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A review of the 4Vn (May-December) cod fishery in 1983

by

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Abstract

Nominal landings of cod in 4Vn (May-December) were 9343 t in 1983, a decrease of 2911 t from 1982. With respect to gear category the largest decrease (2186 t) occurred in the longliner component of the fishery.

This report summarizes the available information from commercial and research sources for this fishery in 1983. Previous optimistic views of this fishery have been based on observations from the fishery in 1981. Current evidence indicates that 1981 was unusual relative to adjacent years.

As before uncertainty regarding stock composition and problems with the reliability of catch rate information complicated analysis of this stock.

Resumé

Les débarquements nominaux de morue dans la division 4Vn (mai-décembre) ont été de 9 343 t en 1983, ce qui représente une diminution de 2 911 t par rapport à 1982. Si l'on considère les résultats par catégorie d'engins, c'est la pêche à la palangre qui enregistre la baisse la plus élevée (2 186 t).

Le présent rapport résume les données commerciales et de recherche dont on disposait sur cette pêche en 1983. Les visions optimistes antérieures que cette pêche avait fait naître étaient essentiellement fondées sur des observations effectuées en 1981. Il apparaît maintenant que les résultats de 1981 étaient inhabituels par rapport à ceux des années précédentes et suivantes.

Comme par le passé, l'analyse du stock s'est trouvée compliquée par l'incertitude qui existe au sujet de la composition du stock et par certains problèmes relatifs à la fiabilité des renseignements sur les taux de capture.

Introduction

The 4Vn (M-D) cod fishery is managed as a unit separate from the 4Vn (J-A) fishery because of large-scale migrations of southern Gulf cod (Division 4T) and, to a lesser extent, Banquereau cod (Subdivision 4Vs) into 4Vn in late December followed by their emmigration in April-May (Halliday 1974, Templeman 1962). While this distinction of management units was made to control exploitation of different cod stocks it is accepted that small but unknown quantities of 4Vn resident fish are caught in the January-April fishery and that fish from adjacent stocks are caught in 4Vn between May and December (CAFSAC 1982a).

The first TAC for the 4Vn(M-D) fishery was set at 10,000 t by ICNAF in 1974 and remained unchanged until 1976. In 1975 the nominal catch was 3998 t the lowest since 1962 (Table 1 and Halliday 1974). Based on evidence that adjacent cod stocks were at very low levels and in order to reduce fishing mortalities ICNAF recommended that the TAC be lowered to 3500 t in 1977 (ICNAF 1976).

Under Canadian jurisdiction since 1978 the 4Vn(M-D) cod TAC was split between mobile and fixed gears. From 1978 to 1980 the mobile gear catch was regulated by quota while the fixed gear portion was an allowance and was not restrictive. In 1978 the mobile gear quota (2500 t) exceeded the fixed gear allowance (1000 t), but this changed in 1979 (1100 t and 2300 t respectively). Since then fixed gear allocations have always exceeded those of mobile gear.

In 1980 the nominal catch was 10,059 t. In this year the fixed gear allowance was 3600 t and the catch was 8549 t. Following the 1980 fishery CAFSAC (1981) recommended that since the adjacent cod stocks were thought to be contributing to the increased 4Vn(M-D) catch and since their catches were approaching their respective long-term averages, the 4Vn(M-D) TAC for 1981 and 1982 could be set at its long-term average of 10,000 t.

In 1981 fixed gear catch was regulated by quota for the first time. The CAFSAC recommendation was accepted but the new 1981 TAC was not implemented until mid-September after the initial 7500 t TAC had been reached. By mid-October the 10,000 t TAC was caught after which the fixed gear fishery was restricted by trip limits. The final catch was reported as 12,581 t (9838 t by longliners).

In April of 1982 fishermen occupied the Sydney, Nova Scotia DFO office to protest the 1981 fishery closure. In response the Regional Director General granted an 1800 t increase in the fixed gear < 65' quota and the possibility of further increases was referred to the 1982 CAFSAC Groundfish Subcommittee meeting in May. Subsequently CAFSAC (1982b) advised that the 1983 TAC could be set at 15,000 t. The Atlantic Groundfish Advisory Committee then adopted a TAC of 14,000 t for 1982-1984. At the end of 1982 the nominal catch was 12,254 t but the longliner catch was only 7287 t, 2551 t less than in 1981. In the fall of 1982 when it was apparent that

the fixed gear < 65' quota would not be reached 1400 t was reallocated to the mobile gear fleet. As a result landings by mobile gears increased by 1440 t in 1982 from 1981.

CAFSAC (1983) advised that there should be no change in the 1983 or 1984 TAC of 14,000 t. However nominal catch in 1983 was 9343 t. This report summarizes the information available for 1983.

Nominal Catch

Nominal catch by country for the period 1970 to 1983 is presented in Table 1. Total landings were down 2911 t from 1982. Longliners experienced the major portion of the decrease with a reduction of 2186 t from the catch in 1982 (Table 2). However, the percentage of the catch landed by otter trawlers was the highest since 1978. The slight drop in the otter trawl catch in 1983 is artificial in that the final 1982 mobile gear quota was higher than in 1983. The TC1 vessels (Table 3) suffered the greatest part of the longliner decrease with 1670 t less being landed in 1983 than in 1982.

The monthly breakdown in Table 4 indicates that the longliner catches during the spring and summer were considerably less in 1983 in comparison to 1982. As in the past good crab prices diverted some of the boats from fishing cod in the summer. Squid became available for bait during September/October and it is interesting to note that catches in October to December for 1982 and 1983 were similar, 2486 t and 2377 t respectively.

In Figure 1 landings by Statistical Districts are presented for the years 1977 to 1983. Statistical Area 1 borders on 4T, Area 6 is off North Sydney and Area 7 extends along the east end of the island to the 4W border (Figure 2). The general trend exhibited here shows that the major portion of the landings occurred in Area 7. Landings from Areas 1 and 6 were concentrated in the spring and late fall possibly due to the influence of 4T cod migration into and out of 4Vn.

Research Survey Results

Interpretation of survey results in recent years has been hampered by changes in research vessels (A.T. Cameron 1970-1981, Lady Hammond 1980-1983, A. Needler 1983) and uncertainties regarding appropriate conversion factors. Koeller and Smith (1983) in a preliminary analysis of conversion factors did not reach a conclusion regarding possible differences in the fishing powers of the A.T. Cameron and Lady Hammond. They did state that for haddock the ratio of catch numbers between Lady Hammond and A.T. Cameron appeared to be close to 1.2 while that for cod was closer to 1.0. Preliminary analysis of comparative fishing results from the Lady Hammond and A. Needler again were inconclusive (Fanning, pers. comm.). Comparison of numbers per tow by NAFO Division indicated that in 4X and 4W the Lady Hammond caught more cod than the A. Needler

while in 4V catches were similar. However the Lady Hammond was unable to make a number of comparative sets in Subdivision 4Vs thus hampering a thorough comparison.

Numbers-at-age estimates from the 3 available comparative surveys are presented in Figure 3 without any adjustments for fishing power. The 1980 and 1983 comparative surveys show close agreement in numbers at age (see also Table 5). In 1981 the A.T. Cameron estimates for ages 2-4 were approximately twice those of the Lady Hammond but for ages 5+ the 2 estimates were quite similar. This comparison indicates that, in 4Vn at least, there was little difference in the fishing power of the three vessels.

Given the uncertainties regarding the comparability of the results from the 3 vessels it is difficult to interpret the data available for 1983 with respect to earlier results (1970-1979). However the Lady Hammond series spans the past 4 years and may be useful in interpreting population size changes over this time period.

The 1981 estimate is the highest of the four years available (Table 5). Estimated population numbers (and no./tow) in 1983 are higher than 1982 and are close to the 1980 estimate. However the estimated weight-per-tow in 1983 is less than in 1980. This is due to the abundance of 3 year olds (1980 year-class) which comprised 32% of the Lady Hammond catch in 1983. The 1977 year-class (6 year olds), which was strong in both 4VSW and 4T fisheries, was only the third largest age 6 estimate in the series. However the 1979, 1978, and 1975 year-classes appear to be relatively strong.

Commercial Catch Composition

The longline age composition for 1982 was recalculated using quarterly age-length keys for TC1 and TC2 longliners separately to take in account the seasonal exploitation pattern. The estimated total numbers landed increased slightly but the overall pattern with respect to age changed very little from that presented in Smith (1983). The numbers at age for 1983 were estimated in the same manner. In 1983 the 1975 and 1977 year-classes continued to predominate followed by the 1978 year-class (Table 6).

The 1983 average lengths-at-age (Table 7) and weights-at-age (Table 8) for ages 6-12 and ages 5-12 were lower than in 1982. This appears to be a trend which began in 1980 for length and 1981 for weight. Landings in 1981 for fish age 9 and older amounted to 4059 t for an estimated 611,000 fish. In 1983 the estimated number landed in this age group was 35% less but the weight landed decreased by 49%. Since average weights and lengths-at-age are obtained via a regression of log weight on log length for survey data the regression parameters obtained in 1981 and 1983 were investigated for potential differences. However the parameters were virtually identical for the two years. Thus this decrease in weight-at-age appears to be due to a change in size-at-age rather than condition factor.

Catch-Per-Unit-Effort

The CPUE estimates for longliners (Tonnage Class 2) and the total longliner catch for 1968-1983 are presented in Table 9. The 1983 estimate is the lowest since 1975 (1976 is of dubious value since it is based on one log record). As pointed out by Smith (1983) the decrease in CPUE from 1981 to 1982 was due in part to a decrease in mean weight-at-age. However, since weights at age in 1982 and 1983 were similar the decrease in CPUE in 1983 is more attributable to a decrease in numbers caught. The proportion of the catch that this estimate represents continues to be small. Of the total longliner catch 10.5% had accompanying effort data from fishing logs. All log records came from TC2 longliners and of this catch only 37% had log records.

Tagging Results

A preliminary report on the distribution of tag returns from various tagging operations in Subarea 4 between 1978-1981 was presented to CAFSAC (1982a). At that time the Groundfish Subcommittee was asked to review the definition of the cod management units 4Tv, 4Vn(M-D), and 4Vsw. Even though only a relatively short time had elapsed between the tagging dates and the report date the trends in tag returns to the end of 1981 supported the present definition of cod management units in the area. An interesting new observation was that cod which support the 4Vn(M-D) fishery were heavily intermixed with 4T tagged fish in the 4Vn(J-A) fishery. Tag return information to the end of 1983 is summarized in this paper.

A list of the tagging experiments used is given in Table 10. Although additional experiments were carried out only those which had numbers tagged in excess of 1000 were used. Three taggings were in Division 4T, 3 in 4Vsw, and 2 in 4Vn (Figure 4). A total of 32,911 fish were tagged between October 1978 and May 1981. In 7 of the experiments fish were caught with otter trawls while in the other a longliner was used. To the end of 1983 a total of 5345 tags had been returned or 16% of the numbers tagged. To limit the effect of immediate recaptures only those returns 2 weeks after the completion of each tagging experiment were considered. Furthermore only those returns with locations that could be unambiguously assigned to specific cod management units were used.

For each tagging experiment all returns received to 1983 were combined by management unit of capture and the percent distributions of returns among the units were calculated (Table 11). The results were used to assess the specificity of returns to the units where tagging occurred.

Returns from fish tagged in 4Vsw were highly specific to that area. Between 91-94% of the returns were from 4Vsw. There was comparatively little leakage to other areas and when this did occur it was to the 2 adjacent NAFO Areas 4X and 4Vn.

Fish tagged in 4T showed a strong and consistent movement to the 4Vn January to April fishery. In all 3 experiments conducted in 4T the highest

percent of returns was in 4T but between 19-36% of the returns came from 4Vn(J-A). Combining returns from 4T and 4Vn(J-A) between 66-84% of the fish tagged in 4T were returned from the 4Vn(J-A) management unit. There was substantial leakage of these fish into other areas. Between 7-11% were recovered in 4Vn(M-D), 6-17% from 4Vsw, and 2-7% from 4RS3Pn.

Returns from fish tagged in 4Vn(M-D) were the least specific to the area tagged. Between 37-60% of the returns came from 4Vn(M-D). It is interesting to note that the tagging done closer to shore (LG001) had a higher percent return in 4Vn(M-D) (60%), and lower percent return in other areas (15% in 4Vsw, 12% 4Vn(J-A), and 8% 4T) while the tagging (AJ002) which was done offshore had lower returns in 4Vn(M-D) (37%) and higher returns from other areas (23% 4Vsw, 17% 4Vn(J-A), and 19% 4T). Of the returns in 4Vsw, the majority came from the unit areas closest to 4Vn (4Wd, 4Vsb). Approximately 10% of the total 4Vsw catch comes from these 2 unit areas (Gagné et al. 1983).

Tag returns in 4Vn from tagging in 4Vn, 4Vsw, and 4T were examined in an attempt to estimate the relative composition of cod catches in 4Vn. To minimize the effect of differential mortality due to time lag between tagging experiments only those taggings in 1980 and 1981 were used. Specifically only taggings H052 in 4Vs, AJ003 and JH002 in 4T, and LG001 and AJ002 in 4Vn were used. All fish were tagged between September 1980 and April 1981. Returns from tagging in the same management units were combined by month and year. The numbers of returns were corrected for the numbers tagged. The results for 1981-83 are given in Figure 5. Monthly total catch trends were added for comparison.

The returns from 4Vs tagged fish were sparse and spread throughout the year. There did not appear to be any trend in these returns indicating that the fish were probably random strays.

The returns from 4T tagged fish were highest in January-March of each year. This corresponded with the period of highest catch. For the period April-September returns were at a lower but consistent level. In October or November returns usually increased again. This corresponded with an increase in landings in Statistical Districts 1 and 6, the areas closest to 4T (Figure 1). Local fishermen in the area have suggested that high catches late in the year are due to immigrations of fish from 4T. These results tend to support this suggestion.

Returns from fish tagged in 4Vn peaked in the July-September period when returns from 4T tagged fish were lowest. This peak of returns did not correspond with an increase in overall 4Vn catch but it does correspond with a peak in landings in Statistical District 7 (Figure 1). Also the peak in recoveries occurred in a time period comparable to the time of tagging, most of which was done in areas adjacent to District 7.

Of special interest here is the large number of returns of 4Vn tagged fish in the January-April period, a time when all of the catch is assumed,

for assessment purposes, to be from the 4TVn stock. Although the level of returns is lower than that of 4T tagged fish, the numbers are still significant. Unfortunately it was not possible to estimate relative proportions of the catches with the available data.

Mortality Estimates

Mortality estimates were obtained using survey population-at-age estimates from Lady Hammond 1980-83 (Table 5), and longline CPUE-at-age (numbers) over the same time period (Table 12). Catch curves were constructed from these data by summing population-at-age and CPUE-at-age estimates over the 4 years and plotting natural logs of the sums (Figure 6). The sum of survey population numbers increased to age 6, then declined steadily to age 12. An estimate of Z over ages 6-12 was obtained by regression, and was found to be .85. CPUE-at-age increased to age 7 followed by a steady decline to age 14. Regression over ages 7-15 gave a Z estimate of .70.

The use of catch curves in estimating mortality rates is discussed by Ricker (1975). Estimates may be biased upwards by relatively higher recruitment in recent years. To reduce this bias estimates from a series of years were combined. However Z estimates from catch curves represent average conditions through the years of recruitment to the sampled population. They do not represent the current situation. In this case the Z values appeared to be consistent across the year-classes used but they probably represent conditions in the mid to late 70s rather than current years.

A more accurate estimate of Z in recent years may be obtained by using the ratio of the number-at-ages $n+$ in one year to the number-at-ages $(n+1)+$ in the following year. These calculations were done for age groups 4+/5+ - 10+/11+ for both survey data and CPUE-at-age data. Separate values were obtained for 1980-81, 1981-82, and 1982-83. These 3 values were averaged for each age group and the results are given in Table 13. Mean estimates from the surveys plateaued at 7+/8+, and peaked at 8+/9+ for CPUE data. This approximates the age of full recruitment to the commercial gear. For the survey data fully recruited Z values were around 1.0, while for CPUE data it was around .7. If natural mortality is assumed to be .2, these data indicate Fs of .8 and .5 respectively.

General Production Model

CAFSAC advice given after the 1981 fishery was based on a preliminary general production model analysis. This used survey numbers-at-age multiplied by commercial mean weight-at-age as a biomass index. This does not seem appropriate since commercial weights-at-age are likely to exceed population weights-at-age for the younger ages. To overcome this source of bias the analysis was run again using mean weight per tow as a biomass

index. Only data from A.T. Cameron surveys from 1970-1981 were used because of the uncertainty about comparability of the results obtained from the different research vessels.

The results of the analysis are given in Table 14. Equilibrium yield at 2/3 EMSY was estimated to be 10,198 t. The r^2 of the regression, as is the case with most analyses of this type, was low (0.46). The results are useful as a general guideline for setting TACs but other data regarding recruitment and stock size should also be considered.

Discussion

The results of tagging experiments conducted in 4Vn and in adjacent NAFO areas suggest that an unknown but significant portion of the catch in the 4Vn(J-A) fishery may be of the 4Vn resident stock. Over the past 3 years the winter fishery has yielded an average of 14,479 t. The data also suggest that there may be considerable leakage of the 4Vn(M-D) stock into adjacent management areas, most notably 4Vsw.

Mortality estimates obtained from research survey results and CPUE-at-age indicate mortalities well above levels considered optimal for cod. Catch curve estimates, which represent mortalities during recruitment to the sampling gear (Ricker 1975) gave Z s of .70 and .85 respectively. These mortalities represent conditions in the mid to late 1970s experienced by the younger ages, probably 4-6. The 4Vn winter fishery is noted for yielding fish of the younger age classes (Sinclair 1980). It is possible that the high Z values may be due, in part, to exploitation of the resident stock in the winter fishery.

Mortality estimates from numbers in adjacent years from research survey results indicated a 5+/6+ Z of .53 averaged over the last 4 years. Commercial CPUE-at-age indicate a fully recruited 7+/8+ Z of .62 over the last 4 years. Thus these 2 data sources give recent F estimates of .33 and .42. This is above the generally accepted $F_{0.1}$ level for cod of .2.

Total catch in 4Vn(M-D) decreased substantially in 1983, the bulk of which was experienced by the longline fleet. If there had not been a reallocation of quota from the fixed gear sector to the mobile sector in 1982 there probably would have been a decrease in total catch in the past 2 years. Longline CPUE has also decreased for the past 2 years. This occurred when a relatively strong year-class, the 1975, was passing through the fishery, and when another large year-class, the 1977, was recruiting to the fishery. These 2 year-classes have contributed greatly to increases in cod catch from the 4TVn(J-A) and 4Vsw management units in recent years.

Longliners generally catch older fish than otter trawlers. The recent decline in catch of the former may be related to a decline in abundance of these older fish while the increase in catch by otter trawlers may be related to an increase in abundance of younger fish. The 1983 summer

research vessel survey indicated higher than average numbers of both the 1980 and 1979 year-classes. These year-classes will not be fully recruited to the longline fishery for 3-4 years and would not be expected to affect longliner catches in the area for at least 2 years. However these year-classes are now of an age which is available to the trawler fishery. If good recruitment to the longliner fishery is to be ensured steps should be taken to limit the exploitation of these young fish.

Both the commercial CPUE and research survey results from 1981 gave an optimistic view of the 4Vn(M-D) stock. However in retrospect 1981 stands out as an unusual year. Catch rates did not remain at that high level and survey population estimates have decreased since then. CAFSAC advised that a catch in excess of the long term equilibrium level could be taken because of indications of good recruitment (Advisory Document 82/13). Currently the 1977 year-class does not appear as strong as was expected and thus the conclusion made in 1982 that the stock was above equilibrium levels no longer appears valid. The revised general production analysis suggests a yield at $2/3 E_{MSY}$ of 10,200 t. Since the stock does not appear to be above equilibrium a TAC of 10,000 t may be appropriate.

Additional information regarding the age composition of the commercial catch and the stock composition of 4Vn cod catches is required before an analytical assessment of the stock is possible. At present the longline catch age composition is available from 1967-1983. Similar estimates for otter trawl catch are not presently available although steps are being taken to address this problem. Estimates of the contributions of the 4Vn (M-D) stock to the catches of the 4Vn (M-D), 4TVn (J-A), and 4Vsw fisheries are not available at present. The results of tagging experiments indicate the possibility that significant quantities of the stock are caught in the winter 4Vn fishery. This uncertainty regarding the stock composition in the area will continue to plague the assessment until an adequate method of stock delimitation in the area is developed. This is a more complex problem and no steps are currently being taken to address it.

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Table 1. Nominal cod catch (t) by countries in Subdivision 4Vn (May - December).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Canada	8707	8469	6729	5245	4836	3363	5746	7786	5496	6301	9957	12480	12102	9238
Spain	1141	2161	1171	241	852	89	-	-	-	-	-	-	-	-
Portugal	-	-	459	189	84	360	-	-	-	-	-	-	-	-
France	34	1	745	-	-	-	211	135	53	73	102	101	152	105
Norway	-	-	-	-	142	186	-	-	-	-	-	-	-	-
U.K.	-	-	-	-	61	-	-	-	-	-	-	-	-	-
F.R.G.	-	-	-	73	14	-	-	-	-	-	-	-	-	-
U.S.A.	5	-	-	-	-	-	-	-	-	-	-	-	-	-
Poland	7	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	9894	10631	9104	5748	5989	3998	5957	7921	5549	6374	10059	12581	12254	9343
% Canadian	88	80	74	91	81	84	95	98	99	99	99	99	99	99
TAC	-	-	-	-	10000	10000	10000	3500	3500	3400	5000	*	**	14000

* Initially set at 7500 t, increased in September to 10,000 t.

** Initially set at 10500 t, increased November 1 to 14,000 t.

Table 2. Nominal catch (t) of cod in Subdivision 4Vn (May-December) by gear type for all countries, 1971-82.
 (Note: numbers in brackets are percentages.)

YEAR	OTTER TRAWLS	SEINES	GILLNETS	LONGLINES	HANDLINES	MISCELLANEOUS	TOTAL
1971	5304 (50)	106 (1)	41 (0)	3725 (35)	696 (7)	759 (7)	10631
1972	4418 (49)	121 (1)	248 (3)	3185 (35)	286 (3)	846 (9)	9104
1973	2099 (37)	143 (2)	649 (11)	1982 (34)	404 (8)	471 (8)	5748
1974	2842 (47)	139 (2)	751 (13)	1474 (25)	568 (9)	215 (4)	5989
1975	1851 (46)	100 (3)	604 (15)	875 (22)	360 (9)	208 (5)	3998
1976	4375 (74)	83 (1)	314 (5)	620 (11)	310 (5)	255 (4)	5957
1977	4613 (58)	554 (7)	199 (3)	1805 (23)	595 (7)	155 (2)	7921
1978	1600 (29)	327 (6)	7 (0)	3035 (55)	466 (8)	114 (2)	5549
1979	624 (10)	278 (4)	5 (0)	4483 (70)	640 (10)	344 (6)	6374
1980	950 (9)	560 (6)	7 (0)	6422 (64)	1820 (18)	300 (3)	10059
1981	1348 (11)	559 (4)	2 (0)	9838 (78)	741 (6)	93 (1)	12581
1982	2623 (21)	724 (6)	168 (1)	7287 (60)	1360 (11)	92 (1)	12254
1983	2312 (25)	864 (9)	49 (0)	5101 (55)	924 (10)	93 (1)	9343

Table 3. Nominal catch (t) by Canada of cod in Subdivision 4Vn (May-December) by vessel size and gear. Percentage of gear total catch by tonnage class is in parentheses.

Tonnage Class (t)	Otter Trawls	Seines	Gillnets	Longlines	Handlines	Other	TOTAL
<u>1982</u>							
0 - 24.9	129 (5)	491 (68)	168 (100)	5049 (69)	1360 (100)	9 (10)	7206
25 - 49.9	175 (7)	220 (30)	-	1758 (24)	-	-	2153
50 - 149.9	358 (15)	13 (2)	-	436 (6)	-	83 (90)	890
150 - 499.9	1060 (43)	-	-	44 (1)	-	-	1104
500 - 999.9	749 (30)	-	-	-	-	-	749
<u>TOTAL</u>	2471	724	168	7287	1360	92	12,102
<u>1983</u>							
0 - 24.9	126 (6)	370 (43)	31 (63)	3379 (67)	920 (100)	21 (23)	4847
25 - 49.9	284 (13)	475 (55)	18 (37)	1460 (29)	4 (0)	-	2241
50 - 149.9	1068 (47)	19 (2)	-	260 (4)	-	72 (77)	1419
150 - 499.9	126 (6)	-	-	2 (0)	-	-	128
500 - 999.9	603 (28)	-	-	-	-	-	603
<u>TOTAL</u>	2207	864	49	5101	924	93	9238

Table 4a. Nominal catch (t) for Canadian cod fishery in Subdivision 4Vn (May-December) by month and gear 1982.

GEAR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTALS
Gillnets	28	64	46	-	-	-	11	19	168
Handlines	1	21	164	513	363	254	37	7	1360
Longlines	1114	1097	782	791	1017	786	790	910	7287
Traps	-	2	3	-	-	-	-	-	5
Miscellaneous	-	-	1	3	-	-	-	-	4
Side OT	41	86	152	3	9	1	-	195	487
Stern OT	105	149	86	22	48	155	231	1188	1984
Danish Seine	337	199	60	6	13	18	48	39	720
Scottish Seine	3	1	-	-	-	-	-	-	4
Shrimp Trawl	20	44	8	5	-	-	-	-	77
Scallop Drag	6	-	-	-	-	-	-	-	6
TOTAL	1655	1663	1302	1343	1450	1214	1117	2358	12102
France	-	152	-	-	-	-	-	-	152
<u>TOTAL</u>	1655	1815	1302	1343	1450	1214	1117	2358	12254

Table 4b. 1983 Nominal catch (t) for cod fishery in Subdivision 4Vn (May-December) by month and gear.

GEAR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTALS
Gillnets	2	24	3	3	17	-	-	-	49
Handlines	3	45	187	317	194	162	13	3	924
Longlines	703	675	353	338	655	693	646	1038	5101
Traps (fixed)	-	9	2	-	-	-	-	-	11
Misc.	-	1	-	-	-	-	-	-	1
OTB1	36	4	13	1	5	2	1	-	62
OTB2	226	260	65	79	278	337	197	703	2145
Danish Seine	349	274	48	10	42	38	2	86	849
Scottish Seine	8	1	-	-	-	-	6	-	15
Shrimp Trawl	17	12	18	14	9	2	-	-	72
Scallop Dragger	-	4	5	-	-	-	-	-	9
TOTAL	1344	1309	694	762	1200	1234	865	1830	9238
France (OTB)	105								
<u>TOTAL</u>	1449	1309	694	762	1200	1234	865	1830	9343

Table 5. Research vessel abundance indices (age composition expressed as no.s x 10⁻³) from Lady Hammond¹ (1980-1983) and A. Needler¹ (A.N.) (1983) in Division 4Vn (May-Dec) cod strata 40-42.

Needler Data Unadjusted					
AGE	1980 ²	1981 ²	1982	1983 ³	1983 (A.N.)
1	-	-	-	-	-
2	238	784	721	1073	1245
3	2987	1426	495	5928	6298
4	1393	5379	1644	2577	2250
5	6164	3174	2911	3337	3031
6	4837	7444	2169	3175	2859
7	2297	4039	2634	488	485
8	906	456	972	1193	970
9	202	518	377	396	432
10	110	387	127	39	187
11	110	27	29	63	72
12+	-	68	66	-	123
UK	71	174	27	334	77
TOTAL	19,315	23,876	12,172	18,603	18,029
<u>Mean No./Tow</u>					
Lady Hammond	67.82	83.03	42.73	65.32	63.26
A.T. Cameron	63.84	110.98	-	-	-
<u>Mean wt./tow</u>					
Lady Hammond	110.65	150.14	74.82	77.82	78.60
A.T. Cameron	85.55	161.81	-	-	-

¹ Sample unit defined by 41 ft. trawl opening

² Age-length key from A.T. Cameron comparative survey

³ Age-length key from A. Needler comparative survey

Table 6. 4Vn (May - December) inshore cod: catch-at-age by longlines (thousands of fish).

Ages	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-
3	5	5	2	3	10	-	7	15	44	-	-	35	-	-	85	32	8
4	122	96	42	62	43	676	133	179	177	-	-	277	17	8	221	227	69
5	336	393	240	322	236	39	437	181	127	5	-	265	208	105	310	662	412
6	266	382	346	314	492	604	87	184	73	10	-	197	480	532	409	477	436
7	67	102	370	181	600	444	193	54	36	25	-	120	305	747	672	805	294
8	112	122	184	208	63	209	230	66	17	27	-	76	185	386	529	507	492
9	24	68	41	56	152	2	51	82	13	17	-	49	91	219	267	209	163
10	23	10	55	40	48	21	17	26	11	15	-	54	17	127	151	78	137
11	33	12	24	82	14	50	9	-	4	10	-	20	39	32	57	50	35
12	11	10	24	21	7	2	5	4	-	10	-	18	8	8	52	22	33
13	4	10	17	17	28	1	6	1	-	-	-	13	4	8	53	8	11
14	3	2	8	11	1	-	1	1	1	-	-	3	4	-	5	3	5
15	1	1	2	1	7	1	-	1	-	-	-	8	-	-	8	2	5
16	2	-	1	-	5	1	2	1	-	10	-	4	-	-	18	15	11

'18

Table 7. 4Vn (May - December) inshore cod: average length-at-age from longline samples (cm).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	31.00	-	-	-	-	-	28.00	-	-
3	40.00	37.00	-	34.72	37.31	38.25	-	-	38.90	-	43.00	37.67	39.77	41.28
4	43.43	43.25	43.97	42.26	44.01	44.55	-	-	46.94	46.68	51.43	45.90	46.56	44.94
5	48.55	47.82	46.00	49.74	51.10	51.24	58.00	-	52.76	55.58	60.85	52.78	53.30	51.31
6	55.80	53.17	56.41	56.94	56.26	57.26	64.00	-	60.77	63.90	64.23	61.81	58.89	56.55
7	60.33	58.91	55.44	57.22	65.40	62.04	68.20	-	69.57	72.75	70.37	68.20	62.12	61.67
8	67.79	77.04	59.38	60.44	62.58	59.23	76.00	-	75.53	72.94	80.66	78.42	70.18	63.19
9	76.31	71.65	100.00	65.83	63.50	68.66	76.86	-	80.25	78.37	89.69	83.95	78.29	72.68
10	74.53	81.59	89.03	81.97	67.17	71.79	87.00	-	81.81	88.13	94.00	89.29	89.13	74.75
11	79.49	87.47	70.67	84.64	94.00	75.74	86.50	-	86.82	90.77	97.00	95.16	89.80	88.72
12	94.99	96.47	100.00	80.53	75.18	92.23	92.50	-	86.31	97.38	100.00	102.27	96.84	99.34
13	97.24	78.98	118.00	90.09	106.00	106.00	-	-	94.06	100.92	-	100.55	103.39	103.74
14	100.44	113.17	-	103.00	103.23	97.97	-	-	98.56	88.00	-	100.00	102.3	106.15
15	109.00	108.56	106.00	112.00	106.70	-	-	-	97.91	-	-	103.54	115.00	109.60
16	-	104.42	118.00	91.00	84.47	97.00	100.00	-	114.86	-	-	110.65	110.28	111.78

Table 8. 4Vn (May-December) inshore cod: mean weight-at-age for longline catch (kg).

AGES	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	0.28	-	-	-	-	-	0.21	-	-
3	0.44	0.54	0.46	0.60	0.48	-	0.40	0.49	0.53	-	-	0.56	-	-	0.50	0.58	0.65
4	0.96	0.87	0.94	0.79	0.77	0.82	0.72	0.81	0.84	-	-	0.99	0.93	0.73	0.90	0.91	0.84
5	1.49	1.38	1.26	1.09	1.04	0.91	1.17	1.28	1.29	1.82	-	1.40	1.63	1.22	1.35	1.33	1.22
6	2.03	2.00	1.86	1.67	1.45	1.72	1.75	1.72	1.79	2.46	-	2.14	2.54	2.03	2.15	1.79	1.63
7	2.45	2.87	2.38	2.14	2.01	1.66	1.78	2.65	2.29	3.08	-	3.27	3.78	2.49	2.94	2.09	2.12
8	2.93	2.38	3.14	3.11	4.33	2.10	2.14	2.40	2.00	4.18	-	4.14	3.92	3.14	4.28	3.01	2.31
9	4.51	3.29	4.44	4.38	3.60	9.29	2.79	2.50	3.18	4.23	-	4.97	4.99	4.55	5.21	4.09	3.50
10	4.07	4.97	4.19	4.39	5.24	6.91	5.33	3.14	3.50	6.19	-	5.27	6.95	6.21	6.23	5.87	3.95
11	4.10	6.70	4.67	5.15	6.29	3.46	5.98	7.72	4.41	6.07	-	6.27	7.78	6.99	7.75	6.22	6.41
12	5.13	5.97	4.63	8.07	8.55	9.29	5.68	4.15	7.72	7.50	-	6.45	9.78	7.65	9.29	7.39	8.53
13	7.44	4.58	6.69	8.79	4.84	15.23	7.24	11.06	11.06	-	-	7.98	10.72	8.36	8.80	8.91	9.75
14	7.04	7.55	8.01	9.49	13.45	-	10.15	10.26	8.79	-	-	8.93	6.88	-	8.53	8.60	10.22
15	13.42	11.06	9.39	12.02	12.03	11.06	13.03	11.37	-	-	-	9.16	-	-	9.45	11.94	11.34
16	3.55	-	9.37	-	10.71	15.23	7.01	6.08	8.48	9.39	-	14.09	-	-	11.59	10.80	12.24

Table 9. Longliner catch of cod and associated catch-per-unit-effort 1968-1983, 4Vn (May - December).

Year	Longliner Catch (t)	Proportion of catch for which effort reported	CPUE (t/1000 hks)
1968	2455	0.066	0.452
1969	3300	0.097	0.646
1970	3229	0.130	0.625
1971	3725	0.071	0.507
1972	3185	0.138	0.440
1973	1982	0.192	0.338
1974	1332	0.217	0.325
1975	689	0.028	0.232
1976	620	0.011*	0.084
1977	1805	0.027	0.499
1978	3035	0.141	0.442
1979	4483	0.169	0.545
1980	6422	0.111	0.504
1981	9838	0.028	0.666**
1982	7287	0.077	0.408
1983	5101	0.105	0.319

* based on one log record

** calculated for records from May to September only (see Smith 1983).

Table 10: List of tagging experiments used in present analysis

Cruise	Date	Unit Area	Gear	Number tagged
AJ001	Oct. 28-Nov. 4/78	4We	O.T.	6022
P218	Apr. 12-18/79	4Vc	O.T.	4302
H024	Sept.13-19/79	4T1-g	O.T.	3957
LG001	Sept. 4-23/80	4Vn	L.L.	2923
AJ002	Sept. 30-Oct.12/80	4Vn	O.T.	2852
JH002	Nov. 24-Dec. 8/80	4Tg	O.T.	4877
AJ003	Apr. 11-21/81	4Tg	O.T.	3530
H052	Apr.28-May 5/81	4Vc	O.T.	4448

Table 11: Percent distribution of tag returns from specific tagging operations
 The '*' indicates area of tagging and a '+' indicates values less than .5%.

Management Unit of Capture

Cruise	Area	5Z	4X	4VsW	4Vn (M-D)	4Vn (J-A)	4T	4RS3Pn	3Ps	3N0	2J3KL	Total Recaptured
H052 Apr-May 81	4Vs	+	0	91*	3	+	2	+	1	0	3	644
AJ001 Nov. 78	4W	+	3	94*	1	+	1	+	+	+	1	1621
P218 Apr. 79	4Vs	+	1	91*	4	1	1	1	+	+	1	892
AJ003 Apr. 81	4T	0	1	9	11	24	52*	2	1	0	0	220
JH002 Nov-Dec 80	4T	0	+	6	6	36	48*	4	+	0	+	662
H024 Sept. 79	4T	0	0	16	11	19	47*	7	0	0	0	103
LG001 Sept. 80	4Vn	0	+	15	60*	12	8	2	1	0	0	462
AJ002 Sept-Oct. 80	4Vn	1	0	23	37*	17	19	1	1	0	1	187

Table 12. 4Vn (M-D) cod longliner CPUE (numbers)-at-age 1980-1983.

AGE	1980	1981	1982	1983
1	-	-	-	-
2	-	1	-	-
3	-	58	12	5
4	6	150	127	43
5	82	210	371	258
6	418	277	267	273
7	586	455	451	184
8	303	358	284	308
9	172	181	117	102
10	100	102	44	86
11	25	39	28	22
12	6	35	12	21
13	6	36	4	7
14	-	3	2	3
15	-	5	1	3
16+	-	12	8	7

Table 13. 4Vn (M-D) cod total mortality estimates from surveys and CPUE (numbers)-at-age averaged for 1980-83.

AGE GROUPS	SURVEYS	CPUE
4+/5+	.354	.151
5+/6+	.534	.303
6+/7+	.876	.410
7+/8+	1.025	.623
8+/9+	.774	.785
9+/10+	1.047	.696
10+/11+	1.241	.647

Table 14. Results of a general production analysis of 4Vn (M-D) cod using catch biomass and survey mean weight per tow (A.T. Cameron) for 1970-1981.

<u>Year</u>	<u>Catch (t)</u>	<u>Mean Weight per tow</u>	<u>Effort</u>
1970	9894	57.47	172
1971	10631	128.20	83
1972	9104	22.12	412
1973	5748	53.25	108
1974	5989	14.44	415
1975	3998	32.75	122
1976	5957	43.41	137
1977	7921	26.58	298
1978	5549	67.55	82
1979	6374	27.58	231
1980	10059	85.55	118
1981	12581	161.81	78

Results of Regression

Slope = 0.2474
Origin = 105.56
 $r^2 = 0.46$

2/3 EMSY = 10,198

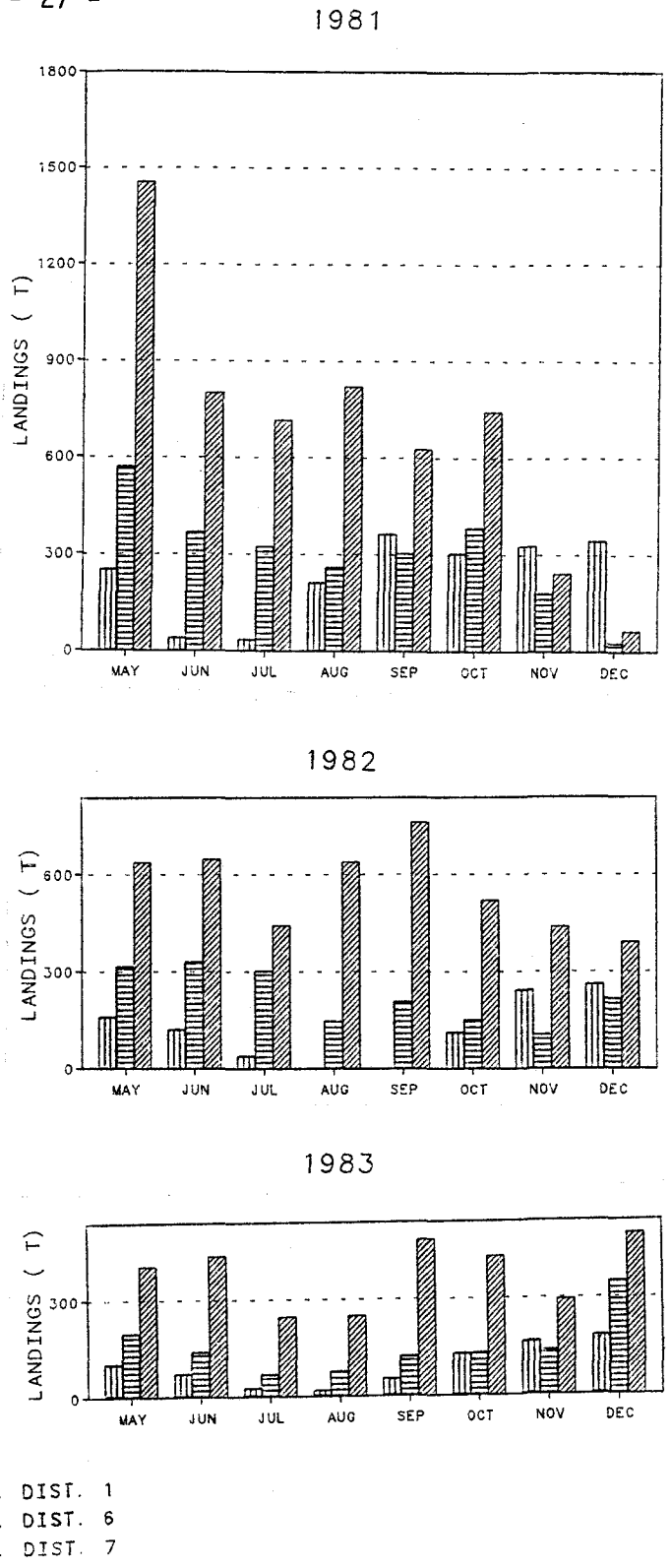
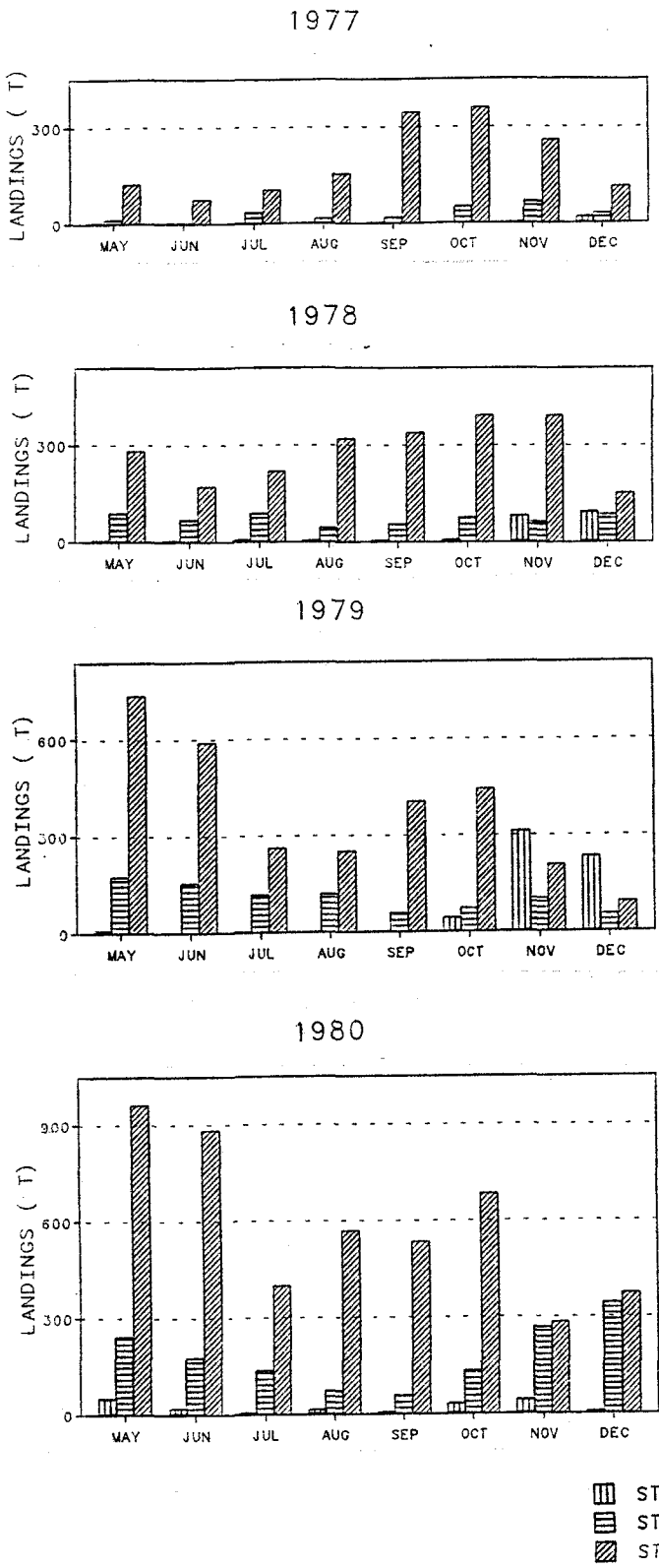


Figure 1. Monthly landings of 4Vn (M-D) by statistical district.

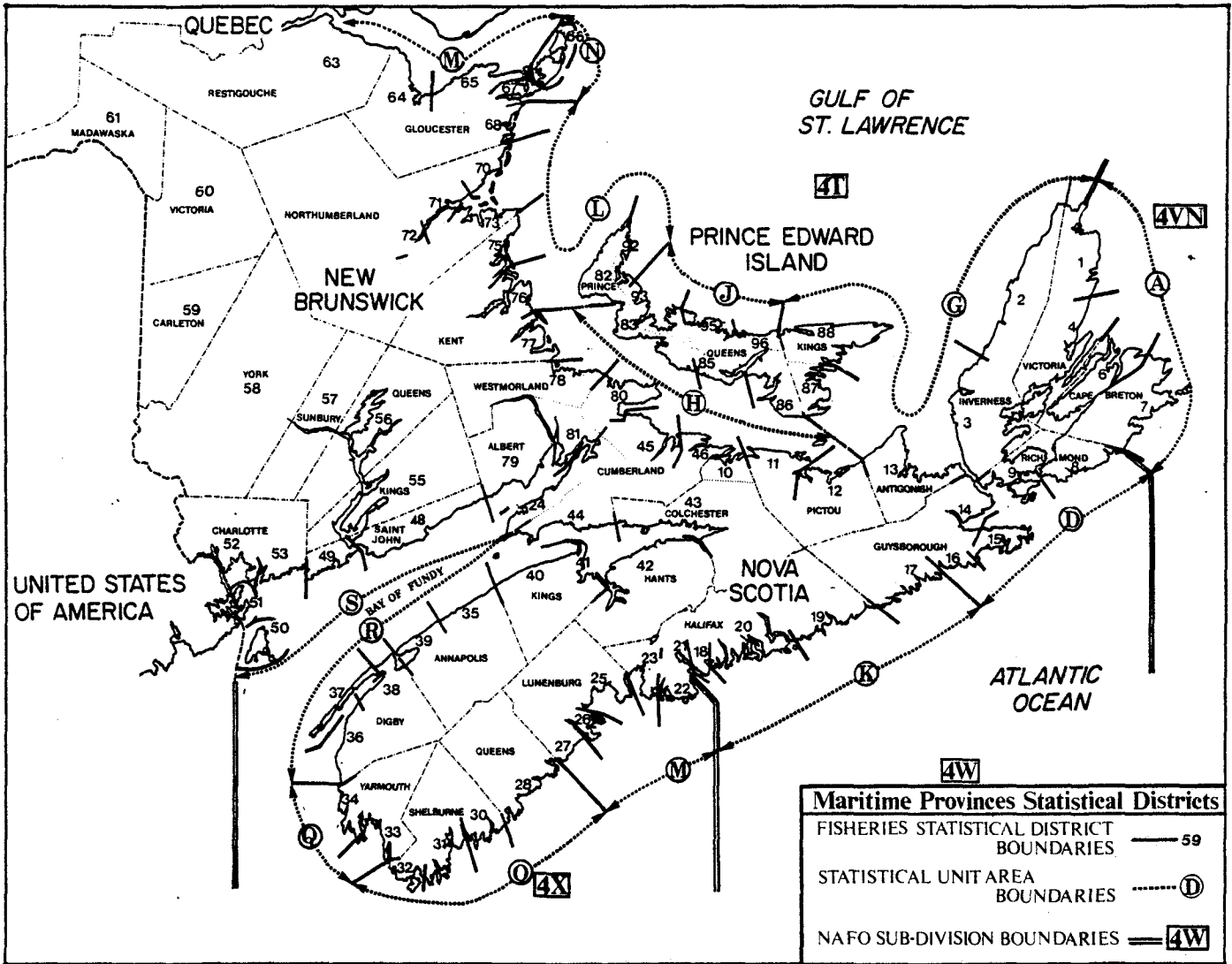
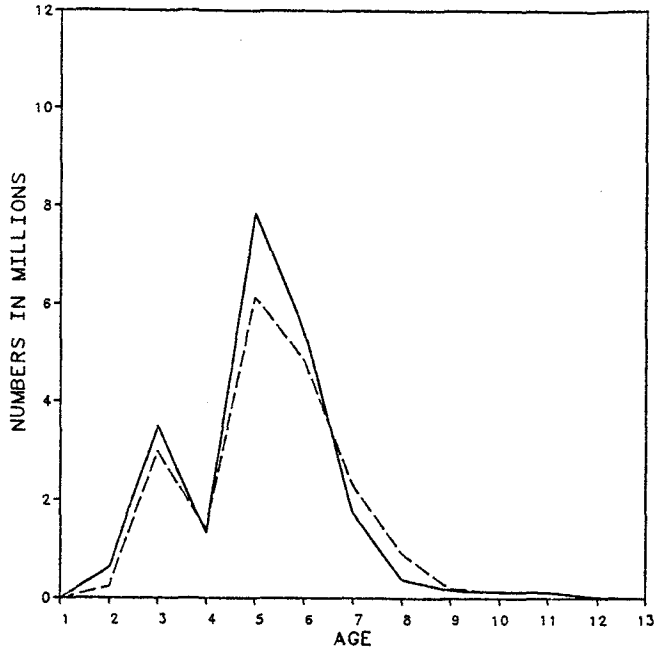


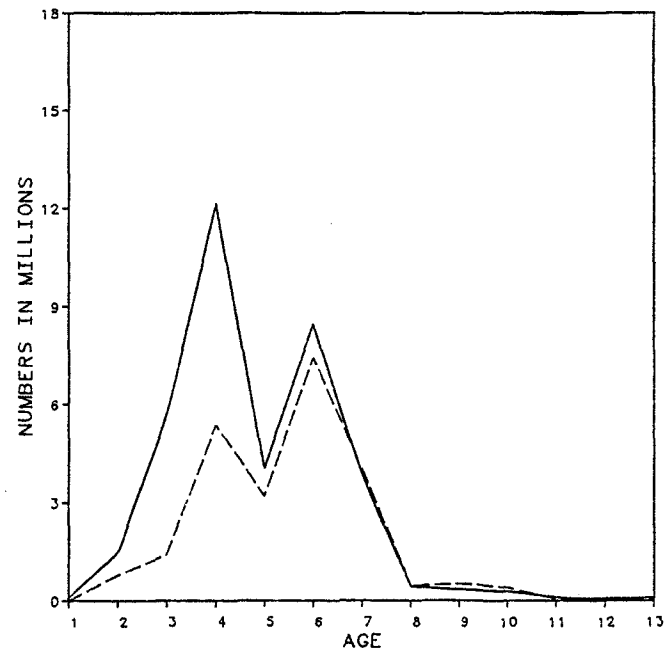
Figure 2. Maritime Provinces Statistical Districts.

4VN(M-D) COD COMPARATIVE SURVEY
1980



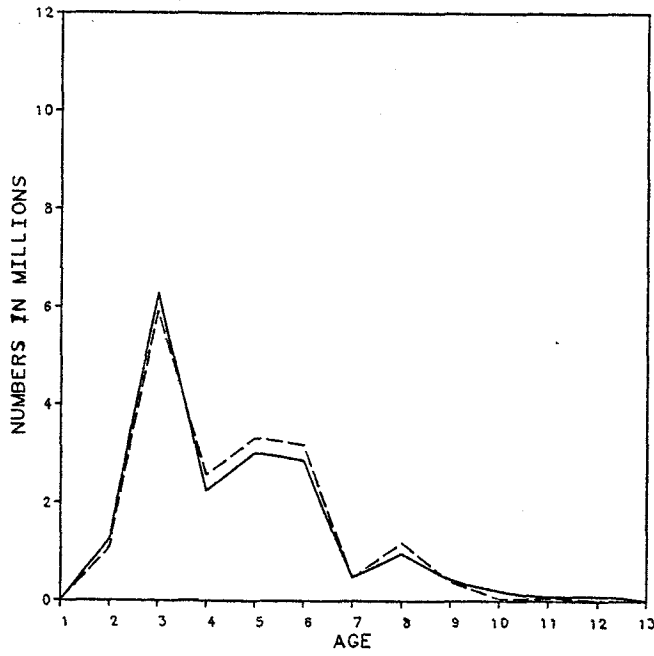
— A. T. CAMERON
- - - LADY HAMMOND

4VN(M-D) COD COMPARATIVE SURVEY
1981



— A. T. CAMERON
- - - LADY HAMMOND

4VN(M-D) COD COMPARATIVE SURVEY
1983



— A. NEEDLER
- - - LADY HAMMOND

Figure 3. 4Vn cod population-at-age estimates from comparative surveys 1980, 1981, and 1983.

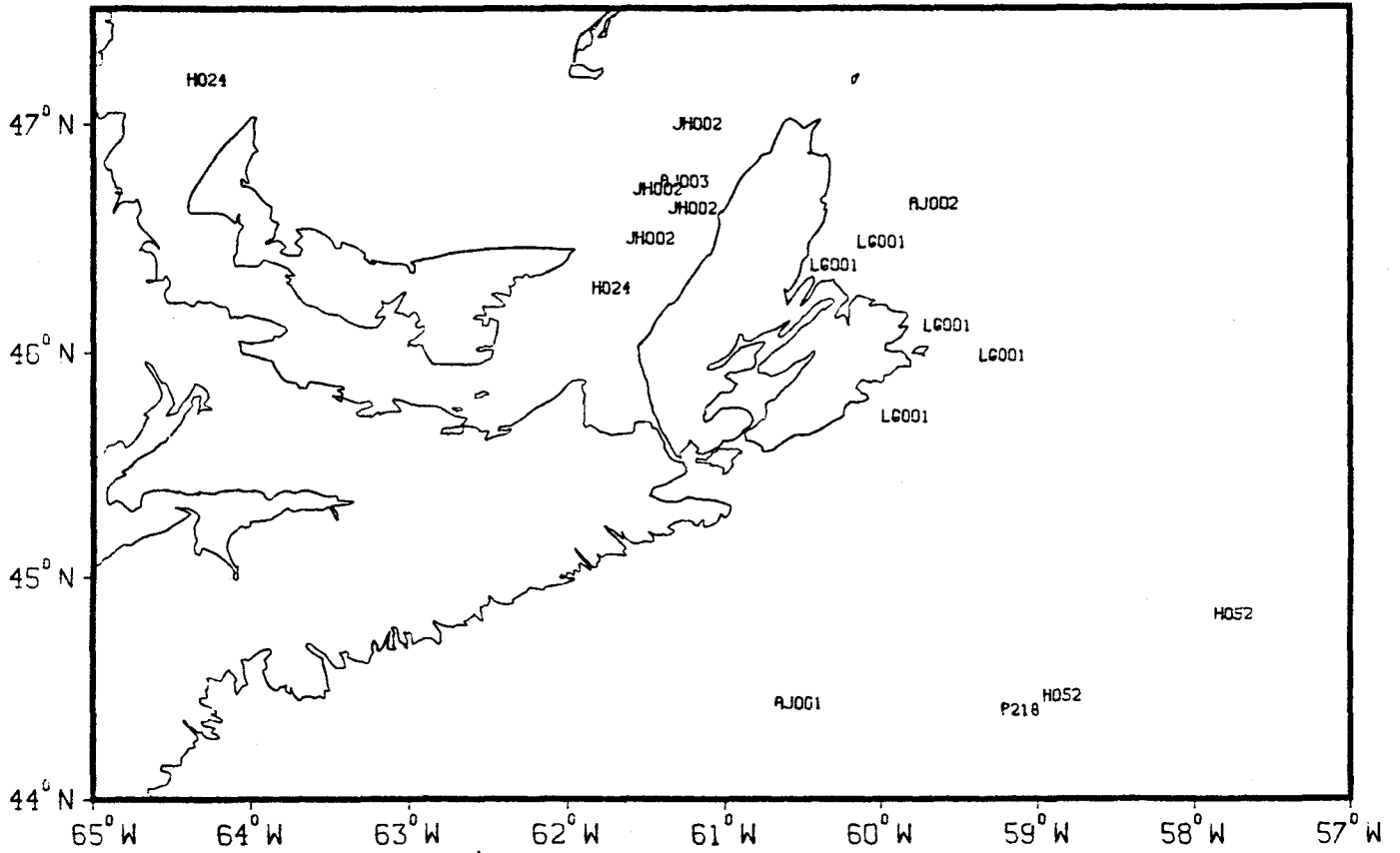
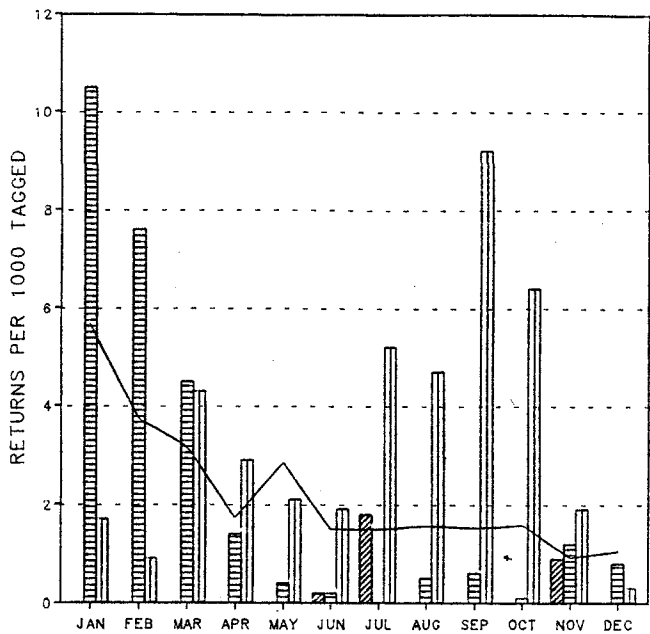
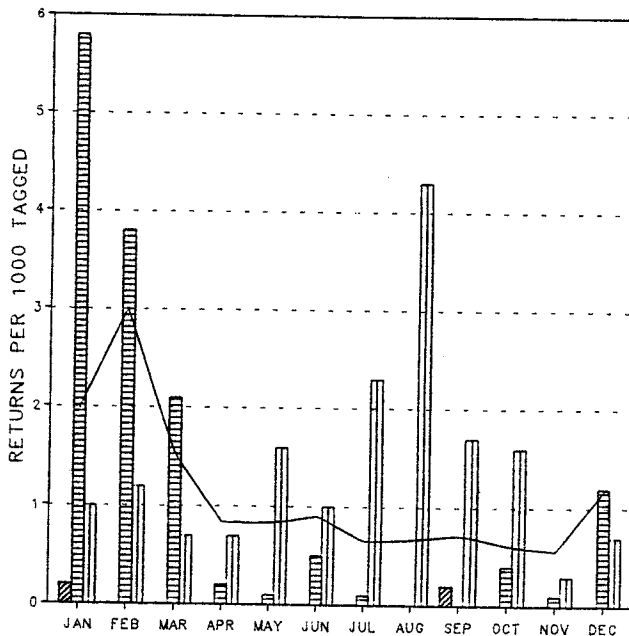


Figure 4. Locations of tagging sites used in this analysis.

1981



1982



1983

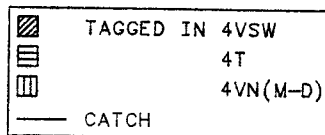
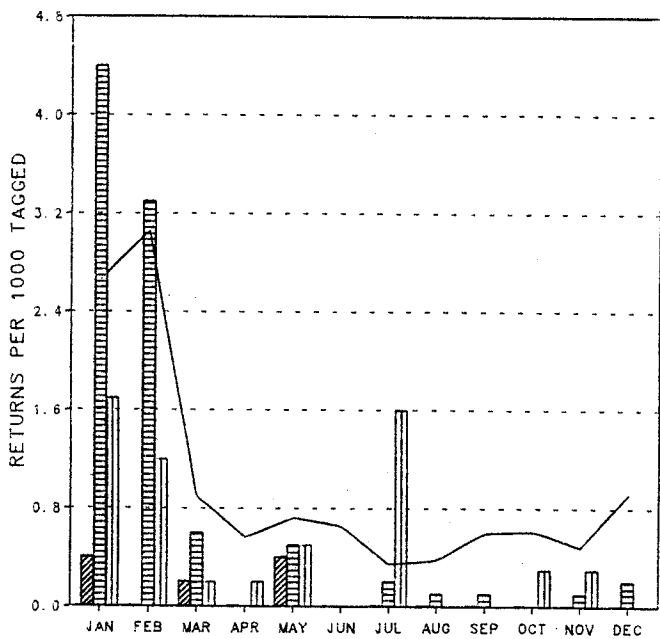
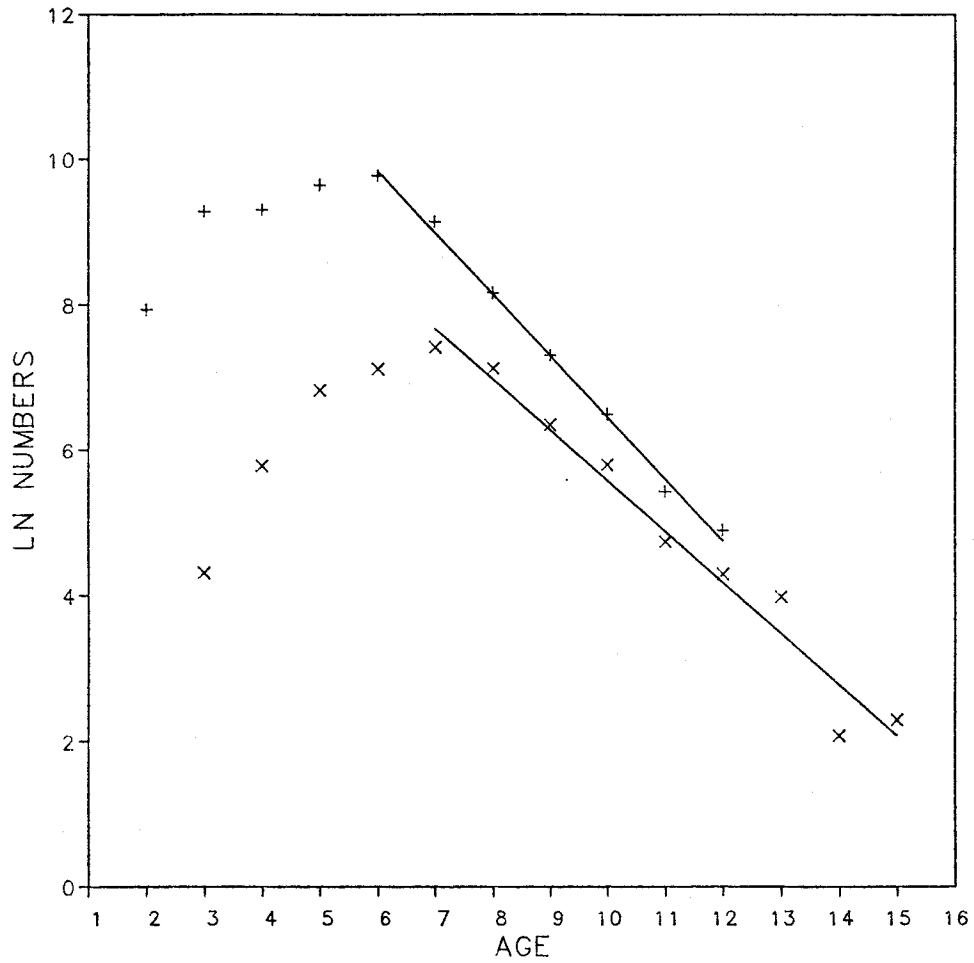


Figure 5. Cod tag returns in 4Vn by month and area tagged, standardized for numbers tagged. The solid line represents monthly trends in total landings from 4Vn.

SURVEY R2=1.00 Z=.85
CPUE R2=0.97 Z=.70



+ SURVEY NUMBERS 80-83
X CPUE AT AGE 80-83

Figure 6. Catch curves of 4Vn (M-D) cod from Lady Hammond summer research survey numbers at-age estimates and longliner CPUE at-age summed over the 1980-83 period.