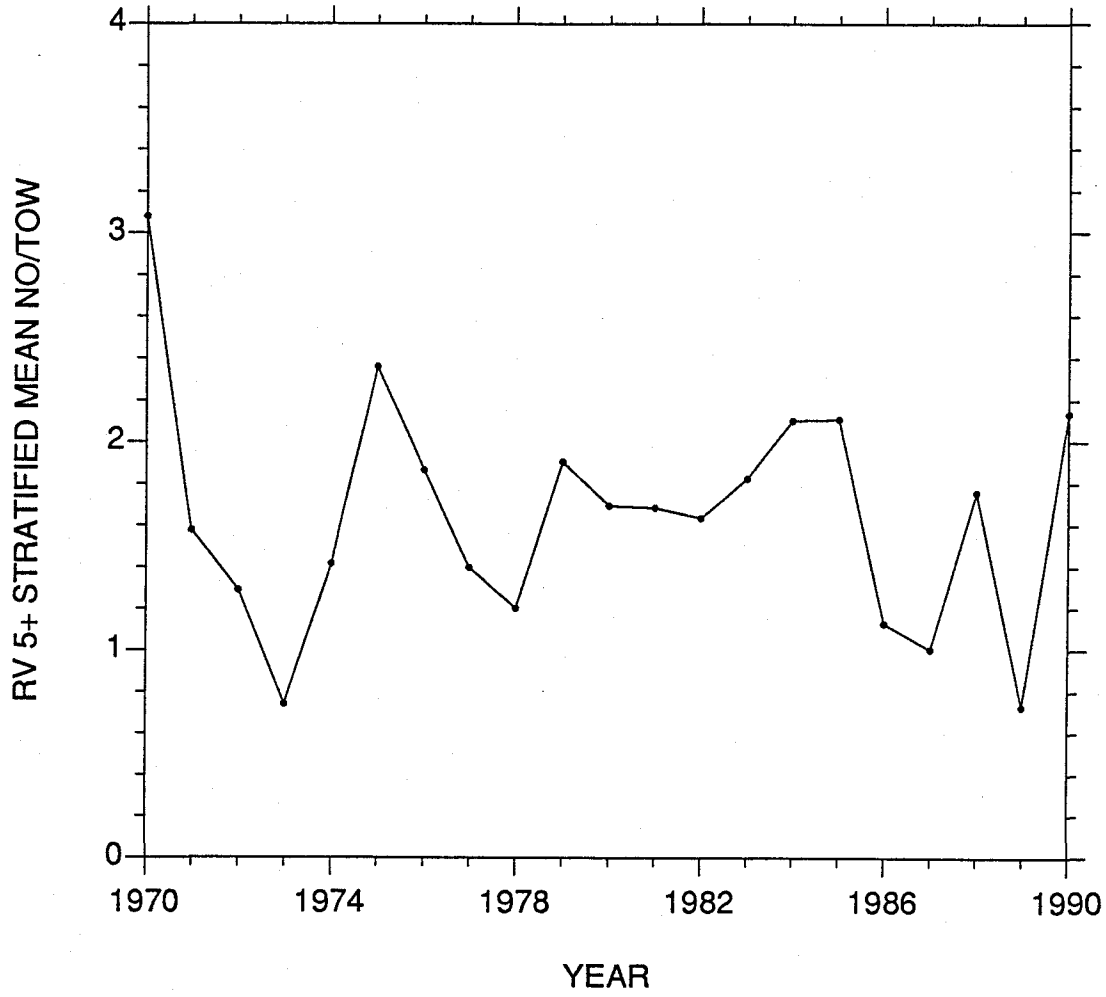


FIG. 9 RV WEIGHT PER TOW.

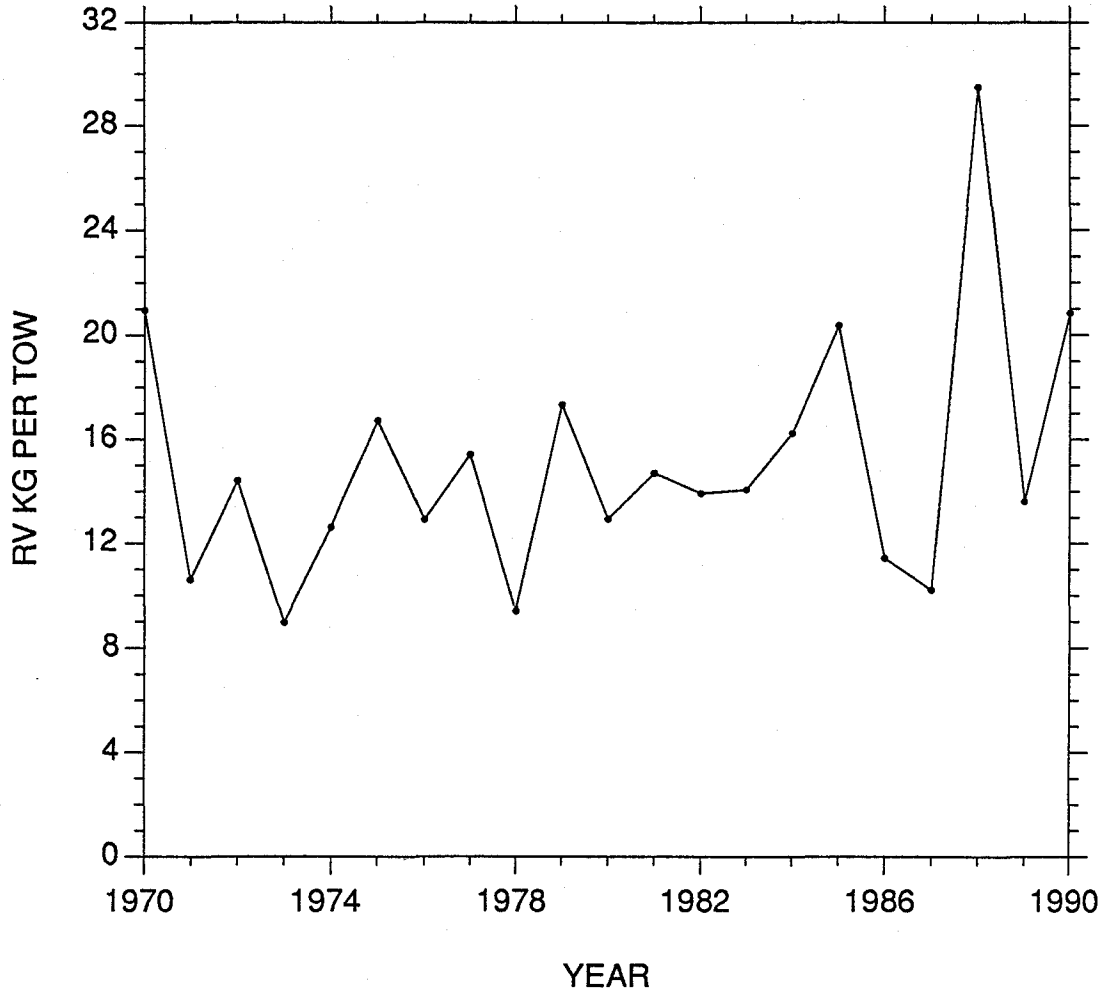


FIG.10 RV NUMBERS PER TOW AT AGES 2-4.

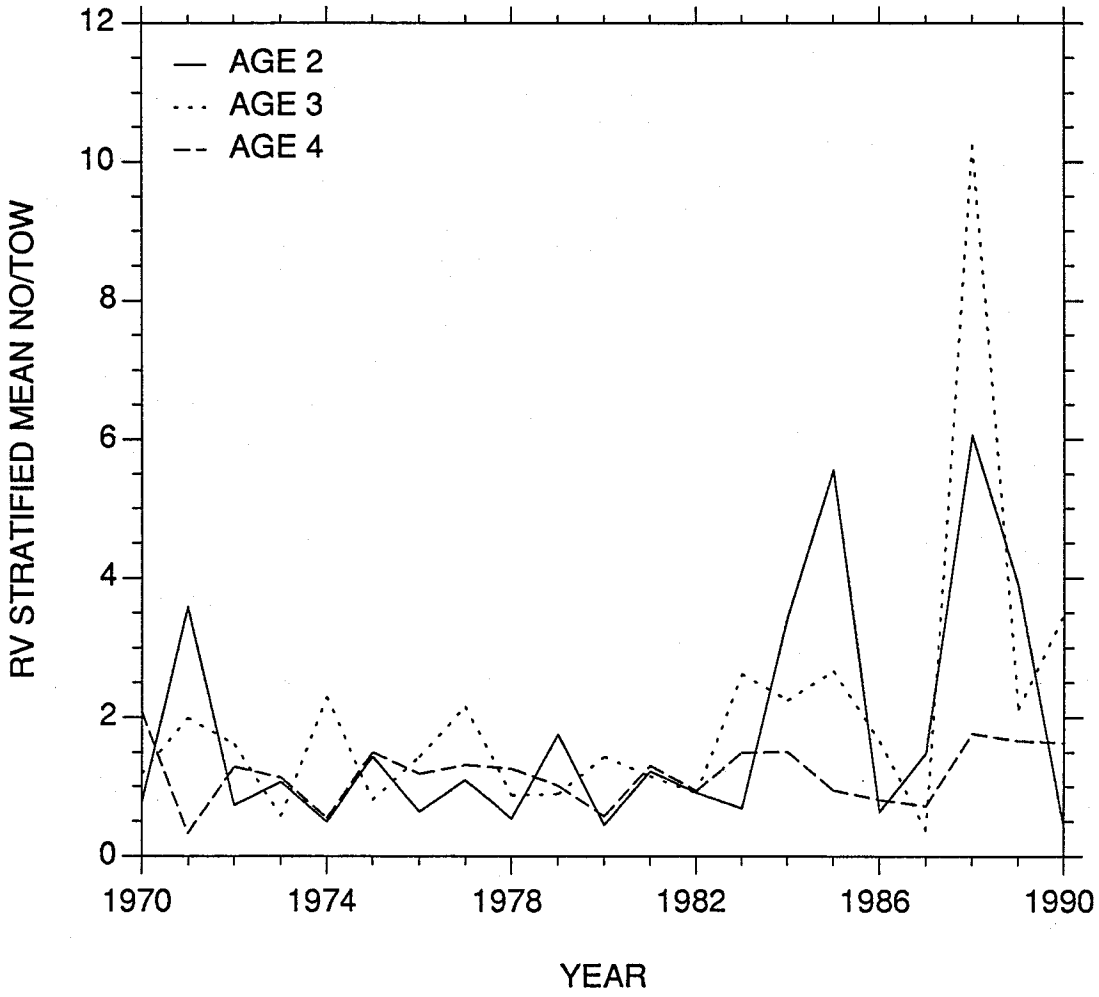


FIG. 11 OBSERVED AGE COMPOSITION IN 1990 CATCH VERSUS THAT PREDICTED IN 1989.

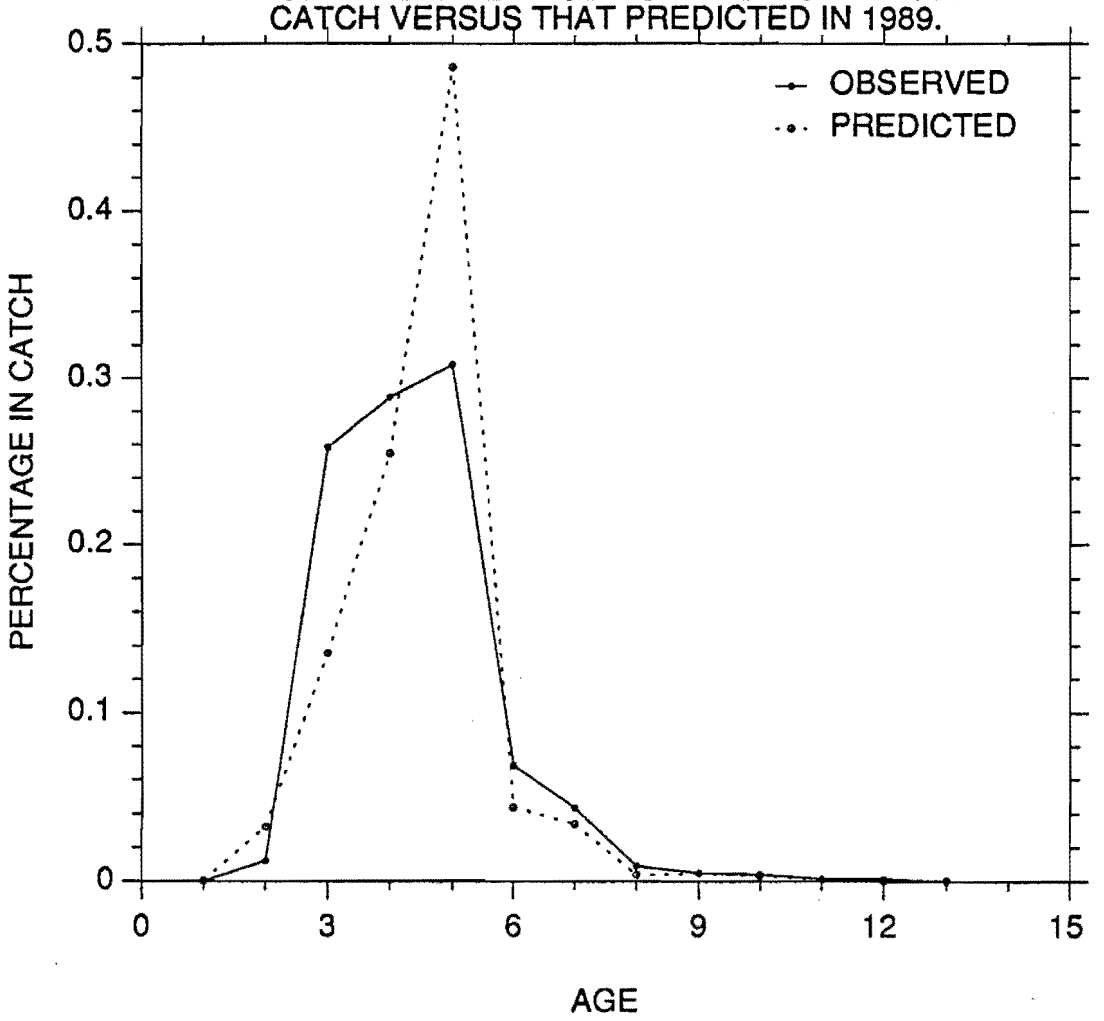


FIG.12WEIGHT AT AGE IN CATCH.

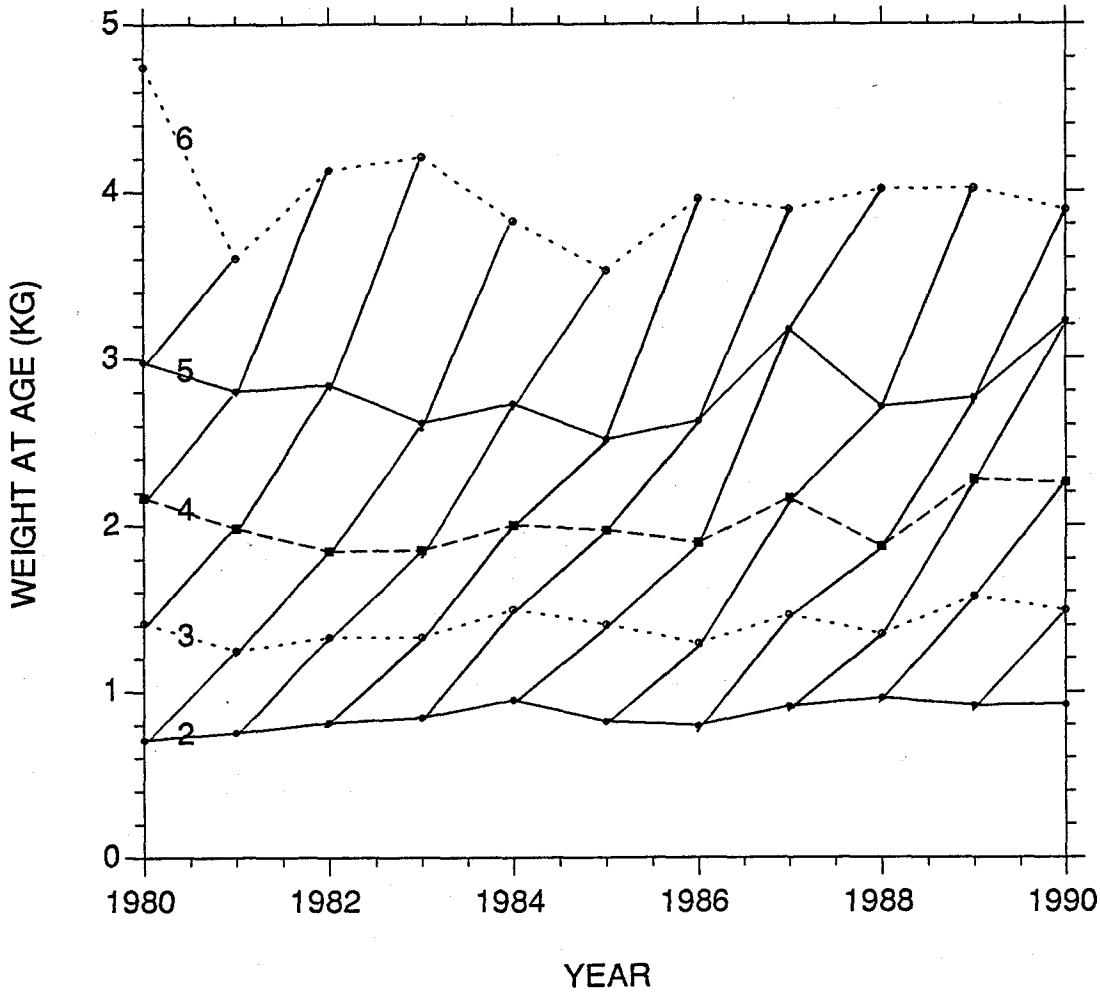


FIG. 13 SCALED POPULATION NUMBERS FROM ADAPT VS OBSERVED RV NUMBERS, AGES 3-7

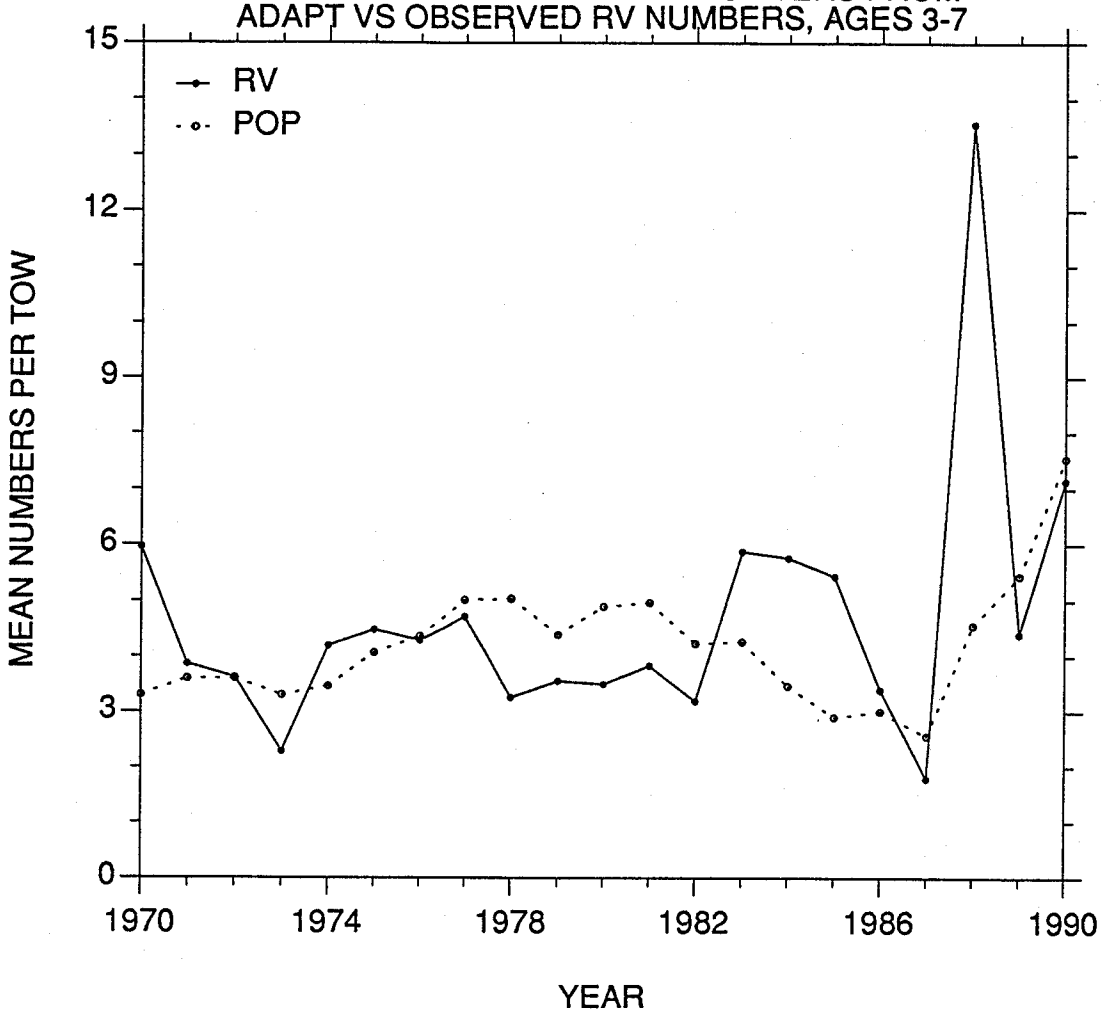


FIG14 FULLY RECRUITED (6+) FISHING MORTALITY.

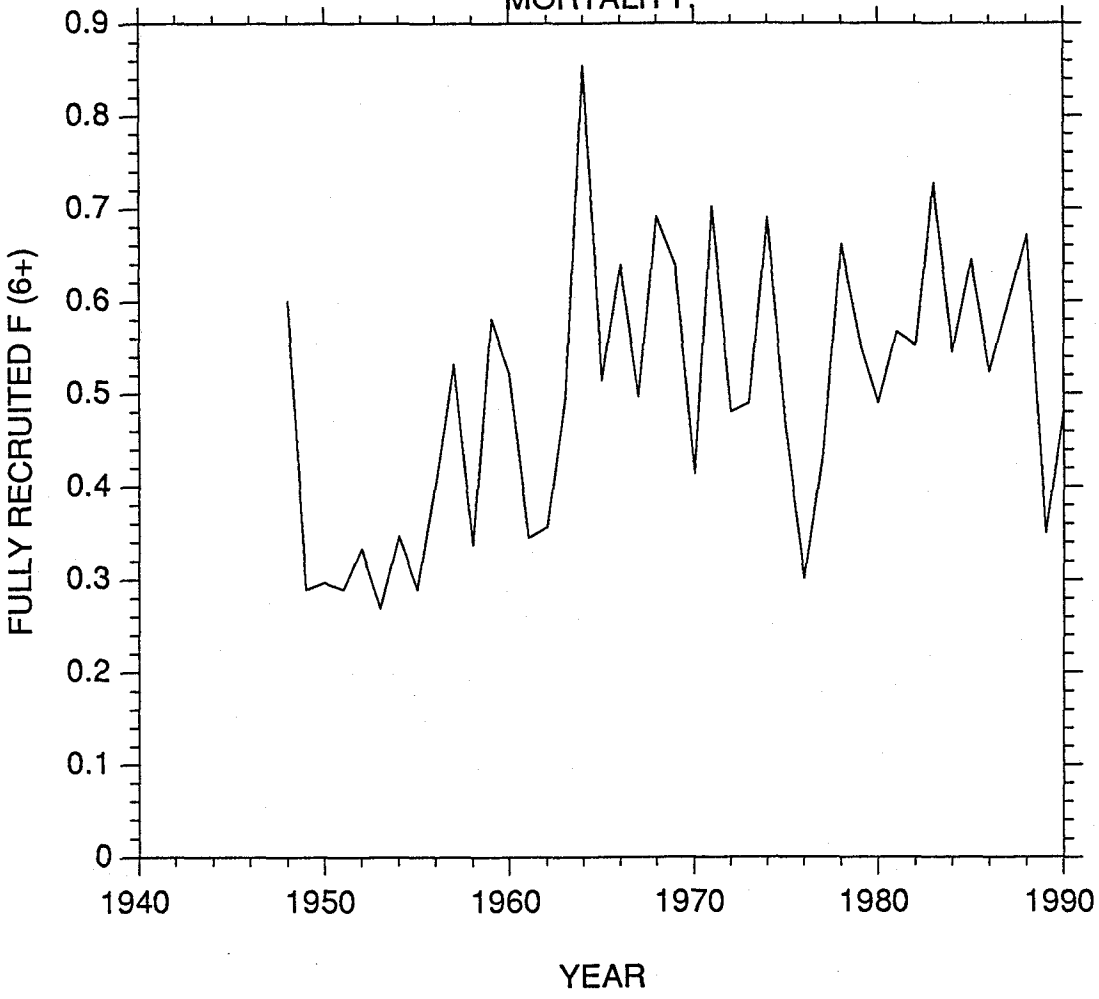


FIG.15 RETROSPECTIVE FISHING MORTALITY.

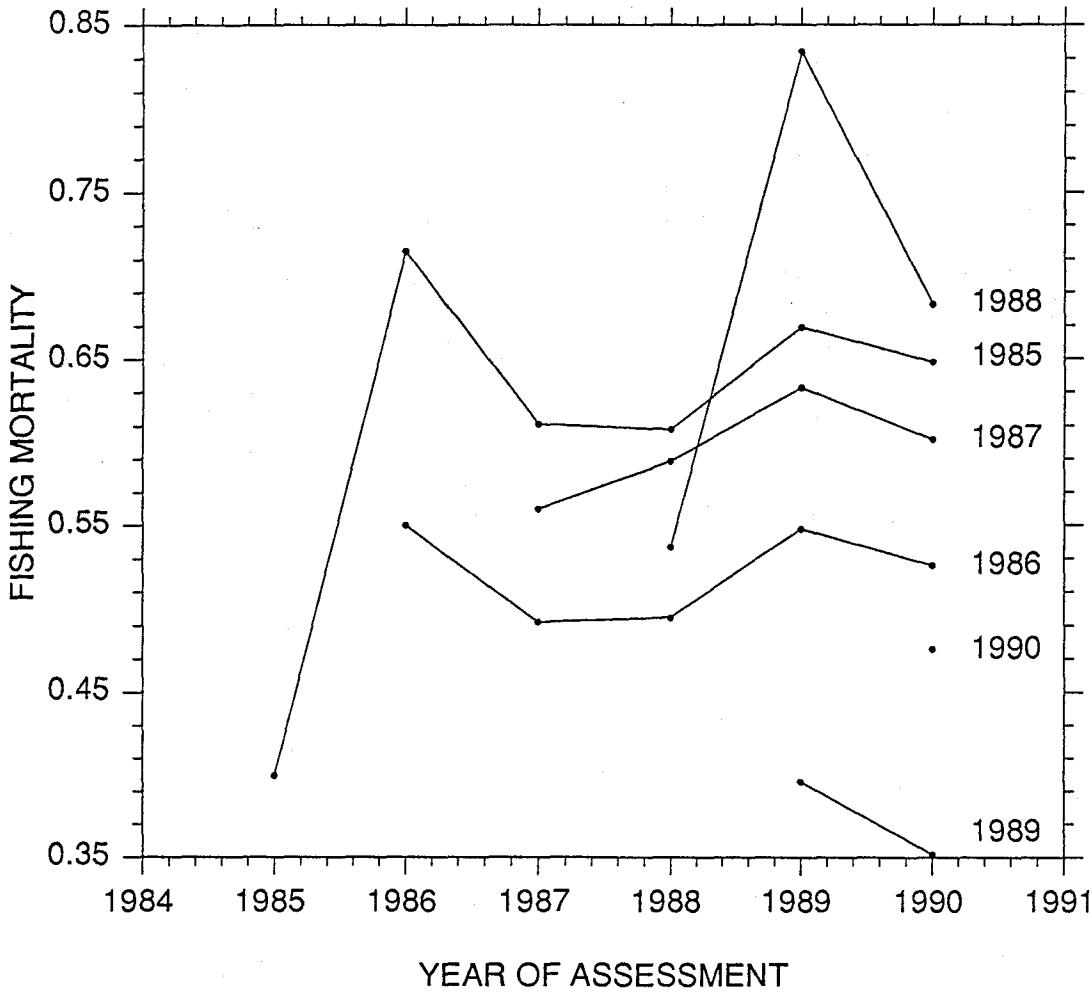


FIG.16MEAN WEIGHT (KG) IN CATCH.

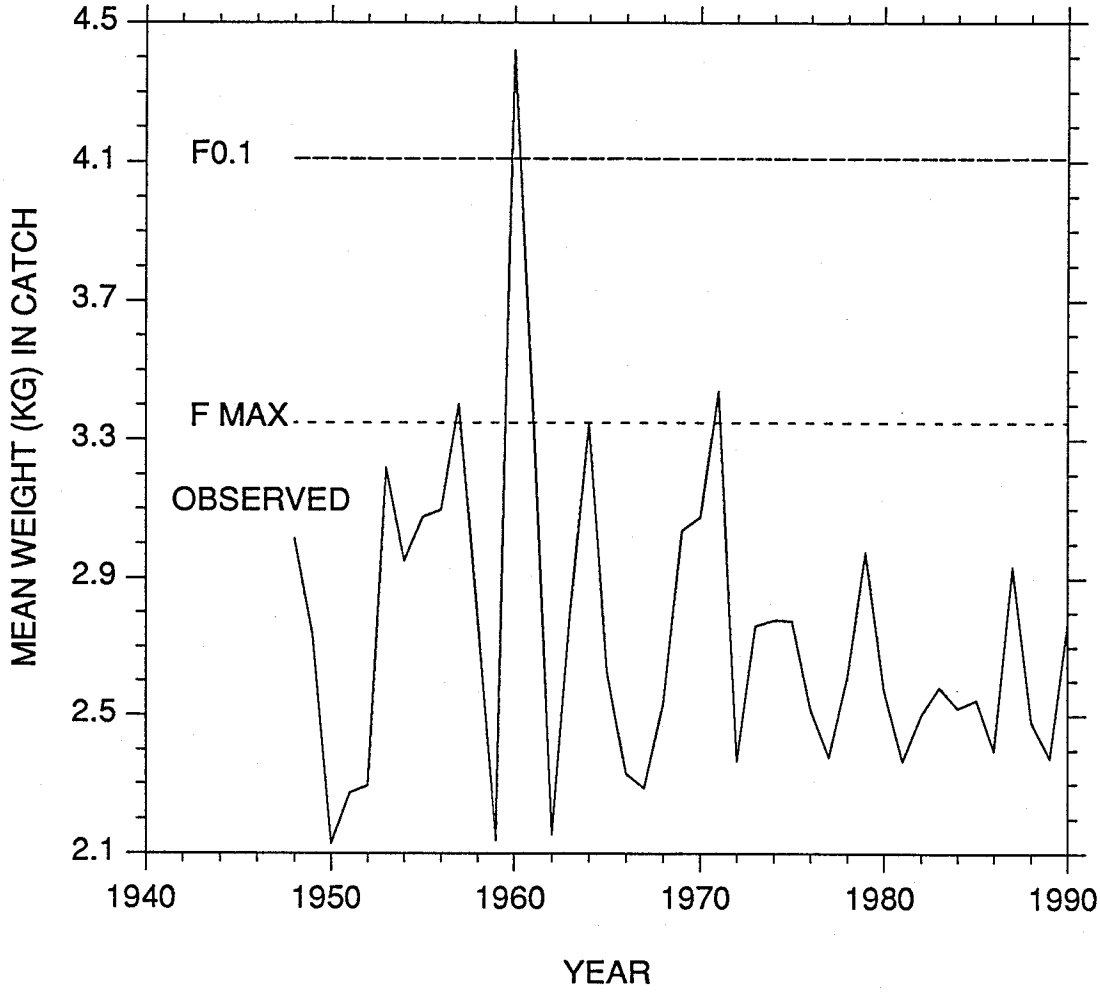
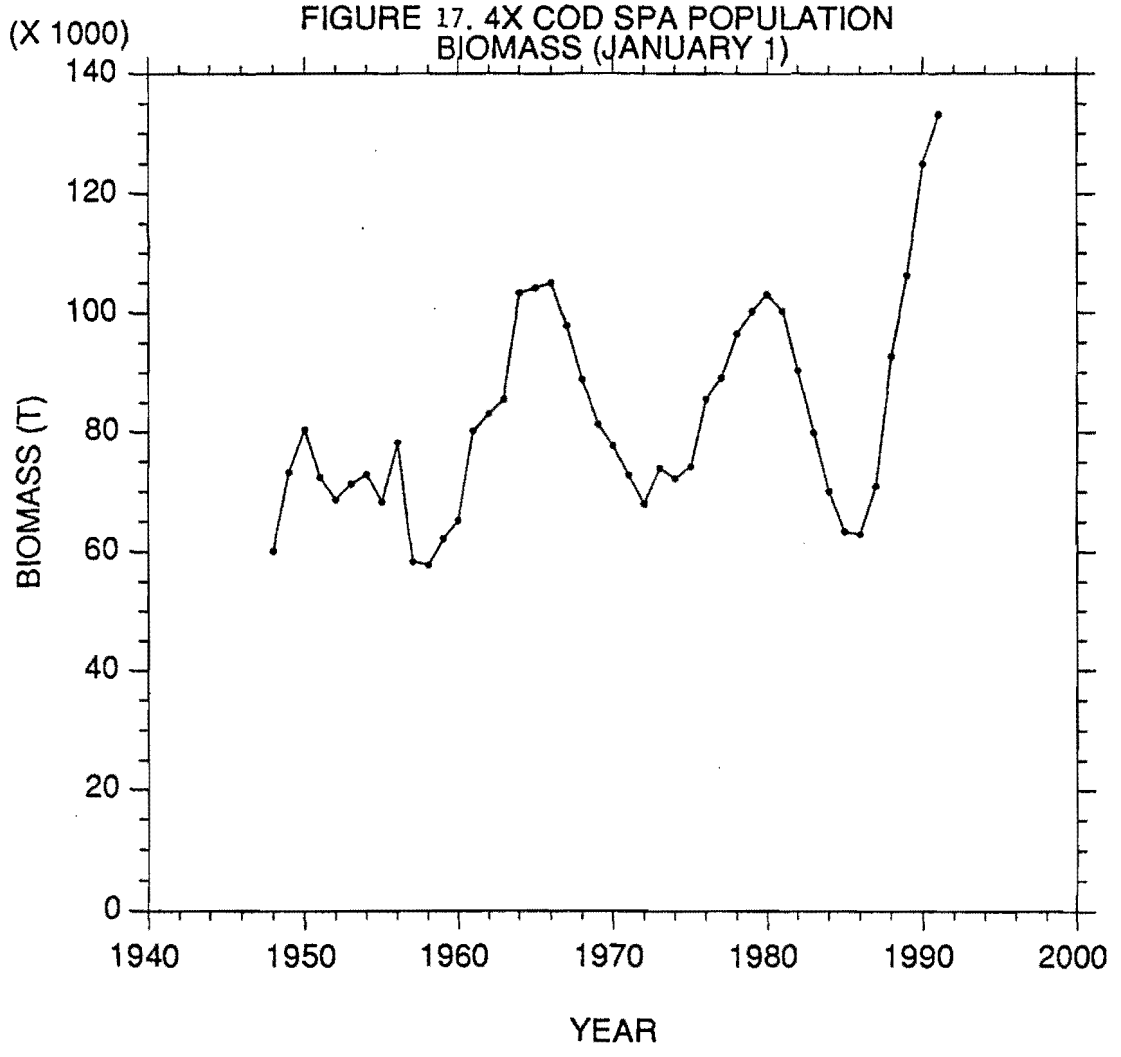


FIGURE 17. 4X COD SPA POPULATION BIOMASS (JANUARY 1)



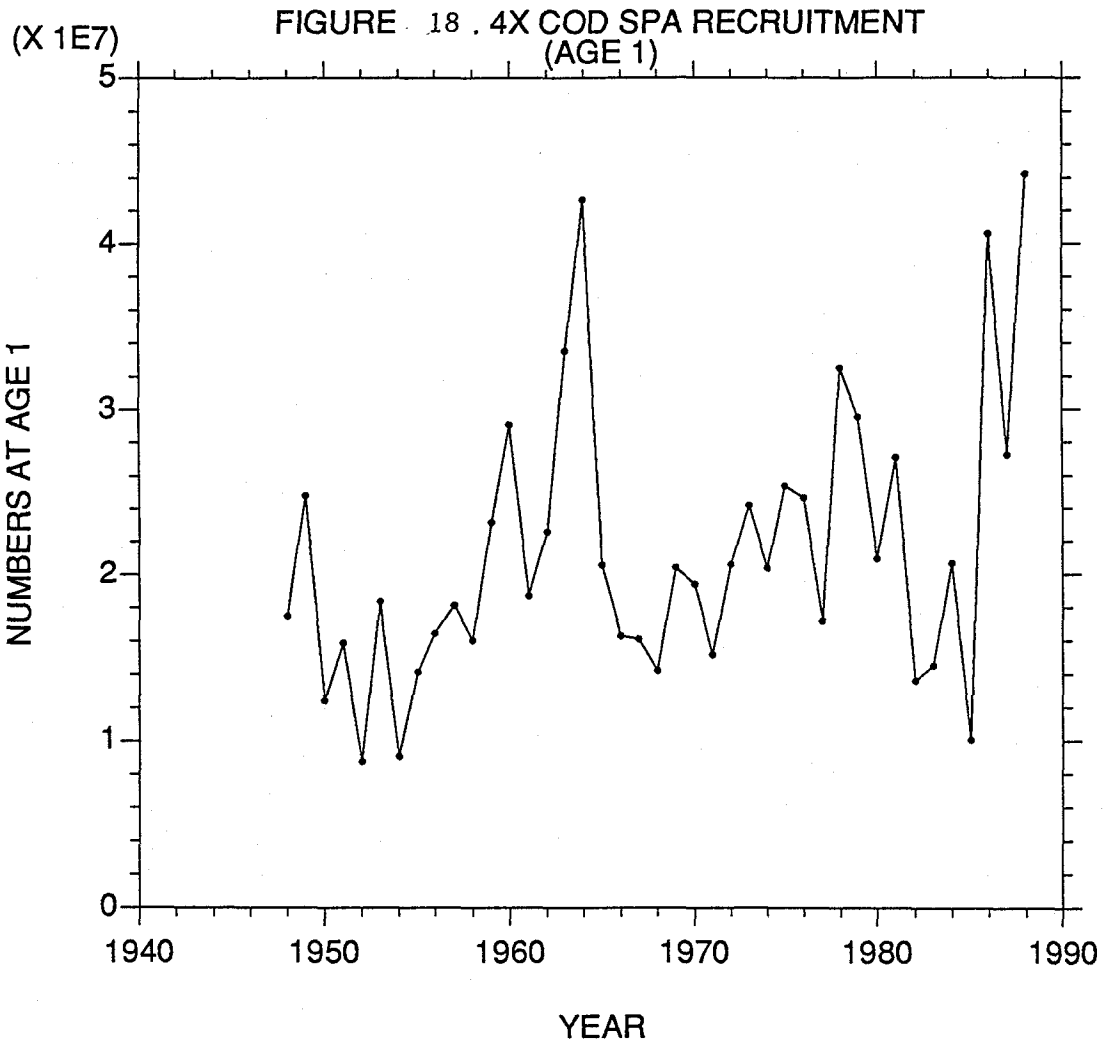


FIGURE 18 . 4X COD SPA RECRUITMENT
(AGE 1)
(X 1E7)
NUMBERS AT AGE 1
0
1
2
3
4
5
1940
1950
1960
1970
1980
1990
YEAR

FIG. 19. REGRESSION OF 1ST PC OF 4 US RV INDICES OF 5Z COD ON 4X COD SPA AGE 1